Choice of Detector Shielding

For low-level counting of samples, shielding of the detector to reduce ambient background radiation is essential. Many materials are used in shield designs, lead being the most common because of its high atomic number and density. Pre-World War II steel is used in some designs.

The thickness chosen for the principal shielding material depends on the required attenuation of gamma rays of a specific energy. For environmental applications covering the energy range from 0 to 2 MeV, 4 in. of lead is sufficient. Figure 1 shows the half-thickness values vs energy for commonly used shielding materials. For lead, the half-thickness for a 1 MeV gamma ray is 0.85 cm, which means that a 1-MeV gamma ray passing through 10 cm (4 in.) of lead will be attenuated by a factor of 3200; a 2-MeV gamma ray, by a factor of 175. These attenuation factors are adequate for most applications. Still greater thicknesses provide additional attenuation of gamma rays, but also increase the probability of undesired cosmic-ray interaction within the shield. Beyond 4 to 5 in. of lead, the background will actually increase because of this effect. Figure 2, showing the fraction remaining of photons incident on the shield, leads to the same conclusions.

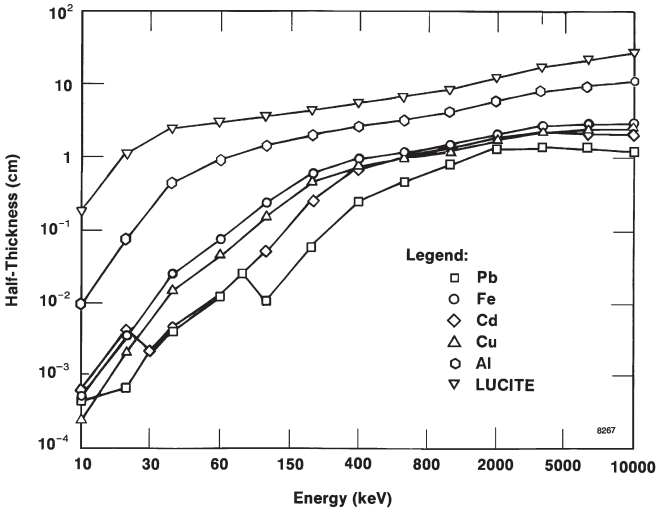


Fig. 1. Half-Thickness Values vs. Energy for Commonly Used Shielding Materials.

Figure 1 also shows that the half-thickness does not increase significantly at energies above 2 MeV, so that the conclusions for shield thickness also apply to prompt gamma measurements up to 10 MeV.

For some applications, the reduction of the lead K x ray is desirable. A graded-Z shield may be used for this purpose. The graded-Z shield works by providing materials with decreasing atomic numbers toward the detector in order to absorb the lead x ray photoelectrically and emit a secondary x ray of lower energy. Typical graded-Z shields use lead-cadmium-copper as the shielding materials. The required thickness of the cadmium and copper may be determined by examining Fig. 1 and noting the half-thickness values in those materials at the energies of interest.

For example, 0.3 mm is the half-thickness of cadmium at 80 keV (Pb K x rays); therefore, 10 half-thicknesses (3 mm) would reduce the peak by a factor of 1000. The copper is used to absorb the cadmium x rays at 22 keV and emit lower-energy x rays at about 3 keV. The half-thickness of copper for 20-keV photons is 0.03 mm and for 80-keV photons is 1 mm; so 0.3 mm would attenuate the 22-keV photons by a factor of 1000, but would also provide an additional 20% attenuation at 80 keV. Commercially available graded-Z liner thicknesses vary, but typical specifications are 0.02 in. (0.5 mm) for the Cd liner and 0.62 in. (1.57 cm) for the Cu liner. These dimensions would result in a 100-fold decrease in the Pb x rays and essentially complete attenuation (2 X 10^{16}) for the Cd x rays.

