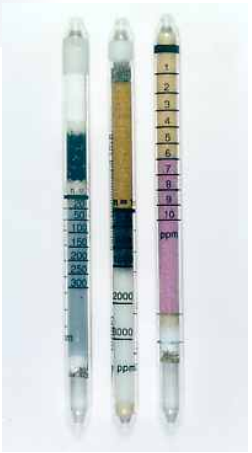
Lesson Topic 7.5

GAS FREE ENGINEERING EQUIPMENT



Enabling Objectives

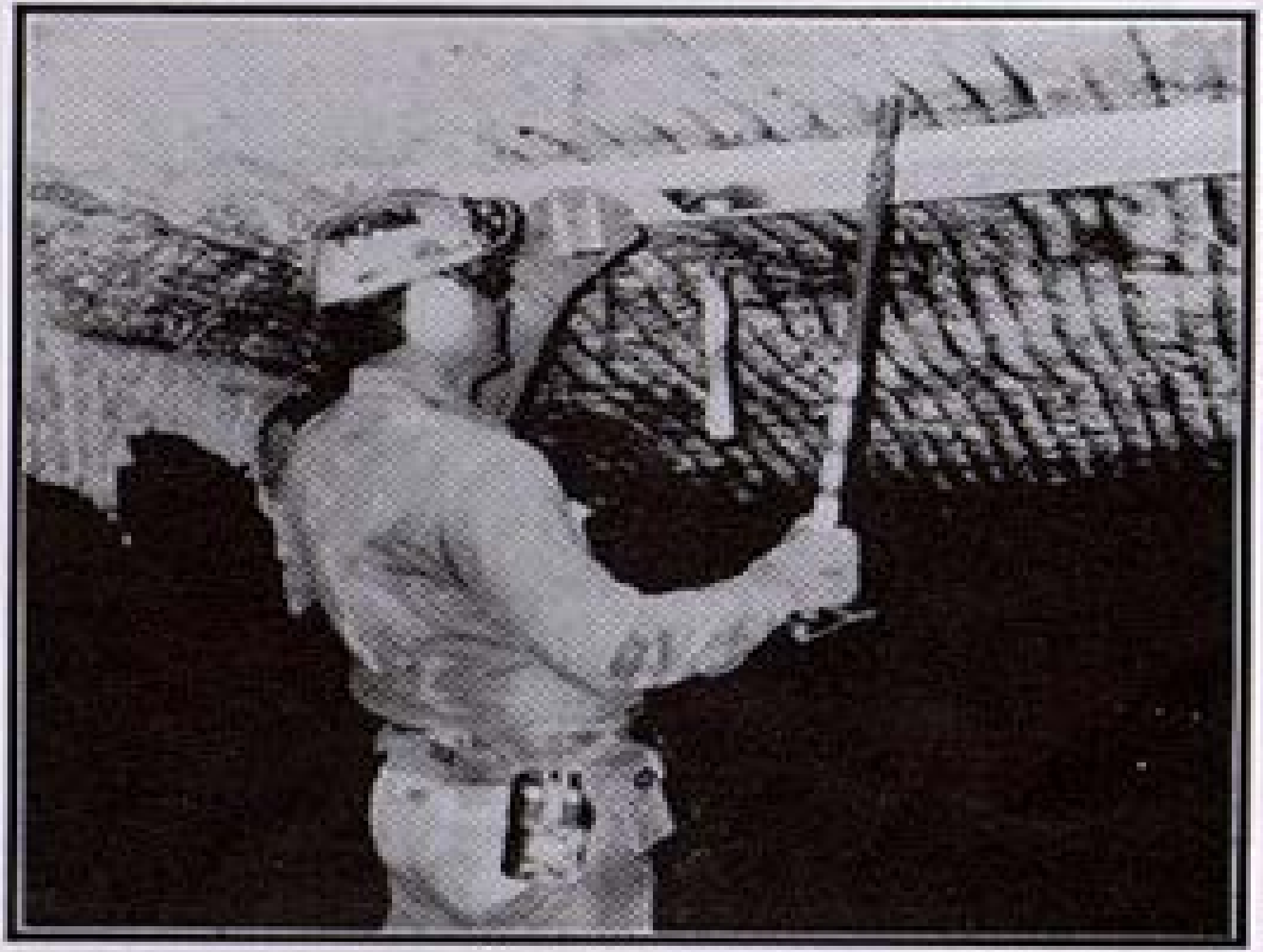
- DESCRIBE the operating procedures, parameters, safety precautions, and maintenance requirements of the PHD Ultra.
- EXPLAIN the principles of operation of the Draeger Gas Detector.
- DESCRIBE the operating procedures, parameters, safety precautions and maintenance requirements for the Draeger Gas Detector.
- DEMONSTRATE: Testing gas free engineering equipment prior to use.
- DEMONSTRATE: Opening a draeger tube and conduct test.

HISTORY OF EQUIPMENT

In the early 1700's, coal mines were being dug deeper and so began to encounter methane gas. Many miners using open lights for lighting lost their lives in explosions of the methane and coal dust. During this period, a "fireman" or "fire boss" was sent into the mine prior to the beginning of the shift with an open flame lamp on the end of a long pole, wearing wetted clothes in an attempt to provide protection against burns. He would thrust the flame into areas where methane might accumulate to detect and burn it out. It was not a long term career.

HISTORY OF EQUIPMENT

In the early 1800's, efforts were focused on making the mines safer. Canaries, being extremely sensitive to the presence of methane, were sometimes taken into the mines to provide advance warning. About 1815, several men independently came up with similar designs for a "safety lamp", the most famous of these inventors being Sir Humphry Davy. The flame safety lamp is sometimes called the Davy Lamp.



Four Gas Analyzer

Four Gas Analyzer
General Information

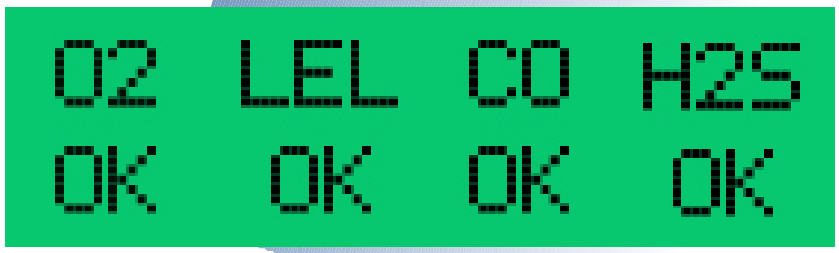
- Portable battery powered instrument
- Monitors up to four gases
  - Oxygen 19.5-22%
  - Explosive 10%
  - Hydrogen Sulfide 10 PPM
  - Carbon Monoxide 35 PPM

Four Gas Analyzer

Modes of Operation

Four Gas Analyzer
Modes of Operation

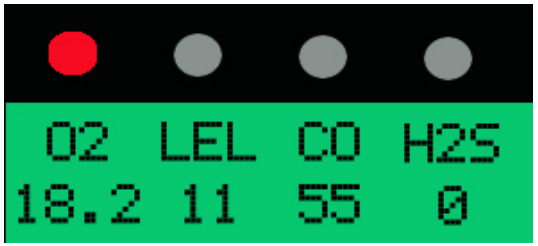
- Text only mode

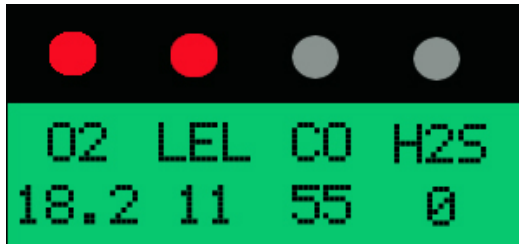


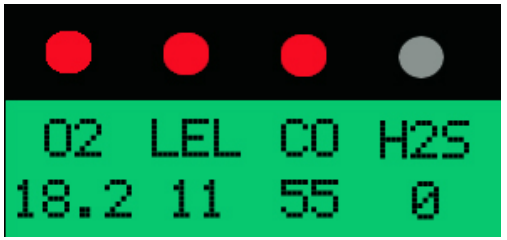
- Good mode when used for PPE
- Will display numerical values in alarm condition

Four Gas Analyzer
Modes of Operation

- Basic Mode
  - Auto calibration mode can be accessed.
  - Zero calibration
  - Span calibration
  - LED (red) light flashes above the corresponding gas when it exceeds a preset alarm value.







