SUMMARY:

The electrical properties measurements have never been very precise nor reproducible. The precision has been limited by instrumental techniques and hardware. The poor reproducibility is more directly related to sampling, sample manipulation and contamination.

Dr. Munch was commissioned by the Business Group and Marketing to improve the instrumental techniques and hardware for the electrical properties measurements. The justifications were: To maintain Monsanto's position in dielectric technology; To improve the precision of the test and get the improvements accepted by ASTM; To provide a means of measuring the improved Aroclor from Monsanto's plants after installation of column treatment. The latter justification has faded somewhat. The existing test shows a good quality improvement.

The improvements have been developed. Accurate measurements of what is in the test cell is possible. The reproducibility problems between locations and repetitive samples are still with us. Implementation of the test has been slow. In addition to the natural inertness of the industry to change, money is tight. The idea of buying new equipment when production can run without it is generally unpopular. Inside Monsanto the new instrumentation has been provided. However, it is probable that to realize the full potential of the improved instrumentation, more money will be required to get improved reproducibility. Clean air rooms may be necessary as well as field work on sampling devices.

It is recommended that the new power factor instruments and cells be made Monsanto's standard test procedure. Let's take advantage of what we already have, and spend the additional time and money gaining reproducibility as it becomes justified. The accuracy improvement of the power factor measurement is roughly a factor of 4 on the 60 hz measurement and 8 on the 1000 hz measurement.

It is also recommended that the resistivity test and specification be dropped. The resistivity test as performed technically relates to nothing. This latter recommendation, although technically sound, may be difficult for Marketing "to sell".

Details supporting the recommendations are in the body of this memo.

Implementation of the recommendations will need re-commitment of Marketing, the Business Group, Research and Production. Obviously in addition to a specification change, a lot of customer calls will also be necessary.

TOWOLDMON0057210

DETAILS:

PART A - POWER FACTOR:

At this time there are four procedures for measuring power factor in use within Monsanto. Three tests are laboratory types while the fourth is an in-line measurement.

There is a new power factor test procedure developed by Dr. Munch which is technically superior to all existing laboratory tests in terms of accuracy.

There is a Monsanto standard test procedure which is equivalent to, if not identical to, the industry wide, ASTM procedure. The WGK Plant, G.E., Westinghouse, and all major users or producers of dielectric fluids use this procedure. This test is the one specified on our official specification.

There is also a modification of this standard procedure practiced by the Anniston plant. It differs only in the cell cleaning procedure. The results indicate better quality than the non-modified test.

Finally, there is an in-line measurement used for monitoring product quality during production. This test is also used by a few of our customers on their capacitor production lines. The in-line test is an excellent aid to the production of a high quality product. It is, in concept, the best and most accurate indication of quality. It cannot however, replace the need for laboratory measurements. There will always be a need for sample exchanges and testing on smaller quantities than can adequately flush and clean an in-line cell.

At this point let's restrict consideration to the laboratory tests. The column treated Aroclor's have significantly better (lower power factor) electrical properties than our former products. The standard test procedure shows an improvement in power factor. The typical power factor value for 60 hz, 100°C is listed as about 5 on our specification sheet. The recent average of 35 shipments to G.E. averaged 1.88 by this standard procedure. The range of the power factor is now so low (especially at 1,000 hz) that significant dial reading errors occur due to interpolation. Significant errors are also introduced by miscellaneous stray capacitance effects (e.g. the capacitance between the test leads). The power factor as measured by our standard test method is now only an indication of the true reading.

The modified standard test as practiced by Anniston, does not eliminate known errors as indicated above. The values however, are closer to the correct value due to the superior cell cleaning technique. If we did not have an alternate, specifically a better test, the Anniston or some other improved cell cleaning method should be made standard by proper notification of our customers, formal procedure change involving all Monsanto locations and recommendations to ASTM. No further consideration should be given to this test procedure unless the alternates are rejected.

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DETAILS:

PART A - POWER FACTOR (Continued)

The alternate test was developed by Dr. Munch. Marketing requested better quality Aroclor (electrical properties and stability). In order to eliminate known errors from our electrical measurements and continue Monsanto's reputation as a leader in dielectric technology, test procedures are requested which could become industry standards. The Business Group sponsored the research work and the objectives.

