# OPERATION/MAINTENANCE MANUAL

PORTABLE TRITIUM MONITOR

MODEL 200SB-HTO

**OVERHOFF TECHNOLOGY CORPORATION**
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## 1.0. INTRODUCTION

Model 200SB portable tritium monitor is a small, high sensitivity, hand held, battery operated fully gamma compensated survey meter.

The instrument will measure tritium in its elemental form.

## 1.1. PHYSICAL DESCRIPTION

Model 200SB-HTO uses two identical ionization chambers in a side by side arrangement. One ionization chamber, with a total volume of 200 cc, is used for measurement, the second chamber serves for gamma compensation.

The sample stream is drawn through the ionization chamber by means of a small rotary vane pump which is plumbed at the outlet of the ionization chamber. Entry of dust particulates is prevented by attaching a good quality particulate filter ahead of the instrument sampling inlet.

A large easy to read liquid crystal digital panel meter with a range from 0.1 to 2000.0 $MBq/m^3$ is used for measurement display. Other units of measurement, such as MPCa, $\mu Ci/m^3$, $\mu Sv/hr$, or others may be specified by the user at time of an requesting a unit. The instrument exhibits a basic sensitivity of the order of 0.1 $MBq/m^3$, which it is able to attain due to the fact that it is immune to response to both radon and cosmic ray noise.

Power is supplied by a pair of "D" size batteries. While it is recommended that Alkaline cells be used, the instrument will also operate with NiMH or even Carbon Zinc batteries, although operating duration will be shorter. Onset of battery depletion is signaled by illumination of an LED located next to the meter face.

A nine position alarm level stepped attenuator, adjustable over partial scale (.01 - 5 %) is located on the front panel. A steady tone is emitted by an acoustic signaler if the measurement exceeds the set point. A steady tone is heard if the sample air flow has been interrupted. The alarms are non-latching.

The instrument case is constructed of light weight aluminum. A handle is attached for hand held survey use.

Gas flow connections are made externally to the instrument by appropriate attachment of flexible plastic hose. See Figure 2 .

A cartridge filled with disposable desiccant can be interposed between the measurement and compensation chambers for measurement of HTO where other radioactive gases may also be present.

## 2.0. TECHNICAL SPECIFICATIONS

| | |
|---|---|
| MEASUREMENT DISPLAY | 4 1/2 digit LCD<br>0.1 - 1999.9 MBq/$m^3$ |
| GAMMA COMPENSATION | two chambers in a side by side arrangement |
| RESPONSE RATE | 20 seconds to reach 90 % of final reading, |
| NOISE LEVEL | $\pm$0.1 MBq/$m^3$ , 1 S.D.<br>(5 second electronic time constant) |
| ZERO STABILITY | after 1 minute (or less) warm up, the zero drift to less than 0.1 MBq/$m^3$ |
| ALARM (ACOUSTIC) | 1. nine position stepped attenuator set point for signal of 0.2 - 100 MBq/$m^3$, steady tone<br>2. low flow produces a steady tone |
| ALARM (VISUAL) | signal level: red LED<br>low flow: yellow LED,<br>low battery: red LED |
| DUST FILTER | in line disposable cartridge, Pall No. 12082 |
| SAMPLING SYSTEM | 6 hose barb ports are located on the front panel |
| IONIZATION CHAMBER VOLUME | effective volume: 200 $cm^3$<br>port to port volume: 220 $cm^3$ |
| PUMP | special high volume internal pump for a flow rate from 2-3 LPM |
| POWER | two “D” size batteries alkaline, carbon-zinc or NiCd |
| ENVIRONMENTAL | -20° C to +40° C, 0 - 98 % RH |
| CASE | light weight aluminum |
| SIZE AND WEIGHT | 7.6" L, 5.2" W, 4.4" H excluding handle,<br>5 lbs (2.3 kg) |
| ACCESSORIES | • 2 “D” size batteries<br>• sniffer hose<br>• dust filter<br>• transit case (optional, on request)<br>• two desiccant cartridges for HTO only measurement<br>• container of replacement desiccant<br>• power converter, 100-240 VAC, 50/60 Hz, .25A to 3.3 Vdc @1.2A, 5.5 mm O.D. x 2.1 mm I.D. plug, center pin is positive |

## 3.0. CIRCUIT DESCRIPTION

**CAUTION:** This instrument has not been designed for indiscriminate opening or disassembly of the internal parts. It contains highly sensitive semiconductors which are destroyed by even the slightest electrostatic discharge.

## 3.1. IONIZATION CHAMBERS

In its simplest form, an ionization chamber is an enclosed volume with two electrodes. Voltage is applied between the electrodes, generating an electric field which will segregate and collect electric charges which are created by nuclear events occurring inside the chambers. Nuclear events may consist of ionization of air molecules by external or internal alpha, beta or gamma radiation.

Model 200SB monitors are designed to measure tritium. Activity of tritium decay is such that a concentration of 1 $\mu Ci/m^3$ in a volume of one liter will generate an ionization current of about $0.95 \times 10^{-15}$ amperes. This is a very weak current.

Alpha pulses from naturally occurring radon, are much more energetic, they can produce short current bursts of up to $10^{-13}$ amperes during decay, and therefore appear as large noise "spikes" which can seriously impair tritium measurement.

Gamma radiation also has a strong effect. In practice, a gamma radiation field of 1 mR/hr will create the same amount of ionization as 90 $\mu Ci/m^3$ (3.3 $MBq/m^3$) of tritium.

A tritium monitor, in order to measure to low concentrations, must be able to respond only to tritium and be immune to alpha or gamma radiation. For this purpose, a second ionization chamber system has been included to balance out any ionization current contribution from external gamma radiation.

