NEI NEI Peebles - Electric Products, Inc.

-28

LIS ORIGINAL

17045 Euclid Avenue
Cleveland, Ohio 44112
Telephone: (216) 481-1500
Telex: 241564
Facsimile: (216) 481-8386

February 16, 1987

Mr. James Taylor Director
Office Of Inspection And Enforcement
US Nuclear Regulatory Commission
Washington D.C. 02055

Subject: 10CF21 Notification of existance of a reportable defect in class IE Diesel Generator.

Dear Sir:

Further to our letter of November 24th 1986. Enclosed is a report from our Engineering Department dated 10th February, 1987. This completes our investigation and evaluation of this matter.

Should you require any further information or assistance please contact us.

Your sincerely,

NEI PEEBLES - ELECTRIC PRODUCTS, INC.

Ron B. Politi

Vice President & General Manager

RP/jj

cc: Cooper-Bessemer Reciprocating
Bechtel Power Corp
Arizona Nuclear Power Project

E19
1/3

NEI · NEI Peebles - Electric Products, Inc.

Interoffice Memorandum

EI-3313

To: R.B. Politi

Date: February 10, 1987

From: J.V. Pospisil

Subject: 10CFR21 - Conclusion of Investigation of Probable Causes of a Defect in Class 1E Equipment Reported by EI-3306. Palo Verde, Unit 3, D-C Serial 17609966 & 969.

Reference:

a. Telephone Notes dated Nov. 25 & 26, 1986, J.A. MacKinnon of Bechtel and J.V. Pospisil of NEI Peebles, TN-E-5168 and TN-E-5166.

b. Receiving Inspection Report dated Dec. 8, 1986, 2 pages with attachments, NEI Peebles.

c. Letter of Certification, Resin D-111, dated May 9, 1980, Sterling Div. of Reichhold Chem. to Parsons Peebles, with attachments.

d. Letter EF-3308 dated Dec. 9, 1986, NEI Peebles to Reichhold Chemicals, Inc., Sterling Group.

e. Letter dated Jan. 13, 1987, Reichhold Chemicals, Inc. (D.E. Campbell) to NEI Peebles (R.A. Rossman) with attachments.

f. Sketch of Failed Rotor Pole, Diesel Generator 3B, Attachment to Service Report F-1063, NEI Peebles.

g. Low Magnification Views of Failed Coil Area, Photographic Lab Records, Jan. 26-30, 1987, NEI Peebles.

h. Overspeed Test Record, Standard Test Form 2002 for Serial No. 17609964-200 dated Dec. 7, 1977, Portec, Inc., E.P. Div.

Our internal correspondence EI-3306, a copy of which was attached to your letter of Nov. 24, 1986, addressed to Mr. James Taylor, Director of Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, reflected the status of our investigations as of that date. As stated in EI-3306, three potential causes were identified, however, one of them (a. Mechanical damage by impact or excessive overspeed) was immediately eliminated from any further consideration due to a total absence of any corroboratory evidence. Two remaining potential causes to be investigated further were identified as:

a. Improper formulation, mix or cure of the resin.

b. Improper application of resin or contamination of the wire surfaces.

As apparent from Ref. a., arrangements were made by telephone with Bechtel to ship the pole with the damaged coil promptly to Cleveland where it could be inspected in detail and examined further by our Engineering Lab. Ref b. contains the results of the inspection performed. As there were no dominant signs symptomatic of improper

application of the resin and/or surface contamination, it was decided to proceed with the verification of resin characteristics by physical or chemical testing of resin samples obtained from the failed rotor pole. If the results of these tests would confirm a very high probability that the resin used is indeed factory-mixed Sterling formulation of D-111A with no apparent anomaly due to its cure, the potential cause b. could be eliminated from any further consideration. This then would confirm the potential cause c. as the probable cause of failure by a process of elimination. If, however, significant anomalies would be detected by these tests, the potential cause b. must be retained as a probable cause (either alone or combined with c.) and its generic implications must be also considered.

