Fermilab Radiation Physics Note No. 24

Delay Correction Factors for Dodo Neutron Measurements

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Addendum

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Both the Dodo and the Fermilab Albatross utilize neutron activation of a silver foil around a Geiger-Mueller (G-M) tube. However, unlike the Albatross, the Dodo does not have a second G-M tube to subtract charged particle background. This lack of compensation means that a Dodo must be taken out of the radiation field to be read for neutrons only. Given the sometimes complex fields present, this relocation could involve a delay of one or more minutes.

During this delay the activation in the silver foil will decrease, particularly that of ^{110}Ag with a 24.3 second half-life, but there will also be a measurable effect from the 2.4 minute half-life of ^{108}Ag. The upper curve in Figure 1, taken from TM-291, indicates the loss in total activity with time. Figure 2 shows, as a function of the delay time, the correction factor that should be applied. The reading on the Dodo should be multiplied by the factor for the time elapsed since it was removed from this survey location. For example, given a two minute delay, the actual dose rate would be 8.6 times higher than the Dodo reads.

Addendum

This calculated composite decay (or correction) curve was recently verified experimentally at BNL. A neutron source was placed next to the Dodo for 15 minutes, a long enough time to saturate both silver isotopes. It was then rapidly removed. A strip chart recorder, connected across the meter movement, showed the decay of activity with time. The Victoreen 491 meter was set to its fastest time constant. The tracing so obtained was fitted by eye with a smooth curve. This curve, extrapolated back to the time the source was removed, gave the saturated beta activity in the silver. The decay and corrections were computed with respect to this point. The data points for two runs are shown on Figure 2. I consider the agreement to be quite reasonable.

One of the problems encountered in using the Dodo is that the calculated correction curve of Figure 2 is valid only for meter time constants which are much shorter than the 24.3 second silver time constant. But using the shortest meter time constant results in large fluctuations of the meter pointer, making it hard to read accurately.

I therefore measured the three time constants in the Victoreen 491 meter, these were found to be 0.75, 3.0, and 13.5 seconds. I then calculated correction curves for each of the two longer meter time constants. (The BASIC program is attached.) These are shown, along with the original curve of Figure 2, in Figure 3.

For ease of use, I recommend that one of the longer time constants be selected. The time constant switch should be in the same position during the irradiation and counting of the instrument. One disadvantage of the longest time constant is that readings made just after a range change will be inaccurate; and the longer the time constant chosen, the longer it will take for this error to disappear. And while one is waiting for this to damp out, the signal is also decaying. Thus the middle (3 seconds) time constant may be best.

