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LAWRENCE LIVERMORE LABORATORY

University of California/Livermore, California

UNDERGROUNDING OF NUCLEAR REACTORS
BY OPEN PIT EXCAVATION

D. WOOSTER

February 13, 1973

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ENGINEERING NOTE

ENN 73-30

1

SUBJECT

UNDERGROUNDING OF NUCLEAR REACTORS BY OPEN

NAME

D. Wooster

PIT EXCAVATION

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It has been proposed that the primary reactor circuits of commercial nuclear reactor power plants be placed underground.

The space requirement would consist of a cylindrical room 180' in height and 90' in diameter. Bottom of the room would be at 400' depth.

For full safety it is thought that the room must have a support shell capable of supporting lithostatic pressure, regardless of the competency of geologic stratum involved.

Several openings from the surface to the room would also be needed for circulation of fluids, service access, etc.

To develop such a complex by underground mining techniques is possible; but expensive. Also, emplacement of equipment of the dimensions and weights envisioned through any reasonably sized access shaft becomes complicated and costly.

In view of the above, perhaps excavation of a large hole to the desired depth, allowing ready placement of the reactor room support structure and equipment, becomes feasible. Of added interest would be the easy installation of access shaft lining, piping, etc., during the stemming operation. A sealing layer of clay or other material to aid in isolation of the reactor from the surrounding media could be placed if desired.

Burial of the "surface" plant at shallow depth would come naturally, if desired.

The following cost estimates are based on a model providing a general excavation to 265' depth with slope angles of 45° for competent rock and 30° for earth. A work area 210' in dia. is provided at the bottom of this excavation and a 110' hole 135' in depth with vertical walls to contain the reactor room support structure is located at center point, though it could readily be located off center to provide a better equipment and work area at the 265' level. Access would be by spiral road way used in making the excavation.

Cost estimates are based on current practice and bids - see attached sheet from the Dodge Estimating Guide. Also, a recent excavation bid of 1.75 per yd of competent sandstone at Trinidad, Colorado was recorded.

For this note, a figure of \$2.25 per yd of rock, and \$1.00 per yd for earth will be used. You will also note this corresponds to excavation slope angles of 45° and 30°. For intermediate materials, intermediate slope angles (with intermediate volumes) and intermediate unit excavation costs are envisioned. In other words, total costs should average out between the 2 end limits, in nearly all locations. Material replacement is estimated at \$1.00 for rock and .75 for earth.

Cost for excavation of the 110' x 135' bottom hole is estimated at 10.00 per yd for both rocks and earth - Earth digs easier; but needs more wall support, during excavation.

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2

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45° SLOPE

$$\begin{aligned}
 \text{Vol Truncated Cone} &= \frac{1}{4} \pi h [(R+R')^2 + \frac{1}{3}(R-R')^2] \\
 &= .25 \times \pi \times 265 [(370+105)^2 + \frac{1}{3}(370-105)^2] \\
 &= 51,800,000 \text{ cu ft} \\
 &= 1,919,000 \text{ cu yds} \\
 \text{at 2.25} &= \$4,320,000 \\
 \text{Vol 110' d. cylinder} &= \pi r^2 h = \pi \times 55^2 \times 135 = 1,282,905 \text{ cu ft} \\
 &= 47,515 \text{ cy yds} \\
 \text{at 10.00} &= \$475,000
 \end{aligned}$$

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3

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Cost of replacement	1,919,000 yds
@ \$1.00	\$1,919,000

Total cost in rock

Pit excavation	\$4,320,000
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Room excavation	475,000
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Pit replacement	1,919,000
-----------------	-----------

\$6,714,000

30° Slope

The 30° slope excavation was found to be 1130' dia at the top and to contain 4,003,000 cu yds.

Total cost in earth

Pit excavation @1.00	\$4,003,000
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Room excavation @10.00	475,000
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Pit replacement	3,000,000
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\$7,478,000

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