Performance Results for the Stability of the ORTEC DSPEC® Digital Electronics in the Sentinel™ On-line, Unattended Measurement Application

Upp, Daniel L., EG&G Instruments, Inc.; Sillanpää, Risto, Teollisuuden Voima Oy

Introduction

The ORTEC Sentinel monitoring system is used for real-time data acquisition of either the primary coolant water or the off-gas system of nuclear power plants. The purpose of the instrument system is to measure noble gas activity levels in order to aid the facility in predicting and locating a fuel element failure during reactor operations.

The Sentinel consists of:

- High Purity Germanium (HPGe) Detector,
- Shielded cabinet assembly,
- Coolant or Gas sample holder,
- Automated check source assembly,
- DSPEC digital electronics,
- Personal Computer, and
- Acquisition and analysis software.

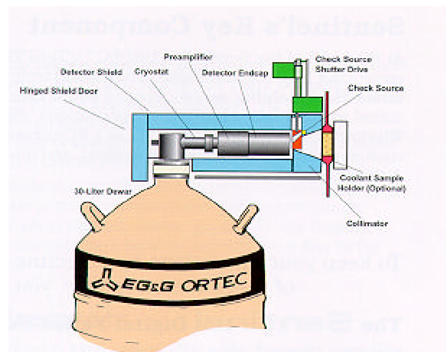

Figure 1. Sentinel Detector Geometry Overview.

The entire system operates in a continuous mode. Samples are measured at preset intervals (i.e. 1000 seconds detector live time) 24 hours a day, every day of reactor operation. It is of importance that the unit function properly during this operational period. To provide a check of the health of the system, a radioactive source is exposed to the detector once per day. The source, a ^{133}Ba point source, has a fixed geometry relative to the detector for reproducible counting conditions (see Figure 1).

The data collected for the check source measurement is analyzed by the system software (ORTEC GammaVision version 4.12). The results are then compared to the limits in the system. Data is stored off to a database for further analysis and trending.

Operational Experience

In December of 1996, ORTEC installed a Sentinel system into the nuclear power plant Unit #2 operated by Teollisuuden Voima Oy in Olkiluoto, Finland. The unit was placed into full time operation in June of 1997 upon completion of a planned outage. The Sentinel was installed in a remote location where excessive noise exists and which has minimal environmental controls. Temperatures in the area did not exceed standard laboratory-type conditions, but could change by 10 degrees Celsius in a matter of hours.

The check source measurements were recorded starting in early June, 1997. The data was logged over the next 9 months ending in late March, 1998 for this study. Results of the measured data are shown in Figures 2-4. The data was collected while the built-in digital gain and zero stabilizers of the DSPEC were disabled. This gave us a true performance measurement of the inherent stability of the digital electronics.

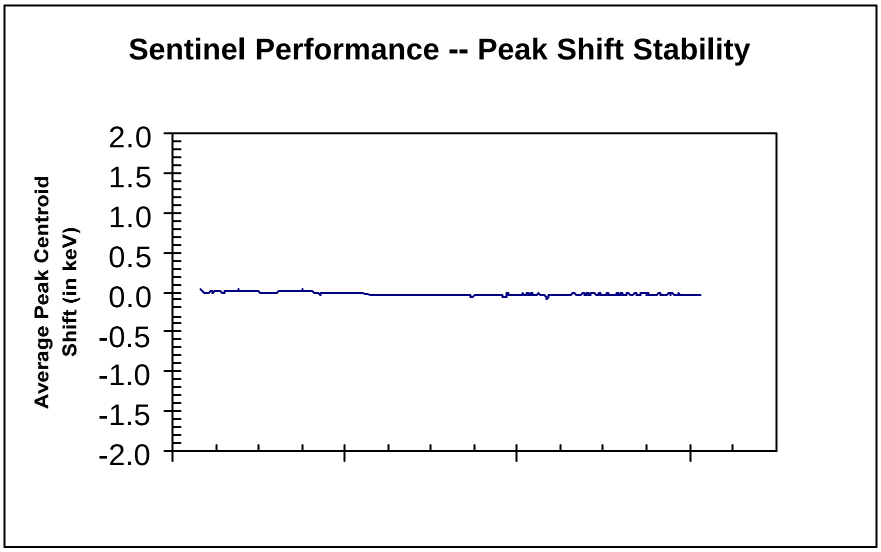

Figure 2. Peak Shift of Sentinel System measured between June 1997 and March 1998.