Relevant methodology of testing was discussed by our Engineering Specialist, Mr. C.J. Moosbrugger, with the Reichhold Chemicals, Sterling Group's expert, Mr. Ray Cushner and it was agreed that a positive resin identification from small samples can be made by Infrared (IR) Spectroscopy but the Thermal Gravimetric Analysis (TGA) could provide also some information on the cure of specific samples. Since our Lab lacks equipment required by either method, testing was subcontracted to Sterling. In order to eliminate any doubt about the proper resin formulation and mix, the Sterling Lab agreed to prepare a sample batch of D-111A Polyester Compound, such as certified by Ref. c. Further, our Lab was to provide a thermally aged specimen of D-111A in addition to the samples obtained from the failed rotor pole winding in order to evaluate thermal effects of curing and aging. Ref. d. identifies the samples according to their origin. Sample B was thermally aged for 2352 hours at 140°C after the cure. On the other hand, samples A1, A2, A3 and C had no significant history of thermal aging following the standard cure because of a very few operating hours accumulated by the Train B Generator from which the failed pole was removed. Of course, the freshly mixed compound (by Sterling Lab) called "standard" was initially uncured.

As reported in Ref. e., Sterling Laboratory performed the Thermal Gravimetric Analysis (TGA), determined the filler content of samples provided and compared the results with those of a freshly made batch of D-111A Polyester Compound. Upon completion of their analytical study, they concluded that:

> "Comparison of the TGA indexes, shape of curve and filler content indicates a very high probability that Samples A1, B & C are cured specimens of D-111A."

These conclusions can be verified by copies of TGA Charts attached to Ref. e. and enable us to eliminate the potential cause b. (Improper formulation, mix or cure of the resin), from any further consideration. Thus an improper application of resin or contamination of the wire surfaces remain to be examined as probable causes of the failure meager corroborating evidence premitting.

As apparent from Ref. f., the outer winding layer, one wire thick, separated on one side of the pole from the rest of the coil "as a sheet" deflecting outward due to centrifugal forces acting on individual wires (turns) of the layer. In spite of the complete resin bond failure between this "sheetlike" layer and the rest of the coil, resin bonds between adjacent wires of this "sheet" remained mostly intact. Although two outer layers were cut and "peeled off" from the coil before it reached our Lab, some wires of the outer layer (with black varnish coat) remained bonded together in pairs, or groups of three and four, giving an indication that the bond between individual wires of the outer layer was considerably stronger than that between the outer layer and the rest of the coil. This fact can be considered as conclusive evidence that the wire

surfaces were not contaminated. Were it otherwise, equally weak bonds would have been found on all three sides of the (square profile) wire. That is, between adjacent turns (wires) of the outer layer as well as between the outer layer and the coil. Furthermore, even if it could be accepted that only one side of the square wire were contaminated, this would have to happen in regular 8½ foot intervals 25 times over, so that the contaminated surface could position itself in the failure area. Of course, there is no credibility to this scenario and the hypothesis of wire surface contamination should be discarded.

Relatively low magnification (10X) microscopic examination of the outside-facing surfaces of a portion of second layer (received still intact) revealed relatively large areas in the failure zone that appeared significantly "smoother" than the remaining surfaces. Few small irregular "rough-appearing" areas randomly distributed over the large "smooth" areas contrasted quite sharply with their general background. Our first-hand notion that the "smooth" appearance is a result of mechanical polishing due to a relative motion between the first (failed) and the second layer had to be dismissed as there were no pervasive signs of abrasion, except for the "rough" spots. Similar microscopic examination of the inside-facing surfaces of wire groups (received separated) of the corresponding portion of the first layer revealed the existence of like contrasts also there and again, no signs of abrasion in the "smooth" areas. This implied that a contact between the first and the second layer in the failure zone was limited to the "rough-appearing" areas only and the "smooth" areas never touched each other. Ref. g. illustrates the details.

