

# LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE



For The Technical Direction Of The LTPP Program



Program Area: Monitoring

Directive Number: SM-13

Date: August 17, 1995

Supersedes: n/a

Subject: TDR Trace Interpretation Method for Calibration and Function Checks

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The TDR trace interpretation methods presented in this document should be used for the calibration and function checks on the TDR probes as presented in LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guides. These interpretation methods are to be used for determination of apparent length in the computation of the dielectric constant of air and water as required for the completion of Data Sheet SMP-C01.

## Probe in Air

The apparent length with the probe held in air shall be determined using the following modified peaks method. The initial inflection point,  $D_1$  is the position of the maxima value when the probe is shorted at its beginning while in air. The final inflection point of the trace obtained while the probe is held in air, is the intersection of two secants drawn through four points located on each side of the inflection point. The following process should be used for determining the apparent length of the in-air trace. This process is illustrated in Figure 1, 2 and 3 which represents the left most half of a typical trace from a TDR probe in air.

1. Locate the first inflection point. As per the instruction contained on page II-41 of the SMP Guidelines, with the probe shorted at its beginning while in air, position the cable tester's cursor on maxima value of the sharp peak in the trace. This should occur at a distance of approximately 16.15 m. This will be used as the first inflection point,  $D_1$ .
2. Locate the approximate location of the final inflection point. On a normally functioning probe, this should be the first point in which the trace angle changes from  $\sim 35^\circ$  to  $\sim 70^\circ$ . This should occur approximately .20 to .22 m from the first inflection point. The approximate location of the final inflection point is indicated in Figure 1.

3. From this point, mark a point on the trace that is located approximately half the distance between the first inflection point and the approximate location of the final inflection point determined in step 2. As illustrated in Figure 1, this will be called point A.
4. Mark a second point on the trace which is located half the distance between point A, as determined in step 3, and the final inflection point. This will be called point B.
5. As shown in Figure 1, draw a straight line connecting points A and B that extends past the location of the final inflection point.
6. As shown in Figure 2, on the opposite side of the final inflection point from points A and B, locate a point C on the trace at the same approximate distance along the trace from the final inflection as point A is located.
7. Locate a point D on the trace half the distance between the final inflection point and point C as determined in step 6.
8. Draw a straight line connecting points C and D that intersects with the previously drawn A-B line, as shown in Figure 3.
9. The intersection of the A-B and C-D lines should be used as the location of the final inflection point,  $D_2$ .
10. The horizontal distance between  $D_1$  and  $D_2$  should be scaled and used as the apparent length in the calculation of the dielectric constant.

## Probe in Water

The apparent length of the probe in water should be determined using the method illustrated in Figure 4.

1. The first inflection point is located at the intersection of a horizontal maxima line drawn through the first peak on the trace and a line extended from points A and B located on the trace left of the first peak. The position of the start of the probe, as determined by shorting it in air should not be used in this analysis. Point A should be located .25-m from the approximate location of the first peak using the horizontal distance scale as a reference. Point B should be located approximately half way between point A and the peak. The intersection of the A-B line and the horizontal maxima line should be used as the first inflection point  $D_1$ .
2. The final inflection point is located at the intersection of a horizontal minima line drawn through the lowest point on the curve and a line extend from point C and D. The lowest point on the curve should occur near the inflection point where the slope changes from negative to positive. Point C is located .25-m to left of the approximate location of the final inflection point. The distance from the approximate location of the inflection point to point C should be measured along the curve using the horizontal distance scale as a reference. Point D should be located approximately halfway between point C and the location of the final

inflection point. The intersection of the line extended through C and D and the horizontal minima line should be used as the final inflection point,  $D_2$ .

3. The horizontal distance between  $D_1$  and  $D_2$  should be scaled and used as the apparent length in the calculation of the dielectric constant.

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