APPENDIX A4A: BIOTREATMENT SYSTEM

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1 INTRODUCTION

This sub-plan describes pilot testing of the Biotreatment System (BTS).

1.1 SYSTEM DESCRIPTION

The BTS is designed to treat the agent hydrolysate produced from hydrolysis of distilled mustard (HD) and mustard T mixture (HT) using Immobilized Cell Bioreactors (ICB™). The ICBs will be started up and will process the maximum organic loading of agent hydrolysate during the 155-mm projectile campaign.

The BTS consists of four biotreatment modules to treat the agent hydrolysate. These four modules are designed to operate independently. Each is equipped with a feed tank with agitator, a feed pump, two air blowers, four ICBs with a recycle pump per bioreactor, a moisture separator, an effluent tank, an effluent pump, a urea feed pump, a diammonium phosphate (DAP) feed pump, a sulfuric acid tote package (one for every two modules), and an Off-gas Treatment System (OTS). Figure A4A-1 provides a general layout of a biotreatment module. The following paragraphs provide a general description of the BTS components. Further information can be found in the *System Design Description for Biotreatment System No. B09*, 24852-RD-3YD-B09-B0001, in the *System Design Description for Bioreactor Off-gas Treatment System No. B11*, 24852-RD-3YD-B11-B0001, and in the BTS *Combined Installation Operation and Maintenance Manual,* 24852-V1A-MS00-0143s01.

The feed tank for each of the four biotreatment modules provides flexibility for modular operation and plant start-up. The ICB feed tanks receive hydrolysate from the 30-day hydrolysate storage tanks and dilute it with process water to achieve a target feed concentration of 7000 mg/L thiodiglycol (TDG). Nutrients (urea and DAP) are added to support biological activity. During start-up, acid is manually added to the ICB Feed Tank to assure that the pH of the solution being fed is not too high to inhibit initial biomass activity. During normal operations, acid addition is not required because biodegradation of TDG produces sulfuric acid. Each tank is equipped with a feed pump that supplies ICB feed to each of the four bioreactors in an ICB module. A composite sampling system on the feed pump discharge outlet collects samples. In-line probes monitor the pH and conductivity of the feed to each bioreactor module.

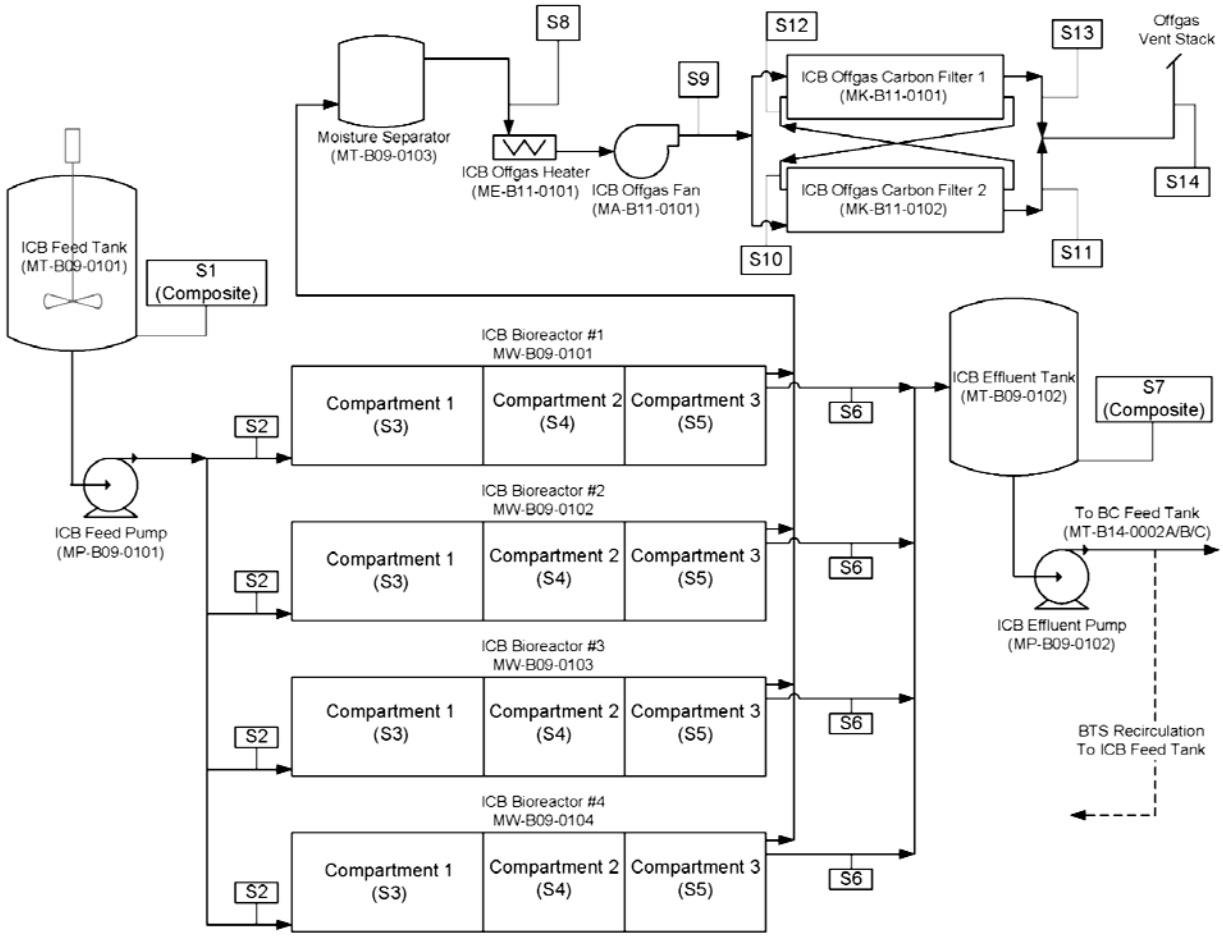

Figure A4A-1. Simplified Drawing for Module 1 of Four Biotreatment Modules of the PCAPP BTS identifying key components and sampling locations (S#). (Excerpt from *Combined Installation Operation and Maintenance Manual*, 24852-V1A-MS00-0143s01)

Each of the four bioreactors within a biotreatment module has a nominal 40,000-gal hydraulic capacity and consists of three compartments/cells (1, 2, and 3), with Compartment 1 having a ~20,000-gal capacity, and Compartments 2 and 3 each having a ~10,000-gal capacity. Flow from compartment to compartment is based on overflow of a weir to a downcomer pipe which discharges near the bottom of the subsequent chamber, eliminating potential short-circuiting. A recycle pump (not shown in Figure A4A-1) can recirculate liquid from compartments 2 and/or 3 to compartment 1, but normally recirculates liquid from the outlet side of compartment 1 to the inlet side of compartment 1. Caustic metered into this recirculation line provides pH adjustment, as required. Each unit is equipped with sampling ports and sludge removal ports and is aerated by a two-blower system through a manifold dedicated to each unit to maintain aerobic conditions.

