ALASKA LNG

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

APPENDIX 13A – PROJECT MANAGEMENT

A.1 – Site Location Maps and Drawing

Document Number:	Description:	Revision:	Appendix:
USAG-EC-LDLAY-00-001004-000	Gas Treatment Plant Site Plan	1	Public
USAG-EC-LDLAY-00-001005-001	Gas Treatment Plant Plot Plan	0	Public
USAG-EC-LDLAY-00-001005-002	Gas Treatment Plant Plot Plan	0	Public

A.2 – Organizational Chart

Document Number:	Description:	Revision:	Appendix:
USAG-PG-BAORG-00-000001-000	Staffing Structure	0	Public

*A.3 – Construction Workforce Organizational Chart**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*A.4 - Operation Workforce Organizational Chart**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

A.5 - Schedule

Document Number:	Description:	Revision:	Appendix:
USAI-PT-BYSCH-00-000001-000	Gantt Chart	0	Public

A.6 – Execution Plan

Document Number:	Description:	Revision:	Appendix:
USAG-EC-SRZZZ-00-000006-000	GTP Preliminary Execution Plan	0	P&C

APPENDIX 13B – DESIGN BASIS, CRITERIA, AND PHILOSOPHIES

B.1 - Engineering Design Standard

Document Number:	Description:	Revision:	Appendix:
USAG-PG-BSZZZ-00-000001-000	GTP Engineering Design Standard	0	P&C

B.2 - GTP Basis of Design

Document Number:	Description:	Revision:	Appendix:
USAG-PG-BBPDB-00-000002-000	Gas Treatment Plant Design Basis	3	P&C

B.3 - Civil Design Basis

Document Number:	Description:	Revision:	Appendix:
USAG-EC-CBDES-00-000001-000	Civil Design Basis	1	P&C

B.4 - Architectural Design Basis

Document Number:	Description:	Revision:	Appendix:
USAG-EC-CBDES-00-000010-000	Architectural Design Basis	1	P&C

B.5 - Structural Design Basis

Document Number:	Description:	Revision:	Appendix:
USAG-EC-NBDES-00-000001-000	Structural Design Basis	3	P&C

B.6 - Piping Design Basis

Document Number:	Description:	Revision:	Appendix:
USAG-EC-LBDES-00-000001-000	Piping Design Basis	1	P&C

B.7 - Integrated Control and Safety Design Basis

Document Number:	Description:	Revision:	Appendix:
USAG-EC-IBICS-00-000001-000	Integrated Control and Safety System Design Basis	1	P&C

B.8 - Fire & Gas Detection Philosophy

Document Number:	Description:	Revision:	Appendix:
USAG-EC-FBDES-00-000005-000	Fire & Gas Detection Philosophy	1	P&C

B.9 - Flare, Relief, and Blowdown Philosophy

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PBDES-00-000018-000	Flare, Relief, and Blowdown Philosophy	3	P&C

APPENDIX 13C – REGULATIONS AND PERMITS

C.1 – Table of Regulatory Agencies, Permits, and Approvals

Document Number:	Description:	Revision:	Appendix:
USAI-PE-SRREG-00-000013-000-A	List of Permits and Approvals	0	Public

C.2 – Regulatory Agency Correspondence

Document Number:	Description:	Revision:	Appendix:
N/A	Refer to Resource Report 1 and Resource Report 11	N/A	Public

C.3 – Regulatory Compliance Matrix

Document Number:	Description:	Revision:	Appendix:
	Not Applicable		Public

APPENDIX 13D –CODES AND STANDARDS

D.1 - Design Codes and Standards

Document Number:	Description:	Revision:	Appendix:
USAG-EC-BSCOD-00-000001-000	GTP Design Codes and Standards	0	Public

APPENDIX 13E – ENGINEERING DESIGN INFORMATION

E.1 – Block Diagram of Facilities

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDBLK-00-000001-000	Block Flow Diagram - Plant Overview	2	P&C
USAG-EC-PDBLK-00-000002-000	Block Flow Diagram - Stream Distribution	2	P&C
USAG-EC-PDBLK-10-000004-000	Block Flow Diagram - Process Heat Medium System	2	P&C
USAG-EC-PDBLK-60-000003-000	Block Flow Diagram - Overall Plant Water Balance	2	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDBLK-60-000005-000	Block Flow Diagram - Building Heat Medium System	2	P&C

E.2 - Process Flow Diagrams

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDSYM-00-000001-000	Symbols & Legends - Drawing Index	1	P&C
USAG-EC-PDSYM-00-000002-000	Symbols & Legends - Drawing Nomenclature	1	P&C
USAG-EC-PDSYM-00-000003-000	Symbols & Legends - Equipment Symbols	1	P&C
USAG-EC-PDSYM-00-000004-000	Symbols & Legends - Equipment Nomenclature	1	P&C
USAG-EC-PDPFD-50-000609-001	Process Flow Diagram - GTP Interface	1	P&C
USAG-EC-PDPFD-50-000609-002	Process Flow Diagram - PTU Inlet Facilities	1	P&C
USAG-EC-PDPFD-10-000662-010	Process Flow Diagram - Acid Gas Removal Unit Absorber	1	P&C
USAG-EC-PDPFD-10-000662-011	Process Flow Diagram - Acid Gas Removal Unit Circulation Pumps	1	P&C
USAG-EC-PDPFD-10-000662-012	Process Flow Diagram - Acid Gas Removal Unit Regeneration	1	P&C
USAG-EC-PDPFD-60-000678-013	Process Flow Diagram - Acid Gas Removal Unit Storage	1	P&C
USAG-EC-PDPFD-10-000661-020	Process Flow Diagram - TGDU - TEG Contactor	1	P&C
USAG-EC-PDPFD-10-000661-021	Process Flow Diagram - TGDU - Regeneration System	1	P&C
USAG-EC-PDPFD-10-000661-022	Process Flow Diagram - TGDU - Off gas	1	P&C
USAG-EC-PDPFD-10-000651-031	Process Flow Diagram - Treated Gas Compression	1	P&C
USAG-EC-PDPFD-10-000651-032	Process Flow Diagram - Treated Gas Compressor Turbine & HRU	1	P&C
USAG-EC-PDPFD-50-000666-040	Process Flow Diagram - Treated Gas Chilling	1	P&C
USAG-EC-PDPFD-50-000666-041	Process Flow Diagram - Refrigeration	1	P&C
USAG-EC-PDPFD-10-000658-051	Process Flow Diagram - CO2 Compression-Low Pressure	1	P&C
USAG-EC-PDPFD-10-000667-052	Process Flow Diagram - CO2 Dehydration System - TEG Contactor	1	P&C
USAG-EC-PDPFD-10-000667-053	Process Flow Diagram - CO2 Dehydration Regeneration System	1	P&C
USAG-EC-PDPFD-10-000658-054	Process Flow Diagram - CO2 Compression-High Pressure	1	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDPFD-10-000658-055	Process Flow Diagram - CO2 Compression Turbine & HRU	1	P&C

E.3 - Utility Flow Diagrams

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDUFD-50-000612-060	Utility Flow Diagram - HP Hydrocarbon Flare	1	P&C
USAG-EC-PDUFD-50-000612-061	Utility Flow Diagram - HP CO2 Flare	1	P&C
USAG-EC-PDUFD-50-000613-062	Utility Flow Diagram - LP Hydrocarbon Flare	1	P&C
USAG-EC-PDUFD-50-000613-063	Utility Flow Diagram - LP CO2 Flare	1	P&C
USAG-EC-PDUFD-50-000965-070	Utility Flow Diagram - Fuel Gas System Common System	1	P&C
USAG-EC-PDUFD-10-000965-072	Utility Flow Diagram - Fuel Gas System Process Train	1	P&C
USAG-EC-PDUFD-10-000966-073	Utility Flow Diagram - LP Fuel Gas Treating	1	P&C
USAG-EC-PDUFD-10-000942-080	Utility Flow Diagram - Process Heat Medium System	1	P&C
USAG-EC-PDUFD-60-000942-081	Utility Flow Diagram - Building Heat Medium System	1	P&C
USAG-EC-PDUFD-50-000927-082	Utility Flow Diagram - Cooling Medium System - Common	1	P&C
USAG-EC-PDUFD-10-000927-083	Utility Flow Diagram - Cooling Medium System - Process Train	1	P&C
USAG-EC-PDUFD-10-000991-091	Utility Flow Diagram - Closed Drain System	1	P&C
USAG-EC-PDUFD-10-000992-092	Utility Flow Diagram - Open Drain System	1	P&C
USAG-EC-PDUFD-60-000991-094	Utility Flow Diagram - Common Closed Drain System	1	P&C
USAG-EC-PDUFD-60-000992-095	Utility Flow Diagram - Common Open Drain System	1	P&C
USAG-EC-PDUFD-10-000883-100	Utility Flow Diagram - Power Generator Turbine	1	P&C
USAG-EC-PDUFD-60-000837-101	Utility Flow Diagram - Emergency Power Gen.	1	P&C
USAG-EC-PDUFD-60-000911-103	Utility Flow Diagram - Diesel Fuel Supply	1	P&C
USAG-EC-PDUFD-60-000955-110	Utility Flow Diagram - Air Compressors & Dryers	1	P&C
USAG-EC-PDUFD-60-000955-111	Utility Flow Diagram – Utility/Service Air Distribution	1	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDUFD-60-000952-112	Utility Flow Diagram - Instrument Air Distribution	1	P&C
USAG-EC-PDUFD-60-000954-113	Utility Flow Diagram - Breathing Air Systems	1	P&C
USAG-EC-PDUFD-60-000961-114	Utility Flow Diagram - Nitrogen Generation	1	P&C
USAG-EC-PDUFD-60-000961-115	Utility Flow Diagram - Nitrogen Distribution	1	P&C
USAG-EC-PDUFD-60-000976-116	Utility Flow Diagram - Raw Water Storage Tank	1	P&C
USAG-EC-PDUFD-00-000411-117	Utility Flow Diagram - Camp Firewater System Pumps	1	P&C
USAG-EC-PDUFD-60-000683-118	Utility Flow Diagram - Process Water Treating and Storage	1	P&C
USAG-EC-PDUFD-60-000976-119	Utility Flow Diagram - Service Water Distribution	1	P&C
USAG-EC-PDUFD-70-000976-120	Utility Flow Diagram - PUT Reservoir Water Facilities	1	P&C
USAG-EC-PDUFD-60-000977-121	Utility Flow Diagram - Potable Water Storage	1	P&C
USAG-EC-PDUFD-60-000977-122	Utility Flow Diagram - Potable Water GTP Distribution	1	P&C
USAG-EC-PDUFD-00-000412-124	Utility Flow Diagram - Camp Firewater Tank	1	P&C
USAG-EC-PDUFD-60-000678-130	Utility Flow Diagram - Fresh TEG Supply	1	P&C
USAG-EC-PDUFD-60-000679-132	Utility Flow Diagram -Hydrocarbon Holding Tank	1	P&C
USAG-EC-PDUFD-00-000679-133	Utility Flow Diagram - Gasoline Fuel Supply	0	P&C

E.4 - Heat and Material Balances

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDPFD-50-000609-100	Heat and Material Balance - RR13, U.3 - Winter - GTP Inlet	0	P&C
USAG-EC-PDPFD-10-000662-102	Heat and Material Balance - Base Case - Winter - AGRU	1	P&C
USAG-EC-PDPFD-10-000661-103	Heat and Material Balance - Base Case - Winter - Treated Gas Dehydration	1	P&C
USAG-EC-PDPFD-10-000651-104	Heat and Material Balance - Base Case - Winter - Treated Gas Compression and Chilling	1	P&C
USAG-EC-PDPFD-10-000658-105	Heat and Material Balance - Base Case - Winter - CO2 Compression	1	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDPFD-10-000667-106	Heat and Material Balance - Base Case - Winter - CO2 Gas Dehydration	1	P&C
USAG-EC-PDPFD-60-000965-107	Heat and Material Balance - Base Case - Winter - Fuel Gas	1	P&C
USAG-EC-PDPFD-50-000666-109	Heat and Material Balance - Base Case - Winter - Refrigerant	1	P&C
USAG-EC-PDPFD-50-000609-200	Heat and Material Balance - RR13, U.3 - Summer - GTP Inlet	0	P&C
USAG-EC-PDPFD-10-000662-202	Heat and Material Balance - Base Case - Summer - AGRU	1	P&C
USAG-EC-PDPFD-10-000661-203	Heat and Material Balance - Base Case - Summer - Treated Gas Dehydration	1	P&C
USAG-EC-PDPFD-10-000651-204	Heat and Material Balance - Base Case - Summer - Treated Gas Compression and Chilling	1	P&C
USAG-EC-PDPFD-10-000658-205	Heat and Material Balance - Base Case - Summer - CO2 Compression	1	P&C
USAG-EC-PDPFD-10-000667-206	Heat and Material Balance - Base Case - Summer - CO2 Gas Dehydration	1	P&C
USAG-EC-PDPFD-60-000965-207	Heat and Material Balance - Base Case - Summer- Fuel Gas	1	P&C
USAG-EC-PDPFD-50-000666-209	Heat and Material Balance - Base Case - Summer - Refrigerant	1	P&C

E.5 - Piping and Instrument Diagrams

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDSYM-00-000005-000	Legend Sheets - HIPPS & Manual Valve Details	0	P&C
USAG-EC-PDSYM-00-000006-000	Legend Sheets - On/Off Valve Details	0	P&C
USAG-EC-PDSYM-00-000007-000	Legend Sheets - PSV & Regulator Details	0	P&C
USAG-EC-PDSYM-00-000008-000	Legend Sheets - Level Details	0	P&C
USAG-EC-PDSYM-00-000009-000	Legend Sheets - Pressure Details	0	P&C
USAG-EC-PDSYM-00-000010-000	Legend Sheets - Control Valve/Temperature Details	0	P&C
USAG-EC-PDSYM-00-000011-000	Legend Sheets - Flow Details	0	P&C
USAG-EC-PDSYM-00-000012-000	Legend Sheets - Winterized Air Cooler Details	0	P&C
USAG-EC-PDSYM-00-000013-000	Legend Sheets - Non-Winterized Air Coolers	0	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDSYM-00-000014-000	Legend Sheets - Pump Details	0	P&C
USAG-EC-PDZZZ-50-000609-001	GTP Interface -- Feed	0	P&C
USAG-EC-PDZZZ-50-000609-002	GTP Interface -- Outlet	0	P&C
USAG-EC-PDZZZ-50-000609-003	GTP Interface -- Utilities	0	P&C
USAG-EC-PDZZZ-50-000609-004	PTU Inlet Facilities	0	P&C
USAG-EC-PDZZZ-10-000662-010	Acid Gas Removal Unit Filter Separator	0	P&C
USAG-EC-PDZZZ-10-000662-011	Acid Gas Removal Unit Absorber	0	P&C
USAG-EC-PDZZZ-10-000662-012	Acid Gas Removal Unit Circulation Pumps	0	P&C
USAG-EC-PDZZZ-10-000996-018	Acid Gas Removal Unit Drain	0	P&C
USAG-EC-PDZZZ-10-000662-013	Acid Gas Removal Unit Flash Drum	0	P&C
USAG-EC-PDZZZ-10-000662-014	Acid Gas Removal Unit Lean/Rich Exchanger	0	P&C
USAG-EC-PDZZZ-10-000662-016	Acid Gas Removal Unit Reboilers	0	P&C
USAG-EC-PDZZZ-10-000662-017	Acid Gas Removal Unit Regenerator Reflux	0	P&C
USAG-EC-PDZZZ-60-000678-019	Acid Gas Removal Unit Storage	0	P&C
USAG-EC-PDZZZ-10-000661-025	TGDU - TEG Contactor	0	P&C
USAG-EC-PDZZZ-10-000661-026	TGDU - TEG Flash Drum	0	P&C
USAG-EC-PDZZZ-10-000661-027	TGDU - Regenerator	0	P&C
USAG-EC-PDZZZ-10-000661-028	TGDU - TEG Regeneration Heat Exchange	0	P&C
USAG-EC-PDZZZ-10-000661-029	TGDU - Off gas	0	P&C
USAG-EC-PDZZZ-10-000661-030	TGDU - Off Gas Compression	0	P&C
USAG-EC-PDZZZ-10-000661-031	TGDU - Drain	0	P&C
USAG-EC-PDZZZ-10-000651-032	Treated Gas Compression - Stage 1 - Unit 2	0	P&C
USAG-EC-PDZZZ-10-000651-033	Treated Gas Compression - Stage 2 - Unit 2	0	P&C
USAG-EC-PDZZZ-10-000651-034	Treated Gas Compressor Turbine & HRU - Unit 2	0	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDZZZ-10-000651-035	Treated Gas Compression - Stage 1 - Unit 1	0	P&C
USAG-EC-PDZZZ-10-000651-036	Treated Gas Compression - Stage 2 - Unit 1	0	P&C
USAG-EC-PDZZZ-10-000651-037	Treated Gas Compressor Turbine & HRU -Unit 1	0	P&C
USAG-EC-PDZZZ-50-000666-040	Treated Gas Chilling -- Unit 1	0	P&C
USAG-EC-PDZZZ-50-000666-042	Refrigeration Compressor -- Unit 1	0	P&C
USAG-EC-PDZZZ-50-000666-043	Refrigeration Compressor -- Unit 2	0	P&C
USAG-EC-PDZZZ-50-000666-044	Refrigeration Condenser/Accumulator	0	P&C
USAG-EC-PDZZZ-10-000658-048	CO2 Compression - LP, Stage 1 - Unit 2	0	P&C
USAG-EC-PDZZZ-10-000658-049	CO2 Compression - LP, Stage 2 - Unit 2	0	P&C
USAG-EC-PDZZZ-10-000658-050	CO2 Compression - LP, Stage 1-Unit 1	0	P&C
USAG-EC-PDZZZ-10-000658-051	CO2 Compression - LP, Stage 2-Unit 1	0	P&C
USAG-EC-PDZZZ-10-000667-054	CO2 Dehydration System - TEG Contactor - Unit 2	0	P&C
USAG-EC-PDZZZ-10-000667-055	CO2 Dehydration System - TEG Contactor - Unit 1	0	P&C
USAG-EC-PDZZZ-10-000667-056	CO2 Dehydration Flash Drum/Heat Exchange	0	P&C
USAG-EC-PDZZZ-10-000667-057	CO2 Dehydration Regenerator	0	P&C
USAG-EC-PDZZZ-10-000667-058	CO2 Dehydration Regeneration Circulation	0	P&C
USAG-EC-PDZZZ-10-000658-062	CO2 Compression - HP, Stage 3-Unit 2	0	P&C
USAG-EC-PDZZZ-10-000658-063	CO2 Compression - HP, Stage 4 -Unit 2	0	P&C
USAG-EC-PDZZZ-10-000658-065	CO2 Compression - HP, Stage 3 -Unit 1	0	P&C
USAG-EC-PDZZZ-10-000658-066	CO2 Compression - HP, Stage 4 -Unit 1	0	P&C
USAG-EC-PDZZZ-10-000658-067	CO2 Compression Turbine & HRU – Unit 1	0	P&C
USAG-EC-PDZZZ-50-000612-070	HP Hydrocarbon Flare	0	P&C
USAG-EC-PDZZZ-50-000612-071	HP CO2 Flare	0	P&C
USAG-EC-PDZZZ-50-000613-072	LP Hydrocarbon Flare	0	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDZZZ-50-000613-073	LP CO2 Flare	0	P&C
USAG-EC-PDZZZ-50-000965-075	Fuel Gas System Common System	0	P&C
USAG-EC-PDZZZ-10-000965-076	Fuel Gas System Process Train	0	P&C
USAG-EC-PDZZZ-10-000966-077	LP Fuel Gas Treating - Inlet	0	P&C
USAG-EC-PDZZZ-10-000966-078	LP Fuel Gas Treating - Contactor	0	P&C
USAG-EC-PDZZZ-10-000942-085	Process Heat Medium System - Drum & Pumps	0	P&C
USAG-EC-PDZZZ-10-000942-086	Process Heat Medium System - Distribution	0	P&C
USAG-EC-PDZZZ-60-000942-087	Building Heat Medium System - Drum & Pumps	0	P&C
USAG-EC-PDZZZ-60-000942-088	Building Heat Medium System - Distribution	0	P&C
USAG-EC-PDZZZ-50-000927-089	Cooling Medium System	0	P&C
USAG-EC-PDZZZ-10-000927-090	Cooling Medium System - Process Train	0	P&C
USAG-EC-PDZZZ-10-000991-095	Closed Drain System	0	P&C
USAG-EC-PDZZZ-10-000992-098	Open Drain System - AGRU	0	P&C
USAG-EC-PDZZZ-10-000992-099	Open Drain System	0	P&C
USAG-EC-PDZZZ-60-000991-096	Common Closed Drain System	0	P&C
USAG-EC-PDZZZ-60-000991-097	Common Closed Drain Injection	0	P&C
USAG-EC-PDZZZ-60-000992-100	Common Open Drain System - Sheet 2	0	P&C
USAG-EC-PDZZZ-10-000833-105	Power Generator Turbine - Unit 1	0	P&C
USAG-EC-PDZZZ-10-000833-106	Power Generator Turbine - Unit 2	0	P&C
USAG-EC-PDZZZ-60-000837-108	Emergency Power Gen.	0	P&C
USAG-EC-PDZZZ-60-000911-109	Diesel Fuel Supply	0	P&C
USAG-EC-PDZZZ-60-000955-110	Air Compressors	0	P&C
USAG-EC-PDZZZ-60-000955-111	Air Compressors Dryers	0	P&C
USAG-EC-PDZZZ-60-000951-112	Utility /Service Air Distribution	0	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDZZZ-60-000952-113	Instrument Air Distribution	0	P&C
USAG-EC-PDZZZ-60-000954-114	Breathing Air Systems	0	P&C
USAG-EC-PDZZZ-60-000961-115	Nitrogen Generation	0	P&C
USAG-EC-PDZZZ-60-000961-116	Nitrogen Distribution	0	P&C
USAG-EC-PDZZZ-60-000976-120	Raw Water Storage Tank	0	P&C
USAG-EC-PDZZZ-00-000411-121	Camp Firewater Pumps - System 1	0	P&C
USAG-EC-PDZZZ-60-000683-122	Process Water Treating & Storage System	0	P&C
USAG-EC-PDZZZ-60-000976-124	Service Water Distribution	0	P&C
USAG-EC-PDZZZ-70-000976-125	Put River Water Facilities	0	P&C
USAG-EC-PDZZZ-70-000976-126	Put Reservoir Water Facilities	0	P&C
USAG-EC-PDZZZ-60-000977-127	Potable Water Storage	0	P&C
USAG-EC-PDZZZ-60-000977-128	Potable Water Storage Pumps	0	P&C
USAG-EC-PDZZZ-60-000977-129	Potable Water Distribution	0	P&C
USAG-EC-PDZZZ-00-000412-132	Camp Firewater Tank - System 1	0	P&C
USAG-EC-PDZZZ-60-000678-135	Fresh TEG Supply	0	P&C
USAG-EC-PDZZZ-60-000679-137	Hydrocarbon Holding Tank	0	P&C
USAG-EC-PDZZZ-00-000679-138	Gasoline Fuel Supply	0	P&C
USAG-EC-PDZZZ-00-000412-140	Camp Firewater Tank – System 2	0	P&C
USAG-EC-PDZZZ-00-000411-141	Camp Firewater Pumps – System 2	0	P&C
USAG-EC-PDZZZ-00-000412-142	Camp Firewater Tank – System 3	0	P&C
USAG-EC-PDZZZ-00-000411-143	Camp Firewater Pumps – System 3	0	P&C
USAG-EC-PDZZZ-10-000658-064	CO2 Compression Turbine & HRU – Unit 2	0	P&C
USAG-EC-PDZZZ-50-000666-041	Treated Gas Chilling Unit 2	0	P&C
USAG-EC-PDZZZ-10-000662-015	Acid Gas Removal Unit – Solvent Regenerator	0	P&C

E.6 – Plant and Equipment Layouts

Document Number:	Description:	Revision:	Appendix:
USAG-EC-LDEQL-0R-001001-001	Housing Utilities - Module 0R - Plan and Section	0	P&C
USAG-EC-LDEQL-0T-001003-001	Hydrocarbon Holding Tank - Module 0T - Plan and Section	0	P&C
USAG-EC-LDEQL-1B-001002-001	AGRU Absorber / Flash Drum - Module 1B Plans	0	P&C
USAG-EC-LDEQL-1B-001002-002	AGRU Absorber / Flash Drum - Module 1B - Sections	0	P&C
USAG-EC-LDEQL-1A-001001-001	AGRU Absorber - Module 1A - Plan and Section	0	P&C
USAG-EC-LDEQL-1C-001003-001	Gas Treatment Plant Treated Gas Compression -1C Plans	0	P&C
USAG-EC-LDEQL-1C-001003-002	Gas Treatment Plant Treated Gas Compression Module 1C Sections	0	P&C
USAG-EC-LDEQL-1D-001004-001	Gas Treatment Plant Treated Gas Compression Stack Module 1D plans	0	P&C
USAG-EC-LDEQL-1E-001005-001	Gas Treatment Plant Treated Gas Compression Module 1E plans	0	P&C
USAG-EC-LDEQL-1F-001006-001	Gas Treatment Plant Treated Gas Compression Stack Module 1F plans	0	P&C
USAG-EC-LDEQL-1G-001007-001	Gas Treatment Plant CO2 and Treated Gas Dehydration Module 1G plans	0	P&C
USAG-EC-LDEQL-1G-001007-002	Gas Treatment Plant CO2 and Treated Gas Dehydration Module 1G Sections	0	P&C
USAG-EC-LDEQL-1H-001008-001	Gas Treatment Plant AGRU Lean/Rich Exchanger Module 1H plans	0	P&C
USAG-EC-LDEQL-1H-001008-002	Gas Treatment Plant AGRU Lean/Rich Exchanger Module 1H Sections	0	P&C
USAG-EC-LDEQL-1I-001009-001	Gas Treatment Plant CO2 Gas Compression Module 1I - Plans	0	P&C
USAG-EC-LDEQL-1J-001010-001	Gas Treatment Plant CO2 Gas Compression Stack Module 1J - Plans	0	P&C
USAG-EC-LDEQL-1K-001011-001	Gas Treatment Plant CO2 Gas Compression Module 1K - plans	0	P&C
USAG-EC-LDEQL-1K-001011-002	Gas Treatment Plant CO2 Gas Compression Module 1K - sections	0	P&C
USAG-EC-LDEQL-1L-001012-001	Gas Treatment Plant CO2 Gas Compression Stack Module 1L - Plans	0	P&C
USAG-EC-LDEQL-1M-001013-001	Gas Treatment Plant Process Heat Medium Module - 1M - plan	0	P&C
USAG-EC-LDEQL-1M-001013-002	Gas Treatment Plant Process Heat Medium Module - 1M - sections	0	P&C
USAG-EC-LDEQL-1N-001014-001	Gas Treatment Plant AGRU Regeneration Module 1N- Plans	0	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-LDEQL-1N-001014-002	Gas Treatment Plant AGRU Regeneration Module 1N- Sections	0	P&C
USAG-EC-LDEQL-1T-001015-001	Gas treatment Plant Main Piperack - Module 1T plans and section	0	P&C
USAG-EC-LDEQL-5A-001001-001	Gas Treatment Plant Inlet Metering Station Module 5A-plan	0	P&C
USAG-EC-LDEQL-5G-001004-001	Gas Treatment Plant Piperack & Refrig. Condensers Module 5G - plans and section	0	P&C
USAG-EC-LDEQL-6C-001001-001	Gas Treatment Plant Storage Pumps & Filters - Module 6C - plans and sections	0	P&C
USAG-EC-LDEQL-6G-001005-001	Gas Treatment Plant Water Treatment/Building Heat Medium Module 6G plans and section	0	P&C
USAG-EC-LDEQL-5D-001003-001	Gas Treatment Plant CO2 and HP/LP Flare KO Drums Module 5D-plan and section	0	P&C
USAG-EC-LDEQL-5B-001002-001	GTP Refrigeration - Module 5B - plan and section	0	P&C
USAG-EC-LDEQL-6D-001002-001	GTP AGRU and TEG Storage Tank - Module 6D - plan and sections	0	P&C
USAG-EC-LDEQL-6E-001003-001	GTP Diesel Storage Tanks - Module 6E - plan and sections	0	P&C
USAG-EC-LDEQL-6F-001004-001	GTP Raw Water - Module 6F - plan and sections	0	P&C
USAG-EC-LDEQL-6H-001006-001	GTP Utilities - Module 6H - plan and sections	0	P&C
USAG-EC-LDEQL-6J-001008-001	GTP Building Heat Medium Heaters - Module 6J - plans and section	0	P&C
USAG-EC-LDEQL-7A-001001-001	GTP Water Reservoir Pump General Arrangement	1	P&C
USAG-EC-LDEQL-7B-001001-001	GTP PUT Reviser Intake Pump Module General Arrangement	1	P&C
USAG-EC-LDLAY-00-001006-000	GTP Module Index Plot Plan	1	P&C

*E.7 – Plant Reliability, Availability, and Maintainability (RAM) Analyses**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

E.8 - Piperack Drawings

Document Number:	Description:	Revision:	Appendix:
USAG-EC-LDEQL-1T-001015-001	Main Piperack Module 1T - Plan and Sections	0	P&C
USAG-EC-LDPGA-00-001001-000	Gas Treatment Plant Train Piperack - Conceptual Layout	0	P&C
USAG-EC-LDPGA-00-001002-000	Gas Treatment Plant Utility Piperack - Conceptual Layout	0	P&C
USAG-EC-LDPGA-00-001003-000	Gas Treatment Plant N/S Piperack to Flare - Conceptual Layout	0	P&C
USAG-EC-LDPGA-00-001004-000	Gas Treatment Plant Treated Gas to Refrigeration - Conceptual Layout	0	P&C

E.9 - Civil Drawings

Document Number:	Description:	Revision:	Appendix:
USAG-EC-CDRAL-00-001002-000	Emergency Road Access	0	CEII
USAG-EC-CDRAL-00-001003-000	River Access Road	0	CEII

E.10 - Security Plot Plan

Document Number:	Description:	Revision:	Appendix:
USAG-EC-LDLAY-00-001016-000	Security Plot Plan	0	P&C

APPENDIX 13F –SPECIFICATIONS

F.1 – Civil Specifications

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-CCC-LIS-DOC-00001	Civil Specification List	0	P&C
USAG-PG-NSZZZ-00-000001-000	Criteria for Pile Foundation Design	0	P&C
USAG-EC-CSZZZ-00-000002-000	Site Preparation Specification	0	P&C

F.2 – Mechanical Specifications

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-MMM-LIS-DOC-00004	Mechanical Specification List	0	P&C
USAI-PT-LSPDS-00-000001-000	Upstream Piping Classification Line Class 150	1	P&C
USAI-PT-LSPDS-00-000002-000	Upstream Piping Classification Line Class 300	1	P&C

USAI-PT-LSPDS-00-000003-000	Upstream Piping Classification Line Class 600	1	P&C
USAI-PT-LSPDS-00-000004-000	Upstream Piping Classification Line Class 900	1	P&C
USAI-PT-LSPDS-00-000005-000	Upstream Piping Classification Line Class 1500	0	P&C
USAI-PT-LSPDS-00-000006-000	Upstream Piping Classification Line Class 2500	1	P&C

F.3 – Electrical and Instrumentation Specifications

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-EEE-LIS-DOC-00010	Electrical and Instrumentation Specification List	0	P&C
USAI-PT-ISPDS-00-150707-000	Safety Instrument System Specification	0	P&C

F.4 – Security and Fire Safety Specifications

Document Number:	Description:	Revision:	Appendix:
AKLNG-4030-HSE-LIS-DOC-00002	Security and Fire Safety Specification List	0	P&C

APPENDIX 13G – HAZARD IDENTIFICATION

G.1 – Process Hazard Analyses and Recommendations

Document Number:	Description:	Revision:	Appendix:
USAG-PG-FRHAZ-00-000001-000	Pre-FEED Hazard Identification (HAZID) Review Report	0	Public

G.2 – Simultaneous Operations Studies

Document Number:	Description:	Revision:	Appendix:
N/A	N/A	N/A	Public

G.3 – Waterway Safety and Reliability Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Not Applicable to the GTP	N/A	Public

G.4 – Road Safety and Reliability Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

G.5 – Rail Safety and Reliability Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

G.6 – Air Safety and Reliability Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

G.7 – Crane and Lifting Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

G.8 – Security Threat and Vulnerability Analyses

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

APPENDIX 13H – HAZARD ANALYSES

H.1 – Safety Data Sheets

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-HSE-RTA-DOC-00002	Safety Data Sheets	0	Public

H.2 – Hazardous Release List

Document Number:	Description:	Revision:	Appendix:
N/A	Hazardous Release List is included in the Hazard Analysis Report in Appendix H.3	N/A	Public

H.3 – Hazard Analysis Reports

Document Number:	Description:	Revision:	Appendix:
USAG-EX-FRRSK-00-000001-000	GTP Facility Hazard Analysis Report	0	Public/P&C

H.4 – Meteorological Data

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-HSE-RTA-DOC-00001	Meteorological Data Report	0	Public

APPENDIX 13I – NATURAL HAZARD DESIGN INVESTIGATIONS AND FORCES

This Appendix is not applicable to the GTP.

APPENDIX 13J – SITE INVESTIGATION AND CONDITIONS, AND FOUNDATION DESIGN

J.1 - Geotechnical Hazard Report

Document Number:	Description:	Revision:	Appendix:
USAG-EC-SRZZZ-00-000005-000	Gas Treatment Plan - Borehole Plan for Resource Report 13	0	Public
USAG-EC-CDBOR-00-000010-000	Geotechnical Borehole Location Plan Sht. 9 of 17	0	Public
USAG-EC-CDBOR-00-000011-000	Geotechnical Borehole Location Plan Sht. 10 of 17	0	Public
USAG-EC-CDBOR-00-000012-000	Geotechnical Borehole Location Plan Sht. 11 of 17	0	Public
USAG-EC-CDBOR-00-000013-000	Geotechnical Borehole Location Plan Sht. 12 of 17	0	Public
USAG-EC-CDBOR-00-000014-000	Geotechnical Borehole Location Plan Sht. 13 of 17	0	Public
USAG-EC-CDBOR-00-000015-000	Geotechnical Borehole Location Plan Sht. 14 of 17	0	Public
USAG-EC-CDBOR-00-000016-000	Geotechnical Borehole Location Plan Sht. 15 of 17	0	Public
USAG-EC-CDBOR-00-000017-000	Geotechnical Borehole Location Plan Sht. 16 of 17	0	Public
USAG-EC-CDBOR-00-000018-000	Geotechnical Borehole Location Plan Sht. 17 of 17	0	Public

J.2 – Foundation Drawings

Document Number:	Description:	Revision:	Appendix:
USAG-EC-NDPIL-10-001001-001	General Details Pile Concept Details	0	CEII
USAG-EC-NDCPT-10-001003-001	General Details – Typical Module Details and Sections	0	CEII
USAG-EC-NDCPT-10-001003-002	General Details – Typical Module Details and Sections	0	CEII

APPENDIX 13K – MARINE SYSTEMS

This Appendix is not applicable to the GTP.

APPENDIX 13L – LNG TANK INFORMATION

This Appendix is not applicable to the GTP.

APPENDIX 13M – EQUIPMENT INFORMATION

*M.1 – Piping and Valve List**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*M.2 – Tie-In List**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

M.3 - Equipment List

Document Number:	Description:	Revision:	Appendix:
USAG-EC-SRZZZ-00-000002-000	GTP Mechanical Equipment List	0	P&C

M.4 – Data Sheets

Document Number:	Description:	Revision:	Appendix:
USAG-EC-MTTDS-1B-MAF662105	AGRU Water Wash Tower	2	P&C
USAG-EC-MTTDS-1B-MAF662105-INT	AGRU Water Wash Tower - Internals	1	P&C
USAG-EC-MTTDS-1C-MBD651100	Treated Gas Compressor 1st Stage KO Drum	1	P&C
USAG-EC-MTTDS-5B-MBD666505	Refrigeration Compressor Suction Drum	2	P&C
USAG-EC-MTTDS-1A-MAF662103	AGRU Absorber	1	P&C
USAG-EC-MTTDS-1B-MAF662103-INT	AGRU Absorber - Internals	1	P&C
USAG-EC-MTTDS-5D-MBD613500	LP CO2 Flare KO Drum	2	P&C
USAG-EC-MTTDS-1B-MBD662113	AGRU Solvent Flash Drum	1	P&C
USAG-EC-MTTDS-1M-HFF662130	AGRU Solvent Regenerator Condenser	1	P&C
USAG-EC-MTTDS-1H-PBA662112	AGRU Lean Solvent Pump	1	P&C
USAG-EC-MTTDS-6D-BBJ678600	AGRU Solvent Storage Tank	2	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-MTTDS-1A-CBA661125	TGDU Off Gas Compressor	1	P&C
USAG-EC-MTTDS-1G-HAP661116	TGDU TEG Reboiler	2	P&C
USAG-EC-MTTDS-1G-HAP667107	CO2 Dehy TEG Reboiler	1	P&C
USAG-EC-MTTDS-1B-HFF662108	AGRU Lean Solvent Cooler	2	P&C
USAG-EC-MTTDS-1B-MAF661100	TGDU TEG Contactor	2	P&C
USAG-EC-MTTDS-1B-MAF661100-INT	TGDU TEG Contactor - Internals	1	P&C
USAG-EC-MTTDS-1B-MAF662114-INT	AGRU Flash Gas Absorber - Internals	1	P&C
USAG-EC-MTTDS-1B-MAF662114	AGRU Flash Gas Absorber	1	P&C
USAG-EC-MTTDS-1C-HFF651102	Treated Gas Compressor Interstage Cooler	2	P&C
USAG-EC-MTTDS-1C-HFF651105	Treated Gas Compressor After Cooler	1	P&C
USAG-EC-MTTDS-1G-HBG661102	TGDU Cool TEG Lean/Rich Exchanger	1	P&C
USAG-EC-MTTDS-1G-HBG661108	TGDU Hot TEG Lean/Rich Exchanger	1	P&C
USAG-EC-MTTDS-1H-HPL662119	AGRU Lean Rich Exchanger	1	P&C
USAG-EC-MTTDS-1H-MAJ662110	AGRU Activated Carbon Filter	1	P&C
USAG-EC-MTTDS-1I-TGT833100	Main Power Gas Turbine Generators	1	P&C
USAG-EC-MTTDS-1K-HFF658102	CO2 Compression 1st Stage Aftercooler	1	P&C
USAG-EC-MTTDS-1K-HFF658104	CO2 Compression 2nd Stage Aftercooler	2	P&C
USAG-EC-MTTDS-1K-HFF658109	CO2 Compression 3rd Stage Aftercooler	2	P&C
USAG-EC-MTTDS-1K-HFF658111	CO2 Compression 4th Stage Aftercooler	2	P&C
USAG-EC-MTTDS-1K-MAF667100	CO2 Dehy TEG Contactor	1	P&C
USAG-EC-MTTDS-1K-MAF667100-INT	CO2 Dehy TEG Contactor - Internals	1	P&C
USAG-EC-MTTDS-1K-MBD658100	CO2 Compression 1st Stage KO Drum	1	P&C
USAG-EC-MTTDS-1K-MBD658103	CO2 Compression 2nd Stage KO Drum	1	P&C
USAG-EC-MTTDS-1K-MBD658105	CO2 Compression 2nd Stage Outlet KO Drum	1	P&C
USAG-EC-MTTDS-1K-MBD658107	CO2 Compression 3rd Stage KO Drum	2	P&C
USAG-EC-MTTDS-1K-MBD658110	CO2 Compression 4th Stage KO Drum	2	P&C
USAG-EC-MTTDS-1M-MBA942100	Process Heat Medium Expansion Drum	2	P&C
USAG-EC-MTTDS-1N-MAF662128	AGRU Solvent Regenerator	1	P&C
USAG-EC-MTTDS-1N-HBC662133	AGRU Solvent Reboiler	2	P&C
USAG-EC-MTTDS-1N-MAF662128-INT	AGRU Solvent Regenerator - Internals	1	P&C
USAG-EC-MTTDS-1N-PBA662129	AGRU Lean Solvent Booster Pump	1	P&C
USAG-EC-MTTDS-1T-HFF662104	AGRU Absorber Overhead Cooler	2	P&C
USAG-EC-MTTDS-5B-CBA666509	Refrigeration Compressor	1	P&C
USAG-EC-MTTDS-5B-HBG666500	Treated Gas Chiller	1	P&C
USAG-EC-MTTDS-5D-MBD612500	HP CO2 Flare KO Drum	2	P&C
USAG-EC-MTTDS-5D-MBD612506	HP Hydrocarbon Flare KO Drum	2	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-MTTDS-5D-MBD613506	LP Hydrocarbon Flare KO Drum	2	P&C
USAG-EC-MTTDS-5G-HFF666511	Refrigerant Condenser	1	P&C
USAG-EC-MTTDS-5M-FLRH612502	HP CO2 Flare	2	P&C
USAG-EC-MTTDS-5M-FLRH613502	LP CO2 Flare	2	P&C
USAG-EC-MTTDS-5M-FLRH613508	LP Hydrocarbon Flare	2	P&C
USAG-EC-MTTDS-6D-BBJ678604	AGRU Fresh Solvent Storage Tank	2	P&C
USAG-EC-MTTDS-6F-BBJ976602	Raw Water Storage Tank	2	P&C
USAG-EC-MTTDS-6G-MBA942600	Building Heat Medium Expansion Drum	2	P&C
USAG-EC-MTTDS-6H-VNTG961600	Nitrogen Membrane Package	1	P&C
USAG-EC-MTTDS-1B-MAK662100101	AGRU Filter Separator	2	P&C
USAG-EC-MTTDS-1C-CAX651101BASE	Treated Gas Compressor	1	P&C
USAG-EC-MTTDS-1D-EAP651107	Treated Gas Compressor Heat Recovery Unit (HRU)	2	P&C
USAG-EC-MTTDS-1E-CAR658101BASE	CO2 Compressor	2	P&C
USAG-EC-MTTDS-1L-EAP658113	CO2 Compression Heat Recovery Unit	2	P&C
USAG-EC-MTTDS-5E-HAP965508	Buyback Gas Bath Heater	2	P&C
USAG-EC-MTTDS-5M-FLRH612508	HP Hydrocarbon Flare	2	P&C
USAG-EC-MTTDS-6J-EAP942608	Building Heat Medium Utility Heater	2	P&C

M.5 – Manufacturer's Data

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

M.6 – List of Buildings and Structures

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-AAA-LIS-DOC-00001	List of Buildings and Structures	0	Public

M.7 – Building Siting Analysis

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

M.8 - Building Drawings

Document Number:	Description:	Revision:	Appendix:
USAG-EC-CDAED-00-001060-001	Control Building Plans, Elevation and Sections	0	P&C

USAG-EC-CDAED-00-001061-001	Control Building Plans, Elevation and Sections	0	P&C
USAG-EC-CDAED-00-001062-001	Control Building Plans, Elevation and Sections	0	P&C
USAG-EC-EDLAY-5C-001001-001	Refrigeration Module 5C Electrical Equipment Layout	0	P&C
USAG-EC-EDLAY-5C-001001-002	Refrigeration Module 5C Electrical Equipment Layout	0	P&C
USAG-EC-EDLAY-6P-001001-001	Utilities and Control Bldg. Module 6P, Electrical Equipment Layout	0	P&C
USAG-EC-EDLAY-6P-001001-002	Utilities and Control Bldg. Module 6P, Electrical Equipment Layout	0	P&C
USAG-EC-EDLAY-8A-001001-001	Main Power Generation Module 8A, Electrical Equipment Layout 1st and 4th Floor - Main Power Generation	0	P&C
USAG-EC-EDLAY-8A-001001-002	Main Power Generation Module 8A, Electrical Equipment Layout 1st and 4th Floor - Main Power Generation	0	P&C

APPENDIX 13N – ELECTRICAL DESIGN INFORMATION

N.1 – Electrical Load List

Document Number:	Description:	Revision:	Appendix:
USAG-EC-ELLSC-00-001001-000	Gas Treatment Plant Electrical Load List – Summer Case	0	P&C
USAG-EC-ELLSC-00-001002-000	Gas Treatment Plant Electrical Load List – Winter Case	0	P&C
USAG-EC-ELLSC-00-001003-000	Gas Treatment Plant Black Electrical Load List	0	P&C

N.2 - Transformer List

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

N.3 - One Line Diagrams

Document Number:	Description:	Revision:	Appendix:
USAG-EC-EDSLD-00-001001-001	Overall Generation and 13.8kV Main Power System Distribution Electrical One Line Diagram	0	P&C
USAG-EC-EDSLD-00-001003-001	Electrical One Line Diagram Operations Center	0	P&C
USAG-EC-EDSLD-10-001001-001	Electrical One Line Diagram Train Area Sheet 1	0	P&C

USAG-EC-EDSLD-10-001001-002	Electrical One Line Diagram Train Area Sheet 2	0	P&C
USAG-EC-EDSLD-50-001001-001	Electrical One Line Diagram Refrigeration Area	0	P&C
USAG-EC-EDSLD-60-001001-001	Electrical One Line Diagram Utilities Area	0	P&C
USAG-EC-EDSLD-80-001001-001	Electrical One Line Diagram Generation Area	0	P&C

N.4 - Overall Power Distribution Block Diagram

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

N.5 - Electrical Area Classification Drawings

Document Number:	Description:	Revision:	Appendix:
USAG-EC-EDHAC-00-001001-001	Area Classification Plan Process and Utilities	0	CEII
USAG-EC-EDHAC-00-001001-002	Area Classification Plan Flare and Operations Center	0	CEII
USAG-EC-EDHAC-00-001002-001	Area Classification Plan Aerial Coolers	0	CEII
USAG-EC-EDHAC-00-001003-001	Area Classification Plan Notes and Details	0	CEII

N.6 – Electrical Seal Drawings

Document Number:	Description:	Revision:	Appendix:
N/A	Not Applicable to the GTP	N/A	Public

APPENDIX 13O – PLANS AND PROCEDURES

O.1 - Management of Change and Reporting Procedure

Document Number:	Description:	Revision:	Appendix:
USAI-PS-BPMOC-00-000004-000	Management of Change and Reporting Procedure	0	Public

*O.2 – QA/QC Plans and Procedures**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*O.3 – Commissioning Plans**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*O.4 – Operating Plans and Procedures**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*O.5 – Maintenance Plans and Procedures**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*O.6 – Safety Procedures**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

APPENDIX 13P – PROCESS CONTROL AND INSTRUMENTATION

P.1 – Instrument Lists

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

P.2 - Control System Architecture Drawings

Document Number:	Description:	Revision:	Appendix:
USAG-EC-IDBLK-00-000002-000	Integrated Control and Safety System (ICSS) Architecture Diagram	0	P&C

P.3 - Preliminary Control Room Layout

Document Number:	Description:	Revision:	Appendix:
USAG-EC-IDLAY-00-000001-000	Gas Treatment Plant Control Room Operator Console / Monitor Layout	0	P&C

APPENDIX 13Q – SAFETY INSTRUMENTED SYSTEMS AND SHUT OFF VALVES

Q.1 - Cause and Effect Matrix

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDZZZ-00-000000-199	Overall	0	P&C
USAG-EC-PDZZZ-50-000609-200	Inlet Facilities	0	P&C
USAG-EC-PDZZZ-10-000662-202	Acid Gas Removal Unit	0	P&C
USAG-EC-PDZZZ-10-000661-204	Treated Gas Dehydration Unit	0	P&C
USAG-EC-PDZZZ-10-000651-206	Treated Gas Compression - Unit 1	0	P&C
USAG-EC-PDZZZ-50-000666-208	Treated Gas Chilling & Refrigeration	0	P&C
USAG-EC-PDZZZ-10-000658-210	CO2 Compression - Unit 1 (Sheet 1)	0	P&C
USAG-EC-PDZZZ-10-000658-211	CO2 Compression - Unit 1 (Sheet 2)	0	P&C
USAG-EC-PDZZZ-10-000667-212	CO2 Dehydration System	0	P&C
USAG-EC-PDZZZ-50-000612-214	Utilities - Flares	0	P&C
USAG-EC-PDZZZ-10-000965-215	Utilities - Fuel Gas	0	P&C
USAG-EC-PDZZZ-10-000833-217	Utilities - Power Generation	0	P&C
USAG-EC-PDZZZ-10-000942-218	Utilities - Heat & Cooling Medium Systems	0	P&C
USAG-EC-PDZZZ-10-000991-220	Utilities - Closed Drain Systems	0	P&C
USAG-EC-PDZZZ-10-000992-221	Utilities - Open Drain Systems	0	P&C
USAG-EC-PDZZZ-10-000678-222	Utilities - Chemical Storage	0	P&C
USAG-EC-PDZZZ-60-000955-223	Utilities - Air & Nitrogen Systems	0	P&C
USAG-EC-PDZZZ-60-000976-224	Utilities - Water Systems	0	P&C

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PDZZZ-10-000651-256	Treated Gas Compression - Unit 2	0	P&C
USAG-EC-PDZZZ-10-000658-260	CO2 Compression - Unit 2 (Sheet 1)	0	P&C
USAG-EC-PDZZZ-10-000658-261	CO2 Compression - Unit 2 (Sheet 2)	0	P&C

Q.2 - Block Diagrams

Document Number:	Description:	Revision:	Appendix:
USAG-EC-IDBLK-00-000001-000	Integrated Control and Safety System (ICSS) Block Diagram	0	P&C

Q.3 - Shutdown Valve List

Document Number:	Description:	Revision:	Appendix:
USAG-EC-PLZZZ-00-000005-000	Shutdown Valve List	1	P&C

Q.4 – Drawing of ESD Manual Activation Devices

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

Q.5 – Shutoff Valve Manufacturer's Data

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

APPENDIX 13R – RELIEF VALVES AND FLARE/VENT SYSTEMS

R.1 – Relief Valves Capacities and Sizing

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

R.2 – Flaring Load and Venting Capacities and Sizing

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

Appendix 13S – Spill, Toxic, Fire, and Explosion Protection

S.1 - Building and Fire Codes

Document Number:	Description:	Revision:	Appendix:
USAG-EC-FRZZZ-00-001001-000	Fine Water Mist System Summary	0	CEII
USAG-EC-FRZZZ-00-001003-000	Building and Fire Code Analysis	0	CEII

S.2 - Spill Containment Sizing Matrix

Document Number:	Description:	Revision:	Appendix:
N/A	Refer to Appendix S.3	0	Public

S.3 - Spill Containment Drawings (Secondary Containment for Tanks)

Document Number:	Description:	Revision:	Appendix:
USAG-EC-MRRSK-00-000001-000	Secondary Containment of Tanks Report	1	P&C

S.4 – Passive Protection Drawings

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested and needed	N/A	Public

S.5 - Hazard Detection Matrix

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-FNG-LIS-DOC-00001	Fire and Gas Detection Matrix	0	P&C

S.6 - Hazard Detection Drawings

Document Number:	Description:	Revision:	Appendix:
USAG-EC-FDFGS-00-001004-000	Typical Train Layout Fire & Gas Devices – Process Modules L	0	P&C
USAG-EC-FDFGS-00-001001-001	Fire and Gas Device Location Plans - Process Modules Lower Level	1	P&C
USAG-EC-FDFGS-00-001001-002	Fire and Gas Device Location Plans - Process Modules ML	1	P&C
USAG-EC-FDFGS-00-001001-003	Fire and Gas Device Location Plans - Process Modules UL	1	P&C
USAG-EC-FDFGS-00-001001-004	Fire and Gas Device Location Plans - Utilities Module & Storage Pumps	1	P&C
USAG-EC-FDFGS-00-001003-000	Gas Treatment Plant Control Building - Fire and Gas Device Location Plans	1	P&C

S.7 - Hazard Control Matrix

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-HSE-LIS-DOC-00002	Hazard Control Matrix	0	P&C

S.8 - Hazard Control Drawings

Document Number:	Description:	Revision:	Appendix:
N/A	Refer to Appendix S.6	0	Public

S.9 – Fire Water Matrix

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-FNG-LIS-DOC-00002	Fire Water Matrix	0	CEII

S.10 - Firewater Drawings (Fine Water Mist Plan)

Document Number:	Description:	Revision:	Appendix:
USAG-EC-FDFGS-00-1002-001	Typical Train Layout Fine Water Mist - Process Modules Plan	1	CEII
USAG-EC-FDFGS-00-1002-002	Storage Pumps / Filter Module Fine Water Mist	2	CEII

APPENDIX 13T – TECHNOLOGY, PROCESS, AND EQUIPMENT SELECTION AND ALTERNATIVES

T.1 - Alternative Refrigerant Study

Document Number:	Description:	Revision:	Appendix:
USAT-WD-PRTEC-00-0016_0_OS1	Alternative Refrigerant Review	0	P&C

T.2 - Gas Treating and Dehydration Alternative Study

Document Number:	Description:	Revision:	Appendix:
USAG-WD-PRTEC-000002	Gas Treating and Dehydration Alternative Study	0	P&C

A.1 – Site Location Maps and Drawing

Document Number:	Description:	Revision:	Appendix:
USAG-EC-LDLAY-00-001004-000	Gas Treatment Plant Site Plan	1	Public
USAG-EC-LDLAY-00-001005-001	Gas Treatment Plant Plot Plan	0	Public
USAG-EC-LDLAY-00-001005-002	Gas Treatment Plant Plot Plan	0	Public

USAG-EC-LDLAY-00-001004-000

NOTES:

1. EXISTING PRUDHOE DISCOVERY WELL MONUMENT TO BE VERIFIED BY SURVEY.
2. IF THIS FACILITY IS LOCATED PARALLEL TO EXISTING CGF PLANT, THE ANGLE BETWEEN TRUE NORTH AND PLANT NORTH WILL BE 15 DEGREES.

REVISION APPROVAL RECORD			REV 1		
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
ARCH.			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON.			PROCESS		
GEN. ARRANG.			QA / QC		
HVAC			STRUCTURAL		
I & C					

REV NO	DATE	REVISIONS	BY	CHKR	ENDORSED BY
A	03/03/2016	ISSUED FOR REVIEW	CAH	CRP	
0	04/13/2016	ISSUED FOR USE	CRP	CAH	JL
1	5/11/16	ISSUED FOR USE	MJ	MJ	

DRAWING STATUS				
ISSUED	REV	DATE	SDE	PEM
PRELIMINARY	1	5/11/16		
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REV.NO.

Alaska LNG™

URS ENERGY & CONSTRUCTION Inc. – an AECOM Company
6901 S. Havana St.
Englewood, CO 80112
(303) 843-2000

AECOM

PROJECT NO.: 31409	
DRAWN: MJ	DATE: 02/02/2016
CHECKED: CAH	DATE: 02/17/2016
CONFIDENTIAL PRE-FEED PHASE	
SCALE: 1" = 1000'-0"	

GAS TREATMENT PLANT SITE PLAN

DWG. NO. USAG-EC-LDLAY-00-001004-000 REV 1

$AECOM$DESIGN_FILE_PATH_AND_NAME_EXTENSION$
$AECOM$PLOT_DATE_AND_TIME$

31409_BDR.dwg

INCHES 1 2 CENTIMETERS 1 2 3 4 5 6

8 7 6 5 4 3 2 1

D C B A

USAG-EC-LDLAY-00-001005-001

FOR CONT. SEE DWG. USAG-EC-LDLAY-00-001005-002

DWG LIMITS NO MATCH DWG.

PLANT NORTH
TRUE NORTH
15°
67.5°
PREVAILING WIND

INJECTION WELL PAD

FLARE K.O. DRUMS
TRANSFORMERS
ELECTRICAL SWITCHGEAR
REFRIGERATION COMPRESSORS AND CHILLERS

EAST FLARE 1500'-0" RAD. 500 BTU/HR/FT2

60" FEED GAS
2" HP HC
2" REFRIGERANT
6" FUEL GAS

OPEN CATWALK

REFRIGERANT CONDENSERS
ELECTRICAL
ELECTRICAL

1500'-0" RAD. 500 BTU/HR/FT2 WEST FLARE

PTU FEED GAS K.O. & METER
PBU AND CO2 METERING
ANALYZER ROOM

TREATED GAS OUTLET METERING (BY OTHERS)

PTU GAS INLET PIG RECEIVER (BY OTHERS)

EDGE OF GTP PAD

TRAIN 3

PROCESS HEAT MEDIUM

AGRU LEAN/RICH EXCHANGERS

CO2 & TREATED GAS DEHYDRATION

AGRU ABSORBER/FLASH DRUM

AGRU REGENERATION

CO2 COMP UNIT 1

CO2 COMP UNIT 2

T.G. COMP UNIT 2

T.G. COMP UNIT 1

TRAIN 2

TREATED GAS. COMPRESSOR HEAT RECOVERY STACK

CO2 COMPRESSOR HEAT RECOVERY STACK

TRAIN 1

1 PSI OVERPRESSURE 1000'-0" RAD.

ELECTRICAL RACK

HEATED UTILIDOR

ESSENTIAL DIESEL GENERATOR

TRANSFORMERS

POWER GENERATION

STRG. PUMPS & FILTERS

DIESEL STORAGE

AGRU STORAGE

UTILITIES

WATER TREATING & BLDG. HEAT MED.

SPACE RQMT.

50' RAD.

UTILIDOR

RAW WATER

GTP CONTROL ROOM

LER

BUILDING HEAT MEDIUM UTILITY HEATERS

PARKING

PROPOSED 69KV ELECTRICAL INTER-TIE UNDERGROUND LINE

TREATED GAS PIPELINE MP-0
N. 1320.00 LAT. 70° 19' 9.21"N
E. 3224.00 LONG. 148° 32' 39.14"W

6" RAW WATER
32" PTU GAS
(3)16" BYPRODUCT
42" TREATED GAS (UNDERGROUND)

ENCASEMENT

50' 25' 0 100' 200' 300'
SCALE: 1"=100'-0"

DWG LIMITS NO MATCH DWG.

DWG LIMITS NO MATCH DWG.

LEGEND

HEATED UTILIDOR BENEATH PIPERACK IN OPEN MODULE

REVISION APPROVAL RECORD					REV 0
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
ARCH.			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON.			PROCESS		
GEN. ARRANG.			QA / QC		
HVAC			STRUCTURAL		
I & C					

REV NO	DATE	REVISIONS	BY	CHKR	ENDORSED BY
A	03/03/2016	ISSUED FOR REVIEW	MJ	CRP	
0	4/13/16	ISSUED FOR USE			

DRAWING STATUS				
ISSUED	REV	DATE	SDE	PEM
PRELIMINARY	0	4/13/16		
APPROVED FOR CONSTRUCTION				

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(303) 843-2000
AECOM

PROJECT NO.: 31409	
DRAWN: MJ	DATE: 02/02/2016
CHECKED: CAH	DATE: 02/17/2016
CONFIDENTIAL PRE-FEED PHASE	
SCALE: 1"=100'-0"	

GAS TREATMENT PLANT PLOT PLAN PROCESS AND UTILITIES

DWG. NO. USAG-EC-LDLAY-00-001005-001 REV 0

$AECOM$DESIGN_FILE_PATH_AND_NAME_EXTENSION$
$AECOM$PLOT_DATE_AND_TIME$

31409_BDR.dwg

INCHES 1 2 CENTIMETERS 1 2 3 4 5 6

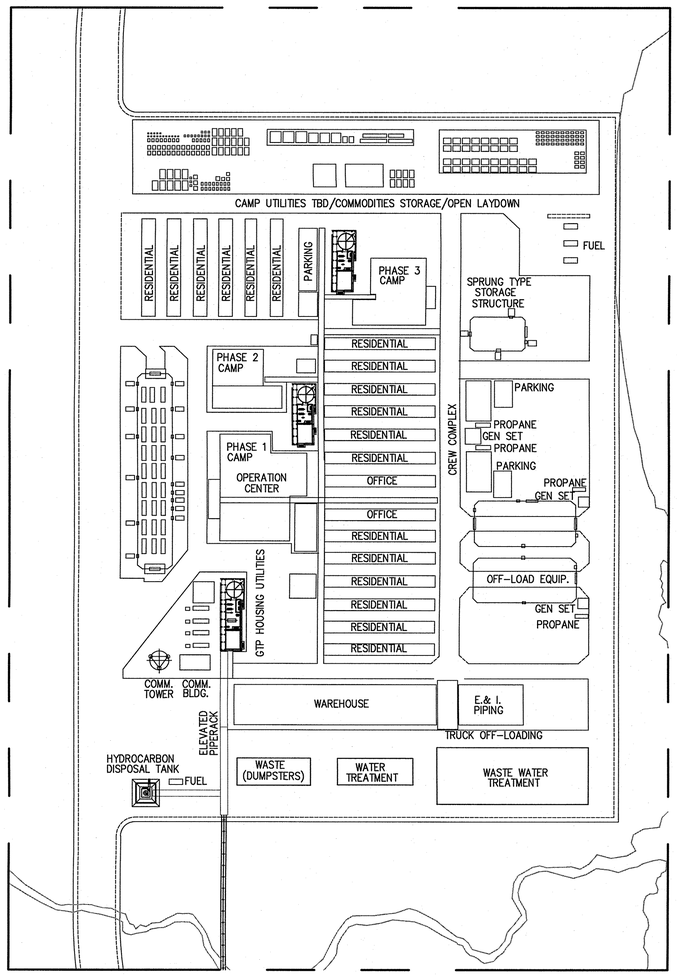
8 7 6 5 4 3 2 1

D C B A

USAG-EC-LDLAY-00-001005-002

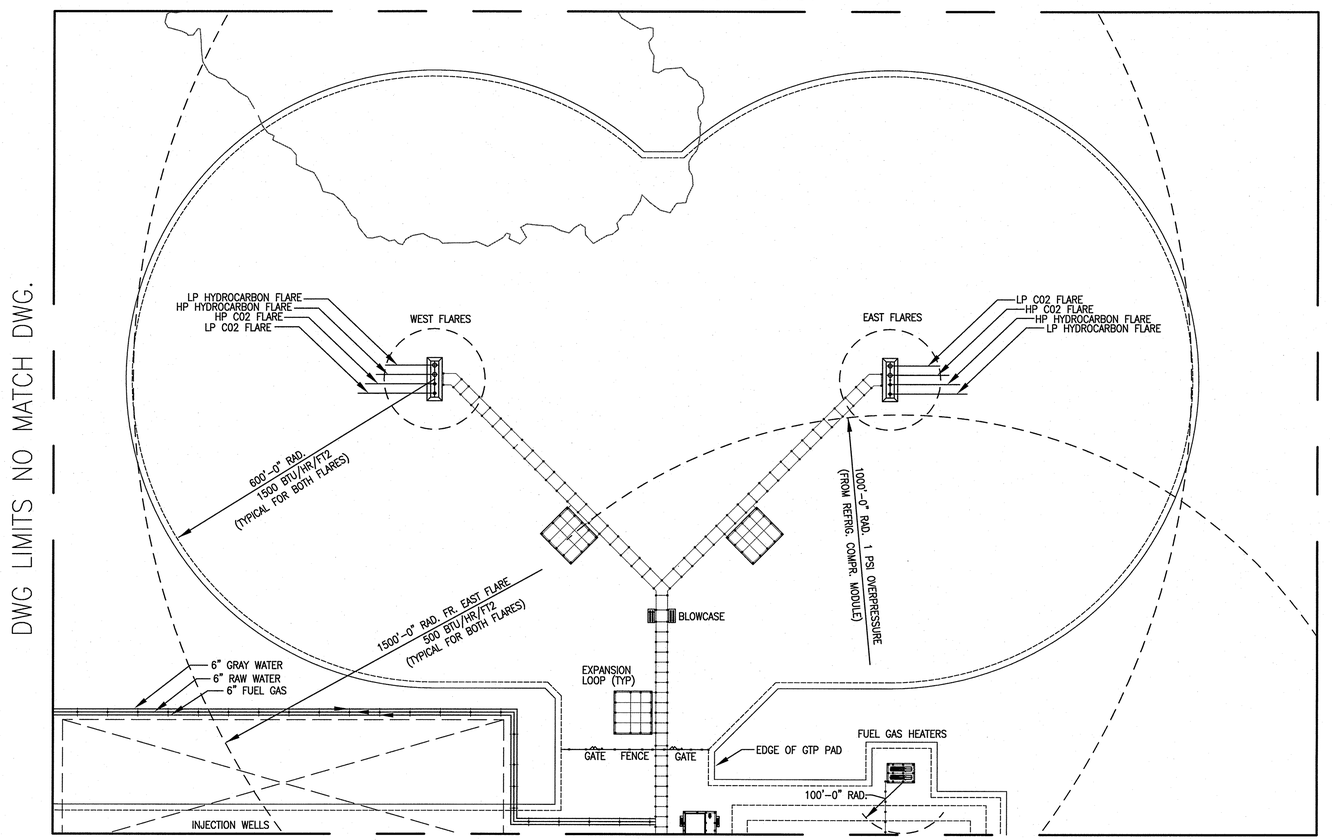
PLANT NORTH
TRUE NORTH
15°
67.5°
PREVAILING WIND

DWG LIMITS NO MATCH DWG.



DWG LIMITS NO MATCH DWG.

OPERATIONS CENTER
(NOT TO SCALE)



DWG LIMITS NO MATCH DWG.

FOR CONT. SEE DWG. USAG-EC-LDLAY-00-001005-001

FLARE

75' 0 150' 300' 450'
SCALE: 1"=150'-0"

REVISION APPROVAL RECORD				REV 0	
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
ARCH.			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON.			PROCESS		
GEN. ARRANG.			QA / QC		
HVAC			STRUCTURAL		
I & C					

REV NO	DATE	REVISIONS	BY	CHKR	ENDORSED BY
A	03/03/2016	ISSUED FOR REVIEW	MJ	CAH	
0	4/13/16	ISSUED FOR USE			

DRAWING STATUS				
ISSUED	REV	DATE	SDE	PEM
PRELIMINARY	0	4/13/16		
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REV.NO.

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URS ENERGY & CONSTRUCTION Inc. – an AECOM Company
6901 S. Havana St.
Englewood, CO 80112
(303) 843-2000
AECOM

PROJECT NO.: 31409	
DRAWN: MJ	DATE: 02/02/2016
CHECKED: CAH	DATE: 02/17/2016
CONFIDENTIAL PRE-FEED PHASE	
SCALE: 1"=150'-0"	

GAS TREATMENT PLANT
PLOT PLAN
FLARE & OPS CENTER

DWG. NO. USAG-EC-LDLAY-00-001005-002 REV 0

$AECOM$DESIGN_FILE_PATH_AND_NAME_EXTENSION$
$AECOM$PLOT_DATE_AND_TIME$

31409_BDR.dwg

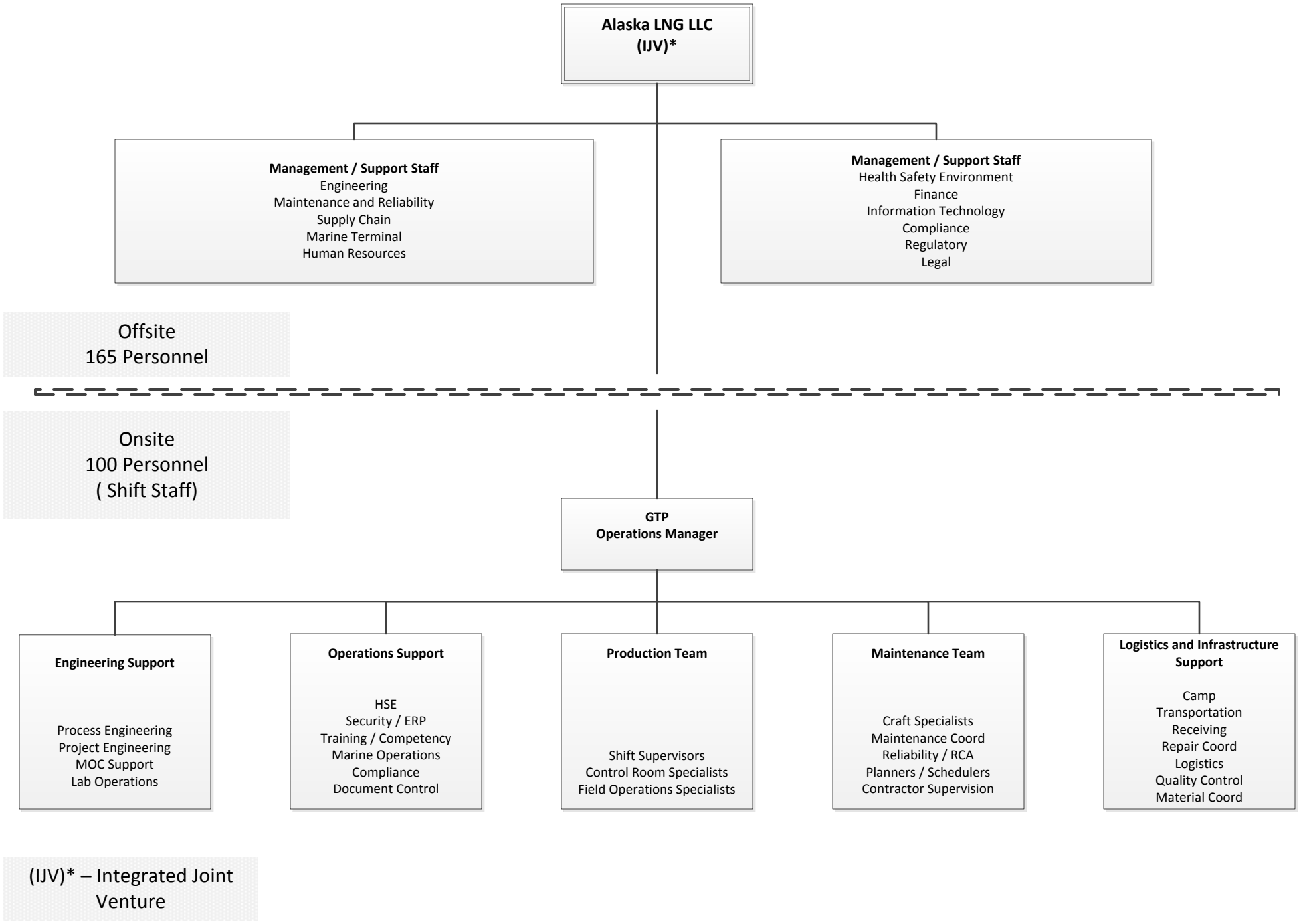
INCHES 1 2 CENTIMETERS 1 2 3 4 5 6

8 7 6 5 4 3 2 1

D C B A

A.2 – Organizational Chart

Document Number:	Description:	Revision:	Appendix:
USAG-PG-BAORG-00-000001-000	Staffing Structure	0	Public


Alaska LNG LLC
(IJV)*
Management / Support Staff
Engineering
Maintenance and Reliability
Supply Chain
Marine Terminal
Human Resources
Management / Support Staff
Health Safety Environment
Finance
Information Technology
Compliance
Regulatory
Legal
Offsite
165 Personnel
Onsite
100 Personnel
(Shift Staff)
GTP
Operations Manager
Engineering Support
Process Engineering
Project Engineering
MOC Support
Lab Operations
Operations Support
HSE
Security / ERP
Training / Competency
Marine Operations
Compliance
Document Control
Production Team
Shift Supervisors
Control Room Specialists
Field Operations Specialists
Maintenance Team
Craft Specialists
Maintenance Coord
Reliability / RCA
Planners / Schedulers
Contractor Supervision
Logistics and Infrastructure Support
Camp
Transportation
Receiving
Repair Coord
Logistics
Quality Control
Material Coord
(IJV)* – Integrated Joint Venture

*A.3 – Construction Workforce Organizational Chart**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*A.4 - Operation Workforce Organizational Chart**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

A.5 - Schedule

Document Number:	Description:	Revision:	Appendix:
USAI-PT-BYSCH-00-000001-000	Gantt Chart	0	Public

Confidential

Alaska LNG™

INTEGRATED PROJECT SUMMARY SCHEDULE

USAI-PT-BYSCH-00-000001-000

Rev	Date	Revision Description	Originator	Reviewer / Endorser	Response Code	Approver
0	11-May-16	Issued for Use	P. Connor			
1	30-Aug-16	Issued for Use	P. Connor			

Document Control No.	Country	Facility	Originator	Discipline	Type	Sub-Type	Location	Sequence	Identifier
	US	AI	PT	B	Y	SCH	00	000001	000

TABLE OF CONTENTS

Major Milestones	Start Date	End Date
Application Submittal		4Q 2016
Anticipated Draft EIS	4Q 2016	4Q 2017
Anticipated Final EIS	4Q 2017	2Q 2018
Anticipated FERC Order		3Q 2018
Anticipated FERC Notices to Proceed for Construction Start	3Q 2019	1Q 2020
LNG Facility		
Construction Infrastructure Development (Camps, Granular Material, Access, etc.)	4Q 2019	2Q 2022
Site Preparation Activities, Commence Piling and Equipment Concrete Foundations	1Q 2020	3Q 2023
Commence LNG Tank Construction	2Q 2021	4Q 2024
Installation and Interconnection of Train 1 and 2 Modules and Equipment, Power and Utilities	2Q 2022	2Q 2025
Mechanical Complete of Train 1, Power and Utilities. LNG Product Loading (Trestle) Mechanically Complete. Installation and Interconnection of Train 2 and 3 Modules/Equipment. Commence Pre-Commissioning.	1Q 2024	3Q 2025
Train 2 and Train 3 Mechanically Complete	1Q 2025	4Q 2025
LNG Train 1 Commissioning and Start-up (with GTP Train 1 Gas)	3Q 2024	4Q 2025
LNG Train 2 Commissioning and Start-Up (with GTP Train 1 Gas)	4Q 2025	1Q 2026
LNG Train 3 Commissioning and Start-Up (with GTP Train 2 Gas)	2Q 2026	3Q 2026
Kenai Spur Highway Relocation	1Q2019	1Q2020
Marine Terminal		
Site Preparation Activities, MOF Construction	4Q 2019	2Q 2021
Dredging, Complete MOF	1Q 2021	2Q 2021
Commence Installation of Trestle and Berths, Quadropod Installation	1Q 2022	4Q 2022
Complete Installation of Trestle, Continue Installation of Berths, Commence Installation of PLF Modules, Berths, and Mooring Dolphins	1Q 2023	4Q 2023
Complete Installation of PLF	1Q 2024	4Q 2024
MOF Reclamation/Demobilization	3Q 2026	3Q 2027
GTP		
Construction Infrastructure Development (Camps, Granular Material, Access, Etc.)	3Q 2019	1Q 2023
Site Preparation Activities and Field Erected Equipment Delivery/Setting	4Q 2019	2Q 2023
Sealift # 1		
Offload/Set Modules	3Q 2023	3Q 2023
Install Plant Utilities, Flares and Flare Pipe-Racks	3Q 2023	1Q 2024
Make Utility Interconnects and Start-Up	1Q 2024	2Q 2024
Sealift # 2		
Offload/Set Modules	3Q 2024	3Q 2024
Install Train 1 and Propane Modules and Make Interconnects	3Q 2024	1Q 2025
Commissioning and Start-Up Train 1 and Propane Refrigeration	4Q 2024	2Q 2025
Sealift # 3		
Offload/Set Modules	3Q 2025	3Q 2025
Install Train 2 and Make Interconnects	3Q 2025	1Q 2026
Commissioning and Start-Up Train 2	4Q 2025	2Q 2026
Sealift # 4		
Offload/Set Modules	3Q 2026	3Q 2026
Install Train 3 and Make Interconnects	3Q 2026	1Q 2027
Commissioning and Start-Up Train 3	4Q 2026	2Q 2027

Major Milestones	Start Date	End Date
PBTL Construction		
Install VSMs and Supports	1Q 2022	3Q 2022
Pipeline Construction	1Q 2022	3Q 2023
Hydrostatic test and Final Tie-In	3Q 2023	3Q 2022
Mainline		
Spread 1		
Construction Infrastructure Development (Camps, Borrow Sites, Access and Pads)	2Q 2020	4Q 2022
Site Preparation Activities (ROW Construction)	2Q 2021	3Q 2023
Pipeline Construction	4Q 2022	4Q 2024
Hydrostatic test and Final Tie-In (Summer months only)	2Q 2023	4Q 2024
Spread 2		
Construction Infrastructure Development (Camps, Borrow Sites, Access and Pads)	2Q 2020	4Q 2022
Site Preparation Activities (ROW Construction)	4Q 2020	4Q 2022
Pipeline Construction	4Q 2022	4Q 2024
Hydrostatic test (Summer months only) and Final Tie-In	2Q 2023	4Q 2024
Spread 3		
Construction Infrastructure Development (Camps, Borrow Sites, Access and Pads)	2Q 2020	3Q 2022
Site Preparation Activities (ROW Construction)	3Q 2020	3Q 2022
Pipeline Construction	4Q 2021	4Q 2023
Hydrostatic test (Summer months only) and Final Tie-In	2Q 2022	4Q 2023
Spread 4		
Construction Infrastructure Development (Camps, Borrow Sites, Access and Pads)	2Q 2020	4Q 2022
Site Preparation Activities (ROW Construction)	4Q 2020	1Q 2023
Pipeline Construction	4Q 2021	4Q 2023
Hydrostatic test (Summer months only) and Final Tie-In	2Q 2022	4Q 2023
Aboveground Mainline Facilities Construction[a]		
Sagwon Compressor Station	2Q 2025	2Q 2026
Galbraith Lake Compressor Station	2Q 2024	2Q 2025
Coldfoot Compressor Station	2Q 2025	2Q 2026
Ray River Compressor Station	2Q 2023	2Q 2024
Minto Compressor Station	2Q 2024	2Q 2025
Healy Compressor Station	2Q 2023	2Q 2024
Honolulu Creek Compressor Station	2Q 2025	2Q 2026
Rabideux Creek Compressor Station	2Q 2024	2Q 2025
Theodore Heater Station	2Q 2023	2Q 2024
Point Thomson Meter Station	1Q 2024	1Q 2025
GTP/Mainline Meter Station	1Q 2024	1Q 2025
Nikiski Meter Station	1Q 2024	1Q 2025
Fill Main Pipeline and Commissioning/Start-up Facilities (with GTP Gas)	2Q 2024	3Q 2025

Major Milestones	Start Date	End Date
Offshore (Cook Inlet) Spread		
Offshore Pipeline Construction	2Q 2022	1Q 2023
Hydrostatic test and Final Tie-In	2Q 2023	3Q 2023
PTTL		
Spread 1		
Construction Infrastructure Development (Ice Road Construction)	4Q 2022	1Q 2023
Site Preparation Activities (ROW Construction)	4Q 2022	1Q 2023
Pipeline Construction	4Q 2022	1Q 2023
Hydrostatic test and Final Tie-In	2Q 2023	3Q 2023
Spread 2		
Construction Infrastructure Development (Ice Road Construction)	4Q 2022	1Q 2023
Site Preparation Activities (ROW Construction)	4Q 2022	1Q 2023
Pipeline Construction	4Q 2022	1Q 2023
Hydrostatic test and Final Tie-In	2Q 2023	3Q 2023
Project Commissioning/In-Service		
First LNG Product, Train 1 Start-up	3Q 2024	4Q 2025
Intermediate LNG Product, Train 2 Start-Up		1Q 2026
Full LNG Product, Train 3 Start-Up		3Q 2027

[a] The construction schedule for compressor stations and the heater station is preliminary and subject to further optimization.

Note:

Construction Quarters (Q)

1Q = Jan-01 to Mar-31; 2Q = Apr-01 to June-30; 3Q = Jul-01 to Sept-30; 4Q = Oct-31 to Dec-31

C.1 – Table of Regulatory Agencies, Permits, and Approvals

Document Number:	Description:	Revision:	Appendix:
USAI-PE-SRREG-00-000013-000-A	List of Permits and Approvals	0	Public

APPENDIX C.1 LIST OF PERMITS AND APPROVALS

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
Order Granting Section 3 Authorization, Authorization to Construct, Operate or Modify Facilities Used for the Export or Import of Natural Gas; Federal Energy Regulatory Commission (FERC)	2-3 years	Section 3 of NGA of 1938, as amended; Executive Order (EO) 10485, as amended by EO 12038; 15 USC § 717; 18 CFR §157	Designates FERC as the National Environmental Policy Act (NEPA) lead federal agency and requires the applicant to be in compliance with all other federal requirements.	Applications for authorization to construct, operate, or modify facilities used for the export or import of natural gas. Includes the analysis by the Department of Energy for an LNG export license.	X	X	X	• Section 3(b) Application. • Sponsor Finances. • Financial and Corporate relationship. • Environmental Report. • Liquefaction Facility Map and Ownership.
NEPA EIS; FERC Lead Federal Agency	2-3 years	Public Law 91-190, 42 USC §4321-4327, January 1, 1970, as amended; Council on Environmental Quality, 40 CFR §1502.9; 15 USC 719(h)(c)(3) Alaska Natural Gas Pipeline Act (ANGPA);	NEPA is a national mandate for the protection of the environment; requires full consideration of reasonable project alternatives to minimize potentially adverse impacts to the human and natural environment, and provides public disclosure of the environmental impacts associated with federal actions.	NEPA is triggered by a “major federal action” such as the need for federal permits and approvals. A detailed statement of environmental effects of the project, in this case an EIS, is prepared by FERC; U.S. Environmental Protection Agency (EPA) reviews and comments on the environmental document. Numerous other federal agencies could be designated as “cooperating agencies” during the development of the EIS.	X	X	X	• Purpose and need. • Alternatives description. • Information provided in the FERC Resource Reports used to develop Affected Environment and Environmental Consequences. • Evaluation of direct, indirect, and cumulative impacts. Upstream and midstream footprints and facility impacts will be addressed as cumulative impacts as non-jurisdictional related facilities.

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
U.S. Department of Transportation (USDOT), Pipeline and Hazardous Materials Safety Administration (PHMSA) Special Permit	2-3 years	Hazardous Materials Safety and Security Reauthorization Act of 2005, 49 USC 5101 et seq. Pipeline Safety Regulations, 49 CFR 105-107, 171-180 49 CFR 190.341	Special Permits and Approvals to the Hazardous Materials regulations are issued by PHMSA, and can modify compliance with existing regulations for certain activities as long as safety is maintained. The PHSMA Special Permit process runs concurrently with the overall NEPA process and can take over a year to complete. New Special Permits are granted for two years, and renewals are granted for four years.	Special Permits are required for any actions that vary from what existing PHSMA regulations allow.		X		• Special Permit Enclosure A requires information on manufacturing quality controls, material specifications, engineering design factors, identification of hazards and demonstration the pipeline is capable of withstanding the stresses, operational conditions, and future maintenance, including in-line inspection. • Special Permit Enclosure B requires a focused Environmental Assessment and a Risk Analysis. • Cost and safety justification.
Response Plans, Safety and Operations Documentation; USDOT, PHMSA	3-6 months	Pipeline Safety Regulations, 49 CFR 190-199 Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006, Public Law 109-468, 49 USC 60101 Pipeline Safety Statues, 49 USC 60101-60301	PHMSA is the primary federal regulatory agency responsible for protecting people and the environment from the risks associated with transporting hazardous materials, via pipeline and other modes of transportation. Their goals are to ensure that pipelines are safe, reliable, and environmentally sound, and to be prepared for spill response in order to minimize harmful consequences. PHMSA also works to standardize requirements for pipelines that cross international borders.	Pipeline design must conform to the Pipeline Safety Regulations and Safety Statutes established by law and enforced by PHMSA.		X		• Response Plans. • Annual Accident, and Safety-Related Condition Reporting. • Incident Reports. • Procedural Manual for operations, maintenance, and emergencies. • Records. • Pipeline personnel Qualification Program and documentation. • Integrity Management – Pipeline Integrity Management Plan.
Response Plans, Safety	3-6 months	Hazardous Materials Regulations (HMR), 49 CFR 100-185	The HMR are issued by PHMSA and govern the transportation of hazardous	Transportation of hazardous material by highway, rail, vessel, and air to and from	(X)	X	(X)	• Oil Spill Prevention and Response Plans. • Security Plans.

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
and Operations Documentation; USDOT, PHMSA		Federal Hazardous Materials Transportation Law of 2005, 49 USC 5101-5128	materials by highway, rail, vessel, and air.	project facilities are regulated by the HMR.				• Hazardous Materials Communications. • Emergency Response Information. • Training Requirements. • Shipment Requirements and Documentation.
Section 404 Wetlands Dredge or Fill Permit, Section 10 Navigable Waters Permit, U.S. Army Corps of Engineers (USACE)	1-2 yr.	Rivers and Harbors Act of 1899, § 10, 33 USC § 40; Clean Water Act (CWA), Section 404, 33 USC §1344; 33 CFR 320-330;	Prevents unauthorized obstruction or alteration of U.S. navigable waters (Section 10); authorizes USACE to issue permits (Section 404) for the discharge of dredge or fill material into federally designated wetlands and waters	Section 404 permit is necessary for placement of fill of wetlands; Section 10 permit is necessary for dock improvements and dredging at West Dock and Nikiski, possibly major river crossings (e.g., Yukon River, Tanana River, etc.), Cook Inlet crossing and construction in navigable waters;	X	X	X	• Description of project activity • Location information • Requires identification of quantity and footprint of fill material for the pad, roads, and pipeline support • Requires identification of quantity of dredge material, dredge, and disposal sites • In a tiered fashion, requires testing of sediments and water prior to dredging, sampling to describe the biological communities at the dredge location and disposal locations, and if contamination found in the sediments, elutriate testing. • Requires completion of the EIS process and a signed ROD. • Requires selection of the Least Environmentally Damaging Practicable Alternative •
Section 103 Permit, Transportation of Dredged Material for Ocean Disposal	Same as 404/10 (processed simultaneously.	MPRSA § 103 (40 CFR § 220-228) Section 103 is the intended use and is the preferred citation for a project-specific	Section 103 of the Marine Protection, Research and Sanctuaries Act (MPRSA), as amended (33 U.S.C. 1413) authorizes transportation of dredged material for the purpose of dumping it into	Section 103 permit is necessary for transport and disposal of Project dredged material in marine waters; USACE adheres to NEPA guidelines for all permits. .	X		X	• Section 103 authorization requires applicant to evaluate alternatives for marine disposal • Requires baseline studies of ocean dump area including aqueous and sediment samples, benthic invertebrate and fish

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U.S. Army Corps of Engineers (USACE)		disposal activity and site designation.	ocean waters, where the Secretary determines that the dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological system, or economic potentialities.					studies, tissue samples, and hydrographic and bathymetry studies • Requires completion of the EIS process
Section 102 Ocean Disposal Site Designation; EPA	Same as 404/10 (processed simultaneously.	MPRSA § 102 (40 CFR § 220-228).	Designates a site for use as an ocean dumping site for disposal of dredged material.	Section 102 permit is required for designation of an ocean dump site of necessary for disposal of dredge material from turning basin and Marine Terminal. Section 102 may apply depending on the longevity required for maintenance dredging.	X		X	• Requires baseline studies of ocean dump area including aqueous and sediment samples, benthic invertebrate and fish studies, tissue samples, and hydrographic and bathymetry studies • Requires completion of the EIS process
Section 10 Navigable Waters Permit USACE	1-2 years	Rivers and Harbors Act of 1899, § 10, 33 USC § 40	Requires a permit under Section 10 for activities in or placement of structures in U.S. navigable waters.	Section 10 permit is necessary for dock improvements and dredging at West Dock and Nikiski, possibly major river crossings (e.g., Yukon River, Tanana River, etc.), Cook Inlet crossing and construction in navigable waters	X	X	X	• Description of project activity. • Location information. • Requires identification of quantity and footprint of fill material for the pad, roads, and pipeline support. • Requires identification of quantity of dredge material, and dredge sites. • In a tiered fashion, requires testing of sediments and water prior to dredging, sampling to describe the biological communities at the dredge location and disposal locations, and if contamination found in the sediments, elutriate testing. • Requires completion of the EIS process and a signed ROD.

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								• Requires selection of the Least Environmentally Damaging Practicable Alternative.
Waterway Suitability Analysis; U.S. Coast Guard (USCG)	9-12 month lead time in conjunction with FERC pre-filing process; Letter of Recommendation (LOR) issued prior to DEIS; Per Navigation and Vessel Inspection Circular No. 05-05	33 CFR Part 104; 33 CFR Part 105; U.S. Department of Homeland Security 33 CFR 127, Waterfront Facilities Handling LNG and Liquefied Hazardous Gas (Liquefaction Facility) USCG 33 CFR 127, Letter of Intent (Liquefaction Facility) Permission to Establish Aids to Navigation (Marine Terminal) Waterway Suitability Assessments - NVIC 05-05	USCG will perform a significant review of the Liquefaction Facility and marine transportation component, the waterway suitability analysis of the LNG carriers.	The International Ship and Port Facility Security Code (ISPS Code) is a comprehensive set of measures to enhance the security of ships and port facilities, developed in response to the perceived threats to ships and port facilities in the wake of the 9/11 attacks in the United States.			X	Per the following guidance documents: • National Environmental Policy Act Implementing Procedures and Policy for Considering Environmental Impacts, COMDTINST M16475.lD (series). • Environmental Considerations for Decision Making, COMDTPUB P16475.6. • Nav. and Vessel Inspection Circ. No. 10-04, Guidelines for Handling of Sensitive Security Information (SSI), COMDTPUB P16700.4. • Sandia National Laboratories Report SAND2004-6258, "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water," dated December 2004. • LNG and LPG - Views and Practices, Policy and Safety, COMDTINST M16616.4 (old *CG-478).* • 33 CFR 127: *"Waterfront Facilities Handling Liquefied Natural Gas and Liquefied Hazardous Gas."* • Navigation and Vessel Inspection Circular No. 9-02, Ch-I, Guidelines for Development of Area Maritime Security Committees and Area Maritime Security Plans for U.S. Ports, COMDTPUB P16700.I. • Risk-Based Decision-Making, COMDTINST M16010.3 (series), and

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								Risk-Based Decision-Making Guidelines, 3rd edition.
Operations Manual and Emergency Manual; USCG	1 month	Executive Order 10173; Magnuson Act (50 U.S.C. § 191); the Ports and Waterways Safety Act of 1972, as amended (33 U.S.C. § 1221, et seq.); the Maritime Transportation Security Act of 2002 (46 U.S.C. § 701), the Safety and Accountability For Every Port Act (46 U.S.C. § 70101), and 33 CFR 127	USCG exercises regulatory authority over waterfront LNG facilities and the associated LNG vessel traffic, which affect the safety and security of port areas and navigable waterways.	Required by 33 CFR 127.019 to be approved by the local Captain of the Port (COTP) prior to the transfer of LNG.			X	Operations Manual: • Description of the transfer system. • Duties of each person assigned for transfer operations. • Maximum relief valve setting or maximum allowable working pressure of the transfer system. • Facility contact information. • A description of the security systems for the marine transfer area for LNG. • Procedures for transfer operations including gauging, cool down, pumping, venting, shutdown, start-up, security incidents, and communications systems. • Training programs. Emergency Manual: • LNG release response procedures. • Emergency shutdown procedures. • A description of the fire equipment and systems and their operating procedures. • A description of the emergency lighting and emergency power systems. • Emergency response contact information. • Shelter description. • First aid procedures and locations. • Emergency procedures for mooring and unmooring a vessel.

