AN INTERIM REPORT
ON THE USE OF HEAVY AGGREGATES
AS RADIATION SHIELDING FILL FOR
THE STANFORD LINEAR ACCELERATOR M

REPORT TO PROJECT M - NO. ABA-27

STANFORD UNIVERSITY SUBCONTRACT S-128

UNDER AEC CONTRACT AT(04-3)-363

Submitted by A H Gilbert Approved by R L Sharpe

AETRON-BLUME-ATKINSON
A Joint Venture
ARCHITECT-ENGINEER-MANAGER
1455 California Avenue
Palo Alto, California

October 1961

AN INTERIM REPORT ON THE USE OF HEAVY AGGREGATES AS RADIATION SHIELDING FILL FOR THE STANFORD LINEAR ACCELERATOR M

A preliminary investigation is being made on the availability and cost of various heavy materials which could be used to reduce the height of the shielding fill over the accelerator housing. The determination of the possible savings in machine components, such as wave guides, vacuum system, etc., that might accrue from a reduction in shielding fill is beyond the scope of this study.

The following materials are being considered:

1. Iron Ore
2. Magnetite Sand
3. Steel Mill Scale
4. Pig Iron
5. Barite (or Barytes)
6. Ferrophosphorus

Iron Ore: There are two possible sources located in California which could furnish large quantities of iron ore. They are the Eagle Mountain deposits of the Kaiser Steel Corporation in Southern California and the mines of the Mountain Copper Company in the vicinity of Redding, in Shasta County. The freight rate from the Kaiser mines would be roughly twice that from the Shasta mines. The rate could probably be reduced, in both instances, if classified rock fill instead of iron ore. In order to obtain the maximum density when compacted in the fill, it will be necessary to have this material properly

graded. Tests will be made to determine the maximum bulk specific gravity of this material after compaction and the size gradation required to achieve this result. These tests will be made after ore samples, which have been requested, are received. Tentative quotations have been received on this material F.O.B. cars, Palo Alto, and range from $15 to $17 per net ton. To this figure should be added the cost of loading on trucks and hauling to the site. If this material has to be stock piled before placement, the added cost of rehandling should be included also. After the data is received from these tests it will be possible to determine, more accurately, the reduction in total fill height when using a combination of iron ore and earth.

Attached to this report are two drawings as follows:

SK-C10201 Cross Section of Iron Ore and Earth Shielding

SK-C10231 Cost of Iron Ore in Place

The first drawing shows the reduction in total height of fill, with varying amounts of iron ore, up to a maximum of 5 feet; the remainder being compacted earth. The second drawing is a graph showing the total cost of varying heights of iron ore. The figures shown are subject to verification after the results of the laboratory tests are available.

Magnetite Sand: Magnetite sand has been recovered, in the past, from beach sands on Monterey Bay south of Santa Cruz. Sand dunes close to Watsonville contain from 5 to 10 percent magnetite sand, but at present there are no facilities for handling this material and separating the magnetite. It is suggested that further study be given to the possibility of obtaining this material at a reasonable cost, as the hauling distance to the accelerator site is the shortest of any other comparable material.

Other sources of magnetite ore are located in southern California.

Mill Scale: Mill scale has been suggested as a high density shielding material and is being investigated as to cost and availability. This material is derived from steel rolling and has an iron content of about 70 percent. It would be necessary to break up this material before using it as a shielding fill, in order to attain the maximum density after placement. If the use of mill scale appears promising, the effects of possible corrosion or leaching of the material should be investigated.

Pig Iron: The use of pig iron as a shielding material has been studied, but due to the irregular size and shape of the ingots it would be very difficult to place as a homogeneous shielding. The cost of pig iron is quoted at this time as $82.87 per gross ton F.O.B. Palo Alto, and is too high to warrant further consideration.

Barite: Barite aggregate is being investigated as a shielding fill to determine its relative cost and availability. Data and samples of this material have been requested from suppliers but have not been received at this time.

Ferrophosphorus: Ferrophosphorus is an extremely heavy material with about 4.8 specific gravity. The cost of this material is very high, being quoted at about $100 per long ton F.O.B. Palo Alto. This practically rules out its use as shielding fill over the accelerator, although it might be suitable as aggregate in high density concrete.

Preliminary Conclusions and Recommendations

It appears from the data developed to date that iron ore or other heavy aggregate, will add appreciably to the total cost of the shielding fill required

over the accelerator housing, as the saving in earth fill and wave guide passages is not large. Therefore, if use of a heavy aggregate will be justified on an economic basis, the savings in the vacuum pumping and piping system, wave guides, cooling water piping, control wires, and other items affected by the lesser fill depth, will have to be considerable.

As the additional cost of heavy aggregate appears excessive, it is requested that Project M review the above data together with the attached sketches to determine if further detailed studies, such as laboratory testing of certain aggregates, is warranted.