The ICB effluent tanks receive effluent from the bioreactors by gravity flow. Effluent is periodically sampled using a composite liquid sampler to verify biotreatment system performance. It is pumped to the Brine Concentrator (BC) feed tanks, also called the Water Recovery System (WRS), which feed the Brine Reduction System (BRS). If the

effluent does not meet TDG removal performance criteria, the module is placed in recirculation mode.

The function of the OTS is to mitigate nuisance odors and reduce organic emissions generated by the biotreatment system. Each biotreatment OTS consists of an electric heater to lower the relative humidity (RH) of the off-gas and two granular activated carbon (GAC) adsorbers that operate in a lead-lag configuration. The relative position of the two carbon adsorbers (i.e., lead vs. lag) can be adjusted to support carbon changeout.

1.2 OBJECTIVES

The objectives of BTS pilot testing are:

1. Demonstrate removal of TDG from hydrolysate waste stream.
2. Control chemicals of potential concern (COPC) and odor emissions in air.
3. Collect and assess data to validate and/or define critical operating parameters for the BTS.

1.3 LIMITATIONS

Start-up of the BTS requires sufficient accumulation of agent hydrolysate in the 30-day hydrolysate storage tanks to ensure continued BTS feed should Agent Processing Building (APB) operations need to be stopped. Buffer storage must also allow for continued operation of the APB systems (see Appendix B). The start-up procedure to be used for pilot testing may be modified based on data collected during systemization phase testing and therefore is not defined here. Appendix B of the *Pilot Test Demonstration Plan* (PTDP) contains additional considerations for BTS start-up with implications on upstream and downstream processes.

The demonstration testing discussed in this plan will occur after select modules are operating at a feed rate required to support APB operations with stable TDG removal over a minimum of two hydraulic residence times (HRT). Stability will be demonstrated with daily TDG sampling of the feed and effluent streams. PCAPP intends to operate the modules with TDG removal of ≥ 95% as defined in SOP 24852-SOP-B09-W00001, *Biotreatment and Off-gas Treatment*. However, if the system is demonstrating stable operations with TDG removal resulting in maximum effluent concentrations of 0.1 wt% (corresponding to ≥ 86% removal at a feed rate of 7000 mg/L), BRS effluent satisfies permit requirements for recycle, and the Joint Test Group (JTG) determines operational enhancements are not available to improve performance, pilot testing will proceed.

PCAPP will assess emissions against risk and hazard thresholds defined in the *Multiple Pathway Health Risk Assessment Report for the Pueblo Chemical Agent Destruction Pilot Plant with Explosive Destruction System* [MPHRA], 24852- 3RC-000-V0007 as per the *Summary Plan for Evaluating Pilot Test Data against MPHRA*, 24852-30H-000-L0003. As detailed in that plan, pilot test data for (1) COPC sampling per the *Laboratory Sampling and Analysis Plan for Pilot Test Phase Operations*, 24852-GPP-GGL-00013 (LSAP), (2) odor monitoring per the *Odor Monitoring Plan for Pilot Test Phase Operations* (OMP), 24852-GPP-GGG-V0018 and (3) carbon sampling for butane activity

per the *Carbon Sampling Strategy,* 24852-30H-000-W0004 will be used to demonstrate process facilities and equipment operate as designed, validate the Multiple Pathway Health Risk Assessment, and help CDPHE assess recommended PCAPP operating parameters for the Part B Permit.

2 PILOT TEST DEMONSTRATION APPROACH

2.1 OVERVIEW

BTS pilot testing consists of start-up, demonstration, and integrated facility demonstration (IFD) and proceeds in accordance with the decision tree provided in Figure A4A-2. Start-up is completed when the BTS is processing at the required operational feed rate for a minimum of 2 HRT at a minimum of 86% TDG removal (≤ 0.1 wt% TDG in effluent) and the BRS distillate satisfies criteria for recycle (see Appendix A4B). Demonstration involves operation at the feed rate required to support the 155 mm schedule and changeover for 2 HRTs to demonstrate TDG removal. During the IFD, the BTS continues to operate at required feed rates with TDG removal of ≥ 86% while emissions samples are collected from operating BTS stacks during three four-hour periods consistent with Appendix A7. Control of COPCs and odor emissions throughout start-up, demonstration, and IFD is monitored in accordance with the OMP, LSAP, and *Carbon Sampling Strategy,* 24852-30H-000-W0004.

2.2 MATERIALS

There are no pilot test-specific materials or equipment required for this testing.

2.3 DESIGN

2.3.1 Start-up

Start-up will involve the start-up of ICB units with daily monitoring of TDG removal (treatment objectives) and process parameters (e.g., dissolved oxygen [DO], pH, temperature) to demonstrate performance per success criteria. During start-up, sampling for Dissolved Organic Carbon (DOC) is performed in the feed and effluent to establish whether it may be used as an indicator of biological treatment in lieu of direct analysis of TDG. Start-up operations will be complete when the required number of treatment modules is operating to support the 155 mm schedule and changeover with TDG removal of ≥ 86% and the BRS distillate resulting from processing of this BTS effluent satisfies recycle criteria (see Section 1.3 and Figure A4A-2). Process parameter ranges and set points will be reviewed and validated against performance to confirm values for continued operations.

Throughout start-up, odor monitoring and COPC air sampling is conducted in accordance with the OMP and LSAP. OTS carbon sampling is performed in accordance with the *Carbon Sampling Strategy,* 24852-30H-000-W0004. These items will be continued through completion of the IFD. Unless sampling is already performed as a result of odor detections per OMP, COPC and carbon sampling will be conducted during

a period of operation after the first module is successfully operating at full rate for 2 HRT.

