



# Air Monitoring

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US/Mexico Border 2025  
Program

Eagle Pass/Piedras Negras  
Exercise



# Air Monitoring

The use of direct-reading instruments to produce real-time data



# Air Sampling

The use of specific media to collect a sample



# Air Monitoring Requirements

Required to determine the appropriate level of respiratory protection

## Specific Entry Air Monitoring Requirements

- Identify IDLH Conditions
- Oxygen Deficiency
- Exposure Over the PEL
- Exposure to Radioactive Materials
- Flammable Atmosphere
- Other Dangerous Conditions





- **Inhalation:** primary pathway for contaminant exposure
- Airborne contaminants can also have a dermal exposure threat
- Air Monitoring Instrumentation:
  - Perimeter vs. Personal air monitoring

# Standard Entry Monitoring Equipment

- Multi-Gas Meter  
(O<sub>2</sub>, H<sub>2</sub>S, LEL, CO, VOCs)
- Compound Specific Meters and/or sensors (as needed)
- Radiation



# Air Monitoring Contaminates

- Mercury Vapor (Lumex)
- Organic Hydrocarbon Compound Vapor (MultiRAE/AreaRAE/TVA)
- Airborne particulates (Dust-Trak/DataRAM)
- Inorganic Gases (Draeger Tubes)



# Air Monitoring Contaminates

- Lower Explosive Limit (MultiRAE/AreaRAE)
- Displaced Oxygen (MultiRAE/AreaRAE)
- Airborne asbestos fibers (Data Ram/Air Sampling)
- Radiation (Ludlum Model 19, Model 2214-2)



# MultiRAE

- Multi-Gas Meter
- Personal protection and point detection
- 25 interchangeable sensor options
- Extensive on-board gas library for VOCs (190 compounds) and combustible gases (55 compounds).



# MultiRAE

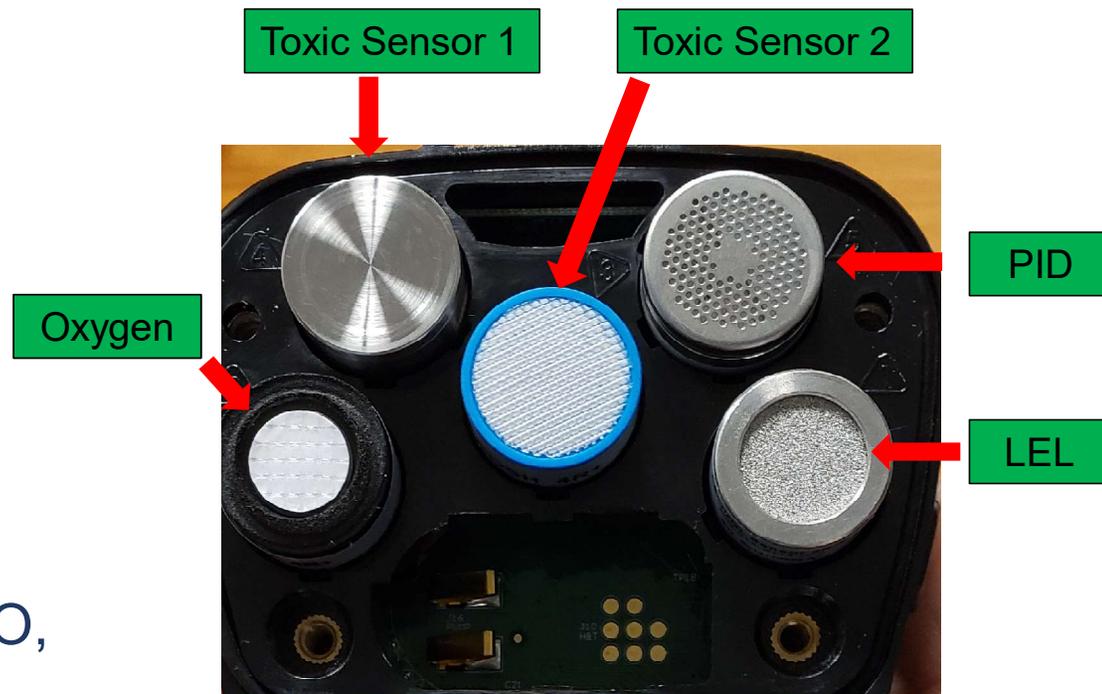
- Intrinsically safe
- Wireless connectivity
- 5 built in alarms including man down
- PID lamp ionization energy (9.8 eV or 10.6 eV)



