

INSTRUCTION MANUAL

**LUDLUM MODEL 2223
SCALER/RATEMETER**

**July 1999
Serial No. 107629 and Succeeding
Serial Numbers**



LUDLUM MEASUREMENTS, INC.

P.O. Box 810 / 501 Oak Street
SWEETWATER, TEXAS 79556

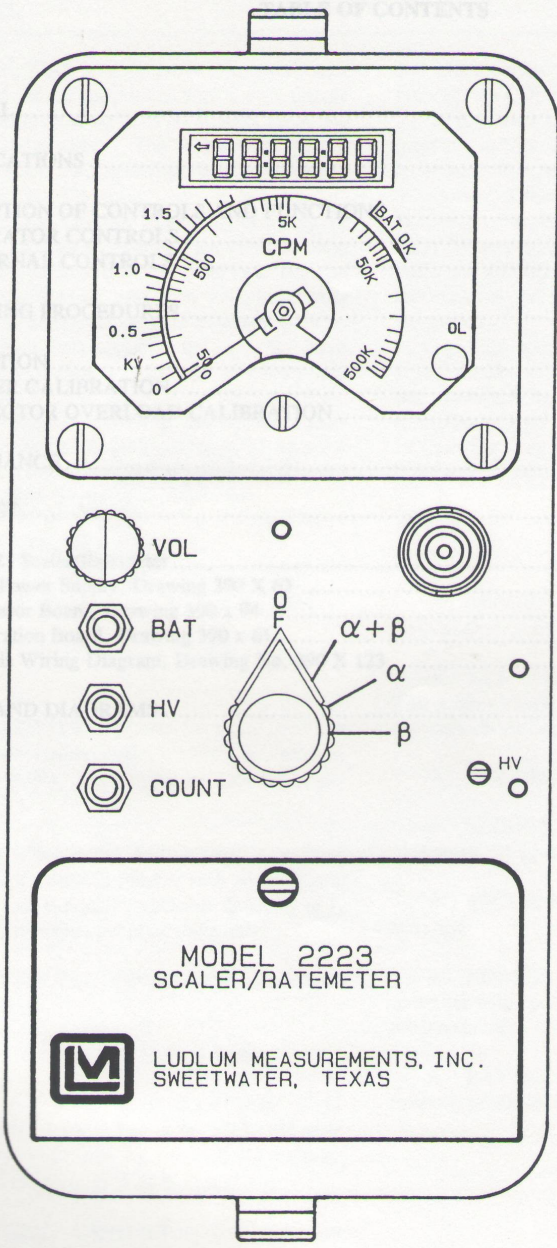
Phone: 800-622-0828(USA), 915-235-5494 Fax: 915-235-4672

Serving The Nuclear Industry Since 1962

MODEL 2223 SCALER/RATEMETER
July 1999

CONTENTS

1. GENERAL INFORMATION
2. SPECIFICATIONS
3. DESCRIPTION OF OPERATION
 - 3.1 OPERATING CONTROLS
 - 3.2 INTERNAL CONTROLS
4. OPERATING PROCEDURES
5. CALIBRATION PROCEDURES
 - 5.1 METERS
 - 5.2 DETECTOR
6. MAINTENANCE
7. PARTS LIST



CHK NO.		CHK	CHK	APP
DRN DATE	BK 11-8-92	CHK DATE	APP DATE	
TOL: SHOP STD <input type="checkbox"/>		SCALE: FULL <input type="checkbox"/>		
OTHER		OTHER		
TITLE M 2223 SCALER/RATEMETER				
LUDLUM MEASUREMENTS, INC. 501 DAK STREET SWEETWATER, TEXAS 79080		REVISED	390	SHEET 52

M2223 Scaler/Ratemeter
July 1999

TABLE OF CONTENTS

I. GENERAL

1. GENERAL	1
2. SPECIFICATIONS	1
3. DESCRIPTION OF CONTROLS AND FUNCTIONS	1
3.1 OPERATOR CONTROLS	1
3.2 INTERNAL CONTROLS	2
4. OPERATING PROCEDURES	3
5. CALIBRATION	4
5.1 METER CALIBRATION	4
5.2 DETECTOR OVERLOAD CALIBRATION	4
6. MAINTENANCE	5
7. PARTS LIST	6
2. Model 2223 Scaler/Ratemeter	6
Amp/Power Supply, Drawing 390 X 63	6
Processor Board, Drawing 390 x 94	7
Calibration Board, Drawing 390 x 61	7
Chassis Wiring Diagram, Drawing No. 390 X 123	8
DRAWINGS AND DIAGRAMS	9

10mV for beta threshold (β-T), 15 mV to 70mV for beta window (β-W), and 50mV to 180 for alpha threshold (α-T)

- * **AUDIO:** Selectable dual or single tone click per event through a built-in speaker with an adjustable volume control and internally switchable divide by of 1, 10, 100, and 1000 counts per click (beta only).
- * **HIGH VOLTAGE:** externally adjustable from 200 to 1500 volts
- * **LINEARITY:** within 10% of reading
- * **Response Time:** from 0-1/4 scale ≤ 11 seconds, 1/4 to 1/2 scale - 7 seconds, 1/2 to 3/4 scale - 2 seconds, 3/4 to full scale ≤ 1 second (all response times measured from 10-90 % of final reading)
- * **BATTERY DEPENDENCE:** Instrument calibration change less than 5% to battery endpoint

- * **CONNECTOR:** Series C
- * **SIZE:** 10.67cm (4.2") H x 8.9cm (3.5") W x 21.4cm (8.5") L, exclusive of handle
- * **WEIGHT:** 1.36kg (3 lbs.) less detector and batteries
- * **FINISH:** drawn-and-rod aluminum, with computer-beige polyurethane enamel and silk-screened nomenclature
- * **BATTERY LIFE:** Exceeds 300 hours with a fresh set of alkaline "D" cell batteries

M2223 Scaler/Ratemeter

July 1999

1. GENERAL

The Model 2223 is a portable micro-processor based radiation survey instrument with a four decade logarithmic readout reading from 50 to 500K CPM and a six-digit LCD counter. The instrument features selectable alpha/beta discrimination when used with an alpha/beta scintillation detector.

The ratemeter can display alpha only, beta only, or alpha and beta together by selecting the corresponding switch selection. Audible click per event tones can also be selected to discriminate beta (low pitch tone) from alpha (high pitch tone) via the side mounted speaker. The beta threshold, beta window, and alpha threshold are adjustable to optimize alpha/beta efficiency and count separation.