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Facility Security Plan; USCG	2 months	Executive Order 10173; Magnuson Act (50 U.S.C. § 191); the Ports and Waterways Safety Act of 1972, as amended (33 U.S.C. § 1221, et seq.); the Maritime Transportation Security Act of 2002 (46 U.S.C. § 701), the Safety and Accountability For Every Port Act (46 U.S.C. § 70101), and 33 CFR 105	USCG exercises regulatory authority over waterfront LNG facilities and the associated LNG vessel traffic, which affect the safety and security of port areas and navigable waterways.	Required by 33 CFR 105.410 to be approved by the local Captain of the Port (COTP) prior to the transfer of LNG.			(X)	Facility Security Plan: • Security administration and organization. • Personnel training. • Drills and exercises. • Records and documentation. • Response to change in MARSEC Level. • Procedures for interfacing with vessels. • Declaration of Security. • Communications. • Security systems and equipment maintenance. • Security measures for access control, including designated public access areas. • Security measures for restricted areas. • Security measures for handling cargo. • Security measures for delivery of vessel stores and bunkers. • Security measures for monitoring. • Security incident procedures. • Audits and security plan amendments. • Facility Security Assessment (FSA) report. • Facility Vulnerability and Security Measures Summary (Form CG–6025).
Bridge Permit; USCG, Bridge Administration	Processed simultaneously with EIS process, issued 3-6 months after FEIS is issued.	General Bridge Act of 1946; 33 CFR parts 114, 115; 33 USC 525;	For the construction of a new bridge or causeway or for the reconstruction or modification of an existing bridge or causeway across the navigable waters of the U.S.	Bridges over navigable waters of the U.S. (temporary and permanent).		X		• Applicant information. • Consultant information. • Project information. • Authority information. • Proposed clearances and elevations.

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		Section 9 of the Rivers and Harbors Act of 1899						• Existing bridge structure at bridge site. • Bridge removal. • Construction activity. • Environmental effects. • Required authorizations. • Other federal agencies with jurisdiction. • Fill. • Adjacent property owners. • Underlying studies, reports, and other information. • Project drawings. • Alaska Department of Transportation & Public Facilities (ADOT&PF) will need to know what existing highway bridges, if any, the proposed pipeline may use or attach to. • A separate utility permit is required for each bridge crossing. • List of generic conditions for utility attachment to a highway bridge – subject to change. Please note this includes: - Allowance of conduits carrying flammable, hazardous, or corrosive material will be permitted on the bridge only after the exhaustion of all reasonable crossing alternatives. • Shutoff valves are required to be located beyond both abutments, outside the limits of the bridge. Keep valves operational and accessible, clear of snow, ice, dirt, and debris.

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								• Use valve vaults in areas where environmental elements and/or vandalism pose concern. • Provide a casing extending the full length of the bridge. • Size the casing to carry the entire contents of the conduit and vent the line at points well away from the structure. • Expect additional requirements on large and/or high-pressure lines.
Underground Injection Control (UIC) Program; EPA	Class I - 3 -12 months for all approvals; requires initial approval, interim approval, and final approval.	40 CFR 144	The UIC program in the State of Alaska for Class I, III, IV, and V wells, and for all classes of wells on Indian lands, is administered by the EPA. The EPA has direct implementation responsibility in Alaska for the regulation of Class I injection wells through the UIC program, which is authorized by Part C of the Safe Drinking Water Act (SDWA).	EPA-issued Class I UIC permit covers the construction, operation and closure requirements for a Class I injection well. The GTP will have two Class I disposal wells.	X			• Owner information and SIC code. • Legal information. • Well status and type of permit. • Class and type of well. • Location of wells. • Maps of well/area of review. • Corrective action plan and well data. • Maps and cross section of underground sources of drinking water (USDWs). • Name and depth of USDWs. • Maps and cross sections of geologic structure of area. • Geological data of inject and confining zones. • Operating data. • Formation testing program. • Stimulation program. • Injection procedures. • Construction procedures and details.

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								• Changes in injected fluid. • Plan for well failures. • Monitoring program. • Plugging and abandonment plan. • Aquifer exemptions.
Facility Response Plan (FRP); EPA—if applicable.	FRP must be submitted 60 Days prior to operation	Facility Response Plan Rule; Section 311 of the CWA, as amended by the Oil Pollution Act of 1990; Oil Pollution Prevention and Response Regulation; 33 USC 123(j)(5); 40 CFR 112.20 and 112.21	Facilities that store and use oil are required to prepare and submit this plan to demonstrate the facility's preparedness to respond to a worst-case oil discharge. If applicable based on volume of fuels to be stored.	Facilities that could reasonably be expected to cause "substantial harm" to the environment by discharging oil into or on navigable waters are required to prepare and submit a Facility Response Plan. Facility may pose "substantial harm" according to the FRP rule if it: 1. has a total oil storage capacity greater than or equal to 42,000 gallons and it transfers oil over water to/from vessels; or 2. has a total oil storage capacity greater than or equal to 1 million gallons and meets one of the following conditions: a. does not have sufficient secondary containment for each aboveground storage area. b. is located at a distance such that a discharge from the facility could cause "injury" to fish, wildlife, and sensitive environments. c. is located at a distance such that a discharge from the facility would shut down a public drinking water intake.	(X)	(X)	(X)	• Emergency Response Action Plan. • Facility information. • Emergency notification, equipment, personnel, and evacuation information. • Identification and analysis of potential spill hazards and previous spills. • Discussion of discharge detection procedures and equipment. • Detailed implementation plan for response, containment, and disposal. • Description and records of self-inspections, drills, and exercises, and response training. • Diagrams of Facility Site Plan, drainage, and Evacuation Plan. • Security. • Response Plan coversheet.

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				d. has had, within the past five years, a reportable discharge greater than or equal to 10,000 gallons. If the facility does not meet the criteria (either under 1 or 2), then the facility is not subject to the FRP rule via self-identification				
Federal Temporary Use Permits, ROW Grant and Notice to Proceed (NTP); DOI, BLM	Issued within 90 days of FEIS, processed simultaneously with EIS.	Mineral Leasing Act of 1920, Section 28(e); 30 USC 185; 43 CFR 2880 Federal Land Policy and Management Act; USC 1761-1771 CFR 36	Authorization to use a specific piece of public land for certain project and authorizes rights and privileges for a specific use of the land for a specific period of time.	Relevant for pipeline and compressor stations, material sites; access roads; and communication sites.		X		• Project purpose. • Description of activities, including dimensions and area of site to be occupied. • Timing and duration of activities. • Location of all work areas including legal description, maps, and land ownership and status. • Summary of environmental effects including socio-economic, air, visual, surface and groundwater quality, streams or other water bodies, noise, soil, permafrost vegetation and plant life, fish, wildlife, marine life, threatened and endangered species, and marine mammals. • Description of the use, production, transportation, or storage of any hazardous materials. • Status of other required state or local approvals. • Non-returnable application fee. • Bonding and Insurance. • Rental fee for land use.

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Purchase of Mineral Material/Mineral Sales Contract; U.S. Department of the Interior (DOI), Bureau of Land Management (BLM)	6-12 months	Mineral Management Act, 30 USC Sections 601, 602, 604; 43 CFR parts 3600, 3610, 3620, 23, and 5400	There is no specific application form for requesting removal of mineral material from public lands.	Contract required for material sites on federal land. Removal of rock, crushed rock, or gravel will include a cost per cubic yard fee.		X		• Contact is the BLM District or Resource Area office closest to the area of need or closest to the public land where the desired material is found. • Compliance with applicable laws, including the Environmental Protection Act. • May require duplicative permit with the State if related to a disputed Navigable waterway.
Endangered Species Act (ESA) Section 7 Consultation; USFWS and National Marine Fisheries Service (NMFS)	Consultation — simultaneous with EIS	ESA, § 7(a)(2); 16 USC § 1531-1544	Federal agencies that permit, license, fund, or otherwise authorize activities must ensure their actions will not jeopardize the continued existence of any listed species.	Section 7 Consultation will occur in conjunction with the EIS process and USACE Section 404/10 permitting.	X	X	X	• Consultation with USFWS and NMFS for listed species and critical habitat that occur within the project area. • Preparation of Biological Assessment to accompany the FERC application. • A Biological Assessment should include: - Project description. - Description of the project area and delineate the “action area.” - Description of the physical and biological attributes of the action area (e.g., topography, vegetation, condition and trend). - Identify listed or proposed species that “may be present” including candidate species, in addition any designated critical habitat. - For each species that may be present, describe the current habitat conditions within the action area. For critical habitat, identify the primary constituent elements that occur in the

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								action area (refer to the rule in the Federal Register that designated the critical habitat). - Describe how the action may affect each protected species. - Complete a cumulative effects analysis. Cumulative effects are effects resulting from future state or private activities (not involving federal activities) that are reasonably certain to occur within the action area of the federal action subject to consultation. This step is necessary only if listed resources will be adversely affected and Formal Consultation is necessary - Make a Section 7 finding for proposed or listed species and proposed or designated critical habitat that may be present in the action area. Findings include: No effect; May effect, but not likely to adversely affect; and may affect and likely to adversely affect. - NMFS/USFWS will issue a Biological Opinion, along with an Incidental Take Statement (ITS) if necessary. The MMPA and ESA permits are closely tied to each other.
Migratory Bird Treaty Act (MBTA); USFWS	Consultation — simultaneous with EIS	MBTA 16 USC § 703-712	Prohibits taking of migratory birds unless specifically exempt or authorized.	Must be addressed as part of the EIS process and USACE Section 404/10 permitting.	X	X	X	• Consultation with USFWS. • Complete Avian Protection Plan with FERC application. • Undertake permitting under Special Purpose permit provisions of MBTA (50 CFR 21.27).

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								• General land clearing guidance to avoid disturbing nesting migratory birds (for compliance with Migratory Bird Treaty Act) can be found at: http://www.fws.gov/alaska/fisheries/fieldoffice/anchorage/pdf/vegetation_clearing.pdf .
Bald and Golden Eagle Take Permit pursuant to Bald and Golden Eagle Protection Act (BGEPA); USFWS	Consultation — simultaneous with EIS; 60 days	BGEPA 16 USC 668-668d, as amended;, 50 CFR 22.25; 50 CFR 13	Provides protection to the bald eagle and golden eagle.	Prohibiting, except under specified conditions, the taking, possession, and commerce of eagles. Take includes nests, parts, or eggs.		X	X	• Consultation with USFWS. • Conduct studies as recommended by the USFWS including eagle and raptor nest surveys.
Essential Fish Habitat (EFH) Consultation; NMFS	Consultation — simultaneous with EIS.	Magnuson-Stevens Fishery Conservation and Management Act/Sustainable Fisheries Act, 16 USC § 1801 et seq.	Establishes national standards for fisheries conservation and management. EFH is defined as, "…those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity…"	Federal agencies must consult with NMFS and assess the effects of their actions on EFH; EFH must be addressed as part of the EIS process.	X	X	X	• Consultation with NMFS. • Preparation of EFH Assessment with FERC application. • Required for APDES and NPDES permits for waste water treatment and disposal. • Review following guidance documents 1) Anadromous Salmonid Passage Facility Design, DOC-NMFS 2011, and/or 2) Stream Simulation.
Marine Mammal Protection Act (MMPA) Incidental Harassment (IHA) Authorization or Letter of	Consultation — simultaneous with EIS; LOA 12-18 months; ITA 6-12 months	MMPA, Title 1, 16 USC §1371 Sec. 101(a)(5); Section 101 (a) 5 of the MMPA, 16 U.S.C. § 1371.101 (a) (5), and 50 C.F.R. § 216,	MMPA prohibits take of any marine mammal species in U.S. waters except under specific authorization such as a Letter of Authorization (LOA). Incidental Take Authorizations (ITAs) are the overarching	Required for dredging and dock improvement activities and marine pipe lay and impacts to marine mammals in Cook Inlet and on the North Slope, and activities on land located in designated polar bear habitat. (Note: no critical habitat has been designated yet)	X	X	X	• Detailed description of activity that could result in take of marine mammals. • Dates and duration of activities. • Species and number of marine mammals likely to be found in activity area.

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Authorization (LOA) NMFS and USFWS		50 CFR §18 50 C.F.R. Part 216, Subpart I (216.101 – 216.106). Section 216 Subpart R (216.200 – 216.210) describes the specific regulations for operation of oil and gas facilities in the U.S. Beaufort Sea. Section 216.207 references the 14 requirements in section 216.104 in order to apply for a new LOA.	authorization. There are two types of ITAs that can be issued under the MMPA: Incidental Harassment Authorization (IHA) and Letter of Authorization (LOA). The latter requires the promulgation of regulations. LOAs are for projects found to take small numbers of marine mammals and which have no more than a negligible impact on marine mammal species not listed as depleted under the MMPA (i.e., listed under the ESA) and not having an immitigable effect on subsistence harvests of these species.					• Description of the status, distribution, and seasonal distribution of affected species or stocks of marine mammals. • Type of incidental taking auth. Requested. • Number of marine mammals by age, sex, and reproductive condition. • Anticipated impact of the activity upon the species or stock. • Anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence use. • Anticipated impact of the activity on the habitat of marine mammal populations. • Anticipated impact of the loss or modification of the habitat on the marine mammal populations. • Availability and feasibility of equipment, methods, and manner of conducting such an activity. • Plan of cooperation. • Monitoring and reporting methods. • Means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.
Spill Prevention, Control, and Countermeasure (SPCC) Plan; EPA	Reviewed prior to construction; draft in EIS.	SPCC Rule Section 311 (j)(1)(C). of the CWA, as amended by the Oil Pollution Act of 1990;	Plan to help prevent the discharge of oil into navigable waters or adjoining shorelines. Emphasis on prevention rather than mitigation measures provided in contingency plans.	Required for project facilities with petroleum storage of an aggregate capacity greater than 1,320 gallons or completely buried with a capacity greater than 42,000 gallons; and, due to facility location, could reasonably be expected to discharge oil in quantities that may be	X	X	X	• Identify all individual storage tanks with an oil storage capacity greater than 55 gallons, or multiple tank or drum fuel storage with a combined capacity greater than 1,320 gallons.

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		Oil Pollution Prevention and Response Regulation; 40 CFR 112 (Subparts A though C); Executive Order 12777.	EPA - regulatory and enforcement role for oil spill prevention activities under CWA section 311 for onshore and near shore non-transportation related facilities landward of the coastline.	harmful, as described in 40 C.F.R. part 110, into or upon navigable waters of the U.S. or adjoining shorelines.				
Notice for Construction, Alteration and Deactivation of Airports; FAA	2-3 months	14 CFR 77.13	For structures interfering with flight paths during reactivation or construction of airstrip or helipads.	Potentially required for helipads or construction within airport zones.		X		FAA Form 7480-1 • Description of new construction or alteration. • Contact information • Permanency. • Type of structure. • Construction dates. • Geographic coordinates. • Relationship of road to other existing structures.
Radio and Wire Communications Permits and Licenses; Federal Communications Commission (FCC)	0-2 months Depending on Type	47 USC 151 et seq.; 47 CFR 100 et seq.	For project activities requiring communication (including frequencies).	Project activities or facilities that require radio and wire communications and frequencies.	X	X	X	• Complete the appropriate form found on the FCC web site: http://www.fcc.gov/formpage.html. • In addition to the FCC, the USFW Service can provide recommendations for lighting and tower construction to minimize the likelihood of bird collisions with transmission towers.
Permit to Appropriate Water, Water Right Certificate of Appropriation; Alaska Department of	2-4 months for Permit to Appropriate Water; 1-5 years for Water Right Certificate of Appropriation	Alaska Water Use Act, Alaska Statute (AS) 46.15 / 11 AAC 93.035 - .130 and 11 AAC 93.210 - .220	Water is a common property resource in Alaska. Withdrawal of water requires approval. This permit appropriates water from a source for permanent use	For constructing works for an appropriation, or diverting, impounding, withdrawing, or using a significant amount of water from any source (the term significant amount of water is defined in 11 AAC 93.035).	X		X	As stated in the instructions on each application form. • Permit to Appropriate Water requires: Property Description (location of water use, location of water source, location of water return flow or discharge); water source; method of taking water (pump,

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Natural Resources (ADNR), Division of Mining, Land and Water (DMLW)	(Note: Issuance time for a Water Right Certificate includes time needed to demonstrate Beneficial Use)			Permit is required to withdraw water for long-term use such as for camps, construction, maintenance, and operations activities.				gravity, ditch, etc.); amount of water and type of use. • An application must include: evidence that the applicant has a present possessory interest in the property where the water is to be beneficially used; a map; evidence that the applicant has obtained or is in the process of obtaining a right of access to the property; a legal description of the point of withdrawal, diversion, or impoundment; the point of water use; and, if water is to be returned to a stream or water body, the point of return flow; a description of the source; a description of any impoundment, diversion, or withdrawal structures, a description of the nature of the water use and times of the year during which water is to be used; a statement of the dates water use is expected to begin and when the maximum amount will be beneficially used; a statement of beneficial use; an application for a ROW, filed in accordance with AS 38.05.850 , if access to or across state land is needed; a statement of the quantity of water requested, with documentation and calculations justifying the request if either the use or quantity is different from those listed in (d) of this section; for a water use of more than 100,000 gpd (0.15 cfs) from a stream, a description of the mean annual flow, or mean monthly flow if available.
Temporary Water Use Authorization for	Minimum 2 months	Alaska Water Use Act, Alaska Statute (AS) 46.15 / 11 AAC 93.035	Water is a common property resource in Alaska. Withdrawal of water requires approval. This	For constructing works for an appropriation, or diverting, impounding, withdrawing, or using a significant	X	X	X	• Temporary Water Use Authorization requires: Map showing withdrawal, use, and discharge points; water system plan

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non-permanent water use ; ADNR DMLW		- .130 and 11 AAC 93.210 - .220	permit authorizes short-term water withdrawal of water within the unappropriated volumes of a source (the volume remaining after the appropriated amount).	amount of water from any source (the term significant amount of water is defined in 11 AAC 93.035). Permit is required to withdraw water for short-term use such as for camps, construction, maintenance, and operations activities and also for gravel mine dewatering.				and project description; DNR fish habitat permit; driller's well log for drilled wells; method and details of taking water (pump intake/output, hours per day, etc.); amount of water taken (per day; duration; max rate); potential impacts descriptions.
Section 401 Certification – Certificate of Reasonable Assurance; ADEC Division of Water Quality	Simultaneous with USACE permitting.	CWA, Section 401; 33 USC § 1344; 18 AAC 15	Authorizes the state to grant, deny, or condition certification of CWA Section 404 permits, Rivers and Harbors Act Section 10 permits	Must accompany Section404 permits.	X	X	X	• USACE will notify ADEC automatically when Section 404 permit application is received • Application to ADEC is made via the USACE permit application filing
APDES Permit ; ADEC Noncontact Cooling NPDES Permit** **Since the project is currently proposing a design that includes air cooling rather than water (groundwater or seawater) cooling at the LNG facility, the ADEC NPDES	1-2 years	Section 402 of the Clean Water Act; 40 CFR 125 (specifically 40 CFR.80– 125.89) 18 AAC 83.010; 18 AAC 83.380.	Permit for the discharge of non-hazardous waste to surface waters; requires establishment of mixing zone criteria for thermal plume dispersion and salinity	The Alaska Department of Environmental Conservation issues all APDES permits in Alaska except Denali National Park and Preserve, Metlakatla, and for 301(h) facilities.			(X)	• DEC may consider a mixing zone on a case-by-case. Baseline studies of receiving water biological, chemical, thermal characteristics. • Source water physical data - narrative description and scaled drawings showing the physical configuration of all source water bodies used by the facility. • Extensive modeling of proposed discharges to predict impacts. • A statement that the thermal component of the discharge is subject to effluent limitations under 33 USC 1311 and 1316, and a brief description, including a quantitative statement, of the thermal effluent limitations proposed under 33 USC 1311 and 33 USC 1316.

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Permit data needs are included here only in the event that the project design changes in the future.								• Source water body's hydrological and geomorphological features, as well as the methods used to conduct any physical studies to determine the intake's area of influence within the water body and the results of the studies. • Description of the cooling water intake structure(s), including - The configuration of each cooling water intake structure and its location in the water body and in the water column. - Latitude and longitude in degrees, minutes, and seconds for each cooling water intake structure. - The operation of each cooling water intake structure, including design intake flows, daily hours of operation, number of days of the year in operation, and seasonal changes, if applicable. - A flow distribution and water balance diagram that includes all sources of water to the facility, recirculating flows, and discharges. • Engineering drawings of each cooling water intake structure.
APDES General Permit (GP) for Stormwater Associated with Large and Small Construction Activities for	2-4 weeks	CWA § 402; 33 USC §1342; 40 CFR §122 18 AAC 83	Allows for discharge of stormwater / surface water runoff from soil disturbing construction activities exposing one or more acres of cleared land to potential erosion and runoff to nearby surface waters.	Project disturbs greater than 1-acre and therefore requires a permit.	X	X	X	• Stormwater Pollution Prevention Plan (SWPPP). o Site description. o Site map. o Summary of potential pollutant sources.

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Alaska Construction General Permit (CGP); ADEC, Division of Water			Developed as part of the APDES CGP for stormwater and as required by the EPA, the SWPPP is intended to prevent and minimize releases of storm water into waters of the U.S.					o Spill prevention and response procedures. o Maintenance. o Management and Physical Controls Best Management Practices (BMPs). o Erosion and sediment controls. o Management of runoff. o Employee training. o Control measures. o Monitoring. o Inspections and documentation. • An applicant is required to submit a Notice of Intent (NOI) to gain coverage under the GP.
Prevention of Significant Deterioration (PSD); ADEC Division of Air Quality; Construction Permit for a Major Source of Hazardous Air Pollutant (HAP); ADEC, Division of Air Quality	1.5-2 years; 3 years if site is in or near non-attainment or Class I airshed.	18 AAC 50.306; 18 AAC 50.316; 42 USC 7401 et seq.; AS 46.14	PSD permits apply to new major stationary sources and major modifications; HAP permits apply to major sources of HAPs subject to a standard under 40 CFR 63.	Must comply with the requirements of 40 CFR 52.21. Permit issued following the procedures and other requirements of 40 CFR 52.166(f) and (q)(2) and 40 CFR 52.21; application must be prepared and submitted per 40 CFR 63.5(d); dept. will issue permit only if the criteria of 40 CFR 63.5(e)(1) are met.	X		X	• ADEC approval of a modeling protocol is necessary. • PSD permits require significantly more analyses than Title V permits. • Typically, a long-range transport model is used to assess potential visibility issues. • An air quality related value (AQRV) analysis is usually required to address sulfate and nitrate deposition, visibility, and potential growth impacts. • Conduct Best Available Control Technology (BACT) Analysis
Title V Air Permit; ADEC Division of Air Quality	60 days for “permit shield” (unless information is	18 AAC 50.326	Operations Permit	Title V of the CAA requires that sources that either emit over 100 tons per year of any criteria air pollutant or are subject to certain New Source Performance Standards (NSPS) or and National	X	X	X	• Emissions calculations

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	missing). A permit shield enables a facility to comply with the need to have an operating permit by following all applicable requirements identified in the permit application, until ADEC issues the Title V permit.			Emission Standards for Hazardous Air Pollutants (NESHAP) subparts obtain an operating permit. ADEC is responsible for issuing operating permits in Alaska pursuant to 18 AAC 50.326. A new source must submit a complete application for an operating permit within 12 months after the start of operation. Based on information available at this time, the LNG Plant, GTP, and Sagwon Compressor Station would each be required to obtain a Title V permit. At this time sufficient information is not available to determine whether a Title V permit would be required for any construction sources. This information will be provided in the final FERC filing.				
Minor Construction Permit for Permanent Facilities; ADEC Division of Air Quality	9 months for approval if does not fall within threshold for notification	18 AAC 50.502; 50.508; 50.540, and 50.544	Permits apply to emission sources that do not fall within the PSD but may fall within Title V categories.	Permit is needed for emissions categorized as minor for permanent facilities such as compressor stations.	X	X	X	
Minor Construction Permit for Temporary Facilities; ADEC Division of Air Quality	9 months for approval if does not fall within threshold for notification	18 AAC 50.502; 50.508; 50.540, and 50.544	Permits apply to emission sources that do not fall within the PSD but may fall within Title V categories.	Permit is needed for emissions categorized as minor for temporary facilities such as camps and rock crushers.	X	X	X	

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Approval to Construct and Operate a Public Water Supply System; ADEC, Division of Environmental Health	6-9 months; Multi-phase approval process requiring Approval to Construct – 3 months, Interim Approval to Operate – 1 month, and Final Approval to Operate – 2 months	18 AAC 80.200-235 Safe Drinking Water Act of 1974; Amended 1996; 42 U.S.C. § 300f	ADEC must approve construction and operations of water treatment systems.	Prior to construction, ADEC must approve detailed engineering reports, plans, and specifications for construction of a public water system. Permanent operations camps will likely have water treatment systems requiring approval.	X	X	X	• Purpose and type of construction. • Facility Information Form. • Drinking Water Program – Project Information Form. • Engineering Plan Review Checklists. • Construction and Operations Plan required.
Domestic and Non-Domestic Wastewater Disposal System Plan Review; ADEC, Division of Water	6-9 months; Multi-phase approval process requiring Approval to Construct – 3 months, Interim Approval to Operate – 1 month, and Final Approval to Operate – 2 months	18 AAC 72.200 18 AAC 72.600 (Non-Domestic) ADEC approval under CWA Section 401	ADEC Plan Review and Approval is required for Domestic and Non-Domestic Wastewater Systems by State Wastewater Disposal Regulations.	Review of disposal plans needed to insure compliance with minimum standards of performance. Permanent operations camps will likely have wastewater treatment systems requiring approval.	X	X	X	• Legal information. • Proposed project type. • Plan review. • Reports, drawings, and / or specifications.
Alaska Pollutant Elimination Discharge (APDES) Permits (18 AAC 83); ADEC, Division of Water	1-2 months	18 AAC 72; AS 46.03.100; 18 ACC 15.120(c); 18 AAC 70 – Alaska Water Quality Standards; 18 AAC 83 – APDES Program	To protect the water quality of state land and water. ADEC authorizes discharge of wastewater into and upon all waters and land surfaces. ADEC authorizes discharge of non-domestic and domestic wastewater (APDES permit).	For disposal of wastewater from large temporary work camps (<24 people), construction sites, waste water treatment facilities, underground injection, ballast water treatment facilities, etc. Domestic wastewater treatment facility (WWTF) required for any system that treats wastewater for disposal of water-borne human wastes or graywater from dwellings, commercial buildings, institutions, or similar structures.	X	X	X	• Data needs address the application process prior to obtaining authorization. Whereas, BMPs are requirements under the permit after the authorization. • Mixing Zone Analysis (if Applicable). • Anti-degradation Policy analysis. • Wastewater Characterization. • Environmental Mapping of Discharge Locations.

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				Coverage for Domestic and Non-Domestic Wastewater may be obtained through various General Permits or through the Statewide Pipeline GP. Project work camps may also need to seek separate coverage for Drinking Water, and Food Service through the Department's Environmental Health Division:				
ADEC UIC Waste Water Disposal	Before injection activities	AS 46.03.100; AAC 72.010(a), 18 AAC 70, 18 AAC 72.215, and 18 AAC 72.500(a)	ADEC permits Class I wells under a waste water disposal permit *after* EPA issues the Class I permit requirements. Permit for disposal of domestic or Non-domestic wastewater.	Compliance with Waste Disposal under AS 46.03.100 and 18 AAC 72."	X		X	• ADEC General Permit Notice of Intent (GP 2010DB0001) to ADEC. • Copy of the EPA UIC authorization. • Description of project. • Injection flow rates and volume. • Location of well and information on receiving area.
Oil Discharge Prevention and Contingency Plan; ADEC, Division of Spill Prevention and Response	Reviewed prior to construction; draft in EIS. 2-6 months Proof of Financial Responsibility needs to be submitted no sooner than 90 days prior to the start of production and no later than 30 days prior to.	18 AAC 75.400-.495; 18 AAC 75.005-.090; AS 46.04.030	Approval of the plan is required prior to commencement of operation of vessels and oil barges on state waters or for facilities capable of storing more than 1,320 gallons above ground or more than 42,000 gallons underground.	Defines how state lands and waters will be protected from spill incidents.	X	X	X	• Prevention Requirements for secondary containment, oil pipelines, oil storage and fueling operations. • Emergency actions. • Strategies and Scenarios are required to demonstrate ability to comply with State requirements. • Notifications in event of oil spill. • Chain-of-command. • Facility or tank vessel information. • Response planning standards. • Training. • Staff and equipment.

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Food Sanitation Permit and Food Service Permit; ADEC, Division of Environmental Health	1-2 months	18 AAC 31.020; AS 03.05.011 and .020; AS 44.46.020	Requires a permit for construction and operation of permanent, temporary, or mobile food-services, regardless of whether there is a charge for food.	Permit necessary to serve food at permanent camps or facilities; governed by Alaska Eating and Drinking Establishment Regulations.	X	X	X	• Application for Food Establishment Permit Form 18-31-APP.01. • Food Establishment Plan Review Supplement required.
Open Burning Permit; ADEC	2-4 months	18 AAC 15.020; 18 AAC 50.065	Open-burning of woody debris material if the intent is to clear and burn 40 acres or more per year.	Potentially needed to dispose of woody debris during clearing and grubbing.		X	X	Develop an Open Burn Plan: • Location, duration, and inclusive dates considered for the burn. • Location of all sensitive features. • How public will be informed. • Indicate coordination with concerned agencies. • Obtain weather forecasts and monitor changes. • Predicted smoke dispersion. • Enhancement of active fire phase and reduce the smoldering phase. • How to contact sensitive features. • Alternative disposal options. • Coordination with air quality authorities.
Cultural, Historical, and Archeological Resources Consultation (Section 106 Review); ADNR, Office of History &	Consultation—simultaneous with EIS; Programmatic Agreement (PA) covers review during construction.	National Historic Preservation Act (NHPA), § 106, 16 USC § 470 et seq.; EO 11593, Protection and Enhancement of the Cultural Environment; Alaska Historic	Provides for the identification and protection of historic, archeological, and cultural properties; requires federal agencies to avoid and minimize impacts to properties on or eligible for the National Register of Historic Places (NRHP).	Must be addressed as part of the EIS process and USACE Section 404/10/203 permitting. A cultural clearance by SHPO is required for all state permits including some permits needed for field studies	X	X	X	Consultation with FERC, ADNR, OHA, SHPO, and other federal agency cultural resource staff for NEPA Section 106 consultation.

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Archaeology (OHA), and State Historic Preservation Office (SHPO)	30 days for Cultural Clearances	Preservation Act, AS 41.35.010-240						
Open Burn Permits; ADNR, Division of Forestry	30-day notice	11 AAC 95.400-495; AS 41.15.010-41.15-170	Burn permits required during the fire season for all burning, with few exceptions.	Required for the open-burning of materials (such as slash trees, shrubs or other organic material or other waste materials) on site.		X	X	• Burn permits are required for some Division of Forestry offices – applications must be submitted for those units that require burn permits within the established fire seasons. • Check Alaska Wildland Fire Organization Administrative Units and Operational Centers status.
Title 16 Fish Habitat Permit; Alaska Department of Fish and Game (ADF&G)	1-2 months	Alaska Fishway Act, AS 16.05.841 and Anadromous Fish Act AS 16.05.871	Project must notify and obtain authorization and approval for all activities within the limits of ordinary high water of any streams with fish presence to prevent adverse effects on anadromous fish or their habitat and prevent the obstruction of efficient passage and movement of fish.	Gravel removal activities may require a Fish Habitat Permit if the mining site is located within or affects a designated anadromous fish stream. Required for water withdrawal from anadromous and resident fish streams. Required for ice road construction across fish-bearing streams. Required for tundra travel across anadromous fish streams. Required for the installation of culverts or bridges associated with roads across resident fish streams. Required for the installation of Vertical Support Members associated with pipeline construction within anadromous fish streams.	X	X	X	Title 16 Fish Habitat Permit to Conduct In-Water Activities Affecting Anadromous Fish Streams: • Type and purpose of project. • Location and type of crossing (including legal description). • Name of river, stream, or lake, and water body characteristics, including anadromous stream number, if applicable. • Plans, specifications, and aerial photos. • Project timeframe. • Description of any alteration, modification, bed, bank, or floodplain (including temporary or material deposited or removed), stream diversion, etc. • Time of year when crossing would occur. • Description of precautions to minimize adverse impacts to fish and other aquatic organisms.

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								• Hydraulic evaluation, if applicable.
Special Area Permit; ADF&G, Division of Habitat	1-2 months	AS 38.05.027; AS 16.20; 5 AAC 95.420-440; 5 AAC 95.700-770	Required for any disturbance-producing or habitat-altering activity that will occur in a designated state refuge, critical habitat area, or game sanctuary. May not be applicable.	Required for off-road travel and other field activities on State critical habitat areas (CHA) or game refuges (SGR). Required for Minto Flats SGR and Susitna Flats SGR.		X		Special Area Permit Application: • Applicant information. • Location of project site. • Description of the project or activity. • Plans and specifications of the scope of the proposed project or activity. • Purpose of the project or activity. • Timeframe. • Description of methods. • Access to project area. • Detailed map of project dimensions. • Current aerial photograph. • List of other required federal or state permits and authorizations. • Mitigation measures.
Public Safety Permit, ADF&G, Division of Habitat	6 weeks	5 AAC 92.33	Permits from ADF&G are needed before a person can kill, destroy, relocate, or haze (systematically harass) wild animals that are creating a nuisance or a threat to public safety.	Wildlife nuisance or threat during construction.	X	X	X	• Applicant information. • Species. • Numbers of species anticipated proposed activities (Lethal take, haze or relocation). • Time period. • Locations. • Name of persons that can act on this permit. • Public safety concerns. • Final disposition of specimens.

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Material Sales Contract; ADNR DMLW,	12-18 months, tied to SPCS ROW Lease	AS 38.05.110-.133; 11 AAC 71.005 et seq.; AS 27.19	Authority to govern sales of materials (sand, gravel, stone, and timber) by State of Alaska.	Gravel may be purchased from state lands as a negotiated sale; if opening a new site, mining and restoration plans must be approved; regulations govern sales, bids, pricing, bonding, and insurance.	X	X	(X)	• Negotiated material sale application • Environmental risk questionnaire • Development Plan • Reclamation Plan • Bonding deposit and insurance • More-involved public interest process for new undeveloped sites
Temporary Land Use Permit (Uplands and Non-Marine Waters, Off Road Travel, and Tidal and Submerged Lands); ADNR SPCS or DMLW	12-18 months, tied to SPCS ROW Lease	AS 38.05.850; 11 AAC 96; 11 AAC 58.210	Temporary activities occurring on state lands, including activities in non-marine waters, uplands, off-road travel, and tidal and submerged lands.	For temporary project activities including ice roads, ice pads, access roads, camps, staging, and construction areas, placement of buoys or scientific equipment placement in state waters, tidelands, or uplands.	X	X	X	Land Use Permit Application (102-1084A) including Supplemental Questionnaires for Use of Uplands and Non-Marine Waters, for Off-Road Travel, and Tide and Submerged Lands, if applicable: • Project Description. • General vicinity and site maps (1:250,000 or 1:63,60) and CPQ. • Duration and season. • Specific location, including proposed access routes (GPS coordinates, township, range, section, meridian, and size of area). • Boundaries and dimensions of the proposed area and relation to geographic features. • Site description (condition, improvements, use, materials present, noting any trash, garbage, debris, or signs of possible contamination). • Description of toxic and hazardous materials, and hydrocarbons, types, volumes, storage location, and description of spill plan and methods.

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								• Locations and dimensions of structures and storage areas. • Site access including mode of transportation (including, if applicable, type and size of any aircraft), terrain, number, kind, and weight of vehicles, mileage, number of trips, season, water crossings. • Number of people. • Non-refundable filing fee of $100. • Use fees, certificate of insurance, and potentially performance guaranty (bond). • For off-road travel, include description of vehicles and weights to be used, terrain, mileage, stream and water body crossings, proposed travel dates, and volume of fuel and hazardous substances to be used. • For uplands and non-marine waters, include description of temporary structures, harvest of non-timber related products, motorized equipment, storage and parking areas, water and wastewater, commercial recreation camps, and restoration plan, if applicable. • For marine waters (tide and submerged lands), indicate property owners and adjacent property owners, type of use, activity or development, description of structures, dredging of placement of fill activities, and restoration plan, if applicable.

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Oversize and Overweight Permit; Alaska Department of Transportation and Public Facilities (ADOT&PF), Division of Measurement Standards & Commercial Vehicle Enforcement	2-4 weeks	17 AAC 25.310-380; AS 44.33.020; 03 AAC 35.120	Required for project activities that require the use of oversize / overweight vehicles on public roads and highways.	May be necessary for transport of oversize / overweight construction materials on ADOT&PF-owned roads.	X	X	X X	• Origin and exact route. • Overall length, overhangs, overall width, overall height. • Conditions. • Bridge condition attachment.
Driveway/Approach Road Permit; ADOT&PF, Design and Engineering Services, ROW	2-3 months	AS 19.05.20; 17 AAC 10.020 - 17 AAC 10.095)	For access roads intersecting with a state road.	Needed if construction-access roads intersect a state highway.		X	X	• Recorded subdivision plat • Engineered drawings for approach road • Site plan of subject property indicating location of proposed driveway, related parking arrangements and location of improvements • Proof of ownership or lease agreement • Traffic Impact Analysis • Traffic Control Plan • Lane Closure Permit • Schedule of Operations • Retainer fee
Lane Closure Permit; ADOT&PF, Design and	1-2 months	17 AAC 20.017	Required for project activities that require the use of a highway ROW for access to or construction and maintenance	Lane closures may be necessary during construction activities.		X	X	• Applicant information • Activity location. • Purpose of closure. • Start and end dates.

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Engineering Services, ROW			of a utility facility. ***May not be applicable***					• Schedule details. • Traffic Control Plan. • Proof of insurance. • $100 nonrefundable application fee.
Airport Building Permit; ADOT&PF, Airport Leasing Office	6 months	17 AAC 42.280	Construction on a state airport requires written state-authorization.	Improvements to state airports for construction or operation will require state authorization.		(X)	(X)	• Applicant information. • Construction dates. • Site description. • List of proposed improvements. • Contractor name. • Construction plan drawings. • Site plan. • APDES NOI and SWPPP. • ADEC approval. • FAA approval (Form 7460-1). • Drainage plan. • State fire marshall approval.
Air Carrier Agreement or Terminal Lease or Land Lease; ADOT&PF, Airport Leasing Office	6 months	AS 02.15; 17 AAC 42	Lease agreements on state-operated airports; could include air carrier agreements, terminal leases, or land leases of airport property.	Transportation of construction crews, ROW through airport property.	(X)	X	X	• Lease application and site plan. • $100 nonrefundable fee.
Utility Permits ROW; ADOT&PF	3 months	17 AAC 15.	A Utility Permit will be required for any location where the pipeline occupies the highway right of way (crossings or longitudinal). This would also apply to permanent pipeline infrastructure – such has block	For facilities crossing utility ROWs.		X	X	• Type of facility. • Location of facility. • Location and extent of required clearing. • Joint use (if applicable). • Facility construction plans and specifications (detailed).

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			valves or compressor stations, etc.					• A diagram or drawing showing the location of all known overhead, surface, and underground facilities existing in the vicinity of the proposed facility. • Permit applications for pipeline installations must describe the nature of the substance to be transmitted; the maximum working, test, and design pressures; and the design standards for the pipe. • Approval from applicable land owners/managers. • Construction period.
Encroachment Permit; ADOT&PF	6 months	17 AAC 10.010 - 17 AAC 10.015, AS 19.05.010.	Required for temporary use of the ROW, such as for construction staging areas. It is issued for up to a 5 year term.	For crossing ADOT&PF highway ROW.		X	X	• Applicant information. • Proposed use of ROW. • Property appraisal. • Description of structure. • Size of proposed permit area. • Detailed site layout/site plan. • Required photographs. • Fee negotiation.
Special Use Permit; ADOT&PF	2-3 months			For DOT related activities		X	X	•
Building Plan Review; Fire System Permit Alaska Division of Fire and Life Safety (State	2-4 months	AS 18.70.080; 13 AAC 50.027; 13 AAC 50.035; 13 AAC 50.060	Required for the construction, repair, remodel, addition, or change of occupancy of any buildings or structures, or installation or change of fuel tanks. Must be approved before work is started. Fire System Permit is required for	For project facilities and potentially for some construction campsites and any permanent camps or operations centers. To ensure fire systems and fuel tanks meet state standards	X	X	X	• Plan Review application. • Plans and specifications of occupied facilities including electrical systems, mechanical systems, fuel storage tanks and their appurtenances, automatic fire-extinguishing systems, and fire alarm systems must be submitted to the State

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Fire Marshall's Office)			the design, installation, testing, or maintenance of fire alarm signaling systems or automatic fire suppression systems, and for the ability to provide direct oversight and supervision of work being performed on the fire systems.					Fire Marshal for examination and issuance of an approval certificate. • Compliance with applicable fire and building codes (13 AAC 50.020 Building Code; 13 AAC 50.025(30) *Fire Code*).
ROW Lease ADNR, Division of Oil and Gas, State Pipeline Coordinator's Section (SPCS)	12-18 months	Alaska Right-of-Way Leasing Act AS 38.35.050; AS 38.35.015; AS 38.35.121. AS 38.35.210 11 AAC 80.005 - 80.085	ROWs on state land including ROWs over, under, along, across, or upon the ROW of a public road or highway or the ROW of a railroad or other public utility, or across, upon, over, or under a river or other body of water or land belonging to or administered by the state may be granted by noncompetitive lease by the commissioner for pipeline purposes for the transportation of oil, products, or natural gas under those conditions prescribed by law or by administrative regulation. Except to the extent authorized by an oil and gas lease, a gas only lease, or an oil and gas or gas only unit agreement approved by the state, no person may engage in any construction or operation of any part of an oil, products, or natural gas pipeline, which in whole or in part is or is proposed to be on state land	The ROW Lease is required for leasing of State owned or managed lands (including State determined navigable waters) for transportation pipeline system ROW purposes.	(X)	X		• AS 38.35.050 Pipeline ROW Lease Application will be required • Application consists of 7 parts and 59 items to be completed refer to application for specific data needs • Part 1- Proposed Route – provide detailed maps depicting alignment, crossing, supports, temporary rows • Part II Detailed Project Description – requires detailed engineering design basis information; capacity; row width and length; pipeline structure and types; waterbody crossing methods; bridges; detailed state land legal descriptions and tracts with reservations or commitments; detailed off row facility information; off/on row infrastructure – roads, airports, storage sites, construction camps, temporary construction areas and material sites. • Part III Availability of interconnections, terminal facilities and storage facilities • Part IV Safeguards for persons, property, the public, and the environment • Part V Special safeguards for natives and others subsiding on the biotic

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			unless that person has obtained from the commissioner a ROW lease of the land under this chapter (AS 38.35)					resources of the general area of the proposed ROW • Part VI Financial Information • Part VII Other Information- contractor, pipeline operator • The commissioner of natural resources may require additional information after submission. • Public notice of application will be published and an analysis and public hearing • Commissioner's Analysis and Proposed Decision is written and a second public notice is issued. Any public comment received by the SPCS is considered and addressed in the Commissioner's final decision. • Covenants may be required to be in a lease to a natural gas pipeline that is a contract carrier • Up to a 10-year conditional lease may be provided if applicant is determined not 'fit' -applicant must comply with conditions until determined fit and lease will be amended
Special Use Permit: DNR Division of Parks & Outdoor Recreation Park Use Permit	2-3 months	AS 38.05; AS 38.35, AS 38.05.1274, AS 1.21.010; AS 41.21.010 Denali State Park - 41.21.151; Captain Cook State Recreation Area – AS 41.21.415; Nancy Lake State	Alaska State Parks and Recreation Areas – Legislative designated areas (LDA) set aside for public use. Each recreation area or park have a management plan used for surface use permitting. Recreational Areas are established with the main goal	Required for all development activities on State Park Lands and Recreation Areas		X		• Generally same information as submitted for Land Use Permits and Easements with some additional information specific to each park or recreation area and designated in park/recreational area management plan.

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					GTP	ML/ PTTL	LF	
		Recreation Area – AS 41.21.455; Willow Creek State Recreation Area – AS 41.21.491; 11 AAC 12.010-.250 Land Use regulations	of recreation purposes. State Parks are established for conservation, recreation, and fish and game management.					
Recreation Rivers Special Use Permit; DNR DMLW (if applicable)	Same as for other DNR Land Use Permits	Recreation Rivers Act (AS 41.23. 41.23.400 - 510 AS 38.05.035(e); 11 AAC 09.030; 11 AAC 09.005; 11 AAC 09.200; 11 AAC 09.200	Recreational Use Rivers Permit is issued for activities in legislatively designated recreational river areas.	Permit is needed for activities not listed as a "Generally Allowed use". Needed for non-recreation activities within the Recreation Rivers Management Area (Deshka River, Alexander Creek, Yentna).		x		• Susitna Basin Recreation Rivers Management Plan area–-management guidelines for development and use. • Development May require a "Best Interest of the State" Finding.
Blanket Permit, Alaska Railroad Corporation	3 months		ROW, Land Use, Utility, Roadway/Trail, Crossing Early works – Staging/Laydown yards, Rail yard expansion	Permit is needed for any rail yard expansions at existing railroads		x		Description of the proposed activity including the scope of work, distance from tracks, details on excavation or other ground disturbance near tracks, and locations of track crossings.
ROW Lease; University of Alaska	12-18 months, tied to SPCS ROW Lease	AS 38.05, AS 38.35, 11 AAC 54.030. 11 AAC 58.120	To access University of Alaska lands	Mainline ROW crosses UAA lands at MP 515, MP 581		X		• Description of proposed activity, including access and any vehicles and equipment that would be used. • Duration, start date and end date. • General vicinity and detailed site maps. • Location and description of the property and access routes (coordinates, township, range, section, meridian, and size of area). • Description of site development considerations (e.g., sensitive habitats, physical hazards).

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
ROW Lease; Alaska Mental Health Trust Authority	12-18 months, tied to SPCS ROW Lease	AS 44.37.050(a) AS 38.05.801; 11 AAC 99; 11 AAC 51.085; AS 38.05.801	To access Alaska Mental Health Trust Authority lands.	Project activities that require use of Alaska Mental Health Trust Authority lands.		X		• Description of proposed activity, including access and any vehicles and equipment that would be used. • Duration, start date and end date. • General vicinity and detailed site maps. • Location and description of the property and access routes (coordinates, township, range, section, meridian, and size of area). • Description of site development considerations (e.g., sensitive habitats, physical hazards). • Known encumbrances on the property (e.g., ROW, leases, etc.) or other property conflicts. • Proof of commercial, general, and business auto liability insurance. • Non-refundable application fee.
Third-Party Utility Company Easements or Leases				For local utility companies leases for any long-term facilities that are required for pipeline operation, yet not issued AKLNG, such as: • Electric distribution lines that feed pipeline facilities. • Water lines. • Natural gas heat lines. • Fiber optic cables. • Cellular towers. • Radio towers.	X	X	X	• Type of facility. • Location of facility. • Location and extent of required clearing. • Joint use (if applicable). • Facility construction plans and specifications (detailed). • A diagram or drawing showing the location of all known overhead, surface, and underground facilities existing in the vicinity of the proposed facility. • Permit applications for pipeline installations must describe the nature of the substance to be transmitted; the maximum working, test, and design

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
								pressures; and the design standards for the pipe. • Approval from applicable land owners/managers. • Construction period.
Surface Use Permits, Leases; LNOs; Native Corporation and Village Corporation lands	Varies		Surface Use of Lands	Construction, gravel use, surveys - any use of Native lands		X		Each Regional or Village Corporation will have its own requirements. Engage Stakeholder Relations group in identifying and negotiating lands use agreements.
Kenai Peninsula Borough (KPB) Code of Ordinances Permits	6 months	Title 10 – Health and Safety • Chapter 10.04 - Solid Waste Disposal • Chapter 10.20 - Hazardous Materials Reporting and Placarding Title 21 – Zoning • KPB 21.18.081 Conditional Land Use Permit; KPB • 21.06. - Floodplain Management: • KPB 21.18 - Anadromous Streams Habitat Protection	Regulations for site development, construction, operation, land use, and use of gravel or timber.	Facility construction regulations affecting floodplains, anadromous fish streams, material extraction, solid waste handling and disposal; temporary use of municipal lands and special protections for anadromous streams and floodplains.		X	X	• Maps, drawings and project plans to support permit applications. • Management plans for gravel pit and timber clearing. • Kenai River Center Permit Form. • For Lease —development plan and development and construction time table.

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
		• KPB 21.29 - Material Site Permits; • Material (Gravel) and Forest Resources KPB 17.10.200-.210 Temporary Land Use (up to 4 years) KPB 17.10.180						
KPB Land Use - Easement	3-6 months	KPB 17.10.140 - 17.10.160;	Granting ROWs and easements	Use of Borough lands for greater than five years		X	X	Development plan which shall disclose the use, nature of improvements, estimate of value of the improvements, and a development and construction time table.
KPB ROW construction permits	3 months	KPB 14.40	Construction and use of rights of way	ROW use permits: • Construction; • Closing ROWs; • Traffic routing; and Oversize and overweight permits.		X	X	• Statement of the length and width of ROW to be constructed, the proposed uses after construction, and a drawing on the plat of the location and proposed design and method of the construction. • Approximate locations of flood plain, floodways, wetlands, streams, lakes, or other water bodies adjacent to or within 50 feet of the outer boundaries of the ROW. • Approximate grades of the natural terrain and final grade of the proposed road. • Soil conditions of the area subject to construction. • Identification of all properties to be served or accessed by the proposed construction. • Amount, type and placement of materials used in construction.

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
								Where information provided by existing topographic maps, aerial photography, and photographs is inadequate to accurately reflect conditions of the ROW or potential problems created or exacerbated by construction, additional information, surveys, or engineering analysis may be required prior to issuance of a permit.
Matanuska-Susitna Borough permits	6 months	8.30.155 Air Operation Permit 11.10.020 - Encroachment permits 11.30.030- Utility permit 17.30 Conditional Use Permit (CUP) earth material extraction 17.02.020 Land Use Permit – placement of building within 75 feet of waterway 17.64 CUP -waste incineration 17.04.120-.130 Nancy Lake State Recreational Area Special Land Use District – Land Use Permit 17.17.150 Denali State Park CUP MacKenzie Special Use District	Regulations for construction within a flood hazard area, gravel extraction, and use borough lands including indoor facilities and outdoor storage areas at Port MacKenzie.	To access and use borough lands during construction if necessary including material extraction. Includes use of Point MacKenzie dock, transfer of goods to rail/truck, etc.		X		Completed forms and fees for designated permits. Negotiated lease, public notification, and borough assembly approval are required for some permits.

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
		Development Permit - 17.23.150-.220 17.29.100 – Flood Hazard Dev't Permit Dev. Permit 17.60.030 -CUP material extraction(Title 18 Port Title 23 Real Property Management Title 28 Natural Resource Utilization 28.60.080 Timber Transport Permit						
Denali Borough Permits (Temporary Use and Lease)	3-6 months	Title 4 Real Property Acquisition, Management, and Disposal 4.10.050 Leasing borough land. 4.10.070 Temporary Use of Borough Lands	Regulations for borrow material extraction and sales; Temporary use of borough land; and lease of borough land.	To access and use borough lands during construction if necessary including material extraction.		X		• Completed application. Management Plan for project. Public notification and approval from borough assembly required for some permits.
Construction in ROW; Fairbanks North Star Borough (FNSB)	6 months	Service Areas Title FNSBC 14.03.050	Excavation and Construction on Public Roads within Road Service Areas Permit application.	Pipeline construction and access may require FNSB roads within their road service areas.		X		• Project Description. • Plans or diagrams. • Borough computes allowable time for completion of roadway restoration and appropriate security. • Permit fee.
Floodplain Permit;	6 months	Buildings & Construction Title 15.04.040-.050;	Construction within a flood hazard area requires a floodplain permit from the	If pipeline construction occurs within a FNSB floodplain, a permit would be required.		(X)		• Floodplain Permit Application. • Certified report from an engineer within one year of the application.

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
FNSB Department of Community Planning If Applicable.		FNSBC 21.40.010-.030	Department of Community Planning.					• Construction Site Storm Water Runoff Control
Temporary Land Use Permit; FNSB	6 months		Development projects, environmental and engineering surveys, off-road travel, solid waste disposal, and gravel extraction requires a Development Permit from the FNSB.	A Temporary Land Use Permit is required for activities on FNSB lands. Some uses are considered casual use and would not require a permit. If long-term land use is required (five years or longer) an easement would be required from the FNSB.		X		Temporary Land Use Permit application process: • Project purpose. • Description of activities including off-road travel, camps, and water use. • Field study locations, timing, and protocols from the field teams. • General vicinity and specific location maps, including nearby existing development and natural features. • Start-up and completion dates. • Mode of transportation (including aircraft) to access site including equipment. • If off-road travel necessary, include all vehicles and equipment, and period of travel. • Identification of fuel / hazardous materials, solid waste treatment / management, snow removal, air emissions, noise / vibration, and sensitive habitats involved. • List of other required federal and state permits. • $100 application fee.
Administrative Approvals and	6 months to 1 year for Master Plan Approval or	NSB Municipal Code; 19.50 and 19.60 and	Development projects, environmental and engineering surveys, off-road travel, solid	Permit(s) and administrative approvals are necessary for any construction,	X	X		• Land Management Regulations (LMR) Permit Application:

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
Development Permits; North Slope Borough (NSB) Permitting and Zoning Division	Re-Zone; 2 weeks for Administrative Approvals and 2 months for Development Permits once Master Plan or Re-Zone is approved	18.54.060 for zoning permits	waste disposal, and gravel extraction requires a Development Permit from the NSB.	operation, or studies conducted in the NSB.				- Applicant Information. - Permit Type (Development/ Administrative Approval). - Location (TRS) Permit Type (Development/Administrative Approval). - Location (TRS). - Project name. - Proposed start date. - Completion date. - Proposed Development. - Purpose of Development. - Fill/Dredge (material and acres). - Temp Water use sources and amounts. - Off-road Travel Period and site Access. - Fuel Storage (type, amount and handling). - Hazardous material (type, amount and handling. - Solid waste treatment. - Air Emissions (type and amount). - Noise/Vibrations (type and amount). - Sensitive habitat (floodplain/shoreline). - Transportation. - Marine Tanker Facility. - Seismic Work Causeway Construction. - Offshore Drilling.

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
								- Airport or Helicopter Pad. - Utility Development. • Road Plan. • Zoning. • Landfill Use Permission. • Wetlands. • Habitat. • Subsistence. • Wildlife.
IHLC Clearance, NSB Inupiat History, Language, and Culture (IHLC) Division of the Planning Department	30 days for IHLC clearance, form 600 IHLC resource information can take 60 days	NSBMC §19.50.030(F) and §19.60.040(K)	A Certificate of IHLC/TLUI Clearance is a formal approval process developed by the NSB Department of Planning and Community Services (DPCS), IHLC Division to ensure that those sites listed in NSB's TLUI are protected.	A cultural clearance is required before any land use or development permit can be issued in the NSB. Requires a request under form 600 for IHLC Resource information, Form 500 request for a cultural Resource clearance.	X	X		• Application Forms and fees. • Description of activity. • Record of Consultation with the nearest affected Village Tribal President(s) and City Mayors, pre-app with IHLC. • A study of the proposed development site by a professional trained to identify and document any possible Critical Sites within the vicinity of the proposed development site. This study must include: (a) field survey, (b) literature review, and (c) record of consultation with the nearest affected Village Tribal President(s) and City Mayor(s) to ensure all sites are included in the study.. • For all new sites identified during study work, GPS coordinates and GIS data is to be provided. • Any previous permits for the site. • SHPO clearance.

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
PBU and PTU Letters of Non-Objection and Other Use Agreements	3-6 months		Access to other Operators leased lands.	To access lands previously leased by other Operators.	X	X		• Description of activities. • Field study protocols, timing, and locations from field team. • Air monitoring locations and protocols by air permitting team. • Invasive field study protocols, timing, and locations, and GTP and pipeline route locations from engineering teams. • Access route(s) and mode(s) of transportation. • Personnel.
Letter of Non-Objection; Alyeska Pipeline Service Company (APSC), SPCS, BLM Authorized Officer, and Joint Pipeline Office (JPO)	3-6 months		For access through or activities on any portions of Trans-Alaska Pipeline System (TAPS) facilities, fuel gas line, access roads, work pads, and/or pipeline.	To access lands previously leased by ASPC.		X		• Start and end dates. • Description of proposed access and purpose, including details of vehicles, equipment, communication system(s), mitigation, security measures, lodging, meals, and waste disposal. • Number and names of all personnel, including subcontractors. • Each location by TAPS mile point or other facility ID (e.g., pump station). • Land ownership. • Training, field coordination, and proof of commercial, general, and business auto liability insurance required.
Permit to Drill; Alaska Oil and Gas Conservation Commission (AOGCC)	Varies by well class and complexity, 1-2 months	40 CFR 147-Subpart C; 20 AAC 25.002-005; AS 31.05.090 – 31.05.120; 20 AAC 25.005-.080; 20 AAC 25.200 –.290	The UIC program for injection wells in Alaska, other than those on Indian lands, the program administered by the AOGCC, approved by EPA pursuant to Section 1425 of the SDWA, implemented June	A Permit to Drill (Form 10-401) from AOGCC is required in order to drill a well for oil or gas in Alaska. This requirement applies not only to exploratory, stratigraphic tests, and development wells, but also injection	X			• Operator must fill out Form 10-401 and provide accompanying information as required by regulation 20 AAC 25.002 for the Permit to Drill

Permit or Plan; Agency	Estimated Time for Permit Approval	Statute/Regulation	Definition	Why Permit is Required	Facility [1]			Data Needs
					GTP	ML/ PTTL	LF	
			1986. EPA regulates Class I wells AOGCC regulates Class II wells all injection wells require an AGOCC Permit to Drill	wells and other service wells related to oil and gas activities.				

NOTES:

1. Facilities Key :
   GTP =Gas Treatment Plant
   ML/PTTL= Mainline Pipeline/Point Thomson Unit Gas Transmission Line
   LF= Liquefaction Facility (LF)
   X = Permit/Plan/Approval is applicable to facility
   (X) = Potentially applicable, dependent on final siting and design

C.2 – Regulatory Agency Correspondence

Document Number:	Description:	Revision:	Appendix:
N/A	Refer to Resource Report 1 and Resource Report 11	N/A	Public

C.3 – Regulatory Compliance Matrix

Document Number:	Description:	Revision:	Appendix:
	Not Applicable		Public

D.1 - Design Codes and Standards

Document Number:	Description:	Revision:	Appendix:
USAG-EC-BSCOD-00-000001-000	GTP Design Codes and Standards	0	Public

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GTP DESIGN CODES AND STANDARDS

USAG-EC-BSCOD-00-000001-000

Rev	Date	Revision Description	Originator	Reviewer	Approver	Endorser
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	US	AG	EC	B	S	COD	00	000001

Table of Contents

1.0 OVERVIEW

This document lists the codes and standards that will be used in the design of the Alaska LNG GTP Facility. All applicable local codes and standards that have not been included in the list shall be satisfied in the final design.

The current version for each code and standard at the time of preparation of this document shall be used unless a specific version or edition is stated. The version to be used during final design of the project is as follows:

- If at the time of final design the code or standard version is the same as listed in this document, the final design shall be in accordance with the version listed.
- If at the time of final design the code or standard version listed in this document has been superseded, the appropriate version to be used shall be agreed to by Alaska LNG, to ensure that the final design features affected are within the Facility design basis.

Where there is a conflict between an international standard and a local one, the most stringent requirements shall apply.

1.1 ALASKA ADMINISTRATIVE CODE

- Title 13
- Title 8, Chapter 70 – Electrical Safety Code
- Title 18, Chapter 50 – Air Quality Control

1.2 AMERICAN CONCRETE INSTITUTE (ACI)

- ACI 117/117R, Standard Specifications for Tolerances for Concrete Construction and Materials and Commentary,
- ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete,
- ACI 301-10, Specifications for Structural Concrete,
- ACI 302.1R, Guide for Concrete Floor and Slab Construction,
- ACI 304R, Guide for Measuring, Mixing, Transportation and Placing of Concrete,
- ACI 306.1-90, Standard Specification for Cold Weather Concreting,
- ACI 306R-10, Cold Weather Concreting,
- ACI 308.1, Standard Specification for Curing Concrete,
- ACI 311.4R, Guide for Concrete Inspection, 2005ACI 318, Building Code Requirements for Structural Concrete,
- ACI 318R-11, Building Code Requirements for Structural Concrete, Commentary,
- ACI 347R-04, Guide to Formwork for Concrete,
- ACI 350R-06, Code Requirements for Environmental Engineering Concrete Structures and Commentary,

- ACI 360R-10, Guide to Design of Slabs-on-Ground,
- ACI 530/530.1-11, Building Code Requirements and Specifications for Masonry Structures,
- ACI SP 66, Detailing Manual,

1.3 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

- AISC, Steel Construction Manual, 14th Edition,
- AISC 303-10, Code of Standard Practic for Steel Buildings and Bridges,
- AISC, Detailing for Steel Construction, 3rd Edition,
- AISC, Seismic Design Manual, 2nd Edition,
- AISC, RCSC Specification for Structural Joints Using ASTM A325 and A490 Bolts,

1.4 AMERICAN IRON AND STEEL INSTITUTE

- North American Specification for the Design of Cold-Formed Steel Structural Members AISI S100-12 and AISI S100-12-C – Commentary on the Specification, 2012 Edition.

1.5 AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

- ANSI B16.20, Metallic Gaskets for Pipe Flanges—Ring-Joint, Spiral-Wound and Jacketed,
- ANSI B16.47, Large Diameter Steel Flanges, NPS 26 Through NPS 60 Metric/Inch Standard,
- ANSI/AISC 360-10, Specification for Structural Steel Buildings,
- ANSI S84.01-2004, Application of Safety Instrumented Systems for the Process Industry (IEC 1511 MOD)
- ANSI/ASSE A1264.1-2007, Safety Requirements for Workplace Walking/Working Surfaces & Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrails Systems,
- ANSI/ICEA S-108-720, Standard for Extruded Insulation Power Cables Rated Above 46 Through 345 kV
- ANSI/NEMA C50.41, Polyphase Induction Motors for Generating Stations
- ANSI/NEMA C80.1, Electrical Rigid Steel Conduit (ERSC)
- ANSI/NEMA C80.6, Electrical Intermediate Metal Conduit (EIMC)
- ANSI/NEMA C84.1, American National Standard for Electric Power systems and Equipment – Voltage Ratings (60 Hertz)

1.6 AMERICAN PETROLEUM INSTITUTE (API)

- API SPEC 2B, Specification for the Fabrication of Structural Steel Pipe,
- API SPEC 5L, Specification for Line Pipe,
- API SPEC 6D, Specification for Pipeline Valves,

- API MPMS 14.3 P1, Natural Gas Fluid Measurement - Concentric, Square-edged Orifice Meters Part 1: General Equations and Uncertainty Guidelines,
- API RP 14C, Protective Systems - Recommended Practice for Analysis, Design, installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms.
- API RP 14F, Recommended Practice for Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1 and Division 2 Locations
- API RP 500, Recommended Practice for Classification of Locations for Electrical Installation at Petroleum Facilities Classified as Class I, Division 1 and Division 2,
- API RP 520 Part 1, Sizing, Selection and Installation of Pressure Relieving Devices in Refineries, Part 1-Sizing and Selection,
- API RP 520 Part 2, Sizing, Selection and Installation of Pressure Relieving Devices in Refineries, Part 2-Installation,
- API RP 521, Guide for Pressure-Relieving and Depressuring Systems,
- API 526, Flanged Steel Pressure Relief Valves,
- API 527, Seat Tightness of Safety Relief Valves,
- API 530, Calculation of Heater-tube Thickness in Petroleum Refineries
- API RP 534,
- API 537, Flare Details for General Refinery and Petrochemical Services
- API 541, Form-wound Squirrel Cage Induction Motors – 375 kW (500HP) and Larger
- API 546, Brushless Synchronous Motors 500 kVA and Larger,
- API 547, General Purpose Form-wound Squirrel Cage Induction Motors – 250 HP and Larger
- API RP 551, Process Measurement Instrumentation,
- API 554, Process Control Systems,
- API 560, Fired Heaters for General Refinery Services,
- API 600, Steel Gate Valves – Flanged and Butt-Welding Ends, Bolted Bonnets,
- API 602, Steel Gate, Globe and Check Valves for Sizes DN 100 and Smaller for the Petroleum and Natural Gas Industries,
- API 607, Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats,
- API 609, Butterfly Valves: Double Flanged- Lug and Wafer Type,
- API 610, Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries,
- API 613, Special-Purpose Gear Units for Petroleum, Chemical and Gas Industry Services,
- API 614, Lubrication, Shaft-Sealing, and Control-Oil systems and Auxiliaries for Petroleum, Chemical and Gas Industry Services,
- API 617, Axial and Centrifugal Compressors and Expander-Compressors for Petroleum, Chemical, and Gas Industry Services,
- API 618, Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services,
- API 619, Rotary Type Positive Displacement Compressors for Petroleum, Petrochemical and Natural Gas Industries,

- API 620, Design and Construction of Large, Welded, Low-Pressure Storage Tanks,
- API 660, Shell-and-Tube Heat Exchangers for General Refinery Service (Parts 1& 2),
- API 661, Air Cooled Heat Exchangers for General Refinery Services,
- API 662, Plate Heat Exchanger for General Refinery Service,
- API 670, Machinery Protection Systems,
- API 672, Packaged, Integrally Geared, Centrifugal Air Compressors for Petroleum, Chemical and Gas Industry Services,
- API 674, Positive Displacement Pumps – Reciprocating,
- API 682, Pumps—Shaft Sealing Systems for Centrifugal and Rotary Pumps,
- API RP 1102, Steel pipelines crossing railroads and highways
- API Std 1104, Welding of pipelines and related facilities
- API RP 1162, Public awareness programs for pipeline operators
- API 2000, Venting Atmospheric and Low Pressure Storage Tanks

1.7 AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

- ASCE/SEI 7-10, Minimum Design Loads for Buildings and Other Structures,
- ASCE, Wind Load for Petrochemical and Other Industrial Structures, 2011
- ASCE 37-02, Design Loads on Structures During Construction,

1.8 AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR CONDITIONING ENGINEERS (ASHRAE)

- ASHRAE Handbook – Fundamentals,
- ASHRAE Handbook - HVAC Systems & Equipment,
- ASHRAE Handbook - HVAC Applications,

1.9 THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- ASME Boiler and Pressure Vessel Code, and Boiler and Pressure Vessel Code including all mandatory addenda,
- Section I, Power Boilers
- Section II, Material Specifications
- Part A - Ferrous Materials
- Part B - Nonferrous Materials
- Part C - Welding Rods, Electrodes and Filler Materials
- Section IV, Heating Boilers
- Section V, Nondestructive Examination
- Section VIII, Pressure Vessels, Division 1
- Section VIII, Pressure Vessels, Division 2 -Alternative Rules

- Section IX, Welding and Brazing Qualifications
- ASME B1.20.1, Pipe Threads General Purpose (Inch),
- ASME B16.5, Pipe Flanges and Flanged Fittings—NPS ½ through 24,
- ASME B16.9, Factor-made wrought buttwelding fittings
- ASME B16.10, Face to Face and End to End Dimensions of Valves,
- ASME B16.11, Forged Fittings, Socket-Welding and Threaded,
- ASME B16.20, Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed,
- ASME B16.34, Valves Flanged, Threaded and Welding End,
- ASME B16.47, Large Diameter Steel Flanges, NPS 26 through NPS 60
- ASME B16.49, Factory-made, wrought steel, buttwelding induction bends for transportation and distribution systems
- ASME B31.3, Process Piping,
- ASME B31.4, Pipeline Transportation Systems,
- ASME B31.8, Gas Transmission and Distribution Piping Systems,
- ASME B73.1, Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process,
- ASME B73.2, Specification for Vertical In-line Centrifugal Pumps for Chemical Process,
- ASME RTP-1, Reinforced Thermoset Plastics Corrosion Resistant Equipment
- ASME STS-1, Steel Stacks

1.10 AMERICAN SOCIETY FOR NON-DESTRUCTIVE TESTING (ASNT)

- ASNT 2504, Standard for Qualification and Certification of Nondestructive Testing Personnel

1.11 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM material specifications will be used unless otherwise specified. Below is a partial listing of ASTM material specifications that may be used:

- ASTM A1, Standard Specification for Carbon Steel Tee Rails.
- ASTM A3 Standard Specification for Steel Joint Bars, Low, Medium, and High Carbon (Non-Heat-Treated).
- ASTM A6 Standard Specification for General Requirements for Rolled Steel Bars, Plates, Shapes, and Sheet Piling.
- ASTM A36/A36M, Standard Specification for Carbon Structural Steel
- ASTM A49 Standard Specification for Heat-Treated Carbon Steel Joint Bars Microalloyed Joint Bars, and Forged Carbon Steel Compromise Joint Bars.
- ASTM A90 Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- ASTM A108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
- ASTM A143 Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

- ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- A322 Standard Specification for Steel Bars, Alloy, Standard Grades
- A354 Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
- A370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
- A384 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
- A385 Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
- A449 Standard Specification for Hex Cap Screws, Bolts and Studs, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
- ASTM A490 Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
- ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- ASTM A514 Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
- ASTM A530 Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
- ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts.
- ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
- ASTM A588 Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance.
- ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- ASTM A668 Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
- ASTM A673 Standard Specification for Sampling Procedure for Impact Testing of Structural Steel.
- ASTM A706 Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
- ASTM A759 Standard Specification for Carbon Steel Crane Rails.
- ASTM A775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
- ASTM A786 Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
- ASTM A924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- ASTM A962 Standard Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range.
- ASTM A992 Standard Specification for Structural Steel Shapes.

- ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- ASTM B3, Specifications for Soft or Annealed Copper Wire
- ASTM B8, Specification for Concentric Lay Stranded Copper Conductors, Hard, Medium-Hard, and Soft
- ASTM B695 Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
- ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- ASTM C42 Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- ASTM C94 Standard Specification for Ready-Mixed Concrete.
- ASTM C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
- ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete.
- ASTM C171 Standard Specification for Sheet Materials for Curing Concrete.
- ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete.
- ASTM C192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
- ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- ASTM C311 Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
- ASTM C494 Standard Specification for Chemical Admixtures for Concrete.
- ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- ASTM C685 Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
- ASTM C920 Standard Specification for Elastomeric Joint Sealants.
- ASTM C1017 Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
- ASTM C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- ASTM C1116 Standard Specification for Fiber-Reinforced Concrete.
- ASTM C1218 Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
- ASTM C1330 Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
- ASTM C1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

- ASTM D994 Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- ASTM D1752 Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- ASTM D5249 Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints.
- ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
- ASTM E23 Standard Test Methods for Notched Bar Impact Testing of Metallic Materials.
- ASTM E165 Standard Practice for Liquid Penetrant Examination for General Industry.
- ASTM E709 Standard Guide for Magnetic Particle Testing.
- ASTM F436 Standard Specification for Hardened Steel Washers.
- ASTM F959 Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
- ASTM F1852 Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- ASTM F2280 Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
- ASTM F2329 Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
- ASTM A36, Carbon Structural Steel,

- ASTM A53, Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless,
- ASTM A105, Carbon Steel Forgings for Piping Applications,
- ASTM A106, Seamless Carbon Steel Pipe for High-Temperature Service,
- ASTM A123, Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products,
- ASTM A153, Zinc Coating (Hot Dip) on Iron and Steel Hardware,
- ASTM A185, Steel Welded Wire Reinforcement, Plain, for Concrete,
- ASTM A194, Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both,
- ASTM A240, Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications,
- ASTM A307, Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength,
- ASTM A320, Alloy-Steel Bolting Materials for Low-Temperature Service,
- ASTM A325, Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength,
- ASTM A333, Seamless and Welded Steel Pipe for Low-Temperature Service,
- ASTM A351, Castings, Austenitic, for Pressure-Containing Parts,
- ASTM A420, Piping Fittings of Wrought Carbon Steel and Alloy Steel for LowTemperature Service,
- ASTM A490, Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength,
- ASTM C33, Concrete Aggregates,
- ASTM C150, Specification for Portland Cement,
- ASTM C260, Air-Entraining Admixtures for Concrete,
- ASTM D75, Standard Practice for Sampling Aggregates,
- ASTM D422, Test Method for Particle-Size Analysis of Soils,
- ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)),
- ASTM D1241, Materials for Soil-Aggregate Subbase, Base, and Surface Courses,
- ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700kN-m/m^3)),
- ASTM D4945, High-strain Dynamic Testing of Piles,
- ASTM D6938, Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth),
- ASTM F1554, Standard Specification for Anchor Bolts, Steel, 36,55, and 105 ksi Yield Strength,

1.12 AMERICAN WELDING SOCIETY (AWS)

- AWS A2.1, Welding Symbol Charts,
- AWS A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination,
- AWS A5.1, Covered Carbon Steel Arc-Welding Electrodes,
- AWS A5.5, Low-Alloy Steel Covered Arc-Welding Electrodes,
- AWS A5.17, Carbon Steel Electrodes and Fluxes for Submerged Arc Welding,
- AWS D1.1, Structural Welding Code, Steel,
- AWS D1.4, Structural Welding Code, Reinforcing Steel,

1.13 Code Of Federal Regulations (CFR)

- 29 CFR Part 1910, Occupational Safety and Health Standards
- 29 CFR Part 1926, Safety and Health Regulations for Construction
- 40 CFR 60, Protection of the Environment
- 49 CFR Part 191, Transportation of Natural and Other Gas by Pipeline, Annual Reports, Incident Reports, and Safety-Related Condition Reports,
- 49 CFR 192, Transportation of Natural Gas and Other gas by Pipeline: Federal Safety Standards,

1.14 Concrete Reinforcing Steel Institute (CRSI)

- CRSI Manual of Practice
- CRSI 63, Recommended Practice for Placing Reinforcing Bars
- CRSI 65, Recommended Practice for Placing Bar Supports, Specification and Nomenclature

1.15 CSA

- C22.2 No.0.3, Test Methods for Electrical Wires and Cables

1.16 Federal Aviation

- FAA AC 70.7460-1, Obstruction Marking and Lighting

1.17 Gas Processors Association (GPA)

- GPA 2145, Table of Physical Constants for the Hydrocarbons and Other Compounds of Interest to the Natural Gas Industry,
- GPA 2166, Obtaining Natural Gas Samples for Analysis by Gas Chromatography,
- GPA 2172, Calculation of Gross Heating Value, Relative Density and Compressibility Factor for Natural Gas Mixtures for Compositional Analysis,
- GPA 2261, Analysis for Natural gas and Similar Gaseous Mixtures by Gas Chromatography,

1.18 INTERNATIONAL CODE COUNCIL (ICC)

- International Building Code (IBC) 2012 edition

1.19 INTERNATIONAL ELECTROTECHNICAL COMMISION (IEC)

- IEC 61850, Communication Networks and Systems in Substations

1.20 INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

- IEEE C2, National Electrical Safety Code, (Also NFPA 70)
- IEEE C37, Circuit Breakers, Switchgear, Relays, Substations, and Fuses. Institute of Electrical and Electronics Engineers,
- IEEE 32, IEEE Standard Requirements, Terminology and Test Procedure for Neutral Grounding Devices
- IEEE 80, Guide for Safety in Substation Grounding,

- IEEE 112, IEEE - Standard Test Procedure for Polyphase Induction Motors and Generators
- IEEE 115, IEEE - Guide for Test Procedures for Synchronous Machines Part I-Acceptance and Performance Testing Part II-Test Procedures and Parameter Determination for Dynamic Analysis
- IEEE C57.12.80, Standard Terminology for Power and Distribution Transformers,
- IEEE C57.12.90, Standard Test Code for Liquid Immersed Distribution, Power and Regulating Transformers
- IEEE Std. 141, Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book),
- IEEE Std. 142, Recommended Practice for Grounding of industrial and Commercial Power System (Green Book),
- IEEE Std. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book),
- IEEE 315, Graphic symbols for Electrical and Electronics Diagrams (Including Reference Designation Class Designation Letters)
- IEEE 315A, Supplement to Graphic symbols for Electrical and Electronics Diagrams
- IEEE Std. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book),
- IEEE 400, IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above
- IEEE 422, IEEE Guide for the Design of Cable Raceway Systems for Electric Generating Facilities
- IEEE 446, IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
- IEEE 484 IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications
- IEEE 485 IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
- IEEE 493 IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems - IEEE Gold Book (Color Book Series)
- IEEE 515 The Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Industrial Applications
- IEEE 519 IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
- IEEE 525 IEEE Guide for the Design and Installation of Cable Systems in Substations
- IEEE 575 IEEE Guide for the Bonding Shield and Sheaths of Single-Conductor Power Cables Rated 5kV through 500kV
- IEEE 622A Recommended Practice for the Design and Installation of Electric Pipe Heating Control and Alarm Systems for Power Generating Stations
- IEEE 666 IEEE Design Guide for Electric Power Service Systems for Generating Stations
- IEEE 829, Standards for software Test Documentation

- IEEE 841 IEEE Petroleum and Chemical Industry—Premium- Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp)
- IEEE 844 IEEE Recommended Practice for Electrical Impedance, Induction, and Skin Effect Heating of Pipelines and Vessels
- IEEE 979 IEEE Guide for Substation Fire Protection
- IEEE 980 IEEE Guide for Containment and Control of Oil Spills in Substations
- IEEE 1184 Guide for Batteries for Uninterruptible Power Supply Systems
- IEEE 1187 IEEE Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
- IEEE 1189 IEEE Guide for Selection of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
- IEEE 1202 IEEE Standard for Flame-Propagation Testing of Wire and Cable
- IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations - Includes Access to Additional Content
- IEEE C37.04 IEEE Standard Rating Structure for AC High Voltage Circuit Breakers
- IEEE C37.06 IEEE Standard for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities
- IEEE C37.010 IEEE Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
- IEEE C37.013 IEEE Standard for AC High-voltage Generator Circuit Breakers Rated on a Symmetrical Current Basis
- IEEE C37.13 IEEE Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
- IEEE C37.16 IEEE Standard for Preferred Ratings, Related Requirements and Application Recommendations for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors
- IEEE C37.20.1 IEEE Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
- IEEE C37.20.2 IEEE Standard for Metal-Clad Switchgear
- IEEE C37.20.7 IEEE Guide for Testing Metal-Enclosed Switchgear Rated up to 38kV for Internal Arcing Faults
- IEEE C37.23 IEEE Standard for Metal-Enclosed Bus
- IEEE C37.122 IEEE Standard for High Voltage Gas-Insulated Substations Rated Above 52 kV
- IEEE C57.12.00 IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
- IEEE C57.12.01 IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers, Including Those with Solid-Cast and/or Resin Encapsulated Windings
- IEEE C57.12.10 IEEE Requirements for Liquid-Immersed Power Transformers
- IEEE C57.13 IEEE Standard Requirements for Instrument Transformers
- IEEE C57.91
- IEEE Guide for Loading Mineral-Oil-Immersed Transformers

- IEEE C57.94 IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers
- IEEE C57.96 IEEE Guide for Loading Dry Type Distribution and Power Transformers
- IEEE C57.116 IEEE Guide for Transformers Directly Connected to Generators
- IEEE C62.22 IEEE Guide for the Application of Metal-Oxide Arresters for alternating-current systems
- IEEE C62.92.2 IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems, Part II - Grounding of Synchronous Generator Systems
- IEEE C62.92.3 IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems, Part III -Generator Auxiliary Systems

1.21 ILLUMINATING ENGINEER SOCIETY (IES) OF NORTH AMERICA

- The Lighting Handbook

1.22 INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

- ISA 5.1, Instrumentation Symbols and Identification,
- ISA 5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems,
- ISA 5.4, Instrument Loop Diagrams,
- ISA 5.5 Graphic Symbols for Process Displays,
- ISA RP55.1, Hardware testing for Digital Process Computers
- ISA S91.01, Identification of Emergency Shutdown Systems and Controls that are critical to maintaining safety in process industries

- ISA 18.1, Annunciator Sequences and Specifications,
- ISA 18.2, Management of Alarm Systems for the Process Industries,
- ISA 20, Specification Forms,
- ISA 50.00.01 Compatibility of Analog Signals for Electronic Industrial Process Instruments,
- ISA 75.01.01, Flow Equation for Sizing Control Valves,
- ISA 84.01, Application of Safety Instrumented Systems for the Process Industry,
- ISA 91.00.01, Identification of Emergency Shutdown Systems and Controls that are Critical to Maintaining Safety in Process industries.,
- ISA-99.00.01, Security for Industrial Automation and Control Systems Part 1: Terminology, Concepts, and Models,
- ISA-99.02.01, Security for Industrial Automation and Control Systems: Establishing an Industrial Automation and Control Systems Security Program,
- ISA-61804-3, Function Blocks (FB) for Process Control – Part 3: Electronic Device Description Language (EDDL),
- ISA RP 12.4, Instrument Purging for Reduction of Hazardous Area Classification,

1.23 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

- IEC 61508, Functional Safety of Electrical/Electronic Programmable Electronic Safety Related Systems,
- IEC 61511, Functional Safety – Safety Instrumented Systems for the Process Industry Sector,

1.24 INTERNATIONAL STANDARDS ORGANIZATION (ISO)

- ISO 9241, Ergonomic Requirements for Office Work with Visual Display
- ISO 11064, Ergonomic Design of Control Centre

1.25 LOCAL CODES

- AS 18.60.580 thru 650, Alaska Statues- Electrical Safety
- Local building codes, where applicable

1.26 MANUFACTURER'S STANDARDIZATION SOCIETY (MSS)

- MSS-SP-44, Steel Pipeline Flanges,
- MSS SP-67, Butterfly Valves,

1.27 NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

- NACE SP0490, Holiday detection of fusion-bonded epoxy external pipeline coatings
- NACE RP0274, High-voltage electrical inspection of pipeline coatings

- NACE MR1075, Petroleum and Natural Gas Industries Materials for Use in H2S-Containing Environments in Oil and Gas Production
- NACE RP0178, Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service
- NACE No. 2/SSPC-SP 10, Near-White Metal Blast Cleaning

1.28 PROCESS INDUSTRY PRACTICES (PIP)

- PIP Coatings, Process Industry Practices

1.29 NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- NEMA ICS 2, Industrial Control and System Controllers Contactors and Overload Relays Rated 600 Volts,
- NEMA ICS 18, Motor Control Centers,
- NEMA 250, Enclosures for Electrical Equipment 1000 Volts Maximum,
- NEMA MG 1, Motors and Generators,
- NEMA MG2, Safety Standard and Guide for Selection, Installation, and Use of Electric Motors and Generators,
- NEMA PB-1, Panelboards,
- NEMA PB-2, Deadfront Distribution Switchboards,
- NEMA PE-1, Uninterrupted Power Systems (UPS) – Specification and Performance Verification,
- NEMA PE-5, Utility Type Battery Chargers,
- NEMA SG-4, Alternating Current High Boltage Circuit Breakers,
- NEMA SG-5, Power Switchgear Assemblies,
- NEMA ST-20, Dry Type Transformers for General Application,
- NEMA TR 1, Transformers, Regulators and Reactors,

- NEMA VE-1, Metal Cable Tray Systems
- NEMA VE-2, Cable Tray Systems
- NEMA WC 26, Binational Wire and Cable Packaging Standard,
- NEMA WC-57, Standard for Control, Thermocouple Extension and Instrumentation Cables (ICEA S-73-532)
- NEMA WC-70, Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy (ICEA S-95-658)
- NEMA WC74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy (ICEA S-93-639)
- NEMA Z535.1, Safety Colors
- NEMA Z535.2, Environmental and Facility Safety Signs
- NEMA Z535.3, Criteria for Safety Symbols
- NEMA Z535.4, Product Safety Signs and Labels
- NEMA Z535 Color Chart, Safety Color Chart

1.30 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 13, Standard for Installation of Sprinkler Systems,
- NFPA 14, Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems,
- NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances,
- NFPA 30, Flammable and Combustible Liquids Code,
- NFPA 70, National Electrical Code,
- NFPA 70E, Electrical Safety in Work Place,
- NFPA 72, National Alarm Code,

- NFPA 101, Life Safety Code,
- NFPA 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment
- NFPA 497, Recommended Practive for the Classification of Flammable Liquids, Gases or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas,
- NFPA 750- Standard on Water Mist Fire Protection Systems
- NFPA 780, Standard for the Installation of Lightning Protection Systems,
- NFPA 2001, Standard on Clean Agent Fire extinguishing Systems

1.31 RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

- Specification for Structural Joints Using High-Strength Bolts, 2009.

1.32 SOCIETY FOR PROTECTIVE COATINGS (SSPC)

- SSPC PA 1, Shop, Field and Maintenance Painting of Steel,
- SSPC SP 1, Solvent Cleaning,
- SSPC SP 2, Hand Tool Cleaning,
- SSPC SP 3, Power Tool Cleaning,
- SSPC SP 4, Flame Cleaning of New Steel
- SSPC SP 5, White Metal Blast Cleaning,
- SSPC SP 6, Commercial Blast Cleaning,
- SSPC SP 10, Near-White Blast Cleaning,

1.33 TUBULAR EXCHANGER MANUFACTURERS ASSOCIATION (TEMA)

- TEMA, Standards of the Tubular Exchanger Manufacturers Association,

1.34 UNITED STATES CODE OF FEDERAL REGULATIONS

- 29 CFR Part 1910 – Occupational Safety and Health Standards
- 29 CFR Part 1926 – Safety and Health Regulations for Construction.
- 40 CFR – Protection of the Environment

1.35 UNDERWRITER'S LABORATORIES (UL)

- UL 1, Standard for Flexible Metal Conduit,
- UL 4, Standard for Armored Cable,
- UL 5, Standard for Surface Metal Raceways and Fittings,
- UL 6, Electric Rigid Metal Conduit Steel,
- UL 13, Standard for Safety – Power-limited Circuit Cables
- UL 44, Thermost Insulated Wire and Cables,
- UL 50, Enclosures for Electrical Equipment,
- UL 67, Panelboards,
- UL 96A, Standard for Safety - Installation Requirements for Lightning Protection Systems
- UL 467, Grounding and Bonding Equipment,
- UL 508 , Standard for Safety - Industrial Control Equipment
- UL 508A, Standard for Safety - Industrial Control Panels
- UL 845, Standard for Safety - Motor Control Centers
- UL 924 , Standard for Safety - Emergency Lighting and Power Equipment
- UL 1072,Standard for Safety - Medium Voltage Power Cables
- UL 1277, Standard for Safety - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
- UL 1564, Standard for Safety - Industrial Battery Chargers
- UL 1778, Standard for Safety - Uninterruptible Power Systems

- UL 498, Standard for Attachment Plugs and Receptacles,
- UL 508, Standard for Industrial Control Equipment,
- UL 823, Electric Heaters for Use in Hazardous (Classified) Locations,
- UL 844, Standard for Luminaries for Use in Hazardous (Classified) Locations,
- UL 857, Busways,
- UL 870, Wireways, Auxiliary Gutters, and Associated Fittings,

*E.7 – Plant Reliability, Availability, and Maintainability (RAM) Analyses**

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G.1 – Process Hazard Analyses and Recommendations

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Alaska LNG™

PRE-FEED HAZARD IDENTIFICATION (HAZID) REVIEW REPORT

USAG-PG-FRHAZ-00-000001-000

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1.0 EXECUTIVE SUMMARY

This report documents the Hazard Identification (HAZID) studies performed for the Alaska LNG (AKLNG) Gas Treatment Plant (GTP) Project that were conducted May 19th – 21st, 2015 and June 8th, 2016, at AECOM's office located in Denver, Colorado.

The studies considered normal operating conditions, start-up and shutdown operations, and potential upset conditions which might occur. The effectiveness of the planned safeguards / controls in the project design were identified and assessed by the HAZID teams.

The first session of the study (early Pre-Front End Engineering Design [FEED]) examined approximately fifty-seven (57) Relief and Blowdown Diagrams (RBDs), comprising of forty-seven (47) nodes reviewed by the team. The team identified thirty-six (36) recommendations and nine (9) parking lot items.

At the end of Pre-FEED, a second HAZID study was performed to evaluate the changes made since early Pre-FEED and to capture any new hazards / concerns identified during Pre-FEED Optimization. The review was based on ninety-five (95) Pre-FEED Piping and Instrumentation Diagrams (P&IDs) developed to support the Federal Energy Regulatory Commission (FERC) filing requirements. The intent of the review was to capture the impact of changes between the first session and the design after the Optimization phase was finalized. A reassessment of all P&IDs was not part of the second review session. One (1) node was added to the list of nodes from Session 1, and the team identified sixteen (16) new recommendations.

The HAZID sessions included all process equipment, piping and instrumentation identified in the Nodes (Attachments 1 and 2, Appendix A of each session) and the color coded Relief and Blowdown Diagrams (RBDs) in Attachment 1, Appendix G (Session 1) and Process and Instrumentation Diagrams (P&IDs) in Attachment 2, Appendix G (Session 2).

Table 1: Categories and Recommendations

Category	Recommendations	
	Session 1	**Session 2**
Safety (S)	28	07
Environment (E)	06	0
Financial (FIN)	0	06
Reputation (REP)	0	0
Operability (OP)	02	03
Total:	**36**	**16**
	52	

2.0 PURPOSE AND SCOPE

2.1 PURPOSE

This report describes the results of the Hazard Identification studies using the HAZID methodology performed for the Alaska LNG (AKLNG) Gas Treatment Plan (GTP) Project. It includes two separate sessions, one started on May 19th, 2015 and concluded on May 21st, 2015, and the second one conducted on June 8th, 2016. Both sessions took place at AECOM's office, in Denver, Colorado.

The intent of the study was based on the premise that if a process always operates within the intended design, hazards and operability issues are unlikely to be encountered. The methodology used guidewords to identify deviations from the intended process operation that is included in the design of the facility.

2.2 SCOPE

The intent of the HAZID studies was to:

- Identify credible causes, consequences and safeguards / controls for deviations from normal operating conditions which could lead to Safety, Environmental, Financial, Reputational and / or Operability impact(s);
- Where appropriate, recommend improvements to the process design or its operation that increase process safety or enhance operability of the unit; and
- Provide information that is compatible with other process safety management activities, such as operator training, development of operating procedures, or maintenance and inspection schedules.

The HAZID sessions included all process equipment, piping and instrumentation identified in the Nodes (Attachments 1 and 2, Appendix A of each session) and the color coded Relief and Blowdown Diagrams (RBDs) in Attachment 1, Appendix G (Session 1) and Process and Instrumentation Diagrams (P&IDs) in Attachment 2, Appendix G (Session 2).

Any hazard / concern not associated with the scope (e.g., design issue, drawing correction, etc.) was documented as a Parking Lot item (Attachment 1, Appendix E).

3.0 TEAM MEMBERS

The teams were comprised of the following members:

Table 2: Team Members – Session 1

Name	Company	Job Title
Adrian Becerra	AKLNG	GTP Process Eng.
Art Klink	AKLNG	GTP Machinery Eng.
Aubrey Woodley	PSRG	Facilitator
Craig Donner	AKLNG	GTP Operations Advisor
David Brown	ASRC	Process Engineer
Ed Ricks	AECOM	GTP Engineering Manager
Jeff Lipscomb	AKLNG	GTP Facilities Lead
Joe King	ExxonMobil	Loss Prevention SME
Johnny Johnson	AECOM	GTP Technology Director
Ken Lambert	CB&I	Execution Lead
Kevin Tran	PSRG	Scribe
Mark Elkins	AKLNG	GTP Process Eng. Lead
Neal Janusz	AECOM	GTP I&C Eng. Lead
Paul McKenney	AKLNG	GTP Environmental and Regulatory Advisor
Raul Lopez	AKLNG	GTP Project Manager
Robert Rood	AKLNG	GTP Eng. Manager
Scott Gillis	AKLNG	GTP Loss Prevention Eng.
Sjoerd Hoogwater	AECOM	GTP Process Engineer Lead

Sign-in sheets of the attendees are included in Attachment 1, Appendix D.