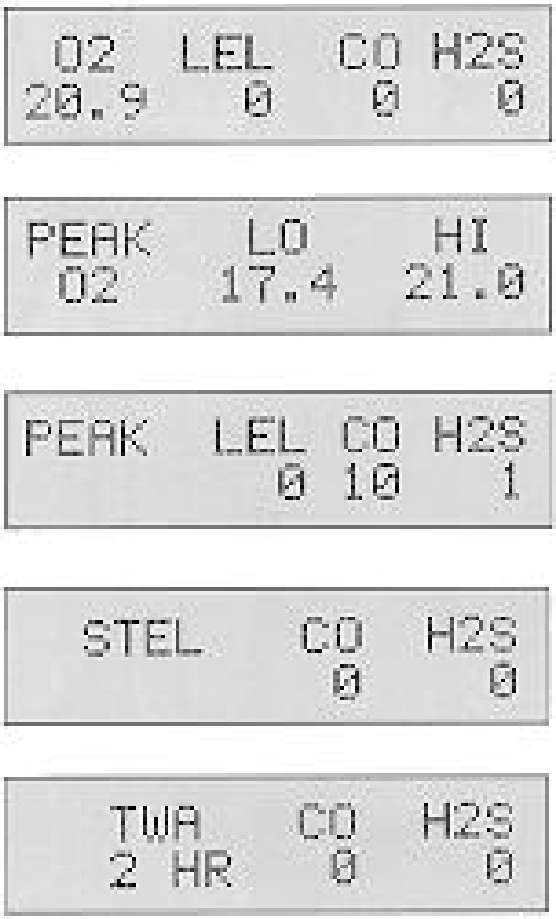
Four Gas Analyzer
Modes of Operation

- Basic Mode (Cont'd)

NOTE:The Basic Mode is the ideal mode to use when performing Gas Free operations.

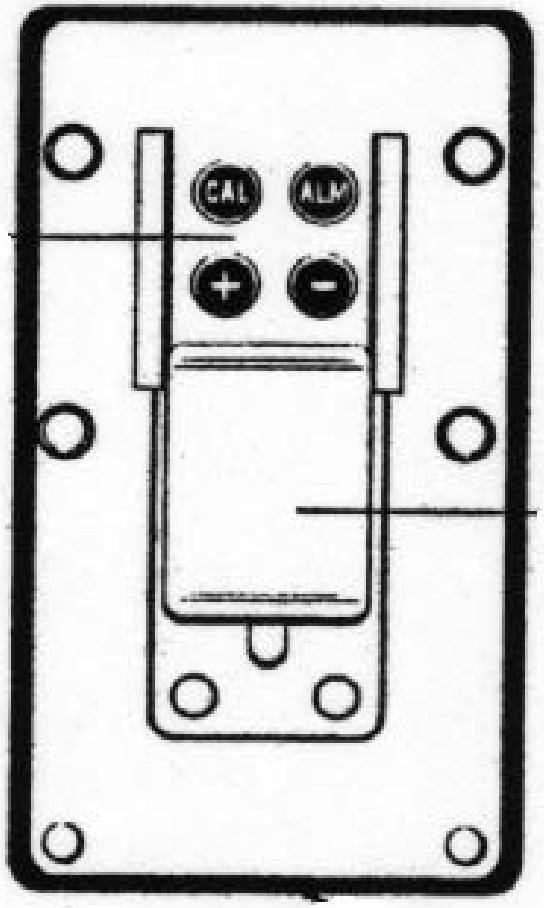
Four Gas Analyzer
Modes of Operation

- Technician Mode
  - Simply adds the following functions
  - to the basic mode.
    - Peak readings
    - STEL readings
    - TWA readings



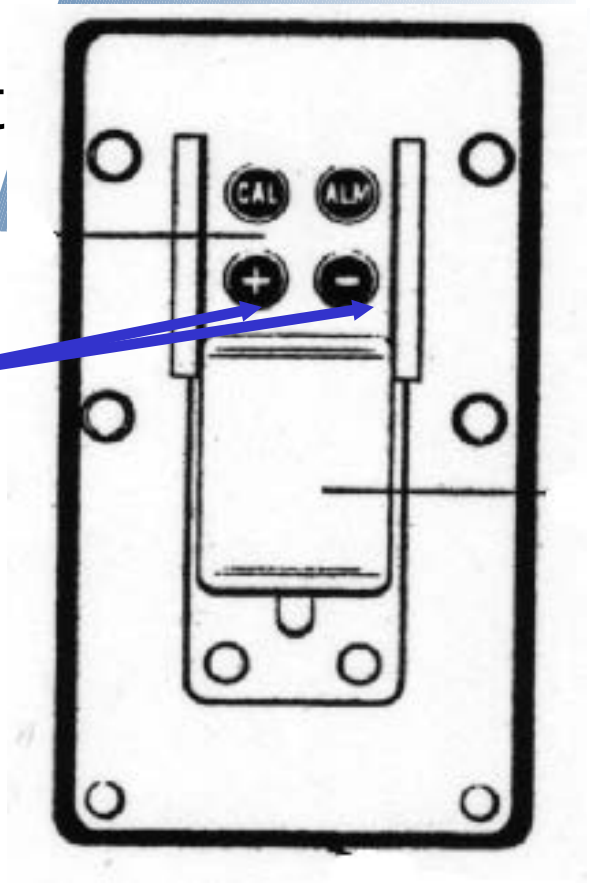
Four Gas Analyzer
Modes of Operation

Changing operating modes can be done while unit is in operation. Previously obtained data will not be lost.



Four Gas Analyzer
Changing Modes

- Slide belt clip on back of unit downward
- Push the "+" and "-" buttons at the same time to change operating modes.
- Text, basic or Technician



Four Gas Analyzer

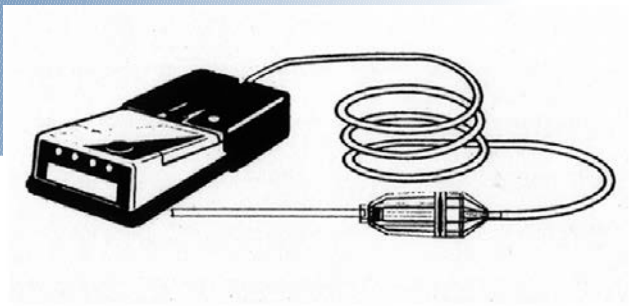
Methods of sampling

Four Gas Analyzer
Methods of sampling

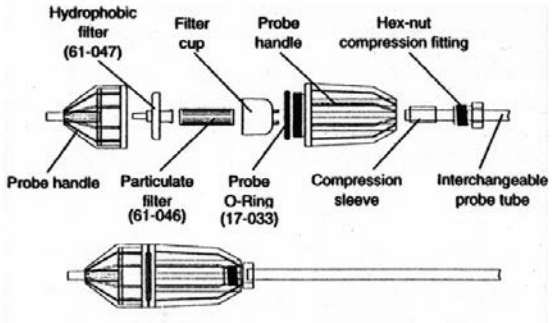
- Diffusion
  - Worn on the belt, used with its shoulder strap, or held by hand.
  - Once turned on, the PhD Ultra monitors continuously.

Four Gas Analyzer
Methods of sampling

- Continuous (slip-on) sample draw pump and probe assembly.
- 1 ft per second



- Draws power from battery pack on instrument
- Sample probe must be use



Four Gas Analyzer
Sensors

- The "smart" sensors are easily replaced

Four Gas Analyzer
Sensors

- LEL Combustible gas sensors attempt to burn a sample of air and are governed by fire chemistry. If there is too much fuel the sample will not burn.
- The PHD ultra displays an “X” in the LEL reading if the instrument is in a UEL environment.

Four Gas Analyzer
Batteries

- Interchangeable NiCad or alkaline battery packs
- Rechargeable
- Either pack provides up to 12 hours of continuous operation in the diffusion sampling.