Increased magnification (25X) confirmed that the "rough-appearing" areas were a result of a "brittle fracture" of cured Polyester resin bonds while the "smooth" areas were undisturbed surfaces of Polyester compound-impregnated fibrous wire covering of either layer, separated by a void. Although this interpretation was consistent with the postulated failure mechanism, there was one unexplainable discrepancy originating in the method of pole winding and curing. With the Polyester compound applied by brush over the entire surface of each completed layer before the next layer is wound, the inside-facing wire surfaces of the next layer can be impregnated only by bringing them into contact with the coating of the preceeding layer and keeping them in place during the cure. Since the coil sides are held compressed against the pole body between two full-length clamp plates to which the pressure is applied by a series of C-clamps distributed over the entire length of the pole, only small (one wire wide by a few inches long) voids can be sustained during the cure in either coil side. Major voids can exist only in the free coil ends where they are benign due to their orientation relative to the forces acting on the coil. In order to create larger voids in the coil sides, it is necessary to apply the Polyester compound so sparingly over relatively large areas of the preceeding layer, so that the inside-facing wire surfaces of the following layer do not establish a normal contact with the coating when the coil is compressed by C-clamps for baking. In such a case, however, the fibrous covering of the inside-facing wire surfaces will not be uniformly impregnated. That, of course, is contrary to the conditions actually observed. On the other hand, a relatively uniform impregnation of fibrous wire covering on the layer surfaces facing each other with a gap between them could be achieved by using Polyester compound diluted by a volatile solvent. This would allow a relatively uniform wetting of the fibrous wire coverings which would readily wick the more fluid compound during the winding and clamping process. Thermal cure would then drive out the volatiles leaving voids in their stead because the "scabbed-over" surfaces of the compound impregnating the fibrous wire coverings of both layers would no longer bond with each other. Of course, this hypothesis does not hold for several reasons. First of all, the Polyester compound used and

positively identified as Sterling D-111A is solventless and factory-premixed from 100% non-volatile components. Secondly, the voidy area is highly localized, being confined to the central section of the last layer on one coil side only, even though the Polyester compound must be applied to the entire preceeding layer before the next layer can be wound over it. Furthermore, all the poles were wound on the "day shift" by the same person, who had more than 10 years experience winding rotor poles and was known to be a conscientious worker, who would recognize a different "feel" of the diluted compound being brushed on the windings.

All the above reasons notwithstanding, the hypothesis of "locally diluted" compound seems to fit all the symptoms found. A probable scenario can be constructed under which a coating of the properly premixed compound can be applied over the entire layer of the pole winding in a manner that permits its localized dilution in one confined area, such as observed. It is only necessary to assume that the pole winding operation was not completed in one shift and the last layer was left to be wound during the following shift. In accordance with the Shop Practices then in effect, the partially wound rotor pole would have been left in the pole-winding lathe and covered with a polyethylene sheet, the unused part of the 5 gallon can of the compound mix would have been put in the "in-process" cold storage and the brush would have been cleaned and stored in a can of Xylene (MS-10.1 - a solvent). Before resuming winding operations on the next shift, the winder would remove the can with partly used compound from the cold storage, allowing it to warm up and, meanwhile, would remove the brush from the Xylene can and squeeze it dry into a clean rag or paper towel. When ready to resume pole winding process, the first operation to be performed by the winder would consist of coating the entire surface of the last layer already wound on the pole. This requires starting on one side and progressing towards the trailing end, then advancing the pole-winding lathe by 1/4 revolution to coat the end surface and 1/4 revolution again to coat the other side surface. Two more 1/4 revolutions of the lathe enable the application of Polyester compound to the entire layer surface so that the next layer of wire can be wound over it. Now, let us suppose that the winder was distracted by somebody or something and did not properly dry the brush after removing it from the Xylene can but just laid it aside. Resuming his work, he would stir the compound in its container first, then pick up the brush (no longer in the Xylene can), dip it in the container and start brushing the compound on the coil side facing up without being aware that the coating is diluted by Xylene released from the brush. He might not even feel less drag on the brush because the compound is still cooler than normal and its higher viscosity tends to compensate for the effect of solvent. By the time the central area of the coil side is coated, nearly all solvent would have been purged from the brush so that the coil ends and the other side are coated with practically undiluted compound. While there might be some slight difference in the visual appearance of one coil side and the other, they can never be viewed simultaneously, thus making a detection of this condition by the winder or the inspector quite unlikely.