In the 200SB instruments, two ionization chambers are arrayed in a side by side ensuring good gamma compensation in all directions.

The ionization chamber polarizing voltage is supplied by a set of dry batteries with a long life. The surfaces of the ionization chambers themselves are bare, and, to avoid damage to the electrometer, must NOT be touched by hand.

## 3.2. ELECTROMETER

Also known as a transimpedance amplifier, it serves the purpose of converting the extremely feeble ionization current into a voltage suitable for further signal processing and measurement display.

The heart of the electrometer consists of a specially selected ultra high impedance semiconductor device which has been chosen both for ultra low internal current leakage as well as long term d.c. stability. The semiconductors used in Model 200SB instruments are suitable for measurement of currents as low as$10^{-16}$ amperes.

In Model 200SB, the electrometer is directly attached to the ionization chamber assembly, which is protected by a rectangular metal cover.

## 3.3. SIGNAL PROCESSING AMPLIFIER

A single printed circuit board attached directly to the front face of the instrument contains all power supply and signal processing electronics.

Proprietary circuitry is used for the recognition and elimination of transient signals due to radon or high energy cosmic ray pulses.  Model 200SB instruments, with digital display, use a dedicated internal circuit to disable the pulse rejection circuit when the measured signal reaches approximately 30 $\mu Ci/m^3$ (1.1 $MBq/m^3$).

A front panel control has been provided for adjustment of the set point (level) at which the acoustic alarm is desired to sound. The acoustic signaler has the second function of alerting the user that sample gas flow is impeded.

## 4.0. CONFIGURATION

## 4.1. EXTERNAL FEATURES

The front panel features include:

1. the digital panel meter, 0.1 - 1999.9 MBq/$m^3$
2. function control knob
3. alarm level control knob, 0.2 - 100 MBq/$m^3$
4. low battery LED
5. signal level alarm LED
6. low flow alarm LED
7. acoustic signaler
8. calibration potentiometer (under phillips screwhead)
9. offset potentiometer knob
10. sample IN/OUT hose barbs
11. battery compartments
12. jack for external power supply, 3Vdc (never exceed 3.5V)

Side features include:

13. snap holder for dust filter
14. target for gamma source calibration

## 4.2. HOSE CONNECTIONS

The instrument may be operated in either of two modes. In the first mode, the instrument will respond to any radioactive gas passing through the instrument as well as tritium. In the second mode, it will respond only to HTO, even in the presence of other radioactive gases. The external plumbing (hose attachments) is selected to suit the mode in use.

FIRST MODE (refer to Figure 2)

A sniffer hose is attached to a small in line dust filter, which is directly attached to the "IN" hose barb. The other measurement chamber hose barb is routed to the inlet of the pump by means of a short piece of hose. Connecting a short loop of hose to each hose barb closes off the compensation chambers hose connections.

SECOND MODE (refer to Figure 2)

In this mode, the exhaust from the measurement chambers is connected to a desiccant cartridge. The exhaust end of the desiccant cartridge is connected to a second dust filter and then to the inlet of the compensation chamber. The other compensation chamber hose barb is routed to the inlet of the pump by means of a short piece of hose. In this mode, the sample stream passes first through the measuring (upstream) chambers, and then through the desiccant cartridge, it continues through the compensation (downstream) chambers and finally exits via the pump.

**NOTE 1: NEVER OPERATE THE INSTRUMENT WITHOUT A DUST FILTER IN THE SAMPLE STREAM**

**NOTE 2: THE INSTRUMENT MUST BE IN THERMAL EQUILIBRIUM WITH ITS SURROUNDINGS.**

**NOTE 3: TO AVOID ERRATIC RESPONSE, THE PUMP <u>MUST ALWAYS</u> BE PLACED DOWNSTREAM OF THE LAST IONIZATION CHAMBER IN THE SAMPLE PATH.**

## 5.0. OPERATION

Ensure that a dust filter is connected in line ahead of this instrument flow inlet in use.

The following steps are necessary and sufficient to operate the instrument:

1. Set measurement alarm level to desired value.

2. Rotate mode switch to the MEASURE position.

**Allow one minute or less for the instrument to stabilize.**

The instrument is now ready for use. In this mode the ionization chambers are active, but the pump is not. The instrument is in a so called “standby mode” ready to sample the instant the mode switch is advanced to the next position.

3. Rotate the mode switch to the **SAMPLE** position.

NOTE: If the LOW FLOW LED is illuminated, the sampling hoses are obstructed, or, for whatever reason, sample flow through the chambers has ceased.

It is IMPERATIVE that the sample stream be free from dust, dirt or moisture. Not only will the instrument show erratic behavior, but it may cease to function entirely. If moisture is ingested, then continued pumping to evaporate and expel the moisture can be attempted. If this fails, the instrument must be returned to the factory for service.

Condensation can occur if an instrument is brought from a cold environment into warmer surroundings.

Furthermore, temperature changes to the instrument, both lower to higher as well as higher to lower will create transient currents in the electrometer which can appear as large phantom measurement signals.

The instrument must be allowed to thermally equilibrate to its surroundings prior to use.

If there is an OFFSET due to thermal disequilibrium, use the following procedure:

**OFFSET COMPENSATION:**

1. Switch the instrument into the measure mode
2. After approximately three minutes. The instrument should indicate 0000 on the digital panel meter. An offset of 4 - 6 $\mu Ci/m^3$ (0.1 - 0.2 $MBq/m^3$) is typical for situations due to temperature changes. This offset should disappear as thermal equilibrium is attained.
3. Adjust the “offset” compensation potentiometer knob as required. The location is shown in Figure 1.