# MultiRAE Sensors

## COMMON SENSORS

- **Oxygen:** 0 – 30%
- **LEL:** 0 – 100%
- **PID (VOCs):** 0 – 10,000 ppm, Resolution 10 ppb
- **Toxic Gases:** CO, H<sub>2</sub>S, SO<sub>2</sub>, NO, NO<sub>2</sub>, Cl<sub>2</sub>, HCN, NH<sub>3</sub>, PH<sub>3</sub>



# MultiRAE Limitations

- Sensitive to extreme temperatures and high humidity
- Sensor response/soak times –  $t_{90}$
- Sensor cross-sensitivities (interference)
  - Correction factors (CF)

## Combustible Gases and Vapors (LEL-1)

<b>Sensor Type:</b>	Protected catalytic bead
<b>Gases Detected:</b>	Most combustible gases and vapors
<b>Range:</b>	0 to 100%
<b>LEL Resolution:</b>	1% LEL
<b>Response Time (<math>t_{90}</math>):</b>	30 sec.
<b>Bias/Equilibration:</b>	No bias/10 min. after installation
<b>Drift:</b>	< 10% LEL/month
<b>Storage Life:</b>	2 years in sealed container
<b>Operating Life:</b>	2 years in air
<b>Warranty:</b>	2 years from date of shipment
<b>Calibration Gas:</b>	50% LEL of Methane, or 2.5% by volume, balance air
<b>Part Number(s):</b>	014-0101-000, 008-1171-001
<b>Supported Instruments:</b>	AreaRAE, MultiRAE IR, MultiRAE Plus, QRAE, RAEGuard, RAEGuard S

Catalytic Bead LEL-1 Sensor Response Data		
Compound	LEL Relative Sensitivity <sup>1</sup>	LEL CF
Acetone	45	2.2
Ammonia	125	0.8
Benzene	36	2.8
Carbon monoxide	83	1.2
Cyclohexane	40	2.5
Ethanol	59	1.7
Ethyl acetate	45	2.2
Hydrogen	43	2.3
Isobutylene	67	1.5
Isopropanol	38	2.6
Leaded gasoline	36	2.8
Methane	100	1
Methanol	34	2.0
Methyl ethyl ketone	38	2.6
n-Butane	63	1.6
n-Heptane	29	3.5
n-Hexane	30	3.3
n-Octane	26	3.8
n-Pentane	45	2.2
Phosphine	385	0.26
Propane	63	1.6
Propene	67	1.5
Toluene	29	3.5
Turpentine	34	2.9

<sup>1</sup> - Response of the RAE Systems LEL sensor to a range of gases at the same LEL, expressed as percent of Methane response (=100). These figures are for guidance only and are rounded to the nearest 5%. For the most accurate measurements, the instrument should be calibrated with the gas under investigation. See Technical Note TN-156 for more details and more compounds

# MultiRAE Limitations

- Periodic O<sub>2</sub> and VOC sensor drift is possible
- Difficulty detecting chemicals with high ionization energy/potential (i.e., >10.6 eV)

Chemical	Ionization Energy (eV)	Lamp 1 (9.8 eV)	Lamp 2 (10.6 eV)	Lamp 3 (11.7 eV)
Benzene	9.25	0.55	0.47	0.60
Ammonia	10.16	No Response	10.90	5.70
Methylene Chloride	11.32	No Response	No Response	0.89
Methane	12.61	No Response	No Response	No Response
Isobutylene (Cal Gas)	9.24	1.00	1.00	1.00

# Instrument Startup

- Turn on the instrument and allow at least ~15 minutes to warm-up
- The instrument needs to acclimate to the conditions it will be used in
- Ensure instrument accuracy
  - Fresh Air Calibration
  - Bump Test/Calibration