The LCD display is used to display the counts accumulated during the preset count time. There are 4 count times selectable via internal switches. These count times are 6 seconds, 30 seconds, 60 seconds,

and 120 seconds. The counter is reset and started by pressing the COUNT button.

A regulated high voltage power supply adjustable from 200 to 1500 volts with detector overload detection is utilized to operate a wide range of scintillation detectors. Other operating features of the instrument include programmable audio divide by (beta channel only), a two-position switch (internal) for selecting the audio discrimination mode, an adjustable volume, push button battery test switch, and a push button high voltage test switch.

The unit body is made of cast aluminum with a drawn aluminum can. The unit is operated with two "D" cell flashlight batteries for operation from 0°C to approximately 65°C. For temperature operation to -17°C, either very fresh alkaline or rechargeable NiCd batteries may be used.

2. SPECIFICATIONS

- **POWER:** two standard "D" size batteries.
- **FOUR DECADE LOG RANGE:** from 1 to 10k CPM
- **SENSITIVITY:** Adjustable from 2mV to 10mV for the beta threshold (β -T), 15 mV to 70mV for beta window (β -W), and 80mV to 180 for alpha threshold (α -T)
- **AUDIO:** Selectable dual or single tone click per event through a built-in speaker with an adjustable volume control and internally switchable divide by of 1, 10, 100, and 1000 counts per click (beta only).
- **HIGH VOLTAGE:** externally adjustable from 200 to 1500 volts
- **LINEARITY:** within 10% of reading
- **Response Time:** from 0-1/4 scale - 11 seconds, 1/4 to 1/2 scale - 7 seconds, 1/2 to 3/4 scale - 2 seconds, 3/4 to full scale - \leq 1 second (all response times measured from 10-90 % of final reading)
- **BATTERY DEPENDENCE:** Instrument calibration change less than 3% to battery endpoint
- **METER:** 1mA, 250 degree, 8.3cm scale, with pivot-and-jewel suspension
- **LCD display:** 6 digit Liquid Crystal Display with 6.4mm characters and a counter overflow arrow. Colons indicate count in process.
- **CONNECTOR:** Series "C"
- **SIZE:** 10.67cm (4.2") H x 8.9cm (3.5") W x 21.6cm (8.5") L, exclusive of handle
- **WEIGHT:** 1.36kg (3 lbs.) less detector and batteries
- **FINISH:** drawn-and-cast aluminum, with computer-beige polyurethane enamel and silk-screened nomenclature
- **BATTERY LIFE:** Exceeds 350 hours with a fresh set of alkaline "D" cell batteries

M2223 Scaler/Ratemeter
July 1999

3. DESCRIPTION OF CONTROLS AND FUNCTIONS

3.1 OPERATOR CONTROLS

● **OFF/ α + β / α / β Switch:** A four-position switch used to select the sum of both alpha and beta count channels ($\alpha + \beta$), alpha count only (α), or beta count only (β), for display. This switch affects both the ratemeter and the counter. The separate ratemeter and counter channels are active regardless of the switch position and will continue to function when the channel is not selected for display. This allows the operator to view each channel separately or together by simply selecting the appropriate switch position.

During the initial turn ON, the meter will be driven full scale for about 2 seconds and then return to zero. The LCD display will show "888888" and then display the processor program version and then 0.

● **LCD DISPLAY:** 6 digit display that displays the scaler count for the selected channel. The display also indicates when a count is in progress by turning on two colons. The colons are turned off when the count is completed. If the counter counts over 999999, an arrow in the upper left corner of the display turns on to indicate the overflow and the counter rolls over to zero and continues counting.

● **VOL:** The volume control for the speaker. Turning this control clockwise will increase the speaker volume and counter clockwise will decrease the volume.

✓**NOTE:** The volume should be turned down when not required to reduce battery drain.

● **COUNT:** When pressed, resets the counter to zero and starts the timer. The colons on the display will turn on and stay on until the count time has expired.

● **BAT:** When pressed, provides indication of battery strength on meter.

● **HV:** When pressed, provides a readout of the detector high voltage on the meter.

■ Remove the CAL cover to access the following controls.

● **HV Adjustment:** Provides a means to vary the high voltage from 200 to 1500 volts.

3.2 INTERNAL CONTROLS

■ Remove the instrument cover (can) to access the following controls.

● **AUDIO Divide Select Switch:** A two-pole DIP switch (1 & 2) used to select the audio divide ratios of 1, 10, 100, 1000.

✓**NOTE:** The AUDIO divide function only effects the lower frequency beta tones. The higher frequency alpha clicks per events will be unaffected by the divide by selection.

The ratio is selected from the following table. O is open and C is closed.

SWITCH		DIVIDE BY
1	2	RATIO
C	C	1
O	C	10
C	O	100
O	O	1000

● **COUNT TIME Select Switch:** A two-pole DIP switch (3 & 4) used to select the count times of 6, 30, 60, and 120 seconds.

The count time is selected from the following table. O is open and C is closed.

SWITCH		COUNT TIME
3	4	
C	C	6 seconds
O	C	30 seconds
C	O	60 seconds
O	O	120 seconds

● **TONE:** A one-pole DIP switch (5) used to select tone discrimination between alpha and beta count channels. When in the DUAL mode, alpha and beta pulse tones will be audible in all selector switch positions (i.e. if in the α only position and β is detected, the β tones will be heard in addition to the α tones and visa versa).

When the SNGL tone position is selected, both alpha and beta pulse tones can be heard in the $\alpha + \beta$ selection, but alpha pulses cannot be heard in the beta only channel selection and beta pulse tones will not be heard in the alpha only channel selection.

M2223 Scaler/Ratemeter
July 1999

SWITCH	TONE
5	MODE
C	DUAL
O	SINGLE

✓ Note: The following controls are utilized during calibration only and should only be performed by a qualified calibrator.

- **MTR:** A multi-turn potentiometer used to calibrate the meter to the CPM reading.

- **α -T:** A multi-turn potentiometer used to vary the alpha pulse threshold from ≈ 40 to 700mV.

- **β -W:** A multi-turn potentiometer used to vary the beta pulse upper window limit from the beta threshold to the alpha threshold setting and anywhere in between those two parameters. The beta window can be disabled by adjusting the β -W control to the maximum clockwise position allowing

the upper beta threshold limit to equal the alpha threshold.

