framatome

Wide Range Solutions

Excore Neutron Flux Measurement

Framatome's excore wide range neutron flux measurement system provides high-speed data acquisition and accurate monitoring by using three different simultaneous measurement modes, covering up to 10 decades of neutron flux levels.

Challenge

Neutron flux in a reactor spans several orders of magnitude, from very low (in shutdown or low-power conditions) to very high (during full-power operations or transients). Neutron flux measurement systems must be able to measure across this broad range with consistent accuracy.

Each customer's unique operational requirements add another layer of complexity, necessitating tailored solutions that address specific needs and objectives. Additionally, it may be necessary to integrate seamlessly with current monitoring systems and existing installed detectors to maintain continuity.

For post-accident monitoring, neutron flux measurement systems must not only assess data precisely but also be capable of rapidly detecting and reporting neutron flux changes.

Framatome wide range module

Solution

The excore wide range neutron flux measurement system provides adaptable and customizable solutions designed to fully meet the unique needs of each customer. With a focus on flexibility, our systems address specific operational requirements, ensuring optimal performance and efficiency for every application. For example, the high voltage and discrimination functions can be adapted for use with either fission chambers or proportional counter tubes.

Our solution provides high-speed data acquisition and exact measurements, ensuring rapid detection and accurate monitoring. The excore wide range neutron flux measurement system covers neutron flux from 1 nv to $2x10^{10}$ nv* when associated with a single detector compatible with this range (Framatome also supplies such detectors). Thanks to its three distinct measurement modes—pulse, Campbelling, and current—the system offers exceptional adaptability to varying flux levels.

When integrated with the appropriate configuration, it can easily cover the full measurement range, two overlapping ranges or a customized subset like source, intermediate or power ranges. This flexibility is achieved using a single detector, tailored to the user-defined measurement range.

*nv=neutrons/(cm^2·s)

Customer benefits

- Easy and efficient maintenance
- Accurate neutron flux display for better plant operation
- High level of safety and reliability to support plant availability
- High-level technical guidance and support for detectors, electronics, commissioning
- Enhanced long-term support

Technical information

The Framatome wide range excore neutron flux measurement system module is based on a Field-Programmable Gate Array (FPGA). The processing functions are as follows:

- Pulse mode: Pulse amplification, discrimination, shaping and count rate calculation
- Campbelling mode: Fluctuation amplification, filtering, and variance calculation
- Current mode: Current acquisition, and neutron noise filtering
- High voltage (up to 1000V) detector power supply
- Self-tests
- Integrated test mode

PULSE MODE

Pulses are acquired by the module, amplified, and discriminated based on their amplitude, allowing for rejection of pulses below a set threshold (typically noise and gamma flux pulses).

- Neutron flux coverage: ~1 nv to $2x10^6$ nv (corresponding to ~0.5 to 10^6 cps*)
- Log count rate output in 0-10Vdc

CAMPBELLING MODE

The principle of this output is to process the signal from fission chamber detectors in fluctuation mode. The calculated Mean Square Value (MSV) is linearly proportional to the neutron flux.

- Neutron Flux coverage: ~$1.4x10^5$ nv to 10^{10} nv
- Log MSV output in 0-$10V_{dc}$

CURRENT MODE

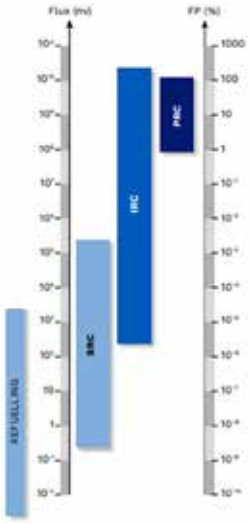
Current measurement for fission or uncompensated ionization chamber detectors.

- Three adaptable measurement ranges (max. currents): 3µA, 1mA and 3mA
- Linear current output in 0-$10V_{dc}$

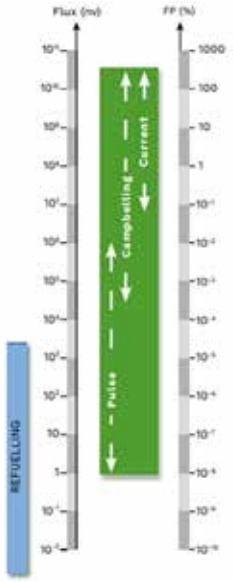
QUALIFICATION AND LICENSING

- Qualified according to IEC 60980 / IEEE 344-2004
- Including seismic tests (bi-axial tests with frequency research, tested in weighted cabinet)
- Operating conditions: Temperature: 50°F to 140°F, Pressure: 0 psig, Humidity: 93%
- Developed for Cat A / C1 applications IEEE / IEC 61226 - 1E (IEEE 603)
- NRC RG 1.97 compliant for post-accident application

*cps=counts/s



Typical flux measured with a source, intermediate and power range system.



Example of flux measurement and associated modes using the wide range system with a fission chamber (post accident compatible configuration).

Key Figures

3 distinct measurement modes in one single module

10 Decades Neutron flux measurement range from 1 nv* to $2x10^{10}$ nv

FPGA based solution

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is **our** everyday **commitment**

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