APPENDIX A1: MUNITIONS UNPACKING and PROJECTILE/MORTAR DISASSEMBLY

Each PMD is a complete, stand-alone unit, with a dedicated controls package integrated with the PCAPP Facility Control System.

Downstream of each PMD is a PMD Discharge system located in the Monitoring Areas to the east of the ECRs. Each PMD Discharge system consists of three Munitions Monitoring Enclosures (MME), three Parts and Energetics Monitoring Enclosures (PME), and associated transfer equipment. The MMEs receive munitions following enhanced reconfiguration in the PMD system and hold the munitions for at least one continuous MINICAMS monitoring cycle (nominal monitoring time of 10 minutes following loading of the last munitions body into the MME) to assess potential agent hazards prior to release of munitions to appropriately protected workers. Three MMEs are associated with each PMD line. During normal operations, one MME operates in loading mode, one in monitoring mode, and one in unloading mode. A maximum of 10 munitions is held for monitoring within each MME. Each MME is equipped with a dedicated MINICAMS which cycles constantly throughout MME operations; as such, MINICAMS monitor during the loading, monitoring and unloading modes. Munitions monitored at less than the action level are offloaded from the MME and manually loaded onto slave pallets for further processing.

The energetics and miscellaneous parts removed from munitions are released into one of three PMEs. The PMEs hold the parts trays for at least one continuous MINICAMS monitoring cycle (nominal monitoring time of 10 minutes) to assess potential agent hazards prior to release of energetics and miscellaneous parts to appropriately protected workers. During normal operations, one PME operates in loading mode, one in monitoring mode, and one in unloading mode. A maximum of 10 parts trays is held for monitoring within each PME. Each PME is equipped with a dedicated MINICAMS which cycles constantly throughout PME operations (i.e., throughout the loading, monitoring, and unloading modes). If a PME demonstrates monitoring levels less than the action level, personnel manually package the energetics and miscellaneous parts for disposition.

Reference *System Design Description (SDD) for Munitions Unpacking and Projectile/Mortar Disassembly System No. B01*, 24852-RD-3YD-B01 for additional details.

1.2 OBJECTIVES

The objectives of Munitions Unpacking and PMD System pilot testing are:

- Demonstrate energetics removal/handling and disposition and demonstrate the PMD will support the operating schedule.
- Collect and assess data to validate and/or define critical operating parameters.
- Certify the monitoring protocol for the disposition of dunnage (OPP) relative to agent contamination (K901/K902).

1.3 LIMITATIONS

PMD operations are limited by available buffer storage in the Munitions Body Storage Building and Munitions Washout System (MWS) processing rates.

Characterization of dunnage for other applicable waste codes will be conducted in accordance with the *Wooden Dunnage Sampling and Analysis Plan*, 24852-GPP-GGL-00015.

2 PILOT TEST DEMONSTRATION APPROACH

2.1 OVERVIEW

Munitions Unpacking and PMD system pilot testing involves ramp-up to a rate sufficient to support the project schedule. Munitions Unpacking and PMD pilot test operations are coordinated with downstream pilot tests (e.g., MWS and Munitions Treatment Unit [MTU] pilot testing) to ensure sufficient munitions are available for downstream processing.

2.2 MATERIALS

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

2.3 DESIGN

The gradual ramp-up of the Munitions Unpacking and PMD system will involve daily review of rejects and system performance to verify proper function. A single PMD is used during initial processing to minimize potential contamination of the remaining lines should equipment modifications be required as a result of lessons-learned. The PMD is ramped to full operations with continuous data collection in concert with available buffer capacity and ramp-up of downstream process systems (i.e., MWS and MTU).

During PMD operations, monitoring protocols are certified in accordance with the *Laboratory Quality Control Plan* (LQCP), 24852-GPP-GGL-00003.

2.4 MATRIX

The test matrix for Munitions Unpacking and PMD pilot testing is included in Table A1-1.

Table A1-1. Test Matrix for Munitions Unpacking and PMD pilot testing.

ACTIVITY	OBJECTIVE	KEY VARIABLES	PERFORMANCE CRITERIA
Ramp-up	Demonstrate energetics removal/handling and disposition and demonstrate the PMD will support the operating schedule. Collect and assess data to validate and/or define critical operating parameters. Certify the monitoring protocol for the disposition of dunnage (OPP) relative to agent contamination (K901/K902).*	Process parameters: See Table A1-2 Monitoring data Treatment, storage, and disposal facility (TSDF) acceptance criteria	PMD set-up verified and stations performing intended function ≤ 59 rejects during ramp-up ≤ 0.01% leaker rate Process at a rate that supports 85.5 weeks for the 155-mm campaign Monitoring results for waste disposition of < 1.0 Vapor Screening Level (VSL) with no evidence of staining and/or liquid**

* Performance criteria for monitoring certification are defined in the LQCP. Characterization of dunnage for other applicable waste codes will be conducted in accordance with the *Wooden Dunnage Sampling and Analysis Plan*, 24852-GPP-GGL-00015.

** Energetics monitored at greater than TSDF acceptance criteria are dispositioned in the Explosive Destruction System (EDS). Miscellaneous parts or dunnage monitored at greater than TSDF acceptance criteria are treated in the Supplemental Decontamination Unit (SDU) and/or shipped for off-site disposition in accordance with the Chemical Materials Agency (CMA) *Bounding Transportation Risk Assessment* (BTRA).

2.5 PROCEDURE

Munitions Unpacking and PMD ramp-up starts with approval to commence agent operations and proceeds using Standing Operating Procedure (SOP) 24852-SOP-PT-001, *Pilot Test Evolutions,* and SOP 24852-SOP-B01-W0001, *Projectile/Mortar Disassembly*. Early in ramp-up, the PMD is verified to perform through a slow ramp-up of munitions processing. Initially, only a single line is used to minimize potential contamination of the other lines. As experience is gained, parallel line operations commence and ramp-up continues until full throughput is achieved. Throughout ramp-up, operations are paused and the Joint Test Group (JTG) is convened if the observed reject or leaker rates are greater than that anticipated by design documentation. Monitoring protocols are certified throughout ramp-up in accordance with the LQCP. Monitoring results and visual inspections are used to support disposition of dunnage, energetics, and miscellaneous parts in accordance with treatment, storage, and disposal facility (TSDF) acceptance criteria.

2.6 DATA COLLECTION

During Munitions Unpacking and PMD ramp-up, 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.

Additional data to be collected include data from the instrumentation identified in Table A1-2, which will be recorded by the Process Data Acquisition and Recording System (PDARS) and collected by the test team following processing. Data are attached to the TPCS either as electronic media or as appropriate hardcopy reports.

Table A1-2. PDARS-Recorded Process Parameters and Instruments

PARAMETER	INSTRUMENT
Munitions reconfigured	Programmable Logic Controller (PLC) counter QI8000A/B/C-A
Munitions rejected	PLC counter QI8000A/B/C-B
Munitions processed	PLC counter QI8000A/B/C-C

* 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.

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. The following unique considerations apply for the PMD:

- Air monitoring data for process areas will be reviewed using laboratory data tracking methods to confirm munitions, energetics, and miscellaneous parts do not pose a potential risk to workers in accordance with the Laboratory Analysis and Monitoring Plan (LAMP) 24852-GPP-GGL-00002.

- In the event agent is detected visually or using existing monitoring stations in the MAVs, Munitions Service Magazines (MSM), OPPs, Reconfiguration Room (RR), Vapor Containment Room (VCR), ECRs, MME, or PME during operations, an investigation will be conducted to determine the nature of the contamination. This investigation will be comprehensive and will determine the cause of the event or clearance failure and evaluate the potential for contamination of materials or surfaces as a result of the event.

4 REPORTING

A letter report will summarize the data collected during Munitions Unpacking and PMD pilot testing. General requirements for letter reports are included within the main body of the Pilot Test Demonstration Plan (PTDP). The letter report for Munitions Unpacking and PMD will focus on performance (e.g., throughput, reject rate) and will define any critical operating parameters identified through testing. Data generated and collected during testing (see Section 2.6) will be appended to this report. The following list describes the data to be summarized in the report.

- Daily munitions processed
- Calculated reject rate for ramp-up
- Calculated leaker rate for ramp-up
- Average throughput
- Critical operating parameters (if any)

4.1 CALCULATIONS

Average throughput will be calculated as the total number of munitions reconfigured (per PLC counter QI8000A-A) divided by the total processing time.

The reject rate is calculated as the number of rejects found per cumulative munitions processed.

The leaker rate is calculated as the number of leakers identified per cumulative munitions received.

Attachment 1

Munitions Unpacking and Projectile Mortar Disassembly System Example Test Performance Control Sheet

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Munitions Unpacking and Projectile Mortar Disassembly System Test Performance Control Sheet			
TPCS no.		Shifts	
Date:		Crews	
Munitions Lot #(s)			
Use a new sheet for each operating day.			

Step #	**Operation**	**Value, ✓, or comment**
1	OPP MINICAMS results < 0.2 VSL (Y/N) If no, document actions taken in comments section. Append supporting data (as required).	
2	Date/Time start feed to PMD_____ (specify PMD station ID) Date/Time start feed to PMD _____ (specify PMD station ID)	
3	MME MINICAMS results < 0.2 VSL (Y/N) If no, document actions taken in comments section. Append supporting data (as required).	
4	PME MINICAMS results < 0.2 VSL (Y/N) If no, document actions taken in comments section. Append supporting data (as required).	
5	Date/ Time PMD feed stopped_____ (specify PMD station ID) Date/Time PMD feed stopped_____ (specify PMD station ID)	
6	ECR MINICAMS alarm (Y/N) If yes, document actions and findings in comments.	
7	Munitions processed between steps 2 and 5 on: _____ (specify PMD station ID) _____ (specify PMD station ID)	
	Munitions reconfigured between steps 2 and 5: _____ (specify PMD station ID) _____	

EXAMPLE

	(specify PMD station ID)	
	Munitions rejected between steps 2 and 5 on: _____ (specify PMD station ID) _____ (specify PMD station ID)	
8	Calculated throughput: _____ (specify PMD station ID) _____ (specify PMD station ID)	
	Calculated reject rate: _____ (specify PMD station ID) _____ (specify PMD station ID)	
	Leakers identified (Y/N). If yes, specify location.	
9	Supporting PDARS data appended? (Y/N)	
Comments:		

EXAMPLE

APPENDIX A2A: MUNITIONS WASHOUT SYSTEM

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1 INTRODUCTION

This sub-plan describes pilot testing of the Munitions Washout System (MWS).

1.1 System Description

The MWS consists of two identical lines, both dedicated to processing the same caliber of munition simultaneously. The various munitions types are processed in separate campaigns. Only the 155-mm process is discussed here.

There are two MWS lines. Each MWS line feeds drained and washed munitions to a dedicated Munitions Treatment Unit (MTU) and consists of the following equipment:

1. One MWS munitions loading conveyor with a laser burster detector
2. One manual loading lift assist
3. One MWS airlock/conveyor
4. One MWS feed conveyor
5. One MWS robot
6. Five Cavity Access Machine (CAM) stations, two of which are installed spares
7. One reject table with four slots which allow the munition bodies to be stored in a vertical (ogive end up) orientation
8. One washed agent and water surge drum
9. Two washed agent and water booster pumps
10. One MWS high pressure washout water (HPWW) skid (one additional installed spare pump supports both lines)
11. One hydraulic power unit which provides hydraulic fluid power for CAM actuation
12. One CAM valve station, containing hydraulic control valves
13. Five CAM Utility Stations, which provide the utility systems/CAM interface
14. A safety fence surrounding the robot working area and enclosing the CAMS and reject table, which prevents inadvertent access by operating personnel to the robot swing area

Munitions are transferred via a loading conveyor to the airlock conveyor and then to the feed conveyor in the MWS room where the MWS robot picks up the munitions and places them nose-down into the rotary drain cup in a CAM. The CAM bail is raised to provide a vertical “stop” above the munition. A bladder seal is inflated which lifts the munition against the bail and makes a tight seal between the munition ogive and the CAM drain cup to contain agent liquid and headspace gas. The CAM uses a hydraulic ram to access the agent cavity by breaking the adapter, pausing, and then collapsing the burster well. To accommodate pressurized rounds, the ram pauses for 5 seconds as

soon as the adapter is breached; this controls the munition depressurization rate before completing the full punch.

After collapsing the burster well, the ram is partially retracted and HPWW is sprayed into the munition through two nozzles in the ram to clean the agent cavity. The HPWW skids can generate a maximum pressure of 10,000 psig. The HPWW Drum skid is fed with treated water from the reverse osmosis (RO) product water system. The skid is equipped with a heater that heats the incoming RO water to 110 ± 5°F. During washout, the munition is first rotated clockwise and then rotated counterclockwise in order to maximize agent and heel removal.

Drained agent and washout water are collected in a drain header. The liquid flows through the header, through a solids strainer containing a filter sock, and into the washed agent and water surge drum. The CAM drain header is continuously purged with air in order to remove and dilute any headspace gas vented from the munitions during agent access. Mixed agent and water is transferred from the washed agent and water surge drum to the agent/water separators in the Agent Collection and Neutralization System via the washed agent and water booster pump.

After washout of the munition, the robot picks up the drained round and transfers it to the MTU Drained Munitions Weigh Station (DMWS). If a munition exceeds the allowable maximum weight tolerance it is automatically returned to the same CAM for reprocessing. The maximum weight tolerance set point will be evaluated as part of pilot testing.

Reference *System Design Description (SDD) for Munitions Washout System (MWS) System No. B02* 24852-RD-3YD-B02-R0001 for additional system descriptions.

1.2 Objectives

The objectives of MWS pilot testing are to:

1. Establish ranges and set points to achieve cleanliness of munitions bodies to the extent reasonably possible
    a. Establish optimal operating ranges and set points
    b. Collect and assess data to validate and/or define critical operating parameters for the MWS
2. Confirm maximum munitions' body weight limit at DMWS (within the MTU system) is sufficient to allow confirmation of a breached munition

1.3 Limitations

1. MWS operations are limited by the availability of the MTU to process washed and drained munitions.
2. There is both a maximum (10,000 psig) and a minimum (approximately 5,000 psig) pressure for the HPWW. Water flow rate at each pressure is determined by

the HPWW nozzles in the ram and can only be altered by changing out the ram nozzles during an MWS shutdown.

3. The duration for the high-pressure wash must take into account other limiting factors such as robot processing times (i.e., the robot cycle times with three CAMS operating per line make it unlikely that wash times lower than 70 seconds would result in increased throughput).

2 PILOT TEST DEMONSTRATION APPROACH

The following paragraphs define MWS pilot testing activities. MWS pilot testing is coordinated with upstream and downstream pilot tests (e.g., Projectile Mortar Disassembly [PMD], MTU, Agent/Water Separator, and Off-gas Treatment System [OTS] and Agent Filtration Area [AFA] pilot testing) as defined in the *Pilot Test Demonstration Plan* (PTDP). Where applicable the PTDP main plan or appendices are referenced for direct support of MWS pilot test activities.

MWS pilot testing provides final validation of MWS operations using Pueblo Chemical Depot (PCD) stockpile munitions. Proper MWS operation and standing operating procedure (SOP) validation is demonstrated during systemization.

2.1 Overview

MWS pilot testing includes ramp-up, testing, and integrated facility demonstration (IFD). During ramp-up, the MWS processes munitions for increasing periods of continuous operations to confirm proper MWS operations (i.e., achieve the cleanliness of munitions to the extent reasonably possible). Initial ramp-up is conducted using a single MWS line to allow any required equipment modifications, identified as a result of lessons-learned, to be more easily incorporated into the second line prior to its contamination with agent. Processing during the ramp-up phase will establish a baseline for key operating parameters for the MWS and MTU (see Appendix A2B, MTU). For example, MWS ramp-up will establish the set point of the DMWS. Although the DMWS is within the MTU (B03) system, validation of the DMWS weight tolerance is included as part of MWS pilot testing based on its direct association with MWS performance.

Following ramp-up, optimization testing is performed to identify the independent and dependent variables and define optimal (sustainable and operable) settings for dependent variables which achieve cleanliness, to the extent reasonably possible, and satisfy the operating schedule of 85.5 weeks for the 155-mm campaign. If successful, the optimized parameters will be used for subsequent testing with same DMWS developed using the baseline parameters.

During the IFD, munitions are processed to support collection of facility emissions samples (see Appendix A7 for further details).

2.2 Materials

A weigh scale with specifications equivalent to the DMWS scale is located in the Munitions Receiving Room (MRR) (this scale is also specified in the MTU sub-plan [Appendix A2B]).

Equipment and materials required for off-gas sampling during MWS pilot testing as specified in the OTS/AFA sub-plan (see Appendix A6) are defined in the analytical methods and procedures identified in the *Laboratory Sampling and Analysis Plan for Pilot Test Phase Operations*, 24852-GPP-GGL-00013 (LSAP).

2.3 Design

MWS pilot testing consists of three activities:

Ramp-up: The MWS is slowly ramped-up using operating parameters validated during systemization. Processing during this phase confirms the ability of the MWS to achieve the cleanliness of munitions to the extent reasonably possible, collects data to confirm or revise the DMWS set point, and supports other pilot test activities (i.e., MTU and OTS/AFA pilot testing, see Appendices A2B and A6).

Testing: A design of experiment (DOE) is used to define independent and dependent variables and establish optimal settings for the dependent variables that achieve cleanliness, to the extent reasonably possible, at a throughput that supports the operating schedule.

Integrated Facility Demonstration: The MWS is operated at the critical operating parameters defined through ramp-up and testing during three 4-hr periods to support facility emissions sampling. See Appendix A7 for additional details on the IFD.

Ramp-up and testing activities are further discussed in the paragraphs that follow. Figure A2A-1 and Figure A2A-2 provide the decision trees applicable to MWS pilot test demonstration.

2.3.1 Ramp-up

MWS ramp-up uses operating parameters determined during pre-operations testing to achieve reasonable cleanliness. Ramp-up involves daily review of rejects and system performance to verify proper function. Both MWS and MTU process parameters are used as indicators of MWS performance. MWS process parameters pertinent to pilot testing are provided in Table A2A-3. Set points and alarms for critical system parameters are provided SOP 24852-SOP-PT-001, Pilot Test Evolutions. MTU process parameters are defined in Appendix A2B but include zone temperature, zone current, offgas temperature, offgas flow, and readings from a carbon dioxide sensor located in the exhaust.

Ramp-up is conducted slowly to allow for system evaluations. A single MWS line is used during initial processing to minimize potential contamination of the remaining line should equipment modifications be required as a result of lessons-learned. As

operational experience is gathered, processing on the second line is initiated. The first 59 munitions processed will automatically be washed twice to assess the ability of the MWS to achieve cleanliness to the extent reasonably possible. These 59 munitions will be taken from a minimum of 2 munitions lots. The first wash will be conducted as per design MWS operating conditions. The second wash will be conducted under design operating conditions except that a total wash duration of 280 sec (vs. 140 s design) will be used. The differential weight between the initial weight (as measured by the DMWS following the initial wash) and the second weight (as measured by the DMWS after the rewash) will be used to assess munition cleanliness. Observation of a change in weight greater than scale variability established through systemization phase testing (i.e., observation of an *incompletely washed round*) will pause operations for evaluation of MWS operations. A munitions that demonstrates no change in weight between washes but is still rejected by the DMWS based on weight will be identified as a *false reject* and will be processed through the MTU. If more than two false rejects are observed during processing of the first 59 munitions, operations will be paused and the Joint Test Group (JTG) convened to evaluate data and develop a path forward.

Following these initial 59 munitions, MWS operations will continue to ramp-up to achieve continuous operations on parallel lines for a minimum of 4 hours at a maximum sustained rate as required to support the MWS/MTU demonstration (see Appendix A6). During this ramp-up, MWS and MTU process conditions will be reviewed for any deviations that could indicate incomplete washout of munitions. MTU baseline parameters will be established after execution of the MWS/MTU demonstration (see Appendix A6). Deviations from this baseline will be assessed during normal and off-normal (see Section 2.3.2) operations for indications of MWS upset conditions. Any munition rejected at the DMWS during this period will be rewashed using a 280-sec wash duration. In addition to proceeding with the evaluation of the DMWS set point discussed below, ramp-up testing will collect data on MWS performance and support downstream testing (i.e., MTU testing [see Appendix A2B] and OTS/AFA testing [see Appendix A6]) by processing during periods of continuous operations at a sustained rate.

Evaluation of the DMWS set point during ramp-up commences with the first 59 munitions discussed above. As shown in Figure A2A-2, if any incompletely washed round or more than 2 false rejects are observed during processing the first 59 munitions, operations will be paused for evaluation. Data collected following processing of the first 384 munitions (including the first 59 munitions discussed above) will be used to assess the DMWS set point. If, after 384 munitions, a delta weight greater than the established DMWS variability is observed in ≥ 1% of munitions processed, MWS operations will be paused while the JTG is convened to evaluate data and develop a path forward. If ≥ 1% incompletely washed rounds are observed the JTG will be convened and a path forward will be developed. If ≥ 1% false rejects are observed, the DMWS set point will be revised to the mean ($\overline{W}$) plus three standard deviations (3 SD) of the tare weight data collected for the 384 munitions processed to that point (see Section 4.1 for calculations). The set point is reassessed after a cumulative total of 8,000 rounds has been processed as shown in Figure A2A-2. If the observed SD is >1.5

lbs, the JTG is convened to evaluate data and develop the path forward. If tare weight variability demonstrates an SD > 1.5 lbs, resetting the DMWS to $\overline{W} + 3SD$ could impact the ability of the DMWS to detect an unbreached round of low initial agent fill. The set-point will be continuously evaluated throughout pilot testing afterprocessing 8000 rounds as shown in Figure A2A-2.