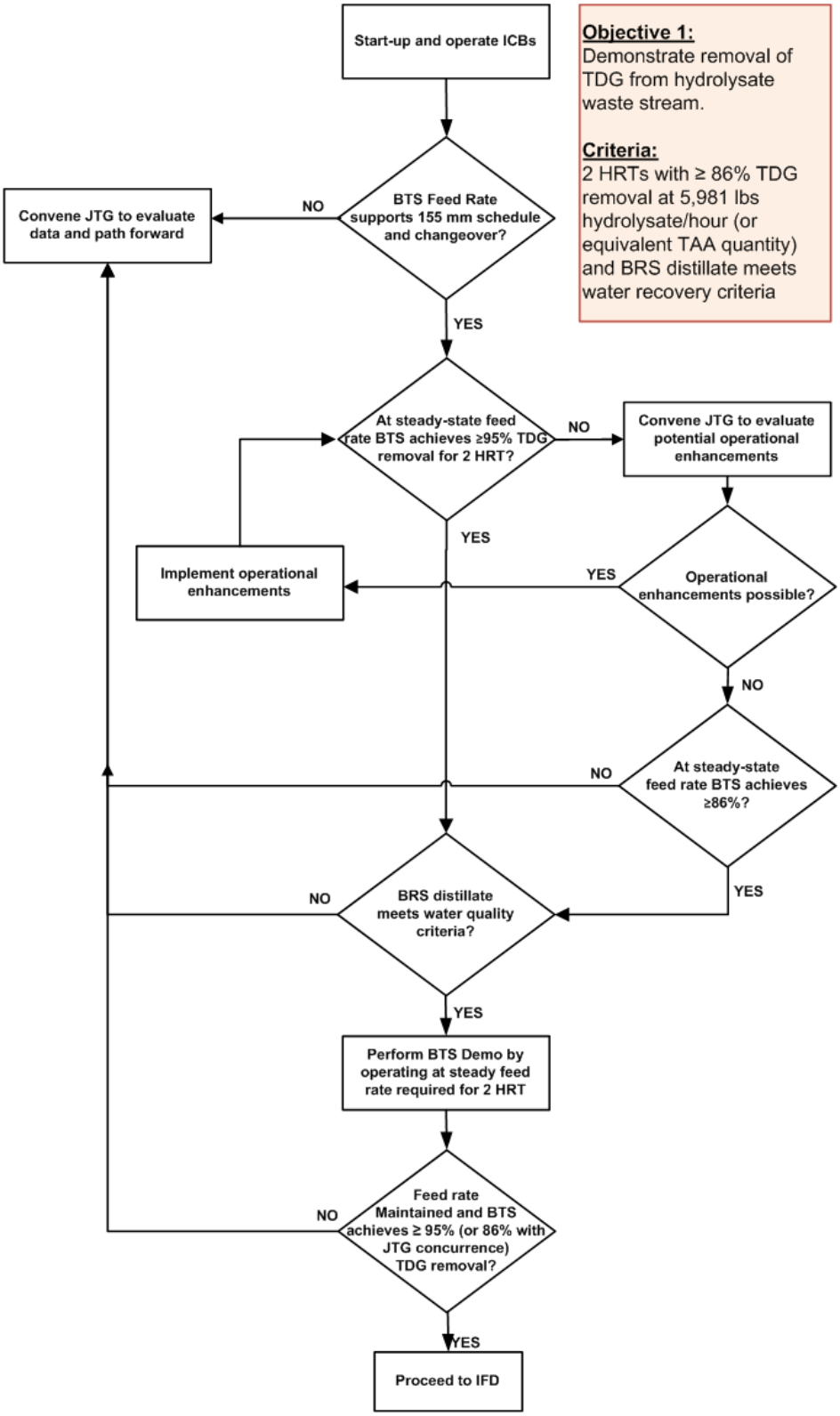

Figure A4A-2. Decision tree for BTS pilot testing.

2.3.2 Demonstration

BTS demonstration, involves operating the BTS at the feed rate required to support the 155 mm schedule and changeover for two HRTs. Feed and effluent concentrations are monitored daily using composite samples to demonstrate performance goals for TDG removal are met (see Section 1.3 and Figure A4A-2). Process parameter ranges and set points are validated.

2.3.3 Integrated Facility Demonstration

Following demonstration, the BTS will continue to process hydrolysate at required feed rates with required TDG removal until such time as the IFD is performed. During the IFD, the BTS will operate under the operating parameters validated and/or defined during start-up and demonstration activities to demonstrate acceptable TDG removal at the required facility feed rates. The IFD will correspond to three demonstration periods in which facility systems are operated with collection of emissions samples at each operating stack. BTS operations will not be interrupted either before or after the IFD and must continue to demonstrate acceptable TDG removal. See Appendix A7 for additional details.

2.4 MATRIX

The test matrix for BTS pilot testing is provided in Table A4A-1. The decision tree for BTS pilot testing is provided in Figure A4A-2.

Table A4A-1. Test Matrix for BTS pilot testing.

ACTIVITY	OBJECTIVE	KEY VARIABLES	PERFORMANCE CRITERIA
Start-up	Demonstrate removal of TDG from hydrolysate waste stream Control fugitive COPC and odor emissions in air Collect and assess data to validate and/or define critical operating parameters for BTS	Feed rate/HRT TDG/DOC concentration in feed and effluent Process parameters: - see Table A4A-2 Odor Monitoring per OMP OTS COPC sampling before, between, and downstream of filter units per LSAP OTS carbon sampling (baseline and periodic sampling with analysis per *Carbon Sampling Strategy, 24852-30H-000-W0004*)	2 HRTs with ≥ 86% TDG removal (see Section 1.3 and Figure A4A-2) at operational feed rate* and BRS distillate meets water recovery criteria (start-up and demonstration) No odor detections per OMP Emissions within MPHRA thresholds** or MPHRA Update (start-up, demonstration, IFD) PPost-IFD MPHRA must exhibit a maximum estimated lifetime cancer risk to any human receptor less than a risk level of 1 in a million (i.e., 1.0 E-06), a maximum estimated combined Hazard Index (HI) to any human receptor less than 0.25, or a total acute HI for any receptor less than 1.0, See Appendix A7
Demonstration			
Integrated Facility Demonstration			

* The operational feed rate is 5,981 lbs hydrolysate/hour (or equivalent *Process Design Throughput and Availability Analysis* (TAA), 24852-RD-30V-000-B0001, quantity). It is the feed rate required to support the 155 mm schedule and changeover.

** Evaluation of emissions against MPHRA thresholds is discussed within Summary Plan for Evaluating Pilot Test Data against MPHRA, 24852-30H-000-L0003.

2.5 PROCEDURE

Hydrolysate is fed to a single feed tank and adjusted as required to support start-up operations. BTS start-up proceeds using standing operating procedure (SOP) 24852-SOP-PT-001, *Pilot Test Evolutions*, and SOP 24852-SOP-B09-W00001, *Biotreatment and Off-gas Treatment*. Throughout start-up, equipment performance and leak detection systems are monitored. Process parameters included in Table A4A-2 in addition to laboratory results for TDG and DOC are evaluated to confirm operating ranges and set points for continued operations. Start-up operations are complete when the BTS operates for two HRTs at the sustained hydrolysate feed rate required to support the 155 mm campaign and changeover with ≥ 86% TDG removal (see Section 1.3 and Figure A4A-2) and BRS distillate satisfies criteria for recycle.

