ES EXECUTIVE SUMMARY

Title: Executive Summary **Doc. No.** 2015-MMTS-0

Approval Signatures and Date

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☐ Initial Release ☐ Annual Review/No Revision Required ☐ Annual Review/Update (see history below)

NOTE: *This document will be reviewed at least annually to ensure its suitability.*

Revision History

Rev. No.	Change description	Author
4	Added the MMTS Operating Limits Table	Burton Packard and Renee Rodriguez
3	Change description Crosswalk Between NDEP CAPP Review Comments (dated 2014-12-09, 2015-01-30 and 2015-02-26) and Mercury Storage and Transfer Program Document Contents March 10, 2015	Burton Packard and Renee Rodriguez
2	Pg. vii, 2nd bullet, added text to clarify which tray is described. Pg. viii, 1st bullet, changed scale capacity from 5,000 to 3,000 lb. and added explanation.	
1	Pg. xxii, revised description of placing the 30th flask in a sequence into special six-pack tray and noting when to process the contents of that special six-pack tray.	

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Reference Documents

Document number	Document title
2015-MSSP-41	Process Safety Information for the Mobile Mercury Transfer System to Comply with NDEP- CAPP

Purpose: The Executive Summary procedure 2015-MMTS-ES is intended to provide a brief background and a list of requirements common to many procedures. Part of worker training includes reading this procedure and following all requirements.

Background: Defense Logistics Agency Strategic Materials (DLA Strategic Materials) is the custodian of the national stockpile of mercury, which is now located at the Hawthorne Army Depot (HWAD), Hawthorne, Nevada. At the direction of DLA Strategic Materials, the mercury inventory currently stockpiled at HWAD will be transferred from the existing 76-lb flasks to 1-MT containers in a purposely constructed facility called the Mobile Mercury Transfer System (MMTS).

The MMTS is mobile and could be located adjacent to any or all of those HWAD warehouses that currently store the existing mercury flask stockpile. The MMTS is installed adjacent to Building 110-66, to re-containerize inventory in that warehouse, based in part on the existing synergies for the electrical upgrade required. To minimize costs and downtime, the MMTS is expected to remain in its current location until the entire mercury stockpile has been transferred from the existing 76-lb flasks to 1-MT containers.

This report was developed by Oak Ridge National Laboratory (ORNL) to document operations and maintenance procedures needed for use in the MMTS. Specific actions for 27 separate topical categories of MMTS procedures are described. A summary listing of each set of these procedures is given in Table S.1 below. The procedures are written for use and implementation by DLA Strategic Materials. Some procedures are stand-alone such as Mercury Training Plan (SOC.QP.EMP.HG.0002). Mercury handling procedures require execution in combination with others. For instance, executing pallet and drum handling and flask removal (2015-MMTS-4 and 2015-MMTS-5) are required prior to Fume Hood 1 and Fume Hood 2 operations (2015-MMTS-6 and 2015-MMTS-7). The content and interfaces of each procedure must be understood by the MMTS operating staff.

Consistent with ensuring required employee participation all operators of the MMTS facility shall have the opportunity to comment and improve these procedures. The DLA Strategic Materials Safety Manager and MMTS Facility Manager shall assure that cross-training shall be implemented for special mercury container and handling operations to be performed in the drum and flask handling processing rooms.

The procedures address findings and suggestions identified in the Process Hazards Assessment. To ensure that each document being used is the latest revision available, each MMTS Operating Procedure contains the following statement: "***NOTE**: Hard copies of this document may not be the current version. Refer to the "IAmTheKey" to verify the current version.*

It is the user's responsibility to ensure, prior to use, the revision of this document is the latest available. Check the master list, if unsure of document status, prior to use. Downloaded, printed or copied document, unless supplied and so indicated by a DCA as being a controlled document are uncontrolled.

It is the responsibility of management and workers to ensure that all documents are current. Check the revision history and current operating conditions; advise management if existing conditions do not accurately reflect document content. Each worker is responsible to ensure that the document being followed is the current version.

The DLA Strategic Materials shall strive for excellence in safety, health, and environmental leadership through the implementation of sustainable, sound, and proactive programs. All DLA Strategic Materials staff and subcontractors are expected to adhere to safety, health, and environmental requirements defined by Hawthorne Army Depot (HWAD) and DLA Strategic Materials for the work they perform.