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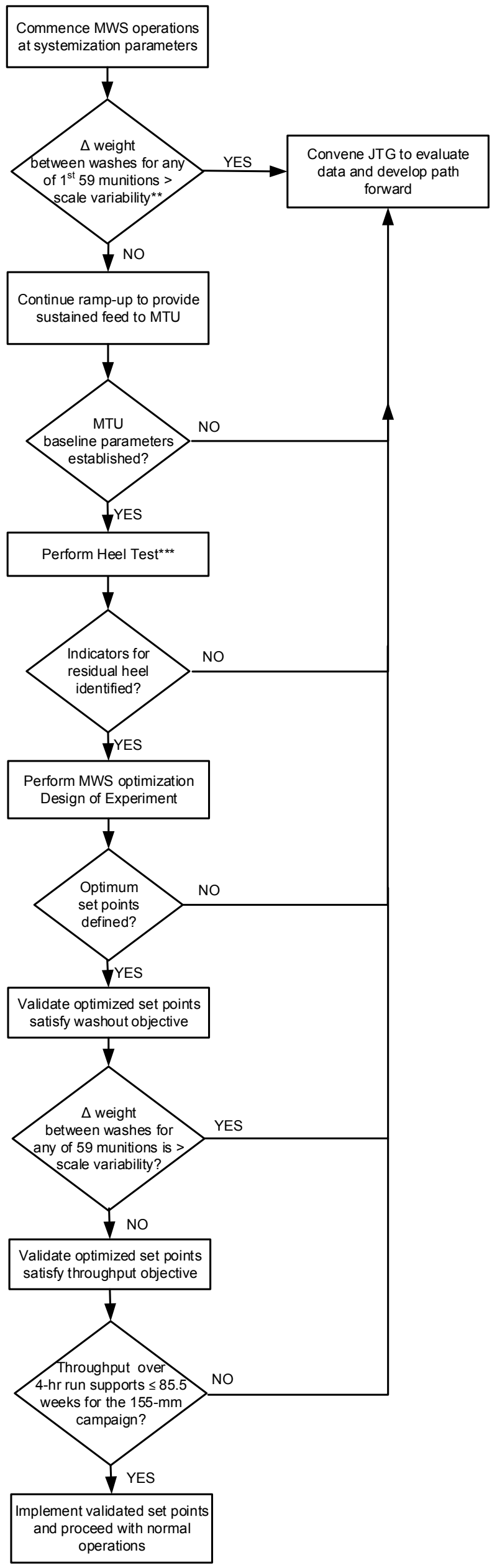
Objective 1*:
Establish ranges and set-points to achieve cleanliness of munitions to extent reasonably possible.

Criteria:
- MWS operations, alarms, and interlocks verified
- DMWS delta (Δ) weights are within scale variability**
- MTU alarms per *Operations Plan*
- MTU exit conveyor MINICAMS alarm (≥ 0.2 VSL) confirmed

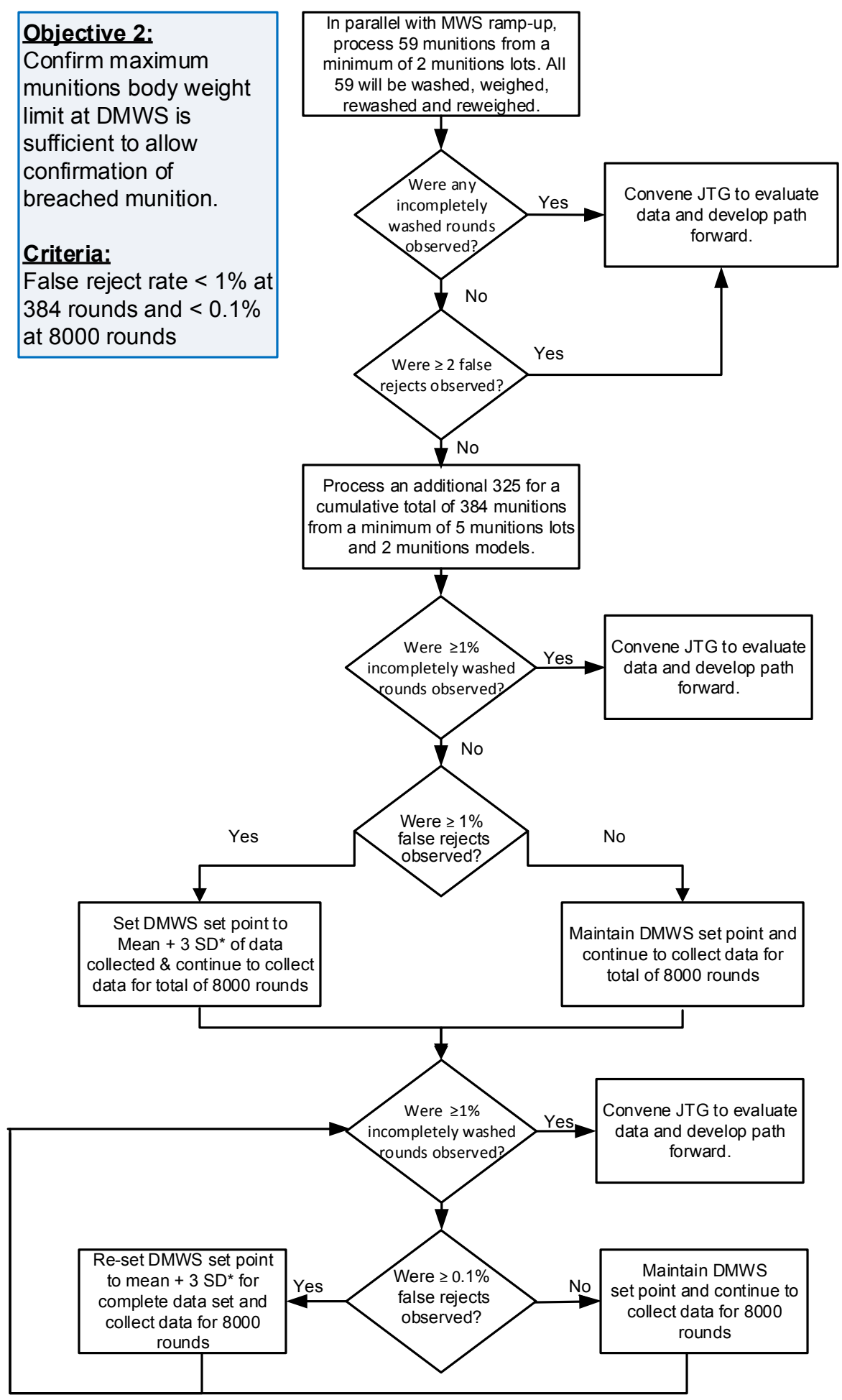
Objective 1a*:
Establish optimal operating ranges and set points

Criteria:
- Dependent and independent variables defined
- Optimum setpoints for dependent variables provide a sustainable processing rate that supports 85.5 wks or less for the 155mm campaign
- DMWS delta weights are within scale variability**
- MTU set points and alarms per Appendix A2B



* Objective 1b, "Collect and assess data to validate and/or define critical operating parameters for the MWS" is met through objectives 1 and 1a.
** Scale variability will be established during the systemization phase and incorporated into 24852-SOP-PT-001, Pilot Test Evolutions.
*** Objectives/criteria for MTU Heel Test are provided in Appendix A2B for the Munitions Treatment Unit.

Figure A2A-1. Decision Tree for MWS PTD Objectives 1, 1a, and 1b.



* If SD > 1.5 lbs, convene JTG to review data and determine path forward.

Notes: Incompletely washed rounds are rounds that show a delta weight greater than scale variability between washes. False rejects are defined as rounds rejected by the DMWS after two wash cycles.

Figure A2A-2. Decision tree for MWS PTD Objective 2

2.3.2 Testing

As shown in Figure A2A-1, MWS optimization testing is performed after MTU heel testing (see Appendix A2B) identifies parameters to be used as indicators of residual heel processing. Optimization testing consists of the following activities:

1. Perform a designed experiment to define independent and dependent variables and define optimal ranges for dependent variables that achieve cleanliness, to the extent reasonably possible, at a rate that supports the operations schedule.
2. Validate optimized parameters meet the washout objective by processing an additional 59 munitions using the double-wash approach.
3. Validate optimized parameters meet the throughput objective by processing during a four-hour demonstration run.

The experimental design to be used is provided in Table A2A-1. As shown, the experimental design will evaluate the impact of washout pressure, duration, and agent lot on washout effectiveness as determined by the differential weight approach described above for the first 59 munitions. Munitions are processed using parameters defined in the experimental design on a single line. After being weighed on the DMWS, the munitions are rewashed for 280 sec, replaced on the DMWS, and processed through the MTU. Once testing is complete, ECHIP Design of Experiments Software or other statistical and mathematical software is used to analyze the data. The software is used to develop two- and three-dimensional (2-D, 3-D) response surfaces showing the impact of the variables evaluated (e.g., wash time, pressure) on measured results (i.e., change in weight between washes), if such impacts exist. The response surfaces plots define the optimal operating parameters at which to continue testing and operations.

Testing continues to (1) validate the optimal set points achieve the washout objectives and (2) validate the optimal set points achieve the throughput objective. The first validation period involves processing 59 munitions using the optimized operating parameters, weighing, and rewashing using a 280-sec wash. As before, these 59 munitions will be pulled from a minimum of 2 lots and differential weights greater than the established scale variability will be used to indicate potential issues with washout effectiveness that will require operations to pause and convene the JTG to evaluate data and develop a path forward. If none of the 59 munitions demonstrate a delta weight between washes greater than the established scale variability, the MWS is operated under the optimal parameters for a four-hour period to demonstrate throughput can support 85.5 weeks or less for the 155-mm campaign.

Table A2A-1. MWS Optimization Testing Experimental Design

Trial No (randomized)	Pressure, psig	Time, sec	Lot*
22	8000	70	3
1	6500	70	1
23	6500	105	4
2	9500	70	1
10	6500	105	3
18	9500	140	2
16	9500	70	2
9	9500	105	2
3	6500	70	2
21	8000	70	2
4	9500	70	3
28	9500	140	4
19	6500	140	3
14	6500	70	4
1 (replicate)	6500	70	1
11	6500	140	1
2 (replicate)	9500	70	1
8	8000	140	1
25	8000	105	3
27	8000	105	4
7	6500	140	2
15	9500	70	4
5	6500	140	4
17	6500	70	3
24	8000	105	1
3 (replicate)	6500	70	2
26	8000	105	2
4 (replicate)	9500	70	3
28 (replicate)	9500	140	4
12	9500	140	1
13	8000	70	4
6	9500	140	3
20	6500	105	1

* A general designation of 1 through 4 is used here to designate the four different lots used in the DOE. Specific lots to be used are determined by operations in cooperation with PCD based on availability and accessibility.

2.4 Matrix

The test matrix for MWS pilot testing is provided in Table A2A-2.

Table A2A-2. Test Matrix for MWS pilot testing with 155-mm projectiles.

Activity	Objective	Key Variables	Performance Criteria
Ramp-up	Establish ranges and set points to achieve cleanliness of munitions bodies to the extent reasonably possible Collect and assess data to validate and/or define critical operating parameters for the MWS Confirm maximum munitions' body weight limit at DMWS is sufficient to allow confirmation of a breached munition	MWS parameters (Table A2A-3) MTU parameters (see Appendix A2B) Munitions/Agent lot/type	DMWS delta weight ≤DMWS variability* MTU alarms for parameters in Appendix A2B per *SOP 24852-SOP-PT-001, Pilot Test Evolutions* and MTU exit conveyor MINICAMS alarm confirmed < 1% false rejects and < 1% incompletely washed rounds after 384 munitions and < 0.1% false rejects and < 1% incompletely washed rounds after processing 8000 munitions
Testing	Establish optimal operating ranges and set points Collect and assess data to validate and/or define critical operating parameters for the MWS	Experimental design (Table A2A-1) MWS parameters (Table A2A-3) Throughput Munitions/Agent lot/type	Dependent and independent variables defined Sustainable processing rate supports 85.5 weeks or less for the 155 mm campaign DMWS delta weights during validation testing ≤DMWS variability*
Integrated Facility Demonstration	See Appendix A7		

* DMWS variability will be established during systemization phase testing and incorporated into 24852-SOP-PT-001, *Pilot Test Evolutions*.

2.5 Procedure

MWS ramp-up and testing are conducted in accordance with SOPs 24852-SOP-PT-001, *Pilot Test Evolutions*, and 24852-SOP-B02-W0001, *Munitions Washout System*. The following provides additional details for test execution in accordance with the decision trees included in Figure A2A-1 and Figure A2A-2.

2.5.1 Ramp-up

MWS ramp-up occurs after sufficient enhanced reconfigured munitions have been supplied by the PMD. Prior to the start of pilot testing, water is filled to the low-low liquid level in each agent and washwater surge drum to support start-up with agent. Ramp-up proceeds through a slow and steady ramp-up commencing with a single line and progressing to two lines as operational experience with stockpile munitions is gained.

The first 59 munitions processed will be taken from a minimum of two distinct agent and munitions lots and will be processed using the following procedure:

1. Weigh intact munition on scale in the MRR
2. Process munitions through CAM per starting operating parameters (Table A2A-3)
3. Weigh munitions on the DMWS
4. Return munitions to the CAM for rewash using starting operating parameters and a total wash duration of 280 sec
5. Weigh munitions on the DMWS
6. Process munitions through the MTU. NOTE: If the munition fails to satisfy the DMWS set point, designate the munitions as a *false reject* and process through MTU.
7. If the second weight is less than the initial weight by a magnitude greater than the DMWS variability, pause operations and convene the JTG to evaluate data and MWS performance and develop a path forward for continued operations.
8. Monitor MWS (Table A2A-3) and MTU (Appendix A2B) operating parameters for alarms indicating off normal conditions. If a process variable alarm is reached, pause operations and convene the JTG to evaluate data and determine a path forward.

If no munition is observed to have a differential weight greater than the established DMWS variability, operations will proceed with ramp-up under normal operations as follows:

1. Process munitions through CAM per starting operating parameters (Table A2A-3)
2. Weigh munitions on the DMWS
3. If munition passes DMWS set point, process through MTU.
4. If munition fails to meet DMWS set point, reprocess munition using a total wash duration of 280 sec. If the second weight is less than the initial weight by a magnitude greater than the established DMWS variability, document observation of an *incompletely washed round*. If the difference in initial and final weight is within the established DMWS variability, process through the MTU and document observation of a *false reject*.
5. Monitor MWS (Table A2A-3) and MTU (Appendix A2B) operating parameters for alarms indicating off normal conditions. If a process variable alarm is reached, pause operations and convene the JTG to evaluate data and determine a path forward.

After the first 384 cumulative munitions have been processed from a minimum of five munitions lots and two munitions models, the DMWS set point is evaluated. If ≥ 1% *incompletely washed rounds* (3 rounds) are observed, operations will be paused and

the JTG convened to evaluate data and develop a path forward. If ≥ 1% *false rejects* (3 rounds) are observed, reset the DMWS set point to correspond to $\overline{W} + 3SD$ (see Section 4.1) of the measured DMWS weights of the 384 munitions processed unless the standard deviation (SD) is > 1.5 lbs. If SD is > 1.5 lbs, the DMWS set point is retained and the JTG convened to evaluate data and develop a path forward.

Ramp-up will continue (using steps 1 - 5 above) until periods of continuous operation sufficient to support MTU testing (see Appendix A2B for description of Paint Residue Removal Station [PRRS] testing and preliminary MTU heel evaluation) and OTS testing (MWS/MTU demonstration) are achieved. MWS (Table A2A-3) and MTU (Appendix A2B) operating data will be monitored for potential indications of upset conditions. MTU operating data (Table A2B-2) will be used to establish a baseline for normal operations that can be used to identify MWS upset conditions (see Appendix A2B). MWS testing will then support execution of the MTU heel test (Appendix A2B). MWS (Table A2A-3) and MTU (Appendix A2B) operating data generated during this testing will be reviewed to identify key indicators of potential MWS upset conditions that can be applied to future operations and MWS testing.

After a cumulative total of 8,000 munitions have been processed, the DMWS set point will be re-evaluated. If ≥ 0.1% *false rejects* are observed, reset the DMWS set point to correspond to $\overline{W} + 3SD$ (see Section 4.1) of the measured DMWS weights of the 8,000 munitions processed unless the SD is > 1.5 lbs. If SD is > 1.5 lbs, the DMWS set point is retained and the JTG convened to evaluate data and develop a path forward. The DMWS setpoint will be evaluated by this process after each additional 8,000 rounds are processed throughout pilot test demonstration.

2.5.2 Testing

After completion of MTU heel testing and establishment of key process indicators for potential MWS upset conditions, MWS optimization testing is conducted. Any scheduled preventative maintenance is conducted prior to execution of testing. Testing consists of execution of the designed experiment included in Table A2A-1 on a single line according to the following steps:

1. Weigh intact munition on scale in the MRR
2. Process munitions through CAM per operating conditions identified in DOE trial number (Table A2A-1)
3. Weigh munitions on the DMWS
4. Return munitions to the CAM for rewash using starting operating parameters and a total wash duration of 280 sec
5. Weigh munitions on the DMWS
6. Process through MTU. NOTE: If the munition fails to satisfy the DMWS set point, designate the munitions as a *false reject* and process through MTU.

The data collected following execution of the designed experiment is analyzed using ECHIP or other statistical and mathematical software to develop two- and three-dimensional (2-D, 3-D) response surfaces showing the impact of the variables evaluated (wash time, pressure, lot) on measured results (i.e., change in weight between washes), if such impacts exist. The response surfaces plots define the optimal operating conditions at which to continue testing and operations.

Validation testing is performed immediately following execution of the DOE and implementation of the modified optimal operating parameters. During validation testing, the first 59 munitions processed through parallel lines are handled as follows:

1. Process munitions through CAM per DOE defined operating parameters
2. Weigh munitions on the DMWS
3. If munition passes DMWS set point, process through MTU
4. If munition fails to meet DMWS set point, reprocess munition using a total wash duration of 280 sec. If the second weight is less than the initial weight by a magnitude greater than the established DMWS variability, process munition through MTU, document observation of an *incompletely washed round*, pause operations and convene the JTG to evaluate data and determine a path forward. If the difference in initial and final weight is within the established DMWS variability, process through the MTU and document observation of a *false reject*.
5. Monitor key indicators identified from MTU heel testing for potential indications of off normal conditions. If a potential off normal condition is observed, pause operations and convene the JTG to evaluate data and determine a path forward.

If none of the 59 munitions demonstrate a delta weight greater than DMWS variability, a 4-hr continuous run is performed using the following steps:

1. Process munitions through CAM per optimized operating parameters.
2. Weigh munitions on the DMWS.
3. If munition passes DMWS set point, process through MTU.
4. If munition fails to meet DMWS set point, reprocess munition using a total wash duration of 280 sec. If the second weight is less than the initial weight by a magnitude greater than the established DMWS variability, document observation of an *incompletely washed round*. If the difference in initial and final weight is within the established DMWS variability, process through the MTU and document observation of a *false reject*.
5. Monitor key indicators identified from MTU heel testing for potential indications of off-normal conditions. If a potential off-normal condition is observed, pause operations and convene the JTG to evaluate data and determine a path forward.

If there is no indication of a process upset and throughput supports 85.5 weeks or less for the 155 mm campaign, the optimized operating parameters are implemented for continued operations for the remainder of Pilot Testing..

2.6 Data Collection

Data are collected on Test Performance Control Sheets (TPCS) or data forms to be provided in SOP 24852-SOP-PT-001, *Pilot Test Evolutions*. Examples of such forms are included in Attachment 1.

Additional data to be collected include data from the instrumentation identified in Table A2A-3 which are recorded by the Process Data Acquisition and Recording System (PDARS) and collected by the test team following testing. Data associated with OTS/AFA sampling or MTU operations are collected in accordance with those sub-plans (Appendix A6 and A2B, respectively). Data are attached to the TPCS either as electronic media or as hard copy reports.

Table A2A-3. PDARS-Recorded Process Parameters and Instruments *

PARAMETER	INSTRUMENT
Washout duration	B02-HI-0681
Rotation	B02-SI-0681
HPWW Temperature	B02-TI-0697AA/AB/AC/AD/AE B02-TI-0697BA/BB/BC/BD/BE
HPWW Pressure	B02-PT-0662AA/AB/AC/AD/AE B02-PT-0662BA/BB/BC/BD/BE
Washout Flow rate	FIT-0667-AA/AB/AC/AD/AE FIT-0667BA/BB/BC/BD/BE
Vertical Extension of Burster Ram	B02-ZT-0681AAH/ACH/ADH/AEH B02-ZT-0681BAH/BCH/BDH/BEH
Munitions Count (as measured by MTU counter)	XI-9312A XI-9312B
DMWS weight	WI-9304A-A WI-9304B-A

* These parameters are the subset of permitted operating parameters defined in the *Operations Plan* (Permit Modification 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 a pilot test objective. 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 PTDP. Revisions to standard instrument controls required for test execution will be validated and tested during systemization. No additional controls are required for this testing.

4 REPORTING

Two letter reports will be prepared to document MWS pilot testing:

- Letter report on MWS Optimization Testing
- Letter report on MWS pilot testing activities

General requirements for letter reports are included within the main body of the PTDP.

The letter report on MWS optimization testing will be prepared within two weeks of completing MWS optimization testing. This report will document the results of executing the DOE and validating washout and throughput objectives. The data generated and collected will be appended to the report. The report will include a summary of the critical operating parameters identified as part of testing as well as any revisions implemented to set points and operating ranges for MWS operations. Adoption of optimized operating parameters will be recommended following the completion of Pilot Testing.