Four Gas Analyzer Operation/Calibration Procedures

Note:

A **Span Calibration Gas Test** is Required before each days use.

A **Fresh Air Test** is required before each use.

Four Gas Analyzer Operation/Calibration Procedures

Accuracy Check ("Bump Test")

- Push the mode button
- Allow readings to stabilize
- At least 3 minutes

O2	LEL	CO	H2S
20.9	0	0	0

Four Gas Analyzer Operation/Calibration Procedures

Accuracy Check ("Bump Test")

- When readings have stabilized, verify accuracy by exposing sensors to known concentration test gas using the following steps

Four Gas Analyzer Operation/Calibration Procedures

Automatic "Zero" Calibration

- Press the Mode Button 3 times in rapid succession (within 2 seconds) to enter "Auto Calibration Mode"

Four Gas Analyzer Operation/Calibration Procedures

Automatic "Zero" Calibration

- Press Mode within 5 seconds (when prompted) to make "Auto Zero" adjustment

Four Gas Analyzer Operation/Calibration Procedures

Automatic "Zero" Calibration

- When "Auto-Zero" is completed, you will be prompted to press Mode to perform automatic Span Calibration (By not pressing the mode button, this allows the instrument to resume normal operation)

Four Gas Analyzer Operation/Calibration Procedures

SPAN CALIBRATION TEST

- Attach calibration / sample draw adapter to PhD Ultra and begin flowing gas to the sensors
- Allow at least 45 seconds for readings to stabilize

Four Gas Analyzer Operation/Calibration Procedures

SPAN CALIBRATION TEST

- Verify that readings are =/> value printed on calibration cylinder label and confirm appropriate alarms are activated
- > amount must not exceed 10%

Four Gas Analyzer Operation/Calibration Procedures

FRESH AIR TEST

- Slide belt clip on back of unit downward.
- Depress the CAL button once.
- Observe the display, when prompted depress the CAL button again.
- When completed reading should be

  20.9 - O2, 0 - EXP, 0 - CO, 0 - H2S
- Slide belt clip on back of unit up.

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Internet

GasAlertClip ™
USCG ONLY

- O_2 or H_2S detector only!
- Electro-chemical sensor
- Use at entrance to enclosed space
- Two year battery life
- Must hold reset button for 5 seconds weekly!
- Continuously ON
- One-button activation/test
- Wide visual alarm bar

GasAlertClip ™
USCG ONLY

- Two alarm levels LOW and HIGH
- Vibrator alarm
- Continuous LCD confidence display
- No battery or sensor replacement
- No calibration required

- LOW and HIGH setpoints displayed on demand in ppm or %
- Compact and lightweight--weighs only 2.6 oz. (73 g)

GasAlertMicro ™
USCG ONLY

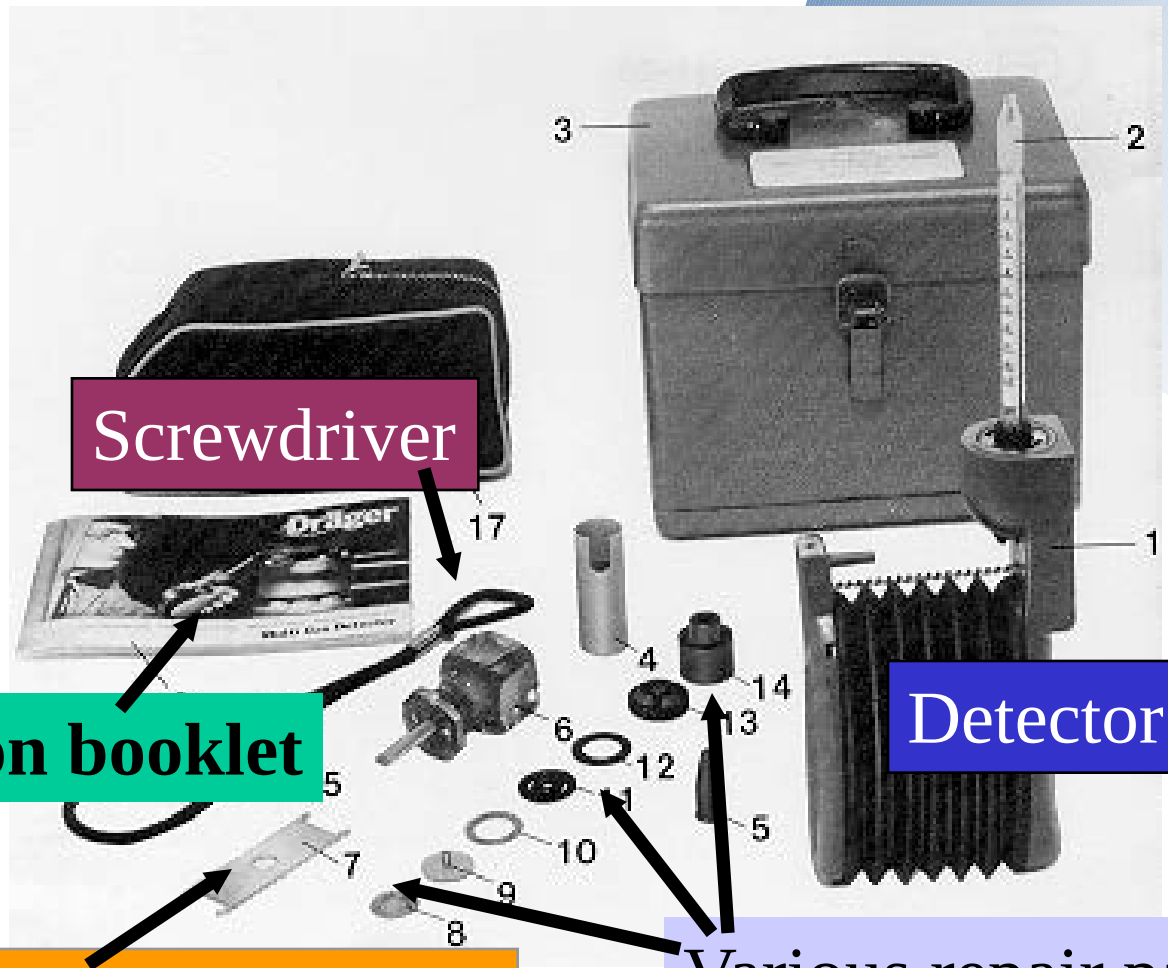
- Detect O_2, H_2S, CO, LEL
- Use at entrance to enclosed space
- High-contrast LCD shows continuous and simultaneous real-time gas concentrations
- LOW, HIGH, TWA (time weighted average) and STEL (short-term exposure limit) alarms
- 95 dB audible alarm
- Dual visual alarm bars