- **β -T:** A multi-turn potentiometer used to vary the beta pulse threshold from ≈ 2 to 15mV.

- **OL:** A multi-turn potentiometer which provides a means to vary the detector current overload set point.

- **LIM:** A multi-turn potentiometer used to set the maximum HV limit to 1500 VDC.

- **HV:** A multi-turn potentiometer used to adjust the high voltage test reading to correspond with the actual high voltage output. The HV switch must be depressed during adjustment.

- **LB:** A multi-turn potentiometer used to adjust the minimum battery voltage level corresponding to the low battery indication on the meter dial. The BAT switch must be depressed during adjustment.

4. OPERATING PROCEDURES

- Release the can latches and remove the can from the 2223 taking care not to damage the speaker wires. Using a ball point pen, set the switches for the AUDIO divide by, TONE, and COUNT TIME to the desired selection. Then replace the can and fasten the latches.

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

- Open the Battery 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. Close the battery box lid.

- Switch the OFF/ α + β / α / β switch to the α + β position. The meter should read full scale for about 2 seconds and then return to zero. The display should show all eights and then display the program version number and then display 0. Then press the BAT button. The meter should indicate above the BAT OK portion of the scale. If the meter does not respond correctly, recheck that the batteries have proper polarity and are good.

- Connect a detector to the M2223.

- The detector operating parameters are established by adjusting the detector operating voltage (HV), alpha threshold, beta threshold, and beta window to find an optimum efficiency for the alpha/beta scintillator.

The threshold and window parameters can be adjusted to optimize alpha/beta count discrimination, count efficiency, and minimize "cross talk" between channels. Once the thresholds and window settings are established, an operating voltage versus count rate plot should be performed for both alpha and beta count channels with alpha and beta particle emission sources.

The following procedure is example of determining the operating voltage for and alpha/beta scintillation detector:

- Connect a Ludlum Model 500 Pulser or equivalent to the Model 2223.

- Switch the 2223 to the β position. Adjust the beta threshold (β -T) for 4mV and the beta window (β -W) for 30mV. The pulser counts should be detected on the 2223 ratemeter above 4mV and should shut off above 30mV.

- Switch the channel selector switch to the α position. Adjust the pulser for a 120mV pulse

M2223 Scaler/Ratemeter

July 1999

output and vary the α -T control until counts are detected on the ratemeter.

- Depress the HV switch and adjust the HV potentiometer for 0.4 to 0.5KV on the 0-1.5 KV scale. Connect the scintillator and switch to the β only position. Place an alpha source on the detector face.

- Slowly increase the HV potentiometer to observe an increase, then decrease, and increase again in count as the HV is increased. Decrease the HV until the ratemeter is in the "dip" of the observed count rate versus HV plot just performed. Depress the HV switch and note the HV setting.

- Plot a HV versus count rate plateau in 25 volt increments, 50 volts each side of the HV

reading found in the above step (ie, HV setting for count "dip" in the above step = 675 volts, start the plot at 625 volts and increase in 25 volts steps until 725 volts is reached). Plot alpha source, beta source, and background counts for both the α and β channel positions.

- Find the optimum operating voltage from the plot which gives the greatest alpha and beta source efficiency while maintaining no greater than the maximum acceptable level of "cross talk" between channels.

- Select the desired count channel display and proceed to use instrument.

5. CALIBRATION

5.1 METER CALIBRATION

- A Ludlum Model 500 Pulser or equivalent is required. If the Pulser does not have a high voltage readout, use a high impedance voltmeter with at least 1000 Megohm input resistance to measure the detector voltage.

- Ensure that the meter movement has proper mechanical zero. The adjustment is on the front of the meter bezel. It must be adjusted to "zero" with the ON/OFF selector switch in the OFF position.

- Connect the Model 500 Pulser to the Model 2223 with the appropriate cable. Rotate the 2223 OFF/ α + β / α / β switch to the α + β position.

- Adjust the Pulser for 50,000 CPM and adjust the pulse amplitude to twice the beta threshold level (ie; β -T adjusted to 10 millivolts, set pulser to 20mV).

- Remove the instrument cover and adjust the MTR potentiometer until the meter reads 50K CPM. Decade the Pulser count rate switch to check the meter linearity at 500, 5K and 500K CPM. Linearity should be within \pm 10% of each reading.

- Adjust the β -T, β -W, and α -T controls for the appropriate set points as described in section 4.