Table 3: Team Members – Session 2

Name	Company	Job Title
Adrian Becerra	AKLNG	GTP Facility Eng. – PBU / GTP Interface
Craig Donner	AKLNG	GTP Operations Advisor
Ed Ricks	AECOM	GTP Eng. Manager
Jeff Lipscomb	AKLNG	GTP Facilities Eng. Lead
Luci Machado	AKLNG	Risk Coordinator / Facilitator
Mark Elkins	AKLNG	GTP Process Eng. Lead
Robert Rood	AKLNG	GTP Eng. Manager
Sjoerd Hoogwater	AECOM	Process Eng. Lead / Scribe

Sign-in sheets of the attendees are included in Attachment 2, Appendix D.

4.0 HAZID METHODOLOGY

The HAZID studies were conducted according to the Pre-FEED HAZID Review Charter (USAG-EC-FBCHT-00-000001-000). The primary references were as follows:

- Session 1: layout drawings, RBDs, Heat and Material Balance (HMB), and Material Safety Data Sheets (as needed).
- Session 2: layout drawings, P&IDs, Heat and Material Balance (HMB), and Material Safety Data Sheets (as needed).

The Hazard / Category was the primary basis for development of scenarios in the HAZID studies. The various guidewords associated with the Categories were simply prompters to initiate conversation and / or bring to remembrance potential issues / experiences for discussion and documentation. Therefore, these guidewords are only depicted in the Global Node and Deviations List of the study but there were not used in each Node (refer to Appendix A of the Pre-FEED HAZID Review Charter for a list of the guidewords used).

4.1 NODE BREAK-UP

For session 1, the RBDs were divided into manageable sections called Nodes. These systems were systematically analyzed by the HAZID team and discussion recorded using the PHAPro software. The HAZID study identified forty-seven (47) nodes (Attachment 1, Appendix A).

For session 2, the P&IDs were divided into the same nodes as Session 1, and a list of the changes made since the HAZID session 1 occurred were captured (Attachment 2, Appendix A). A new node (Node 48, Gasoline Fuel Supply Tank) was included in the list to reflect the addition of the gasoline fuel supply tank since the HAZID session 1 took place. These changes were systematically analyzed by the HAZID team and discussion recorded using the PHAPro software.

4.2 GUIDEWORDS

The guidewords used were those agreed upon by the team members (i.e., had an impact on the entire project or were specific to an area of the facility). All of the guidewords were commented on whether or not a consequence was found and whether or not an action item was generated.

The detailed list of these nodes, including the Global Node, is included in Attachments 1 and 2 (Appendix A). The nodes, which have been color-coded, can be viewed on the drawings included in Attachments 1 and 2 (Appendix G).

4.3 CONSEQUENCES

The consequences were documented based on the result of a deviation from the design intention occurring. The consequences were considered as follows:

- No credit giving to safeguards (assumption was made there were no safeguards in place).
- Team thought through the consequence all the way to the most severe consequence that is credible. In some cases, that could be considering the most consequence and lower likelihood, while in other cases it could be the most likely but less consequential outcome.
- Consequences were identified according to Safety (S), Environment (E), Financial (FIN), Reputation (REP) and Operability (OP).

The HAZID worksheets include all consequences identified (Attachments 1 and 2, Appendix B).

4.4 SAFEGUARDS

The safeguards were documented based on the prevention and / or mitigation of the consequences. These are engineered system(s) as defined in the RBDs / P&IDs and administrative controls (e.g., operator response to alarms) that can prevent or mitigate the hazard. The HAZID worksheets include all safeguards identified (Attachments 1 and 2, Appendix B).

The safeguards were considered as follows:

- Engineering and / or administrative controls were documented referencing the appropriate equipment tag numbers, when available.
- Typical safeguards that prevent or minimize consequences and likelihoods include:
  - Process design
  - Control: basic process control system, process alarms, operating procedures, operator intervention, etc.
  - Prevention: safety critical process alarms, safety instrumented systems, etc.
  - Mitigation: pressure relief devices, etc.
  - Physical barriers: dikes, etc.
  - Fire protection, fire and gas detection systems: deluge, sprinkler, gas detection, alarms, etc.
  - Emergency response

5.0 RESULTS AND RECOMMENDATIONS

During the HAZID reviews, the teams identified a number of recommendations:

Table 4: Categories and Number of Recommendations

Category	Number of Recommendations	
	Session 1	Session 2
Safety (S)	28	07
Environment (E)	06	0
Financial (FIN)	0	06
Reputation (REP)	0	0
Operability (OP)	02	03
Total:	**36**	**16**
	52	

Table 5: Recommendations

#	Recommendations		
	Recommendation	Session 1	Session 2
1.	Modify PTU inlet overpressure protection design or increase MAWP of KO Drum MAM-609501 to the maximum pipeline pressure expected (per ASME B31.8).	✓	N/A
2.	Include off design PTU feed in GTP Operating Envelope study.	✓	N/A
3.	Identify which Organization will operate and maintain metering skids.	✓	N/A
4.	Verify fire and gas detection and water mist system if decision is made not to provide enclosure for the treated gas compressor driver. (Note current fire and gas detection design is based on turbine driver enclosure)	✓	N/A
5.	Implement procedural controls to comply with Hearing Protection requirements.	✓	N/A
6.	Implement justifiable sound mitigation (such as acoustic insulation, low noise valves).	✓	N/A
7.	Perform dispersion modeling to evaluate impact of discharge of flammable gases through HVAC exhaust on Treated Gas module and provide safeguards as necessary.	✓	N/A
8.	Ensure removal of heavy hydrocarbon from the Treated Gas Chiller Oil Drum HAP-666525 /526 is routed to a safe location.	✓	N/A
9.	Evaluate impact of propane discharge to grade, provide area drainage via sloping to prevent pool accumulation under module.	✓	N/A
10.	Provide secondary containment for external heat medium system to prevent large scale leaks and impact to tundra.	✓	N/A
11.	Include AGRU plate frame exchanger leak scenarios in CFD modeling review to address potential discharge of rich solvent to module floor with potential personnel exposure to CO_2 and H_2S, and provide safeguards as necessary.	✓	N/A
12.	Evaluate risk of pluggage in LP Fuel Gas TEG Contactor MAF-966102 including distributor and provide safeguards as necessary (e.g. upgrade 150# class to 600# class).	✓	N/A
13.	Work with environmental team to include planned maintenance flaring for TGDU Off Gas Compressor CBA-661125 in air emissions "cookbook".	✓	N/A

#	Recommendations		
	Recommendation	**Session 1**	**Session 2**
14.	Consider sparing of TGDU Off Gas Compressor CBA-661125.	✓	N/A
15.	Ensure temperature shutdown is provided to prevent brittle fracture.	✓	N/A
16.	Perform CFD toxic dispersion analysis for CO_2 Compression module.	✓	N/A
17.	Perform dispersion modeling to evaluate impact of discharge of toxic gases through HVAC exhaust on CO_2 Compression module and provide safeguards as necessary.	✓	N/A
18.	Perform hydraulic surge analysis on CO_2 piping in dense phase service.	✓	N/A
19.	Coordinate with regulatory team to identify permissible CO_2 flaring duration during CO_2 injection system unavailability.	✓	N/A
20.	Perform CFD dispersion analysis for CO_2 Dehy Off Gas Compressor CBA-667117 and CO_2 Dehy Regen Column MAF-667106 leak to verify H_2S concentrations from leak or opening of equipment for maintenance.	✓	N/A
21.	Work with environmental team to include planned maintenance flaring for CO_2 Dehy Off Gas Compressor CBA-667117 in air emissions "cookbook".	✓	N/A
22.	Consider sparing of CO_2 Dehy Off Gas Compressor CBA-667117.	✓	N/A
23.	Include cold start up scenario in the operating envelope study.	✓	N/A
24.	Include idled winter condition scenario for the refrigeration system in the operating envelope study.	✓	N/A
25.	Segregate open and closed drain systems.	✓	N/A
26.	Provide Oxygen analyzer on plant supply breathing air system at takeoff from plant air system (Dwg. 00954-113).	✓	N/A
27.	Evaluate breathing air system to determine if additional capacity is needed in the event that breathing air supply is lost. (i.e., volume bottle or wide spot in the line).	✓	N/A
28.	Generate flare flame out dispersion model scenarios for hydrocarbons (methane).	✓	N/A
29.	Design flare header to account for CO_2 solids.	✓	N/A
30.	Generate flare flame out dispersion model scenarios for CO_2 / H_2S.	✓	N/A
31.	Review process simulation and locate areas where leaks to atmosphere result in high H_2S concentrations.	✓	N/A
32.	Perform CFD dispersion analysis in areas identified in above recommendation 31 (e.g. TEG Dehy Regen, Overhead Reflux Water, Hot / Lean TEG).	✓	N/A
33.	Confirm with Prudhoe Bay that GTP facility is sited outside their consequence analysis zone for blast and dispersion.	✓	N/A
34.	Optimize outside equipment with winterization philosophy to ensure instrumentation and valves can be operated and maintained (e.g. AGRU module, skimmed oil valves, absorber).	✓	N/A
35.	Areas where potential for falling ice exist, review during 3-D model review and provide safeguards to protect equipment and personnel.	✓	N/A
36.	Utilize PBU experience during 3-D model review.	✓	N/A
37.	Consider parallel HIPPS valves or locked closed manual bypass valves.	N/A	✓
38.	Consider designing WHRU for loss of circulation (i.e. no flow in the WHRU tubes).	N/A	✓
39.	Add high level alarm on LT-942100-01. Add high level alarm on LT-942100-01.	N/A	✓
40.	Consider heat exchanger design that minimizes risk of tube leakage, e.g. double pipe exchanger.	N/A	✓
41.	Ensure pipe stress analysis considers sudden temperature decrease when gas starts flowing into hot bath heater.	N/A	✓

#	Recommendations		
	Recommendation	**Session 1**	**Session 2**
42.	Ensure bath heater design includes overpressure detection with automatic shutdown (SDV-965001-01 and SDV-965001-02).	N/A	✓
43.	Limit rate of gas flow increase to reduce thermal shock.	N/A	✓
44.	Install chokes in vent lines to limit venting rate.	N/A	✓
45.	Consider low pressure alarm on MBA927600.	N/A	✓
46.	Consider low pressure alarm on MBA927100.	N/A	✓
47.	Add PALL to MBA942600.	N/A	✓
48.	Consider designing heaters for loss of circulation (i.e. no flow in the heater tubes).	N/A	✓
49.	Add high temperature alarm to BBJ678600 and 604.	N/A	✓
50.	Add low temperature alarm to BBJ678600 and 604.	N/A	✓
51.	Consider adding spare strainer in parallel to STR976605.	N/A	✓
52.	Ensure liquid containment outside the module is provided for the potential overflow, or re-evaluate seal pot design to avoid potential liquid release to atmosphere.	N/A	✓

6.0 COMBINED HAZID WORKSHEETS (SESSIONS 1 AND 2)

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 1. Prudhoe Bay Unit / Point Thomson Unit Feed Gas to the Gas Treatment Plant Including MAM-609501 PTU Inlet KO Drum, MAJ-609504A/B PTU Liquid Re-injection Filter, MAK-662100 / 101 AGRU Filter Separators, KGR-609500 PTU Inlet Pig Receiver, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-50-000609-001; USAG-EC-PDZZZ-50-000609-004; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide feed gas from PTU and PBU

Winter rates
Pressure: PTU 650-1130 psig / PBU 580-620 psig
Temperature: PTU / PBU Ambient , Flow: PTU 950 scfd / PBU 3 billion scfd

Comment: -New HP HC vent to flare on Pig Receiver KGR609500
-PBU feed gas metering station now upstream of HCV to flare and SDV
-PCV is now upstream of the KO drum, new PDC downstream of KO drum
-New PT to GTP historian to satisfy B31.3 requirements
-liquids SDV from KO drum is now upstream of flare take off
-new PSV on shell side of AGRU feed gas preheater

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy – remote / local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. Response time of HIPPS valve: Potential overpressure and failure of piping and equipment, due to slow closing time resulting in loss of primary containment.	S	1. HIPPS design, assessment and verification are part of the project scope		
		2.1.2. High pressure in PTU Inlet KO Drum MAM-609501 due to PC valve closure on overhead outlet of the KO Drum, potential to exceed design pressure rating of MAM-609501 KO Drum and filter.	S	1. PTU inlet KO Drum MAWP matches pipeline MAOP	1. Modify PTU inlet overpressure protection design or increase MAWP of KO Drum MAM-609501 to the maximum pipeline pressure expected (per ASME B31.8).	
	2.2. Operating/Design Temperature (hot/ cold surfaces, low temperature embrittlement)	2.2.1. For the case of low throughput through PTU feed gas line: JT effect across PC in PTU feed gas overhead exit line from PTU inlet KO Drum MAM-609501, resulting in possible brittle failure, loss of containment.	S	1. None identified	2. Include off design PTU feed in GTP Operating Envelope study.	
	2.3. Fatigue / Corrosion mechanisms	2.3.1. Potential for metal fatigue based on process conditions (high velocity, etc.) through discharges into the flare line.	S	1. Third party verification of flare system is part of project requirement		
	2.4. Flanges, joints, connections	2.4.1. Potential methanol carryover from upstream facility to GTP resulting in potential for flange leaks due to degradation of gasket from methanol with hydrocarbon discharge to atmosphere.	S	1. Material selection process 2. Design basis identifies methanol as a potential contaminant		
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Maintenance philosophy	3.1.1. Identification of responsibility for operating and maintaining metering skids is unclear at this stage of the project resulting in possible operability issue.	OP		3. Identify which Organization will operate and maintain metering skids.	
		3.1.2. Testing of HIPPS valves		1. Operational procedures require temporary slowdown of PTTL to test HIPPS valves	37. Consider parallel HIPPS valves or locked closed manual bypass valves	1. Operational issue
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and	5.1. No credible scenario identified in this Node for this Hazard / Category					

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 1. Prudhoe Bay Unit / Point Thomson Unit Feed Gas to the Gas Treatment Plant Including MAM-609501 PTU Inlet KO Drum, MAJ-609504A/B PTU Liquid Re-injection Filter, MAK-662100 / 101 AGRU Filter Separators, KGR-609500 PTU Inlet Pig Receiver, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-50-000609-001; USAG-EC-PDZZZ-50-000609-004; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide feed gas from PTU and PBU

Winter rates
Pressure: PTU 650-1130 psig / PBU 580-620 psig
Temperature: PTU / PBU Ambient , Flow: PTU 950 scfd / PBU 3 billion scfd

Comment: -New HP HC vent to flare on Pig Receiver KGR609500
-PBU feed gas metering station now upstream of HCV to flare and SDV
-PCV is now upstream of the KO drum, new PDC downstream of KO drum
-New PT to GTP historian to satisfy B31.3 requirements
-liquids SDV from KO drum is now upstream of flare take off
-new PSV on shell side of AGRU feed gas preheater

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Rescue Systems	having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 2. Treated Gas from Overhead of MAF-662103 AGRU Absorber through the HFF-662104-01 thru 04 AGRU Absorber Overhead Cooler / AGRU Water Wash Tower / TGDU TEG Contactor through the MBD-651100 Treated Gas Compressor 1st Stage KO Drum / CAX-651101 Treated Gas Compressor 1st Stage / HFF-651102-01 thru 08 Treated Gas Compressor Interstage Coolers / MBD-651103 Treated Gas Compressor 2nd Stage KO Drum / CAX-651101 Treated Gas Compressor 2nd Stage / HFF-651105-01 thru 08 Treated Gas Compressor After Coolers to the Treated Gas Chiller, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-10-000651-035; USAG-EC-PDZZZ-10-000651-036; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000651-032; USAG-EC-PDZZZ-10-000651-033; USAG-EC-PDZZZ-10-000651-035

Design Conditions/Parameters: To provide sweet / dry gas to pipeline

Winter rates
Pressure: Gas is compressed from 553-2151 psia
Temperature: PTU / PBU Ambient , Flow: Combined flow rate 3.3 billion scfd

Comment: -new 2nd compressor string (6x20% compressors), 2 per train
-liquid outlet SDV now upstream of LCV
-Treated Gas Compression 2nd Stage KO drum is deleted
-treated gas lines from compressors now tie into chiller header - second SDV for each train was deleted

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. For case of blocked compressor discharge: Potential to exceed flare capacity (1 train plus 40% startup of second train), resulting in potential loss of integrity in the flare system due to high velocity, pressure and potential reduction of PSV relief capacities and damage to flare tips.	S	1. High integrity SIS will be developed and implemented to mitigate consequence per note 6 on RBD drawing 010. (now Note 8 on P&ID drawing 035) 2. Overpressure Protection Study report		1. Consequence 2.1.1 is no longer applicable because compressor configuration is now 20% which is lower capacity than previous 33% per train
	2.2. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.2.1. Very low temperature and off-design gas composition during startup could result in liquids entering the second stage of the Treated Gas Compressor and cause equipment damage.		1. Operating procedures		1. During P&ID review the second stage suction scrubber was deleted.
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Treated gas compressor driver and or compressor if not in a enclosure, leading to potential gas detection delay.	S	1. Fire and gas detection design and loss prevention philosophy	4. Verify fire and gas detection and water mist system if decision is made not to provide enclosure for the treated gas compressor driver. (Note current fire and gas detection design is based on turbine driver enclosure)	
		4.1.2. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. Chemicals to be used Health and safety data - toxics/irritants/carcinogens Substitution PPE and procedures Noise and Vibration Ergonomics (illumination, accessibility, manual handling) Heat radiation Thermal stress (cold / hot environment) Ionizing and Electromagnetic Radiation Shift patterns - stress Biological hazards (e.g. Legionella)	7.1.1. Personnel exposure to noise from turbine, compressor and high velocity piping inside Treated Gas module.	S	1. Noise control philosophy 2. Noise survey 3. PPE requirement	5. Implement procedural controls to comply with Hearing Protection requirements. 6. Implement justifiable sound mitigation (such as acoustic insulation, low noise valves).	
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or					

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 2. Treated Gas from Overhead of MAF-662103 AGRU Absorber through the HFF-662104-01 thru 04 AGRU Absorber Overhead Cooler / AGRU Water Wash Tower / TGDU TEG Contactor through the MBD-651100 Treated Gas Compressor 1st Stage KO Drum / CAX-651101 Treated Gas Compressor 1st Stage / HFF-651102-01 thru 08 Treated Gas Compressor Interstage Coolers / MBD-651103 Treated Gas Compressor 2nd Stage KO Drum / CAX-651101 Treated Gas Compressor 2nd Stage / HFF-651105-01 thru 08 Treated Gas Compressor After Coolers to the Treated Gas Chiller, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-10-000651-035; USAG-EC-PDZZZ-10-000651-036; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000651-032; USAG-EC-PDZZZ-10-000651-033; USAG-EC-PDZZZ-10-000651-035

Design Conditions/Parameters: To provide sweet / dry gas to pipeline

Winter rates
Pressure: Gas is compressed from 553-2151 psia
Temperature: PTU / PBU Ambient , Flow: Combined flow rate 3.3 billion scfd

Comment: -new 2nd compressor string (6x20% compressors), 2 per train
-liquid outlet SDV now upstream of LCV
-Treated Gas Compression 2nd Stage KO drum is deleted
-treated gas lines from compressors now tie into chiller header - second SDV for each train was deleted

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. Construction components	11.1.1. Potential loss of containment in treated gas compressor module. Upon confirm gas detection in module, ventilation is increased potentially exhausting a flammable mixture	S	1. None identified	7. Perform dispersion modeling to evaluate impact of discharge of flammable gases through HVAC exhaust on Treated Gas module and provide safeguards as necessary.	
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 3. Treated Gas from Treated Gas Compressor through the HBG-666500 / 501 Treated Gas Chillers / Treated Gas Metering Station and Pig Launcher (as necessary) to the Pipeline, Refrigerant Liquid Inlet / Exit Lines for the Chillers, MBD-666520 / 521 Treated Gas Chiller Oil Drum, HAP-666525 / 526 Treated Gas Chiller Oil Drum Vaporizer, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-50-000666-040 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-50-000666-040; USAG-EC-PDZZZ-50-000666-041

Design Conditions/Parameters: To chill and meter treated gas to pipeline

Winter rates
Pressure: 2075 psig
Temperature: 30 F, Flow: 3.3 billion scfd

Comment: -pig launcher for treated gas mainline to pipeline deleted from drawing (shown on Pipeline Drawing)
-there is now a bypass on the treated gas side of the chillers (not on RBDs)
-oil drum/ vaporizer only one (common) for chillers (RBDs had one per chiller)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. If the chiller bypass is open while it should be closed, the temperature to the mainline could exceed 30F, which could cause damage to the permafrost.	ENV	1. Operating procedures 2. Temperature TAHH-666500-01		1. Bypass was added in P&ID review to be able to maintain the chillers without reducing capacity.
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Hydrocarbon release through manually operated drain valve off Treated Gas Chiller Oil Drum HAP-666525 / 526, loss of containment of propane vapors.	S	1. Operator procedure	8. Ensure removal of heavy hydrocarbon from the Treated Gas Chiller Oil Drum HAP-666525 / 526 is routed to a safe location.	
		4.1.2. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Propane release to pad during winter months. Hazard propane remains a liquid and does not flash off. Base case design does not account for containment / impoundment	S		9. Evaluate impact of propane discharge to grade, provide area drainage via sloping to prevent pool accumulation under module.	
		6.1.2. Propane release to pad during winter months. Hazard propane remains a liquid and does not flash off. Base case design does not account for containment / impoundment	ENV		9. Evaluate impact of propane discharge to grade, provide area drainage via sloping to prevent pool accumulation under module.	
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Section 10 Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant					

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Updated: 4. 6/8/2016

Node: 3. Treated Gas from Treated Gas Compressor through the HBG-666500 / 501 Treated Gas Chillers / Treated Gas Metering Station and Pig Launcher (as necessary) to the Pipeline, Refrigerant Liquid Inlet / Exit Lines for the Chillers, MBD-666520 / 521 Treated Gas Chiller Oil Drum, HAP-666525 / 526 Treated Gas Chiller Oil Drum Vaporizer, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-50-000666-040 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-50-000666-040; USAG-EC-PDZZZ-50-000666-041

Design Conditions/Parameters: To chill and meter treated gas to pipeline

Winter rates
Pressure: 2075 psig
Temperature: 30 F, Flow: 3.3 billion scfd

Comment: -pig launcher for treated gas mainline to pipeline deleted from drawing (shown on Pipeline Drawing)
-there is now a bypass on the treated gas side of the chillers (not on RBDs)
-oil drum/ vaporizer only one (common) for chillers (RBDs had one per chiller)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Updated: 4. 6/8/2016

Node: 4. EAP-651107 / EAP-658113 / EAP-833102/103 Heat Recovery Units for Treated Gas Compressor / CO2 Compression / Power Generator Including Supplemental Firing BMSs Utilizing LP Fuel Gas, Fuel Conditioning & Control Skids for HP Fuel Gas, CGT-651106 Treated Gas Compressor Gas Turbine / CGT-658106 CO2 Compression Turbine / TGT-833100/101 Power Generator Gas Turbines, STKV-651108 Treated Gas Compressor Turbine Stack / STKV-65814 CO2 Compression Turbine Stack / STKV-833104/105 Power Generator Turbine Stacks, STKV-651109 Treated Gas Compressor Turbine Bypass Stack / STKV-658115 CO2 Compression Turbine Bypass Stack / STKV-833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-032 Rev. B; USAG-EC-PDRBD-10-000942-080 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000658-055 Rev. B; USAG-EC-PDRBD-10-000833-100 Rev. B; USAG-EC-PDZZZ-10-000942-085; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000651-034; USAG-EC-PDZZZ-10-000651-037; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000942-086

Design Conditions/Parameters: To provide heat to AGRU reboiler for regeneration of amine from waste heat recovery unit on turbine exhausts.

Pressure: Expansion Tank 200 psig discharge of pump 360 psig
Temperature: TEG is heated from 300 F to 380 F, Flow: 15000 GPM

Comment: -heat medium changed from TEG/Water to Water
-tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-RBDs had two filters, there is only on PHM filter now
-New oxygen scavenger and corrosion inhibitor injection package (previously on raw water line)
-new makeup water line to the process heat medium expansion drum

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. Excess temperature leading to degradation of glycol, resulting in corrosion product in system.	OP	1. Bypass to stack 2. 3 circulation pumps to maintain circulation 3. Trim cooler 4. Turndown capability in duct burner		1. Consequence no longer applicable, replaced by Consequence 2.1.2. TEG/Water heat medium replaced by pressurized water
		2.1.2. Excess temperature leading to vaporization of water	OP	1. Bypass to stack 2. 3 circulation pumps to maintain circulation 3. Trim cooler 4. Turndown capability in duct burner		1. TEG/Water heat medium replaced by pressurized water

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 4. EAP-651107 / EAP-658113 / EAP-833102/103 Heat Recovery Units for Treated Gas Compressor / CO2 Compression / Power Generator Including Supplemental Firing BMSs Utilizing LP Fuel Gas, Fuel Conditioning & Control Skids for HP Fuel Gas, CGT-651106 Treated Gas Compressor Gas Turbine / CGT-658106 CO2 Compression Turbine / TGT-833100/101 Power Generator Gas Turbines, STKV-651108 Treated Gas Compressor Turbine Stack / STKV-65814 CO2 Compression Turbine Stack / STKV-833104/105 Power Generator Turbine Stacks, STKV-651109 Treated Gas Compressor Turbine Bypass Stack / STKV-658115 CO2 Compression Turbine Bypass Stack / STKV-833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-032 Rev. B; USAG-EC-PDRBD-10-000942-080 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000658-055 Rev. B; USAG-EC-PDRBD-10-000833-100 Rev. B; USAG-EC-PDZZZ-10-000942-085; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000651-034; USAG-EC-PDZZZ-10-000651-037; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000942-086

Design Conditions/Parameters: To provide heat to AGRU reboiler for regeneration of amine from waste heat recovery unit on turbine exhausts.

Pressure: Expansion Tank 200 psig discharge of pump 360 psig
Temperature: TEG is heated from 300 F to 380 F, Flow: 15000 GPM

Comment: -heat medium changed from TEG/Water to Water
-tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-RBDs had two filters, there is only on PHM filter now
-New oxygen scavenger and corrosion inhibitor injection package (previously on raw water line)
-new makeup water line to the process heat medium expansion drum

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	2.2. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.2.1. Loss of nitrogen supply could result in lower pressure in the heat medium system, which could result in generation of steam in the waste heat recovery units, and potential hot spots and ultimately WHRU tube failure causing loss of containment.	FIN	1. PALL-942100-01 2. Operating procedures	38. Consider designing WHRU for loss of circulation (i.e. no flow in the WHRU tubes)	1. New consequence since fuel gas was replaced by nitrogen, which is a limited supply
		2.2.2. New make-up water line to the expansion drum could overfill and potentially overpressure the expansion drum.		1. PSV-942100-01 2. Operating procedures	39. Add high level alarm on LT-942100-01	1. New consequence since a water line was added for make-up
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Potential large leak of TEG water solution, environmental impact relative to tundra (sensitive area).	ENV		10. Provide secondary containment for external heat medium system to prevent large scale leaks and impact to tundra.	1. TEG/Water heat medium replaced by pressurized water. Note: "Consequences" and "Recommendations" were identified in Session 1, prior to TEG/Water heat medium replaced by pressurized water.
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Section 10	10.1. Arctic Operations	10.1.1. Reference global node.				

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Updated: 4. 6/8/2016

Node: 4. EAP-651107 / EAP-658113 / EAP-833102/103 Heat Recovery Units for Treated Gas Compressor / CO2 Compression / Power Generator Including Supplemental Firing BMSs Utilizing LP Fuel Gas, Fuel Conditioning & Control Skids for HP Fuel Gas, CGT-651106 Treated Gas Compressor Gas Turbine / CGT-658106 CO2 Compression Turbine / TGT-833100/101 Power Generator Gas Turbines, STKV-651108 Treated Gas Compressor Turbine Stack / STKV-65814 CO2 Compression Turbine Stack / STKV-833104/105 Power Generator Turbine Stacks, STKV-651109 Treated Gas Compressor Turbine Bypass Stack / STKV-658115 CO2 Compression Turbine Bypass Stack / STKV-833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-032 Rev. B; USAG-EC-PDRBD-10-000942-080 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000658-055 Rev. B; USAG-EC-PDRBD-10-000833-100 Rev. B; USAG-EC-PDZZZ-10-000942-085; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000651-034; USAG-EC-PDZZZ-10-000651-037; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000942-086

Design Conditions/Parameters: To provide heat to AGRU reboiler for regeneration of amine from waste heat recovery unit on turbine exhausts.

Pressure: Expansion Tank 200 psig discharge of pump 360 psig
Temperature: TEG is heated from 300 F to 380 F, Flow: 15000 GPM

Comment: -heat medium changed from TEG/Water to Water
-tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-RBDs had two filters, there is only on PHM filter now
-New oxygen scavenger and corrosion inhibitor injection package (previously on raw water line)
-new makeup water line to the process heat medium expansion drum

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Arctic Operations						
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 5. Lean Solvent for the AGRU Absorber: MAF-662128 AGRU Solvent Regenerator and Bottoms Outlet Flow through the HPL-662119-121 AGRU Lean Rich Exchanger through the Tubeside of the HBG-662102 AGRU Feed Gas Preheater through the HFF-662108-01 thru 24 AGRU Lean Solvent Coolers and MAJ-662109 / MAJ-662110 / MAJ-662111 (sidestream Filters) through the PBA-662112A/B/C AGRU Lean Solvent Pump to the AGRU Absorber, HBC-662133-138 AGRU Solvent Reboiler, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-011 Rev. B; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000662-012; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000662-014; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-60-000678-019

Design Conditions/Parameters: To provide lean amine to absorb CO2 and H2S from feed gas

Winter rates
Pressure: Regenerator 33 psia Contactor 562 psia
Temperature: Regenerator 266°F Contactor 97°F , Flow: 15000 gpm

Comment: -new PSV downstream of air cooler

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Fatigue / Corrosion mechanisms	2.1.1. Corrosion in the lean amine system with potential release of amine inside module.	OP	1. Material selection: Stainless steel cladding for Regenerators. Stainless steel Reboilers 2. Filtration and amine quality monitoring		
		2.1.2. Corrosion leading to tube leak in the reboiler HBC-662133-138, resulting in potential for glycol contamination in the amine.	OP	1. Material selection: Stainless steel cladding for Regenerators. Stainless steel Reboilers 2. Filtration and amine quality monitoring 3. Ability to run with up to 5% glycol contamination in amine system (greater than 5% results in production loss)		
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Section 10 Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 5. Lean Solvent for the AGRU Absorber: MAF-662128 AGRU Solvent Regenerator and Bottoms Outlet Flow through the HPL-662119-121 AGRU Lean Rich Exchanger through the Tubeside of the HBG-662102 AGRU Feed Gas Preheater through the HFF-662108-01 thru 24 AGRU Lean Solvent Coolers and MAJ-662109 / MAJ-662110 / MAJ-662111 (sidestream Filters) through the PBA-662112A/B/C AGRU Lean Solvent Pump to the AGRU Absorber, HBC-662133-138 AGRU Solvent Reboiler, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-011 Rev. B; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000662-012; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000662-014; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-60-000678-019

Design Conditions/Parameters: To provide lean amine to absorb CO2 and H2S from feed gas

Winter rates
Pressure: Regenerator 33 psia Contactor 562 psia
Temperature: Regenerator 266°F Contactor 97°F , Flow: 15000 gpm

Comment: -new PSV downstream of air cooler

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 6. AGRU Water Wash System: Make-up Process Water from Treatment through the PBA-662107A/B AGRU Water Wash Makeup Pump through the MAF-662105 AGRU Water Wash Tower to the Solvent Flash Drum Including Circulation through the PBA-662106A/B AGRU Water Wash Pump, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDZZZ-50-000609-004; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000662-011; USAG-EC-PDZZZ-10-000662-013

Design Conditions/Parameters: To provide make-up water for scrubbing of AGRU Absorber overhead stream at 80°F / 47.2 gpm. Wash tower operates at 80°F / 557 psia. Wash water from the wash tower is routed to solvent flash drum at 80°F / 165 psia.

Comment: -liquid outlet SDV is now upstream of LCV

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. 150 # / 600 # spec break on suction of PBA-662107A/B leading to potential overpressure of upstream piping on trip of pump as a result of backflow of gas from water wash tower MAF-662105.	S	1. Design development will address overpressure requirement		
	2.2. Flanges, joints, connections	2.2.1. Reference global node.				
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Sections of make-up water piping to water wash tower MAF-662105 is outside, leading to potential for freezing and resulting in loss of scrubbing efficiency and off--spec product.	OP	1. Supervised heat traced circuit 2. Operations procedure for maintenance of heat traced circuit		
		10.1.2. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents /	13.1. No credible scenario identified in					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 6. AGRU Water Wash System: Make-up Process Water from Treatment through the PBA-662107A/B AGRU Water Wash Makeup Pump through the MAF-662105 AGRU Water Wash Tower to the Solvent Flash Drum Including Circulation through the PBA-662106A/B AGRU Water Wash Pump, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDZZZ-50-000609-004; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000662-011; USAG-EC-PDZZZ-10-000662-013

Design Conditions/Parameters: To provide make-up water for scrubbing of AGRU Absorber overhead stream at 80°F / 47.2 gpm. Wash tower operates at 80°F / 557 psia. Wash water from the wash tower is routed to solvent flash drum at 80°F / 165 psia.

Comment: -liquid outlet SDV is now upstream of LCV

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Experiences	this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 7. MFA-662103 AGRU Absorber and Bottoms Outlet Flow through the MBD-662113 AGRU Solvent Flash Drum through the HPL-662119-121 AGRU Lean Rich Exchanger to the AGRU Solvent Regenerator, VPBK-662123 AGRU Anti-Foam Injection Package, Treated Flash Gas from the MAF-662114 AGRU Flash Gas Absorber to the LP Fuel Gas Dehy Inlet Scrubber Feed Line, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000662-014; USAG-EC-PDZZZ-10-000966-077

Design Conditions/Parameters: Rich solvent from AGRU absorber is routed on level control to AGRU Solvent Flash Drum at 161°F / 565 psia / 47332 gpm where gas is allowed to flash at 161°F / 165 psia. Rich solvent from flash drum is preheated to 243°F and transferred to AGRU Solvent Regenerator at 214°F / 32.5 psia.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Fatigue / Corrosion mechanisms	2.1.1. Presence of high concentration wet CO2 and H2S,	S	1. Piping and vessel material selection is suitable for process conditions 2. Corrosion monitoring 3. Review by CoV subject matter experts		
	2.2. Flanges, joints, connections	2.2.1. Failure of Plate Frame Exchanger gasket resulting in possible discharge of rich solvent to module floor with potential personnel exposure to CO2 and H2S.	S	1. Gasket material selection 2. Plate bolt up procedure 3. Operating procedure (startup / shutdown)	11. Include AGRU plate frame exchanger leak scenarios in CFD modeling review to address potential discharge of rich solvent to module floor with potential personnel exposure to CO2 and H2S, and provide safeguards as necessary.	
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents /	13.1. No credible scenario identified in					

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Updated: 4. 6/8/2016

Node: 7. MFA-662103 AGRU Absorber and Bottoms Outlet Flow through the MBD-662113 AGRU Solvent Flash Drum through the HPL-662119-121 AGRU Lean Rich Exchanger to the AGRU Solvent Regenerator, VPBK-662123 AGRU Anti-Foam Injection Package, Treated Flash Gas from the MAF-662114 AGRU Flash Gas Absorber to the LP Fuel Gas Dehy Inlet Scrubber Feed Line, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000662-014; USAG-EC-PDZZZ-10-000966-077

Design Conditions/Parameters: Rich solvent from AGRU absorber is routed on level control to AGRU Solvent Flash Drum at 161°F / 565 psia / 47332 gpm where gas is allowed to flash at 161°F / 165 psia. Rich solvent from flash drum is preheated to 243°F and transferred to AGRU Solvent Regenerator at 214°F / 32.5 psia.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Experiences	this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Updated: 4. 6/8/2016

Node: 8. Lean TEG for the TGDU TEG Contactor: MAF-6611112 TGDU Regen Column and Bottoms Outlet through the Shellside of the HBG-661108 / 109 TGDU Hot TEG Lean / Rich Exchanger and HBG-661102 TGDU Cool TEG Lean / Rich Exchanger xthrough the PBA-661113A/B TGDU TEG Circulation Pump through the HFF-661114 TGDU Lean TEG Cooler to the TGDU TEG Contactor, HP Fuel Gas through the HAP-661122 TGDU Stripping Gas Heater, HAP-661116-121 TGDU TEG Reboiler, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000966-078; USAG-EC-PDZZZ-10-000965-076

Design Conditions/Parameters: To regen TEG in the TGDU Regen Column by stripping with heated HP Fuel Gas. Rich TEG is regenerated and exits as Lean TEG at 24 psia / 374°F and is used to preheat rich feed to the Column before being fed to the TGDU TEG Contactor at 568 psia / 90°F / 241 gpm.

Comment: -new PSV on outlet of TGDU lean TEG cooler
-new Lean TEG filters and corresponding PSVs (not on RBDs)
-new PSV on outlet of TGDU TEG reboiler
-new SDV on lean TEG from TGDU to Fuel Gas Treating

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. Potential for exposure of 150# class piping to 600# spec condition as a result of pluggage in distributor in lean TEG line to LP Fuel Gas TEG Contactor MAF-966102 resulting in possible loss of containment.	S		12. Evaluate risk of pluggage in LP Fuel Gas TEG Contactor MAF-966102 including distributor and provide safeguards as necessary (e.g. upgrade 150# class to 600# class).	
		2.1.2. Potential for exposure of 150# class piping to 600# spec condition as a result of pluggage in distributor in lean TEG line to LP Fuel Gas TEG Contactor MAF-966102 resulting in possible loss of containment.	ENV		12. Evaluate risk of pluggage in LP Fuel Gas TEG Contactor MAF-966102 including distributor and provide safeguards as necessary (e.g. upgrade 150# class to 600# class).	
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Node: 8. Lean TEG for the TGDU TEG Contactor: MAF-6611112 TGDU Regen Column and Bottoms Outlet through the Shellside of the HBG-661108 / 109 TGDU Hot TEG Lean / Rich Exchanger and HBG-661102 TGDU Cool TEG Lean / Rich Exchanger xthrough the PBA-661113A/B TGDU TEG Circulation Pump through the HFF-661114 TGDU Lean TEG Cooler to the TGDU TEG Contactor, HP Fuel Gas through the HAP-661122 TGDU Stripping Gas Heater, HAP-661116-121 TGDU TEG Reboiler, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000966-078; USAG-EC-PDZZZ-10-000965-076

Design Conditions/Parameters: To regen TEG in the TGDU Regen Column by stripping with heated HP Fuel Gas. Rich TEG is regenerated and exits as Lean TEG at 24 psia / 374°F and is used to preheat rich feed to the Column before being fed to the TGDU TEG Contactor at 568 psia / 90°F / 241 gpm.

Comment: -new PSV on outlet of TGDU lean TEG cooler
-new Lean TEG filters and corresponding PSVs (not on RBDs)
-new PSV on outlet of TGDU TEG reboiler
-new SDV on lean TEG from TGDU to Fuel Gas Treating

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Updated: 4. 6/8/2016

Node: 9. MAF-661100 TGDU TEG Contactor and Rich TEG Oulet Flow through the Tubeside of the HBG-661101 TGDU Offgas Cross Exchanger through the Tubeside of the HBG-661102 TGDU Cool TEG Lean / Rich Exchanger through the MBD-661104 TGDU TEG Flash Drum through MAJ-661105A/B TGDU TEG Cartridge Filters / MAJ-661106 TGDU TEG Activated Carbon Filter / MAJ-661107 TGDU TEG After Filter through the Tubeside of the HBG-661108 / 109 TGDU Hot TEG Lean / Rich Exchanger to the TGDU Regen Column, TGDU Flash Gas from the TEG Flash Drum to Fuel Gas Dehy System, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000661-028

Design Conditions/Parameters: To provide for removal of moisture in Treated Gas from the AGRU Water Wash Tower by contact with TEG. Treated Gas enters the TGDU TEG Contactor at 80°F / 555 psia / 1162 MMSCFD per Train / 133.9 lbmole/hr H_2O and exits at 82°F / 539 psia / 1160 MMSCFD / 0.17 lbmole/hr H_2O (Winter base case).

Comment: -no more integral scrubber on TGDU TEG contactor (no water outlet line)
-only one rich TEG filter now (3 on RBDs)
-new fire PSV on tube side of TGDU Hot L/R HEX
-new PCV to flare on vapor outlet from TGDU TEG flash drum
-new SDV on vapor outlet from TGDU TEG flash drum

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant					

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Node: 9. MAF-661100 TGDU TEG Contactor and Rich TEG Oulet Flow through the Tubeside of the HBG-661101 TGDU Offgas Cross Exchanger through the Tubeside of the HBG-661102 TGDU Cool TEG Lean / Rich Exchanger through the MBD-661104 TGDU TEG Flash Drum through MAJ-661105A/B TGDU TEG Cartridge Filters / MAJ-661106 TGDU TEG Activated Carbon Filter / MAJ-661107 TGDU TEG After Filter through the Tubeside of the HBG-661108 / 109 TGDU Hot TEG Lean / Rich Exchanger to the TGDU Regen Column, TGDU Flash Gas from the TEG Flash Drum to Fuel Gas Dehy System, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000661-028

Design Conditions/Parameters: To provide for removal of moisture in Treated Gas from the AGRU Water Wash Tower by contact with TEG. Treated Gas enters the TGDU TEG Contactor at 80°F / 555 psia / 1162 MMSCFD per Train / 133.9 lbmole/hr H_2O and exits at 82°F / 539 psia / 1160 MMSCFD / 0.17 lbmole/hr H_2O (Winter base case).

Comment: -no more integral scrubber on TGDU TEG contactor (no water outlet line)
-only one rich TEG filter now (3 on RBDs)
-new fire PSV on tube side of TGDU Hot L/R HEX
-new PCV to flare on vapor outlet from TGDU TEG flash drum
-new SDV on vapor outlet from TGDU TEG flash drum

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Node: 10. TGDU Overhead Vapor from the TGDU Regen Column through the Shellside of the HBG-661101 TGDU Offgass Cross Exchanger through the HFF-661123 TGDU Offgas Cooler through the MBF-661124 TGDU Offgas Scrubber through the CBA-661125 TGDU Offgas Compressor 1st Stage through the HFF-661126 TGDU Offgas Interstage Cooler through the MBF-661127 TGDU Offgas Interstage Scrubber through the CBA-661125 TGDU Offgas Compressor 2nd Stage through the HFF-966100-01 LP Fuel Gas Dehy Inlet Cooler through the MBD-966101 LP Fuel Gas Dehy Inlet Scrubber to the LP Fuel Gas TEG Contactor, Bottoms Outlet from MBD-966101 to the Closed Drain Collection Drum, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000661-028; USAG-EC-PDZZZ-10-000661-029; USAG-EC-PDZZZ-10-000661-030; USAG-EC-PDZZZ-10-000966-077; USAG-EC-PDZZZ-10-000966-078; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide for recovery of Fuel Gas from the TGDU Regen Column overhead vapor. Vapor exits the Column at 241°F / 15.4 psia and is cooled to 77°F / 14.9 psia before being fed to the TGDU Offgas Scrubber where condensed liquids are returned to the Regen Column and vapors are routed to the suction of the TGDU Offgas Compressor. Vapors are compressed to 125 psia / 254°F, cooled and then routed to the LP Fuel Gas TEG Contactor via the LP Fuel Gas Dehy Inlet Scrubber at 77°F / 119.7 psia.

Comment: -HFF661123 deleted (air cooler). Cooling medium shell/tube exchanger instead (HBG661131).
-liquid outlet SDV (to Closed Drain Drum) deleted from RBDs
-TGDU interstage scrubber and cooler have been deleted -compressor is shown as a vendor box - type changed to oil flooded screw compressor.
-HFF966100 deleted (air cooler). Cooling medium shell/tube exchanger instead (HBG966105).
-SDV deleted from liquid outlet of inlet scrubber

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Fatigue / Corrosion mechanisms	2.1.1. Tube leakage of HBG661131 could result in Cooling medium entering TGDU regenerator overhead system. Cooling medium is a mixture of EG and water. EG can decompose in TGDU reboiler and potentially cause corrosion and degraded TEG dehy performance.	FIN	1. Sampling program 2. Loss of volume/level in cooling medium system	40. Consider heat exchanger design that minimizes risk of tube leakage, e.g. double pipe exchanger.	1. New consequence since air cooler was replaced by shell/tube exchanger
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. TGDU Off Gas Compressor CBA-661125 outage for planned maintenance resulting in flaring event and potential impact on permit.	ENV		13. Work with environmental team to include planned maintenance flaring for TGDU Off Gas Compressor CBA-661125 in air emissions "cookbook". 14. Consider sparing of TGDU Off Gas Compressor CBA-661125.	
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard /					

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Node: 10. TGDU Overhead Vapor from the TGDU Regen Column through the Shellside of the HBG-661101 TGDU Offgass Cross Exchanger through the HFF-661123 TGDU Offgas Cooler through the MBF-661124 TGDU Offgas Scrubber through the CBA-661125 TGDU Offgas Compressor 1st Stage through the HFF-661126 TGDU Offgas Interstage Cooler through the MBF-661127 TGDU Offgas Interstage Scrubber through the CBA-661125 TGDU Offgas Compressor 2nd Stage through the HFF-966100-01 LP Fuel Gas Dehy Inlet Cooler through the MBD-966101 LP Fuel Gas Dehy Inlet Scrubber to the LP Fuel Gas TEG Contactor, Bottoms Outlet from MBD-966101 to the Closed Drain Collection Drum, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000661-028; USAG-EC-PDZZZ-10-000661-029; USAG-EC-PDZZZ-10-000661-030; USAG-EC-PDZZZ-10-000966-077; USAG-EC-PDZZZ-10-000966-078; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide for recovery of Fuel Gas from the TGDU Regen Column overhead vapor. Vapor exits the Column at 241°F / 15.4 psia and is cooled to 77°F / 14.9 psia before being fed to the TGDU Offgas Scrubber where condensed liquids are returned to the Regen Column and vapors are routed to the suction of the TGDU Offgas Compressor. Vapors are compressed to 125 psia / 254°F, cooled and then routed to the LP Fuel Gas TEG Contactor via the LP Fuel Gas Dehy Inlet Scrubber at 77°F / 119.7 psia.

Comment: -HFF661123 deleted (air cooler). Cooling medium shell/tube exchanger instead (HBG661131).
-liquid outlet SDV (to Closed Drain Drum) deleted from RBDs
-TGDU interstage scrubber and cooler have been deleted -compressor is shown as a vendor box - type changed to oil flooded screw compressor.
-HFF966100 deleted (air cooler). Cooling medium shell/tube exchanger instead (HBG966105).
-SDV deleted from liquid outlet of inlet scrubber

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Node: 11. MAF-966102 LP Fuel Gas TEG Contactor and Bottoms Outlet through the PBA-966103A/B LP Fuel Gas Dehy Rich TEG Recycle Pump to the TGDU TEG Flash Drum, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000966-078

Design Conditions/Parameters: To provide for scrubbing of Offgas Vapor from the TGDU Regen Column by contact with Lean TEG in the LP Fuel Gas TEG Contactor operating at 90°F / 119.7 psia.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or					

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Node: 11. MAF-966102 LP Fuel Gas TEG Contactor and Bottoms Outlet through the PBA-966103A/B LP Fuel Gas Dehy Rich TEG Recycle Pump to the TGDU TEG Flash Drum, and Associated Piping and Instrumentation.
Drawing: USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000966-078
Design Conditions/Parameters: To provide for scrubbing of Offgas Vapor from the TGDU Regen Column by contact with Lean TEG in the LP Fuel Gas TEG Contactor operating at 90°F / 119.7 psia.
Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Node: 12. Treated LP Fuel Gas and LP Fuel Gas from Common Area to Users: MBD-966104 LP Fuel Gas KO Drum Including Overhead Feed Line from the LP Fuel Gas TEG Contactor through MBD-966104, Treated LP Fuel Gas from Overhead Outlet of MBD-966104 to Users, Bottoms Outlet from MBD-966104 to the Closed Drain Collection Drum, LP Fuel Gas from Common Area, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000966-078

Design Conditions/Parameters: To provide LP Fuel Gas to Train header at 60.5°F / 60 psig / 21.4 MMSCFD.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant					

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Updated: 4. 6/8/2016

Node: 12. Treated LP Fuel Gas and LP Fuel Gas from Common Area to Users: MBD-966104 LP Fuel Gas KO Drum Including Overhead Feed Line from the LP Fuel Gas TEG Contactor through MBD-966104, Treated LP Fuel Gas from Overhead Outlet of MBD-966104 to Users, Bottoms Outlet from MBD-966104 to the Closed Drain Collection Drum, LP Fuel Gas from Common Area, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000966-078

Design Conditions/Parameters: To provide LP Fuel Gas to Train header at 60.5°F / 60 psig / 21.4 MMSCFD.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 13. Treated HP Fuel Gas and HP Fuel Gas to/from Common Area Including Buyback Gas and Backup HP Fuel Gas to Users: MBD-965100 HP Fuel Gas KO Drum Including Split Stream from Overhead Line from the TGDU TEG Contactor through MBD-965100, HP Fuel Gas from Overhead Outlet of MBD-965100 to Users, Bottoms Outlet from MBD-966100 to the Closed Drain Collection Drum, HP Fuel Gas from Common Area, MAJ-965501 Buyback Gas Filter, HAP-965503 Buyback Gas Heater, KAU-965500 Buyback Metering Station, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-50-000666-040 Rev. B; USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide HP Fuel Gas to users at 82.1°F / 530 psig / 135.5 MMSCFD.

Comment: -electric heater has been replaced with two bath heaters for buyback gas (fire tube / ethylene glycol)
-new SDV between HP and LP fuel gas

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. Potential for brittle failure of piping downstream of PC valve in buyback gas line to HP fuel gas system as result of failure of HAP-965503 Buyback Gas Heater, resulting in loss of containment.	S	1. Multiple sources of HP fuel gas 2. Multiple heater elements	15. Ensure temperature shutdown is provided to prevent brittle fracture If not provide.	1. Session 2: "Consequences", "Controls" and "Recommendations" no longer applicable due to configuration change. Refer to new Consequence 2.1.2.
		2.1.2. Potential for brittle failure of piping downstream of PC valve in buyback gas line to HP fuel gas system as result of failure of HAP-965508/509 Buyback Gas Heater, resulting in loss of containment.	S	1. Multiple sources of HP fuel gas 2. Multiple heaters 3. Temperature shutdown TAHH-965507-02	41. Ensure pipe stress analysis considers sudden temperature decrease when gas starts flowing into hot bath heater. 43. Limit rate of gas flow increase to reduce thermal shock.	1. New consequence since configuration changed.
	2.2. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.2.1. Tube leak in the bath heater will result in loss of containment	S	1. Equipment location/spacing	42. Ensure bath heater design includes overpressure detection with automatic shutdown (SDV-965001-01 and SDV-965001-02).	1. New consequence since configuration changed.
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard /					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 13. Treated HP Fuel Gas and HP Fuel Gas to/from Common Area Including Buyback Gas and Backup HP Fuel Gas to Users: MBD-965100 HP Fuel Gas KO Drum Including Split Stream from Overhead Line from the TGDU TEG Contactor through MBD-965100, HP Fuel Gas from Overhead Outlet of MBD-965100 to Users, Bottoms Outlet from MBD-966100 to the Closed Drain Collection Drum, HP Fuel Gas from Common Area, MAJ-965501 Buyback Gas Filter, HAP-965503 Buyback Gas Heater, KAU-965500 Buyback Metering Station, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-50-000666-040 Rev. B; USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide HP Fuel Gas to users at 82.1°F / 530 psig / 135.5 MMSCFD.

Comment: -electric heater has been replaced with two bath heaters for buyback gas (fire tube / ethylene glycol)
-new SDV between HP and LP fuel gas

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Updated: 4. 6/8/2016

Node: 14. CO2 Overhead from the AGRU Solvent Regenerator through the HFF-662130-01 thru 12 AGRU Solvent Regenerator Condensers to the AGRU Regenerator Reflux Drum, CO2 Overhead from the AGRU Regenerator Reflux Drum through the MBD-658100 CO2 Compression 1st Stage KO Drum / CAR-658101 Low Pressure CO2 Compressor 1st Stage / HFF-658102-01 thru 04 CO2 Compression 1st Stage Aftercoolers / MBD-658103 CO2 Compression 2nd Stage KO Drum / CAR-658101 Low Pressure CO2 Compressor 2nd Stage / HFF-658104-01 thru 02 CO2 Compression 2nd Stage Aftercoolers / MBD-658105 CO2 Compression 2nd Stage Outlet KO Drum to the CO2 TEG Contactor, Bottoms Outlets from the KO Drums to the Closed Drain Collection Drum, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000658-050; USAG-EC-PDZZZ-10-000658-051; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-10-000662-017; USAG-EC-PDZZZ-10-000658-048; USAG-EC-PDZZZ-10-000658-049; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To remove liquids and compress CO2 gas from overhead of the AGRU Solvent Regenerator for subsequent dehydration. Overheads from the Regenerator are at 206°F / 32 psia and enters the suction of the CO2 Compressor after cooling, liquid separation, and pressure letdown at 79.7°F / 13 psig / 146.5 MMSCFD (Winter base case) and is discharged via the Compressor 2nd stage after liquid separation and cooling at 56.5°F / 517.1 psig / 144.3 MMSCFD to the CO2 TEG Contactor.

Comment: -new 2nd compressor string (6x20% compressors), 2 per train
-new header PC on suction header (updated control configuration)
-liquid outlet SDV now upstream of LCV
-no more "water from TEG contactor" line coming from the TGDU TEG Integral Scrubber (deleted)
-no more outlet SDV on the 2nd stage outlet KO drum - each compressor string has its own contactor

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Fatigue / Corrosion mechanisms	2.1.1. Loss of containment from small bored piping fatigue resulting in discharge of CO2 into module	S	1. Supplied breathing air 2. Controlled access into the module 3. CCTV, toxic gas detection and blowdown, ventilation	16. Perform CFD toxic dispersion analysis for CO2 Compression module.	
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. Construction components	11.1.1. Potential loss of containment in CO2 compressor module. Upon confirm gas detection in module, ventilation is increased potentially exhausting a toxic mixture.	S	1. None identified	17. Perform dispersion modeling to evaluate impact of discharge of toxic gases through HVAC exhaust on CO2 Compression module and provide safeguards as necessary.	
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents /	13.1. No credible scenario identified in					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 14. CO2 Overhead from the AGRU Solvent Regenerator through the HFF-662130-01 thru 12 AGRU Solvent Regenerator Condensers to the AGRU Regenerator Reflux Drum, CO2 Overhead from the AGRU Regenerator Reflux Drum through the MBD-658100 CO2 Compression 1st Stage KO Drum / CAR-658101 Low Pressure CO2 Compressor 1st Stage / HFF-658102-01 thru 04 CO2 Compression 1st Stage Aftercoolers / MBD-658103 CO2 Compression 2nd Stage KO Drum / CAR-658101 Low Pressure CO2 Compressor 2nd Stage / HFF-658104-01 thru 02 CO2 Compression 2nd Stage Aftercoolers / MBD-658105 CO2 Compression 2nd Stage Outlet KO Drum to the CO2 TEG Contactor, Bottoms Outlets from the KO Drums to the Closed Drain Collection Drum, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000658-050; USAG-EC-PDZZZ-10-000658-051; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-10-000662-017; USAG-EC-PDZZZ-10-000658-048; USAG-EC-PDZZZ-10-000658-049; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To remove liquids and compress CO2 gas from overhead of the AGRU Solvent Regenerator for subsequent dehydration. Overheads from the Regenerator are at 206°F / 32 psia and enters the suction of the CO2 Compressor after cooling, liquid separation, and pressure letdown at 79.7°F / 13 psig / 146.5 MMSCFD (Winter base case) and is discharged via the Compressor 2nd stage after liquid separation and cooling at 56.5°F / 517.1 psig / 144.3 MMSCFD to the CO2 TEG Contactor.

Comment: -new 2nd compressor string (6x20% compressors), 2 per train
-new header PC on suction header (updated control configuration)
-liquid outlet SDV now upstream of LCV
-no more "water from TEG contactor" line coming from the TGDU TEG Integral Scrubber (deleted)
-no more outlet SDV on the 2nd stage outlet KO drum - each compressor string has its own contactor

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Experiences	this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Updated: 4. 6/8/2016

Node: 15. CO2 Overhead from the CO2 TEG Contactor through the MBD-658107 CO2 Compression 3rd Stage KO Drum / CAR-658108 High Pressure CO2 Compressor 3rd Stage / HFF-658109 CO2 Compression 3rd Stage Aftercooler / MBD-658110 CO2 Compression 4th Stage KO Drum / CAR-658108 High Pressure CO2 Compressor 4th Stage / HFF-658111-01 thru 02 CO2 Compression 4th Stage Aftercoolers / KAU-658112 CO2 Transfer Metering Station to the Prudhoe Bay Unit, Bottoms Outlets from the KO Drums to the HP CO2 Flare, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000658-054 Rev. B; USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000658-062; USAG-EC-PDZZZ-10-000658-063; USAG-EC-PDZZZ-10-000658-065; USAG-EC-PDZZZ-10-000658-066

Design Conditions/Parameters: To remove liquids and further compressor CO2 gas from overhead of the CO2 Contactor for subsequent transfer and metering to PBU. Overheads from the Contactor are at 67°F / 524 psia following pressure letdown and enters the 3rd stage suction of the CO2 Compressor after liquid separation at 56.8°F / 509.6 psig / 144 MMSCFD (Winter base case) and is discharged via the Compressor 4th stage after liquid separation, cooling, and metering at 147.6°F / 3949.5 psig / 431.9 MMSCFD (total flow) to PBU.

Comment: -Byproduct (CO2) to Injection Points and sweep gas from PBU now shown on drawings
-New vent line to CO2 flare

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. Closing speed of SDVs on CO2 Compression system could result in hydraulic surge, resulting in piping damage and loss of containment due to CO2 exhibiting liquid characteristics.	S		18. Perform hydraulic surge analysis on CO2 piping in dense phase service.	
		2.1.2. CO2 discharge to flare due to CO2 injection system unavailability at PBU, potential to exceed permissible flaring limit.	ENV		19. Coordinate with regulatory team to identify permissible CO2 flaring duration during CO2 injection system unavailability.	
	2.2. Fatigue / Corrosion mechanisms	2.2.1. Loss of containment from small bored piping fatigue resulting in discharge of CO2 into module.	S	1. Supplied breathing air 2. Controlled access into the module 3. CCTV, toxic gas detection and blowdown, ventilation	16. Perform CFD toxic dispersion analysis for CO2 Compression module.	
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Manual venting	3.1.1. Uncontrolled blowdown of one of the byproduct injection lines to the GTP CO2 Flare could exceed its capacity.	S		44. Install chokes in vent lines to limit venting rate.	1. New vent line to CO2 flare
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 15. CO2 Overhead from the CO2 TEG Contactor through the MBD-658107 CO2 Compression 3rd Stage KO Drum / CAR-658108 High Pressure CO2 Compressor 3rd Stage / HFF-658109 CO2 Compression 3rd Stage Aftercooler / MBD-658110 CO2 Compression 4th Stage KO Drum / CAR-658108 High Pressure CO2 Compressor 4th Stage / HFF-658111-01 thru 02 CO2 Compression 4th Stage Aftercoolers / KAU-658112 CO2 Transfer Metering Station to the Prudhoe Bay Unit, Bottoms Outlets from the KO Drums to the HP CO2 Flare, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000658-054 Rev. B; USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000658-062; USAG-EC-PDZZZ-10-000658-063; USAG-EC-PDZZZ-10-000658-065; USAG-EC-PDZZZ-10-000658-066

Design Conditions/Parameters: To remove liquids and further compressor CO2 gas from overhead of the CO2 Contactor for subsequent transfer and metering to PBU. Overheads from the Contactor are at 67°F / 524 psia following pressure letdown and enters the 3rd stage suction of the CO2 Compressor after liquid separation at 56.8°F / 509.6 psig / 144 MMSCFD (Winter base case) and is discharged via the Compressor 4th stage after liquid separation, cooling, and metering at 147.6°F / 3949.5 psig / 431.9 MMSCFD (total flow) to PBU.

Comment: -Byproduct (CO2) to Injection Points and sweep gas from PBU now shown on drawings
-New vent line to CO2 flare

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 16. See Node 4 - HAZID of Node 16 was included in the Node 4 evaluation

EAP-658113 CO2 Compression Heat Recovery Unit Including Supplemental Firing BMS Utilizing LP Fuel Gas, Fuel Conditioning & Control Skid for the HP Fuel Gas, CGT-658106 CO2 Compression Turbine, STKV-65814 CO2 Compression Turbine Stack, STKV-658115 CO2 Compression Turbine Bypass Stack, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000658-055 Rev. B; USAG-EC-PDRBD-10-000942-080 Rev. B; USAG-EC-PDZZZ-10-000658-064; USAG-EC-PDZZZ-10-000658-067; USAG-EC-PDZZZ-10-000965-076

Design Conditions/Parameters: See Node 4 - HAZID of Node 16 was included in the Node 4 evaluation

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. See Node 4 - HAZID of Node 16 was included in the Node 4 evaluation						

Session: 2. 5/20/2015
Updated: 4. 6/8/2016
Node: 17. MBD-662131 AGRU Regenerator Reflux Drum, Bottoms Outlet from the Reflux Drum through the PBA-662132A/B AGRU Solvent Regenerator Reflux Pump to the AGRU Solvent Regenerator, Make-up Water from the Process Water Storage Tank to the Reflux Drum, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-10-000662-017; USAG-EC-PDZZZ-10-000991-095
Design Conditions/Parameters: To provide reflux to the AGRU Solvent Regenerator via the Reflux Drum operating at 80°F / 29.7 psia.
Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Flanges, joints, connections	2.1.1. Potential discharge of treated water / reflux water to pad / tundra	ENV	1. Supervised heat traced circuit 2. Operations procedure for maintenance of heat traced circuit 3. Spill response team and spill clean up equipment on site		
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Sections of make-up water piping to water wash tower is outside, leading to potential for freezing and resulting in loss of scrubbing efficiency and offspec product.	OP	1. Supervised heat traced circuit 2. Operations procedure for maintenance of heat traced circuit		
		10.1.2. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 17. MBD-662131 AGRU Regenerator Reflux Drum, Bottoms Outlet from the Reflux Drum through the PBA-662132A/B AGRU Solvent Regenerator Reflux Pump to the AGRU Solvent Regenerator, Make-up Water from the Process Water Storage Tank to the Reflux Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-10-000662-017; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide reflux to the AGRU Solvent Regenerator via the Reflux Drum operating at 80°F / 29.7 psia.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 18. MAF-667106 CO2 Dehy Regen Column, Bottoms Outlet from the Column through the HBG-667104 CO2 Dehy Hot TEG Lean/Rich Exchanger Shellside / HBG-667102 CO2 Dehy Cool TEG Lean/Rich Exchanger Shellside / PBA-667109A/B CO2 Dehy TEG Circulation Pump / MAJ-667110A/B CO2 Dehy TEG Cartridge Filter / MAJ-667111 CO2 Dehy TEG Activated Carbon Filter / MAJ-667112 CO2 Dehy TEG After Filter / HFF-667113 CO2 Dehy Lean TEG Cooler to the CO2 TEG Contactor, CO2 Stripping Gas from CO2 TEG Contactor Overhead through the HAP-667108 CO2 Dehy Stripping Gas Heater, HAP-667107 CO2 Dehy Teg Reboiler, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000667-056; USAG-EC-PDZZZ-10-000667-057; USAG-EC-PDZZZ-10-000667-058

Design Conditions/Parameters: To regen TEG in the CO2 Dehy Regen Column for use in the dehydration of CO2 gas from the 2nd stage of the CO2 Compressor. The Regen Column is operated at 197-400°F / 15.4-21.7 psia.

Comment: -CO2 Dehy Lean TEG Cooler converted from air cooler (on RBD's) to a cooling medium S/T HEX
-there is now only one CO2 Dehy Lean TEG filter (RBD's had 3)
-HAP667108 no longer exist. Stripping gas heater deleted - gas is now heated up with a coil in the regen column sump.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Fatigue / Corrosion mechanisms	3.1.1. Tube leakage of HBG667119 could result in TEG leaking into cooling medium system, leading to low level in CO2 dehydration unit regenerator sump, causing shutdown of the affected CO2 compressor system.	FIN	1. LALL-667106-01		1. New consequence since air cooler was replaced by shell/tube exchanger
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 19. MAF-667100 CO2 TEG Contactor, Sidedraw from the Contactor through the HBG-667102 CO2 Dehy Cool TEG Lean/Rich Exchanger Tubeside / MBD-667103 CO2 Dehy TEG Flash Drum / HBG-667104 CO2 Dehy Hot TEG Lean/Rich Exchanger Tubeside to the CO2 Dehy Regen Column, Bottoms Outlet from the Contactor to the CO2 Compression 2nd Stage KO Drum, Overhead from the Flash Drum to the CO2 1st Stage Compression KO Drum Feed Line, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000667-056 Rev. B; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000667-056; USAG-EC-PDZZZ-10-000667-057

Design Conditions/Parameters: To provide for contact of CO2 stream from the 2nd stage of the CO2 Compressor with TEG for removal of water. Lean TEG enters the CO2 TEG Contactor at 66.3°F / 529.6 psig / 12.3 gpm / 0.0 lbmole/hr H_2O and exits Rich at 57.3°F / 516.1 psig / 14 gpm / 14.92 lbmole/hr H_2O (Winter base case) to the CO2 Dehy TEG Flash Drum operating at 160°F / 90 psia. The bottoms outlet TEG from the Flash Drum is further heated to 300°F and the pressure dropped to 30 psia before feeding into the CO2 Dehy Regen Column. CO2 Dehy Flash Gas is routed to the CO2 Compressor 1st stage from the Flash Drum at 153.7°F / 15.3 psig.

Comment: -there is no longer an integral scrubber on the CO2 Dehy TEG Contactor
-there are now two CO2 Dehy TEG contactors per train (like the CO2 Compressors). Regeneration is common per contactor pair (one per train)
-New PSV on CO2 Dehy TEG Contactor for "check valve failure"
-there is now a reflux condenser coil in the CO2 Dehy Regen Column and no offgas cooler (air cooler)
-MBD667103 (CO2 Dehy Flash Drum) and liquid outlet SDV were deleted
-HBG667104 (CO2 Dehy Hot L/R HEX) was deleted. There is now only one L/R HEX for the CO2 Dehy.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Toxic/hazardous inventories & minimization	2.1.1. Reference global node.				
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety,					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 19. MAF-667100 CO2 TEG Contactor, Sidedraw from the Contactor through the HBG-667102 CO2 Dehy Cool TEG Lean/Rich Exchanger Tubeside / MBD-667103 CO2 Dehy TEG Flash Drum / HBG-667104 CO2 Dehy Hot TEG Lean/Rich Exchanger Tubeside to the CO2 Dehy Regen Column, Bottoms Outlet from the Contactor to the CO2 Compression 2nd Stage KO Drum, Overhead from the Flash Drum to the CO2 1st Stage Compression KO Drum Feed Line, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000667-056 Rev. B; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000667-056; USAG-EC-PDZZZ-10-000667-057

Design Conditions/Parameters: To provide for contact of CO2 stream from the 2nd stage of the CO2 Compressor with TEG for removal of water. Lean TEG enters the CO2 TEG Contactor at 66.3°F / 529.6 psig / 12.3 gpm / 0.0 lbmole/hr H_2O and exits Rich at 57.3°F / 516.1 psig / 14 gpm / 14.92 lbmole/hr H_2O (Winter base case) to the CO2 Dehy TEG Flash Drum operating at 160°F / 90 psia. The bottoms outlet TEG from the Flash Drum is further heated to 300°F and the pressure dropped to 30 psia before feeding into the CO2 Dehy Regen Column. CO2 Dehy Flash Gas is routed to the CO2 Compressor 1st stage from the Flash Drum at 153.7°F / 15.3 psig.

Comment: -there is no longer an integral scrubber on the CO2 Dehy TEG Contactor
-there are now two CO2 Dehy TEG contactors per train (like the CO2 Compressors). Regeneration is common per contactor pair (one per train)
-New PSV on CO2 Dehy TEG Contactor for "check valve failure"
-there is now a reflux condenser coil in the CO2 Dehy Regen Column and no offgas cooler (air cooler)
-MBD667103 (CO2 Dehy Flash Drum) and liquid outlet SDV were deleted
-HBG667104 (CO2 Dehy Hot L/R HEX) was deleted. There is now only one L/R HEX for the CO2 Dehy.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 20. Overhead Vapor Line from the CO2 Dehy Regen Column through the HFF-667114 CO2 Dehy Offgas Cooler / MBD-667116 CO2 Dehy Offgas Scrubber / CBA-667117 CO2 Dehy Offgas Compressor to the CO2 1st Stage Compression KO Drum Feed Line, Bottoms Outlet from the Scrubber through the PBA-667118A/B CO2 Dehy Reflux Pump to the CO2 Dehy Regen Column / Closed Drain Collection Drum Feed Header and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000667-056 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000667-057

Design Conditions/Parameters: To remove liquids and compress CO2 gas from overhead of the CO2 Dehy Regen Column for subsequent dehydration. Overhead vapors from the Regen Column are at 192.5°F / 15.2 psig and enters the CO2 Dehy Offgas Scrubber after cooling at 77°F / 14.9 psia. Water from the bottoms outlet of the Scrubber is pumped back to the Regen Column as reflux while the overhead vapor from the Scrubber is compressed and routed to the 1st stage of the CO2 Compressor at 166.4°F / 25 psia (Winter base case).

Comment: -Node 20 deleted, no CO2 Dehy Offgas System. Offgas cooler, reflux pump, scrubber, and compressor deleted. Dehy gas is flared

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Toxic/hazardous inventories & minimization	2.1.1. Potential exposure of personnel to H2S due to loss of containment.	S		20. Perform CFD dispersion analysis for CO2 Dehy Off Gas Compressor CBA-667117 and CO2 Dehy Regen Column MAF-667106 leak to verify H2S concentrations from leak or opening of equipment for maintenance.	1. Session 2: No longer applicable; Node 20 deleted.
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. CO2 Dehy Off Gas Compressor CBA-667117 outage for planned maintenance resulting in flaring event and potential impact on permit.	ENV		21. Work with environmental team to include planned maintenance flaring for CO2 Dehy Off Gas Compressor CBA-667117 in air emissions "cookbook". 22. Consider sparing of CO2 Dehy Off Gas Compressor CBA-667117.	1. Session 2: No longer applicable; Node 20 deleted. Offgas is used to supplement CO2 Flare purge gas.
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard /					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 20. Overhead Vapor Line from the CO2 Dehy Regen Column through the HFF-667114 CO2 Dehy Offgas Cooler / MBD-667116 CO2 Dehy Offgas Scrubber / CBA-667117 CO2 Dehy Offgas Compressor to the CO2 1st Stage Compression KO Drum Feed Line, Bottoms Outlet from the Scrubber through the PBA-667118A/B CO2 Dehy Reflux Pump to the CO2 Dehy Regen Column / Closed Drain Collection Drum Feed Header and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000667-056 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000667-057

Design Conditions/Parameters: To remove liquids and compress CO2 gas from overhead of the CO2 Dehy Regen Column for subsequent dehydration. Overhead vapors from the Regen Column are at 192.5°F / 15.2 psig and enters the CO2 Dehy Offgas Scrubber after cooling at 77°F / 14.9 psia. Water from the bottoms outlet of the Scrubber is pumped back to the Regen Column as reflux while the overhead vapor from the Scrubber is compressed and routed to the 1st stage of the CO2 Compressor at 166.4°F / 25 psia (Winter base case).

Comment: -Node 20 deleted, no CO2 Dehy Offgas System. Offgas cooler, reflux pump, scrubber, and compressor deleted. Dehy gas is flared

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 21. Refrigerant Vapor from the Treated Gas Chillers through the MBD-666505/506 Refrigeration Compressor Suction Drum / CBA-666509/510 Refrigeration Compressor / HFF-666511 thru 26 Refrigerant Condensers to the MBD-666512 Refrigerant Accumulator, Refrigerant Liquid from Bottoms Outlet of the Accumulator to the Treated Gas Chillers, Bottoms Outlet from the Suction Drums to the HP HC Flare, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-50-000666-041 Rev. B; USAG-EC-PDZZZ-50-000666-042; USAG-EC-PDZZZ-50-000666-043; USAG-EC-PDZZZ-50-000666-044

Design Conditions/Parameters: To condense refrigerant vapors to provide refrigerant liquid for the Treated Gas Chillers. Refrigerant Vapor from the Chillers enter the suction of the Refrigerant Compressors at 17.7°F / 51.7 psia and discharges at 124.6°F / 187.6 psia and cooled before discharge into the Refrigerant Accumulator at 97°F / 184.6 psia (Summer base case).

Comment: -no longer a PCV off high point on refrigerant accumulator (no PAHH and PSV)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Potential for cold start issues, related to warm up of the propane system.	OP		23. Include cold start up scenario in the operating envelope study.	
		1.1.2. Reference global node (Manning Philosophy)				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. Potential to pull vacuum on Refrigerant Accumulator MBD-666512 at temperature below -40°F with resulting potential for air ingress and explosive environment.	S		24. Include idled winter condition scenario for the refrigeration system in the operating envelope study.	
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Propane release to pad during winter months. Hazard propane remains a liquid and does not flash off. Base case design does not account for containment / impoundment	S		9. Evaluate impact of propane discharge to grade, provide area drainage via sloping to prevent pool accumulation under module.	
		6.1.2. Propane release to pad during winter months. Hazard propane remains a liquid and does not flash off. Base case design does not account for containment / impoundment	ENV		9. Evaluate impact of propane discharge to grade, provide area drainage via sloping to prevent pool accumulation under module.	
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 21. Refrigerant Vapor from the Treated Gas Chillers through the MBD-666505/506 Refrigeration Compressor Suction Drum / CBA-666509/510 Refrigeration Compressor / HFF-666511 thru 26 Refrigerant Condensers to the MBD-666512 Refrigerant Accumulator, Refrigerant Liquid from Bottoms Outlet of the Accumulator to the Treated Gas Chillers, Bottoms Outlet from the Suction Drums to the HP HC Flare, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-50-000666-041 Rev. B; USAG-EC-PDZZZ-50-000666-042; USAG-EC-PDZZZ-50-000666-043; USAG-EC-PDZZZ-50-000666-044

Design Conditions/Parameters: To condense refrigerant vapors to provide refrigerant liquid for the Treated Gas Chillers. Refrigerant Vapor from the Chillers enter the suction of the Refrigerant Compressors at 17.7°F / 51.7 psia and discharges at 124.6°F / 187.6 psia and cooled before discharge into the Refrigerant Accumulator at 97°F / 184.6 psia (Summer base case).

Comment: -no longer a PCV off high point on refrigerant accumulator (no PAHH and PSV)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 22. See Node 4 - HAZID of Node 22 was included in the Node 4 evaluation
EAP-833102/103 Heat Recovery Unit for Power Generator Including Supplemental Firing BMS Utilizing LP Fuel Gas, Fuel Conditioning & Control Skid for HP Fuel Gas, TGT-833100/101 Power Generator Gas Turbines, STKV-833104/105 Power Generator Turbine Stacks, STKV-833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000833-100 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDZZZ-10-000833-105; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000833-106

Design Conditions/Parameters: See Node 4 - HAZID of Node 22 was included in the Node 4 evaluation

Comment: -Power Gen. turbine fuel gas take-offs are no longer on the HP fuel gas KO drum drawing, now on Common Fuel Gas System drawing
-WHRU has been deleted - this node is no longer similar to Node 4. No process (except fuel gas feed)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. See Node 4 - HAZID of Node 22 was included in the Node 4 evaluation						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 23. Open Drain System: BBH-992100 / BBH-992101 / BBH-992102 Oily Water Collection Sumps - AGRU Module #1 thru #3, PBA-992103 / PBA-992104 / PBA-992105 Oily Water Pumps - AGRU Module #1 thru #3, BBH-992110 Oily Water Collection Sump - TGDU & CO2 Gas Dehydration Regen Area, PBA-992111 Oily Water Pump - TDGU & CO2 Gas Dehydration Regen Area, BBH-992106 Oily Water Collection Sump - CO2 Compression Area, PBA-992107 Oily Water Pump - CO2 Compression Area, BBH-992108 Oily Water Collection Sump - Treated Gas Compression Area, PBA-992109 Oily Water Pump - Treated Gas Compression Area, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000992-092 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-10-000992-098; USAG-EC-PDZZZ-10-000992-099

Design Conditions/Parameters: To provide oily water collection sumps in the AGRU / Treated Gas Compression / TGDU & CO2 Gas Dehydration Regen / CO2 Compression Areas. Design details to be completed during FEED.

Comment: -new open drain system for second string of compression and process heat medium, same as original (copy)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential for backflow of hazardous components from tie in to closed drain system into module sumps. (Note: Open Drain module sumps are generally expected to be empty and funnels around equipment discharges into sump)	S		25. Segregate open and closed drain systems.	
	4.2. Loss of Containment	4.2.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents /	13.1. No credible scenario identified in					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 23. Open Drain System: BBH-992100 / BBH-992101 / BBH-992102 Oily Water Collection Sumps - AGRU Module #1 thru #3, PBA-992103 / PBA-992104 / PBA-992105 Oily Water Pumps - AGRU Module #1 thru #3, BBH-992110 Oily Water Collection Sump - TGDU & CO2 Gas Dehydration Regen Area, PBA-992111 Oily Water Pump - TDGU & CO2 Gas Dehydration Regen Area, BBH-992106 Oily Water Collection Sump - CO2 Compression Area, PBA-992107 Oily Water Pump - CO2 Compression Area, BBH-992108 Oily Water Collection Sump - Treated Gas Compression Area, PBA-992109 Oily Water Pump - Treated Gas Compression Area, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000992-092 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-10-000992-098; USAG-EC-PDZZZ-10-000992-099

Design Conditions/Parameters: To provide oily water collection sumps in the AGRU / Treated Gas Compression / TGDU & CO2 Gas Dehydration Regen / CO2 Compression Areas. Design details to be completed during FEED.

Comment: -new open drain system for second string of compression and process heat medium, same as original (copy)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Experiences	this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 24. Firewater from the Camp Potable Water Tank through the PPW-977007 Firewater Supply Pump / BBJ-412004 Camp Firewater Storage Tank / PFW-411600 Firewater Jockey Pump / PFW-411601 Main Firewater Pump (Electric) / PFW-411602 Main Firewater Pump (Diesel Engine) to Occupied Buildings Firewater Loop, HAP-412005 Camp Firewater Storage Tank Heating Element, MBA-412604 Firewater Diesel Day Storage Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-00-000977-123 Rev. A; USAG-EC-PDRBD-00-000412-124 Rev. A; USAG-EC-PDRBD-00-000411-117 Rev. B; USAG-EC-PDZZZ-00-000412-132; USAG-EC-PDZZZ-00-000412-140; USAG-EC-PDZZZ-00-000411-141; USAG-EC-PDZZZ-00-000412-142; USAG-EC-PDZZZ-00-000411-143

Design Conditions/Parameters: To provide potable water for camp Firewater System. Two electric and one diesel operated pump will be used to meet system requirements and provide firewater at 50°F / 165 psia / 1500 USGPM (175 psia / 100 USGPM for the Firewater Jockey Pump).

Comment: -Camp firewater systems - now 3 per camp (instead of one)
-New firewater supply pump (not on RBDs) - PPW412007
-Camp firewater systems - now 3 per camp (instead of one)
-new biocide injection on camp firewater

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 24. Firewater from the Camp Potable Water Tank through the PPW-977007 Firewater Supply Pump / BBJ-412004 Camp Firewater Storage Tank / PFW-411600 Firewater Jockey Pump / PFW-411601 Main Firewater Pump (Electric) / PFW-411602 Main Firewater Pump (Diesel Engine) to Occupied Buildings Firewater Loop, HAP-412005 Camp Firewater Storage Tank Heating Element, MBA-412604 Firewater Diesel Day Storage Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-00-000977-123 Rev. A; USAG-EC-PDRBD-00-000412-124 Rev. A; USAG-EC-PDRBD-00-000411-117 Rev. B; USAG-EC-PDZZZ-00-000412-132; USAG-EC-PDZZZ-00-000412-140; USAG-EC-PDZZZ-00-000411-141; USAG-EC-PDZZZ-00-000412-142; USAG-EC-PDZZZ-00-000411-143

Design Conditions/Parameters: To provide potable water for camp Firewater System. Two electric and one diesel operated pump will be used to meet system requirements and provide firewater at 50°F / 165 psia / 1500 USGPM (175 psia / 100 USGPM for the Firewater Jockey Pump).

Comment: -Camp firewater systems - now 3 per camp (instead of one)
-New firewater supply pump (not on RBDs) - PPW412007
-Camp firewater systems - now 3 per camp (instead of one)
-new biocide injection on camp firewater

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 25. BBJ-977001/2 Camp Potable Water Tanks, Outlet from the Tanks through the PPW-977005A/B/C Camp Potable Water Distribution Pump / Camp Users Distribution Loop / VMBM-977006 Camp UV Sterilization Package, HAP-977003/4 Camp Potable Water Tank Heating Elements, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-00-000977-123 Rev. A

Design Conditions/Parameters: To provide potable water for the Camp users. Camp Potable Water Distribution Pump operates at 105 psia discharge pressure / 28 USGPM and takes suction at 14.7 psia / 50°F.

Comment: -Node 25 no longer exists - no more camp potable water storage.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard /					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 25. BBJ-977001/2 Camp Potable Water Tanks, Outlet from the Tanks through the PPW-977005A/B/C Camp Potable Water Distribution Pump / Camp Users Distribution Loop / VMBM-977006 Camp UV Sterilization Package, HAP-977003/4 Camp Potable Water Tank Heating Elements, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-00-000977-123 Rev. A

Design Conditions/Parameters: To provide potable water for the Camp users. Camp Potable Water Distribution Pump operates at 105 psia discharge pressure / 28 USGPM and takes suction at 14.7 psia / 50°F.

Comment: -Node 25 no longer exists - no more camp potable water storage.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 26. MBA-927600 Cooling Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-927601A/B Cooling Medium Pump (Common) / Cooling Medium Users / MAJ-927602 Cooling Medium Filter (Common) / HFF-927604-01 thru -02 Cooling Medium Cooler (Common); MBA-927100 Cooling Medium Expansion Drum (Process Train), Bottoms Outlet from Process Train Drum through the PBA-927103A/B Cooling Medium Pump (Process Train) / Cooling Medium Users (including Treated Gas Compressor & Turbine, CO2 Compressor & Turbine, Power Generation Turbines) / MAJ-927101 Cooling Medium Filter (Process Train) / HFF-927104-01 thru -05 Cooling Medium Cooler (Process Train) and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000927-082 Rev. B; USAG-EC-PDRBD-10-000927-083 Rev. B; USAG-EC-PDZZZ-10-000927-090; USAG-EC-PDZZZ-50-000927-089

Design Conditions/Parameters: To provide cooling medium (ethylene glycol / water solution) to Refrigeration Compressor / Other Plant-Wide / Treated Gas Compressor & Turbine / CO2 Compressor & Turbine / Power Generation Turbines / Other Process Train users. Cooling Medium Expansion Drums operate at 90°F / 65 psia. Cooling Medium Pump (Common) operates at 102 psia discharge pressure / 512 USGPM. Cooling Medium Pump (Process) operates at 147 psia discharge pressure / 4348 USGPM.

Comment: -tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-MAJ927602 (cooling medium filter, common) deleted. No longer exists.
-on RBD's a box showing "other plant-wide cooling medium users" was deleted from P&IDs
-cooling medium no longer going to "power generation turbines" (these have their own cooling medium system on-skid)
-cooling medium now also going to TGDU, CO2 Dehy, and Fuel Gas Treating heat exchangers

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. Loss of nitrogen blanket on MBA927600 could result in low pressure causing loss of suction head to PBA927601A/B, and subsequent pump trip, loss of circulation, and trip of refrigeration compressors.	FIN		45. Consider low pressure alarm on MBA927600	1. New consequence since fuel gas was replaced by nitrogen, which is a limited supply
		2.1.2. Loss of fuel gas blanket on MBA927100 could result in low pressure causing loss of suction head to PBA927103A/B, and subsequent pump trip, loss of cooling medium circulation, shut down of one train.	FIN		46. Consider low pressure alarm on MBA927100	1. New consequence since configuration changed.
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard /					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 26. MBA-927600 Cooling Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-927601A/B Cooling Medium Pump (Common) / Cooling Medium Users / MAJ-927602 Cooling Medium Filter (Common) / HFF-927604-01 thru -02 Cooling Medium Cooler (Common); MBA-927100 Cooling Medium Expansion Drum (Process Train), Bottoms Outlet from Process Train Drum through the PBA-927103A/B Cooling Medium Pump (Process Train) / Cooling Medium Users (including Treated Gas Compressor & Turbine, CO2 Compressor & Turbine, Power Generation Turbines) / MAJ-927101 Cooling Medium Filter (Process Train) / HFF-927104-01 thru -05 Cooling Medium Cooler (Process Train) and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000927-082 Rev. B; USAG-EC-PDRBD-10-000927-083 Rev. B; USAG-EC-PDZZZ-10-000927-090; USAG-EC-PDZZZ-50-000927-089

Design Conditions/Parameters: To provide cooling medium (ethylene glycol / water solution) to Refrigeration Compressor / Other Plant-Wide / Treated Gas Compressor & Turbine / CO2 Compressor & Turbine / Power Generation Turbines / Other Process Train users. Cooling Medium Expansion Drums operate at 90°F / 65 psia. Cooling Medium Pump (Common) operates at 102 psia discharge pressure / 512 USGPM. Cooling Medium Pump (Process) operates at 147 psia discharge pressure / 4348 USGPM.

Comment: -tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-MAJ927602 (cooling medium filter, common) deleted. No longer exists.
-on RBD's a box showing "other plant-wide cooling medium users" was deleted from P&IDs
-cooling medium no longer going to "power generation turbines" (these have their own cooling medium system on-skid)
-cooling medium now also going to TGDU, CO2 Dehy, and Fuel Gas Treating heat exchangers

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 27. MBA-942600 Building Heat Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-942601A/B/C Building Heat Medium Pump / EAP-942608/609/610 Building Heat Medium Utility Heater / Heat Medium Users (Building, Process Train Building, Process Train Tank / Sump / Drum, and Common Area Tank / Sump / Drum Heaters) / MAJ-942602/603 Building Heat Medium Filter, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000942-081 Rev. B; USAG-EC-PDZZZ-60-000942-087; USAG-EC-PDZZZ-60-000942-088; USAG-EC-PDZZZ-60-000965-075

Design Conditions/Parameters: To provide building heat medium (ethylene glycol / water solution) to Building Heaters / Process Train Building Heaters / Process Train Tank, Sump, and Drum Heaters / Common Area Tank, Sump, and Drum Heaters. Building Heat Medium Expansion Drum operates at 80°F / 65 psia. Building Heat Medium Pump operates 293 psia discharge pressure / 5356 USGPM. Building Heat Medium Utility Heater operates at 200°F discharge temperature / 287 psia.

Comment: -tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-RBDs had two filters, there is only on BHM filter now
-we now have a BMS shown on the heaters (added detail only)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. Loss of nitrogen supply could result in lower pressure in the heat medium system, which could result in generation of steam/degradation products in the heaters, and ultimately tube failure causing loss of containment.	FIN	1. Operating procedures	48. Consider designing heaters for loss of circulation (i.e. no flow in the heater tubes) 47. Add PALL to MBA942600	1. New consequence since fuel gas was replaced by nitrogen, which is a limited supply
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard /					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 27. MBA-942600 Building Heat Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-942601A/B/C Building Heat Medium Pump / EAP-942608/609/610 Building Heat Medium Utility Heater / Heat Medium Users (Building, Process Train Building, Process Train Tank / Sump / Drum, and Common Area Tank / Sump / Drum Heaters) / MAJ-942602/603 Building Heat Medium Filter, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000942-081 Rev. B; USAG-EC-PDZZZ-60-000942-087; USAG-EC-PDZZZ-60-000942-088; USAG-EC-PDZZZ-60-000965-075

Design Conditions/Parameters: To provide building heat medium (ethylene glycol / water solution) to Building Heaters / Process Train Building Heaters / Process Train Tank, Sump, and Drum Heaters / Common Area Tank, Sump, and Drum Heaters. Building Heat Medium Expansion Drum operates at 80°F / 65 psia. Building Heat Medium Pump operates 293 psia discharge pressure / 5356 USGPM. Building Heat Medium Utility Heater operates at 200°F discharge temperature / 287 psia.

Comment: -tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-RBDs had two filters, there is only on BHM filter now
-we now have a BMS shown on the heaters (added detail only)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 28. VCBA-955600A/B/C Air Compressor Packages: CEM-955602A/B/C Air Compressor Motors, CBA-955601A/B/C Air Compressors, VNBA-956600 Air Dryer Package, MBA-956601 Dry Air Receiver, Air Header to Service Air Users, Air Header to Instrument Air Users Including MBA-952100/200/300 Instrument Air Receivers, Air Header to Breathing Air Users Including AAJ-954100/200/300 Breathing Air Train Header Filters, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000955-110 Rev. B; USAG-EC-PDRBD-60-000951-111 Rev. B; USAG-EC-PDRBD-60-000952-112 Rev. B; USAG-EC-PDRBD-60-000954-113 Rev. B; USAG-EC-PDZZZ-60-000955-110; USAG-EC-PDZZZ-60-000951-112; USAG-EC-PDZZZ-60-000952-113; USAG-EC-PDZZZ-60-000954-114; USAG-EC-PDZZZ-60-000955-111

Design Conditions/Parameters: To compress, dry, and filter atmospheric air for use as Breathing Air, Instrument Air, Service Air, and supply to Nitrogen Membrane Package. To provide cooling for Air Compressor stages. Air Compressors (3) operate at discharge pressure of 155 psia / 100°F / 7250 ACFM and provides air to users at 145 psia / 100°F / -100°F dewpoint.

Comment: -No SDVs coming from each air compressor package anymore
-No utility air to control room
-No instrument air to control room
-Breathing air is now a vendor package with one common breathing air filter, not one per train
-Breathing air now goes to CO2 Meter Module also (new module)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Personal Protective Equipment (PPE)	5.1.1. Plant supply breathing air system contamination.	S		26. Provide Oxygen analyzer on plant supply breathing air system at take-off from plant air system (Dwg 00954-113). 27. Evaluate breathing air system to determine if additional capacity is needed in the event that breathing air supply is lost. (i.e. volume bottle or wide spot in the line)	
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in					

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 28. VCBA-955600A/B/C Air Compressor Packages: CEM-955602A/B/C Air Compressor Motors, CBA-955601A/B/C Air Compressors, VNBA-956600 Air Dryer Package, MBA-956601 Dry Air Receiver, Air Header to Service Air Users, Air Header to Instrument Air Users Including MBA-952100/200/300 Instrument Air Receivers, Air Header to Breathing Air Users Including AAJ-954100/200/300 Breathing Air Train Header Filters, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000955-110 Rev. B; USAG-EC-PDRBD-60-000951-111 Rev. B; USAG-EC-PDRBD-60-000952-112 Rev. B; USAG-EC-PDRBD-60-000954-113 Rev. B; USAG-EC-PDZZZ-60-000955-110; USAG-EC-PDZZZ-60-000951-112; USAG-EC-PDZZZ-60-000952-113; USAG-EC-PDZZZ-60-000954-114; USAG-EC-PDZZZ-60-000955-111

Design Conditions/Parameters: To compress, dry, and filter atmospheric air for use as Breathing Air, Instrument Air, Service Air, and supply to Nitrogen Membrane Package. To provide cooling for Air Compressor stages. Air Compressors (3) operate at discharge pressure of 155 psia / 100°F / 7250 ACFM and provides air to users at 145 psia / 100°F / -100°F dewpoint.