# Bump Test / Calibration

## Fresh Air Calibration

- Every time instrument is turned on
- Prior to any sensor calibration
- Ambient air (upwind of contamination) or Zero air

## Bump Test

- Functional Test
- Before every use

## Full Calibration

- Every 30 days or when the instrument fails a bump test



# Bump Test / Calibration

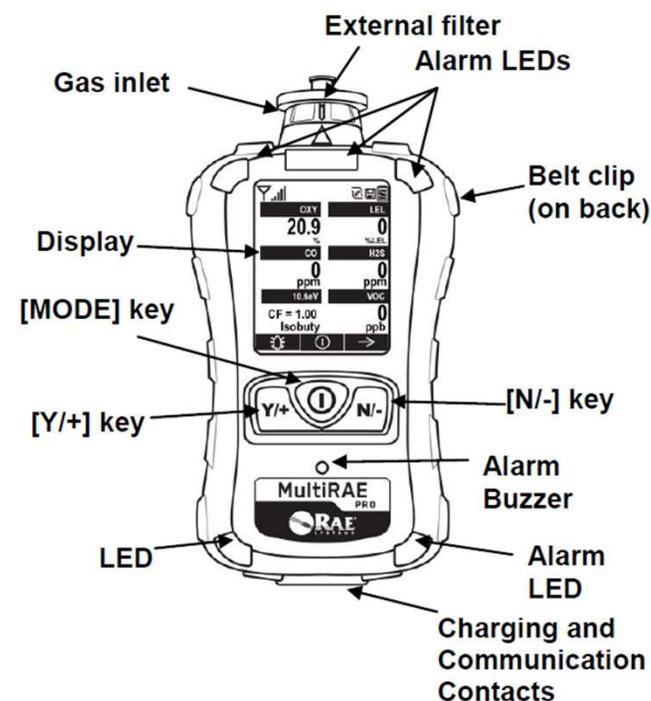
- Sensors store calibration data
- Icons indicate when a calibration or bump test is due
- Sensors should be challenged periodically

	Sensor due for calibration
	Sensor due for a bump test



# How to Calibrate

- Hold down [Mode] and [N/-] keys simultaneously for 5 seconds to enter Programming Mode.
- On the display menu, scroll to the calibration icon using the [N/-] key. Press [Y/+] to enter the calibration menu.
- A list of calibration options will be displayed.
- Scroll to the calibration you want to perform (e.g., Fresh Air, Multi-Sensor Span, Single Sensor Span, bump test) using the [N/-] key. Press the [Y/+] key to select.
- Attach the calibration gas to the unit using a regulator, hose, and calibration adaptor. Open the gas cylinder.
- Press [Y/+] and follow the prompts on the screen.
- Shut off the gas and disconnect the regulator when the calibration is complete.



# AreaRAE Pro

- Multi-gas Meter
  - 7 gas sensors
  - PID (VOCs) - measure in ppb
  - Optional gamma radiation sensor slot
- Typically used for Area/Perimeter monitoring and hot zones
- Intrinsically safe