**NOTE: The rotation direction for the adjustment is clockwise for change in a positive direction.**

# 6.0. CALIBRATION

## 6.1. METHOD

Tritium monitors employing ionization chambers, such as Model 200SB may be calibrated with either of two methods. The first method consists of injecting a known activity of tritium gas; the second method uses external gamma radiation of a known field strength.

To ensure trace ability to National Standards, the first method must be employed. This method is time consuming and quite difficult to perform with precision. The first method is, however, useful as a “type” test, and can serve as a basic accurate calibration from which the gamma response (the second method) can be cross correlated.

The second method uses an external gamma field. In this instance, the ionization chamber must be shielded with a lead brick.

## 6.2. GAS CALIBRATION

Since the instrument is essentially linear, a relatively high concentration can be used for most accurate results. Values between 4 MBq/$m^3$ to 40 MBq/$m^3$ are convenient, but any other values from 1.0 MBq/$m^3$ to 200 MBq/$m^3$ can be used.

Instructions for the use of gas calibrators are generally provided by the manufacturer of the gas calibrator, and these should be followed.

Some general hints can be given.

It is important that the calibration sample be well circulated through the entire calibration system loop. The calibration loop should include the measurement chambers only.

Adequate time should be allowed for the system pressure and temperature to come to equilibrium, and that no excess pressure is built up.

The inclusion of a previously calibrated "master" or "reference" tritium monitor in the sampling loop is highly recommended.

The calibration can actually be repeated for several levels of tritium activity. This is not done to verify the linearity of the tritium monitor (which is highly linear) but to ensure that the calibration process itself is free from subtle errors.

If calibration is performed, and the instrument response is somewhat different from the expected value, then small adjustments can be made by turning the calibration potentiometer with a small screw driver. The calibration potentiometer is accessed by removing the phillips head screw.

## 6.3. GAMMA CALIBRATION

If the unit has previously been calibrated with tritium gas, then it is sufficient to use a small check source to any type of gamma radiation to produce a response when placed at a specified location relative to the instrument under test. If the check source is long lived, no chronological correction is needed. To verify calibration, the original check source must be used. Records must be kept to identify relative location of the check source and the expected result. Use a lead brick to shield the compensation chamber as necessary.

If calibration by either of these methods is performed, and the instrument response is somewhat different from the expected value, then small adjustments can be made by turning the calibration potentiometer with a small screw driver. The calibration potentiometer is accessed by removing the small phillips screw.

Large changes in calibration are evidence of malfunction. The factory should be consulted at once at Tel. (513) 248 2400 or by FAX (513) 248 2402.

## 7.0. MAINTENANCE

Very little maintenance is required for Model 200SB tritium monitors, but some periodic attention may be necessary, especially if the instrument is to be used in adverse environments.

The batteries should be replaced within half an hour when the low battery light illuminates. Access to the batteries is made by twisting off the caps located on the front panel of the instrument.

Pump life is in excess of 1000 hours of actual use, its life is preserved by ensuring that the instrument is operated only with dust filters in line.

When not in use, the monitor should be stored in a cool dry environment.

Any battery of the proper shape and voltage can be used. NiCd cells, while having smaller ampere hour capacity at room temperature, will outperform dry batteries below about 0° C. NiCd batteries will operate at any temperature, down to -50° C.

## 8.0. SERVICE

This instrument contains components that are easily destroyed if the case is opened and handled without proper precaution.

Overnight service is provided by the factory. Special training can be given to qualified technical personnel who are entrusted with instrument service and repair responsibility.

Warranty is void if maintenance or repair (other than that which is listed in this manual) is performed by an unauthorized repair facility.

## 9.0. REPLACEABLE PARTS

The following parts and components are disposable items and may be obtained from Overhoff Technology Corporation or from any original supplier:

| | |
|---|---|
| Batteries, primary power | "D" size, alkaline, EN95 |
| Batteries, polarizing | 45 V, No. 415 |
| Dust filter | Pall No. 12082 |
| Dust Filter Clip | Clic No. 51 |
| Ionization Chamber | P/N 1020686 |
| Pump | P/N 50085 |
| Hose Barb, sample in | Brass, P/N 22BH-4-2 |
| Hose Barb, sample out | Brass, P/N 230-4-2 |
| Panel Meter | P/N DMO-742 |
| Desiccant Column | Drierite P/N 26800 |
| Desiccant, five pound jar | Drierite P/N 23005 |

## 10.0. WARRANTY

All instruments built by Overhoff Technology Corporation are warranted to perform as claimed.

Defective components or workmanship of the instrument will be corrected free of charge for parts or labor within a period of one year from delivery. Nonperformance of the instrument as a result of negligence on behalf of the customer is not covered by this warranty.

Should it appear to be necessary to return the instrument to our factory, authorization for the return must be obtained from Overhoff Technology Corporation prior to shipping. In-freight charges will be borne by the customer.

