MIRION TECHNOLOGIES

Neutron Detectors – NP Series

NP Series

NP100H, NP100B

Features

- Designed to respond to thermal, epithermal and fast neutrons
- Measurement of tissue equivalent dose rate of the neutron field
- SMART probe retains probe information in non-volatile memory
- $^{3}He/BF_3$ proportional counter
- ^{10}B attenuator
- Polyethylene moderator
- Excellent linearity and accuracy
- Detectors are easily interchanged

Quality

The NP Series detectors are designed and manufactured under a quality system in compliance with the following standards and requirements:

- ISO 9001
- 10CFR21
- 10CFR50, Appendix “B”
- IEEE-730
- ANSI/ASME NQA-1, ANSI/ASME NQA-2, Part 2.7

Description

The NP Series provides customers with the capability of detecting slow and fast neutrons and measurement of tissue equivalent dose rate of the neutron field. The detectors contain a proportional counter which produces pulses resulting from neutron interactions within it. The probes contain components which moderate and attenuate neutrons so that the net incident flux at the proportional counter is a thermal and low epithermal flux representative of the tissue equivalent dose rate and the neutron field.

The neutron probe also contains a Circuit Card Assembly (CCA), Amplifier and Logic, and a CCA High Voltage supply.

The NP Series detectors are SMART probes, which retain probe information in non-volatile memory. When calibrated, data such as probe calibration constants and identifying information are stored and verified in the EEPROM memory in the probe circuitry. This arrangement allows the CANBERRA NP Series detectors to be interchangeable.

The NP Series detectors are “maintenance free” in design and require no routine servicing or preventive maintenance.

The NP Series can be connected to multifunction control and display units such as iR7040, ADM606, ADM606M and ADM616.

Principle of Operation

Because neutrons have no charge, they can only be detected indirectly through nuclear reactions that create charged particles. The NP100B detector uses BF_3, whereas the NP100H uses ^{3}He as the conversion target. The charged particle – alpha or proton (respectively) created in the nuclear reaction ionizes the gas.

The detector is housed in a polyethylene moderator with high hydrogen content. The hydrogen presents a large scattering section to the neutrons. Through elastic collisions with the hydrogen atoms the fast and epithermal neutrons give up a large part of their energy and are reduced to thermal neutrons.

A cylindrical attenuator containing ^{10}B isotope surrounds an inner moderator which contains the proportional counter.

The thermal neutron flux densities resulting from the moderation by the detector housing are attenuated as a result of the high absorption of the ^{10}B. Neutrons which are not thermalized and which are not attenuated will be thermalized by the inner polyethylene moderator.

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The combined effect of the 2.25 in. thickness of ^{10}B attenuator and 0.75 in. thickness of the inner polyethylene moderator gives a probe pulse rate output proportional to the tissue equivalent dose rate of the neutron field. See Figure 1 for a curve of actual vs. theoretical response.

The **NP100H** uses a ^{3}He proportional counter consisting of a cylindrical metal shell with a center anode wire maintained at a high positive potential with respect to the shell. ^{3}He gas is contained within the shell and the neutrons are detected by their nuclear interaction with the helium. The thermal neutron-helium reaction produces a charged particle (proton) which ionizes the gas.

Respectively, the **NP100B** uses a BF_3 proportional counter consisting of a cylindrical metal shell with a center anode wire maintained at a high positive potential with respect to the shell. Boron-trifluoride gas is contained within the shell and the neutrons are detected by their nuclear interaction with the BF_3. The thermal neutron-boron reaction produces a charged particle (alpha) which ionizes the gas.

The ionization event causes a burst of electrons to arrive at the center anode wire. From this point, the charge produced by the burst of electrons is coupled by an interconnecting cable to the input of the charge sensitive amplifier.

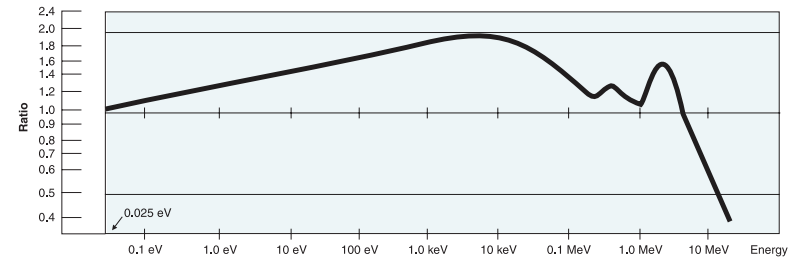

Figure 1. Energy Response Curve.

The NP Series detectors are used with the CANBERRA Model iR7040, ADM606, ADM606M and ADM616 series of digital ratemeters. These instruments provide low operating voltages to the detectors while displaying the count rate from them. High voltage necessary for the proportional tube operation is produced via a circuitry inside the detectors allowing use of low voltage cabling.

Specifications

Detectors/Characteristics	**NP100H**	**NP100B**
Detector Type	^{3}He Proportional Counter	BF_3 Proportional Counter
Operating Range	0.1 µSv/hr (10 µR/hr) to 200 mSv/hr (20 R/hr)	0.1 µSv/hr (10 µR/hr) to 200 mSv/hr (20 R/hr)
Energy Range	0.025 eV – 15 MeV	0.025 eV – 15 MeV
Operating Temperature Range	–10 °C to +50 °C (+14 °F to +122 °F)	–10 °C to +50 °C (+14 °F to +122 °F)
Size, mm (inch) (dia. x L)	244 x 292 mm (9.6 x 11.5 in.)	244 x 292 mm (9.6 x 11.5 in.)
Weight kg (lb)	10 kg (22 lb)	10 kg (22 lb)
Housing	Moisture Proof Aluminum	Moisture Proof Aluminum
Operating Humidity	0–100% non-condensing	0–100% non-condensing
Detector Linearity	±5%	±5%
Accuracy	±10%	±10%
High Voltage Supply	1750–1950 V **(internally generated)**	1750–1950 V **(internally generated)**
Typical Application	Area Monitor, Boundary Monitor, Accelerator Instrumentation	Area Monitor, Boundary Monitor, Accelerator Instrumentation

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