LUDLUM MODEL 19
MICRO R METER

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Serial No. 95406 and Succeeding
Serial Numbers

LUDLUM MEASUREMENTS, INC.
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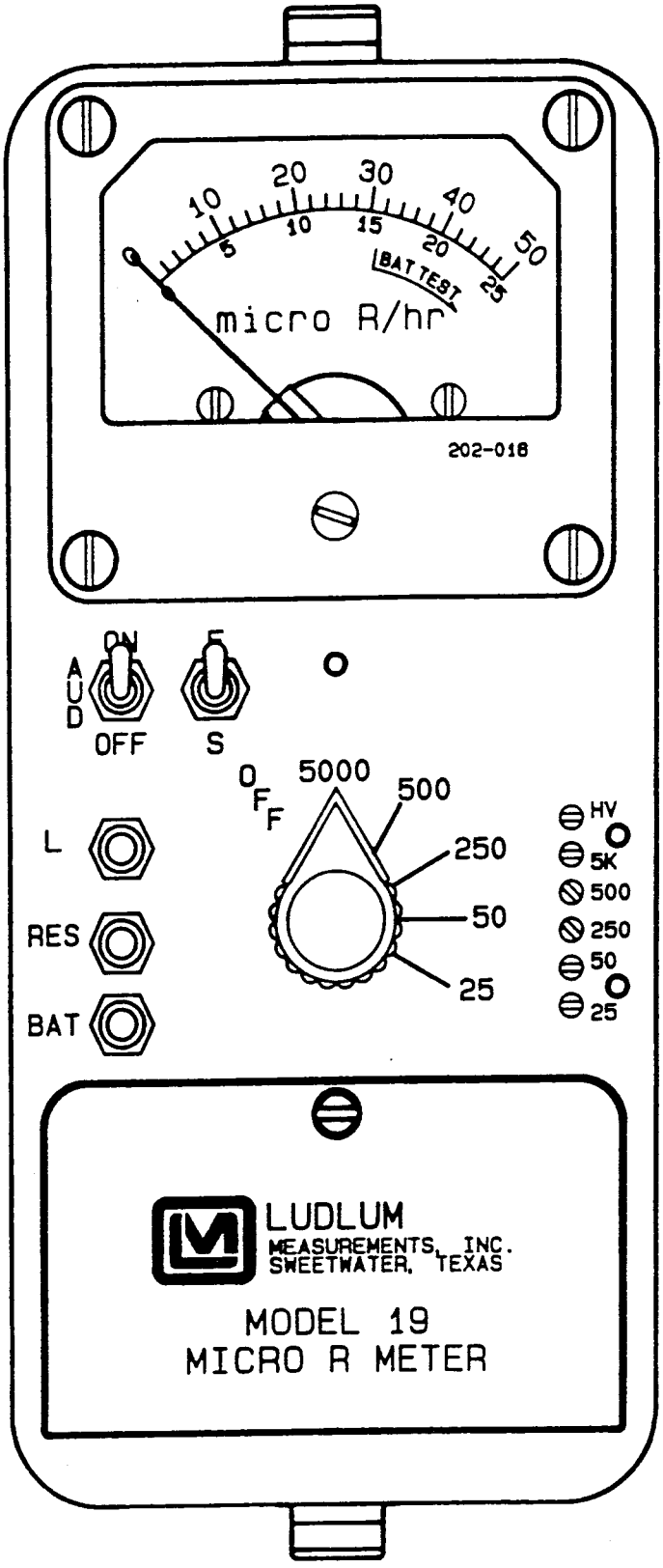

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TITLE MODEL 19 MICRO R METER							
LUDLUM MEASUREMENTS, INC. SWEETWATER, TEXAS			SERVICES		SHEET		

WARRANTY CERTIFICATE

Ludlum Measurements, Inc. warrants the products covered in this instruction manual to be free of defects due to workmanship, materials, and design for a period of twelve months from the date of delivery, with the exception of photomultiplier tubes and geiger tubes, which are warranted defect-free for 90 days. This warranty is voided in instances of improper installation, abuse, mishandling, misuse, freight damage, or repair by unqualified persons.

In the event of instrument failure, notify Ludlum Measurements, Inc. for repair or replacement. Liability of this warranty is limited to the purchase price of the instrument.