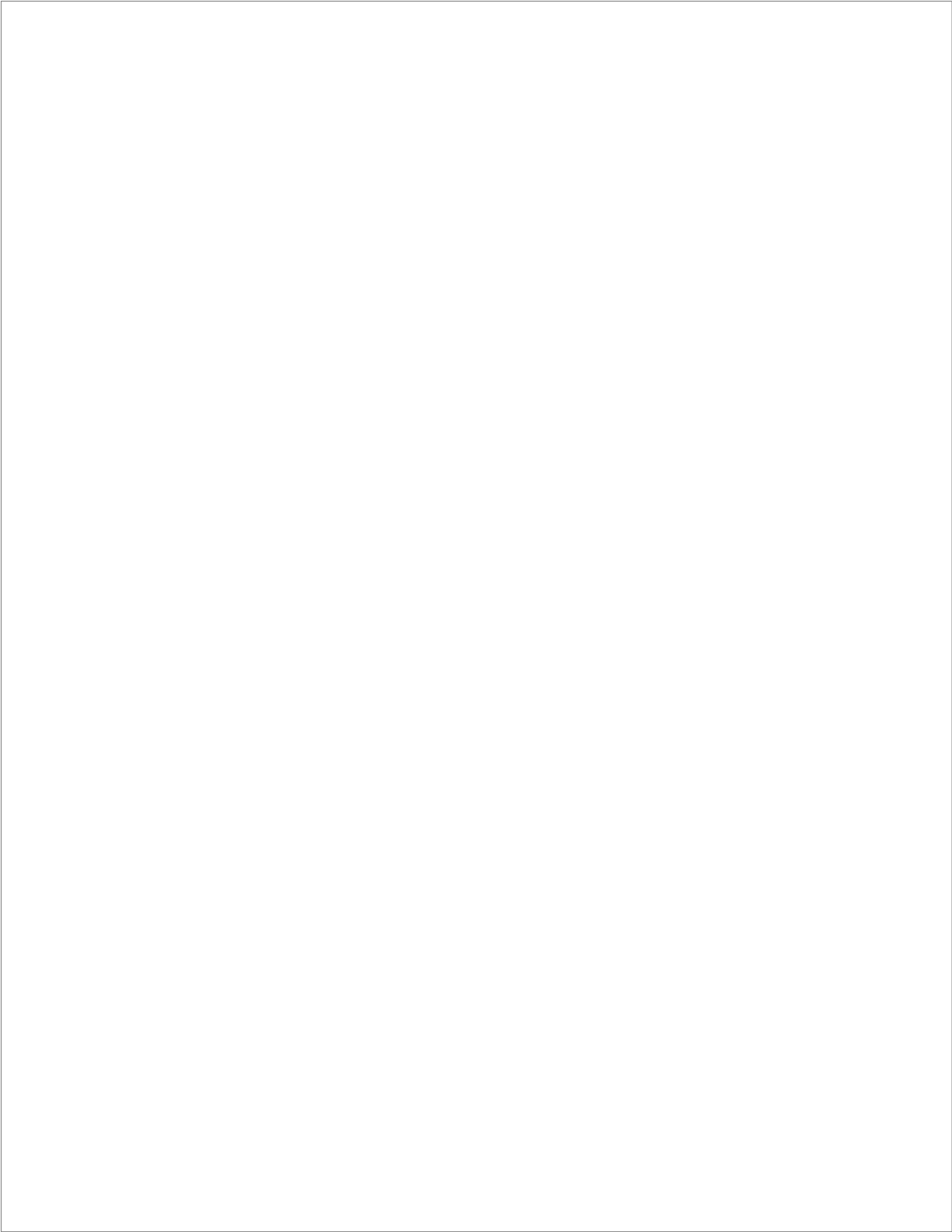
- Connect high impedance high voltage meter (may use the Model 500 Pulser if equipped with a HV meter) and adjust the HV control for a reading of 1000 VDC on the voltmeter.

- Depress the HV pushbutton switch and adjust the HV potentiometer located on the circuit board for a reading of 1.0 KV on the meter dial. Adjust the HV output from 500 to 1500 VDC and confirm that the 2223 HV meter corresponds to the external voltmeter within \pm 10% of each reading.

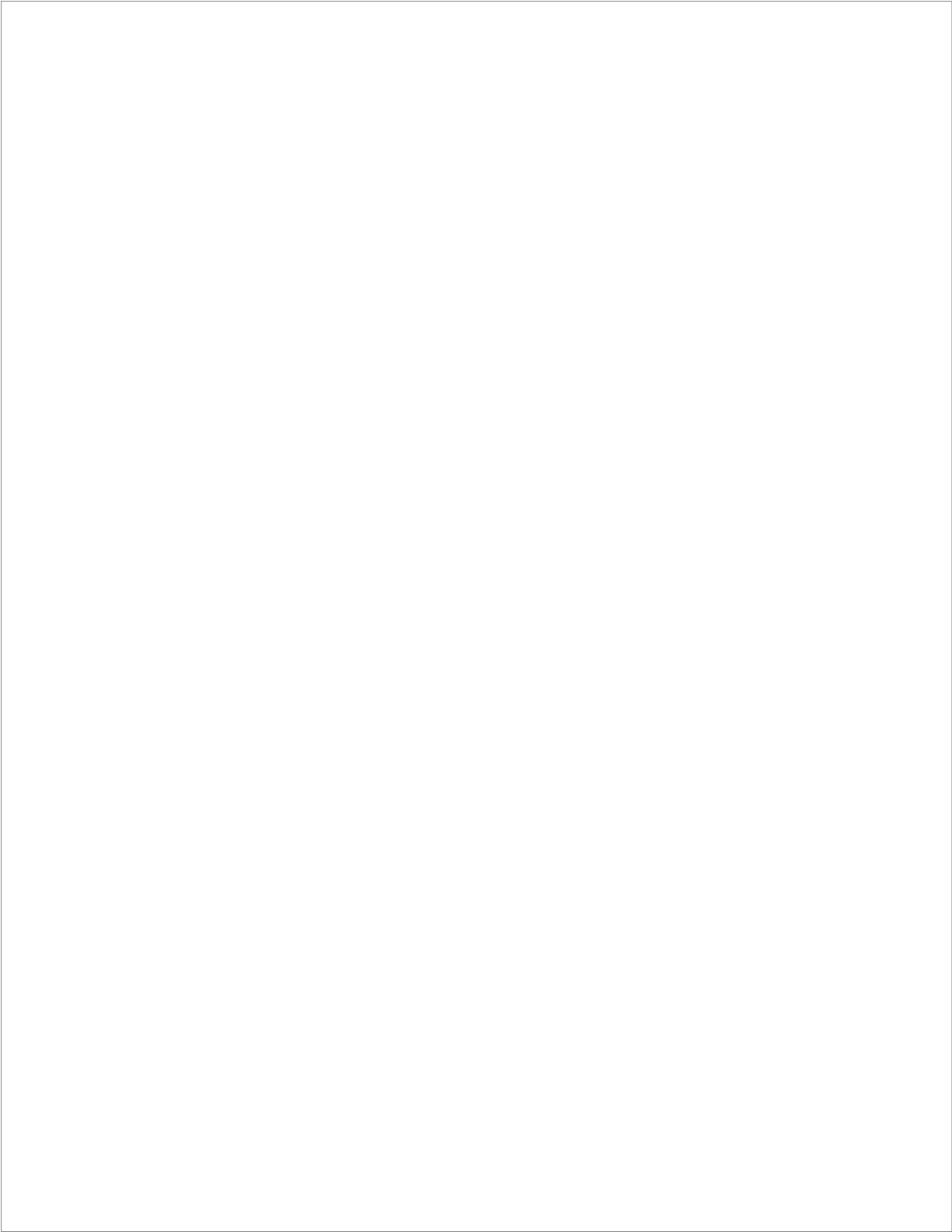
- Remove batteries from the battery compartment and connect a DC power supply to the two screw terminals located at the rear of the battery compartment. The positive power supply lead should connect to the terminal with the red wire and the negative lead to the terminal with the black wire.