Although no claim can be made that the above scenario represents a factual account of events resulting in an improper application of the resin being investigated, it is justified to accept the <u>local dilution of resin</u> as the <u>most probable cause</u> of failure based on the existing symptoms as well as the credibility of the events described above. Manufacturing defects such as this are detectible after curing by tapping the coils for hollow sounds, which is a part of routine Q.C. procedures. Why such detection was not successful defies deterministic explanations and can be considerated only in the realm of statistical probabilities. Viewed in this perspective, the failure can be considered a premature failure ("infant mortality") due to a random, readily

detectible but undetected, manufacturing defect having a low probability of recurrence. It can, therefore, be treated as an isolated incident with no significant generic implications.

As readily apparent from Ref. h., the inherent capability of the generator to withstand without injury the postulated overspeed of 25% above its synchronous speed was confirmed by testing the first generator of this design built for Palo Verde Unit 1 at 750 RPM. This generator, identified by the Serial No. 17609964-200 was overspeed-tested energized at its rated voltage in accordance with IEEE Std. 115, Section 2.45 while asembled on the factory test bed with an auxiliary jack shaft and inboard bearing for other running tests. Driven by a direct-coupled D.C. Dynamometer and excited from an auxiliary D.C. source, the generator rotor was kept at its synchronous speed (600 RPM) long enough to obtain stable electrical readings and a set of mechanical vibration measurements at both its bearing housings. It was then accelerated to 125% rated speed (750 RPM) at a rate of 25 RPM/sec (while its excitation was reduced to maintain the rated voltage at the generator terminals) and held at these conditions with no further change for 300 seconds. Upon repeating the vibration measurements and obtaining a new set of electrical readings during the elapsed time, the rotor speed was reduced back to synchronous (600 RPM) at a similar rate and its excitation increased again as required. Upon obtaining another set of electrical readings and performing all vibration measurements at the synchronous speed again, the rig was shut down for a thorough visual inspection which revealed no changes in any part, nor any evidence of injury. Cursory examination of the vibration measurements recorded in Ref. h. confirms a high degree of dynamic stability of all rotating parts and the low vibration levels at 750 RPM together with the results of visual inspection provide conclusive evidence of the generator design integrity.

Since all Diesel Generators are run at 10% overspeed after they are installed at the site in order to set or to verify the setting of their overspeed trip devices, it is advisable to verify the integrity of their generator rotors by a thorough visual inspection following the overspeed trip setting run for each. This can be facilitated by a boroscope inserted into interpolar spaces upon removal of the outboard air intake covers. Thus the effort required to perform such inspection is minimal. While it is recognized that a limited overspeed exposure, such as this, falls short of confirming the specified overspeed capability of the generator, it certainly exposes the Diesel Generator system to the highest speed encountered in its normal operation. It simply does not verify the margin available in the generator rotor within the speed range normally considered unsafe for the diesel engine (110% 125%). On the other hand, centrifugal forces acting on the rotating parts at 110% of the rated speed reach magnitudes 21% higher than those at the rated speed and exaggerate the critical stresses and deformations of defective parts sufficiently to permit visual identification of significant manufacturing defects, if any. Duration of the overspeed exposure is of a secondary importance as long as the time at the overspeed required to set the overspeed trip devices and confirm their function is equal to or exceeds the time at the overspeed experienced by the system when the trip devices actually operate. In any case, the magnitude as well as the duration of the overspeed condition must not be injurious to any part of the Diesel Generator but, at the same time, must adequately simulate the most severe condition the system is required to tolerate during its operation. Arbitrarily set overspeed duration, such as 5 minutes suggested initially, is not really applicable here even though it has been traditionally used by the electrical industry as a typical duration of proof tests.