Dr. Munch selected the test instrument and auxiliaries to eliminate the errors specifically mentioned in the preceding paragraphs. Along with the instrumentation, a very good cell cleaning procedure was developed. The test has been presented before the ASTM. It has also been publicized through one trade journal. Dr. Munch has just returned from a visit with G.E. Their research people have been getting experience with the new test and are enthusiastic about it. They are starting to influence their routine laboratory toward changing to the new procedure. Sangamo at Pickering, N.C. are using the new method. Hercules is using most of the method. The business group authorized purchase of the new instruments for the changeover. The WGK laboratory has been reporting values to G.E. by both tests for some time. The Anniston plant has the equipment for the new test but it has not been used on a routine basis. The costs for the two tests are the same.

Since the new test is technically superior, costs no more, and we have some indication of acceptance outside Monsanto, and at least the WGK and Anniston plants have the equipment, it seems strange that we have not made the change. The reasons and rebuttals are:

1. A comparison of the data from the two laboratory power factor tests do not give a clear cut relationship. See attachments 1, 2 and 3. There are assignable causes for the data scatter. Sample contamination is possible from numerous sources inside and outside the laboratory. All contaminations which affect the power factor give a higher (poorer) value. This is external to the measurement and should not discredit either test. The new test is not affected by stray capacitance. The old test is affected.

2. The results by the new test at the WGK lab are not as high or as consistent as those obtained at South 2nd Street. This is due to contamination in varying degrees from the air in the laboratory. The same errors should be present with the old test.

TOWOLDMON0057212

DETAILS:

PART A - POWER FACTOR (Continued)

3. The cell preparation for the new test takes longer and only one cell at a time can be prepared. Closer liaison between production and the laboratory can solve the time delay. Redesign of the cleaning equipment to handle more than one cell should not be too difficult.

4. Customers may not accept test results by the new procedure. Marketing and Dr. Munch have been working on this for awhile. If we certify the material by the best technology available, customer acceptance should be attainable. Eventual customer changeover to the new technique should occur if we and some major customers lead out in attaining ASTM acceptance of the new test.

5. When customers do change over to the improved test they may get different test results than we do. The most probable cause would be differences in airborne contamination. We may eventually need a special test room for Aroclor electrical properties. The laboratory has installed a chemical air cleaner and improved the situation somewhat. A project is awaiting approval to reduce the outside air usage in the laboratory. This should extend the life of the scrubbers between charges and increase the efficiency of the scrubbers.

6. The present test and specifications are all set up. We and our customers recognize the present test as official, why change? The old test arrangement is known to be inaccurate. Continued use of the old test does not further our position in dielectric technology.

The steps to be taken to reach a decision on implementing the test are:

1. Marketing and Research affirmation that the new test is the one of choice and that customer acceptance can be achieved.

2. Business Group affirmation that the concept of dielectric technology leadership is a legitimate goal at this time.

3. Business Group acceptance of the concept of appropriation of additional funds for a "clean air" room if it becomes necessary. In addition, more testing related to sampling techniques and reproducibility will be required at some point in time.

4. Preparation and approval of a specification for Aroclor 1242. The change will propose a new limit and list the new test procedure number.

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DETAILS:

PART A - POWER FACTOR (Continued)

5. Generation of data for Aroclor 1248, 1254 and 1260 specification changes. Then preparation of specification and approval for the changes.

PART B - RESISTIVITY

The electrical property measurements also include measurements of resistivity. The resistivity measurements are made in the same test cell as the power factor. Accordingly, a new test procedure was evaluated for resistivity. Comparative data were generated between the two resistivity measurements at WGK. There is no correlation of the two resistivity measurements to one another. There is also a theoretical relationship between power factor and resistance. The test cell resistance can be calculated from the resistivity measurement. The test data for resistivity by either measurement, back calculated to resistance, does not come close to relating to the power factor. The reasons for the non-agreement are:

1. The stress voltage has been arbitrarily picked. Each stress voltage will give a slightly different result under the same charge time and decay times.

