

The 10-Minute Cooling Curve

***A Distribution Transformer
Manufacturer's Perspective***

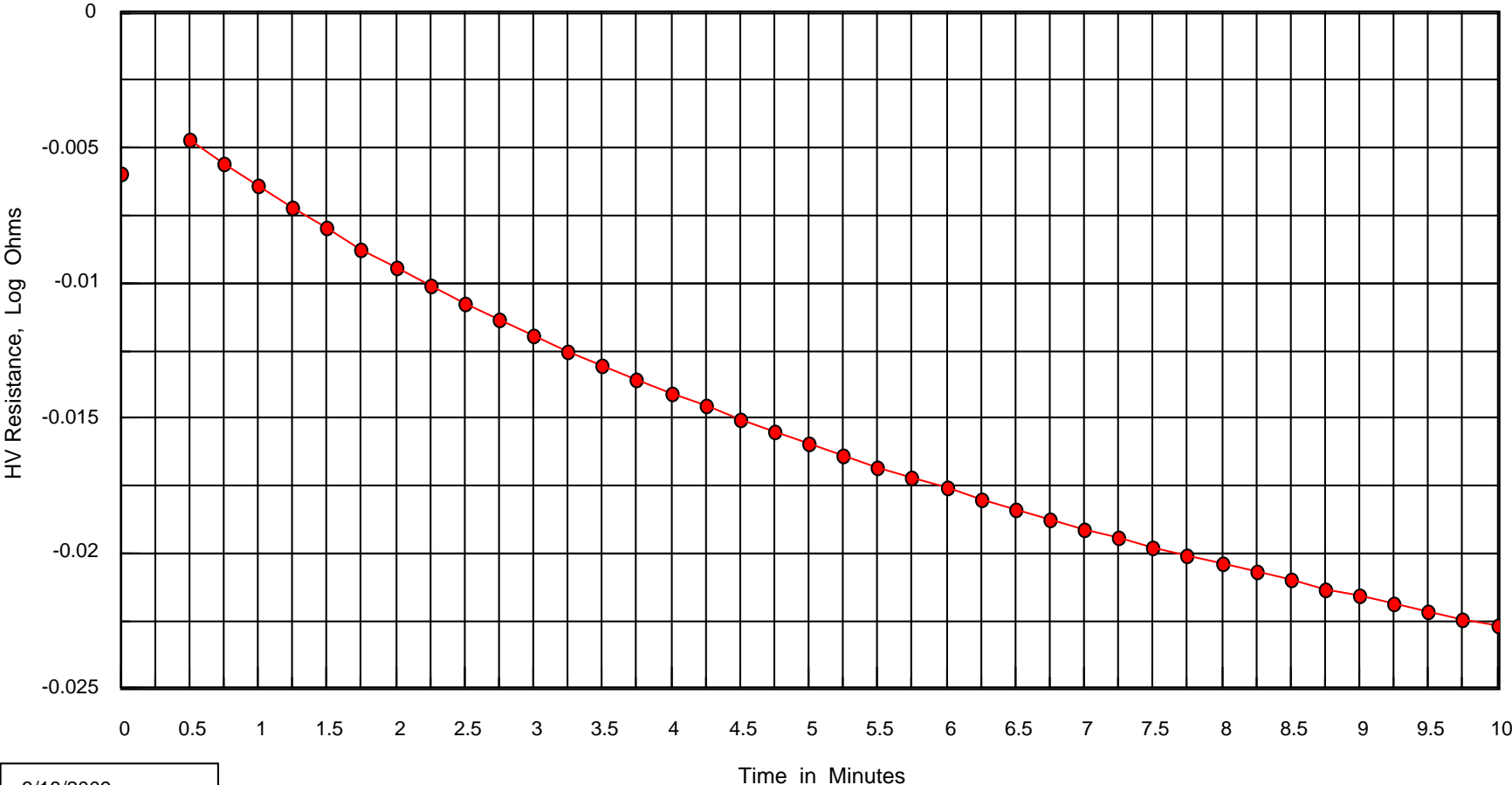
- The Working Group on Temperature Rise Test Procedures in Section 11 of C57.12.90 has proposed as mandatory a 10-minute period of collecting hot resistance data for temperature rise tests.
- While this may serve the interests of the power transformer manufacturers and users, it imposes requirements upon producers/users of smaller transformers that :
 - Provides less accurate temperature rise projections
 - Requires more time to perform the test
 - Makes it more difficult to collect all the desired data

- Two distribution transformers were tested, size 50 kVa and 250 kVA, single-phase. 10-minutes of hot resistance data was collected in 15-second intervals. Both tests were conducted by the “Short-Circuit” method **AND** the “Opposition” method, for comparison purposes.
- For each, the data was then analyzed for the time zero intercept as if 3 different data sets :
0 – 3 minutes, 0 – 5 minutes, 0 – 10 minutes

