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Evaluation of the Safety of the Situation (ESS): Management of Mercury Hazards in Tank Farm Evaporators (PISA PI-2015-0001)

APPROVALS

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2/4/2015

1.0 PISA Description/Summary

PISA PI-2015-0001 pertains to the Concentration, Storage, and Transfer Facilities (CSTF) Documented Safety Analysis (DSA), WSRC-SA-2002-00007, and is described in the PISA Database as follows:

"Mercury removal from the 242-25H Mercury Removal Tank (MRT) was completed on 01/07/2015. A quantity of 5950 mL (5.95L) of mercury was collected. The CST Safety Basis requires mercury removal every 21 days of operation to protect the initial condition assumption of the maximum quantity of mercury present in the MRT (40lbs / 1.3L). The periodic draining ensures that mercury release will not exceed analysis thresholds regarding fire/spill events associated with the MRT and its drain system. Quantities above 40lbs (1.3L) are not analyzed for these related scenarios.

Another Chemical Release scenario is evaluated in the DSA in section 3.4.2.21. This DBA is based on a 340 mg/L Hg concentration in the condensed evaporator overhead system. The mercury that was observed in the 242-25H Evaporator overhead system is approximately 260 mg/L Hg (5.95 L of mercury collected from 81000 gallons of overheads). Therefore, this chemical release DBA is not impacted."

Additional information pertaining to PISA PI-2015-0001 includes:

- Date of Discovery: 01/09/2015
- ORPS Report Number: EM-SR--SRR-HTANK-2015-0002

References pertaining to PISA PI-2015-0001 and/or this Evaluation of the Safety of the Situation (ESS) include:

1. Concentration, Storage, and Transfer Facilities Documented Safety Analysis, WSRC-SA-2002-00007, Rev. 16, June 2014.
2. SW9.2-IOP-EVAP-25H-6.13, Mercury Collection from 25H Evaporator, 11/7/14
3. SW9.2-IOP-EVAP-16H-6.10, Mercury Collection from 16H Evaporator, 11/7/14
4. Consolidated Hazard Analysis Process (CHAP) Program & Methods Manual. SCD-11
5. Input Data and Assumptions for the Concentration, Storage, and Transfer Facilities (U), S-CLC-G-00235, Rev. 7, July 2011.
6. Fire Protection Program, Procedure Manual 2Q.
7. 242-16F (2F) 2013 Layup Plan and Path Forward, X-ESR-F-00171, Rev. 1, August 2014.
8. Fire Hazards Analysis for the H-Area Tank Farm (U). F-FHA-H-00069
9. Letter, Folk, J.L. to MacVean, S., Evaluation of Mercury in Liquid Waste Process Facilities. WDED-15-10, U.S. Department of Energy, February 3, 2015.

2.0 Compensatory Measures / Operational Restrictions

2.1 PISA Compensatory Measures / Operational Restrictions

The following compensatory measures are currently in place as documented in PISA PI-2015-0001:

2.1.1 The 242-25H secondary (building) ventilation system shall be functional and operating. If ventilation is found to be nonfunctional/non-operating, and cannot be made functional/restarted in 12 hours, immediately isolate steam to the tube bundle and lance.

2.1.2 Verify every 24 hours the overheads receiver cell has adequate housekeeping (minimal transient combustible/flammable materials). This is applicable to 242-25H only.

2.1.3 242-11H sprinkler system shall be operable. If the sprinkler system is inoperable, immediately isolate steam to the tube bundle and lance.

2.1.4 Drain and collect mercury from the MRT every 8 days of evaporator operation. If MRT is not drained, immediately isolate steam to the tube bundle and lance, until mercury is drained and collected from the MRT. This is applicable to 242-25H only.

2.1.5 Drain and collect mercury from the MRT every 14 days of evaporator operation. If MRT is not drained, immediately isolate steam to the tube bundle and lance, until mercury is drained and collected from the MRT. This is applicable to 242-16H only.

