FLEMING-MASON ENERGY
COOPERATIVE, INC.

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MAY 1 1 2004

PUBLIC SERVICE
COMMISSION

May 7, 2004

Mr. Don Mills
Executive Director
Kentucky Public Service Commission
211 Sower Boulevard
Frankfort, KY 40602-0615

Case 2004-00173

RE: Application for approval to adopt a sample meter testing plan.

Dear Mr. Mills:

Fleming-Mason Energy Cooperative Corporation is submitting this letter as an application for authorization to adopt and implement a sample meter testing plan in accordance to Regulation 807 KAR 5:041, Section 16. We are currently up-to-date on our eight year meter test cycle.

By implementing a sample meter testing plan, Fleming-Mason Energy would realize a significant cost reduction each year of over $120,000. The savings are derived from the amount of time required to change out the meters to be tested and the time needed to test these meters. In addition, Fleming-Mason Energy is taking a proactive approach to prevent future problems by redirecting the meter personnel to perform periodic infrared thermography on the distribution system.

Fleming-Mason Energy is committed to providing quality service while keeping costs under control. The sample meter testing plan would allow both of these objectives without sacrificing meter reliability. We would appreciate your consideration of this plan and look forward to answering any questions that may arise. If you need any additional information, please do not hesitate to contact me.

Sincerely,

Chris Perry, PE

Chris Perry, PE
Manager of Engineering

SAMPLE METER TESTING FOR SINGLE PHASE METERS

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Prepared for
Don Mills,
Executive Director
Kentucky Public Service Commission

Prepared by
Chris Perry, PE
Manager of Engineering
Fleming-Mason Energy

May 7, 2004

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INTRODUCTION

Fleming-Mason Energy Cooperative Corporation (FMECC) is currently testing single phase meters in accordance with PSC KAR 5:041E, Section 15. The cooperative is currently up-to-date with its eight year meter testing cycle. In the spring of 1996 the cooperative began reading meters monthly with contract meter readers and will continue to do so. By adopting a sample meter testing procedure in compliance with PSC KAR 5:041E, Section 16, the costs associated with testing single phase meters will be greatly reduced.

PSC RULES AND REGULATIONS

The Kentucky Public Service Commission (PSC) rules and regulations clearly identify provisions under which single phase meters can be statistically tested. FMECC will comply with all the rules outlined in PSC KAR 5:041E, Section 16 with its sample meter testing program.

The PSC requires any electrical utility statistically testing meters to separate it meters into groups to recognize the different operating characteristics. FMECC will divide its meters into groups based on manufacturer and type as identified in Figure 1.

New meters purchased and installed over the course of a given year will be added to the appropriate meter population or group for random sampling the following year. Similarly, new meter types other than those listed in Table 1 or new meters of an existing type with substantive changes in design and/or operating characteristics will be segregated into new meter populations.

Each group in Figure 1 will be statistically tested by randomly selecting 2%, or a minimum of 30 meters, where applicable, each year. Test results will be expected to conform to a normal distribution curve in which a sample mean and standard deviation will completely define the cumulative distribution function (cdf) for each group. The cdf will be used to calculate the percentage of meters in the population that are within the 4% bandwidth (98% to 102%) allowed by the PSC. This sampling technique has been chosen to comply with section 16(2) and section 16(3) of PSC KAR 5:041E.

The number of meters in a particular group to be tested will be determined by the percentage of meters with the 4% bandwidth allowed by the PSC, as computed from the most recent test results. Figure 2 shows the percentage of meters to be tested the following year as required by the PSC.

Meter Manufacturers and Groups					
Code	Manufacturer	Type Code	Description	Population	Initial Sample
1	Duncan	11	MSII	180	30
		13	MFS	10	10
2	GE	22	I60S	192	32
		23	I70S	5414	108
		27	I70S 2Wire	23	5
3	Westinghouse	30	CS	41	13
		31	D3S	8	8
		32	D4S	2152	43
		33	D5S	2	2
4	Sangamo	40	J5 2Wire	22	5
		41	J4S	245	30
		42	J5S	5187	105
		44	Load Control	60	6
5	Landis & Gyr	51	MSII	2176	44
		52	MX	2213	44
6	ABB	62	D5S	378	31
8	Landis & Gyr	82	MX	2835	58

Figure 1. Groups segregated by manufacturer and type.

