OBJECTIVES

High Purity Germanium detectors allows for measurements with high energy resolution. However, a more robust system of detecting gamma radiation using commercial off the shelf scintillator detectors such as LaBr₃, NaI or BGO might be needed for used fuel verification for a long-term reliable operation for e.g. verification in connection with a deep geological repository.

We aim to:

• Evaluate if different scintillator detectors can be used to determine parameters such as Burnup, Cooling Time and Decay Heat of used nuclear fuel assemblies.

• Evaluate in what range of fuel parameters different scintillator detectors can be used.

These studies have been performed by collecting gamma-ray energy spectra from used nuclear PWR fuel with four different detector types at the Swedish central interim storage of used nuclear fuel (CLAB).

RESULTS

We present here results from analyses focused primarily on determination of decay heat using the 137Cs peaks. The figures show the measured gamma-ray energy spectra. The table show values on the 137Cs peak for all measured spectra was quantified.

<table>
<thead>
<tr>
<th>Assembly Id</th>
<th>Type</th>
<th>BU [GWd/tU]</th>
<th>CT [years]</th>
<th>IE [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWR 5</td>
<td>17×17</td>
<td>47</td>
<td>5.2</td>
<td>3.94</td>
</tr>
<tr>
<td>PWR 19</td>
<td>15×15</td>
<td>35</td>
<td>28.3</td>
<td>3.20</td>
</tr>
<tr>
<td>PWR 24</td>
<td>17×17</td>
<td>23</td>
<td>18.1</td>
<td>2.10</td>
</tr>
</tbody>
</table>

As can be noted, the ratio between measured intensities approximately constant, indicating that the LaBr₃ could be used instead of HPGe for all the fuel assemblies measured in this study.

CONCLUSIONS

• LaBr₃ is a viable option for passive gamma assay of used fuel, with its energy resolution of about 3% being good enough to resolve the most dominant gamma peaks in the energy spectrum even at short cooling times (in the order of 5 years).

• For long cooling times even NaI or BGO detector can be used to evaluate the intensity of the dominant 112Cs peak at 662 keV. According to the data measured in this study, they are usable for cooling times beyond 18 years. Further studies are needed to determine at which cooling times (earlier than 18 years) that NaI and BGO detectors become a usable option.

Acknowledgements

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