Comment: -No SDVs coming from each air compressor package anymore
-No utility air to control room
-No instrument air to control room
-Breathing air is now a vendor package with one common breathing air filter, not one per train
-Breathing air now goes to CO2 Meter Module also (new module)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 29. VNTG-961600 Nitrogen Membrane Package, MBA-961605 Nitrogen Receiver, MBA-961602 Liquid Nitrogen Storage Vessel, PBA-961603 Liquid Nitrogen Pump, HAP-961604 Liquid Nitrogen Vaporizer, HAP-961606 Vaporized Nitrogen Heater, Nitrogen Distribution Header, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000961-114 Rev. B; USAG-EC-PDRBD-60-000961-115 Rev. B; USAG-EC-PDZZZ-60-000961-115; USAG-EC-PDZZZ-60-000961-116

Design Conditions/Parameters: To provide nitrogen for users via Nitrogen Membrane Package and Liquid Nitrogen System as a backup. Nitrogen Membrane Package operates at 145 psia / 100°F / 2.59 MMSCFD. Liquid Nitrogen System operates at 125 psia / 100°F / 0.8 MMSCFD. Nitrogen is provided to users at 125 psia / 100°F.

Comment: -VNTG961601 has been deleted (Liquid Nitrogen Vaporizer Package) - truck connection instead
-No nitrogen distribution to control room

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Toxic/hazardous inventories & minimization	2.1.1. Potential asphyxiation hazard on or around nitrogen package.		1. O2 detection on nitrogen package for ambient atmosphere in enclosure		
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Reference global node.				
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 29. VNTG-961600 Nitrogen Membrane Package, MBA-961605 Nitrogen Receiver, MBA-961602 Liquid Nitrogen Storage Vessel, PBA-961603 Liquid Nitrogen Pump, HAP-961604 Liquid Nitrogen Vaporizer, HAP-961606 Vaporized Nitrogen Heater, Nitrogen Distribution Header, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000961-114 Rev. B; USAG-EC-PDRBD-60-000961-115 Rev. B; USAG-EC-PDZZZ-60-000961-115; USAG-EC-PDZZZ-60-000961-116

Design Conditions/Parameters: To provide nitrogen for users via Nitrogen Membrane Package and Liquid Nitrogen System as a backup. Nitrogen Membrane Package operates at 145 psia / 100°F / 2.59 MMSCFD. Liquid Nitrogen System operates at 125 psia / 100°F / 0.8 MMSCFD. Nitrogen is provided to users at 125 psia / 100°F.

Comment: -VNTG961601 has been deleted (Liquid Nitrogen Vaporizer Package) - truck connection instead
-No nitrogen distribution to control room

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 30. BBJ-678600 AGRU Solvent Storage Tank, PBJ-678602 Agru Solvent Transfer Pump, MAJ-678603 AGRU Solvent Makeup Filter, BBJ-678604 AGRU Fresh Solvent Storage Tank, PBJ-678606 AGRU Fresh Solvent Transfer Pump, HAP-678601 AGRU Solvent Storage Tank Heater, HAP-678605 AGRU Fresh Solvent Storage Tank Heater,Lean Solvent Line to the AGRU Solvent Flash Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000678-013 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-60-000678-019

Design Conditions/Parameters: To provide for fresh Solvent storage and transfer to the AGRU. The AGRU Fresh Solvent Transfer Pump operates at 218 psia discharge pressure / 50 USGPM. The AGRU Solvent Transfer Pump operates at 237.1 psia discharge pressure / 1200 USGPM / 80°F.

Comment: -SDV for solvent from makeup filter is now downstream of FCV
-building heat medium coils no longer controlled with TC (globe valve now)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. High temperature in BBJ678600/604 could cause risk to personnel	S		49. Add high temperature alarm to BBJ678600 and 604	1. New consequence since temperature controlled heating medium changed to manual.
		2.1.2. Low temperature in BBJ678600/604 could cause freezing of AGRU solvent or precipitation of activator	OP		50. Add low temperature alarm to BBJ678600 and 604	1. New consequence since temperature controlled heating medium changed to manual.
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard /					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 30. BBJ-678600 AGRU Solvent Storage Tank, PBJ-678602 Agru Solvent Transfer Pump, MAJ-678603 AGRU Solvent Makeup Filter, BBJ-678604 AGRU Fresh Solvent Storage Tank, PBJ-678606 AGRU Fresh Solvent Transfer Pump, HAP-678601 AGRU Solvent Storage Tank Heater, HAP-678605 AGRU Fresh Solvent Storage Tank Heater,Lean Solvent Line to the AGRU Solvent Flash Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000678-013 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-60-000678-019

Design Conditions/Parameters: To provide for fresh Solvent storage and transfer to the AGRU. The AGRU Fresh Solvent Transfer Pump operates at 218 psia discharge pressure / 50 USGPM. The AGRU Solvent Transfer Pump operates at 237.1 psia discharge pressure / 1200 USGPM / 80°F.

Comment: -SDV for solvent from makeup filter is now downstream of FCV
-building heat medium coils no longer controlled with TC (globe valve now)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 31. ABJ-671600 Methanol Storage Tank, PBJ-671601 Methanol Injection Pump, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-60-000671-131 Rev. B
Design Conditions/Parameters: To provide methanol for various injection points. Methanol Injection Pump operates at 737.3 psia / 50 USGPM.
Comment: -Node 31 no longer exists (methanol tank deleted).

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard /					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 31. ABJ-671600 Methanol Storage Tank, PBJ-671601 Methanol Injection Pump, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-60-000671-131 Rev. B
Design Conditions/Parameters: To provide methanol for various injection points. Methanol Injection Pump operates at 737.3 psia / 50 USGPM.
Comment: -Node 31 no longer exists (methanol tank deleted).

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 32. BBJ-678607 TEG Makeup Storage Tank, HAP-678608 TEG Makeup Storage Tank Heating Coil, PBJ-678609 TEG Supply Pump, MAJ-678613 TEG Solvent Filter, TEG Piping to the TGDU / CO2 Dehy Flash Drums and Trains 1 / 2 Headers, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-60-000678-130 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDZZZ-60-000678-135; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000667-057
Design Conditions/Parameters: To provide for storage, filtering, and transfer of TEG to the process. The TEG Supply Pump operates at 216.7 psia discharge pressure / 95 USGPM.
Comment: -MAJ678613 no longer exists, deleted, (TEG Solvent Filter)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard /					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 32. BBJ-678607 TEG Makeup Storage Tank, HAP-678608 TEG Makeup Storage Tank Heating Coil, PBJ-678609 TEG Supply Pump, MAJ-678613 TEG Solvent Filter, TEG Piping to the TGDU / CO2 Dehy Flash Drums and Trains 1 / 2 Headers, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-60-000678-130 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDZZZ-60-000678-135; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000667-057
Design Conditions/Parameters: To provide for storage, filtering, and transfer of TEG to the process. The TEG Supply Pump operates at 216.7 psia discharge pressure / 95 USGPM.
Comment: -MAJ678613 no longer exists, deleted, (TEG Solvent Filter)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

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Node: 33. BBJ-911600 Diesel Fuel Storage Tank, PBJ-911605 Diesel fuel Pump, MAJ-911606 Diesel Fuel Filter, PBJ-911608 Diesel Fueling Station Delivery Pump, MBA-911607 Diesel Fueling Station Storage Drum, MAJ-911604 Diesel Recycle Filter, VMBA-911603 Diesel Drain Centrifuge, PBJ-911602 Diesel Drain Pump, MBA-837600 Dormitory Emergency Diesel Generator Day Storage, MBA-837601 Essential Diesel Generator Day Storage, Communication Tower Diesel Day, Water from the Centrifuge to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000911-103 Rev. B; USAG-EC-PDRBD-60-000837-101 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000911-109; USAG-EC-PDZZZ-60-000837-108

Design Conditions/Parameters: To provide for storage, water separation, filtering, and transfer of Diesel Fuel to the users. The Diesel Fuel Pump operates at 54.7 psia discharge pressure / 50 USGPM / ambient suction temperature. The Diesel Drain Pump operates at 54.7 psia / 10 USGPM / ambient suction temperature.

Comment: -Diesel drain centrifuge, diesel drain pump, and diesel recycle filter DELETED
-SDV upstream of diesel fuel pump deleted
-MAJ991606 (diesel fuel filter) DELETED.
-Diesel Fueling Station Storage Drum only filled by truck (not delivery pump)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard /					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 33. BBJ-911600 Diesel Fuel Storage Tank, PBJ-911605 Diesel fuel Pump, MAJ-911606 Diesel Fuel Filter, PBJ-911608 Diesel Fueling Station Delivery Pump, MBA-911607 Diesel Fueling Station Storage Drum, MAJ-911604 Diesel Recycle Filter, VMBA-911603 Diesel Drain Centrifuge, PBJ-911602 Diesel Drain Pump, MBA-837600 Dormitory Emergency Diesel Generator Day Storage, MBA-837601 Essential Diesel Generator Day Storage, Communication Tower Diesel Day, Water from the Centrifuge to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000911-103 Rev. B; USAG-EC-PDRBD-60-000837-101 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000911-109; USAG-EC-PDZZZ-60-000837-108

Design Conditions/Parameters: To provide for storage, water separation, filtering, and transfer of Diesel Fuel to the users. The Diesel Fuel Pump operates at 54.7 psia discharge pressure / 50 USGPM / ambient suction temperature. The Diesel Drain Pump operates at 54.7 psia / 10 USGPM / ambient suction temperature.

Comment: -Diesel drain centrifuge, diesel drain pump, and diesel recycle filter DELETED
-SDV upstream of diesel fuel pump deleted
-MAJ991606 (diesel fuel filter) DELETED.
-Diesel Fueling Station Storage Drum only filled by truck (not delivery pump)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 34. TGT-837610-612 Essential Power Generator Gas Turbine, STKV-837607-609 Essential Power Generator Turbine Stack, HP Fuel Gas Piping from the Fuel Gas Header, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDRBD-60-000837-101 Rev. B; USAG-EC-PDZZZ-60-000965-075
Design Conditions/Parameters: To provide HP Fuel Gas to the Essential Power Generator Gas Turbines at 82.1°F / 530 psig.
Comment: -Node 34 no longer exists - this was for the Essential Power Generators which have been deleted.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 34. TGT-837610-612 Essential Power Generator Gas Turbine, STKV-837607-609 Essential Power Generator Turbine Stack, HP Fuel Gas Piping from the Fuel Gas Header, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDRBD-60-000837-101 Rev. B; USAG-EC-PDZZZ-60-000965-075
Design Conditions/Parameters: To provide HP Fuel Gas to the Essential Power Generator Gas Turbines at 82.1°F / 530 psig.
Comment: -Node 34 no longer exists - this was for the Essential Power Generators which have been deleted.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	operability impact					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 35. BBJ-678614 Hydrocarbon Disposal Tank, HAP-678615 Hydrocarbon Disposal Tank Heating Coil, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-60-000679-132 Rev. B; USAG-EC-PDZZZ-60-000679-137
Design Conditions/Parameters: To provide storage for hydrocarbons to be disposed of. Hydrocarbon Disposal Tank operates at atmospheric pressure with 350 bbl capacity and electrical heating element to maintain a minimum temperature to be specified.
Comment: -Tank has been renamed (Hydrocarbon Holding Tank) and tank no longer has an electric heating coil.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard /					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 35. BBJ-678614 Hydrocarbon Disposal Tank, HAP-678615 Hydrocarbon Disposal Tank Heating Coil, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-60-000679-132 Rev. B; USAG-EC-PDZZZ-60-000679-137
Design Conditions/Parameters: To provide storage for hydrocarbons to be disposed of. Hydrocarbon Disposal Tank operates at atmospheric pressure with 350 bbl capacity and electrical heating element to maintain a minimum temperature to be specified.
Comment: -Tank has been renamed (Hydrocarbon Holding Tank) and tank no longer has an electric heating coil.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 36. MBD-612506 HP Hydrocarbon Flare KO Drum, PBA-612507A/B HP Hydrocarbon Flare Blowdown Pumps, FLRH-612508 HP Hydrocarbon Flare, FLRH-612511 HP Hydrocarbon Flare, LP Fuel Gas Lines to Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the AGRU Solvent Storage Tank, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDZZZ-60-000678-019; USAG-EC-PDZZZ-50-000612-070; USAG-EC-PDZZZ-60-000965-075

Design Conditions/Parameters: To provide means to flare high pressure hydrocarbon systems. The HP Hydrocarbon Flare KO Drum operates at -150-200°F / 115 psia. The HP Hydrocarbon Flare Blowdown Pump operates at 54.6 psia discharge pressure / 150°F suction temperature / 1260 USGPM. Maximum flowrate basis is one train relief and start-up of one train. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential flare flame out scenario venting hydrocarbons(methane) out of flare stack	S		28. Generate flare flame out dispersion model scenarios for hydrocarbons (methane).	
		4.1.2. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard /					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 36. MBD-612506 HP Hydrocarbon Flare KO Drum, PBA-612507A/B HP Hydrocarbon Flare Blowdown Pumps, FLRH-612508 HP Hydrocarbon Flare, FLRH-612511 HP Hydrocarbon Flare, LP Fuel Gas Lines to Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the AGRU Solvent Storage Tank, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDZZZ-60-000678-019; USAG-EC-PDZZZ-50-000612-070; USAG-EC-PDZZZ-60-000965-075

Design Conditions/Parameters: To provide means to flare high pressure hydrocarbon systems. The HP Hydrocarbon Flare KO Drum operates at -150-200°F / 115 psia. The HP Hydrocarbon Flare Blowdown Pump operates at 54.6 psia discharge pressure / 150°F suction temperature / 1260 USGPM. Maximum flowrate basis is one train relief and start-up of one train. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 37. MBD-612500 HP CO2 Flare KO Drum, PBA-612501A/B HP CO2 Flare Blowdown Pumps, FLRH-612502 HP CO2 Flare, FLRH-612505 HP CO2 Flare, LP Fuel Gas / Backup Assist Gas / Assist Gas Lines to the Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000612-061 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-50-000612-071

Design Conditions/Parameters: To provide means to flare high pressure CO2 systems. The HP CO2 Flare KO Drum operates at -130-110°F / 65 psia. The HP CO2 Flare Blowdown Pump operates at 53.7 psia discharge pressure / 40°F suction temperature / 25 USGPM. Maximum flowrate basis is one train blocked outlet. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. Potential for cold discharge into flare header with result in CO2 solids in the flare header and possible plugging.	S	1. Pipe size and velocity calculations 2. Demonstrated testing has been completed and velocity criteria has been developed.	29. Design flare header to account for CO2 solids.	
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential flare flame out scenario venting CO2 / H2S out of flare stack	S		30. Generate flare flame out dispersion model scenarios for CO2 / H2S.	
		4.1.2. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Potential flare flame out scenario venting CO2 / H2S out of flare stack	ENV	1. Assist Gas and Backup assist gas	30. Generate flare flame out dispersion model scenarios for CO2 / H2S.	
		6.1.2. Potential flare flame out scenario venting CO2 / H2S out of flare stack	S	1. Assist Gas and Backup assist gas	30. Generate flare flame out dispersion model scenarios for CO2 / H2S.	
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 37. MBD-612500 HP CO2 Flare KO Drum, PBA-612501A/B HP CO2 Flare Blowdown Pumps, FLRH-612502 HP CO2 Flare, FLRH-612505 HP CO2 Flare, LP Fuel Gas / Backup Assist Gas / Assist Gas Lines to the Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000612-061 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-50-000612-071

Design Conditions/Parameters: To provide means to flare high pressure CO2 systems. The HP CO2 Flare KO Drum operates at -130-110°F / 65 psia. The HP CO2 Flare Blowdown Pump operates at 53.7 psia discharge pressure / 40°F suction temperature / 25 USGPM. Maximum flowrate basis is one train blocked outlet. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 38. MBD-613506 LP Hydrocarbon Flare KO Drum, PBA-613507A/B LP Hydrocarbon Flare Blowdown Pumps, FLRL-613508 LP Hydrocarbon Flare, FLRL-613512 LP Hydrocarbon Flare, CAL-613509 LP Hydrocarbon Flare Air Blower, CAL-613513 LP Hydrocarbon Flare Air Blower, LP Fuel Gas to Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000613-062 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-50-000613-072; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide means to flare low pressure hydrocarbon systems. The LP Hydrocarbon Flare KO Drum operates at 37-165°F / 30 psia. The LP Hydrocarbon Flare Blowdown Pump operates at 47.8 psia discharge pressure / 165°F suction temperature / 80 USGPM. Maximum flowrate basis is HP to LP fuel gas blowby. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential flare flame out scenario venting hydrocarbons(methane) out of flare stack	S		28. Generate flare flame out dispersion model scenarios for hydrocarbons (methane).	
		4.1.2. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard /					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 38. MBD-613506 LP Hydrocarbon Flare KO Drum, PBA-613507A/B LP Hydrocarbon Flare Blowdown Pumps, FLRL-613508 LP Hydrocarbon Flare, FLRL-613512 LP Hydrocarbon Flare, CAL-613509 LP Hydrocarbon Flare Air Blower, CAL-613513 LP Hydrocarbon Flare Air Blower, LP Fuel Gas to Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000613-062 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-50-000613-072; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide means to flare low pressure hydrocarbon systems. The LP Hydrocarbon Flare KO Drum operates at 37-165°F / 30 psia. The LP Hydrocarbon Flare Blowdown Pump operates at 47.8 psia discharge pressure / 165°F suction temperature / 80 USGPM. Maximum flowrate basis is HP to LP fuel gas blowby. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 39. MBD-613500 LP CO2 Flare KO Drum, PBA-613501A/B LP CO2 Flare Blowdown Pump, FLRL-613502 / 514 / 515 LP CO2 Flare, FLRL-613505 / 516 / 517 LP CO2 Flare, LP Fuel Gas / Backup Assist Gas / Assist Gas Lines to the Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000613-063 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-50-000609-003; USAG-EC-PDZZZ-50-000613-073

Design Conditions/Parameters: To provide means to flare low pressure CO2 systems. The LP CO2 Flare KO Drum operates at -40-245°F / 25 psia. The LP CO2 Flare Blowdown Pump operates at 42.7 psia discharge pressure / 160°F suction temperature / 25 USGPM. Maximum CO2 flowrate basis is blocked-in CO2 injection line. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -new assist gas jumpover from PBU - not previously on RBDs
-blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. Potential for cold discharge into flare header with result in CO2 solids in the flare header and possible plugging.	S	1. Pipe size and velocity calculations 2. Demonstrated testing has been completed and velocity criteria has been developed.	29. Design flare header to account for CO2 solids.	
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential flare flame out scenario venting CO2 / H2S out of flare stack	S		30. Generate flare flame out dispersion model scenarios for CO2 / H2S.	
		4.1.2. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Potential flare flame out scenario venting CO2 / H2S out of flare stack	ENV	1. Assist Gas and Backup assist gas	30. Generate flare flame out dispersion model scenarios for CO2 / H2S.	
		6.1.2. Potential flare flame out scenario venting CO2 / H2S out of flare stack	S	1. Assist Gas and Backup assist gas	30. Generate flare flame out dispersion model scenarios for CO2 / H2S.	
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 39. MBD-613500 LP CO2 Flare KO Drum, PBA-613501A/B LP CO2 Flare Blowdown Pump, FLRL-613502 / 514 / 515 LP CO2 Flare, FLRL-613505 / 516 / 517 LP CO2 Flare, LP Fuel Gas / Backup Assist Gas / Assist Gas Lines to the Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000613-063 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-50-000609-003; USAG-EC-PDZZZ-50-000613-073

Design Conditions/Parameters: To provide means to flare low pressure CO2 systems. The LP CO2 Flare KO Drum operates at -40-245°F / 25 psia. The LP CO2 Flare Blowdown Pump operates at 42.7 psia discharge pressure / 160°F suction temperature / 25 USGPM. Maximum CO2 flowrate basis is blocked-in CO2 injection line. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -new assist gas jumpover from PBU - not previously on RBDs
-blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 40. STR-976700A/B Put River Water Pump Strainers, PBJ-976701A/B Put River Water Pumps, KAU-976708 Put Water Regulatory Metering, Put Water Reservoir, STR-976702A/B Reservoir Water Strainers, PBJ-976703A/B Reservoir Water Supply Pumps, VPBK-976704 Reservoir Water Biocide Injection Package, VPBK-976705 Reservoir Water Oxygen Scavenger Injection Package, MAJ-976706A/B Reservoir Water Filter, PBJ-976707A/B Reservoir Water Delivery Pumps, BBJ-976602 / BBJ-976604 Raw Water Storage Tanks, HAP-976601 / HAP-976603 Raw Water Storage Tank Heating Elements, PBJ-976600A/B Service Water Pumps, VMBM-683610 UV Sterilization Package, Service Water to the Process Water Treatment System IncludingChemical Injection Package and R.O. Filter, Service Water to Utility Station Users, Raw Water to Potable Water Treatment System, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-70-000976-120 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-60-000976-116 Rev. B; USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-60-000976-119 Rev. B; USAG-EC-PDRBD-60-000977-121 Rev. B; USAG-EC-PDZZZ-50-000609-003; USAG-EC-PDZZZ-60-000976-120; USAG-EC-PDZZZ-60-000976-124; USAG-EC-PDZZZ-70-000976-125; USAG-EC-PDZZZ-70-000976-126

Design Conditions/Parameters: To provide for transfer, treatment, filtering, storage, and sterilization of Raw Water from the Put River to meet Service / Process / Potable Water requirements. Conditions of service are yet to be defined for the transfer and treatment of Put River water to the GTP Raw Water Storage Tanks. Service Water Pumps operate at 117.5 psia discharge pressure / 392 USGPM to supply Service Water at 50°F / 110 psia to Process Water Treatment and Utility Station Distribution header.

Comment: -new raw water line to operations camp (line not on RBDs)
-New Service Water Jockey pump for continuous circulation/flow (PBJ976609)
-New Service Water Strainer (STR976605)
-New biocide and O2 scavenger injection packages on service water
-New Raw Water Reservoir Regulatory Meter (not on RBDs)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Maintenance philosophy	3.1.1. Potential plugging of STR976605 requires shutting down service water system, potentially causing disruption of water supply to AGRU water treatment and utility stations and potable water treatment	OP	1. Storage in water treatment packages	51. Consider adding spare strainer in parallel to STR976605	1. New consequence because strainer was added.
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety,					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 40. STR-976700A/B Put River Water Pump Strainers, PBJ-976701A/B Put River Water Pumps, KAU-976708 Put Water Regulatory Metering, Put Water Reservoir, STR-976702A/B Reservoir Water Strainers, PBJ-976703A/B Reservoir Water Supply Pumps, VPBK-976704 Reservoir Water Biocide Injection Package, VPBK-976705 Reservoir Water Oxygen Scavenger Injection Package, MAJ-976706A/B Reservoir Water Filter, PBJ-976707A/B Reservoir Water Delivery Pumps, BBJ-976602 / BBJ-976604 Raw Water Storage Tanks, HAP-976601 / HAP-976603 Raw Water Storage Tank Heating Elements, PBJ-976600A/B Service Water Pumps, VMBM-683610 UV Sterilization Package, Service Water to the Process Water Treatment System IncludingChemical Injection Package and R.O. Filter, Service Water to Utility Station Users, Raw Water to Potable Water Treatment System, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-70-000976-120 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-60-000976-116 Rev. B; USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-60-000976-119 Rev. B; USAG-EC-PDRBD-60-000977-121 Rev. B; USAG-EC-PDZZZ-50-000609-003; USAG-EC-PDZZZ-60-000976-120; USAG-EC-PDZZZ-60-000976-124; USAG-EC-PDZZZ-70-000976-125; USAG-EC-PDZZZ-70-000976-126

Design Conditions/Parameters: To provide for transfer, treatment, filtering, storage, and sterilization of Raw Water from the Put River to meet Service / Process / Potable Water requirements. Conditions of service are yet to be defined for the transfer and treatment of Put River water to the GTP Raw Water Storage Tanks. Service Water Pumps operate at 117.5 psia discharge pressure / 392 USGPM to supply Service Water at 50°F / 110 psia to Process Water Treatment and Utility Station Distribution header.

Comment: -new raw water line to operations camp (line not on RBDs)
-New Service Water Jockey pump for continuous circulation/flow (PBJ976609)
-New Service Water Strainer (STR976605)
-New biocide and O2 scavenger injection packages on service water
-New Raw Water Reservoir Regulatory Meter (not on RBDs)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Updated: 4. 6/8/2016

Node: 41. Process Water Treatment System: BBJ-683601 R.O. Feed Tank, HAP-683602 R.O. Feed Tank Heating Element, R.O. Feed Pump, Chemical Injection Package, R.O. Modules, BBJ-683603 Process Water Storage Tank, HAP-683604 Process Water Storage Tank Heating Element, PBJ-683608A/B Process Water Pump, Permeate Recirculation Pump, BBJ-683605 R.O. Rejection Water Storage Tank, HAP-683606 R.O. Rejection Water Storage Tank Heating Element, PBJ-683609A/B R.O. Reject Water Pump and Discharge Piping to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-000683-122

Design Conditions/Parameters: To provide for the treatment, storage, and transfer of Process Water and R.O. Rejection Water. The Process Water Pumps operate at 210 psia discharge pressure / 50-70 USGPM. The R.O. Reject Water Pumps operate at 33.5 psia discharge pressure / 16-25 USGPM.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 41. Process Water Treatment System: BBJ-683601 R.O. Feed Tank, HAP-683602 R.O. Feed Tank Heating Element, R.O. Feed Pump, Chemical Injection Package, R.O. Modules, BBJ-683603 Process Water Storage Tank, HAP-683604 Process Water Storage Tank Heating Element, PBJ-683608A/B Process Water Pump, Permeate Recirculation Pump, BBJ-683605 R.O. Rejection Water Storage Tank, HAP-683606 R.O. Rejection Water Storage Tank Heating Element, PBJ-683609A/B R.O. Reject Water Pump and Discharge Piping to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-000683-122

Design Conditions/Parameters: To provide for the treatment, storage, and transfer of Process Water and R.O. Rejection Water. The Process Water Pumps operate at 210 psia discharge pressure / 50-70 USGPM. The R.O. Reject Water Pumps operate at 33.5 psia discharge pressure / 16-25 USGPM.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

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Updated: 4. 6/8/2016

Node: 42. VMBM-977606 Potable Water Treatment System, BBJ-977600 / 601 Potable Water Tanks, HAP-977602 / 603 Potable Water Tank Heating Elements, PPW-977604A/B/C Potable Water Pumps, PPW-977607A/B Potable Water Camp Supply Pumps, VMBM-977605 UV Sterilization Package, Potable Water Supply / Return Headers for Users, Reject Water Line from the Potable Water Treatment System to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000977-121 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDRBD-60-000977-122 Rev. B; USAG-EC-PDZZZ-60-000977-127; USAG-EC-PDZZZ-60-000977-128; USAG-EC-PDZZZ-60-000977-129; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide Potable Water to the GTP Distribution Header / Camp Potable Water Storage and recirculation from eyewash / safety showers back to the Potable Water Tanks. Potable Water Pumps operate at 92.5 psia discharge pressure / 28 USGPM. Potable Water Camp Supply Pumps operate at 165 psia discharge pressure / 250 USGPM.

Comment: -Pumps PPW977607A/B (Potable Water Camp Supply Pumps) have been deleted.
-Potable water no longer going to the following areas: HP/LP flare KO drums, treated gas chilling and metering, inlet metering, warehouse

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 42. VMBM-977606 Potable Water Treatment System, BBJ-977600 / 601 Potable Water Tanks, HAP-977602 / 603 Potable Water Tank Heating Elements, PPW-977604A/B/C Potable Water Pumps, PPW-977607A/B Potable Water Camp Supply Pumps, VMBM-977605 UV Sterilization Package, Potable Water Supply / Return Headers for Users, Reject Water Line from the Potable Water Treatment System to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000977-121 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDRBD-60-000977-122 Rev. B; USAG-EC-PDZZZ-60-000977-127; USAG-EC-PDZZZ-60-000977-128; USAG-EC-PDZZZ-60-000977-129; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide Potable Water to the GTP Distribution Header / Camp Potable Water Storage and recirculation from eyewash / safety showers back to the Potable Water Tanks. Potable Water Pumps operate at 92.5 psia discharge pressure / 28 USGPM. Potable Water Camp Supply Pumps operate at 165 psia discharge pressure / 250 USGPM.

Comment: -Pumps PPW977607A/B (Potable Water Camp Supply Pumps) have been deleted.
-Potable water no longer going to the following areas: HP/LP flare KO drums, treated gas chilling and metering, inlet metering, warehouse

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 43. MBA-996112 TEG Drain Drum, PBA-996113 TEG Drain Drum, MAJ-996114 TEG Drain Filter, TEG Lines to the TGDU / CO2 TEG Flash Drums, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000661-031
Design Conditions/Parameters: To provide for the collection, filtration, and transfer of TEG drains. The TEG Drain Drum operates at 66°F / 14.7 psia. The TEG Drain Pump operates at 189.2 psia discharge pressure / 30 USGPM.
Comment: -TEG from the TEG drain drum can no longer be routed to CO2 Dehy, only the TGDU

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety,					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 43. MBA-996112 TEG Drain Drum, PBA-996113 TEG Drain Drum, MAJ-996114 TEG Drain Filter, TEG Lines to the TGDU / CO2 TEG Flash Drums, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000661-031
Design Conditions/Parameters: To provide for the collection, filtration, and transfer of TEG drains. The TEG Drain Drum operates at 66°F / 14.7 psia. The TEG Drain Pump operates at 189.2 psia discharge pressure / 30 USGPM.
Comment: -TEG from the TEG drain drum can no longer be routed to CO2 Dehy, only the TGDU

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 44. MBA-996100 AGRU Solvent Drain Drum, HAP-996101 AGRU Solvent Drain Drum Heater, PBA-996103 AGRU Solvent Drain Drum Pump, MAJ-996106 AGRU Solvent Drain Filter, Solvent Lines to the AGRU Solvent Storage Tank and AGRU Solvent Flash Drum, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-10-000662-011 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-60-000678-013 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000678-018
Design Conditions/Parameters: To provide for the collection, filtration, and transfer of AGRU Solvent drains. The AGRU Solvent Drain Drum operates at 66°F / 15 psia. The AGRU Solvent Drain Drum Pump operates at 217.7 psia discharge pressure / 225 USGPM.
Comment: -SDV for solvent from AGRU solvent drain filter has been deleted

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard /					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 44. MBA-996100 AGRU Solvent Drain Drum, HAP-996101 AGRU Solvent Drain Drum Heater, PBA-996103 AGRU Solvent Drain Drum Pump, MAJ-996106 AGRU Solvent Drain Filter, Solvent Lines to the AGRU Solvent Storage Tank and AGRU Solvent Flash Drum, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-10-000662-011 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-60-000678-013 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000678-018
Design Conditions/Parameters: To provide for the collection, filtration, and transfer of AGRU Solvent drains. The AGRU Solvent Drain Drum operates at 66°F / 15 psia. The AGRU Solvent Drain Drum Pump operates at 217.7 psia discharge pressure / 225 USGPM.
Comment: -SDV for solvent from AGRU solvent drain filter has been deleted

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 45. MBA-991106 Closed Drain Collection Drum, LP Fuel Gas Supply Line to the Collection Drum, PBA-991107A/B Closed Drain Collection Drum Pump, Collection Drum Supply Header, Bottoms Outlet from the Collection Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-60-000991-096
Design Conditions/Parameters: To provide for the collection and transfer of process drains requiring a closed system. The Closed Drain Collection Drum operates at 66°F / 15 psia. The Closed Drain Collection Drum Pump operates at 84.2 psia discharge pressure / 25 USGPM.
Comment: -seal pot and seal pot pump are new (not on RBDs)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	3.1.1. Overfilling MBA991108 when PBA991109A/B trips or does not start could cause open drain liquids to be released.	S	1. LAHH991108-04 trips upstream pumps feeding MBA991108	52. Ensure liquid containment outside the module is provided for the potential overflow, or re-evaluate seal pot design to avoid potential liquid release to atmosphere.	1. New consequence since configuration changed.
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential for backflow of hazardous components from tie in to closed drain system into module sumps. (Note: Open Drain module sumps are generally expected to be empty and funnels around equipment discharges into sump)	S		25. Segregate open and closed drain systems.	1. Session 2: "Consequences" and "Recommendations" no longer applicable; isolation provided by MBA991108.
		4.1.2. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety,					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 45. MBA-991106 Closed Drain Collection Drum, LP Fuel Gas Supply Line to the Collection Drum, PBA-991107A/B Closed Drain Collection Drum Pump, Collection Drum Supply Header, Bottoms Outlet from the Collection Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation
Drawing: USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-60-000991-096
Design Conditions/Parameters: To provide for the collection and transfer of process drains requiring a closed system. The Closed Drain Collection Drum operates at 66°F / 15 psia. The Closed Drain Collection Drum Pump operates at 84.2 psia discharge pressure / 25 USGPM.
Comment: -seal pot and seal pot pump are new (not on RBDs)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 46. BBH-992500 Oily Water Collection Sump - Refrigeration Compressor Module Including Heat Medium Supply / Return Piping and PBA-992501 Oily Water Pump - Refrigeration Compressor Module, BBH-992602 Oily Water Collection Sump - Service Water Area Including Heat Medium Supply / Return Piping and PBA-992603 Oily Water Pump - Service Water Area, BBH-992600 Oily Water Collection Sump - Common Utilities Including Heat Medium Supply / Return Piping and PBA-992601 Oily Water Pump - Common Utilities, BBH-992000 Oily Water Collection Sump - Integrated Housing Utilities Module Including HAP-992002 Oily Water Collection sump Heating Element - Integrated Housing Utilities Module and PBA-992001 Oily Water Pump - Integrated Housing Utilities Module, BBH-992606 Oily Water Collection Sump - Building Heat Medium Including Heat Medium Supply / Return Piping and PBA-992607 Oily Water Pump - Building Heat Medium, BBH-992604 Oily Water Collection Sump - Chemical Storage Including Heat Medium Supply / Return Piping and PBA-992605 Oily Water Pump - Chemical Storage, BBH-992502 Oily Water Collection Sump - Flare KO Drum Module Including Heat Medium Supply / Return Piping and PBA-992503 Oily Water Pump - Flare KO Drum Module, BBH-992608 Collection Sump - Water Treatment Module Including Heat Medium Supply / Return Piping and PBA-992609 Oily Water Pump - Water Treatment Module, MBA-991611 Common Closed Drain Collection Drum Including LP Fuel Gas Supply Line and Drain Supply Header, PAT-991612A/B Closed Drain Injection Booster Pumps, VPBK991602 Chemical Injection Package, MAJ-991613A/B Closed Drain Injection Filter, PAT-991614A/B Closed Drain Injection Pumps, KAU-991615 Closed Drain Injection Well Metering Station, QAT-991606A/B Class I Injection Wells, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000992-095 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-000991-097; USAG-EC-PDZZZ-60-000992-100

Design Conditions/Parameters: To provide for the collection, chemical injection, metering, and transfer of oily water drains from various process systems to Class I Injection Wells. Oily Water Pumps operate at 66.1 psia discharge pressure / 30 USGPM and discharge to the Common Closed Drain Collection Drum which operates at 66°F / 15 psia. The Closed Drain Injection Booster Pump operates at 161.6 psia discharge pressure / 130 USGPM. The Closed Drain Injection Pump operates at 2209 psia discharge pressure / 130 USGPM.

Comment: -seal pot and seal pot pump are new (not on RBDs)
-BBH992602 - deleted from this drawing. No more "raw water" open drain in the common open drain system - removed from drawing

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	3.1.1. Overfilling MBA991616 when PBA991617A/B trips or does not start could cause open drain liquids to be released.	S	1. LAHH991611-04 trips upstream pumps feeding MBA991616	52. Ensure liquid containment outside the module is provided for the potential overflow, or re-evaluate seal pot design to avoid potential liquid release to atmosphere.	1. New consequence since configuration changed.
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential for backflow of hazardous components from tie in to closed drain system into module sumps. (Note: Open Drain module sumps are generally expected to be empty and funnels around equipment discharges into sump)	S		25. Segregate open and closed drain systems.	1. Session 2: "Consequences", and "Recommendations" no longer applicable due to configuration change (isolation provided by MBA991616).
		4.1.2. Reference global node.				
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in					

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 46. BBH-992500 Oily Water Collection Sump - Refrigeration Compressor Module Including Heat Medium Supply / Return Piping and PBA-992501 Oily Water Pump - Refrigeration Compressor Module, BBH-992602 Oily Water Collection Sump - Service Water Area Including Heat Medium Supply / Return Piping and PBA-992603 Oily Water Pump - Service Water Area, BBH-992600 Oily Water Collection Sump - Common Utilities Including Heat Medium Supply / Return Piping and PBA-992601 Oily Water Pump - Common Utilities, BBH-992000 Oily Water Collection Sump - Integrated Housing Utilities Module Including HAP-992002 Oily Water Collection sump Heating Element - Integrated Housing Utilities Module and PBA-992001 Oily Water Pump - Integrated Housing Utilities Module, BBH-992606 Oily Water Collection Sump - Building Heat Medium Including Heat Medium Supply / Return Piping and PBA-992607 Oily Water Pump - Building Heat Medium, BBH-992604 Oily Water Collection Sump - Chemical Storage Including Heat Medium Supply / Return Piping and PBA-992605 Oily Water Pump - Chemical Storage, BBH-992502 Oily Water Collection Sump - Flare KO Drum Module Including Heat Medium Supply / Return Piping and PBA-992503 Oily Water Pump - Flare KO Drum Module, BBH-992608 Collection Sump - Water Treatment Module Including Heat Medium Supply / Return Piping and PBA-992609 Oily Water Pump - Water Treatment Module, MBA-991611 Common Closed Drain Collection Drum Including LP Fuel Gas Supply Line and Drain Supply Header, PAT-991612A/B Closed Drain Injection Booster Pumps, VPBK991602 Chemical Injection Package, MAJ-991613A/B Closed Drain Injection Filter, PAT-991614A/B Closed Drain Injection Pumps, KAU-991615 Closed Drain Injection Well Metering Station, QAT-991606A/B Class I Injection Wells, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000992-095 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-000991-097; USAG-EC-PDZZZ-60-000992-100

Design Conditions/Parameters: To provide for the collection, chemical injection, metering, and transfer of oily water drains from various process systems to Class I Injection Wells. Oily Water Pumps operate at 66.1 psia discharge pressure / 30 USGPM and discharge to the Common Closed Drain Collection Drum which operates at 66°F / 15 psia. The Closed Drain Injection Booster Pump operates at 161.6 psia discharge pressure / 130 USGPM. The Closed Drain Injection Pump operates at 2209 psia discharge pressure / 130 USGPM.

Comment: -seal pot and seal pot pump are new (not on RBDs)
-BBH992602 - deleted from this drawing. No more "raw water" open drain in the common open drain system - removed from drawing

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 47. Global Node
Drawing:
Design Conditions/Parameters: To document hazard scenarios not specific to a particular process, but global in nature.
Comment:

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy	1.1.1. No issues identified. Process for establishing manning requirements, control philosophy, and alarm rationalization is part of the project scope.				
	1.2. Facility risk exposure					
	1.3. Control philosophy - remote/local operations					
	1.4. Alarm minimization (EEMUA 191) Control room functions / capacity / modifications Control Room Operator Stress / manning levels					
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Toxic/hazardous inventories & minimization	2.1.1. Potential exposure of personnel to H2S due to loss of containment.	S		31. Review process simulation and locate areas where leaks to atmosphere result in high H2S concentrations. 32. Perform CFD dispersion analysis in areas identified in above recommendation 31 (e.g. TEG Dehy Regen, Overhead Reflux Water, Hot / Lean TEG).	
	2.2. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction					
	2.3. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)					
	2.4. Chemical reaction					
	2.5. Fatigue / Corrosion mechanisms					
	2.6. Flanges, joints, connections					
	2.7. Mechanical Failure (Flexible hoses, seals, bearings, compressors)					
	2.8. Foundation failure, ground heave					
	2.9. Restriction of movement					
	2.10. Impact damage (missiles, dropped objects, vehicles)					
	2.11. Human Factors					
	2.12. Electrical / utilities failure					
	2.13. Brownfield / Greenfield interface	2.13.1. Project construction next to live operating train		1. Simultaneous operation and construction execution plan is part of the project development		
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Maintenance philosophy					
	3.2. Equipment reliability					
	3.3. Access requirements					
	3.4. Manual venting					
	3.5. Manual draining					
	3.6. Use of bypasses					
	3.7. Use of overrides					
	3.8. Crane/lifting operations/dropped					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 47. Global Node
Drawing:
Design Conditions/Parameters: To document hazard scenarios not specific to a particular process, but global in nature.
Comment:

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	objects					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Loss of containment resulting in gas release, explosion, or fire.	S	1. Dispersion modeling (flammable and toxic) 2. Fire hazard analysis 3. Preliminary facility siting layout (based on blasting and dispersion analysis) 4. Fire hazard analysis, dispersion modeling and blast analysis will be updated as project progresses		
	4.2. Ignition sources - EX/hot surfaces					
	4.3. Lightning earthing conductors					
	4.4. Gas Flash Fires					
	4.5. Gas Jet Fires					
	4.6. Escalations between fire areas					
	4.7. Escalations between new plant & existing plant					
	4.8. Vulnerable Critical Equipment & Structure					
	4.9. Gas Explosion					
	4.10. Accumulation of gas clouds					
	4.11. Confinement					
	4.12. Pool Formation/Bunding/Drainage					
	4.13. Smoke/Gas Ingress					
	4.14. Predominant wind direction					
	4.15. Flammable gas detection					
	4.16. Fire/heat/smoke detection					
	4.17. Emergency shutdown functions					
	4.18. Emergency depressurisation functions					
	4.19. Passive fire protection					
	4.20. Active fire protection					
	4.21. Explosion Protection					
	4.22. Class A Fires					
	4.23. Low Temperatures/Brittle fracture					
	4.24. Air intake locations					
	4.25. Non Rated equipment outside hazardous areas					
	4.26. Plant Layout Standards					
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. Emergency Egress	5.1.1. Potential for long egress time during emergency event in the modules due to the size of the modules.	S	1. Codes, standards and regulations 2. Egress Evacuation and Rescue study		
	5.2. Escape routes					
	5.3. Emergency communications					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 47. Global Node
Drawing:
Design Conditions/Parameters: To document hazard scenarios not specific to a particular process, but global in nature.
Comment:

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	5.4. Emergency lighting					
	5.5. Muster areas					
	5.6. Personal Protective Equipment (PPE)					
	5.7. Means of evacuation					
	5.8. Means of escape					
	5.9. Rescue facilities					
	5.10. Post Accident Control					
	5.11. Fire Service Access					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Potential discharge of process stream to pad / tundra	ENV	1. Spill response team and spill clean up equipment on site 2. Supervised heat traced circuit 3. Operations procedure for maintenance of heat traced circuit		
	6.2. Discharges to Water/Sea (ground water, aquifers) normal operations (drains, sewerage, surface water, cooling water), maintenance/interventions (hydrostatic test fluids), emergency conditions					
	6.3. Facility Impact (flora & fauna)					
	6.4. Solids & Other Wastes					
	6.5. Fuel & Energy Consumption					
	6.6. Materials selection/use (selection & cost)					
	6.7. Use of fresh water					
	6.8. Noise and Vibration					
	6.9. Odour					
	6.10. Land Use (brownfield, greenfield, underground services, contaminated soil)					
	6.11. Visual Impact (landscape)					
	6.12. Delivery traffic					
	6.13. Hazards to Voles					
7. Section 7 Occupational Health Hazards	7.1. Chemicals to be used Health and safety data - toxics/irritants/carcinogens Substitution PPE and procedures Noise and Vibration Ergonomics (illumination, accessibility, manual handling) Heat radiation Thermal stress (cold / hot environment) Ionising and Electromagnetic Radiation Shift patterns - stress Biological hazards (e.g. Legionella)					
8. Section 8 Utility & Support Systems	8.1. Fuel gas					
	8.2. Diesel fuel					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 47. Global Node
Drawing:
Design Conditions/Parameters: To document hazard scenarios not specific to a particular process, but global in nature.
Comment:

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	8.3. Power supply					
	8.4. Drinking water					
	8.5. Potable water					
	8.6. Wash down water					
	8.7. Heating and ventilation					
	8.8. Drains - Open/Closed/grey/black/surface/hazardous					
	8.9. Inert gas					
	8.10. Chemical storage					
	8.11. Waste storage and treatment					
	8.12. Sewerage					
9. Section 9 External Hazards	9.1. Earthquake					
	9.2. Lightning					
	9.3. Subsidence					
	9.4. Flooding					
	9.5. Solar heating					
	9.6. Extreme weather - wind					
	9.7. Extreme weather - snow and ice					
	9.8. Extreme weather - very high ambient temperatures					
	9.9. Extreme weather - very low ambient temperatures					
	9.10. Security / Terrorist Acts					
	9.11. Aircraft crash					
	9.12. Neighboring facility	9.12.1. Neighboring facility has major loss of containment scenario resulting in unignited gas cloud or blast	S	1. Facility siting away from neighboring facility	33. Confirm with Prudhoe Bay that GTP facility is sited outside their consequence analysis exclusion zone for blast and dispersion.	
10. Section 10 Arctic Operations	10.1. Arctic Operations	10.1.1. Winterization and maintenance access to equipment located exterior to the modules results inability to safely maintain equipment due to snow and ice buildup impeding egress routes, extreme cold temperatures, and wind.	S	1. Winterization philosophy	34. Optimize outside equipment with winterization philosophy to ensure instrumentation and valves can be operated and maintained (e.g. AGRU module, Skim Oil valves, Absorber).	
		10.1.2. Falling ice off elevated equipment, resulting in equipment damage, loss of containment and potential personnel injury.	S	1. Winterization philosophy	35. Areas where potential for falling ice exist, review during 3-D model review and provide safeguards to protect equipment and personnel. 36. Utilize PBU experience during 3-D model review.	
11. Modules	11.1. Construction components					
12. Interfaces	12.1. Upstream / downstream facilities					
13. Previous incidents / Experiences	13.1. Construction execution					

Session: 3. 5/21/2015
Updated: 4. 6/8/2016
Node: 47. Global Node
Drawing:
Design Conditions/Parameters: To document hazard scenarios not specific to a particular process, but global in nature.
Comment:

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
14. Simultaneous Operation	14.1. Simultaneous Operation					

Session:
Updated: 4. 6/8/2016
Node: 48. MBA-679001 Gasoline Fuel Supply Tank
Drawing: USAG-EC-PDZZZ-00-000679-138
Design Conditions/Parameters: To supply gasoline for the facility. Note: this is a vendor package, details to be developed during FEED
Comment: -NEW NODE. Gasoline Fuel Supply tank not on RBDs.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				1. Vent to atmosphere (safe location) to be designed in accordance with all applicable regulations
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9 External Hazards	9.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard /					

Session:
Updated: 4. 6/8/2016
Node: 48. MBA-679001 Gasoline Fuel Supply Tank
Drawing: USAG-EC-PDZZZ-00-000679-138
Design Conditions/Parameters: To supply gasoline for the facility. Note: this is a vendor package, details to be developed during FEED
Comment: -NEW NODE. Gasoline Fuel Supply tank not on RBDs.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	Category having a safety, environmental, or significant operability impact					

7.0 ACRONYMS

Term	Definition
AGRU	Acid Gas Removal Unit
AKLNG	Alaska LNG Project
CB&I	Chicago Bridge & Iron Company
CFD	Computational Fluid Dynamics
FEED	Front End Engineering Design
FERC	Federal Energy Regulatory Commission
GTP	Gas Treatment Plant
HAZID	Hazard Identification
HIPPS	High Integrity Pressure Protection System
HMB	Heat and Material Balance
HP	High Pressure
HVAC	Heating, Ventilation and Air Conditioning
KO	Knock-out
LP	Low Pressure
MAOP	Maximum Allowable Working Pressure
P&ID	Piping and Instrumentation Diagram
PBU	Prudhoe Bay Unit
PPE	Personnel Protection Equipment
PSRG	Process Safety and Reliability Group
PTTL	Point Thompson Transmission Line
PTU	Point Thomson Unit
RBD	Relief and Blowdown Diagram
SDV	Shutdown Valve
TEG	Tri-ethylene Glycol
TGDU	Treated Gas Dehydration Unit
WHRU	Waste Heat Recovery Unit

8.0 REFERENCES

Document Number	Document Title
Refer to Documents included in Attachments 1 and 2 (Appendix A)	
USAG-EC-FBCHT-00-000001-000	Pre-FEED HAZID Review Charter
USAG-EC-LDLAY-00-000004-000	Gas Treatment Plant – Site Plan
USAG-EC-LDLAY-00-000005-001	Gas Treatment Plant – Plot Plan

9.0 ATTACHMENT 1 – HAZID REVIEW SESSION 1

HAZID Review Report - Session 1

10.0 ATTACHMENT 2 – HAZID REVIEW SESSION 2

10.1 APPENDIX A – HAZID NODES

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
1.	Prudhoe Bay Unit / Point Thomson Unit Feed Gas to the Gas Treatment Plant Including MAM-609501 PTU Inlet KO Drum, MAJ-609504A/B PTU Liquid Re-injection Filter, MAK-662100 / 101 AGRU Filter Separators, KGR-609500 PTU Inlet Pig Receiver, and Associated Piping and Instrumentation.	To provide feed gas from PTU and PBU Winter rates Pressure: PTU 650-1130 psig / PBU 580-620 psig Temperature: PTU / PBU Ambient , Flow: PTU 950 scfd / PBU 3 billion scfd	-New HP HC vent to flare on Pig Receiver KGR609500 -PBU feed gas metering station now upstream of HCV to flare and SDV -PCV is now upstream of the KO drum, new PDC downstream of KO drum -New PT to GTP historian to satisfy B31.3 requirements -Liquids SDV from KO drum is now upstream of flare take off -New PSV on shell side of AGRU feed gas preheater	USAG-EC-PDZZZ-50-000609-001; USAG-EC-PDZZZ-50-000609-004; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-60-000991-096	June 8th, 2016
2.	Treated Gas from Overhead of MAF-662103 AGRU Absorber through the HFF-662104-01 thru 04 AGRU Absorber Overhead Cooler / AGRU Water Wash Tower / TGDU TEG Contactor through the MBD-651100 Treated Gas Compressor 1st Stage KO Drum / CAX-651101 Treated Gas Compressor 1st Stage / HFF-651102-01 thru 08 Treated Gas Compressor Interstage Coolers / MBD-651103 Treated Gas Compressor 2nd Stage KO Drum / CAX-651101 Treated Gas Compressor 2nd Stage / HFF-651105-01 thru 08 Treated Gas	To provide sweet / dry gas to pipeline Winter rates: Pressure: Gas is compressed from 553-2151 psia Temperature: PTU / PBU Ambient , Flow: Combined flow rate 3.3 billion scfd	-New 2nd compressor string (6x20% compressors), 2 per train -Liquid outlet SDV now upstream of LCV -Treated Gas Compression 2nd Stage KO drum is deleted -Treated gas lines from compressors now tie into chiller header - second SDV for each train was deleted	USAG-EC-PDZZZ-10-000651-035; USAG-EC-PDZZZ-10-000651-036; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000651-032; USAG-EC-PDZZZ-10-000651-033; USAG-EC-PDZZZ-10-000651-035	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	Compressor After Coolers to the Treated Gas Chiller, and Associated Piping and Instrumentation.				
3.	Treated Gas from Treated Gas Compressor through the HBG-666500 / 501 Treated Gas Chillers / Treated Gas Metering Station and Pig Launcher (as necessary) to the Pipeline, Refrigerant Liquid Inlet / Exit Lines for the Chillers, MBD-666520 / 521 Treated Gas Chiller Oil Drum, HAP-666525 / 526 Treated Gas Chiller Oil Drum Vaporizer, and Associated Piping and Instrumentation.	To chill and meter treated gas to pipeline. Winter rates: Pressure: 2075 psig Temperature: 30 F, Flow: 3.3 billion scfd	-Pig launcher for treated gas mainline to pipeline deleted from drawing (shown on Pipeline Drawing) -There is now a bypass on the treated gas side of the chillers (not on RBDs) -Oil drum/ vaporizer only one (common) for chillers (RBDs had one per chiller)	USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-50-000666-040; USAG-EC-PDZZZ-50-000666-041	June 8th, 2016
4.	EAP-651107 / EAP-658113 / EAP-833102/103 Heat Recovery Units for Treated Gas Compressor / CO2 Compression / Power Generator Including Supplemental Firing BMSs Utilizing LP Fuel Gas, Fuel Conditioning & Control Skids for HP Fuel Gas, CGT-651106 Treated Gas Compressor Gas Turbine / CGT-658106 CO2 Compression Turbine / TGT-833100/101 Power Generator Gas Turbines, STKV-651108 Treated Gas Compressor Turbine Stack / STKV-65814 CO2 Compression Turbine Stack / STKV-833104/105 Power Generator Turbine Stacks, STKV-651109 Treated Gas Compressor Turbine Bypass Stack / STKV-658115 CO2 Compression Turbine Bypass Stack / STKV-	To provide heat to AGRU reboiler for regeneration of amine from waste heat recovery unit on turbine exhausts. Pressure: Expansion Tank 200 psig discharge of pump 360 psig Temperature: TEG is heated from 300 F to 380F, Flow: 15000 GPM	-Heat medium changed from TEG/Water to Water -Tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles -RBDs had two filters, there is only on PHM filter now -New oxygen scavenger and corrosion inhibitor injection package (previously on raw water line) -New makeup water line to the process heat medium expansion drum	USAG-EC-PDZZZ-10-000942-085; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000651-034; USAG-EC-PDZZZ-10-000651-037; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000942-086	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.				
5.	Lean Solvent for the AGRU Absorber: MAF-662128 AGRU Solvent Regenerator and Bottoms Outlet Flow through the HPL-662119-121 AGRU Lean Rich Exchanger through the Tubeside of the HBG-662102 AGRU Feed Gas Preheater through the HFF-662108-01 thru 24 AGRU Lean Solvent Coolers and MAJ-662109 / MAJ-662110 / MAJ-662111 (sidestream Filters) through the PBA-662112A/B/C AGRU Lean Solvent Pump to the AGRU Absorber, HBC-662133-138 AGRU Solvent Reboiler, and Associated Piping and Instrumentation.	To provide lean amine to absorb CO2 and H2S from feed gas. Winter rates: Pressure: Regenerator 33 psia Contactor 562 psia Temperature: Regenerator 266°F Contactor 97°F , Flow: 15000 gpm	New PSV downstream of air cooler.	USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000662-012; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000662-014; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-60-000678-019	June 8th, 2016
6.	AGRU Water Wash System: Make-up Process Water from Treatment through the PBA-662107A/B AGRU Water Wash Makeup Pump through the MAF-662105 AGRU Water Wash Tower to the Solvent Flash Drum Including Circulation through the PBA-662106A/B AGRU Water Wash Pump, and Associated Piping and	To provide make-up water for scrubbing of AGRU Absorber overhead stream at 80°F / 47.2 gpm. Wash tower operates at 80°F / 557 psia. Wash water from the wash tower is routed to solvent flash drum at 80°F / 165 psia.	Liquid outlet SDV is now upstream of LCV	USAG-EC-PDZZZ-50-000609-004; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000662-011; USAG-EC-PDZZZ-10-	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	Instrumentation.			000662-013	
7.	MFA-662103 AGRU Absorber and Bottoms Outlet Flow through the MBD-662113 AGRU Solvent Flash Drum through the HPL-662119-121 AGRU Lean Rich Exchanger to the AGRU Solvent Regenerator, VPBK-662123 AGRU Anti-Foam Injection Package, Treated Flash Gas from the MAF-662114 AGRU Flash Gas Absorber to the LP Fuel Gas Dehy Inlet Scrubber Feed Line, and Associated Piping and Instrumentation.	Rich solvent from AGRU absorber is routed on level control to AGRU Solvent Flash Drum at 161°F / 565 psia / 47332 gpm where gas is allowed to flash at 161°F / 165 psia. Rich solvent from flash drum is preheated to 243°F and transferred to AGRU Solvent Regenerator at 214°F / 32.5 psia.	N/A	USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000662-014; USAG-EC-PDZZZ-10-000966-077	June 8th, 2016
8.	Lean TEG for the TGDU TEG Contactor: MAF-6611112 TGDU Regen Column and Bottoms Outlet through the Shellside of the HBG-661108 / 109 TGDU Hot TEG Lean / Rich Exchanger and HBG-661102 TGDU Cool TEG Lean / Rich Exchanger xthrough the PBA-661113A/B TGDU TEG Circulation Pump through the HFF-661114 TGDU Lean TEG Cooler to the TGDU TEG Contactor, HP Fuel Gas through the HAP-661122 TGDU Stripping Gas Heater, HAP-661116-121 TGDU TEG Reboiler, and Associated Piping and Instrumentation.	To regen TEG in the TGDU Regen Column by stripping with heated HP Fuel Gas. Rich TEG is regenerated and exits as Lean TEG at 24 psia / 374°F and is used to preheat rich feed to the Column before being fed to the TGDU TEG Contactor at 568 psia / 90°F / 241 gpm.	-New PSV on outlet of TGDU lean TEG cooler -New Lean TEG filters and corresponding PSVs (not on RBDs) -New PSV on outlet of TGDU TEG reboiler -New SDV on lean TEG from TGDU to Fuel Gas Treating	USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000966-078; USAG-EC-PDZZZ-10-000965-076	June 8th, 2016
9.	MAF-661100 TGDU TEG Contactor and Rich TEG Oulet Flow through the Tubeside of the HBG-661101 TGDU Offgas Cross Exchanger through the	To provide for removal of moisture in Treated Gas from the AGRU Water Wash Tower by contact	-No more integral scrubber on TGDU TEG contactor (no water outlet line)	USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	Tubeside of the HBG-661102 TGDU Cool TEG Lean / Rich Exchanger through the MBD-661104 TGDU TEG Flash Drum through MAJ-661105A/B TGDU TEG Cartridge Filters / MAJ-661106 TGDU TEG Activated Carbon Filter / MAJ-661107 TGDU TEG After Filter through the Tubeside of the HBG-661108 / 109 TGDU Hot TEG Lean / Rich Exchanger to the TGDU Regen Column, TGDU Flash Gas from the TEG Flash Drum to Fuel Gas Dehy System, and Associated Piping and Instrumentation.	with TEG. Treated Gas enters the TGDU TEG Contactor at 80°F / 555 psia / 1162 MMSCFD per Train / 133.9 lbmole/hr H2O and exits at 82°F / 539 psia / 1160 MMSCFD / 0.17 lbmole/hr H2O (Winter base case).	-Only one rich TEG filter now (3 on RBDs) -New fire PSV on tube side of TGDU Hot L/R HEX -New PCV to flare on vapor outlet from TGDU TEG flash drum -New SDV on vapor outlet from TGDU TEG flash drum	000661-026; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000661-028	
10.	TGDU Overhead Vapor from the TGDU Regen Column through the Shellside of the HBG-661101 TGDU Offgass Cross Exchanger through the HFF-661123 TGDU Offgas Cooler through the MBF-661124 TGDU Offgas Scrubber through the CBA-661125 TGDU Offgas Compressor 1st Stage through the HFF-661126 TGDU Offgas Interstage Cooler through the MBF-661127 TGDU Offgas Interstage Scrubber through the CBA-661125 TGDU Offgas Compressor 2nd Stage through the HFF-966100-01 LP Fuel Gas Dehy Inlet Cooler through the MBD-966101 LP Fuel Gas Dehy Inlet Scrubber to the LP Fuel Gas TEG Contactor, Bottoms Outlet from MBD-966101 to the Closed Drain Collection Drum, and Associated Piping and Instrumentation.	To provide for recovery of Fuel Gas from the TGDU Regen Column overhead vapor. Vapor exits the Column at 241°F / 15.4 psia and is cooled to 77°F / 14.9 psia before being fed to the TGDU Offgas Scrubber where condensed liquids are returned to the Regen Column and vapors are routed to the suction of the TGDU Offgas Compressor. Vapors are compressed to 125 psia / 254°F, cooled and then routed to the LP Fuel Gas TEG Contactor via the LP Fuel Gas Dehy Inlet Scrubber at 77°F / 119.7 psia.	-HFF661123 deleted (air cooler). Cooling medium shell/tube exchanger instead (HBG661131). -Liquid outlet SDV (to Closed Drain Drum) deleted from RBDs -TGDU interstage scrubber and cooler have been deleted -compressor is shown as a vendor box - type changed to oil flooded screw compressor. -HFF966100 deleted (air cooler). Cooling medium shell/tube exchanger instead (HBG966105). -SDV deleted from liquid outlet of inlet scrubber	USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000661-028; USAG-EC-PDZZZ-10-000661-029; USAG-EC-PDZZZ-10-000661-030; USAG-EC-PDZZZ-10-000966-077; USAG-EC-PDZZZ-10-000966-078; USAG-EC-PDZZZ-10-000991-095	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
11.	MAF-966102 LP Fuel Gas TEG Contactor and Bottoms Outlet through the PBA-966103A/B LP Fuel Gas Dehy Rich TEG Recycle Pump to the TGDU TEG Flash Drum, and Associated Piping and Instrumentation.	To provide for scrubbing of Offgas Vapor from the TGDU Regen Column by contact with Lean TEG in the LP Fuel Gas TEG Contactor operating at 90°F / 119.7 psia.	N/A	USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000966-078	June 8th, 2016
12.	Treated LP Fuel Gas and LP Fuel Gas from Common Area to Users: MBD-966104 LP Fuel Gas KO Drum Including Overhead Feed Line from the LP Fuel Gas TEG Contactor through MBD-966104, Treated LP Fuel Gas from Overhead Outlet of MBD-966104 to Users, Bottoms Outlet from MBD-966104 to the Closed Drain Collection Drum, LP Fuel Gas from Common Area, and Associated Piping and Instrumentation.	To provide LP Fuel Gas to Train header at 60.5°F / 60 psig / 21.4 MMSCFD.	N/A	USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000966-078	June 8th, 2016
13.	Treated HP Fuel Gas and HP Fuel Gas to/from Common Area Including Buyback Gas and Backup HP Fuel Gas to Users: MBD-965100 HP Fuel Gas KO Drum Including Split Stream from Overhead Line from the TGDU TEG Contactor through MBD-965100, HP Fuel Gas from Overhead Outlet of MBD-965100 to Users, Bottoms Outlet from MBD-966100 to the Closed Drain Collection Drum, HP Fuel Gas from Common Area, MAJ-965501 Buyback Gas Filter, HAP-965503 Buyback Gas Heater, KAU-965500 Buyback Metering Station,	To provide HP Fuel Gas to users at 82.1°F / 530 psig / 135.5 MMSCFD.	-Electric heater has been replaced with two bath heaters for buyback gas (fire tube / ethylene glycol) -New SDV between HP and LP fuel gas	USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000991-095	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	and Associated Piping and Instrumentation.				
14.	CO2 Overhead from the AGRU Solvent Regenerator through the HFF-662130-01 thru 12 AGRU Solvent Regenerator Condensers to the AGRU Regenerator Reflux Drum, CO2 Overhead from the AGRU Regenerator Reflux Drum through the MBD-658100 CO2 Compression 1st Stage KO Drum / CAR-658101 Low Pressure CO2 Compressor 1st Stage / HFF-658102-01 thru 04 CO2 Compression 1st Stage Aftercoolers / MBD-658103 CO2 Compression 2nd Stage KO Drum / CAR-658101 Low Pressure CO2 Compressor 2nd Stage / HFF-658104-01 thru 02 CO2 Compression 2nd Stage Aftercoolers / MBD-658105 CO2 Compression 2nd Stage Outlet KO Drum to the CO2 TEG Contactor, Bottoms Outlets from the KO Drums to the Closed Drain Collection Drum, and Associated Piping and Instrumentation.	To remove liquids and compress CO2 gas from overhead of the AGRU Solvent Regenerator for subsequent dehydration. Overheads from the Regenerator are at 206°F / 32 psia and enters the suction of the CO2 Compressor after cooling, liquid separation, and pressure letdown at 79.7°F / 13 psig / 146.5 MMSCFD (Winter base case) and is discharged via the Compressor 2nd stage after liquid separation and cooling at 56.5°F / 517.1 psig / 144.3 MMSCFD to the CO2 TEG Contactor.	-New 2nd compressor string (6x20% compressors), 2 per train -New header PC on suction header (updated control configuration) -Liquid outlet SDV now upstream of LCV -No more "water from TEG contactor" line coming from the TGDU TEG Integral Scrubber (deleted) -No more outlet SDV on the 2nd stage outlet KO drum - each compressor string has its own contactor	USAG-EC-PDZZZ-10-000658-050; USAG-EC-PDZZZ-10-000658-051; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-10-000662-017; USAG-EC-PDZZZ-10-000658-048; USAG-EC-PDZZZ-10-000658-049; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000991-095	June 8th, 2016
15.	CO2 Overhead from the CO2 TEG Contactor through the MBD-658107 CO2 Compression 3rd Stage KO Drum / CAR-658108 High Pressure CO2 Compressor 3rd Stage / HFF-658109 CO2 Compression 3rd Stage Aftercooler / MBD-658110 CO2 Compression 4th Stage KO Drum / CAR-658108 High Pressure CO2	To remove liquids and further compressor CO2 gas from overhead of the CO2 Contactor for subsequent transfer and metering to PBU. Overheads from the Contactor are at 67°F / 524 psia following pressure	-Byproduct (CO2) to Injection Points and sweep gas from PBU now shown on drawings -New vent line to CO2 flare	USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	Compressor 4th Stage / HFF-658111-01 thru 02 CO2 Compression 4th Stage Aftercoolers / KAU-658112 CO2 Transfer Metering Station to the Prudhoe Bay Unit, Bottoms Outlets from the KO Drums to the HP CO2 Flare, and Associated Piping and Instrumentation.	letdown and enters the 3rd stage suction of the CO2 Compressor after liquid separation at 56.8°F / 509.6 psig / 144 MMSCFD (Winter base case) and is discharged via the Compressor 4th stage after liquid separation, cooling, and metering at 147.6°F / 3949.5 psig / 431.9 MMSCFD (total flow) to PBU.		000658-062; USAG-EC-PDZZZ-10-000658-063; USAG-EC-PDZZZ-10-000658-065; USAG-EC-PDZZZ-10-000658-066	
16.	See Node 4 - HAZID of Node 16 was included in the Node 4 evaluation EAP-658113 CO2 Compression Heat Recovery Unit Including Supplemental Firing BMS Utilizing LP Fuel Gas, Fuel Conditioning & Control Skid for the HP Fuel Gas, CGT-658106 CO2 Compression Turbine, STKV-65814 CO2 Compression Turbine Stack, STKV-658115 CO2 Compression Turbine Bypass Stack, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.	See Node 4 - HAZID of Node 16 was included in the Node 4 evaluation	N/A	USAG-EC-PDZZZ-10-000658-064; USAG-EC-PDZZZ-10-000658-067; USAG-EC-PDZZZ-10-000965-076	June 8th, 2016
17.	MBD-662131 AGRU Regenerator Reflux Drum, Bottoms Outlet from the Reflux Drum through the PBA-	To provide reflux to the AGRU Solvent Regenerator via the Reflux	N/A	USAG-EC-PDZZZ-10-000662-015;	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	662132A/B AGRU Solvent Regenerator Reflux Pump to the AGRU Solvent Regenerator, Make-up Water from the Process Water Storage Tank to the Reflux Drum, and Associated Piping and Instrumentation.	Drum operating at 80°F / 29.7 psia.		USAG-EC-PDZZZ-10-000662-017; USAG-EC-PDZZZ-10-000991-095	
18.	MAF-667106 CO2 Dehy Regen Column, Bottoms Outlet from the Column through the HBG-667104 CO2 Dehy Hot TEG Lean/Rich Exchanger Shellside / HBG-667102 CO2 Dehy Cool TEG Lean/Rich Exchanger Shellside / PBA-667109A/B CO2 Dehy TEG Circulation Pump / MAJ-667110A/B CO2 Dehy TEG Cartridge Filter / MAJ-667111 CO2 Dehy TEG Activated Carbon Filter / MAJ-667112 CO2 Dehy TEG After Filter / HFF-667113 CO2 Dehy Lean TEG Cooler to the CO2 TEG Contactor, CO2 Stripping Gas from CO2 TEG Contactor Overhead through the HAP-667108 CO2 Dehy Stripping Gas Heater, HAP-667107 CO2 Dehy Teg Reboiler, and Associated Piping and Instrumentation.	To regen TEG in the CO2 Dehy Regen Column for use in the dehydration of CO2 gas from the 2nd stage of the CO2 Compressor. The Regen Column is operated at 197-400°F / 15.4-21.7 psia.	-CO2 Dehy Lean TEG Cooler converted from air cooler (on RBD's) to a cooling medium S/T HEX -There is now only one CO2 Dehy Lean TEG filter (RBD's had 3) -HAP667108 no longer exist. Stripping gas heater deleted - gas is now heated up with a coil in the regen column sump.	USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000667-056; USAG-EC-PDZZZ-10-000667-057; USAG-EC-PDZZZ-10-000667-058	June 8th, 2016
19.	MAF-667100 CO2 TEG Contactor, Sidedraw from the Contactor through the HBG-667102 CO2 Dehy Cool TEG Lean/Rich Exchanger Tubeside / MBD-667103 CO2 Dehy TEG Flash Drum / HBG-667104 CO2 Dehy Hot TEG Lean/Rich Exchanger Tubeside	To provide for contact of CO2 stream from the 2nd stage of the CO2 Compressor with TEG for removal of water. Lean TEG enters the CO2 TEG Contactor at 66.3°F / 529.6	-There is no longer an integral scrubber on the CO2 Dehy TEG Contactor -There are now two CO2 Dehy TEG contactors per train (like the CO2 Compressors).	USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000667-056 Rev. B; USAG-EC-PDZZZ-10-	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	to the CO2 Dehy Regen Column, Bottoms Outlet from the Contactor to the CO2 Compression 2nd Stage KO Drum, Overhead from the Flash Drum to the CO2 1st Stage Compression KO Drum Feed Line, and Associated Piping and Instrumentation.	psig / 12.3 gpm / 0.0 lbmole/hr H2O and exits Rich at 57.3°F / 516.1 psig / 14 gpm / 14.92 lbmole/hr H2O (Winter base case) to the CO2 Dehy TEG Flash Drum operating at 160°F / 90 psia. The bottoms outlet TEG from the Flash Drum is further heated to 300°F and the pressure dropped to 30 psia before feeding into the CO2 Dehy Regen Column. CO2 Dehy Flash Gas is routed to the CO2 Compressor 1st stage from the Flash Drum at 153.7°F / 15.3 psig.	Regeneration is common per contactor pair (one per train) -New PSV on CO2 Dehy TEG Contactor for "check valve failure" -There is now a reflux condenser coil in the CO2 Dehy Regen Column and no offgas cooler (air cooler) -MBD667103 (CO2 Dehy Flash Drum) and liquid outlet SDV were deleted -HBG667104 (CO2 Dehy Hot L/R HEX) was deleted. There is now only one L/R HEX for the CO2 Dehy.	000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000667-056; USAG-EC-PDZZZ-10-000667-057	
20.	Overhead Vapor Line from the CO2 Dehy Regen Column through the HFF-667114 CO2 Dehy Offgas Cooler / MBD-667116 CO2 Dehy Offgas Scrubber / CBA-667117 CO2 Dehy Offgas Compressor to the CO2 1st Stage Compression KO Drum Feed Line, Bottoms Outlet from the Scrubber through the PBA-667118A/B CO2 Dehy Reflux Pump to the CO2 Dehy Regen Column / Closed Drain Collection Drum Feed Header and Associated Piping and Instrumentation.	To remove liquids and compress CO2 gas from overhead of the CO2 Dehy Regen Column for subsequent dehydration. Overhead vapors from the Regen Column are at 192.5°F / 15.2 psig and enters the CO2 Dehy Offgas Scrubber after cooling at 77°F / 14.9 psia. Water from the bottoms outlet of the Scrubber is pumped back to the Regen Column as reflux while the overhead vapor from the Scrubber is compressed	Node 20 deleted; no CO2 Dehy Offgas System. Offgas cooler, reflux pump, scrubber, and compressor deleted. Dehy gas is flared	USAG-EC-PDZZZ-10-000667-057	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
		and routed to the 1st stage of the CO2 Compressor at 166.4°F / 25 psia (Winter base case).			
21.	Refrigerant Vapor from the Treated Gas Chillers through the MBD-666505/506 Refrigeration Compressor Suction Drum / CBA-666509/510 Refrigeration Compressor / HFF-666511 thru 26 Refrigerant Condensers to the MBD-666512 Refrigerant Accumulator, Refrigerant Liquid from Bottoms Outlet of the Accumulator to the Treated Gas Chillers, Bottoms Outlet from the Suction Drums to the HP HC Flare, and Associated Piping and Instrumentation.	To condense refrigerant vapors to provide refrigerant liquid for the Treated Gas Chillers. Refrigerant Vapor from the Chillers enter the suction of the Refrigerant Compressors at 17.7°F / 51.7 psia and discharges at 124.6°F / 187.6 psia and cooled before discharge into the Refrigerant Accumulator at 97°F / 184.6 psia (Summer base case).	-No longer a PCV off high point on refrigerant accumulator (no PAHH and PSV)	USAG-EC-PDZZZ-50-000666-042; USAG-EC-PDZZZ-50-000666-043; USAG-EC-PDZZZ-50-000666-044	June 8th, 2016
22.	See Node 4 - HAZID of Node 22 was included in the Node 4 evaluation EAP-833102/103 Heat Recovery Unit for Power Generator Including Supplemental Firing BMS Utilizing LP Fuel Gas, Fuel Conditioning & Control Skid for HP Fuel Gas, TGT-833100/101 Power Generator Gas Turbines, STKV-833104/105 Power Generator Turbine Stacks, STKV-833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters,	See Node 4 - HAZID of Node 22 was included in the Node 4 evaluation	-Power Gen. turbine fuel gas take-offs are no longer on the HP fuel gas KO drum drawing, now on Common Fuel Gas System drawing -WHRU has been deleted - this node is no longer similar to Node 4. No process (except fuel gas feed)	USAG-EC-PDZZZ-10-000833-105; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000833-106	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.				
23.	Open Drain System: BBH-992100 / BBH-992101 / BBH-992102 Oily Water Collection Sumps - AGRU Module #1 thru #3, PBA-992103 / PBA-992104 / PBA-992105 Oily Water Pumps - AGRU Module #1 thru #3, BBH-992110 Oily Water Collection Sump - TGDU & CO2 Gas Dehydration Regen Area, PBA-992111 Oily Water Pump - TDGU & CO2 Gas Dehydration Regen Area, BBH-992106 Oily Water Collection Sump - CO2 Compression Area, PBA-992107 Oily Water Pump - CO2 Compression Area, BBH-992108 Oily Water Collection Sump - Treated Gas Compression Area, PBA-992109 Oily Water Pump - Treated Gas Compression Area, and Associated Piping and Instrumentation.	To provide oily water collection sumps in the AGRU / Treated Gas Compression / TGDU & CO2 Gas Dehydration Regen / CO2 Compression Areas. Design details to be completed during FEED.	-New open drain system for second string of compression and process heat medium, same as original (copy)	USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-10-000992-098; USAG-EC-PDZZZ-10-000992-099	June 8th, 2016
24.	Firewater from the Camp Potable Water Tank through the PPW-977007 Firewater Supply Pump / BBJ-412004 Camp Firewater Storage Tank / PFW-411600 Firewater Jockey Pump / PFW-411601 Main Firewater Pump (Electric) / PFW-411602 Main Firewater Pump (Diesel Engine) to Occupied Buildings Firewater Loop, HAP-412005 Camp Firewater Storage Tank Heating Element, MBA-	To provide potable water for camp Firewater System. Two electric and one diesel operated pump will be used to meet system requirements and provide firewater at 50°F / 165 psia / 1500 USGPM (175 psia / 100 USGPM for the Firewater Jockey Pump).	-Camp firewater systems - now 3 per camp (instead of one) -New firewater supply pump (not on RBDs) - PPW412007 -Camp firewater systems - now 3 per camp (instead of one)	USAG-EC-PDZZZ-00-000412-132; USAG-EC-PDZZZ-00-000412-140; USAG-EC-PDZZZ-00-000411-141; USAG-EC-PDZZZ-00-000412-142; USAG-EC-PDZZZ-00-	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	412604 Firewater Diesel Day Storage Drum, and Associated Piping and Instrumentation.		-New biocide injection on camp firewater	000411-143	
25.	BBJ-977001/2 Camp Potable Water Tanks, Outlet from the Tanks through the PPW-977005A/B/C Camp Potable Water Distribution Pump / Camp Users Distribution Loop / VMBM-977006 Camp UV Sterilization Package, HAP-977003/4 Camp Potable Water Tank Heating Elements, and Associated Piping and Instrumentation.	To provide potable water for the Camp users. Camp Potable Water Distribution Pump operates at 105 psia discharge pressure / 28 USGPM and takes suction at 14.7 psia / 50°F.	Node 25 no longer exists - no more camp potable water storage.	N/A	June 8th, 2016
26.	MBA-927600 Cooling Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-927601A/B Cooling Medium Pump (Common) / Cooling Medium Users / MAJ-927602 Cooling Medium Filter (Common) / HFF-927604-01 thru -02 Cooling Medium Cooler (Common); MBA-927100 Cooling Medium Expansion Drum (Process Train), Bottoms Outlet from Process Train Drum through the PBA-927103A/B Cooling Medium Pump (Process Train) / Cooling Medium Users (including Treated Gas Compressor & Turbine, CO2 Compressor & Turbine, Power Generation Turbines) / MAJ-927101 Cooling Medium Filter (Process Train) / HFF-927104-01 thru -05 Cooling Medium Cooler (Process Train) and Associated Piping and Instrumentation.	To provide cooling medium (ethylene glycol / water solution) to Refrigeration Compressor / Other Plant-Wide / Treated Gas Compressor & Turbine / CO2 Compressor & Turbine / Power Generation Turbines / Other Process Train users. Cooling Medium Expansion Drums operate at 90°F / 65 psia. Cooling Medium Pump (Common) operates at 102 psia discharge pressure / 512 USGPM. Cooling Medium Pump (Process) operates at 147 psia discharge pressure / 4348 USGPM.	-Tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles -MAJ927602 (cooling medium filter, common) deleted. No longer exists. -On RBD's a box showing "other plant-wide cooling medium users" was deleted from P&IDs -Cooling medium no longer going to "power generation turbines" (these have their own cooling medium system on-skid) -Cooling medium now also going to TGDU, CO2 Dehy, and Fuel Gas Treating heat	USAG-EC-PDZZZ-10-000927-090; USAG-EC-PDZZZ-50-000927-089	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
			exchangers		
27.	MBA-942600 Building Heat Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-942601A/B/C Building Heat Medium Pump / EAP-942608/609/610 Building Heat Medium Utility Heater / Heat Medium Users (Building, Process Train Building, Process Train Tank / Sump / Drum, and Common Area Tank / Sump / Drum Heaters) / MAJ-942602/603 Building Heat Medium Filter, and Associated Piping and Instrumentation.	To provide building heat medium (ethylene glycol / water solution) to Building Heaters / Process Train Building Heaters / Process Train Tank, Sump, and Drum Heaters / Common Area Tank, Sump, and Drum Heaters. Building Heat Medium Expansion Drum operates at 80°F / 65 psia. Building Heat Medium Pump operates 293 psia discharge pressure / 5356 USGPM. Building Heat Medium Utility Heater operates at 200°F discharge temperature / 287 psia.	-Tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles -RBDs had two filters, there is only on BHM filter now -We now have a BMS shown on the heaters (added detail only)	USAG-EC-PDZZZ-60-000942-087; USAG-EC-PDZZZ-60-000942-088; USAG-EC-PDZZZ-60-000965-075	June 8th, 2016
28.	VCBA-955600A/B/C Air Compressor Packages: CEM-955602A/B/C Air Compressor Motors, CBA-955601A/B/C Air Compressors, VNBA-956600 Air Dryer Package, MBA-956601 Dry Air Receiver, Air Header to Service Air Users, Air Header to Instrument Air Users Including MBA-952100/200/300 Instrument Air Receivers, Air Header to Breathing Air Users Including AAJ-954100/200/300 Breathing Air Train Header Filters, and Associated Piping and Instrumentation.	To compress, dry, and filter atmospheric air for use as Breathing Air, Instrument Air, Service Air, and supply to Nitrogen Membrane Package. To provide cooling for Air Compressor stages. Air Compressors (3) operate at discharge pressure of 155 psia / 100°F / 7250 ACFM and provides air to users at 145 psia / 100°F / -100°F dewpoint.	-No SDVs coming from each air compressor package anymore -No utility air to control room -No instrument air to control room -Breathing air is now a vendor package with one common breathing air filter, not one per train -Breathing air now goes to CO2 Meter Module also	USAG-EC-PDZZZ-60-000955-110; USAG-EC-PDZZZ-60-000951-112; USAG-EC-PDZZZ-60-000952-113; USAG-EC-PDZZZ-60-000954-114; USAG-EC-PDZZZ-60-000955-111	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
			(new module)		
29.	VNTG-961600 Nitrogen Membrane Package, MBA-961605 Nitrogen Receiver, MBA-961602 Liquid Nitrogen Storage Vessel, PBA-961603 Liquid Nitrogen Pump, HAP-961604 Liquid Nitrogen Vaporizer, HAP-961606 Vaporized Nitrogen Heater, Nitrogen Distribution Header, and Associated Piping and Instrumentation.	To provide nitrogen for users via Nitrogen Membrane Package and Liquid Nitrogen System as a backup. Nitrogen Membrane Package operates at 145 psia / 100°F / 2.59 MMSCFD. Liquid Nitrogen System operates at 125 psia / 100°F / 0.8 MMSCFD. Nitrogen is provided to users at 125 psia / 100°F.	-VNTG961601 has been deleted (Liquid Nitrogen Vaporizer Package) - truck connection instead -No nitrogen distribution to control room	USAG-EC-PDZZZ-60-000961-115; USAG-EC-PDZZZ-60-000961-116	June 8th, 2016
30.	BBJ-678600 AGRU Solvent Storage Tank, PBJ-678602 Agru Solvent Transfer Pump, MAJ-678603 AGRU Solvent Makeup Filter, BBJ-678604 AGRU Fresh Solvent Storage Tank, PBJ-678606 AGRU Fresh Solvent Transfer Pump, HAP-678601 AGRU Solvent Storage Tank Heater, HAP-678605 AGRU Fresh Solvent Storage Tank Heater, Lean Solvent Line to the AGRU Solvent Flash Drum, and Associated Piping and Instrumentation.	To provide for fresh Solvent storage and transfer to the AGRU. The AGRU Fresh Solvent Transfer Pump operates at 218 psia discharge pressure / 50 USGPM. The AGRU Solvent Transfer Pump operates at 237.1 psia discharge pressure / 1200 USGPM / 80°F.	-SDV for solvent from makeup filter is now downstream of FCV -Building heat medium coils no longer controlled with TC (globe valve now)	USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-60-000678-019	June 8th, 2016
31.	ABJ-671600 Methanol Storage Tank, PBJ-671601 Methanol Injection Pump, and Associated Piping and Instrumentation.	To provide methanol for various injection points. Methanol Injection Pump operates at 737.3 psia / 50 USGPM.	Node 31 no longer exists (methanol tank deleted).	N/A	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
32.	BBJ-678607 TEG Makeup Storage Tank, HAP-678608 TEG Makeup Storage Tank Heating Coil, PBJ-678609 TEG Supply Pump, MAJ-678613 TEG Solvent Filter, TEG Piping to the TGDU / CO2 Dehy Flash Drums and Trains 1 / 2 Headers, and Associated Piping and Instrumentation.	To provide for storage, filtering, and transfer of TEG to the process. The TEG Supply Pump operates at 216.7 psia discharge pressure / 95 USGPM.	MAJ678613 no longer exists, deleted, (TEG Solvent Filter)	USAG-EC-PDZZZ-60-000678-135; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000667-057	June 8th, 2016
33.	BBJ-911600 Diesel Fuel Storage Tank, PBJ-911605 Diesel fuel Pump, MAJ-911606 Diesel Fuel Filter, PBJ-911608 Diesel Fueling Station Delivery Pump, MBA-911607 Diesel Fueling Station Storage Drum, MAJ-911604 Diesel Recycle Filter, VMBA-911603 Diesel Drain Centrifuge, PBJ-911602 Diesel Drain Pump, MBA-837600 Dormitory Emergency Diesel Generator Day Storage, MBA-837601 Essential Diesel Generator Day Storage, Communication Tower Diesel Day, Water from the Centrifuge to the Common Closed Drain Drum, and Associated Piping and Instrumentation.	To provide for storage, water separation, filtering, and transfer of Diesel Fuel to the users. The Diesel Fuel Pump operates at 54.7 psia discharge pressure / 50 USGPM / ambient suction temperature. The Diesel Drain Pump operates at 54.7 psia / 10 USGPM / ambient suction temperature.	-Diesel drain centrifuge, diesel drain pump, and diesel recycle filter DELETED -SDV upstream of diesel fuel pump deleted -MAJ991606 (diesel fuel filter) DELETED. -Diesel Fueling Station Storage Drum only filled by truck (not delivery pump)	USAG-EC-PDZZZ-60-000911-109; USAG-EC-PDZZZ-60-000837-108	June 8th, 2016
34.	TGT-837610-612 Essential Power Generator Gas Turbine, STKV-837607-609 Essential Power Generator Turbine Stack, HP Fuel Gas Piping from the Fuel Gas Header, and Associated Piping and Instrumentation.	To provide HP Fuel Gas to the Essential Power Generator Gas Turbines at 82.1°F / 530 psig.	Node 34 no longer exists - this was for the Essential Power Generators which have been deleted.	USAG-EC-PDZZZ-60-000965-075	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
35.	BBJ-678614 Hydrocarbon Disposal Tank, HAP-678615 Hydrocarbon Disposal Tank Heating Coil, and Associated Piping and Instrumentation.	To provide storage for hydrocarbons to be disposed of. Hydrocarbon Disposal Tank operates at atmospheric pressure with 350 bbl capacity and electrical heating element to maintain a minimum temperature to be specified.	-Tank has been renamed (Hydrocarbon Holding Tank) and tank no longer has an electric heating coil.	USAG-EC-PDZZZ-60-000679-137	June 8th, 2016
36.	MBD-612506 HP Hydrocarbon Flare KO Drum, PBA-612507A/B HP Hydrocarbon Flare Blowdown Pumps, FLRH-612508 HP Hydrocarbon Flare, FLRH-612511 HP Hydrocarbon Flare, LP Fuel Gas Lines to Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the AGRU Solvent Storage Tank, and Associated Piping and Instrumentation.	To provide means to flare high pressure hydrocarbon systems. The HP Hydrocarbon Flare KO Drum operates at -150-200°F / 115 psia. The HP Hydrocarbon Flare Blowdown Pump operates at 54.6 psia discharge pressure / 150°F suction temperature / 1260 USGPM. Maximum flowrate basis is one train relief and start-up of one train. Flares are two 100% flares, one in operation and the other purge-pilot active.	Blowcase added for flare line, not previously on RBDs	USAG-EC-PDZZZ-60-000678-019; USAG-EC-PDZZZ-50-000612-070; USAG-EC-PDZZZ-60-000965-075	June 8th, 2016
37.	MBD-612500 HP CO2 Flare KO Drum, PBA-612501A/B HP CO2 Flare Blowdown Pumps, FLRH-612502 HP CO2 Flare, FLRH-612505 HP CO2 Flare, LP Fuel Gas / Backup Assist Gas / Assist Gas Lines to the Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the	To provide means to flare high pressure CO2 systems. The HP CO2 Flare KO Drum operates at -130-110°F / 65 psia. The HP CO2 Flare Blowdown Pump operates at 53.7 psia discharge pressure / 40°F	Blowcase added for flare line, not previously on RBDs	USAG-EC-PDZZZ-50-000612-071	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	Common Closed Drain Collection Drum, and Associated Piping and Instrumentation.	suction temperature / 25 USGPM. Maximum flowrate basis is one train blocked outlet. Flares are two 100% flares, one in operation and the other purge-pilot active.			
38.	MBD-613506 LP Hydrocarbon Flare KO Drum, PBA-613507A/B LP Hydrocarbon Flare Blowdown Pumps, FLRL-613508 LP Hydrocarbon Flare, FLRL-613512 LP Hydrocarbon Flare, CAL-613509 LP Hydrocarbon Flare Air Blower, CAL-613513 LP Hydrocarbon Flare Air Blower, LP Fuel Gas to Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation.	To provide means to flare low pressure hydrocarbon systems. The LP Hydrocarbon Flare KO Drum operates at 37-165°F / 30 psia. The LP Hydrocarbon Flare Blowdown Pump operates at 47.8 psia discharge pressure / 165°F suction temperature / 80 USGPM. Maximum flowrate basis is HP to LP fuel gas blowby. Flares are two 100% flares, one in operation and the other purge-pilot active.	Blowcase added for flare line, not previously on RBDs	USAG-EC-PDZZZ-50-000613-072; USAG-EC-PDZZZ-60-000991-096	June 8th, 2016
39.	MBD-613500 LP CO2 Flare KO Drum, PBA-613501A/B LP CO2 Flare Blowdown Pump, FLRL-613502 / 514 / 515 LP CO2 Flare, FLRL-613505 / 516 / 517 LP CO2 Flare, LP Fuel Gas / Backup Assist Gas / Assist Gas Lines to the Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation.	To provide means to flare low pressure CO2 systems. The LP CO2 Flare KO Drum operates at -40-245°F / 25 psia. The LP CO2 Flare Blowdown Pump operates at 42.7 psia discharge pressure / 160°F suction temperature / 25 USGPM. Maximum CO2 flowrate basis is blocked-in CO2 injection line. Flares	-New assist gas jumpover from PBU - not previously on RBDs -Blowcase added for flare line, not previously on RBDs	USAG-EC-PDZZZ-50-000609-003; USAG-EC-PDZZZ-50-000613-073	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
		are two 100% flares, one in operation and the other purge-pilot active.			
40.	STR-976700A/B Put River Water Pump Strainers, PBJ-976701A/B Put River Water Pumps, KAU-976708 Put Water Regulatory Metering, Put Water Reservoir, STR-976702A/B Reservoir Water Strainers, PBJ-976703A/B Reservoir Water Supply Pumps, VPBK-976704 Reservoir Water Biocide Injection Package, VPBK-976705 Reservoir Water Oxygen Scavenger Injection Package, MAJ-976706A/B Reservoir Water Filter, PBJ-976707A/B Reservoir Water Delivery Pumps, BBJ-976602 / BBJ-976604 Raw Water Storage Tanks, HAP-976601 / HAP-976603 Raw Water Storage Tank Heating Elements, PBJ-976600A/B Service Water Pumps, VMBM-683610 UV Sterilization Package, Service Water to the Process Water Treatment System Including Chemical Injection Package and R.O. Filter, Service Water to Utility Station Users, Raw Water to Potable Water Treatment System, and Associated Piping and Instrumentation.	To provide for transfer, treatment, filtering, storage, and sterilization of Raw Water from the Put River to meet Service / Process / Potable Water requirements. Conditions of service are yet to be defined for the transfer and treatment of Put River water to the GTP Raw Water Storage Tanks. Service Water Pumps operate at 117.5 psia discharge pressure / 392 USGPM to supply Service Water at 50°F / 110 psia to Process Water Treatment and Utility Station Distribution header.	-New raw water line to operations camp (line not on RBDs) -New Service Water Jockey pump for continuous circulation/flow (PBJ976609) -New Service Water Strainer (STR976605) -New biocide and O2 scavenger injection packages on service water -New Raw Water Reservoir Regulatory Meter (not on RBDs)	USAG-EC-PDZZZ-50-000609-003; USAG-EC-PDZZZ-60-000976-120; USAG-EC-PDZZZ-60-000976-124; USAG-EC-PDZZZ-70-000976-125; USAG-EC-PDZZZ-70-000976-126	June 8th, 2016
41.	Process Water Treatment System: BBJ-683601 R.O. Feed Tank, HAP-683602 R.O. Feed Tank Heating Element, R.O. Feed Pump, Chemical	To provide for the treatment, storage, and transfer of Process Water and R.O. Rejection Water.	N/A	; USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	Injection Package, R.O. Modules, BBJ-683603 Process Water Storage Tank, HAP-683604 Process Water Storage Tank Heating Element, PBJ-683608A/B Process Water Pump, Permeate Recirculation Pump, BBJ-683605 R.O. Rejection Water Storage Tank, HAP-683606 R.O. Rejection Water Storage Tank Heating Element, PBJ-683609A/B R.O. Reject Water Pump and Discharge Piping to the Common Closed Drain Drum, and Associated Piping and Instrumentation.	The Process Water Pumps operate at 210 psia discharge pressure / 50-70 USGPM. The R.O. Reject Water Pumps operate at 33.5 psia discharge pressure / 16-25 USGPM.		000683-122	
42.	VMBM-977606 Potable Water Treatment System, BBJ-977600 / 601 Potable Water Tanks, HAP-977602 / 603 Potable Water Tank Heating Elements, PPW-977604A/B/C Potable Water Pumps, PPW-977607A/B Potable Water Camp Supply Pumps, VMBM-977605 UV Sterilization Package, Potable Water Supply / Return Headers for Users, Reject Water Line from the Potable Water Treatment System to the Common Closed Drain Drum, and Associated Piping and Instrumentation.	To provide Potable Water to the GTP Distribution Header / Camp Potable Water Storage and recirculation from eyewash / safety showers back to the Potable Water Tanks. Potable Water Pumps operate at 92.5 psia discharge pressure / 28 USGPM. Potable Water Camp Supply Pumps operate at 165 psia discharge pressure / 250 USGPM.	-Pumps PPW977607A/B (Potable Water Camp Supply Pumps) have been deleted. -Potable water no longer going to the following areas: HP/LP flare KO drums, treated gas chilling and metering, inlet metering, warehouse	USAG-EC-PDZZZ-60-000977-127; USAG-EC-PDZZZ-60-000977-128; USAG-EC-PDZZZ-60-000977-129; USAG-EC-PDZZZ-60-000991-096	June 8th, 2016
43.	MBA-996112 TEG Drain Drum, PBA-996113 TEG Drain Drum, MAJ-996114 TEG Drain Filter, TEG Lines to the TGDU / CO2 TEG Flash Drums, and Associated Piping and Instrumentation.	To provide for the collection, filtration, and transfer of TEG drains. The TEG Drain Drum operates at 66°F / 14.7 psia. The TEG Drain Pump	TEG from the TEG drain drum can no longer be routed to CO2 Dehy, only the TGDU	USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000661-031	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
		operates at 189.2 psia discharge pressure / 30 USGPM.			
44.	MBA-996100 AGRU Solvent Drain Drum, HAP-996101 AGRU Solvent Drain Drum Heater, PBA-996103 AGRU Solvent Drain Drum Pump, MAJ-996106 AGRU Solvent Drain Filter, Solvent Lines to the AGRU Solvent Storage Tank and AGRU Solvent Flash Drum, and Associated Piping and Instrumentation.	To provide for the collection, filtration, and transfer of AGRU Solvent drains. The AGRU Solvent Drain Drum operates at 66°F / 15 psia. The AGRU Solvent Drain Drum Pump operates at 217.7 psia discharge pressure / 225 USGPM.	SDV for solvent from AGRU solvent drain filter has been deleted.	USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000678-018	June 8th, 2016
45.	MBA-991106 Closed Drain Collection Drum, LP Fuel Gas Supply Line to the Collection Drum, PBA-991107A/B Closed Drain Collection Drum Pump, Collection Drum Supply Header, Bottoms Outlet from the Collection Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation.	To provide for the collection and transfer of process drains requiring a closed system. The Closed Drain Collection Drum operates at 66°F / 15 psia. The Closed Drain Collection Drum Pump operates at 84.2 psia discharge pressure / 25 USGPM.	Seal pot and seal pot pump are new (not on RBDs)	USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-60-000991-096	June 8th, 2016
46.	BBH-992500 Oily Water Collection Sump - Refrigeration Compressor Module Including Heat Medium Supply / Return Piping and PBA-992501 Oily Water Pump - Refrigeration Compressor Module, BBH-992602 Oily Water Collection Sump - Service Water Area Including Heat Medium Supply / Return Piping and PBA-992603 Oily Water Pump - Service Water Area, BBH-992600	To provide for the collection, chemical injection, metering, and transfer of oily water drains from various process systems to Class I Injection Wells. Oily Water Pumps operate at 66.1 psia discharge pressure / 30 USGPM and discharge to the Common Closed Drain	- Seal pot and seal pot pump are new (not on RBDs) -BBH992602 - deleted from this drawing. No more "raw water" open drain in the common open drain system - removed from drawing	USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-000991-097; USAG-EC-PDZZZ-60-000992-100	June 8th, 2016

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	Oily Water Collection Sump - Common Utilities Including Heat Medium Supply / Return Piping and PBA-992601 Oily Water Pump - Common Utilities, BBH-992000 Oily Water Collection Sump - Integrated Housing Utilities Module Including HAP-992002 Oily Water Collection sump Heating Element - Integrated Housing Utilities Module and PBA-992001 Oily Water Pump - Integrated Housing Utilities Module, BBH-992606 Oily Water Collection Sump - Building Heat Medium Including Heat Medium Supply / Return Piping and PBA-992607 Oily Water Pump - Building Heat Medium, BBH-992604 Oily Water Collection Sump - Chemical Storage Including Heat Medium Supply / Return Piping and PBA-992605 Oily Water Pump - Chemical Storage, BBH-992502 Oily Water Collection Sump - Flare KO Drum Module Including Heat Medium Supply / Return Piping and PBA-992503 Oily Water Pump - Flare KO Drum Module, BBH-992608 Collection Sump - Water Treatment Module Including Heat Medium Supply / Return Piping and PBA-992609 Oily Water Pump - Water Treatment Module, MBA-991611 Common Closed Drain Collection Drum Including LP Fuel Gas Supply Line and Drain Supply Header, PAT-991612A/B Closed Drain Injection Booster Pumps, VPBK991602 Chemical Injection Package, MAJ-	Collection Drum which operates at 66°F / 15 psia. The Closed Drain Injection Booster Pump operates at 161.6 psia discharge pressure / 130 USGPM. The Closed Drain Injection Pump operates at 2209 psia discharge pressure / 130 USGPM.			

