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This document consists of 5 pages, No. [redacted]

VERTICAL ROD TEMPERATURES

INTRODUCTION

An important factor affecting the decision on the use of a seal around the VSR on "C" is the temperature at which the rod can be expected to reach. Also the temperature of the rod-tip affects the choice of tip moderating material. These temperatures are calculated for a given set of conditions for "C" pile.

SUMMARY

The results of the calculations are best seen by referring to the attached figures. The effects of emissivity and weight of rod can be estimated by comparing the proper curves. The assumed conditions for calculating each curve are important and therefore, the basis for each curve is given separately below.

DISCUSSION

The sharp rise in temperature from time zero to time zero plus two seconds is by virtue of heat generated from neutrons captured in shutting down the pile and is therefore a function of power level. The temperature rise from then on is a function of graphite temperature (i.e., the temperature of the graphite surrounding the rod hole). The decay of graphite temperature with time is dependent upon the conductivity of the graphite and is slower in piles where there has been considerable damage due to neutron irradiation. The curves given below, would not be appreciably altered by using higher powers as the basis since only the first part from zero to zero plus is affected.

The graphite temperatures at the face of the hole would be reduced slightly due to the cooling to the rod. This effect was neglected, and leads to slight conservativeness.

Curve 1 is probably the most realistic case and should be considered the best estimate for "C" pile operating at graphite temperatures of 380° centigrade. Should a new pile atmosphere be used at a later date, with resulting higher graphite temperatures, these curves would obviously no longer hold. The production test being run by the Technical Division at "D" will serve to substantiate the method of calculation.

[redacted]

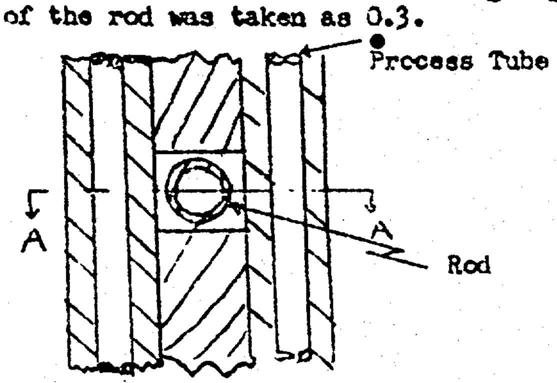
BASES

A common basis for all calculations is a power level of the 800 mw. For Curves 2 and 3 the relaxation time is 120 minutes; while for Curves 1 and 4 the relaxation time is 100 minutes. The other assumptions used differ for each curve and are listed below.

Figure I

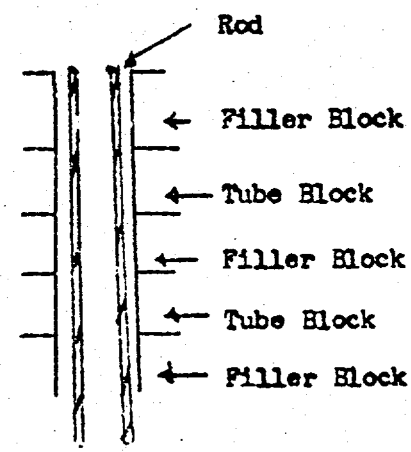
Curve 1

The temperature of the graphite in the filler block is that of Curve 1 - Figure 2, while the temperature in the tube block is that of Curve 2 - Figure 2. Curve 1 is based on the results given in Document HW 18609, and Curve 2 was taken from the electrical analogue results, (HDC-1855). Calculations were made on the assumption that alternate filler blocks and tube blocks surround the rod in going from top to bottom. The emissivity of the rod was taken as 0.3.



Section of
Plan-view

The next layer below or above this section results in filler blocks completely surrounding the rod.



A - A in Elevation

shows up as alternate

tube & filler blocks

Curve 2

The same assumptions as for Curve 1 were used, except that the filler block temperature was assumed to exist throughout and therefore, no allowance was made for the cooler tube block temperatures. The emissivity of the rod was taken as 0.8. This, then, represents the very most conservative case and is the worst condition that would occur. Also the graphite relaxation time was taken as 120 minutes. This is Curve 3 - figure 2.

Curve 3

Same as Curve 2 except that a rod emissivity of 0.4 was used.