50 kVA	3-Minute	5-Minute	10-Minute
Opposition	HV 61.1	HV 61.0	HV 60.7
	LV 60.9	LV 60.8	LV 60.7
Short-Circuit	HV 60.6	HV 60.6	HV 60.4
	LV 62.0	LV 62.0	LV 61.9

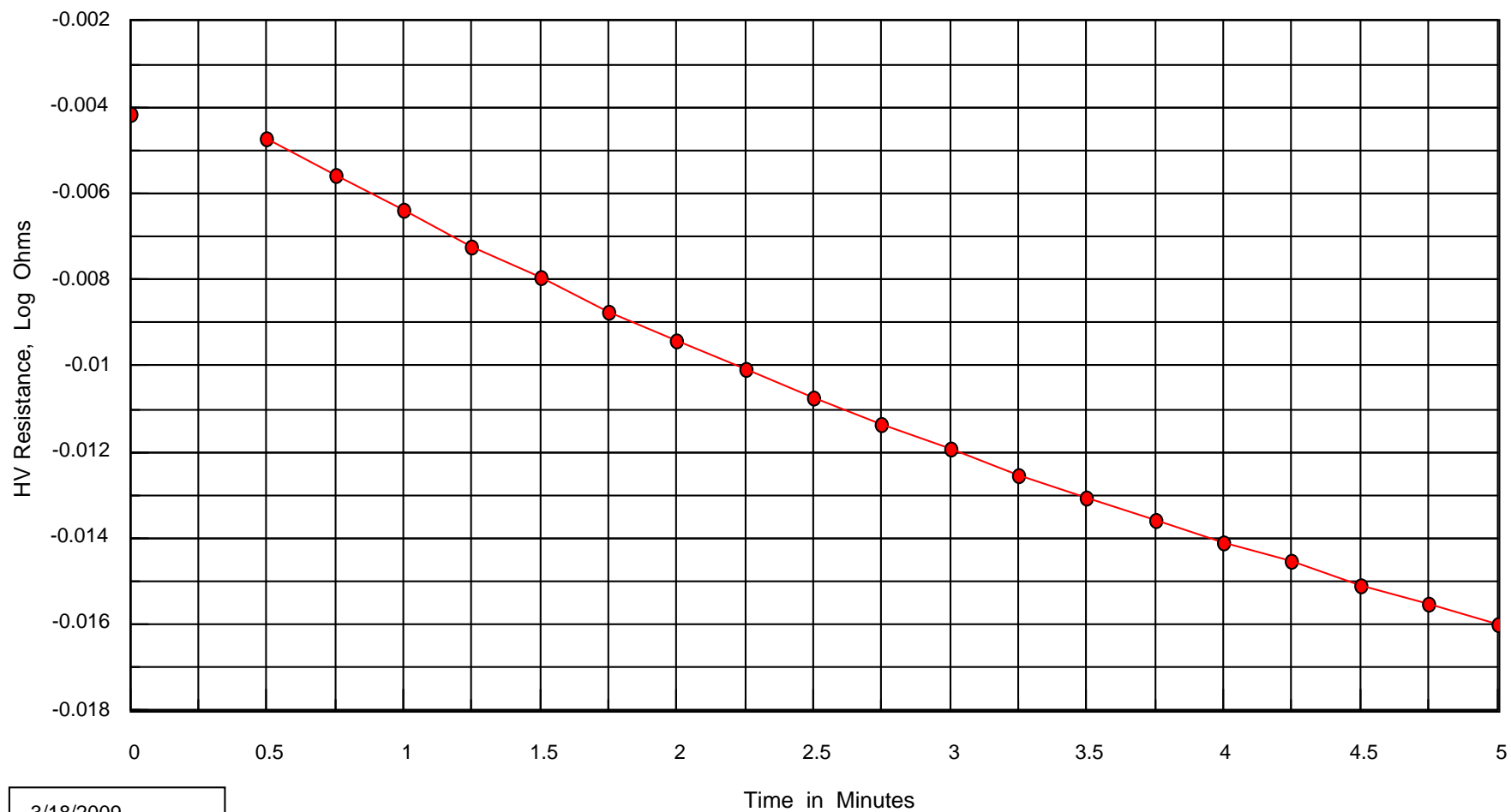
250 kVA	3-Minute	5-Minute	10-Minute
Opposition	HV 56.6	HV 56.1	HV 54.8
	LV 59.3	LV 58.9	LV 57.6
Short-Circuit	HV 55.4	HV 54.9	HV 53.5
	LV 56.4	LV 56.0	LV 54.9