2. The charge time for the capacitor has been arbitrarily selected. Each charge time gives a different charge on the capacitor. This then gives a slightly different reading.

3. The decay time after charging and before reading is arbitrarily picked. This decay time affects the final reading.

4. Resistivity measurements appear to be more sensitive to contamination than power factor measurements. The cummulative errors of both procedures affect any expected correlation.

From Items 1, 2 and 3 above it appears that the test should be dropped on a sheerly technical basis. Alternately we could set out to find the right conditions to satisfy a calculated resistivity. G.E. research has some interest and work going on in this direction. However, since one is theoretically derived from the other, it appears that G.E.'s interest is only of academic interest.

The steps required for elimination of the resistivity test are similar to those for changing the power factor test.

1. Marketing and Research affirmation that the test can be dropped.

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DETAILS:

PART B - RESISTIVITY (Continued)

2. Agreement of the Business Group that we drop the test.

3. Preparation and approval of the specifications without the resistivity test.

TOWOLDMON0057215

Attachment # 1

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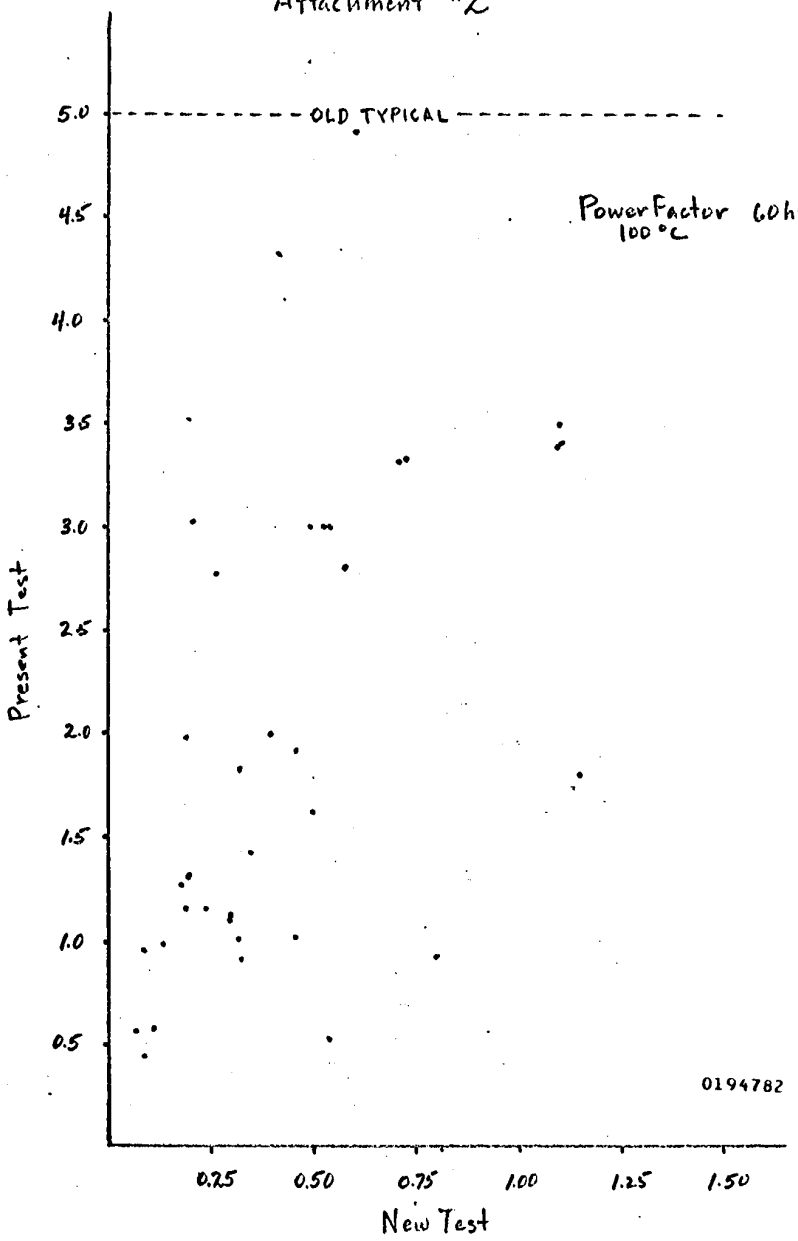
WGK Aroclor 1242