Summary of conclusions:

1. The wire-wound rotor pole failure is a direct result of a readily detectible but undetected manufacturing defect.

2. The manufacturing defect resulted from improper application of the specified Polyester bonding compound, most probably caused by local dilution of the resin in the area of failure.

3. The design integrity and the identity of critical materials were confirmed by testing. No evidence of additional debilitating effects was found.

4. The manufacturing defect causing the premature failure of the rotor pole appears to be a result of an isolated incident with no significant generic implications.

5. The corrective action suggested in EI-3306 appears to be adequate, however, the arbitrary 5 minute overspeed condition de-energized shall not be considered mandatory.

It is recommended that the failed rotor pole be rewound with no change in the originally specified materials or manufacturing technology. When accepted upon the specified routine inspection and tests, it shall be returned to Palo Verde renewal parts stores for future use.

J.V. Pospisil, P.E.
State of Ohio License E-039040
Manager of Engineering

cc: NDM, CJM

Attach Ref. a. through h.

ATTACHMENT A

TELEPHONE NOTES F0008279 TN-E-5168

DISTRIBUTION
D. R. Anderson
~~D. R. Hawkinson~~
G. A. Hierzer
~~J. D. Houchen~~
T. L. Mack
~~J. R. Melvin~~
R. R Stiens
~~H. H. Weber~~
T. G. Ballweg
~~J. A. MacKinnon~~
Ray Miklos

BY: J. A. MacKinnon OF Bechtel PHONE (602) 932-5300 ~~Ext. 7360~~

TO: Joe Pospisil OF NEI-Peebles PHONE (216) 481-1500

DATE November 25, 26, 1986 JOB NO. 10407 FILE M.11.04

SUBJECT Damaged Rotor Coil in Unit 3 Diesel Generator

NOTES Talked with Joe both days regarding the coil status and proposed disposition for releasing the machine to APS. The following points were discussed:

1. Joe wants to pursue the chemical analysis of the coil resin to rule out the problem with the compound. The coil is to be forwarded to the following:

   NEI-Peebles Electric Products, Inc.
   17045 Euclid Avenue
   Cleveland, Ohio 44112
   Attention: Mr. Richard Rossman, Manager of Materials

2. Joe does not have a problem with replacing the coil washer on the spare coil and returning it to spares in the warehouse.

3. The spare coils and the Unit 3 (Train A and B) coils were from the same batch of resin.

4. Joe will inspect the coil when received, consult with the resin manufacturer to determine the course of action, perform an analysis, review the results. This effort is forecast for one to two weeks.

I indicated to Joe that next week (December 1st) Norwalk Home Office Engineering will contact him regarding support for the DER resolution.

Recorded by: J. A. MacKinnon

Reviewed by: C. M. Herbst

CMH:DRA:JAM:cb

ATTACHMENT A

TELEPHONE NOTES F0005277 TN-E-5166

DISTRIBUTION
D. R. Anderson
~~D. R. Hawkinson~~
G. A. Hierzer
~~J. D. Houchen~~
T. L. Mack
~~J. R. Melvin~~
R. R Stiens
~~H. H. Weber~~
T. G. Ballweg
~~J. A. MacKinnon~~
Ray. Miklos

BY: J. A. MacKinnon/ D. R. Anderson OF Bechtel PHONE (602) 932-5300 ~~Ext. 7360~~

