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NM Tech Mercury Spill Response

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NM Institute of Mining and Technology, NM Tech, reached out to Sandia National Laboratories to perform a causal analysis resulting in lessons learned for a mercury spill on campus earlier in the academic year. That causal analysis meeting was held on October 30, 2018 on the NM Tech campus and this report is a result of interviews and information gathered prior to, during, and after that meeting.

Many thanks to Dr. Van Romero, Gina Chavez, and Ruth Horowitz of New Mexico Institute of Mining and Technology for their assistance with scoping, scheduling and encouraging people to attend and to Dr. Diane Peebles, of Sandia National Laboratories, for making time available to conduct this causal analysis.

CONTENTS

LIST OF FIGURES

ACRONYMS AND DEFINITIONS

Abbreviation	Definition
EPA	Environmental Protection Agency
HazMat	Hazardous Materials
Hg	Mercury
HVAC	Heating, Ventilation, and Air Conditioning
NM Tech	New Mexico Institute of Mining and Technology
NMDOH	New Mexico Department of Health
Sandia Labs or SNL	Sandia National Laboratories

1. EXECUTIVE SUMMARY

A mercury-based sphygmomanometer was used in the New Mexico Tech Medical clinic because a patient had consistently high blood pressure measurements when a mercury-free sphygmomanometer was used. The mercury-based unit was chosen to verify the mercury-free measurements. When the nurse began pumping up the cuff, mercury leaked from the bottom of the machine. Prior to that use, the sphygmomanometer functioned correctly, and inspection showed no visible cracks. Knowing that mercury (Hg) was hazardous to patients, that it vaporized at room temperature, and that the clinic had no windows, the nurse moved the sphygmomanometer from the clinic to a nearby biohazard room. In addition, the nurse taped the door gaps on the outside of the biohazard room to limit exposure. The biohazard room was vented to the outside, but that fact was not commonly known by the incident response team. The floor between the clinic and biohazard room was carpeted, resulting in Hg contamination of the carpet as well as the clinic and the biohazard room.

Immediately the nurse notified the clinic nurse practitioner, and simultaneously a call went out to Facilities and Campus Police. A call also went out to the NM Tech HazMat Officer who was conducting a training session and was unwilling to respond immediately. Subsequently, poison control was notified which then notified the NM Department of Health (NMDOH). NMDOH advised evacuating the entire building as Hg is toxic to pregnant women and the building had the potential of having a pregnant woman present. The Fidel Student Center, where the clinic was located, had many people inside, and none of the windows opened to the outside in that building. The building was evacuated by activating the fire alarm. Facilities shut down the heating, ventilation, and cooling system (HVAC) system to prevent further potential contamination. After the building was evacuated, campus police attempted to secure the entrances to prevent reentry, however that building has many exits and it was difficult to cover all of them. To their knowledge, no one re-entered the building after evacuation. The call to the NMDOH went out just before a shift change, so their Emergency Response Office (ERO) took two hours to respond in what normally would have taken one hour. After the ERO response, the fire alarm was deactivated. The building was turned over to NM State Police to secure. In addition, there was a response from the Socorro City Fire Department, and several other government agencies because of several points of contact at NM Tech making phone calls.

A mercury clean-up kit was retrieved from the Chemistry building and the NM Tech HazMat officer was asked to clean up the spill. Because the extent of contamination was not known and there were no means to test for mercury contamination on campus, she declined and pursued other local clean up options.

It was determined by the NM Tech HazMat officer that the amount of mercury spilled was a reportable quantity to the Environmental Protection Agency (EPA). Over the weekend, the NM Tech HazMat officer attempted to find a local business to clean up the mercury, ensuring the building would be open to student use on Monday. While there were local businesses who could do the clean-up, they did not have a mercury detector (LUMEX) to ensure adequate clean-up. An EPA team out of Dallas was activated and arrived in Albuquerque at 6pm Saturday and worked through Sunday 7am to clean up the spill. The EPA had the appropriate testing equipment and engaged a local contractor to conduct the clean-up work. The building was safely reopened Monday.

