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NAVIGATING ORGANIZATIONAL CHANGE IN THE HEALTH PHYSICS COMMUNITY

Maxwell Koester

Sandia National Laboratories

ACKNOWLEDGMENTS

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HPS JOURNAL

- Hill, M. B., Koester, M. T., *Navigating Organizational Change: New Processes, New Personnel, and Faulty Assumptions Lead to Tritium Uptake and Loss of Radiological Control.*

Navigating Organizational Change: New Processes, New Personnel, and Faulty Assumptions Lead to Tritium Uptake and Loss of Radiological Control

Matthew Hill, B.S. RRPT, ASP

Maxwell Koester, B.S.

Sandia National Laboratories

“Your assumptions are your windows on the world. Scrub them off every once in a while, or the light won’t come in.”
-Isaac Asimov

PROBLEM STATEMENT

Mature radiation protection programs, although robust, rely on health physics professionals and operational staff of all experience levels to implement work planning and control practices. When an organization implements changes to work processes and relies upon complacent or inexperienced staff, it cannot fully remove the possibility of radiological incidents occurring.

OVERVIEW: SANDIA NATIONAL LABORATORY-ABQ (SNL)

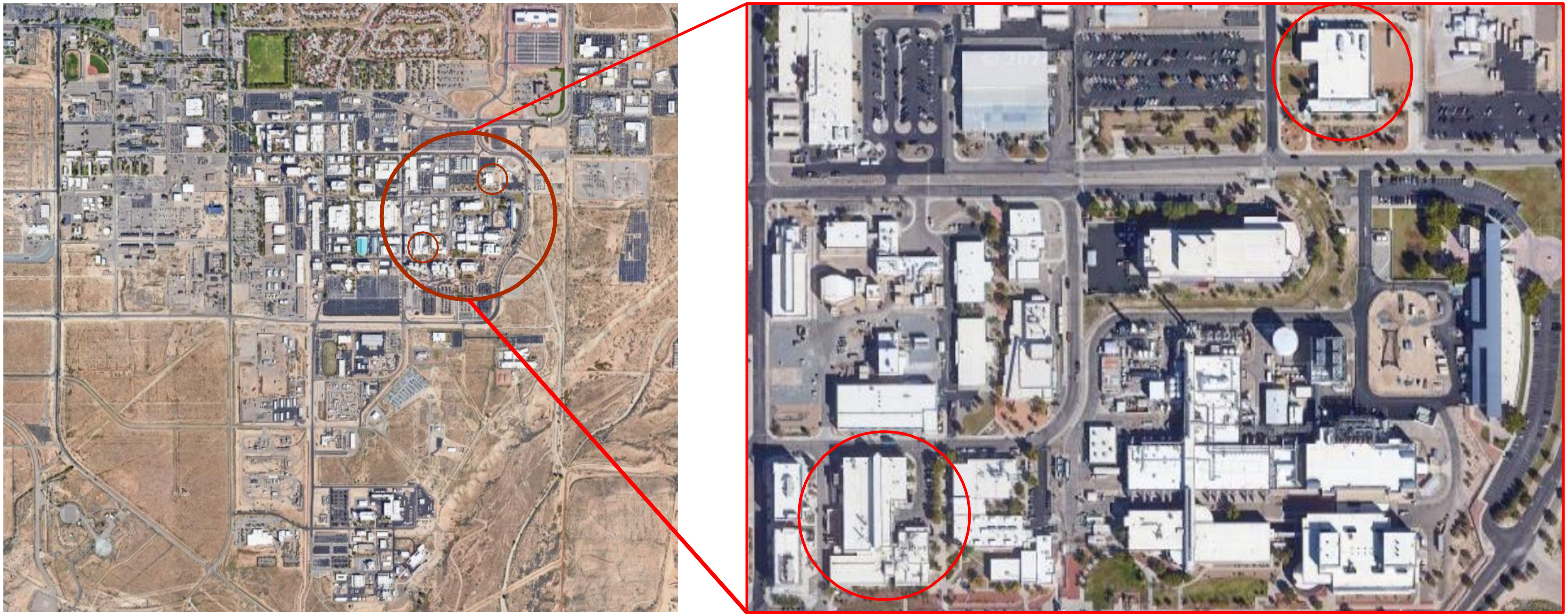

Figure 1. A map of SNL, outlining facilities of importance.