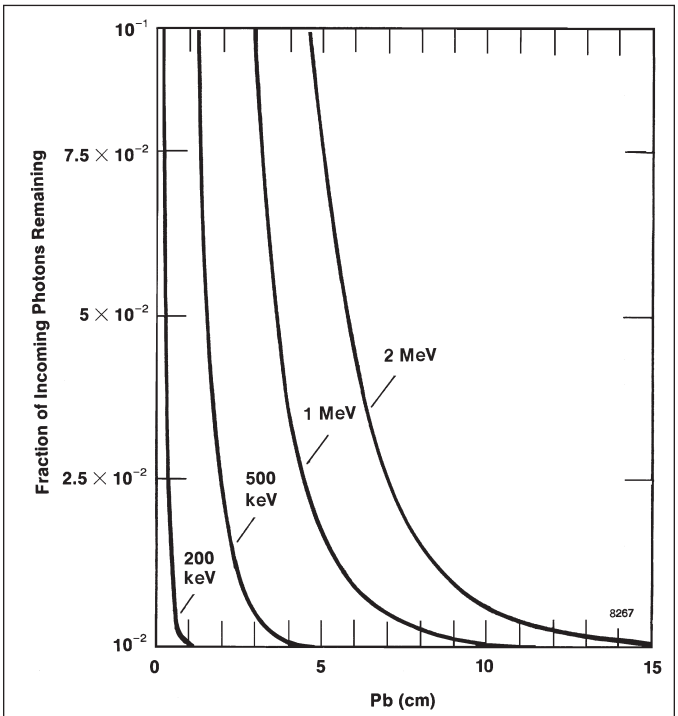


Fig. 2. Photon Attenuation as a Function of Pb Shield Thickness for Various Energies.

Other materials, such as Al and Lucite, are sometimes used in graded-Z shields used with x-ray detectors. Use of the graded-Z shield will result in higher backscatter effects within the shield and may actually reduce the detection limit for nuclides with principal peaks within the backscatter peak energies.

For the primary shielding material, both the graded-Z liner and the support structure should be constructed from materials with concentrations of radioactive nuclides as low as possible.

For even lower-level measurements, active shielding methods provide additional enhancement of signal-to-background ratio. These methods should be considered if passive shielding alone will not provide the required measurement sensitivity.

Detector Shielding

HPLBS Series

- **4-in.-thick low-background Doe Run™ lead with low-carbon steel casing**
- **Standard copper/tin-graded liner to suppress lead x rays**
- **Split-top lid, with adjustable maintenance-free pivot bearings, for years of trouble-free operation**
- **Front-loading and "J" Type cryostat versions available**
- **11-in.-diam x 16-in.-deep cavity can accommodate 4-liter Marinelli beakers**
- **Textured polyurethane finish**
- **Options for table-top leveling, detector-dewar leveling**

ORTEC's high-performance, low-background Ge detector shields feature highest quality workmanship and the best materials. They include features which have evolved over years of experience in lead shield design. Options that make the shield easier to use also ensure continued smooth operation.

All ORTEC high-performance, low-background lead shields feature an 11-in.-diam X 16-in.-deep cavity, suitable for accommodating even 4-liter Marinelli beakers. A graded liner of copper and tin is provided for the suppression of lead x rays. The bulk shielding material is certified Doe Run virgin lead (4-in.-thick). The support stand and shield jacket are made from low-carbon steel. All external surfaces are finished in a durable, attractive textured polyurethane. Internal (copper and lead) surfaces are polished and coated with a clear-acrylic lacquer to minimize tarnishing of the copper liner and prevent human exposure to lead.

With each ORTEC HPLBS, the following are supplied:

1. Rigid support stand
2. Installation and maintenance manual
3. Touch-up paint
4. Assembly tools
5. Lifting eyes and lid restraint brackets
6. Two heavy-duty, wood pallet/crate sets suitable for overseas shipping

HPLBS1 Shield

The HPLBS1 shield is designed to accommodate ORTEC “vertical dipstick” Model CFG-PV4, CFG-PV-1, or CFG-SV cryostat Ge detectors. Detectors incorporating other cryostat models may require a custom plug — contact the factory in that instance.

HPLBS1F Front-Loading Shield

The HPLBS1F Shield is similar to the HPLBS1 Shield function, material, and appearance with the additional benefit of a hinged-front door to allow easy access to the sample chamber.

Detailed Technical Specifications

(Models HPLBS1 and HPLBS1F)

SHIELDED CAVITY DIMENSIONS 28-cm i.d. X 40-cm high (11-in. i.d. X 16-in. high).

SHIELDING TYPE Solid-cast virgin lead with steel casing and graded-Z liner.

