1853

UCRL-~~1775~~

UNCLASSIFIED

UNIVERSITY OF CALIFORNIA — BERKELEY

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545

RADIATION LABORATORY

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

UCRL-1853
Unclassified-Instrumentation Distribution

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

INSTRUCTION MANUAL FOR UCRL PORTABLE VAPOR DETECTOR MODEL 1EPS

C. S. Presenz

May 10, 1952

Berkeley, California

TABLE OF CONTENTS

Objective.....2

Theory of Operation.....2

Physical Data.....3-4

General Description.....4-5

Operation.....5-6

Circuit Analysis.....6-7-8

Calibration of X1 and X10 Ranges.....8-9

Stability (Unit Warm Up Period).....9-10

Detectable Vapors.....10

ILLUSTRATIONS

Figure 1 - Circuit Diagram.....11

Figure 2 - Photograph of Detector.....12

Figure 3 - Functional Diagram.....13

Figure 4 - Control Layout.....14

Figure 5 - Hg Calibration Curve.....15

INSTRUCTION MANUAL FOR UCRL PORTABLE VAPOR DETECTOR MODEL 1EPS

C. S. Presenz

OBJECTIVE

Development of a safety monitor highly sensitive to mercury (Hg) vapors, stable regardless of line variations between 100 and 140 volts RMS, and yet simple in operation thus avoiding interference with normal working habits of personnel.

The instrument is based on quantitave, not qualitative, measurements and should not be considered in any sense an analytical type detector. A list of vapors detectable with this instrument are shown in the section called Detectable Vapors.

As the prime purpose is the detection of Hg vapor, and to avoid confusion, all reference from this point on, unless otherwise stated, will be based on Hg vapor concentrations.

THEORY OF OPERATION

All substances absorb light at some region of the spectrum. If a spectral region exists where a vapor has a high absorption and the diluant a high transmission, the concentration of the vapor can be measured in terms of light absorbed. The ideal instrument would be one using a monochromatic source of light of wave length corresponding to the maximum absorption of the vapor and a minimum absorption of the diluent and a highly sensitive and stable light measuring device sensitive only to this wave length. The operation of this detector is based on the Beer-Lambert law which states that the light absorption depends on the distance traversed and the molar concentration of the light absorbent.

PHYSICAL DATA

Use

The Portable Vapor Detector Model 1EPS is designed to indicate small concentrations of vapor which provide various degrees of opacity to ultra-violet light. The instrument is specifically intended for vapors having a strong absorption in the 2537 Angstrom region of the spectrum.

Equipment

Model 1EPS is supplied with the following equipment and spares

1 UCRL Model 1EPS Vapor Detector

2 50 ft. 3 conductor A C Power Cable

1 7 ft. 3 conductor A C Power Cable

1 Collapsible Hand Probe with 5 ft. of 1/2 inch Rubber Hose

1 Spare Stainless Steel Vapor Chamber

6 Spare Neoprene Vapor Chamber Ring

3 Spare Rubber Hose Clamp

2 Spare 935 Phototube

1 Spare GE 4T4/1 Germicidal Lamp

1 Spare GE 47 (Brown Bead) Pilot Lamp

1 Spare 5692 or 6SN7 GTA Bridge Tube

1 Spare GE 58G827 Ballast Transformer

Power

115 Volt, 60 cycle power source required. Total consumption 195 watts. Three conductor cables are supplied in order to maintain unit at ground potential. In view of the possible safety hazard involved, care should be taken to check power source receptacle to establish correctly grounded third contact.

(3.2 milligrams equals 78 percent of full scale)

X 10 Ultra-sensitivity (0 - 0.1 milligrams Hg per cubic meter)
(0.1 milligrams equals full scale)

Functions:

AUD Audio Pulsed Tone Alarm. (This is normally adjusted to operate at the toxic limit for Hg vapor. 0.1 Mg of Hg per cubic meter)

EXT Indicator voltage for external instrumentation. For remote operation requiring long wires, some form of d.c. amplification should be provided.

OPERATION

See Figure 4 for Central Layout.