Following start-up, the BTS will enter a demonstration period involving operation of the BTS for a minimum of 2 HRT under operating ranges and set points validated during start-up while collecting daily composite samples from the Feed Tank and Effluent Tank to demonstrate TDG removal. Should a system upset occur during this period, the ICB unit is placed into recovery mode and demonstration testing is re-initiated after units achieve stable operations (i.e., 2 HRT with ≥ 86% TDG removal).

The BTS continues to operate with ≥ 86% TDG removal until the facility is ready to perform the IFD. During IFD demonstration periods, PCAPP collects emissions samples in accordance with Appendix A7. There will be no interruption in stable BTS operations after initial start-up, though feed rates may be adjusted based on hydrolysate generation rates from APB operations.

2.6 DATA COLLECTION

During each of the two test sequences discussed above (i.e., 2 HRT during start-up and 2 HRT during demonstration) and during each IFD period, test data are collected on a Test Performance Control Sheet (TPCS) or data form to be provided in SOP 24852-SOP-PT-001, *Pilot Test Evolutions*. An example of this form is included in Attachment 1. Data collection throughout BTS pilot testing will be in accordance with SOP 24852-SOP-B09-W00001, *Biotreatment and Off-gas Treatment* and governing project plans and procedures.

Additional data to be collected during test sequences include:

(1) Data from the instrumentation identified in Table A4A-2, which will be recorded by the Process Data Acquisition and Recording System (PDARS) and collected by the test team following processing;

(2) Copies of analytical data packages generated from sampling and analyses activities during the demonstration period (i.e., TDG in feed and effluent tanks [performed daily]), which will be collected by the test team after laboratory quality review;

Data are attached to the TPCS either as electronic media or as hardcopy reports. Data for odor monitoring and off-gas sampling will be handled in accordance with Appendix A7 and the OMP. Data associated with carbon loading evaluations will be handled in accordance with the *Carbon Sampling Strategy,* 24852-30H-000-W0004.

Table A4A-2. PDARS-recorded process parameters and instruments[α].

PARAMETER	INSTRUMENT[β]
Hydrolysate from hydrolysate storage tank	FIT-1309
Flow to ICBs Unit 1 Unit 2 Unit 3 Unit 4	 FIT-1350 FIT-1351 FIT-1352 FIT-1353
Nitrogen Nutrient Totalizer	SC-1317
Phosphorus Nutrient Totalizer	SC-1321
ICB feed tank pH	AIT-1325
ICB pH transmitter, Unit 1 Recycle line Compartment 1 Compartment 2 Compartment 3	 AIT-1381 AIT-1407 AIT-1391 AIT-1395
ICB pH transmitter, Unit 2 Recycle line Compartment 1 Compartment 2 Compartment 3	 AIT-1411 AIT-1437 AIT-1421 AIT-1425
ICB pH transmitter, Unit 3 Recycle line Compartment 1 Compartment 2 Compartment 3	 AIT-1441 AIT-1467 AIT-1451 AIT-1455
ICB pH transmitter, Unit 4 Recycle line Compartment 1 Compartment 2 Compartment 3	 AIT-1471 AIT-1497 AIT-1481 AIT-1485
ICB DO transmitter, Unit 1 Compartment 1 Compartment 2 Compartment 3	 AIT-1386 AIT-1392 AIT-1396
ICB DO transmitter, Unit 2 Compartment 1 Compartment 2 Compartment 3	 AIT-1416 AIT-1422 AIT-1426
ICB DO transmitter, Unit 3 Compartment 1 Compartment 2 Compartment 3	 AIT-1446 AIT-1452 AIT-1456
ICB DO transmitter, Unit 4 Compartment 1 Compartment 2 Compartment 3	 AIT-1476 AIT-1482 AIT-1486
ICB temperature, Unit 1 Compartment 1 Compartment 2 Compartment 3	 TIT-1381 TIT-1391 TIT-1395
ICB temperature, Unit 2 Compartment 1 Compartment 2 Compartment 3	 TIT-1411 TIT-1421 TIT-1425

PARAMETER	INSTRUMENT[β]
ICB temperature, Unit 3 Compartment 1 Compartment 2 Compartment 3	 TIT-1441 TIT-1451 TIT-1455
ICB temperature, Unit 4 Compartment 1 Compartment 2 Compartment 3	 TIT-1471 TIT-1481 TIT-1485
ICB Air Flow Unit 1 Unit 2 Unit 3 Unit 4	 FIT-1363 FIT-1364 FIT-1365 FIT-1366
ICB Air Flow Moisture	MT-1782
ICB Air Flow temperature	TIT-1782 TIT-1755
ICB Air Flow Pressure	PIT1505 PIT1749
ICB Headspace Pressure Unit 1 Unit 2 Unit 3 Unit 4	 PI-1405 PI-1435 PI-1465 PI-1495
ICB effluent tank headspace pressure	PIT-1511
BTS OTS hydrogen sulfide analyzer	AIT-1722
BTS OTS temperature at Off-gas Blower	TIT-1782
BTS OTS relative humidity	MT-1782
BTS OTS Pressure	PI-1749
BTS OTS Stack temperature	TI-1755

TBD – To be determined

[α] These parameters are the subset of permitted operating parameters defined in the *Operations Plan* (Permit Modifiation 48) that will be evaluated during pilot testing. In accordance with the responsibility to oversee data collection, analyses, and reporting, and determine when test criteria objectives are satisfied, the Test Coordinator may choose to expand the data collected from PDARS to satisfy pilot test objectives. Set-points and alarms are provided in the SOP 24852-SOP-PT-001, Pilot Test Evolutions.

[β] Instruments from Module 1 will have an additional suffix A, Module 2 a suffix B, etc.

3 SPECIAL QUALITY, SAFETY, SURETY, SECURITY, AND ENVIRONMENTAL REQUIREMENTS

Quality, Safety, Surety, Security, and Environmental considerations for pilot testing are included within the main body of the PTDP. There are no unique considerations that apply to BTS pilot testing.