2.1.6 For 242-16H Evaporator operations, prior to adding a waste stream other than current evaporator feed (DWPF Recycle, Tank 22 material, Tank 38, and Tank 43) to the evaporator system or starting slurry pumps in Tank 22 an engineering evaluation shall be performed to ensure the mercury that will be produced to the overheads system is less than or equal to 1.3L of mercury (initial condition of hazard analysis) for 21 days of evaporator operation time, which is within the limit of the current Hazard Analysis (1.3L) with 21 days of operation.

2.2 ESS Compensatory Measures / Operational Restrictions

Based on the evaluation provided in this Evaluation of the Safety of the Situation (ESS), the PISA compensatory measures in section 2.1 will be replaced with the compensatory measures below, which adequately prevent/mitigate any potential mercury release from the Evaporator Systems, and will be implemented by this ESS.

2.2.1 The 242-25H secondary (building) ventilation system shall be functional and operating. If ventilation is found to be nonfunctional/non-operating, and cannot

be made functional/restarted in 12 hours, immediately isolate steam to the tube bundle and lance. Subsequent use of the lance may be utilized in order to avoid salting issues in the pot.

2.2.2 Ensure, every 24 hours, the overheads receiver cell has adequate housekeeping (minimal transient combustible/flammable materials). This compensatory measure is applicable to 242-25H only.

2.2.3 242-11H sprinkler system shall be operable. If the sprinkler system is inoperable, immediately isolate steam to the tube bundle and lance. Subsequent use of the lance may be utilized in order to avoid salting issues in the pot.

2.2.4 Drain and collect mercury from the MRT every 8 days of evaporator operation. If MRT is not drained, immediately isolate steam to the tube bundle and lance, until mercury is drained and collected from the MRT. This compensatory measure is applicable to 242-25H only.

2.2.5 Drain and collect mercury from the MRT every 14 days of evaporator operation. If MRT is not drained, immediately isolate steam to the tube bundle and lance, until mercury is drained and collected from the MRT. This compensatory measure is applicable to 242-16H for its current feed (DWPF Recycle, Tank 22 material, Tank 38, and Tank 43) and provided no slurry pump operation in Tank 22.

2.2.6 Drain and collect mercury from the MRT every 8 days of evaporator operation. If MRT is not drained, immediately isolate steam to the tube bundle and lance, until mercury is drained and collected from the MRT. This compensatory measure is applicable to 242-16H for new feed streams (i.e., those not addressed by Compensatory Measure 2.2.5) and Tank 22 material following slurry pump operation in Tank 22.

2.2.7 Ensure, every 24 hours, no gasoline or diesel fuel oil engines is within 20 feet of the open side of the 242-16H Evaporator Overheads Receiver Cell. This compensatory measure is applicable to 242-16H for new feed streams (i.e., those not addressed by Compensatory Measure 2.2.5) and Tank 22 material following slurry pump operation in Tank 22.

2.2.8 Ensure the mercury drain valve (WEE-V-517) is closed when not performing the drain and collect activity (Compensatory Measure 2.2.6). This is applicable to the 242-16H Evaporator when operating (i.e., steam to the tube bundle). Valve WEE-V-517 may remain open when the 242-16H Evaporator is not operating, provided the MRT has been drained and collected post shutdown and ensured closed prior to restart. This compensatory measure is applicable to 242-16H for new feed streams (i.e., those not addressed by Compensatory Measure 2.2.5) and Tank 22 material following slurry pump operation in Tank 22.

2.2.9 Drain and collect mercury from the MRT every 30 days when steam is continuously secured to the tube bundle. This is applicable to both 242-16H and 242-25H Evaporators.

Neither PISA PI-2015-0001 nor this ESS provides compensatory measures for the 242-16F Evaporator. This evaporator is currently non-operational with no plans to repair/restart for the foreseeable future (Ref. 7) and has had zero hours of operation since the last mercury draining and collection (associated with the implementation of the Mercury Management Program). There are also no compensatory measures required for the 242-16H Evaporator during evaporator chemical cleaning. This is based on the following: the MRT is required to be drained of mercury prior to evaporator chemical cleaning, there is no appreciable amount of waste (for producing mercury) remaining in the pot following the required de-inventorying prior to acid cleaning, and the reduced operating temperatures during chemical cleaning (less than boiling). Additionally, when performing the desalt/descale activity, the time that steam is supplied to the tube bundle does not have to be counted as evaporator operations. This is based on the nature of the process (only seconds of steam supply) and procedural requirements (e.g. inspecting the pot) that would recognize, and secure, if the steam were erroneously left on the tube bundle for this activity.