To start the Vapor Detector, connect a.c. cord to outlet, set Selector Switch (H) to X 1 and turn On - Off Switch (G) to ON position. Following an approximate 30 second warm up period the Neon Power Indicator Lamp (E) will light. With Lamp (E) lit, depress the U.V. Start Button (F) (blue dot) and hold for approximately 4 seconds, then release. While the U.V. Start Button (F) is depressed the U. V. Pilot Lamp (A) should operate at approximately one quarter of normal brilliancy. The reason being: During the U.V. warm up period 120 MA is drawn by the G 4T4/1 filaments; when the push-button is

released this current decreases to 80 MA which is the rated gas discharge current required to maintain the mercury arc. Therefore the U.V. Pilot Lamp (A) is a perpetual monitor of the vapor detector ultra-violet source. It should be noted; unless this indicator lamp is energized the instrument will not function. With the U.V. Pilot Lamp glowing, the unit should be allowed to run for approximately 5 minutes to allow the G 4T4/1 to gain some order of stability. Following this period the Zero Set (D) should be set for zero deflection of the microammeter. Following this adjustment depress the calibration push-button (B) (red) and rotate Calibrate Control (C) (red index) until the microammeter reads full scale.

It is advisable to repeat the Zero Set and Full Scale Calibrate adjustments before using instrument. With these preliminary adjustments completed, the Vapor Detector is ready for vapor measurements.

CAUTION

DO NOT USE THIS INSTRUMENT UNTIL THE VAPOR SAMPLING CHAMBER HAS APPROXIMATED AMBIENT TEMPERATURE. If this precaution is not adhered to, condensation of Hg vapor may take place, thus contaminating the Sampling Chamber which in turn will produce inaccurate results.

ALL LINE UP PROCEDURE MUST BE DONE WITH RANGE SWITCH (H) SET AT X 1: UNDER NO CIRCUMSTANCES SHOULD ANY ATTEMPT BE MADE TO CALIBRATE WITH RANGE SWITCH IN THE X 10 POSITION. IF THIS IS NOT OBSERVED, SERIOUS DAMAGE TO MICROAMMETER MOVEMENT MAY RESULT.

CIRCUIT ANALYSIS

Power Supply

The prime purpose is to supply a regulated voltage source to maintain G 4T4/1

and VTVM circuits in a stable manner, regardless of line variations from 100 to 135 volts RMS. This section is typical of standard voltage regulated power supplies and should not require further explanation.

G 4T4/1 U.V. Source

The circuit functions on a basis of filament pre-heat and inductive surge firing. The U.V. Pilot Lamp (A) is used primarily as a G 4T4/1 operational indicator. In the event of equipment failure this light may also be used to establish whether B voltage is available, provided of course, the G 4T4/1 is operating. The normal life of this bulb is considered indefinite. However, in the event that failure occurs in the U.V. light source section, an inspection should be made first to establish filament continuity. When replacement is necessary use a # 40-a or # 47 (brown bead) pilot bulb.

Vacuum Tube Voltmeter

A standard bridge type vacuum tube voltmeter circuit is used for quantitative measurements. It should be noted, R15 is used to balance minor plate current irregularities when replacing the dual triode VTVM tube (5692 or 6SN7 GTA). Bridge unbalance is measured in the cathode circuit. The Calibrate Push-button (B) (red) is used to calibrate the microammeter for maximum deflection. This is accomplished by setting Selector Switch (H) to X 1 Sensitivity and adjusting Calibrate Control (C) (red index). Zero Set (D), of course, is used previously to zeroize instrument correctly. Correct sequence is listed in the section, Operation. CAUTION: ALWAYS set Selector Switch (H) to X 1 when calibrating instrument. If this switch is left on X 10 Sensitivity possible microammeter damage may result.

Audio Alarm

With Selector Switch set to AUD position, a predetermined concentration of

vapor (Set Screwdriver Adjust R 9, marked AUD, mounted on chassis) will energize RE-1 and interrupt bias voltage of Pulser Tube (V 9), this in turn controls RE-2 in plate circuit of thyratron and keys Audio Oscillator (V 8) which energizes speaker.

Chamber Contamination Switch

If Vapor Chamber is suspected of contamination by Hg, the instrument should be adjusted for Zero Set and Full Scale Calibrate in the normal manner. S-3 (Contamination Switch) should then be turned off, stopping Vapor Blower (B-1). If the chamber is contaminated with Hg the microammeter will show a definite positive deflection.