		Regular Elec Prep				New Elec Prep			
DATE	CAR	Pre 60	Pre 1600	De	Resistivity X10⁹	Pre 60	Pre 1600	De	Resistivity X10⁹
8-27	MCNX 8612	1.27	0.08	4.85	3680	0.318	0.010	4.86	149,925
8-22	MCNX 8617	2.81	0.09	4.83	2200	0.576	0.023	4.88	33,450
8-17	MCNX 8613	3.46	0.24	4.84	1600	1.092	0.089		39,600
8-12	MCNX 8626	1.32	0.15	4.83	9600	0.182	0.009	4.86	61,600
8-7	MCNX 8610	1.12	0.10	4.86	6800	0.297	0.011	4.87	115,400
7-28	MCNX 8604	1.18	0.09	4.83	5950	0.228	0.010	4.85	86,700
7-23	MCNX 8624	1.83	0.14	4.84	2800	0.318	0.010	4.87	12,700
7-20	MCNX 8607	0.93	0.08	4.84	7600	0.324	0.013	4.87	99,950
7-17	MCNX 8613	3.01	0.19	4.82	2900	0.528	0.020	4.87	86,650
7-14	MCNX 8612	1.92	0.13	4.82	6100	0.462	0.019	4.82	76,900
7-7	MCNX 8626	4.92	0.34	4.83	1400	0.600	0.038	4.88	61,700
7-1	MCNX 8610	3.09	0.22	4.86	1650	0.206	0.009	4.89	84,650
6-26	MCNX 8604	1.61	0.16	4.86	4800	0.498	0.020	4.88	119,300
6-23	MCNX 8617	3.07	0.28	4.83	2250	0.534	0.020	4.85	61,900
6-20	MCNX 8624	1.00	0.09	4.86	8800	0.311	0.014	4.86	32,700
6-18	MCNX 8612	4.32	0.27	4.83	1960	0.414	0.015	4.87	67,275
6-4	MCNX 8626	0.59	0.06	4.85	11,850	0.110	0.006	4.87	21,240
6-1	MCNX 8604	1.17	0.09	4.86	3760	0.182	0.012	4.89	58,250
5-22	MCNX 8610	3.36	0.22	4.83	2480	0.768	0.028	4.87	76,275
5-26	MCNX 8617	1.98	0.13	4.81	7280	0.462	0.016	4.89	15,330
5-16	MCNX 8613	0.93	0.06	4.84	7760	0.805	0.027	4.86	26,770
5-20	MCNX 8624	1.01	0.09	4.84	9205	0.462	0.016	4.87	16,350
5-13	MCNX 8607	0.44	0.06	4.83	25,000	0.091	0.006	4.86	146,200
5-5	MCNX 8626	0.56	0.05	4.86	20,800	0.054	0.004	4.87	165,800
5-1	MCNX 8604	3.21	0.22	4.84	2900	0.504	0.017	4.87	46,000
4-28	MCNX 8610	1.98	0.14	4.83	6400	0.190	0.009	4.87	13,709
4-22	MCNX 8716	1.80	0.12	4.86	5680	1.164	0.037	4.88	5380
4-20	MCNX 8613	0.54	0.06	4.85	24,814	0.072	0.004	4.88	21,150
4-11	MCNX 8607	1.32	0.08	4.85	6304	0.192	0.009	4.87	14,100
4-10	MCNX 8626	3.42	0.22	4.85	2720	1.104	0.039	4.87	7300
4-13	MCNX 8624	0.66	0.05	4.83	10,460	0.354	0.014	4.87	8100
3-26	MCNX 8604	0.99	0.06	4.81	11,200	0.126	0.007	4.87	31,400
3-23	MCNX 8617	1.44	0.09	4.82	3440	0.348	0.012	4.87	30,780
3-30	MCNX 8610	2.79	0.20	4.83	2480	0.252	0.010	4.87	99,950
3-18	MCNX 8613	0.93	0.07	4.82	16,119	0.086	0.006	4.87	46,170
	H V S	1.88	.13	4.84	7,242	.403	.007	4.87	58.24