Warning and alarm limits for the parameters of the check source measurements are given in Table 1 below along with the measured minimum and maximum values during the inspection period.

Table 1. Results of Check Source measurements.

Parameter	Warning Level	Alarm Level	Min Observed	Max Observed
Peak Shift	±0.25 keV	±0.5 keV	-0.0796 keV	0.0301 keV
Resolution	0.75 -0.90 or 1.20 – 1.5	<0.80 or >1.50	0.981	1.03
Peak Shape	0.50 - 0.75 or 1.50 - 2.00	<0.5 or >2.0	0.973	1.02

In Figure 2, the data is measured by finding the peak centroid energy in the spectrum and comparing that to the energy calibration value. The differences among all peaks in the library are averaged to give the value stored in the database. Values close to 0 are desired for this parameter.

For the resolution parameter, the software calculates the full width half max (FWHM) for each peak in the library. These values are then ratioed to the values as determined by the energy calibration. An average of the ratios is then made. Values close to 1 are desired. Figure 3 plots the performance of this parameter.

In Figure 4, the stability performance of the peak shape parameter is tracked. The peak shape parameter is calculated in much the same way as the resolution parameter. The software first calculates the measured peak full width at tenth max (FWTM) value for every peak in the library. These values are then ratioed to the values determined by the energy calibration and an average is calculate. Like the resolution parameter, FWTM ratios close to 1 are desired.

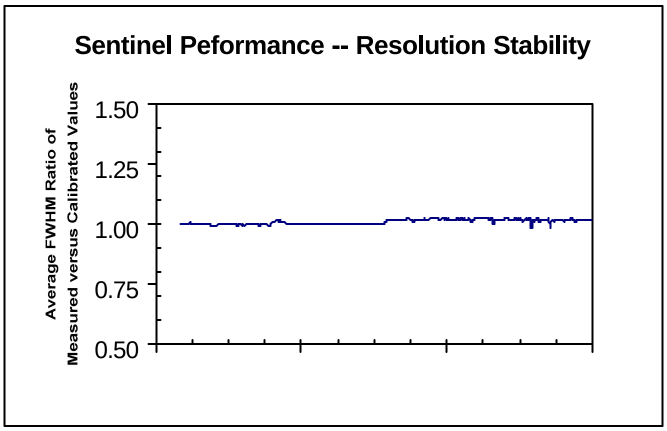

Figure 3. Resolution Performance of Sentinel System measured between June 1997 and March 1998.

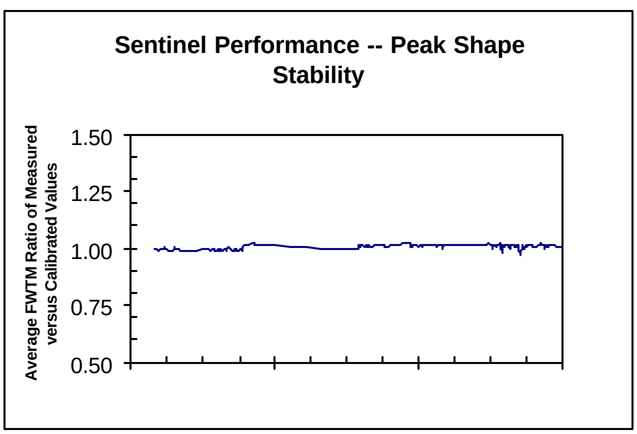

Figure 4. Peak Shape Performance of Sentinel System measured between June 1997 and March 1998.

Conclusions

From the data presented, it is clear to see that over long periods of continuous operation the Sentinel system using the DSPEC electronics is a stable instrument. Even with the gain and zero stabilizers disabled, the DSPEC electronics performed well in the conditions of the measurements. The data certainly supports using the DSPEC in measurement systems whereby continuous, unattended use of the equipment is desired.