SHIELDING SPECIFICATIONS

9.5 mm (3/8 in.) low-carbon steel casing

101 mm (4 in.) certified Doe Run lead

0.5 mm (0.02 in.) tin sheet liner

1.6 mm (0.064 in.) soft-copper sheet liner

SUPPORT STAND MATERIAL Low-carbon steel square tubing and plate.

WEIGHT

Total Assembled 1,134 kg (2,500 lb).

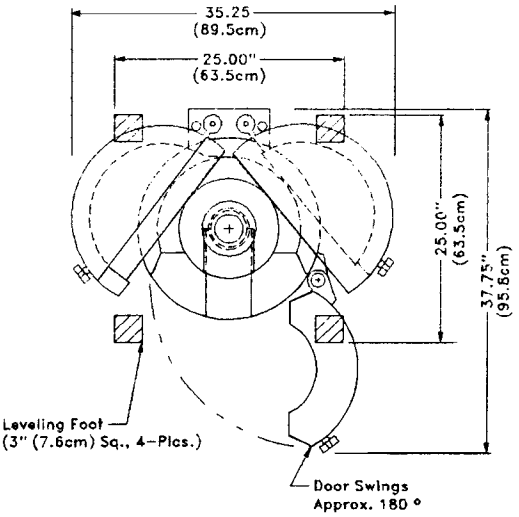
Shipping 1,270 kg (2,800 lb).

EXTERNAL DIMENSIONS

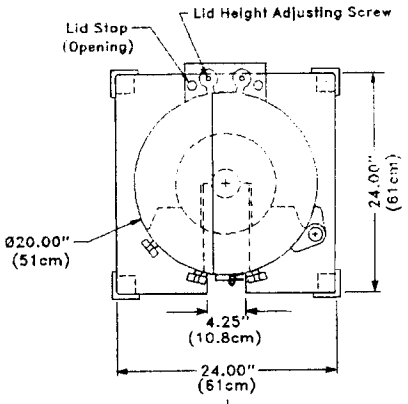
Shield 51-cm diameter X 63-cm high (20-in. diam X 24-5/8-in. high).

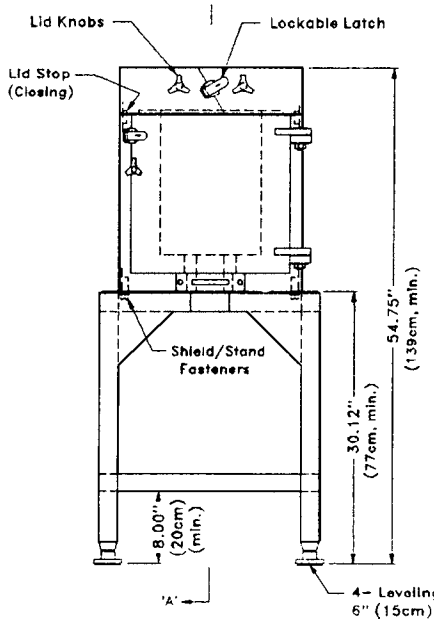
Stand 61-cm square X 77-cm high (minimum) [24-in. square X 30-1/8-in. high (minimum)].

Assembled Height 139 cm (minimum) to 154 cm (maximum) [54-3/4 in. (minimum) to 60-3/4 in. (maximum)].



Top View With Lids And Front Door Opened
Floor Loading: 70 Lbs./sq.in. (5Kg/sq.cm)





Detector Shielding

HPLBS2F

The HPLBS2F Shield is similar to the HPLBS1F, in that it combines front loading with the split-top shield. It differs, however, in that it is designed for use with an ORTEC “J” Type cryostat Model CFG-SJ or CFG-PJ. A compact design results in the need for only 2-ft X 4-ft floor space [61-cm X 117-cm], plus clearance for opening of lids and the front door.

Detailed Technical Specifications in addition to those listed above (Model HPLBS2):

SHIELDED CAVITY DIMENSIONS
28-cm i.d. X 40-cm high
(11-in. i.d. X 16-in. high).

SHIELDING TYPE Solid-cast virgin lead with steel casing and graded-Z liner.