Prior to shipment of the MMTS, the MMTS functional testing was completed at the seller equipment installation site. Site preparation at Building 110-66, installation-readiness requirements, and inspection during set-up was completed. Acceptance and functional operational testing was performed on the installed equipment and systems at the Hawthorne, Nevada off-site location. Acceptance and functional operational testing was performed on the installed equipment and systems at Building 110-66 which is the current operating location on the HWAD site. The MMTS could be moved to other mercury buildings on the site, but utility and site upgrades would be required.

The first shipment of metric ton containers from the Tooele Army Depot (TEAD), vendor supplied Mercury Monitoring System, HVAC units, personnel access steps, rails and platforms arrived and were installed at Building 110-66 timely with the MMTS transport and set-up. The HWAD site preparation requirements specified by DLA Strategic Materials were completed prior to MMTS transport to and setup at Building 110-66.

Table ES 1. MMTS procedures documented in this report

Section	Procedure topic (description)	Document number
ES	Mobile Mercury Transfer System Procedures Executive Summary	2015-MMTS-ES
1	Metric Ton Container Acceptance and Staging	2015-MMTS-1
2	Metric Ton Container Setup	2015-MMTS-2
3	Metric Ton Container Transport and Storage	2015-MMTS-3
4	Pallet Transport and Handling	2015-MMTS-4
5	Drum Handling	2015-MMTS-5
6	Fume Hood 1 – Mercury Access	2015-MMTS-6
7	Fume Hood 2 – Mercury Transfer	2015-MMTS-7
8	Metric Ton Container Unhook and Close	2015-MMTS-8
9	Empty Flask Disposition and Transport	2015-MMTS-9
10	Waste Management	2015-MMTS-10
11	Routine Cleaning	2015-MMTS-11
12	Emergency Response and Spill Clean Up	2015-MMTS-12
13	Data Acquisition and Inventory Management	2015-MMTS-13
14	Mercury Vapor Monitoring System	2015-MMTS-14
15	Inspection, Testing and Maintenance	2015-MMTS-15
16	Fire Protection	2015-MMTS-16
17	Equipment Calibration	2015-MMTS-17
18	Security	2015-MMTS-18
	Training	SOC.QP.EMP.HG.0002
20	Mercury Medical Surveillance	2015-MMTS-20

21	Decontaminating and Decommissioning	2015-MMTS-21
22	Personnel Notifications	2015-MMTS-22
23	Operations Under Adverse Conditions	2015-MMTS-23
24	Diesel Generator Operations-Startup, Shutdown, Refueling, and Periodic Maintenance	2015-MMTS-24
25	Air Handling System — Startup, Shutdown, and Filter Replacement	2015-MMTS-25
26	Mercury Transfer from Mercury Drum	2015-MMTS-26
27	Defense National Stockpile Mercury Inventory Control	2015-MMTS-27

Common Requirements:

Design

- The Process Safety Information for the Mobile Mercury Transfer System to Comply with the NDEP – CAPP (2015-MSSP-41, Rev. 1) (PSI) examines process limits in Chapter 3, §3.4.1 Safe Upper and Lower Limits, Pressure and Temperature. Regarding pressure and thermal limits, the PSI states that 'The MMTS process is a material transfer process; there are no chemical, thermal or pressure requirements associated with the transfer process, other than building environment conditions that are suitable for personnel safety and comfort.

- Section 3.4.2 of the PSI documents an examination of the actions of the peristaltic pump that cause the flow of mercury through a stainless steel siphon tube and Tygon® tubing to the metric ton container. The peristaltic pump and the flow of mercury can be stopped by the operator taking his/her foot off the actuating switch, someone pushing either of the two Emergency Stop switches, or automatically through the Process Control and Data Acquisition System interface based on the weight of mercury or the height (level) of the mercury column in the metric ton container. The automated shutoff designs are described in §§ 4.4.3 and 4.4.4 of the PSI for weight and level, respectively.

- In procedure 7, §§7.4.3 and 7.4.5, Procedure 8, §8.3.2 and Procedure 27, §27.3, the operator is directed to limit to 29 the number of flasks emptied into a metric ton container. The transferred mass would be very close to 1 metric ton. The automated mercury weight and mercury level shutdowns are designed to prevent overflow of the metric ton container in the event the operator attempts to transfer the contents of more than 29 flasks into the metric ton container. The automatic shutdowns of the peristaltic pump are set to operate at a weight of 2280 lb and, as a backup to the weight limit, at a level 2 inches below the top of the metric ton container.