While the impact of this event affected use of the Fidel student services building and required response from many agencies, the economic impact to NM Tech or to the State of New Mexico is not yet clear. A meta-analysis of mercury spill responses in five states (2012-2015) determined the average cost of mercury spill cleanup ranged from $30,000 to $75,000, with the highest cost of cleanup coming in at $913,915 (Wozniak, Hirsch, et al, 2017).

1.1. Background

There was some discussion around incident response during the causal analysis meeting. Response to the spill was not clear because of several issues.

The NM Tech HazMat officer was performing training and could not immediately respond. Phone calls from numerous points of contact at NM Tech went out, resulting in responses from many government agencies.

NM Tech has had a recent change in HazMat safety personnel and there was discussion around how or if that role had changed since the previous role occupant. The school administration subsequently advised that the role had not changed, and the new role occupant was either unaware of the responsibility or unwilling to respond.

In addition, reference was made to existing procedures at NM Tech for responding to chemical spills, including mercury, and some participants suggested the procedures were not followed.

NM Tech does not have the ability to test for the presence of mercury, and that is a recommendation the team suggested.

Campus Police had difficulty monitoring all exits to prevent reentry from the Fidel Student Services building.

The amount of mercury spilled was probably not reportable to the EPA given amounts of mercury in common sources (Wozniak, Hirsch, et al, 2017). Reportable amounts to the EPA are ten pounds of mercury (US EPA, 2-18), while most sphygmomanometers hold only .15-.20 pounds of mercury. Had there been a procedure for cleaning up small spills of mercury, action from the EPA may not have been warranted.

Figure 1-1. Common sources of Mercury

TABLE 2

Common sources of mercury in homes, schools and health care facilities — United States, 2001–2017

Source	Approximate amount (pounds)	(grams)
Compact fluorescent lightbulbs*	0.00001	0.004
Thermostats (tilt switches)†	0.0001–0.0100	0.05–5
Thermometers§	0.001–0.020	0.5–10
Float switches†	0.0002–0.1500	0.1–70
Blood pressure monitors§	0.15–0.20	70–90
Manometers¶,**	0.07–0.75	30–340
Gas pressure regulators (residential) ††	≤0.3	≤140
Esophageal dilators§	≤1.0	≤450
Barometers§	≤1.8	≤800
Boiler heating systems††	≤3.5	≤1600
Grandfather clocks (pendulum) §§	≤15.0	≤6800

* https://www.epa.gov/cfl/what-are-connections-between-mercury-and-cfls.

† http://www.newmoa.org/prevention/mercury/imerc/factsheets/switches_relays_2014.pdf.

§ https://www3.epa.gov/region9/waste/p2/projects/hospital/mercury.pdf.

¶ http://www.newmoa.org/prevention/mercury/imerc/factsheets/measuring_devices.cfm.

** http://www.epa.ohio.gov/portals/41/p2/mercury_pbt/manometer_web.pdf.

†† https://www.epa.gov/sites/production/files/2015-10/documents/before_you_tear_it_down.pdf.

§§ https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5623a2.htm.

