SAND2019-0330R

Causal Analysis Report for

NA-SS-SNL-5000-2018-0005 858EL ARSENIC RELEASE ABOVE PERMIT LEVEL

Causal Analysis Report
12/21/2018

U.S. DEPARTMENT OF ENERGY NNSA

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Sandia National Laboratories

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1. Report Number: *NA-SS-SNL-5000-2018-0005*

2. Subject/Title of NOTE: 858EL Arsenic Release Above Permit Level

3. Discovery Date/Time: 11/28/2018 **and time provided in hour / minute format** (16:17)

4. ESH Coordinator: Benjamin Cryder / (505) 844-5779
Martina Padilla / (505) 284-8891

5. Tech Area (Plant Area): Tech Area I **and System/Building/Equipment:** 858 EL room 1855

6. Recurring Event: ☒ YES ☐ NO

A similar event happened in 2010 (NA-SS-SNL-1000-2010-0007) in 858 EF/858N. In the 2010 event, analysis of environmental samples collected by Albuquerque Bernalillo County Water Utility Authority (ABCWUA) and SNL on April 20, 2010 reported an arsenic result of 0.131mg/L which exceeded the ABCWUA limit of 0.051mg/l. A Notice of Violation (NOV) was received by Sandia National Laboratories (SNL) on June 21, 2010. The description of the evaluation results from this event was:

> *"Further investigation determined that cleaning activities associated with the metalorganic chemical vapor deposition (MOCVD) tools that generate arsenic deposits were the likely the cause of the high arsenic levels in the wastewater. Equipment records suggest that there was a cleaning procedure carried out on stainless steel vacuum lines removed from one MOCVD system that was completed on April 20. The cleaning solution uses a basic mixture of ammonium hydroxide (NH4OH) and hydrogen peroxide (H2O2) to dissolve arsenic-containing deposits from stainless steel parts. The equipment records suggest that when the cleaning was completed on April 20, the 11 liters of arsenic contaminated cleaning solution was released to a drain connected to the wastewater neutralization system. This is believed to be the source of the excursion. The corrective action for this process is to collect the cleaning solutions that contain arsenic into a carboy and dispose of the solution as hazardous waste. This will eliminate this waste stream from the wastewater treatment system and from being discharged to the sanitary sewer."*

It was from this event that revisions to operations included:

> *"The cleaning bench operating procedure will be modified to require collection of the cleaning solutions that contain arsenic into a carboy and disposal of the solutions as hazardous waste".*

7. Subcontractors Involved: ☐ YES ☒ NO ***If YES, Subcontractor Name:*** ***NA***

8(a). Description of Event: On November 28, 2018 at approximately 4:17pm the arsenic monitor in the Acid Waste Neutralization (AWN) room located in 858N was registering a concentration above the permit level of 51ppb as stated in ABCWUA Permit 2069G Daily Composite Limit. 100ml samples had been drawn from the waste stream at ~6pm November 28, 2018. The samples were analyzed, results received on November 29, 2018 confirmed an arsenic concentration above the permit level.

8(b). Operating Conditions of Facility at Time of NOTE: Normal

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8(c). Immediate Actions:

All acid wet processing in micro-fab work was paused from 11/29/18-12/3/18.

9. Notifications:

OM Team Member: Emily Wright / 11/29/2018 / 10:27
SFO FR: Veronica Martinez - ORPS Program Manager / 11/29/2018 / 14:00