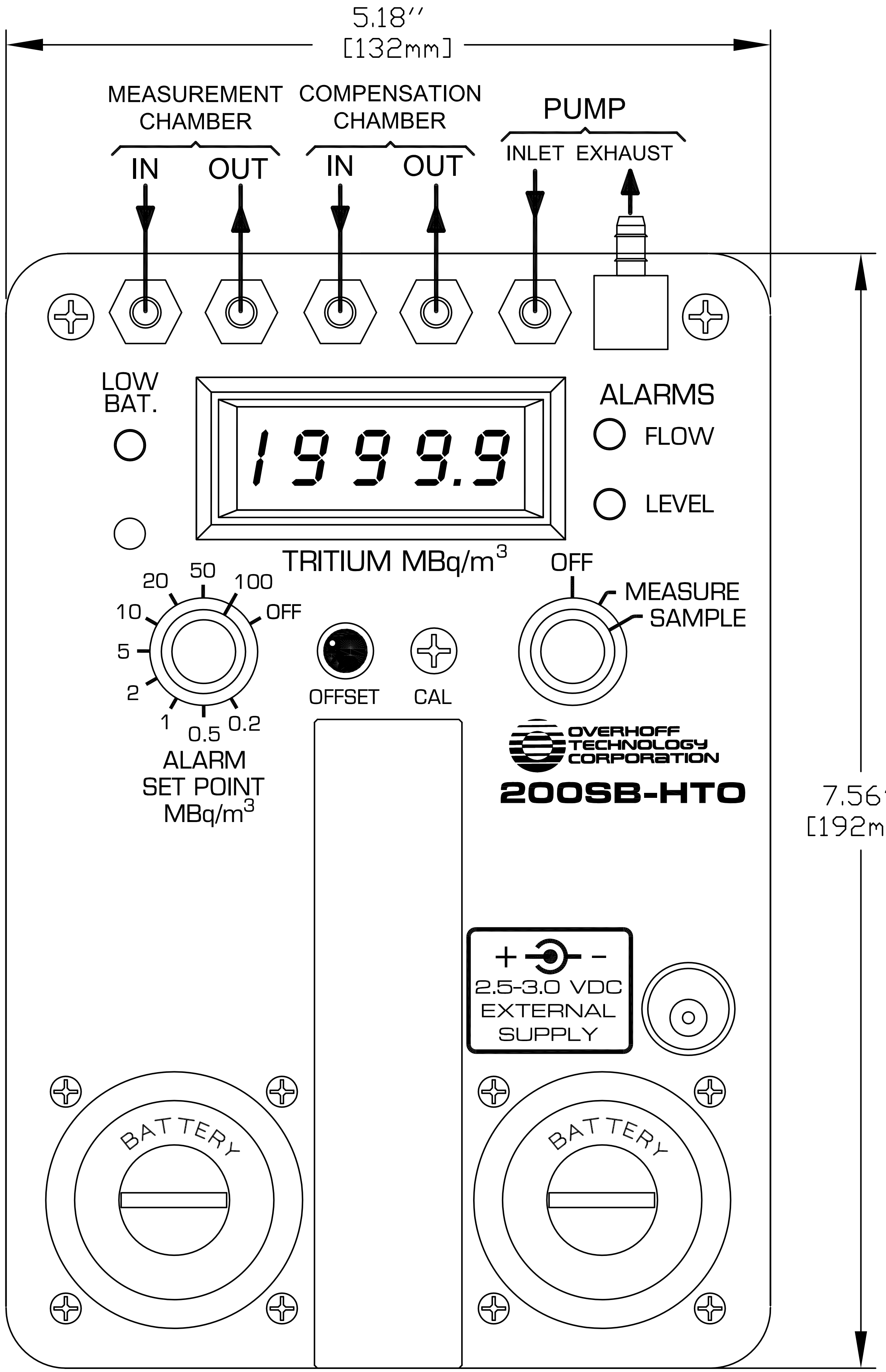
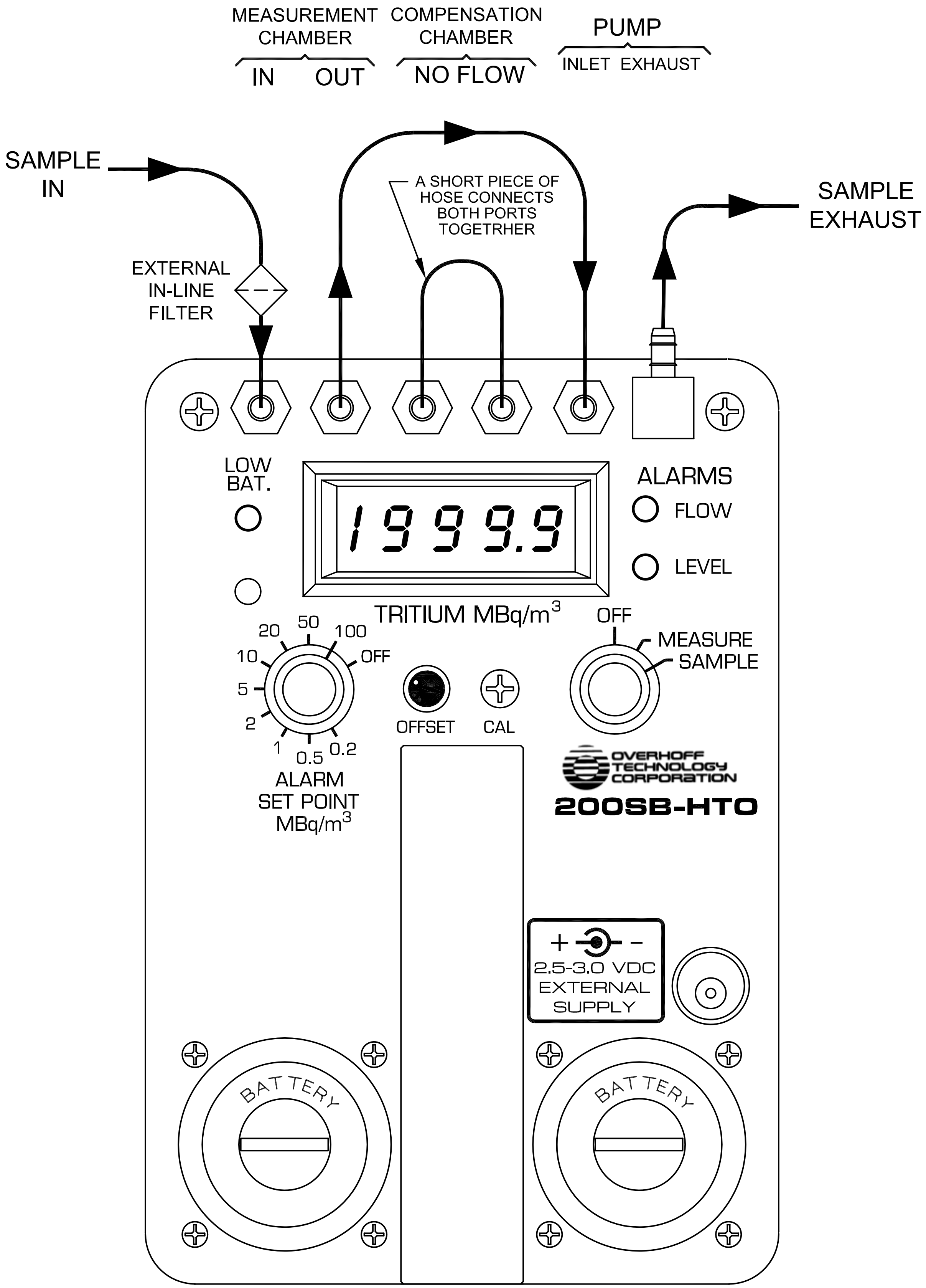