The letter report on MWS pilot testing will summarize the data collected during MWS ramp-up and will include the letter report on MWS optimization testing as an attachment. Data collected during the IFD, to include emissions sampling, will be included with the letter report generated following the IFD (see Appendix A7). The letter report on MWS pilot testing will focus on overall system performance (e.g., throughput) and will be the basis for any recommendrd operating ranges and set points for continued operations. 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 munitions throughput with total hours of continuous operations and number of lines on-line.
- Key indicators of potential MWS upset conditions
- Pilot-testing defined DMWS set point with supporting data and calculation

4.1 Calculations

4.1.1 Calculation of Mean Tare Weight and Standard Deviation

The mean and standard deviation for munitions' tare weights (drained and washed munitions) is calculated using equations 1 and 2.

$$\bar{W} = \frac{1}{n}\sum_{1}^{n} W_i \qquad \text{(Eq. 1)}$$

$$SD_W = \sqrt{\frac{\sum(W_i - \bar{W})^2}{n-1}} \qquad \text{(Eq. 2)}$$

Where:

$\bar{W}$ = Average weight
W_i = Weight per munitions body
n = total number of weights
SD_W = standard deviation of weight

4.1.2 Calculation of Throughput

Average throughput will be calculated as the total number of munitions processed (as counted using the MTU counter located at the rotary valve, XI-9312-A/B) divided by the total time allotted for the duration of the testing period.

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Attachment 1

Munitions Washout System
Example Test Performance Control Sheets

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Munitions Washout Test Performance Control Sheet **Ramp-up and Demonstration**			
Date:		Shift	
MWS Line ID		Crew	
Munitions Lot #			
Complete one form per shift.			

Step #	**Operation**	**Value, ✓, or comment**
1	Process conditions: (Starting, DOE, or Optimized)	
2	Date/Time first munition processed	
3	Date/Time last munition transferred to MTU	
4	Total munitions processed as measured by MTU counter (PDARS XI-9312) between step 2 and 3.	
	Number of treaty rounds sampled:	
	Number of non-DMWS rejects. Provide breakdown of reject class in comments section.	
	Number of *false rejects* (i.e., munitions rejected following second wash)	
	Number of *incompletely washed munitions* (i.e., munitions with a delta weight greater than DMWS variability after second wash)	
5	Average throughput	
6	PDARS data appended? (Y/N)	
7	Additional data sheets or summary tables appended? (Y/N)	

Comments:

EXAMPLE

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MWS Optimization Testing Results Table											
Run No.	**ECHIP Trial No.**	**Processing Date/ Time**	**CAM**	**Pressure, psig**	**Wash Duration, s**	**Lot ID***	**MRR Gross Weight, lbs**	**DMWS weight 1 (W_1), lbs**	**DMWS weight 2 (W_2), lbs**	**Date / Time fed to MTU**	**Delta weight ($\Delta W = W_1 - W_2$), lbs**
1	22			8000	70	3					
2	1			6500	70	1					
3	23			6500	105	4					
4	2			9500	70	1					
5	10			6500	105	3					
6	18			9500	140	2					
7	16			9500	70	2					
8	9			9500	105	2					
9	3			6500	70	2					
10	21			8000	70	2					
11	4			9500	70	3					
12	28			9500	140	4					
13	19			6500	140	3					
14	14			6500	70	4					
15	1 (rep)			6500	70	1					
16	11			6500	140	1					
17	2 (rep)			9500	70	1					
18	8			8000	140	1					
19	25			8000	105	3					
20	27			8000	105	4					
21	7			6500	140	2					
22	15			9500	70	4					
23	5			6500	140	4					
24	17			6500	70	3					
25	24			8000	105	1					
26	3 (rep)			6500	70	2					
27	26			8000	105	2					
28	4 (rep)			9500	70	3					
29	28 (rep)			9500	140	4					
30	12			9500	140	1					
31	13			8000	70	4					
32	6			9500	140	3					
33	20			6500	105	1					

* Lot 1 = _____
Lot 2 = _____
Lot 3 = _____
Lot 4 = _____

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APPENDIX A2B: MUNITIONS TREATMENT UNIT

APPENDIX A2A: MUNITIONS WASHOUT SYSTEM

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1 INTRODUCTION

This sub-plan describes pilot testing of the Munitions Washout System (MWS).

1.1 System Description

The MWS consists of two identical lines, both dedicated to processing the same caliber of munition simultaneously. The various munitions types are processed in separate campaigns. Only the 155-mm process is discussed here.

There are two MWS lines. Each MWS line feeds drained and washed munitions to a dedicated Munitions Treatment Unit (MTU) and consists of the following equipment:

1. One MWS munitions loading conveyor with a laser burster detector
2. One manual loading lift assist
3. One MWS airlock/conveyor
4. One MWS feed conveyor
5. One MWS robot
6. Five Cavity Access Machine (CAM) stations, two of which are installed spares
7. One reject table with four slots which allow the munition bodies to be stored in a vertical (ogive end up) orientation
8. One washed agent and water surge drum
9. Two washed agent and water booster pumps
10. One MWS high pressure washout water (HPWW) skid (one additional installed spare pump supports both lines)
11. One hydraulic power unit which provides hydraulic fluid power for CAM actuation
12. One CAM valve station, containing hydraulic control valves
13. Five CAM Utility Stations, which provide the utility systems/CAM interface
14. A safety fence surrounding the robot working area and enclosing the CAMS and reject table, which prevents inadvertent access by operating personnel to the robot swing area

Munitions are transferred via a loading conveyor to the airlock conveyor and then to the feed conveyor in the MWS room where the MWS robot picks up the munitions and places them nose-down into the rotary drain cup in a CAM. The CAM bail is raised to provide a vertical “stop” above the munition. A bladder seal is inflated which lifts the munition against the bail and makes a tight seal between the munition ogive and the CAM drain cup to contain agent liquid and headspace gas. The CAM uses a hydraulic ram to access the agent cavity by breaking the adapter, pausing, and then collapsing the burster well. To accommodate pressurized rounds, the ram pauses for 5 seconds as

soon as the adapter is breached; this controls the munition depressurization rate before completing the full punch.

After collapsing the burster well, the ram is partially retracted and HPWW is sprayed into the munition through two nozzles in the ram to clean the agent cavity. The HPWW skids can generate a maximum pressure of 10,000 psig. The HPWW Drum skid is fed with treated water from the reverse osmosis (RO) product water system. The skid is equipped with a heater that heats the incoming RO water to 110 ± 5°F. During washout, the munition is first rotated clockwise and then rotated counterclockwise in order to maximize agent and heel removal.

Drained agent and washout water are collected in a drain header. The liquid flows through the header, through a solids strainer containing a filter sock, and into the washed agent and water surge drum. The CAM drain header is continuously purged with air in order to remove and dilute any headspace gas vented from the munitions during agent access. Mixed agent and water is transferred from the washed agent and water surge drum to the agent/water separators in the Agent Collection and Neutralization System via the washed agent and water booster pump.

After washout of the munition, the robot picks up the drained round and transfers it to the MTU Drained Munitions Weigh Station (DMWS). If a munition exceeds the allowable maximum weight tolerance it is automatically returned to the same CAM for reprocessing. The maximum weight tolerance set point will be evaluated as part of pilot testing.

Reference *System Design Description (SDD) for Munitions Washout System (MWS) System No. B02* 24852-RD-3YD-B02-R0001 for additional system descriptions.

1.2 Objectives

The objectives of MWS pilot testing are to:

1. Establish ranges and set points to achieve cleanliness of munitions bodies to the extent reasonably possible
    a. Establish optimal operating ranges and set points
    b. Collect and assess data to validate and/or define critical operating parameters for the MWS
2. Confirm maximum munitions' body weight limit at DMWS (within the MTU system) is sufficient to allow confirmation of a breached munition

1.3 Limitations

1. MWS operations are limited by the availability of the MTU to process washed and drained munitions.
2. There is both a maximum (10,000 psig) and a minimum (approximately 5,000 psig) pressure for the HPWW. Water flow rate at each pressure is determined by

the HPWW nozzles in the ram and can only be altered by changing out the ram nozzles during an MWS shutdown.

3. The duration for the high-pressure wash must take into account other limiting factors such as robot processing times (i.e., the robot cycle times with three CAMS operating per line make it unlikely that wash times lower than 70 seconds would result in increased throughput).

2 PILOT TEST DEMONSTRATION APPROACH

The following paragraphs define MWS pilot testing activities. MWS pilot testing is coordinated with upstream and downstream pilot tests (e.g., Projectile Mortar Disassembly [PMD], MTU, Agent/Water Separator, and Off-gas Treatment System [OTS] and Agent Filtration Area [AFA] pilot testing) as defined in the *Pilot Test Demonstration Plan* (PTDP). Where applicable the PTDP main plan or appendices are referenced for direct support of MWS pilot test activities.

MWS pilot testing provides final validation of MWS operations using Pueblo Chemical Depot (PCD) stockpile munitions. Proper MWS operation and standing operating procedure (SOP) validation is demonstrated during systemization.

2.1 Overview

MWS pilot testing includes ramp-up, testing, and integrated facility demonstration (IFD). During ramp-up, the MWS processes munitions for increasing periods of continuous operations to confirm proper MWS operations (i.e., achieve the cleanliness of munitions to the extent reasonably possible). Initial ramp-up is conducted using a single MWS line to allow any required equipment modifications, identified as a result of lessons-learned, to be more easily incorporated into the second line prior to its contamination with agent. Processing during the ramp-up phase will establish a baseline for key operating parameters for the MWS and MTU (see Appendix A2B, MTU). For example, MWS ramp-up will establish the set point of the DMWS. Although the DMWS is within the MTU (B03) system, validation of the DMWS weight tolerance is included as part of MWS pilot testing based on its direct association with MWS performance.

Following ramp-up, optimization testing is performed to identify the independent and dependent variables and define optimal (sustainable and operable) settings for dependent variables which achieve cleanliness, to the extent reasonably possible, and satisfy the operating schedule of 85.5 weeks for the 155-mm campaign. If successful, the optimized parameters will be used for subsequent testing with same DMWS developed using the baseline parameters.

During the IFD, munitions are processed to support collection of facility emissions samples (see Appendix A7 for further details).

2.2 Materials

A weigh scale with specifications equivalent to the DMWS scale is located in the Munitions Receiving Room (MRR) (this scale is also specified in the MTU sub-plan [Appendix A2B]).

Equipment and materials required for off-gas sampling during MWS pilot testing as specified in the OTS/AFA sub-plan (see Appendix A6) are defined in the analytical methods and procedures identified in the *Laboratory Sampling and Analysis Plan for Pilot Test Phase Operations*, 24852-GPP-GGL-00013 (LSAP).

2.3 Design

MWS pilot testing consists of three activities:

Ramp-up: The MWS is slowly ramped-up using operating parameters validated during systemization. Processing during this phase confirms the ability of the MWS to achieve the cleanliness of munitions to the extent reasonably possible, collects data to confirm or revise the DMWS set point, and supports other pilot test activities (i.e., MTU and OTS/AFA pilot testing, see Appendices A2B and A6).

Testing: A design of experiment (DOE) is used to define independent and dependent variables and establish optimal settings for the dependent variables that achieve cleanliness, to the extent reasonably possible, at a throughput that supports the operating schedule.

Integrated Facility Demonstration: The MWS is operated at the critical operating parameters defined through ramp-up and testing during three 4-hr periods to support facility emissions sampling. See Appendix A7 for additional details on the IFD.

Ramp-up and testing activities are further discussed in the paragraphs that follow. Figure A2A-1 and Figure A2A-2 provide the decision trees applicable to MWS pilot test demonstration.

2.3.1 Ramp-up

MWS ramp-up uses operating parameters determined during pre-operations testing to achieve reasonable cleanliness. Ramp-up involves daily review of rejects and system performance to verify proper function. Both MWS and MTU process parameters are used as indicators of MWS performance. MWS process parameters pertinent to pilot testing are provided in Table A2A-3. Set points and alarms for critical system parameters are provided SOP 24852-SOP-PT-001, Pilot Test Evolutions. MTU process parameters are defined in Appendix A2B but include zone temperature, zone current, offgas temperature, offgas flow, and readings from a carbon dioxide sensor located in the exhaust.

Ramp-up is conducted slowly to allow for system evaluations. A single MWS line is used during initial processing to minimize potential contamination of the remaining line should equipment modifications be required as a result of lessons-learned. As

operational experience is gathered, processing on the second line is initiated. The first 59 munitions processed will automatically be washed twice to assess the ability of the MWS to achieve cleanliness to the extent reasonably possible. These 59 munitions will be taken from a minimum of 2 munitions lots. The first wash will be conducted as per design MWS operating conditions. The second wash will be conducted under design operating conditions except that a total wash duration of 280 sec (vs. 140 s design) will be used. The differential weight between the initial weight (as measured by the DMWS following the initial wash) and the second weight (as measured by the DMWS after the rewash) will be used to assess munition cleanliness. Observation of a change in weight greater than scale variability established through systemization phase testing (i.e., observation of an *incompletely washed round*) will pause operations for evaluation of MWS operations. A munitions that demonstrates no change in weight between washes but is still rejected by the DMWS based on weight will be identified as a *false reject* and will be processed through the MTU. If more than two false rejects are observed during processing of the first 59 munitions, operations will be paused and the Joint Test Group (JTG) convened to evaluate data and develop a path forward.

Following these initial 59 munitions, MWS operations will continue to ramp-up to achieve continuous operations on parallel lines for a minimum of 4 hours at a maximum sustained rate as required to support the MWS/MTU demonstration (see Appendix A6). During this ramp-up, MWS and MTU process conditions will be reviewed for any deviations that could indicate incomplete washout of munitions. MTU baseline parameters will be established after execution of the MWS/MTU demonstration (see Appendix A6). Deviations from this baseline will be assessed during normal and off-normal (see Section 2.3.2) operations for indications of MWS upset conditions. Any munition rejected at the DMWS during this period will be rewashed using a 280-sec wash duration. In addition to proceeding with the evaluation of the DMWS set point discussed below, ramp-up testing will collect data on MWS performance and support downstream testing (i.e., MTU testing [see Appendix A2B] and OTS/AFA testing [see Appendix A6]) by processing during periods of continuous operations at a sustained rate.

Evaluation of the DMWS set point during ramp-up commences with the first 59 munitions discussed above. As shown in Figure A2A-2, if any incompletely washed round or more than 2 false rejects are observed during processing the first 59 munitions, operations will be paused for evaluation. Data collected following processing of the first 384 munitions (including the first 59 munitions discussed above) will be used to assess the DMWS set point. If, after 384 munitions, a delta weight greater than the established DMWS variability is observed in ≥ 1% of munitions processed, MWS operations will be paused while the JTG is convened to evaluate data and develop a path forward. If ≥ 1% incompletely washed rounds are observed the JTG will be convened and a path forward will be developed. If ≥ 1% false rejects are observed, the DMWS set point will be revised to the mean ($\overline{W}$) plus three standard deviations (3 SD) of the tare weight data collected for the 384 munitions processed to that point (see Section 4.1 for calculations). The set point is reassessed after a cumulative total of 8,000 rounds has been processed as shown in Figure A2A-2. If the observed SD is >1.5

lbs, the JTG is convened to evaluate data and develop the path forward. If tare weight variability demonstrates an SD > 1.5 lbs, resetting the DMWS to $\overline{W} + 3SD$ could impact the ability of the DMWS to detect an unbreached round of low initial agent fill. The set-point will be continuously evaluated throughout pilot testing afterprocessing 8000 rounds as shown in Figure A2A-2.

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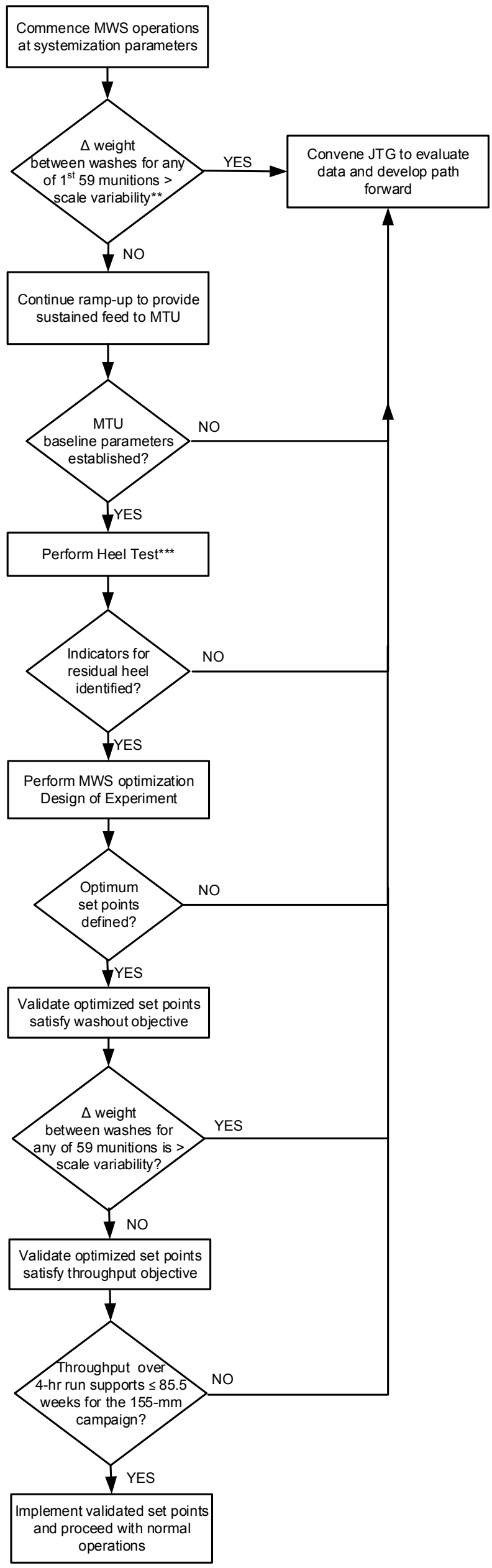
Objective 1*:
Establish ranges and set-points to achieve cleanliness of munitions to extent reasonably possible.

Criteria:
- MWS operations, alarms, and interlocks verified
- DMWS delta (Δ) weights are within scale variability**
- MTU alarms per *Operations Plan*
- MTU exit conveyor MINICAMS alarm (≥ 0.2 VSL) confirmed

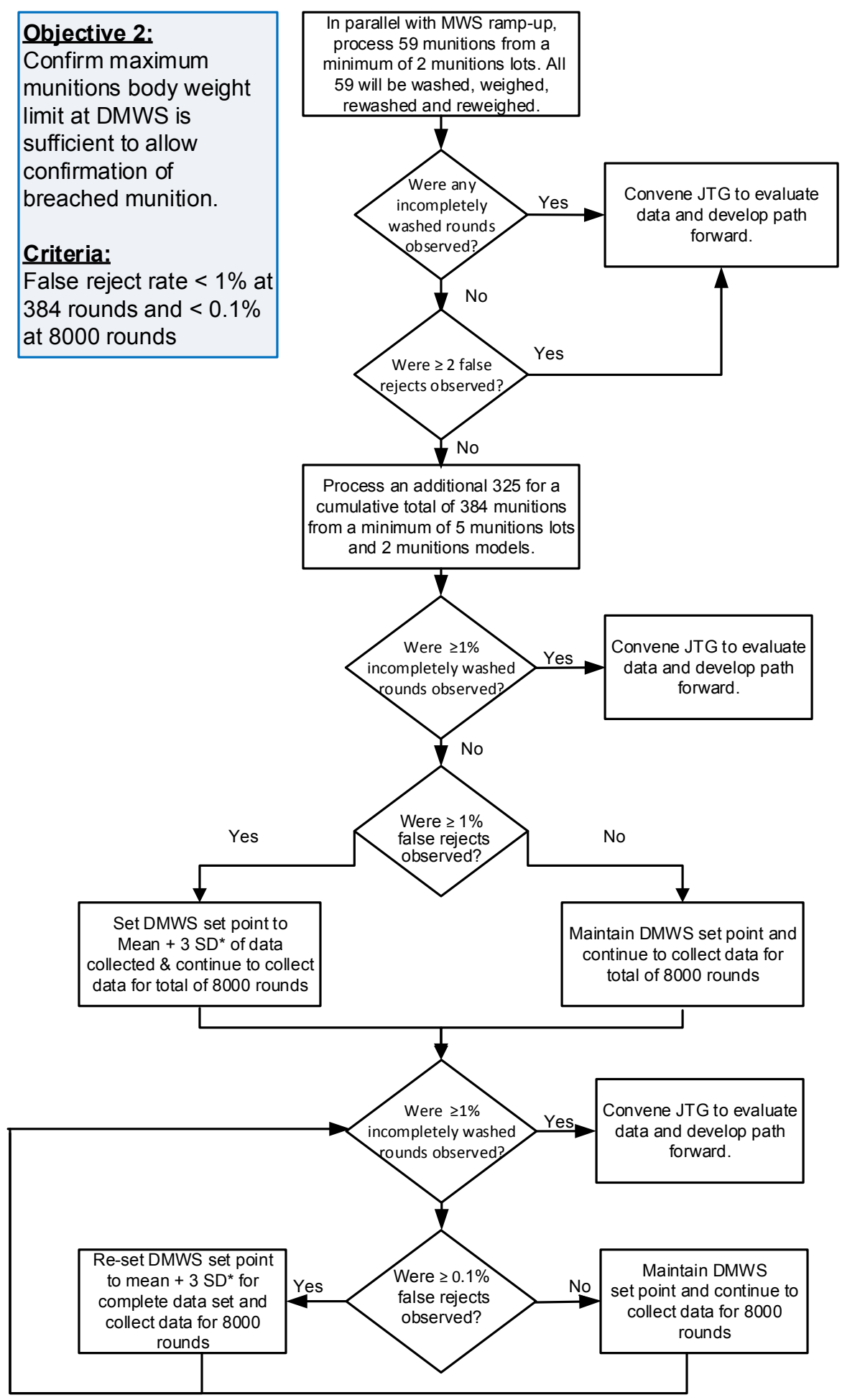
Objective 1a*:
Establish optimal operating ranges and set points

Criteria:
- Dependent and independent variables defined
- Optimum setpoints for dependent variables provide a sustainable processing rate that supports 85.5 wks or less for the 155mm campaign
- DMWS delta weights are within scale variability**
- MTU set points and alarms per Appendix A2B



* Objective 1b, "Collect and assess data to validate and/or define critical operating parameters for the MWS" is met through objectives 1 and 1a.
** Scale variability will be established during the systemization phase and incorporated into 24852-SOP-PT-001, Pilot Test Evolutions.
*** Objectives/criteria for MTU Heel Test are provided in Appendix A2B for the Munitions Treatment Unit.