- The design of the ventilation system is detailed in §4.10 of the PSI. The ventilation system, including the fume hoods and portable Airfiltronix™ snorkels, is designed to allow mercury transfer activities without the need for respirators. In the absence of the ventilation system function, mercury vapor concentrations could exceed the 25 $\mu g/m^3$ exposure limit set by DLA Strategic Materials and HWAD. The Mercury Monitoring System (MMS) is described in §5.1 of the PSI and in Procedure 14 (2015-MMTS-14). The MMS samples mercury vapor concentrations at 16 location throughout the MMTS and alarms if the mercury vapor concentration at any of the sample points reaches or exceeds 25 $\mu g/m^3$. Procedure 22, Personnel Notifications, §22.3, directs the workers to leave the MMTS if the MMS alarm sounds. The 25 $\mu g/m^3$ limit is very protective of health; leave in an orderly manner and avoid incidental injuries.

- Although not listed among the typical operating limits, extreme weather conditions may necessitate safe shutdown of operations. Severe dust storms may clog the ventilation system and lightning from severe thunderstorms may interrupt power. Procedure 23, §§23.3.1 and 23.3.2 describe the appropriate responses for the Facility Manager and workers in the event such severe weather conditions occur.

- Procedure 22, Personnel Notifications, §22.3, explains what the worker should do to correct low flow (less than 100 ft/min face velocity) through a fume hood face – reduce the opening size.

- If the peristaltic pump unexpectedly shuts off, Procedure 22, §22.3 directs the worker to perform specific actions. Section 22.3 gives the worker no specific corrective actions resulting from an unexpected peristaltic pump shut off. Any corrective actions depend upon determining the cause of the shutoff. The shutoff may result from reaching an automatic shutoff (mercury weight > 2280 lb or height of mercury < 2 in from the top of the metric ton container top plate) or power to the peristaltic pump may have been interrupted.

- The system is designed with engineering controls and redundancy to maintain 29 flasks per container. In the event the mass per metric ton container and/or number of flasks processed for a specific metric ton container becomes an issue, an orderly, normal start-up is allowed once weights and flask numbers are resolved using scales and available electronic and hard copy records. The use of the 2,500 lb ± 0.25 lb and calibrated scales allows uncertainties to be resolved.

- If the MMS alarms, the worker should respond as directed in Procedure 22, §22.3. Corrective actions may include following the directions in Procedure 12, Emergency Response and Spill Cleanup, to don appropriate PPE, including a respirator, and clean up mercury.

- The green/red lights at the entrance to the MMTS are activated by the readings received from the MMS. Corrective actions from encountering a red light would be the same as those described for hearing an MMS alarm.

- If a scale reset (re-zero) is required during daily operations, e.g., power to the scale is lost, follow the directions for beginning of day reset (re-zero) given in Procedure 2, §2.3.

- The design of the ventilation system is described in detail in Chapter 4 of the PSI [Process Safety Information for the Mobile Mercury Transfer System to Comply with the NDEP – CAPP (2015-MSSP-41, Rev. 1)]. The filtration system [pre-filters to remove dust and debris and sulfur-impregnated carbon – HEGA (high efficiency gas adsorber) filters to remove mercury] is described in Chapter 5 of the PSI. Changeout of the pre-filters is determined by pressure drop and is discussed in Procedure 15, Inspection, Testing, and Maintenance (2015-MMTS-15). The sulfur-impregnated carbon system contains 220 lb of sulfur and is conservatively sized in terms of mercury sorption capacity and air flow to never require change-out. Change-out procedures for HEGA filters and pre-filters are given in Procedure 15, §15.8, Attachment 15.5. The filtration system design is based on no change-out expected for the HEGA filters. Mercury monitoring ports to the MMS-16 are included both upstream and downstream to collect performance data and allow for emission modelling as required. A continuing increase of the monitored mercury emissions over an extended period may indicate a need to plan for replacement of the HEGA filters.