4 REPORTING

A letter report will summarize the data collected during BTS start-up and demonstration (Section 2.6). Data collected during the IFD will be reported in accordance with Appendix A7. General requirements for letter reports are included within the main body of the PTDP. The letter report for BTS demonstration will focus on performance (i.e., feed rate and TDG removal efficiency) but will also define the operating ranges and set points that are required to sustain performance. The data generated and collected

during start-up and demonstration (see Section 2.6) will be appended to this report. The following list describes the data to be summarized in the report.

- Daily feed rate of undiluted hydrolysate and TDG
- Daily effluent TDG concentrations
- Calculated daily TDG % removal
- Evaluation of DOC correlation with TDG and relevance of DOC as a performance indicator
- Discussion of proposed changes to any operating range or set point required to achieve system performance. At a minimum, this will provide the basis for recommended final operating ranges and set points for pH, DO, TDG feed rate, and nutrient feed ratios.
- Summary of results from odor monitoring if impacted by BTS operations (*Odor Monitoring Report* will provide formal documentation of odor monitoring results and conclusions).
- Summary of results from off-gas sampling and analysis and carbon sampling and analysis for butane activity.

4.1 CALCULATIONS

Percent TDG removal is calculated using equation 1.

$$\%R_{TDG} = \left(1 - \frac{W_{out}}{W_{in}}\right) \times 100 \qquad \text{Equation 1}$$

where:

W_{in} = Mass feed rate of TDG to the BTS

W_{out} = Mass effluent rate of TDG to effluent tank.

The HRT (in days) is calculated using equation 2.

$$HRT = \frac{V}{F \times 1{,}440\ min/day}$$

where:

V = reactor volume, 44,735 gallons

F= Flow to ICBs defined by FIT-1350, FIT-1351, FIT-1352, and FIT-1353 in gpm

Attachment 1

Biotreatment System
Example Test Performance Control Sheet

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Biotreatment System Test Performance Control Sheet			
TPCS No.:		Shift	
Date:		Crew	
ICB Module ID #			
Use a new sheet for each operating day and for each module			

Step #	**Operation**	**Value, ✓, or comment**
1	Review BTS performance metrics:	
	Units on-line:	
	Hydrolysate Feed during past 24-hr period	
	Average TDG removal during past 24-hr period	
	Process parameters within established set points during past 24-hr period? (Y/N), If no, provide reference to appropriate documentation to proceed.	
2	Date/time Sampling of 30-day storage tank used for feed completed:	
	Provide data summary reference number:	
	TDG concentration:	
3	Date/Time Sampling of feed tank influent	
	Sample number/chain of custody (COC) number	
	▪ TDG concentration:	
	▪ DOC concentration (as performed):	
4	Date/Time Sampling of feed tank effluent complete:	
	Sample number/COC number	
	▪ TDG concentration	
	▪ DOC concentration (as performed):	
5	ICB feed flow rate as monitored by PDARS	
	Average flow rate for this 24-hour period	

EXAMPLE

Biotreatment System Test Performance Control Sheet			
TPCS No.:		Shift	
Date:		Crew	
ICB Module ID #			
Use a new sheet for each operating day and for each module			
6	Date/Time Sampling of Effluent Tank complete		
	Sample number/COC number		
	▪ TDG concentration		
	▪ DOC concentration (as performed)		
	Results appended? (Y/N)		
7	Calculated percent removal of TDG:		
	▪ Calculated percent removal of DOC (as performed):		
9	PDARS data per Table A4A-2 or as expanded by the Test Coordinator appended? (Y/N)		
	Process maintained within established operating ranges? (Y/N). If no, reference documentation describing appropriate actions taken.		
Comments:			

APPENDIX A4B: BRINE REDUCTION SYSTEM

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1 INTRODUCTION

This sub-plan describes pilot testing of the Water Recovery System (WRS) and the Brine Reduction System (BRS).

1.1 SYSTEM DESCRIPTION

The WRS includes equipment to temporarily store biologically-treated wastewater prior to transfer to the BRS. The BRS includes equipment and components to remove solids and organic compounds from the brine liquid and to recover water for reuse in the Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP) facility. The BRS produces both a solids cake suitable for offsite disposition and recovered water of sufficient quality to allow it to be recycled in the process.

The WRS is comprised of three Brine Concentrator (BC) feed tanks equipped with agitation and aeration, stores the Immobilized Cell Bioreactor (ICB™) effluent, cooling tower blowdown, boiler blowdown, and reverse osmosis (RO) reject, and equalizes and transfers the mixed brine to the BRS.

Brine from the BC feed tanks is pumped to the BC evaporator feed tank in the BRS, where sulfuric acid and an anti-scale agent are added to eliminate carbonate alkalinity and suppress formation of solids, respectively. The conditioned feed is then preheated and passed through the evaporator Feed De-aerator to the BC Evaporator where the brine is concentrated into a slurry. The concentrated slurry is pumped to the Crystallizer Feed Tank. The evaporated water passes to the Vapor Washer where it is sprayed with water to promote agglomeration of small particles and then to the Vapor Compressor, which increases the pressure and temperature of the vapor. The vapor is then passed through the tubes of the evaporator to both heat the evaporator and to cool the gas to below the dew point. The condensed portion of the water drains to the BC Evaporator Distillate Tank.

From the Crystallizer Feed Tank, the concentrated brine is pumped by the Crystallizer Feed Pump to the Crystallizer, where a recirculation pump circulates the slurry through the heater, producing water vapor and supersaturated crystal slurry. The recirculation pump blows down a portion of the slurry to the BRS Belt Filter, an automatic pressure filter which produces a wet cake containing no free moisture. Filtrate from the belt filter is recycled to the Crystallizer Feed Tank. Evaporated water vapor from the Crystallizer brine enters the Crystallizer Surface Condenser, where the majority condenses. The resulting crystallizer distillate stream drains to the BC Evaporator Distillate Tank where it mixes with the Evaporator vapor condensate. The mixed stream is pumped through the shell side of the BC Feed Preheaters, the Distillate Cooler, and finally to the Distillate Carbon Filter Feed Tank. Following pH adjustment, the distillate passes through the Distillate Carbon Filters before being returned as recovered water to the Process Water Tank. The remaining vapor leaving the Crystallizer Surface Condenser combines with the vent from the Feed De-aerator and passes to the BRS Vent Condenser where some of the vapor condenses and drains to the Distillate Carbon Filter Feed Tank.

Both the WRS and BRS are equipped with an Off-gas Treatment Systems (OTS) incorporating granular activated carbon (GAC) to remove nuisance odors from the vent gases before they are released to the atmosphere.

Further information on the system design is provided in *System Design Description (SDD) for Brine Reduction System (BRS) System No B12*, 24852-RD-3YD-B12-B0001, *System Design Description (SDD) for Water Recovery System (WRS) System No. B14*, 24852-RD-3YD-B14-B0001, and the *Start-up and Operating Manual* for the BRS, 24852-V10A-M000-0713s01.

