We present significant results in recent advances in the determination of neutron energy. Neutron energy measurements are a small but very significant part of radiological emergency response applications. Mission critical information can be obtained by analyzing the neutron energy given off from radioactive materials. In the case of searching for special nuclear materials, neutron energy information from an unknown source can be of paramount importance.

At the Remote Sensing Laboratory (RSL) of National Security Technologies, LLC, a series of materials, viz., liquid organic scintillator (LOS), Lithium Gadolinium Borate (LGB) or Li$_6$Gd(BO$_3$)$_3$ in a plastic matrix, a recently developed crystal of Cs$_2$LiYCl$_6$: Ce (called “CLYC”), and normal plastic scintillator (BC-408) with He-3 tubes have been used to study their effectiveness as a portable neutron energy spectrometer. Comparisons, illustrating the strengths, of the various materials will be provided.

Of these materials, LGB offers the ability to tailor its response to the neutron spectrum by varying the isotopic composition of the key constituents (Lithium, Gadolinium [Yttrium], and Boron). All three of the constituent elements possess large neutron capture cross section isotopes for highly exothermic reactions. These compounds of composition Li$_6$Gd(Y)(BO$_3$)$_3$ can be activated by Cerium ions Ce$^{3+}$.

CLYC, on the other hand, has a remarkable gamma response in addition to superb neutron discrimination, comparable to that of Europium-doped Lithium Iodide ($^6$Li: Eu). Comparing these two materials, CLYC has higher light output (4500 phe/MeV) than that from $^6$Li: Eu and shows better energy resolution for both gamma and neutron pulse heights. Using CLYC, gamma energy pulses can be discriminated from the neutron signals by simple pulse height separation.

For the cases of both LGB and LOS, careful pulse shape discrimination is needed to separate the gamma energy signals from neutron pulses. Both analog and digital methods have been applied to obtain a clear gamma and neutron energy spectrum in a mixed radiation field. A waveform digitizer manufactured by Agilent Technology Inc. has been successfully used to digitize the signal and separate the gamma and neutron signals to obtain a high gamma rejection ratio. These results along with some interesting data from a plastic (BC-408) and He-3 dual gamma-neutron detector will be presented.
Acknowledgment

This work was done by National Security Technologies, LLC, under Contract No. DE-AC52-06NA25946 with the U. S. Department of Energy