GasAlertMicro ™
USCG ONLY

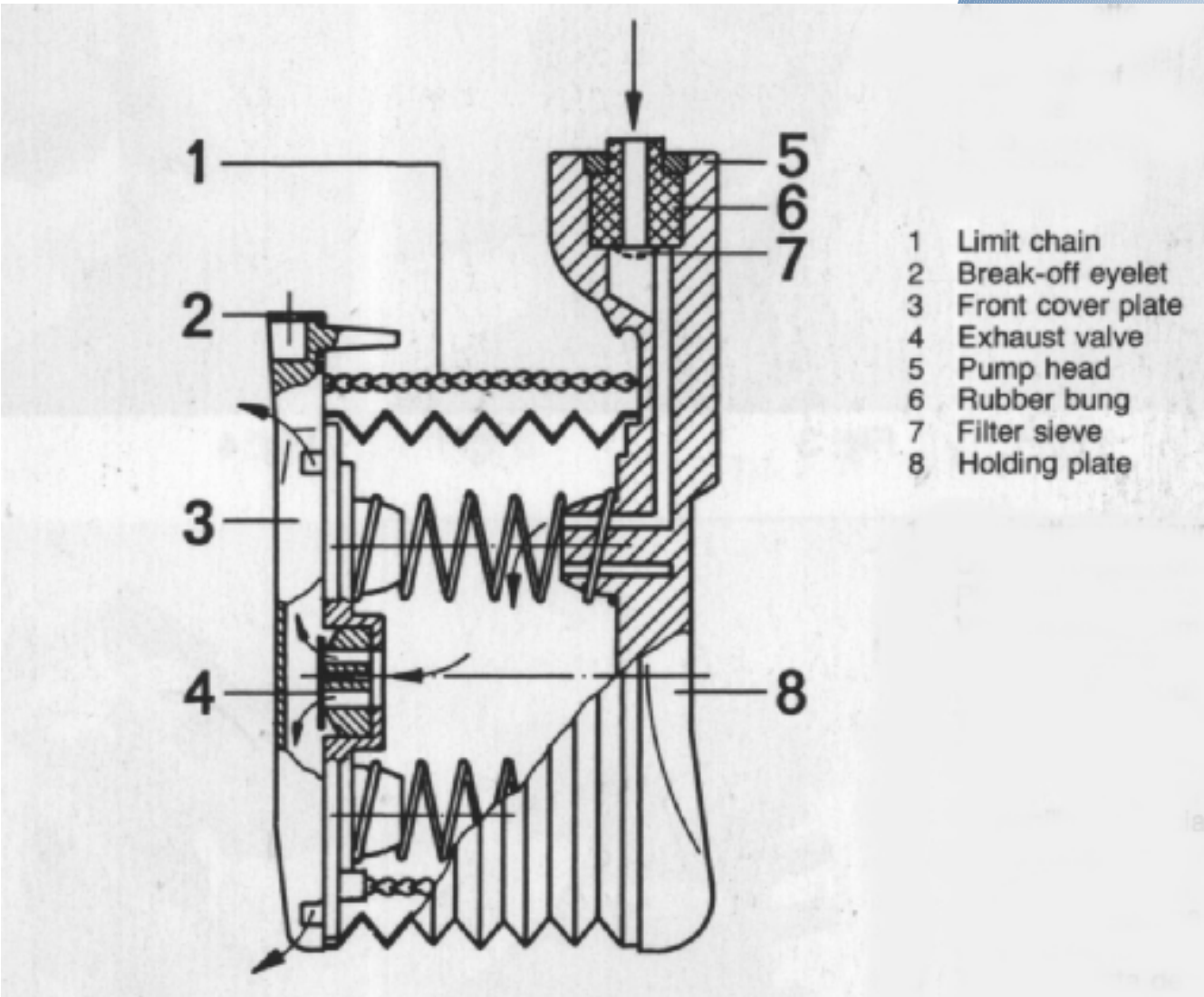
- vibration alarm (standard)
- Built-in concussion-proof boot
- Backlight in low light (auto), in alarm (auto) and on demand
- Simple auto zero and auto calibration with diagnostics protection
- Records and displays TWA, STEL & peak exposures to gas on demand
- Continuous instrument status advice
- Battery 4-16 hours
- Accessories manual aspirator pump
- Confined space kits

Draeger (Model 31) Toxic Gas Detector

Draeger (Model 31) Toxic Gas Detector



Draeger (Model 31) Toxic Gas Detector
Parts of the pump (Bellows)



Draeger (Model 31) Toxic Gas Detector Preparation

- Check pump prior to each use
- Insert unbroken tube and compress

  bellows pump.
- If bellows does not completely

  expand after 30 minutes, pump is good.

Draeger (Model 31) Toxic Gas Detector
Principle of Operation

- The resistance of the tube causes the air in the bellows to escape through the outlet valve, when the bellows is compressed.

- The volume of air sucked through the Draeger tube is <u>100 cm3</u> per stroke.

Draeger (Model 31) Toxic Gas Detector
Gas Sampling Process

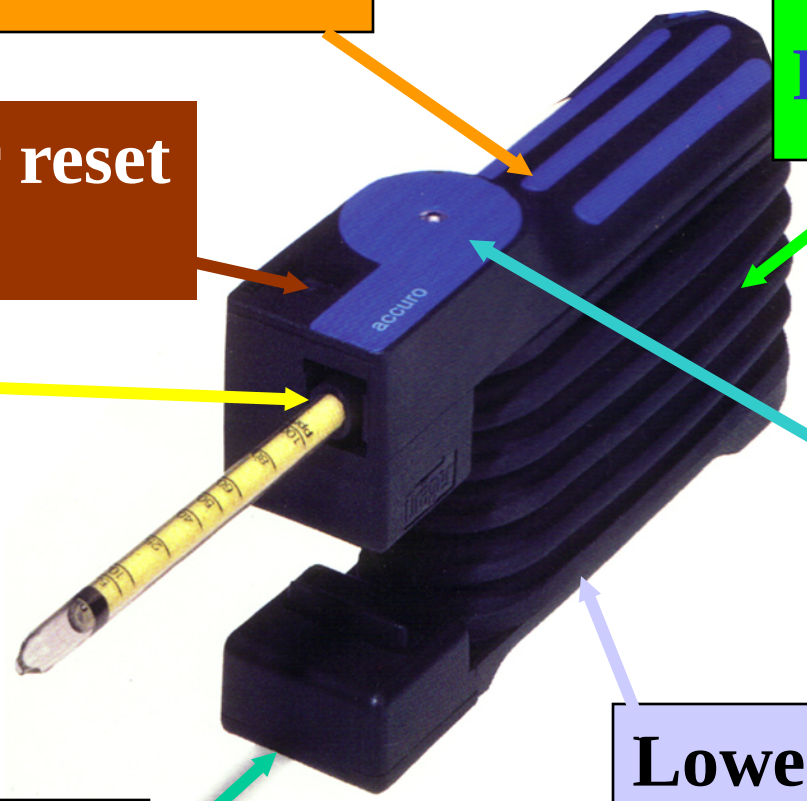
- Break off both tips of the Draeger tube
- Tightly insert Draeger tube in the pump head with the arrow pointing towards the pump.
- Fully compress the bellows.
- Repeat the suction process as specified in the tube operating instructions.

Draeger (Model 31) Toxic Gas Detector Maintenance

- Any leaks encountered during the leak test can usually be eliminated by cleaning the valve disk.
- If the valve disk is sticky, brittle, hard or cracked, it must be replaced.
- The filter sieve must be cleaned, about every four weeks when the bellows is used frequently.

Draeger (accuro) Toxic Gas Detector

Draeger (accuro) Toxic Gas Detector



Cover plate

Rubber bellows

Stroke counter reset button

Socket

End-of-Stroke Indicator

Lower pump plate

Tube opener with ceramic cutter

Draeger (accuro) Toxic Gas Detector

- Principle of operation is identical to the Model 31

Draeger (accuro) Toxic Gas Detector Preparation for use

- Insert unopened Draeger tube into the socket
- Squeeze pump completely and release.
- Pump is adequately leak-proof if the end-of-stroke indicator has not appeared after 15 minutes.
- The end of stroke indicator will turn white at the end of a stroke.

Draeger (accuro) Toxic Gas Detector
Preparing the tube

- Select the appropriate Draeger tube
- Break off both tips of the tube and insert into pump.

WARNING:Be careful in opening the Draeger tube since glass splinters may come off. Keep the pump facing downwards by holding the loop handle, to prevent glass splinters from entering the pump. The tips of the tubes have sharp edges; risk of injury.

Draeger (accuro) Toxic Gas Detector
Making a Measurement

- Same as Draeger Model 31

<u>NOTE</u>: When the end-of-stroke indicator appears (white), the pump is ready to be squeezed again.