FACILITY OVERVIEW – ION BEAM LABORATORY (IBL)

- Nano and HVEE Ion Implanters (100 kV and 350 kV respectively)
- The Pelletron and Tandem Van de Graaf accelerators (3 MeV and 6 MeV respectively)
- IBL was designed to allow both experimental lab spaces and office spaces

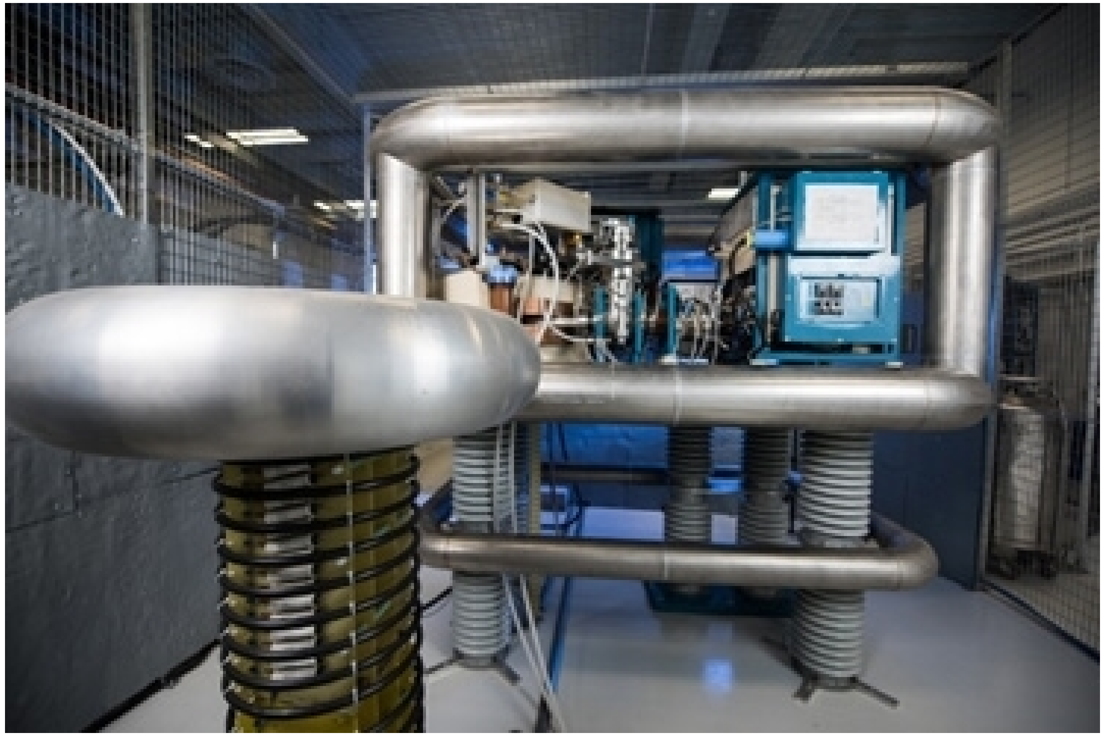

Figure 2. A 400 kV HVEE ion implanter similar to that used at IBL.[1]

OVERVIEW - HVEE ACCELERATOR OPERATIONS

- HVEE is capable of producing a variety of neutron radiation fields
- Year round operation undergoing approximately 38 target changes per year
- End stations are kept under vacuum and vented through an exhaust system on the roof of the building