Figure A2A-1. Decision Tree for MWS PTD Objectives 1, 1a, and 1b.



* If SD > 1.5 lbs, convene JTG to review data and determine path forward.

Notes: Incompletely washed rounds are rounds that show a delta weight greater than scale variability between washes. False rejects are defined as rounds rejected by the DMWS after two wash cycles.

Figure A2A-2. Decision tree for MWS PTD Objective 2

2.3.2 Testing

As shown in Figure A2A-1, MWS optimization testing is performed after MTU heel testing (see Appendix A2B) identifies parameters to be used as indicators of residual heel processing. Optimization testing consists of the following activities:

1. Perform a designed experiment to define independent and dependent variables and define optimal ranges for dependent variables that achieve cleanliness, to the extent reasonably possible, at a rate that supports the operations schedule.
2. Validate optimized parameters meet the washout objective by processing an additional 59 munitions using the double-wash approach.
3. Validate optimized parameters meet the throughput objective by processing during a four-hour demonstration run.

The experimental design to be used is provided in Table A2A-1. As shown, the experimental design will evaluate the impact of washout pressure, duration, and agent lot on washout effectiveness as determined by the differential weight approach described above for the first 59 munitions. Munitions are processed using parameters defined in the experimental design on a single line. After being weighed on the DMWS, the munitions are rewashed for 280 sec, replaced on the DMWS, and processed through the MTU. Once testing is complete, ECHIP Design of Experiments Software or other statistical and mathematical software is used to analyze the data. The software is used to develop two- and three-dimensional (2-D, 3-D) response surfaces showing the impact of the variables evaluated (e.g., wash time, pressure) on measured results (i.e., change in weight between washes), if such impacts exist. The response surfaces plots define the optimal operating parameters at which to continue testing and operations.

Testing continues to (1) validate the optimal set points achieve the washout objectives and (2) validate the optimal set points achieve the throughput objective. The first validation period involves processing 59 munitions using the optimized operating parameters, weighing, and rewashing using a 280-sec wash. As before, these 59 munitions will be pulled from a minimum of 2 lots and differential weights greater than the established scale variability will be used to indicate potential issues with washout effectiveness that will require operations to pause and convene the JTG to evaluate data and develop a path forward. If none of the 59 munitions demonstrate a delta weight between washes greater than the established scale variability, the MWS is operated under the optimal parameters for a four-hour period to demonstrate throughput can support 85.5 weeks or less for the 155-mm campaign.

Table A2A-1. MWS Optimization Testing Experimental Design

Trial No (randomized)	Pressure, psig	Time, sec	Lot*
22	8000	70	3
1	6500	70	1
23	6500	105	4
2	9500	70	1
10	6500	105	3
18	9500	140	2
16	9500	70	2
9	9500	105	2
3	6500	70	2
21	8000	70	2
4	9500	70	3
28	9500	140	4
19	6500	140	3
14	6500	70	4
1 (replicate)	6500	70	1
11	6500	140	1
2 (replicate)	9500	70	1
8	8000	140	1
25	8000	105	3
27	8000	105	4
7	6500	140	2
15	9500	70	4
5	6500	140	4
17	6500	70	3
24	8000	105	1
3 (replicate)	6500	70	2
26	8000	105	2
4 (replicate)	9500	70	3
28 (replicate)	9500	140	4
12	9500	140	1
13	8000	70	4
6	9500	140	3
20	6500	105	1

* A general designation of 1 through 4 is used here to designate the four different lots used in the DOE. Specific lots to be used are determined by operations in cooperation with PCD based on availability and accessibility.

2.4 Matrix

The test matrix for MWS pilot testing is provided in Table A2A-2.

Table A2A-2. Test Matrix for MWS pilot testing with 155-mm projectiles.

Activity	Objective	Key Variables	Performance Criteria
Ramp-up	Establish ranges and set points to achieve cleanliness of munitions bodies to the extent reasonably possible Collect and assess data to validate and/or define critical operating parameters for the MWS Confirm maximum munitions' body weight limit at DMWS is sufficient to allow confirmation of a breached munition	MWS parameters (Table A2A-3) MTU parameters (see Appendix A2B) Munitions/Agent lot/type	DMWS delta weight ≤DMWS variability* MTU alarms for parameters in Appendix A2B per *SOP 24852-SOP-PT-001, Pilot Test Evolutions* and MTU exit conveyor MINICAMS alarm confirmed < 1% false rejects and < 1% incompletely washed rounds after 384 munitions and < 0.1% false rejects and < 1% incompletely washed rounds after processing 8000 munitions
Testing	Establish optimal operating ranges and set points Collect and assess data to validate and/or define critical operating parameters for the MWS	Experimental design (Table A2A-1) MWS parameters (Table A2A-3) Throughput Munitions/Agent lot/type	Dependent and independent variables defined Sustainable processing rate supports 85.5 weeks or less for the 155 mm campaign DMWS delta weights during validation testing ≤DMWS variability*
Integrated Facility Demonstration	See Appendix A7		

* DMWS variability will be established during systemization phase testing and incorporated into 24852-SOP-PT-001, *Pilot Test Evolutions*.

2.5 Procedure

MWS ramp-up and testing are conducted in accordance with SOPs 24852-SOP-PT-001, *Pilot Test Evolutions*, and 24852-SOP-B02-W0001, *Munitions Washout System*. The following provides additional details for test execution in accordance with the decision trees included in Figure A2A-1 and Figure A2A-2.

2.5.1 Ramp-up

MWS ramp-up occurs after sufficient enhanced reconfigured munitions have been supplied by the PMD. Prior to the start of pilot testing, water is filled to the low-low liquid level in each agent and washwater surge drum to support start-up with agent. Ramp-up proceeds through a slow and steady ramp-up commencing with a single line and progressing to two lines as operational experience with stockpile munitions is gained.

The first 59 munitions processed will be taken from a minimum of two distinct agent and munitions lots and will be processed using the following procedure:

1. Weigh intact munition on scale in the MRR
2. Process munitions through CAM per starting operating parameters (Table A2A-3)
3. Weigh munitions on the DMWS
4. Return munitions to the CAM for rewash using starting operating parameters and a total wash duration of 280 sec
5. Weigh munitions on the DMWS
6. Process munitions through the MTU. NOTE: If the munition fails to satisfy the DMWS set point, designate the munitions as a *false reject* and process through MTU.
7. If the second weight is less than the initial weight by a magnitude greater than the DMWS variability, pause operations and convene the JTG to evaluate data and MWS performance and develop a path forward for continued operations.
8. Monitor MWS (Table A2A-3) and MTU (Appendix A2B) operating parameters for alarms indicating off normal conditions. If a process variable alarm is reached, pause operations and convene the JTG to evaluate data and determine a path forward.

If no munition is observed to have a differential weight greater than the established DMWS variability, operations will proceed with ramp-up under normal operations as follows:

1. Process munitions through CAM per starting operating parameters (Table A2A-3)
2. Weigh munitions on the DMWS
3. If munition passes DMWS set point, process through MTU.
4. If munition fails to meet DMWS set point, reprocess munition using a total wash duration of 280 sec. If the second weight is less than the initial weight by a magnitude greater than the established DMWS variability, document observation of an *incompletely washed round*. If the difference in initial and final weight is within the established DMWS variability, process through the MTU and document observation of a *false reject*.
5. Monitor MWS (Table A2A-3) and MTU (Appendix A2B) operating parameters for alarms indicating off normal conditions. If a process variable alarm is reached, pause operations and convene the JTG to evaluate data and determine a path forward.

After the first 384 cumulative munitions have been processed from a minimum of five munitions lots and two munitions models, the DMWS set point is evaluated. If ≥ 1% *incompletely washed rounds* (3 rounds) are observed, operations will be paused and

the JTG convened to evaluate data and develop a path forward. If ≥ 1% *false rejects* (3 rounds) are observed, reset the DMWS set point to correspond to $\overline{W} + 3SD$ (see Section 4.1) of the measured DMWS weights of the 384 munitions processed unless the standard deviation (SD) is > 1.5 lbs. If SD is > 1.5 lbs, the DMWS set point is retained and the JTG convened to evaluate data and develop a path forward.

Ramp-up will continue (using steps 1 - 5 above) until periods of continuous operation sufficient to support MTU testing (see Appendix A2B for description of Paint Residue Removal Station [PRRS] testing and preliminary MTU heel evaluation) and OTS testing (MWS/MTU demonstration) are achieved. MWS (Table A2A-3) and MTU (Appendix A2B) operating data will be monitored for potential indications of upset conditions. MTU operating data (Table A2B-2) will be used to establish a baseline for normal operations that can be used to identify MWS upset conditions (see Appendix A2B). MWS testing will then support execution of the MTU heel test (Appendix A2B). MWS (Table A2A-3) and MTU (Appendix A2B) operating data generated during this testing will be reviewed to identify key indicators of potential MWS upset conditions that can be applied to future operations and MWS testing.

After a cumulative total of 8,000 munitions have been processed, the DMWS set point will be re-evaluated. If ≥ 0.1% *false rejects* are observed, reset the DMWS set point to correspond to $\overline{W} + 3SD$ (see Section 4.1) of the measured DMWS weights of the 8,000 munitions processed unless the SD is > 1.5 lbs. If SD is > 1.5 lbs, the DMWS set point is retained and the JTG convened to evaluate data and develop a path forward. The DMWS setpoint will be evaluated by this process after each additional 8,000 rounds are processed throughout pilot test demonstration.

2.5.2 Testing

After completion of MTU heel testing and establishment of key process indicators for potential MWS upset conditions, MWS optimization testing is conducted. Any scheduled preventative maintenance is conducted prior to execution of testing. Testing consists of execution of the designed experiment included in Table A2A-1 on a single line according to the following steps:

1. Weigh intact munition on scale in the MRR
2. Process munitions through CAM per operating conditions identified in DOE trial number (Table A2A-1)
3. Weigh munitions on the DMWS
4. Return munitions to the CAM for rewash using starting operating parameters and a total wash duration of 280 sec
5. Weigh munitions on the DMWS
6. Process through MTU. NOTE: If the munition fails to satisfy the DMWS set point, designate the munitions as a *false reject* and process through MTU.

The data collected following execution of the designed experiment is analyzed using ECHIP or other statistical and mathematical software to develop two- and three-dimensional (2-D, 3-D) response surfaces showing the impact of the variables evaluated (wash time, pressure, lot) on measured results (i.e., change in weight between washes), if such impacts exist. The response surfaces plots define the optimal operating conditions at which to continue testing and operations.

Validation testing is performed immediately following execution of the DOE and implementation of the modified optimal operating parameters. During validation testing, the first 59 munitions processed through parallel lines are handled as follows:

1. Process munitions through CAM per DOE defined operating parameters
2. Weigh munitions on the DMWS
3. If munition passes DMWS set point, process through MTU
4. If munition fails to meet DMWS set point, reprocess munition using a total wash duration of 280 sec. If the second weight is less than the initial weight by a magnitude greater than the established DMWS variability, process munition through MTU, document observation of an *incompletely washed round*, pause operations and convene the JTG to evaluate data and determine a path forward. If the difference in initial and final weight is within the established DMWS variability, process through the MTU and document observation of a *false reject*.
5. Monitor key indicators identified from MTU heel testing for potential indications of off normal conditions. If a potential off normal condition is observed, pause operations and convene the JTG to evaluate data and determine a path forward.

If none of the 59 munitions demonstrate a delta weight greater than DMWS variability, a 4-hr continuous run is performed using the following steps:

1. Process munitions through CAM per optimized operating parameters.
2. Weigh munitions on the DMWS.
3. If munition passes DMWS set point, process through MTU.
4. If munition fails to meet DMWS set point, reprocess munition using a total wash duration of 280 sec. If the second weight is less than the initial weight by a magnitude greater than the established DMWS variability, document observation of an *incompletely washed round*. If the difference in initial and final weight is within the established DMWS variability, process through the MTU and document observation of a *false reject*.
5. Monitor key indicators identified from MTU heel testing for potential indications of off-normal conditions. If a potential off-normal condition is observed, pause operations and convene the JTG to evaluate data and determine a path forward.

If there is no indication of a process upset and throughput supports 85.5 weeks or less for the 155 mm campaign, the optimized operating parameters are implemented for continued operations for the remainder of Pilot Testing..

2.6 Data Collection

Data are collected on Test Performance Control Sheets (TPCS) or data forms to be provided in SOP 24852-SOP-PT-001, *Pilot Test Evolutions*. Examples of such forms are included in Attachment 1.

Additional data to be collected include data from the instrumentation identified in Table A2A-3 which are recorded by the Process Data Acquisition and Recording System (PDARS) and collected by the test team following testing. Data associated with OTS/AFA sampling or MTU operations are collected in accordance with those sub-plans (Appendix A6 and A2B, respectively). Data are attached to the TPCS either as electronic media or as hard copy reports.

Table A2A-3. PDARS-Recorded Process Parameters and Instruments *

PARAMETER	INSTRUMENT
Washout duration	B02-HI-0681
Rotation	B02-SI-0681
HPWW Temperature	B02-TI-0697AA/AB/AC/AD/AE B02-TI-0697BA/BB/BC/BD/BE
HPWW Pressure	B02-PT-0662AA/AB/AC/AD/AE B02-PT-0662BA/BB/BC/BD/BE
Washout Flow rate	FIT-0667-AA/AB/AC/AD/AE FIT-0667BA/BB/BC/BD/BE
Vertical Extension of Burster Ram	B02-ZT-0681AAH/ACH/ADH/AEH B02-ZT-0681BAH/BCH/BDH/BEH
Munitions Count (as measured by MTU counter)	XI-9312A XI-9312B
DMWS weight	WI-9304A-A WI-9304B-A

* These parameters are the subset of permitted operating parameters defined in the *Operations Plan* (Permit Modification 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 a pilot test objective. 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 PTDP. Revisions to standard instrument controls required for test execution will be validated and tested during systemization. No additional controls are required for this testing.

4 REPORTING

Two letter reports will be prepared to document MWS pilot testing:

- Letter report on MWS Optimization Testing
- Letter report on MWS pilot testing activities

General requirements for letter reports are included within the main body of the PTDP.

The letter report on MWS optimization testing will be prepared within two weeks of completing MWS optimization testing. This report will document the results of executing the DOE and validating washout and throughput objectives. The data generated and collected will be appended to the report. The report will include a summary of the critical operating parameters identified as part of testing as well as any revisions implemented to set points and operating ranges for MWS operations. Adoption of optimized operating parameters will be recommended following the completion of Pilot Testing.

The letter report on MWS pilot testing will summarize the data collected during MWS ramp-up and will include the letter report on MWS optimization testing as an attachment. Data collected during the IFD, to include emissions sampling, will be included with the letter report generated following the IFD (see Appendix A7). The letter report on MWS pilot testing will focus on overall system performance (e.g., throughput) and will be the basis for any recommendrd operating ranges and set points for continued operations. 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 munitions throughput with total hours of continuous operations and number of lines on-line.
- Key indicators of potential MWS upset conditions
- Pilot-testing defined DMWS set point with supporting data and calculation

4.1 Calculations

4.1.1 Calculation of Mean Tare Weight and Standard Deviation

The mean and standard deviation for munitions' tare weights (drained and washed munitions) is calculated using equations 1 and 2.

$$\bar{W} = \frac{1}{n}\sum_{1}^{n} W_i \qquad \text{(Eq. 1)}$$

$$SD_W = \sqrt{\frac{\sum(W_i - \bar{W})^2}{n-1}} \qquad \text{(Eq. 2)}$$

Where:

$\bar{W}$ = Average weight
W_i = Weight per munitions body
n = total number of weights
SD_W = standard deviation of weight

4.1.2 Calculation of Throughput

Average throughput will be calculated as the total number of munitions processed (as counted using the MTU counter located at the rotary valve, XI-9312-A/B) divided by the total time allotted for the duration of the testing period.

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Attachment 1

Munitions Washout System
Example Test Performance Control Sheets

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Munitions Washout Test Performance Control Sheet **Ramp-up and Demonstration**			
Date:		Shift	
MWS Line ID		Crew	
Munitions Lot #			
Complete one form per shift.			

Step #	**Operation**	**Value, ✓, or comment**
1	Process conditions: (Starting, DOE, or Optimized)	
2	Date/Time first munition processed	
3	Date/Time last munition transferred to MTU	
4	Total munitions processed as measured by MTU counter (PDARS XI-9312) between step 2 and 3.	
	Number of treaty rounds sampled:	
	Number of non-DMWS rejects. Provide breakdown of reject class in comments section.	
	Number of *false rejects* (i.e., munitions rejected following second wash)	
	Number of *incompletely washed munitions* (i.e., munitions with a delta weight greater than DMWS variability after second wash)	
5	Average throughput	
6	PDARS data appended? (Y/N)	
7	Additional data sheets or summary tables appended? (Y/N)	

Comments:

EXAMPLE

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MWS Optimization Testing Results Table											
Run No.	**ECHIP Trial No.**	**Processing Date/ Time**	**CAM**	**Pressure, psig**	**Wash Duration, s**	**Lot ID***	**MRR Gross Weight, lbs**	**DMWS weight 1 (W_1), lbs**	**DMWS weight 2 (W_2), lbs**	**Date / Time fed to MTU**	**Delta weight ($\Delta W = W_1 - W_2$), lbs**
1	22			8000	70	3					
2	1			6500	70	1					
3	23			6500	105	4					
4	2			9500	70	1					
5	10			6500	105	3					
6	18			9500	140	2					
7	16			9500	70	2					
8	9			9500	105	2					
9	3			6500	70	2					
10	21			8000	70	2					
11	4			9500	70	3					
12	28			9500	140	4					
13	19			6500	140	3					
14	14			6500	70	4					
15	1 (rep)			6500	70	1					
16	11			6500	140	1					
17	2 (rep)			9500	70	1					
18	8			8000	140	1					
19	25			8000	105	3					
20	27			8000	105	4					
21	7			6500	140	2					
22	15			9500	70	4					
23	5			6500	140	4					
24	17			6500	70	3					
25	24			8000	105	1					
26	3 (rep)			6500	70	2					
27	26			8000	105	2					
28	4 (rep)			9500	70	3					
29	28 (rep)			9500	140	4					
30	12			9500	140	1					
31	13			8000	70	4					
32	6			9500	140	3					
33	20			6500	105	1					

* Lot 1 = _____
Lot 2 = _____
Lot 3 = _____
Lot 4 = _____

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1 INTRODUCTION

This sub-plan describes pilot testing of the Munitions Treatment Unit (MTU).

1.1 System Description

The MTU is a continuous link belt, muffle-type furnace that decontaminates drained and washed munitions bodies by heating them to a minimum of 1000°F for a minimum of 15 minutes. The Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP) design incorporates two MTUs that operate in parallel and are fully automated. These units receive, treat, and discharge the three types of munitions bodies and mortar baseplates in separate campaigns. This test plan has been specifically prepared to address processing of 155-mm projectiles.

The MTUs are located within the MTU room with the load end located in the Munitions Washout System (MWS) room. The MWS robot places a drained and washed munitions body on the Drained Munitions Weigh Station (DMWS) located at the feed end of the MTU. A munitions body that is within the weight tolerance is released to the MTU while a munitions body outside the weight tolerance is rejected, picked up by the MWS robot and either reprocessed in the MWS Cavity Access Machines (CAM) or placed on the MWS reject table. In the MTU, munitions bodies are thermally-treated over approximately 90 minutes and transferred to the Paint Residue Removal System (PRRS) built into the discharge rotary valve where compressed air jets and a vacuum remove loose paint debris from the munitions bodies and baseplates. Munitions exiting the rotary valve are deposited onto a discharge conveyor which transports them to the Munitions Bodies Bin Enclosure (MBBE) located outside the Agent Processing Building (APB). The MTU is maintained at negative pressure relative to both the MWS and the MTU rooms. The MTU purge air is vented from the muffle to the Off-gas Treatment System (OTS). For additional information on system design, refer to *System Design Description (SDD) for Munitions Treatment Unit (MTU) System No. B03*, 24852-RD-3YD-B03-B0001 and *System Design Description (SDD) for Residue Handling System No. B15*, 24852-RD-3YD-B15-B0001.