Draeger Toxic Gas Detector Tubes

See Appendix L-6 in NSTM 074 V3r4

for required list & NSN

Draeger Toxic Gas Detector Tubes

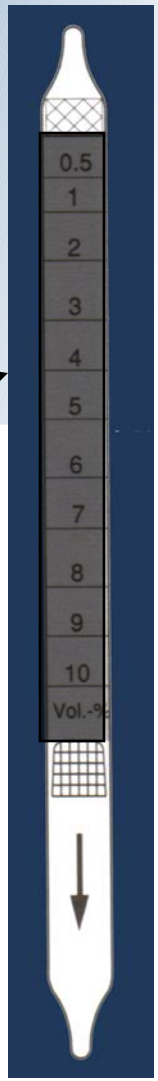
Carbon Dioxide (CO^2)

- Reads in percent
- Two scales
  - **n = 1**
  - **n = 5**

Draeger Toxic Gas Detector Tubes

Carbon Dioxide (CO^2)

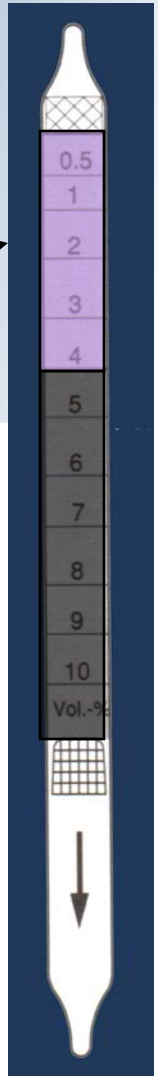
- **Tube contains two layers**
  - **White colored pre-layer**
  - **White colored <u>indicating layer</u>**



Draeger Toxic Gas Detector Tubes

Carbon Dioxide (CO^2)

- Turns violet in the presence of CO^2



Draeger Toxic Gas Detector Tubes

Carbon Dioxide (CO^2) Measurement and evaluation

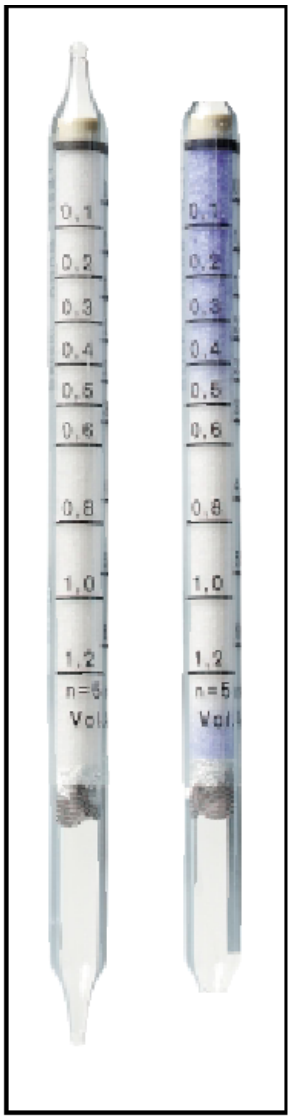
- Break off both tips of the tube
- Insert the tube tightly into the pump
- Give 1 stroke
- Read discoloration (violet) on the n=1 scale.

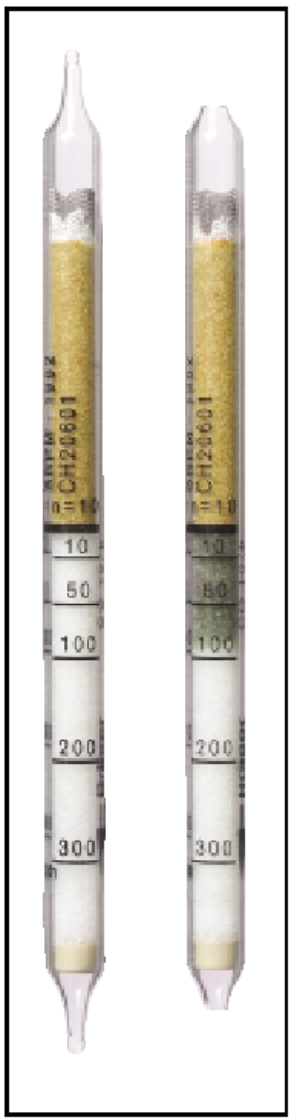
Draeger Toxic Gas Detector Tubes

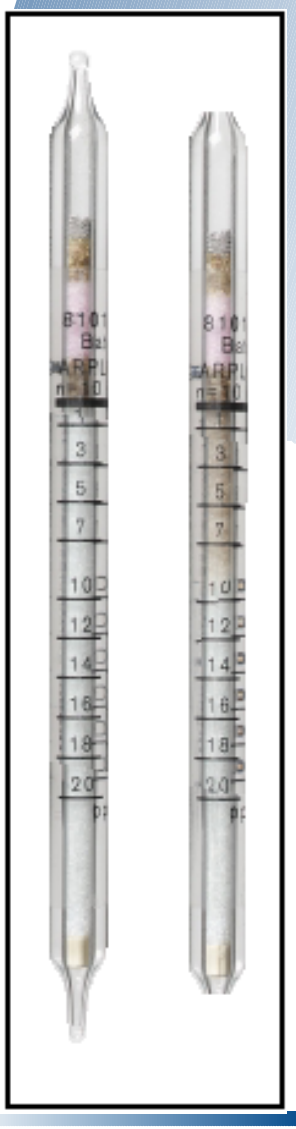
Carbon Dioxide (CO^2) Measurement and evaluation

- If no discoloration, give 4 additional strokes and read on the n=5 scale.
- Record results

Carbon Dioxide 0.1%/a **Carbon Monoxide 10/b** **Hydrogen Sulphide 1/d**

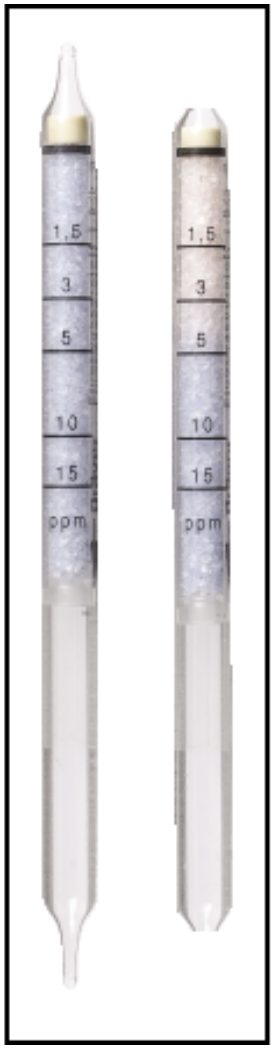




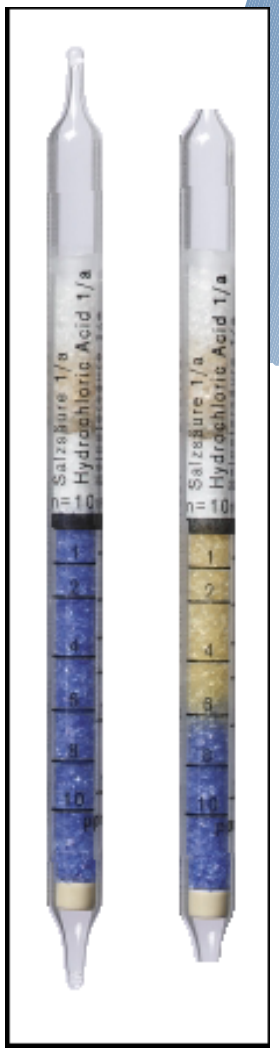


Hydrocarbons 2

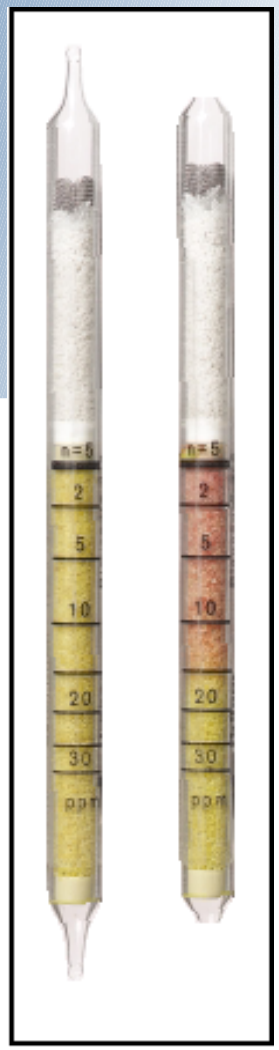
Hydrogen Fluoride 1.5/b



Hydrochloric Acid 1/a



Hydrocyanic Acid 2/a



HYDROCARBON 2 TUBE

SUCK AIR OR GAS SAMPLE THROUGH TUBE WITH AN APPROPRIATE NUMBER OF STROKES, UNTIL THE COLOR SHADE OF THE INDICATING LAYER CORRESPONDS TO THAT OF THE COMPARISON LAYER. DO NOT EFFECT MORE THAN 24 STROKES.