TO: Joe Pospisil OF NEI-Peebles PHONE (216) 481-1500

DATE November 26, 1986 JOB NO. 10407 FILE M.11.04

SUBJECT Release "B" Train Diesel Generator to APS

NOTES Joe concurred with releasing the Unit 3 train "B" diesel generator to APS to complete start-up testing based on the following reasons:

1. Train "A" has been run on site for over 140 hours, energized and unenergized, and has performed the overspeed trip verification.
2. Train "B" has been run on site for three hours unenergized. (It was not discussed during the telecon, but was verified that "B" diesel has verified the overspeed trip setting.)
3. "A" and "B" train generators' coils and spare coils were wound using the same resin batch.

Based on the above and the concurrence of Fred Lamcha of NEI-Peebles that the generator is in satisfactory condition, the diesel generator train "B" can be released to APS.

Recorded by: JAMacKinnon DRAnderson
J. A. MacKinnon/D. R. Anderson

Reviewed by: DRAnderson for C. M. Herbst

CMH:DRA:JAM:cb

44

NEI

NEI Peebles - Electric Products, Inc.

17045 Euclid Avenue
Cleveland, Ohio 44112

December 8, 1986

RECEIVING INSPECTION REPORT ATTACHMENT-B

CUSTOMER: Cooper Energy Services

SITE: Arizona Public Services
Palo Verde Nuclear Station

RECEIVED FROM: General Electric Co.
Apparatus Service Shop
6 Anderson Drive
Albany, New York 12205

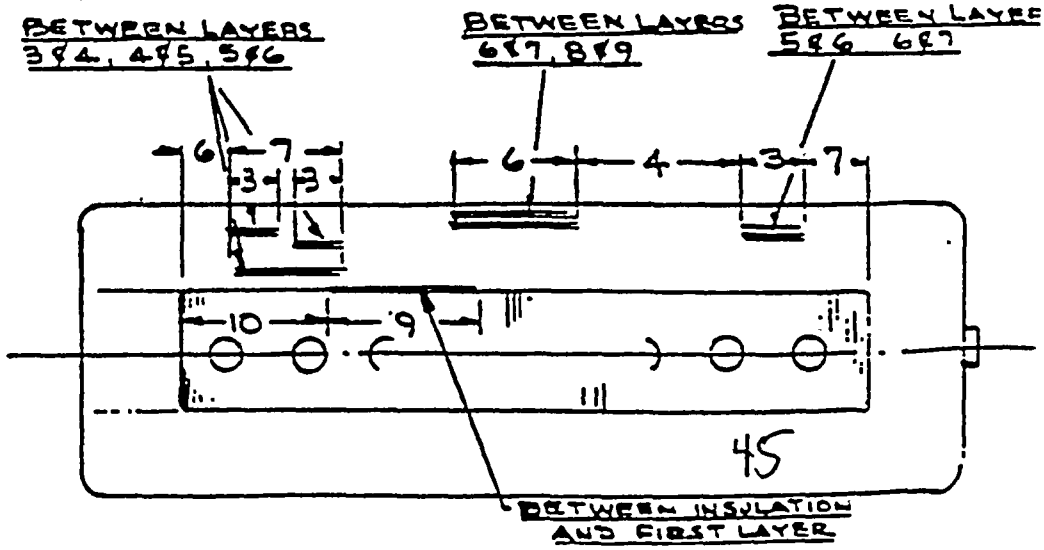
PART: One Wound Pole Assembly A-64665-50
From Synchronous Generator 17609966

REFERENCE: Customer Order CES 3621D6493
Portec, Inc./Parsons Peebles-Electric Products No. S.O. 17609964-69

DATE: 12/4/86

PROBLEM: Outer Two Layers of Rotor Coil Reported to be loose.