# AreaRAE Pro

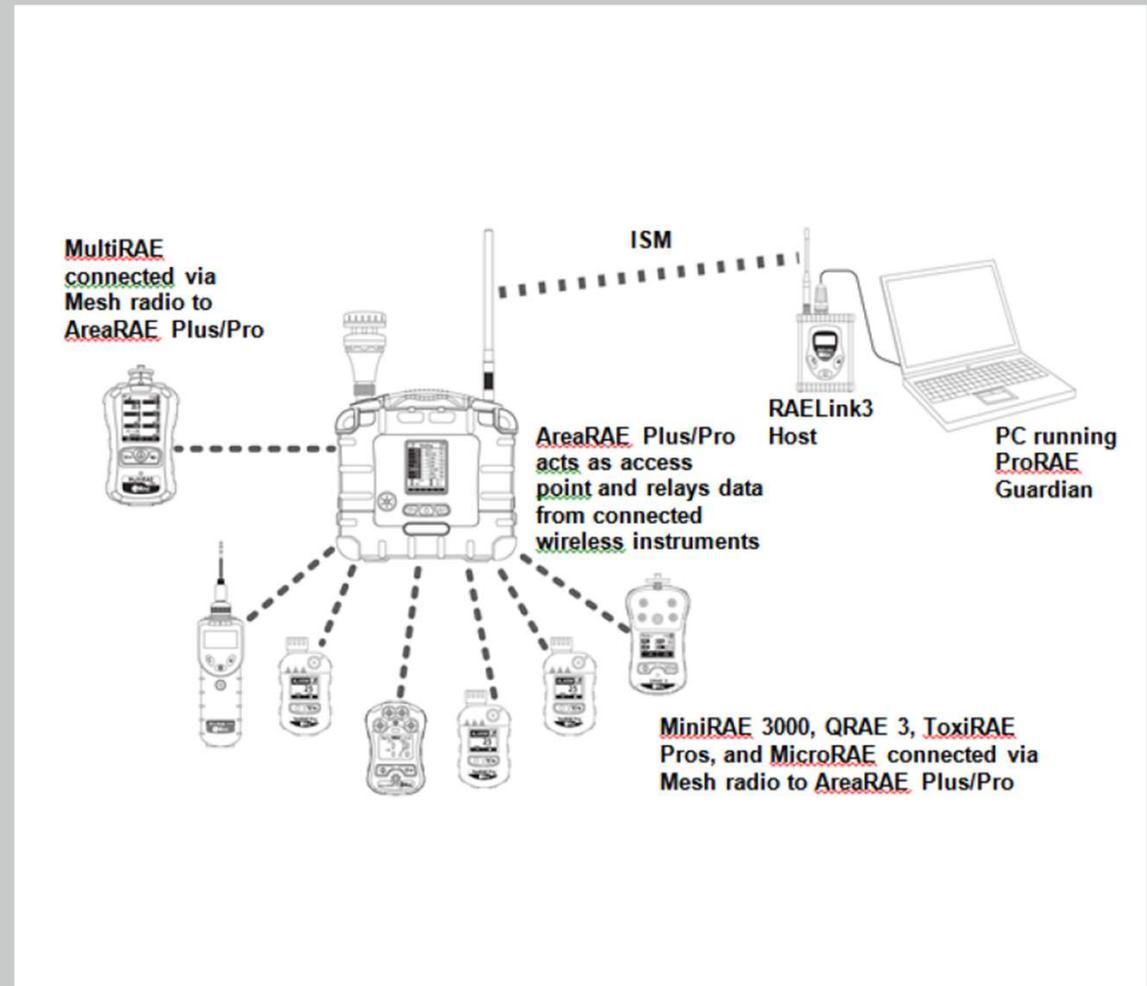
- Interchangeable sensors with the MultiRAE Pro
- Extensive built in library for VOCs (>200 compounds) and combustible gases (>50 compounds)
- Meteorological sensor (RaeMet) removable
  - Can function as weather station
    - Wind speed, wind direction, temperature, relative humidity
  - Internal compass

RaeMet  
Meteorological  
Sensor



# AreaRAE Pro

- Wireless technology (Wi-Fi)
  - GPS
  - Real time monitoring of data via ProRAE Guardian software
  - Long Range - transmit data up to 2 miles away
  - Can be used as a host (MESH network): transmit data for up to 8 devices



# AreaRAE Limitations

- Sensitive to extreme temperatures and high humidity
- Sensor response/soak times –  $t_{90}$
- Sensor cross-sensitivities (interference)
  - Correction factors (CF)
- Sensor poisoning – avoid exposure to high concentrations of solvent vapors

Sensor	Sensor Response Time ( $t_{90}$ , sec.)	Instrument Calibration Time (sec.)	AutoRAE2 Soak Time (sec.)
Cl <sub>2</sub>	30	200	90
ClO <sub>2</sub>	120	150	90
CO <sub>2</sub>	60	120	45 (std. cal.)
HCN	200	230	170
NH <sub>3</sub>	60	180	120
PH <sub>3</sub>	60	120	60
SO <sub>2</sub>	75	120	60