Strokes	3	5	7	12	16	24
Mg/L	23	14	10	6	4.5	3

HYDROCARBON 2 TUBE

STROKES

3 = 23 Mg/L = 23,000 Mg/M3

5 = 14 Mg/L = 14,000 Mg/M3

7 = 10 Mg/L = 10,000 Mg/M3

12 = 6 Mg/L = 6,000 Mg/M3

16 = 4.5 Mg/L = 4,500 Mg/M3

24 = 3 Mg/L = 3,000 Mg/M3

PEL = 350 Mg/M3 (DFM/JP-5)

Order No.
CH 25401

Hydrocarbons 2

Standard Measuring Range	:	3 to 23 mg hydrocarbon / L
Number of Strokes (n)	:	24 to 3
Time for Measurement	:	max. 5 min
Standard Deviation	:	± 30 to 40 %
Colour Change	:	pale yellow —> brown

Ambient Operating Conditions

Temperature	:	0 to 35 °C
Absolute Humidity	:	3 to 15 mg H_2O / L

Reaction Principle

$C_8H_{18} + SeO_2$ —> brown reaction product

Cross Sensitivity

Aliphatic and aromatic hydrocarbons are indicated. It is impossible to differentiate them.

Aromatic hydrocarbons (e.g. benzene, toluene) produce a reddish colour in the indication layer, the aromatic content of a mixture should not exceed 50%.

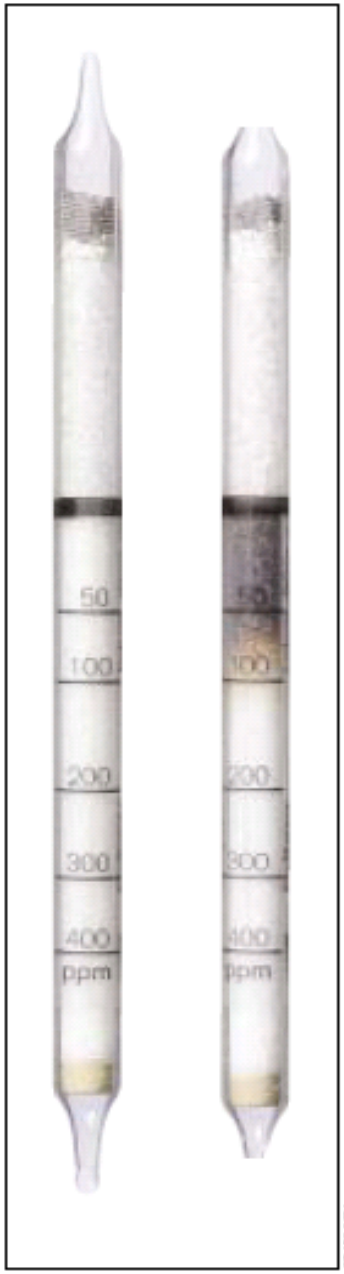
Carbon monoxide in the TLV range does not interfere.

Additional Information

The standard deviation is valid for hydrocarbon mixtures with boiling points in the range of 50°C to 200°C and in technical gases, (e.g. extraction benzene and carburetor fuels).

Toluene 50/a

Order No.
81 01701



Standard Measuring Range	:	50 to 400 ppm
Number of Strokes (n)	:	5
Time for Measurement	:	app. 1.5 min
Standard Deviation	:	± 10 to15%
Colour Change	:	white —> brown

Ambient Operating Conditions

Temperature	:	10 to 30 °C
Absolute Humidity	:	5 to 12 mg H_2O / L

Reaction Principle

Toluene + I_2O_5 + H_2SO_4 —> I_2

Cross Sensitivity

Xylenes are indicated, but with a lower sensitivity.

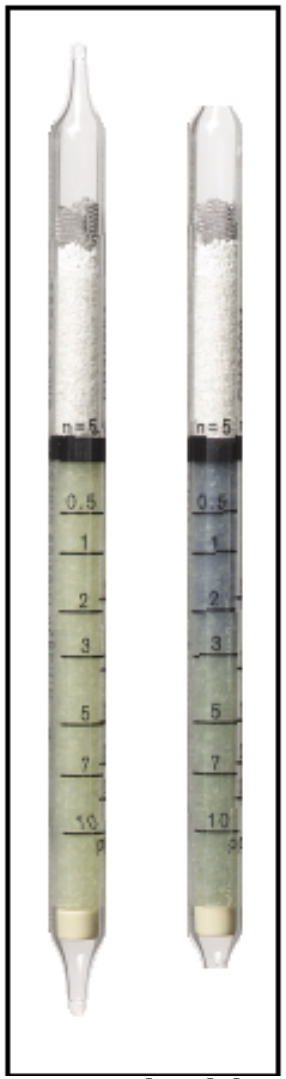
Benzene discolours the entire indicating layer a diffuse yellow.

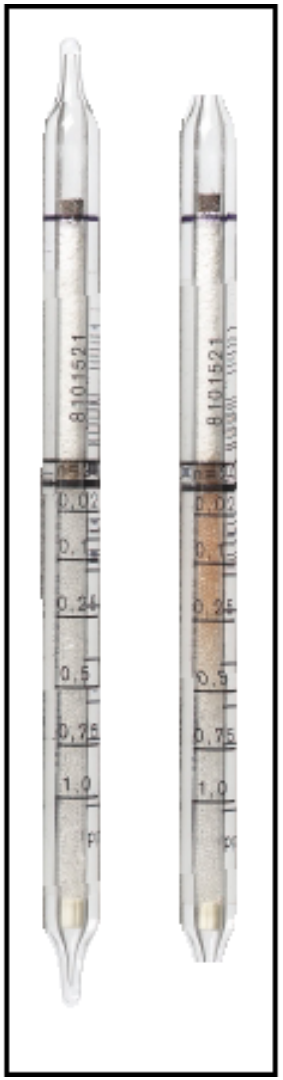
Petroleum hydrocarbons discolour the entire indicating layer a diffuse reddish brown.

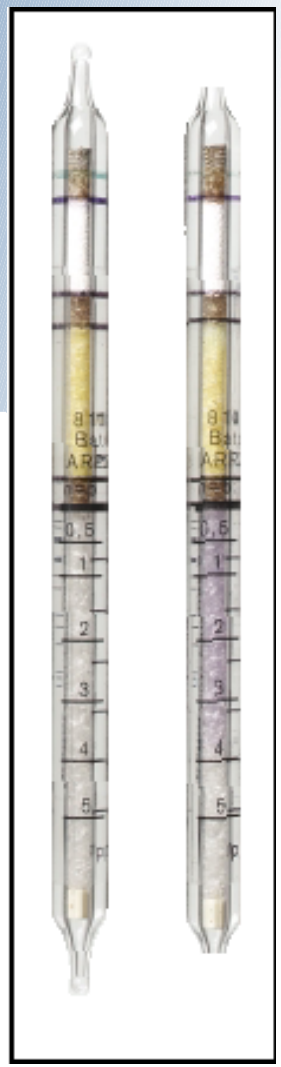
Methanol, ethanol, acetone and ethyl acetate in the TLV range do not interfere.

Phosgene 0.02/a

Vinyl Chloride 0.5/b







Nitrogen Dioxide 0.5/c

Ethylene Oxide 1/a

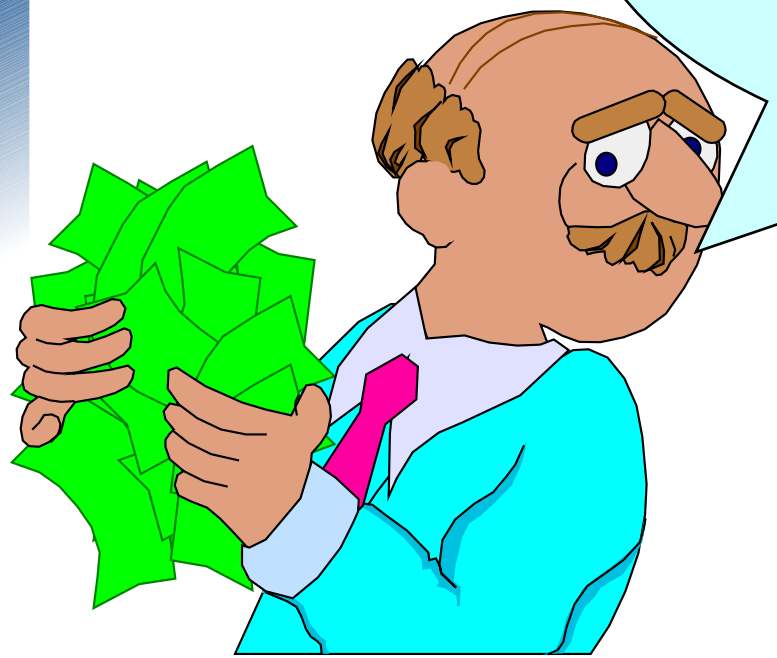
Now how do we go about ordering these tubes?

