DOE/NNSA response to July 27, 2023 letter, EPA Region 6 (Dr. Earthea Nance) to NNSA Los Alamos Field Office (Theodore A Wyka)

EPA Questions on FTWC Operations and Alternatives

1. **Transport of FTWC without venting:**
   - Please describe the current condition of the FTWC containers and their contents. ○ There are four FTWCs in controlled storage at 54-1028. The containers are safe and stable in the current configuration. The containers hold a mix of tritium contaminated parts and waste items. The contents are well documented, and modeling indicates that the containers likely consist of an explosive or flammable hydrogen/oxygen mixture. Each FTWC atmosphere can be slightly different dependent on specific contents.
   - Please clarify what conditions result in a restriction on the transportation of the containers in their current condition.
     - DOT regulations and worker safety requirements do not allow for handling or movement of the containers in the current configuration. Movement without mitigating the anticipated headspace gas can result in an uncontrolled, unmitigated, and unmonitored release
   - Given the presence of hydrogen gas in the headspace, is there concern that an explosive mixture may be present in the FTWCs?
     - Yes. While not directly measurable in the current configuration, modeling indicates an explosive or flammable hydrogen/oxygen mixture within the FTWCs; each FTWC atmosphere can be slightly different.
   - Does this concern result in a prohibition on moving the containers in their current condition? ○ Yes. The internal pressures must be mitigated prior to handling/venting to prevent an uncontrolled, unmitigated, and unmonitored release.
   - What precautions are necessary during the handling and venting of these containers to address this concern?
     - Any movement without mitigating the anticipated headspace gas can result in an unacceptable uncontrolled, unmitigated, and unmonitored release. The controlled venting operational design addresses this concern by allowing pressure mitigation in place at 54-1028. Only the actions necessary to achieve a safe handling condition will be performed at 54-1028. Further handling, packaging, and offsite shipment will be performed at the LANL Tritium Facility.
   - Can sampling be performed to characterize the headspace gas to inform option selection? ○ Sampling is included in the operational plan and procedures, throughout all operational phases. Opening the FTWCs for headspace sampling requires the same level of ventilation, emissions monitoring, and regulatory permitting/approval that is needed for full venting.
   - If sampling confirms that an explosive mixture is not a concern, what transportation restrictions apply to the containers due to the contents and pressure?
     - The primary objective of the field operations will be to meet DOT and worker safety requirements by resolving the pressure hazard. The controlled venting operation is designed to mitigate the pressure in the containers. Once accomplished, all additional processing will occur at the LANL Tritium Facility.
   - Please describe the requirements and availability of overpack/shipping containers necessary to transport the FTWCs in their current condition to WETF for processing.
     - There are no overpack/shipping containers that would allow for compliant shipping. Moving the containers into an overpack container poses the risk of an uncontrolled, unmitigated, and unmonitored release. Further, if the FTWCs release into an overpack container, then the

overpack becomes a new difficult, contaminated container with the same concerns and restrictions.

- Are there any limitations at WETF that would not allow for receiving and processing of the FTWCs in their current state? o No.

2. Venting into container:

- A variation of the current planned operation would involve venting the gas (after passing through the capture device) into an evacuated or negative pressure cylinder to capture all remaining tritium that is not removed by the capture device. The FTWC and this cylinder would then be transported to WETF for further processing. Please provide a full detailed analysis of this option.
    - This is technically possible, but creates new risks and new waste streams. The additional storage container(s) would need to be qualified to handle a hydrogen-rich/explosive atmosphere within the container, and would become additional waste. The effectiveness of the current design and capture system already minimize the potential release, and maximize worker and environmental protection. Adding additional components, complexity, and time to redesign the operation and system may provide for a very small reduction in the potential release, but will result in an increase in pressure in the containers and therefore increase the overall risk of the operation.
- What is the anticipated release associated with disconnection of hoses once the FTWC and the additional container are sealed?
    - At some point the process would reach a pressure equilibrium between the initial FTWC being vented and a storage cylinder; this remaining quantify of headspace gas would need to be vented to the environment. Connection equipment (hoses/valves/etc.) would also represent a possible tritium release after headspace gas transfer. Such releases would be a very small fraction of the original headspace gas volume and associated tritium emissions would be similarly small. All of these small releases will pass through the ventilation and sampling system and are part of the overall sampling and reporting plan.
- Can the hoses and connections be flushed with air and into the additional container to minimize this source of potential release?
    - Any flush gas would need to be at higher pressure than the storage container, or would require additional storage containers. Every change of a storage container creates additional waste and additional small releases.
- Under the current operational plan, what is the anticipated release associated with disconnection of hoses and sampling equipment once venting is complete and FTWC is sealed?
    - In the current operational plan, the connection lines are vented out the system stack. Also, the ambient air within 54-1028 is vented out the stack as well to measure any potential releases during system connection/disconnection activities. All of these small releases are accounted for in the sampling plan.
- Another alternative that would potentially eliminate a release would be to place the FTWCs inside a larger containment vessel and then vent or puncture the FTWC into the sealed vessel to relieve the pressure. The vessel containing the FTWC would then be transported for additional treatment. Please provide an evaluation of this option.
    - In this scenario, there is still the potentially explosive mixture within the new headspace and the same potential for igniting the headspace. Handling the FTWCs to load them into these new containers would have the same operational risks and concerns of the original FTWCs, and a larger contaminated container would be more difficult to handle, transport, and ultimately permanently disposition.

