Neutron and Gamma Dose Equivalents from Two ISFSIs

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ISFSIs

- Independent Spent Fuel Storage Installation(s)
  - Dry Cask Fuel Storage
  - Fuel Elements Contained in Steel Cannister
  - Steel Canister Contained in Concrete “Vertical Concrete Container”, or VCC
  - Gamma and Neutron Emissions from VCCs
Two ISFSIs

Connecticut Yankee

Maine Yankee
Goal

- Establish the Unrestricted Area Boundary
  - 40CFR190 Dose Limit
  - 25 mrem/year
  - 100% Occupancy
  - 2.85 urem/hr
Gamma Exposure Measurements

- High Pressure Ionization Chamber
  - Reuter Stokes RS-111
  - 8 Liter Chamber
  - 25 ATM Argon
- Omni-Directional
- Flat Energy Response
- Excellent Sensitivity
- Ten 30 sec Integrations at Each Location
- 21 Pre-Op Locations for BKG (10.89 uR/hr +/- 9%)
Neutron Measurements

- Tissue Equivalent Proportional Counter, TEPC
  - Far West Technologies (FWT) “Hawk” TEPC
  - Initially Conceived for Air-flight Dosimetry
  - Measures Gamma and Neutron Dose and Dose Equivalent
  - Based on Micro-dosimetry Principles
Hawk (TEPC) Operation

- 5 inch Hollow Sphere of A150 Plastic in SS Cylindrical Housing
  - 7 Torr (0.0135 psig) TE Proportional Gas
  - Simulates 2 um Tissue Sphere
  - Bragg-Gray Principle
  - Measures LET Distribution
  - High and Low Gain MCAs
- 15 Minute to 3 Hour Integrations (1 minute Measurements)
- NIST Traceable Calibration (Cf-252 & Cs-137)
- QFs from ICRP-21 vs ICRP-60
Maine Yankee Results
Gamma Rate (uR/hr)
Maine Yankee Results
Gamma Rate Detail, uR/hr
Maine Yankee Results
(“Short Axis”)

Distance (ft) from Center of VCC Array on Short Axis (West to East)
Maine Yankee Results ("Short Axis")

Graph showing the Dose Equivalent Rate (Dose Equiv. Rate) in terms of urem/hr against the Distance (ft) from the Center of VCC Array on the Short Axis (West to East). The graph includes a line representing the 25 mrem/yr Limit and another line representing the 100 mrem/yr Limit.
Maine Yankee Results ("Long Axis")

Distance (ft) from Center of VCC Array on Long Axis (South to North)

Dose Equiv. Rate (urem/hr)

-600 -400 -200 0 200 400 600

-10 0 10 20 30 40 50 60 70 80 90 100

Dose Equiv. Rate Limit
25 mrem/yr Limit
100 mrem/yr Limit
# Maine Yankee Summary

- 169 Gamma Locations
- 55 Neutron Locations

<table>
<thead>
<tr>
<th>Boundary</th>
<th>Axis</th>
<th>Distance to 25-mrem/yr from Center-of-ISFSI Array</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>Long</td>
<td>-379.8</td>
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<tr>
<td>North</td>
<td>Long</td>
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<td>West</td>
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<td>East</td>
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<td>321.5</td>
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Connecticut Yankee Results ("Long Axis")

Dose Equiv. Rate on VCC Array Long Axis (Downfield)

- Total (Neutron+Gamma)
- 25 mrem/yr Limit
- Neutron
- Neutron (Measured)
- Neutron (Estimated)

Distance (ft) from Center of VCC Array on Long Axis (West to East)
Connecticut Yankee Results ("Short Axis")

Dose Equiv. Rate on VCC Array Short Axis (Downfield)

- Total
- 25 mrem/yr Limit
- Neutron
- Neutron (Measured)
- Neutron (Estimated)

Distance (ft) from Center of VCC Array on Short Axis (South to North)
## Connecticut Yankee Summary

- 142 Gamma Locations
- 40 Neutron Locations

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<tr>
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<th>Distance to 25-mrem/yr from Center-of-ISFSI Array</th>
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<tbody>
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<tr>
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<td>East</td>
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TEPC Quality Factor Summary

- Wt. Average
- Dose Event Spectra

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<tr>
<th>Measurement</th>
<th>Quality Factor</th>
<th>Quality Factor Uncert.</th>
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<tr>
<td>Maine Yankee ISFSI</td>
<td>7.20</td>
<td>6.3%</td>
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<tr>
<td>CT Yankee ISFSI</td>
<td>7.61</td>
<td>1.3%</td>
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<tr>
<td>Bare Cf-252 (PNNL)</td>
<td>7.58</td>
<td>0.3%</td>
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