3.0 Safety Assessment Results

3.1 Immediate Safety Assessment

The analyzed event in the Consolidated Hazard Analysis (CHA) for 242-25H Evaporator is a fire that damages the MRT and/or associated piping releasing mercury.

The 242-25H secondary (building) ventilation system ventilates the overheads receiver cell. To be functional, the secondary ventilation system requires an operating fan and intact exhaust duct/stack. By ensuring that the ventilation system is functional the mercury would be released at an elevated height and minimize the worker hazard. If this system should become non-functional/non-operational, securing steam to the tube bundle and lance in conjunction with the additional compensatory measures will minimize the mercury hazard. Twelve (12) hours is judged to be sufficient time to reestablish the ventilation system to functional for a variety of failures and spurious conditions. Subsequent use of the lance may be utilized in order to avoid salting issues in the pot. This is typically achieved by operation of the lance approximately every 4 hours for durations of approximately 15 minutes (i.e., not continuous). Also, the lance operates at a significantly lower steam pressure than the tube bundle. Therefore, little to no mercury is expected to be produced with steam only on the lance. A non-functional/ non-operational ventilation system will not cause a mercury release without a fire, therefore, with the additional compensatory measures the mercury hazard is minimized

A housekeeping walk down provides confidence that transient combustible materials in the overheads receiver cell will be identified and removed. This will reduce the intensity of a fire that could occur in the overheads receiver cell which would impact the MRT.

An operable 242-11H sprinkler system would ensure that if a fire occurred in the 242-11H building, the sprinkler would control any fire growth until manual fire suppression by the fire department can be achieved. Operable is defined in Manual 2Q Procedure 5.6, Section 3.0 as a fire protection system that is "in-service", meets functional requirements and is designed and installed in accordance with NFPA code requirements. If this system becomes inoperable, the 2Q impairment program will ensure adequate compensatory measures are created. Ensuring the evaporator is shutdown (steam secured to tube bundle and lance), minimizes mercury that will be collected in the MRT. For the same reasons discussed above, subsequent use of the lance may be utilized in order to avoid salting issues in the pot.

Completion of draining and collection of mercury is defined as when only overheads material (not mercury) is observed in the sight glass during performance of the collection procedure (Reference 1, Section 5.5.4.2.51). Draining and collecting the mercury from the MRT every 8 days of evaporator operation reduces the mercury in the 242-25H Evaporator system. Using the maximum mercury concentration in waste (0.5g/L, Reference 5) and maximum evaporator overheads flowrate (35 gpm, Reference 5) the MRT would be required to be collected and drained every 7 days. This would ensure that the evaluation guideline value (PAC-2) is not exceeded to the offsite receptor. However, at the accumulation rate associated with the PISA condition (5950 mL, ~ 120 hours of operation), it would take approximately 43 days to exceed PAC-2 values. Thus, eight (8) days is judged to be a sufficient frequency to drain and collect mercury from the MRT. This is based upon the observed PISA condition which would allow for a frequency approximately 6 times greater than the bounding case. This, in conjunction with the house keeping walk down (Compensatory Measure 2.2.2) should reduce the possibility of the event.

Completion of draining and collection of mercury is defined as when only overheads material (not mercury) is observed in the sight glass during performance of the collection procedure (Reference 1, Section 5.5.4.2.51). Draining and collecting the mercury from the MRT every 14 days of evaporator operation reduces the mercury in the 242-16H Evaporator system. Every 14 days of evaporator operation is based on the current feed streams (DWPF Recycle, Tank 22 material, Tank 38, and Tank 43) and increasing the current monitoring frequency by 1/3. This is judged to be a sufficient frequency when performed with the additional compensatory measures.

