The Current Status and Performance Test of the DSNC

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1. Introduction

The DSNC(DUPIC Safeguards Neutron Counter) was developed jointly to account for nuclear materials with KAERI and LANL at the end of the 1990's. The DSNC was authorized by IAEA at the IMEF M6 hotcell of KAERI and had operated normally until 2003. But the IAEA inspection of early 2004 was not performed by the abnormal state of the DSNC. The LANL specialist was invited to examine the abnormal state of the DSNC, but did not solve the problem. The test of the DC power supply through the IAEA cabinet was performed in early 2006 and the state of the DSNC got back almost normally. This paper is results of analysis about the current status and performance test of DSNC after applied 6V to amplifier.

2. Abnormal Status and Signal Analysis of the DSNC

Figure 1 is a well-type neutron coincidence counter that consists of eighteen of He-3 tubes [1, 2]. Each He-3 tube is directly attached to PDT-110A modules. The A, B and C signals group that each 6 amplifiers are grouped are connected to the OR box and the output signal of the OR box is connected to the JSR-12(neutron coincidence analyzer). If each A, B and C group signal is the same value, DSNC will be a normal operation. A verification test of 3's groups was carried out by using the spent fuel standards (SFS). The single rates were measured by the PSR-B as table 1. Table 1 shows that signal group A is about 85% and signal group C is about 35% compared to signal group B. Therefore, 5 PDT's are a normal state in group A and only 2 PDT's are a normal state in group C.

The DSNC can be confirmed as a normal state from the LED panel. The TTL outputs of each PDT are connected to each LED. Each LED's display is proportional to the neutron counts. But the current LED states of the DSNC do not have a confidence due to a unstable blink.

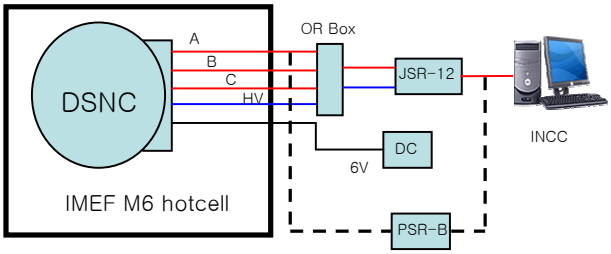

Figure 1. Connection of the DSNC

Table 1. Verification of DSNC Signals A, B, C

Signal cps	A1 SFS 21,600 MWD/MtU	A5 SFS 21,600 MWD/MtU	B9 SFS 21,600 MWD/MtU
A	112	762	944
B	131	873	1075
C	49	333	394

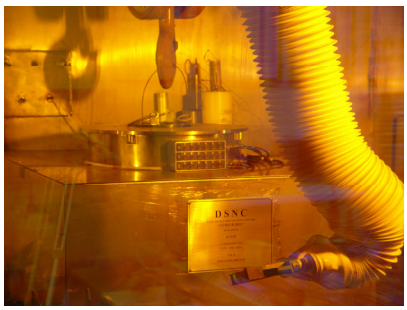

Figure 2. Performance test of the DSNC

3. DSNC Performance

The neutron counting efficiency of the DSNC was about 13.5% using the cf source K868 [3.4]. But the efficiency of the DSNC must be recalculated because of the abnormal PDT's. Also, the DSNC must be recalibrated using SFS.

3. 1. The detection efficiency

HV setting value was changed from 1820 V to 1840 V [5]. The mass of source K868 was 2.717×10^{-9} g on 2000-01-01. As the decay constant of K868 (1/yr) is 0.2623, the mass of source K868 is 4.158×10^{-10} g and the neutron emission rate is 973 n/s on 2007-02-27. A count time of 30s and a 10 cycles measurement was made on 2007-02-27 to give

Singles = 221 c/s
Background = 122 c/s

Therefore, the efficiency is

$$\varepsilon = (221-122) / 973 = 10.2\%$$

3.2. Calibration Using Cf-244

The singles count is given by the equation,

$$S = \varepsilon \; m\, y \; (1 + a)$$

ε = singles efficiency (0.102)
m = Cm-244 grams
y = neutron yield from Cm-244 spontaneous fission (1.08×10^7 n/s · g)
M = neutron multiplication (1.012)
a = alpha neutron/spontaneous fission neutrons (0.04)

Thus,

$$S = m\,(1.159 \times 10^6)$$

For B9 SFS,

$$m = 2487 / 1.159 \times 10^6 = 2.041 \text{ mg}$$

The Cm-244 mass from the ORIGEN2 calculation is 2.13 mg, so the difference is 4.3%. The result of the Cm-244 mass for B9 SFS is very good compared to the IAEA authentication test of the DSNC.

3.3. Calibration of Pu and U

Cm ratio is Cm/Pu and Cm/U. Pu and U masses are calculated using the ORIGEN2 code. The DSNC measured values for Cm-244 and the ORIGEN2 calculated values for Pu and U (B9 SFS) are

$$Cm / Pu = 2.041 \times 10^{-3} / 0.63 = 3.24 \times 10^{-3}$$
$$Cm / U_{235} = 2.041 \times 10^{-3} / 0.31 = 6.58 \times 10^{-3}$$
$$Cm / U = 2.041 \times 10^{-3} / 58.71 = 3.48 \times 10^{-3}$$

The Cm-244 calibration of the DSNC uses several SFSs of a similar burn-up. The calibration slope will be obtained in future test.

4. Conclusion

The current status and performance test of the DSNC was analyzed after applied 6V to an amplifier. The result of the analysis from singles measurement is that 5's PDTs are a normal state in group A and 2's PDTs are a normal state in group C. Only, the PDTs of group C are a normal state. The efficiency of the DSNC dropped from 13.5% to 10.2% due to the PDT's abnormal state. But the result of the Cm-244 mass for B9 SFS is very good compared to the IAEA authentication test of DSNC.

Next tests well are performed to obtain a calibration slope and analyze a symmetry influence of the DSNC.

Acknowledgement

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