# AreaRAE Limitations

- Some electrochemical sensors (NO, NH<sub>3</sub>) require warm-up time of at least 6 hours when first installed to become stable
- Difficulty detecting chemicals with high ionization energy/potential (i.e., >10.6 eV)

Chemical	Ionization Energy (eV)	Lamp 1 (9.8 eV)	Lamp 2 (10.6 eV)	Lamp 3 (11.7 eV)
Benzene	9.25	0.55	0.47	0.60
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Methane	12.61	No Response	No Response	No Response
Isobutylene (Cal Gas)	9.24	1.00	1.00	1.00

# Bump Test / Calibration

## Fresh Air Calibration

- Every time instrument is turned on
- Prior to any sensor calibration
- Ambient air (upwind of contamination) or Zero air

## Bump Test

- Functional Test
- Before every use

## Full Calibration

- At least every 180 days or when the instrument fails a bump test



# Bump Test / Calibration

- Sensors store calibration data
- Icons indicate when a calibration or bump test is due
- Sensors should be challenged periodically
- Allow instrument to warm up for 20 minutes before calibrating

	Sensor due for calibration
	Sensor due for a bump test



# How to Calibrate

## Bump Testing and Calibration Setup

Manually calibrate using a fixed-flow regulator (flow rate between 0.5 and 1.0 liters per minute) and the supplied special calibration adapter that covers the gas inlet.

1. Connect the gas cylinder, flow regulator, and tubing (must use Teflon tubing for a PID sensor) to the instrument.
2. With the instrument in Normal Mode, enter Programming Mode by pressing and holding both [MODE] and [N/-] until the password screen appears.
3. Input the 4-digit password. (The default password is "0000." If you do not know the password, select "Done.") Then follow the menus to select single- or multi-sensor bump test, zero, or span calibration.

**Important!** After a bump test or calibration, disconnect tubing (if used) to ensure correct readings.

12.

## Fresh Air Calibration

This procedure determines the zero point for all the sensors that require a zero calibration. For the oxygen sensor, Fresh Air calibration sets the point equal to the concentration of oxygen in ambient air (approximately 20.9% volume). To perform Fresh Air calibration on multiple sensors at the same time:

1. Connect the instrument's inlet to a source of dry, clean ambient air.
2. At the Calibration Menu, select "Fresh Air." Press [Y/+] once to enter the fresh air calibration sub-menu.
3. Start the flow of dry zero air, if used.
4. Press [Y/+] to start fresh air calibration.
5. A countdown screen appears. You can abort the calibration at any time during the countdown by pressing [N/-].
6. After completion, shut off the flow of zero air (if used) and remove any connected tubing.

13.

## Multi-Sensor Span Calibration

Depending on the configuration of your AreaRAE Plus/Pro and the span gas you have, you can perform a Span calibration simultaneously on multiple sensors.

The selected sensors are shown on the screen, along with the concentration settings for their Span gas. With calibration gas connected to the instrument, start a multi span by applying gas to the instrument. Calibration should start after a few seconds. If not, press [Y/+] . If you do not want to perform a multi span, press [MODE].

**Note:** You can abort a multi span by pressing [N/-] once testing has started.

When the Multi Span is done, a screen is shown, with the sensor names and either "Pass" or "Fail" shown next to them.

14.

## Single Sensor Zero Calibration

This allows you to perform zero (fresh air) calibration on individual sensors. Even though most toxic gas sensors can be zeroed in fresh air, some sensors such as a parts-per-billion PID sensor for volatile organic compounds (VOCs) should not be zeroed in fresh air. VOCs are normally present in ambient air, so zeroing these sensors in ambient air will not allow for a true zero to be set for such sensors. The parts-per-billion PID sensor with should only be zeroed with zero air or in ambient air using a charcoal filter or a VOC zeroing tube.

1. If you are using a charcoal filter, connect it to the instrument.
2. If you are using dry air, connect the instrument to a source of zero air.

3. At the Calibration Menu, select "Single Sensor Zero." Press [Y/+] once to enter the zero calibration sub-menu.
4. Start the flow of zero air, if used.
5. Press [Y/+] to start zero calibration.
6. A countdown screen appears. You can abort the calibration at any time during the countdown by pressing [N/-].
7. If the calibration is not aborted, the display shows the sensor names and tells you whether the zero calibration passed or failed, followed by the sensors' zero calibration readings.

