

LEAD INDUSTRIES ASSOCIATION

192 MADISON AVENUE

NEW YORK 17, N. Y.

November 6, 1961

SUBJECT: COMPREHENSIVE
REPORT ON LEAD IN FALLOUT
SHELTERS

To Members of the Lead Industries Association:

We have now prepared a much more comprehensive report, as attached, on the use of lead in the construction of fallout shelters. We plan on using this to answer future inquiries in place of the report sent to you on October 16, 1961.

Additional copies up to twenty-five may be had free of charge on request, larger quantities at 4¢ per copy.

If you need additional copies, please let us know.

Sincerely yours,

David M. Borcina
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DMB:EDM

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Revision 10/30/61

LEAD IN FALLOUT SHELTERS

Among the many commonly available materials for use in the construction of fallout shelters, lead, in terms of weight and space, provides the most efficient shield against gamma rays -- the prime dangerous radiation to be expected in fallout.

The reason for this is that the degree of protection or "attenuation" afforded by any material is closely related to its mass. Therefore, lead being the most massive common shielding material is correspondingly more efficient and therefore thinner and lighter than other equivalent shields. Where weight and space are not critical, however, and cost is a major factor, other materials may be selected either alone or in combination with lead.

The following table taken from the Atomic Energy Commission manual entitled "CEX-58.8" indicates "barrier" or "shield" thicknesses required for various degrees of protection or "attenuation" against fallout.

Approximate Attenuation Factors for Gamma Rays from Fission Products as a Function of Shield Thickness for Indicated Materials

Shield thickness for indicated materials, in inches

Attenuation factor	Lead (710 lb cu ft)	Iron & Steel (490 lb cu ft)	Concrete (144 lb cu ft)	Earth (104 lb cu ft)	Water (62.4 lb cu ft)	Wood (fir) (34 lb cu ft)
2	0.29	0.7	2.5	3.5	4.4	9.2
4	0.58	1.0	4.5	6.9	13	25
10	1.0	2.7	9.7	13	19	36
50	2.4	4.2	14	20	29	55
100	2.9	5.0	16	23	33	62
1,000	2.7	4.8	22	32	45	88
10,000	3.5	6.0	27	39	56	110
100,000	4.3	11	32	44	70	140

There is some question about the amount and energy of gamma radiation to be protected against and, as a function of this, the shielding required. Data in the above table and in recommendations of the Office of Civil Defense Mobilization, OCM, are based on a minimum protection factor of 100 and an assumed energy of .7 Mev. The figure 100 simply means a barrier with this factor will reduce intensity inside the shelter to 1/100 of its intensity outside at any given moment. Mev. means million electron volta, a measure of energy.

Using this basic data, and assuming a shelter built in the basement (below grade) of an average two story frame house, OCM recommends 8" of concrete of a density equal to 144 lbs. per cu. ft. or its equivalent. Since quick reference to the above table reveals an attenuation factor of only about 5 for this

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thickness of concrete, it becomes evident that the roof, floors, and earth about the walls of the cellar are contributing the remainder of the protection factor of 100. Should this same shelter be built outside, above ground, the required thickness of concrete would be 16".

Another source of confusion comes from differing views of some authorities as to radiation energies to be expected. Energies of from 1.4 to 2 or 3 Mev. have been suggested. Naturally, far heavier shields would be required in these cases. Additionally, some authorities recommend higher protection factors and, in fact, assuming the worst weather conditions, addition of cobalt or other isotopes to weapons or the possibility of repeated bombings, factors up to 2,800 have been used. In any event, if discrepancies exist between one set of recommendations and another, check these two items: radiation energies expected and protection factors used.

Based on the minimum adequate factor of 100 (for .7 Mev. radiation) however, the actual construction of a basement shelter poses several problems. It is important to note, again referring to the table, that the concrete used in building fallout shelters should have a density of 144 lb. per cu. ft. This means an 8" concrete wall will weigh approximately 96 lb. per sq. ft. and a wall 8' high will weigh roughly 770 lb. a running ft.

The construction of the concrete walls may not pose a serious problem but the ceiling is another matter. The concrete for the ceiling of a shelter 10 x 10 ft. will weigh roughly 10,000 lb. Lead on the other hand will weigh roughly 6,000 lb. and require only 1" of head room rather than the 8" required if concrete is used.

Lead also offers advantages for use in doors, hatches, window coverings, atop shallow underground shelters and other critical areas.

Composite materials such as lead and concrete, lead and earth, or lead and steel are other structural possibilities. The necessary thickness of the various materials making up the composite is not a straight interpolation of the figures given in the table. Several acceptable composites are shown on the following pages. For others it is suggested that AEC or OCIM be contacted for advice.