SHIELDING SPECIFICATIONS

9.5 mm (3/8 in.) low-carbon steel casing

101 mm (4 in.) certified Doe Run lead

0.5 mm (0.02 in.) tin sheet liner

1.6 mm (0.064 in.) soft-copper sheet liner

SUPPORT STAND MATERIAL Low-carbon steel square tubing and plate.

DETECTOR ACCESS SLOT WIDTH 4.5 cm (1-3/4 in.).

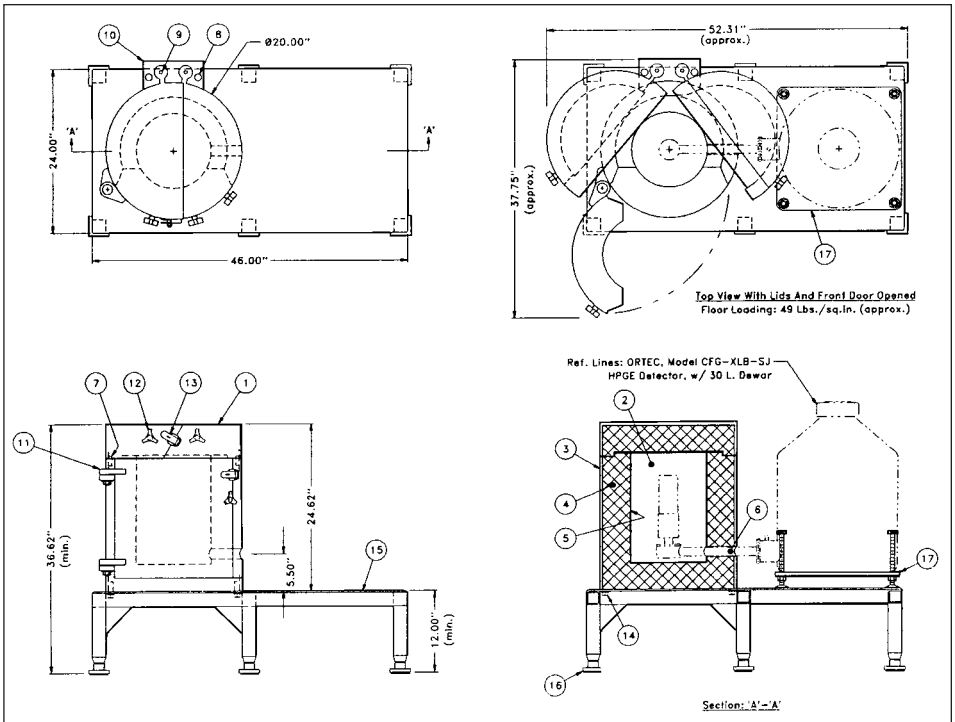
WEIGHT

Total Assembled 1,134 kg (2,500 lb).

Shipping Weight 1,270 kg (2,800 lb).

EXTERNAL DIMENSIONS

Shield 51-cm diam X 63-cm high
(20-in. diameter X 24-5/8-in. high).



1. Model LSSJ-1116 Low background lead shield
2. Shielded cavity: 11” i.d. X 16” tall
3. Steel casing: 3/8” thick, low carbon
4. Cast virgin lead: 4” thick (minimum)
5. Sample cavity liner: .020” Cd and .064” Cu
6. Detector coldfinger slot with cable way
7. Lid stop (closing)
8. Lid stop (opening)
9. Adjusting screw, lid height
10. Enclosure, lid pivot mechanism
11. Front-door pivot hinge
12. Knob for front door and lids
13. Lockable latch for front door and lids
14. Shield to table fasteners
15. Low carbon steel support stand
16. Leveling foot (3” square) allows 6” vertical adj
17. Model DS-30, dewar stand (optional extra)

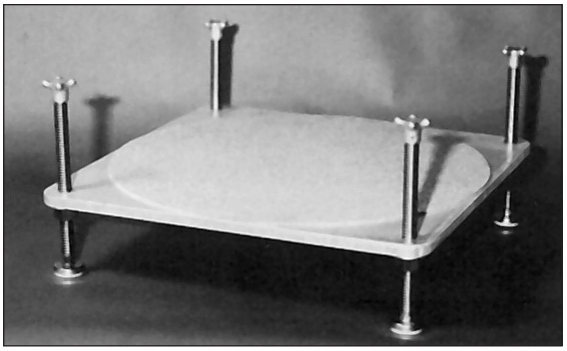
Stand 61 cm X 117 cm X 77-cm high (minimum) [24 in. X 46 in. X 12-in. high (minimum)].