[redacted]

Curve 4

This curve was computed using the same basis of graphite temperatures as that used to calculate Curve 1. The emissivity was taken as 0.3. The only difference is that the tip contained masonite and therefore, the heat capacity is larger. The density used for masonite was 123 lbs. per cubic foot, with a Cp = 0.3 Btu / lb - °F

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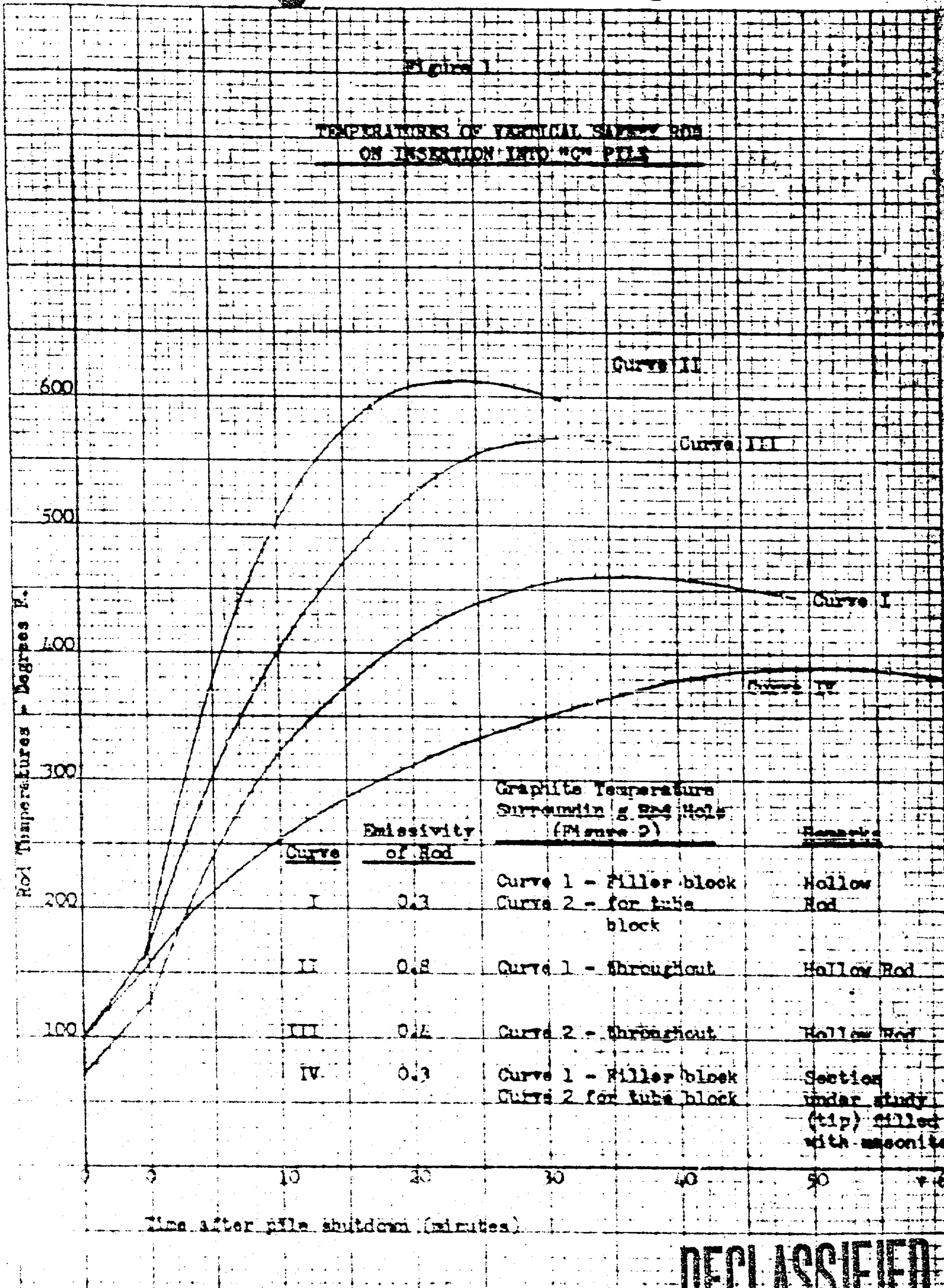

Curve	Emissivity of Rod	Graphite Temperature Surrounding Rod Hole (Figure 2)	Remarks
I	0.3	Curve 1 - filler block Curve 2 - for tube block	Hollow Rod
II	0.8	Curve 1 - throughout	Hollow Rod
III	0.4	Curve 2 - throughout	Hollow Rod
IV	0.3	Curve 1 - Filler block Curve 2 for tube block	Section under study (tip) filled with masonite.

Figure 2