Node #	Node Description	Design Conditions / Parameters	Comments / Changes from Session 1	Drawings (Rev. 0)	Session
	991613A/B Closed Drain Injection Filter, PAT-991614A/B Closed Drain Injection Pumps, KAU-991615 Closed Drain Injection Well Metering Station, QAT-991606A/B Class I Injection Wells, and Associated Piping and Instrumentation.				
47.	Global Node.	To document hazard scenarios not specific to a particular process, but global in nature.	N/A	N/A	June 8th, 2016
48.	MBA-679001 Gasoline Fuel Supply Tank.	To supply gasoline for the facility. Note: this is a vendor package, details to be developed during FEED.	New Node: Gasoline Fuel Supply tank not on RBDs.	USAG-EC-PDZZZ-00-000679-138	June 8th, 2016

10.2 APPENDIX B – HAZID WORKSHEETS

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 1. Prudhoe Bay Unit / Point Thomson Unit Feed Gas to the Gas Treatment Plant Including MAM-609501 PTU Inlet KO Drum, MAJ-609504A/B PTU Liquid Re-injection Filter, MAK-662100 / 101 AGRU Filter Separators, KGR-609500 PTU Inlet Pig Receiver, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-50-000609-001; USAG-EC-PDZZZ-50-000609-004; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide feed gas from PTU and PBU

Winter rates
Pressure: PTU 650-1130 psig / PBU 580-620 psig
Temperature: PTU / PBU Ambient , Flow: PTU 950 scfd / PBU 3 billion scfd

Comment: -New HP HC vent to flare on Pig Receiver KGR609500
-PBU feed gas metering station now upstream of HCV to flare and SDV
-PCV is now upstream of the KO drum, new PDC downstream of KO drum
-New PT to GTP historian to satisfy B31.3 requirements
-liquids SDV from KO drum is now upstream of flare take off
-new PSV on shell side of AGRU feed gas preheater

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Maintenance philosophy	3.1.2. Testing of HIPPS valves	OP	1. Operational procedures require temporary slowdown of PTTL to test HIPPS valves	37. Consider parallel HIPPS valves or locked closed manual bypass valves	1. Operational issue

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 2. Treated Gas from Overhead of MAF-662103 AGRU Absorber through the HFF-662104-01 thru 04 AGRU Absorber Overhead Cooler / AGRU Water Wash Tower / TGDU TEG Contactor through the MBD-651100 Treated Gas Compressor 1st Stage KO Drum / CAX-651101 Treated Gas Compressor 1st Stage / HFF-651102-01 thru 08 Treated Gas Compressor Interstage Coolers / MBD-651103 Treated Gas Compressor 2nd Stage KO Drum / CAX-651101 Treated Gas Compressor 2nd Stage / HFF-651105-01 thru 08 Treated Gas Compressor After Coolers to the Treated Gas Chiller, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-10-000651-035; USAG-EC-PDZZZ-10-000651-036; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000651-032; USAG-EC-PDZZZ-10-000651-033; USAG-EC-PDZZZ-10-000651-035

Design Conditions/Parameters: To provide sweet / dry gas to pipeline

Winter rates
Pressure: Gas is compressed from 553-2151 psia
Temperature: PTU / PBU Ambient , Flow: Combined flow rate 3.3 billion scfd

Comment: -new 2nd compressor string (6x20% compressors), 2 per train
-liquid outlet SDV now upstream of LCV
-Treated Gas Compression 2nd Stage KO drum is deleted
-treated gas lines from compressors now tie into chiller header - second SDV for each train was deleted

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. For case of blocked compressor discharge: Potential to exceed flare capacity (1 train plus 40% startup of second train), resulting in potential loss of integrity in the flare system due to high velocity, pressure and potential reduction of PSV relief capacities and damage to flare tips.	S	1. High integrity SIS will be developed and implemented to mitigate consequence per note 6 on RBD drawing 010. (now Note 8 on P&ID drawing 035)		1. Consequence 2.1.1 is no longer applicable because compressor configuration is now 20% which is lower capacity than previous 33% per train
	2.2. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.2.1. Very low temperature and off-design gas composition during startup could result in liquids entering the second stage of the Treated Gas Compressor and cause equipment damage.		1. Operating procedures		1. During P&ID review the second stage suction scrubber was deleted.

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 3. Treated Gas from Treated Gas Compressor through the HBG-666500 / 501 Treated Gas Chillers / Treated Gas Metering Station and Pig Launcher (as necessary) to the Pipeline, Refrigerant Liquid Inlet / Exit Lines for the Chillers, MBD-666520 / 521 Treated Gas Chiller Oil Drum, HAP-666525 / 526 Treated Gas Chiller Oil Drum Vaporizer, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-50-000666-040 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-50-000666-040; USAG-EC-PDZZZ-50-000666-041

Design Conditions/Parameters: To chill and meter treated gas to pipeline

Winter rates
Pressure: 2075 psig
Temperature: 30 F, Flow: 3.3 billion scfd

Comment: -pig launcher for treated gas mainline to pipeline deleted from drawing (shown on Pipeline Drawing)
-there is now a bypass on the treated gas side of the chillers (not on RBDs)
-oil drum/ vaporizer only one (common) for chillers (RBDs had one per chiller)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. If the chiller bypass is open while it should be closed, the temperature to the mainline could exceed 30F, which could cause damage to the permafrost.	ENV	1. Operating procedures 2. Temperature TAHH-666500-01		1. Bypass was added in P&ID review to be able to maintain the chillers without reducing capacity.

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 4. EAP-651107 / EAP-658113 / EAP-833102/103 Heat Recovery Units for Treated Gas Compressor / CO2 Compression / Power Generator Including Supplemental Firing BMSs Utilizing LP Fuel Gas, Fuel Conditioning & Control Skids for HP Fuel Gas, CGT-651106 Treated Gas Compressor Gas Turbine / CGT-658106 CO2 Compression Turbine / TGT-833100/101 Power Generator Gas Turbines, STKV-651108 Treated Gas Compressor Turbine Stack / STKV-65814 CO2 Compression Turbine Stack / STKV-833104/105 Power Generator Turbine Stacks, STKV-651109 Treated Gas Compressor Turbine Bypass Stack / STKV-658115 CO2 Compression Turbine Bypass Stack / STKV-833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-032 Rev. B; USAG-EC-PDRBD-10-000942-080 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000658-055 Rev. B; USAG-EC-PDRBD-10-000833-100 Rev. B; USAG-EC-PDZZZ-10-000942-085; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000651-034; USAG-EC-PDZZZ-10-000651-037; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000942-086

Design Conditions/Parameters: To provide heat to AGRU reboiler for regeneration of amine from waste heat recovery unit on turbine exhausts.

Pressure: Expansion Tank 200 psig discharge of pump 360 psig
Temperature: TEG is heated from 300 F to 380 F, Flow: 15000 GPM

Comment: -heat medium changed from TEG/Water to Water
-tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-RBDs had two filters, there is only on PHM filter now
-New oxygen scavenger and corrosion inhibitor injection package (previously on raw water line)
-new makeup water line to the process heat medium expansion drum

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. Excess temperature leading to degradation of glycol, resulting in corrosion product in system.	OP	1. Bypass to stack 2. 3 circulation pumps to maintain circulation 3. Trim cooler 4. Turndown capability in duct burner		1. Consequence no longer applicable, replaced by Consequence 2.1.2. TEG/Water heat medium replaced by pressurized water
		2.1.2. Excess temperature leading to vaporization of water	OP	1. Bypass to stack 2. 3 circulation pumps to maintain circulation 3. Trim cooler 4. Turndown capability in duct burner		1. TEG/Water heat medium replaced by pressurized water
	2.2. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.2.1. Loss of nitrogen supply could res in lower pressure in the heat med system, which could result in generation of steam in the waste heat recovery units, and potential spots and ultimately WHRU tube failure causing loss of containmer	FIN	1. PALL-942100-01 2. Operating procedures	38. Consider designing WHRU for loss of circulation (i.e. no flow in the WHRU tubes)	1. New consequence since fuel gas was replaced by nitrogen, which is a limited supply
		2.2.2. New make-up water line to the expansion drum could overfill and potentially overpressure the expansion drum.		1. PSV-942100-01 2. Operating procedures	39. Add high level alarm on LT-942100-01	1. New consequence since a water line was added for make-up
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality)	6.1.1. Potential large leak of TEG water solution, environmental impact	ENV		10. Provide secondary containment for external heat medium system	1. TEG/Water heat medium replaced by

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 4. EAP-651107 / EAP-658113 / EAP-833102/103 Heat Recovery Units for Treated Gas Compressor / CO2 Compression / Power Generator Including Supplemental Firing BMSs Utilizing LP Fuel Gas, Fuel Conditioning & Control Skids for HP Fuel Gas, CGT-651106 Treated Gas Compressor Gas Turbine / CGT-658106 CO2 Compression Turbine / TGT-833100/101 Power Generator Gas Turbines, STKV-651108 Treated Gas Compressor Turbine Stack / STKV-65814 CO2 Compression Turbine Stack / STKV-833104/105 Power Generator Turbine Stacks, STKV-651109 Treated Gas Compressor Turbine Bypass Stack / STKV-658115 CO2 Compression Turbine Bypass Stack / STKV-833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-032 Rev. B; USAG-EC-PDRBD-10-000942-080 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000658-055 Rev. B; USAG-EC-PDRBD-10-000833-100 Rev. B; USAG-EC-PDZZZ-10-000942-085; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000651-034; USAG-EC-PDZZZ-10-000651-037; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000942-086

Design Conditions/Parameters: To provide heat to AGRU reboiler for regeneration of amine from waste heat recovery unit on turbine exhausts.

Pressure: Expansion Tank 200 psig discharge of pump 360 psig
Temperature: TEG is heated from 300 F to 380 F, Flow: 15000 GPM

Comment: -heat medium changed from TEG/Water to Water
-tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-RBDs had two filters, there is only on PHM filter now
-New oxygen scavenger and corrosion inhibitor injection package (previously on raw water line)
-new makeup water line to the process heat medium expansion drum

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
	normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	relative to tundra (sensitive area)			to prevent large scale leaks and pressurized water. impact to tundra.	Note: "Consequences" and "Recommendations" were identified in Session 1, prior to TEG/Water heat medium replaced by pressurized water.

Session: 1. 5/19/2015

Updated: 4. 6/8/2016

Node: 5. Lean Solvent for the AGRU Absorber: MAF-662128 AGRU Solvent Regenerator and Bottoms Outlet Flow through the HPL-662119-121 AGRU Lean Rich Exchanger through the Tubeside of the HBG-662102 AGRU Feed Gas Preheater through the HFF-662108-01 thru 24 AGRU Lean Solvent Coolers and MAJ-662109 / MAJ-662110 / MAJ-662111 (sidestream Filters) through the PBA-662112A/B/C AGRU Lean Solvent Pump to the AGRU Absorber, HBC-662133-138 AGRU Solvent Reboiler, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-011 Rev. B; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000662-012; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000662-014; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-60-000678-019

Design Conditions/Parameters: To provide lean amine to absorb CO2 and H2S from feed gas

Winter rates
Pressure: Regenerator 33 psia Contactor 562 psia
Temperature: Regenerator 266°F Contactor 97°F , Flow: 15000 gpm

Comment: -new PSV downstream of air cooler

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 6. AGRU Water Wash System: Make-up Process Water from Treatment through the PBA-662107A/B AGRU Water Wash Makeup Pump through the MAF-662105 AGRU Water Wash Tower to the Solvent Flash Drum Including Circulation through the PBA-662106A/B AGRU Water Wash Pump, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDZZZ-50-000609-004; USAG-EC-PDZZZ-10-000662-010; USAG-EC-PDZZZ-10-000662-011; USAG-EC-PDZZZ-10-000662-013

Design Conditions/Parameters: To provide make-up water for scrubbing of AGRU Absorber overhead stream at 80°F / 47.2 gpm. Wash tower operates at 80°F / 557 psia. Wash water from the wash tower is routed to solvent flash drum at 80°F / 165 psia.

Comment: -liquid outlet SDV is now upstream of LCV

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 7. MFA-662103 AGRU Absorber and Bottoms Outlet Flow through the MBD-662113 AGRU Solvent Flash Drum through the HPL-662119-121 AGRU Lean Rich Exchanger to the AGRU Solvent Regenerator, VPBK-662123 AGRU Anti-Foam Injection Package, Treated Flash Gas from the MAF-662114 AGRU Flash Gas Absorber to the LP Fuel Gas Dehy Inlet Scrubber Feed Line, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-010 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000662-014; USAG-EC-PDZZZ-10-000966-077

Design Conditions/Parameters: Rich solvent from AGRU absorber is routed on level control to AGRU Solvent Flash Drum at 161°F / 565 psia / 47332 gpm where gas is allowed to flash at 161°F / 165 psia. Rich solvent from flash drum is preheated to 243°F and transferred to AGRU Solvent Regenerator at 214°F / 32.5 psia.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 8. Lean TEG for the TGDU TEG Contactor: MAF-6611112 TGDU Regen Column and Bottoms Outlet through the Shellside of the HBG-661108 / 109 TGDU Hot TEG Lean / Rich Exchanger and HBG-661102 TGDU Cool TEG Lean / Rich Exchanger xthrough the PBA-661113A/B TGDU TEG Circulation Pump through the HFF-661114 TGDU Lean TEG Cooler to the TGDU TEG Contactor, HP Fuel Gas through the HAP-661122 TGDU Stripping Gas Heater, HAP-661116-121 TGDU TEG Reboiler, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000966-078; USAG-EC-PDZZZ-10-000965-076

Design Conditions/Parameters: To regen TEG in the TGDU Regen Column by stripping with heated HP Fuel Gas. Rich TEG is regenerated and exits as Lean TEG at 24 psia / 374°F and is used to preheat rich feed to the Column before being fed to the TGDU TEG Contactor at 568 psia / 90°F / 241 gpm.

Comment: -new PSV on outlet of TGDU lean TEG cooler
-new Lean TEG filters and corresponding PSVs (not on RBDs)
-new PSV on outlet of TGDU TEG reboiler
-new SDV on lean TEG from TGDU to Fuel Gas Treating

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 9. MAF-661100 TGDU TEG Contactor and Rich TEG Oulet Flow through the Tubeside of the HBG-661101 TGDU Offgas Cross Exchanger through the Tubeside of the HBG-661102 TGDU Cool TEG Lean / Rich Exchanger through the MBD-661104 TGDU TEG Flash Drum through MAJ-661105A/B TGDU TEG Cartridge Filters / MAJ-661106 TGDU TEG Activated Carbon Filter / MAJ-661107 TGDU TEG After Filter through the Tubeside of the HBG-661108 / 109 TGDU Hot TEG Lean / Rich Exchanger to the TGDU Regen Column, TGDU Flash Gas from the TEG Flash Drum to Fuel Gas Dehy System, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-020 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000661-025; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000661-028

Design Conditions/Parameters: To provide for removal of moisture in Treated Gas from the AGRU Water Wash Tower by contact with TEG. Treated Gas enters the TGDU TEG Contactor at 80°F / 555 psia / 1162 MMSCFD per Train / 133.9 lbmole/hr H_2O and exits at 82°F / 539 psia / 1160 MMSCFD / 0.17 lbmole/hr H_2O (Winter base case).

Comment: -no more integral scrubber on TGDU TEG contactor (no water outlet line)
-only one rich TEG filter now (3 on RBDs)
-new fire PSV on tube side of TGDU Hot L/R HEX
-new PCV to flare on vapor outlet from TGDU TEG flash drum
-new SDV on vapor outlet from TGDU TEG flash drum

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 10. TGDU Overhead Vapor from the TGDU Regen Column through the Shellside of the HBG-661101 TGDU Offgass Cross Exchanger through the HFF-661123 TGDU Offgas Cooler through the MBF-661124 TGDU Offgas Scrubber through the CBA-661125 TGDU Offgas Compressor 1st Stage through the HFF-661126 TGDU Offgas Interstage Cooler through the MBF-661127 TGDU Offgas Interstage Scrubber through the CBA-661125 TGDU Offgas Compressor 2nd Stage through the HFF-966100-01 LP Fuel Gas Dehy Inlet Cooler through the MBD-966101 LP Fuel Gas Dehy Inlet Scrubber to the LP Fuel Gas TEG Contactor, Bottoms Outlet from MBD-966101 to the Closed Drain Collection Drum, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000661-027; USAG-EC-PDZZZ-10-000661-028; USAG-EC-PDZZZ-10-000661-029; USAG-EC-PDZZZ-10-000661-030; USAG-EC-PDZZZ-10-000966-077; USAG-EC-PDZZZ-10-000966-078; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide for recovery of Fuel Gas from the TGDU Regen Column overhead vapor. Vapor exits the Column at 241°F / 15.4 psia and is cooled to 77°F / 14.9 psia before being fed to the TGDU Offgas Scrubber where condensed liquids are returned to the Regen Column and vapors are routed to the suction of the TGDU Offgas Compressor. Vapors are compressed to 125 psia / 254°F, cooled and then routed to the LP Fuel Gas TEG Contactor via the LP Fuel Gas Dehy Inlet Scrubber at 77°F / 119.7 psia.

Comment: -HFF661123 deleted (air cooler). Cooling medium shell/tube exchanger instead (HBG661131).
-liquid outlet SDV (to Closed Drain Drum) deleted from RBDs
-TGDU interstage scrubber and cooler have been deleted -compressor is shown as a vendor box - type changed to oil flooded screw compressor.
-HFF966100 deleted (air cooler). Cooling medium shell/tube exchanger instead (HBG966105).
-SDV deleted from liquid outlet of inlet scrubber

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Fatigue / Corrosion mechanisms	2.1.1. Tube leakage of HBG661131 cou result in Cooling medium entering TGDU regenerator overhead system. Cooling medium is a mix of EG and water. EG can decompose in TGDU reboiler and potentially cause corrosion and degraded TEG dehy performance	FIN	1. Sampling program 2. Loss of volume/level in cooling medium system	40. Consider heat exchanger design that minimizes risk of tube leakage, e.g. double pipe exchanger.	1. New consequence since air cooler was replaced by shell/tube exchanger

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 11. MAF-966102 LP Fuel Gas TEG Contactor and Bottoms Outlet through the PBA-966103A/B LP Fuel Gas Dehy Rich TEG Recycle Pump to the TGDU TEG Flash Drum, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000966-078

Design Conditions/Parameters: To provide for scrubbing of Offgas Vapor from the TGDU Regen Column by contact with Lean TEG in the LP Fuel Gas TEG Contactor operating at 90°F / 119.7 psia.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 12. Treated LP Fuel Gas and LP Fuel Gas from Common Area to Users: MBD-966104 LP Fuel Gas KO Drum Including Overhead Feed Line from the LP Fuel Gas TEG Contactor through MBD-966104, Treated LP Fuel Gas from Overhead Outlet of MBD-966104 to Users, Bottoms Outlet from MBD-966104 to the Closed Drain Collection Drum, LP Fuel Gas from Common Area, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000966-073 Rev. B; USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000966-078

Design Conditions/Parameters: To provide LP Fuel Gas to Train header at 60.5°F / 60 psig / 21.4 MMSCFD.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 13. Treated HP Fuel Gas and HP Fuel Gas to/from Common Area Including Buyback Gas and Backup HP Fuel Gas to Users: MBD-965100 HP Fuel Gas KO Drum Including Split Stream from Overhead Line from the TGDU TEG Contactor through MBD-965100, HP Fuel Gas from Overhead Outlet of MBD-965100 to Users, Bottoms Outlet from MBD-966100 to the Closed Drain Collection Drum, HP Fuel Gas from Common Area, MAJ-965501 Buyback Gas Filter, HAP-965503 Buyback Gas Heater, KAU-965500 Buyback Metering Station, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-50-000666-040 Rev. B; USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide HP Fuel Gas to users at 82.1°F / 530 psig / 135.5 MMSCFD.

Comment: -electric heater has been replaced with two bath heaters for buyback gas (fire tube / ethylene glycol)
-new SDV between HP and LP fuel gas

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. Potential for brittle failure of piping downstream of PC valve in buyback gas line to HP fuel gas system as result of failure of HAP-965503 Buyback Gas Heater, resulting in loss of containment.	S	1. Multiple sources of HP fuel gas 2. Multiple heater elements	15. Ensure temperature shutdown is provided to prevent brittle fracture If not provide.	1. Session 2: "Consequences", "Controls" and "Recommendations" no longer applicable due to configuration change. Refer to new Consequence 2.1.2.
		2.1.2. Potential for brittle failure of piping downstream of PC valve in buyback gas line to HP fuel gas system as result of failure of HAP-965508/50 Buyback Gas Heater, resulting in loss of containment.	S	1. Multiple sources of HP fuel gas 2. Multiple heaters 3. Temperature shutdown TAHH-965507-02	41. Ensure pipe stress analysis considers sudden temperature decrease when gas starts flowing into hot bath heater. 43. Limit rate of gas flow increase to reduce thermal shock.	1. New consequence since configuration changed.
	2.2. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.2.1. Tube leak in the bath heater will result in loss of containment	S	1. Equipment location/spacing	42. Ensure bath heater design includes overpressure detection with automatic shutdown (SDV-965001-01 and SDV-965001-	1. New consequence since configuration changed.

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 13. Treated HP Fuel Gas and HP Fuel Gas to/from Common Area Including Buyback Gas and Backup HP Fuel Gas to Users: MBD-965100 HP Fuel Gas KO Drum Including Split Stream from Overhead Line from the TGDU TEG Contactor through MBD-965100, HP Fuel Gas from Overhead Outlet of MBD-965100 to Users, Bottoms Outlet from MBD-966100 to the Closed Drain Collection Drum, HP Fuel Gas from Common Area, MAJ-965501 Buyback Gas Filter, HAP-965503 Buyback Gas Heater, KAU-965500 Buyback Metering Station, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-50-000666-040 Rev. B; USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000965-076; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide HP Fuel Gas to users at 82.1°F / 530 psig / 135.5 MMSCFD.

Comment: -electric heater has been replaced with two bath heaters for buyback gas (fire tube / ethylene glycol)
-new SDV between HP and LP fuel gas

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
					02).	

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 14. CO2 Overhead from the AGRU Solvent Regenerator through the HFF-662130-01 thru 12 AGRU Solvent Regenerator Condensers to the AGRU Regenerator Reflux Drum, CO2 Overhead from the AGRU Regenerator Reflux Drum through the MBD-658100 CO2 Compression 1st Stage KO Drum / CAR-658101 Low Pressure CO2 Compressor 1st Stage / HFF-658102-01 thru 04 CO2 Compression 1st Stage Aftercoolers / MBD-658103 CO2 Compression 2nd Stage KO Drum / CAR-658101 Low Pressure CO2 Compressor 2nd Stage / HFF-658104-01 thru 02 CO2 Compression 2nd Stage Aftercoolers / MBD-658105 CO2 Compression 2nd Stage Outlet KO Drum to the CO2 TEG Contactor, Bottoms Outlets from the KO Drums to the Closed Drain Collection Drum, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000658-050; USAG-EC-PDZZZ-10-000658-051; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-10-000662-017; USAG-EC-PDZZZ-10-000658-048; USAG-EC-PDZZZ-10-000658-049; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To remove liquids and compress CO2 gas from overhead of the AGRU Solvent Regenerator for subsequent dehydration. Overheads from the Regenerator are at 206°F / 32 psia and enters the suction of the CO2 Compressor after cooling, liquid separation, and pressure letdown at 79.7°F / 13 psig / 146.5 MMSCFD (Winter base case) and is discharged via the Compressor 2nd stage after liquid separation and cooling at 56.5°F / 517.1 psig / 144.3 MMSCFD to the CO2 TEG Contactor.

Comment: -new 2nd compressor string (6x20% compressors), 2 per train
-new header PC on suction header (updated control configuration)
-liquid outlet SDV now upstream of LCV
-no more "water from TEG contactor" line coming from the TGDU TEG Integral Scrubber (deleted)
-no more outlet SDV on the 2nd stage outlet KO drum - each compressor string has its own contactor

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 15. CO2 Overhead from the CO2 TEG Contactor through the MBD-658107 CO2 Compression 3rd Stage KO Drum / CAR-658108 High Pressure CO2 Compressor 3rd Stage / HFF-658109 CO2 Compression 3rd Stage Aftercooler / MBD-658110 CO2 Compression 4th Stage KO Drum / CAR-658108 High Pressure CO2 Compressor 4th Stage / HFF-658111-01 thru 02 CO2 Compression 4th Stage Aftercoolers / KAU-658112 CO2 Transfer Metering Station to the Prudhoe Bay Unit, Bottoms Outlets from the KO Drums to the HP CO2 Flare, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000658-054 Rev. B; USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000658-062; USAG-EC-PDZZZ-10-000658-063; USAG-EC-PDZZZ-10-000658-065; USAG-EC-PDZZZ-10-000658-066
Design Conditions/Parameters: To remove liquids and further compressor CO2 gas from overhead of the CO2 Contactor for subsequent transfer and metering to PBU. Overheads from the Contactor are at 67°F / 524 psia following pressure letdown and enters the 3rd stage suction of the CO2 Compressor after liquid separation at 56.8°F / 509.6 psig / 144 MMSCFD (Winter base case) and is discharged via the Compressor 4th stage after liquid separation, cooling, and metering at 147.6°F / 3949.5 psig / 431.9 MMSCFD (total flow) to PBU.

Comment: -Byproduct (CO2) to Injection Points and sweep gas from PBU now shown on drawings
-New vent line to CO2 flare

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Manual venting	3.1.1. Uncontrolled blowdown of one of the byproduct injection lines to the GTP CO2 Flare could exceed its capacity.	S		44. Install chokes in vent lines to limit venting rate.	1. New vent line to CO2 flare

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 16. See Node 4 - HAZID of Node 16 was included in the Node 4 evaluation

EAP-658113 CO2 Compression Heat Recovery Unit Including Supplemental Firing BMS Utilizing LP Fuel Gas, Fuel Conditioning & Control Skid for the HP Fuel Gas, CGT-658106 CO2 Compression Turbine, STKV-65814 CO2 Compression Turbine Stack, STKV-658115 CO2 Compression Turbine Bypass Stack, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000658-055 Rev. B; USAG-EC-PDRBD-10-000942-080 Rev. B; USAG-EC-PDZZZ-10-000658-064; USAG-EC-PDZZZ-10-000658-067; USAG-EC-PDZZZ-10-000965-076

Design Conditions/Parameters: See Node 4 - HAZID of Node 16 was included in the Node 4 evaluation

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 17. MBD-662131 AGRU Regenerator Reflux Drum, Bottoms Outlet from the Reflux Drum through the PBA-662132A/B AGRU Solvent Regenerator Reflux Pump to the AGRU Solvent Regenerator, Make-up Water from the Process Water Storage Tank to the Reflux Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDZZZ-10-000662-015; USAG-EC-PDZZZ-10-000662-017; USAG-EC-PDZZZ-10-000991-095

Design Conditions/Parameters: To provide reflux to the AGRU Solvent Regenerator via the Reflux Drum operating at 80°F / 29.7 psia.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 18. MAF-667106 CO2 Dehy Regen Column, Bottoms Outlet from the Column through the HBG-667104 CO2 Dehy Hot TEG Lean/Rich Exchanger Shellside / HBG-667102 CO2 Dehy Cool TEG Lean/Rich Exchanger Shellside / PBA-667109A/B CO2 Dehy TEG Circulation Pump / MAJ-667110A/B CO2 Dehy TEG Cartridge Filter / MAJ-667111 CO2 Dehy TEG Activated Carbon Filter / MAJ-667112 CO2 Dehy TEG After Filter / HFF-667113 CO2 Dehy Lean TEG Cooler to the CO2 TEG Contactor, CO2 Stripping Gas from CO2 TEG Contactor Overhead through the HAP-667108 CO2 Dehy Stripping Gas Heater, HAP-667107 CO2 Dehy Teg Reboiler, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000667-056; USAG-EC-PDZZZ-10-000667-057; USAG-EC-PDZZZ-10-000667-058

Design Conditions/Parameters: To regen TEG in the CO2 Dehy Regen Column for use in the dehydration of CO2 gas from the 2nd stage of the CO2 Compressor. The Regen Column is operated at 197-400°F / 15.4-21.7 psia.

Comment: -CO2 Dehy Lean TEG Cooler converted from air cooler (on RBD's) to a cooling medium S/T HEX
-there is now only one CO2 Dehy Lean TEG filter (RBD's had 3)
-HAP667108 no longer exist. Stripping gas heater deleted - gas is now heated up with a coil in the regen column sump.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Fatigue / Corrosion mechanisms	3.1.1. Tube leakage of HBG667119 could result in TEG leaking into cooling medium system, leading to low level in CO2 dehydration unit regenerator sump, causing shutdown of the affected CO2 compressor system.	FIN	1. LALL-667106-01		1. New consequence since air cooler was replaced by shell/tube exchanger

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 19. MAF-667100 CO2 TEG Contactor, Sidedraw from the Contactor through the HBG-667102 CO2 Dehy Cool TEG Lean/Rich Exchanger Tubeside / MBD-667103 CO2 Dehy TEG Flash Drum / HBG-667104 CO2 Dehy Hot TEG Lean/Rich Exchanger Tubeside to the CO2 Dehy Regen Column, Bottoms Outlet from the Contactor to the CO2 Compression 2nd Stage KO Drum, Overhead from the Flash Drum to the CO2 1st Stage Compression KO Drum Feed Line, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000667-052 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000667-056 Rev. B; USAG-EC-PDZZZ-10-000667-054; USAG-EC-PDZZZ-10-000667-055; USAG-EC-PDZZZ-10-000667-056; USAG-EC-PDZZZ-10-000667-057

Design Conditions/Parameters: To provide for contact of CO2 stream from the 2nd stage of the CO2 Compressor with TEG for removal of water. Lean TEG enters the CO2 TEG Contactor at 66.3°F / 529.6 psig / 12.3 gpm / 0.0 lbmole/hr H_2O and exits Rich at 57.3°F / 516.1 psig / 14 gpm / 14.92 lbmole/hr H_2O (Winter base case) to the CO2 Dehy TEG Flash Drum operating at 160°F / 90 psia. The bottoms outlet TEG from the Flash Drum is further heated to 300°F and the pressure dropped to 30 psia before feeding into the CO2 Dehy Regen Column. CO2 Dehy Flash Gas is routed to the CO2 Compressor 1st stage from the Flash Drum at 153.7°F / 15.3 psig.

Comment: -there is no longer an integral scrubber on the CO2 Dehy TEG Contactor
-there are now two CO2 Dehy TEG contactors per train (like the CO2 Compressors). Regeneration is common per contactor pair (one per train)
-New PSV on CO2 Dehy TEG Contactor for "check valve failure"
-there is now a reflux condenser coil in the CO2 Dehy Regen Column and no offgas cooler (air cooler)
-MBD667103 (CO2 Dehy Flash Drum) and liquid outlet SDV were deleted
-HBG667104 (CO2 Dehy Hot L/R HEX) was deleted. There is now only one L/R HEX for the CO2 Dehy.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 20. Overhead Vapor Line from the CO2 Dehy Regen Column through the HFF-667114 CO2 Dehy Offgas Cooler / MBD-667116 CO2 Dehy Offgas Scrubber / CBA-667117 CO2 Dehy Offgas Compressor to the CO2 1st Stage Compression KO Drum Feed Line, Bottoms Outlet from the Scrubber through the PBA-667118A/B CO2 Dehy Reflux Pump to the CO2 Dehy Regen Column / Closed Drain Collection Drum Feed Header and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000667-056 Rev. B; USAG-EC-PDRBD-10-000658-051 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000667-057

Design Conditions/Parameters: To remove liquids and compress CO2 gas from overhead of the CO2 Dehy Regen Column for subsequent dehydration. Overhead vapors from the Regen Column are at 192.5°F / 15.2 psig and enters the CO2 Dehy Offgas Scrubber after cooling at 77°F / 14.9 psia. Water from the bottoms outlet of the Scrubber is pumped back to the Regen Column as reflux while the overhead vapor from the Scrubber is compressed and routed to the 1st stage of the CO2 Compressor at 166.4°F / 25 psia (Winter base case).

Comment: -Node 20 deleted, no CO2 Dehy Offgas System. Offgas cooler, reflux pump, scrubber, and compressor deleted. Dehy gas is flared

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Toxic/hazardous inventories & minimization	2.1.1. Potential exposure of personnel to H2S due to loss of containment.	S		20. Perform CFD dispersion analysis for CO2 Dehy Off Gas Compressor CBA-667117 and CO2 Dehy Regen Column MAF-667106 leak to verify H2S concentrations from leak or opening of equipment for maintenance.	1. Session 2: No longer applicable; Node 20 deleted.
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. CO2 Dehy Off Gas Compressor CBA-667117 outage for planned maintenance resulting in flaring event and potential impact on permit.	ENV		21. Work with environmental team to include planned maintenance flaring for CO2 Dehy Off Gas Compressor CBA-667117 in air emissions "cookbook". 22. Consider sparing of CO2 Dehy Off Gas Compressor CBA-667117.	1. Session 2: No longer applicable; Node 20 deleted. Offgas is used to supplement CO2 Flare purge gas.

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 21. Refrigerant Vapor from the Treated Gas Chillers through the MBD-666505/506 Refrigeration Compressor Suction Drum / CBA-666509/510 Refrigeration Compressor / HFF-666511 thru 26 Refrigerant Condensers to the MBD-666512 Refrigerant Accumulator, Refrigerant Liquid from Bottoms Outlet of the Accumulator to the Treated Gas Chillers, Bottoms Outlet from the Suction Drums to the HP HC Flare, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-50-000666-041 Rev. B; USAG-EC-PDZZZ-50-000666-042; USAG-EC-PDZZZ-50-000666-043; USAG-EC-PDZZZ-50-000666-044

Design Conditions/Parameters: To condense refrigerant vapors to provide refrigerant liquid for the Treated Gas Chillers. Refrigerant Vapor from the Chillers enter the suction of the Refrigerant Compressors at 17.7°F / 51.7 psia and discharges at 124.6°F / 187.6 psia and cooled before discharge into the Refrigerant Accumulator at 97°F / 184.6 psia (Summer base case).

Comment: -no longer a PCV off high point on refrigerant accumulator (no PAHH and PSV)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Node: 22. See Node 4 - HAZID of Node 22 was included in the Node 4 evaluation
EAP-833102/103 Heat Recovery Unit for Power Generator Including Supplemental Firing BMS Utilizing LP Fuel Gas, Fuel Conditioning & Control Skid for HP Fuel Gas, TGT-833100/101 Power Generator Gas Turbines, STKV-833104/105 Power Generator Turbine Stacks, STKV-833106/107 Power Generator Turbine Bypass Stacks, MBA-942100 Process Heat Medium Expansion Drum, PBA-942101A/B/C Process Heat Medium Pumps, MAJ-942102 / 103 Process Heat Medium Filters, HFF-942104-01 thru 02 Process Heat Medium Trim Coolers, and Associated Piping and Instrumentation.

Drawing: USAG-EC-PDRBD-10-000833-100 Rev. B; USAG-EC-PDRBD-10-000965-072 Rev. B; USAG-EC-PDZZZ-10-000833-105; USAG-EC-PDZZZ-60-000965-075; USAG-EC-PDZZZ-10-000833-106

Design Conditions/Parameters: See Node 4 - HAZID of Node 22 was included in the Node 4 evaluation

Comment: -Power Gen. turbine fuel gas take-offs are no longer on the HP fuel gas KO drum drawing, now on Common Fuel Gas System drawing
-WHRU has been deleted - this node is no longer similar to Node 4. No process (except fuel gas feed)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. See Node 4 - HAZID of Node 22 was included in the Node 4 evaluation						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 23. Open Drain System: BBH-992100 / BBH-992101 / BBH-992102 Oily Water Collection Sumps - AGRU Module #1 thru #3, PBA-992103 / PBA-992104 / PBA-992105 Oily Water Pumps - AGRU Module #1 thru #3, BBH-992110 Oily Water Collection Sump - TGDU & CO2 Gas Dehydration Regen Area, PBA-992111 Oily Water Pump - TDGU & CO2 Gas Dehydration Regen Area, BBH-992106 Oily Water Collection Sump - CO2 Compression Area, PBA-992107 Oily Water Pump - CO2 Compression Area, BBH-992108 Oily Water Collection Sump - Treated Gas Compression Area, PBA-992109 Oily Water Pump - Treated Gas Compression Area, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000992-092 Rev. B; USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-10-000992-098; USAG-EC-PDZZZ-10-000992-099

Design Conditions/Parameters: To provide oily water collection sumps in the AGRU / Treated Gas Compression / TGDU & CO2 Gas Dehydration Regen / CO2 Compression Areas. Design details to be completed during FEED.

Comment: -new open drain system for second string of compression and process heat medium, same as original (copy)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 24. Firewater from the Camp Potable Water Tank through the PPW-977007 Firewater Supply Pump / BBJ-412004 Camp Firewater Storage Tank / PFW-411600 Firewater Jockey Pump / PFW-411601 Main Firewater Pump (Electric) / PFW-411602 Main Firewater Pump (Diesel Engine) to Occupied Buildings Firewater Loop, HAP-412005 Camp Firewater Storage Tank Heating Element, MBA-412604 Firewater Diesel Day Storage Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-00-000977-123 Rev. A; USAG-EC-PDRBD-00-000412-124 Rev. A; USAG-EC-PDRBD-00-000411-117 Rev. B; USAG-EC-PDZZZ-00-000412-132; USAG-EC-PDZZZ-00-000412-140; USAG-EC-PDZZZ-00-000411-141; USAG-EC-PDZZZ-00-000412-142; USAG-EC-PDZZZ-00-000411-143

Design Conditions/Parameters: To provide potable water for camp Firewater System. Two electric and one diesel operated pump will be used to meet system requirements and provide firewater at 50°F / 165 psia / 1500 USGPM (175 psia / 100 USGPM for the Firewater Jockey Pump).

Comment: -Camp firewater systems - now 3 per camp (instead of one)
-New firewater supply pump (not on RBDs) - PPW412007
-Camp firewater systems - now 3 per camp (instead of one)
-new biocide injection on camp firewater

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 25. BBJ-977001/2 Camp Potable Water Tanks, Outlet from the Tanks through the PPW-977005A/B/C Camp Potable Water Distribution Pump / Camp Users Distribution Loop / VMBM-977006 Camp UV Sterilization Package, HAP-977003/4 Camp Potable Water Tank Heating Elements, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-00-000977-123 Rev. A

Design Conditions/Parameters: To provide potable water for the Camp users. Camp Potable Water Distribution Pump operates at 105 psia discharge pressure / 28 USGPM and takes suction at 14.7 psia / 50°F.

Comment: -Node 25 no longer exists - no more camp potable water storage.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Node deleted.						

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 26. MBA-927600 Cooling Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-927601A/B Cooling Medium Pump (Common) / Cooling Medium Users / MAJ-927602 Cooling Medium Filter (Common) / HFF-927604-01 thru -02 Cooling Medium Cooler (Common); MBA-927100 Cooling Medium Expansion Drum (Process Train), Bottoms Outlet from Process Train Drum through the PBA-927103A/B Cooling Medium Pump (Process Train) / Cooling Medium Users (including Treated Gas Compressor & Turbine, CO2 Compressor & Turbine, Power Generation Turbines) / MAJ-927101 Cooling Medium Filter (Process Train) / HFF-927104-01 thru -05 Cooling Medium Cooler (Process Train) and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000927-082 Rev. B; USAG-EC-PDRBD-10-000927-083 Rev. B; USAG-EC-PDZZZ-10-000927-090; USAG-EC-PDZZZ-50-000927-089

Design Conditions/Parameters: To provide cooling medium (ethylene glycol / water solution) to Refrigeration Compressor / Other Plant-Wide / Treated Gas Compressor & Turbine / CO2 Compressor & Turbine / Power Generation Turbines / Other Process Train users. Cooling Medium Expansion Drums operate at 90°F / 65 psia. Cooling Medium Pump (Common) operates at 102 psia discharge pressure / 512 USGPM. Cooling Medium Pump (Process) operates at 147 psia discharge pressure / 4348 USGPM.

Comment: -tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-MAJ927602 (cooling medium filter, common) deleted. No longer exists.
-on RBD's a box showing "other plant-wide cooling medium users" was deleted from P&IDs
-cooling medium no longer going to "power generation turbines" (these have their own cooling medium system on-skid)
-cooling medium now also going to TGDU, CO2 Dehy, and Fuel Gas Treating heat exchangers

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 26. MBA-927600 Cooling Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-927601A/B Cooling Medium Pump (Common) / Cooling Medium Users / MAJ-927602 Cooling Medium Filter (Common) / HFF-927604-01 thru -02 Cooling Medium Cooler (Common); MBA-927100 Cooling Medium Expansion Drum (Process Train), Bottoms Outlet from Process Train Drum through the PBA-927103A/B Cooling Medium Pump (Process Train) / Cooling Medium Users (including Treated Gas Compressor & Turbine, CO2 Compressor & Turbine, Power Generation Turbines) / MAJ-927101 Cooling Medium Filter (Process Train) / HFF-927104-01 thru -05 Cooling Medium Cooler (Process Train) and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000927-082 Rev. B; USAG-EC-PDRBD-10-000927-083 Rev. B; USAG-EC-PDZZZ-10-000927-090; USAG-EC-PDZZZ-50-000927-089

Design Conditions/Parameters: To provide cooling medium (ethylene glycol / water solution) to Refrigeration Compressor / Other Plant-Wide / Treated Gas Compressor & Turbine / CO2 Compressor & Turbine / Power Generation Turbines / Other Process Train users. Cooling Medium Expansion Drums operate at 90°F / 65 psia. Cooling Medium Pump (Common) operates at 102 psia discharge pressure / 512 USGPM. Cooling Medium Pump (Process) operates at 147 psia discharge pressure / 4348 USGPM.

Comment: -tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-MAJ927602 (cooling medium filter, common) deleted. No longer exists.
-on RBD's a box showing "other plant-wide cooling medium users" was deleted from P&IDs
-cooling medium no longer going to "power generation turbines" (these have their own cooling medium system on-skid)
-cooling medium now also going to TGDU, CO2 Dehy, and Fuel Gas Treating heat exchangers

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. Loss of nitrogen blanket on MBA927600 could result in low pressure causing loss of suction head to PBA927601A/B, and subsequent pump trip, loss of circulation, and trip of refrigeration compressors.	FIN		45. Consider low pressure alarm on MBA927600	1. New consequence since fuel gas was replaced by nitrogen, which is a limited supply
		2.1.2. Loss of fuel gas blanket on MBA927100 could result in low pressure causing loss of suction head to PBA927103A/B, and subsequent pump trip, loss of cooling medium circulation, shut down of one train.	FIN		46. Consider low pressure alarm on MBA927100	1. New consequence since configuration changed.

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 27. MBA-942600 Building Heat Medium Expansion Drum, Bottoms Outlet from Drum through the PBA-942601A/B/C Building Heat Medium Pump / EAP-942608/609/610 Building Heat Medium Utility Heater / Heat Medium Users (Building, Process Train Building, Process Train Tank / Sump / Drum, and Common Area Tank / Sump / Drum Heaters) / MAJ-942602/603 Building Heat Medium Filter, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000942-081 Rev. B; USAG-EC-PDZZZ-60-000942-087; USAG-EC-PDZZZ-60-000942-088; USAG-EC-PDZZZ-60-000965-075

Design Conditions/Parameters: To provide building heat medium (ethylene glycol / water solution) to Building Heaters / Process Train Building Heaters / Process Train Tank, Sump, and Drum Heaters / Common Area Tank, Sump, and Drum Heaters. Building Heat Medium Expansion Drum operates at 80°F / 65 psia. Building Heat Medium Pump operates 293 psia discharge pressure / 5356 USGPM. Building Heat Medium Utility Heater operates at 200°F discharge temperature / 287 psia.

Comment: -tank blanket on RBDs was fuel gas - now tank is blanketed with nitrogen bottles
-RBDs had two filters, there is only on BHM filter now
-we now have a BMS shown on the heaters (added detail only)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	2.1.1. Loss of nitrogen supply could res in lower pressure in the heat med system, which could result in generation of steam/degradation products in the heaters, and ultimately tube failure causing los containment.	FIN	1. Operating procedures	48. Consider designing heaters for loss of circulation (i.e. no flow in the heater tubes) 47. Add PALL to MBA942600	1. New consequence in since fuel gas was replaced by nitrogen, which is a limited supply

Session: 2. 5/20/2015

Updated: 4. 6/8/2016

Node: 28. VCBA-955600A/B/C Air Compressor Packages: CEM-955602A/B/C Air Compressor Motors, CBA-955601A/B/C Air Compressors, VNBA-956600 Air Dryer Package, MBA-956601 Dry Air Receiver, Air Header to Service Air Users, Air Header to Instrument Air Users Including MBA-952100/200/300 Instrument Air Receivers, Air Header to Breathing Air Users Including AAJ-954100/200/300 Breathing Air Train Header Filters, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000955-110 Rev. B; USAG-EC-PDRBD-60-000951-111 Rev. B; USAG-EC-PDRBD-60-000952-112 Rev. B; USAG-EC-PDRBD-60-000954-113 Rev. B; USAG-EC-PDZZZ-60-000955-110; USAG-EC-PDZZZ-60-000951-112; USAG-EC-PDZZZ-60-000952-113; USAG-EC-PDZZZ-60-000954-114; USAG-EC-PDZZZ-60-000955-111

Design Conditions/Parameters: To compress, dry, and filter atmospheric air for use as Breathing Air, Instrument Air, Service Air, and supply to Nitrogen Membrane Package. To provide cooling for Air Compressor stages. Air Compressors (3) operate at discharge pressure of 155 psia / 100°F / 7250 ACFM and provides air to users at 145 psia / 100°F / -100°F dewpoint.

Comment: -No SDVs coming from each air compressor package anymore
-No utility air to control room
-No instrument air to control room
-Breathing air is now a vendor package with one common breathing air filter, not one per train
-Breathing air now goes to CO2 Meter Module also (new module)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 29. VNTG-961600 Nitrogen Membrane Package, MBA-961605 Nitrogen Receiver, MBA-961602 Liquid Nitrogen Storage Vessel, PBA-961603 Liquid Nitrogen Pump, HAP-961604 Liquid Nitrogen Vaporizer, HAP-961606 Vaporized Nitrogen Heater, Nitrogen Distribution Header, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000961-114 Rev. B; USAG-EC-PDRBD-60-000961-115 Rev. B; USAG-EC-PDZZZ-60-000961-115; USAG-EC-PDZZZ-60-000961-116

Design Conditions/Parameters: To provide nitrogen for users via Nitrogen Membrane Package and Liquid Nitrogen System as a backup. Nitrogen Membrane Package operates at 145 psia / 100°F / 2.59 MMSCFD. Liquid Nitrogen System operates at 125 psia / 100°F / 0.8 MMSCFD. Nitrogen is provided to users at 125 psia / 100°F.

Comment: -VNTG961601 has been deleted (Liquid Nitrogen Vaporizer Package) - truck connection instead
-No nitrogen distribution to control room

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 30. BBJ-678600 AGRU Solvent Storage Tank, PBJ-678602 Agru Solvent Transfer Pump, MAJ-678603 AGRU Solvent Makeup Filter, BBJ-678604 AGRU Fresh Solvent Storage Tank, PBJ-678606 AGRU Fresh Solvent Transfer Pump, HAP-678601 AGRU Solvent Storage Tank Heater, HAP-678605 AGRU Fresh Solvent Storage Tank Heater,Lean Solvent Line to the AGRU Solvent Flash Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000678-013 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-60-000678-019

Design Conditions/Parameters: To provide for fresh Solvent storage and transfer to the AGRU. The AGRU Fresh Solvent Transfer Pump operates at 218 psia discharge pressure / 50 USGPM. The AGRU Solvent Transfer Pump operates at 237.1 psia discharge pressure / 1200 USGPM / 80°F.

Comment: -SDV for solvent from makeup filter is now downstream of FCV
-building heat medium coils no longer controlled with TC (globe valve now)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. Operating/Design Temperature (hot / cold surfaces, low temperature embrittlement)	2.1.1. High temperature in BBJ678600/604 could cause risk to personnel	S		49. Add high temperature alarm to BBJ678600 and 604	1. New consequence since temperature controlled heating medium changed to manual.
		2.1.2. Low temperature in BBJ678600/604 could cause freezing of AGRU solvent or precipitation of activator	OP		50. Add low temperature alarm to BBJ678600 and 604	1. New consequence since temperature controlled heating medium changed to manual.

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 31. ABJ-671600 Methanol Storage Tank, PBJ-671601 Methanol Injection Pump, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000671-131 Rev. B

Design Conditions/Parameters: To provide methanol for various injection points. Methanol Injection Pump operates at 737.3 psia / 50 USGPM.

Comment: -Node 31 no longer exists (methanol tank deleted).

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Node deleted.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 32. BBJ-678607 TEG Makeup Storage Tank, HAP-678608 TEG Makeup Storage Tank Heating Coil, PBJ-678609 TEG Supply Pump, MAJ-678613 TEG Solvent Filter, TEG Piping to the TGDU / CO2 Dehy Flash Drums and Trains 1 / 2 Headers, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000678-130 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDZZZ-60-000678-135; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000667-057

Design Conditions/Parameters: To provide for storage, filtering, and transfer of TEG to the process. The TEG Supply Pump operates at 216.7 psia discharge pressure / 95 USGPM.

Comment: -MAJ678613 no longer exists, deleted, (TEG Solvent Filter)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 33. BBJ-911600 Diesel Fuel Storage Tank, PBJ-911605 Diesel fuel Pump, MAJ-911606 Diesel Fuel Filter, PBJ-911608 Diesel Fueling Station Delivery Pump, MBA-911607 Diesel Fueling Station Storage Drum, MAJ-911604 Diesel Recycle Filter, VMBA-911603 Diesel Drain Centrifuge, PBJ-911602 Diesel Drain Pump, MBA-837600 Dormitory Emergency Diesel Generator Day Storage, MBA-837601 Essential Diesel Generator Day Storage, Communication Tower Diesel Day, Water from the Centrifuge to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000911-103 Rev. B; USAG-EC-PDRBD-60-000837-101 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000911-109; USAG-EC-PDZZZ-60-000837-108

Design Conditions/Parameters: To provide for storage, water separation, filtering, and transfer of Diesel Fuel to the users. The Diesel Fuel Pump operates at 54.7 psia discharge pressure / 50 USGPM / ambient suction temperature. The Diesel Drain Pump operates at 54.7 psia / 10 USGPM / ambient suction temperature.

Comment: -Diesel drain centrifuge, diesel drain pump, and diesel recycle filter DELETED
-SDV upstream of diesel fuel pump deleted
-MAJ991606 (diesel fuel filter) DELETED.
-Diesel Fueling Station Storage Drum only filled by truck (not delivery pump)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 34. TGT-837610-612 Essential Power Generator Gas Turbine, STKV-837607-609 Essential Power Generator Turbine Stack, HP Fuel Gas Piping from the Fuel Gas Header, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDRBD-60-000837-101 Rev. B; USAG-EC-PDZZZ-60-000965-075

Design Conditions/Parameters: To provide HP Fuel Gas to the Essential Power Generator Gas Turbines at 82.1°F / 530 psig.

Comment: -Node 34 no longer exists - this was for the Essential Power Generators which have been deleted.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
Node deleted.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 35. BBJ-678614 Hydrocarbon Disposal Tank, HAP-678615 Hydrocarbon Disposal Tank Heating Coil, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000679-132 Rev. B; USAG-EC-PDZZZ-60-000679-137

Design Conditions/Parameters: To provide storage for hydrocarbons to be disposed of. Hydrocarbon Disposal Tank operates at atmospheric pressure with 350 bbl capacity and electrical heating element to maintain a minimum temperature to be specified.

Comment: -Tank has been renamed (Hydrocarbon Holding Tank) and tank no longer has an electric heating coil.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 36. MBD-612506 HP Hydrocarbon Flare KO Drum, PBA-612507A/B HP Hydrocarbon Flare Blowdown Pumps, FLRH-612508 HP Hydrocarbon Flare, FLRH-612511 HP Hydrocarbon Flare, LP Fuel Gas Lines to Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the AGRU Solvent Storage Tank, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000965-070 Rev. B; USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDZZZ-60-000678-019; USAG-EC-PDZZZ-50-000612-070; USAG-EC-PDZZZ-60-000965-075

Design Conditions/Parameters: To provide means to flare high pressure hydrocarbon systems. The HP Hydrocarbon Flare KO Drum operates at -150-200°F / 115 psia. The HP Hydrocarbon Flare Blowdown Pump operates at 54.6 psia discharge pressure / 150°F suction temperature / 1260 USGPM. Maximum flowrate basis is one train relief and start-up of one train. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 37. MBD-612500 HP CO2 Flare KO Drum, PBA-612501A/B HP CO2 Flare Blowdown Pumps, FLRH-612502 HP CO2 Flare, FLRH-612505 HP CO2 Flare, LP Fuel Gas / Backup Assist Gas / Assist Gas Lines to the Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000612-061 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-50-000612-071

Design Conditions/Parameters: To provide means to flare high pressure CO2 systems. The HP CO2 Flare KO Drum operates at -130-110°F / 65 psia. The HP CO2 Flare Blowdown Pump operates at 53.7 psia discharge pressure / 40°F suction temperature / 25 USGPM. Maximum flowrate basis is one train blocked outlet. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 38. MBD-613506 LP Hydrocarbon Flare KO Drum, PBA-613507A/B LP Hydrocarbon Flare Blowdown Pumps, FLRL-613508 LP Hydrocarbon Flare, FLRL-613512 LP Hydrocarbon Flare, CAL-613509 LP Hydrocarbon Flare Air Blower, CAL-613513 LP Hydrocarbon Flare Air Blower, LP Fuel Gas to Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000613-062 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-50-000613-072; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide means to flare low pressure hydrocarbon systems. The LP Hydrocarbon Flare KO Drum operates at 37-165°F / 30 psia. The LP Hydrocarbon Flare Blowdown Pump operates at 47.8 psia discharge pressure / 165°F suction temperature / 80 USGPM. Maximum flowrate basis is HP to LP fuel gas blowby. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 39. MBD-613500 LP CO2 Flare KO Drum, PBA-613501A/B LP CO2 Flare Blowdown Pump, FLRL-613502 / 514 / 515 LP CO2 Flare, FLRL-613505 / 516 / 517 LP CO2 Flare, LP Fuel Gas / Backup Assist Gas / Assist Gas Lines to the Flares and KO Drum, Bottoms Outlet Line from the KO Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-50-000612-060 Rev. B; USAG-EC-PDRBD-50-000613-063 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-10-000651-031 Rev. B; USAG-EC-PDZZZ-50-000609-003; USAG-EC-PDZZZ-50-000613-073

Design Conditions/Parameters: To provide means to flare low pressure CO2 systems. The LP CO2 Flare KO Drum operates at -40-245°F / 25 psia. The LP CO2 Flare Blowdown Pump operates at 42.7 psia discharge pressure / 160°F suction temperature / 25 USGPM. Maximum CO2 flowrate basis is blocked-in CO2 injection line. Flares are two 100% flares, one in operation and the other purge-pilot active.

Comment: -new assist gas jumpover from PBU - not previously on RBDs
-blowcase added for flare line, not previously on RBDs

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 40. STR-976700A/B Put River Water Pump Strainers, PBJ-976701A/B Put River Water Pumps, KAU-976708 Put Water Regulatory Metering, Put Water Reservoir, STR-976702A/B Reservoir Water Strainers, PBJ-976703A/B Reservoir Water Supply Pumps, VPBK-976704 Reservoir Water Biocide Injection Package, VPBK-976705 Reservoir Water Oxygen Scavenger Injection Package, MAJ-976706A/B Reservoir Water Filter, PBJ-976707A/B Reservoir Water Delivery Pumps, BBJ-976602 / BBJ-976604 Raw Water Storage Tanks, HAP-976601 / HAP-976603 Raw Water Storage Tank Heating Elements, PBJ-976600A/B Service Water Pumps, VMBM-683610 UV Sterilization Package, Service Water to the Process Water Treatment System IncludingChemical Injection Package and R.O. Filter, Service Water to Utility Station Users, Raw Water to Potable Water Treatment System, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-70-000976-120 Rev. B; USAG-EC-PDRBD-50-000609-001 Rev. B; USAG-EC-PDRBD-60-000976-116 Rev. B; USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-60-000976-119 Rev. B; USAG-EC-PDRBD-60-000977-121 Rev. B; USAG-EC-PDZZZ-50-000609-003; USAG-EC-PDZZZ-60-000976-120; USAG-EC-PDZZZ-60-000976-124; USAG-EC-PDZZZ-70-000976-125; USAG-EC-PDZZZ-70-000976-126

Design Conditions/Parameters: To provide for transfer, treatment, filtering, storage, and sterilization of Raw Water from the Put River to meet Service / Process / Potable Water requirements. Conditions of service are yet to be defined for the transfer and treatment of Put River water to the GTP Raw Water Storage Tanks. Service Water Pumps operate at 117.5 psia discharge pressure / 392 USGPM to supply Service Water at 50°F / 110 psia to Process Water Treatment and Utility Station Distribution header.

Comment: -new raw water line to operations camp (line not on RBDs)
-New Service Water Jockey pump for continuous circulation/flow (PBJ976609)
-New Service Water Strainer (STR976605)
-New biocide and O2 scavenger injection packages on service water
-New Raw Water Reservoir Regulatory Meter (not on RBDs)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Maintenance philosophy	3.1.1. Potential plugging of STR976605 requires shutting down service wa system, potentially causing disruption of water supply to AGR water treatment and utility station and potable water treatment	OP	1. Storage in water treatment packages	51. Consider adding spare strainer in parallel to STR976605	1. New consequence because strainer was added.

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 41. Process Water Treatment System: BBJ-683601 R.O. Feed Tank, HAP-683602 R.O. Feed Tank Heating Element, R.O. Feed Pump, Chemical Injection Package, R.O. Modules, BBJ-683603 Process Water Storage Tank, HAP-683604 Process Water Storage Tank Heating Element, PBJ-683608A/B Process Water Pump, Permeate Recirculation Pump, BBJ-683605 R.O. Rejection Water Storage Tank, HAP-683606 R.O. Rejection Water Storage Tank Heating Element, PBJ-683609A/B R.O. Reject Water Pump and Discharge Piping to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000683-118 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-000683-122

Design Conditions/Parameters: To provide for the treatment, storage, and transfer of Process Water and R.O. Rejection Water. The Process Water Pumps operate at 210 psia discharge pressure / 50-70 USGPM. The R.O. Reject Water Pumps operate at 33.5 psia discharge pressure / 16-25 USGPM.

Comment: -

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 42. VMBM-977606 Potable Water Treatment System, BBJ-977600 / 601 Potable Water Tanks, HAP-977602 / 603 Potable Water Tank Heating Elements, PPW-977604A/B/C Potable Water Pumps, PPW-977607A/B Potable Water Camp Supply Pumps, VMBM-977605 UV Sterilization Package, Potable Water Supply / Return Headers for Users, Reject Water Line from the Potable Water Treatment System to the Common Closed Drain Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000977-121 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDRBD-60-000977-122 Rev. B; USAG-EC-PDZZZ-60-000977-127; USAG-EC-PDZZZ-60-000977-128; USAG-EC-PDZZZ-60-000977-129; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide Potable Water to the GTP Distribution Header / Camp Potable Water Storage and recirculation from eyewash / safety showers back to the Potable Water Tanks. Potable Water Pumps operate at 92.5 psia discharge pressure / 28 USGPM. Potable Water Camp Supply Pumps operate at 165 psia discharge pressure / 250 USGPM.

Comment: -Pumps PPW977607A/B (Potable Water Camp Supply Pumps) have been deleted.
-Potable water no longer going to the following areas: HP/LP flare KO drums, treated gas chilling and metering, inlet metering, warehouse

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 43. MBA-996112 TEG Drain Drum, PBA-996113 TEG Drain Drum, MAJ-996114 TEG Drain Filter, TEG Lines to the TGDU / CO2 TEG Flash Drums, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000661-022 Rev. B; USAG-EC-PDRBD-10-000667-053 Rev. B; USAG-EC-PDRBD-10-000661-021 Rev. B; USAG-EC-PDZZZ-10-000661-026; USAG-EC-PDZZZ-10-000661-031

Design Conditions/Parameters: To provide for the collection, filtration, and transfer of TEG drains. The TEG Drain Drum operates at 66°F / 14.7 psia. The TEG Drain Pump operates at 189.2 psia discharge pressure / 30 USGPM.

Comment: -TEG from the TEG drain drum can no longer be routed to CO2 Dehy, only the TGDU

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 44. MBA-996100 AGRU Solvent Drain Drum, HAP-996101 AGRU Solvent Drain Drum Heater, PBA-996103 AGRU Solvent Drain Drum Pump, MAJ-996106 AGRU Solvent Drain Filter, Solvent Lines to the AGRU Solvent Storage Tank and AGRU Solvent Flash Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000662-011 Rev. B; USAG-EC-PDRBD-10-000662-012 Rev. B; USAG-EC-PDRBD-60-000678-013 Rev. B; USAG-EC-PDZZZ-10-000662-013; USAG-EC-PDZZZ-10-000678-018

Design Conditions/Parameters: To provide for the collection, filtration, and transfer of AGRU Solvent drains. The AGRU Solvent Drain Drum operates at 66°F / 15 psia. The AGRU Solvent Drain Drum Pump operates at 217.7 psia discharge pressure / 225 USGPM.

Comment: -SDV for solvent from AGRU solvent drain filter has been deleted

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 45. MBA-991106 Closed Drain Collection Drum, LP Fuel Gas Supply Line to the Collection Drum, PBA-991107A/B Closed Drain Collection Drum Pump, Collection Drum Supply Header, Bottoms Outlet from the Collection Drum to the Common Closed Drain Collection Drum, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-10-000991-091 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-10-000991-095; USAG-EC-PDZZZ-60-000991-096

Design Conditions/Parameters: To provide for the collection and transfer of process drains requiring a closed system. The Closed Drain Collection Drum operates at 66°F / 15 psia. The Closed Drain Collection Drum Pump operates at 84.2 psia discharge pressure / 25 USGPM.

Comment: -seal pot and seal pot pump are new (not on RBDs)

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	3.1.1. Overfilling MBA991108 when PBA991109A/B trips or does not start could cause open drain liqui to be released.	S	1. LAHH991108-04 trips upstream pumps feeding MBA991108	52. Ensure liquid containment outside the module is provided for the potential overflow, or re-evaluate seal pot design to avoid potential liquid release to atmosphere.	1. New consequence since configuration changed.
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential for backflow of hazardou components from tie in to closed drain system into module sumps. (Note: Open Drain module sumps are generally expected to be emp and funnels around equipment discharges into sump)	S		25. Segregate open and closed drain systems.	1. Session 2: "Consequences" and "Recommendations" no longer applicable; isolation provided by MBA991108.

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 46. BBH-992500 Oily Water Collection Sump - Refrigeration Compressor Module Including Heat Medium Supply / Return Piping and PBA-992501 Oily Water Pump - Refrigeration Compressor Module, BBH-992602 Oily Water Collection Sump - Service Water Area Including Heat Medium Supply / Return Piping and PBA-992603 Oily Water Pump - Service Water Area, BBH-992600 Oily Water Collection Sump - Common Utilities Including Heat Medium Supply / Return Piping and PBA-992601 Oily Water Pump - Common Utilities, BBH-992000 Oily Water Collection Sump - Integrated Housing Utilities Module Including HAP-992002 Oily Water Collection sump Heating Element - Integrated Housing Utilities Module and PBA-992001 Oily Water Pump - Integrated Housing Utilities Module, BBH-992606 Oily Water Collection Sump - Building Heat Medium Including Heat Medium Supply / Return Piping and PBA-992607 Oily Water Pump - Building Heat Medium, BBH-992604 Oily Water Collection Sump - Chemical Storage Including Heat Medium Supply / Return Piping and PBA-992605 Oily Water Pump - Chemical Storage, BBH-992502 Oily Water Collection Sump - Flare KO Drum Module Including Heat Medium Supply / Return Piping and PBA-992503 Oily Water Pump - Flare KO Drum Module, BBH-992608 Collection Sump - Water Treatment Module Including Heat Medium Supply / Return Piping and PBA-992609 Oily Water Pump - Water Treatment Module, MBA-991611 Common Closed Drain Collection Drum Including LP Fuel Gas Supply Line and Drain Supply Header, PAT-991612A/B Closed Drain Injection Booster Pumps, VPBK991602 Chemical Injection Package, MAJ-991613A/B Closed Drain Injection Filter, PAT-991614A/B Closed Drain Injection Pumps, KAU-991615 Closed Drain Injection Well Metering Station, QAT-991606A/B Class I Injection Wells, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000992-095 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-000991-097; USAG-EC-PDZZZ-60-000992-100

Design Conditions/Parameters: To provide for the collection, chemical injection, metering, and transfer of oily water drains from various process systems to Class I Injection Wells. Oily Water Pumps operate at 66.1 psia discharge pressure / 30 USGPM and discharge to the Common Closed Drain Collection Drum which operates at 66°F / 15 psia. The Closed Drain Injection Booster Pump operates at 161.6 psia discharge pressure / 130 USGPM. The Closed Drain Injection Pump operates at 2209 psia discharge pressure / 130 USGPM.

Comment: -seal pot and seal pot pump are new (not on RBDs)
-BBH992602 - deleted from this drawing. No more "raw water" open drain in the common open drain system - removed from drawing

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 46. BBH-992500 Oily Water Collection Sump - Refrigeration Compressor Module Including Heat Medium Supply / Return Piping and PBA-992501 Oily Water Pump - Refrigeration Compressor Module, BBH-992602 Oily Water Collection Sump - Service Water Area Including Heat Medium Supply / Return Piping and PBA-992603 Oily Water Pump - Service Water Area, BBH-992600 Oily Water Collection Sump - Common Utilities Including Heat Medium Supply / Return Piping and PBA-992601 Oily Water Pump - Common Utilities, BBH-992000 Oily Water Collection Sump - Integrated Housing Utilities Module Including HAP-992002 Oily Water Collection sump Heating Element - Integrated Housing Utilities Module and PBA-992001 Oily Water Pump - Integrated Housing Utilities Module, BBH-992606 Oily Water Collection Sump - Building Heat Medium Including Heat Medium Supply / Return Piping and PBA-992607 Oily Water Pump - Building Heat Medium, BBH-992604 Oily Water Collection Sump - Chemical Storage Including Heat Medium Supply / Return Piping and PBA-992605 Oily Water Pump - Chemical Storage, BBH-992502 Oily Water Collection Sump - Flare KO Drum Module Including Heat Medium Supply / Return Piping and PBA-992503 Oily Water Pump - Flare KO Drum Module, BBH-992608 Collection Sump - Water Treatment Module Including Heat Medium Supply / Return Piping and PBA-992609 Oily Water Pump - Water Treatment Module, MBA-991611 Common Closed Drain Collection Drum Including LP Fuel Gas Supply Line and Drain Supply Header, PAT-991612A/B Closed Drain Injection Booster Pumps, VPBK991602 Chemical Injection Package, MAJ-991613A/B Closed Drain Injection Filter, PAT-991614A/B Closed Drain Injection Pumps, KAU-991615 Closed Drain Injection Well Metering Station, QAT-991606A/B Class I Injection Wells, and Associated Piping and Instrumentation

Drawing: USAG-EC-PDRBD-60-000992-095 Rev. B; USAG-EC-PDRBD-60-000991-094 Rev. B; USAG-EC-PDZZZ-60-000991-096; USAG-EC-PDZZZ-60-000991-097; USAG-EC-PDZZZ-60-000992-100

Design Conditions/Parameters: To provide for the collection, chemical injection, metering, and transfer of oily water drains from various process systems to Class I Injection Wells. Oily Water Pumps operate at 66.1 psia discharge pressure / 30 USGPM and discharge to the Common Closed Drain Collection Drum which operates at 66°F / 15 psia. The Closed Drain Injection Booster Pump operates at 161.6 psia discharge pressure / 130 USGPM. The Closed Drain Injection Pump operates at 2209 psia discharge pressure / 130 USGPM.

Comment: -seal pot and seal pot pump are new (not on RBDs)
-BBH992602 - deleted from this drawing. No more "raw water" open drain in the common open drain system - removed from drawing

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. Operating/Design Pressure - Overpressure, Vacuum, Overfilling, Overextraction	3.1.1. Overfilling MBA991616 when PBA991617A/B trips or does not start could cause open drain liqui to be released.	S	1. LAHH991611-04 trips upstream pumps feeding MBA991616	52. Ensure liquid containment outside the module is provided for the potential overflow, or re-evaluate seal pot design to avoid potential liquid release to atmosphere.	1. New consequence since configuration changed.
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Potential for backflow of hazardou components from tie in to closed drain system into module sumps. (Note: Open Drain module sumps are generally expected to be emp and funnels around equipment discharges into sump)	S		25. Segregate open and closed drain systems.	1. Session 2: "Consequences", and "Recommendations" no longer applicable due to configuration change (isolation provided by MBA991616).

Session: 3. 5/21/2015

Updated: 4. 6/8/2016

Node: 47. Global Node

Drawing:

Design Conditions/Parameters: To document hazard scenarios not specific to a particular process, but global in nature.

Comment:

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
No new hazards identified.						

Session:

Updated: 4. 6/8/2016

Node: 48. MBA-679001 Gasoline Fuel Supply Tank

Drawing: USAG-EC-PDZZZ-00-000679-138

Design Conditions/Parameters: To supply gasoline for the facility. Note: this is a vendor package, details to be developed during FEED

Comment: -NEW NODE. Gasoline Fuel Supply tank not on RBDs.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
1. Section 1 Manning/Control Philosophy	1.1. Manning philosophy / Control philosophy - remote/local operations Alarm minimization	1.1.1. Reference global node.				
2. Section 2 Process Hazards - Aim to minimize inventory, leak sources and potential for loss of containment by inherent safety	2.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
3. Section 3 Operations and Maintenance - Aim to minimize process interventions and complex operations	3.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
4. Section 4 - Fire and Explosion Hazards - Aim to prevent ignition, then manage hazard by detecting, controlling and mitigating event	4.1. Hazardous Release	4.1.1. Reference global node.				1. Vent to atmosphere (safe location) to be designed in accordance with all applicable regulations
5. Section 5 Evacuation, Escape and Rescue Systems	5.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
6. Section 6 Environmental Impacts	6.1. Emissions to Air (climate, local air quality) normal operations (vents, flares, exhausts, fugitive emissions, heat), maintenance/intervention, emergency conditions	6.1.1. Reference global node.				
7. Section 7 Occupational Health Hazards	7.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
8. Section 8 Utility & Support Systems	8.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
9. Section 9	9.1. No credible scenario identified in					

Session:

Updated: 4. 6/8/2016

Node: 48. MBA-679001 Gasoline Fuel Supply Tank

Drawing: USAG-EC-PDZZZ-00-000679-138

Design Conditions/Parameters: To supply gasoline for the facility. Note: this is a vendor package, details to be developed during FEED

Comment: -NEW NODE. Gasoline Fuel Supply tank not on RBDs.

Hazard/Category	Guide Word	Consequences	Category	Controls (Barrier and Recovery)	Recommendations	Remarks
External Hazards	this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
10. Arctic Operations	10.1. Arctic Operations	10.1.1. Reference global node.				
11. Modules	11.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
12. Interfaces	12.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
13. Previous incidents / Experiences	13.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					
14. Simultaneous Operation	14.1. No credible scenario identified in this Node for this Hazard / Category having a safety, environmental, or significant operability impact					

10.3 APPENDIX C – HAZID RECOMMENDATIONS

Table 6: Session 2 Recommendations

#	Recommendations
1.	Consider parallel HIPPS valves or locked closed manual bypass valves.
2.	Consider designing WHRU for loss of circulation (i.e. no flow in the WHRU tubes).
3.	Add high level alarm on LT-942100-01. Add high level alarm on LT-942100-01.
4.	Consider heat exchanger design that minimizes risk of tube leakage, e.g. double pipe exchanger.
5.	Ensure pipe stress analysis considers sudden temperature decrease when gas starts flowing into hot bath heater.
6.	Ensure bath heater design includes overpressure detection with automatic shutdown (SDV-965001-01 and SDV-965001-02).
7.	Limit rate of gas flow increase to reduce thermal shock.
8.	Install chokes in vent lines to limit venting rate.
9.	Consider low pressure alarm on MBA927600.
10.	Consider low pressure alarm on MBA927100.
11.	Add PALL to MBA942600.
12.	Consider designing heaters for loss of circulation (i.e. no flow in the heater tubes).
13.	Add high temperature alarm to BBJ678600 and 604.
14.	Add low temperature alarm to BBJ678600 and 604.
15.	Consider adding spare strainer in parallel to STR976605.
16.	Ensure liquid containment outside the module is provided for the potential overflow, or re-evaluate seal pot design to avoid potential liquid release to atmosphere.

10.4 APPENDIX D – HAZID ATTENDEES SIGN-IN SHEET

Table 7: Attendees List

#	Name	Company	Responsibility / Function
1.	Adrian Becerra	AKLNG	GTP Facility Eng. – PBU/GTP Interface
2.	Jeff Lipscomb	AKLNG	GTP Facilities Eng. Lead
3.	Luci Machado	AKLNG	Risk Coordinator
4.	Mark Elkins	AKLNG	GTP Process Eng. Lead
5.	Robert Rood	AKLNG	GTP Eng. Manager
6.	Sjoerd Hoogwater	AECOM	GTP Lead Process Engineer / Scribe

HAZID Sign-in Sheet - Session 2

10.5 APPENDIX E – HAZID PARKING LOT ITEMS

No Parking Lot items identified.

10.6 APPENDIX F – PRE-FEED HAZID REVIEW CHARTER

HAZID Review Charter - Session 2

10.7 APPENDIX G – NODED P&IDS

Noded P&IDs

10.8 APPENDIX H – LAYOUT DRAWINGS

Layout Drawings

Certificate Of Completion

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grizelda.m.cabrera@exxonmobil.com
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Electronic Record and Signature Disclosure: Accepted: 8/2/2016 5:06:19 PM ID: 6595d6a2-b2fe-4210-aaf1-89263de5f05c Company Name: Exxon Mobil Corporation		
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Electronic Record and Signature Disclosure: Accepted: 8/3/2016 8:06:44 AM ID: c399c12f-834e-474e-9d04-d3ddc8e13310 Company Name: Exxon Mobil Corporation		
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Electronic Record and Signature Disclosure: Accepted: 8/3/2016 10:46:22 AM ID: bd7383df-362f-459c-8676-69d824796297 Company Name: Exxon Mobil Corporation		
Robert Rood robert.rood@exxonmobil.com Security Level: Email, Account Authentication (None)	DocuSigned by: Robert Rood 5E93ACDA043B4DA...	Sent: 8/3/2016 10:46:32 AM Viewed: 8/3/2016 1:00:10 PM Signed: 8/3/2016 1:00:24 PM
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Electronic Record and Signature Disclosure: Accepted: 8/3/2016 1:00:10 PM ID: 85afc740-9e2b-46d6-81c9-82f23357299f Company Name: Exxon Mobil Corporation		

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G.2 – Simultaneous Operations Studies

Document Number:	Description:	Revision:	Appendix:
N/A	N/A	N/A	Public

G.3 – Waterway Safety and Reliability Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Not Applicable to the GTP	N/A	Public

G.4 – Road Safety and Reliability Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

G.5 – Rail Safety and Reliability Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

G.6 – Air Safety and Reliability Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

G.7 – Crane and Lifting Impact Studies

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

G.8 – Security Threat and Vulnerability Analyses

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

H.1 – Safety Data Sheets

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-HSE-RTA-DOC-00002	Safety Data Sheets	0	Public

ALASKA LNG PROJECT – GTP SAFETY DATA SHEETS

AKLNG-4010-HSE-RTA-DOC-00002

GTP Safety Data Sheets

by

Rev No.	Issue Purpose:	Date:	By	CHK	APP
A	For Client Review	March 27, 2017	JMP	PJS	PJS
0	Issued for Information	April 3, 2017	JMP	PJS	PJS

Table of Contents

Safety Data Sheets

SAFETY DATA SHEET

Methane

Section 1. Identification

GHS product identifier : Methane

Chemical name : methane

Other means of identification : Methane or natural gas; Marsh gas; Methyl hydride; CH4; Fire Damp;

Product use : Synthetic/Analytical chemistry.

Synonym : Methane or natural gas; Marsh gas; Methyl hydride; CH4; Fire Damp;

SDS # : 001033

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE GASES - Category 1
GASES UNDER PRESSURE - Compressed gas

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Extremely flammable gas.
May form explosive mixtures with air.
Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Approach suspected leak area with caution.

Prevention : Never Put cylinders into unventilated areas of passenger vehicles. Keep away from heat, sparks, open flames and hot surfaces. - No smoking. Use and store only outdoors or in a well ventilated place.

Response : Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

Storage : Protect from sunlight. Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Disposal : Not applicable.

Section 2. Hazards identification

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : methane

Other means of identification : Methane or natural gas; Marsh gas; Methyl hydride; CH4; Fire Damp;

CAS number/other identifiers

CAS number : 74-82-8

Product code : 001033

Ingredient name	%	CAS number
methane	100	74-82-8

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Wash contaminated skin with soap and water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : No known significant effects or critical hazards.

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Section 4. First aid measures

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Extremely flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Section 6. Accidental release measures

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid contact with eyes, skin and clothing. Avoid breathing gas. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
methane	**ACGIH TLV (United States, 3/2012).** TWA: 1000 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Section 8. Exposure controls/personal protection

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Compressed gas.]

Color : Colorless.

Molecular weight : 16.05 g/mole

Molecular formula : C-H4

Boiling/condensation point : -161.48°C (-258.7°F)

Melting/freezing point : -187.6°C (-305.7°F)

Critical temperature : -82.45°C (-116.4°F)

Odor : Odorless.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: -188.15°C (-306.7°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : Not available.

Flammability (solid, gas) : Extremely flammable in the presence of the following materials or conditions: open flames, sparks and static discharge and oxidizing materials.

Lower and upper explosive (flammable) limits : Lower: 1.8%
Upper: 8.4%

Section 9. Physical and chemical properties

Vapor pressure : Not available.

Vapor density : 0.55 (Air = 1) Liquid Density@BP: 26.5 lb/ft3 (424.5 kg/m3)

Specific Volume (ft ^{3}/lb) : 2.3641

Gas Density (lb/ft ^{3}) : 0.423 (25°C / 77 to °F)

Relative density : Not applicable.

Solubility : Not available.

Solubility in water : 0.0244 g/l

Partition coefficient: n-octanol/water : 1.09

Auto-ignition temperature : 287°C (548.6°F)

Decomposition temperature : Not available.

SADT : Not available.

Viscosity : Not applicable.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

Incompatibility with various substances : Extremely reactive or incompatible with the following materials: oxidizing materials.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Section 11. Toxicological information

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : No known significant effects or critical hazards.

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Section 11. Toxicological information

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
methane	1.09	-	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1971	UN1971	UN1971	UN1971	UN1971
UN proper shipping name	Methane, compressed	Methane, compressed or Methane or Natural gas, compressed (with high methane content)	Methane, compressed	Methane, compressed	Methane, compressed
Transport hazard class(es)	2.1 	2.1 	2.1 	2.1 	2.1 

Section 14. Transport information

Packing group	-	-	-	-	-
Environment	No.	No.	No.	No.	No.
Additional information	-	**Explosive Limit and Limited Quantity Index** 0.125 **ERAP Index** 3000 **Passenger Carrying Ship Index** Forbidden **Passenger Carrying Road or Rail Index** Forbidden	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 0 Forbidden **Cargo Aircraft Only** Quantity limitation: 150 kg

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act (CAA) 112 regulated flammable substances: methane

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Fire hazard
Sudden release of pressure

Composition/information on ingredients

Section 15. Regulatory information

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
methane	100	Yes.	Yes.	No.	No.	No.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

Canada inventory : This material is listed or exempted.

International regulations

International lists : **Australia inventory (AICS)**: This material is listed or exempted.
China inventory (IECSC): This material is listed or exempted.
Japan inventory: This material is listed or exempted.
Korea inventory: This material is listed or exempted.
Malaysia Inventory (EHS Register): Not determined.
New Zealand Inventory of Chemicals (NZIoC): This material is listed or exempted.
Philippines inventory (PICCS): This material is listed or exempted.
Taiwan inventory (CSNN): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

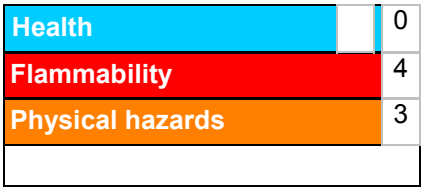
Canada

WHMIS (Canada) : Class A: Compressed gas.
Class B-1: Flammable gas.
CEPA Toxic substances: This material is listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.
Class B-1: Flammable gas.

Hazardous Material Information System (U.S.A.)



Section 16. Other information

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of printing : 5/20/2015.

Date of issue/Date of revision : 5/20/2015.

Date of previous issue : 1/27/2015.

Version : 0.04

Key to abbreviations :
ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists
AIHA – American Industrial Hygiene Association
CAS – Chemical Abstract Services
CEPA – Canadian Environmental Protection Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)
CFR – United States Code of Federal Regulations
CPR – Controlled Products Regulations
DSL – Domestic Substances List
GWP – Global Warming Potential
IARC – International Agency for Research on Cancer
ICAO – International Civil Aviation Organisation
Inh – Inhalation
LC – Lethal concentration
LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health

Section 16. Other information

TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

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SAFETY DATA SHEET

Ethane

Section 1. Identification

GHS product identifier : Ethane

Chemical name : ethane

Other means of identification : Bimethyl; Dimethyl; Ethyl hydride; Methylmethane; C2H6; UN 1035;

Product use : Synthetic/Analytical chemistry.

Synonym : Bimethyl; Dimethyl; Ethyl hydride; Methylmethane; C2H6; UN 1035;

SDS # : 001024

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE GASES - Category 1
GASES UNDER PRESSURE - Compressed gas

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Extremely flammable gas.
Contains gas under pressure; may explode if heated.
May form explosive mixtures in Air.
May displace oxygen and cause rapid suffocation.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Approach suspected leak area with caution.

Prevention : Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.

Response : Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

Storage : Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Disposal : Not applicable.

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : ethane

Other means of identification : Bimethyl; Dimethyl; Ethyl hydride; Methylmethane; C2H6; UN 1035;

CAS number/other identifiers

CAS number : 74-84-0

Product code : 001024

Ingredient name	%	CAS number
ethane	100	74-84-0

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Wash contaminated skin with soap and water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : No known significant effects or critical hazards.

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Section 4. First aid measures

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Extremely flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid contact with eyes, skin and clothing. Avoid breathing gas. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
ethane	Oxygen Depletion [Asphyxiant]

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Section 8. Exposure controls/personal protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Liquefied compressed gas.]

Color : Colorless.

Molecular weight : 30.08 g/mole

Molecular formula : C2-H6

Boiling/condensation point : -161.48°C (-258.7°F)

Melting/freezing point : -187.6°C (-305.7°F)

Critical temperature : 32.35°C (90.2°F)

Odor : Odorless.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: -104°C (-155.2°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : 3.85 (butyl acetate = 1)

Flammability (solid, gas) : Extremely flammable in the presence of the following materials or conditions: oxidizing materials.

Lower and upper explosive (flammable) limits : Lower: 2.9%
Upper: 13%

Vapor pressure : 543 (psig)

Vapor density : 1.1 (Air = 1) Liquid Density: BP@34.1 lb/ft3 (546 kg/m3)

Specific Volume (ft ^{3}/lb) : 12.6582

Gas Density (lb/ft ^{3}) : 0.079 (25°C / 77 to °F)

Relative density : Not applicable.

Solubility : Not available.

Solubility in water : 0.0244 g/l

Partition coefficient: n-octanol/water : 1.09

Auto-ignition temperature : 287°C (548.6°F)

Decomposition temperature : Not available.

