

A Plausible Method to Reduce the Noise from Nuclear Instruments of Research Reactors

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1. Introduction

Noise has the feature of a random fluctuation induced in electronic and electric circuits. The noise from the instruments used in research reactors also vastly varies as it is produced by several different sources. Especially, old reactors have many noise problems in some sensitive instrument such as neutron measuring system. Since noise is a combination of unwanted or disturbing signal by various sources, the caution of noise is surmised from the operation experience and analysis. Considering that the analysis on noise source is very difficult, instead the practical measure to mitigate the noise effect is thought more effective. The BF3(boron tri-fluoride) proportional counter with NIM(nuclear instrumentation modules) and NMS(neutron measuring system) has very sensitive nature on electromagnetic noise coupling or ground loop noise. Herein several remedies in site to actually reduce the noise effect are introduced with the outcome.

2. Noise Problem in Neutron Measuring Instruments

The NMS and BF3 systems are necessary to the reactor power operation of the research reactors. In particular, during the commissioning, those systems play a large role in the power calibration and also highly precise measurement is required due to low neutron flux. However, the condition of ground and quality of electrical power are not decent for reactors in developing countries. This kind of noise relatively tends to be often found not long after installation of the systems. The practical effect of noise problem in BF3 system and NMS are discussed in order.

2.1 Noise Found after BF3 System Installation

The noise pattern of the BF3 systems is estimated from the ground loop noise that is mostly affected by site electrical power. As shown in Fig. 1, fluctuation around the signal as well as background noise is distributed since there is no line filter and mesh ground is neither good. The BF3 system around crane is likely influenced by the motors of it. This kind of noise could be mostly cancelled off by adapting the noise cut transformer and ground cables replaced.



Fig. 1. Noise pattern of BF3 system

2.2 Noise Found after NMS Initial Operation

There are installed three channels of NMS for reactor protection system and reactor regulating system, respectively. The first observation of noise made as type of spike in the log power signal, when the reactor power increased up to 1e-05%FP(Full power), was shown in Fig 2. Some periodic surges in one UPS(Uninterruptible Power Supply) channel's current are found, which is likely estimated stemming from CID(Confinement Isolation Damper).

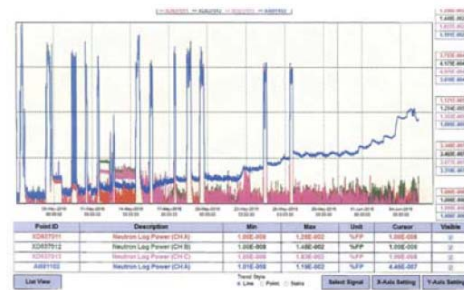


Fig. 2. Log power signal with spikes in the NMS

The second symptom of noise showed steady rise and simple maintenance such as connecting or disconnecting signal cables did not work. In order to identify the cause, the detector was exchanged with normal one and the interconnected cables then were exchanged. During this test, we obtained the conclusion that noise comes from the cable tray and shield of cables should be reinforced. Fig 3. displays the field works for compensating poor ground and cable shield scheme. From upper left to the right bottom, flexible cable conduits with aluminum foil, gland sealing, isolation of the NMS cabinet from support frame are represented.



Fig. 3. Reinforcement of ground/cable in the NMS

3. Actual measures for noise reduction

The first step of check points for noise in the field is started from confirmation on what the situation of the ground is.

- Is the ground line lied in good condition?
- Is a proper ground bolt used to connection?
- How about the connected condition?

The width of the ground bolt that is connected with the plant ground is as wide as possible to pass the leak current at maximum. The plant ground surface and the ground bolt should be perfectly touched not to allow the interference. If not, the strap with tightness is recommended.

The remedy to reduce noise from the BF3 system was to check the signal cables between the detector and the signal processor that should be enclosed with meticulous care by shielded conduits to prevent radio frequency interference. The housing of portable NIM of BF3 system was to apply the fastidious ground scheme since signal noise takes place around the high voltage cable connectors.

For the NMS, every ground point inside and out was reconfirmed while HV and SIG cable were in turn taken off to see what the source is. One thing we assumed was the deviation between the ground voltage and the module ground in the preamplifier inside NMS cabinet seemed to arise the different voltage to induce interference and this was relaxed by floating the preamp's ground. The second thing is to block every possible path that interference trespasses such as gland opening for not used one, not shielded part of the signal cables. The insulator to enhance the isolation between the cabinet housing and the support was also reinforced.

4. Conclusions

It is heavily hard to handle system noise sparsely found in a field since it is a combination of various sources. Herein the noise happened in NMS and BF3 system and the practical measures are briefly introduced. Considering the condition of a site and field, noise related data should be more accumulated for the expert system to resolve noise problem in more systematic approach. Together with the effort, basically, the ground and signal isolation are strictly constructed according to the manual.

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