1.2 OBJECTIVES

The objective of BRS pilot testing is to satisfy the following data elements:

1. Validate BRS operating ranges and setpoints required to produce a distillate acceptable for reuse in the facility at a throughput that supports the operations schedule
2. Control chemicals of potential concern (COPC) and odor emissions in air
3. Collect and assess data to validate and/or define critical operating parameters for the BRS

1.3 LIMITATIONS

1. The system runs best when it is operated continuously at or near full design capacity. BRS testing is dependent on the ICB operations as ICB effluent is the principal feed stream for the BRS. Because the system has a long lag time, changes in capacity are performed slowly.
2. Recovered water will not be transferred to the process water tank until there is sufficient certainty that it will meet the requirements defined in the *BRS Recovered Water Sampling and Analysis Plan* (BRS SAP), 24852-GPP-GGL-00011. It will be temporarily transferred to a BC feed tank and will be reprocessed through the BRS.
3. PCAPP will assess emissions against risk and hazard thresholds defined in the *Multiple Pathway Health Risk Assessment Report for the Pueblo Chemical Agent Destruction Pilot Plant with Explosive Destruction System* [MPHRA], 24852-3RC-000-V0007 as per the *Summary Plan for Evaluating Pilot Test Data against MPHRA*, 24852-30H-000-L0003. As detailed in that plan, pilot test data for (1) COPC sampling per the *Laboratory Sampling and Analysis Plan for Pilot Test Phase Operations*, 24852-GPP-GGL-00013 (LSAP), (2) odor monitoring per the *Odor Monitoring Plan for Pilot Test Phase Operations* (OMP), 24852-GPP-GGG-V0018 and (3) carbon sampling for butane activity per the *Carbon Sampling Strategy*, 24852-30H-000-W0004 to demonstrate process facilities and equipment operate as designed, validate the Multiple Pathway Health Risk Assessment, and help CDPHE assess recommended PCAPP operating parameters for the Part B Permit.

4. Pilot testing of the WRS is limited to validation of COPC and odor control in accordance with bullet 3.

2 PILOT TEST DEMONSTRATION APPROACH

2.1 OVERVIEW

BRS pilot testing consists of ramp-up and integrated facility demonstration (IFD). Ramp-up consists of processing at full rate for limited daily intervals until upstream processes allow for continuous operations. Ramp-up operations are used to validate critical operating ranges and set points provide distillate water of sufficient quality for recycling and produce filter cake properties satisfying disposition requirements. Such operating ranges and set points include distillate carbon maintenance requirements and throughput (i.e., feed rate). Once critical operating parameters and set points are validated and the BRS is operating at full throughput, the BRS will continue to operate at required feed rates with production of distillate satisfying BRS SAP criteria through completion of the IFD when emissions samples are collected from the BRS stack during three four-hour periods consistent with Appendix A7. Throughout ramp-up and IFD, control of COPCs and odor emissions is monitored in accordance with the OMP, LSAP and *Carbon Sampling Strategy*.

2.2 MATERIALS

No pilot-test-specific materials or equipment are required.

2.3 DESIGN

2.3.1 Ramp Up

During ramp-up, the BRS operates for limited intervals determined by ICB start-up and available buffer storage capacity in the WRS. Treated water discharged from the BRS Distillate Carbon Filters is redirected to one of the BC Feed Tanks until CDPHE agrees there is sufficient assurance that the distillate will satisfy requirements defined in the BRS SAP for recycle. This distillate is then processed through the BRS for recovery of water. Distillate sampling is conducted in accordance with the LSAP and the BRS SAP. Throughout ramp-up, the test team monitors and records the operating parameters listed in Table A4B-2 to verify system operation at the required throughput and validate critical operating parameters, alarms, and set points for continued operations. The dewatered salt cake is tested in accordance with the LSAP. Odor monitoring and COPC sampling in OTS is conducted in accordance with the OMP from the start of ramp-up through completion of the IFD.

2.3.2 Integrated Facility Demonstration

Following ramp-up, the BRS continues to process brine at the required feed rates while producing distillate satisfying BRS SAP criteria until the IFD is performed. During the IFD, the BRS operates under the operating parameters validated and/or defined during ramp-up activities to demonstrate acceptable distillate quality at the required facility feed

rates. The IFD corresponds to three demonstration periods in which facility systems are operated with concurrent collection of emissions samples at each operating stack. See Appendix A7 for additional details.

2.4 MATRIX

The test matrix for BRS pilot testing is provided in Table A4B-1. The decision tree for BRS pilot testing is provided in Figure A4B-1.

Table A4B-1. Test Matrix for BRS pilot testing.

ACTIVITY	OBJECTIVE	KEY VARIABLES	PERFORMANCE CRITERIA
Ramp-up	Validate BRS operating ranges and set points required to produce a distillate acceptable for reuse in the facility at a throughput that supports the operations schedule Control fugitive COPC and odor emissions in air Collect and assess data to validate and/or define critical operating parameters for the BRS.	Process Parameters (see Table A4B-2) and process data (e.g., total suspended solids [TSS]) Sampling and analysis of BRS effluent Sampling upstream, between, and downstream of distillate carbon Analytical methods' defined tolerance, precision, and bias Throughput/ Feed rate Free liquids test of filter cake OTS carbon sampling (baseline and periodic sampling with analysis per *Carbon Sampling Strategy, 24852-30H-000-W0004*) Odor monitoring per OMP OTS COPC sampling before, between, and downstream of filter units	Distillate satisfies BRS SAP criteria Throughput supports 155-mm schedule and changeover No odor detections per OMP Emissions within MPHRA thresholds* or MPHRA Update Post-IFD MPHRA must exhibit a maximum estimated lifetime cancer risk to any human receptor less than a risk level of 1 in a million (i.e., 1.0 E-06), a maximum estimated combined Hazard Index (HI) to any human receptor less than 0.25, or a total acute HI for any receptor less than 1.0, See Appendix A7
Integrated Facility Demonstration			

Evaluation of emissions against MPHRA thresholds is discussed within the *Summary Plan for Evaluating Pilot Test Data against MPHRA,* 24852-30H-000-L000.