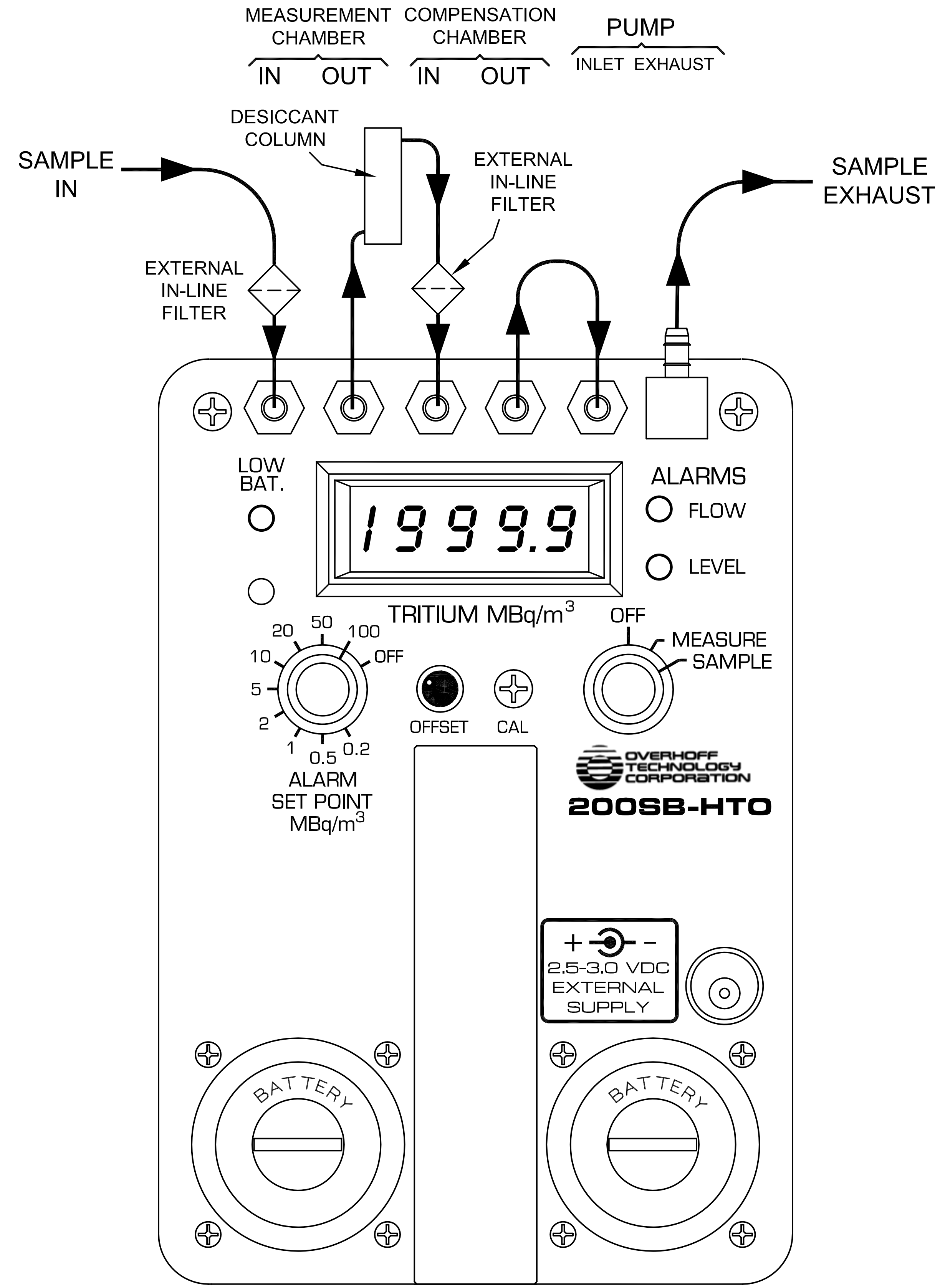