Draeger Toxic Gas Detector Tubes

Paperless Ordering Placement System (POPS)

- A computer ordering system
- To use the POPS system, insert a **S9G** under the routing identifier code (RIC) on the standard MIL-STRIP format, NAVSUP 1250.

Once used or expired how do we dispose of our Draeger tubes?



It is important to note that these procedures may vary from one disposal agent to another.

Draeger Toxic Gas Detector Tubes

Proper disposal of detector tubes

- Expired tubes must be identified, quantified and recorded on local authorized chain of custody forms by chemical name and stock number.
  - The expired tubes are packaged for safe transportation and sent to the Defense Reutilization Marketing Office (DRMO)

Draeger Toxic Gas Detector Tubes

Proper disposal of detector tubes

- Used tubes must be identified, quantified and recorded on local authorized chain of custody forms by chemical name and stock number.
  - A description of the atmosphere that the tube was exposed to must also be provided.
- The tubes will then be packaged and sent to PWC

Dräger - Microsoft Internet Explorer

http://www.draegersafety.com

Address http://www.draeger.com/english/index.htm

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Welcome to Dräger on the Internet

Internet

Converting Parts Per Million (PPM) to Percent and Percent to Parts Per Million (PPM)

PPM to Percent and Percent to PPM

Converting PPM to Percent and Percent to PPM is necessary in order to find the PEL of various toxic detector tubes.

PPM to Percent and Percent to PPM

Conversion table

10 ppm = .001%
100 ppm = .01%
1,000 ppm = .1%
5,000 ppm = .5%
10,000 ppm = 1%

PPM to Percent and Percent to PPM

PPM to Percent

$$\frac{\text{PPM}}{10{,}000} = \%$$

PPM to Percent and Percent to PPM

PPM to Percent

$$\frac{\text{PPM}}{10{,}000} = \%$$

Example

$$\frac{10 \text{ PPM}}{10{,}000} = .001\%$$

PPM to Percent and Percent to PPM

Percent to PPM

% X 10,000 = PPM

PPM to Percent and Percent to PPM

Percent to PPM

% X 10,000 = PPM

EXAMPLE:

.10% X 10,000 = 1,000 PPM

Convert Parts Per Million (PPM) to MG/M3 and MG/M3 to Parts Per Million (PPM)

PPM to MG/M³ and MG/M³ to PPM

Knowledge of conversion formulas is necessary when obtaining readings in PPM and having to adapt (or convert) to the OSHA standards, which sometimes appear as MG/M^3

PPM to MG/M³ and MG/M³ to PPM

PPM to MG/M³

$$\frac{\text{PPM X Molecular Weight}}{24.1} = \text{MG/M}^3$$

the mole volume of any gas is

24.1

PPM to MG/M³ and MG/M³ to PPM

MG/M³ to PPM

$$\frac{\text{MG/M}^3 \text{ X } 24.1}{\text{Molecular Weight}} = \text{PPM}$$

PPM to MG/M³ and MG/M³ to PPM

- You just tested for benzene and found 125 PPM. The molecular weight is 78.11. Find the MG/M³.

$$\frac{125 \times 78.11}{24.1} = 405 \text{ MG/M}^3$$

$$\frac{405 \times 24.1}{78.11} = 124.95 \text{ PPM}$$

MG/L to MG/M³ and MG/M³ to MG/L

- ON THE HYDROCARBON 2 TUBE YOUR COLOR CHANGE HAPPENED AT 5 STROKES – YET IT IS IN MG/L AND 074 APPENDIX G STATES PEL IS 350 MG/M³ FOR DFM & JP-5. WHAT IS THE CONVERSION FACTOR?
- 1 MG/L = 1,000 MG/M³
- 23 MG/L X 1,000 = 23,000 MG/M³

