



North Anna ESP Hearing

Topic 3 – Tritium

NRC Staff Presentation

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Discussion Topics

- Tritium properties
- Sources of tritium
- Release mechanisms to environment
- Tritium release source term
- Exposure pathways
- Concentrations in environment

Tritium Properties

- Weak beta emitter
- Half-life of ~12.5 years
- Physical forms – elemental and tritiated water
- Internal exposure concern (ingestion, inhalation, absorption through skin)
- Biological half-life of ~10 days

Sources of Tritium

- **Produced in reactors by:**
 - Neutron reactions with light elements in reactor coolant (e.g. boric acid)
 - Ternary fission in fuel
- **Boiling Water Reactors**
 - Small amounts in primary coolant via activation of deuterium and fuel clad defects
 - Typical tritium releases to environment
 - Liquid (~45 Ci/yr for 1000 MW(e) reactor)¹
 - Air (~ 20 Ci/yr for 1000 MW(e) reactor)¹

1 – NCRP Report No. 62 (Tritium in the Environment), p. 62-63

Sources of Tritium

- **Pressurized Water Reactors**
 - Same as BWRs plus activation of boron in coolant
 - Typical tritium releases to environment
 - Liquid (~800 Ci/yr for 1000 MW(e) reactor)¹
 - Air (~ 35 Ci/yr for 1000 MW(e) reactor)¹
- **Heavy Water Reactors**
 - Neutron activation of deuterium
 - ACR-700 tritium releases (Liquid – 3100 Ci/yr;
Air – 3500 Ci/yr) – 1462 MW(e)
- **Gas-Cooled Reactors**
 - GT-MHR tritium release (Liquid - <35 Ci/yr;
Air – 74 Ci/yr) – 1140 MW(e)²

2 – Idaho National Engineering and Environmental Laboratory (INEEL). 2003. *Early Site Permit Environmental Report Sections and Supporting Documentation*. Engineering Design File Number 3747, Idaho Falls, Idaho. (GT-MHR section, Appendix A, p. A-5 and p. A-10)

Release Mechanisms

- Normal Releases
 - Liquid waste management system (discharge canal, WHTF, Lake Anna)
 - Gaseous waste management system (process vents)
- Abnormal Releases
 - Not evaluated in EIS
 - Basis for decision
 - Proposed Permit Condition 4
 - PPE approach – design details not available

Tritium Release Source Term

- PPE Approach
 - Most conservative release value
 - ABWR, ESBWR, AP1000, ACR-700
 - PPE values evaluated at CP or COL
- Liquid Effluent Source Term
 - Revised tritium source term
 - 3100 Ci/yr to 850 Ci/yr
 - Lake Anna tritium concentrations less than EPA drinking water standard
- Gaseous Effluent Source Term
 - Reactor (PPE value – 3500 Ci/yr)
 - Unit 3 wet cooling tower – 216 Ci/yr

Exposure Pathways

- Liquid Effluent Pathways
 - Drinking water
 - Aquatic food (fish, invertebrates)
- Gaseous Effluent Pathways
 - Inhalation
 - Vegetable consumption
 - Meat consumption

Tritium Concentrations in Environment

- **Existing Units**

- Radiological Environmental Monitoring Program (REMP)
- Monitors surface waters for tritium
 - Waste Heat Treatment Facility (2nd lagoon)
 - North Anna River (5.8 mi downstream)
 - Lake Anna (12.9 mi upstream)
- Monitors onsite well for tritium
- Results for 2000-2005 (less than EPA drinking water standard)
 - WHTF – 3049 pCi/L average
 - North Anna River – 2961 pCi/L average
 - Lake Anna upstream and Onsite well – background
- No monitoring at different depths

Tritium Concentrations in Environment

- **Proposed Units**
 - PPE liquid effluent release – 850 Ci/yr
 - Estimated Lake Anna tritium concentration – ~6400 pCi/L
 - Assumes two units
 - Based on past relationship of liquid releases and lake concentrations