SADT : Not available.

Section 9. Physical and chemical properties

Viscosity : Not applicable.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

Incompatible materials : Oxidizers

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Section 11. Toxicological information

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : No known significant effects or critical hazards.

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
ethane	1.09	-	low

Mobility in soil

Section 12. Ecological information

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1035	UN1035	UN1035	UN1035	UN1035
UN proper shipping name	ETHANE	ETHANE	ETHANE	ETHANE	ETHANE
Transport hazard class(es)	2.1 	2.1 	2.1 	2.1 	2.1 
Packing group	-	-	-	-	-
Environment	No.	No.	No.	No.	No.
Additional information	**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: Forbidden. **Cargo aircraft** Quantity limitation: 150 kg	Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2). **Explosive Limit and Limited Quantity Index** 0.125 **ERAP Index** 3000 **Passenger Carrying Ship Index** Forbidden **Passenger Carrying Road or Rail Index** Forbidden	-	-	**Passenger and Cargo Aircraft** Quantity limitation: 0 Forbidden **Cargo Aircraft Only** Quantity limitation: 150 kg

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Section 14. Transport information

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act (CAA) 112 regulated flammable substances: ethane

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Fire hazard
Sudden release of pressure

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
ethane	100	Yes.	Yes.	No.	No.	No.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

International regulations

International lists

National inventory

Australia : This material is listed or exempted.

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Europe : This material is listed or exempted.

Japan : This material is listed or exempted.

Malaysia : This material is listed or exempted.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Section 15. Regulatory information

Taiwan : This material is listed or exempted.

Canada

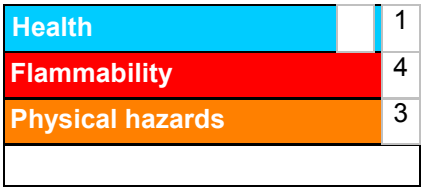
WHMIS (Canada) : Class A: Compressed gas.
Class B-1: Flammable gas.

CEPA Toxic substances: This material is listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.
Class B-1: Flammable gas.

Hazardous Material Information System (U.S.A.)



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The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
Flam. Gas 1, H220 Press. Gas Comp. Gas, H280	Regulatory data According to package

History

Date of printing : 6/1/2016

Date of issue/Date of revision : 6/1/2016

Date of previous issue : No previous validation

Version : 0.01

Section 16. Other information

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

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SAFETY DATA SHEET

Propane

Section 1. Identification

GHS product identifier : Propane

Chemical name : propane

Other means of identification : Propyl hydride; n-Propane; Dimethyl methane; Bottled gas; propane in gaseous state; propane liquefied, n-Propane; Dimethylmethane; Freon 290; Liquefied petroleum gas; Lpg; Propyl hydride; R 290; C3H8; UN 1075; UN 1978; A-108; Hydrocarbon propellant.

Product use : Synthetic/Analytical chemistry.

Synonym : Propyl hydride; n-Propane; Dimethyl methane; Bottled gas; propane in gaseous state; propane liquefied, n-Propane; Dimethylmethane; Freon 290; Liquefied petroleum gas; Lpg; Propyl hydride; R 290; C3H8; UN 1075; UN 1978; A-108; Hydrocarbon propellant.

SDS # : 001045

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE GASES - Category 1
GASES UNDER PRESSURE - Liquefied gas

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Extremely flammable gas.
Contains gas under pressure; may explode if heated.
May cause frostbite.
May form explosive mixtures in Air.
May displace oxygen and cause rapid suffocation.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Always keep container in upright position. Approach suspected leak area with caution.

Prevention : Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.

Response : Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

Storage : Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Section 2. Hazards identification

Disposal : Not applicable.

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : propane

Other means of identification : Propyl hydride; n-Propane; Dimethyl methane; Bottled gas; propane in gaseous state; propane liquefied, n-Propane; Dimethylmethane; Freon 290; Liquefied petroleum gas; Lpg; Propyl hydride; R 290; C3H8; UN 1075; UN 1978; A-108; Hydrocarbon propellant.

CAS number/other identifiers

CAS number : 74-98-6

Product code : 001045

Ingredient name	%	CAS number
Propane	100	74-98-6

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Wash contaminated skin with soap and water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : No known significant effects or critical hazards.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Section 4. First aid measures

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Extremely flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Section 6. Accidental release measures

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid contact with eyes, skin and clothing. Avoid breathing gas. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
Propane	**NIOSH REL (United States, 10/2013).** TWA: 1800 mg/m³ 10 hours. TWA: 1000 ppm 10 hours. **OSHA PEL (United States, 2/2013).** TWA: 1800 mg/m³ 8 hours. TWA: 1000 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989).** TWA: 1800 mg/m³ 8 hours. TWA: 1000 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Section 8. Exposure controls/personal protection

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Liquefied compressed gas.]

Color : Colorless.

Molecular weight : 44.11 g/mole

Molecular formula : C3-H8

Boiling/condensation point : -161.48°C (-258.7°F)

Melting/freezing point : -187.6°C (-305.7°F)

Critical temperature : 96.55°C (205.8°F)

Odor : Odorless.BUT MAY HAVE SKUNK ODOR ADDED.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: -104°C (-155.2°F)
Open cup: -104°C (-155.2°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : Not available.

Flammability (solid, gas) : Extremely flammable in the presence of the following materials or conditions: open flames, sparks and static discharge and oxidizing materials.

Lower and upper explosive (flammable) limits : Lower: 1.8%
Upper: 8.4%

Vapor pressure : 109 (psig)

Vapor density : 1.6 (Air = 1)

Section 9. Physical and chemical properties

Specific Volume (ft ^{3}/lb) : 8.6206

Gas Density (lb/ft ^{3}) : 0.116 (25°C / 77 to °F)

Relative density : Not applicable.

Solubility : Not available.

Solubility in water : 0.0244 g/l

Partition coefficient: n-octanol/water : 1.09

Auto-ignition temperature : 287°C (548.6°F)

Decomposition temperature : Not available.

SADT : Not available.

Viscosity : Not applicable.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

Incompatible materials : Oxidizers

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

IDLH : 2100 ppm

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Section 11. Toxicological information

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : No known significant effects or critical hazards.

Skin contact : No known significant effects or critical hazards.

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
Propane	1.09	-	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1978	UN1978	UN1978	UN1978	UN1978
UN proper shipping name	PROPANE	PROPANE	PROPANE	PROPANE	PROPANE
Transport hazard class(es)	2.1 	2.1 	2.1 	2.1 	2.1 
Packing group	-	-	-	-	-
Environment	No.	No.	No.	No.	No.
Additional information	**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: Forbidden. **Cargo aircraft** Quantity limitation: 150 kg **Special provisions** 19, T50	Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2). **Explosive Limit and Limited Quantity Index** 0.125 **ERAP Index** 3000	-	-	**Passenger and Cargo Aircraft** Quantity limitation: 0 Forbidden **Cargo Aircraft Only** Quantity limitation: 150 kg

Section 14. Transport information

		Passenger Carrying Ship Index 65 **Passenger Carrying Road or Rail Index** Forbidden **Special provisions** 29, 42			

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act (CAA) 112 regulated flammable substances: propane

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Fire hazard
Sudden release of pressure

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
Propane	100	Yes.	Yes.	No.	No.	No.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

Section 15. Regulatory information

New Jersey : This material is listed.

Pennsylvania : This material is listed.

International regulations

International lists

National inventory

Australia : This material is listed or exempted.

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Europe : This material is listed or exempted.

Japan : This material is listed or exempted.

Malaysia : This material is listed or exempted.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Taiwan : This material is listed or exempted.

Canada

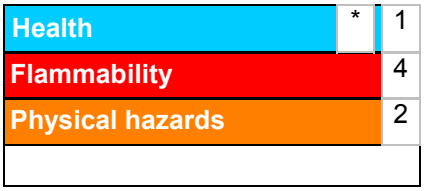
WHMIS (Canada) : Class A: Compressed gas.
Class B-1: Flammable gas.

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.
Class B-1: Flammable gas.

Hazardous Material Information System (U.S.A.)



Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

Section 16. Other information

Procedure used to derive the classification

Classification	Justification
Flam. Gas 1, H220 Press. Gas Liq. Gas, H280	Expert judgment Expert judgment

History

Date of printing : 10/20/2015

Date of issue/Date of revision : 10/20/2015

Date of previous issue : No previous validation

Version : 0.01

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Indicates information that has changed from previously issued version.

Other special considerations : The information below is given to call attention to the issue of “Naturally occurring radioactive materials”. Although Radon-222 levels in the product represented by this MSDS do not present any direct Radon exposure hazard, customers should be aware of the potential for Radon daughter build up within their processing systems, whatever the source of their product streams. Radon-222 is a naturally occurring radioactive gas which can be a contaminant in natural gas. During subsequent processing , Radon tends to be concentrated in Liquefied Petroleum Gas streams and in product streams having a similar boiling point range. Industry experience has shown that this product may contain small amounts of Radon-222 and its radioactive decay products, called Radon “daughters”. The actual concentration of Radon-222 and radioactive daughters in the delivered product is dependent on the geographical source of the natural gas and storage time prior to delivery. Process equipment (i.e. lines, filters, pumps and reaction units) may accumulate significant levels of radioactive daughters and show a gamma radiation reading during operation. A potential external radiation hazard exists at or near any pipe valve or vessel containing a Radon enriched stream, or containing internal deposits of radioactive material due to the transmission of gamma radiation through its wall. Field studies reported in the literature have not shown any conditions that subject workers to cumulative exposures in excess of general population limits. Equipment emitting gamma radiation should be presumed to be internally contaminated with alpha emitting decay products which may be a hazard if inhaled or ingested. Protective equipment such as coveralls, gloves, and respirator (NIOSH/MHSA approved for high efficiency particulates and radionuclides, or supplied air) should be worn by personnel entering a vessel or working on contaminated process equipment to prevent skin contamination, ingestion, or inhalation of any residues containing alpha radiation. Airborne contamination may be minimized by handling scale and/or contaminated materials in a wet state.

Notice to reader

Section 16. Other information

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

N-Butane

Section 1. Identification

GHS product identifier : N-Butane

Chemical name : Butane

Other means of identification : n-Butane; Diethyl; Freon 600; Liquefied petroleum gas; LPG; n-C4H10; Butanen; Butani; Methylethylmethane; UN 1011; UN 1075; A-17; Bu-Gas.

Product use : Synthetic/Analytical chemistry.

Synonym : n-Butane; Diethyl; Freon 600; Liquefied petroleum gas; LPG; n-C4H10; Butanen; Butani; Methylethylmethane; UN 1011; UN 1075; A-17; Bu-Gas.

SDS # : 001007

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE GASES - Category 1
GASES UNDER PRESSURE - Liquefied gas

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Extremely flammable gas.
May form explosive mixtures with air.
Contains gas under pressure; may explode if heated.
May cause frostbite.
May displace oxygen and cause rapid suffocation.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Always keep container in upright position. Approach suspected leak area with caution.

Prevention : Never Put cylinders into unventilated areas of passenger vehicles. Keep away from heat, sparks, open flames and hot surfaces. - No smoking. Use and store only outdoors or in a well ventilated place.

Response : Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

Section 2. Hazards identification

Storage : Protect from sunlight. Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Disposal : Not applicable.

Hazards not otherwise classified : Liquid can cause burns similar to frostbite.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : Butane

Other means of identification : n-Butane; Diethyl; Freon 600; Liquefied petroleum gas; LPG; n-C4H10; Butanen; Butani; Methylethylmethane; UN 1011; UN 1075; A-17; Bu-Gas.

CAS number/other identifiers

CAS number : 106-97-8

Product code : 001007

Ingredient name	%	CAS number
Butane	100	106-97-8

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Get medical attention if symptoms occur. In case of contact with liquid, warm frozen tissues slowly with lukewarm water and get medical attention. Do not rub affected area. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if adverse health effects persist or are severe. Ingestion of liquid can cause burns similar to frostbite. If frostbite occurs, get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. As this product rapidly becomes a gas when released, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Section 4. First aid measures

Eye contact : Liquid can cause burns similar to frostbite.

Inhalation : No known significant effects or critical hazards.

Skin contact : Dermal contact with rapidly evaporating liquid could result in freezing of the tissues or frostbite.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : Ingestion of liquid can cause burns similar to frostbite.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:
frostbite

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:
frostbite

Ingestion : Adverse symptoms may include the following:
frostbite

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Extremely flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Gas may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back, causing fire or explosion.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. For incidents involving large quantities, thermally insulated undergarments and thick textile or leather gloves should be worn.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Do not get in eyes or on skin or clothing. Avoid breathing gas. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
Butane	**ACGIH TLV (United States, 3/2012).** TWA: 1000 ppm 8 hours. **NIOSH REL (United States, 1/2013).** TWA: 1900 mg/m³ 10 hours. TWA: 800 ppm 10 hours. **OSHA PEL 1989 (United States, 3/1989).** TWA: 1900 mg/m³ 8 hours. TWA: 800 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. If contact with the liquid is possible, insulated gloves suitable for low temperatures should be worn. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Section 8. Exposure controls/personal protection

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Liquefied compressed gas.]

Color : Colorless.

Molecular weight : 58.14 g/mole

Molecular formula : C4-H10

Boiling/condensation point : -0.5°C (31.1°F)

Melting/freezing point : -138°C (-216.4°F)

Critical temperature : 151.85°C (305.3°F)

Odor : Odorless.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: -60°C (-76°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : Not available.

Flammability (solid, gas) : Extremely flammable in the presence of the following materials or conditions: open flames, sparks and static discharge and oxidizing materials.

Lower and upper explosive (flammable) limits : Lower: 1.8%
Upper: 8.4%

Vapor pressure : 16.3 (psig)

Vapor density : 2.1 (Air = 1)

Specific Volume (ft^3/lb) : 6.435

Gas Density (lb/ft^3) : 0.1554

Relative density : Not applicable.

Solubility : Not available.

Solubility in water : 0.061 g/l

Partition coefficient: n-octanol/water : 2.89

Auto-ignition temperature : 365°C (689°F)

Decomposition temperature : Not available.

SADT : Not available.

Viscosity : Not applicable.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Section 10. Stability and reactivity

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. Do not allow gas to accumulate in low or confined areas.

Incompatibility with various substances : Extremely reactive or incompatible with the following materials: oxidizing materials.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
Butane	LC50 Inhalation Vapor	Rat	658000 mg/m³	4 hours

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Liquid can cause burns similar to frostbite.

Inhalation : No known significant effects or critical hazards.

Section 11. Toxicological information

Skin contact : Dermal contact with rapidly evaporating liquid could result in freezing of the tissues or frostbite.

Ingestion : Ingestion of liquid can cause burns similar to frostbite.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following: frostbite

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following: frostbite

Ingestion : Adverse symptoms may include the following: frostbite

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Section 12. Ecological information

Product/ingredient name	$LogP_{ow}$	BCF	Potential
Butane	2.89	-	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1011	UN1011	UN1011	UN1011	UN1011
UN proper shipping name	BUTANE	BUTANE	BUTANE	BUTANE	BUTANE
Transport hazard class(es)	2.1 	2.1 	2.1 	2.1 	2.1 
Packing group	-	-	-	-	-
Environment	No.	No.	No.	No.	No.
Additional information	**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: Forbidden. **Cargo aircraft** Quantity limitation: 150 kg **Special provisions** 19, T50	**Explosive Limit and Limited Quantity Index** 0.125 **ERAP Index** 3000 **Passenger Carrying Ship Index** Forbidden **Passenger Carrying Road or Rail Index** Forbidden **Special provisions** 29	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 0 Forbidden **Cargo Aircraft Only** Quantity limitation: 150 kg

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Section 14. Transport information

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act (CAA) 112 regulated flammable substances: Butane

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Fire hazard
Sudden release of pressure

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
Butane	100	Yes.	Yes.	No.	No.	No.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

Canada inventory : This material is listed or exempted.

International regulations

Section 15. Regulatory information

International lists : **Australia inventory (AICS)**: This material is listed or exempted.
China inventory (IECSC): This material is listed or exempted.
Japan inventory: This material is listed or exempted.
Korea inventory: This material is listed or exempted.
Malaysia Inventory (EHS Register): Not determined.
New Zealand Inventory of Chemicals (NZIoC): This material is listed or exempted.
Philippines inventory (PICCS): This material is listed or exempted.
Taiwan inventory (CSNN): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

Canada

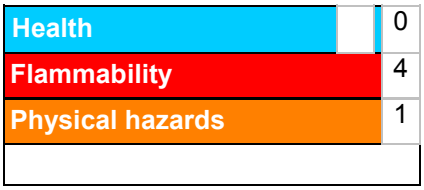
WHMIS (Canada) : Class A: Compressed gas.
Class B-1: Flammable gas.

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.
Class B-1: Flammable gas.

Hazardous Material Information System (U.S.A.)



Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

Section 16. Other information

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History

Date of printing : 5/7/2015.

Date of issue/Date of revision : 5/7/2015.

Date of previous issue : 10/15/2014.

Version : 0.03

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists
AIHA – American Industrial Hygiene Association
CAS – Chemical Abstract Services
CEPA – Canadian Environmental Protection Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)
CFR – United States Code of Federal Regulations
CPR – Controlled Products Regulations
DSL – Domestic Substances List
GWP – Global Warming Potential
IARC – International Agency for Research on Cancer
ICAO – International Civil Aviation Organisation
Inh – Inhalation
LC – Lethal concentration
LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health
TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

Section 16. Other information

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

Nitrogen

Section 1. Identification

GHS product identifier : Nitrogen

Chemical name : nitrogen

Other means of identification : nitrogen (dot); nitrogen gas; Nitrogen NF, Nitrogen FG

Product use : Synthetic/Analytical chemistry.

Synonym : nitrogen (dot); nitrogen gas; Nitrogen NF, Nitrogen FG

SDS # : 001040

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : GASES UNDER PRESSURE - Compressed gas

GHS label elements

Hazard pictograms :

Signal word : Warning

Hazard statements : Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction.

Prevention : Not applicable.

Response : Not applicable.

Storage : Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Disposal : Not applicable.

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : nitrogen

Other means of identification : nitrogen (dot); nitrogen gas; Nitrogen NF, Nitrogen FG

CAS number/other identifiers

CAS number : 7727-37-9

Product code : 001040

Ingredient name	%	CAS number
Nitrogen	100	7727-37-9

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : No known significant effects or critical hazards.

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Section 4. First aid measures

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. In a fire or if heated, a pressure increase will occur and the container may burst or explode.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
nitrogen oxides

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid contact with eyes, skin and clothing. Avoid breathing gas. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Section 7. Handling and storage

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
Nitrogen	Oxygen Depletion [Asphyxiant]

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Compressed gas.]

Color : Colorless.

Molecular weight : 28.02 g/mole

Molecular formula : N2

Boiling/condensation point : -196°C (-320.8°F)

Melting/freezing point : -210.01°C (-346°F)

Critical temperature : -146.95°C (-232.5°F)

Odor : Odorless.

Odor threshold : Not available.

pH : Not available.

Flash point : [Product does not sustain combustion.]

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : Not available.

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Not available.

Vapor pressure : Not available.

Vapor density : 0.967 (Air = 1) Liquid Density@BP: 50.46 lb/ft3 (808.3 kg/m3)

Specific Volume (ft^3/lb) : 13.8889

Gas Density (lb/ft^3) : 0.072

Relative density : Not applicable.

Solubility : Not available.

Solubility in water : Not available.

Partition coefficient: n-octanol/water : 0.67

Auto-ignition temperature : Not available.

Decomposition temperature : Not available.

SADT : Not available.

Viscosity : Not applicable.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : No specific data.

Incompatible materials : No specific data.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 10. Stability and reactivity

Irritation/Corrosion
Not available.

Sensitization
Not available.

Mutagenicity
Not available.

Carcinogenicity
Not available.

Reproductive toxicity
Not available.

Teratogenicity
Not available.

Specific target organ toxicity (single exposure)
Not available.

Specific target organ toxicity (repeated exposure)
Not available.

Aspiration hazard
Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : No known significant effects or critical hazards.

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects
Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Section 11. Toxicological information

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
Nitrogen	0.67	-	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1066	UN1066	UN1066	UN1066	UN1066
UN proper shipping name	NITROGEN, COMPRESSED	NITROGEN, COMPRESSED	NITROGEN, COMPRESSED	NITROGEN, COMPRESSED	NITROGEN, COMPRESSED
Transport hazard class(es)	2.2 	2.2 	2.2 	2.2 	2.2 

Section 14. Transport information

Packing group	-	-	-	-	-
Environment	No.	No.	No.	No.	No.
Additional information	**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 75 kg **Cargo aircraft** Quantity limitation: 150 kg	Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2). **Explosive Limit and Limited Quantity Index** 0.125 **Passenger Carrying Road or Rail Index** 75	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 75 kg **Cargo Aircraft Only** Quantity limitation: 150 kg

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: This material is listed or exempted.
United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Sudden release of pressure

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
Nitrogen	100	No.	Yes.	No.	No.	No.

Section 15. Regulatory information

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

International regulations

International lists

National inventory

Australia : This material is listed or exempted.

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Europe : This material is listed or exempted.

Japan : Not determined.

Malaysia : Not determined.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Taiwan : This material is listed or exempted.

Canada

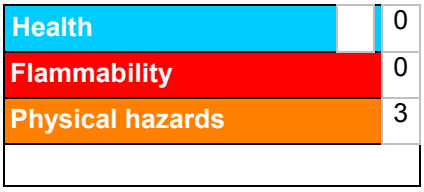
WHMIS (Canada) : Class A: Compressed gas.

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is not listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.

Hazardous Material Information System (U.S.A.)



Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

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Section 16. Other information

Procedure used to derive the classification

Classification	Justification
Press. Gas Comp. Gas, H280	Expert judgment

History

Date of printing : 5/26/2016

Date of issue/Date of revision : 5/26/2016

Date of previous issue : 8/7/2015

Version : 0.02

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

Hydrogen Sulfide

Section 1. Identification

GHS product identifier : Hydrogen Sulfide

Chemical name : hydrogen sulfide

Other means of identification : Hydrogen sulfide; Hydrogen sulfide (H2S); Sulfuretted hydrogen; Sewer gas; Hydrosulfuric acid; dihydrogen sulfide

Product use : Synthetic/Analytical chemistry.

Synonym : Hydrogen sulfide; Hydrogen sulfide (H2S); Sulfuretted hydrogen; Sewer gas; Hydrosulfuric acid; dihydrogen sulfide

SDS # : 001029

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE GASES - Category 1
GASES UNDER PRESSURE - Liquefied gas
ACUTE TOXICITY (inhalation) - Category 2
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Respiratory tract irritation) - Category 3
AQUATIC HAZARD (ACUTE) - Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Extremely flammable gas.
Contains gas under pressure; may explode if heated.
May cause frostbite.
May form explosive mixtures in Air.
Fatal if inhaled.
Extended exposure to gas reduces the ability to smell sulfides.
Corrosive to respiratory tract.
Very toxic to aquatic life with long lasting effects.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Always keep container in upright position. Do not depend on odor to detect presence of gas. Approach suspected leak area with caution.

Prevention : Wear respiratory protection. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Do not breathe gas.

Section 2. Hazards identification

Response : Collect spillage. IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER or physician. Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

Storage : Store locked up. Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : hydrogen sulfide

Other means of identification : Hydrogen sulfide; Hydrogen sulfide (H2S); Sulfuretted hydrogen; Sewer gas; Hydrosulfuric acid; dihydrogen sulfide

CAS number/other identifiers

CAS number : 7783-06-4

Product code : 001029

Ingredient name	%	CAS number
hydrogen sulfide	100	7783-06-4

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Get medical attention immediately. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : Fatal if inhaled. May cause respiratory irritation.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Section 4. First aid measures

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : Adverse symptoms may include the following:, respiratory tract irritation, coughing

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Extremely flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. This material is very toxic to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
sulfur oxides

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Do not breathe gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Section 6. Accidental release measures

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Do not get in eyes or on skin or clothing. Do not breathe gas. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Store locked up. Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
hydrogen sulfide	**ACGIH TLV (United States, 3/2016).** STEL: 5 ppm 15 minutes. TWA: 1 ppm 8 hours. **NIOSH REL (United States, 10/2013).** CEIL: 15 mg/m³ 10 minutes. CEIL: 10 ppm 10 minutes. **OSHA PEL 1989 (United States, 3/1989).** STEL: 21 mg/m³ 15 minutes. STEL: 15 ppm 15 minutes. TWA: 14 mg/m³ 8 hours. TWA: 10 ppm 8 hours. **OSHA PEL Z2 (United States, 2/2013).** AMP: 50 ppm 10 minutes. CEIL: 20 ppm

Section 8. Exposure controls/personal protection

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Liquefied compressed gas.]

Color : Colorless.

Molecular weight : 34.08 g/mole

Molecular formula : H2-S

Boiling/condensation point : -60°C (-76°F)

Melting/freezing point : -82°C (-115.6°F)

Critical temperature : 100.5°C (212.9°F)

Odor : Rotten eggs.

Odor threshold : Not available.

pH : Not available.

Section 9. Physical and chemical properties

Flash point : Not available.

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : Not available.

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Lower: 4.3%
Upper: 45%

Vapor pressure : 252 (psig)

Vapor density : 1.19 (Air = 1)

Specific Volume (ft^3/lb) : 11.236

Gas Density (lb/ft^3) : 0.089

Relative density : Not applicable.

Solubility : Not available.

Solubility in water : 5 g/l

Partition coefficient: n-octanol/water : Not available.

Auto-ignition temperature : 270°C (518°F)

Decomposition temperature : Not available.

SADT : Not available.

Viscosity : Not applicable.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

Incompatible materials : Oxidizers

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
hydrogen sulfide	LC50 Inhalation Gas.	Rat	712 ppm	1 hours

IDLH : 100 ppm

Irritation/Corrosion

Not available.

Sensitization

Section 11. Toxicological information

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Name	Category	Route of exposure	Target organs
hydrogen sulfide	Category 3	Not applicable.	Respiratory tract irritation

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : Fatal if inhaled. May cause respiratory irritation.

Skin contact : No known significant effects or critical hazards.

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : Adverse symptoms may include the following:, respiratory tract irritation, coughing

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Section 11. Toxicological information

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Other information : IDLH : 100 ppm

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
hydrogen sulfide	Acute EC50 62 µg/l Fresh water Acute LC50 2 µg/l Fresh water	Crustaceans - Gammarus pseudolimnaeus Fish - Coregonus clupeaformis - Yolk-sac fry	2 days 96 hours

Persistence and degradability

Not available.

Bioaccumulative potential

Not available.

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

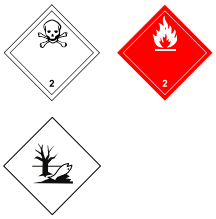
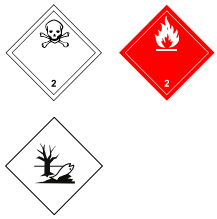
Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

United States - RCRA Toxic hazardous waste "U" List

Ingredient	CAS #	Status	Reference number
Hydrogen sulfide; Hydrogen sulfide H2S	7783-06-4	Listed	U135

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1053	UN1053	UN1053	UN1053	UN1053
UN proper shipping name	HYDROGEN SULFIDE	HYDROGEN SULFIDE; OR HYDROGEN SULPHIDE	HYDROGEN SULFIDE	HYDROGEN SULPHIDE	HYDROGEN SULPHIDE
Transport hazard class(es)	2.3 (2.1) 	2.3 (2.1) 	2.3 (2.1) 	2.3 (2.1) 	2.3 (2.1) 
Packing group	-	-	-	-	-
Environment	No.	No.	No.	Yes.	No.
Additional information	Toxic - Inhalation hazard Zone B **Reportable quantity** 100 lbs / 45.4 kg Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements. **Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: Forbidden. **Cargo aircraft** Quantity limitation: Forbidden. **Special provisions** 2, B9, B14	Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2), 2.13-2.17 (Class 2), 2.7 (Marine pollutant mark). The marine pollutant mark is not required when transported by road or rail. **Explosive Limit and Limited Quantity Index** 0 **ERAP Index** 0 **Passenger Carrying Ship Index** Forbidden **Passenger Carrying Road or Rail Index** Forbidden	-	The marine pollutant mark is not required when transported in sizes of ≤5 L or ≤5 kg.	The environmentally hazardous substance mark may appear if required by other transportation regulations. **Passenger and Cargo Aircraft**Quantity limitation: 0 Forbidden **Cargo Aircraft Only** Quantity limitation: 0 Forbidden

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Water Act (CWA) 311: hydrogen sulfide

Clean Air Act (CAA) 112 regulated toxic substances: hydrogen sulfide

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

Name	%	EHS	SARA 302 TPQ		SARA 304 RQ	
			(lbs)	(gallons)	(lbs)	(gallons)
hydrogen sulfide	100	Yes.	500	-	100	-

SARA 304 RQ : 100 lbs / 45.4 kg

SARA 311/312

Classification : Fire hazard
Sudden release of pressure
Immediate (acute) health hazard

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
hydrogen sulfide	100	Yes.	Yes.	No.	Yes.	No.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	hydrogen sulfide	7783-06-4	100
Supplier notification	hydrogen sulfide	7783-06-4	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.

New York : This material is listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

International regulations

International lists

National inventory

Australia : This material is listed or exempted.

Section 15. Regulatory information

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Europe : This material is listed or exempted.

Japan : This material is listed or exempted.

Malaysia : Not determined.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Taiwan : This material is listed or exempted.

Canada

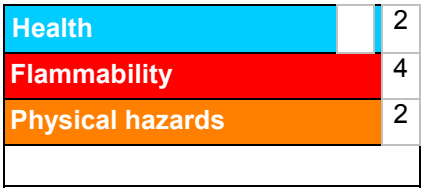
WHMIS (Canada) : Class A: Compressed gas.
Class B-1: Flammable gas.
Class D-1A: Material causing immediate and serious toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.
Class B-1: Flammable gas.
Class D-1A: Material causing immediate and serious toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

Hazardous Material Information System (U.S.A.)



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The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Section 16. Other information

Procedure used to derive the classification

Classification	Justification
Flam. Gas 1, H220	Expert judgment
Press. Gas Liq. Gas, H280	Expert judgment
Acute Tox. 2, H330	On basis of test data
STOT SE 3, H335	Expert judgment
Aquatic Acute 1, H400	Expert judgment
Aquatic Chronic 1, H410	On basis of test data

History

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Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Safety Data Sheet

Material Name: Diesel Fuel, All Types

SDS No. 9909
US GHS

Synonyms: Ultra Low Sulfur Diesel; Low Sulfur Diesel; No. 2 Diesel; Motor Vehicle Diesel Fuel; Non-Road Diesel Fuel; Locomotive/Marine Diesel Fuel

* * * Section 1 - Product and Company Identification * * *

Manufacturer Information

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

Phone: 732-750-6000 Corporate EHS
Emergency # 800-424-9300 CHEMTREC
www.hess.com (Environment, Health, Safety Internet Website)

* * * Section 2 - Hazards Identification * * *

GHS Classification:

Flammable Liquids - Category 3
Skin Corrosion/Irritation – Category 2
Germ Cell Mutagenicity – Category 2
Carcinogenicity - Category 2
Specific Target Organ Toxicity (Single Exposure) - Category 3 (respiratory irritation, narcosis)
Aspiration Hazard – Category 1
Hazardous to the Aquatic Environment, Acute Hazard – Category 3

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

DANGER

Hazard Statements

Flammable liquid and vapor.
Causes skin irritation.
Suspected of causing genetic defects.
Suspected of causing cancer.
May cause respiratory irritation.
May cause drowsiness or dizziness.
May be fatal if swallowed and enters airways.
Harmful to aquatic life.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep container tightly closed.
Ground/bond container and receiving equipment.

Use explosion-proof electrical/ventilating/lighting/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Wear protective gloves/protective clothing/eye protection/face protection.
Wash hands and forearms thoroughly after handling.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Avoid breathing fume/mist/vapours/spray.

Response

In case of fire: Use water spray, fog or foam to extinguish.
IF ON SKIN (or hair): Wash with plenty of soap and water. Remove/Take off immediately all contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical advice/attention.
IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a poison center/doctor if you feel unwell.
If swallowed: Immediately call a poison center or doctor. Do NOT induce vomiting.
IF exposed or concerned: Get medical advice/attention.

Storage

Store in a well-ventilated place. Keep cool.
Keep container tightly closed.
Store locked up.

Disposal

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 3 - Composition / Information on Ingredients * * *

CAS #	Component	Percent
68476-34-6	Fuels, diesel, no. 2	100
91-20-3	Naphthalene	<0.1

A complex mixture of hydrocarbons with carbon numbers in the range C9 and higher.

* * * Section 4 - First Aid Measures * * *

First Aid: Eyes

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

First Aid: Skin

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or with waterless hand cleanser. Obtain medical attention if irritation or redness develops. Thermal burns require immediate medical attention depending on the severity and the area of the body burned.

First Aid: Ingestion

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

* * * Section 5 - Fire Fighting Measures * * *

General Fire Hazards

See Section 9 for Flammability Properties.

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, and other gaseous agents.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment/Instructions

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment. Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

* * * Section 6 - Accidental Release Measures * * *

Recovery and Neutralization

Carefully contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Caution, flammable vapors may accumulate in closed containers.

Emergency Measures

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Prevention of Secondary Hazards

None

* * * Section 7 - Handling and Storage * * *

Handling Procedures

Handle as a combustible liquid. Keep away from heat, sparks, excessive temperatures and open flame! No smoking or open flame in storage, use or handling areas. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

Storage Procedures

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks."

Incompatibilities

Keep away from strong oxidizers.

* * * Section 8 - Exposure Controls / Personal Protection * * *

Component Exposure Limits

Fuels, diesel, no. 2 (68476-34-6)

ACGIH: 100 mg/m3 TWA (inhalable fraction and vapor, as total hydrocarbons, listed under Diesel fuel)
Skin - potential significant contribution to overall exposure by the cutaneous route (listed under Diesel fuel)

Naphthalene (91-20-3)

ACGIH: 10 ppm TWA
15 ppm STEL
Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA: 10 ppm TWA; 50 mg/m3 TWA
NIOSH: 10 ppm TWA; 50 mg/m3 TWA
15 ppm STEL; 75 mg/m3 STEL

Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Personal Protective Equipment: Respiratory

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Personal Protective Equipment: Hands

Gloves constructed of nitrile, neoprene, or PVC are recommended.

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Personal Protective Equipment: Skin and Body

Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

* * * Section 9 - Physical & Chemical Properties * * *

Appearance:	Clear, straw-yellow.	**Odor:**	Mild, petroleum distillate odor
Physical State:	Liquid	**pH:**	ND
Vapor Pressure:	0.009 psia @ 70 °F (21 °C)	**Vapor Density:**	>1.0
Boiling Point:	320 to 690 °F (160 to 366 °C)	**Melting Point:**	ND
Solubility (H2O):	Negligible	**Specific Gravity:**	0.83-0.876 @ 60°F (16°C)
Evaporation Rate:	Slow; varies with conditions	**VOC:**	ND
Percent Volatile:	100%	**Octanol/H2O Coeff.:**	ND
Flash Point:	>125 °F (>52 °C) minimum	**Flash Point Method:**	PMCC
Upper Flammability Limit (UFL):	7.5	**Lower Flammability Limit (LFL):**	0.6
Burning Rate:	ND	**Auto Ignition:**	494°F (257°C)

* * * Section 10 - Chemical Stability & Reactivity Information * * *

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources.

Incompatible Products

Keep away from strong oxidizers.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

* * * Section 11 - Toxicological Information * * *

Acute Toxicity

A: General Product Information

Harmful if swallowed.

B: Component Analysis - LD50/LC50

Naphthalene (91-20-3)

Inhalation LC50 Rat >340 mg/m3 1 h; Oral LD50 Rat 490 mg/kg; Dermal LD50 Rat >2500 mg/kg; Dermal LD50 Rabbit >20 g/kg

Potential Health Effects: Skin Corrosion Property/Stimulativeness

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

Potential Health Effects: Eye Critical Damage/ Stimulativeness

Contact with eyes may cause mild irritation.

Potential Health Effects: Ingestion

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

Potential Health Effects: Inhalation

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

Respiratory Organs Sensitization/Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

This material has been positive in a mutagenicity study.

Carcinogenicity

A: General Product Information

Suspected of causing cancer.

Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation.

B: Component Carcinogenicity

Fuels, diesel, no. 2 (68476-34-6)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans (listed under Diesel fuel)

Naphthalene (91-20-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
NTP: Reasonably Anticipated To Be A Human Carcinogen (Possible Select Carcinogen)
IARC: Monograph 82 [2002] (Group 2B (possibly carcinogenic to humans))

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product is not reported to have any specific target organ general toxicity single exposure effects.

Specified Target Organ General Toxicity: Repeated Exposure

This product is not reported to have any specific target organ general toxicity repeat exposure effects.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

* * * Section 12 - Ecological Information * * *

Ecotoxicity

A: General Product Information

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

B: Component Analysis - Ecotoxicity - Aquatic Toxicity

Fuels, diesel, no. 2 (68476-34-6)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	35 mg/L [flow-through]	

Naphthalene (91-20-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	5.74-6.44 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	1.6 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	0.91-2.82 mg/L [static]	
96 Hr LC50 Pimephales promelas	1.99 mg/L [static]	

96 Hr LC50 Lepomis macrochirus	31.0265 mg/L [static]
72 Hr EC50 Skeletonema costatum	0.4 mg/L
48 Hr LC50 Daphnia magna	2.16 mg/L
48 Hr EC50 Daphnia magna	1.96 mg/L [Flow through]
48 Hr EC50 Daphnia magna	1.09 - 3.4 mg/L [Static]

Persistence/Degradability
No information available.

Bioaccumulation
No information available.

Mobility in Soil
No information available.

* * * Section 13 - Disposal Considerations * * *

Waste Disposal Instructions
See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging
Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 14 - Transportation Information * * *

DOT Information
Shipping Name: Diesel Fuel
NA #: 1993 **Hazard Class:** 3 **Packing Group:** III
Placard:

* * * Section 15 - Regulatory Information * * *

Regulatory Information

Component Analysis

This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).

Naphthalene (91-20-3)

CERCLA: 100 lb final RQ; 45.4 kg final RQ

SARA Section 311/312 – Hazard Classes

Acute Health	Chronic Health	Fire	Sudden Release of Pressure	Reactive
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product may contain listed chemicals below the de minimis levels which therefore are not subject to the supplier notification requirements of Section 313 of the Emergency Planning and Community Right- To-Know Act (EPCRA) of 1986 and of 40 CFR 372. If you may be required to report releases of chemicals listed in 40 CFR 372.28, you may contact Hess Corporate Safety if you require additional information regarding this product.

State Regulations

Component Analysis - State

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA	RI
Fuels, diesel, no. 2	68476-34-6	No	No	No	Yes	No	No
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	Yes	No

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

WARNING! This product contains a chemical known to the state of California to cause cancer.

Component Analysis - WHMIS IDL

No components are listed in the WHMIS IDL.

Additional Regulatory Information

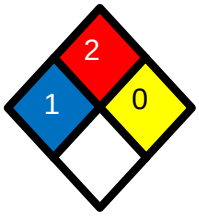
Component Analysis - Inventory

Component	CAS #	TSCA	CAN	EEC
Fuels, diesel, no. 2	68476-34-6	Yes	DSL	EINECS
Naphthalene	91-20-3	Yes	DSL	EINECS

* * * Section 16 - Other Information * * *

NFPA® Hazard Rating

Health	1
Fire	2
Reactivity	0



HMIS® Hazard Rating

Health	1*	Slight
Fire	2	Moderate
Physical	0	Minimal
		*Chronic

Key/Legend

ACGIH = American Conference of Governmental Industrial Hygienists; ADG = Australian Code for the Transport of Dangerous Goods by Road and Rail; ADR/RID = European Agreement of Dangerous Goods by Road/Rail; AS = Standards Australia; DFG = Deutsche Forschungsgemeinschaft; DOT = Department of Transportation; DSL = Domestic Substances List; EEC = European Economic Community; EINECS = European Inventory of Existing Commercial Chemical Substances; ELINCS = European List of Notified Chemical Substances; EU = European Union; HMIS = Hazardous Materials Identification System; IARC = International Agency for Research on Cancer; IMO = International Maritime Organization; IATA = International Air Transport Association; MAK = Maximum Concentration Value in the Workplace; NDSL = Non-Domestic Substances List; NFPA = National Fire Protection Association; NOHSC = National Occupational Health & Safety Commission; NTP = National Toxicology Program; STEL = Short-term Exposure Limit; TDG = Transportation of Dangerous Goods; TLV = Threshold Limit Value; TSCA = Toxic Substances Control Act; TWA = Time Weighted Average

Literature References

None

Other Information

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

End of Sheet

COLUMBUS CHEMICAL INDUSTRIES INC.

Safety Data Sheet

MDEA

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name: MDEA

Synonyms/Generic Names: 2,2′-Methyliminodiethanol; N,N-Diethanolmethylamine; N,N-Bis(2-hydroxyethyl)methylamine; N-Methyldiethanolamine

Product Number: 3378

Product Use: Industrial, Manufacturing or Laboratory use

Manufacturer: Columbus Chemical Industries, Inc.
N4335 Temkin Rd.
Columbus, WI. 53925

For More Information Call: 920-623-2140 (Monday-Friday 8:00-4:30)

In Case of Emergency Call: CHEMTREC - 800-424-9300 or 703-527-3887 (24 Hours/Day, 7 Days/Week)

2. HAZARDS IDENTIFICATION

OSHA Hazards: Harmful by ingestion, Irritant

Target Organs: None

Signal Word: Warning

Pictograms:

GHS Classification:

Acute toxicity, Oral	Category 4
Skin irritation	Category 3
Eye irritation	Category 2A

GHS Label Elements, including precautionary statements:

Hazard Statements:

H302	Harmful if swallowed.
H316	Causes mild skin irritation.
H319	Causes serious eye irritation.

Precautionary Statements:

P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Potential Health Effects

Eyes	Causes eye irritation.
Inhalation	May be harmful if inhaled. Causes respiratory tract irritation.
Skin	Harmful if absorbed through skin. Causes skin irritation.
Ingestion	Harmful if swallowed.

NFPA Ratings

Health	2
Flammability	1
Reactivity	0
Specific hazard	Not Available

HMIS Ratings

Health	2
Fire	1
Reactivity	0
Personal	E

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	Weight %	CAS #	EINECS# / ELINCS#	Formula	Molecular Weight
N-Methyldiethanolamine	>95	105-59-9	203-312-7	$C_5H_{13}NO_2$	119.16 g/mol

4. FIRST-AID MEASURES

Eyes	Rinse with plenty of water for at least 15 minutes and seek medical attention.
Inhalation	Move casualty to fresh air and keep at rest. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention.
Skin	Flush with plenty of water for at least 15 minutes and wash using soap. Get medical attention.
Ingestion	**Do Not Induce Vomiting!** Never give anything by mouth to an unconscious person. If conscious, wash out mouth with water. Get medical attention.

5. FIRE-FIGHTING MEASURES

Suitable (and unsuitable) extinguishing media	May be flammable at high temperatures. Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide. Cool unopened containers with water.
Special protective equipment and precautions for firefighters	Wear self-contained, approved breathing apparatus and full protective clothing, including eye protection and boots.
Specific hazards arising from the chemical	Emits toxic fumes (carbon oxides, nitrogen oxides) under fire conditions. (See also Stability and Reactivity section).

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	See section 8 for recommendations on the use of personal protective equipment.
Environmental precautions	Prevent spillage from entering drains. Any release to the environment may be subject to federal/national or local reporting requirements.
Methods and materials for containment and cleaning up	Absorb spill with noncombustible absorbent material, then place in a suitable container for disposal. Clean surfaces thoroughly with water to remove residual contamination. Dispose of all waste and cleanup materials in accordance with regulations.

7. HANDLING AND STORAGE

Precautions for safe handling
See section 8 for recommendations on the use of personal protective equipment. Use with adequate ventilation. Wash thoroughly after using. Keep container closed when not in use. Avoid formation of aerosols.

Conditions for safe storage, including any incompatibilities
Store in cool, dry well ventilated area. Keep away from incompatible materials (see section 10 for incompatibilities). Keep away from sources of ignition.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational exposure controls: Contains no substances with occupational exposure limit values.

Personal Protection

Eyes	Wear chemical safety glasses or goggles with face shield.
Inhalation	Provide local exhaust, preferably mechanical. If exposure levels are excessive, use an approved respirator.
Skin	Wear nitrile or rubber gloves, flame retardant antistatic protective clothing.
Other	Not Available

Other Recommendations
Provide eyewash stations, quick-drench showers and washing facilities accessible to areas of use and handling.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance (physical state, color, etc.)	Clear, colorless to light yellow viscous liquid.
Odor	Sharp irritating odor.
Odor threshold	Not Available
pH	11.5 at 100 g/l at 20 °C (68 °F)
Melting point/freezing point	-21 °C (-6 °F)
Initial boiling point and boiling range	246 - 248 °C (475 - 478 °F)
Flash point	127 °C (261 °F) - closed cup
Evaporation rate	Not Available
Flammability (solid, gas)	Flammable at high temperatures
Upper/lower flammability or explosive limit	Lower: 1.4%; Upper: 8.8%
Vapor pressure	0.01 hPa (0.01 mmHg) at 20 °C (68 °F)
Vapor density	4.11 - (Air = 1.0)
Density	1.038 g/cm^3 at 25 °C (77 °F)
Solubility (ies)	Completely miscible
Partition coefficient: n-octanol/water	log Pow: -1.08
Auto-ignition temperature	265 °C (509 °F)
Decomposition temperature	Not Available

10. STABILITY AND REACTIVITY

Chemical Stability	Stable
Possibility of Hazardous Reactions	Will not occur.
Conditions to Avoid	Heat.
Incompatible Materials	Oxidizing agents. Do not store near acids.
Hazardous Decomposition Products	Carbon oxides, nitrogen oxides

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Skin	Skin - rabbit - Mild skin irritation
Eyes	Eyes - rabbit - Mild eye irritation
Respiratory	Not Available
Ingestion	LD50 Oral - rat - 1,945 mg/kg

Carcinogenicity

IARC	No components of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH	No components of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP	No components of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA	No components of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Signs & Symptoms of Exposure

Skin	Irritation, redness, itchiness.
Eyes	Irritation, redness, watering eyes, itchiness.
Respiratory	Irritation, coughing, wheezing, shortness of breath, headache.
Ingestion	Irritation, nausea, vomiting, diarrhea.

Chronic Toxicity	Not Available
Teratogenicity	Not Available
Mutagenicity	Not Available
Embryotoxicity	Not Available
Specific Target Organ Toxicity	Not Available
Reproductive Toxicity	Reproductive toxicity - rat - Skin Maternal Effects: Other effects.
Respiratory/Skin Sensitization	Not Available

12. ECOLOGICAL INFORMATION

Ecotoxicity

Aquatic Vertebrate	Not Available
Aquatic Invertebrate	Not Available
Terrestrial	Not Available

Persistence and Degradability	Not Available
Bioaccumulative Potential	Not Available
Mobility in Soil	Not Available
PBT and vPvB Assessment	Not Available
Other Adverse Effects	Not Available

13. DISPOSAL CONSIDERATIONS

Waste Residues	Users should review their operations in terms of the applicable federal/national or local regulations and consult with appropriate regulatory agencies if necessary before disposing of waste product or residue.
Product Containers	Users should review their operations in terms of the applicable federal/national or local regulations and consult with appropriate regulatory agencies if necessary before disposing of waste product container.

The information offered in section 13 is for the product as shipped. Use and/or alterations to the product may significantly change the characteristics of the material and alter the waste classification and proper disposal methods.

14. TRANSPORTATION INFORMATION

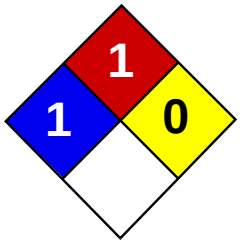
US DOT	Not Dangerous Goods
TDG	Not Dangerous Goods
IMDG	Not Dangerous Goods
Marine Pollutant	No
IATA/ICAO	Not Dangerous Goods

15. REGULATORY INFORMATION

TSCA Inventory Status	All ingredients are listed on the TSCA inventory.
DSCL (EEC)	All ingredients are listed on the DSCL inventory.
California Proposition 65	Not Listed
SARA 302	Not Listed
SARA 304	Not Listed
SARA 311	N-Methyldiethanolamine
SARA 312	N-Methyldiethanolamine
SARA 313	Not Listed
WHMIS Canada	Not Listed

16. OTHER INFORMATION

Revision	Date
Revision 1	03/21/2013



Health	1
Fire	1
Reactivity	0
Personal Protection	J

Material Safety Data Sheet
Triethylene glycol MSDS

Section 1: Chemical Product and Company Identification

Product Name: Triethylene glycol

Catalog Codes: SLT2644

CAS#: 112-27-6

RTECS: YE4550000

TSCA: TSCA 8(b) inventory: Triethylene glycol

CI#: Not available.

Synonym: 2,2'-[1,2-Ethanediylbis(oxy)]bisethanol

Chemical Formula: C6H14O4

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Triethylene glycol	112-27-6	100

Toxicological Data on Ingredients: Triethylene glycol: ORAL (LD50): Acute: 17000 mg/kg [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of eye contact (irritant), of ingestion. Slightly hazardous in case of inhalation. Inflammation of the eye is characterized by redness, watering, and itching.

Potential Chronic Health Effects:
Very hazardous in case of eye contact (irritant). Slightly hazardous in case of inhalation. CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to kidneys, the nervous system. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.

Skin Contact: No known effect on skin contact, rinse with water for a few minutes.

Serious Skin Contact: Not available.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

Serious Inhalation: Not available.

Ingestion:
Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 371°C (699.8°F)

Flash Points: CLOSED CUP: 177°C (350.6°F). OPEN CUP: 165.5°C (329.9°F).

Flammable Limits: LOWER: 0.9% UPPER: 9.2%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances: Not available.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Absorb with an inert material and put the spilled material in an appropriate waste disposal. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapour/spray. Avoid contact with eyes If ingested, seek medical advice immediately and show the container or the label.

Storage:

Keep container dry. Keep in a cool place. Ground all equipment containing material. Keep container tightly closed. Keep in a cool, well-ventilated place. Combustible materials should be stored away from extreme heat and away from strong oxidizing agents.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection: Splash goggles. Lab coat.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Boots. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Hygroscopic liquid.)

Odor: Not available.

Taste: Not available.

Molecular Weight: 150.18 g/mole

Color: Colorless.

pH (1% soln/water): Not available.

Boiling Point: 285°C (545°F)

Melting Point: -5°C (23°F)

Critical Temperature: Not available.

Specific Gravity: 1.1274 (Water = 1)

Vapor Pressure: Not available.

Vapor Density: 5.17 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility: Easily soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Not available.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Eye contact. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 17000 mg/kg [Rat].

Chronic Effects on Humans: The substance is toxic to kidneys, the nervous system.

Other Toxic Effects on Humans:
Very hazardous in case of ingestion. Slightly hazardous in case of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations:
Pennsylvania RTK: Triethylene glycol TSCA 8(b) inventory: Triethylene glycol

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada): Not controlled under WHMIS (Canada).

DSCL (EEC): R41- Risk of serious damage to eyes.

HMIS (U.S.A.):

Health Hazard: 1

Fire Hazard: 1

Reactivity: 0

Personal Protection: j

National Fire Protection Association (U.S.A.):

Health: 1

Flammability: 1

Reactivity: 0

Specific hazard:

Protective Equipment:
Not applicable. Lab coat. Not applicable. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:31 PM

Last Updated: 05/21/2013 12:00 PM

H.2 – Hazardous Release List

Document Number:	Description:	Revision:	Appendix:
N/A	Hazardous Release List is included in the Hazard Analysis Report in Appendix H.3	N/A	Public

H.3 – Hazard Analysis Reports

Document Number:	Description:	Revision:	Appendix:
USAG-EX-FRRSK-00-000001-000	GTP Facility Hazard Analysis Report	0	Public/P&C

Alaska LNG™

CH·IV
THE LNG SPECIALISTS

ALASKA LNG PROJECT - GTP FACILITY
HAZARD ANALYSIS REPORT

USAG-EX-FRRSK-00-000001-000

ALASKA LNG PROJECT - GTP FACILITY HAZARD ANALYSIS REPORT

Prepared for:

Alaska LNG

Prepared by:

CH·IV
THE LNG SPECIALISTS

REV NUMBER:	A	0			
ISSUE PURPOSE:	For Client Review	Issued For FEED			
DATE:	7/20/16	10/20/16			
BY:	JMP	JMP			
CHECKED:	JCR	JCR			
APPROVED:	PJS	PJS			

Table of Contents

Table of Figures

Figure **Page**

ACRONYMS AND TERMS

Terms	Definition
AEGL	Acute Exposure Guideline Levels
AGRU	Acid Gas Removal Unit
BLEVE	Boiling Liquid Expanding Vapor Explosion
BST	Baker-Strehlow-Tang
CFR	Code of Federal Regulations
CGF	Central Gas Facility
ESD	Emergency Shutdown
Facility	GTP
FERC	Federal Energy Regulatory Commission
FWM	Fine Water Mist
GTP	Gas Treatment Plant
HMB	Heat and Material Balance
LFL	Lower Flammability Limit
NAS/COT	National Academy of Science / Committee on Toxicity
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram
Project	Alaska LNG Project
SALS	Single Accidental Leakage Source
TGDU	Treated Gas Dehydration Unit

REFERENCES

Document Number	Document Title
USAG-EC-PDPFD-50-000609-001	Gas Treatment Plant Process Flow Diagram GTP Interface
USAG-EC-PDPFD-10-000662-010	Gas Treatment Plant Process Flow Diagram Acid Gas Removal Unit - Absorber
USAG-EC-PDPFD-10-000661-020	Gas Treatment Plant Process Flow Diagram TGDU – TEG Contactor
USAG-EC-PDPFD-50-000666-040	Gas Treatment Plant Process Flow Diagram Treated Gas Chilling
USAG-EC-PDPFD-10-000651-031	Gas Treatment Plant Process Flow Diagram Treated Gas Compression
USAG-EC-PDPFD-10-000609-002	Gas Treatment Plant Process Flow Diagram PTU Inlet Facilities
USAG-EC-PDPFD-50-000666-041	Gas Treatment Plant Process Flow Diagram Refrigeration
USAG-EC-PDPFD-10-000662-012	Gas Treatment Plant Process Flow Diagram Acid Gas Removal Unit – Regeneration
USAG-EC-PDPFD-10-000658-051	Gas Treatment Plant Process Flow Diagram CO2 Compression – Low Pressure
USAG-EC-PDPFD-10-000667-052	Gas Treatment Plant Process Flow Diagram CO2 Dehydration System – TEG Contactor
USAG-EC-PDPFD-10-000658-054	Gas Treatment Plant Process Flow Diagram CO2 Compression – Low Pressure
USAG-EC-PDPFD-10-000662-102	Gas Treatment Plant Heat and Material Balance Base Case – Winter – AGRU
USAG-EC-PDPFD-10-000662-302	Gas Treatment Plant Heat and Material Balance Rating Case #1 – AGRU
USAG-EC-PDPFD-10-000662-402	Gas Treatment Plant Heat and Material Rating Case #2 – AGRU
USAG-EC-PDPFD-10-000661-103	Gas Treatment Plant Heat and Material Balance Base Case – Winter – Treated Gas Dehy
USAG-EC-PDPFD-10-000661-403	Gas Treatment Plant Heat and Material Rating Case #2 – Treated Gas Dehy
USAG-EC-PDPFD-50-000609-101	Gas Treatment Plant Heat and Material Balance Base Case – Winter – GTP Inlet
USAG-EC-PDPFD-50-000609-301	Gas Treatment Plant Heat and Material Balance Rating Case #1 – GTP Inlet
USAG-EC-PDPFD-50-000609-401	Gas Treatment Plant Heat and Material Balance Rating Case #2 – GTP Inlet
USAG-EC-PDPFD-10-000651-104	Gas Treatment Plant Heat and Material Balance Base Case – Winter – Treated Gas Compr & Chill

Document Number	Document Title
USAG-EC-PDPFD-10-000651-404	Gas Treatment Plant Heat and Material Balance Rating Case #2 – Treated Gas Compr & Chill
USAG-EC-PDPFD-50-000666-109	Gas Treatment Plant Heat and Material Balance Base Case – Winter – Refrigerant
USAG-EC-PDPFD-50-000666-209	Gas Treatment Plant Heat and Material Balance Base Case – Summer – Refrigerant
USAG-EC-PDPFD-50-000666-409	Gas Treatment Plant Heat and Material Balance Rating Case #2 – Refrigerant
USAG-EC-PDPFD-10-000658-305	Gas Treatment Plant Heat and Material Balance Rating Case #1 – CO2 Compression
USAG-EC-PDPFD-10-000667-306	Gas Treatment Plant Heat and Material Balance Rating Case #1 – CO2 Gas Dehy
USAG-EC-MRRSK-00-000001-000	Secondary Containment of Tanks Report
USAG-EC-LDLAY-00-001006-000	Gas Treatment Plant Module Index Plot Plan

1 INTRODUCTION

In accordance with the Energy Policy Act of 2005, the Federal Energy Regulatory Commission (FERC) has responsibility for 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 from the United States to a foreign country. The Alaska LNG Project (Project) including the GTP (Facility) will be under the jurisdiction of the FERC.

2 METHODOLOGY

Although the Facility is not under the jurisdiction of 49 CFR Part 193 which details siting requirements for LNG facilities, this hazard analysis for the Facility followed the intent of the requirements specified in 49 CFR Part 193 in order to develop an equivalent hazard analysis for the Facility. The Project's Process Flow Diagrams (PFDs), Process and Instrumentation Diagrams (P&IDs) and Heat and Material Balances (HMBs) were used to determine flow, temperature and pressure for the Hazard Analysis.

3 REPORT PURPOSE

The purpose of this Report is to provide modeling assumptions and the results of the Hazard Analysis for the Facility to demonstrate that none of the hazards impact the public. Hazards include:

- Thermal radiation associated with flammable liquid containment dikes. Analysis was performed using the LNGFIREIII software.
- Vapor dispersion, jet fire, overpressure and toxicity associated with hydrocarbon release. Analysis was performed using the Phast software Version 6.7.

4 HAZARDOUS MATERIALS

The GTP will 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 sub-process systems listed below:

- AGRU;
- TGDU;
- Treated Gas Compression;
- CO2 Compression; and
- CO2 Dehydration.

A Treated Gas Chilling system will be downstream of the trains. Propane will be the primary constituent in the refrigerant stream and will be supplied via a proposed pipeline tying directly into the refrigerant system.

5 SPILL CONTAINMENT

This Facility contains two storage tanks with flammable liquids: the Diesel Fuel Storage Tank and the Hydrocarbon Holding Tank. Both tanks will have containment dikes to contain 110 percent of the liquid volume. The Diesel Fuel Storage Tank will store two weeks of diesel for all the emergency and essential generators, diesel firewater pumps and diesel fuel for service vehicles. The Hydrocarbon Holding Tank is designed to hold recyclable waste diesel, glycol, solvents, miscellaneous fuels and lubricants.

Table 5 summarizes the dimensions of the Containment Dikes that will be installed at the Project. Document USAG-EC-MRRSK-00-000001-000, Secondary Containment of Tanks Report, includes detailed information on the containment sizing basis.

Table 5 Impounding Basin Capacity

Spill Basin	**Width (feet)**	**Length (feet)**	**Depth (feet)**
Diesel Fuel Dike	25	25.5	3
Hydrocarbon Holding Tank Dike	50[1]	50[1]	4.5

6 WEATHER DATA ASSUMPTIONS

For weather conditions used to determine thermal radiation distances associated with fire hazards, the following criteria was used:

- The wind speed producing the maximum exclusion distances shall be used except for wind speeds that occur less than five percent of the time based on recorded data for the area.
- The ambient temperature and relative humidity that produce the maximum thermal flux distances shall be used except for values that occur less than five percent of the time based on recorded data for the area.

The weather data used for the Hazard Analysis is located in Appendix B.

The following criteria was used for the thermal radiation analysis:

Table 6.1 Thermal Radiation Weather Assumptions

Parameter	**Value**
Ambient Temperature (°F)	-29
Wind Speed (mph)	0-32
Relative Humidity (%)	50

For weather conditions used to determine dispersion hazards, the following criteria was used:

- Atmospheric Stability (Pasquill Class) F,

[1] The dimensions at the top of the Hydrocarbon Holding Tank Dike will 50 feet by 50 feet.

- Surface roughness factor of 0.03m
- Wind speed = 4.5 miles per hour (2.01 meters/sec) at reference height of 10 meters,
- Relative humidity = 50.0 percent and
- Atmospheric temperature = average in the region.

The following criteria was used for the vapor dispersion analysis:

Table 6.2 Vapor Dispersion Weather Assumptions

Parameter	**Value**
Average Ambient Temperature (°F)	49
Wind Speed (m/s)	1 - 2
Relative Humidity (%)	50
Pasquill-Gifford Atmospheric Stability	F

7 THERMAL RADIATION HAZARD ZONES

As detailed in Section 3, the LNGFIRE3 model was used with the weather assumptions detailed in Section 6 to calculate the thermal radiation hazard zones for the Project's Containment Dikes.

Table 7.1 summarizes the thermal radiation hazard zones for both Containment Dikes:

Table 7.1 Containment Dike Thermal Radiation Hazard Zones

		Distance (feet) to:		
Basin:		**1,600 BTU/ft²-hr**	**3,000 BTU/ft²-hr**	**10,000 BTU/ft²-hr**
Diesel Fuel Tank Containment Dike	**Front**[2]	160.2	140.0	110.8
	Side[2]	160.0	140.0	111.0
Hydrocarbon Holding Tank Containment Dike		279.9	241.0	187.9

All of the Containment Dike thermal radiation scenarios do not impact the public. The Project's plot plans have been marked to illustrate the thermal radiation hazard zones and are located in Figures 7.1 and 7.2.

[2] Since the length and width for the Diesel Fuel Tank Containment Dike are not equal, the heat flux from the length direction (Front) and the width direction (Side) will not be equal either.

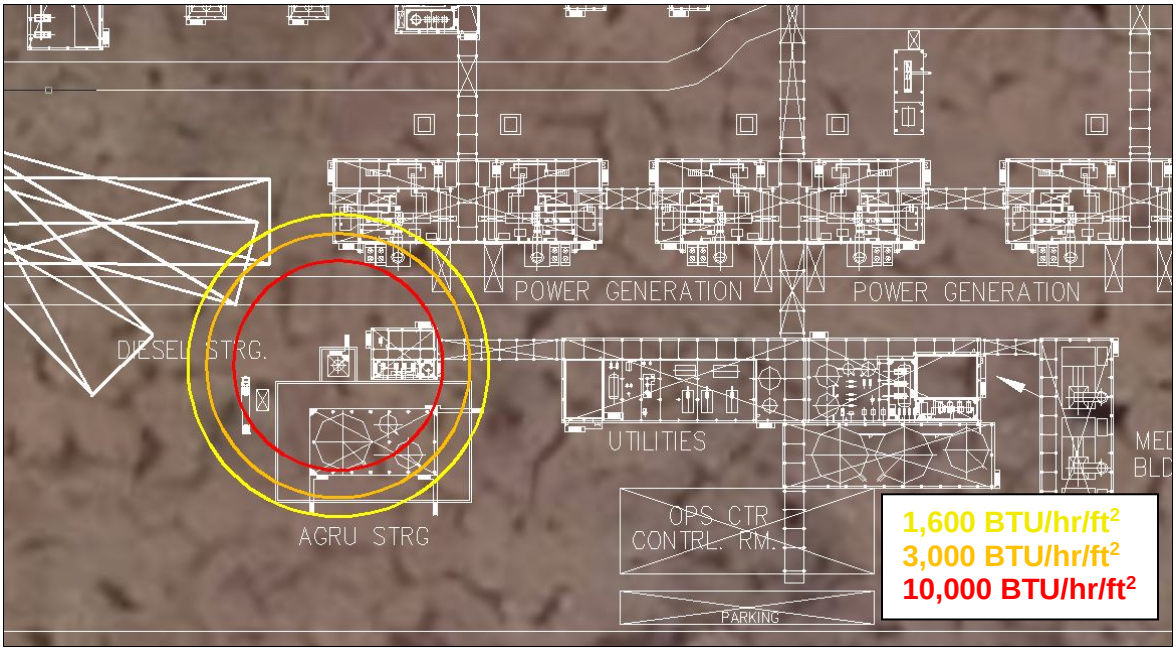


Figure 7.1: Thermal Radiation Hazard Zones - Diesel Fuel Tank Containment Dike

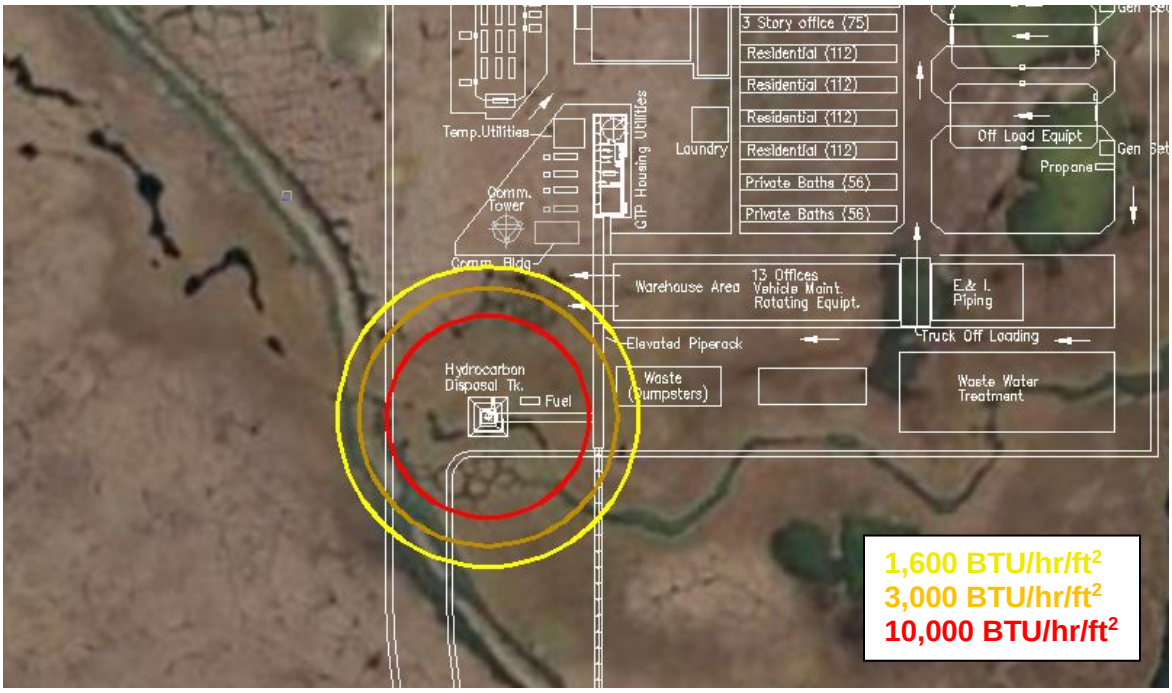


Figure 7.2: Thermal Radiation Hazard Zones- Hydrocarbon Holding Tank Containment Dike

8 NATURAL GAS VAPOR DISPERSION MODELING

The Project has used Phast (v6.7) dispersion software tools to perform vapor dispersion analysis to 50% lower flammability limit (1/2 LFL) to vapor dispersion hazard zones for a natural gas release.

8.1 Natural Gas Composition

The properties of pure methane were used in the natural gas vapor dispersion analysis.

8.2 Natural Gas Design Spills

The design spills associated with the potential single accidental leakage source of natural gas lines are detailed in the Piping Inventory Database provided in Appendix A. Table 8.2-1 lists all of the single accidental leakage source scenarios that bound the vapor dispersion modeling for leaks occurring at the Facility.

Table 8.2-1: Natural Gas Single Accidental Leakage Source

Service	Scenario #	Single Accidental Leakage Source (inch)[3]
NG	1	2.0
NG	2	2.0
NG	3	2.0
NG	4	2.0
NG	5	2.0
NG	6	2.0
NG	7	2.0
NG	8	2.0
NG	8A	2.0
NG	9	2.0
NG	10	2.0
NG	11	2.0
NG	12	2.0
NG	13	2.0
NG	14	2.0
NG	15	2.0
NG	16	2.0
NG	17	2.0
NG	18	2.0

Operating conditions, such as temperature, pressure, flow rate and release elevation used in the analysis are presented in Appendix A.

[3] Assumed to be a universally 2-inch Single Accidental Leakage Source.

8.3 Natural Gas Vapor Dispersion

The location and flow rate considerations for determining the design spills to be analyzed for dispersion determined the worst-case scenarios (bounding scenarios) for the single accidental leakage sources detailed in 8.2-1. Phast was used to perform an analysis on all of the scenarios to determine the bounding scenarios. The results of the Phast modeling are included in Table 8.3-1.

Table 8.3-1 Natural Gas Vapor Dispersion Phast Results

Scenario #	Hole Size (inch)	Distance to ½ LFL (feet)	Total Vapor Mass Flow Rate (lb/hr)
NG-1	2	218	107,182
NG-2	2	218	107,159
NG-3	2	211	106,257
NG-4	2	194	96,794
NG-5	2	189	93,805
NG-6	2	190	95,017
NG-7	2	192	94,875
NG-8	2	190	93,999
NG-8A	2	189	92,853
NG-9	2	195	92,245
NG-10	2	256	160,837
NG-11	2	305	189,986
NG-12	2	405	352,800
NG-13	2	459	459,581
NG-14	2	457	456,265
NG-15	2	491	450,566
NG-16	2	248	129,118
NG-17	2	231	115,582
NG-18	2	214	105,220

All natural gas vapor dispersion scenarios do not impact the public. The results of NG-1, NG-13, NG-15, NG-16 and NG-18 are illustrated in Figure 8.3-1. These scenarios were determined to be the bounding scenarios based on the location of the leak and the ½ LFL dispersion distance.

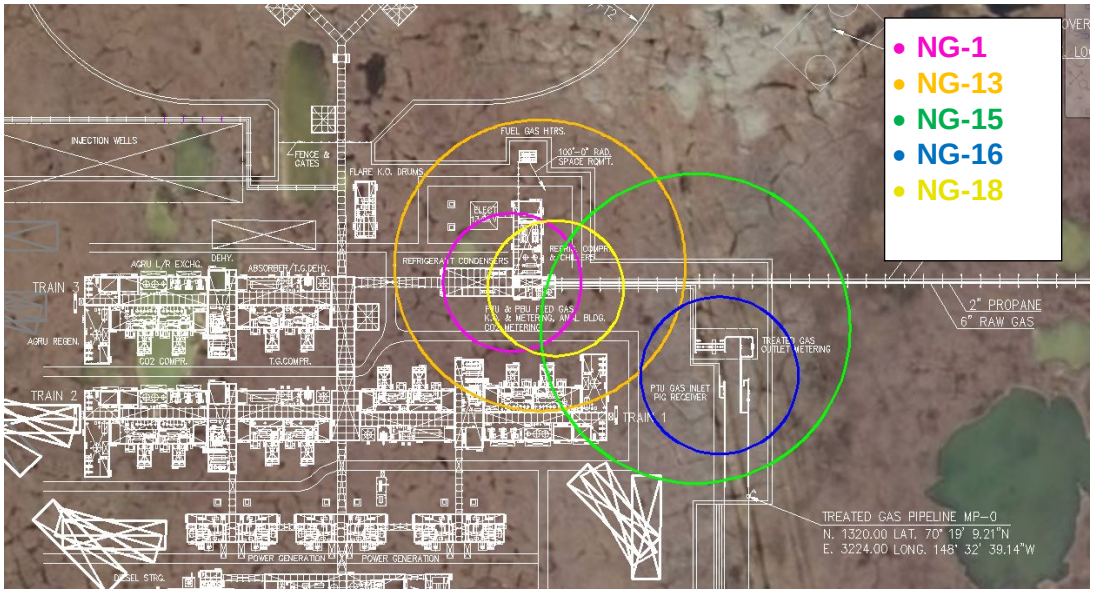


Figure 8.3-1 Natural Gas Scenarios Distance to ½ LFL

9 REFRIGERANT DISPERSION MODELING

The Project has also analyzed the hazards associated with refrigerant vapor cloud dispersion using the same methodology that was used to calculate natural gas design spills.

9.1 Refrigerant Compositions

Compositions for refrigerant modeling are based on the compositions listed in the Project Heat and Material Balances, Document Number USAG-EC-PDPFD-50-000666-209. A 2-inch propane pipeline, originating from the existing CGF, provides refrigerant to the Facility. This line is used to fill the Facility refrigeration system prior to start up and for occasional top off the refrigeration inventory. This line is not intended for continuous operation. The stream is composed mostly of liquid propane, with ethane and butane present in trace amounts.

9.2 Refrigerant Design Spills

The design spills associated with the potential single accidental leakage source of refrigerants are detailed in the Piping Inventory Databases, located in Appendix A. Table 9.2-1 lists the single accidental leakage source scenarios that will bound refrigerant releases for leaks occurring at the Facility.

Table 9.2-1: Refrigerant Single Accidental Leakage Source

Service	Scenario #	Single Accidental Leakage Source (inch)[3]
Refrigerant	1	2.0

Service	Scenario #	Single Accidental Leakage Source (inch)[3]
Refrigerant	2	2.0
Refrigerant	3	2.0
Refrigerant	4	2.0
Refrigerant	5	2.0
Refrigerant	6	2.0
Refrigerant	7	2.0

Operating conditions, such as temperature, pressure, flow rate and release elevation used in the analysis are presented in Appendix A.

9.3 Refrigerant Dispersion

The design spills associated with the potential single accidental leakage source of refrigerant lines are detailed in the Piping Inventory Database provided in Appendix A. Table 9.2-1 lists all of the single accidental leakage source scenarios that will bound the vapor dispersion modeling for refrigerant leaks occurring at the Facility.

The resulting dispersion distance for each bounding scenario is shown in Table 9.3-1.

Table 9.3-1: Refrigerant Dispersion Distances

Scenario #	Bounding Scenario Hole Size (inch)	½ LFL Dispersion Distance (feet)
R-1	2.0	75
R-2	2.0	75
R-3	2.0	75
R-4	2.0	126
R-5	2.0	126
R-6	2.0	132
R-7	2.0	132

All refrigerant dispersion scenarios remained within the plant designated land and therefore do not impact the public. The results of R-5 and R-6 are illustrated in Figure 9.3-1. These scenarios were determined to be the bounding scenarios based on the location of the leak and the ½ LFL dispersion distance[4].

[4] Although R-4 and R-5 have the same dispersion distance, R-5 was chosen as the bounding scenario since it had the larger of the two flowrates.

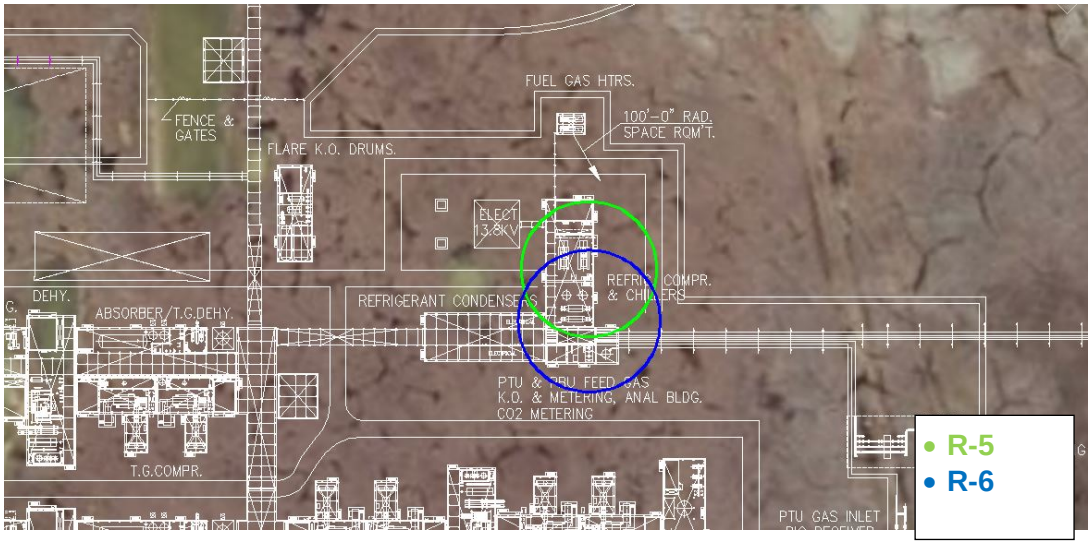


Figure 9.3-1 Refrigerant Scenarios Distance to ½ LFL

9.4 Overpressure Modeling

The Project has also analyzed the hazards associated with refrigerant dispersion scenarios that could result in an overpressure.

Ethane, propane and butane have higher reactivity than methane and pose a greater risk for generating overpressure or vapor cloud explosion.

Overpressures are calculated based on the design spills as listed in Section 9.3. The Baker-Strehlow-Tang (BST) Explosion Model was used in Phast (v6.7) to estimate the distances to the 1 psig threshold resulting from a refrigerant (primarily propane) release. Within the Phast calculations, the flammable vapor cloud is ignited at the greatest LFL cloud extent and conservative assumptions were used to define obstacle density and flame expansion.

Table 9.4-1 lists the overpressure scenarios and the resulting distance to 1 psig.

Table 9.4-1: Natural Gas Release Overpressure Distances

Scenario #	Bounding Scenario Hole Size (inch)	Distance to 1 psig Overpressure Threshold (feet)
R-1	2.0	154
R-2	2.0	154
R-3	2.0	154
R-4	2.0	244
R-5	2.0	244
R-6	2.0	281

Scenario #	Bounding Scenario Hole Size (inch)	Distance to 1 psig Overpressure Threshold (feet)
R-7	2.0	281

The results of the Phast modeling are illustrated in Figure 9.4-1. The results of the overpressure analysis illustrate that a 1 psig threshold would not impact the public. These overpressures would also not compromise critical equipment, hazardous liquid storage tanks, firewater storage tank, or occupied buildings. The results of R-5 and R-6 are illustrated in Figure 9.4-1. These scenarios were determined to be the bounding scenarios based on the location of the leak and the 1 psig overpressure distance.

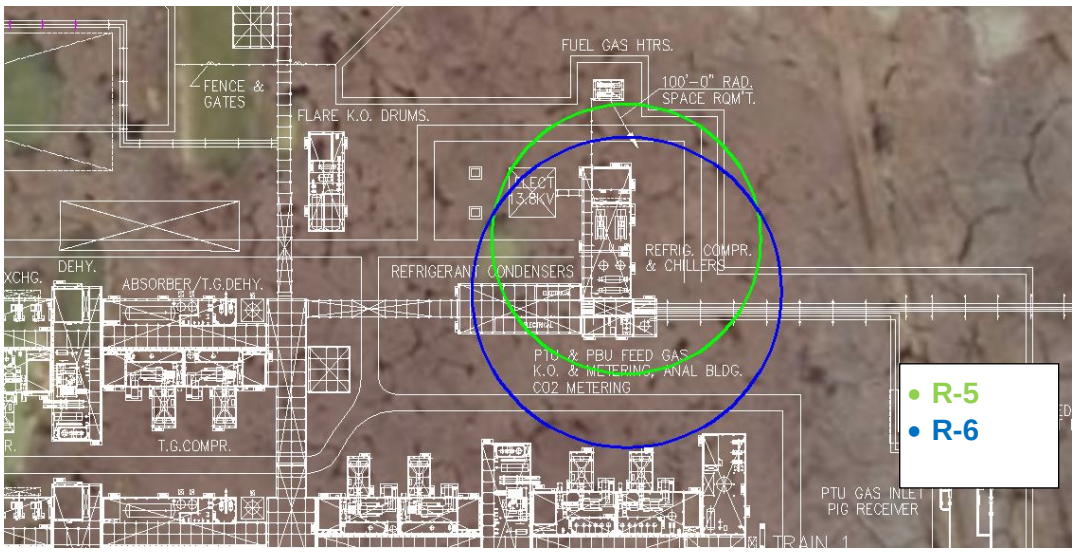


Figure 9.4-1 Refrigerant Scenarios in to 1 psig

10 JET FIRE MODELING

The Phast model was used to calculate the jet fire thermal radiation distances for all spill scenarios, as shown in Tables 8.2-1 and 9.2-1. Table 10 summarizes the distances to 10,000 BTU/ft^2-hr, 3,000 BTU/ft^2-hr and 1,600 BTU/ft^2-hr for the flammable fluid release scenarios:

Table 10: Jet Fire Thermal Distances

Scenario #	Hole Size (in)	1,600 BTU/ft^2-hr Distance: (feet)	3,000 BTU/ ft^2-hr Distance: (feet)	10,000 BTU/ ft^2-hr Distance: (feet)
NG-1	2.0	207	178	128
NG-2	2.0	207	177	128

Scenario #	Hole Size (in)	1,600 BTU/ft^2-hr Distance: (feet)	3,000 BTU/ ft^2-hr Distance: (feet)	10,000 BTU/ ft^2-hr Distance: (feet)
NG-3	2.0	206	176	126
NG-4	2.0	188	149	Not Reached
NG-5	2.0	191	160	102
NG-6	2.0	193	161	103
NG-7	2.0	183	140	Not Reached
NG-8	2.0	190	157	Not Reached
NG-8A	2.0	189	156	Not Reached
NG-9	2.0	192	165	119
NG-10	2.0	252	216	155
NG-11	2.0	273	234	167
NG-12	2.0	367	311	222
NG-13	2.0	415	347	241
NG-14	2.0	413	346	240
NG-15	2.0	411	346	242
NG-16	2.0	227	194	139
NG-17	2.0	215	184	132
NG-18	2.0	205	176	127
R-1	2.0	99	87	68
R-2	2.0	99	87	68
R-3	2.0	99	87	68
R-4	2.0	138	118	84
R-5	2.0	138	118	84
R-6	2.0	141	121	86
R-7	2.0	141	121	86

The plant layout illustrating the bounding 10,000, 3,000 and 1,600 BTU/ft^2-hr jet fire thermal distances for natural gas and refrigerants are located in Figure 10-1 and Figure 10-2, respectively. None of the 1,600 BTU/ft^2-hr isopleths impact the public.

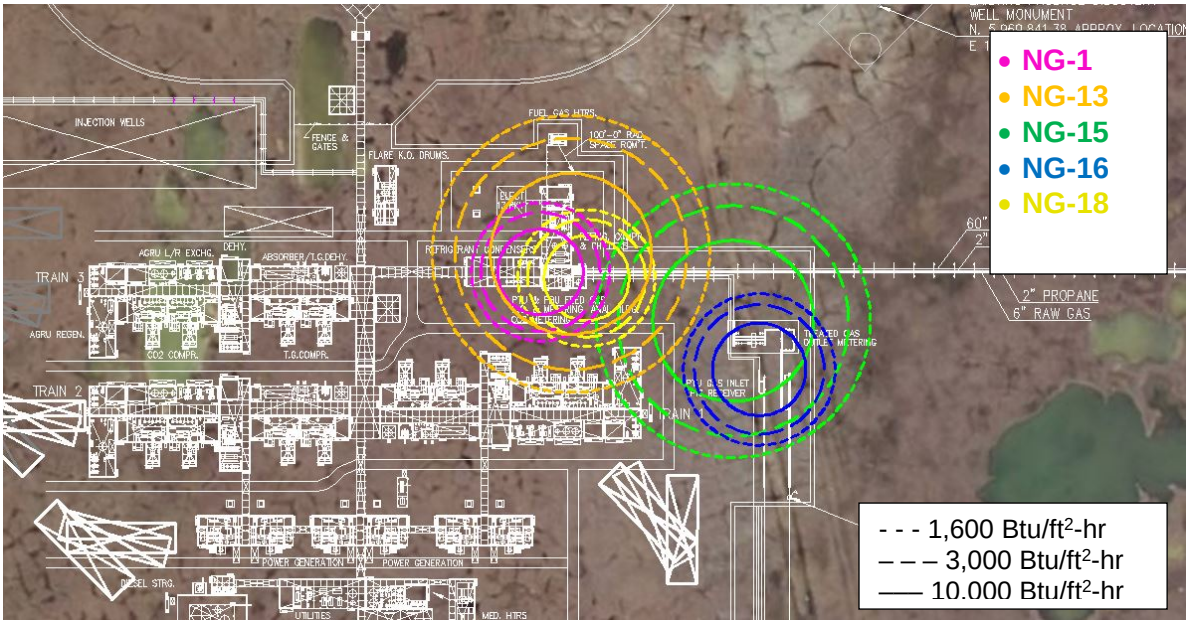


Figure 10-1: Jet Fire Distances for Natural Gas Releases

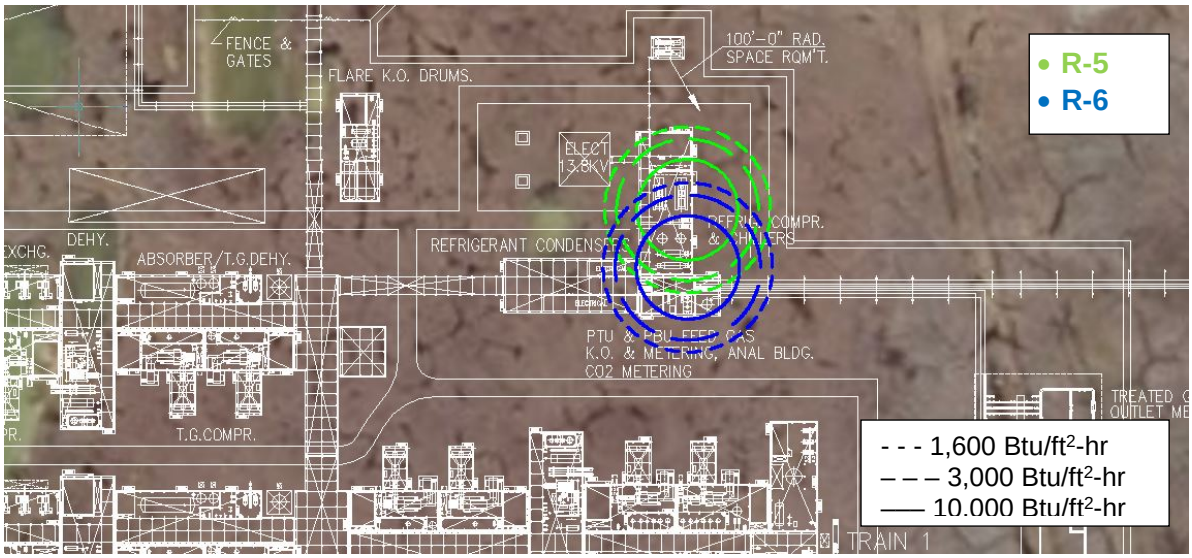


Figure 10-2: Jet Fire Distances for Refrigerant Releases

Unlike a pool fire, a jet fire will only be present when there is sufficient pressure and inventory in the system to sustain the jet fire. While a large liquid pool fire will continue to burn until all of the fuel is consumed, a jet fire will lose its duration and associated thermal radiation flux distance when ESD valves are actuated and the pressure in the system decreases. To prevent cascading failures and BLEVEs, numerous mitigation measures are in place in the current design.

- The design provides compliance with applicable codes for equipment selection and system design. Examples include use of well-proven equipment and materials,

implementation of methods for minimizing flanges and potential leakage sources, and installation of appropriate control and safety systems

- Facilities would be laid out in accordance with the requirements of 40 CFR Part 68, OSHA regulation 29 CFR 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.
- The Project has been designed such that areas likely to contain flammable gas mixtures will be isolated from ignition sources in accordance with NFPA 70 and the National Electric Code. Electrical equipment used within these designated areas will be housed in enclosures approved for this service and application.
- The design will include the installation of hazard detection equipment which may alarm and/or shutdown process equipment as detailed in Section 13.16 of Resource Report 13.
- The design of the Emergency Shut Down (ESD) system to isolate inventory, decrease pressure, and limit a jet fire duration.
- Fire protection for the Facility process and utility modules would be accomplished by using zoned Firewater 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., 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 standalone water mist system and will include the installation of wheeled and portable dry chemical fire extinguishers. Details of the location of the dry chemical fire extinguishers are included in Appendix P of Resource Report 13.
- The project will implement facility operations to prevent failures and mitigate consequences through the use of appropriate procedures, inspections, maintenance, training, and supervision. Examples include the operations and maintenance manual, emergency response plan/manual, and frequent training sessions.

The inclusion of the above independent mitigation measures will conservatively mitigate the potential for jet fires to cause cascading effects to adjacent equipment and piping and will mitigate the potential for BLEVEs.

11 TOXICITY ANALYSIS

Hazards associated with toxic vapor cloud dispersion were evaluated. Based on a review of the facility Process and Instrumentation Drawings (P&IDs), Heat and Material Balances

(H&MBs), and Process Flow Diagrams (PFDs), the following toxic components have been identified:

- Hydrogen sulfide in acid gas and CO_2 compression streams, and
- Benzene, toluene and hexane in process gas stream

FERC has requested applicants perform toxicity modeling in accordance with the Acute Exposure Guideline Levels (AEGL) maintained by the U.S. Environmental Protection Agency.

With respect to hazards to the general public, the National Advisory Committee for the Development of Acute Exposure Guideline Levels developed levels for hazardous substances and defines the three AEGL levels as:

- AEGL 1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
- AEGL 2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long lasting adverse health effects or an impaired ability to escape.
- AEGL 3: airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

The concentrations associated with the three AEGL levels are dependent on the time a person could ingest, inhale, or be exposed to a toxic substance and are listed as 10 minute, 30 minute, 60 minute, 4 hour, and 8 hour exposure durations. For additional information, see the National Advisory Committee for AEGL Development.

11.1 Design Spills

Design spills for toxicity modeling are based on the same methodology currently used to determine single accidental leakage sources for natural gas releases. Design spills for toxic components are included in the Piping Inventory Database which can be found in Appendix A of this report.

Table 11.1-1: Toxics Single Accidental Leakage Source

Service	Toxic Components	Scenario #	Single Accidental Leakage Source $(inch)^3$
Acid Gas (AG)	H_2S	3	2.0
Acid Gas (AG)	H_2S	4	2.0
Acid Gas (AG)	H_2S	6	2.0
Acid Gas (AG)	H_2S	7	2.0

Service	Toxic Components	Scenario #	Single Accidental Leakage Source (inch)[3]
NG	Benzene, Toluene, Hexane and H_2S	1	2.0
NG	Benzene, Toluene, Hexane and H_2S	7	2.0
NG	Benzene, Toluene, Hexane and H_2S	13	2.0
NG	Benzene, Toluene, Hexane and H_2S	15	2.0
NG	Benzene, Toluene, Hexane and H_2S	16	2.0
NG	Benzene, Toluene, Hexane and H_2S	18	2.0

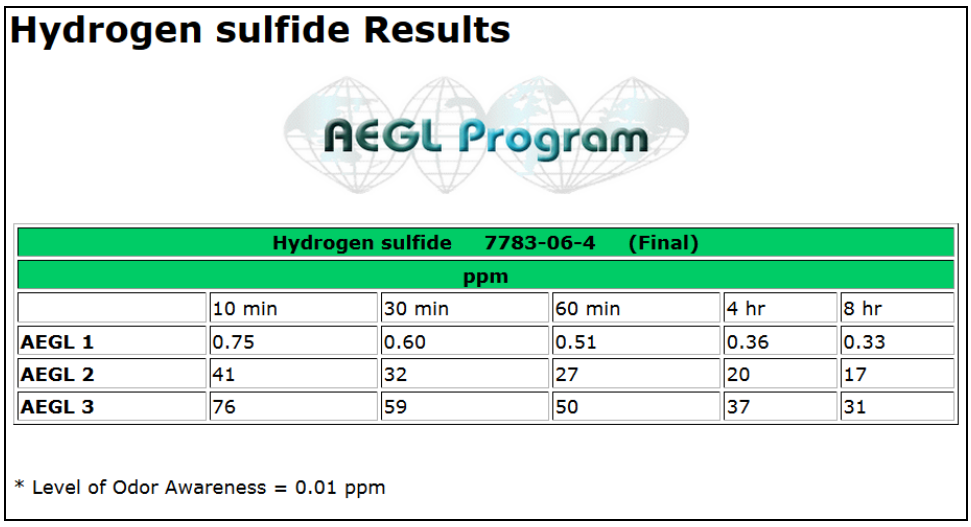
Operating conditions, such as temperature, pressure, flow rate and release elevation used in the analysis are presented in Appendix A. Since the pipes will be located aboveground in an open piperack, each scenario was modeled as a horizontal release.