1) Shipping container.	Received in skidmounted wood crate, condition - fair.
2) Packing of parts received.	One Wound Pole Assembly with two outer coil layers and bottom pole washer removed. Wound Pole Assembly was loosely braced in center of crate. No additional damage. The two outer coil layers, cut from top to bottom turn, were packed on each side of assembly.
3) Condition of parts.	a) Pole stack was tight. b) One end ring tab was bent. c) Insulation washer (bottom) was in good condition - no cracks or brakes. d) Coil winding, which remained on pole assembly, appears to be bonded and tight. There are voids in between layers on one side of pole only. These were .010 to .015 wide and one wire deep. Location of voids per sketch below:



NEI Peebles - Electric Products, Inc.
17045 Euclid Avenue
Cleveland, Ohio 44112

ATTACHMENT-B

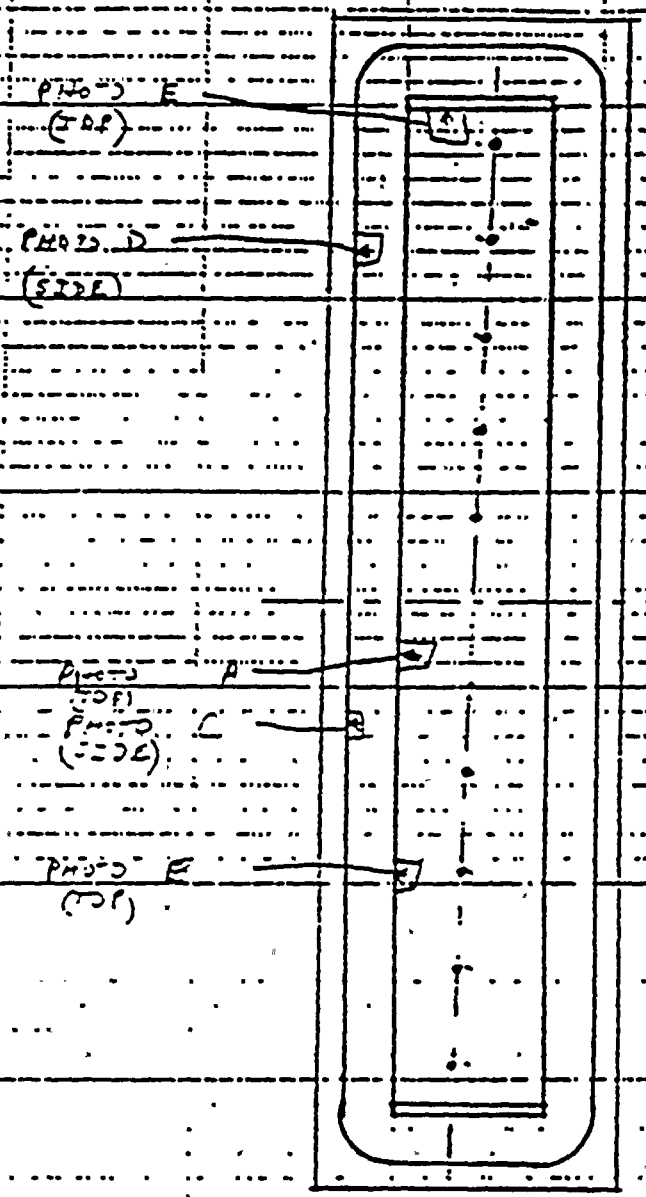
Electrical Check:	
Insulation Resistance at 500 V, 1 minute.	50,000 + M Ohms.
Winding Resistance	0.395 Ohms at 21.5 °C.
AC Volt Drop	108 Volts at 3.00 A.