RECEIVING CONDITION EXAMINATION

Be sure to verify that the shipping carton is received in good condition with no visible damage. Should the instrument be received in a damaged condition, save the shipping container and the packing material and request an immediate inspection by the carrier.

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
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1. GENERAL

The Ludlum Model 19 Micro R Meter utilizes an internally-mounted, 1" x 1" NaI(T1) scintillator to offer an optimum performance in counting low-level gamma radiation. The unit features a pushbutton lighted meter and was designed to be moisture and dust resistant.

Five range divisions are provided in the 0-5000 micro R/hr spectrum. The meter face is made up of two scales, 0-50 and 0-25, plus battery test. The 0-50 scale corresponds to the 50, 500 and 5000 positions on the range selector switch. The 0-25 scale corresponds to the 25 and 250 position on the range selector switch.

The instrument is capable of using either standard flashlight batteries or nickel-cadmium rechargeable batteries. However, the M19 does not include circuitry for recharging the batteries.

All controls, including a calibration potentiometer for each range, are located on the front panel. Two "D" cell batteries are located in an isolated compartment and easily changed from the front panel. The meter is housed in a rugged aluminum bezel with waterproof seals.

2. SPECIFICATIONS

- **LINEARITY**: Plus or minus 5% of full scale
- **INPUT IMPEDANCE**: 0.1 megohm
- **HIGH VOLTAGE**: Variable from 400 to 1500 volts DC, electronically regulated to within ±1%
- **BATTERY DEPENDANCE**: Instrument calibration change less than 3% within battery check limits on meter
- **BATTERY COMPLEMENT**: Two standard size "D" cell batteries, secured in a isolated compartment
- **AUDIO OUTPUT**: Built-in unimorph speaker and ON-OFF switch provided on front panel
- **COUNTING RANGES**: Two-scale meter face presenting 0-50 Micro R/hr with full scale range positions of 5000, 500 and 50; and 0-25 Micro R/hr with full scale range positions of 250 and 25
- **METER**: 1mA, 2 1/2-inch scale, pivot-and-jewel suspension
- **DETECTOR**: Photomultiplier coupled to a 1" x 1" NaI(Tl) crystal mounted inside the instrument housing
- **FINISH**: Instrument housing of drawn-and-cast aluminum fabrication with computer-beige, polyurethane enamel and silk-screened nomenclature; rubber-booted switches
- **SIZE**: 15.75 cm (6.2") H x 8.9 cm (3.5") W x 21.6 cm (8.5") L, exclusive of handle
- **WEIGHT**: 1.36 kg (3 lbs.), less detector and batteries

3. DESCRIPTION OF CONTROLS AND FUNCTIONS

- **Range Selector Switch**: A six-position switch marked OFF, 5000, 500, 250, 50 and 25. Moving the range selector switch to one of the range positions (5000, 500, 250, 50, 25) provides the operator with an overall range of 0-5000 Micro R/hr. Note that the range positions 5000, 500 and 50 are screened in black and correspond to the meter scale screened in black. The range positions 250 and 25 are screened in red and correspond to the meter scale screened in red.
- **AUD ON-OFF Toggle Switch**: In the ON position, operates the unimorph speaker, located on the left side of the instrument. The frequency of the clicks is relative to the rate of the incoming pulses. The higher the rate is, the higher the audio frequency. The audio should be turned OFF when not required to reduce battery drain.
- **F-S Toggle Switch**: Provides meter response. Selecting the fast, "F", position of the toggle switch provides 90% of full scale meter deflection in four

seconds. In the slow, "S", position, 90% of full scale meter deflection takes 22 seconds. In "F" position, there is fast response and large meter deviation. "S" position should be used for slow response and damped, meter deviation.

- **BAT Pushbutton Switch**: When depressed, this switch indicates the battery charge status on the meter. The range selector switch must be out of the OFF position.

- **RES Pushbutton Switch**: When depressed, this switch provides a rapid means to drive the meter to zero.

- **"L" Pushbutton Switch**: When depressed, this switch lights the meter face.

- **HV Adjustment**: Provides a means to vary the high voltage from 400 to 1500 volts.

- **Range Calibration Adjustments**: Recessed potentiometers located under the calibration cover, on the right side of the front panel. These adjustment controls allow individual calibration for each range multiplier.