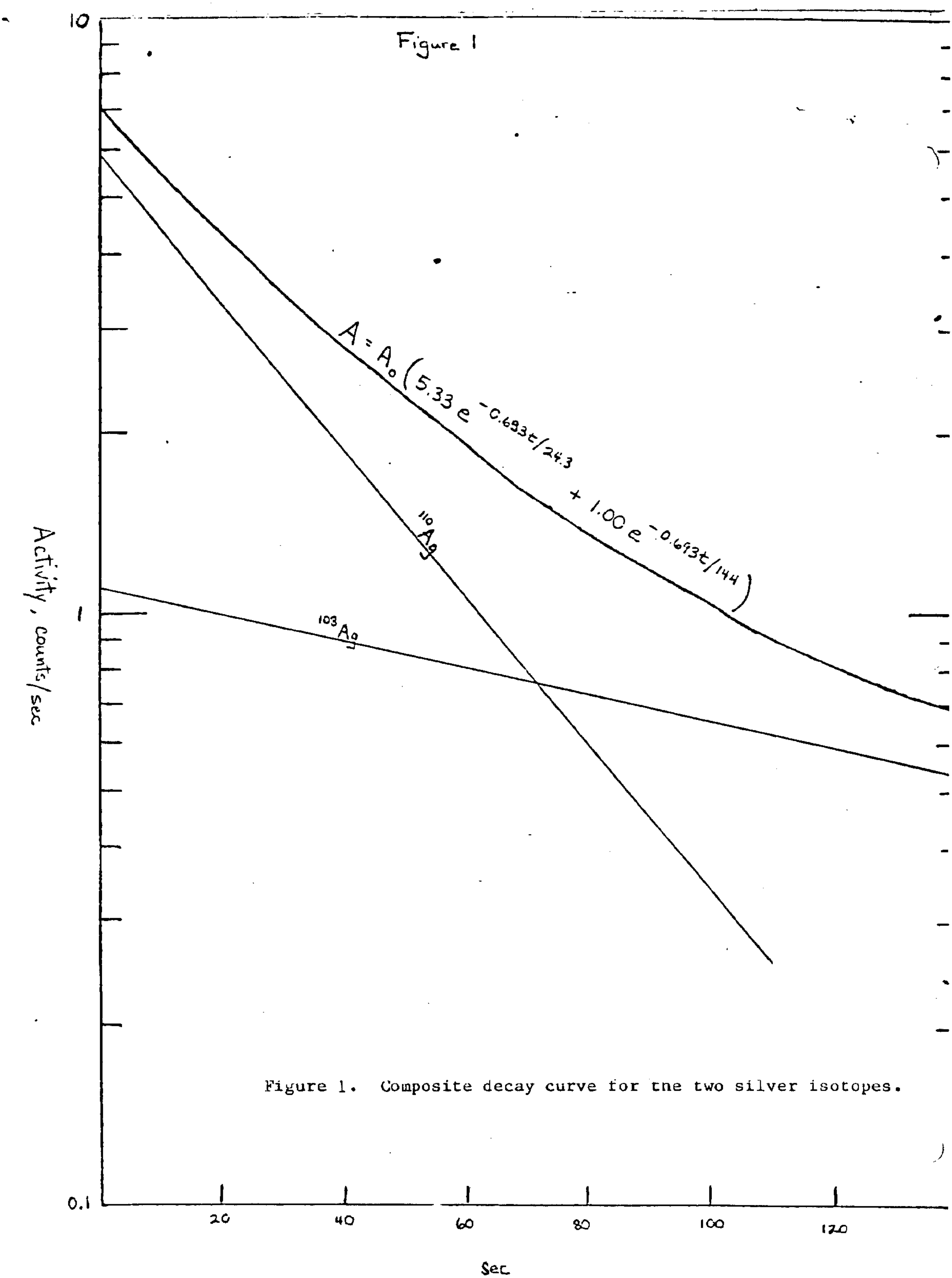

Figure 1. Composite decay curve for the two silver isotopes.