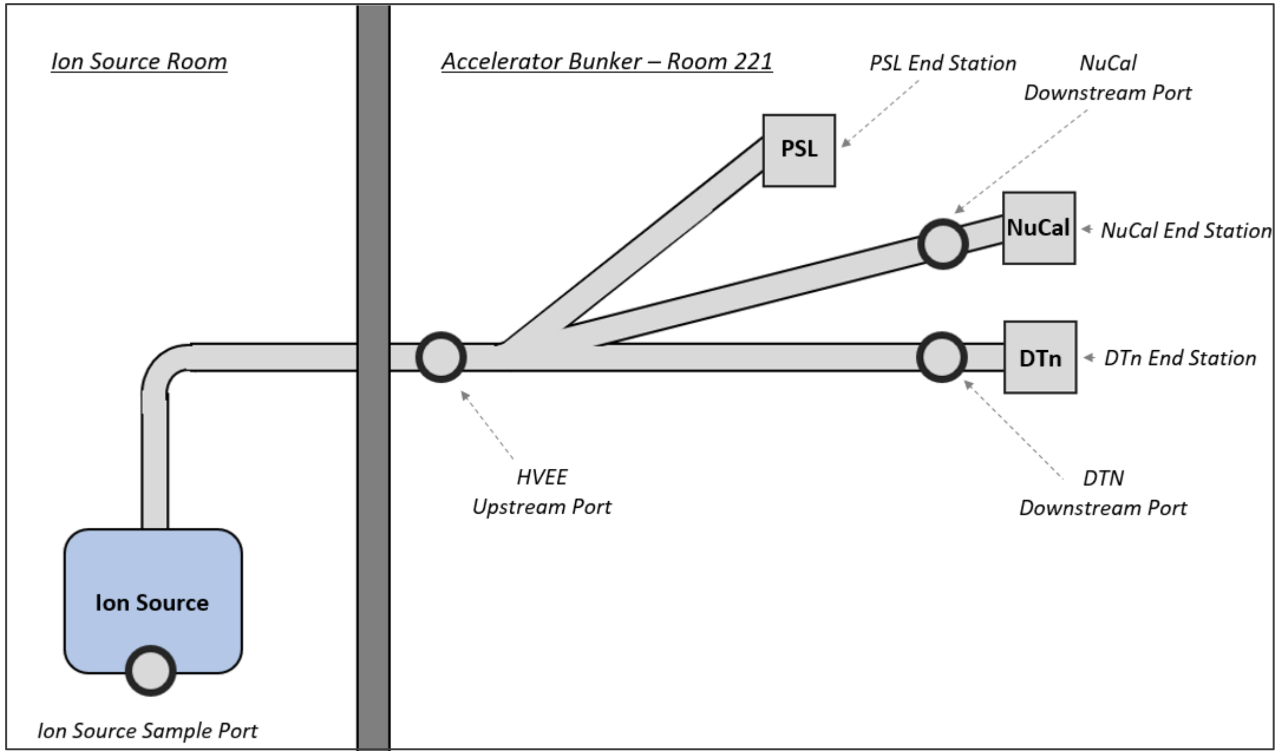

Figure 3. A map of the HVEE facility at IBL.

OVERVIEW – TARGETS AND STORAGE CONTAINERS

- Iron substrate targets
- Staffing changes and new manufacturing process
- The target change process
- Target storage container

Figure 4. A closeup image of the tritiated targets utilized by scientists at IBL

Figure 5. The container used by the new manufacturing team to transport new batches of targets.

TIMELINE OF RADIOLOGICAL INCIDENT

New Target Production Process Begins (Early 2022)

Summer 2022

Initial target change with new targets shows an elevated level of tritium contamination; operations continue

Fall 2022

Contamination levels continue to increase with a peak contamination level of 900k dpm/100cm^2; affected staff placed on bioassay

Pump/Purge (Nov – Jan)

Winter 2023

Bioassay confirms tritium uptake; management decides to conduct a full characterization

Early 2023

Management develops characterization plan; scheduled to be conducted in early January

Characterization Plan

1. Transport container
2. Individual targets
3. Remove Installed Target (DTn)
4. Downstream ports
5. Upstream ports
6. Ion source