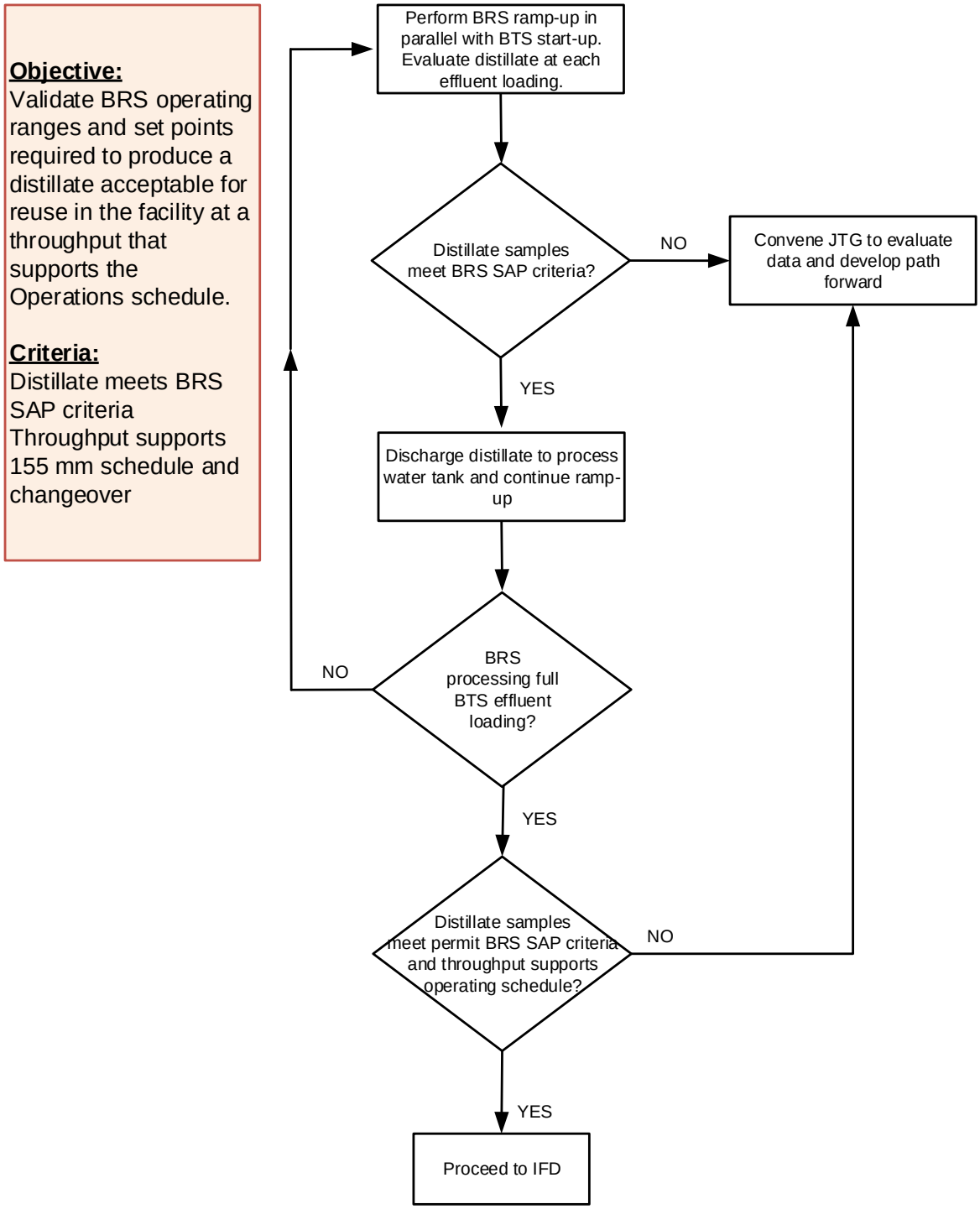

Figure A4B-1. Decision tree for BRS pilot testing.

JTG = Joint Test Group

2.5 PROCEDURE

BRS ramp-up commences after the JTG assesses BTS start-up and corresponding brine generation rates and WRS tank levels and determines that both are sufficient to support ramp-up. BRS ramp-up proceeds using Standing Operating Procedures (SOP) 24852-SOP-PT-001, *Pilot Test Evolutions*, and SOP 24852-SOP-B12-W0001, *Brine Reduction*.

Brine (BTS effluent, cooling tower and boiler blowdown, and RO reject) are fed to the BRS from the BC Feed Tanks at the rate demonstrated and validated during systemization phase activities. Throughout ramp-up, the following activities are performed:

- Equipment performance and leak detection systems are monitored.
- Process parameters included in Table A4B-2 in addition to laboratory results (discussed below) are trended to confirm operating ranges and set points for continued operations.
- Samples are collected from the evaporator brine and crystallizer slurry at the frequency established in SOPs and analyzed in accordance with method PCAPP-0106: *Determination of TSS, TDS, and VSS in Hydrolysate*, 24852-GPP-GGL-00106. Testing validates ranges for these parameters which are currently estimated to be < 1 wt% TSS in the brine concentrator and between 15 and 27% TSS in the crystallizer slurry.
- Distillate sampling is performed at the frequency specified in the SOPs and analyzed in accordance with analysis methods identified in the LSAP and the BRS SAP to confirm criteria for recycle are satisfied.
- Recovered water is temporarily stored in one of the three BC Feed Tanks until sampling and analysis provide assurance that distillate satisfies BRS SAP criteria. When the JTG determines distillate can be transferred to the process water tank, distillate temporarily stored in the BC feed tank is mixed with brine and reprocessed through the BRS prior to transfer to the process water tanks, using process parameters previously demonstrated to yield acceptable distallate.
- Filter cake, collected in roll-off bins, is sampled at the frequency defined in SOPs and analyzed in accordance with method PCAPP-0124, *Determination of Free Liquids*, 24852-GPP-GGL-00124, to confirm disposition requirements.
- Samples are collected upstream, between, and downstream of the distillate carbon filters to validate the vendor-provided changeout schedule for carbon filters at the frequency defined in the BRS SAP.
- Odor monitoring and COPC sampling in the off gas is conducted in accordance with the OMP. Unless sampling is already performed as a result of odor detections per OMP, COPC and carbon sampling will be conducted during a period of operation after the first module of the BTS is operating at full rate.

Following BRS ramp-up the BRS continues to operate until the facility is ready to perform the IFD. During IFD demonstration periods, PCAPP collects emissions samples in accordance with Appendix A7.