1.2 Objectives

The objectives of MTU pilot testing are to:

1. Evaluate stack emissions under MWS process upset condition in which munitions bodies known to contain residual agent are fed to the MTU
2. Recycle munitions bodies
3. Control paint chips, ash, dust and chemicals of potential concern (COPC)
4. Demonstrate loss of PRRS does not result in unacceptable emissions during processing of munitions bodies in the MTU
5. Collect and assess data to validate and/or define critical parameters for the MWS/MTU
6. Demonstrate MTU throughput supports the duration of the operations phase

Although the DMWS is within the MTU system, evaluation of the maximum munitions body weight limit for the DMWS is included as an operational objective within MWS pilot testing based on its relationship to MWS performance (see Appendix A2A).

1.3 Limitations

MTU processing is limited by the supply of drained and washed munitions bodies from the MWS. Throughput of the MTU is determined by the throughput achieved by the MWS.

2 PILOT TEST DEMONSTRATION APPROACH

2.1 Overview

MTU pilot testing includes ramp-up, testing, and integrated facility demonstration (IFD). Ramp-up of the MTU is conducted in parallel with MWS ramp-up (see Appendix A2A) and corresponds to gradually increasing the number of munitions processed per hour and the total time of continuous operations. During ramp-up operations, sampling is conducted to support recycling of munitions bodies and to demonstrate that the system adequately controls paint chips, ash, dust, and COPCs. MTU operating data are used to establish baseline conditions for treatment of munitions achieving cleanliness to the extent reasonably possible from MWS operations (see Appendix A2A).

MTU testing activities are performed in parallel with ramp-up operations. Testing includes: (1) a loss-of-PRRS test to assess the impact on dust control from periods of operations without the PRRS operating; and (2) the MTU heel test to assess the impact of MWS process upset conditions on stack emissions.

Testing and ramp-up operations are used to define critical operating parameters for continued operations to include the IFD. During the IFD, munitions are processed to support collection of facility emissions samples (see Appendix A7 for further details).

2.2 Materials

Test materials include:

1. Equipment for collection of workspace total dust and metals samples for the work areas of the MTUs and MBBE [*]
2. Portable Agent monitoring system for bin monitoring and challenge materials
3. Bins equipped for sampling and equipment for sampling COPCs and dioxins/furans from the bins
4. A weigh scale with specifications equivalent to the DMWS scale in the Munitions Receiving Room (MRR) (this scale is also specified in the MWS sub-plan [Appendix A2A]).
5. A weigh scale in the clean munitions bodies bin staging area capable of weighing full munitions bodies bins.

[*] Specific equipment to be used will be in accordance with the *Industrial Hygiene Implementation Plan*, 24852-30G-GHX-00034.

Equipment and materials required for off-gas sampling during MTU pilot testing as specified in the OTS/Agent Filtration Area (AFA) sub-plan (see Appendix A6) are defined in the analytical methods and procedures identified in the *Laboratory Sampling and Analysis Plan for Pilot Test Phase Operations*, 24852-GPP-GGL-00013 (LSAP).

2.3 Design

MTU pilot testing consists of three activities:

Ramp-up: The MTU is slowly ramped-up in parallel with the MWS (see Appendix A2A) using operating parameters validated during systemization. Processing during this phase confirms the ability of the MTU to produce munitions bodies capable of being recycled, confirms the ability of the MTU to control paint chips, ash, dust, and COPC emissions, and provides baseline MTU operating conditions for use in MWS ramp-up and testing (see Appendix A2A) and MTU testing (see Appendix A2B).

Testing: Two test activities are performed during MTU pilot testing: (1) an off-normal test to evaluate impacts of loss of PRRS operations (i.e., loss of PRRS test), and (2) an evaluation of MTU performance under MWS upset conditions in which munitions known to contain agent are fed to the MTU (i.e., MTU heel test). The data from these activities in combination with ramp-up data are used to establish critical operating conditions for continued operations.

Integrated Facility Demonstration: The MTU is operated at the critical operating parameters defined through ramp-up and testing during three 4-hr periods to support facility emissions sampling. See Appendix A7 for additional details on the IFD.

Ramp-up and testing activities are further discussed in the paragraphs that follow.

2.3.1 Ramp-up

MTU ramp-up involves processing drained and washed MWS munitions for increasing periods of continuous operations. Initially, only one MTU is operated with the corresponding MWS line (see Appendix A2A). Munitions are processed at the rate determined by MWS operations until continuous stable operations for the periods required to support testing activities are achieved. Continuous, stable operations will support MTU testing activities in addition to OTS/AFA testing (see Appendix A6). Throughout ramp-up, MTU operating data (Table A2B-2) will be used to establish a baseline for normal operations that can be used to identify MWS upset conditions.

The first 3 munitions bodies bins filled during ramp-up are taken to the clean munitions body staging area and allowed to cool to < 120°F. The bins are covered to reduce the potential for fugitive emissions during the cooling or sampling process. Cooled bins are sampled for agent, COPCs, and dioxins/furans. Agent sampling data are used to support scrap metal recycling of clean munitions bodies, as indicated in Figure A2B-1. COPC sampling is performed to demonstrate that hazardous constituent emissions are adequately controlled by the MTU process, as indicated in Figure A2B-2. Dioxin/furan sampling is performed to assess and quantify potential dioxin/furan formation. Adequate control is demonstrated if results are below airborne exposure limits (AEL). AELs is used here to include American Conference of Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) and Occupational Safety and Health Administration (OSHA)

Permissible Exposure Levels (PEL). In a few select instances (e.g., specific metals), OSHA PELs are lower than ACGIH TLV. The lower of the two values, as determined by a Certified Industrial Hygienist is used.

PLEASE UPDATE Figure A2B-1 TO REFLECT 0.00002mg/m3, per WAP

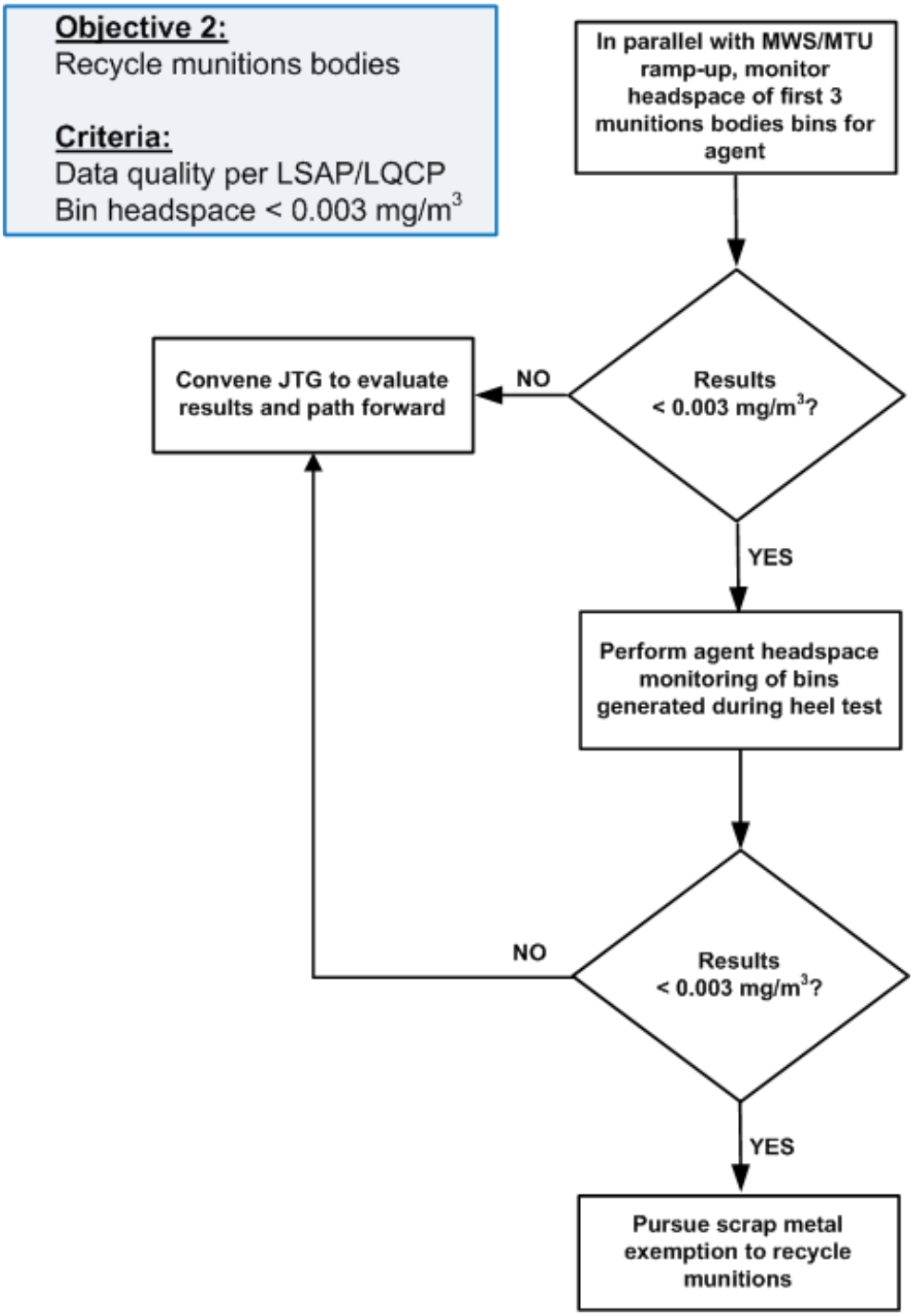

Figure A2B-2. Decision tree for MTU Pilot Test Demonstration (PTD) Objective 2.

During ramp-up, housekeeping and handling of the dust containment drums is performed in accordance with established operational procedures. Dust collected in the dust containment drums is sampled and analyzed for waste characterization which will include analysis for dioxins and furans. Refer to the LSAP for additional information on constituents, methods, and frequency of analysis. Should dioxin/furan analysis suggest the presence of constituents at levels above the established treatment standards, operations will be paused and the Joint Test Group (JTG) convened to evaluate data and develop a path forward.

After stable, continuous operations for periods sufficient to support Industrial Hygiene (IH) sampling are achieved, routine inspections and workspace total dust and metals air sampling are performed in the MTU workspace to confirm the MTU adequately control dust, ash, and paint chips. Successful performance of MTU dust control is demonstrated by total dust and metals sample results below the AELs within the MTU room and no observed build-up of residue at the MBBE or MBBE apron. If either of these conditions is not met, the JTG is convened to determine the path forward.

2.3.2 **Testing**

Testing involves two distinct test activities:

1. Evaluation of loss of PRRS
2. Evaluation of potential MWS upset conditions on site emissions by processing a calculated and controlled number of unwashed rounds (the heel test)

2.3.2.1 Loss of PRRS Testing

After ramp-up has achieved continuous operations with successful demonstration of decontamination and dust capture under expected process conditions, a four-hour test is performed to assess MTU operations without operation of the PRRS. For this test, an MTU is run without operation of the compressed air purge and PRRS vent filter system. Workspace total dust and metals air samples are collected in the MTU workspace as performed during normal operations and the MBBE areas are inspected for residue accumulation. If no build-up of residues is observed and sample results within the MTU room are less than AELs, the JTG will evaluate the need for continuous PRRS operations. If build-up of residues is observed in the MBBE areas and/or sample results are greater than AELs within the MTU room, PRRS operations will be required during normal MTU operations. The decision tree for loss of PRRS testing is included in Figure A2B-2.

2.3.2.2 Heel Test

For the heel test, a calculated number of drained but unwashed munitions bodies are processed through the MTU in parallel with drained/washed munitions at the MWS processing rate achieved during MWS ramp-up (see Appendix A2A). MTU heel testing is performed only after MWS/MTU ramp-up has successfully achieved approximately 6 hours of continuous operations, MWS/MTU baseline parameters are established for munitions cleaned to the extent reasonably possible (see Appendix A2A and Section 2.5.1), the OTS/AFA demonstration testing is complete (see Appendix A6), and a

preliminary evaluation of residual heel (discussed below) is performed. The decision tree for MTU heel testing is included in Figure A2B-3.

A single lot is used for testing which is selected based on quantity and accessibility of munitions, historical data on agent purity, and MWS testing and ramp-up. During ramp-up, a minimum of 40 munitions from this lot will be weighed after drain but before washout and after washout to establish a statistical rate of residual heel level in drained but unwashed munitions. The mean and standard deviation of residual heel thus determined is used to calculate the number of drained but unwashed munitions to be processed during each of three heel tests, which gradually increases the total loading from 25% to 50% to 100% of the maximum number of drained but unwashed munitions bodies possible given MWS throughput capabilities and the limitation not to exceed a total heel load of 23.4 lbs/hr. The number of unwashed munitions to be processed per hour is calculated assuming the residual heel content of drained, unwashed munitions within the selected lot is equal to the observed average plus two standard deviations (i.e., the *98% threshold* of the residual heel, see Section 4.1).

Each of the three MTU heel tests will require approximately 6 hours of continuous MWS/MTU operations for execution and will include (1) processing MWS-washed munitions to establish thermal equilibrium in the MTU, (2) processing drained/unwashed and drained/washed munitions at the average MWS rate for a period sufficient to obtain valid emissions data in accordance with the LSAP (see Appendix A6), and (3) continued processing of washed munitions through the MTU to maintain the thermal load in the MTU until the last drained but unwashed round exits the heated zone of the MTU.

Following testing, bins will be allowed to cool to < 120°F and sampled for agent, COPCs, and dioxins/furans to support scrap metal recycling per Figure A2B-1, confirm ability of the MTU to control fugitive emissions under upset conditions, and assess formation of dioxins/furans, respectively. For the final 100% loading testing, the munitions bins will also be weighed to estimate the total mass of agent processed. The MTU operating parameters will be compared against the established baseline values to identify indicators of MWS upset conditions. Emissions data will be evaluated relative to thresholds in the *Multiple Pathway Health Risk Assessment Report for the Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP) with Explosive Destruction System (EDS)* (MPHRA), 24852- 3RC-000-V0007 as discussed in *Summary Plan for Evaluating Pilot Test Data Against MPHRA*, 24852-30H-000-L0003. Agent sampling data from the AFA, MTU room, OTS room, and bins will be reviewed prior to proceeding to the next ramp-up test and the JTG may terminate further heel testing based on this evaluation, as indicated in Figure A2B-3.

2.4 Matrix

The test matrix for MTU pilot testing is provided in Table A2B-1.

A2 Block 2, Munitions Bodies Treatment
A2B Munitions Treatment Unit

Rev. 003

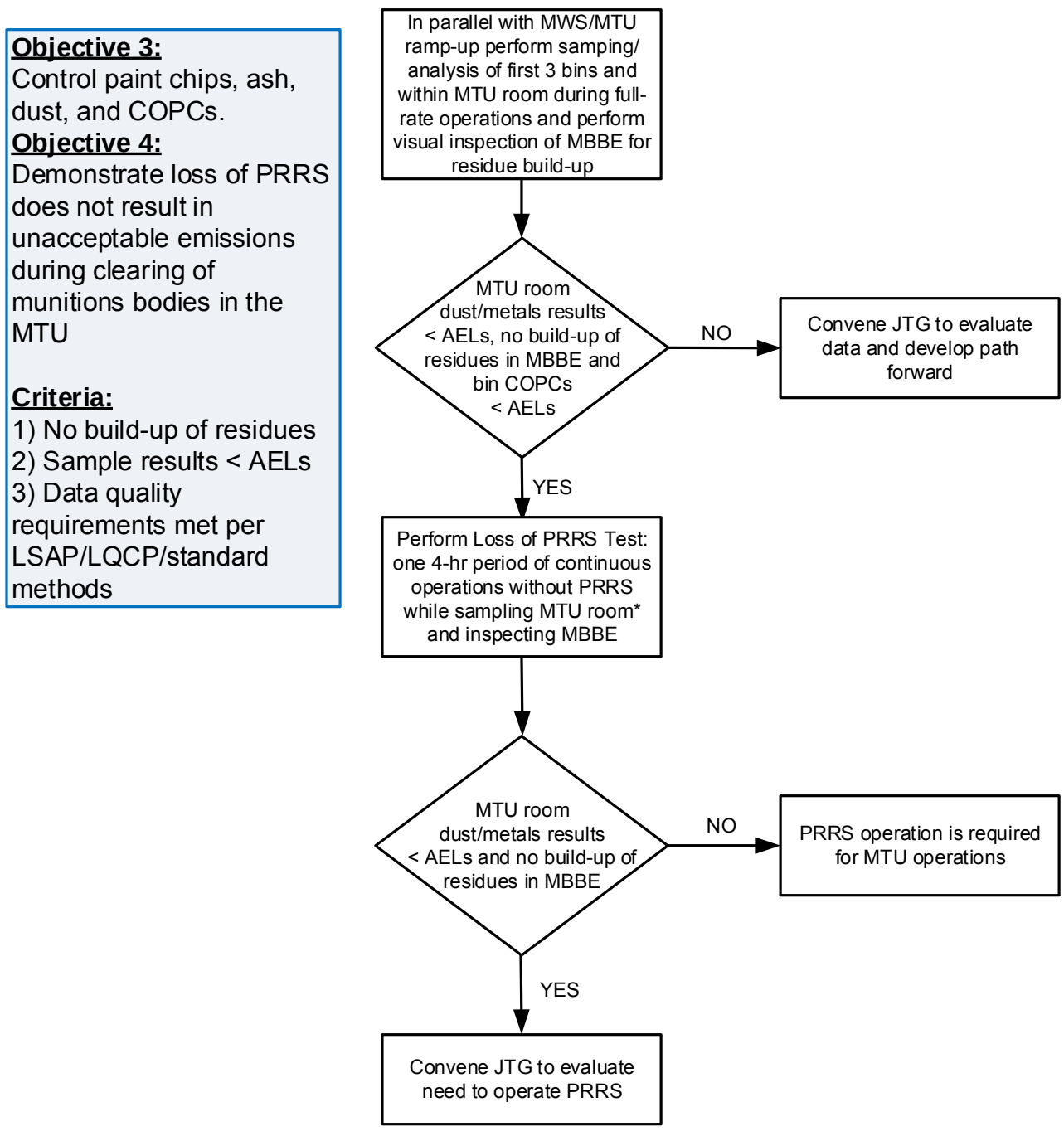

Figure A2B-3. Decision tree MTU PTD Objectives 3 and 4.

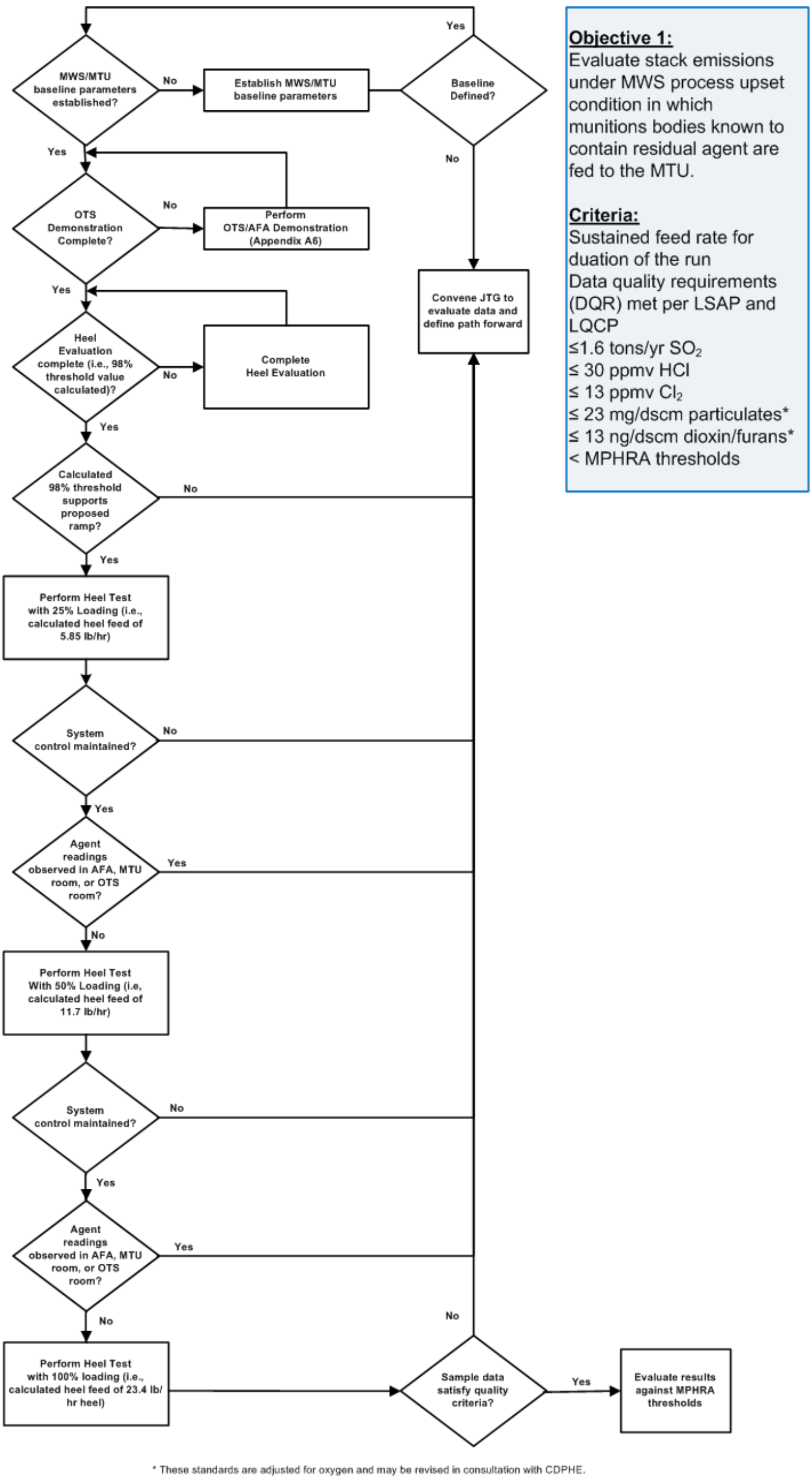

Figure A2B-4. Decision tree for MTU PTD Objective 1.