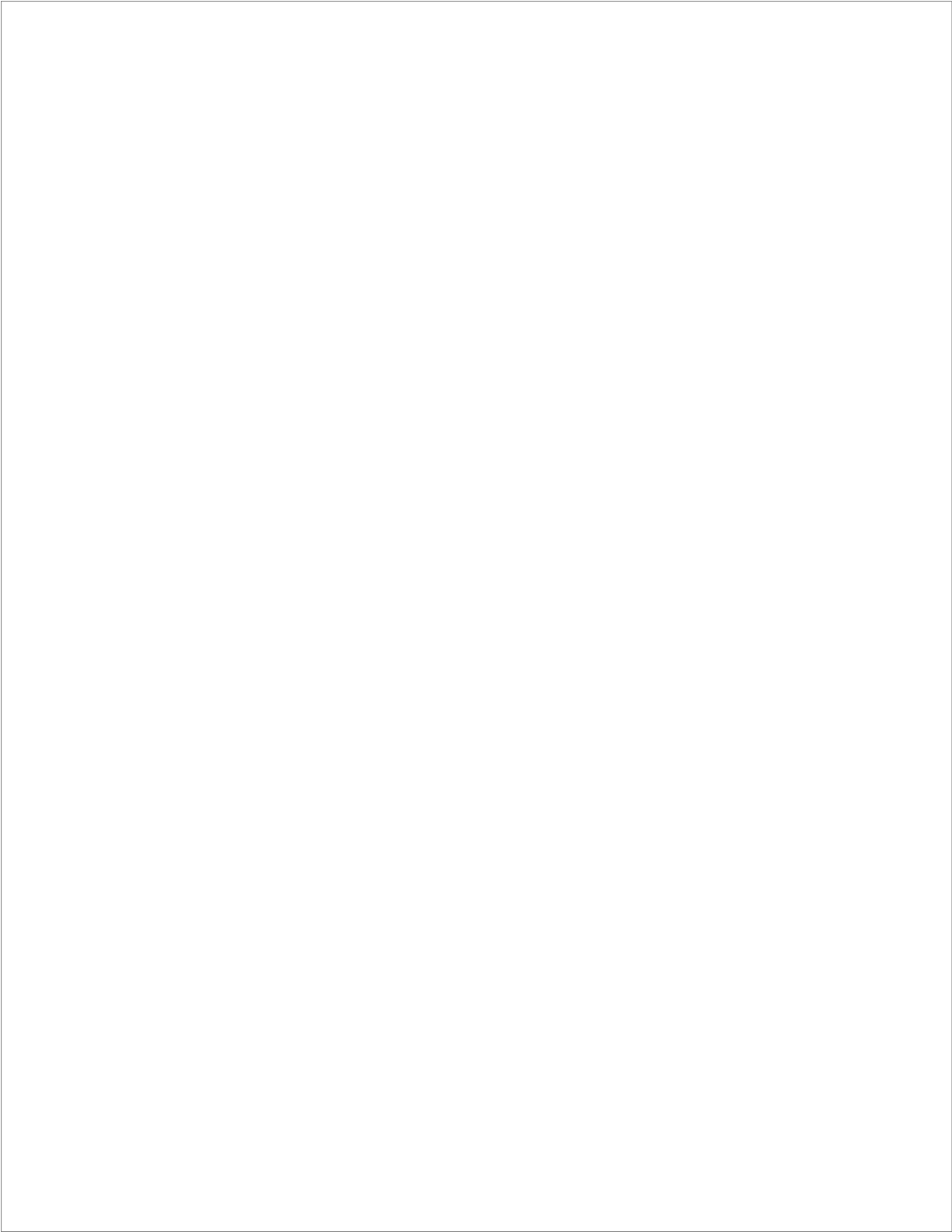
- Adjust the power supply for 2.2 VDC and switch the 2223 to the α + β position. Depress the BAT pushbutton switch and adjust the LB potentiometer to align the meter needle with the low battery mark on the meter dial (vertical line to the left of BAT OK).

- Replace 2223 cover and proceed with use.