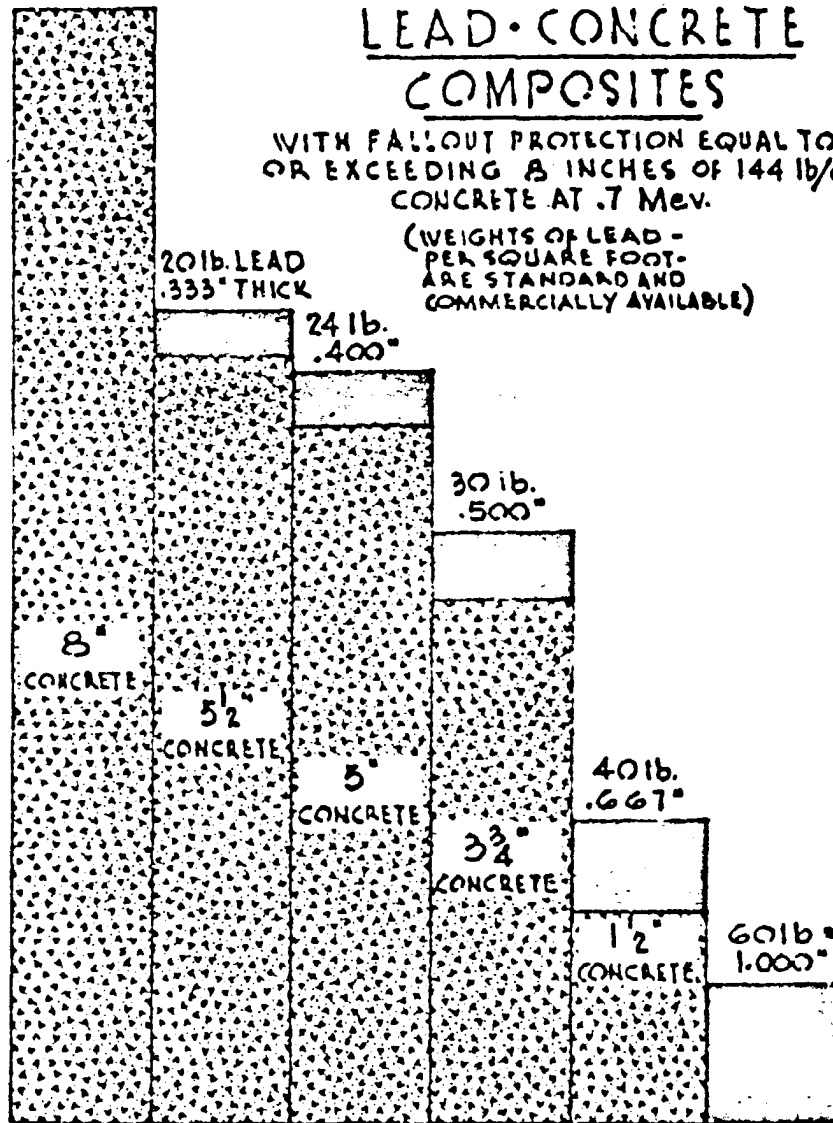
Lead for gamma shielding is available in a number of forms, such as sheet, brick, shot or wool. Lead shot can be cold poured into difficult to protect areas or contained in a steel shell for use in doors, hatches, etc. Lead wool is an ideal caulking material for joints in whatever material or materials are selected for the shelter. Lead glass, which can contain more than 50% lead by weight is available and can be used for viewing ports where desirable.

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LEAD-CONCRETE COMPOSITES

WITH FALLOUT PROTECTION EQUAL TO
OR EXCEEDING 8 INCHES OF 144 lb/cu.ft.
CONCRETE AT .7 Mev.

(WEIGHTS OF LEAD -
PER SQUARE FOOT -
ARE STANDARD AND
COMMERCIALY AVAILABLE)

