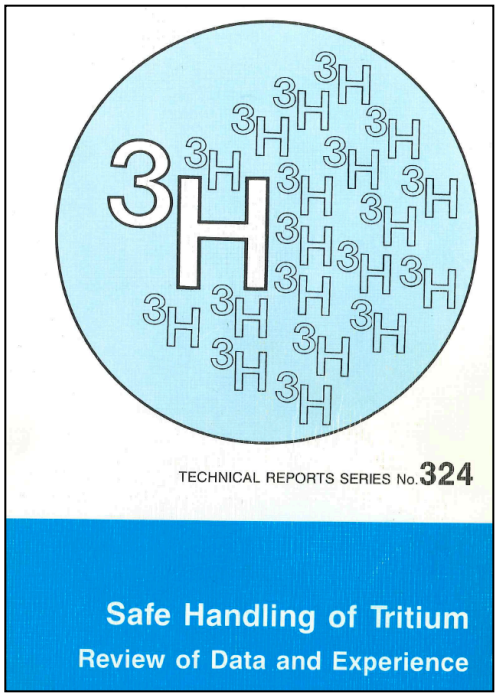
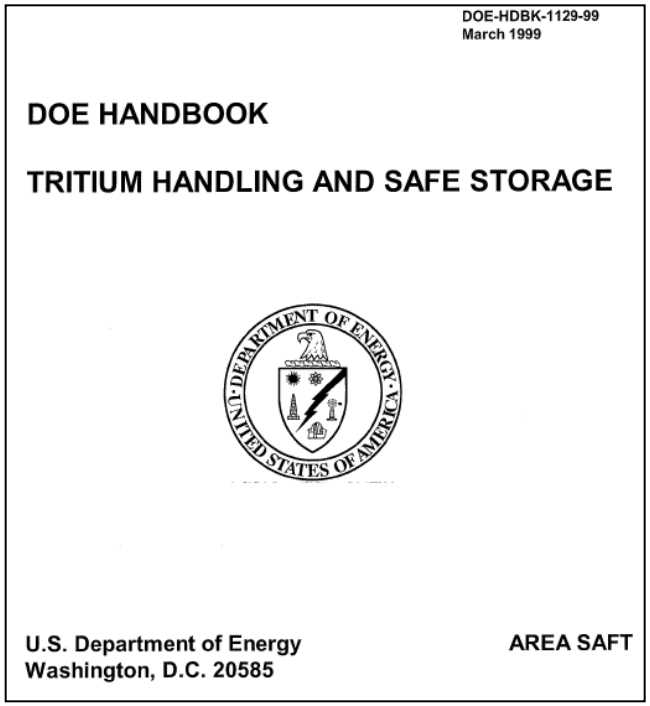
Tritium Design Practices: Part 2





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Tritium Focus Group Workshop
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Federal and state regulations govern the UR/LLE Radiation Safety Program

- Requirements come from the Nuclear Regulatory Commission (NRC), Environmental Protection Agency, and the Department of Transportation
- New York State has accepted regulatory authority from the NRC
  - NYS Department of Health (DOH) governs the use of radioactive material and radiation protection devices in NYS
  - Department of Environmental Conservation governs the release of radioactive material to the general public
- University of Rochester is licensed by the NYS DOH
  - UR's Radiation Safety Unit (RSU) administers the University's radiation safety program
  - UR's Radiation Safety Committee establishes the procedures for the RSU and oversees their operation
  - LLE operates under a permit issued by the RSU

NRC strives to prevent environmental pollution by radioactive materials and to minimize worker exposure

- Questions posed by the NRC are:
  - What can go wrong
  - How likely
  - What are the consequences
  - Which components will be involved

Designers respond to the regulatory bodies with a standard engineering approach

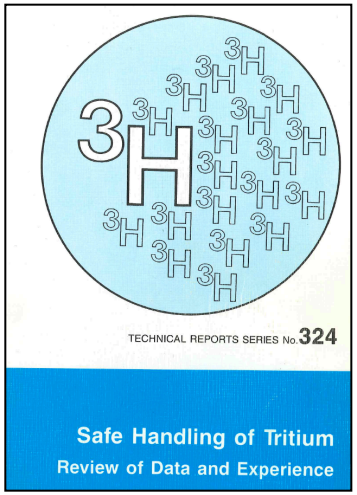
- Codes
- Risk assessment and management
- Failure modes and effects assessment
- Equipment selection and qualification
- Pre-operational safety inspections

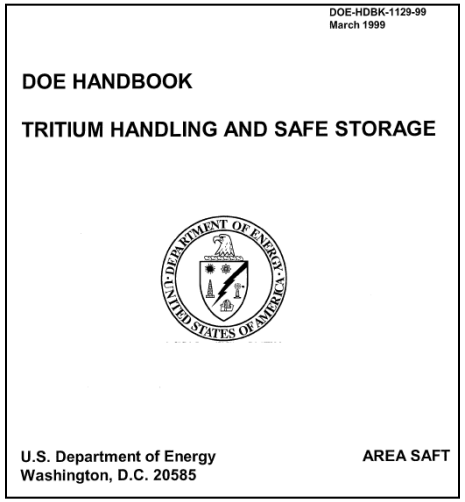
Several codes apply to the construction of process equipment

- ASME
  - Section VIII Div 1 and B31.1 and/or B31.3
  - BPVC Sect IX Welding and Brazing Qualification IEC 61508
  - Relief valves for water and non corrosive liquids up to 250 psig; 120-508120-OI-029
- Design for Earthquakes, and Seismic analysis
- Electrical Code, Fire Code
- Compressed gases and cryogenic fluid code
- Handling radioactive materials NFPA 91 Exhaust Systems for air conveying of vapors, gases

Vacuum practices and two documents provide general guidance for design of equipment for tritium service

- **Helium Leak-tightness: ASME E498-95**
- **Ultrahigh vacuum practice**





- **DOE Handbook for Tritium Handling and Safe Storage (DOE-HDBK- 1129-2008)**
- **IAEA Tritium Safe Handling Manual: Technical Report Series # 324**

Tritium emission reduction requires evaluation of four areas beyond constructing pressurized systems

- Eliminating potential routes for accidental releases
- Fine tuning operations: procedures
- Training and Qualification
- Assessing accidental releases during maintenance

Designed responses to tritium releases vary between facilities

- Automated responses to off-normal events
- Manual ‘E’ stops
- Inert gas glove box containment
  - *Deliberate relief from process systems into the glove box*
- ‘Active’ safety vs ‘Passive’ safety
  - return tritium to storage beds/bypass defective circuits
  - *Rupture discs & expansion vessel*
- Double containment: tritium containment/thermal management

Are the efforts to mitigate tritium releases increasing chronic emissions and tritiated waste streams and driving costs up?

Training and Qualification

- Process loops to show valve alignments for various ‘E’ stops
- Practice emergency response
- Living Procedures include emergency responses

Experience shows that releases increase during maintenance:

- less training
- less familiarity with the operations
- reduced engineering infrastructure

HTO emissions are minimized when both chronic and off-normal T_2 releases are reduced

- Defense in depth
  - Search for common mode failures
  - Tertiary containment with independent T_2 capture technology for critical operations
  - Compartmentalization: low verses high activity
- Compactness
  - Process loops
  - Glove boxes – reduces size of the clean up systems
- Secondary containment for select components
  - Permeation
- Avoid deliberate T_2 conversion to T_2O

A holistic approach to emission reduction is required