4. OPERATING PROCEDURES

The M19 is a simple instrument to operate. All controls and adjustments are located on the front panel along with the battery compartment. The 1" x 1" NaI(Tl) Scintillator is mounted internally.

✓ NOTE: To open the Battery Lid, twist the lid button counterclockwise 1/4 turn. To close, twist clockwise 1/4 turn.

o Open the lid and install two "D" size batteries. Note (+) (-) marks on the inside of the lid. Match the battery polarity to these marks.

✓ NOTE: Center post of flashlight battery is positive.

o Close the battery box lid.

o Adjust the audio AUD ON-OFF switch as desired.

o Adjust the meter response F-S switch as desired.

o Select the 0-5000 range with the Range Selector Switch.

o Depress the BAT Test Button. Check the BAT TEST on the appropriate scale. Replace the batteries if the meter pointer is below the BAT TEST line.

o Depress the Light Button (L). Check for light on the meter face.

o Check the meter response in the "F" and "S" positions.

o Check for audio indication with the AUD ON-OFF switch.

o Check the instrument for the proper scale indication with a known source. Check all the ranges for the appropriate scale indication.

o Depress the reset (RES) pushbutton. Check to see that the meter pointer returns to the zero position.

o The instrument is ready for monitoring.

5. CALIBRATION

The M19 radiation response is energy-sensitive. The detector plateau-characteristic must be determined for the anticipated radiation nuclide. The following is an example calibration:

☐ Remove the instrument from its case.

☐ With the instrument off, remove the HV jumper at the junction of C57-R27 on the circuit board.

☐ Connect a pulser to the C57-R27 junction.

☐ Set the pulse height at 80 millivolts, negative.

☐ Calibrate the scales as shown in Table 1.

☐ Connect the jumper back to the C57-R27 junction.

☐ Replace instrument can

✓ NOTE: The detector is not light-tight outside of the can.

Table I

SCALE	READING	PULSES/MINUTE
25	20	4,000
50	40	8,000
250	200	40,000
500	400	80,000
5,000	4,000	800,000

☐ Plateau instrument using Americium-241 using H..V. adjust potentiometer on front panel.

☐ Determine the plateau center voltage.

☐ Remove can.

☐ Measure detector operating voltage (H.V.) at C1-R5 and record for future reference.

✓ NOTE: Measure High Voltage with a Model 500 pulser or a High Impedance voltmeter with a high meg probe. If one of these instruments is not available use a voltmeter with a minimum of 1000 megohm input resistance.

☐ Replace instrument can.

☐ Take the M19 to a certified calibration range. Calibrate each scale for best fit at 1/5 and 4/5 scale. If the reading error is greater than 10% but less than 20% of reading, record the field versus the meter reading at 5 points on that scale. Place a copy of this meter correction on the instrument case.

☐ If, in the previous step, the calibration range background is too high for the lower scales or if the appropriate radiation fields are not available, calibrate only the 5000 scale at the calibration range and then proceed with the following steps:

☐ Turn instrument off and remove instrument from can.

☐ Remove H.V. Jumper.

☐ Turn instrument on.

☐ Connect pulser and determine pulse rate verses micro R/hr calibration point on 5000 scale.

☐ Calibrate the lower scales with Pulser using information from previous step.

☐ Turn instrument off and reconnect H.V. Jumper.

☐ Replace can.

☐ Recheck all operating functions of the instrument prior to use.

6. MAINTENANCE

Instrument maintenance consists of keeping the instrument clean and periodically checking the batteries and the calibration.

An instrument operational check should be performed prior to each use by exposing the detector to a known source and confirming the proper reading on each scale.

Recalibration should be accomplished after any maintenance or adjustment of any kind has been performed on the instrument. Battery replacements are not considered to be maintenance and do not normally require the instrument to be recalibrated.

Ludlum Measurements recommends recalibration at intervals no greater than one year. Check the appropriate regulatory agencies regulations to determine required recalibration intervals.

The batteries should be removed and the battery contacts cleaned of any corrosion at least every three months. If the instrument has been exposed to a very dusty or corrosive atmosphere, more frequent battery servicing should be used.

Use a spanner wrench to unscrew the battery contact insulators, exposing the internal contacts and battery springs. Removing the handle will facilitate access to these contacts.