- Although the Tygon® tubing used to transfer the mercury is not a 'hard pipe line,' the tubing is inspected daily, and the contact point is moved about one inch daily per Procedure 7, §§7.4.3 and 7.4.5, Procedure 8, §8.3.2 and Procedure 27, §27.3, the operator is directed to limit to 29 the number of flasks emptied into a metric ton container. The transferred mass would be very close to 1 metric ton. The automated mercury weight and mercury level shutdowns are designed to prevent overflow of the metric ton container in the event the operator attempts to transfer the contents of more than 29 flasks into the metric ton container. The automatic shutdowns of the peristaltic pump are set to operate at a weight of 2280 lb and, as a backup to the weight limit, at a level 2 inches below the top of the metric ton container. The design of the ventilation system is detailed in §4.10 of the PSI. The ventilation system, including the fume hoods and portable Airfiltronix™ snorkels, is designed to allow mercury transfer activities without the need for respirators. In the absence of the ventilation system function, mercury vapor concentrations could exceed the 25 $\mu g/m^3$ exposure limit set by DLA Strategic Materials and HWAD. The Mercury Monitoring System (MMS) is described in §5.1 of the PSI and in Procedure 14 (2015-MMTS-14). The MMS samples mercury vapor concentrations at 16 location throughout the MMTS and alarms if the mercury vapor concentration at any of the sample points reaches or exceeds 25 $\mu g/m^3$. Procedure 22, Personnel Notifications, §22.3, directs the workers to leave the MMTS if the MMS alarm sounds. The 25 $\mu g/m^3$ limit is very protective of health; leave in an orderly manner and avoid incidental injuries (Refer to the MMTS Operating Limits Table beginning on page xvii). Although not listed among the typical operating limits, extreme weather conditions may necessitate safe shutdown of operations. Severe dust storms may clog the ventilation system and lightning from severe thunderstorms may interrupt power. Procedure 23, §§23.3.1 and 23.3.2 describe the appropriate responses for the Facility Manager and workers in the event such severe weather conditions occur. The change-out rate of the Tygon® tubing inside the hood is frequent during initial operations and will be maintained at a conservative frequency for establish operations. Workers are instructed on Tygon® tubing change-out timing in Procedure 15, §15.4.3. Should a failure occur the operator promptly stops the mercury flow by releasing the footswitch as directed in Procedure 7, §§7.4.6 - 7.4.8. Spillage is retained in the hood with use of a splash plate over the roller balls. Cleanup is performed as directed in Procedure 12.

- The PHA [Process Hazard Analysis Mobile Mercury Transfer System (MSSP-43 Rev1)] examines in detail the progression of the design from concept to a process flow diagram to P&IDs to construction and assembly. Previous experience and events with mercury are considered. Each step in the process is examined for potential hazards and recommended mitigations are provided for the identified hazards. As applicable, mitigations are incorporated into operating procedures to ensure worker safety.

- The Safety System Description (SSD) is presented in Attachment E to the PSI [Process Safety Information for the Mobile Mercury Transfer System to Comply with the NDEP – CAPP (2015-MSSP-41, Rev. 1)]. The codes to which the MMTS was designed are given in Chapter 6 of the PSI.

General Policies

- Training on the procedures presented in this document is accomplished by reading.

- It is the Facility Manager's (or designee's) responsibility to ensure that workers perform their tasks in accord with the procedure(s) defining those tasks. This responsibility will be executed by observing worker actions and confirming that the actions are called for by the procedure(s) defining the task.

- It is the worker's responsibility to ensure that the procedure being followed is the most current version. The first page of each MMTS procedure contains a directive: ***NOTE:*** *Hard copies of this document may not be the current version. Refer to the "IAmTheKey" website to verify the current version.* The header on each page of SOC procedures contains the statement: *It is the user's responsibility to ensure, prior to use, the revision of this document is the latest available. Check the master list, if unsure of document status, prior to use. Downloaded, printed or copied documents, unless supplied and so indicated by a DCA as being a controlled document, are uncontrolled.*

- All staff and contractors are expected to adhere to safety, health, and environmental requirements defined by HWAD and DLA Strategic Materials for the work they perform.

- Facility Manager will ensure that staff and contractors follow the procedures in this document and that they document inspection, testing, and maintenance of CAPP-regulated equipment. Facility Manager will ensure that staff and contractors are properly trained. Facility Manager will also ensure that maintenance materials, spare parts and equipment are available and suitable for the process for which they will be used and that Management of Change is followed.