Section 16(4b) of PSC KAR 5:041E states that no meter shall remain in service without periodic test for a period longer than twenty-five years. FMECC will test all meters with a last test date older than twenty-five years, regardless of manufacturer and type, in addition to the yearly sample.

Percentage of Meters Within Limits of 2% Fast or Slow As Indicated by Sample	Percentage of Meters to be Tested the Next Year
99.0 % - 100.0 %	2.0 %
98.0 % - 98.9 %	4.0 %
97.0 % - 97.9 %	6.0 %
96.0 % - 96.9 %	8.0 %
95.0 % - 95.9 %	10.0 %
93.0 % - 94.9 %	12.0 %
91.0 % - 92.9 %	14.0 %
Less than 91.9 %	16.0 %

Figure 2. Number of meters to be tested during the next test year based on previous year sampling.

METHODOLOGY

FMECC will sample its meter population each year based on manufacturer and type as shown in Figure 1. The meters will be chosen randomly resulting in statistics conforming to the normal distribution curve. For more information on normal distribution curves please refer to the Appendix. Each year FMECC will perform the following steps for each group.

1. FMECC will test all meters with a last test date older than twenty-five years, regardless of manufacturer and type. The group sample will not include these test results.

2. The metering supervisor will randomly select 2% of the meters and ship them to the meter shop for testing (minimum of 30 where applicable). The supervisor will randomly select and test a different meter for all nonregistering meters originally chosen.

3. The meter shop will test all meters under full load, light load, and at 50% power factor.

4. The metering supervisor will calculate the average between full load and light load for each meter in the sample.

5. The metering supervisor will compute the sample mean and standard deviation for the calculated averages.

6. The metering supervisor will compute the percentage of meters, based on sample mean standard deviation, that are within the 4% bandwidth (98% to 102%) allowed by the PSC. See Appendix for an example.

7. The metering supervisor will refer to the PSC regulations as outlined in Figure 2 to determine the number of additional meters to test the following year.

COSTS AND BENEFITS

FMECC is committed to keeping costs down while working to improve reliability. There is no sacrificing accuracy in metering and it is believed that none would be experienced by switching to sample meter testing. One of the important tasks that FMECC wants to begin working on is using infrared thermography as a means to detect potential problems before they occur. This proactive move is going to help catch hot spots on distribution substations and equipment. Once detected, the equipment will be scheduled for repair or replacement before it becomes the cause of a sustained outage.

The use of the infrared camera is a very technical and sophisticated procedure. To get the maximum benefit from this equipment, FMECC is getting training for the metering supervisor. By freeing up time by using meter sampling, it is possible for personnel to schedule routine inspection at large commercial and industrial customers, substations, and distribution feeders.

The direct cost savings that can be attributed to the new sampling program are also significant and outlined in Table 1.

Cost Savings Using Meter Sampling		
Item		**Savings**
Equipment and personnel needed to change the additional 2,126 meters	2,126 x $52.00	$110,552.00
Personnel required to test the additional 2,126 meters	2,126 x $5.80	$12,330.80
Total		**$122,882.80**

Table 1. Cost savings by switching to sample meter testing.

The figures used in the table are based on actual data from changing out a single phase meter for FMECC of $52.00 per meter. The figure used for the meter testing was derived from the average number of meters tested by FMECC staff and the associated costs. The current number of periodic tests required by FMECC is about 2,700 per year and the number that would be tested using sampling would be 574 meters.

APPENDIX

Normal Distribution Curves

Normal Distribution Curves

A normal distribution curve is completely defined by two variables, the sample mean μ and standard deviation σ. These variables are computed by randomly testing a certain characteristic for a small sample of a given population. The sample mean is a measure of central tendency and the standard deviation is a measure of dispersion about the mean. The normal distribution curve resembles a "bell shape" and is defined mathematically by the the following equation.