HV Hot Resistance Curve



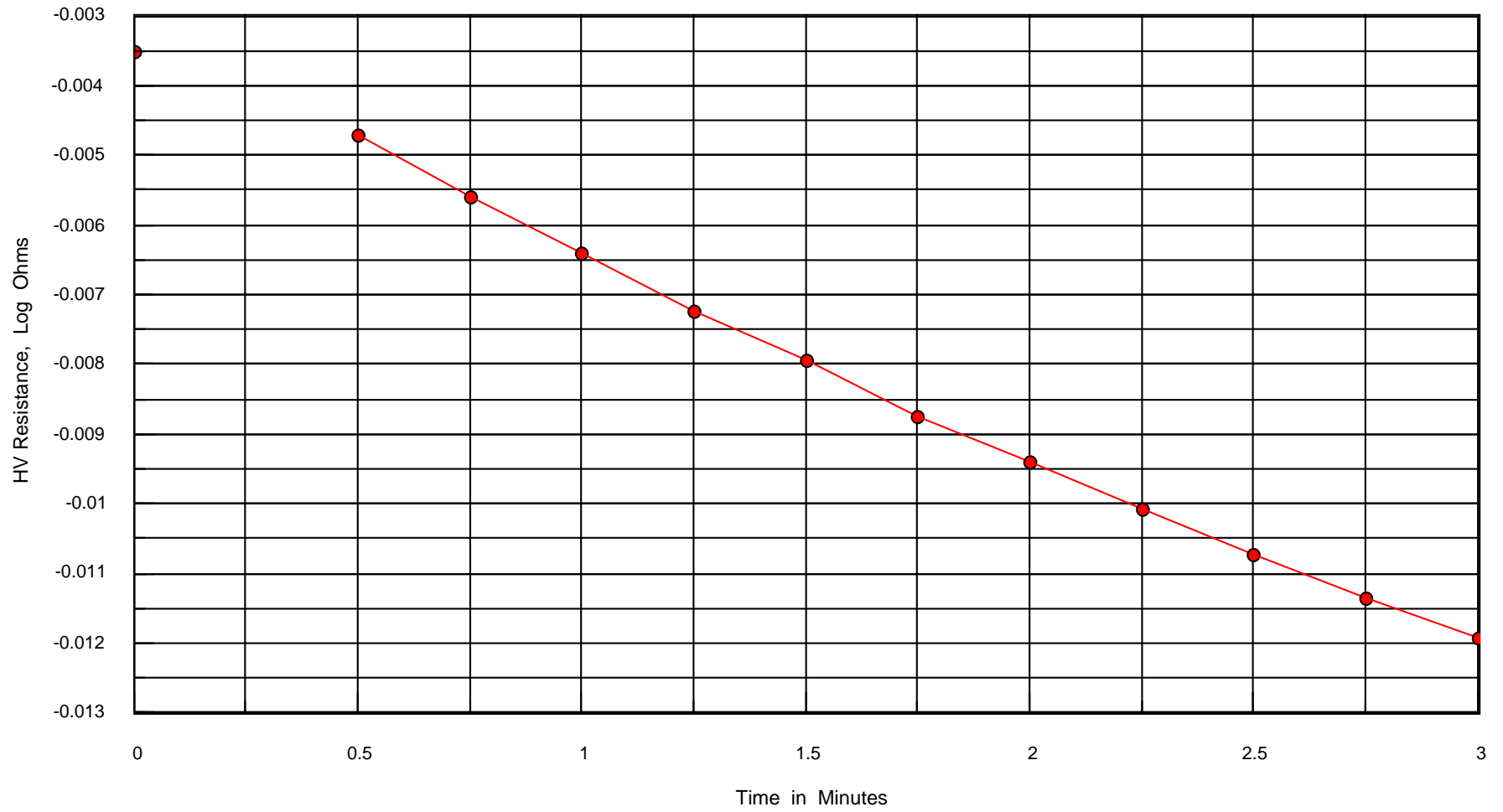
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Opposition Heat Run

HV Hot Resistance Curve



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Opposition Heat Run

HV Hot Resistance Curve



3/18/2009
Opposition Heat Run

- From the 10-minute graph it is easy to see the decreasing slope of the curve as time progresses farther from the instant of shutdown.
- Since the coils are of small mass (compared to power transformer coils), the winding temperature rapidly approaches the surrounding oil temperature, and then the release rate declines as this temperature differential is reduced. This is seen by the flattening out of the curve.

- Performing regression analysis on the entire 10-minutes of data can result in the flat portion of the curve significantly influencing the time zero intercept.
- The curve slope is much greater in the first time interval (0 – 3 minutes), which we believe most accurately reflects the winding temperature decay, and hence leads to the most accurate projection of the “time zero” value.

Conclusion

- Requiring the manufacturers of small transformers to utilize a 10-minute cooling curve for temperature rise tests will produce less accurate results.
- We recommend, for the distribution class transformers, that it is more appropriate to specify a minimum number of points (suggest 10 points) collected over a certain time interval (suggest no longer than 30-second intervals).