- In the event of power loss, the emergency generator (located adjacent to the north end of the MMTS) will be used long enough to close all open mercury. Procedure 23, Operating under Adverse Conditions, §23.3.3 provides detailed guidance. The generator is not used for normal operations in the event of power loss.

- Following a power loss, the peristaltic pump will require manual restart once the power comes back on line after all control logic is in place to activate the use of the footswitch. Procedure 15, §§15.3.4 and 15.4.2, provide the directive to ensure the peristaltic pump functions as described.

- Prior to leaving the MMTS for work breaks and lunch, ensure that the ventilation system is operating, the peristaltic pump is turned off, compression on the Tygon® tubing is released from the peristaltic pump head, loops in the Tygon® tubing are emptied of mercury, the doors to the fume hoods are closed and operating snorkels left in use for venting are positioned to not pose safety hazards to returning workers.

- Staff and contractors perform the required inspections and tests on CAPP-regulated equipment, document those inspections and tests, and complete the required maintenance according to the schedule listed herein.
- A properly functioning fume hood draws room air through the entrance (face) of the fume hood. This air then exits the fume hood sweeping mercury vapors with it into the ventilation system and away from a person working at the face of the fume hood. To ensure optimal functioning of the fume hood, the face velocity should be near or above 100 fpm. One hundred fpm is the face velocity recommended by the American Society of Heating, Refrigeration, and Air-Conditioning Engineers in ASHRAE 110. Procedure 22 details the actions the worker should take upon hearing a face velocity alarm sounds.

- Fume hood airflow is checked daily by momentarily increasing the opening of the fume hood doors until the airflow alarm is sounded. Conversely if the low airflow alarm sounds during operations, decrease the opening of the fume hood doors until the alarm is silenced.

- The allowable fume hood opening for work access is based on maintaining 100 ft/min face velocity to maintain airflow. Slidegate door openings between the two fume hoods should be closed when only working in one hood. Slidegate door opening to the downdraft conveyor should be managed to maintain airflow to Fume Hood 1.

- The operator shall always use two hands when handling individual flasks to minimize the possibilities of injuries or dropping flasks.

General Health and Safety

- Do not eat, drink or smoke when in the MMTS or the mercury buildings.

- The properties of and health hazards presented by mercury are detailed in Chapter 2, §2.1 and Attachment A of the Process Safety Information for the Mobile Mercury Transfer System to Comply with the NDEP – CAPP (2014-MSSP-41, Rev. 1). Significant exposure to mercury may occur through inhalation or contact with the skin and eyes. The mercury MSDS (Attachment A to Process Safety Information for the Mobile Mercury Transfer System to Comply with the NDEP – CAPP (2015-MSSP-41, Rev. 1) provides details of the recommended first-aid treatments for inhalation and contact with the skin and eyes: leave the area of high mercury vapor concentration and apply artificial respiration, if needed, and place the affected body part under running water for at least fifteen minutes, respectively. Because the DLA Strategic Materials' mercury vapor exposure limit is very protective (it is numerically equivalent to the ACGIH-recommended time weighted average for workers exposed 8 hours per day, 5 days per week) and the mercury vapor monitoring system alarms at the DLA Strategic Materials' mercury vapor exposure limit, workers, who follow the instructions in Procedure 22 for what to do if the mercury vapor monitoring system alarm sounds, are very unlikely to require first aid for inhalation of mercury vapors.

- Pregnant mercury operations workers may self-identify and request an alternate assignment for the duration of the pregnancy.

- All workers have the right and responsibility to stop work in the event of any unsafe condition or if a mercury leak is noticed during operation.
- Procedure 5, §5.3.3 directs the worker to leave a leaking flask in its original drum and return that drum to Building 110-66. The drum could be placed in an overpack drum prior to returning it to Building 110-66 (the lifting fixture in the Drum Handling Room could be used to handle it), but there is no reason to use an overpack drum. Drum integrity is established (the entire mercury stockpile was inspected and rusting drums were replaced), and there is no corrosion mechanism other than external rust, of which there is typically little to none. In the over 21,600 drums inspected during the most recent DLA Strategic Materials' inspection campaign, only one flask was found that had leaked.

- Plan-of-day meeting should emphasize worker safety. For example, workers should always apply good safety practice for handling or moving heavy objects, and operating fume hood doors, windows and special tools. Forklift operators should practice safe driving to ensure personnel safety, and exercise care to protect both mercury containers and the MMTS facility.