**Additional Controls

Radiological Incident Occurs

During characterization, STOP WORK points were met within the first 5 minutes…

RADIOLOGICAL INCIDENT

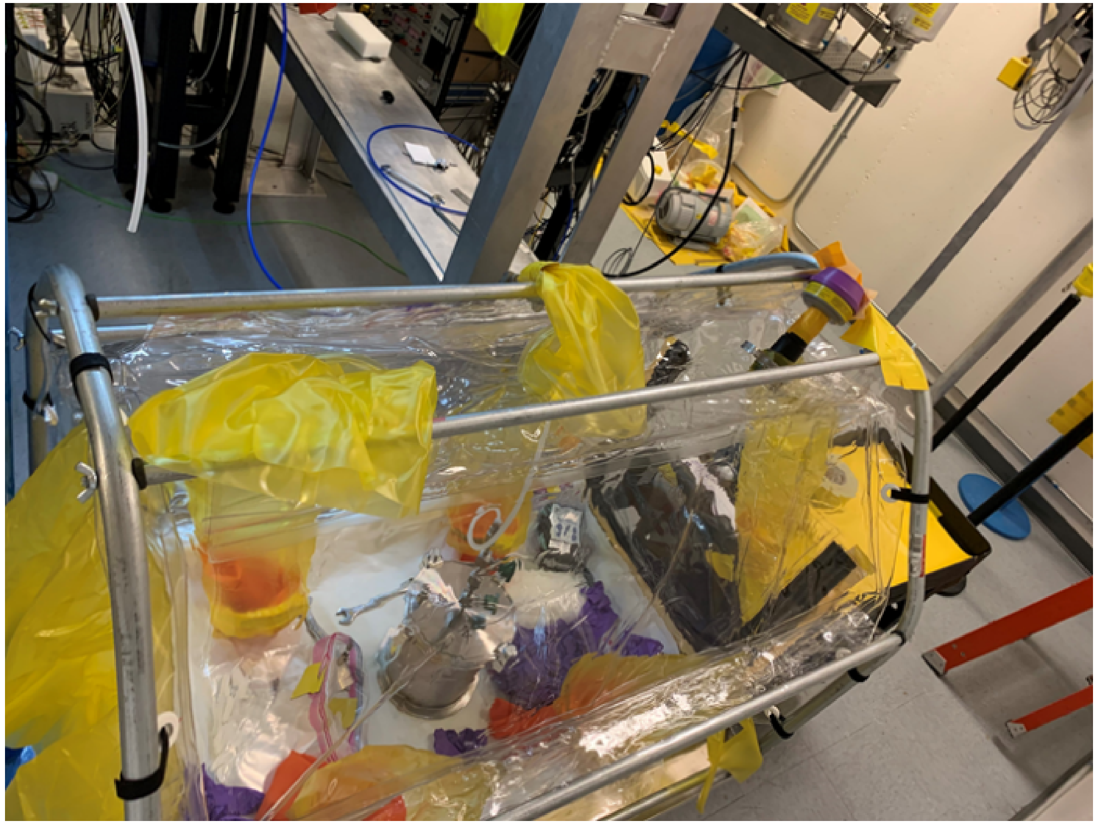

Figure 6. The confinement set up around the transport container storage area.

Figure 7. The target transport container and attached vacuum line.

RADIOLOGICAL INCIDENT (CONTINUED)

- Initial Response:
  - Secured the valve – tritium conditions continued to rise
  - Evacuated room 221
  - Performed independent verification that valve was closed
  - Attempted to understand if Overhoff reading was valid
  - Began drafting recovery plan

- Recovery Plan
  - Install vacuum line(s) from NuCal,
  - Establish vacuum to transport container (safe configuration)
  - Vent the confinement with vacuum line to NuCal

- Duration of Emergency Response: ~12 hours

RESUMPTION OF CHARACTERIZATION

Characterization Plan

1. ~~Transport container~~
2. ~~Individual targets~~
3. Remove Installed Target (DTn)
4. Downstream ports
5. Upstream ports
6. Ion source