## Multi Sensor Bump

Depending on the configuration of your AreaRAE Plus/Pro and the span gas you have, you can perform a bump test simultaneously on multiple sensors.

The selected sensors are shown on the screen. With calibration gas connected to the instrument, start a multiple bump test by applying gas to the instrument and pressing [Y/+] . If you do not want to perform a multiple bump test, press [MODE].

**Note:** You can abort a multiple bump test by pressing [N/-] once testing has started.

When the Multi Bump test is done, a screen is shown, with the sensor names and either "Pass" or "Fail" shown next to them.

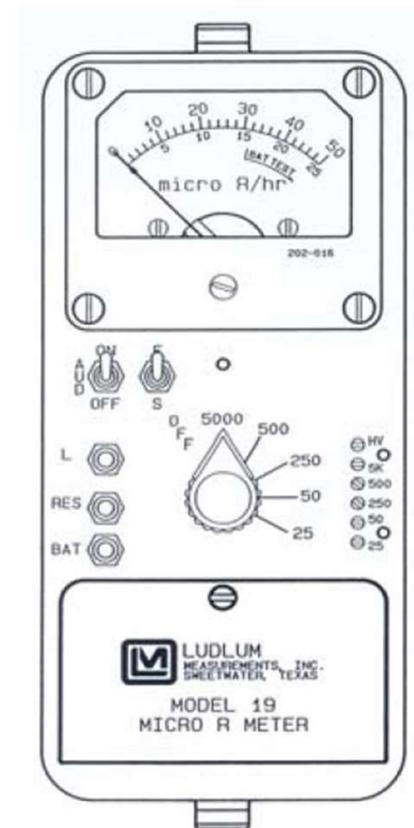
# Ludlum Model-19 Micro R

- Radiation meter
- Real-time measurements of low-level gamma radiation
- Initial entry
  - Survey items or people that may have come in contact with radiation
- Internal 1" x 1" sodium iodide scintillator
  - Range: 0 to 5,000 micro-roentgens per hour ( $\mu\text{R/hr}$ )
- Limitation – only gamma and x-ray radiation



# Start-up and Operation

- Insert batteries
- Check battery levels by depressing the BAT button
- Select 0 - 5000  $\mu\text{R/hr}$  range with range selector



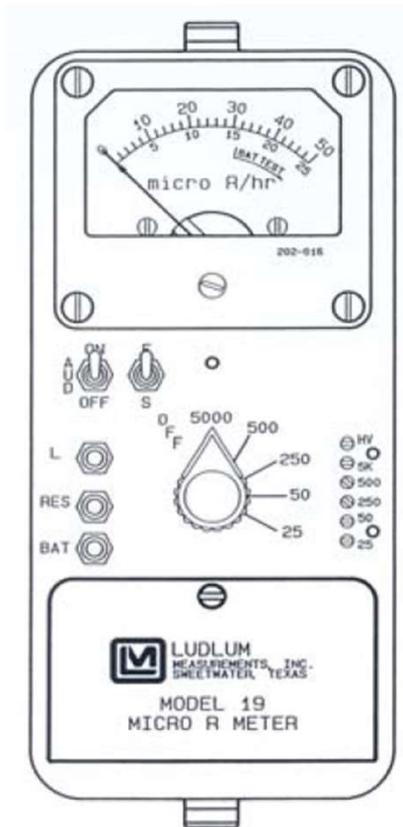
# Functional Test

- Prior to using perform Functional Test
  - Test meter against source - place check source directly against dimple on front while in fast and slow modes
  - Use the same check source, placed in same location and oriented the same way every time
- Instrument response should be within  $\pm 20\%$  of last calibration value
  - Yearly manufacturer calibration required
- Press reset (RES) button to confirm pointer returns to zero



# Operation

- Set audio switch (AUD ON/OFF) as desired
- Set the meter response switch (fast/slow [F/S])
  - Not recommended to keep audio off and slow response – may miss higher exposure rate field
- Check and record background radiation level
- Begin data collection