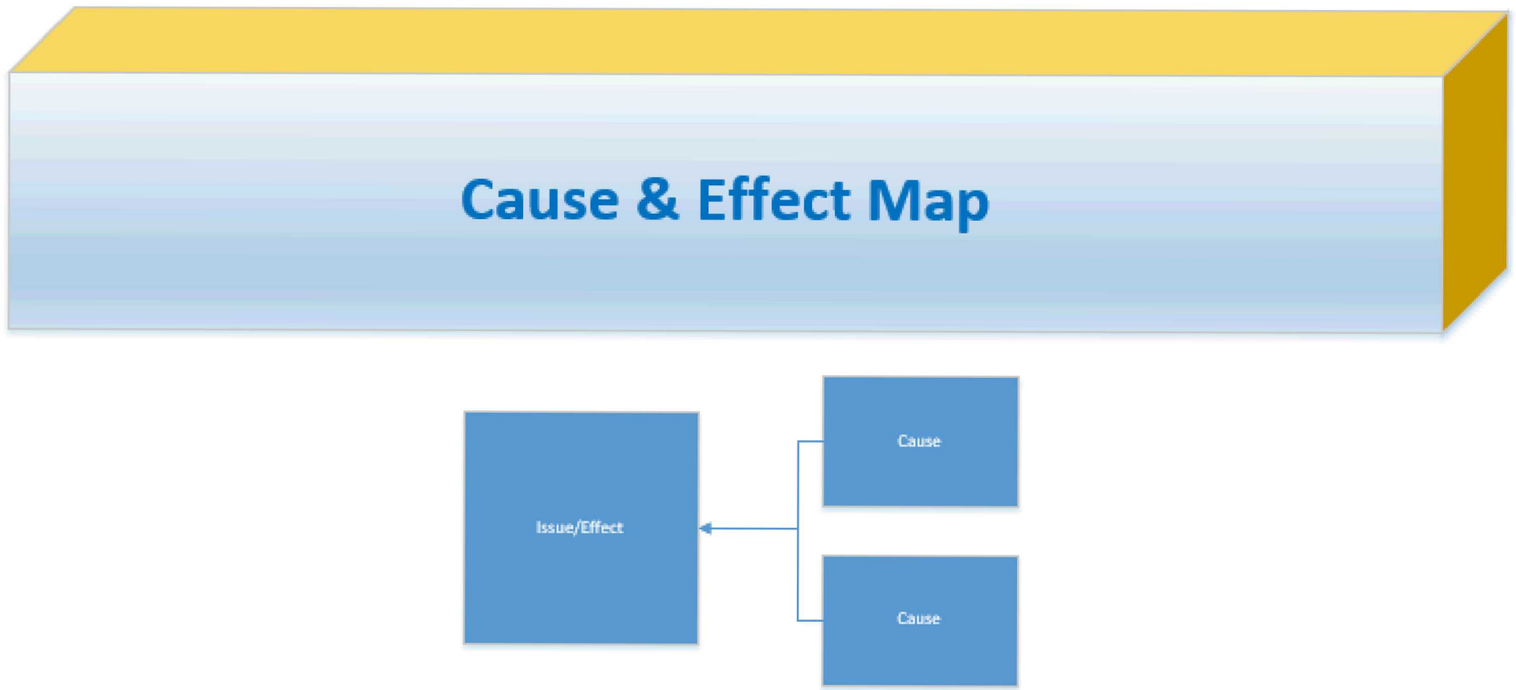
1.2. Causal Analysis

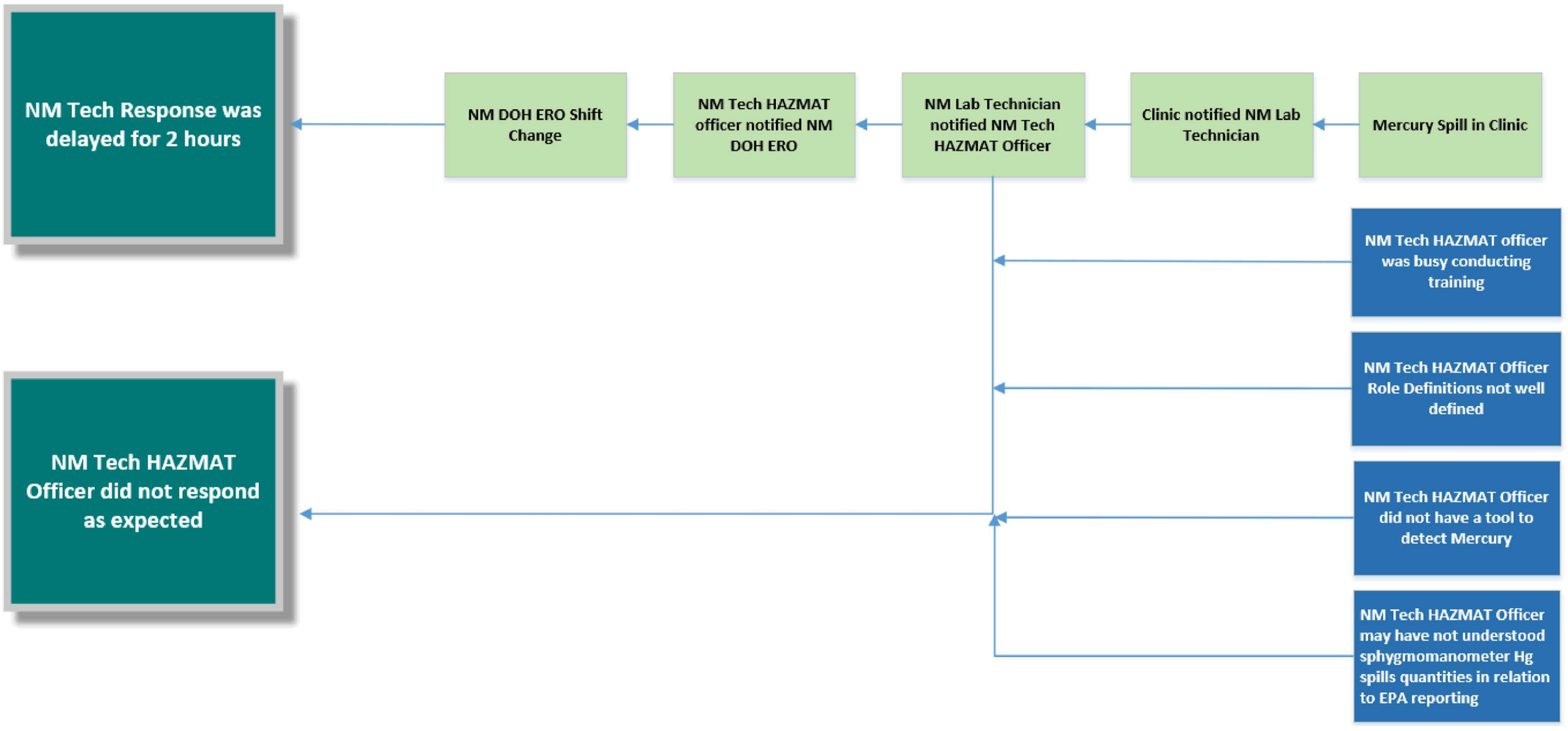
1.2.1. Results of the Casual Analysis and Cause Map