For the 242-16H Evaporator, once new feed material (feed not meeting that documented in the previous paragraph) is introduced into the system, the frequency of draining and collecting mercury has been increased to 8 days. This is due to the degree of uncertainty in being able to accurately predict, via Engineering Evaluation, mercury production in new waste streams. The basis for the 8 days is the same as that provided for the 242-25H Evaporator discussed above. This, in conjunction with Compensatory Measures 2.2.7 and 2.2.8 reduces the possibility of the event. Compensatory Measure 2.2.7 reduces the likelihood of having a fire of such severity to damage the MRT and associated piping. Compensatory Measure 2.2.8 ensures that, when not performing draining and collection, mercury produced while operating the evaporator (steam to the tube bundle) will remain upstream of WEE-V-517 such that it is protected by

Compensatory Measure 2.2.7. This reduces the likelihood of having a fire near the collection station concurrent with mercury present on the west side of the 242-16H Evaporator. For the same reasons discussed above, it is not necessary to keep WEE-V-517 closed when steam is secured to the tube bundle and the lance is being operated to avoid salting issues in the pot.

Completion of draining and collection of mercury is defined as when only overheads material (not mercury) is observed in the sight glass during performance of the collection procedure (Reference 1, Section 5.5.4.2.51). Draining and collecting the mercury from the MRT every 30 days when steam is continuously secured to the tube bundle provides assurance that no significant quantities of mercury are being produced when steam is secured to the tube bundle for extended periods. Every 30 days is based on the difference (with conservatism) in steam pressure for the lance versus the tube bundle (5 times less for the 242-16H Evaporator and more than 10 times less for the 242-25H Evaporator as obtained from the safety analysis values in Reference 5) as applied to the limiting frequency of 8 days (Compensatory Measures 2.2.4 and 2.2.6).

The compensatory measures of Section 2.2, when implemented, will ensure that any mercury released in the event of a fire in the MRT is adequately reduced.

3.2 Final Safety Assessment

An Unreviewed Safety Question Evaluation (USQE), USQ-WPT-2015-00006, was performed for PISA PI-2015-0001 and resulted in a “positive” evaluation. The facility continues normal operation with the compensatory measures identified in the PISA in place.

The USQE was “positive” based on a “Yes” answer to the following Question (Note: Questions 2 through 7 were not answered based on Manual 11Q Procedure 1.05, Section 5.6.1.2.C):

- 2. Increase the consequences of an accident previously evaluated.

The consequences of a chemical release from the 242-25H Evaporator described in Section 3.4.2.21 (Reference 1) are driven by a source term analysis which assumes the Material at Risk (MAR) is 675 g. The MAR is based on a 15 minute exposure with a mercury generation rate of 45 grams/minute in the overheads system. The greater than expected mercury generation rate observed in the recent 242-25H Evaporator operation is less than 12 grams/minute (5950 mL of mercury over ~ 120 hours operation). This generation rate is well within the assumptions of the source term analysis. Other factors important to consequence determination (damage ratio, airborne release fraction, dispersion factor, etc.) are unaffected by the greater than expected mercury generation rate. However, Section 3.4.2.21.5 (Ref. 1) also notes that “the analysis assumes a maximum amount of mercury within the Mercury Removal Tanks and associated collection systems” and credits the Mercury Management Program with limiting the quantity of mercury within the MRT and associated collection system. The associated CHA event (OHHG-1-002 in U-CHA-G-00002) states that quantities greater than 1.3L

(40 lbs) of mercury will not accumulate. The evaluation of the USQE is driven by the discovery that nearly 6L of mercury had accumulated within the 242-25H MRT, which is larger than that assumed by the analysis. As a result, the consequences associated with a chemical release of mercury may not be bounded and thus increases the consequences of an accident previously evaluated in the Safety Basis.

Section 3.4.2.21.4 (Ref. 1) also notes that a mercury release is the only chemical release design basis accident, and chemical release consequences are not addressed cumulatively with other Natural Phenomenon Hazard events in the accident analyses (Sections 3.4.2.17, 3.4.2.18, and 3.4.2.19 of Reference 1). As a result, the consequences evaluated for those accidents are not increased by the greater than expected mercury generation observed for the 242-25H Evaporator.