Table A2B-1. Test Matrix for MTU Pilot Testing.

Activity		Objective	Key Variables	Performance Criteria
Ramp-up		Recycle munitions bodies Control paint chips, ash, and dust and COPCs Collect and assess data to validate and/or define critical parameters for the MWS/MTU MTU throughput supports the duration of the operations phase	MTU parameters (Table A2B-2) MINICAMS bin sampling and analysis results COPCs and dioxin/furan bin sampling results Administrative controls (i.e., housekeeping, inspections) Total dust & metals Visual inspection MTU throughput	Data Quality Requirements per LSAP, *Laboratory Quality Control Plan* (LQCP), and standard methods MINICAMS bin sampling < 0.00002 mg/m^3 COPC, total dust and metals < AELs No build-up of residues in MBBE workspaces Processing rate supports 85.5 weeks or less for the 155-mm campaign
Testing	Loss of PRRS	Loss of PRRS does not result in unacceptable emissions during clearing of munitions bodies in the MTU	MTU parameters (Table A2B-2) MTU throughput Total metals and dust sampling results Visual inspection	Total dust and metals < AELs No build-up of residues in MBBE workspaces

Activity		Objective	Key Variables	Performance Criteria
	Heel Test	Evaluate stack emissions under MWS process upset condition in which munitions bodies known to contain residual agent are fed to the MTU Recycle munitions bodies	MTU parameters (Table A2B-2) MTU throughput Agent/heel processed through MTU (number drained but unwashed rounds processed through MTU) Processing time to collect valid emission results Agent monitoring Stack emissions sampling for COPCs, metals, acid gases, particulates, and dioxin/furans Post-MTU bin munitions weight for 100% loading test	DQR per LSAP and LQCP Sustained feed rate for duration of the run ≤1.6 tons/yr SO2 ≤ 30 ppmv HCl ≤ 13 ppmv Cl2 ≤ 23 mg/dscm particulates* ≤ 13 ng/dscm dioxin/furans* < .17 ng/dscm of 2,3,7,8-TCDD toxicity equivalence (TEQ), calculated as specified in 6 CCR 1007-3, Section 264.342(g)(2) < MPHRA thresholds** or 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. MINICAMS bin sampling < 0.00002 mg/m^3
IFD		See Appendix A7		

* These standards are adjusted for oxygen and may be revised in consultation with CDPHE.
** 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

MTU ramp-up and testing are conducted in accordance with Standing Operating Procedures (SOP) 24852-SOP-PT-001, *Pilot Test Evolutions*, 24852-SOP-B03-W0001, *Munitions Treatment Unit, and* 24852-SOP-B15-W0001*, Residue Handling* (B15). The following provides additional details for each activity.

2.5.1 Ramp-up

MTU ramp-up occurs in parallel with MWS ramp-up (see Appendix A2A). Ramp-up proceeds through a slow and steady process commencing with a single line and progressing to two lines as operational experience with stockpile munitions is gained. Ramp-up will continue until periods of continuous operation sufficient to support MTU testing activities (Section 2.5.2) and OTS Pilot Test Demonstration (PTD) activities (MWS/MTU demonstration and OTS/AFA demonstration, see Appendix A6) are achieved.

Throughout ramp-up, MTU operating data (Table A2B-2) will be used to establish a baseline for normal operations that can be used to identify MWS upset conditions. This baseline will build upon data generated during systemization with Assembled Chemical Weapons Alternatives (ACWA) Test Equipment (ATE) but will specifically consider potential impacts from reduced feed rates, stockpile paint, and stockpile tare weight variability. Control charts will be generated for each of the following parameters:

- Current to heated zones (power input)
- Zone temperatures
- Offgas vent flow
- Offgas vent temperature
- MTU exhaust carbon dioxide (CO_2)

These parameters are integrated into the Process Data Acquisition and Recording System (PDARS) with pre-defined set-points defined in the *SOP 24852-SOP-PT-001, Pilot Test Evolutions* which will be assessed under pilot test demonstration. Data will be evaluated using standard statistical process control techniques. Specifically, readings will be compared against a moving baseline consisting of the average of (at a minimum) the prior hour of measurements with control lines set at three standard deviations of the baseline. Baseline shifts as well as peaks and troughs will be evaluated against plant processing conditions.

It is anticipated that each will be impacted to some extent by the munitions body feed rate. If possible, a linear relationship will be established for these parameters with munitions body feed rate such that process control limits may be defined as a function of feed rate (as required). Parameters will be impacted by the steady-state vs. non-steady state operations and therefore control charts will consider start-up/initial feed and/or operational pauses in data assessment. Operational control limits will be finalized during the MWS/MTU demonstration (see Appendix A6) for continued operations. Control limits will be verified during heel testing to provide adequate

notification of MWS upset conditions. Figure A2B-4 provides the decision diagram for evaluation of MTU process parameters as indicators for residual heel. Initial MWS testing will demonstrate that MWS operating parameters achieve reasonable cleanliness of munitions. During ramp-up, a baseline for each parameter will be established. If a baseline cannot be established for a parameter, the PTD Test Team will review data to determine if continued evaluation of the process parameter as an indicator is warranted. During execution of MTU heel testing, the data will be reviewed to identify which parameters best identified the feed of unwashed rounds. Although a continuous process, those parameters best able to detect unwashed rounds at the lowest feed rate of unwashed rounds (i.e., ramp one) will be selected as the indicators for continued operations.

Data from the CO_2 analyzer will have additional data evaluations to support establishment of a carbon balance around the MTU as defined in Calculation 24852-RD-M6C-B03-M0005 and to determine the applicability of the analyzer in detecting munitions which do not achieve cleanliness to the extent reasonably possible from MWS operations (see Appendix A2A). Pertinent equations for the first evaluation are provided in Section 4.1 and Further details on CO_2 data evaluation are provided in White Paper on Carbon Dioxide Monitoring During Pilot Test Demonstration, 24852-30H-000-V0004.

Under the second evaluation, continuous and hourly average CO_2 analyzer results for the first 59 double washed rounds through the MTU will define a baseline CO_2 emission level for munitions cleaned to the extent reasonably possible. CO_2 analyzer results from subsequent munitions processing, including the heel test will also then be collected and compared to the baseline CO_2 emission level. The evaluation will be used to determine whether or not the CO_2 analyzers will be effective in identifying munitions processed through the MWS that may not be completely washed during PCAPP operations and if possible allow for quantification of agent loadings to the MTU.

The first 3 munitions bodies bins filled during ramp-up will be sampled for agent, COPCs, and dioxins/furans using the following general steps:

1. Cover full munitions bodies bin and move from MBBE to clean munitions body staging area
2. Allow bin to cool to < 120°F
3. Monitor bin per 24852-GPP-GGL-0301, *Mustard Agent (HD) in Air by MINICAMS®*
4. If MINICAMS alarms, take immediate action in accordance with contingency plans
5. If MINICAMS does not alarm, perform sampling for COPCs and dioxins/furans

If agent readings < 0.00002 mg/m^3 are observed, PCAPP will pursue scrap metal recycling for munitions bodies. If agent readings ≥ 0.00002 mg/m^3 are observed, PCAPP will convene the JTG to evaluate data and develop a path forward. If analysis of COPCs demonstrate results < AELs, MTU pilot testing will continue. If results ≥ AELs

are observed, operations will be paused and the JTG convened to evaluate data and determine a path forward.

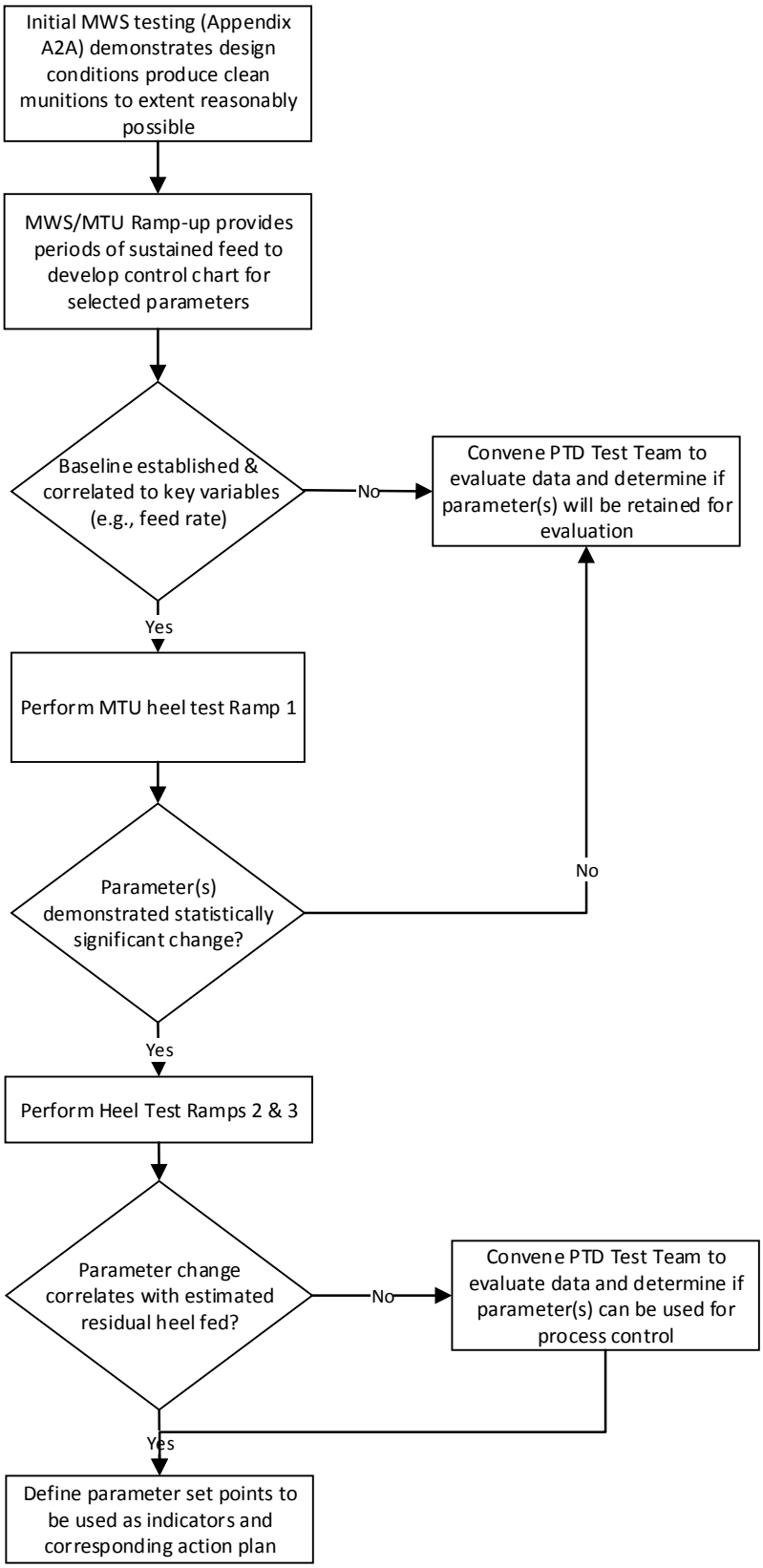

Figure A2B-5. Decision tree for evaluation of MTU process parameters as indicators for residual heel (Appendix A2A Objectives 1a and 1b).

After MTU ramp-up has progressed to stable and continuous operations for the minimum period required for workspace sampling of total dust and metals but before implementation of MTU testing activities, workspace total dust and metals air samples are collected within the MTU room.

Visual inspections are routinely performed of the MTU and MBBE work areas in accordance with operational procedures. If no build-up of residues is observed in the MBBE work areas and total dust and metals samples collected in the MTU room are less than AELs, testing will continue. If residue build-up is observed and/or total dust and metals samples are ≥ AELs, operations will be paused and the JTG convened to evaluate data and determine a path forward.

2.5.2 **Testing**

2.5.2.1 Loss of PRRS Testing

Loss of PRRS testing is conducted per the following general steps:

1. Process munitions with PRRS disabled for 4 hours.
2. During testing, collect workspace total dust and metals air samples within the MTU room.
3. Retrieve samples and inspect areas for dust accumulation

If no build-up of residues is observed in the MBBE area and total dust and metals samples collected in the MTU room are < AELs, the JTG will be convened to evaluate the need for the PRRS in normal operations. If residue build-up is observed and/or samples collected are ≥ AELs, PRRS operations will remain a requirement for normal operations.

2.5.2.2 MTU Heel Testing

MTU heel testing includes a preliminary assessment conducted during ramp-up to statistically characterize the residual heel and tare weight for the selected munitions lot and three heel test runs. These are each discussed here separately. Prior to testing, operations will define the selected lot for heel testing based on the availability and accessibility of munitions, historical data on agent purity or heel quantity, and operational data obtained during pilot testing activities. Approximately 1,630 rounds from the same munitions lot must be available for testing.

<u>Preliminary Assessment:</u>

The preliminary evaluation of the residual agent heel remaining in munitions bodies from the selected lot is performed to estimate the total agent heel loading and provide assurance that testing will not result in an unacceptable heel load to the MTUs. This evaluation, which may be conducted at any time during ramp-up, involves performing the following activities on munitions bodies contained on 2 slave pallets (40 munitions bodies) from the lot selected for MTU heel testing:

1. Weigh munitions bodies in the MRR
2. Drain munitions bodies in the MWS as per treaty sampling procedure (i.e., 2-minute drain with no wash)

3. Weigh munitions bodies on the DMWS
4. Return munitions bodies to the MWS and wash per MWS parameters
5. Weigh munitions bodies on DMWS. If munitions body satisfies DMWS set point, process through MTU; if not, rewash in the MWS, reweigh at the DMWS, and process through the MTU (see Appendix A2A for further details).

The weight data collected for the 40 munitions bodies is used to calculate a mean, standard deviation, and 98% threshold level for both the residual agent heel and munitions bodies tare weight per calculations included in Section 4.1.1. The 98% threshold value for agent heel is used to calculate the number of unwashed rounds to be processed per hour for each test using the equation in Section 4.1.2. If the observed residual heel level and/or variability does not support execution of the ramp-up specified in this plan, the JTG will be convened to evaluate the data and determine a path forward.

<u>MTU Heel Test:</u>

Three tests are performed as part of heel testing. However, as indicated in Figure A2B-4, if during any test period system control is not maintained or agent readings are observed within the MTU room, OTS room, or AFA, testing will be immediately paused and the JTG convened to evaluate data and define the path forward for testing. Heel testing is only executed after the MWS and MTU have been ramped-up to provide stable and sustained operations for a minimum of 6 hours of continuous operations, a baseline for MWS and MTU operating parameters is established, the preliminary assessment discussed above is complete, and OTS/AFA demonstration testing (see Appendix A6) has been successfully performed.

The following steps are followed for MTU heel testing:

1. Verify automation is in place to inhibit washout at the frequency required for each test sequence. Ensure automation is such that it will space out the unwashed rounds between each hour processing period and sequence unwashed rounds so that they are not consistently oriented in the same direction.
2. Evaluate 98% threshold limit for the tare weight against the DMWS set point. If 98% threshold value for tare weight is greater than the DMWS set point, temporarily adjust the DMWS set point to the 98% threshold value. While this modification is in place, only munitions from the selected lot may be processed.
3. Verify stack sampling equipment are in place to support sampling activities (see LSAP and Appendix A6).
4. Verify munitions bodies bins equipped with sampling ports are available and positioned for use. Ensure controls are in place to isolate munitions resulting from normal operations from those generated during off-normal processing. For 100% load test, tare munitions bodies bins (with lids) required for test execution and ensure automation allows direct correlation of munitions bodies in bins with munitions bodies' weights at the DMWS.

5. Commence normal MWS/MTU operations on parallel lines and proceed for the total period defined through systemization phase activities as required to provide thermal equilibrium in the MTU.
6. Initiate AFA sampling as per LSAP and OTS/AFA subplan (see Appendix A6) and commence off-normal processing with the required number of drained but unwashed rounds per hour.
7. Proceed with off-normal processing for the period of time required to obtain valid emissions samples,and sufficiently long to correlate off-normal conditions with stack emissions and PCAPP MPHRA thresholds (confirm with an MPHRA update that meets the MPHRA Benchmark). This period of time will be determined in advance of testing to allow preparation of an adequate number of washed/unwashed rounds, in accordance with the Pilot Test Plan objective.
    a. If a munitions body fails to meet the DMWS weight tolerance (as modified in Step 2), return it to the CAM and handle as per standard protocols. If the munitions body was to be an unwashed round, the next round will remain unwashed to replace it.
    b. If system performance is not verified, or if agent readings are observed, pause testing and convene the JTG to evaluate data and develop a path forward.
    c. Replace bins as required to provide bins containing munitions generated during off-normal processing. Bins containing munitions from periods of normal operations (i.e., to establish thermal equilibrium or to maintain MTU thermal load following testing) will be handled/dispositioned in accordance with the established procedure. Bins containing munitions from off-normal operations will be handled in accordance with Step 10.
8. Return to normal MWS/MTU operations and proceed with normal operations until the last drained but unwashed round passes out of the heated zone of the MTU.
9. Pause MWS/MTU operations and evaluate data.
10. Cover and take munitions bodies bins containing munitions generated during off-normal operations to the clean munitions body staging area and perform the following:
    a. Weigh munitions bodies bins (for bins filled during the 100% loading test only).
    b. Allow bin to cool to < 120°F.
    c. Monitor bin per 24852-GPP-GGL-0301, *Mustard Agent (HD) in Air by MINICAMS®*
    d. If MINICAMS alarms, take immediate action in accordance with contingency plans.
    e. If MINICAMS does not alarm, perform sampling for COPCs and dioxins/furans (2 bins per test).

11. If system control was maintained throughout testing and agent readings were not observed in the MTU room, OTS room, or AFA, proceed to the next agent loading test (as applicable). If any of these is not true, convene the JTG to evaluate data and define the path forward.

Immediate evaluation of heel test success is based on system performance and agent readings. However, complete data evaluation will involve the following decisions/actions:

1. Munitions bodies bin agent readings will be evaluated against the performance criteria of < 0.00002 mg/m^3 to determine if munitions bodies generated under upset conditions can be submitted for scrap metal recycling.
2. Munitions bodies bin COPC and dioxin/furan readings will be used to establish appropriate operating conditions to limit potential hazards.
3. MTU operating parameter data (Table A2B-2) will be reviewed against the established baseline to identify key indicators of potential MWS upset conditions for application in future operations (see Appendix A2A)
4. For the 100% load test, the final munitions bodies bin weight will be compared against the initial tare weight and the DMWS weights for munitions incorporated into the bin to estimate the total mass of agent processed given an estimated paint loss of 0.15 lb/munition[†].
5. Emissions data will be evaluated to determine if emissions are within MPHRA thresholds and if the MPHRA update, based on those data, indicate a maximum estimated lifetime cancer risk to any human receptor of 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, and a total acute HI for any receptor less than 1.0. Data will be confirmed during IFD.

2.6 Data Collection

Data are collected on Test Performance Control Sheets (TPCS) or data forms provided in SOP 24852-SOP-PT-001, *Pilot Test Evolutions*. Examples of such forms are included in Attachment 1.

Additional data to be collected include data from the instrumentation included in Table A2B-2 which will be recorded by the Process Data Acquisition and Recording System (PDARS) and collected by the test team following testing, and analytical data packages generated from the sampling and analyses activities (i.e., dust characterization, total dust and metals, and bin sampling). Data associated with OTS/AFA sampling are collected as part of OTS/AFA testing (see Appendix A6). Data are attached to the TPCS either as electronic media or as appropriate hardcopy.

[†] Value per *Process Flow Diagram, Munitions Treatment Unit Material Balance – 155mm Munitions*, 24852-RD-M5-B03-B0003 considering loss of organics and paint chips.

Table A2B-2. PDARS-Recorded Process Parameters and Instruments *

PARAMETER	INSTRUMENT
DMWS Weight	WI-9304A-A WI-9304B-A
MTU counter	XI-9312-A XI-9312-B
Bin counter	XI-9323A-A XI-9323B-A
Current to heated zones (power input)	IT-9387A-A/B/C/D/E/F IT-9301B-A/B/C/D/E/F
Zone 1 (Z1) Temperature	TE-9301A-A TE-9301B-A
Z2 temperature	TE-9301A-B TE-9301B-B
Z3 temperature	TE-9301A-C TE-9301B-C
Z4 temperature	TE-9301A-D TE-9301B-D
Z5 temperature	TE-9301A-E TE-9301B-E
Z6 temperature	TE-9301A-F TE-9301B-F
Offgas vent flow	FIT-9308A FIT-9308B
Offgas vent temperature	TIT-9309A TIT-9309B
Pressure differential (ΔP) across OTS filter	PDIT-9313A-A PDIT-9313B-A
MTU inlet airflow	FIT-9368A FIT-9368B
MTU belt speed	SIC-9315A-A SIC-9315B-A
MTU exhaust carbon dioxide sensor	AT-9319A AT-9319B

* 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 and Environmental considerations for pilot testing are included within the main body of the PTDP. The following unique considerations apply for pilot testing of the MTU:

- The PCAPP safety department will validate the noise level exclusion zone established during systemization.
- OSHA or personnel area sampling beyond the total dust and metals sampling included in this plan may be performed to establish worker access and personal protective equipment (PPE) requirements for specific areas. Until Safety determines sufficient data are available, access to the Residue Handling System (RHS) area will be limited to essential staff and PPE will be prescribed.
- Room monitoring data for the MTU room (MINICAMS AIT-3309B and AIT-3318B and Depot Area Air Monitoring System [DAAMS] DAAM-3309B and DAAM-3318B) will be reviewed using laboratory data tracking methods to confirm the proper functioning of airflow controls. In the event agent is detected in the MTU or OTS room at or above the alarm level, the test will be suspended and an investigation will be conducted to determine the nature of the contamination. This investigation will be comprehensive and will determine the cause of the agent migration and evaluate the potential for contamination of materials or surfaces as a result of the event.
- Potential risks associated with monitoring munitions bodies bins will be evaluated and risks mitigated.
- Collected paint residue and dust will be characterized as specified in the LSAP. If dioxins/furans are detected at levels above established treatment standards in the residue/dust, the JTG will be convened to evaluate data and develop a path forward.
- Treated munitions bodies will be handled as listed hazardous waste (K901 waste code) until the Colorado Department of Public Health and Environment accepts the results of testing described here.
- Revisions to standard instrument controls required for test execution (e.g., heel test) will be validated and tested during the systemization phase.

