NP100H
Neutron Detector

User's Manual

9236115B

ISO 9001
SYSTEM
CERTIFIED

CE

Canberra Industries, 800 Research Parkway, Meriden, CT 06450
Tel: 203-238-2351 FAX: 203-235-1347 http://www.canberra.com/

Printed in the United States of America.

Table of Contents

Notes

1. Introduction

The Canberra Model NP100H Neutron Probe is based on the design by I. O. Anderson and J. Braun and provides dose response corresponding to the human body. It measures directly the biological dose rate of neutrons in energy from thermal 0.025 eV to 15 MeV.

The NP100H Neutron Probe incorporates a ^{3}He proportional counter for high neutron sensitivity as compared to a BF_3 proportional counter. In addition, the NP100H Neutron Probe is a "smart" probe, which retain probe information in non-volatile memory. When calibrated, data such as probe calibration constants and identifying information are stored and verified in EEPROM memory in the probe circuitry. This arrangement allows the Canberra detectors to be interchangeable, and require no operator adjustments at time of use.

The NP100H is used with the Canberra model ADM600 series of Digital Ratemeters. These instruments provide low voltage operating voltages and signals to the NP100H Neutron Probe, and interprets and displays count rate data from the detector. High voltages necessary for tube operation are produced via circuitry inside the NP100H allowing use of low voltage cabling.

2. Installation

2.1 Unpacking

Visually inspect the detector for damage during shipment due to irregular handling. Report any missing or damaged items to the carrier and to Canberra as soon as possible.

2.2 Mounting

The NP100H detector is equipped with a mounting bracket for wall mounting the detector in any desired location.

2.2 Connections

2.2.1 ADM606 Series Ratemeters

Prior to applying power to the NP100H Neutron Probe, ensure that the probe is attached to the ADM606 or ADM606M Portable Multi-function Digital Meter using the appropriate cable. Connections of the NP100H Neutron Probe to the ADM606 Series should only be made while the ADM606 is de-energized.

When attaching any external cable to either receptacle, confirm that the plug's mechanical key is aligned with the receptacle's mechanical key. Push the connector into the receptacle, rotate the threaded, knurled collar clockwise until the collar is tight.

Insert the key into the key switch on the front of the ADM606 Meter and turn the switch to the KEYPAD or ON position. The meter will begin the program boot process which includes a self diagnostic check. The green "NORMAL" indicator should energize and the digital display should indicate "Please Wait" then begin to indicate an ambient radiation dose rate.

2.2.2 ADM616 Series Ratemeters

Prior to applying power to the NP100H Neutron Probe, ensure that the probe is attached to the ADM616 or ADM616A Multi-function Digital Meter using the appropriate cable assembly. Connections of the NP100H Neutron Probe to the ADM616 should only be made while the ADM616 is de-energized.

When attaching any external cable to either receptacle, confirm that the plug's mechanical key is aligned with the receptacle's mechanical key. Push the connector into the receptacle, rotate the threaded, knurled collar clockwise until the collar is tight.

Insert the key into the key switch on the front of the ADM616 Meter and turn the switch to the KEYPAD or ON position. The meter will begin the program boot process which includes a self diagnostic check. The green "NORMAL" indicator should energize and the digital display should indicate "Please Wait" then begin to indicate an ambient radiation dose rate.

Connections

The NP100B is connected to the ADM600 series via the detector cable at the barrel connector on the end of the detector housing. The other end of the cable is connected to the detector jack J1 on the ADM606 series Ratemeter or PROBE 1 (NEUTRON) on the ADM616 series Ratemeter.

The NP100H end cap connector is MS3116F14-12S. Pin description as follows:

Pin A - +5 V dc	Pin G - Event
Pin B - Ground	Pin H - N/A
Pin C - EE Clock	Pin J - N/A
Pin D - N/A	Pin K - N/A
Pin E - HI Enable	Pin L - –15 V dc
Pin F - EE Enable	Pin M - +15 V dc

2.3 Operation

Because the NP100H Neutron Probe contains all operation and calibration values stored in its internal EEPROM, the detector is simple to put into service. The ratemeter must be de-energized when making or breaking cable connections to prevent possible damage to the detector and/or meter.