FIGURE 1
FRONT PANEL CONTROLS
MODEL 200SB-HTO

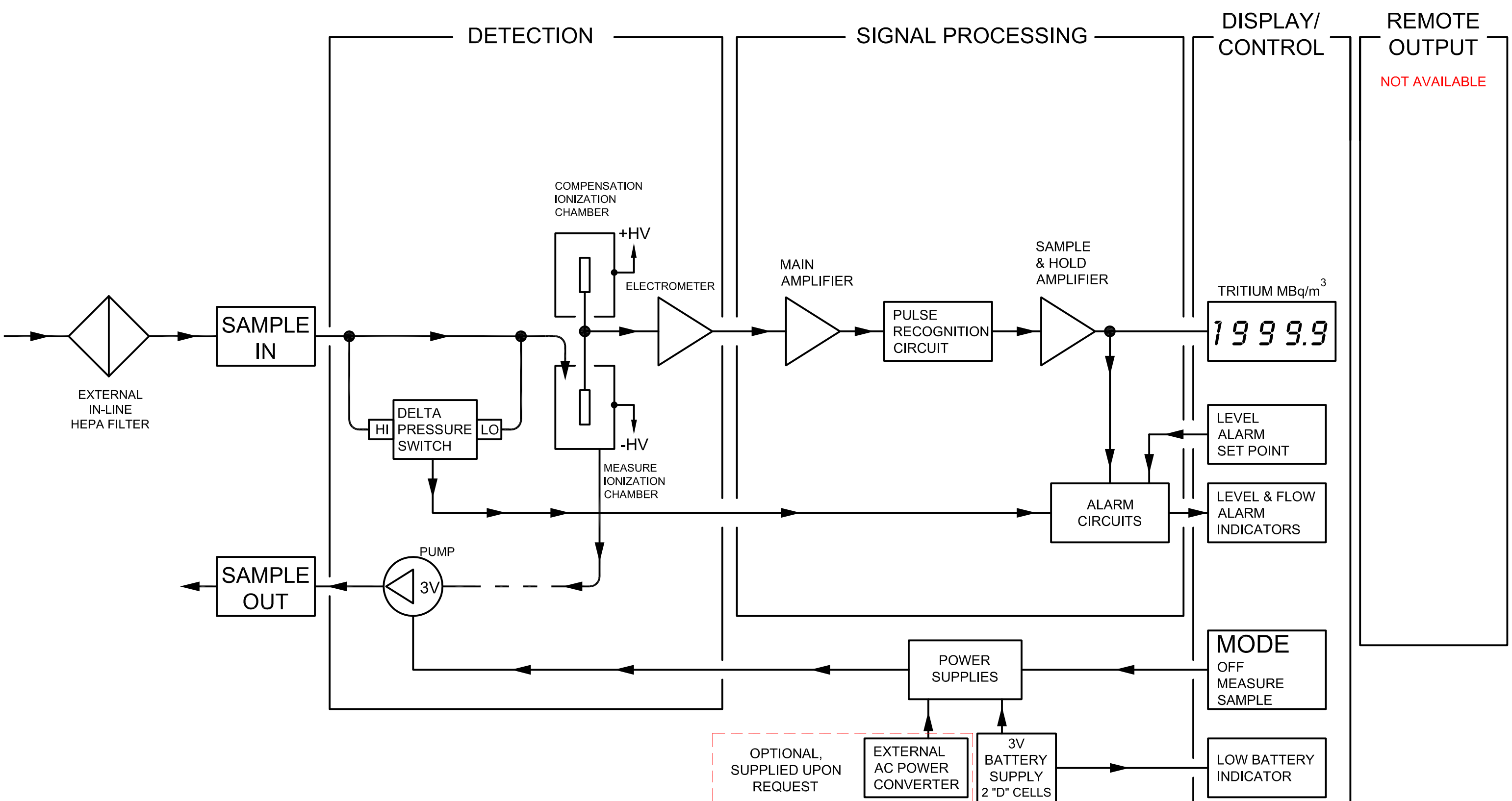



HOSE CONNECTIONS
FOR TOTAL TRITIUM MEASUREMENT




HOSE CONNECTIONS
FOR NOBLE GAS COMPENSATION

FIGURE 2