CALIBRATION OF X 1 AND X 10 RANGES

Hg Calibration - X 1 Range

Hg Calibration of X 1 Sensitivity Range is not necessary under normal operating conditions. If an accuracy check is desired, the instrument should be placed in an area where the air is fresh and devoid of contaminating vapors, smoke, etc. A small, stoppered, flash of Hg (temperature to be at twenty degrees centigrade.) with neck of sufficient diameter to allow convenient insertion of Rubber Sampling Hose, should be readied. After routine adjustments (Zero Set and Full Scale Calibration) have been made, the actual Hg Calibration on X 1 Range may be performed. Upon releasing the stopper, the Sampling Hose should be held within one quarter inch of Hg surface. Following this procedure a reading of 78 (plus or minus a 2 percent movement accuracy) should result. Do not allow Sampling Hose to touch Hg. If this is permitted, a contaminated hose results, causing inaccurate measurements. In case of accidental contamination, the affected portion of the hose should be destroyed.

CAUTION: UNDER NO CIRCUMSTANCES ATTEMPT Hg CALIBRATION CHECK WITH RANGE SWITCH IN X 10 POSITION.

Calibration - X 10 Range

As the X 10 Range is a sensitivity multiplier, no Hg methods are necessary. Following routine adjustments (Zero Set and Full Scale Calibrate, with Range Switch in X 1 position), rotate Zero Set (D) clockwise until the microammeter indicates a deflection of exactly ten divisions. Change Range Switch to X 10 position and a full scale deflection of the meter should result. If this reaction does not occur rotate Screwdriver and adjust R 8 (marked X 10, on chassis) to obtain it. Upon completion of X 10 Sensitivity Calibration, the Range Switch should be returned to X 1 Range and the microammeter restored to zero deflection.

Audio Calibration

This is a Toxic Limit Alarm, and as such, the circuit is calibrated to function with vapor densities of 0.1 milligrams Hg per cubic meter (10 divisions deflection X 1 Range or Full Scale deflection X 10 Range). A check for operation may be obtained by offsetting Zero Range switch over to AUD position. If properly calibrated, Pulsed Tone Alarm will now commence operation. Following this check the instrument may be considered ready for service.

STABILITY (UNIT WARM UP PERIOD)

Short Routine Checks

For routine checks the Vapor Detector should be subjected to a 10 minute warm up period. This allows the U.V. G 4T4/1 and associated tubes to approach working stability.

Continuous Service

If continuous remote external operation is desired a warm up period of 6 hours should be observed. As the precision of the Vapor Detector is governed by a

sensitive bridge circuit, this length of time is required to allow circuit constants to attain a consistent operating temperature.

DETECTABLE VAPORS

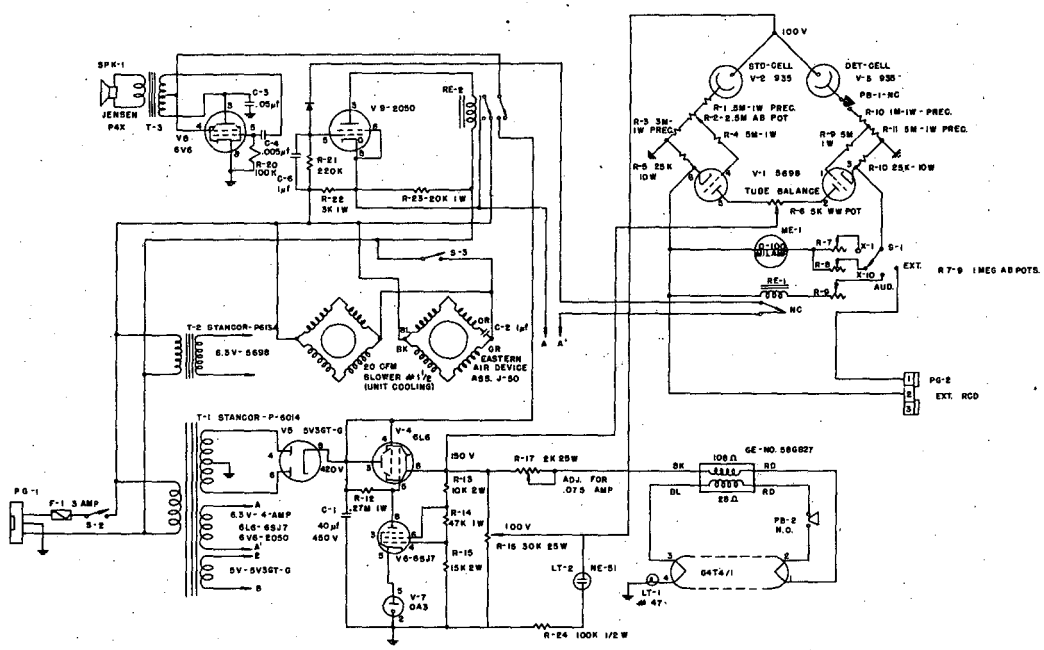
While undertaking vapor measurements in the field, extreme precautions should be taken to see the following conditions do not exist. If they are present, the operator should be cognizant of the fact in as much as this matter could have an appreciable effect upon vapor measurements being attempted. The conditions are:

Smoke
Dust
Fog
Ozone

The Vapor Detector is sensitive to vapors of the following substances, listed below in descending order of magnitude.

Positive Deflection	Moderate Deflection	Slight Deflection
Isopropyl ether	Naptha	Carbon tetrachloride
Tetraethyl lead	Xylene	Nitromethane
Pyridine	Benzyl alcohol	Tetraethyl gasoline
Benzene	Aniline	Dichloro benzene
Mercury*		T-butyl hydropentoxide
Diethyl acetal		Butyl bromide
Acetone		Carbolic acid
Toluene		Tetralin
Illuminating gas		Turpentine

* See Figure 5 for calibrated curve.



MERCURY VAPOR DETECTOR
UCRL MODEL IEPS
FIG. 1

MU 3617

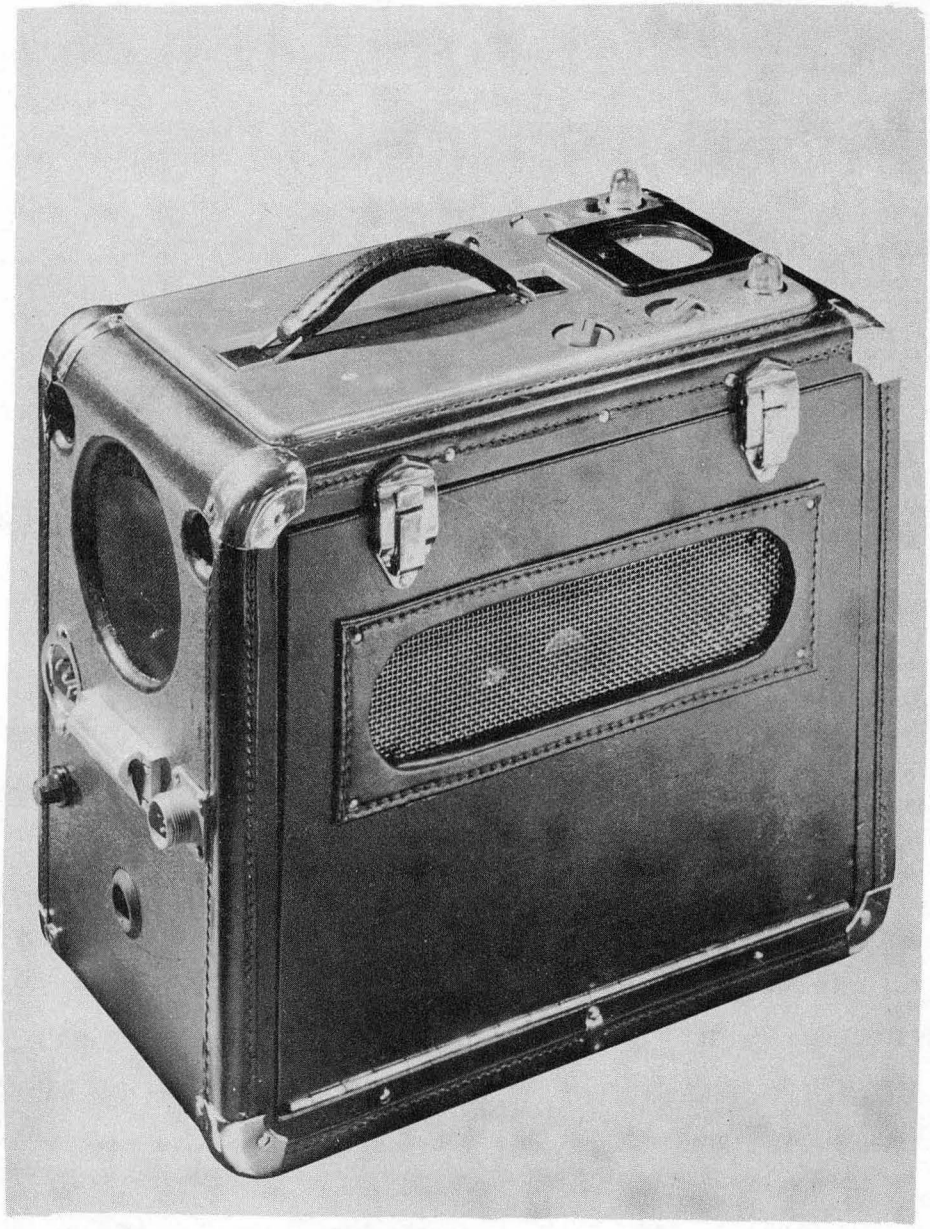
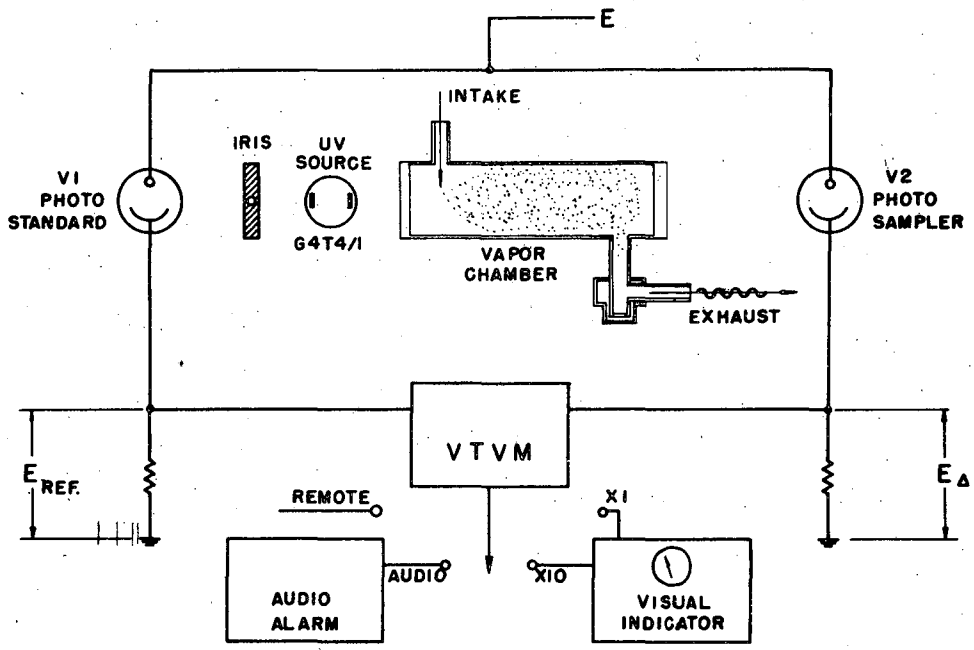