11.2 Hydrogen Sulfide Analysis

The hydrogen sulfide Technical Support Documentation is included in the *Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 9* developed by the Committee on Acute Exposure Guideline Levels, Committee on Toxicology, National Research Council.[5] The Technical Support Documentation describes all the studies, data, and scaling factors used in conservatively determining the AEGL levels for that component.

The hydrogen sulfide AEGL levels are illustrated in Figure 11.2-1 below:

[5] http://www.epa.gov/oppt/aegl/pubs/hydrogen_sulfide_final_volume9_2010.pdf



Hydrogen sulfide Results

AEGL Program

Hydrogen sulfide 7783-06-4 (Final)					
ppm					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	0.75	0.60	0.51	0.36	0.33
AEGL 2	41	32	27	20	17
AEGL 3	76	59	50	37	31

* Level of Odor Awareness = 0.01 ppm

Figure 11.2-1 Hydrogen Sulfide AEGL Levels

The Phast (v6.7) software was used to calculate the ½ AEGL-1, -2, and -3 levels for H_2S to determine the worst case toxic distances for a release. The 10 minute AEGL levels were chosen based on the maximum exposure time. The averaging time was set to the exposure time. Since the pipes will be located aboveground, each release was modeled as a horizontal release.

The PHAST model results for tracking H_2S in the scenarios are presented in Tables 11.2-1 below:

Table 11.2-1 H_2S AEGL Levels

Scenario #	AEGL Level	Distance (ft)
AG-3	½ AEGL-1	5,791
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
AG-4	½ AEGL-1	5,806
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
AG-6	½ AEGL-1	9,285
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
AG-7	½ AEGL-1	11,191
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-1	½ AEGL-1	759
	½ AEGL-2	No Hazard

Scenario #	AEGL Level	Distance (ft)
	½ AEGL-3	No Hazard
NG-7	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-13	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-15	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-16	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-18	½ AEGL-1	1,157
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard

The bounding scenario was modeled in PHAST and results show that none of the clouds will reach a hazardous concentration (½ AEGL-2 or ½ AEGL-3). The distance to ½ AEGL-1 would remain outside of public areas containing schools, hospitals or other sensitive areas as illustrated in Figure 11.2-2.

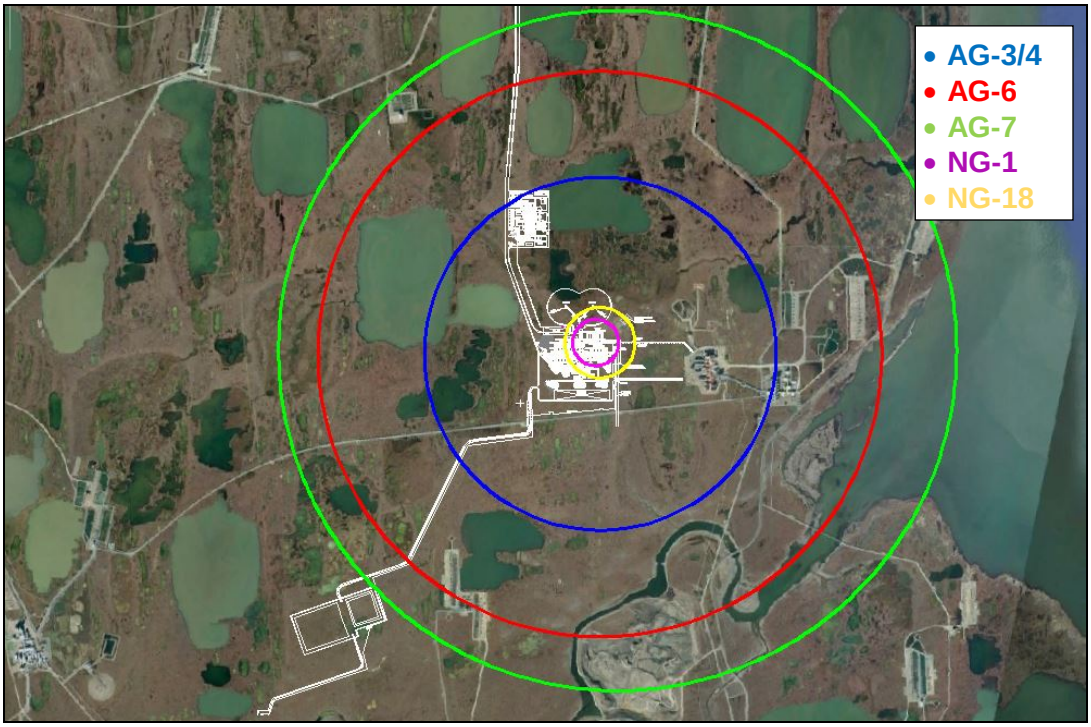


Figure 11.2-2 Hydrogen Sulfide Distance to ½ AEGL-1

11.3 Toluene Analysis

The toluene Technical Support Documentation is included in the *Acute Exposure Guideline Levels for Toluene: Interim 3* developed by Oak Ridge National Laboratory, for the U.S. Department of Energy.[6] The Technical Support Documentation describes all the studies, data, and scaling factors used in conservatively determining the AEGL levels for that component.

The toluene AEGL levels are illustrated in Figure 11.3-1 below:

[6] http://www.epa.gov/oppt/aegl/pubs/toluene_interim_ornl_nov2009c.pdf

Toluene Results

AEGL Program

Toluene 108-88-3 (Final)					
ppm					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	67	67	67	67	67
AEGL 2	1,400*	760	560	310	250
AEGL 3	** 10,000 ppm	5,200*	3,700*	1,800*	1,400*

Lower Explosive Limit (LEL) = 14,000 ppm
* = ≥ 10% LEL; ** = ≥ 50% LEL
AEGL 3 - 10 min = **10,000 ppm

Figure 11.33-1: Toluene AEGL Levels

The Phast (v6.7) software was used to calculate the ½ AEGL-1, -2, and -3 levels for toluene to determine the worst case toxic distances for a release. The AEGL levels were chosen based on the maximum exposure time for scenarios involving rainout. The averaging time was set to the exposure time. Since the pipes will be located aboveground, each release was modeled as a horizontal release.

The PHAST model results for tracking toluene in the scenarios are presented in Tables 11.3-1 below:

Table 11.33-1 Toluene ½ AEGL Levels

Scenario #	AEGL Level	Distance (ft)
NG-1	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-7	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-13	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-15	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-16	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard

Scenario #	AEGL Level	Distance (ft)
NG-18	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard

The Phast model results revealed that all toluene dispersion scenarios disperse prior to reaching an AEGL threshold and therefore remain within the plant property line and therefore do not impact the public.

11.4 Benzene Analysis

The benzene Technical Support Documentation is the *Interim Acute Exposure Guideline Levels*[7] for NAS/COT Subcommittee for AEGLs. The Technical Support Documentation describes all the studies, data, and scaling factors used in conservatively determining the AEGL levels for that component.

The benzene AEGL levels are illustrated in Figure 11.4-1 below:

Benzene Results

AEGL Program

Benzene 71-43-2 (Interim)					
ppm (12/12/06)					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	130	73	52	18	9.0
AEGL 2	2,000*	1,100	800	400	200
AEGL 3	**	5,600*	4,000*	2,000*	990

Lower Explosive Limit (LEL) = 14,000 ppm
* = ≥10% LEL; ** = ≥50% LEL
AEGL 3 - 10 mins = ** 9,700 ppm

Figure 11.4-1 Benzene AEGL Levels

The Phast (v6.7) software was used to calculate the ½ AEGL-1, -2, and -3 levels for benzene to determine the worst case toxic distances for a release. The AEGL levels were chosen based on the maximum exposure time for scenarios resulting in rainout conditions. The averaging time was set to the exposure time. Since the pipes will be located aboveground, each release was modeled as a horizontal release.

[7] http://www.epa.gov/oppt/aegl/pubs/benzene_interim_dec_2008_v1.pdf

The PHAST model results for tracking benzene in the scenarios are presented in Tables 11.4-1 below:

Table 11.44-1 Benzene ½ AEGL Levels

Scenario #	AEGL Level	Distance (ft)
NG-1	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-7	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-13	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-15	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-16	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-18	½ AEGL-1	No Hazard
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard

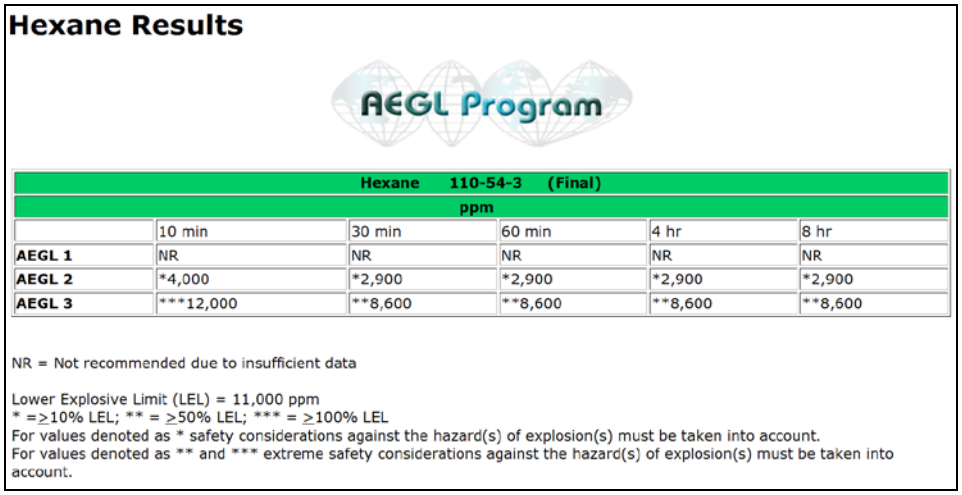
The Phast model results revealed that all benzene dispersion scenarios disperse prior to reaching an AEGL threshold and therefore remain within the plant property line and therefore do not impact the public.

11.5 Hexane Analysis

The hexane Technical Support Documentation is the *Interim Acute Exposure Guideline Levels*[8] for NAS/COT Subcommittee for AEGLs. The Technical Support Documentation describes all the studies, data, and scaling factors used in conservatively determining the AEGL levels for that component.

The hexane AEGL levels are illustrated in Figure 11.5-1 below:

[8] www.epa.gov/oppt/aegl/pubs/n-hexane_final_volume_14_apr_2013.pdf



Hexane Results

AEGL Program

Hexane 110-54-3 (Final) ppm					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	NR	NR	NR	NR	NR
AEGL 2	*4,000	*2,900	*2,900	*2,900	*2,900
AEGL 3	***12,000	**8,600	**8,600	**8,600	**8,600

NR = Not recommended due to insufficient data

Lower Explosive Limit (LEL) = 11,000 ppm
* =≥10% LEL; ** = ≥50% LEL; *** = ≥100% LEL
For values denoted as * safety considerations against the hazard(s) of explosion(s) must be taken into account.
For values denoted as ** and *** extreme safety considerations against the hazard(s) of explosion(s) must be taken into account.

Figure 11.5-1 Hexane AEGL Levels

The Phast (v6.7) software was used to calculate the ½ AEGL-1, -2, and -3 levels for hexane to determine the worst case toxic distances for a release. The AEGL levels were chosen based on the maximum exposure time for scenarios resulting in rainout conditions. The averaging time was set to the exposure time. Since the pipes will be located aboveground, each release was modeled as a horizontal release.

The PHAST model results for tracking hexane in the scenarios are presented in Tables 11.3-1 below:

Table 11.53-1 Hexane ½ AEGL Levels

Scenario #	AEGL Level	Distance (ft)
NG-1	½ AEGL-1	NR
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-7	½ AEGL-1	NR
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-13	½ AEGL-1	NR
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-15	½ AEGL-1	NR
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard
NG-16	½ AEGL-1	NR
	½ AEGL-2	No Hazard

Scenario #	AEGL Level	Distance (ft)
	½ AEGL-3	No Hazard
NG-18	½ AEGL-1	NR
	½ AEGL-2	No Hazard
	½ AEGL-3	No Hazard

The Phast model results revealed that all hexane dispersion scenarios disperse prior to reaching an AEGL threshold and therefore remain within the plant property line and therefore do not impact the public.

12 CONCLUSION

The purpose of this Report is to provide modeling assumptions and the results of the Hazard Analysis for the Facility. The Report:

- Describes the design spill assumptions and methodology used in the hazard analysis performed for the proposed Project,
- Demonstrates that the analysis performed is consistent with current guidance from FERC for determining single accidental leakage source and calculating design spills, and
- Demonstrates that the Project results in no hazards or impacts to off-site public receptors.

The following summarizes the hazard analysis performed for the Facility:

- The dikes analyzed for thermal radiation analysis associated with containment of flammable hydrocarbons and diesel remain within the land to be allocated for the operation of the GTP.
- The ½ LFL vapor dispersion cloud from the 25 flammable fluid releases will not result in any impact to the public.
- The overpressure calculations for the 7 refrigerant fluid releases will not result in any impact to the public. These overpressures would not compromise critical equipment, hazardous liquid storage tanks, firewater storage tank or occupied buildings.
- The 25 scenarios analyzed for thermal radiation analysis associated with jet fires will not result in any impact to the public. Escalation from jet fires will be mitigated by the depressurization and emergency shutdown system as well as significant passive features included in the site layout. Descriptions of the two systems are provided throughout the Project design documents.
- The 32 scenarios analyzed for dispersion of toxic materials will not result in impact to the public. In addition, all of the toxic dispersion scenarios result in a toxic concentration less than the AEGL-1 concentration except for several H_2S scenarios, which would remain outside of public areas containing schools, hospitals or other sensitive areas.

APPENDIX A: PIPING AND EQUIPMENT INVENTORY DATABASE

PRIVILEGED AND CONFIDENTIAL

H.4 – Meteorological Data

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-HSE-RTA-DOC-00001	Meteorological Data Report	0	Public

ALASKA LNG PROJECT - GTP FACILITY METEOROLOGICAL DATA

AKLNG-4010-HSE-RTA-DOC-00001

Alaska LNG

Meteorological Data

By

CH·IV
THE LNG SPECIALISTS

Rev No.	Issue Purpose:	Date:	By	CHK	APP
A	Issued For Client Review	May 20, 2017	JMP	JMW	PJS
0	Issued for Information	April 5, 2017	JMP	JMW	PJS

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List of Tables

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1 WEATHER DATA

A meteorological data analysis has been performed to determine the weather conditions to be used to calculate thermal radiation and vapor dispersion exclusion zones for the Alaska LNG Project (Project) including the GTP (Facility). Federal code 49 CFR Part 193 requires weather data to be "based on figures maintained by National Weather Service of the U.S. Department of Commerce". The National Weather Service is a component of the National Oceanic and Atmospheric Administration (NOAA) and is an operating unit of the U.S. Department of Commerce.

The proposed Facility is to be located in Deadhorse, AK. The source of the weather data used in the analysis was from the Deadhorse Airport Station PASC, which is approximately 9.4 miles from the proposed Facility site. The temperature, wind speed and humidity values are from data reported 2011-2015.

1.1 Thermal Radiation Weather

49 CFR 193.2057 provides that in calculating thermal radiation exclusion distances:

- The wind speed producing the maximum exclusion distances shall be used except for wind speeds that occur less than five percent of the time based on recorded data for the area.
- The ambient temperature and relative humidity that produce the maximum exclusion distances shall be used except for values that occur less than five percent of the time based on recorded data for the area.

Therefore, CH·IV has analyzed local weather data and selected the following criteria for the thermal radiation analysis:

Table 1.1: Thermal Radiation Weather Assumptions

Parameter	Value
Ambient Temperature	-29 °F
Wind Speed	Varies from 0-32 mph
Relative Humidity	50%

The detailed weather data, will be supplied directly to the FERC in spreadsheet format due to its large file size.

1.2 Vapor Dispersion Weather

49 CFR 193.2059 provides that "Dispersion conditions are a combination of those which result in longer predicted downwind dispersion distances than other weather conditions at the site at least 90 percent of the time, based on figures maintained by National Weather Service of the U.S. Department of Commerce, or as an alternative where the model used gives longer distances at lower wind speeds,

- Atmospheric Stability (Pasquill Class) = F,
- Wind speed = 4.5 miles per hour (2.01 meters/sec) at reference height of 10 meters,
- Relative humidity = 50.0 percent and
- Atmospheric temperature = average in the region."

Therefore, CH·IV has analyzed local weather data and selected the following criteria for the vapor dispersion analysis:

Table 1.2: Vapor Dispersion Weather Assumptions

Parameter	**Value**
Average Ambient Temperature	14.0 °F
Wind Speed	Multiple wind speeds will be analyzed to determine longest cloud distance.
Relative Humidity	50%
Pasquill-Gifford Atmospheric Stability	F

The detailed weather data, will be supplied directly to the FERC in spreadsheet format due to its large file size.

APPENDIX 13I – NATURAL HAZARD DESIGN INVESTIGATIONS AND FORCES

This Appendix is not applicable to the GTP.

J.1 - Geotechnical Hazard Report

Document Number:	Description:	Revision:	Appendix:
USAG-EC-SRZZZ-00-000005-000	Gas Treatment Plan - Borehole Plan for Resource Report 13	0	Public
USAG-EC-CDBOR-00-000010-000	Geotechnical Borehole Location Plan Sht. 9 of 17	0	Public
USAG-EC-CDBOR-00-000011-000	Geotechnical Borehole Location Plan Sht. 10 of 17	0	Public
USAG-EC-CDBOR-00-000012-000	Geotechnical Borehole Location Plan Sht. 11 of 17	0	Public
USAG-EC-CDBOR-00-000013-000	Geotechnical Borehole Location Plan Sht. 12 of 17	0	Public
USAG-EC-CDBOR-00-000014-000	Geotechnical Borehole Location Plan Sht. 13 of 17	0	Public
USAG-EC-CDBOR-00-000015-000	Geotechnical Borehole Location Plan Sht. 14 of 17	0	Public
USAG-EC-CDBOR-00-000016-000	Geotechnical Borehole Location Plan Sht. 15 of 17	0	Public
USAG-EC-CDBOR-00-000017-000	Geotechnical Borehole Location Plan Sht. 16 of 17	0	Public
USAG-EC-CDBOR-00-000018-000	Geotechnical Borehole Location Plan Sht. 17 of 17	0	Public

Confidential

Alaska LNG™

AECOM

Gas Treatment Plant - Borehole Plan for Resource Report 13, Appendix J.1

DOCUMENT NO. USAG-EC-SRZZZ-00-000005-000

REV	DATE	REVISION DESCRIPTION	ORIGINATOR	REVIEWER	APPROVER	ENDORSER
0	07/20/2016	Issued for Information	JAC	ACT	LER	

Document Control No.	Country	Facility	Originator	Discipline	Type	Sub-Type	Location	Sequence
	US	AG	EC	S	R	ZZZ	00	000005

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1.0 FUTURE GTP GEOTECHNICAL INVESTIGATION PLAN

Sufficient borings, test pits, core holes, sampling, testing, and other investigative operations will be performed to adequately determine the existing subsurface conditions within each of the specified areas of the project to support design of adfreeze foundations that include: adfreeze piles for static and dynamic loading, and other onshore / offshore structures. The proposed number and location of boreholes are shown in Table 1, below. Additional holes may be recommended by the Geotechnical Engineer that will be conducting the investigation while fewer may be required if data sharing opportunities arise. Proposed bore holes and coring shall be drilled to a depth determined by the Geotechnical Engineer based on the foundation and load conditions provided.

A detailed log, in accordance with ASTM D5434 and ASTM D4083, for each boring will be prepared. The log will include, as a minimum, the names of the Driller and Geotechnical Engineer, date, time at the beginning and completion of the boring, elevation of the top of the hole, coordinate of the hole, a graphical representation showing the various strata encountered, the depth at which each strata is encountered, penetration resistance, and a description of the consistency, moisture condition, ice content and ice characteristics, and general character and environment of the materials, as well as the classification of each by the Unified Classification System. Offshore borings shall include dredge material classification.

Testing will be performed to determine the pertinent engineering characteristics and design parameters of the subsurface conditions. Tests include:

- Dynamic soil property testing in accordance with ASTM D4428
- Ground temperature monitoring
- Field ice volume
- Ice characteristics
- Soil type

The results of the geotechnical investigation will be analyzed and published in a final Geotechnical Engineering Subsurface Investigation Reports. These reports will include all data collected during the geotechnical investigation and take into consideration the requirements of the proposed facility. The reports will conform to general industry standards and will contain, but not be limited to, the following:

- Drawings
- Boring Log
- Laboratory tests
- Recommendations

Table 1. Planned GTP Geotechnical Borehole Location

Planned Boreholes	Coordinates	
	Latitude (degrees)	Longitude (degrees)
BH-1-1	70.41634410	-148.5227979
BH-1-2	70.41472880	-148.5181711
BH-1-3	70.41558360	-148.5234942
BH-1-4	70.41451140	-148.5204225
BH-1-5	70.41549700	-148.5261901
BH-1-6	70.41447590	-148.5245362
BH-1-7	70.41367450	-148.5209679
BH-1-8	70.41418030	-148.5278839
BH-1-9	70.41275830	-148.5238092
BH-2-1	70.41110110	-148.5275177
BH-2-2	70.40811340	-148.5277333
BH-2-3	70.40436540	-148.5280037
BH-2-4	70.40105710	-148.5230874
BH-3-1	70.39821190	-148.526844
BH-3-2	70.39467510	-148.5234972
BH-3-3	70.39184460	-148.5200132
BH-3-4	70.39151880	-148.5205097
BH-3-5	70.39105640	-148.5200747
BH-3-6	70.39059390	-148.5196397
BH-3-7	70.39013150	-148.5192046
BH-3-8	70.38966910	-148.5187697
BH-3-9	70.38946140	-148.5177219
BH-4-1	70.38527310	-148.5193098
BH-4-2	70.38248360	-148.526515
BH-4-3	70.37803120	-148.5358715
BH-5-1	70.37233430	-148.5365502
BH-5-2	70.36969530	-148.5404561
BH-6-1	70.36398440	-148.5644748
BH-6-2	70.36315360	-148.5719811
BH-6-3	70.36232250	-148.5794868
BH-6-4	70.35735970	-148.5911149
BH-7-1	70.35612380	-148.5980883
BH-7-2	70.35453180	-148.5967198
BH-7-3	70.35101430	-148.594308

Planned Boreholes	Coordinates	
	Latitude (degrees)	Longitude (degrees)
BH-7-4	70.34883870	-148.5928168
BH-7-5	70.34698360	-148.5915455
BH-8-1	70.34322890	-148.5889732
BH-8-2	70.33907620	-148.587051
BH-8-3	70.33495140	-148.5851831
BH-9-1	70.33257780	-148.5746805
BH-9-2	70.33028000	-148.5730219
BH-9-3	70.32798190	-148.5713642
BH-9-4	70.33227220	-148.5784342
BH-9-5	70.33134570	-148.5778096
BH-9-6	70.33020730	-148.5778354
BH-9-7	70.32883500	-148.574258
BH-9-8	70.32767500	-148.5751174
BH-9-9	70.33113090	-148.5802375
BH-9-10	70.32865520	-148.5782628
BH-9-11	70.33184780	-148.583597
BH-9-12	70.32948630	-148.5818925
BH-9-13	70.32658820	-148.5798013
BH-9-14	70.32642490	-148.5768933
BH-9-15	70.32962910	-148.5785736
BH-10-1	70.32245230	-148.5697165
BH-10-2	70.32508410	-148.5777797
BH-10-3	70.32273450	-148.5731367
BH-10-4	70.32071930	-148.5691555
BH-11-1	70.32308700	-148.5611786
BH-11-2	70.32366780	-148.5540761
BH-11-3	70.32232210	-148.5568587
BH-11-4	70.32139970	-148.5561944
BH-11-5	70.32095830	-148.564539
BH-12-1	70.32086620	-148.5582468
BH-12-2	70.32105440	-148.5559457
BH-12-3	70.32091830	-148.5552127
BH-12-4	70.32103400	-148.553127
BH-12-5	70.32092800	-148.5519244
BH-12-6	70.31932400	-148.5611343
BH-12-7	70.31969880	-148.5612791

Planned Boreholes	Coordinates	
	Latitude (degrees)	Longitude (degrees)
BH-12-8	70.31973710	-148.5605877
BH-12-9	70.31935790	-148.559907
BH-12-10	70.31951810	-148.5600223
BH-12-11	70.31942790	-148.559051
BH-12-12	70.31958810	-148.5591663
BH-12-13	70.31985260	-148.5590037
BH-12-14	70.31953620	-148.5580754
BH-12-15	70.32002310	-148.5584701
BH-12-16	70.31964450	-148.5567473
BH-12-17	70.31980350	-148.5568623
BH-12-18	70.32007160	-148.5568772
BH-12-19	70.31971570	-148.555881
BH-12-20	70.31987440	-148.5559953
BH-12-21	70.32021520	-148.5558203
BH-12-22	70.32008210	-148.555132
BH-12-23	70.31963070	-148.554807
BH-12-24	70.32001960	-148.5545155
BH-12-25	70.32033660	-148.5544289
BH-12-26	70.32046150	-148.5529025
BH-12-27	70.32053430	-148.5514533
BH-12-28	70.31837340	-148.5604496
BH-12-29	70.31874790	-148.560593
BH-12-30	70.31878640	-148.559903
BH-12-31	70.31840720	-148.5592223
BH-12-32	70.31856740	-148.5593377
BH-12-33	70.31847720	-148.5583663
BH-12-34	70.31863740	-148.5584817
BH-12-35	70.31890190	-148.5583191
BH-12-36	70.31858550	-148.5573911
BH-12-37	70.31907250	-148.5577855
BH-12-38	70.31827320	-148.5568121
BH-12-39	70.31869410	-148.5560635
BH-12-40	70.31885280	-148.5561781
BH-12-41	70.31912090	-148.5561929
BH-12-42	70.31876470	-148.5551958
BH-12-43	70.31892370	-148.5553111

Planned Boreholes	Coordinates	
	Latitude (degrees)	Longitude (degrees)
BH-12-44	70.31926490	-148.5551361
BH-12-45	70.31848670	-148.5540877
BH-12-46	70.31923760	-148.554524
BH-12-47	70.31903780	-148.5537879
BH-12-48	70.31934810	-148.5536023
BH-12-49	70.31953800	-148.5537277
BH-12-50	70.31918170	-148.5527308
BH-12-51	70.31942900	-148.5527305
BH-12-52	70.31960890	-148.5528606
BH-12-53	70.31875090	-148.5511915
BH-12-54	70.31925220	-148.5511539
BH-12-55	70.31950210	-148.5514611
BH-12-56	70.31935460	-148.5505648
BH-12-57	70.31966530	-148.5504394
BH-12-58	70.31982540	-148.5505569
BH-12-59	70.31942880	-148.5498651
BH-12-60	70.31973530	-148.5495833
BH-12-61	70.31989540	-148.5497008
BH-12-62	70.31955440	-148.5483289
BH-12-63	70.31992910	-148.5484734
BH-12-64	70.32050490	-148.5454411
BH-12-65	70.31788230	-148.5571482
BH-12-66	70.31797840	-148.5559812
BH-12-67	70.31810300	-148.5544499
BH-12-68	70.31819840	-148.5532833
BH-12-69	70.31834290	-148.5515155
BH-12-70	70.31843830	-148.5503489
BH-12-71	70.31742760	-148.5573497
BH-12-72	70.31723670	-148.5569
BH-12-73	70.31750660	-148.5568227
BH-12-74	70.31762370	-148.5544248
BH-12-75	70.31724220	-148.553588
BH-12-76	70.31756320	-148.5524319
BH-12-77	70.31776490	-148.5525578
BH-12-78	70.31768660	-148.5509905
BH-13-1	70.32195150	-148.534764

Planned Boreholes	Coordinates	
	Latitude (degrees)	Longitude (degrees)
BH-15-1	70.31295500	-148.5637982
BH-15-2	70.31242400	-148.5634157
BH-15-3	70.31258300	-148.5645781
BH-15-4	70.31279590	-148.5626358
BH-15-5	70.30775830	-148.5794453
BH-16-1	70.29742440	-148.5866491
BH-16-2	70.29369680	-148.6023568
BH-17-1	70.29257720	-148.6007872
BH-17-2	70.29145900	-148.5986551
BH-17-3	70.29057750	-148.5969793
BH-17-4	70.28927290	-148.6151173
BH-17-5	70.29060280	-148.6089893
BH-17-6	70.29193260	-148.6028605
BH-17-7	70.29060690	-148.6046667
BH-17-8	70.28927710	-148.610795
BH-17-9	70.28795150	-148.6126
BH-17-10	70.28928120	-148.6064727
BH-17-11	70.29061100	-148.6003436
BH-17-12	70.28928540	-148.6021499
BH-17-13	70.28795570	-148.608278
BH-17-14	70.28663010	-148.610083
BH-17-15	70.28928940	-148.5978271
BH-17-16	70.29299230	-148.5988734
BH-17-17	70.29344280	-148.596796
BH-17-18	70.29221660	-148.5959344
BH-17-19	70.29099260	-148.5950656
BH-17-20	70.29144310	-148.5929883
BH-17-21	70.29099800	-148.5921507
BH-17-22	70.28740040	-148.591495
BH-17-23	70.28113800	-148.614331

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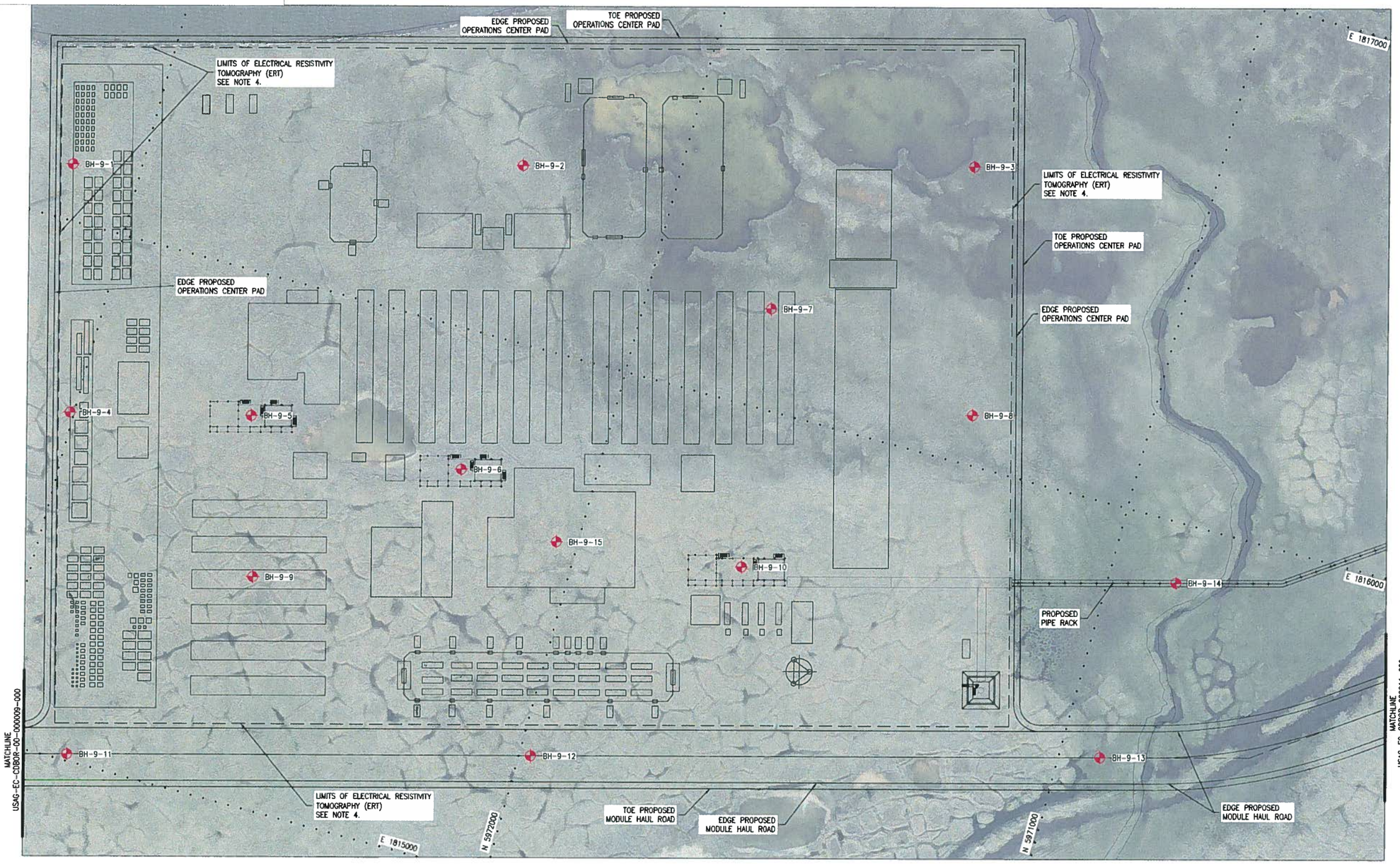


NOTES:

1. SEE DRAWING USAG-EC-CDBOR-00-C00001-000 FOR GENERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS USAG-EC-CDBOR-00-000001, 000009 AND 000011.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.
4. GEOTECHNICAL ENGINEER SHALL USE ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) TECHNIQUES TO SUPPLEMENT BORINGS.

LEGEND:

BOREHOLE LOCATION (BH)

BOREHOLE LOCATIONS

BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-9-1	5973130	1816106	RESISTIVITY TEST
BH-9-2	5972294	1816330	RESISTIVITY TEST, THERMISTOR
BH-9-3	5971458	1816554	RESISTIVITY TEST, THERMISTOR
BH-9-4	5973007	1815646	RESISTIVITY TEST
BH-9-5	5972670	1815731	RESISTIVITY TEST
BH-9-6	5972254	1815737	RESISTIVITY TEST, THERMISTOR
BH-9-7	5971762	1816190	RESISTIVITY TEST
BH-9-8	5971335	1816094	RESISTIVITY TEST
BH-9-9	5972585	1815433	RESISTIVITY TEST
BH-9-10	5971684	1815698	RESISTIVITY TEST
BH-9-11	5972837	1815013	THERMISTOR
BH-9-12	5971978	1815243	
BH-9-13	5970924	1815526	THERMISTOR
BH-9-14	5970872	1815886	
BH-9-15	5972040	1815651	

TRUE NORTH
PLANT NORTH
15°0'0"

100 0 100 200
1" = 100' H

REVISION APPROVAL RECORD					
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
ARCH.			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON.			PROCESS		
GEN. ARRANG.			QA / QC		
HVAC			STRUCTURAL	AET	5/24/16
I & C					

REV. NO.	DATE	REVISIONS	BY (CHK'R)	APPROVED BY
A	5/5/16	ISSUED FOR REVIEW	RHM JBG	
0	5/24/16	ISSUED FOR USE	dmm	

DRAWING STATUS				
ISSUED	REV	DATE	SUC	PEM
PRELIMINARY	0	5/24/16	AET	
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REVNO

PROJECT NO. 1409
DRAWN: dmm DATE: 5/24/16
CHECKED: AET 5/24/16
CONFIDENTIAL
PRE-FEED PHASE
SCALE: 1"=100'

Alaska LNG™

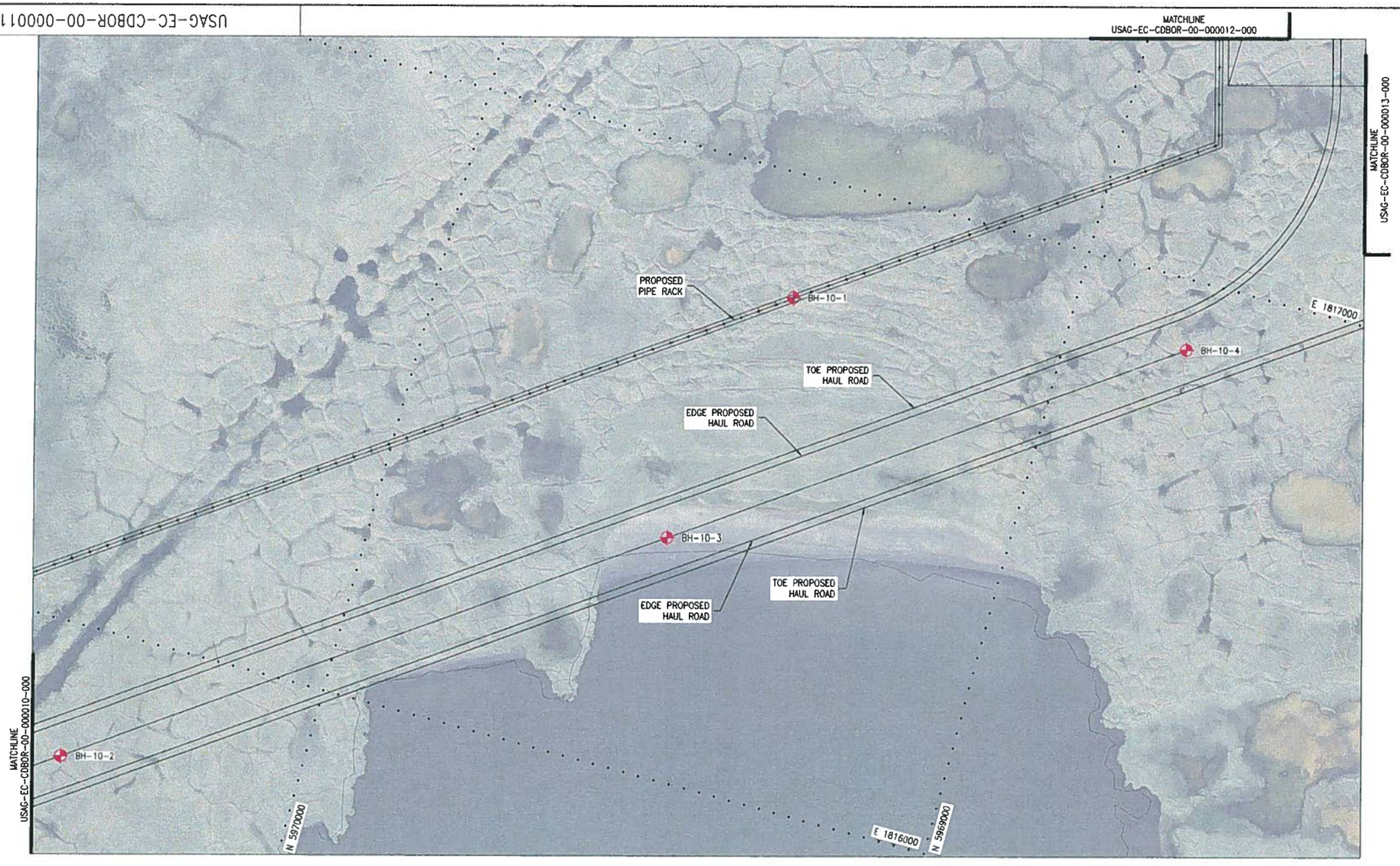
UPC ENERGY & CONSTRUCTION INC — an AECOM Company
5901 S Havana St.
Englewood, CO 80112
(303) 843-2000

AECOM

GAS TREATMENT PLANT
GEOTECHNICAL BOREHOLE LOCATION PLAN SHT. 9 OF 17

DWG NO. USAG-EC-CDBOR-00-000010-000 REV. 0

USAG-EC-CDBOR-00-000011-000



NOTES:

1. SEE DRAWING USAG-EC-CDBOR-00-C00001-000 FOR GEVERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS USAG-EC-CDBOR-00-000001, 000010, 000012 AND 000013.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.

LEGEND:

BOREHOLE LOCATION (BH)

BOREHOLE LOCATIONS			
BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-10-1	5969439	1816805	
BH-10-2	5970379	1815788	
BH-10-3	5969533	1816380	THERMISTOR
BH-10-4	5968807	1816889	

TRUE NORTH
PLANT NORTH
15°0'0"

100 0 100 200
1" = 100' H

REVISION APPROVAL RECORD			REV.			REVISIONS				DRAWING STATUS					PROJECT NO. 91496		Alaska LNG
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE	REV	DATE	BY	CHKD	ISSUED	REV	DATE	CHKD	APPD	DRAWN dmm 5/24/16		BP Energy Development Corp. 6881 S. Holly Cir. Englewood, CO 80112 (303) 644-2080 AECOM
ARCH.			MECHANICAL			0	5/24/16	DMM	JDG	PRELIMINARY	0	5/24/16	Act	JER	CHECKED Act 5/24/16		GAS TREATMENT PLANT
CIVIL			NUCLEAR				ISSUED FOR REVIEW								CONFIDENTIAL		GEOTECHNICAL BOREHOLE
ELECTRICAL			PIPING				ISSUED FOR USE			APPROVED FOR CONSTRUCTION					PRE-FEED PHASE		LOCATION PLAN SHT. 10 OF 17
ENVIRON.			PROCESS							NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REV NO.					SCALE 1"=100'		DWG NO. USAG-EC-CDBOR-00-000011-000 REV. 0
GEN. ARRANG.			QA / QC														
HVAC			STRUCTURAL	Act	5/24/16												
I & C																	

USAG-EC-CDBOR-00-000012-000

NOTES:

1. SEE DRAWING USAG-EC-CDBOR-00-C00001-000 FOR GENERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS USAG-EC-CDBOR-00-000001, 000011 AND 000013.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.

LEGEND:

BOREHOLE LOCATION (BH)

BOREHOLE LOCATIONS

BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-11-1	5969696	1817852	RESISTIVITY TEST, THERMISTOR
BH-11-2	5969930	1818723	RESISTIVITY TEST, THERMISTOR
BH-11-3	5969429	1818391	
BH-11-4	5969094	1818481	
BH-11-5	5968908	1817456	

PLANT NORTH
TRUE NORTH
15°0'0"

100 0 100 200
1" = 100' H

REVISION APPROVAL RECORD

DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
ARCH.			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON.			PROCESS		
GEN. ARRANG.			QA / QC		
HVAC			STRUCTURAL	Act	5/24/16
I & C					

REV. | DATE | REVISIONS | BY | CHKD | APPD
A | 5/5/16 | ISSUED FOR REVIEW | DMM | JDD | ACT
0 | | ISSUED FOR USE | dmm | Act | ACT

DRAWING STATUS

ISSUED	REV.	DATE	DRF	PCM
PRELIMINARY	0	5/24/16	Act	ACT
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REV NO.

PROJECT NO. 61404
DRAWN dmm DATE 5/24/16
CHECKED Act DATE 5/24/16
CONFIDENTIAL
PRE-FEED PHASE
SCALE 1"=100'

Alaska LNG™

BP ENERGY E CONSTRUCTION Nos = the AECOM Company, 5901 S. Havana St. Englewood, CO 80112 (303) 843-2000

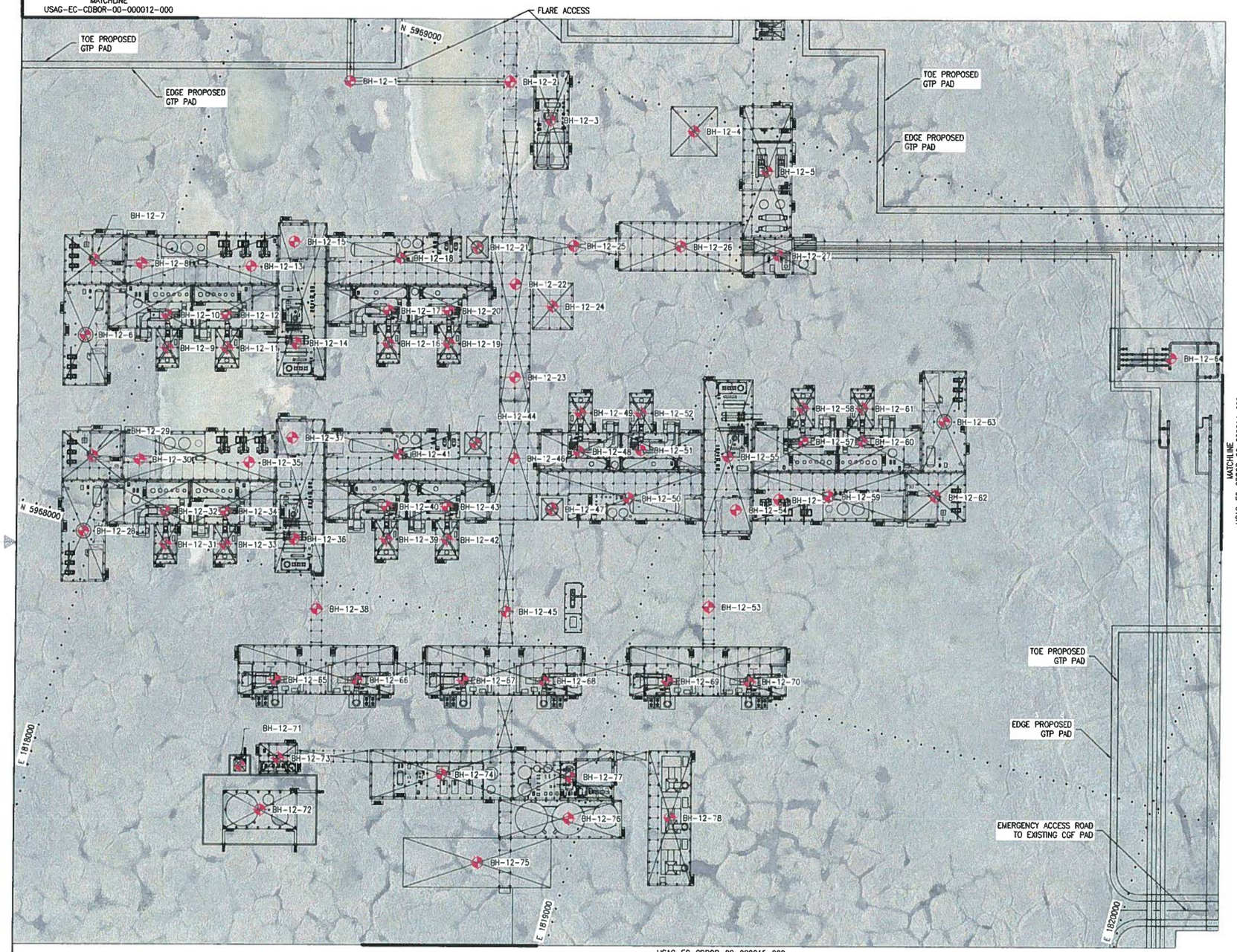
AECOM

GAS TREATMENT PLANT
GEOTECHNICAL BOREHOLE
LOCATION PLAN SHT. 11 OF 17

DWG NO. USAG-EC-CDBOR-00-000012-000 REV 0

INCHES 1 2 3 CENTIMETERS

USAG-EC-CDBOR-00-000013-000



BOREHOLE LOCATIONS			
BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-12-1	5968892	1818233	
BH-12-2	5968968	1818515	
BH-12-3	5968920	1818606	RESISTIVITY TEST, THERMISTOR
BH-12-4	5968969	1818863	RESISTIVITY TEST
BH-12-5	5968934	1819012	RESISTIVITY, CROSS HOLE TESTS
BH-12-6	5968320	1817890	RESISTIVITY TEST
BH-12-7	5968456	1817869	RESISTIVITY TEST, THERMISTOR
BH-12-8	5968472	1817954	RESISTIVITY TEST
BH-12-9	5968336	1818041	
BH-12-10	5968394	1818025	CROSS HOLE TEST
BH-12-11	5968364	1818146	THERMISTOR
BH-12-12	5968422	1818130	RESISTIVITY TEST
BH-12-13	5968519	1818148	
BH-12-14	5968406	1818265	
BH-12-15	5968583	1818212	RESISTIVITY TEST, THERMISTOR
BH-12-16	5968450	1818428	
BH-12-17	5968508	1818413	
BH-12-18	5968606	1818408	RESISTIVITY TEST
BH-12-19	5968478	1818534	
BH-12-20	5968536	1818519	RESISTIVITY, CROSS HOLE TESTS
BH-12-21	5968661	1818538	
BH-12-22	5968615	1818524	
BH-12-23	5968450	1818568	
BH-12-24	5968594	1818700	
BH-12-25	5968710	1818708	
BH-12-26	5968760	1818895	RESISTIVITY TEST, THERMISTOR
BH-12-27	5968791	1819073	THERMISTOR
BH-12-28	5967974	1817983	RESISTIVITY
BH-12-29	5968111	1817962	RESISTIVITY TEST, THERMISTOR
BH-12-30	5968127	1818046	
BH-12-31	5967990	1818134	
BH-12-32	5968048	1818118	CROSS HOLE TEST
BH-12-33	5968018	1818239	
BH-12-34	5968076	1818223	RESISTIVITY TEST
BH-12-35	5968174	1818241	THERMISTOR
BH-12-36	5968060	1818358	
BH-12-37	5968237	1818305	RESISTIVITY TEST, THERMISTOR
BH-12-38	5967948	1818432	THERMISTOR
BH-12-39	5968104	1818521	
BH-12-40	5968162	1818505	
BH-12-41	5968260	1818501	
BH-12-42	5968132	1818627	
BH-12-43	5968190	1818612	RESISTIVITY, CROSS HOLE TESTS
BH-12-44	5968316	1818530	THERMISTOR
BH-12-45	5968034	1818766	
BH-12-46	5968307	1818706	
BH-12-47	5968236	1818798	
BH-12-48	5968351	1818819	CROSS HOLE TEST
BH-12-49	5968420	1818801	
BH-12-50	5968292	1818927	RESISTIVITY TEST, THERMISTOR
BH-12-51	5968383	1818925	
BH-12-52	5968448	1818908	RESISTIVITY TEST, THERMISTOR
BH-12-53	5968139	1819121	THERMISTOR
BH-12-54	5968323	1819121	RESISTIVITY TEST
BH-12-55	5968413	1819081	THERMISTOR

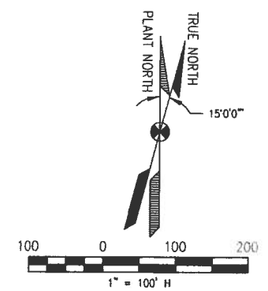
NOTES:

1. SEE DRAWING USAG-EC-CDBOR-00-000001-000 FOR GENERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS USAG-EC-CDBOR-00-000001, 000012, 000014 AND 000015.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.

LEGEND:

BOREHOLE LOCATION (BH)

BOREHOLE LOCATIONS			
BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-12-56	5968362	1819193	
BH-12-57	5968476	1819206	
BH-12-58	5968534	1819190	RESISTIVITY TEST, THERMISTOR
BH-12-59	5968391	1819279	
BH-12-60	5968504	1819311	CROSS HOLE TEST
BH-12-61	5968562	1819295	
BH-12-62	5968442	1819467	RESISTIVITY TEST
BH-12-63	5968578	1819446	RESISTIVITY TEST, THERMISTOR
BH-12-64	5968798	1819815	
BH-12-65	5967804	1818394	RESISTIVITY, CROSS HOLE TESTS
BH-12-66	5967842	1818537	
BH-12-67	5967893	1818725	
BH-12-68	5967931	1818868	CROSS HOLE TEST
BH-12-69	5967989	1819085	RESISTIVITY TEST
BH-12-70	5968027	1819228	CROSS HOLE TEST
BH-12-71	5967637	1818373	
BH-12-72	5967568	1818430	THERMISTOR
BH-12-73	5967667	1818437	RESISTIVITY TEST
BH-12-74	5967717	1818732	RESISTIVITY TEST
BH-12-75	5967580	1818839	RESISTIVITY TEST, THERMISTOR
BH-12-76	5967701	1818978	
BH-12-77	5967774	1818961	RESISTIVITY TEST
BH-12-78	5967750	1819155	RESISTIVITY TEST, THERMISTOR



REVISION APPROVAL RECORD					
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
ARCH.			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON.			PROCESS		
GEN. ARRANG.			QA / QC		
HVAC			STRUCTURAL	Ael	5/24/16
I & C					

REV NO	DATE	REVISIONS	BY CHK'R	ENGR'G APPR'D BY
A	5/5/16	ISSUED FOR REVIEW	DMM	JDG
0	5/24/16	ISSUED FOR USE	dmm	Ael

DRAWING STATUS				
ISSUED	REV	DATE	SDE	PEM
PRELIMINARY	0	5/24/16	Ael	AEL
APPROVED FOR CONSTRUCTION				
NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REV NO.				

PROJECT NO. 61494
DRAWN dmm DATE 5/24/16
CHECKED Ael DATE 5/24/16
CONFIDENTIAL
PRE-FEED PHASE
SCALE 1"=100'

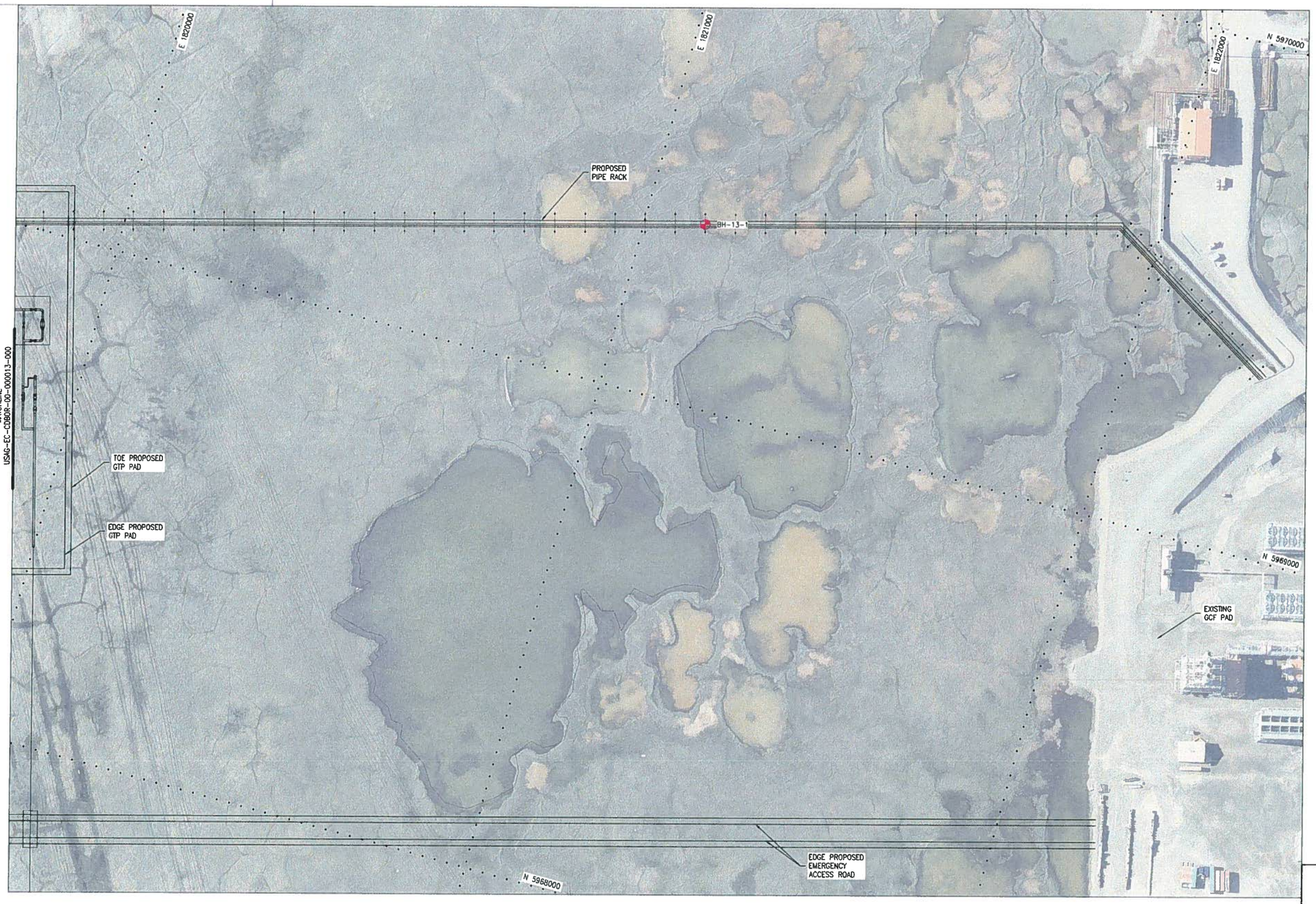
Alaska LNG™

ENERGY & CONSTRUCTION JV
AECOM
8901 Heywood St.
Englewood, CO 80112
(303) 843-2000

GAS TREATMENT PLANT
GEOTECHNICAL BOREHOLE
LOCATION PLAN SHT. 12 OF 17

DWG NO. USAG-EC-CDBOR-00-000013-000 REV. 0

USAG-EC-CDBOR-00-000014-000



NOTES:

1. SEE DRAWING USAG-EC-CDBOR-00-000001-000 FOR GENERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS USAG-EC-CDBOR-00-000001 AND 000013.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.

LEGEND:

BOREHOLE LOCATION (BH)

BOREHOLE LOCATIONS

BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-13-1	5969359	1821119	

PLANT NORTH
TRUE NORTH
15°0'0"

100 0 100 200
1" = 100' H

REVISION APPROVAL RECORD					
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
ARCH			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON.			PROCESS		
GEN. ARRANG.			QA / QC		
HVAC			STRUCTURAL	ACT	5/24/16
I & C					

REVISIONS				
PLAN SET	DATE		BY	CHKR
A	5/5/16	ISSUED FOR REVIEW	DMM	JDG
0	5/24/16	ISSUED FOR USE	dmm	ACT PER

DRAWING STATUS				
ISSUED	REV	DATE	SDE	PEM
PRELIMINARY	0	5/24/16	ACT	PER
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED DESTROY ALL PRINTS BEARING EARLIER DATE AND OR REV NO

PROJECT NO: 31409
DRAWN: dmm DATE: 5/24/16
CHECKED: ACT DATE: 5/24/16
CONFIDENTIAL
PRE-FEED PHASE
SCALE: 1"=100'

Alaska LNG™

UPS ENERGY & CONSTRUCTION INC - AN AECOM Company
8401 S. Havana St
Englewood CO 80112
(303) 843-2000

AECOM

GAS TREATMENT PLANT
GEOTECHNICAL BOREHOLE
LOCATION PLAN SHT. 13 OF 17

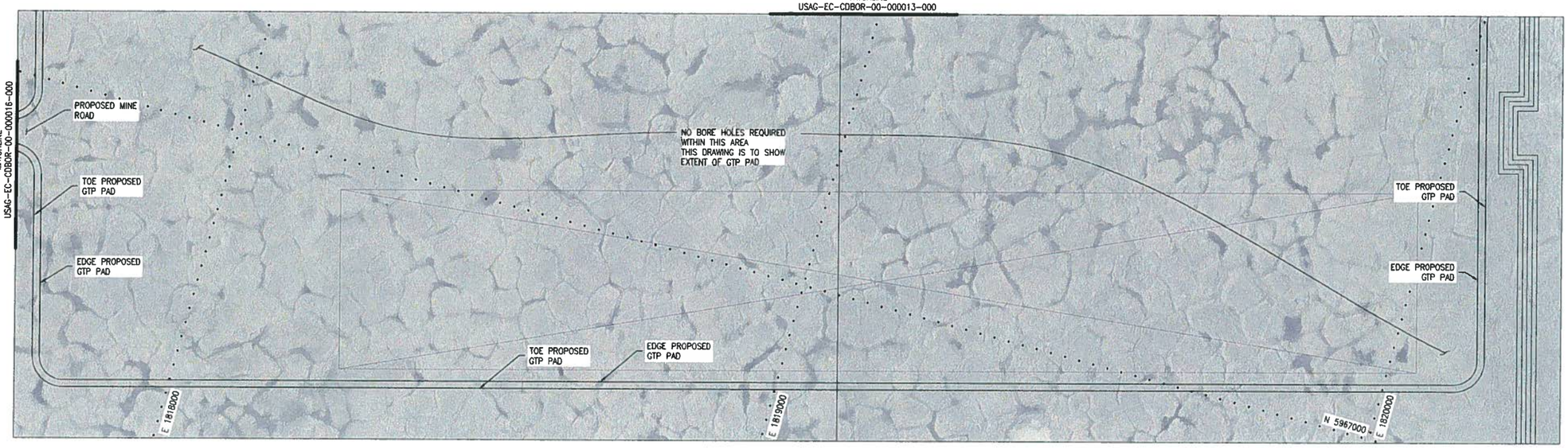
DWG NO: USAG-EC-CDBOR-00-000014-000 REV: 0

INCHES 1 2 CENTIMETERS

USAG-EC-CDBOR-00-000015-000

MATCHLINE
USAG-EC-CDBOR-00-000013-000

MATCHLINE
USAG-EC-CDBOR-00-000016-000

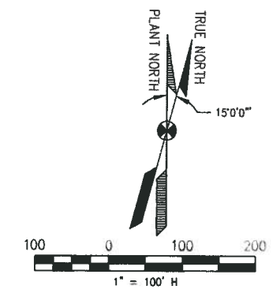


NOTES:

1. SEE DRAWING USAG-EC-CDBOR-00-000001-000 FOR GENERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS USAG-EC-CDBOR-00-000001, 000013 AND 000016.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.

LEGEND:

BOREHOLE LOCATION (BH)



REVISION APPROVAL RECORD

DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
ARCH.			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON.			PROCESS		
GEN. ARRANG			QA / QC		
HVAC			STRUCTURAL	Acb	5/24/16
I & C					

REV	DATE	REVISIONS	BY CHKR APPD
A	5/5/16	ISSUED FOR REVIEW	DMM JDG
0	5/24/16	ISSUED FOR USE	dmm Acb PCR

DRAWING STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY	0	5/24/16	Acb	
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REVISION.

PROJECT NO.
21109

DRWN dmm DATE 5/24/16
CHKD Acb DATE 5/24/16

CONFIDENTIAL
PRE-FEED PHASE

SCALE 1"=100'

DWG NO. USAG-EC-CDBOR-00-000015-000 REV 0

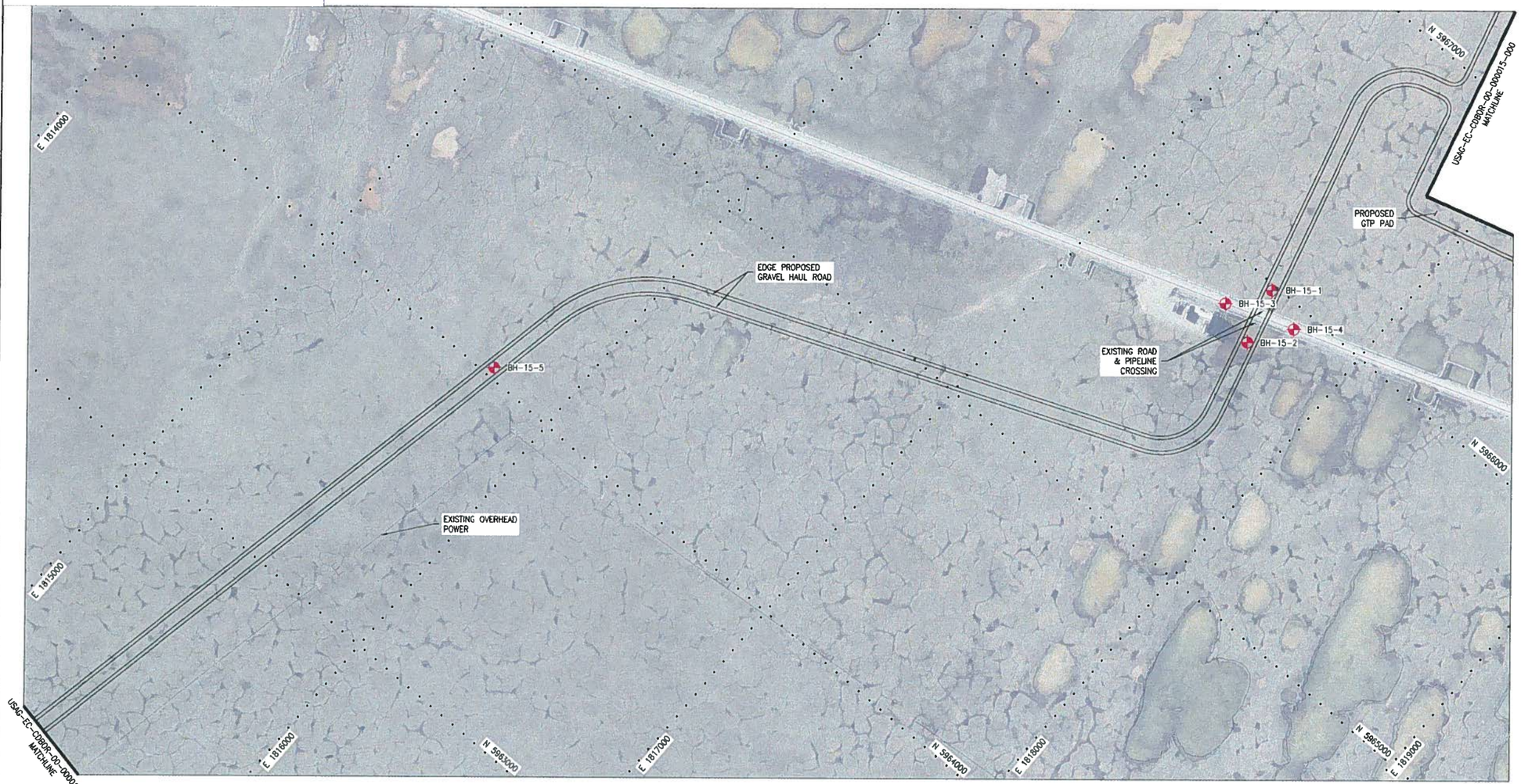
Alaska LNG™

URS ENERGY & CONSTRUCTION INC - AN AECOM Company
6901 S. Havana St.
Englewood, CO 80112
(303) 843-2000

AECOM

GAS TREATMENT PLANT
GEOTECHNICAL BOREHOLE
LOCATION PLAN SHT. 14 OF 17

USAG-EC-CDBOR-00-000016-000



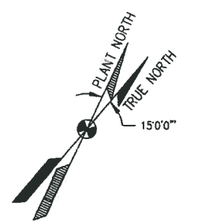
NOTES:

1. SEE DRAWING USAG-EC-CDBOR-00-000001-000 FOR GENERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS. USAG-EC-CDBOR-00-000001, 000015 AND 000017.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.

LEGEND:

BOREHOLE LOCATION (BH)

BOREHOLE LOCATIONS			
BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-15-1	5965982	1817616	
BH-15-2	5965788	1817668	THERMISTOR
BH-15-3	5965843	1817523	
BH-15-4	5965927	1817761	
BH-15-5	5964035	1815731	



200 0 200 400
1" = 200' H

REVISION APPROVAL RECORD			REV			REVISIONS				
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE	REV	DATE	ISSUED FOR REVIEW	BY	APP'D
APCH			MECHANICAL			0	5/3/16	ISSUED FOR USE	dmm	Ket
CIVIL			NUCLEAR			1	5/24/16			
ELECTRICAL			PIPING							
ENVIRON			PROCESS							
GEN ARRANG			QA / QC							
HVAC			STRUCTURAL	Ket	5/24/16					
I & C										

DRAWING STATUS	REV	DATE	CDE	PEM
ISSUED PRELIMINARY	0	5/24/16	Ket	
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED (BESIDE) ALL PRINTS BEARING EARLIER DATE AND/OR REVISION.

PROJECT NO# 31409
DRAWN dmm 5/24/16
DESIGN Ket 5/24/16
CONFIDENTIAL
PRE-FEED PHASE
SCALE 1"=200'

Alaska LNG™

ARS ENERGY & CONSTRUCTION INC. an AECOM Company
3900 C Hawaii St.
Anchorage, AK 99503
(907) 343-3000
AECOM

GAS TREATMENT PLANT
GEOTECHNICAL BOREHOLE
LOCATION PLAN SHT. 15 OF 17

DWG NO. USAG-EC-CDBOR-00-000016-000 REV 0

USAG-EC-CDBOR-00-000017-000

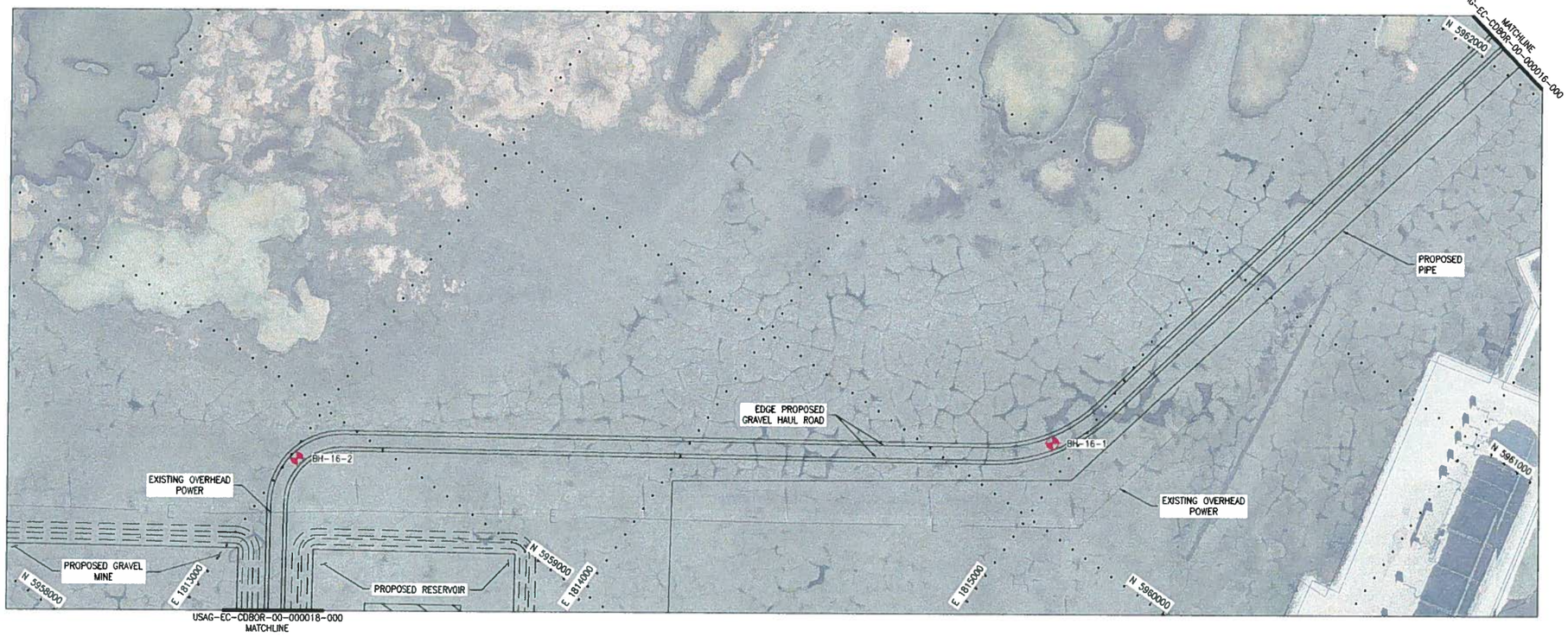
NOTES:

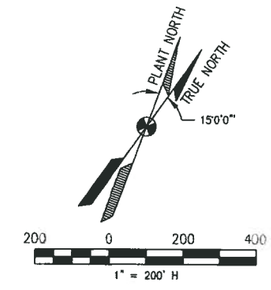
1. SEE DRAWING USAG-EC-CDBOR-00-000001-000 FOR GENERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS. USAG-EC-CDBOR-00-000001, 000016 AND 000018.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.

LEGEND:

BOREHOLE LOCATION (BH)

BOREHOLE LOCATIONS			
BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-16-1	5960233	1814930	THERMISTOR
BH-16-2	5958824	1813022	





REVISION APPROVAL RECORD			REV		
DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
APCH			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON			PROCESS		
GEN ARRANG			QA / QC		
HVAC			STRUCTURAL	Ket	5/24/16
I & C					

NO	DATE	REVISIONS	REV ENGINEER	BY
A	5/5/16	ISSUED FOR REVIEW	DMM	JDG
0	5/24/16	ISSUED FOR USE	dmm	RCR

DRAWING STATUS				
ISSUED	REV	DATE	SME	PEM
PRELIMINARY	0	5/24/16	Ket	RCR
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REV NO

PROJECT NO. 31409

DRAWN: dmm DATE: 5/24/16

CHECKED: Ket DATE: 5/24/16

CONFIDENTIAL
PRE-FEED PHASE

SCALE: 1:200

Alaska LNG™

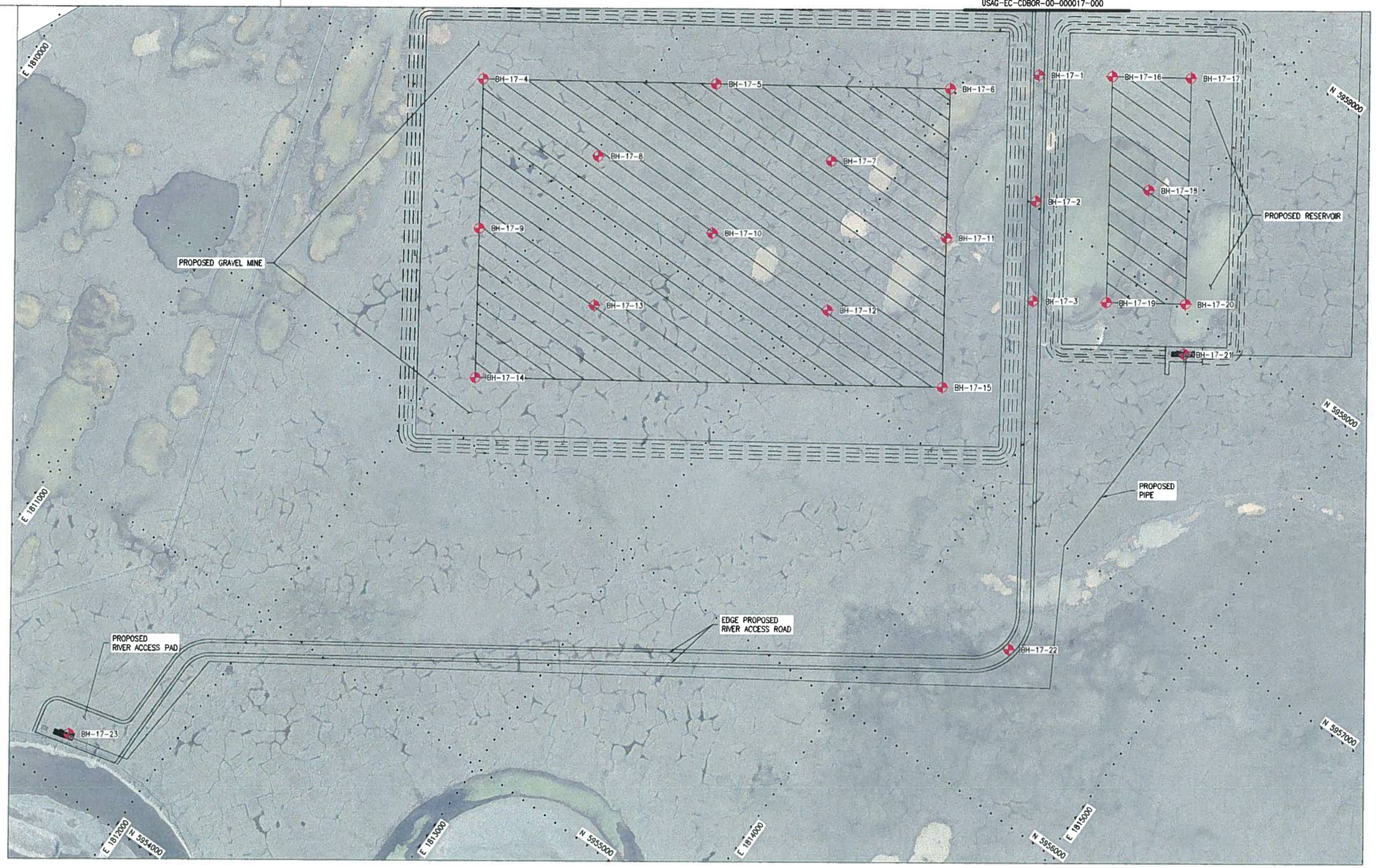
URS ENERGY & CONSTRUCTION INC - AN AECOM Company
5990 Greenwood Plaza Blvd
Englewood CO 80111
(303) 843-2000
AECOM

GAS TREATMENT PLANT
GEOTECHNICAL BOREHOLE
LOCATION PLAN SHT. 16 OF 17

DWG NO. USAG-EC-CDBOR-00-000017-000 REV 0

USAG-EC-CDBOR-00-000018-000

MATCHLINE
USAG-EC-CDBOR-00-000017-000



NOTES:

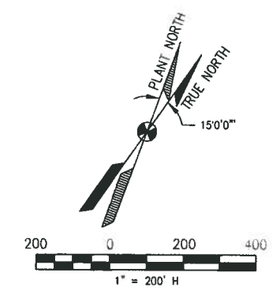
1. SEE DRAWING USAG-EC-CDBOR-00-000001-000 FOR GENERAL NOTES.
2. WORK THIS DRAWING WITH DRAWING NOS USAG-EC-CDBOR-00-000001 AND 000017.
3. SEE TABLE FOR RESISTIVITY, THERMISTOR AND SEISMIC CROSS HOLE TEST LOCATIONS.

LEGEND:

BOREHOLE LOCATION (BH)

BOREHOLE LOCATIONS

BOREHOLE	NORTHING	EASTING	ADDITIONAL TEST
BH-17-1	5958419	1813225	
BH-17-2	5958016	1813498	
BH-17-3	5957698	1813712	
BH-17-4	5957169	1811483	
BH-17-5	5957673	1812229	
BH-17-6	5958177	1812974	
BH-17-7	5957687	1812762	
BH-17-8	5957183	1812017	
BH-17-9	5956693	1811805	
BH-17-10	5957197	1812550	
BH-17-11	5957701	1813296	
BH-17-12	5957210	1813084	
BH-17-13	5956707	1812339	
BH-17-14	5956216	1812127	
BH-17-15	5957224	1813618	
BH-17-16	5958576	1813458	
BH-17-17	5958747	1813710	
BH-17-18	5953301	1813827	
BH-17-19	5957855	1813945	
BH-17-20	5958026	1814197	
BH-17-21	5957866	1814305	RESISTIVITY TEST
BH-17-22	5955551	1814416	
BH-17-23	5954195	1811648	RESISTIVITY TEST, THERMISTOR



REVISION APPROVAL RECORD

DISCIPLINE	BY	DATE	DISCIPLINE	BY	DATE
APEN			MECHANICAL		
CIVIL			NUCLEAR		
ELECTRICAL			PIPING		
ENVIRON			PROCESS		
GEN ARRANG			QA / QC		
HVAC			STRUCTURAL	Ael	5/24/16
I & C					

REVISIONS

REV	DATE	ISSUED FOR REVIEW	BY	APPROVED
A	5/5/16	ISSUED FOR REVIEW	dmm	RCR
0	5/24/16	ISSUED FOR USE	dmm	RCR

DRAWING STATUS

ISSUED	REV	DATE	SDE	PDM
PRELIMINARY	0	5/24/16	Ael	AER
APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. RESIEDY ALL PERMIT HEARING EARLIER DATE AND/OR REVIEW

PROJECT NO.
31409

DRWN: dmm 5/24/16
DSGN: Ael 5/24/16
CHKD:
APPD:

CONFIDENTIAL
PRE-FEED PHASE

SCALE: 1"=200'

Alaska LNG™

UPS ENERGY & CONSTRUCTION Inc. dba AECOM Company
6300 S Havana St
Englewood CO 80112
303 843-2000

AECOM

GAS TREATMENT PLANT
GEOTECHNICAL BOREHOLE
LOCATION PLAN SHT. 17 OF 17

DWG NO. USAG-EC-CDBOR-00-000018-000 REV 0

APPENDIX 13K – MARINE SYSTEMS

This Appendix is not applicable to the GTP.

APPENDIX 13L – LNG TANK INFORMATION

This Appendix is not applicable to the GTP.

*M.1 – Piping and Valve List**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*M.2 – Tie-In List**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

M.5 – Manufacturer's Data

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

M.6 – List of Buildings and Structures

Document Number:	Description:	Revision:	Appendix:
AKLNG-4010-AAA-LIS-DOC-00001	List of Buildings and Structures	0	Public

Alaska LNG™

CH·IV
THE LNG SPECIALISTS

ALASKA LNG PROJECT - GTP BUILDINGS AND ENCLOSED PROCESS MODULES LIST

AKLNG-4010-AAA-LIS-DOC-00001

Alaska LNG

GTP Buildings and Enclosed Process Modules List

by

CH·IV
THE LNG SPECIALISTS

Rev No.	Issue Purpose:	Date:	By	CHK	APP
A	For Client Review	March 20, 2017	PKS	JZZ	PJS
0	Issued for Information	April 3, 2017	PKS	JZZ	PJS

GTP Buildings and Enclosed Process Modules List

Document Number: 14806-LI-000-010
Project Name: Alaska LNG

Date: 3/20/2017
Revision: A

Tag Number	Plot Plan Location	Description	Dimensions (ft, L x W x H)	Occupancy	Special Features
0A	USAG-EC-LDLAY-00-001006-000	COMMUNICATIONS BUILDING	TBD	Occupied	
0R	USAG-EC-LDLAY-00-001006-000	INTEGRATED HOUSING UTILITIES	190 x 63 x 70	Unoccupied	
0S	USAG-EC-LDLAY-00-001006-000	INTEGRATED HOUSING UTILITIES	162 x 63 x 70	Unoccupied	
0T	USAG-EC-LDLAY-00-001006-000	HYDROCARBON HOLDING TANK	22 x 22 x 28	Unoccupied	
0U	USAG-EC-LDLAY-00-001006-000	INTEGRATED HOUSING UTILITIES	162 x 63 x 70	Unoccupied	
1A	USAG-EC-LDLAY-00-001006-000	ABSORBER TOWER BASE (TRAIN 1)	40 x 40 x 13	Unoccupied	
1B	USAG-EC-LDLAY-00-001006-000	AGRU ABSORBER/FLASH DRUM (TRAIN 1)	300 x 90 x 113	Unoccupied	
1C	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION (TRAIN 1)	150 x 70 x 113	Unoccupied	
1D	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION STACK AND HRU (TRAIN 1)	73 x 42.5 x N/A	Unoccupied	
1E	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION (TRAIN 1)	150 x 70 x 113	Unoccupied	
1F	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION STACK AND HRU (TRAIN 1)	73 x 42.5 x N/A	Unoccupied	
1G	USAG-EC-LDLAY-00-001006-000	CO2 & TREATED GAS DEHYDRATION (TRAIN 1)	280 x 90 x 113	Unoccupied	
1H	USAG-EC-LDLAY-00-001006-000	AGRU LEAN/RICH EXCHANGER (TRAIN 1)	280 x 90 x 113	Unoccupied	
1I	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION (TRAIN 1)	155 x 80 x 113	Unoccupied	
1J	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION STACK AND HRU (TRAIN 1)	73 x 42.5 x N/A	Unoccupied	
1K	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION (TRAIN 1)	155 x 80 x 113	Unoccupied	
1L	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION STACK AND HRU (TRAIN 1)	73 x 42.5 x N/A	Unoccupied	
1M	USAG-EC-LDLAY-00-001006-000	PROCESS HEAT MEDIUM (TRAIN 1)	110 x 90 x 113	Unoccupied	
1N	USAG-EC-LDLAY-00-001006-000	AGRU REGENERATION (TRAIN 1)	185 x 80 x 178	Unoccupied	
1P	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION AIR INTAKE (TRAIN 1)	30 x 24 x 43	Unoccupied	
1Q	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION AIR INTAKE (TRAIN 1)	30 x 24 x 43	Unoccupied	
1R	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION AIR INTAKE (TRAIN 1)	30 x 24 x 43	Unoccupied	
1S	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION AIR INTAKE (TRAIN 1)	30 x 24 x 43	Unoccupied	
1T	USAG-EC-LDLAY-00-001006-000	MAIN PIPE RACK W/ BATTERY LIMIT VALVES (TRAIN 1)	218 x 90 x 113	Unoccupied	
2A	USAG-EC-LDLAY-00-001006-000	ABSORBER TOWER BASE (TRAIN 2)	40 x 40 x 13	Unoccupied	
2B	USAG-EC-LDLAY-00-001006-000	AGRU ABSORBER/FLASH DRUM (TRAIN 2)	300 x 90 x 113	Unoccupied	
2C	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION (TRAIN 2)	150 x 70 x 113	Unoccupied	
2D	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION STACK AND HRU (TRAIN 2)	73 x 42.5 x N/A	Unoccupied	
2E	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION (TRAIN 2)	150 x 70 x 113	Unoccupied	
2F	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION STACK AND HRU (TRAIN 2)	73 x 42.5 x N/A	Unoccupied	
2G	USAG-EC-LDLAY-00-001006-000	CO2 & TREATED GAS DEHYDRATION (TRAIN 2)	280 x 90 x 113	Unoccupied	
2H	USAG-EC-LDLAY-00-001006-000	AGRU LEAN/RICH EXCHANGER (TRAIN 2)	280 x 90 x 113	Unoccupied	
2I	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION (TRAIN 2)	155 x 80 x 113	Unoccupied	
2J	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION STACK AND HRU (TRAIN 2)	73 x 42.5 x N/A	Unoccupied	
2K	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION (TRAIN 2)	155 x 80 x 113	Unoccupied	
2L	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION STACK AND HRU (TRAIN 2)	73 x 42.5 x N/A	Unoccupied	

GTP Buildings and Enclosed Process Modules List

Document Number: 14806-LI-000-010
Project Name: Alaska LNG

Date: 3/20/2017
Revision: A

Tag Number	Plot Plan Location	Description	Dimensions (ft, L x W x H)	Occupancy	Special Features
2M	USAG-EC-LDLAY-00-001006-000	PROCESS HEAT MEDIUM (TRAIN 2)	110 x 90 x 113	Unoccupied	
2N	USAG-EC-LDLAY-00-001006-000	AGRU REGENERATION (TRAIN 2)	185 x 80 x 178	Unoccupied	
2P	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION AIR INTAKE (TRAIN 2)	30 x 24 x 43	Unoccupied	
2Q	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION AIR INTAKE (TRAIN 2)	30 x 24 x 43	Unoccupied	
2R	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION AIR INTAKE (TRAIN 2)	30 x 24 x 43	Unoccupied	
2S	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION AIR INTAKE (TRAIN 2)	30 x 24 x 43	Unoccupied	
3A	USAG-EC-LDLAY-00-001006-000	ABSORBER TOWER BASE (TRAIN 3)	40 x 40 x 13	Unoccupied	
3B	USAG-EC-LDLAY-00-001006-000	AGRU ABSORBER/FLASH DRUM (TRAIN 3)	300 x 90 x 113	Unoccupied	
3C	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION (TRAIN 3)	150 x 70 x 113	Unoccupied	
3D	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION STACK AND HRU (TRAIN 3)	73 x 42.5 x N/A	Unoccupied	
3E	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION (TRAIN 3)	150 x 70 x 113	Unoccupied	
3F	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION STACK AND HRU (TRAIN 3)	73 x 42.5 x N/A	Unoccupied	
3G	USAG-EC-LDLAY-00-001006-000	CO2 & TREATED GAS DEHYDRATION (TRAIN 3)	280 x 90 x 113	Unoccupied	
3H	USAG-EC-LDLAY-00-001006-000	AGRU LEAN/RICH EXCHANGER (TRAIN 3)	280 x 90 x 113	Unoccupied	
3I	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION (TRAIN 3)	155 x 80 x 113	Unoccupied	
3J	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION STACK AND HRU (TRAIN 3)	73 x 42.5 x N/A	Unoccupied	
3K	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION (TRAIN 3)	155 x 80 x 113	Unoccupied	
3L	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION STACK AND HRU (TRAIN 3)	73 x 42.5 x N/A	Unoccupied	
3M	USAG-EC-LDLAY-00-001006-000	PROCESS HEAT MEDIUM (TRAIN 3)	110 x 90 x 113	Unoccupied	
3N	USAG-EC-LDLAY-00-001006-000	AGRU REGENERATION (TRAIN 3)	185 x 80 x 178	Unoccupied	
3P	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION AIR INTAKE (TRAIN 3)	30 x 24 x 43	Unoccupied	
3Q	USAG-EC-LDLAY-00-001006-000	CO2 GAS COMPRESSION AIR INTAKE (TRAIN 3)	30 x 24 x 43	Unoccupied	
3R	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION AIR INTAKE (TRAIN 3)	30 x 24 x 43	Unoccupied	
3S	USAG-EC-LDLAY-00-001006-000	TREATED GAS COMPRESSION AIR INTAKE (TRAIN 3)	30 x 24 x 43	Unoccupied	
3T	USAG-EC-LDLAY-00-001006-000	MAIN PIPE RACK W/ BATTERY LIMIT VALVES (TRAIN 3)	300 x 70 x 113	Unoccupied	
3U	USAG-EC-LDLAY-00-001006-000	MAIN PIPE RACK EXPANSION LOOP	85 x 75 x 67	Unoccupied	
5A	USAG-EC-LDLAY-00-001006-000	PTU GAS INLET K.O. DRUM	135 x 67.5 x 40	Unoccupied	
5B	USAG-EC-LDLAY-00-001006-000	REFRIGERATION COMPRESSOR & CHILLERS	240 x 90 x 104	Unoccupied	
5C	USAG-EC-LDLAY-00-001006-000	ELECTRICAL SWITCHGEAR FOR REFRIGERATION	85 x 90 x 85	Unoccupied	
5D	USAG-EC-LDLAY-00-001006-000	HP/LP FLARE KO DRUMS	180 x 65 x 87	Unoccupied	
5E	USAG-EC-LDLAY-00-001006-000	FUEL GAS HEATERS	54 x 38 x 17	Unoccupied	
5G	USAG-EC-LDLAY-00-001006-000	PROPANE CONDENSORS & TREATED GAS PIPERACK	225 x 90 x 89	Unoccupied	
5H	USAG-EC-LDLAY-00-001006-000	TREATED GAS PIPE RACK	162.5 x 30 x 80	Unoccupied	
5J	USAG-EC-LDLAY-00-001006-000	ELECTRICAL RACK	50 x 10 x 25	Unoccupied	
5K	USAG-EC-LDLAY-00-001006-000	TREATED GAS/OUTLET METERING	TBD	Unoccupied	
5L	USAG-EC-LDLAY-00-001006-000	FLARE PIPERACK	200 x 25 x 60	Unoccupied	
5M	USAG-EC-LDLAY-00-001006-000	WEST FLARE STACKS	TBD	Unoccupied	
5N	USAG-EC-LDLAY-00-001006-000	EAST FLARE STACKS	TBD	Unoccupied	
5P.1	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
5P.2	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
5T	USAG-EC-LDLAY-00-001006-000	WEST FLARE BLOWCASE	27 x 13 x 5	Unoccupied	
5U	USAG-EC-LDLAY-00-001006-000	EAST FLARE BLOWCASE	27 x 13 x 5	Unoccupied	
5V	USAG-EC-LDLAY-00-001006-000	SOUTH FLARE EXPANSION LOOP	85 x 75 x 17	Unoccupied	
5W	USAG-EC-LDLAY-00-001006-000	NORTHWEST FLARE EXPANSION LOOP	85 x 75 x 17	Unoccupied	
5X	USAG-EC-LDLAY-00-001006-000	NORTHEAST FLARE EXPANSION LOOP	85 x 75 x 17	Unoccupied	
6A	USAG-EC-LDLAY-00-001006-000	UTILITY PIPERACK W/ UTILIDOR	100 x 25 x 57	Unoccupied	
6B	USAG-EC-LDLAY-00-001006-000	UTILITY PIPERACK W/ UTILIDOR	132.5 x 20 x 52	Unoccupied	
6C	USAG-EC-LDLAY-00-001006-000	STORAGE TANK PUMPS & FILTERS	70 x 55 x 62	Unoccupied	
6D	USAG-EC-LDLAY-00-001006-000	AGRU & TEG STORAGE TANKS	135 x 70 x 81	Unoccupied	
6E	USAG-EC-LDLAY-00-001006-000	DIESEL STORAGE TANK	22 x 22 x 45	Unoccupied	
6F	USAG-EC-LDLAY-00-001006-000	RAW WATER	225 x 70 x 73	Unoccupied	
6G	USAG-EC-LDLAY-00-001006-000	WATER TREATMENT	185 x 90 x 59	Unoccupied	

GTP Buildings and Enclosed Process Modules List

Document Number: 14806-LI-000-010
Project Name: Alaska LNG

Date: 3/20/2017
Revision: A

Tag Number	Plot Plan Location	Description	Dimensions (ft, L x W x H)	Occupancy	Special Features
6H	USAG-EC-LDLAY-00-001006-000	UTILITIES	260 x 90 x 87	Unoccupied	
6I	USAG-EC-LDLAY-00-001006-000	UTILITY PIPERACK W/ UTILIDOR	63 x 15 x 34	Unoccupied	
6J	USAG-EC-LDLAY-00-001006-000	HEAT MEDIUM UTILITIES HEATERS	245 x 78 x XX	Unoccupied	
6P	USAG-EC-LDLAY-00-001006-000	CONTROL ROOM/OPERATIONS CENTER	245 x 90 x 36	Occupied	Blast-resistant
6Q.1	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
6Q.2	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
7A	USAG-EC-LDLAY-00-001006-000	WATER RESERVOIR PUMP	92 x 18 x 34	Unoccupied	
7B	USAG-EC-LDLAY-00-001006-000	PUT RIVER PUMP INTAKE	80 x 20 x 37	Unoccupied	
7C	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	16 x 24 x 25	Unoccupied	
8A	USAG-EC-LDLAY-00-001006-000	POWER GENERATION	286 x 90 x 109	Unoccupied	
8B	USAG-EC-LDLAY-00-001006-000	POWER GENERATION	286 x 90 x 109	Unoccupied	
8C	USAG-EC-LDLAY-00-001006-000	POWER GENERATION	286 x 90 x 109	Unoccupied	
8G	USAG-EC-LDLAY-00-001006-000	UTILITY & ELECTRICAL RACK W/ UTILIDOR	227 x 25 x 57	Unoccupied	
8H	USAG-EC-LDLAY-00-001006-000	UTILITY & ELECTRICAL BRIDGE RACK W/ UTILIDOR	90 x 20 x 18	Unoccupied	
8I	USAG-EC-LDLAY-00-001006-000	ESSENTIAL DIESEL GENERATOR	90 x 31 x 30	Unoccupied	
8J.1	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
8J.2	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
8J.3	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
8J.4	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
8J.5	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
8J.6	USAG-EC-LDLAY-00-001006-000	ELECTRICAL TRANSFORMER	22 x 22 x 25	Unoccupied	
8K	USAG-EC-LDLAY-00-001006-000	UTILITY & ELECTRICAL BRIDGE RACK W/ UTILIDOR	61.5 x 20 x 18	Unoccupied	
8Q	USAG-EC-LDLAY-00-001006-000	POWER GENERATION EXHAUST STACK	27 x 25 x XX	Unoccupied	
8R	USAG-EC-LDLAY-00-001006-000	POWER GENERATION EXHAUST STACK	27 x 25 x XX	Unoccupied	
8S	USAG-EC-LDLAY-00-001006-000	POWER GENERATION EXHAUST STACK	27 x 25 x XX	Unoccupied	
8T	USAG-EC-LDLAY-00-001006-000	POWER GENERATION EXHAUST STACK	27 x 25 x XX	Unoccupied	
8U	USAG-EC-LDLAY-00-001006-000	POWER GENERATION EXHAUST STACK	27 x 25 x XX	Unoccupied	
8V	USAG-EC-LDLAY-00-001006-000	POWER GENERATION EXHAUST STACK	27 x 25 x XX	Unoccupied	

M.7 – Building Siting Analysis

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

N.2 - Transformer List

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

N.4 - Overall Power Distribution Block Diagram

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

N.6 – Electrical Seal Drawings

Document Number:	Description:	Revision:	Appendix:
N/A	Not Applicable to the GTP	N/A	Public

O.1 - Management of Change and Reporting Procedure

Document Number:	Description:	Revision:	Appendix:
USAI-PS-BPMOC-00-000004-000	Management of Change and Reporting Procedure	0	Public

Confidential

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MANAGEMENT OF CHANGE AND REPORTING PROCEDURE

USAI-PS-BPMOC-00-000004-000

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REVISION MODIFICATION LOG

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LIST OF FIGURES

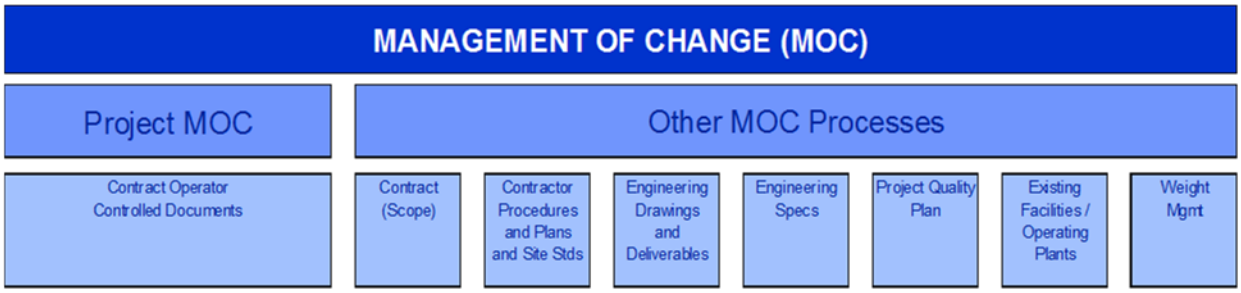
1.0 PURPOSE AND SCOPE

1.1 INTRODUCTION

This document describes the Management of Change (MOC) process from the introduction of the Front End Engineering & Design (FEED) entry, through Execution and Turnover-to-Operations. The MOC Plan explains how project changes to approved design basis, designs, procedures, execution strategies and constructed facilities must be evaluated and managed to ensure Operations Integrity risks arising from these modifications remain at an acceptable level. This plan also defines the areas subject to the Project MOC (PMOC) process, the procedure/processes to be utilized and maintained, as well as the roles, responsibilities, and approval limits for Management of Change. The Alaska LNG (AKLNG) Project Team will utilize this plan with specific emphasis on the FEED Stage and PMOC but will develop updates as the project progresses into Execute Stage.