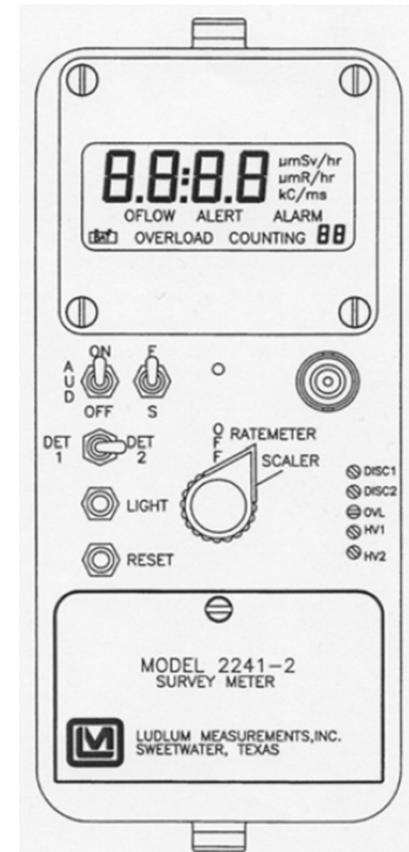
# Ludlum Model 2241-2

- Radiation meter – Ratemeter/Scaler
- Scan surfaces and people
  - Must be close to surface
- Utilizes different probes
  - Geiger-Mueller pancake detector (Model 44-9) – alpha, beta, some gamma
  - Gamma Scintillation Detector (Model 44-2) – gamma, x-ray
- Typically set to read in counts per minute (cpm)



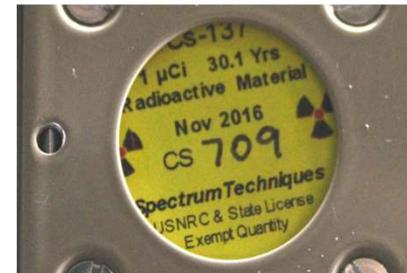
# Start-up and Operation

- Insert batteries
- Connect a “C” cable to the unit and desired probe
  - Toggle detector switch to appropriate detector (Det 1 or Det 2)
- Turn dial switch to Ratemeter
- Check battery level on screen
- To illuminate meter face, press LIGHT button



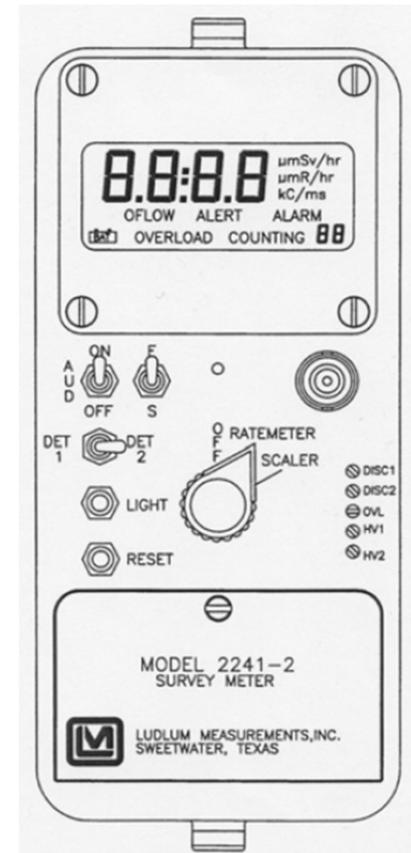
# Functional Test

- Prior to using perform Functional Test
  - Test meter against side mounted source (Cesium-137) – open check source cover, place detector on the center of the check source
  - Check in both fast in slow modes
- Instrument response should be within  $\pm 20\%$  of last calibration value
  - Yearly manufacturer calibration required
- If using more than one detector, check both. Shut off unit, switch probes, then perform another functional test



# Operation

- Set audio switch (AUD ON/OFF) as desired
- Set the meter response switch (fast/slow [F/S])
- Select method of measurement
  - Ratemeter – average counts tallied over specified time period
  - Scaler – displays total counts tallied over specified time period
- Check and record background radiation level
- Begin data collection





**THANK YOU**  
**Any Questions?**