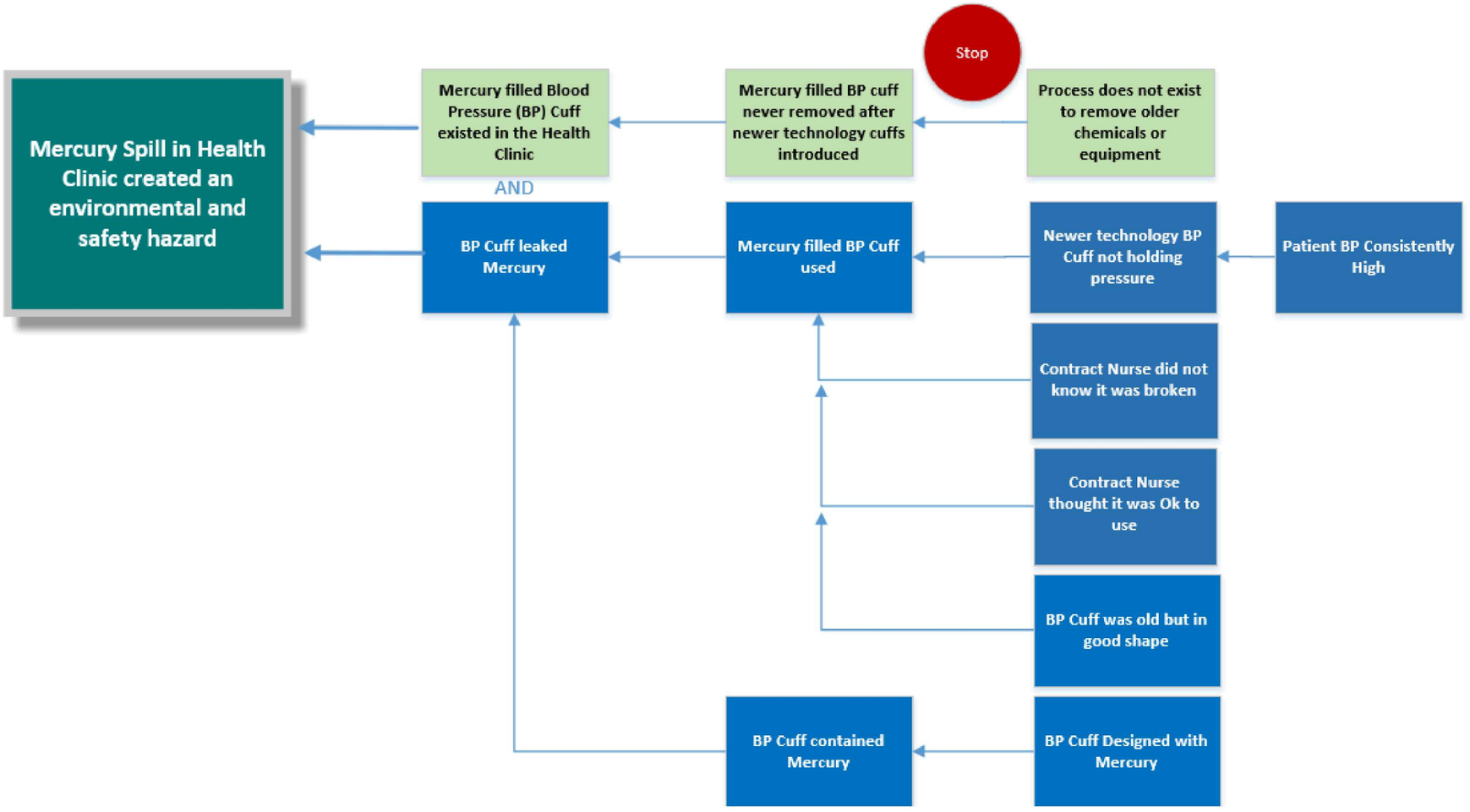
Causal analysis methods used were cause and effect mapping as well as a timeline analysis.