Fig. 2

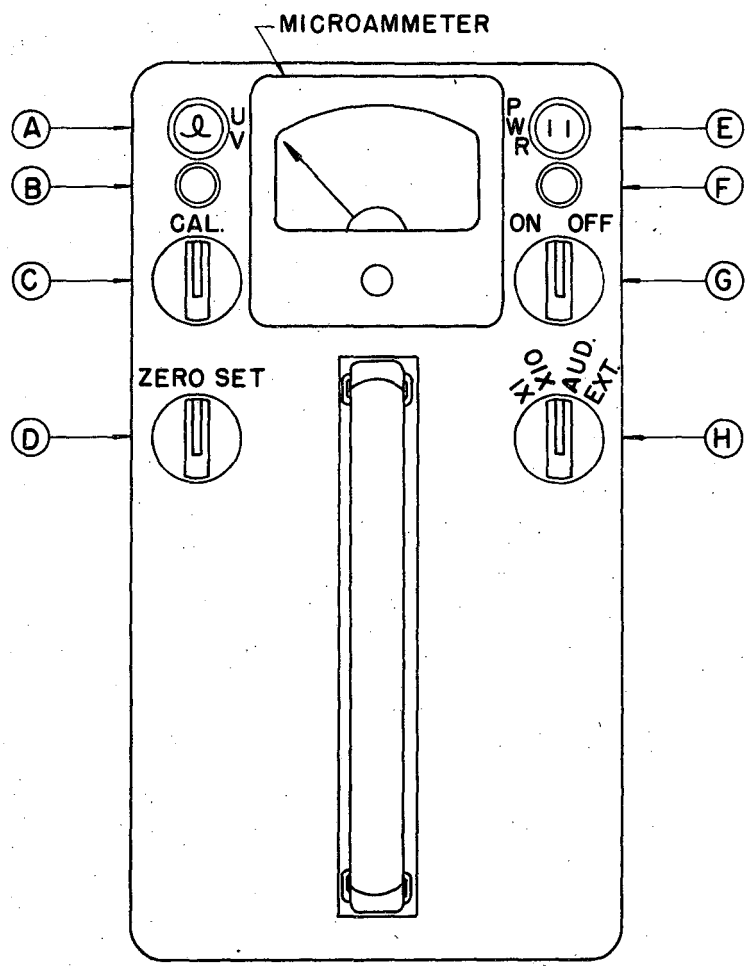
Photograph of Detector



FUNCTIONAL DIAGRAM

MU 3818

FIG. 3

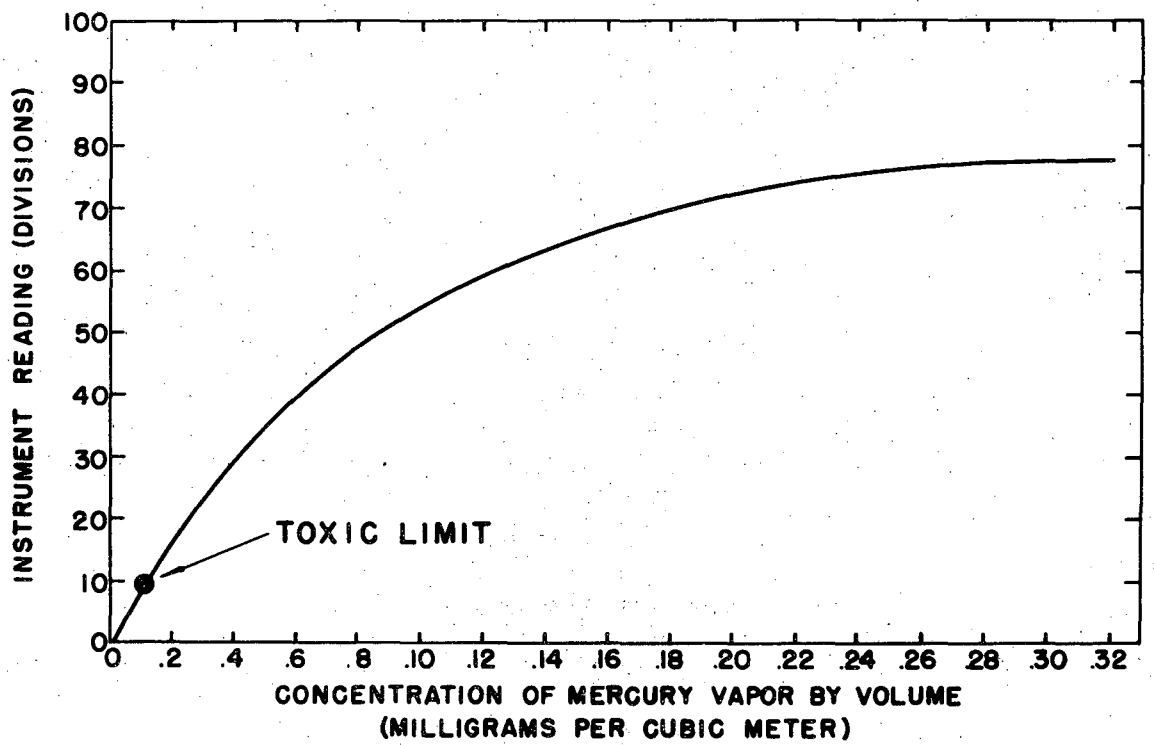


CONTROL LAYOUT

VAPOR DETECTOR MODEL IEPS

FIG. 4

MU 3819



MERCURY CURVE

MU 3820

FIG. 5