4 REPORTING

Two letter reports will be prepared to document MTU pilot testing:

- Letter report to support scrap metal recycling
- Letter report on MTU pilot testing activities

General requirements for letter reports are included within the main body of the Pilot Test Demonstration Plan (PTDP).

The letter report to support scrap metal recycling will be prepared following finalization of bin sampling data for the first 3 bins during initial ramp-up activities. This report will document munitions processing rates, MTU parameter data, and agent, COPC, and dioxin/furan sample results for the first 3 munitions bodies bins. An addendum to this report will be issued after completion of heel testing to provide additional support for scrap metal recycling of munitions generated during upset conditions.

The letter report on MTU pilot testing activities will summarize the data collected during testing and ramp-up of the MTU. Data collected during the IFD, to include emissions sampling, will be included with the letter report generated following the IFD (see Appendix A7). The letter report on MTU pilot testing activities will document ramp-up and testing activities with a special focus on overall system performance (e.g., throughput) and will define the final operating ranges and set points defined for continued operations. The data generated and collected during ramp-up and testing (see Section 2.6) will be appended to this report. The following list describes the data to be summarized in the report:

- Daily munitions throughput with total hours of continuous operations and number of lines on-line
- An evaluation of the ability of the MTU process to control paint chips, ash, dust and COPCs both with and without operation of the PRRS
- An evaluation of MTU heel test results to include evaluation of residual heel processed, identification of key indicators of potential MWS upset conditions, overall system performance, and the impact on facility emissions from MWS upset conditions
- An evaluation of the ability of the MTU to satisfy operational throughput requirements
- Operating conditions for continued operations

4.1 Calculations

4.1.1 Calculation of Residual Heel and Tare Weights

For the preliminary evaluation of residual heel in support of heel testing, the weight of the residual heel in each munition (W_{heel}) is determined by measuring the difference between the weight of the drained munition ($W_{drained}$) and the weight of the washed munition (W_{washed}) as defined in equation 1.

$$\mathrm{W_{heel}} = \mathrm{W_{drained}} - \mathrm{W_{washed}} \qquad \text{(Eq. 1)}$$

The average, standard deviation, and 98% threshold level (T) for the residual agent and tare weights are calculated using equations 2, 3, and 4.

$$\bar{W} = \frac{1}{n}\sum_1^n W_i \qquad \text{(Eq. 2)}$$

$$\sigma_W = \sqrt{\frac{\sum(W_i - \bar{W})^2}{n-1}} \qquad \text{(Eq. 3)}$$

$$T = \bar{W} + 2\sigma_W \qquad \text{(Eq. 4)}$$

Where:

$\bar{W}$ = Average weight
W_i = Weight per munitions body
n = total number of weights
σ_W = standard deviation of weight

4.1.2 Calculation of Number of Unwashed Rounds to Process

The number of unwashed rounds ($N_{unwashed}$) to be processed per hour for each heel test is calculated using equation 5:

$$N_{unwashed} = \frac{ML}{T} \qquad \textit{(Eq. 5)}$$

Where:

ML = maximum heel load defined as follows:

Test 1 = 25% of 23.4 lbs/hr or 5.85 lbs/hr

Test 2 = 50% of 23.4 lbs/hr or 11.7 lbs/hr

Test 3 = 100% of 23.4 lbs/hr or 23.4 lbs/hr

4.1.3 Calculation of Throughput

Average throughput is calculated as the total number of munitions processed (as counted using the MTU counter located at the rotary valve, XI-9312-A/B) divided by the total time allotted for the duration of the testing period.

4.1.4 MTU Carbon Balance

Data generated during pilot testing will be used to define a carbon balance around the MTU. The CO_2 concentration in the exhaust from the MTU during a 1-hr period will vary from the CO_2 concentration in air (background) to the CO_2 concentration in air plus an upper limit determined by a number of factors (e.g., feed rate, heel mass). Unless the variation in concentration is significant during an hourly period, the average mass flowrate will be applied in subsequent calculations. If significant variation is observed,

mass flowrate will be integrated for the hour to generate a total CO_2 mass flow for the hour.

The total mass of CO_2 resulting from agent during the period is the total mass of CO_2 determined from analyzer and flow data minus the mass of CO_2 in air (calculated from background air concentration times flow rate) minus the mass of CO_2 from paint (calculated from number of rounds in the hour times mass of paint per round). Dividing the result by the feed rate (rounds fed in the hour) and by the mass of CO_2 produced per pound of agent and would yield an average mass of agent per round for the 1-hr period.

$$m_{rnd} = \frac{\frac{\dot{m}_{CO2} - \dot{m}_{CO2-air}}{F} - m_{CO2-paint}}{m_{CO2-agent}}$$

Where:

m_{rnd} = agent per round, lbs
$\dot{m}_{CO2}$ = CO_2 mass flow rate in MTU exhaust, lb/hr
$\dot{m}_{CO2-air}$ = CO_2 mass flow rate in air in-leakage, lb/hr
F = MTU feed rate, rounds/hr
$m_{CO2-paint}$= CO_2 produced from paint per round, lbs
$m_{CO2-agent}$= CO_2 produced per pound of agent, lbs

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Attachment 1

Munitions Treatment Unit
Example Test Performance Control Sheets

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Munitions Treatment Unit Test Performance Control Sheet			
Date:		Shift	
MTU Line ID		Crew	
Complete one form per shift.			

Step #	**Operation**	**Value, ✓, or comment**
1	If performed, scale calibrations completed successfully? (Y/N/NA)	
	Date/time for MRR scale calibration:	
	Date/time for DMWS calibration:	
2	If required, media available for sampling of total dust and metals at specified sampling areas? (Y/N/NA)	
	Under MTU discharge conveyor	
	Bin enclosure chute rotary valve	
	The MTU room at _____	
	Bin enclosure work area outside the APB	
	Interior control sample to be collected at _____	
	External control sample to be collected at _____	
3	Date/Time first munition loaded on DMWS	
4	PRRS operational? (Y/N/NA)	
5	Date/Time last munition loaded on DMWS	
6	Total munitions processed	
7	Average throughput as collected by XI-9312	
8	If performed, date, time, and results of visual inspection of dust and debris accumulation in the following areas (attach photographs or NA if not performed):	
	Muffle	
	Belt return area	
	PRRS	

EXAMPLE

	Discharge Conveyor	
	MBBE	
9	If performed, date, time, and results of visual inspection of wear and tear (attach photographs or NA if not performed):	
10	If performed, date, time and results of MTU off-gas filter element inspection/maintenance (attach photographs or NA if not performed):	
11	MTU Room monitoring (MINICAMS AIT-3309, 3318 and DAAMS-3309B, 3318B) results confirm vapor containment (Y/N)?	
12	If required, total Dust and Metals Samples collected at required locations? (Y/N/NA)	
	Total Dust and Metals Sample IDs and COC numbers:	
	Total Dust and Metals results less than AELs? (Y/N/NA)	
13	If performed, date/time of dust collection drum sampling.	
	Analysis performed as per LSAP? (Y/N/NA)	
	Dust collection drum sample ID and COC number	
	Dioxin/Furans detected at levels greater than treatment standards? (Y/N/NA)	
14	If required, emissions sampling performed in accordance with OTS/AFA sub-plan? (Y/N/NA)	
15	Supporting data (PDARS, COCs, summary data sheets, photographs, monitoring data, data packages, etc.) appended? (Y/N)	
Comments:		

EXAMPLE

DATA SHEET - Preliminary Heel Evaluation				
Munitions ID	MRR Scale weight, lb	DMWS Drained Weight ($W_{drained}$), lb	DMWS Washed weight (W_{washed}), lb[1]	Calculated heel weight (W_{heel}), lb[2]
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
Average				
SD				
98% Threshold			T_{tare} =	T_{heel} =
DMWS reset required? (Y/N)				
Number unwashed rounds/hr for heel test 1 ($N_{25\%}$) =				
Number unwashed rounds/hr for heel test 2 ($N_{50\%}$) =				
Number unwashed rounds/hr for heel test 3 ($N_{100\%}$) =				

[1] The tare weight corresponds to the washed weight.
[2] Residual heel is equal to the drained weight minus the washed weight

EXAMPLE

Munitions Treatment Unit Test Performance Control Sheet **Heel Test**			
Date:		Shift	
MTU ID		Crew	
Complete one form per MTU line and per Heel Test sequence.			

Step #	**Operation**	**Value, ✓, or input**
1	Test No.: Number unwashed munitions per hour:	
2	Required automation in place to support testing? (Y/N)	
3	Required equipment for sampling available? (Y/N)	
4	Required agent and emissions sampling equipment per in place? (Y/N)	
5	Date/Time processing of washed rounds commences	
6	Number of washed rounds processed to achieve thermal equilibrium	
7	Date/time first unwashed round is fed to the MTU:	
8	Date/time last unwashed round is fed to the MTU	
9	Total number of unwashed rounds processed per hour:	
10	Average throughput as collected by XI-9312	
11	Number of washed rounds processed to maintain thermal loading	
12	Time last unwashed round exits heated zone	
13	Time last unwashed round exits rotary valve	
14	Time(s) bin(s) containing processed unwashed rounds removed from MBBE and transferred for cooling.	
15	Agent and emissions sampling performed in accordance with OTS/AFA sub-plan? (Y/N)	
	Agent readings observed in AFA? (Y/N)	

EXAMPLE

	Sample IDs and COC numbers	
16	Date/Time cooled bin(s) sampled for agent, COPCs, and dioxins/furans	
	Agent readings observed? (Y/N)	
	COPC and dioxin/furan Sample IDs and COC numbers:	
17	Does MTU Room monitoring (MINICAMS AIT-3309,3318 and DAAMS-3309B,3318B) indicate containment of vapors? (Y/N)	
18	Supporting data (PDARS, COCs, monitoring data, data packages, etc.) appended? (Y/N)	
Comments:		

EXAMPLE

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APPENDIX A3A: AGENT/WATER SEPARATOR

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1 INTRODUCTION

This sub-plan describes pilot testing of the Agent/Water Separators (AWS).

1.1 System Description

Agent and washwater generated in the Munitions Washout System (MWS) are collected in the surge drum and are batch-pumped to the AWS for gravity separation. There are two AWS tanks. One AWS tank is normally operated on a continuous flow basis. The higher-density agent collects in the lower section of the tank and is pumped out by the agent concentrate pumps to an agent hydrolyzer. The lower-density washwater is collected in the upper section of the separators and is pumped out by the washwater pumps to the Washwater Collection Tanks. Separation to neat agent within the AWS vessel is desired, but will depend on many factors such as droplet size, emulsion formation, and throughput. Agent and water separation is determined by density for agent concentrate and washwater pumped out of the separator. Coriolis density meters are installed on the discharge lines of the washwater pump and the agent concentrate pump to provide density readings. Reference *System Design Description (SDD) for Agent Collection and Neutralization System No. B04*, 24852-RD-3YD-B04-B0001 for additional system descriptions.

1.2 Objectives

The objectives of AWS pilot testing are:

1. Control concentration of agent in the ANR
2. Collect and assess data to validate and/or define critical operating parameters for the AWS

1.3 Limitations

The ability to adequately demonstrate the AWS is limited by the total time of continuous operations of the MWS and the ANR.

2 PILOT TEST DEMONSTRATION APPROACH

2.1 Overview

AWS pilot testing includes ramp-up and demonstration. MWS ramp-up will generate a gradual accumulation of agent and washwater in the AWS until ANR ramp-up commences. This gradual accumulation of agent and washwater makes for longer separation times than design. Demonstration commences after MWS (see Appendix A2A) and ANR (see Appendix A3B) ramp-up allow demonstration of the AWS at separation times approaching or at design. AWS performance is measured by results of coriolis density measurement of both the agent and washwater pumped from the AWS. If separation is not achieved, the Joint Test Group (JTG) is convened to define the path forward. Operating parameters and set points established during ramp-up and

demonstration (to include mode of operation) are incorporated into final operating conditions.

2.2 Materials

No special materials are required as part of this testing.

2.3 Design

AWS pilot testing will validate continuous flow operations are adequate to achieve agent/water separation. AWS pilot testing consists of two activities: ramp-up and demonstration. Ramp-up is conducted in parallel with MWS (see Appendix A2A) and ANR (see Appendix A3B) ramp-up and corresponds to longer separation times than design. If separation is not achieved during ramp-up, the JTG is convened to evaluate data and develop a path forward. The demonstration period occurs after MWS and ANR ramp-up has progressed to allow for AWS separation times approaching or at the design time of 100 minutes. Two demonstration periods are performed in which the MWS lines process at the sustained average rate achieved during ramp-up and a minimum of two batches are initiated. The AWS is operated in accordance with design with collection of coriolis meter data to assess the agent/water separation. If separation is not achieved during continuous flow operations, the JTG is convened to evaluate data and develop a path forward. The critical operating parameters validated during ramp-up and demonstration are integrated into continuous operations.

2.4 Matrix

The test matrix for AWS pilot testing is provided in Table A3A-1. The decision tree for AWS pilot testing is provided in Figure A3A-1.

Table A3A-1. Test Matrix for AWS pilot testing.

ACTIVITY	OBJECTIVE	KEY VARIABLES	PERFORMANCE CRITERIA
Ramp-up	Control concentration of agent in the ANR	Process parameters (Table A3A-2)	Washwater specific gravity (SG) ≤ 1.02
Demonstration	Collect and assess data to validate and/or define critical operating parameters for the AWS	Separation time as determined by MWS/ANR throughputs (see Section 4.1)	Agent specific gravity ≥ 1.25

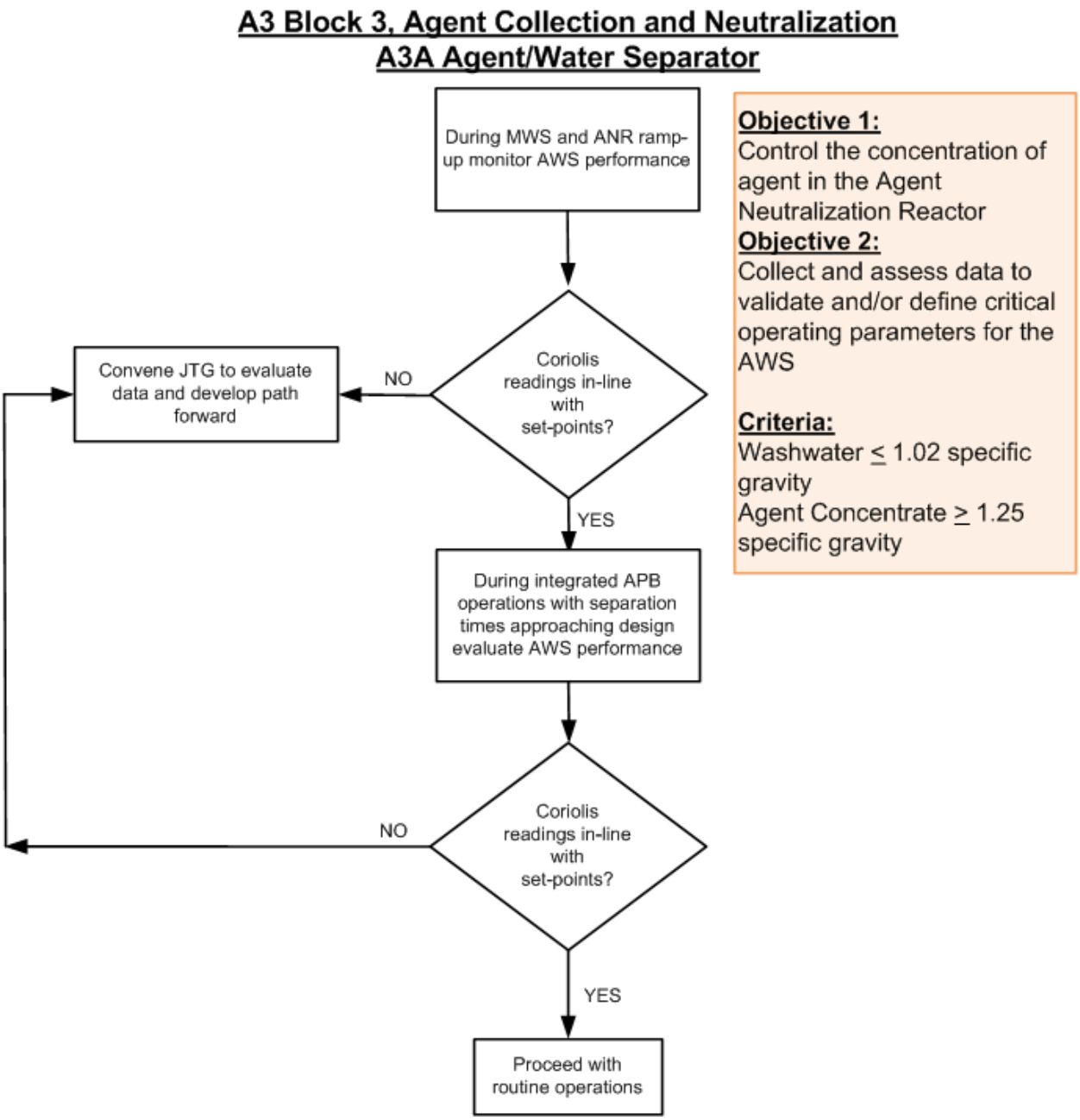

Figure A3A-1. Decision tree for AWS pilot testing.
APB = Agent Processing Building

2.5 Procedure

AWS ramp-up and demonstration are conducted in accordance with Standing Operating Procedures (SOP) 24852-SOP-PT-001, *Pilot Test Evolutions* and 24852-SOP-B04-W0001, *Agent Collection System*. The following provides additional details for test execution in accordance with the decision tree included in Figure A3A-1.

Prior to pilot testing, water is placed within the AWS system (including the washed agent and water booster pumps, the agent concentrate pumps and piping, and the washwater pumps and piping) to a minimum level of 116 inches from bottom tangent. 116 inches from bottom tangent corresponds to the low liquid level for water in the AWS. Initiating operations with water up to this level will provide minimal turbulence within the AWS as agent feed is started.

As MWS ramp-up proceeds, the water level will rise from 116" up to the normal level of about 130". At this time water is transferred to the washwater collection tanks with evaluation of washwater specific gravity. Once sufficient agent is transferred to the AWS to support initiation of two batches, ANR ramp-up operations commence with evaluation of agent specific gravity. If separation is achieved (i.e., specific gravity results meet performance criteria defined in Table A3A-1) with slow ramp-up, operations proceed. If separation is not achieved, operations are paused and the JTG is convened to evaluate data and develop a path forward.

After MWS and ANR ramp-up provide a minimum 4-hr period at sustained operating rates, AWS demonstration is conducted. A minimum of two demonstration periods are run in which the MWS is operated at the sustained average processing rate demonstrated during ramp-up and a minimum of two batches are initiated. Washwater and agent specific gravity measurements are evaluated. If separation is achieved, PCAPP will proceed with routine operations with the AWS operating in continuous mode. If separation is not achieved, PCAPP will convene the JTG to evaluate data and develop a path forward.

The operating parameters and set points demonstrated will be implemented for continued operations.

2.6 Data Collection

Data are collected during each demonstration period on a Test Performance Control Sheet (TPCS) or data form to be provided in Standing Operating Procedure (SOP) 24852-SOP-PT-001, *Pilot Test Evolutions*. An example of the data to be collected on this form is included in Attachment 1.

Additional data to be collected include data from the instrumentation identified in Table A3A-2, which will be recorded by the Process Data Acquisition and Reporting System (PDARS) and collected by the test team following processing. Data will be attached to the TPCS either as electronic media or as appropriate hardcopy reports.

Table A3A-2. PDARS-recorded process parameters and instruments *

PARAMETER	INSTRUMENT
Agent Wash Flow from MWS	FIT-0966
AWS Agent Concentrate Coriolis Flow Meter	FIT-0976AA/AB/BA/BB
AWS Agent Concentrate Coriolis Density Meter	DIT-0976AA/AB DIT-0976BA/BB
AWS washwater coriolis density meter	DIT-0981
AWS washwater coriolis flow meter	FIT-0981
AWS Headspace Pressure	PI-0962A PI-0962B

* 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 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 pilot testing of the AWS.