10. Apparent Cause Analysis Results

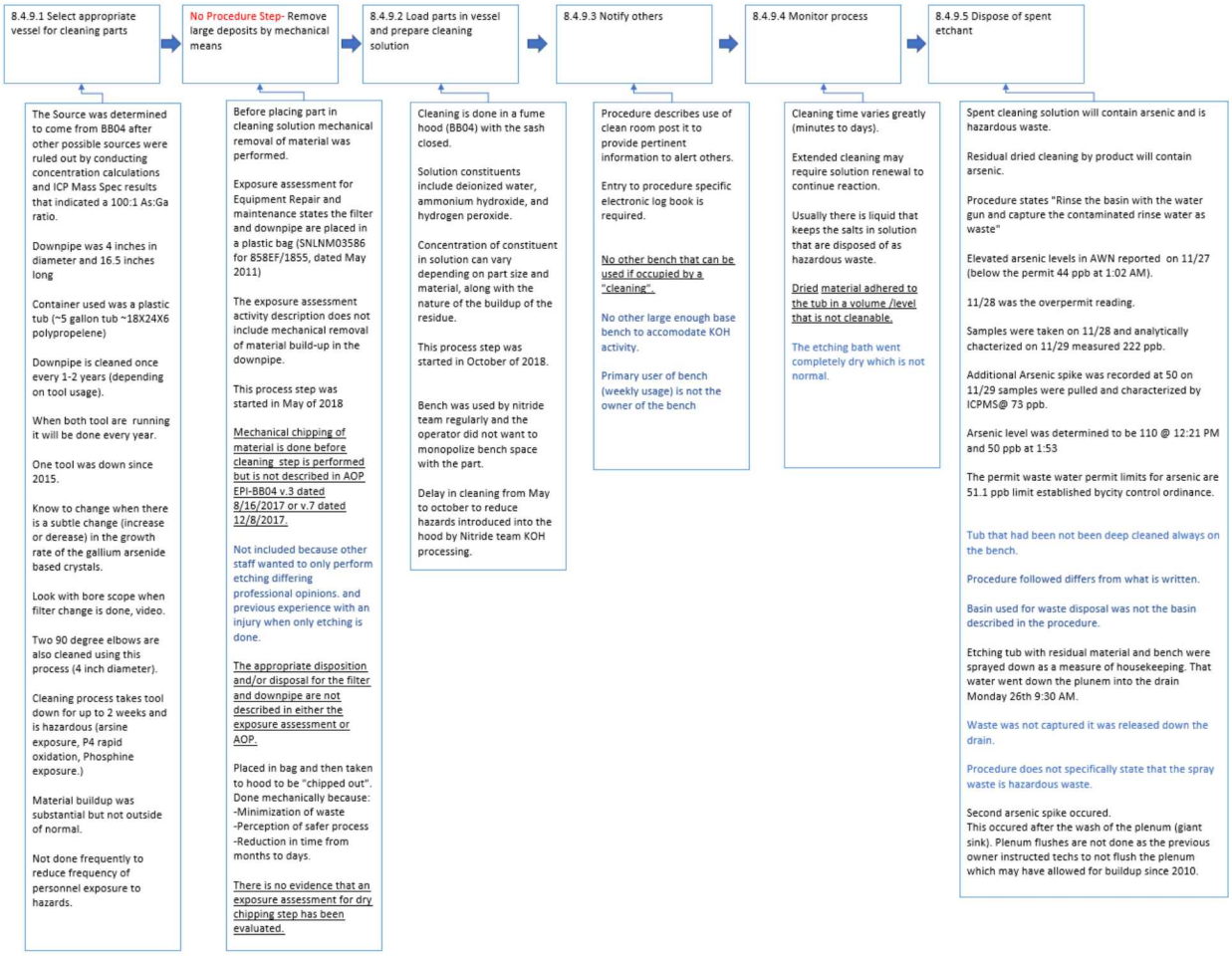
10(a). Date Critique meeting was performed: 12/4/2018

10(b). Causal analysis performed by: Emily Wright Senior Causal Analyst
Vanessa Peters Assisting Causal Analyst

10(c). Personnel Interviewed, if needed: NA

10(d). Causal Analysis Method and Results

Method-Timeline Analysis



10(e) Corrective Action Plan Development (see Table starting on next page)

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Fact(s)	Issue Description	Cause(s) Associated with Issue	Compensatory Measure Action	Long Term Corrective Action(s)
1. A downpipe was cleaned on the BB04 bench after considerable buildup (but not outside of normal parameters) was identified. 2. Downpipe was 4 inches in diameter and 16.5 inches long. 3. Downpipe is cleaned once every 1-2 years (depending on tool usage). 4. Operators know to clean the downpipe when there is a subtle change in the growth rate of the gallium arsenide-based crystals or when visual with bore scope identifies substantial buildup during filter replacement. 5. Cleaning process takes tool down for up to 2 weeks and is hazardous, so cleaning process is only done when necessary, (hazards include, arsine exposure, P4 rapid oxidation, phosphine exposure.) 6. Procedure for cleaning is included in Base Wet Bench BB04 Operating Procedure section 8.4.9. 7. Not included because previous owner of BB04 wanted to only perform etching (differing professional opinions). 8. Placed in bag and then taken to hood to be "chipped out". Done mechanically because: -Minimization of waste -Perception of safer process -Reduction in time from months to days. 9. Procedural steps do not include process for mechanical removal of material before wet etch cleaning. 10. A notice of violation from the Albuquerque Bernalillo County Water Utility Authority was issued on 12/10/2018	1. Mechanical chipping of material is done before the etching step is performed but is not described in AOP EPI-BB04 v.3 dated 8/16/2017 or v.7 dated 12/8/2017.	1. Process followed is not listed as a step in the procedure.	CM #1 Restart plan for BB04 developed and implemented. Owner: Greg Peake Due on: March 1, 2019	LT # 1: Treat entire downpipe and elbows as hazardous waste and dispose of as such without cleaning. Revise operating procedure to reflect disposal packing and removal process in consult with hazardous waste management program. Owner: Greg Peake Due on- February 15, 2019 LT # 2: Evaluate if location of Arsenic processing for smaller parts (that need to be cleaned aside from the down pipe and elbows) can be moved to the copper sulfate bench which does not have a drain. Owner: Gregg Gardner Due on- March 15, 2019 LT # 3: : Change location and generate OP for cleaning arsenic parts, if deemed acceptable by LT#2. Owner: Greg Peake Due On: May 1, 2019