NOTE

NEVER STORE THE INSTRUMENT OVER 30 DAYS WITHOUT REMOVING BATTERIES. ALTHOUGH THIS INSTRUMENT WILL OPERATE AT VERY HIGH AMBIENT TEMPERATURES, BATTERY SEAL FAILURE CAN OCCUR AT TEMPERATURES AS LOW AS 100° FAHRENHEIT.

7. THEORY OF OPERATION

7.1 DETECTOR

The detector consists of a crystal of sodium iodide with Thallium activation (NaI Tl) that gives off light pulses when penetrated by radiation photons.

The light pulses are converted to electrical pulses by the photo cathode of the photomultiplier tube. The photomultiplier includes a 10 or 11 stage electron amplifier. This amplifier utilizes an electrostatic field for each stage, adding up to a required 500 to 1500 volt supply.

7.2 INPUT

Detector pulses are coupled from the detector through C57 to emitter follower Q96. R83, R89 provide bias. R137 protects Q96 from input shorts. R27 couples the detector to the high voltage supply.

7.3 AMPLIFIER

A self-biased amplifier provides gain in proportion to R63 divided by R70. Transistor (pin 6 of U1) provides amplification. Pin 12,15 of U1 are coupled as current mirror to provide a load for pin 6 of U1. The output self-biases to 2 Vbe (approximately 1.4 volts) at pin 7 of U1. This provides just enough bias current through pin 6 of U1 to conduct all of the current from the current mirror.

Positive pulses from pin 7 of U1 are coupled to the discriminator.

7.4 DISCRIMINATOR

Comparator U2 provides discrimination. The discriminator is set by the voltage divider, R75 and R196, coupled to pin 3 of U2. These pulses are coupled to pin 5 of U3 for meter drive and pin 12 of U3 for audio.

7.5 AUDIO

Discriminator pulses are coupled to univibrator pin 13 of U3. Front panel audio ON-OFF selector controls the reset at pin 13 of U4. When ON, pulses from pin 10 of U3 turns on oscillator U5, which drives the can mounted unimorph. Speaker tone is set by R84,C112; duration by R86.

7.6 DIGITAL ANALOG CONVERTOR

Pin 12,15 of U4 are coupled as a current mirror. For each pulse of current through R72, and equal current is delivered to C105. This charge is drained off by R74. The voltage across C105 is proportional to the incoming count rate.

7.7 SCALE RANGING

Detector pulses from the discriminator are coupled to univibrator pin 5 of U3. For each scale, the pulse width of pin 6 of U3 is increased by a factor of 10 with the actual pulse width being controlled by the

front panel calibration controls and their related capacitors. This arrangement allows the same current to be delivered to C105 by one-tenth of a count on the X.1 range as 100 counts on X100 range.

7.8 METER DRIVE

The meter is driven by the emitter to Q6, coupled as a voltage follower in conjunction with pin 1 of U6. For ratemeter drive, the meter is coupled to C105 at P1-15.

For Battery Test, the voltage follower is bypassed and the meter movement is directly coupled to the battery through R150.

7.9 METER COMPENSATION

When the unit is provided with a high torque meter movement, with 1.2 volt drive, a temperature compensation circuit is provided on the Main Circuit board; components R181,R189 & R190.

7.10 FAST/SLOW TIME CONSTANT

For slow time constant, C104 is switched from the output of the meter drive to parallel C105.

7.11 LOW VOLTAGE SUPPLY

Battery voltage is coupled to U7 and associated components (a switching regulator) to provide 5 volts at pin 5 to power all logic circuits. Unregulated battery voltage is used to power the meter drive (Q6) and the high voltage blocking oscillator (Q145).

7.12 LOW VOLTAGE REFERENCE

U101 provides a 1.22 volt precision reference for HV supply. This unit also biases Q96.

7.13 HIGH VOLTAGE SUPPLY

High voltage is developed by blocking oscillator Q145-T165 and rectified by voltage multiplier CR166,167,169 and 175. Output voltage increases as current through Q44 increases, with maximum output voltage with Q44 saturated.

High voltage is coupled back through R47 to opamp pin 6 of U6. R147 completes the high voltage circuit to ground. High voltage output is set by front panel control HV, which sets bias of pin 5 of U6. During stable operation, the voltage at pin 6 of U6 will equal the voltage at pin 5 of U6. Pin 7 of U6 will cause conduction of Q44 to increase or decrease until the high voltage seeks a level of stability.