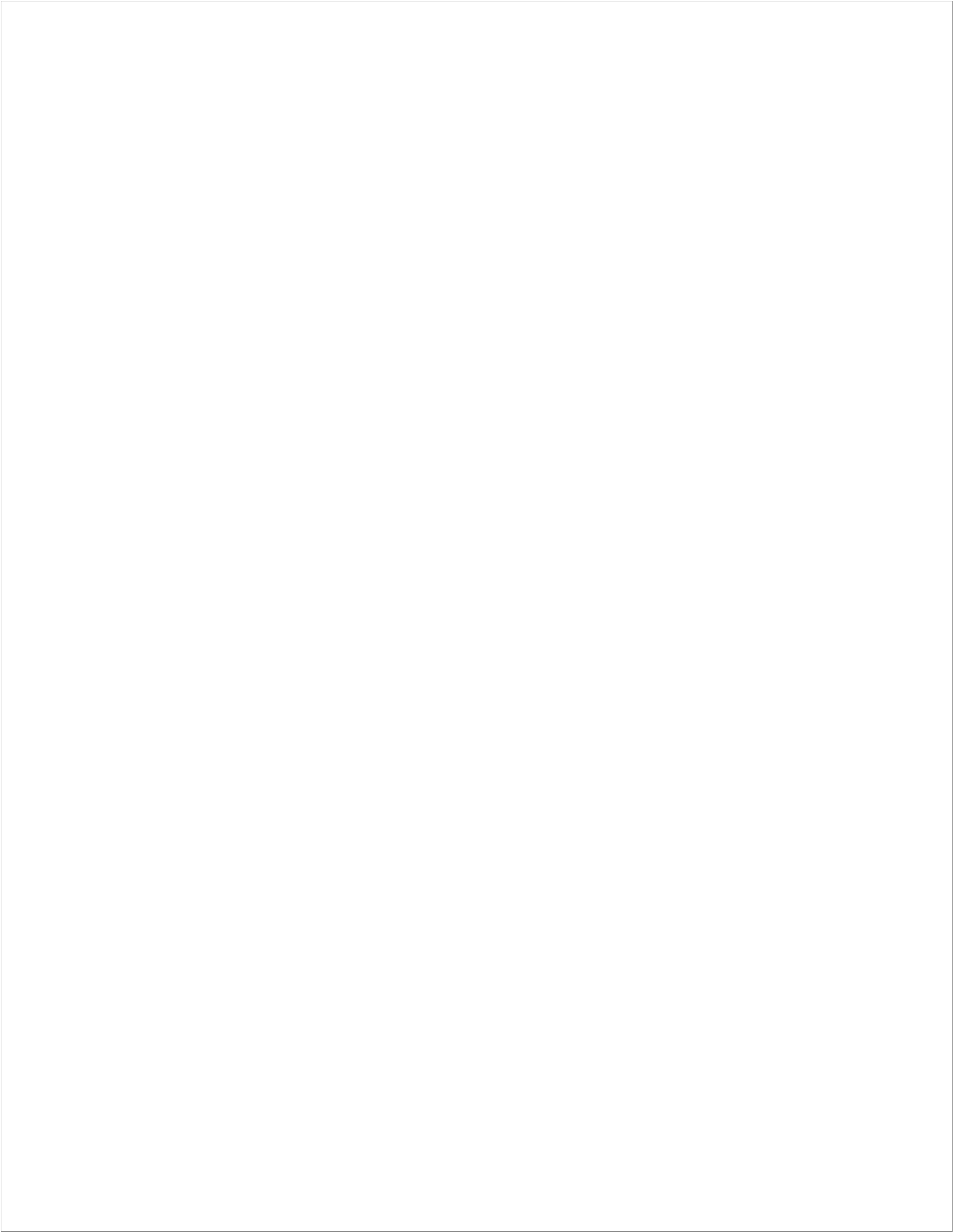


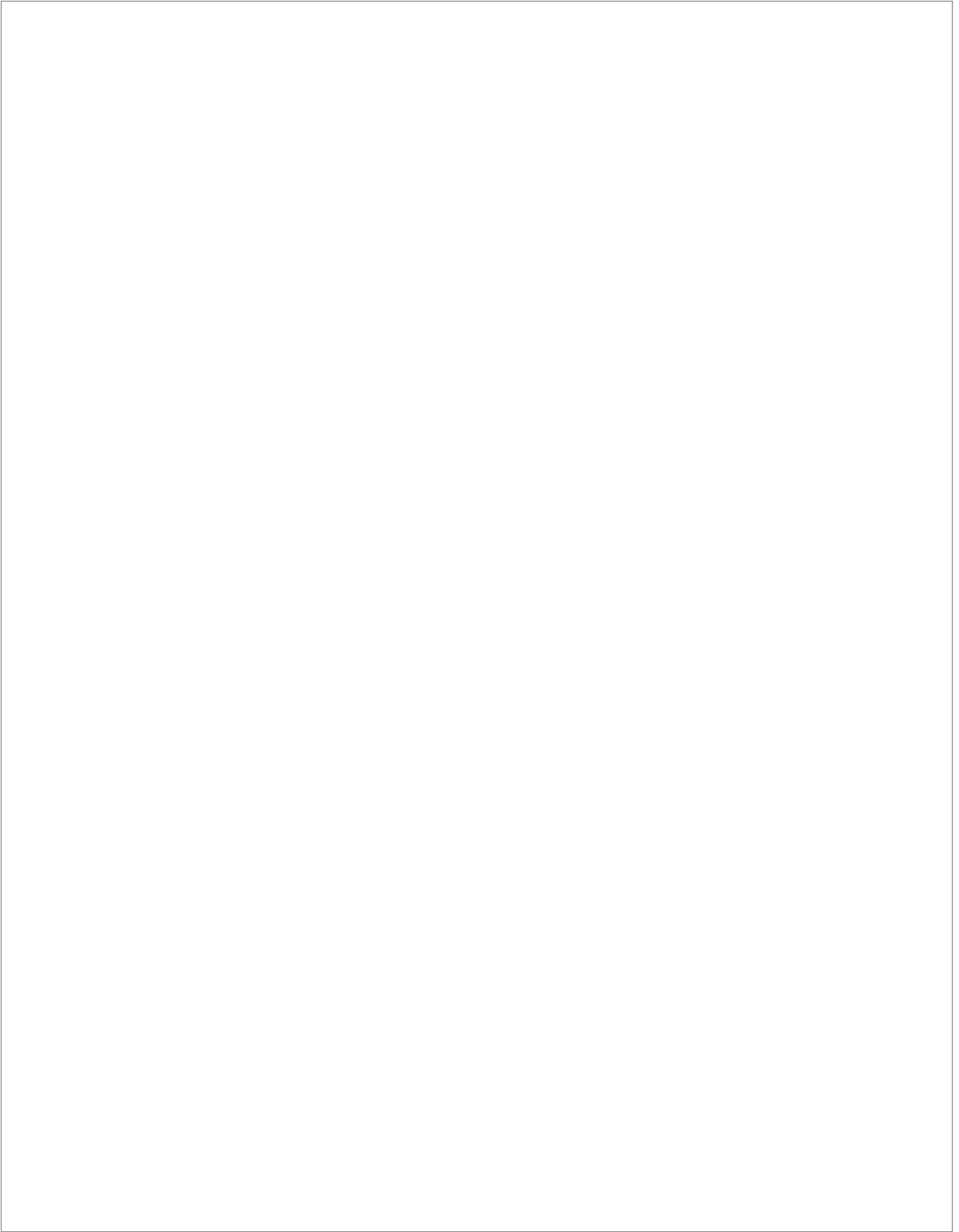


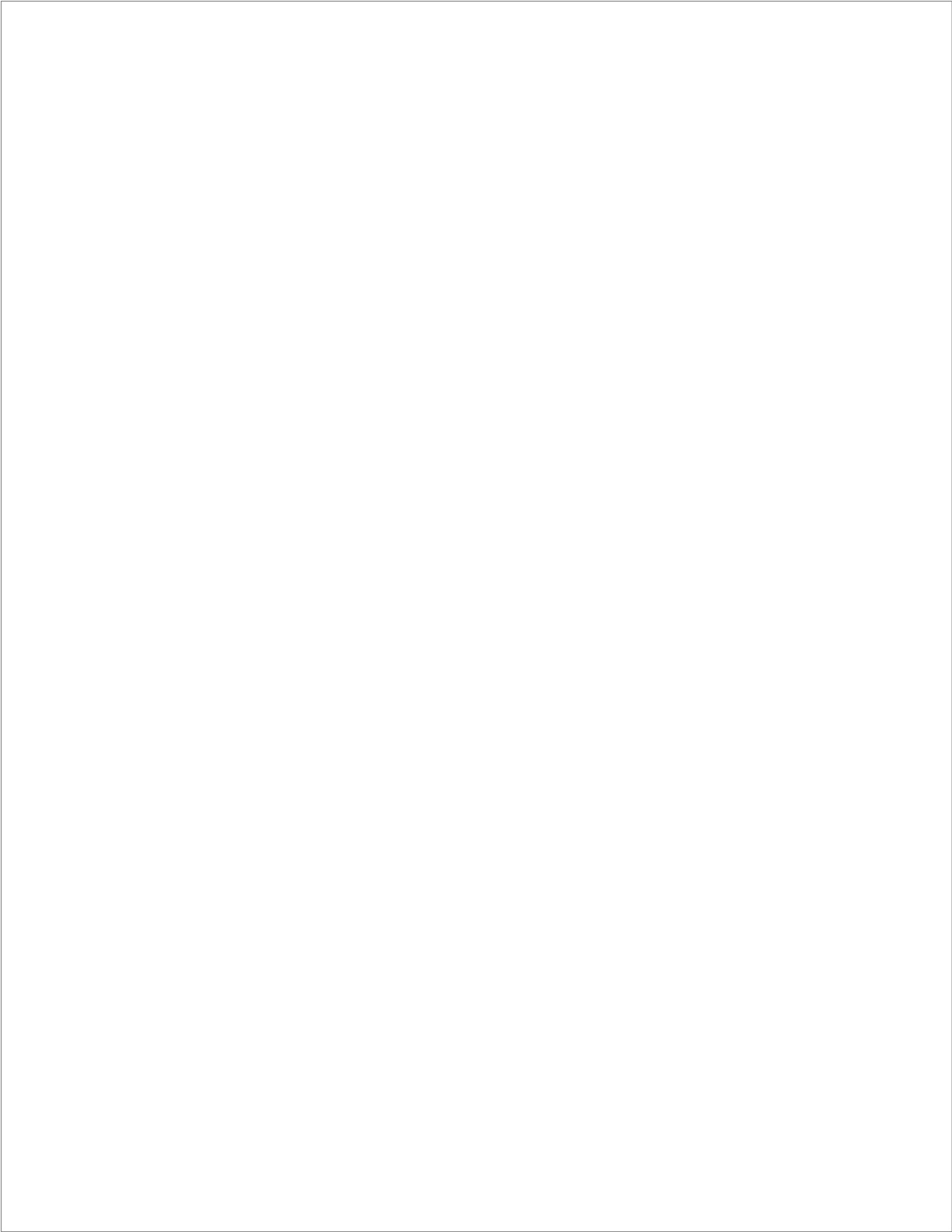


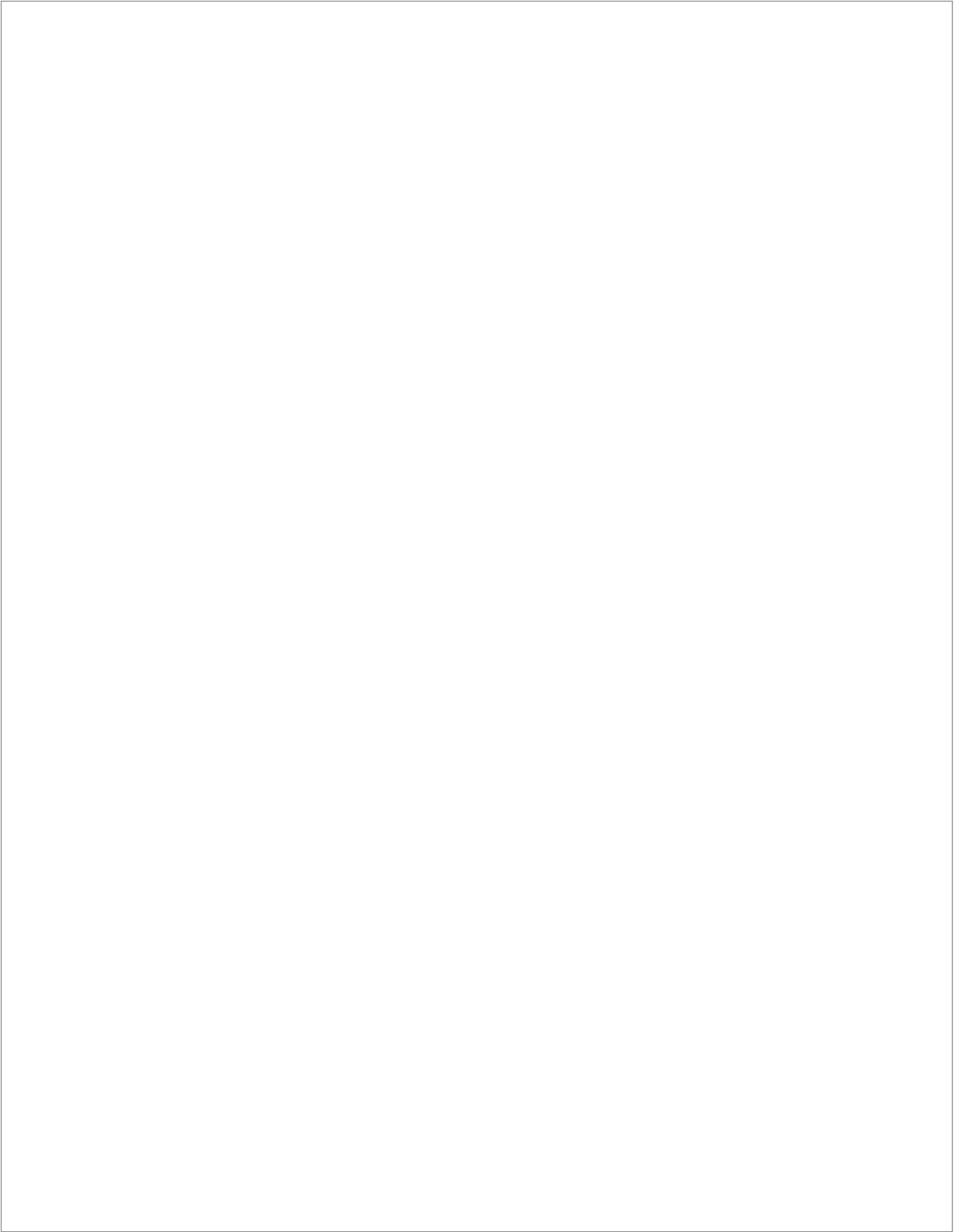


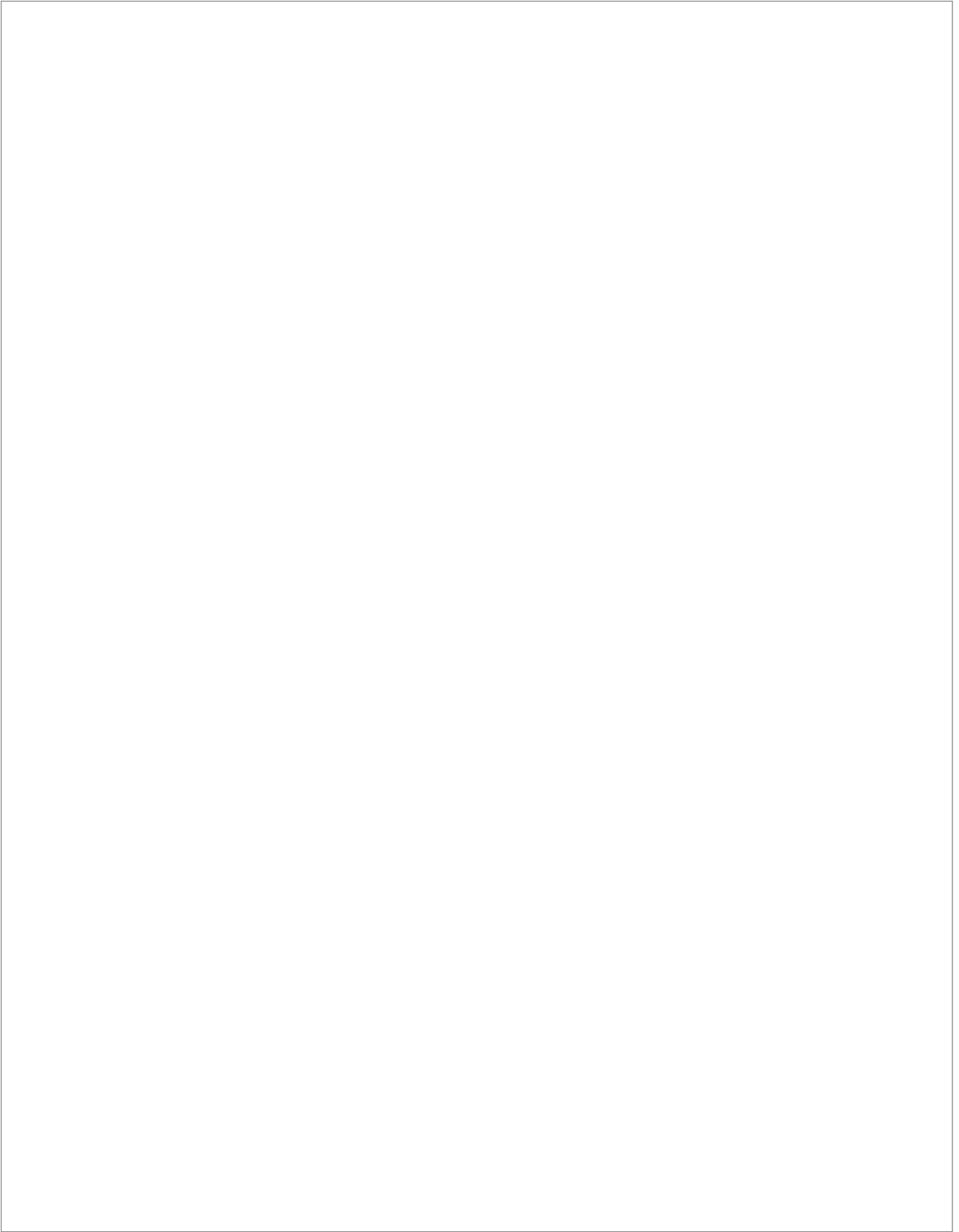












REV	AUTHORITY	ZONE	TLX	DESCRIPTION	DATE	APPROVED

STATEMENT OF WARRANTY

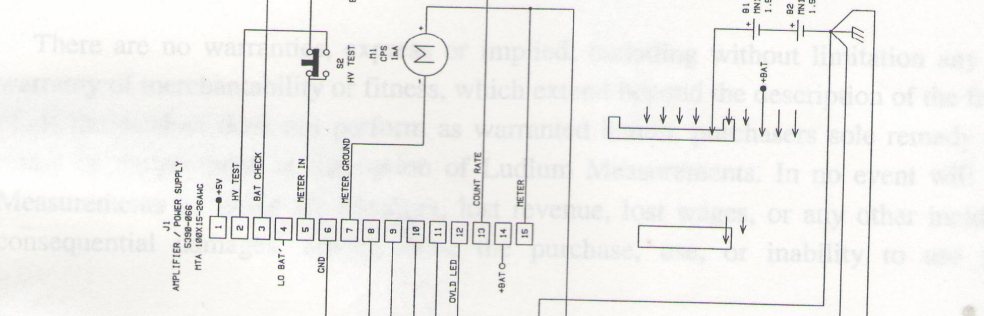
Ludlum Measurements, Inc. warrants the products covered in this manual to be free of defects due to workmanship, material and design for a period of twelve months from the date of delivery. The calibration of a product is warranted to be within its specified limits at the time of shipment. In the event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

This warranty excludes the replacement of vacuum multiplier tubes, G-M and proportional tubes, and other tubes which are subject to wear due to excessive physical abuse or other causes.

There are no warranties or conditions of sale which may limit the application of the law of the State of California in the event of a lawsuit brought against Ludlum Measurements, Inc. or any other person.

Measurement equipment needs to be used properly. Ludlum Measurements, Inc. does not warrant the equipment, please refer to the manual for proper use. All components should include the service repair manual for proper use. Your cooperation in the return of your equipment is appreciated.

LUDLUM MEASUREMENTS
 ATTN: REPAIR DEPARTMENT
 501 OAK STREET
 SWEETWATER, CA 94555
 360-627-4400



UPDATED	LUDLUM MEASUREMENTS, INC.	
JR 208	REV 22/98	TITLE: WIRING DIAGRAM
CHK	DATE: 08/22/98	BOARD: 308-127
ESDA	REV: 22/98	SIZE: D
APPD	BY: LW	MODEL: 2223
	DATE: 10/27/95	SERIES: 308
		SHEET: 127
		SHEET 1 OF 1