HOSE CONNECTIONS
MODEL 200SB-HTO

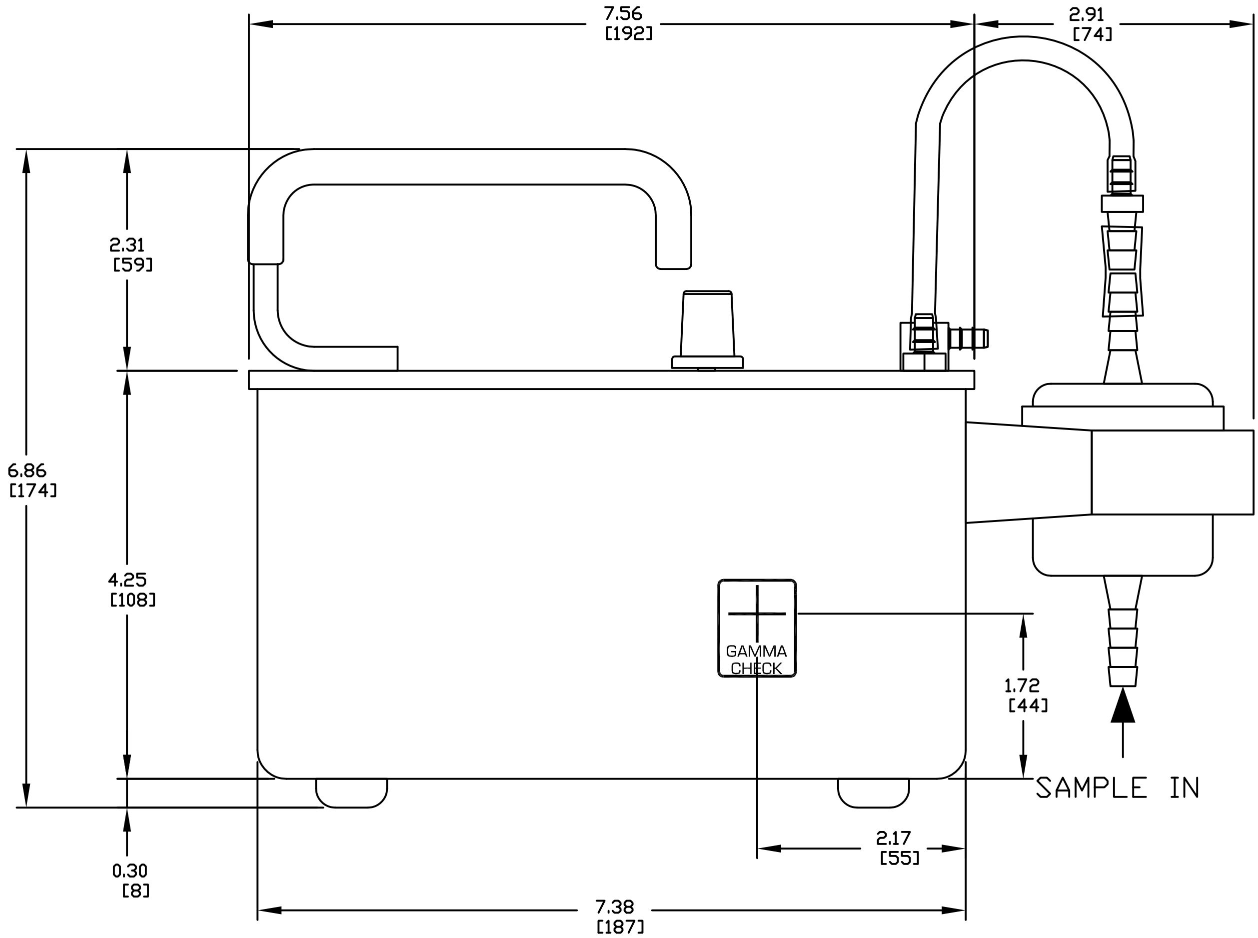



FUNCTIONAL BLOCK DIAGRAM
MODEL 200SB

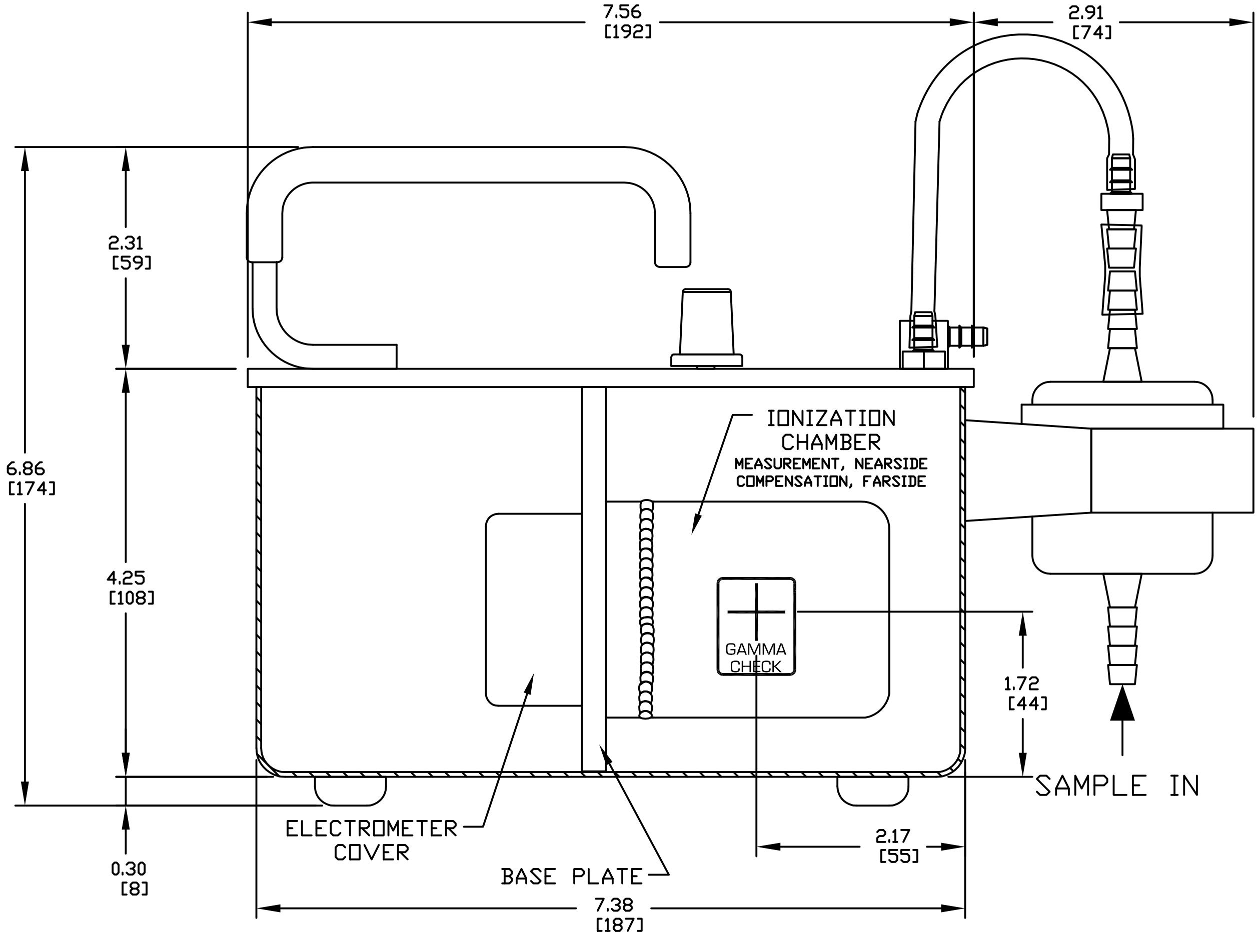
OVERHOFF TECHNOLOGY CORPORATION

NOTES:

1. ALL DIMENSIONS ARE IN INCHES (millimeters) AND ARE FOR REFERENCE ONLY




| | | | | | |
|---|---|---|---|---|---|
| DIMENSIONS ARE IN INCHES (MILLIMETERS) | | **OVERHOFF TECHNOLOGY CORPORATION** MILFORD, OHIO 45150 U.S.A. | | | |
| | | TRITIUM MONITOR MODEL 200SB<br>GENERAL ARRANGEMENT, SIDE VIEW | | | |
| DRAWN<br>D.WILLIAMSON | DATE<br>03-14-02 | SIZE<br>A | FILE NAME<br>200SBGA.DWG | DWG NO.<br>200SBGA | REV |
| APPROVED<br>D.WILLIAMSON | DATE<br>03-14-02 | SCALE 0.5 | | SHEET 1 OF 1 | |




| | | | | | |
|---|---|---|---|---|---|
| DIMENSIONS ARE IN INCHES (MILLIMETERS) | | **OVERHOFF TECHNOLOGY CORPORATION** MILFORD, OHIO 45150 U.S.A. | | | |
| | | TRITIUM MONITOR MODEL 200SB<br>SECTION VIEW SHOWING<br>IONIZATION CHAMBER POSITION | | | |
| DRAWN<br>D.WILLIAMSON | DATE<br>10-28-02 | SIZE<br>A | FILE NAME<br>200SBGA.DWG | DWG NO.<br>200SBGA-IC | REV |
| APPROVED<br>D.WILLIAMSON | DATE<br>10-28-02 | SCALE 0.5 | | SHEET 1 OF 1 | |

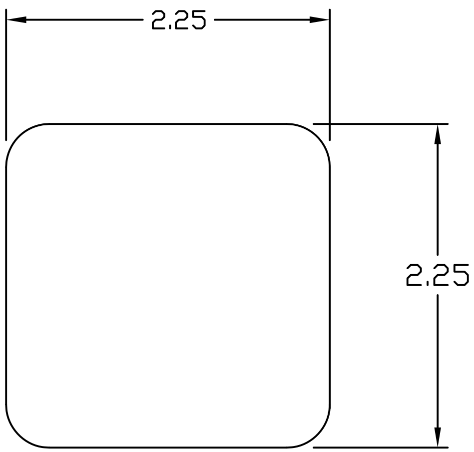
NOTES:
1. MATERIAL: ALUMINUM

2. WELD MUST BE CONTINUOUS AND LEAK TIGHT.

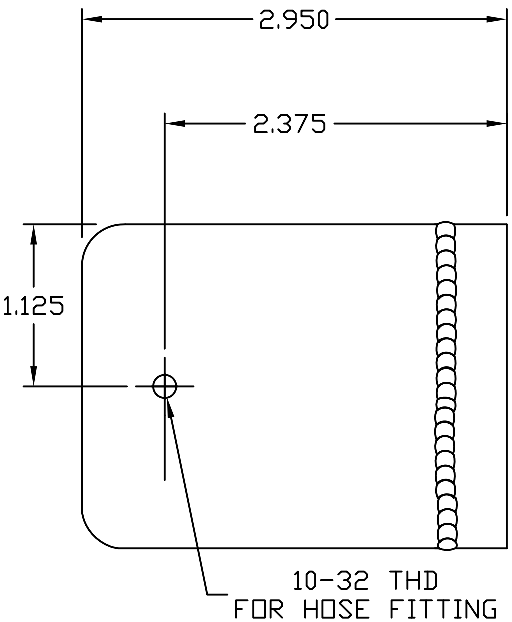
3. CHAMBER TO HAVE ALODINE APPLIED AFTER WELDING.

4. ALL DIMENSIONS ARE IN INCHES AND ARE FOR REFERENCE ONLY

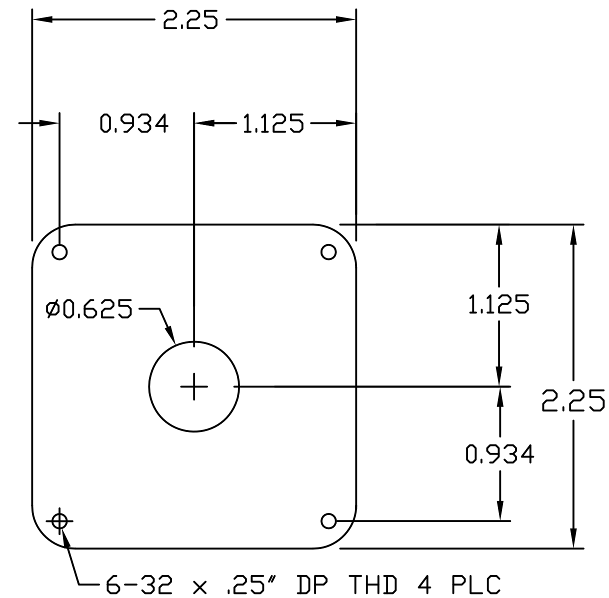
5. INTERNAL VOLUME: 200cc




LEFT END VIEW




SIDE VIEW




RIGHT END VIEW
THIS END MOUNTS TO IONIZATION
CHAMBER BASE PLATE

OVERHOFF
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CORPORATION

PART No. 1020686

IONIZATION CHAMBER CAN
FOR MODEL 200 & 400 PORTABLES

25 OCTOBER 2002