

**LUDLUM MODEL 42-30H
NEUTRON DETECTOR**

December 2009

Serial Number PR247902 and Succeeding

Serial Numbers

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LUDLUM MEASUREMENTS, INC.
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STATEMENT OF WARRANTY

Ludlum Measurements, Inc. warrants the products covered in this manual to be free of defects due to workmanship, material, and design for a period of twelve months from the date of delivery. The calibration of a product is warranted to be within its specified accuracy limits at the time of shipment. In the event of instrument failure, notify Ludlum Measurements to determine if repair, recalibration, or replacement is required.

This warranty excludes the replacement of photomultiplier tubes, G-M and proportional tubes, and scintillation crystals which are broken due to excessive physical abuse or used for purposes other than intended.

There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face there of. If the product does not perform as warranted herein, purchaser's sole remedy shall be repair or replacement, at the option of Ludlum Measurements. In no event will Ludlum Measurements be liable for damages, lost revenue, lost wages, or any other incidental or consequential damages, arising from the purchase, use, or inability to use product.

RETURN OF GOODS TO MANUFACTURER

If equipment needs to be returned to Ludlum Measurements, Inc. for repair or calibration, please send to the address below. All shipments should include documentation containing return shipping address, customer name, telephone number, description of service requested, and all other necessary information. Your cooperation will expedite the return of your equipment.

**LUDLUM MEASUREMENTS, INC.
ATTN: REPAIR DEPARTMENT
501 OAK STREET
SWEETWATER, TX 79556**

**800-622-0828 325-235-5494
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Model 42-30H Neutron Detector

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Model 42-30H Neutron Detector

1. GENERAL

The Ludlum Model 42-30H Neutron Detector is designed for detection of thermal and fast neutrons (0.025 eV to approximately 12 MeV). The neutrons are not directly detected, but through nuclear reactions, which result in energetically charged particles such as protons and tritons. In many instances intense fields of gamma rays are also found with neutrons. Therefore, it is important to choose a method of neutron detection with the ability to discriminate against these gamma rays in the detection process.

A common reaction for the conversion of slow neutrons into directly detectable particles is $n + {}^3\text{He} \rightarrow {}^3\text{H} + {}^1\text{H} + 0.764 \text{ MeV}$.

The Ludlum Model 42-30H utilizes this reaction in the form of helium-3 (${}^3\text{He}$) which fills the gas proportional tube of the detector.

The Model 42-30H is typically used with area monitors. To detect neutrons with energies above the thermal region, the detector is placed inside the moderator. The detector can be removed from the moderator for the detection of thermal neutrons.

2. SPECIFICATIONS

DETECTOR: 2 atm ${}^3\text{He}$ tube LND 25185 or equivalent

MODERATOR: 25.4 cm (10in.) diameter polyethylene sphere

COMPATIBLE INSTRUMENTS:
Typically used with area monitors such as Models 375, 177-50, and 177-61

SENSITIVITY: 200 cpm/mrem/hr (${}^{241}\text{AmBe}$ fast neutrons)

GAMMA REJECTION: 10 cpm or less through 10 R/hr (100mSv/hr) (${}^{137}\text{Cs}$)

DETECTION RANGE: Thermal to approximately 12 MeV

ENERGY RESPONSE: Thermal to 7 MeV follows the radiation protection guide curve for neutron dose

INPUT SENSITIVITY: -2 mV

OPERATING VOLTAGE:
1100 Vdc

CONNECTOR: Series "C" (others available)

SIZE: 38.1 x 25.4 x 26.2 cm (15 x 10 x 10.3 in.) (H x W x D), including bracket

TEMPERATURE RANGE: -20 to 50 °C (-4 to 122 °F)

WEIGHT: 8.8 kg (19.5 lb)

FINISH: Drawn-and-cast aluminum fabrication, with beige powder-coating.

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3. CALIBRATION

The following calibration procedures assume the following:

- Counting instrument: Ludlum Model 2200 Scaler/Ratemeter
- ²⁴¹AmBe neutron source (Note that the Model 42-30H is energy-dependent.)
- ¹³⁷Cs gamma source for gamma rejection check

3.1 Operating Voltage Plateau

- Connect the Model 42-30H to a Model 2200.
- Set the Model 2200 input sensitivity to -2 mV.
- Expose the detector to a 20 mrem/hr ²⁴¹AmBe neutron source.
- “Run a plateau” as follows: Taking one-minute counts, record the count rate for 25-volt incremental steps from approximately 1000 volts through a region in which the count rate steadily increases, becomes relatively constant (“flattens out”), and then increases again. (A typical range will be 1000-1250 volts.) The flattest portion of this region is the desired plateau. The value in the middle of this region is the assumed operating voltage of the detector, subject to the sensitivity and the gamma rejection checks.
- Calculate the sensitivity (cpm/mrem/hr) for the assumed operating voltage as follows:

$$\text{Sensitivity} = \frac{\text{Count Rate}}{\text{Dose - Equivalent Rate}}$$

For example, an assumed operating voltage is 1100 volts, based upon the flattest part of the plateau. The count rate at that voltage is 4900 counts per minute (cpm), and the neutron field dose-equivalent rate is 20 mrem/hr. The sensitivity is calculated as:

$$\begin{aligned} \text{Sensitivity} &= \frac{4900 \text{ cpm}}{20 \text{ mrem/hr}} \\ &= 245 \text{ cpm/mrem/hr} \end{aligned}$$

This value should be approximately 240 cpm/mrem/hr.

3.2 Gamma Rejection Check

- With the Model 42-30H connected to the Model 2200, adjust the Model 2200 HV to the assumed operating voltage determined above.
- Remove the Model 42-30H detector from the moderator and place in a 10R/hr ¹³⁷Cs gamma radiation field.
- Take a one-minute count. If more than 10 counts are observed for the 1-minute period, decrease the operating voltage until the count rate drops below 10 cpm; however, ensure that the HV remains in the plateau region determined above.
- Ensure that sensitivity for the selected operating voltage is approximately 240 cpm/mrem/hr.
- Return the Model 42-30H to the moderator.

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3.3 Conversion Chart

- Expose detector to $^{241}\text{AmBe}$ neutron source at dose-equivalent rate of 400 mrem/hr. Take a one-minute count and record the value, including range/scale setting of counting instrument.
- Repeat for the dose-equivalent rates shown in Table 1.

The values in Table 1 and their corresponding measured values represent a conversion chart for use in relating other measured values to actual dose-equivalent rates.

Ref. Point (mrem/hr)	Reading (cpm)	Range/Scale
400		
200		
80		
20		
8		

Table 1

4. PARTS LIST

<u>Reference</u>	<u>Description</u>	<u>Part Number</u>
<u>Model 42-30H Neutron Detector</u>		
UNIT	Completely Assembled Model 42-30H Neutron Detector	47-3582
*	Probe Assembly	4005-141
*	^3He Tube 25185 2 ATM	01-5793
*	RECPT-UG706/U "C" LMI	4478-011
*	Model 42-30 Ball w/ Mounting Plate	2005-085
*	Model 42-30 Body Tube	2005-071
*	AWG 22 THIN WALL PTFE	29-9747
*	Model 42-31 Sponge Spacer	7005-047
*	Model 42-30, 42-31 Detector Spacer	7005-056
*	Model 42-30 Connector End	7005-067
*	Model 42-30 Polyethylene Spacer	7005-068
*	Model 42-30 Wall Mounting Bracket	7005-066

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