- Previously used personal protective equipment must be removed before exiting the MMTS.

- MMTS workers must not engage in activities that would require a Safety Work Permit, e.g., lock-out/tag-out, hot work, line breaking, and confined space entry. These activities require specialized training. All such activities associated with mercury-related buildings and equipment will be performed by purposely trained personnel, not MMTS personnel.

- Workers must follow manufacturer's recommendations when using lift fixtures.

- Operations must be within safe industrial hygiene limits for mercury vapors (< 25 $\mu g/m^3$). The mercury monitoring system alarms when the mercury vapor concentration reaches or exceeds 25 $\mu g/m^3$. Procedure 22 describes the actions a worker should take upon hearing the mercury monitoring system alarm.

NOTE: *The breathing zone mercury vapor concentrations shall be below the MMTS limit for workers, 25,000 ng/m^3 = 25$\mu g/m^3$. This is a conservative short-term exposure limit adopted by DLA Strategic Materials. This exposure limit is numerically the same as the permissible 8-hour time-weighted average permissible exposure level developed by the American Conference of Governmental Industrial Hygienists.*

- Equipment and tools shall remain in the fume hoods or be carefully cleaned prior to removal.

- Mercury surveillance monitoring is required for the MMTS staff per procedure 2015-MMTS-20.

- A portable dock is required to enhance worker safety and reduce the potential for accidents during forklift operations. Physical stops are installed around the outboard

perimeter of the portable dock to substantially reduce the potential for the forklift to be driven off the dock. A ramp directly in line with doors, with ground loading, may be substituted for a portable dock.

- Ensure that two functional eye wash stations are available in case of emergencies. Inspect and test per manufacturer requirements.

- Periodic inspection and benchmarking mercury concentrations (mapping by location) using a portable monitor is required to monitor for changes in the dress area, office, general access areas, break areas, and rest rooms.

- To prevent personal injury, an operator should never attempt to save a falling flask or tool.

- Prior to using a snorkel, ensure that a flow path exists and verify that suction is occurring.
- Workers should use the sliding doors in the fume hoods, as necessary and practical, as shields from mercury micro-droplets and/or flask solids.

- All workers transporting and staging MT containers require the following personal protective equipment: side-shield safety glasses and steel-toe shoes.

- All workers in the MMTS where drums, flasks, and MT containers are handled require the following personal protective equipment: paper suits (coveralls), side-shield safety glasses, steel-toe shoes, disposable shoe covers, and gloves: leather for protection from pinch points and rotating equipment or nitrile for prevention from contact with mercury. If additional PPE is required for specific tasks, the additional PPE is specified in the procedure that explains the task (e.g., in Procedure 12, Emergency Response and Spill Cleanup, §12.3.1 requires the involved workers to use respirators rated for mercury service). Facility Manager (or designee) ensures that a sufficient supply of personal protective equipment is available for use by the staff dealing with drums, flasks, pumping-related equipment, and metric ton (MT) containers.

NOTE: *Nitrile gloves should be worn during any MMTS operations for which leather gloves are not required.*

- A drum (either full or empty) should never be opened for a casual inspection. A drum should be opened to access flasks or to deposit waste material and only when all equipment is on hand for monitoring and ventilation.

- To prevent excessive exposure to mercury vapors, workers should keep their heads above the top of an opened drum and outside the plane of the fume hood doors and downdraft roller conveyor table door.

- To ensure industrial hygiene control a portable snorkel is used with the fixed vacuum system to direct mercury vapors through absorbers away from workers. Even so, the workers should keep their heads away from the top of an opened drum and outside the plane of the fume hood doors and downdraft roller conveyor table door.

- Each flask should be lifted just a few inches inside the drum and the secure connection to the stopper verified prior to fully lifting and placement in the six-pack.

General Information

- Four six-pack trays containing 6 flasks and one six-pack tray containing 5 flasks are required to fill an MT container; the total batch for transferring mercury is 29 flasks. Twenty-nine (29) flasks of mercury is the maximum amount to be transferred into an MT container.