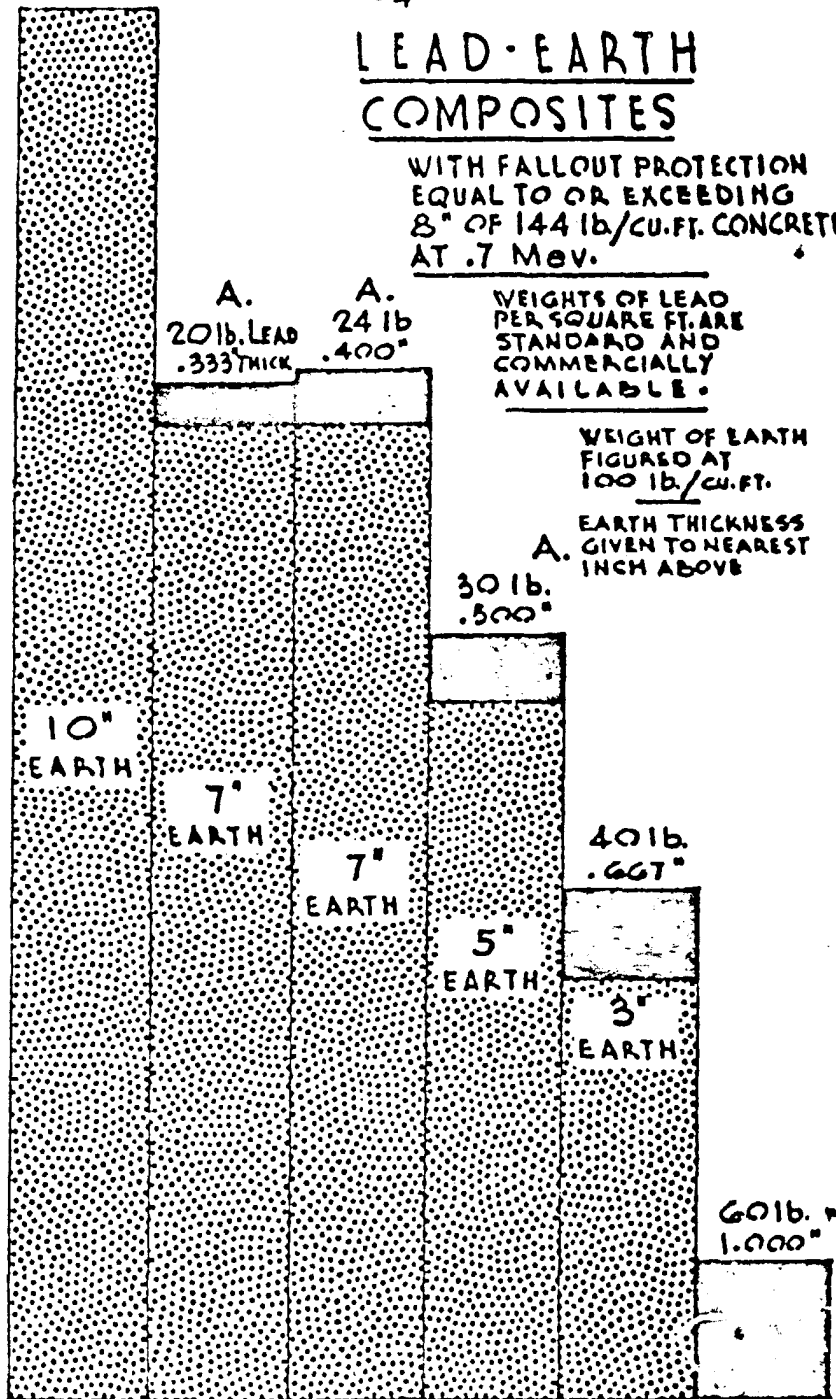


* EXCEEDS REQUIREMENT

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LEAD-EARTH COMPOSITES

WITH FALLOUT PROTECTION
EQUAL TO OR EXCEEDING
8" OF 144 lb./cu.ft. CONCRETE
AT .7 Mev.



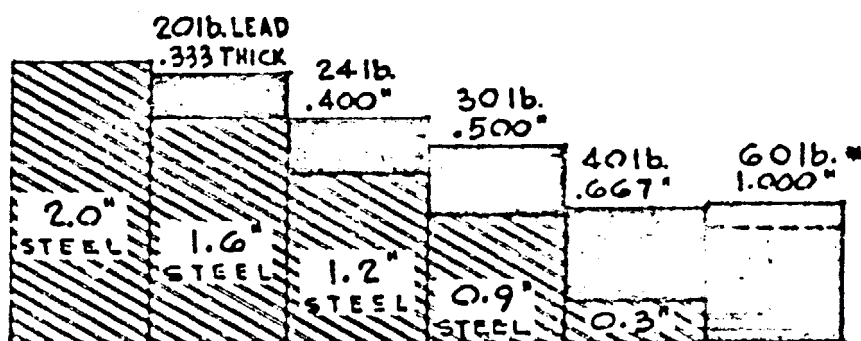
* EXCEEDS REQUIREMENT.

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LEAD - STEEL COMPOSITES

WITH FALLOUT PROTECTION EQUAL TO
OR EXCEEDING 8" OF 144 lb/CU. FT.
CONCRETE AT .7 MeV.

WEIGHTS OF LEAD - PER SQUARE FOOT -
ARE STANDARD AND COMMERCIALY AVAILABLE.



* EXCEEDS REQUIREMENT.