4 REPORTING

A letter report will be prepared to summarize the data collected during AWS ramp-up and demonstration. General requirements for letter reports are included within the main body of the PTDP. The report will focus on system performance (i.e., separation achieved as measured by coriolis meter measurements). The data generated and collected during each demonstration (see Section 2.6) are appended to this report. The following data must be included in the report:

- MWS and ANR throughput during each demonstration period with an estimated separation time (see Section 4.1)
- Average, minimum, and maximum density of agent concentrate and washwater during each demonstration period
- A summary of critical operating parameters to include mode of operation that will be employed during future operations

4.1 Calculations

The separation time (T_s) discussed throughout this plan is the time provided for separation within the separation zone of the AWS (i.e., the residence time). This time is calculated using equation 1.

$$T_S = \frac{V_{SZ}}{F_{Ag-ww}} \qquad \text{(Eq. 1)}$$

Where:

V_{sz} = volume of the separation zone or 1,128 gallons per Calculation 24852-RD-M5C-B04-B0002, *Agent-Water Separator Design*

$F_{Ag\text{-}ww}$ = flowrate of agent and water mixture from the MWS defined by FIT-0966

Attachment 1

Agent/Water Separator

Example Test Performance Control Sheet

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Agent/Water Separator **Test Performance Control Sheet**			
TPCS No.:		Shift	
Date/Time:		Crew	
AWS ID			
Complete one sheet for each demonstration period.			

Step #	**Operation**	**Value, ✓, or comment**
1	Date/Time MWS processing initiated	
2	Date/Time first batch initiated:	
	Average and range of agent concentrate flow (FIT-0976AA/AB/BA/BB):	
	Average and range of agent concentrate density (DIT-0976AA/AB/BA/BB)	
3	Date/Time second batch initiated:	
	Average and range of agent concentrate flow (FIT-0976AA/AB/BA/BB):	
	Average and range of agent concentrate density (DIT-0976AA/AB/BA/BB):	
4	Additional batches initiated during demonstration period? (Y/N) If yes, provide date/time and average/range of agent concentrate flow in comments section.	
5	Date/Time MWS processing stopped	
	Average and range of washwater flow (FIT-0981):	
	Average and range of washwater density (DIT-0981):	
6	MWS throughput and agent/washwater flow rate:	
7	PDARS data appended? (Y/N)	
Comments:		

EXAMPLE

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APPENDIX A3B: AGENT HYDROLYZERS AND HYDROLYSATE HOLD TANKS

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1 INTRODUCTION

This sub-plan describes pilot testing of the Agent Hydrolyzers and the Agent Hydrolysate Hold Tanks.

1.1 SYSTEM DESCRIPTION

Two Agent Hydrolyzers, hereafter referred to as the Agent Neutralization Reactors (ANR), are used for agent hydrolysis. Each titanium ANR is equipped with an agitator and two recirculation loops. The recirculation loops contain the inline static mixers, inline steam mixers, pH metering, controls for the neutralization step, and a control valve that is closed at the end of the reaction sequence. Each steam mixer heats the reactor contents to the required start temperature during the allotted reactor cycle time. The reactors operate on a batch basis and involve two primary steps: agent hydrolysis and neutralization of the hydrolysis reaction products with sodium hydroxide. The batch sequence involves filling the ANR with hot water, Munitions Washout System (MWS) wash water, and spent decon, bringing the ANR to the agent addition temperature, adding agent to each of the inline static mixers on the parallel recirculation loops, completing hydrolysis, and completing pH adjustment. Normally, both ANRs operate nearly simultaneously, with a 15-minute offset for batch start.

The two agent Hydrolysate Hold Tanks are used to sample, and temporarily store, agent hydrolysate pending analytical confirmation of agent destruction. After two batches are transferred to a Hydrolysate Hold Tank, tank contents are recirculated and a sample is taken to confirm agent destruction criteria are met. Agent hydrolysate that is cleared for release is then pumped to the thirty-day storage tanks for storage prior to feeding to the Immobilized Cell Bioreactors (ICB™) within the Biotreatment System (BTS). Agent hydrolysate that is not cleared is pumped back to the ANRs for reprocessing. An ANR batch sequence will not be initiated until at least one of the agent Hydrolysate Hold Tanks has adequate capacity and is ready to receive hydrolysate. In this manner, hydrolysate from the two ANR batches has a place to be stored should the contents of a Hydrolysate Hold Tank require reprocessing in the ANRs.

Reference *System Design Description (SDD) for Agent Collection and Neutralization System No. B04,* 24852-RD-3YD-B04-B0001 for additional system descriptions.

1.2 OBJECTIVES

The objectives of ANR and Hydrolysate Hold Tank pilot testing are:

1. Demonstrate agent destruction with agent loadings up to 15 wt% agent concentrate
2. Demonstrate agent destruction with no agitator
3. Demonstrate throughput can support the project schedule
4. Collect and assess data to validate and/or define critical operating parameters for the ANR

1.3 LIMITATIONS

ANR processing is limited by ramp-up of upstream systems (i.e., MWS and filling of the Agent/Water Separators [AWS]). As per Appendix B of the Main body of the *Pilot Test Demonstration Plan* (PTDP), initial batches through the ANR are likely to be washwater-only batches. As MWS ramp-up continues and agent is accumulated in the AWS, agent batches will commence and ramp-up of the hydrolyzers and Hydrolysate Hold Tanks will proceed in parallel with MWS operations.

Pilot testing of the 30-day tanks is limited to validation of gaseous emissions in accordance with the *Odor Monitoring Plan for Pilot Test Phase Operations* (OMP), 24852-GPP-GGG-V0018, the *Carbon Sampling Strategy,* 24852-30H-000-W0004, and emissions sampling performed as per Appendix A7.

2 PILOT TEST DEMONSTRATION APPROACH

2.1 OVERVIEW

Pilot testing demonstrates successful destruction of HD agent and the successful pH adjustment of the resulting hydrolysate to greater than 10 at agent concentrate loadings up to 15 wt% with and without the agitator. Testing builds upon the operational experience from the Aberdeen Chemical Agent Disposal Facility (ABCDF).

ANR and Hydrolysate Hold Tank pilot testing includes ramp-up, testing, and integrated facility demonstration (IFD). Ramp-up validates successful agent destruction at agent loadings up to 8.6 wt% agent concentrate and involves processing increasing numbers of batches as upstream systems (i.e., the MWS) increase agent supplied to the AWS. Ramp-up establishes whether system performance is capable of supporting the project schedule. Testing validates agent destruction at agent loadings up to 15 wt% agent concentrate and agent destruction with no agitator. Testing will demonstrate that agent destruction is achieved with and without the agitator to allow continued operations at the successfully demonstrated agent loadings should an agitator fail during operations. Following testing, the ANRs will continue to operate under the operating conditions defined during ramp-up and testing to support integrated operations testing (see Appendix A6) through completion of the IFD (see Appendix A7).

2.2 MATERIALS

There are no pilot-test-specific materials required as part of this testing.

2.3 DESIGN

ANR and Hydrolysate Hold Tank pilot testing consists of three activities:

Ramp-up: The ANRs are ramped-up using operating parameters validated during systemization (Table A3B-2). Processing during this phase confirms the ability of the ANRs to satisfy performance criteria and achieve throughput that can support the project schedule (Table A3B-1). This phase will also support other pilot test activities

(i.e., Off-gas Treatment System [OTS]/Agent Filtration Area [AFA] ANR demonstration defined in Appendix A6 and BTS start-up defined in Appendix A4A).

Testing: A minimum of six high-agent-loading batches are performed to demonstrate agent destruction at agent loadings up to 15 wt% agent concentrate. After successfully demonstrating normal agent neutralization at each loading, eight additional batches will be performed without use of the reactor agitator (four at 8.6 wt% and four at the maximum successful agent loading).

Integrated Facility Demonstration: The ANR and Hydrolysate Hold Tanks are operated at the critical operating parameters defined through ramp-up and testing during three 4-hr periods to support facility emissions sampling. See Appendix A7 for additional details on the IFD.

Ramp-up and testing activities are further discussed in the paragraphs that follow. Figure A3B-1 provides the decision tree applicable to ANR and Hydrolysate Hold Tank pilot testing.

2.3.1 **Ramp-up**

Ramp-up of the ANRs and Hydrolysate Hold Tanks is performed in parallel with MWS ramp-up. Increasing numbers of batches are processed daily until the hydrolyzers process between 4 and 8 batches daily. Batches produced throughout this period, which will include washwater only, spent decon only batches, and batches containing up to 8.6 wt% agent concentrate are confirmed to satisfy performance criteria (i.e., glovebox samples show no visually observable organic phase, are non-detect [ND] for HD and have a pH ≥ 10). Additionally, ramp-up demonstrates that system throughput can support the project schedule as defined by a reactor batch time of ≤ 3.5 hrs and a sample collection and analysis time of ≤ 6.5 hrs. Ramp-up supports OTS/AFA pilot testing (i.e., OTS/AFA ANR demonstration) as defined in Appendix A6.

2.3.2 **Testing**

2.3.2.1 High Agent Loading Testing

Following ramp-up operations with demonstration of 0 to 8.6 wt% agent concentrate loading, high-agent-loading testing commences with two batches at a loading of 15 wt% agent concentrate. If successful, additional batches at 15 wt% agent concentrate are performed. If not successful, 12 wt% agent concentrate batches are performed. A minimum of six high-agent-loading batches are performed. Emissions sampling is conducted during high-agent-loading batches as defined in the OTS/AFA sub-plan (see Appendix A6).

2.3.2.2 No Agitator Testing

After successfully demonstrating agent destruction at 8.6 wt% with operation of the agitator, no agitator testing will be commence with four batches at 8.6 wt% agent loading without operation of the agitator. If both high agent loading testing (Section 2.3.2.1) and 8.6 wt% without agitator testing are successful, four batches at the highest successful agent loading will be performed without operation of the agitator.

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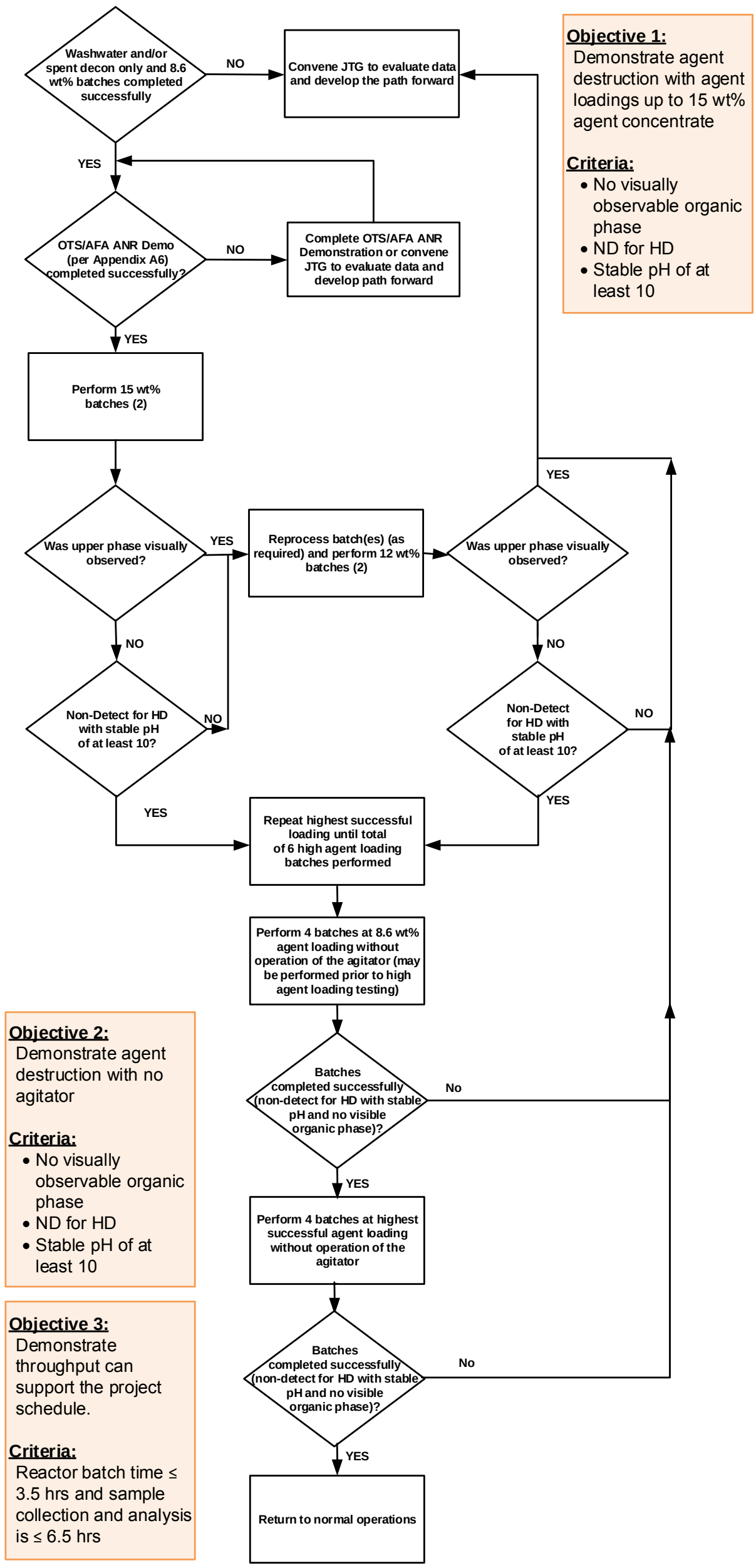

Figure A3B-1. Decision tree for Agent Hydrolyzer and Hydrolysate Hold Tank pilot testing.

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2.4 MATRIX

The test matrix for ANR and Hydrolysate Hold Tank testing is provided in Table A3B-1.

Table A3B-1. Test Matrix for ANR and Hydrolysate Hold Tank pilot testing

Activity		Objective	Key Variables	Performance Criteria
Testing	High-Agent-Loading	Demonstrate agent destruction with agent loading up to 15 wt% agent concentrate . Collect and assess data to validate and/or define critical operating parameters for the ANR.	Process parameters (Table A3B-2) Agent concentrate flow and density (see Table A3A-2 in Appendix A3A) Sample analysis	Glovebox sample shows no visually observable organic phase, is non-detect for HD and has a pH ≥ 10
	No agitator	Demonstrate agent destruction without agitator Collect and assess data to validate and/or define critical operating parameters for the ANR	Process parameters (Table A3B-2) Agent concentrate flow and density (see Table A3A-2 in Appendix A3A) Sample analysis	Glovebox sample shows no visually observable organic phase, is non-detect for HD and has a pH ≥ 10
Ramp-up		Demonstrate agent destruction with agent loading up to 15 wt% agent concentrate.* Demonstrate throughput can support the project schedule. Collect and assess data to validate and/or define critical operating parameters for the ANR.	Process parameters (Table A3B-2) Agent concentrate flow and density (see Table A3A-2 in Appendix A3A) Sample analysis	Glovebox sample shows no visually observable organic phase, is non-detect for HD and has a pH ≥ 10 Reactor batch time ≤ 3.5 hrs and sample collection and analysis time is ≤ 6.5 hrs
Integrated Facility Demonstration				See Appendix A7

* Ramp-up is limited to agent batches up to a loading of 8.6 wt% agent concentrate.

2.5 PROCEDURE

ANR and Hydrolysate Hold Tank ramp-up and testing are conducted in accordance with standing operating procedures (SOP) 24852-SOP-PT-001, *Pilot Test Evolutions*, and 24852-SOP-B04-W0001*, Agent Collection System*. Procedures for sampling and analysis will be as identified in the *Laboratory Sampling and Analysis Plan for Pilot Test Phase Operations* (LSAP), 24852-GPP-GGL-00013. The following provides additional details for test execution in accordance with the decision tree included in Figure A3B-1.

ANR and Hydrolysate Hold Tank pilot testing is coordinated with upstream and downstream pilot tests (e.g., MWS, AWS, OTS/AFA, and BTS). As MWS ramp-up progresses and agent accumulates in the AWS, washwater only batches are required to treat the water placed within the AWS system prior to pilot testing (see Appendix A3A).

As agent continues to accumulate, agent batches are initiated. Each batch and glovebox sample are evaluated against the performance criteria (non-detect for agent, pH ≥ 10, and no visually observed organic phase). If any batch is not successful, it is reprocessed in the ANRs. Successful batches are transferred to the 30-day hydrolysate storage tanks to support BTS start-up (see Appendix A4A). If ANR processing with agent loadings up to 8.6 wt% concentrate are consistently successful, the OTS/AFA ANR demo is executed (see Appendix A6). If not, the Joint Test Group (JTG) is convened to evaluate data and develop a path forward. Process parameters are reviewed to validate and/or define critical ranges and set points established prior to pilot testing.

If the OTS/AFA ANR Demo (see Appendix A6) is successful, PCAPP will initiate high-agent-loading testing with two batches at 15 wt% agent concentrate loading. After batch processing, a sample is collected in the hydrolysate hold tank to validate performance criteria (non-detect for agent, pH ≥ 10, and no visually observed organic phase) are met. Sampling to assess the contribution to emissions from hydrolyzer batches at high agent loadings is performed as specified in the OTS/AFA sub-plan (Appendix A6). If performance criteria are met, another two batches at 15 wt% agent loading will be performed with emissions sampling. If processing at 15 wt% loading is not successful, PCAPP will perform two batches at 12 wt% with emissions sampling. If performance criteria are met, another two 12 wt% batches will be performed. If the batches at 12 wt% are not successful, the JTG is convened to evaluate data and develop a path forward. It is anticipated that a minimum of six high-agent-loading batches will be performed with emissions sampling performed during performance of four batches.

PCAPP will perform off-normal batches to confirm agent destruction with no agitator. Testing will commence with four batches at 8.6 wt% without operation of the agitator, which may be initiated after the OTS/AFA ANR Demo. After batch processing, a sample is collected in the hydrolysate hold tank to validate performance criteria (non-detect for agent, pH ≥ 10, and no visually observed organic phase) are met. If performance criteria are not met, the JTG is convened to evaluate data and develop a path forward. If performance criteria are met, four batches at the highest successful agent loading will be performed without operation of the agitator.

Following completion of testing, ANR and Hold Tank processing will continue per established procedures under the operating parameters defined through ramp-up and testing to support downstream pilot testing through execution of the IFD.

2.6 DATA COLLECTION

Data are collected on Test Performance Control Sheets (TPCS) or data forms to be provided in SOP 24852-SOP-PT-001, *Pilot Test Evolutions*. Examples of such forms are included in Attachment 1.

Additional data to be collected include data from instrumentation included in Table A3B-2 which will be recorded by the Process Data Acquisition and Recording System (PDARS) and collected by the test team following processing, and analytical data

packages generated from sampling and analyses activities. Data are attached to the TPCS either as electronic media or as appropriate hardcopy reports.

Table A3B-2. PDARS-recorded process parameters and instruments *

PARAMETER	INSTRUMENT
Washwater Recirculation flow	FIT-7004
Washwater flow totalizer	FQI-7062A FQI-7062B
Spent decon flow totalizer	FQI-7042A FQI-7042B
Agent Neutralization Reactor Hydrolyzer pH	AI-7108A AI-7108B
ANR Agent Concentrate Flow Totalizer	FQIS-0976AA/AB FQIS-0976BA/BB
ANR reactor temp	TIT-7091
Agitator operation (on/off)	SIT-7087A SIT-7087B
30-Day Tank Level	LI-7154A LI-7154B LI-7154C
30-Day Tank Temperature	TIT-7198A TIT-7198B TIT-7198C

* 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 are included within the main body of the PTDP. The following unique consideration applies for pilot testing for the ANR and Hydrolysate Hold Tanks:

- Determination of an operational method detection limit (MDL) for analysis of agent in hydrolysate will be conducted as defined in the *Laboratory Quality Control Plan*, 24852-GPP-GGL-00003. This must satisfy the requirement to be less than or equal to 20 ppb.

4 REPORTING

A letter report will be prepared which summarizes the data collected during ANR and Hydrolysate Hold Tank ramp-up and testing. Data collected during the IFD, to include emissions sampling, will be included with the letter report generated following the IFD (see Appendix A7). Emissions sampling data collected during the ANR OTS Demo and during High Agent Loading Testing will be included with the letter report for OTS/AFA testing (see Appendix A6). General requirements for letter reports are included within the main body of the PTDP. The letter report on ANR and Hydrolysate Hold Tank ramp-

up and testing will focus on overall system performance (Table A3B-1) and will provide the basis for recommending final operating ranges and set points for continued operations. The data generated and collected during ramp-up and testing (see Section 2.6) will be appended to this report. The following list describes the data to be summarized in the report:

- Daily batches processed (throughput)
- Batch performance (analytical data packages and operating parameters) by agent loading
- Assessment of the ability to operate without the agitator

4.1 CALCULATIONS

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

Attachment 1

Agent Hydrolyzers and Hydrolysate Hold Tanks Example Test Performance Control Sheets

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Agent Hydrolyzers and Hydrolysate Hold Tanks Test Performance Control Sheet			
TPCS Nu:		Shift	
Date/Time:		Crew	
Complete one sheet for each shift.			

Step #	**Operation**	**Value, ✓, or comment**
1	Required data documented in attached data sheet? (Y/N)	
2	Agent and emissions sampling performed in accordance with OTS/AFA sub-plan? (Y/N/NA)	
3	Supporting data (PDARS, COCs, data packages, etc.) appended? (Y/N)	

Comments:

EXAMPLE

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Agent Hydrolyzers and Hydrolysate Hold Tanks Data Sheet								
Hold Tank Batch No								
Hold tank ID								
Hydrolyzer ID								
Agitatator Operational (yes/no)								
Sequence Start-time								
Total spent decon addition								
Total washwater addition								
Start time for agent addition								
Agent Concentrate total flow								
Agent concentrate density range								
Time provided for pH stabilization / Final pH								
Start time for Transfer								
Total hydrolyzer batch cycle time								
Time of sample collection								
Sample & COC ID No.								
Date/time analytical results received								
Results (ND or value)								
Time transferred to 30-day storage								
Hydrolysate hold tank vented? (Y/N)								
Total cycle time								

EXAMPLE

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