- A re-sealable bag is placed in each six-pack flask space prior to placement of the flask in the six-pack. This is a contamination control measure to keep the rollers and other fume hood hardware clean and the bag is ultimately used with empty flask placement in the waste drum.
- Every fifth six-pack tray is configured to be a five-pack tray (one location is blocked), with the 30th flask going into a special dedicated six-pack tray (also known as the BIG ORANGE six pack tray). After the first six (6) pallets are processed (six metric-ton containers are filled), the first BIG ORANGE six-pack tray is processed as the first six-pack tray for the next metric ton container to be filled. The BIG ORANGE six-pack tray is sequenced in a consistent, straight-forward manner without trying to keep track of drum and pallet numbers in the input data for this special six-pack tray.

- A drum containing six (6) mercury-filled flasks weighs approximately 550 lbs.

- The presence of loose mercury is expected to be a rare event; however, each drum must be carefully inspected for mercury prior to flask removal. Portable lights are used in conjunction with cart-mounted portable snorkels (see under General Supplies and Equipment for more details on cart-mounted portable snorkels).

- Slightly more than one-fourth (1110 out of 4300) of the drip trays for drums will be reused as drip trays for metric ton containers. Only drip trays in the best condition should be returned to service.

- The maximum number of six-pack trays that can be in Fume Hood 2 is three.

General Supplies and Equipment

- To enhance cushioning, NoTrax® or equivalent floor tiles can be placed on the floor in front of the fume hoods and on the side of the downdraft hood.

- Herculite® or equivalent material can be placed on the floor in front of the fume hoods, in the vicinity of the conveyer table and where operators handle drums and flasks. Herculite®is non-slip and some taping is required. This added safety measure is used extensively at ORNL to minimize floor contamination of mercury and the cost is simply the cost of the material since available solid waste disposal capacity exists in the quantity 30-ga drums planned for disposal.

- Cart-mounted portable snorkel (Airfiltronix® or equivalent) with sulfur-impregnated charcoal filters are available for MMTS operations and are to be used as needed to supplement fixed snorkels. Appropriate operations include drum opening, flask handling in the Drum Handling Room, and empty flask filling of drums in the Flask Handling Room.

- Supplies needed for MMTS operations include:

    - Re-closable 3-mil (min.) slider zip polyethylene bags; 18" x 20" for flasks, and 13" x 18" for waste containers

    - Gauze wraps, cheesecloth or equivalent

    - Vinyl tape and Herculite®

General Operations

- Wireless handheld data input units with insufficient battery charge for the entire next workday should be plugged into a battery charger. All wireless handheld data input units should be plugged into a battery charger before a weekend (3-day period) or longer holiday or vacation periods.

- Manual shutdown of the Process Control and Data Acquisition System (PCDAS) and the Mercury Monitoring System (MMS) is a rare event other than for maintenance on those systems. If it appears that a power outage will extend beyond 60 minutes [the nominal rating for the uninterruptible power supply (UPS) is 80 minutes], perform a manual shutdown of PCDAS and MMS by following the instructions in Section 13.3.4.

- The 3,000-lb Arlyn scales should be re-zeroed each day as required to ensure no drift has occurred, and the function (accuracy) of the scales function checked using test weights at a frequency consistent with operating experience. Formerly, the full-scale range of the scales was 5,000 lb. The scale accuracy is 0.1% of full scale. At 0.1% of 5,000 lb, the absolute accuracy was unduly large. Following the full scale range reduction from 5000 lb to 3,000 lb, the accuracy is improved from ± 5 lb to ±3 lb. Two new scales, 100% spares, are being purchased as replacement scales with a maximum full scale reading of 3,000 lb.

Informational Videos

As an aid to training and understanding equipment and systems several hours equivalent of basic informational/demonstration videos were prepared during the research and acceptance testing/training phase, including:

- Mercury Transfer_Phase_2_R&D_01_7604_2008_1st_gen_ornl
- Portable_Building_ornl_animation_MMTS_first_gen_outdated
- Fill Coupling Attachment
- Fill Coupling Removal

- Flask Disposal
- MMTS_Hood2_Tube Assembly and Disposal_Dec_2013_ornl

- AirFiltronix_Smoke_Demo2
- AirFlow_Discussion_Drum_Room
- MMTS Equipment_Room_Description
- Oct_2013_Saber_shop_test_Auburn_Ca_ornl
- Pump_deadhead_test-Oct_2013_ornl
- MMS_Computer_Details
- MMS_Computer_Details_Wrap_up
- MMS_Interface_Discussion
- MMS_Rack_Discussion
- PCDAS_MMTS_Saber