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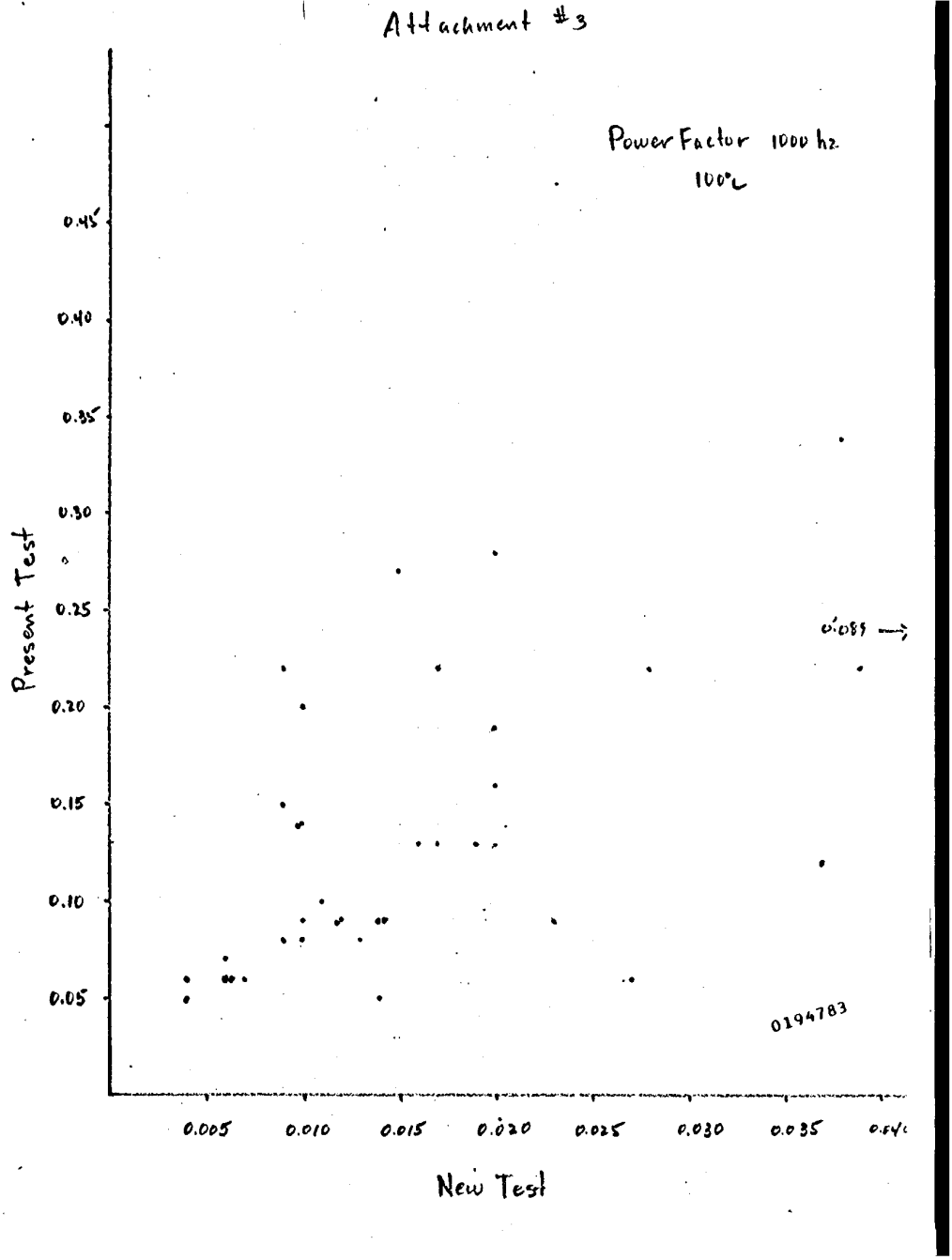
TOWOLDMON0057216

Attachment #2



TOWOLDMON0057217

Attachment #3



TOWOLDMON0057218