Once the cause and effect map was completed during the causal analysis meeting, the group brainstormed corrective actions and lessons learned.

Figure 1-2. Cause and Effect Map




NM Tech Response was delayed for 2 hours
NM DOH ERO Shift Change
NM Tech HAZMAT officer notified NM DOH ERO
NM Lab Technician notified NM Tech HAZMAT Officer
Clinic notified NM Lab Technician
Mercury Spill in Clinic
NM Tech HAZMAT officer was busy conducting training
NM Tech HAZMAT Officer Role Definitions not well defined
NM Tech HAZMAT Officer did not have a tool to detect Mercury
NM Tech HAZMAT Officer may have not understood sphygmomanometer Hg spills quantities in relation to EPA reporting
NM Tech HAZMAT Officer did not respond as expected


Mercury Spill in Health Clinic created an environmental and safety hazard
Mercury filled Blood Pressure (BP) Cuff existed in the Health Clinic
AND
BP Cuff leaked Mercury
Mercury filled BP cuff never removed after newer technology cuffs introduced
Stop
Process does not exist to remove older chemicals or equipment
Mercury filled BP Cuff used
Newer technology BP Cuff not holding pressure
Patient BP Consistently High
Contract Nurse did not know it was broken
Contract Nurse thought it was Ok to use
BP Cuff was old but in good shape
BP Cuff contained Mercury
BP Cuff Designed with Mercury

1.2.2. Results of the Extent of Condition (EoC) Assessment

While this mercury release was, to our knowledge, the only one of its kind at NM Tech, the potential for other releases is possible. Because of their reliability, mercury thermometers and barometers are used by several labs at the school. Mercury also exists in the form of reagents or precipitates in chemical reactions. It is conceivable that thermometers and barometers could break, releasing a less than reportable quantity of mercury, but posing a hazard requiring cleanup and verification of a safe work environment.

Best practices in hazardous material management are to first eliminate the hazard, followed by reducing the likelihood of a release or reducing the impact of a release, thereby reducing the risk. Sandia National Laboratories has begun to exchange more hazardous for less hazardous materials, when possible, to mitigate the risk of release. Other methods of reducing the impact of a release are appropriate storage of the item, secondary containment for potentially hazardous releases, procedures to manage potential releases, and scripted coordinated response procedures.