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-\mu)^2/2\sigma^2} \quad \text{for } -\infty < x < \infty$$

Figure A-1 shows a normal distribution curve reflecting results from a hypothetical experiment in which the values obtained from the sample yielded a mean of 0.0 and a standard deviation of 1.0. Based on these calculated quantities, the percentage of entities from the total population that can be expected between ± one standard deviation is 68.26%. In other words, the area beneath the curve between -1.0 and +1.0 is 68.26% of the total area beneath the curve.

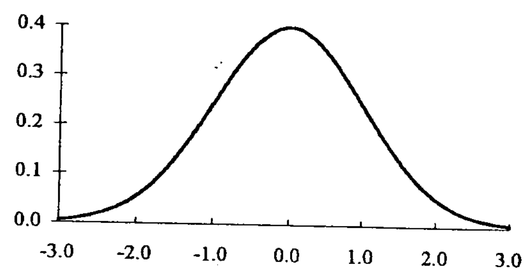

Figure A-1: Normal Distribution Curve; mean = 0.0, St.dev. = 1

To calculate the percentage, or the probability of $a_1 \leq x \leq a_2$, the following mathematical steps are necessary.

$$P(a_1 \le x \le a_2) = P(x \le a_2) - P(x \le a_1)$$

$$P(a_1 \le x \le a_2) = \Phi\left(\frac{a_2 - \mu}{\sigma}\right) - \Phi\left(\frac{a_1 - \mu}{\sigma}\right)$$

substitute $a_1 = -1.0$, $a_2 = 1.0$, $\mu = 0.0, \sigma = 1.0$

$$P(-1.0 \le x \le 1.0) = \Phi\left(\frac{1.0 - 0.0}{1.0}\right) - \Phi\left(\frac{-1.0 - 0.0}{1.0}\right)$$

$$P(-1.0 \le x \le 1.0) = \Phi(1.0) - \Phi(-1.0)$$
$$P(-1.0 \le x \le 1.0) = \Phi(1.0) - [1 - \Phi(1.0)]$$
$$P(-1.0 \le x \le 1.0) = 2\Phi(1.0) - 1$$
$$P(-1.0 \le x \le 1.0) = 2(0.8413) - 1 = 0.6826 = 68.26\%$$

The value for $\Phi(1.0)$ is determined by using Figure A-2.

The same mathematical principles can be used for sample meter testing. A sample mean μ and standard deviation σ can be calculated from a small sample of meter tests. Using the same principles given above, the percentage of meters in the total population that are within the 4% bandwidth (98% to 102% accuracy) allowed by the Public Service Commission (PSC) can be computed. That is,

$$P(98 \le x \le 102) = P(x \le 102) - P(x \le 98)$$

$$P(a_1 \le x \le a_2) = \Phi\left(\frac{102 - \mu}{\sigma}\right) - \Phi\left(\frac{98 - \mu}{\sigma}\right)$$

Example: If 50 meters from a group of 5,000 are tested and the mean accuracy is 99.8% with a standard deviation of 0.8, what percentage of meters are within the 4% bandwidth allowed by PSC?

$$P(98 \le x \le 102) = P(x \le 102) - P(x \le 98)$$

$$P(98 \le x \le 102) = \Phi\left(\frac{102 - 99.8}{0.8}\right) - \Phi\left(\frac{98 - 99.8}{0.8}\right)$$

$$P(98 \le x \le 102) = \Phi(2.75) - \Phi(-2.25)$$

$$P(98 \le x \le 102) = \Phi(2.75) - [1 - \Phi(2.25)]$$

$$P(98 \le x \le 102) = 0.9970 - [1 - 0.9878]$$

$$P(98 \le x \le 102) = 0.9848 \text{ or } 98.48\%$$

From the example, one can be highly confident that 98.48% (or 4,924) of the total meters are within the 4% bandwidth allowed by the PSC. Furthermore, the number of meters to be tested next year is 4% of the total population as required by the PSC (see Figure 2).

Figure A-2 Area $\Phi(x)$ Under the Standard Normal Curve to the Left of x

x	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998