3. Theory of Operation

The NP100H Neutron Probe contains a ^{3}He proportional counter which produces pulses resulting from neutron interactions occurring within it. The ^{3}He proportional counter is essentially a thermal neutron detector, but the NP100H is designed to respond to thermal, epithermal and fast neutrons. The probe contains components which moderate and attenuate neutrons so that the net incident flux at the ^{3}He proportional counter is a thermal and low epithermal flux representative of the tissue equivalent dose rate due the neutron field.

The detector housing is polyethylene, which has a high hydrogen content. The hydrogen presents a large scattering cross 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 of all the neutrons in the field are attenuated as a result of the high scattering cross-section of the ^{10}B. The ^{10}B isotope has a neutron cross-section which is proportional to the square root of the neutron energy. Some of the neutrons arriving at the attenuator are scattered and prevented from reaching the ^{3}He proportional counter. Neutrons which are not thermalized and which are not attenuated will be thermalized by the inner polyethylene moderator. The combined effect of the 2.25 inch thickness of boron attenuator, and 0.75 inch thickness of an inner polyethylene moderator gives a probe pulse rate output proportional to the tissue equivalent dose rate of the neutron field. The output from the probe is connected to an amplifier circuit through an interconnecting cable.

The ^{3}He proportional counter consists 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 interactions with the boron. The Thermal neutron-boron reaction produces a charged (alpha) particle 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.

The ^{3}He proportional counter is a completely sealed device with a coaxial connector at one end.

4. Maintenance

The NP100H Neutron Probe is "maintenance free" in design and requires no routine servicing or preventive maintenance.

Any major disassembly requires that external power be first removed from the NP100H by using the following procedure:

1. Turn the associated digital ratemeter off by placing the ratemeter key switch in the OFF position.

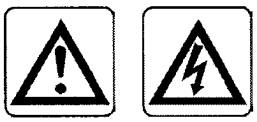
2. Disconnect the NP100H from the associated digital ratemeter.

3. Remove the hardware securing the NP100H and separate the unit from the wall.

4.1 Neutron Probe Electronics and CCA Replacement

The simple construction of the NP100H allows for quick, straightforward removal of the Neutron Probe Electronics Assembly and the circuit card assemblies (CCA's).

The Circuit Card Assemblies (CCA's) are mounted on the inside of the enclosure, making it easily accessible for maintenance.



WARNING

Any disassembly requires that external connections be first remove. See section above.

Note: The NP100H Neutron Probe needs to be recalibrated if the amplifier/logic CCA or the modified neutron HV Supply CCA is replaced.

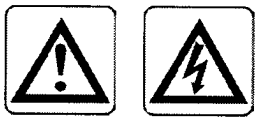
1. Remove the four 10-24 screws and washers holding the cover plate of the neutron probe electronics assembly.

2. Remove the SHV connector from the Neutron Proportional Tube to separate the Neutron Probe Electronics from the Probe.

3. On the Neutron Probe Electronics Assembly, remove the six 4-40 screws and the washers holding the PCB cover over the board and to the case.

4. To reinstall either board, place it on the four standoffs making sure that the CCA is properly seated as shown in the assembly enclosure drawing. Secure the cover to the board by tightening the screws.

4.2 Photomultiplier Tube Replacement



WARNING

Any disassembly requires that external connections be first remove.

Note: The NP100H Neutron Probe needs to be recalibrated if the neutron proportional is replaced

To replace the photomultiplier tube, perform the following steps:

1. Remove the four 10-24 screws and washers holding the cover plate of the neutron probe electronics assembly.

2. Remove the SHV connector from the Neutron Proportional Tube to separate the Neutron Probe Electronics form the Probe.

3. Remove the Polyethylene Low Density Moderator Plug and the Front Boron Attenuator form the Probe Assembly and remove the Neutron Proportional Tube.

4. To reinstall, reverse the order of the above steps.

4.3 Calibration

When recalibration is required, the NP100H Neutron Probe is calibrated in a known, uniform field using the Canberra model ADM600 series ratemeter. These instruments contain the necessary software for calibration and storage of calibration data in the NP100H Neutron Probe EEPROM.

It is recommended that the neutron detector be calibrated at 1 mSv/h (100 mRem/h). This field is chosen because it would provide good statistical data in the default calibration time of approximately two minutes.

A. Specifications

DETECTOR TYPE – ^{3}He Proportional Counter

DETECTOR SENSITIVITIES – 0 - 10 mSv/h (0 - 1 Rem/h)

ENERGY RANGE – 0.025 eV to 15 MeV.