Table – MMTS Operating Limits

Operating Limit	Consequences of deviation	Mitigative Measures	Actions to avoid
Inventory – Overfilling a container - The operating limits to control inventory and overfilling are defined in conjunction with the fact that there is very sound technical data to prove each 3-L flask has very close to 76 lb. mercury contents. Twenty-nine flasks at 76 lb. mercury per flask will fill a metric ton container, which is the industry standard. Each 3-L flask contains ~ 2.5 L mercury.	The metric ton container would fill and change to the peristaltic pump operation in hood 2 would be observed by the operator. The flow of mercury would stop and the entire volume of the container would be filled. The MMS-16 vapor monitor reading would likely increase in the vicinity of the filling station. The system is enclosed and there is no danger to personnel but a process variance would occur. If overfilling occurs the pump can be reversed and pumped back into the 3-L flasks inside hood 2 until the level is restored to the 29 flask basis.	As defined in the PHA engineering controls and administrative controls are implemented to make this event very unlikely. Scales are used with alarm points and interlock shut-off to the pump, as well as a secondary engineering control consisting of a conductively probe set at a preset level with alarm points and interlock shut-off to the pump. The procedures also include administrative action to count 6-packs and flasks fed to control operation so no more than 29 flasks are fed. The capacity of the container.	Operator attention is required to count flasks as the tertiary back-up to the engineering controls so care to manage the recorded data quality is required. Follow procedures for scale usage with care applied daily to ensure functionality as defined above and in the procedures.
Industrial Hygiene - The operating limit for control to the Industrial Hygiene standard (ACGIH) for mercury exposure in the workplace is based on 25 micro-grams/cubic meter for 8-hr exposure time weighted average (40-hr work week) and OSHA is higher. DLA Strategic Materials applies the 25 micro-grams/cubic meters as the alarm point to take action.	The consequence of exceeding the IH limit is to shut hoods and drums and assess the cause of the spike. The 8-hr time weighted average was selected as an alarm point to ensure process induced changes could be addressed systematically.	The conservative set-point for alarm has been applied in the procedures. A fixed vacuum system through sulfur impregnated carbon has been designed and installed and tested to ensure sufficient flow into hoods and over 20 elephant trunk snorkels. There here are multiple portable snorkels used that vent through activated sulfur impregnated carbon for use with drums. This equipment is used in conjunction with a 16-point mercury analyzer with feeds near breathing level and floor level (MMS-16). Besides the MMS-16 there are two (2) portable Jeromes that are used to verify mercury concentrations when needed. Operating experience will allow for optimization of their use for providing local alarms as well.	Ensure that the mercury analyzers remain in calibration and apply lessons learned with

Operating Limit	Consequences of deviation	Mitigative Measures	Actions to avoid
Purge vacuum system flow at constant speed	The ID Fan in the equipment room must be available for controlling hood operations to ensure flow. Operations cannot commence without the ID Fan operating and providing the draft pressure profile required for hoods and snorkels.	The average flow is ~ 1850 scfm and once through and constant speed. The sulfur impregnated carbon adsorption system is designed for full plant life without change-out, with total mercury mass capacity of ~ 20 lbs. Portable snorkels are used to enhance control of mercury concentration management in the vicinity of drums. The flow through the purge vacuum system is once-through and not recycled. There is a spare fan motor and the ID Fan is on the preventative maintenance schedule.	Ensure the ID Fan maintenance is executed per the maintenance plan. Ensure the hoods are tested for 100 fpm inlet velocity minimum per the required certification schedule. Ensure the roughing filters in the system upstream of the carbon adsorber are changed out per required preventative maintenance schedule and that the pressure drop remains within the prescribed range.
Pre-filter and carbon adsorber integrity/pressure drop controlled within range	Pre-filters are used to collect particulate upstream of the carbon adsorber and pressure drop instrumentation is provided with the alarm set point at ~ 1 inch W.C. The filters protect the carbon and remove airborne dust. If the pressure drop is exceeded the pre-filter must be changed out to ensure carbon adsorption integrity is maintained.	The pressure drop across each filter is monitored and alarmed in the control room at ~ 1 inch W.C. The alarm point may be changed to a value slightly higher based on operating experience.	The pressure drop instrumentation (transducer/transmitter) must be maintained per standard maintenance and care is required to evaluate operating data.