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11. Container used for cleaning was a plastic tub (~5-gallon tub ~18X24X6 polypropylene) not the 50-liter polypropylene basin with a lid and valved drain basin described in the procedure. 12. Extended cleaning may require solution renewal to continue reaction. 13. Usually there is liquid that keeps the salts in solution that are poured into a 15-gallon carboy (as described in the procedure) and disposed of as hazardous waste. 14. Spent cleaning solution will contain arsenic and is hazardous waste. 15. Residual dried cleaning by product will contain arsenic. 16. Etching tub with residual material and bench were sprayed down. That water went down the plenum into the drain Monday 26th 9:30 AM. 17. Waste was not captured, it was released down the drain. 18. A second arsenic spike was measured after cleaning of the plenum occurred (the Saturday following the initiating event). 19. The etching bath went completely dry which is not normal.	*2.* Residual dried materials went down the drain from the BB04 bench when the tub was sprayed out (Rinsed). .	2. Dried material adhered to the tub in a volume/level that is not cleanable. *3.* Procedure does not specifically state that the spray waste is hazardous waste.	*See CM#1*	*See LT#1, LT#2, and LT#3*

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Fact(s)	Issue Description	Cause(s) Associated with Issue	Compensatory Measure Action	Long Term Corrective Action(s)
20. The exposure assessment activity description does not include mechanical removal of material build-up in the downpipe. 21. Exposure assessment for Equipment Repair and maintenance states the filter and downpipe are placed in a plastic bag (SNLNM03586 for 858EF/1855, dated May 2011) 22. Procedure states "Rinse the basin with the water gun and capture the contaminated rinse water as waste".	3. The appropriate disposition and/or disposal for the filter and downpipe are not described in either the exposure assessment or AOP.	*4.* There is no evidence that an exposure assessment for dry chipping step has been evaluated.		LT # 4: Complete a new exposure assessment to reflect changes to operating procedures and housekeeping activities. Owner: Benjamin Cryder Due date 5/31/2019
23. Delay in cleaning from May to October to reduce hazards introduced into the hood by Nitride team KOH processing. 24. Bench was used by nitride team regularly and the operator did not want to monopolize bench space the part.	4. No other bench that can be used if occupied by a "cleaning".	5. No other large enough base bench to accommodate KOH activity. 6. Primary user of bench (weekly usage) is not the owner of the bench		*See LT#3*
25. The Microfab is a compound semiconductor fab with significant arsenic processing and was not designed with an arsenic abatement system. 26. A small arsenic abatement system was later purchased to handle the waste from the dicing saws, the spray acid tools, and other miscellaneous tools.	5. The growth area, including bench BB04, was not connected to the small arsenic abatement system.	7. The amount of projected waste would likely have overwhelmed the abatement system.		*See LT#1, LT#2, and LT#3*

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Fact(s)	Issue Description	Cause(s) Associated with Issue	Compensatory Measure Action	Long Term Corrective Action(s)
27. There was a previous arsenic release event in 2010. Corrective actions from that event resulted in operating procedure modifications to avoid future issues.	6. Corrective action from previous event was not effective in preventing repeat event.	8. Corrective actions were not communicated to owners of similar benches doing similar processes.	CM #2 Develop and distribute a communication describing this repeat issue to owners of similar bench owners doing similar processes. Owner: Erica Douglas Due on- February 28, 2019	LT # 5 Develop and document a Microfab communications process for rolling out systemic corrective actions across the Microfab when appropriate. Owner: Erica Douglas Due on- March 15, 2019

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11. AIS Number: (77910)

13. Derivative Classifier (DC) and Review Date Select a Date**:** Kenneth Dean

14. Supporting Documentation

15. RM Approval of completed causal analysis:

Fri 12/21/2018 2:34 PM

Douglas, Erica

Re: RCA - 858EF Arsenic Release

To Wright, Emily D

Cc Padilla, Martina L; Gough, Andrew; Gardner, Gregg A; Burns, Eric

Emily
I concur with this report. Thanks!

Sent from my iPhone