Figure 2

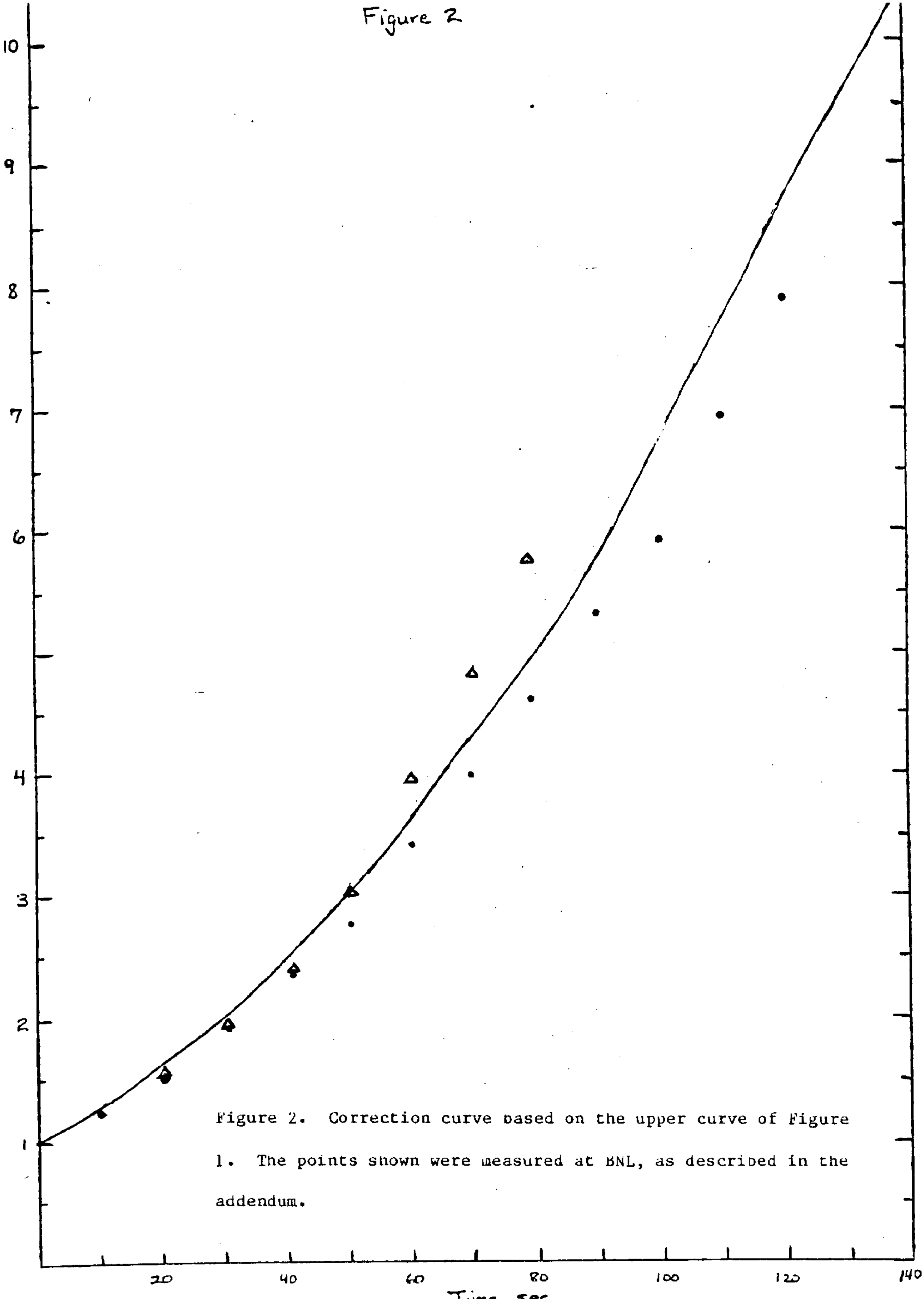

Figure 2. Correction curve based on the upper curve of Figure 1. The points shown were measured at BNL, as described in the addendum.