1.2.3. Recommended Corrective Actions / Benefits of Implementation

Activity	Benefit	Responsible Individual	Estimated Completion Date
Ensure understanding of the appropriate emergency event response with the HazMat officer.	A coordinated response benefits all in the campus community.	TBD by NM Tech	TBD by NM Tech
Determine a cross-departmental procedure for a mercury spill coordinated response and ensure all personnel have been trained. Include a readily available action response table with clearly defined roles, responsibilities, and key contact information for both internal NM Tech personnel and outside responders. Include key thresholds for reportable mercury quantities.	This activity ensures that the proper procedures and actions are taken for any future HazMat events. If key thresholds are documented and understood, unnecessary actions may be avoided.	TBD by NM Tech	TBD by NM Tech

Activity	Benefit	Responsible Individual	Estimated Completion Date
Provide training and tools for safe handling and storage of mercury sources.	Training and providing tools to several NM Tech personnel provides the school with more cleanup capability for any future spills.	TBD by NM Tech	TBD by NM Tech
Consider purchasing a LUMEX machine (Hg sniffer) so that cleanup can be done by a local company. Approximate initial cost is $6000, not including training and maintenance over the life of the machine.	This expense can potentially pay for itself if it eliminates the need for a government agency cleanup.	TBD by NM Tech	TBD by NM Tech
Consider establishing evacuation teams in buildings with large populations or that have potentially hazardous materials. Evacuation team leads and members can assist Campus Police in clearing the building and in preventing re-entry. At Sandia, these evacuation teams also prevent personnel from leaving a building during a lockdown. Also at Sandia, evacuation team members are identified by a red ball cap.	Coordinated evacuation responses ensure the safety of both the faculty and the students during a crisis.	TBD by NM Tech	TBD by NM Tech
Consider writing and sharing lessons learned with other NM state institutions of higher learning.	Other state institutions may have the same vulnerabilities and could benefit from the knowledge gained here.	TBD by NM Tech	TBD by NM Tech

Potential resources for establishing mercury handling, response, and lessons learned include:

1. Agency for Toxic Substances and Disease Registry: "Don't Mess with Mercury"
2. The DOE Operating Experience website, while requiring DOE approval to search the site, once granted, provides searchable lessons learned on a variety of topics, including mercury.
3. The American Diagnostic Corporation advises on Mercury Spill Clean Up.
4. The Sandia National Labs subject matter expert in chemical and hazardous materials, Victoria Atencio, has offered help and her contact information has been relayed to Ruth Horowitz.

1.2.4. Verification Plan Activity Table

It is recommended that all corrective actions are verified. The table below is a suggested means to track due dates of actions and who is responsible for them.

Activity	Responsible Individual	Estimated Completion Date
Perform a desk audit of all new and updated procedures.	TBD	TBD
Verify that the mercury detector is purchased, and key personnel are trained on its use.	TBD	TBD

1.2.5. Validation Plan

Validation is a means of evaluating if the corrective action was effective. Validation can be performed by doing an assessment, observation of work practices, performance tests, HazMat event drills, or interviews. It is recommended to perform validation activities over the course of a year following the implementation of corrective actions.

1.2.6. Team Members

Name	Institution	Role/Title
Van Romero	NM Tech	Chief Research Officer (champion of activity)
Ruth Horowitz	NM Tech	Hazardous Waste Safety
Jeff Altig	NM Tech	Associate Chemistry Professor
Kate Wavrik	NM Tech	Staff/Safety Officer
Dustin Baca	NM Tech BOG	Lab Tech
Bonnie Frey	NM Tech BOG	Lab Manager

Liliya Frolova	NM Tech	Assistant Chemistry Professor
Scott Scarborough	NM Tech PD	Chief of Police
E.P. Higgs	NM Tech PD	Asst. Chief of Police
Linnea Sands	Sandia Labs	Senior Causal Analyst
Angelo Padilla	Sandia Labs	Causal Analyst

1.2.7. Attachments

REFERENCES

References

Persistent Bioaccumulative Toxic (PBT) Chemicals Covered by the TRI Program | US EPA. (2018, January 2). Retrieved from https://www.epa.gov/toxics-release-inventory-tri-program/persistent-bioaccumulative-toxic-pbt-chemicals-covered-tri

Wozniak RJ, Hirsch AE, Bush CR, Schmitz S, Wenzel J. Mercury Spill Responses - Five States, 2012-2015. *MMWR Morb Mortal Wkly Rep*. 2017;66(10):274-277. Published 2017 Mar 17. doi:10.15585/mmwr.mm6610a3

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