2.6 DATA COLLECTION

Test data will be collected on a Test Performance Control Sheet (TPCS) or data form to be provided in SOP 24852-SOP-PT-001, *Pilot Test Evolutions*. An example of this form is included in Attachment 1. Additional data to be collected include (1) data from the instrumentation included in Table A4B-2 which will be recorded by the Process Data Acquisition and Recording System (PDARS) and collected by the test team following testing, and (2) analytical data packages generated from sampling and analyses activities (e.g., settleable solids). Data are attached to the TPCS either as electronic media or as appropriate hardcopy reports. Data for odor monitoring and off-gas sampling will be handled in accordance with Appendix A7 and the OMP. Data associated with carbon loading evaluations will be handled in accordance with the *Carbon Sampling Strategy,* 24852-30H-000-W0004*.*

Table A4B-2. PDARS-recorded process parameters and instruments *

PARAMETER	INSTRUMENT
BC Feed Tank Level	LI-2257 LI-2277 LI-2287
Moisture Content of BC Feed Tank Off-gas (prior to GAC filters)	MIC-2293
Pressure (upstream of BC Feed Tank Off-gas Blowers)	PI-2292
Temperature (upstream of BC Feed Tank Off-gas Blowers)	TI-2230-A
BC Evaporator Feed Tank pH	AIT-1803
BC Evaporator Feed Flow	FI-1806
BC Feed Preheater Distillate Outflow	FI-1814
BRS Distillate Cooler Outlet Temperature	TIT-1871
BRS Distillate Cooler Conductivity	CIC-1873
BRS Evaporator Feed De-aerator Pressure	PIT-1884
BC Evaporator pressure	PIT-1890
BC Evaporator heater pressure	PIT-1897
BC Evaporator Recirc Pump motor current	IT-1898
BC Evaporator Recirc Temperature	TIT-1893
BC Vapor Washer Condensate Conductivity	CIT-1901
Crystallizer Feed Tank Feed Flow	FIT-1945
Crystallizer Feed Tank Level	LIT-1946
Crystallizer Level	LIC-1960
Crystallizer pressure	PIT-1962
Crystallizer Discharge Temperature	TIT-1961
Crystallizer Recirc Pump motor current	IT-1971
BRS Distillate pH control	AI-2025
Distillate Flow to Carbon Filters	FI-2030
Distillate carbon filter differential pressure	PDIT-2033A/B/C
BC Evaporator Antifoam Metering Pump (MP-B12-0012A/B) Operation	SIT-2076A/B
Crystallizer Antifoam Metering Pump (MP-B12-0013A/B) Operation	SIT-2077A/B
BRS Antiscale Metering Pump (MP-B12-0014A/B) Operation	SIT-1806A/B
OTS carbon filter differential pressure	PDIT-2053A/B/C
BRS OTS Heater Relative Humidity	MIT-2046C
BRS OTS Temperature	TIT-2046B
Pressure of BRS Off-gas	PIT-2045

* These parameters are the subset of permitted operating parameters defined in the *Operations Plan* (Permit Modifiation 48) that will be evaluated during pilot testing. In accordance with the responsibility to oversee data collection, analyses, and reporting and determine when test criteria objectives are satisfied, the Test Coordinator may choose to expand the data collected from PDARS to meet pilot test objectives. Set-points and alarms are provided in the SOP 24852-SOP-PT-001, Pilot Test Evolutions.

3 SPECIAL QUALITY, SAFETY, SURETY, SECURITY AND ENVIRONMENTAL REQUIREMENTS

Quality, Safety, Surety, Security and Environmental considerations for pilot testing are included within the main body of the *Pilot Test Demonstration Plan* (PTDP). There are no unique considerations applicable for BRS pilot testing.

4 REPORTING

A letter report will summarize the data collected during BRS ramp-up. Data collected during the IFD will be reported in accordance with Appendix A7. General requirements for letter reports are included within the main body of the PTDP. The letter report for BRS ramp-up will focus on performance (i.e., feed rate and distillate quality), but will also be the basis for recommended operating ranges and set points that are required to sustain performance. The data generated and collected during ramp-up (see Section 2.6) will be appended to this report. The following list describes the data to be summarized in the report.

- Daily brine feed with an assessment of the ability of the BRS throughput to satisfy requirements.
- Results for filter cake analyses with an assessment of disposition requirements.
- Distillate water quality analyses results.
- Identification of recommended critical operating parameters for production of distillate satisfying BRS SAP criteria. This will include a discussion of proposed changes to any operating range or set point required to achieve system performance. Final operating ranges and set points for distillate carbon maintenance, distillate conductivity, distillate filter differential pressure, OTS carbon differential pressure, crystallizer discharge temperature, distillate cooler outlet temperature, evaporator and crystallizer TSS and slurry density, and other parameters defined in Table A4B-2 will be defined or demonstrated to not be critical for system performance.
- Summary of results from odor monitoring if impacted by BRS operations (the *Odor Monitoring Report* defined in the OMP will provide formal documentation of odor monitoring results and conclusions).
- Summary of results from off-gas sampling and analysis and carbon sampling and analysis for butane activity.

4.1 CALCULATIONS

There are no pilot-test-specific calculations associated with this plan.

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Attachment 1

Brine Reduction System
Preliminary Test Performance Control Sheet

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Brine Reduction System Test Performance Control Sheet			
TPCS No.:		Shift	
Date/Time:		Crew	
Complete one sheet per shift			

Step #	**Operation**	**Value, ✓, or comment**
1	Starting conditions:	
	Distillate Carbon Filter unit Lead Bed? (A, B, C)	
	Distillate Carbon Filter unit Lag Bed? (A, B, C)	
	Date/Time of distillate carbon lead bed changeout:	
	Continuous feed? (Y/N)	
	Evaporator Feed Rate:	
	Crystallizer Feed Rate:	
	Average Water Recovery Rate (gpm):	
2	Number of rolloffs of salt cake generated:	
	Dewatered salt cake sampled and analyzed per LSAP? (Y/N)	
	Sample and chain of custody (COC) number	
	COPC and results appended?	
3	Sampling conducted upstream, between, and downstream of distillate carbon filters? (Y/N) If No, go to Step 8.	
	Samples collected upstream of carbon filters? (Y/N/NA)	
	Sample times	
	Sample and COC number:	
	Samples collected between carbon filters? (Y/N/NA)	

EXAMPLE

	Sample times	
	Sample and COC number:	
	Samples collected after carbon filters? (Y/N/NA)	
	Sample times	
	Sample and COC number:	
	Analysis performed in accordance with LSAP? (Y/N)	
	COC and results appended? (Y/N)	
4	Distillate carbon breakthrough observed? (Y/N/NA)	
5	Recovered water meets standards for recycle? (Y/N/NA)	
6	BRS OTS odor and COPC testing/carbon sampling (as required) performed in accordance with OMP? (Y/N)	
7	PDARS data appended? (Y/N)	
Comments:		

EXAMPLE