LINEARITY – ± 5%

ACCURACY – ± 10%

OPERATING TEMPERATURE RANGE – -10° C to +50° C (14° F to 122° F).

OPERATING HUMIDITY – 0 - 100%, non-condensing.

HV SUPPLY, INTERNALLY GENERATED – 1500 - 1900 V.

HOUSING – Moisture Proof Aluminum

WEIGHT – 10 kg (22 lb)

SIZE – 244 x 292 mm (9.6 x 11.5 in.)

TYPICAL APPLICATION – Area Monitor, Boundary Monitor, Accelerator Instrumentation

B. Installation Considerations

This unit complies with all applicable European Union requirements.

Preventive Maintenance

Preventive maintenance is not required for this unit.

When needed, the enclosure of the unit may be cleaned. Remove power from the unit before, cleaning. Use only a soft cloth dampened with warm water and make sure unit is fully dry before restoring power.

Any repairs or maintenance should be performed by a qualified Canberra service representative. Failure to use exact replacement components, or failure to reassemble the unit as delivered, may affect the unit's compliance with the specified EU requirements.

CANBERRA

Warranty

Canberra (we, us, our) warrants to the customer (you, your) that for a period of ninety (90) days from the date of shipment, software provided by us in connection with equipment manufactured by us shall operate in accordance with applicable specifications when used with equipment manufactured by us and that the media on which the software is provided shall be free from defects. We also warrant that (A) equipment manufactured by us shall be free from defects in materials and workmanship for a period of one (1) year from the date of shipment of such equipment, and (B) services performed by us in connection with such equipment, such as site supervision and installation services relating to the equipment, shall be free from defects for a period of one (1) year from the date of performance of such services.

If defects in materials or workmanship are discovered within the applicable warranty period as set forth above, we shall, at our option and cost, (A) in the case of defective software or equipment, either repair or replace the software or equipment, or (B) in the case of defective services, reperform such services.

LIMITATIONS

EXCEPT AS SET FORTH HEREIN, NO OTHER WARRANTIES OR REMEDIES, WHETHER STATUTORY, WRITTEN, ORAL, EXPRESSED, IMPLIED (INCLUDING WITHOUT LIMITATION, THE WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE) OR OTHERWISE, SHALL APPLY. IN NO EVENT SHALL CANBERRA HAVE ANY LIABILITY FOR ANY SPECIAL, EXEMPLARY, PUNITIVE, INDIRECT OR CONSEQUENTIAL LOSSES OR DAMAGES OF ANY NATURE WHATSOEVER, WHETHER AS A RESULT OF BREACH OF CONTRACT, TORT LIABILITY (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE. REPAIR OR REPLACEMENT OF THE SOFTWARE OR EQUIPMENT DURING THE APPLICABLE WARRANTY PERIOD AT CANBERRA'S COST, OR, IN THE CASE OF DEFECTIVE SERVICES, REPERFORMANCE AT CANBERRA'S COST, IS YOUR SOLE AND EXCLUSIVE REMEDY UNDER THIS WARRANTY.

EXCLUSIONS

Our warranty does not cover damage to equipment which has been altered or modified without our written permission or damage which has been caused by abuse, misuse, accident, neglect or unusual physical or electrical stress, as determined by our Service Personnel.

We are under no obligation to provide warranty service if adjustment or repair is required because of damage caused by other than ordinary use or if the equipment is serviced or repaired, or if an attempt is made to service or repair the equipment, by other than our Service Personnel without our prior approval.

Our warranty does not cover detector damage due to neutrons or heavy charged particles. Failure of beryllium, carbon composite, or polymer windows, or of windowless detectors caused by physical or chemical damage from the environment is not covered by warranty.

We are not responsible for damage sustained in transit. You should examine shipments upon receipt for evidence of damage caused in transit. If damage is found, notify us and the carrier immediately. Keep all packages, materials and documents, including the freight bill, invoice and packing list.

Software License

When purchasing our software, you have purchased a license to use the software, not the software itself. Because title to the software remains with us, you may not sell, distribute or otherwise transfer the software. This license allows you to use the software on only one computer at a time. You must get our written permission for any exception to this limited license.

BACKUP COPIES

Our software is protected by United States Copyright Law and by International Copyright Treaties. You have our express permission to make one archival copy of the software for backup protection. You may not copy our software or any part of it for any other purpose.