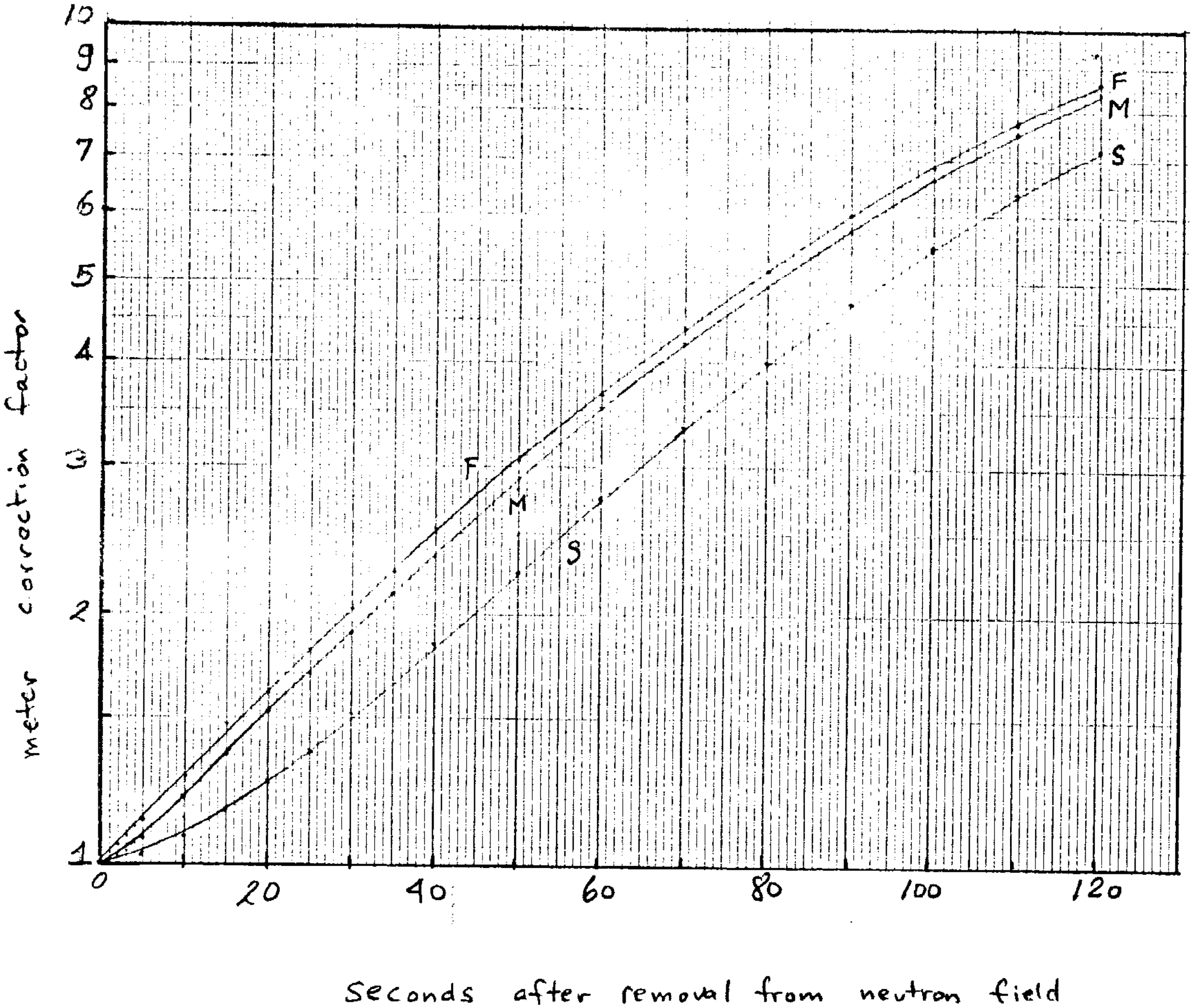

Figure 3. Correction curves for each of three time constants in Victoreen 491. The curve F is for the fastest (0.75 seconds) time constant and should be identical with the curve of Figure 2. The curves M and S are for the medium (3.0 seconds) and Slow (13.5 seconds) time constants.

```
list
10 REM calculate dodo response with and without RC time constant
15 WIDTH "LPT1:",132
20 TC= 13.5
25 STP = 1
27 NORM =    (1-EXP(-STP/TC))
30 DK = EXP (-STP/TC)
35 SIG = 1
37 DAMP = 1
40 FOR T = - 10 TO 120 STEP STP
50 SIGL = SIG
55 DAMPL = DAMP
60 IF T < STP THEN 100 ELSE 150
100 SIG = 1
105 LIMIT = DAMP
110 GOTO 200
150  SIG = (5.33 * EXP (-.693*T/24.3) + 1 * EXP(-.693*T/144))/6.33
160 REM SIG = 0
200 DUM=0
210 DAMP =  DAMPL*DK + SIG* NORM
220 CORR1 = 1/SIG
230 CORR2 = 1/DAMP
240 RATIO = CORR1/CORR2
300 PRINT USING "###.###  "; T,SIG,DAMP,CORR1,CORR2,RATIO
400 NEXT T
500 END
```