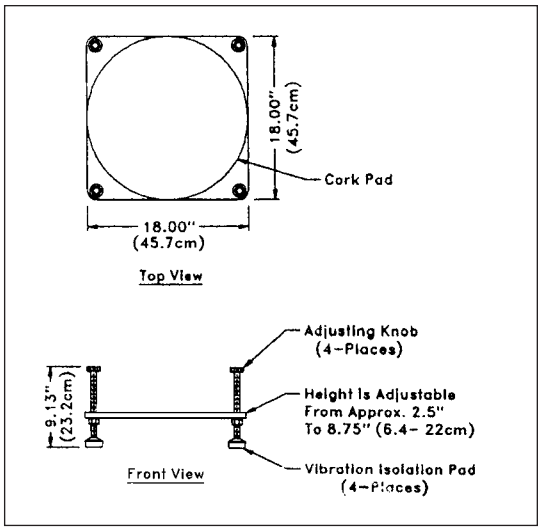
Assembled Height 94 cm (minimum) to 109 cm (maximum) [37 in. (minimum) to 43 in. (maximum)].

Accessories for HPLBS1 and HPLBS1F

DS30 Dewar Leveling Stand

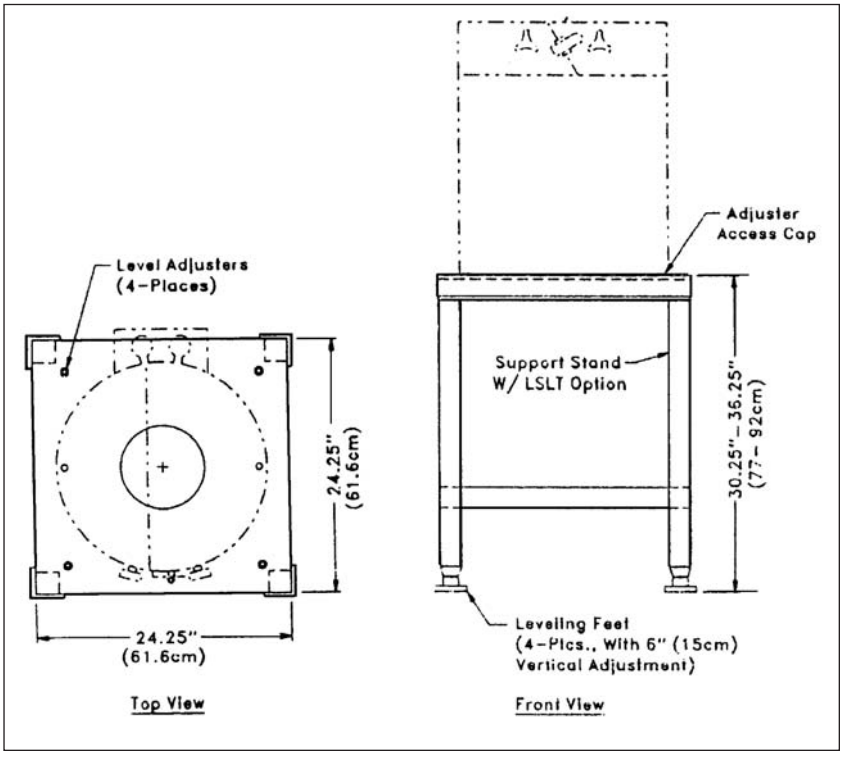
Provides up to 15 cm (6 in.) of vertical height adjustment; features vibration isolation pads to minimize detector microphonics.





LSLT Table-Top Leveling Option

LSLT allows extremely precise adjustment of the leveling of the HPLBS1 Shield. Leveling is performed at table top height using a single hex-key wrench. It can compensate for floor deviations as great as 16 mm in a 61-cm square (5/8 in. in a 24-in. square). When correctly adjusted, the Model LSLT allows the biparting lids of the shield (when unlatched) to swing slowly and gently to the fully open position, and stay there allowing full SAFE access to the counting chamber.



Specifications subject to change
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