3. **Increased capture:**
   - Please describe the expected capture efficiency of the capture device for tritium vapor and gas and provide any supporting research and experimental results.
     - The collection efficiency of the AL-M1 has been studied extensively under a variety of operating conditions. Efficiency is very high (>90%) but can vary with operating temperature and flow rate through the system. The operation is specifically designed to maximize capture efficiency by carefully controlling depressurization rates. This operation and equipment has been successfully used at the LANL Tritium Facility dozens of times, by the same staff.
   - Bubblers are used to sample a small portion of the flow and capture tritium for measurement. Could the combination of the capture device followed by a large volume bubbler or series of bubblers be used to further reduce the anticipated release?
     - The flow rate through the FTWC venting system can be as much as 3000 times higher than the flow rate through the tritium sampler (bubbler). A similar collection system would have to be proportionately larger to accommodate the higher flow rates (technically infeasible).
   - Please describe any applications or limitations (e.g., saturation, flow rate, volume) to the use of a bubbler as a secondary capture device. Please evaluate the use of a secondary capture device to increase capture and provide defense-in-depth during operations.
     - The high flow rate of the FTWC venting system (up to 3000 times higher than the flow rate through the tritium sampler (bubbler)) makes this technically infeasible.
   - Please discuss the application of heat and/or catalyst use for this operation to convert tritium gas to vapor for capture in the device and/or bubblers?
     - The bubbler catalyst operates at 450 degrees Celsius to fully convert elemental tritium gas to water vapor phase and allow for subsequent collection. There are significant operational risks associated with using such high-temperature surfaces on a high-volume air stream that is potentially an explosive hydrogen-oxygen mixture.
   - Is it possible to provide for measurements of tritium before and after capture to assess the capture efficiency and monitor this over the duration of the operation? These measurements would also be helpful in initial characterization of the tritium contents in the headspace of the FTWCs.
     - Tritium concentration will be measured real-time throughout the operation. The primary purpose of this sampling is to ensure compliance and protection of the operational hold points.

4. **Delay venting:**
   - Please provide additional analysis of an operation plan of delaying venting operations to allow for additional decay to further decrease the potential release.
     - With tritium's 12-year half-life, the project would need to be delayed over 80 years to reduce the emissions to 1% of current levels. During that time, pressure continues to build, as does the safety exclusion area around the FTWCs. There is currently a window of time in which safe, compliant controlled venting can be performed. Once that time passes – likely in less than 4-5 years – any effort to move or mitigate the containers becomes much more difficult and introduces new risks, including possible curtailment of Area G cleanup efforts.
   - How will additional time impact the container pressure? o The decay of tritium and radiolysis of water vapor will result in an increase in the FTWC headspace pressure over time. Pressures increase about 5 psi each year of delay. The containers themselves are designed for permanent disposal and are designed to safely hold the maximum pressures possible throughout the entire lifecycle of the container. However, the controlled venting equipment has pressure limitations, and once those are exceeded there is no technology available to meet the worker safety requirements. At that point, the

only feasible options will be to permanently leave the containers in place, or remotely puncture the containers.

- How does increased pressure impact the current operation plan and equipment, including the venting manifold?
    - The currently planned controlled venting process will be unfeasible at some point in the near future. Based on modeling, that time is likely less than 4-5 years (2028). After this time the process becomes immensely more complex.
- What is the maximum amount of time before pressure concerns impact the current vent and transport plan?
    - The currently planned controlled venting process will not be possible after 4-5 years, though every year before then increases operational risk. After this time the process becomes immensely more complex, involving robotic or remotely-operated equipment.

5. Facility construction/containment:

- Please provide analysis of potential construction of a temporary facility, either built at the storage site or built and then transported to the site to provide containment during the venting and possibly sorting/packaging/processing for long term storage.
    - Any construction over the top of the current storage structure 54-1028 introduces the unacceptable risk of an uncontrolled, unmitigated, and unmonitored release.
- How would released tritium be captured and treated within the facility in this scenario? ○ The capture, treatment, and emissions measurement systems on such a temporary facility will be identical to the process planned for the current process.
- How does this compare to the current operation plan in terms of anticipated release? ○ Such a temporary facility would have the exact same tritium release considerations as the currently planned operation. All air inside the facility would have to be sampled through essentially the identical ventilation system that has been designed for 54-1028.

Conclusion/Additional Information

The guiding operational decisions and determination of remediation methods used for this project fall under three main categories with equal importance:

1. Maximize the protection of the public and the environment.
2. Prevent scenarios and conditions that could result in an uncontrolled, unmitigated, and unmonitored release of tritium. Such a release could occur if the potentially explosive hydrogen mixture in the FTWC headspace were to react, or if the containers were unintentionally damaged.
3. Ensure the safety of workers who are performing the hands-on work on the FTWCs.