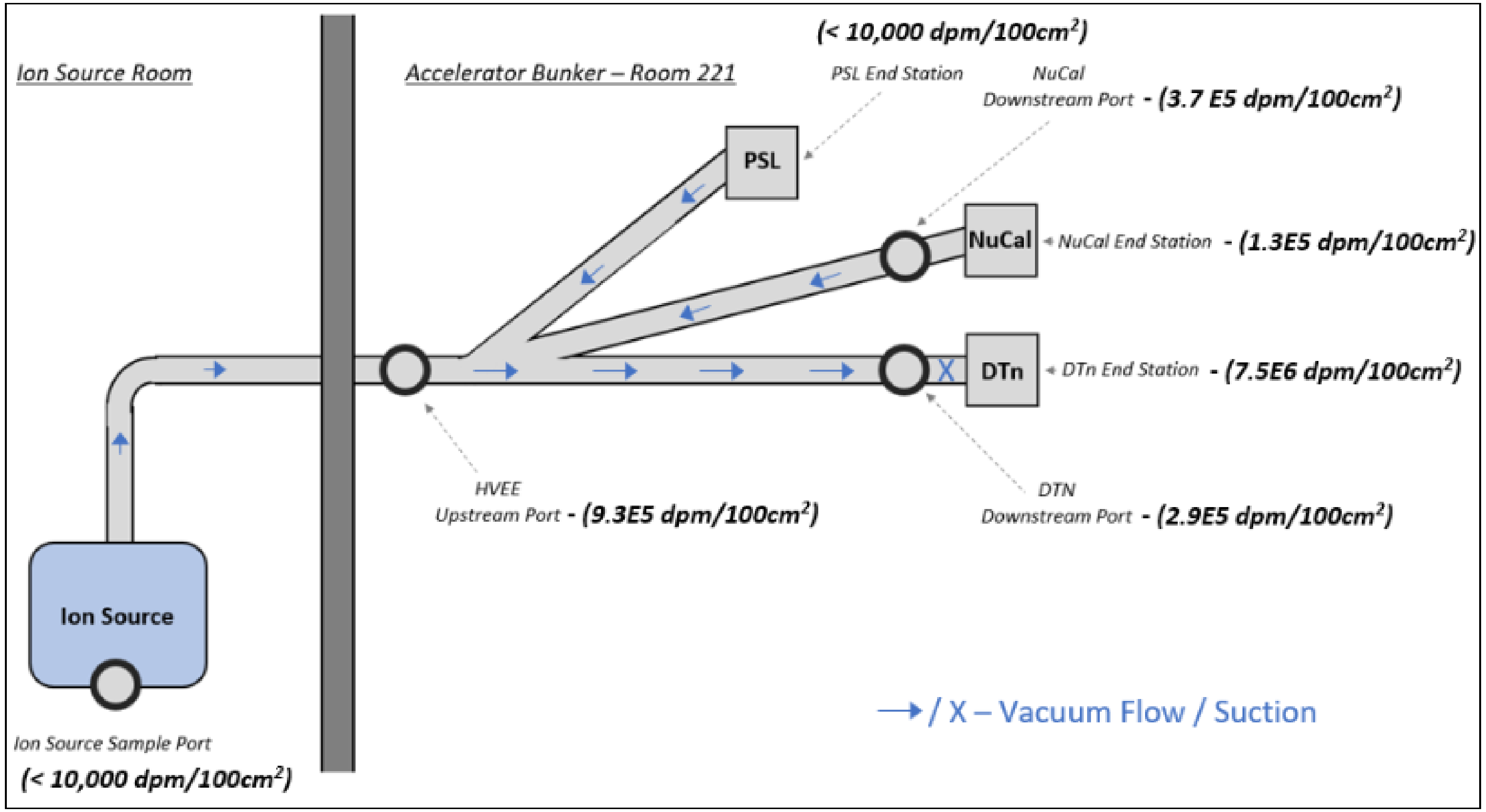

Figure 8. A map of the HVEE system showing the flow of the vacuum system.

FOLLOW – UP ACTIONS

- Pump and purge decontamination efforts
  - Nitrogen purge
  - Moisture changes
  - Temperature changes

- Future Studies
  - Tritium removal techniques under various environments
  - Tritium loading methodologies
  - Tritium retention properties in various materials

FAULTY ASSUMPTIONS

- Inadequate Process Knowledge
  - Storage container seal
  - Target off-gassing
- Pump/Purge cycling effectiveness
  - Temperature
  - Moisture content
- Tritium migration
  - Getter materials
  - Hydrogen interaction
  - Surface roughness
- Molecular flow versus viscous flow
  - Vacuum collection
  - High vacuum conditions

CONCLUSIONS

- The organization came across a series of unexpected conditions
  - Airborne tritium levels continued to rise even after the transport container vent was sealed
  - Tritium contamination remained within the beamlines even after targets were removed
- Even experienced radiation protection organizations are prone to radiological incidents when facing personnel and process changes.
- In light of this there are steps that can be taken to reduce complacency within a radiation protection organization.

REFERENCES

1. *Blue: 400 kV Implantar*. *Michigan Ion Beam Laboratory*, Michigan Engineering, https://mibl.engin.umich.edu/major-instruments/ion-implanter/. Accessed 2023.
2. G. Vizkelethy, B.L. Doyle, F.L. McDaniel, The new Sandia light ion microbeam, Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, Volume 273, 2012, Pages 222-225
3. Fagan, C.E. (2021). *Tritium interactions with austenitic stainless steel type 316* [PhD thesis, University of Rochester]. Retrieved from https://www.lle.rochester.edu/media/publications/documents/theses/Fagan.pdf
4. Dickson, R.S. (1990). *Tritium interactions with steel and construction materials in fusion devices.* Chalk River Laboratories. Retrieved from https://inis.iaea.org/collection/NCLCollectionStore/_Public/24/009/24009449.pdf.
5. W. T. Shmayda, M. Sharpe,A,B. M. Boyce,R. Shea,. Petroski, And W. U. Schro¨ Der, *Dependence Of Tritium Release From Stainless Steel On Temperature And Water Vapor*
6. DOE-HDBK-1097, *Tritium Primer*
7. Sandia National Laboratories: Various Radiological Surveys: *I-20230330-4, I-20230417-4, I-20230307-1, I-20230413-1*

QUESTIONS