- 23,000 MG/M³ DIVIDED BY 1,000 = 23 MG/L

GFE - SPECIAL PMS RELATED EQUIPMENT

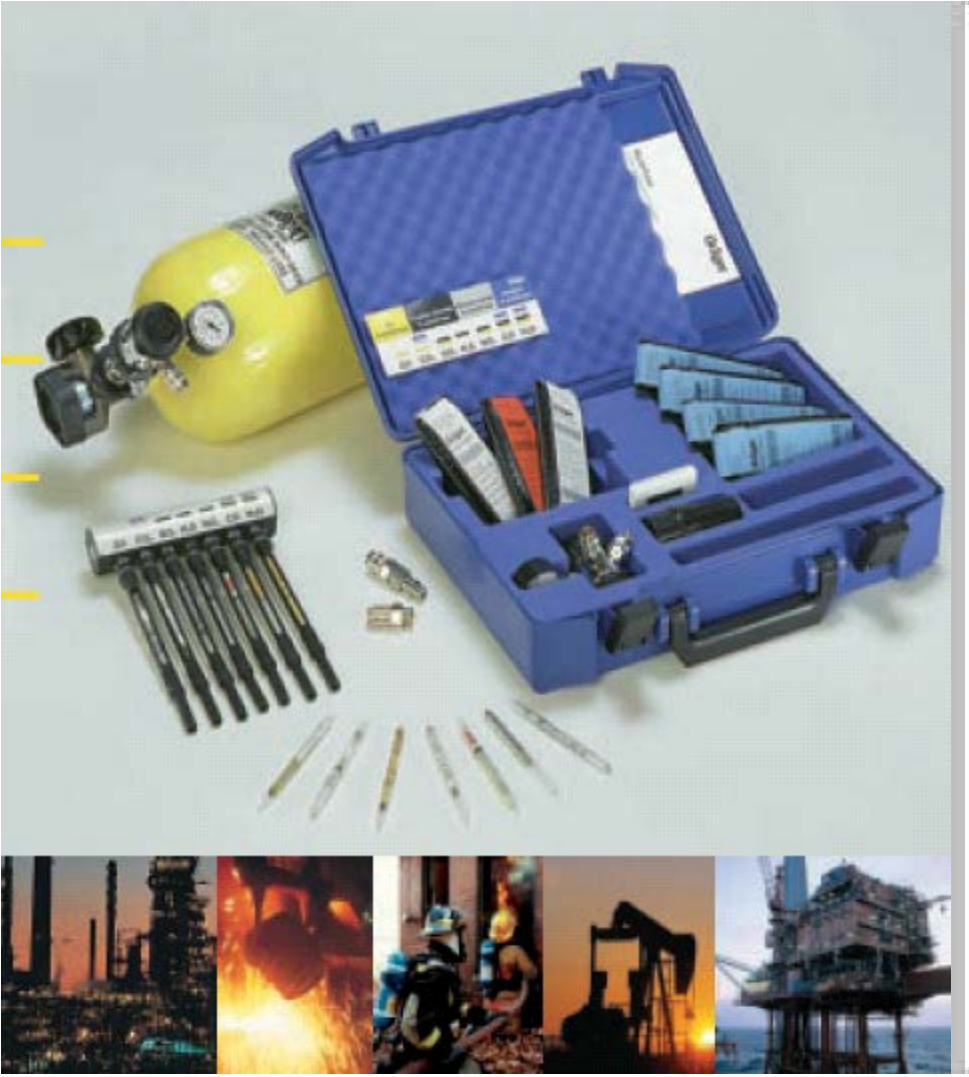
Draeger Safety, Inc

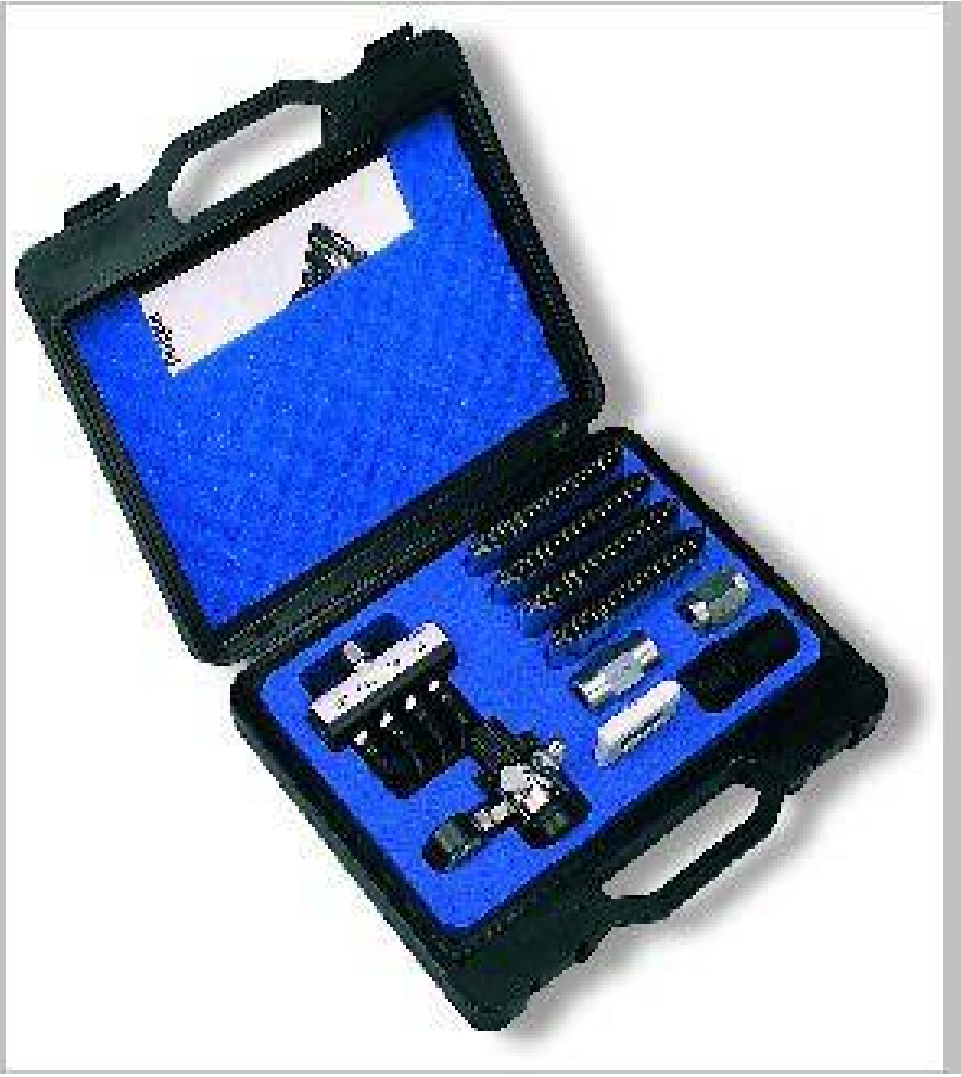
101 Technology Drive
Pittsburgh,PA 15275-1057

1-412-787-8383
Fax: 1-412-787-2207
Customer Service: 1-800-922-5518
Fax: 1-800-922-5519
Technical Support: 1-800-787-8383
Fax: 1-800-787-2207

www.draeger.com

Air Quality Standards





SCBA BREATHING AIR TESTING (BAT)

Aerotest Simultan HP+P
(Aerotest Navy)

DCRA 2004-07 SCBA BREATHING AIR TESTER

(BAT) CHEMICAL DETECTION TUBES

The Carbon Monoxide and Carbon Dioxide tubes required in the BAT (NSN 6665-01-473-8300) are different tubes than required for the Gas Free Engineering Kit (AEL Range 2-880044260 to 4261). Although the appearance of the respective gas detector tubes may be similar between the kits, the tubes have different P/N's, NSN's, sampling methods and detection scales. Chemical detector tubes from the GFE Test Kits and SCBA BAT are not to be used interchangeably.

SUMMARY AND REVIEW

Summary and Review

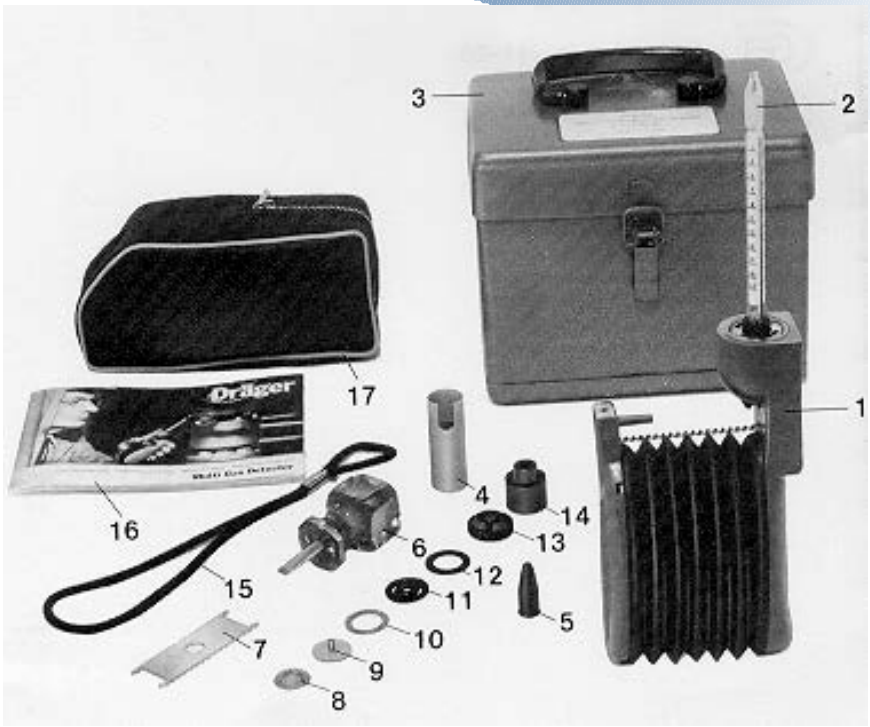
- Four Gas Analyzer

What is pressed to turn unit on?

Summary and Review

- Draeger Toxic Detectors (Model 31)

Pre-test is how long?



Summary and Review

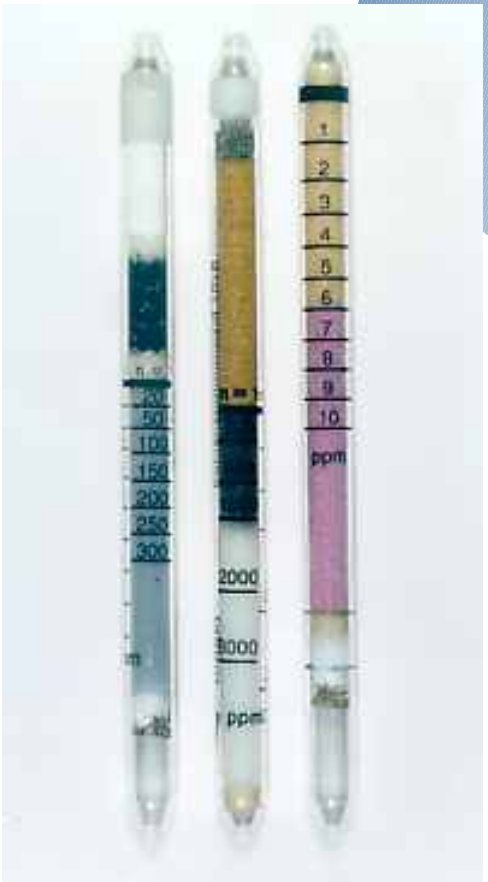
- Draeger (accuro)

This has what new features?

Summary and Review

- Draeger toxic gas detector tubes

What Appendix of the 074?



THE END