With the implementation of the compensatory measures of PISA PI-2015-0001 and subsequently this ESS, it is judged that the likelihood of having a fire that affects greater than 1.3L of mercury is acceptably reduced.

The current operational status of the facility (as related to PISA PI-2015-0001) is not impacted by the PISA or this ESS, excluding the effect of the Compensatory Measure 2.2.8. Compensatory Measures 2.2.1 and 2.2.3 (new per ESS) link 242-25H Evaporator operation to functional/operational building (secondary) ventilation and 211-H sprinkler systems. These are considered very reliable systems and are not expected to significantly impact facility operations due to them becoming non-functional/non-operational. Compensatory Measure 2.2.2 (clarified per ESS) requires daily (every 24 hours) housekeeping rounds on the overheads receiver cell in order to minimize transient combustible/flammable materials (242-25H only). Based on existing housekeeping practices and shiftly evaporator rounds, this is not expected to impact facility operations. Compensatory Measures 2.2.4 (same as 2.1.4), 2.2.5 (clarified per ESS), and 2.2.6 (new per ESS) increase the frequency for draining mercury from the MRTs. Because the facility is already required to drain the MRTs (via the currently implemented safety basis) and the fact that the evaporators are not required to be shutdown to perform the evolution, these compensatory measures are not expected to significantly impact facility operations. Compensatory Measure 2.2.7 (new per ESS) is only applicable to the 242-16H Evaporator and prohibits portable powered equipment within 20 feet of the open side of the 242-16H Evaporator Overheads Receiver Cell to avoid damage to the MRT from an equipment fire outside the cell. Because a similar action is already required by the current facility Fire Hazards Analysis (Ref. 8), there is no impact to facility operations. Compensatory Measure 2.2.8 (new per ESS) is only applicable to the 242-16H Evaporator (once new feed is introduced to the system) and involves manipulation of the mercury drain valve (WEE-V-517). This valve is typically left open by operations so any change has some impacts to facility operations. However, this valve is readily accessible and capable of being manipulated. A concern exists that with the valve closed, material held up has a tendency to “solidify” reducing flow when opened. With the frequency of draining and collecting being every 8 days and the allowance to leave the valve open when not operating (i.e., no steam to the tube bundle), this should not be a significant concern.

Based on these reasons, Compensatory Measure 2.2.8 is not expected to have a significant impact on facility operations. Compensatory Measure 2.2.9 (new per ESS) requires a 30 day draining and collection activity. This is applicable only when steam is secured to the tube bundle for 30 or more consecutive days. Given the need to run the evaporators to support system plans, it is not expected to routinely have the 242-25H or 242-16H Evaporators down for that amount of time. Therefore, this compensatory measure is not expected to significantly impact facility operations.

Based on the above discussion, the compensatory measures stated in Section 2.2 should not significantly impact operational aspects of the facility during resolution of the PISA.

3.3 Path Forward

1. Continue to implement the compensatory measures included in PISA PI-2015-0001 (ESS 2.1.1 through 2.1.6).

2. Upon DOE approval of this ESS, replace the compensatory measures in Section 2.1 with the ESS compensatory measures in Section 2.2.

3. Revise the associated analysis and Safety Basis related to address the management of mercury hazards in the CSTF evaporators.

3.4 Summary of Recommendations and Conclusions

Based on the results of USQ-WPT-2015-00006 and further evaluation of items associated with PISA PI-2015-0001, the PISA and ESS compensatory measures will remain in place until a permanent change is made to the Safety Basis and associated support documents. The Safety Basis change to resolve the Mercury Accumulation in the 242-25H Evaporator PISA (PI-2015-0001) will be submitted to DOE by February 10, 2016. Consistent with the expectation documented in Reference 9, SRR will take an integrated, system-wide approach to evaluate the movement, monitoring, and collection of mercury through the entire Liquid Waste System/Facilities as part of resolving this PISA.