The Change Coordinator and Project Team should be familiar with the following change processes which fall under Management of Change and which interface with the PMOC process. The Change Coordinator should be proactively engaged with the Project Team to ensure actual project changes that meet PMOC criteria are submitted and processed as PMOC records.

Figure 1: Management of Change Overview



Management of Change embodies many types of change during the project life-cycle. This Management of Change procedure addresses all the processes to manage the different types of change, such as Controlled Documents, drawing revisions, specification changes, scope changes, Contract Change orders, schedule changes, execution/strategy changes, changes in regulations and laws, procedure changes, organization changes, etc.

It should also be noted that changes of all types can occur before and after an approved procedure, design or execution plan are in place. It is not the intent of this procedure to manage design development or execution development before approved designs, plans and procedures are in place, as this would be too burdensome to manage. In production/operating companies with existing facilities, changes are handled through the Operations MOC system. These changes occur to operating plants or organization and these changes to existing facilities or procedures are assessed in order to keep the risks at an acceptable level. Development projects are different because the facilities are usually greenfield in nature and have to be designed and installed prior to ever being put into use. Prior to startup and handover to Operations, there is constant design development, execution development and change. "Management of Change" in the Operator Company is meant to cover those changes to approved or existing conditions mentioned above, not design development. However, as project execution and design basis are still evolving in the Define stage, the main purpose of MOC during this stage is to track cost and schedule impacts caused by design development or changes in project scope / execution

assumptions, and to maximize the opportunities for corrective actions prior to FID (Final Investment Decision).

In order to take full advantage of the systems in place to manage these changes and risks, the Project Management of Change processes interface with numerous other processes, rather than require duplicate risk assessments, approvals and paperwork. These systems are designed to manage the risk appropriately and do not require additional PMOC approvals and reviews. These systems assess the risks internally and seek approval at the appropriate levels.

The Project Management of Change is the formal MOC record for managing [the effects of changes to] the Controlled Documents and procedures on a project. There are other processes that manage other types of change and the associated risks with those changes. This process is consistent with Operator requirements, and describes several related, but independent, procedures required to manage change in a timely and efficient manner. Please see Section **Error! Reference source not found.**, Attachment A**,** and Attachment for an overview of Management of Change and the change processes and procedures.

1.2 OBJECTIVES

The objectives of the MOC Process are to ensure that:

- Changes in operations, procedures, site standards, facilities, or organizations must be evaluated and managed to ensure that Operations Integrity risks arising from these changes remain at an acceptable level.
- Operator requirements for Management of Change are fully implemented meeting all Operator management system and Project Management System guidelines.
- Changes are properly evaluated, approved, and documented so any risks remain at an acceptable level and project objectives are met.
- Appropriate stakeholders, including drilling (as applicable), are involved in the change implementation process in a manner commensurate with the stakeholders' roles in the project.
- Changes are communicated and implemented on a timely basis so that all work is done with consistent, up-to-date project documents.
- Appropriate contractual actions are taken to implement changes in a timely and cost-effective manner.
- Approved changes are effectively implemented, documented, and verified.

1.3 SCOPE

1.3.1 FEED Management of Change (Scope Tracking)

Management of Change involves the systematic tracking of significant changes to the facilities basis and/or the execution strategy and the tracking of smaller changes to provide assurance that the accumulation of these smaller changes is not having a significant impact on cost and / or schedule.

As the project execution and design basis are still evolving in the FEED stage, the main purpose of Management of Change during this stage is to track cost and schedule impacts caused by design development or changes in project scope / execution assumptions, and to maximize the opportunities for timely corrective action during FEED. Management of Change focuses on controlling change for a limited number of Controlled Documents and providing cost transparency to prevent a "blackout" period between FEED entry and Execute Estimates (FID). An effective

Change Management process will have a sound FEED entry basis (facilities, execution, and estimating) and the Project Team (PT) will understand the FEED Entry Estimate details.

Attachment B, PMOC Applicability Table, lists the Controlled Documents at FEED entry which, if changed, require Management of Change and lists other documents or situations which fall under the Scope Tracking and Management process. Periodic review meetings should be held during FEED to confirm PT alignment regarding changes that are being prepared and tracked in the tracking log. Prior to FID, Project Teams can bundle accepted optimization initiatives into one or several PMOCs.

It is recommended that the tracking of these smaller changes is done via a Change Log with a column indicating whether or not a PMOC is required for the change. The process should seek to identify and obtain alignment on major changes on a real time basis and provide cost monitoring between FEED and FID estimates. More details on the PMOC requirements and process during FEED can be found in Section 5.

Changes that affect the following Alaska LNG developed project control documents during FEED stage will require PMOCs. (Also see Attachment B).

1) FEED Project Control Documents - Alaska LNG PT Developed

   Significant impacts from changes to:

   a) Project Objectives and Strategies
   b) Interface and Issues Management Plan
   c) Project Execution Plan
   d) Integrated Project Design Basis–IPDB
   e) Initial Contracting Strategy and Contract Plan (CWBS)
   f) Approved Roadmap Deliverables
   g) Security Model or Plan (as affects reliability of the physical design or technical specifications of the site)

2) FEED Project Control Documents - Contractor Developed

   Significant impacts from changes to:

   a) Approved Plot Plans (Significant revisions to facility layouts, field architecture, pipeline routes)
   b) The decision to not produce AKLNG Project FEED Stage deliverables or changes to the approved facilities design basis, project plan, changes to the Equipment List, significant changes to the IFD (Issued for Design) Plot Plans (e.g. changes in foot print), and modifications affecting Security as described above, would all require a Project MOC.
   c) Revisions to the field architecture, field development plan, production profiles and pressures, compositions, the number and location of wells, injection requirements, etc. all require a PMOC.

   External changes may also impact the project. Changes in government laws/regulations may necessitate a Project MOC. An example would be changing local content requirements. Additionally, changes in Joint Operating Agreements (JOA) or Production Sharing Agreements (PSA), or other commercial agreements may necessitate the development and approval of a PMOC to document the impact, or document actions that the PT chooses to take to address one of these external agreements.

1.3.2 Execute – (FID: Final Investment Decision) to Transfer to Operations Management of Change

After FID during the Execute stage, the Management of Change process becomes more restrictive with the goal of zero discretionary changes. In addition, the number of Controlled Documents and procedures has increased, resulting in the process becoming more rigorous as compared to the limited number of Controlled Documents during FEED.

The Project Management of Change process is aimed at controlling modifications to those approved Controlled Documents and procedures required to achieve the change management objectives and requirements captured above. The purpose is to identify the impacts of each change and obtain alignment with all stakeholders before implementation is approved. These changes generally impact the content of the Controlled Documents established at FID as you enter the Execute stage. Changes to Controlled Documents should only be considered if the impetus for the change meets one or more of the conditions below:

- Was not safe
- Did not meet environmental guidelines, expectations or regulations
- Did not comply with laws, regulations or commercial agreements
- Did not meet specifications
- Was significantly higher cost or longer schedule
- Was significantly less profitable
- Did not work or had significant adverse impact on facility reliability, operability or maintainability
- Was a recent lessons learned where significant benefits can be captured

During Execute, other change (MOC) processes are initiated, such as the Contractor change management procedure, Specification Deviation procedure (this could be initiated in FEED; see Section 4), Engineering Drawings Revisions (including drawing and deliverable revisions), etc.

Similar to design development during FEED, normal engineering evolution and execution development will occur in Execute. As the design matures, greater clarity is achieved and the number and type of engineering deliverables increase. This course of project development is expected and is not typically a valid reason for a PMOC.

Attachment B, PMOC Applicability Table, lists the Controlled Documents for Execute and procedures which, if changed, require a PMOC and addresses other documents or situations which fall under the PMOC process. It is the responsibility of the PT to incorporate the intent of this MOC Process in all dealings with contractors and suppliers. The roles and responsibilities for key Project Team members are included in Attachment D.

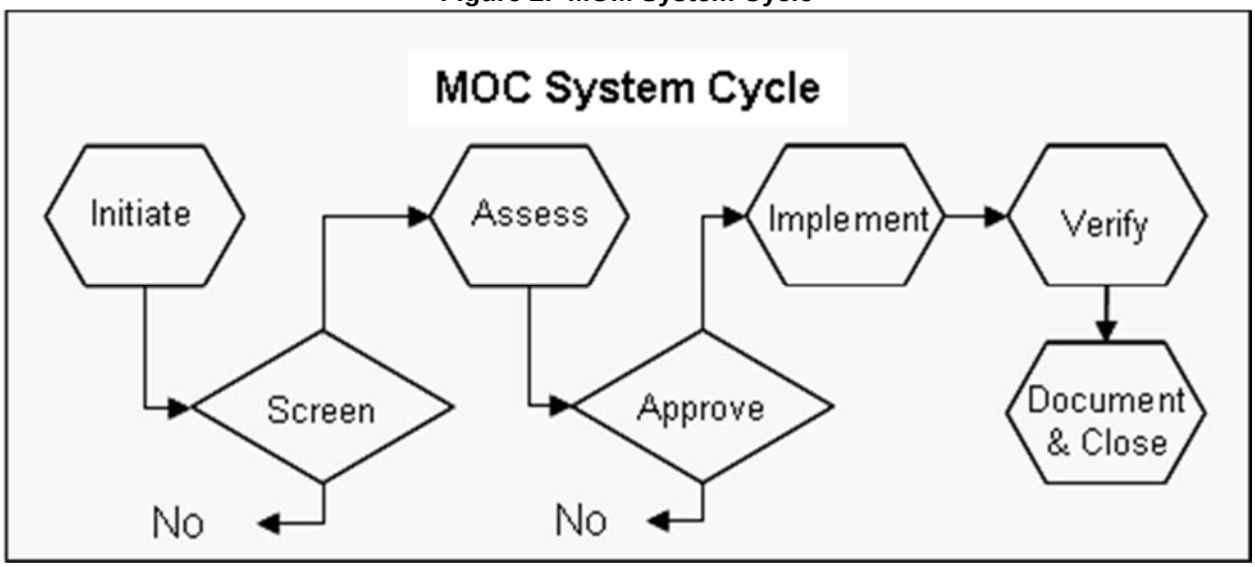
2.0 PMOC PROCEDURE

PMOCs may originate internal or external to the project. Examples are: PT, Operations, Subsurface, Contractors, Vendors, Regulatory Groups, Shareholders, Operators or any other organization associated with the project. Project MOCs are managed through a structured, systematic, and rigorous process of:

- Identification and documentation of reasons and benefits for proposed change
- Evaluation of risk, cost and schedule impacts and any tradeoffs among project objectives
- Approval at an appropriate level before implementation
- Implementation, including communication to all parties affected by the change, obtaining any necessary permits, etc.
- Verification of change implementation and closeout

The basic steps of the Project MOC process are shown in Figure 2.

Figure 2: MOM System Cycle



2.1 PMOC PROCEDURE OVERVIEW

This procedure applies to all PMOCs from FEED through EXECUTE to Turnover to Operations. The PMOC System includes various change management processes that relate to specific project phases or work components.

2.1.1 Step 1 – Change Initiation

The Change Initiator initiates the PMOC by identifying and documenting reasons for the proposed change, along with benefits and areas of impacts. The PMOC should be identified as "Discretionary" or "Non-Discretionary". The Change Initiator identifies a Change Sponsor. The Change Sponsor notifies the Change Coordinator (i.e. - Project Controls Engineer for AKLNG) of the initiated change for inclusion in the next PMOC meeting agenda.

Early discussion between Change Initiator, Change Sponsor, Change Coordinator, and appropriate managers is encouraged to confirm need for PMOC and to avoid unnecessary work in scoping and justifying the need for a PMOC. Cancelled or rejected PMOCs are also expected to be tracked and documented

The Change Sponsor and Change Initiator should identify stakeholders required to be included in review of the PMOC, and identify key actions required to properly assess the proposed change.

2.1.2 Step 2 – Change Screening/Validation

The PT evaluates merit and applicability of PMOC and confirms all stakeholders are identified and included in the PMOC review. Typically, proposed changes will be initially reviewed by the Change Control Committee (or equivalent PT member bodies on each sub-project or with the LT) for merit and validation. Business, Engineering, Construction, Technical, SSHE and Project managers are usual members of the Committee. The Operational Integrity Approval Matrix, in Attachment , identifies appropriate PT members who are required to review and endorse PMOC's based on the Operations Integrity impact (if applicable). The Committee is responsible for deciding if the change requires a PMOC and whether further assessment should be progressed

If the PMOC is approved to progress, the project may issue a Change Inquiry to contractor if applicable.

It is important to maintain records in the PMOC log of what changes were considered for future reference, whether they were accepted or rejected and the reasons for the decision. (Retain record in PMOC Log or equivalent database)

Attachment C addresses the Risk Screening process which is important for determining if a Risk Assessment is required.

2.1.3 Step 3 – Change Assessment

Change assessment will evaluate the PMOC for impacts on cost, schedule, safety, reliability, operability, maintainability, etc. The change assessment is to incorporate all aspects of the underlying issue – i.e. it is not to split the issue into multiple PMOC's

The cost and schedule estimates should be prepared in accordance with Operator estimating practices and, when applicable, up to the same level of detail as the Control Estimate. All estimates are to be accompanied by a written basis that specifies scope and design documents used. They should include the following:

- Description of the change
- Detailed schedule for the execution of the work, showing the required resources and significant milestones
- Details to support estimate and cost assumptions/basis
- Effects on the Control Budget and/or Contract Price, if any, with detailed back-up documentation as per contract
- Effects on the Control Schedule and/or Contract Schedule, if any, with explanatory back-up documentation as per contract
- Estimates should exclude contingency and schedule reserve

The execution schedule for the change needs to identify the impact on start dates and duration for all affected activities.

If applicable, an estimate of potential impacts to project weight should be performed for input to the weight control process.

The project should evaluate the regulatory and environmental impact of the proposed change. This includes examining the change's compliance with regulations and approved standards as well as the possible impact to project permitting (e.g., additional permits or changes to previous regulatory submittals that may cause significant delays).

A risk screening must be performed during this step to determine the potential impact to the overall health, safety, public disruption, environmental, security, operational and financial risks of the project. If the risk screening results in a risk assessment, the risk assessment will be used only to assess the level of risk for the change. If the risk assessment generates actions to mitigate the risk and thus change the risk level, the PMOC should be revised to include those actions in the overall content and not as separate action items. The PMOC must then be resubmitted for Approval to Progress with the mitigating actions and corresponding C&S impacts included in the change.

A Risk Screening is required for all PMOCs (see Attachment C) to assess the level of risk associated with implementing a change. It should be completed by the Change Initiator and must be approved by the Risk Coordinator. The SSH&E Manager will review all PMOCs and endorse all Risk Screenings, ensuring an accurate assessment of potential risk from the proposed change has been completed. The SSH&E Manager may delegate review and endorsement to another SSH&E representative on the project team. This delegation will be documented and retained with PMOC documents.

If a Risk Assessment is completed for a change prior to completing the Risk Screening, (Attachment C), then the Risk Assessment will be included in the PMOC documentation along with the Risk Screening Form.

2.1.4 Step 4 – Change Approval

Once all steps for proper evaluation of the PMOC have been completed, the Change Sponsor forwards the PMOC to the PT for approval. This approval step is the "Authorize for Use" (AFU) approval. If the Manager having the authority for final approval of the change (i.e., DOAG) does not endorse the change at this point, it is rejected and the PMOC is sent back to the Change Coordinator for close-out. The Change Coordinator will notify the Sponsor and all affected groups indicating that the PMOC has been rejected along with the reasons for rejection.

If the PMOC is approved, it is sent back to the Sponsor or Change Coordinator, who issues the approved PMOC to all impacted project groups for implementation. At least one approver must have the proper DOAG in accordance with Attachment – Endorsement & Approval Guide – Project Specific Authority (Figure D-2). The Contracted Cost Limits column of the table, which applies to the current project phase, should be in accordance with the project's DOAG and not exceed the limits in the Operator's DOAG. The approval limits for the Risk Category column are set by the Operator Management System guidelines. The Schedule, Specifications and Non-Contracted Cost Limits are recommended sample approval limits for the given levels. It is the responsibility of the Sr. Project Manager to determine the values in those columns.

If the approved change impacts a contractor's scope, the associated approved Contract Change Order is forwarded to the Business Manager for implementation in accordance with the Contract Procedures.

Senior executive approvals can be obtained via several methods. Direct signature of the PMOC documents is not required. Approval may also be achieved via e-mail or electronic signature.

2.1.5 Step 5 – Implementation

Project implements the PMOC as approved in the PMOC documentation and, if applicable, the associated Contract Change.

2.1.6 Step 6 – Verification

It is confirmed that the change was executed in accordance with PMOC documentation and all affected drawings are updated to reflect "red line" or "as-built" status. Upon completion of all required implementation actions, the verifying PT member(s) is (are) to formally document the date and method of verification on the PMOC form. The Change Coordinator shall not closeout a PMOC until after the required verification has been completed and documented.

FEED verification shall confirm that the change has been incorporated into all applicable documents (plans, specifications, drawings, etc.) so as to satisfy IM requirements and ensure the change will be incorporated into the completed facility.

Execute verification involves actual physical verification that the change has been incorporated into the completed facility if the PMOC affected design.

2.1.7 Step 7 – Document and Closeout

Once the PMOC has been verified as fully implemented, the Change Coordinator is responsible for ensuring that all documentation required for the PMOC is accurate and complete prior to marking the PMOC as "Closed" and sealing the PMOC record.

3.0 ROLES AND RESPONSIBILITIES

A fundamental aspect of an effective Management of Change Process is that recommended changes are reviewed at a level commensurate with the impact and risk involved. Changes that do not have a high level of impact or risk can be reviewed and approved at a lower level than those with a high level of impact and risk. Setting forth and following specific approval and responsibility guidelines will facilitate a consistent and efficient procedure.

Each PT member is responsible for becoming thoroughly familiar with the procedure and must ensure that the proper approval is obtained prior to implementing a change.

3.1 PROJECT TEAM

PT members require sound judgment as no pre-established Roles and Responsibilities list can account for all possible actions. All PT members, contractors, and suppliers should follow procedures established within the respective scope of work for each and provide information/data as required by the Change Coordinator.

All PT members should read the governing Agreements

All PT members involved with the PMOC need to ensure that the requirements listed below, are included in the project's PMOC process.

- Assessment of the effects of a proposed change on interrelated facilities and operations
- Technical review of changes
- Special precautions required to maintain safe operations during implementation of the change
- Method and authority for handling emergency changes Communicating to affected personnel the change and its impacts
- Review and revision of integrity critical documentation prior to startup of facility changes

3.2 PROJECT TEAM ROLES AND RESPONSIBILITIES

Sr. Project Manager and Project Manager

- Demonstrate leadership and commitment to the principles of the system.
- Ensure the PT appropriately applies and follows the processes described in the MOC System.
- Ensure changes are timely and properly approved prior to implementation.
- Provide the necessary resources to achieve the process objectives.
- Ensure Operations, SSH&E, external interfaces (such as Operator Affiliates), and other appropriate members of the PT understand their roles and responsibilities in reviewing and providing input to the PMOC approval process to meet Operator and AKLNG JV expectations.
- Review and endorse PMOCs to ensure proper review by appropriate PT and Operations personnel.
- Provide a focus on PMOC utilization (PMOCs are prepared and approved prior to implementation of the change) as well as recognition of PMOC Cycle Time.
- As necessary, review progress in achieving the process goals and objectives with the System Owner and System Administrator. ("System" = PMOC Plan)

- Develop and document an agreement with the Project Executive and Project V.P. defining the method of securing PMOC approvals (e.g., Quarterly Outlook).

SSH&E / ERL Manager

- Review and endorse all PMOCs to ensure SSH&E requirements are met.
- Ensure that changes undergo a review for regulatory and environmental concerns to maintain regulatory compliance and meet environmental expectations.
- Ensure appropriate Operational Integrity categories are identified on PMOCs.
- Ensure a Risk Screening or Risk Assessment is performed for each PMOC prior to approval, and that the completed and signed Risk Screening Checklist, Risk Screening Matrix and Risk Assessment (if required) are provided to the Change Coordinator for inclusion in the PMOC file

Business Manager

- Primary responsibility for implementation and use of system by PT.
- Review and endorse PMOCs with Financial impact.
- Formally revise the project PMOC system in a timely fashion to include subsequent system revisions when implemented and ensure the PT team is advised and adopts subsequent system revisions.
- Assess the performance and effectiveness of the process and inform the LT.
- Ensure PT's PMOC process includes a Project Specific Authority Approval Guide, and that it complies with the Operator Specific Use Schedule (DOAG), and that appropriate levels of management approval for PMOCs are in accordance with this guide. Develop and implement a project specific PMOC Approval Guide addressing DOAG, Risk, Weight (if applicable), Schedule changes, and revisions to Specifications.
- Ensure principles of PMOC process (changes to controlled documents and IFC drawings) are embodied in contractor's systems as applicable in FEED. If the contractor uses a Field Design Change system that changes a controlled document, then a PMOC must be raised (including risk screening) and review and approval by the proper PT members is required.
- Ensure actions for improvement have been identified and carried out.
- Ensure training requirements are adequately addressed, including refresher training.
- Ensure PMOC logs meet system requirements and are reported to LT monthly, and report PMOC Cycle Time metric in monthly reports to LT and Operator Management as appropriate.
- Support engagement of Project Controls SME to conduct project controls follow-up in support of the PT in the area of PMOC System use.
- Ensure PT Change Coordinator (PCE for AKLNG) is adequately trained
- Periodically, at least annually review and report the results and improvement recommendations to the PMOC System Owner and System Administrator.
- As part of Operator stewardship transfer process, before transfer of the facility or part thereof to Operations, coordinate with Operations counterpart, the PT Business Manager and the PT Change Coordinator to jointly develop a transition document outlining the transfer of the PMOC System to Operations. This PMOC System transfer document is to address management of PMOCs pending but not yet approved, approved but not yet implemented, implemented but not yet verified, and fully implemented, verified and closed.

Project Controls Manager

- Ensure actions for improvement have been identified and carried out.
- Ensure training requirements have been adequately addressed, including refresher training.
- Ensure PMOC logs meet system requirements and are reported to Project Leadership Team and Functional Leadership monthly.
- Support engagement of Project Controls SME to conduct project controls follow-up in support of the PT in the area of PMOC System use.
- Ensure PT Change Coordinator (PCE for AKLNG) is adequately trained.
- Periodically, at least annually, review and report the results and improvement recommendations to the PMOC System Owner and System Administrator.
- Ensure consolidation of the changes to the overall project costs and updating of the Current Control Budget and also the Current Control Schedule
- Evaluate the effect of staffing / work-hour changes on the schedule and of updating the Project Control Schedule

Business Lead – Sub-Project

- Ensure that MoC processes are implemented on the sub-project in a timely manner
- Assign a sub-project Change Coordinator and ensure he/she is adequately trained
- Assist the Change Coordinator and the Engineering Manager in promoting the process, communicating across disciplines, managing bottlenecks, and bringing issues to closure
- Provide sub-project PMOC status information to the integration team monthly to support consolidated AKLNG JV reporting
- Ensure the right people are involved in reviewing / endorsing / approving changes as appropriate
- Establish contract change procedures for each contract under Sub-Project Manager's stewardship. Refer to and comply with the Contract MoC Procedure for issues related to contracts, work orders, PO's, etc

Change Coordinator (Sub-projects and central Project Services team)

- Communicate PMOC changes to the affected groups.
- Develop project PMOC distribution matrices for PMOCs
- Ensure PMOCs are properly routed and approved (verification indicated by Change Coordinator endorsement of each PMOC)
- Consolidate the changes to the overall project costs and update the Current Control Budget and Forecast (similar for Current Control Schedule)
- Evaluate the effect of staffing/work-hour changes on the schedule and of updating the Project Control Schedule.
- Ensure that the completed and signed Risk Screening Checklist, Risk Screening Matrix and Risk Assessment (if required) are included in the PMOC file before PMOC is approved/authorized for use.
- Ensure changes are approved per the PMOC Approval Guide.
- Plot/track the total project and individual project component cumulative cost of changes compared with available contingency, allowances, and/or provisional sums depending upon the nature of the change and as per the Cost Stewardship Initiative guidelines

- Plot/track the overall number of approved and pending changes (maintain a project wide single PMOC log).
- Plot/track PMOC reporting metrics (cycle time, etc)
- Conduct a periodic review (at least biannually) to identify project PMOCs that have been initiated but not yet dispositioned (approved to progress), to determine with the Change Sponsors if such PMOCs continue to represent potential changes, or if they should be voided.
- Compile PMOC documentation or verify that documentation compiled by others is clear and complete
- Assist the Project Controls Manager and Business Leads in reviewing the MOC System with all the key members of the PT to identify the personnel who require training. Ensure training is conducted and document with project training records [7.2].
- Train new PT members in MOC system as they are mobilized to the PT
- Conduct semi-annual document assessments of the IFC and IFD drawing changes, CCOs, and NCRs to ensure PMOCs are submitted when required.
- Coordinate with all PT members the preparation of any required project or phase close-out PMOC documentation.
- Confirm that Change Sponsor designated change as "Discretionary" or "Non-discretionary" directly on PMOC at time of Pending Approval to Progress.
- Confirm that Change Sponsor designated verification method directly on PMOC at time of Pending Approval to Progress.
- Confirm that verification method indicated on PMOC by Change Sponsor was performed and documented before closing out a PMOC.
- Discuss proposed changes with Change Sponsor and Change Initiator to confirm need for PMOCs and avoid unnecessary work in scoping and justifying changes.
- Convene change committee meetings as needed
- Maintain a record of Change Control Committee meetings and participants including associated actions raised during the meeting.

Change Initiator

- Initiate the PMOC by identifying and documenting reasons for proposed change, along with benefits and areas of impacts.
- Identify Change Sponsor to steward the change through the PMOC process.
- Discuss proposed changes with Change Sponsor and Change Coordinator to confirm need for PMOCs and avoid unnecessary work in scoping and justifying changes.
- Along with Change Sponsor, identify stakeholders required to be included in review of PMOC and key actions to properly assess the proposed change.
- Complete Risk Screening Checklist to assess potential impact to overall health, safety, public disruption, environmental, security, operational and financial risks of the project.

Change Sponsor

- Steward the change through the PMOC system.
- Along with Change Initiator, identify stakeholders required to be included in review of PMOC and key actions to properly assess the proposed change.
- Check the completeness of the initiated PMOC prior to submitting a PMOC, including: Designation of change verification method. Designation of "Discretionary" or "Non-

discretionary", Designation of time limitations and other requirements as defined herein for content of Temporary PMOCs

- Designate pre- and post Authorization for Use actions
- Designate the appropriate approval assignments for all stages of the change progression.
- Respond to system status regarding progression / delays of changes through the system.

Engineering Manager

- Ensure that changes undergo a review for engineering concerns and compliance with the integrated Project Design Basis.
- Ensure principles of PMOC process (changes to controlled documents, Specification Deviation Requests, and IFC drawings) are embodied in contractor's systems and detailed work processes.
- Ensure that changes to controlled documents as defined for each Stage Pre-FEED, FEED, Execute) initiated by a Contractor's change system (such as Field Design Change system) are identified by Contractor's change system as PMOC candidates. Changes to controlled documents generated by Contractor's change system should be highly visible and subjected to processes to identify when a PMOC must be raised (including risk screening), reviewed, and approved, by the proper PT members.
- Seek input from the I&C Engineer when changes impact I/O count

Project Execution Manager / Lead (In S/P and also in Central Team)

- Prepare change impact estimates by compiling input from the different engineering disciplines, conducting risk screening required, and forwarding coordinated change packages to the Change Coordinator.
- Assess the effect of proposed changes on cost, schedule, weight, risk, regulatory, environmental, and operability to determine whether a contract change is required.
- Ensure change request/authorization forms for contract and purchase order changes are initiated as required, including monitoring development and maintenance of a CCO (Contract Change Order) log for each contract under Project Engineer's stewardship. Obtain functional approvals as required, including consulting with the Contracts team
- Ensure compliance with the Risk Screening process, the Risk Assessment process, the OI Approval Matrix, and the Project Specific Authority Approval Guide.
- Ensure quality assurance /quality control (QA/QC) for all changes.
- Review change activity with management at monthly stewardship reviews.
- Report on the status of all changes to the Change Coordinator.
- For PMOCs requiring verification by actual visual inspection (as identified by Change Sponsor on each PMOC) ensure the verification is conducted prior to closure of the PMOC. Steward the PMOC closure activities prior to transfer of the facility to Operations (as applicable).

Systems Completion Manager (as applicable)

- Ensure the Systems Completion Team has a process to verify PMOCs have been closed out on a particular system during the Pre-Start-up Safety Review (PSSR).
- Review and endorse PMOCs with commissioning, start-up, or performance testing impact.
- Ensure Brownfield interfaces are appropriately addressed.

- Before transfer of the facility or part thereof to Operations, coordinate with Operations, the PT Business Manager and the PT Change Coordinator to jointly develop a transition document outlining the transfer of the PMOC System to Operations. This PMOC System transfer document is to address management of PMOCs pending but not yet approved, approved but not yet implemented, implemented but not yet verified, and fully implemented, verified and closed out. For those verified as implemented, verification method must be documented

Operations Representative (Operations Readiness or Affiliate Operations Manager)

- Where appropriate review applicable PMOCs for operability, reliability and maintainability.
- Ensure interfaces with existing facility operations groups and other applicable systems are appropriately addressed. Endorse any PMOC with impact of Health/Safety, Security, Environmental, or Operations associated implications.
- Review/Revise integrity critical documentation prior to startup of facility changes

Project Quality Manager

- Work with the Business Manager to assess the performance and effectiveness of the MOC system. Any identified instances of unauthorized changes taking place will be readily addressed with the Business Manager and Project Manager.
- Ensure that changes undergo a review for quality related concerns.

Project Risk Coordinator

- Coordinate and provide guidance/oversight for Risk Screenings to ensure an accurate and adequate screening for risk.
- Review and approve all Risk Screenings.
- Endorse any PMOC that reflects increase in risk levels
- Communicate risks associated with the change and required mitigation measures to Project Team.
- Coordinate risk assessments for changes and specification deviations which identify the need for a risk assessment after completion of the risk screening.
- Track, within the PMOC, any action items generated by risk screening, or mitigation actions identified to maintain acceptable risk levels.

Construction Site Supervisor/Manager (as applicable)

- As required, support PMOC process at construction site to ensure potential cost, schedule and risk impacts are properly identified and evaluated.
- Assess the effect of proposed changes on cost, schedule, weight, risk, regulatory, environmental, and operability to determine whether a contract change is required.
- Establish contract change procedures for each contract under stewardship of Site Supervisor/Manager.
- Ensure change request/authorization forms for contract and purchase order changes are initiated as required including monitoring development and maintenance of a CCO log for each contract under stewardship of Site Supervisor/Manager. Obtain intra-functional approvals as required.
- Ensure compliance with the. Risk Screening process, the Risk Assessment process, the OI Approval Matrix and the Project Specific Authority Approval Guide.
- Ensure quality assurance /quality control (QA/QC) for all changes.
- Review change activity with management at monthly stewardship reviews.

- Report status of implementation of changes to the Change Coordinator.
- For PMOCs requiring verification by actual visual inspection (as identified by Change Sponsor on each PMOC) ensure the verification is conducted prior to closure of the PMOC. Steward the PMOC closure activities prior to transfer of the facility to Operations.

Other PT members, contractors, and suppliers

- Follow procedures established within the respective scope of work of each
- Provide information and data as required by the Change Coordinator to support the PMOC System

4.0 EXAMPLE DOCUMENTS

Figure 3: MOC Log (Example)

Alaska LNG

Proprietary

Alaska LNG

Management of Change - Log

Status: All

Moc No. Tracking #	MOC Title	Originator Date Initiated	Status Status Date	Implement by Date Cycle Time	Verified By Closed Date	Sub-Project Area	Operations Integrity Risk Categories	Net Schedule Impact	Net Cost Impact ($k)	Net Weight Impact (MT)
			Average Cycle Time	0				0	$0	0

Figure 4: Cost / Weight / Schedule Impact Detail (Example)

Proprietary

Alaska LNG **Alaska LNG Project**

Cost Impact Detail

Sub-Project		Description		Approved Change ($k)
		Project Engineering Procurement Fabrication Construction		
			Totals	$0

Weight Impact Detail

Sub-Project	Description	Bulks	Steel Module	Equipment	Outfitting	Other (Describe)	Total
						Totals	0.00

Schedule Impact Detail

Sub-Project	Description	Current Schedule Start	Current Schedule End	MOC Schedule Start	MOC Schedule End	Schedule Impact (+/- wks)
					Totals	

Figure 5: Schedule Major Milestones / Risk Assessment / Deliverables Affected

Proprietary

Alaska LNG **Alaska LNG Project**

Schedule Major Milestones Impact Detail

Sub-Project	Description	Baseline Date	Change Request Date	Schedule Impact (+/- wks)
	FEED Phase Milestones Award Major Contracts at Start of FEED Phase FEED JVA Deliverables Complete & Issued to PSC/CoV Issue ITT Packages to Bidders for Execute Phase Ready to Award Execute Contracts JVA FEED Phase Complete Final Investment Decision (FID) **EPC Phase Milestones** Award Major EPC Contracts at Start of Execute Phase Receive Authorization(s) to Construct LNG Last Vessel Sail Away: Sealift1; Sealift 2; Sealift 3 GTP Last Vessel Sail Away: Sealift1; Sealift 2; Sealift 3 First Gas to GTP First Gas to LNG Complete Start-Ups: Train 1; Train 2; Train 3 First Cargo Full Production			
			Totals	

Risk Assessment

Hazard	Initiating Event	Causes	Consequences	Assumed Safeguard	Risk Level	Action Item

Deliverables Affected

Sub-Project	Documents/Drawings	Reference Document	Impact

5.0 ACRONYMS AND TERMS

5.1 ACRONYMS

Term	Definition
AFE	Authorization for Expenditure
AFU	Authorized for Use
AKLNG	Alaska LNG
CCB	Current Control Budget
CCO	Contract Change Order
CCS	Current Control Schedule
CWBS	Contract WBS
DOAG	Delegation of Authority Guideline
EPDB	Early Project Development Basis
ERL	Environmental, Regulatory, Land
FEED	Front End Engineering Design
GTP	Gas Treatment Plant
HAZOP	Hazardous Operations (i.e. an analysis)
IFC	Issued for Construction
IFD	Issued for Design
IPDB	Integrated Project Design Basis
ITT	Invitation To Tender
JV	Joint Venture
LNG	Liquefied Natural Gas
MOC	Management of Change
OCB	Original Control Budget
OCS	Original Control Schedule
OIPMS	Operator's Integrated Project Master Schedule
P&ID	Piping & Instrumentation Drawing
P/L	Pipeline
PCP	Project Controls Plan
PLT	Project Leadership Team (for AKLNG: Leadership Team -- LT)
PMOC	Project MOC
PS	Project Services
PSC	Project Sub-Committee
PT	Project Team
S/P	Sub-Project
S/P-MS	Sub-Project Master Schedule
SDR	Specification Deviation Request

Term	Definition
SME	Subject Matter Expert
SSHE	Safety, Security, Health, Environmental
WBS	Work Breakdown Structure

5.2 TERMS

Term	Definition
Change Inquiry	A request by Company for Contractor to evaluate cost and schedule implications of a potential Contract Change
Change	Generic term for the act or instance of making something different. Change involves the transformation from a set of agreed conditions, state, or criteria to another.
Change Notice: Project (PCN)	A unilateral notice from Company/Buyer to the Contractor instructing the Contractor of some type of revision or set of instructions. The PCN may be administrative in nature or items with impacts to cost and schedule. PCN may be related to scope, work schedule, revision of deadlines, revision of technical standards, etc. The Contractor is expected to comply with the PCN. If PCN results in a change in cost or schedule, the Contractor may propose and submit a request for a Change order or Amendment to Company/Buyer for approval.
Change Proposal	Contractor's proposal for a Contract Change, including justification, scope of work, detailed cost and schedule impacts and assessments of risks including health, safety, environmental, regulatory and technical implications
Change Request	A request by Contractor or Company to clarify or alter certain aspects of a Work Package. These change requests are approved by both parties and may or may not result in a request for a change order.
Corrective Action Request (CAR):	A document that describes non-fulfillment of a specific project requirement relative to a work process and the action necessary to remedy the condition
Contract Change Order (CCO):	A change within the originally contemplated Contractor scope of work but with impact on cost or schedule. Each change order must comply with the contract terms and conditions. The change order will identify the increase or decrease in the contractor's compensation and may also identify any change to the contractual completion date. Change orders must be approved by both the Contractor and the Company/Buyer consistent with the Operator DOAG (Delegation of Authority Guideline) Specific Use Schedule prior to commencement of work.
Control Budget	The basis in cost, quantities, and/or work hours against which the project measures its performance. The Original Control Budget is the approved level of budgetary expenditures including contingency. The Current Control Budget is the sum of the original budget plus all approved Contract changes. [Also see AKLNG PCP: Project Controls Plan]
Control Schedule	The basis in duration of activities, sequence of activities and milestones against which the project measures its performance. [Original Control Schedule and Current Control Schedule are analogous to control budgets. Also see AKLNG PCP: Project Controls Plan]
Controlled Documents	For the purpose of this procedure, documents that define the project technical and execution basis / scope and associated project deliverables as defined in this procedure and in Section **Error! Reference source not found.**
Cycle Time	The numbers of days for a project change from "Approved to Progress" to Authorized for Use
Design Development:	Occurs during the course of engineering evolution from FEED through detailed design and project execution. As the design matures greater clarity is achieved of the number and type of engineering deliverables, equipment, and bulk material, and project execution requirements. This normal course of project maturation is typical and is not necessarily a valid reason for a PMOC.
Discretionary Change	A change that may improve project performance, but it is not required to achieve project objectives

Term	Definition
Integrity Critical	Activity, equipment, device, process, document, position, etc. determined to be vital to the prevention or mitigation of a major event as they relate to Operations Integrity. Such events include an uncontrolled emission, fire, or explosion that involves serious danger to people, property, or the environment.
Leadership Team	The AKLNG Leadership Team (LT) is led by the Sr. PM and is made up of: Project Managers, Business Manager, Technical Manager, SSHE/ERL Manager, etc. The Operator Functional Leadership Team (FLT) are informed monthly of the project status and ongoing issues to assist in resolution as needed.
MOC	Acronym for Management of Change and the overarching process to ensure changes to approved design bases, designs, documents, procedures, execution strategies, and constructed facilities are managed and controlled
Non-conformance	Non-fulfillment of a specific project requirement. Includes deviations from drawings and specifications
Non-Discretionary Change	A change that is necessary to meet project objectives
Operations Integrity	All aspects of Operator's business, including security, which can impact safety, health, and environmental performance.
Operations Integrity (OI) Category:	A method of categorizing each MOC that identifies the relative Operator management system area such as Health/Safety, Public Disruption, Environmental, Security, Operations and Financial Impact
Operator	Company that will be the designated operator for the FEED stage as per the governance agreement.
Project MOC	Acronym for the formal Project Management of Change process or reference to the formal documented change / modification to Controlled Documents as described in this procedure
Project Deviations	Accepted alternatives to a particular portion of the Job Specification.
Project Team (PT)	The Project Manager and all personnel who report to him/her directly or indirectly
Rough Order of Magnitude Estimate (ROM)	A preliminary estimate that may be based on benchmarks or experience. A ROM is used to provide a relative indicator of the magnitude of the cost and schedule impact associated with a potential change. ROM's have a high degree of uncertainty.
Transfer:	Reallocation of approved budgeted funds from one AFE to another (PMOC is required)
Waiver:	Written authorization to release a work product or process that does not conform to specified requirements. The PT's acceptance of a Deviation Request typically results in the waiver of a requirement.

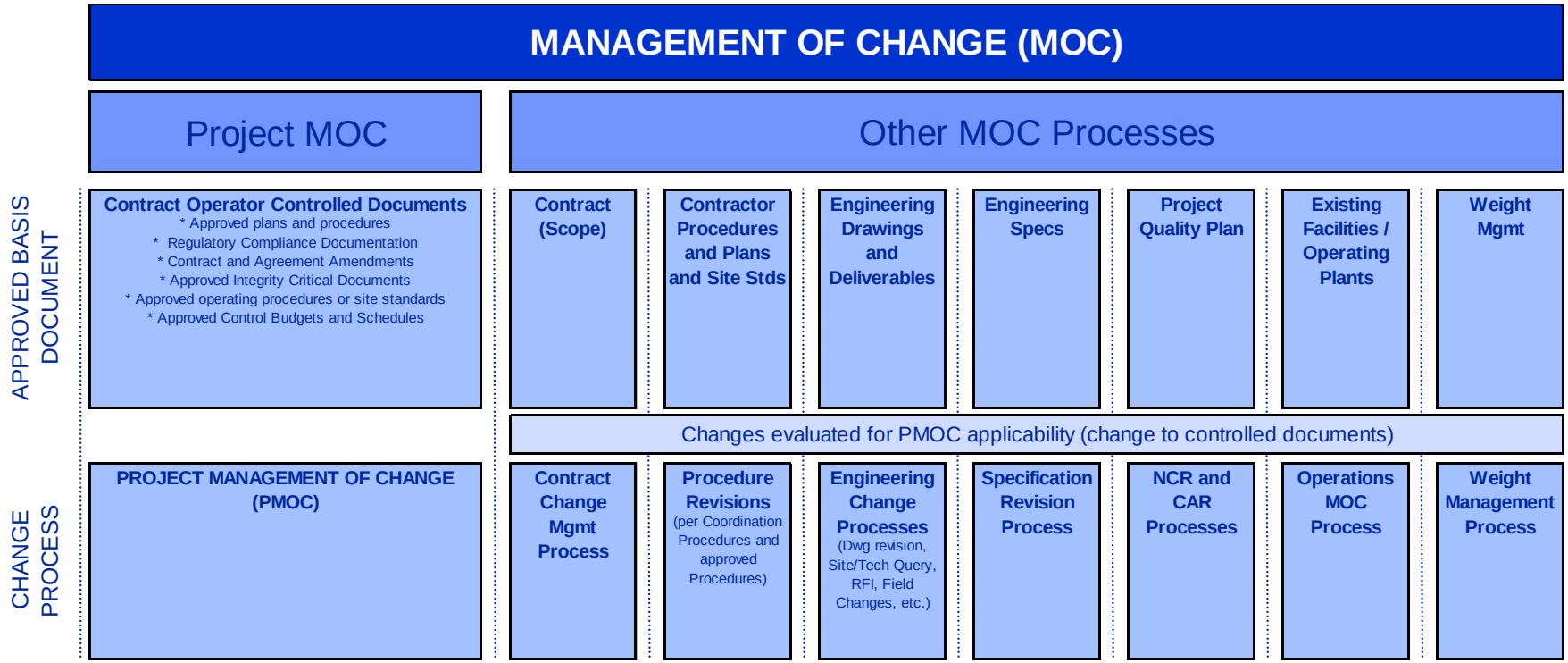
6.0 REFERENCES

Document Number	Document Title
USAI-PS-BPCTL-00-000002-000	FEED Integrated Project Controls Plan
USAI-PS-BPMOC-00-000003-000	AKLNG Contract Management of Change
USAI-PT-BLZZZ-00-000001-000	Key Decision Log

7.0 ATTACHMENTS

Attachment A	Management of Change Overview
Attachment B	Project MOC (PMOC) Applicability Table
Attachment C	Risk Screening Form
Attachment D	Endorsement and Approval Guide
Attachment E	MOC Process Flow
Attachment F	PMOC Example Forms
Attachment G	Abbreviations
Attachment H	MOC Process Overview

7.1 ATTACHMENT A: MANAGEMENT OF CHANGE OVERVIEW



Note: Site/Field originated changes may afffect multiple change processes.

7.2 ATTACHMENT B: PMOC APPLICABILITY TABLE

Attachment B is provided to assist with determining if a proposed change is required to be stewarded by this PMOC procedure. It includes Controlled Documents and other deliverables/situations that, if changed, require a PMOC. Examples are provided for both the FEED and Execute phase.

PMOC Applicability Table	
Operations Integrity Management	The following types of specific changes must be addressed as appropriate for potential Operations Integrity impacts: Additions to/deletions from the unit facilities Installation of equipment or materials not meeting the original installation design intent Addition of new or modified computer control applications or programmable control, surveillance and safety equipment Changes to alarms and interlock set points New or revised procedures and Integrity Critical documentation Deviation from Integrity Critical procedures Changes in operational envelope, approaching safety limitations Changes impacting security Introduction of new chemicals or catalysts

FEED entry to FID	
Controlled Document	Examples of changes requiring a PMOC
Pre-FEED Project Execution Plan (PEP), Contracting Strategy, Pre-Investment (Note: Operator designation for PEP is Early Execution Plan (EPP))	Revisions to these Controlled Documents will require PMOCs. Prior to FID, Project Teams can bundle accepted optimization initiatives into one or several PMOC Revision in execution strategy Revision in execution location and assumptions Change from 1 to 2 prime construction contractors, or from RC to LS (Reimbursable Cost to Lump Sum) Significant change to logistics plan or infrastructure basis
Roadmap of Deliverables based on venture agreement and / or Operator PM System	The project takes the decision not to produce one or more of the deliverables identified on the approved Venture Agreement Deliverables Road Map.

Design Basis / IPDB (Note: Operator designation Facilities Design Basis / Early Project Development Basis (EPDB))	Decision taken to change LNG vaporizers from ORV to SCV Decision to move from stick built to modularized approach Evaluation of engineering/environmental survey data and/or land, environmental, community affairs or regulatory issues indicate re-routing of pipeline segment outside of corridor is warranted Changes to reservoir definition yields sufficient reserves and identifies need to increase throughput from 75 to 120kbd or composition (or # and location of wells). For future expansion - increases in P/L diameter from 12" in Design Basis to 14". Changes to reserve size/definition (GOR/composition). The P/L system configuration is changed to use a significantly higher pressure, smaller diameter, and fewer compressor stations. Completion of the route survey indicates that the P/L corridor needs to be revised. Significant increased CO_2 content of gas in reserve
Organization Plan change	Changes to locations which impact security and safety
Regulation or Commercial Agreement changes	Commercial agreements changed the overall funding basis project duration Significant new legislative issues (national content) Significant changes in operations assumptions New regulation adds 6 months to permitting process or limits flaring emissions
Materials Design Basis Memorandum (MDBM)	Decision to change materials if Operating conditions are changed, such as temp, H_2S pressure, etc.; Facilities design is changed New technologies identified through TQMS are used; Long lead items are not available on schedule.
Security Model	Decision to not use -- or to deviate from – Operator Upstream Security Model Facility Countermeasure Minimum Standards requires special approvals as per process defined in Operator Security Management System. Physical design changes affecting security reliability require PMOC.
Operator Operation Integrity Management System Approved Plans	Decision to deviate from or not follow an Ops Integrity plan that has a SSHE impact requires a PMOC and notification to Operator management system administrator. Examples include: Deleting security check points, gates, and or security buildings Decision to not use -- or to deviate from -- Upstream Security Model Facility Countermeasure Minimum Standards requires special approvals as per process defined in Ops Integrity Management System. Physical design changes affecting security reliability require PMOC.

Examples of Items that do not require an PMOC (FEED entry to FID)
Design development/refinement. Design or Execution development to meet the PEP (EPP) and Design Basis
Pipeline Centerline changes within the Final Corridor prior to FEED entry
Poor FEED contractor performance
Replacement of personnel. Personnel changes (regular changes, not key personnel changes which change the Organizational Plan)
Market fluctuations (captured in monthly Outlook) - Labor cost increase
Performance (captured in monthly Outlook) - LLE delays, material supply constrictions
Schedule extension that does not exceed the FEED project schedule (including Schedule Reserve and SCSA)
Additional studies, such as Geotechnical
Changes to Global Practices or specifications which follow the process set out by Engineering
Changes to Operator Procedures that are entirely focused on business, finances or administration, such as procedures relating to timekeeping, invoicing, lessons learned, progress verification, contingency mgmt., reporting, issues mgmt., contracts admin., work requests, cost recovery, financial controls, HR, banking, etc.
Clarification and revisions/updates to an approved Operator OI Plan or an approved supporting Plan. (e.g., updating this PMOC plan) Note: These changes will be worked through the normal review and approval process.
Estimate Basis Changes that do not require a PMOC: minor changes to Unit Quantities, Unit Rates, Unit Cost, FOREX or Productivity.
In general, activities covered by approved procedures, documents, designs, site standards

Execute to Pre-Startup / Turnover-to-Operations	
At Execute the PMOC process becomes more rigid and the number of Controlled Documents expanded with a goal of zero discretionary changes. Excluding normal updates of the following Controlled Documents that are required per Operator practices for entry to Execute, revisions/changes to the following Controlled Documents will require a PMOC.	
Controlled Document	**Examples of changes requiring a PMOC or MOC**
Project Plan (includes Execution Plan)	Decision taken to change from fabrication in S. Korea to China Decision taken to change module installation from lift to float-over
Project Design Basis	Decision taken to skid equipment packages Decision taken to change sparing philosophy Decision to use a vendor's specification in lieu of an Operator Spec. Decision to change P/L diameter that requires equipment or land not included in IPDB Blowdown valves on a platform were taken out of one contractor's scope but not placed into the other contractor's scope. It is recommended that the transfer of scope from one subproject to another subproject be executed via a formal PMOC so that the impacts are recognized, and interfaces are identified, aware of and agree to the transfer of scope. Revising controls philosophy – adding or deleting control or PSV valves

Cost Control Budget and Control Schedule	Budget Transfer from one AFE to another requires a PMOC Estimate discovered to exclude the costs associated with installation, start-up spares or other significant estimating errors Re-baseline of the Operator's project schedule requires a PMOC
Roadmap of Deliverables based on venture agreement and / or Operator PM System	Decision not to produce one or more of the deliverables identified on the approved Road Map, this requires a PMOC to document deviation
Contract Strategy Plan and Contract Plan - WBS	Decision taken to change contracting model Migration of a lump sum contract to other contractual compensation basis Settling a claim (not supported via normal Contract Changes provisions) Early termination of a major contractor or subcontractor should be documented via a PMOC
Significant Changes to the Final Organizational Plan	Decision taken to eliminate or combine key positions from functionally endorsed organization plan (e.g., Project Executive, Project Manager, SSH&E Manager, Planning & Controls/Business Manager, Technical Manager, Quality Manager, Construction Site Manager, Installation Site Manager, Start-up Manager, and any other positions identified by project leadership to have comparable roles) Decision to relocate PT members from one location to another which could have significant SSH&E impacts (e.g., Decision to relocate team from Houston to PNG)
Operating and Maintenance Procedures	Revising approved operations and maintenance procedures (Engage Operations before taking actions in this area) Addition of new or modified computer control applications or programmable control, surveillance and safety equipment During commissioning and start up, systems often need to be modified in the field. If systems have been transferred to Operations (i.e., endorsed by a Systems Turnover document), an MOC using the Operations system should then be used. If the system has not yet been transferred, use the applicable change management process and check Section **Error! Reference source not found.** to decide if PMOC is required.

Operator Operation Integrity Management System Approved Plans	Decision to deviate from or not follow an Ops Integrity plan requires a PMOC and notification to Operator management system administrator. Examples include: Decision to not use -- or to deviate from -- processes and requirements of Malaria Control and Compliance Program (MCCP) for work in malarial area Decision to not use -- or to deviate from -- processes and requirements of Alcohol and Drug (A&D) program Decision to not use -- or to deviate from -- Upstream Security Model Facility Countermeasure Minimum Standards requires special approvals. Physical design changes affecting security reliability require PMOC. Changes in operating, maintenance or emergency procedures to include security protocols (e.g., standard orders for guards, ID checks, etc.) Changes in security processes used to monitor site (e.g., site entrances, baggage/vehicle check process, etc.) Significant changes in security personnel or organizational structure (e.g., switching from an outside security company to an offsite third party monitoring company)
Project Specifications	Changes to specifications are covered under the Specification Deviation Procedure. See Engineering Manager's Roles and Responsibilities in Attachment D
Operator Procedures	Changes to Operator Procedures which can impact SSHE performance or are involved in the production, manufacture, use, storage, or movement of material or people, such as procedures for start-up, logistics, vehicle transportation, expediting and inspection, site and office visitors, asset disposal, travel, change management/site instructions, field changes, camp management, etc.
Examples of Items that do not require an PMOC Post FID)	
Equipment substitution meeting the same specifications Changes in installation support vessels with no change in method, cost or schedule Change in personnel (Operator and Contractor) if not a Critical Position Rework, Force Majeure and Backcharges Additional site indirect improvements (ex. additional parking space) Estimate Basis Changes that do not require a PMOC: minor changes to Unit Quantities, Unit Rates, Unit Cost, FOREX or Productivity Micro-routing change in pipeline within corridor to address site-specific conditions identified by execution team (micro-route changes are planned for in pipeline execution plan) Changes to Operator Procedures that are entirely focused on business, finances or administration, such as procedures relating to timekeeping, invoicing, lessons learned, progress verification, reporting, issues mgmt., contracts administration, work requests, cost recovery, financial controls, HR, banking, etc. These changes to these procedures are handled in accordance with those procedures.	

7.3 ATTACHMENT C: RISK SCREENING

A Risk Screening is required for all PMOCs to determine potential impact to the overall health, safety, public disruption, environmental, security, operational, and financial risks of the project. This Risk Screening form should be completed by the Change Initiator. However, the Risk Coordinator must approve the Risk Screening and SSHE/ERL Manager must endorse the Risk Screening. The Risk Screening consists of two components, the Risk Screening Checklist and the AKLNG Project Risk Matrix – Table C-2.

The SSH&E/ERL Manager will ensure that the Risk Screening is completed prior to approving any PMOC.

Instructions for AKLNG Project Risk Matrix:

Using Tables C-5, C-4 and C-3, for each of the five considerations (Safety/ Health; Environmental; Community / Public Disruption; Financial: Direct; and Financial: Indirect), determine the Probability and the Consequence levels prior to implementing the change and after implementing the change in accordance with the AKLNG Project Risk Matrix. Fill in Risk Matrix Results Table C-1 below with the risk levels (e.g., III-B or IV-C) prior to change and post change implementation. (The risk "category" is the numerical result from the AKLNG Risk Matrix - Table C-2.)

Increasing Risk Level: A Risk Screening for a proposed change (PMOC) that yields a higher level of assessed risk than existed prior to implementing the change. An increasing risk level is a change that moves the Consequence or Probability determination from a lower risk category to a moderate risk category (higher up or further left on the Risk Screening Matrix).

When a change is categorized as Increasing Risk Level, broad distribution of the pending PMOC should be made to ensure that all applicable interfaces and potential stakeholders have the opportunity to participate in the decision making process. The affected Project Components as well as Operations should participate in the decision process. Where Risk Screening identifies increasing risk levels, the Project Risk Coordinator must be included in the PMOC approval process and confirm the need for a scenario-based risk assessment in accordance with the Operator's system and processes.

Decreasing Risk Level: A Risk Screening for a proposed change (PMOC) that yields a lower level of assessed risk than existed prior to implementing the change. An example of a decreasing risk level would be a change that moves the Consequence level or Probability range level from a higher risk category to a moderate risk category (lower down or further right on the Risk Screening Matrix).

No Change in Risk Level: A Risk Screening for a proposed change (PMOC) that yields no change in the level of risk than existed prior to implementing the change (same Consequence and Probability – same box on Risk Screening Matrix).

If the change increases consequence or probability levels, increasing risk is indicated.

Table C-1:
Risk Screening Results (based on Risk Matrix)

	Prior to PMOC	Post PMOC Implementation
Health/Safety		
Public Disruption		
Environmental Impact		
Financial Impact: Direct		

	Table C-1: Risk Screening Results (based on Risk Matrix)	
	Prior to PMOC	**Post PMOC Implementation**
Financial Impact: Indirect		

The driving risk consideration (area of greatest risk: from Table C-1)

is _____.

The risk category (from Table C-2) Post PMOC Implementation:

From Risk Screening = _____. From Risk Assessment = _____.

The attached Risk Screening consisting of the completed Risk Screening Checklist and the completed AKLNG Project Risk Matrix was prepared by _____.

Instructions for Risk Screening Checklist

Identify / check responses to each question. Increasing risk is indicated if any answer is "Yes" or "Maybe".

When the Risk Screening indicates increased risk, the Project Risk Coordinator must confirm the need for a scenario-based Risk Assessment.

Table C-2: AKLNG Risk Matrix

		PROBABILITY				
		A	**B**	**C**	**D**	**E**
Consequences	**I**	1	1	1	2*	3*
	II	1	1	2	3	4
	III	2	2	3	4	4
	IV	3	4	4	4	4

Note: The Risk Assessment risk category will supersede the Risk Screening risk category

***** For scenarios that have residual risks accepted in the I-D and I-E boxes, the control measures must be periodically verified to ensure the risk assessment has not changed. Frequency and method of verification should be documented in closure comments and approved by the Risk Coordinator.

Table C-3: Probability Considerations

Probability Range	Qualitative Interpretation Guidance	Quantitative Interpretation Guidance (Probability of Occurring per year of exposure)
A	**Very Likely** Similar event has occurred once or more at Site in the last 10 years Has happened several times at Site or many times in Company	0.1 to 1 Mid-point at 0.3
B	**Somewhat Likely** Has happened once before at Site or several times in Company	0.01 to 0.1 Mid-point at 0.03
C	**Unlikely** Has not happened before at Site or has happened a few times in Company	0.001 to 0.01 Mid-point at 0.003
D	**Very Unlikely** Have been isolated occurrences in Company or has happened several times in industry	0.0001 to 0.001 Mid-point at 0.0003
E	**Very Highly Unlikely** Has happened once or not at all in Company Has happened a few times or not at all in industry	<0.0001

Table C-4: Consequence Considerations

Consequence Level	Safety / Health	Environmental Impact	Public Impact	Financial Loss: Direct (*)
I	Fatality(ies); Serious Injury Requiring Medical Treatment to Members of Public	Potential Widespread, Long Term, Significant Adverse Effects	Significant Public Disruption; Extended National or International Media Coverage; Large Community Impact; Large Scale Evacuation; Major Road Closure >24 Hours	Operator
II	Serious or Lost Time Injury / Illness	Potential Localized, Medium Term, Significant Adverse Effects	Small Public Disruption; One Time National or Extended Local Media Coverage; Medium Community Impact; Small Scale Evacuation; Major Road Closure <24 Hours	Project
III	Restricted Work or Medical Treatment	Potential Short Term, Minor Adverse Effects	Public Complaints; One Time Local Media Coverage, Small Community Impact; Secondary Road Closure <24 Hours, Tier 1 PSE	Site

Probability Range	Qualitative Interpretation Guidance			Quantitative Interpretation Guidance (Probability of Occurring per year of exposure)
IV	First Aid / Minor Injury	Inconsequential or No Adverse Effects	Public Complaint; No Media Coverage, Temporary Closure of Side Road; Minor Inconvenience	Other

*) Direct Costs and Property Loss Impact direct loss only; does not include business or production loss

Table C-5: Consequence Considerations
Financial Loss: Indirect

Consequence Level	Working Definitions Financial Impact / Business Loss(*)
I	Corporate 4-month project delay
II	Project 2-month delay
III	Site 2-week delay
IV	Other Less than a week delay

Note:
*) Includes lost or deferred production (indirect).
Table applicable to AKLNG Pre-FEED and FEED per Sr. PM

AKLNG Risk Screening Checklist

		Condition Post Change Implementation		
		No	Yes	Maybe
1	Is it outside industry / Partner(s) operating experience?			
2	Will a Critical Operating Parameter be created or changed?			
3	Will Operations be affected?			
4	Will it cause additional operating complexity / difficulty-of-use?			
5	Will safety systems be bypassed?			
6	Will it require regulatory query or variance?			
7	Does it deviate from Project Philosophies?			
8	Does the change warrant an updated Hazard Assessment?			
9	Will the change impact PBU and / or PTU?			

		Condition Post Change Implementation		
		No	**Yes**	**Maybe**
10	Does it require Operator practices / Project Specification deviation(s) not associated with Safety [S] or Environmental [E]?			
11	Does it require Operator / Project Specification deviation(s) associated with Safety [S] or Environmental [E]?			
12	Does it require revising major risk and loss prevention activities completed to date? Consider: • Escape, Evacuation, and Rescue • Fire and Explosion analysis, including loss of containment • Firewater system sizing • Ventilation and dispersion			
13	Does it require revising major piping or layout activities completed to date? Consider: • Location of people and equipment in "hazardous" vs. "non-hazardous" areas • Piping support(s)			
14	Does it require revising major structural activities completed to date?			
15	Does it require revising major electrical activities completed to date? Consider: • Electrical Area Classification • Electrical load lists			
16	Does it require revising major mechanical activities completed to date? Consider: • Current ventilation design (to prevent explosive mixtures)			
17	Does it require revising major machinery activities completed to date?			
18	Does it require revising major Instrumentation and Controls activities completed to date? Consider: • SAFE Charts • Cause and Effects Analysis • Fire and Gas Detection • Tubing support(s)			
19	Does it require revising major Process activities completed to date? Consider: • Flare, relief, and blowdown scenario development, backflow, blocked flow increase, pressure / vacuum relief (including thermal) • New chemicals • PFD or P&ID changes after HAZOP			

		Condition Post Change Implementation		
		No	**Yes**	**Maybe**
20	Does it require revising major Construction Planning activities completed to date?			
21	Does it require revising major Integration Planning activities completed to date?			
22	Does it require revising major Installation Planning activities completed to date?			
23	Does it impact Human Factors? Consider: • Access / Egress • Noise • Body position, reach • Lighting, etc.			
24	Will personnel protective equipment need to be altered?			
25	Will temporary connections or equipment be installed?			
26	Will utility systems need alteration to support the change?			
27	Will the potential for spill or release increase?			
28	Will normal operating emissions or discharges increase?			
29	Will staffing levels or tour duties / checklists change?			
30	Will security impacted by the change?			
31	Will change result in increased health risks/concerns? (e.g., cold weather exposure, etc.)			
32	Will location change adversely affect availability of specialized or key technical competencies?			
33	Will the schedule's critical path or major project milestone adversely impacted?			

Other Considerations:

Increasing risk is indicated if ANY answers are 'Yes' or 'Maybe'.

Risk Screening Performed by: _____ **Date:** _____

Risk Coordinator Approval: _____ **Date:** _____

SSHE / ERL Manager Endorsement: _____ **Date:** _____

7.4 ATTACHMENT D: ENDORSEMENT & APPROVAL GUIDE

See Section **Error! Reference source not found.** for a description of the overall review, endorsement, and approval of PMOCs by the Project Team. Figure E-1 is used to identify key reviewers/endorsers of an PMOC based on the PMOCs impact, while Figure E-2 lists the appropriate level of management (DOAG) for final approval (i.e. Authorized for Use) of a PMOC.

Figure D-1: Operational Integrity Approval Matrix

	Operational Integrity Category								
Project Team Approvals (Minimum Requirements)	Health / Safety	Security	Public Disruption	Environmental	Operations	Financial	Regulatory	No OI Impact	Comments
Senior Project Manager	√	√	√	√	√	√	√	√	
Project Managers	√	√	√	√	√	√	√	√	For affected subproject(s)
Business Manager						√		o	
Technical Manager	o	o	o	o	o	o	o	o	
Change Coordinator (PCE)	o	o	o	o	o	o	o	o	For affected subproject(s)
SSHE/ERL Manager	√	√	√	√	√	√	√	√	
Enigneering Manager	o	o	o	o	o	o	o	o	For affected subproject(s)
Quality Manager	o	o	o	o	o	o	o	o	For affected Quality Processes
Operations Manager	√	√		√	√			o	
Construction Lead	o	o	o	o	o	o	o	o	For affected subproject(s): Engr / Fab / Constr

Legend: V = Approval Required

o = Review & Endorse as determined by the LT MOC Committee

Figure D-2: Project Specific Authority (*)

Decision Level	DOAG	Risk Category (**)	Schedule	Specifications	PMOC Limit for: Non-Contracted Work For impacts to Execute Phase	PMOC Limit for: Contracted Work Purchase Orders Change Orders For impacts to FEED Phase
Operator Project VP	4	1	>2 weeks	Unlimited		50 $M
Senior Project Manager	5	2	> 2 weeks	Unlimited	Any change that exceeds the last estimate reviewed with the VP	25 $M
GTP Project Manager	6	3	< 2 weeks	Technical & Construction Specs	100 $M	5 M$
Pipeline Project Manager	6	3	< 2 weeks	Technical & Construction Specs	100 $M	5 M$
LNG / Marine Project Manager	6	3	< 2 weeks	Technical & Construction Specs	100 $M	5 M$
SSHE / ERL Manager	6	3	< 2 weeks	Technical & Construction Specs	100 $M	5 M$
Technical Manager	6	3	< 2 weeks	Technical & Construction Specs	100 $M	5 M$
Business Manager	6	3	< 2 weeks	Technical & Construction Specs	100 $M	5 M$
Engineering Manager	7	4	< 2 weeks	Technical & Construction Specs	50 $M	1 M$

Notes:

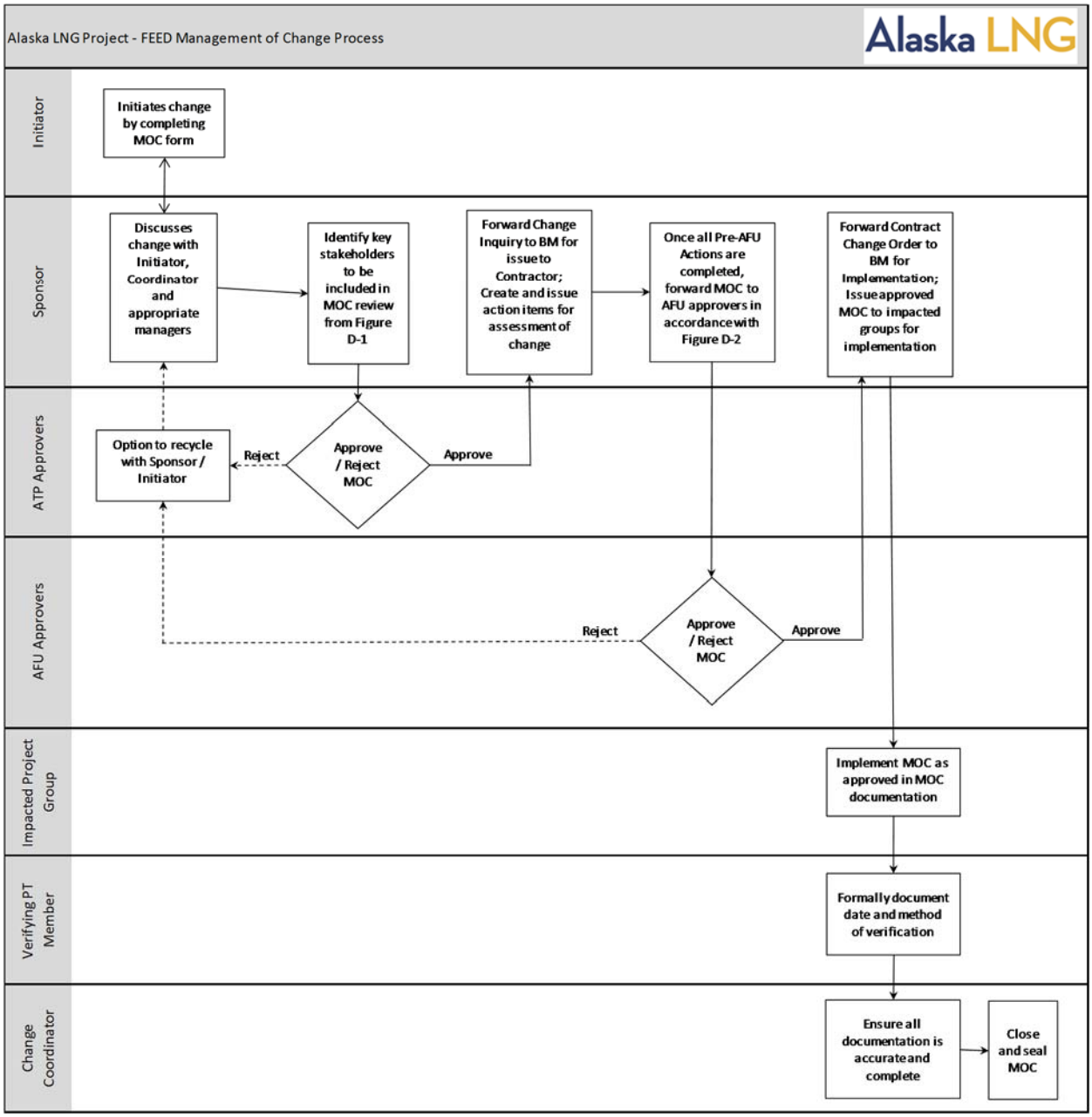
*) PMOC Authority Guide (Changes exceeding Operator - Project VP amounts will require higher-level approval.

**) Refer to the “Risk Category” line listed just after Table C-1

M$=Million $

7.5 ATTACHMENT E: PMOC PROCESS FLOW DIAGRAM

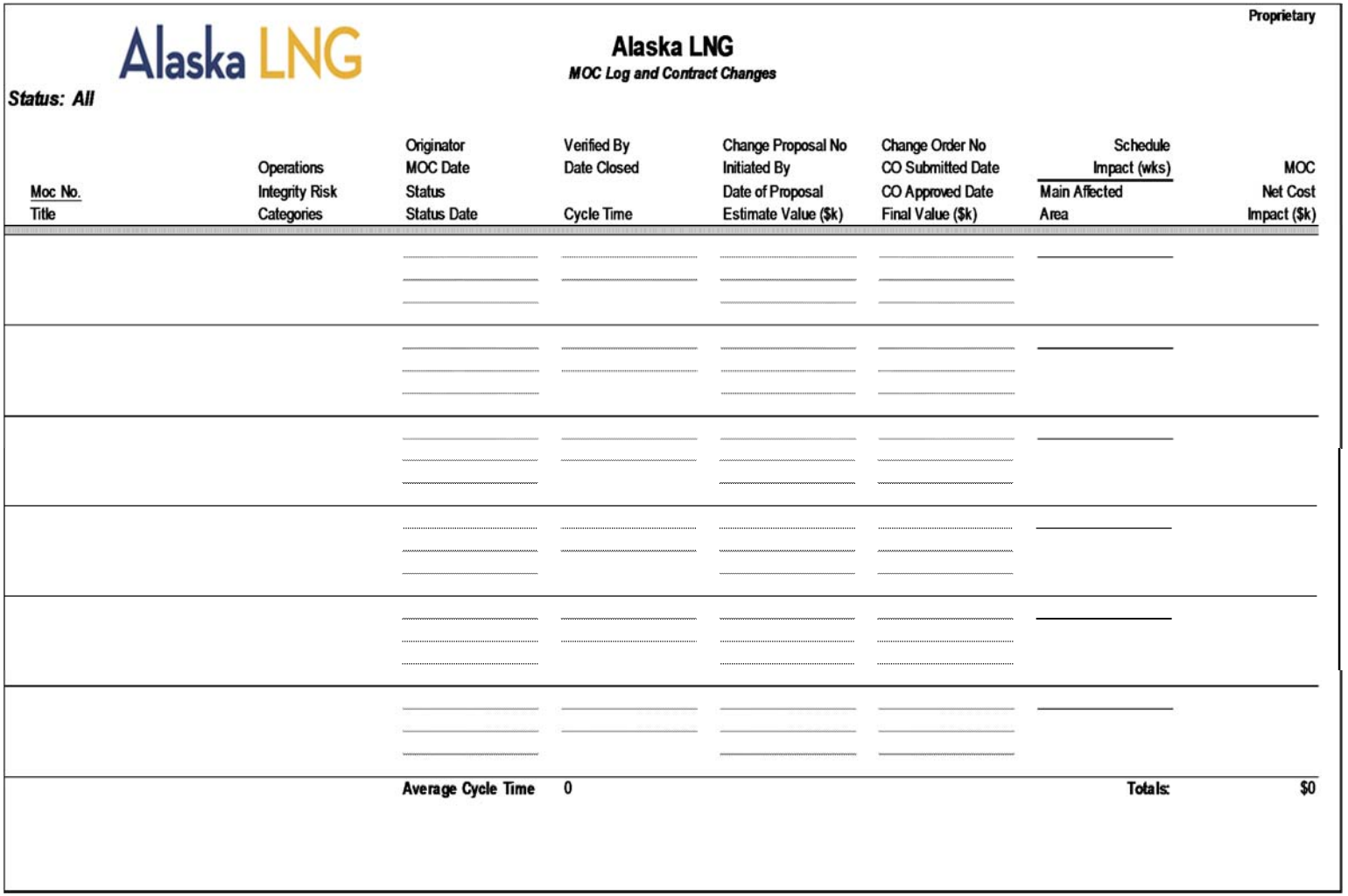
Figure E-1: Typical Flow Diagram for PMOC Process



Note: Reference also **Error! Reference source not found.**

7.6 ATTACHMENT F: PMOC FORMS / REPORTS: EXAMPLES

Figure F-1: PMOC Log for Contract Changes



Proprietary

Alaska LNG

Alaska LNG

MOC Log and Contract Changes

Status: All

Moc No. Title	Operations Integrity Risk Categories	Originator MOC Date Status Status Date	Verified By Date Closed Cycle Time	Change Proposal No Initiated By Date of Proposal Estimate Value ($k)	Change Order No CO Submitted Date CO Approved Date Final Value ($k)	Schedule Impact (wks) Main Affected Area	MOC Net Cost Impact ($k)
		Average Cycle Time	**0**			**Totals:**	**$0**

Figure F-2: PMOC Log Overall

Proprietary

Alaska LNG

Alaska LNG

Management of Change - Log

Status: All

Moc No. Tracking # MOC Title	Originator Date Initiated	Status Status Date	Implement by Date Cycle Time	Verified By Closed Date	Sub-Project Area	Operations Integrity Risk Categories	Net Schedule Impact	Net Cost Impact ($k)	Net Weight Impact (MT)
		Average Cycle Time	0				0	$0	0

Figure F-3: PMOC Summary Sheet

Proprietary

Alaska LNG

Alaska LNG Project

Management of Change - Summary Sheet

Step 1 by Change Requestor

Originator: _____ **Date** _____

MOC Title: _____

MOC Description Justification

Operations Integrity Risk
- ☐ Health / Safety
- ☐ Security
- ☐ Public Disruption
- ☐ Environmental
- ☐ Operations
- ☐ Financial
- ☐ Regulatory
- ☐ No OI Impact

Step 2 by Change Coordinator

MOC No. _____ **Change Coordinator** _____ Lead Supervisor: _____ Date Sent to L.S. _____

Step 3 by Lead Supervisor

Type of Change _____ **MOC Approval Needed by Date** _____

Supervisor's Instructions _____ **Main Affected Area** _____ **Risk Screening** _____

Affected Project Organizations
- ☐ Business Services
- ☐ Technical Team
- ☐ Contracts/Procurement
- ☐ Cost & Schedule
- ☐ Construction
- ☐ Operations

MOC Distribution

Action	Info	Name	Project Title
☐	☐	Steve Butt	Sr Project Manager
☐	☐		Project Manager
☐	☐	Mark Scheffler	Business Manager
☐	☐	Lydia Johnson	Technical Manager
☐	☐	Charlie Kominas	SSHE/ERL Manager
☐	☐		Engineering Manager
☐	☐	Richard Scott	Quality Manager
☐	☐		Operations Manager
☐	☐		Construction Manager
☐	☐		Change Coordinator (PCE)

Step 4 by Product Groups

Step 5 by Change Coordinator

Cost Impact ($k) $0 **Largest Schedule Impact (wks)** 0 **Weight Effect (mt)** 0.00

Source of Funds _____

Final Authorization

Step 6 Appropriate Supervisor / Manager

Title:	Initials	Required	Signature	Date
Sr Project Manager	SB	☐		
Project Manager		☐		
Business Manager	MS	☐		
Technical Manager	LJ	☐		
SSHE/ERL Manager	CK	☐		
Engineering Manager		☐		
Quality Manager	RS	☐		
Operations Manager		☐		
Construction Manager		☐		

Step 7 by Change Coordinator

Implementation

	Yes	No		Yes	No
Technical Documents	☐	☐	Budget	☐	☐
Contracts / Procurment	☐	☐	Schedule	☐	☐

Closed: _____ Date: _____

10/21/2015 7:38

7.7 ATTACHMENT G: MOC PROCESS OVERVIEW (FOR TEAM USE)

Areas Subject to MOC	Types of Change	Relevant System / Process	Approval	Comments
EM Procedures, Plans, Agreement				
Approved OIMS related plans (Safety, Security, Regulatory, etc.)	All changes (except format, typos and minor clarifications)	EM Project MOC Process	Per Project MOC Endorsement and Approval guide	Risk screening in eMOC/PMOC process (or equivalent).
Approved EMCAPS related plans (POS, PDB, WBS, etc.)				Risk screening in PMOC process (or equivalent).
Approved Integrity Critical documents (BCP)				Risk screening in PMOC process (or equivalent).
Formal regulations and laws, incl. Ext. 3rd party commitments				Risk screening in PMOC process (or equivalent).
Approved Owner Agreements (PSA, JV, etc.)				Risk screening in PMOC process (or equivalent).
Approved Control Budget and Schedules (Company P50 plans)				Risk Screening, PMOC not req'd unless change to Co. Control Budget or Schedule (P50).
Approved Organization plan (structure and location changes)				Risk screening in PMOC process (or equivalent). Types of change requiring PMOC detailed in procedure.
Approved EMDC plans and procedure (non-Financial or Admin)				Risk screening in PMOC process (or equivalent).
Approved EMDC plans and procedure (Financial and Admin)		EM Relevant Procedure	Per procedure	Same endorsement/approval levels as original.
Contracts & Materials				
Approved Contracts	Contractor scope, schedule or condition changes	Contract Change Management Procedure	per DOAG	Changes to be tested for PMOC relevance. PMOCs to be approved prior to change approval.
Approved Purchase Orders	PO scope, schedule or condition changes	PO terms and conditions	per DOAG	Changes to be tested for PMOC relevance. PMOCs to be approved prior to change approval.
Approved Service Agreements	SA changes and/or revisions	SA terms and conditions	per DOAG	Changes to be tested for PMOC relevance. PMOCs to be approved prior to change approval.
Approved Work Requests and Work Orders	WR/WO changes and/or revisions	WR/WO terms and conditions	per DOAG	Changes to be tested for PMOC relevance. PMOCs to be approved prior to change approval.
Engineering and Design				
Approved Contractor engineering plans and procedures	All changes (ex format, typos & minor clarifications)	Relevant Procedure	EM Engr Mgr (or delegate)	Same endorsement/approval levels as original.
Approved Engineering / Design	P&IDs (post Hazop)	Contractor Dwg Revision Procedure	EM Engr Mgr (or delegate)	P&ID change evaluated for SSHE risks and potential for Re-HAZOP, PMOC (controlled docs) per DRM.
	Key Design Documents - Post IFD (KDD) (e.g. PFDs, Layouts, MSDs	Contractor Dwg Revision Procedure	EM Engr Mgr (or delegate)	KDD change evaluated for SSHE risks and potential for PMOC (controlled docs) per DRM.
	IFC drawings	Contractor Dwg Revision Procedure	EM Engr Mgr (or delegate)	IFC dwg change evaluated for SSHE risks and potential for PMOC (controlled docs) per DRM.
		Contractor Field Change Request (FCR)	EM Engr Mgr (or delegate)	Used to obtain approval to implement a proposed solution to a site initiated design change.
		Contractor Design Change Notice (DCN)	EM Engr Mgr (or delegate)	Used to notify the field that a design change has been identified or is pending. If site agrees to implement, this document can be used to execute the change.
		Contractor As-Built Procedures Redlines to IFC drawings (As-Builts)	Contractor Sign off of Redlines	Another MOC procedure used to agree to the change; this is documentation purposes only.
	ICSS Change Request (post FAT)	Contractor Instr General Query (IGQ)	EM Engr Mgr (or delegate)	Used to track ICSS changes required after FAT (software, cross wiring, Int. panel wiring & graphics).
	Technical Queries / RFI (Queries to Company)	Contractor-Company TQ / RFI Process	EM Engr Mgr (or delegate)	Used to request clarification or document design instruction decisions. Not to be used for design changes or spec deviations; if change needed, it invokes another process.
	Technical Queries / RFI (Queries to Contractor from Fabricator, Constructor or Vendor)	Contractor-Contractor TQ / RFI Process	Contractor Engr Mgr (or delegate)	Used to request clarification to contractor. Not to be used for design changes or spec deviations; if change needed, it invokes another process.
Approved Specifications	Specification Re-Issue, Addendum or Update	SDR process	EM Engr Mgr (or delegate)	Approver to evaluate SSHE risk prior to approval and test PMOC relevance.
	Specification Deviations	SDR process	EM Engr Mgr (or delegate)	Approver to evaluate SSHE risk prior to approval and test PMOC relevance.
Approved Weight Budget	Changes in weight	Weight Mgmt Plan	Per Plan	Test PMOC relevance
Quality				
Approved Product Specifications or Work Processes	Deficiencies or Non-conformances	NCR and CAR process in Quality Plan	Per EM QP procedure	Risk matrix and approval levels per Quality Plan. Approver to evaluate whether SDR or design change is needed
Execution and Construction				
Approved Contractor Site Standards	Change in Contractor site standards	Various	Contractor	Contractor evaluates the SSHE risk. Notification given to EM.
Approved Contractor Site Project Procedures	Change in Contractor site procedures	Various	EM Site Mgr (or delegate)	Same endorsement/approval levels as original evaluate the SSHE risk and determine RA applicability.
Approved Contractor Execution plans and procedures	Change in Contractor execution plans or procedures	Various	EM Site Mgr (or delegate)	Same endorsement/approval levels as original evaluate the SSHE risk and determine RA applicability.
Approved Contractor Scope of Work / Services	Contract Site Instructions	Contractor change management / CPs	Site Authority	Approver to evaluate SSHE risk prior to approval and test PMOC relevance.
Approved Offshore Installation MOC plan	Change in Contractor execution plans or procedures	Offshore Installation MOC	Site Authority	Approver to evaluate SSHE risk prior to approval and test PMOC relevance.
Operations				
Existing Facilities (Brownfield environment)	Existing facilities or equipment / SIMOPS / PTW changes	Operations MOC procedure	Per Operations MOC	EM Operations evaluates SSHE risk through Operations MOC
NOTE: Not being trained or not following the approved procedures, plans and site standards is not Management of Change. See OIMS 5-1 and 5-4 for details.				

Certificate Of Completion

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Source Envelope:

Document Pages: 47 Signatures: 3 Envelope Originator:

Certificate Pages: 3 Initials: 0 Darleen Espinales

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*O.2 – QA/QC Plans and Procedures**

Document Number:	Description:	Revision:	Appendix:
N/A	An asterisk (*) denotes information that is optional and can be provided in final design.	N/A	Public

*O.3 – Commissioning Plans**

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*O.4 – Operating Plans and Procedures**

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*O.5 – Maintenance Plans and Procedures**

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*O.6 – Safety Procedures**

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P.1 – Instrument Lists

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

Q.4 – Drawing of ESD Manual Activation Devices

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

Q.5 – Shutoff Valve Manufacturer's Data

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

R.1 – Relief Valves Capacities and Sizing

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested	N/A	Public

R.2 – Flaring Load and Venting Capacities and Sizing

Document Number:	Description:	Revision:	Appendix:
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S.2 - Spill Containment Sizing Matrix

Document Number:	Description:	Revision:	Appendix:
N/A	Refer to Appendix S.3	0	Public

S.4 – Passive Protection Drawings

Document Number:	Description:	Revision:	Appendix:
N/A	Will be provided in detailed design, if requested and needed	N/A	Public

S.8 - Hazard Control Drawings

Document Number:	Description:	Revision:	Appendix:
N/A	Refer to Appendix S.6	0	Public