Tested by: R. W. Cup 12-8-8

Inspected by: RC Classen 12/5/86

Approved by: [illegible] 12.8.86

ATTACHMENT-B



SUBJECT ROTOR POLE ASSEMBLY /A-64665-50 LOCATION FOR PHOTOS	S.O. NO. 17609964 ID. NO.
NEI PARSONS PEEBLES—ELECTRIC PRODUCTS, INC. 1725 CLARKSTONE ROAD • CLEVELAND, OHIO 44112	BY CJM DATE 12/3/96 REVISION DATE SHEET NO. OF

ATTACHMENT-C

5029-3
Stock

Sterling
ESTABLISHED 1894
Nacco
SEWICKLEY, PA. 15143
DIVISION OF REICHHOLD CHEMICALS, INC.
(412) 766-7600 • 741-5432
TWX 710 • 668-3877

May 9, 1980

Parson Peebles
Electric Products, Inc.
1725 Clarkstone Rd.
Cleveland, Ohio 44112

Attention: Purchasing Agent

Gentlemen:

This is to certify that the 10 - 5 gal. pails of D-111 furnished against your order 5029-3 were manufactured in accordance with and meet the requirements of our standard manufacturing specification for this item.

Yours very truly,

C G Frost
C. G. Frost, V.P.
Manufacturing

CGF:CB

48

F.1244

ATTACHMENT-C

MATERIAL SPECIFICATION

CODE	DATE	SPEC. NO.
MV	11/9/79	10.1
SUPERSEDES MV	11/16/73	10.1

SHEET NO. 1 OF 1 SUPERSEDED BY

POLYESTER RESIN

1.0 Description:

Polyester resin Varnish for use in "Wet Winding" of poles per insulation Spec EI-1.5.0. Two part compound mixed by vendor prior to shipment Displays high strength and cohersion. Paints on easily.

2.0 Physical Properties:

2.1 Viscosity: 63,000 Cps at 20 RPM, 520,000 Cps at 2 RPM.
2.2 Color Grey
2.3 Composition: 23% Styrene Monomer , 73% curing agent
2.4 Evaporation rate: Essentially 100% non - Volatile
2.5 Flash Point: 93°F setaflash method
2.6 Non - explosive
2.7 TLV: 100 ppm
2.8 Shelf Life: 3 Months at 35° F.
2.9 Gel Time: 10 Minutes at 150° C.
2.10 Weight per gallon: 9.6 Pounds

3.0 Curing Cycle: 2-6 hours at 290-325° F, depending on weight and shape of work piece.

4.0 Cured Properties

4.1 Hardness: 85 Shore D
4.2 Insulation Class: F (155° C)
4.3 Heat Deflection Temperature: 140°C
4.4 Water Absorption: 0.41% (7 Days at R.T.)
4.5 Weight Loss: 1.03% (7 Days at 180° C)

5.0 Approved Sources

Manufacturer	Catalog No.
Sterling Varnish	D-111A
Thermoset Plastics Inc.	DC-9 or DC-529
*McGraw Edison Service	2A353 Varnish

49

* Rev. 7/21/80-PMS

PREPARED BY: DATE: APPROVED BY: DATE: APPROVED BY: DATE:

NEI

NEI Peebles - Electric Products, Inc.

ATTACHMENT-D

17045 Euclid Avenue
Cleveland, Ohio 44112
Telephone: (216) 481-1500
Telex: 241564
Facsimile: (216) 481-8386

December 9, 1986

EF-3308

Reichhold Chemical Company
Sterling Group
Route 65
Sewickley, PA 15143

Attention: Ray Cushner

Dear Mr. Cushner:

As we discussed in our telephone conversation of December 8, 1986, we have enclosed resin samples, labeled A1, A2, A3, B, and C. Please determine by IR or TGA analysis, whether one of the A samples, the B, and the C are D111A.

A1, A2, and A3 are all from the same side of one pole. A2 may have polyester mat imbedded in it. One sample from this group is sufficient. Sample B is an aged sample. If the samples are not identical, we would be interested in learning what the difference in them is.

Your reply is urgently needed. If there is a cost for expediting the answers, please contact our Purchasing Manager, Mr. Richard Rossman.

Thank you for your assistance.

Yours truly,

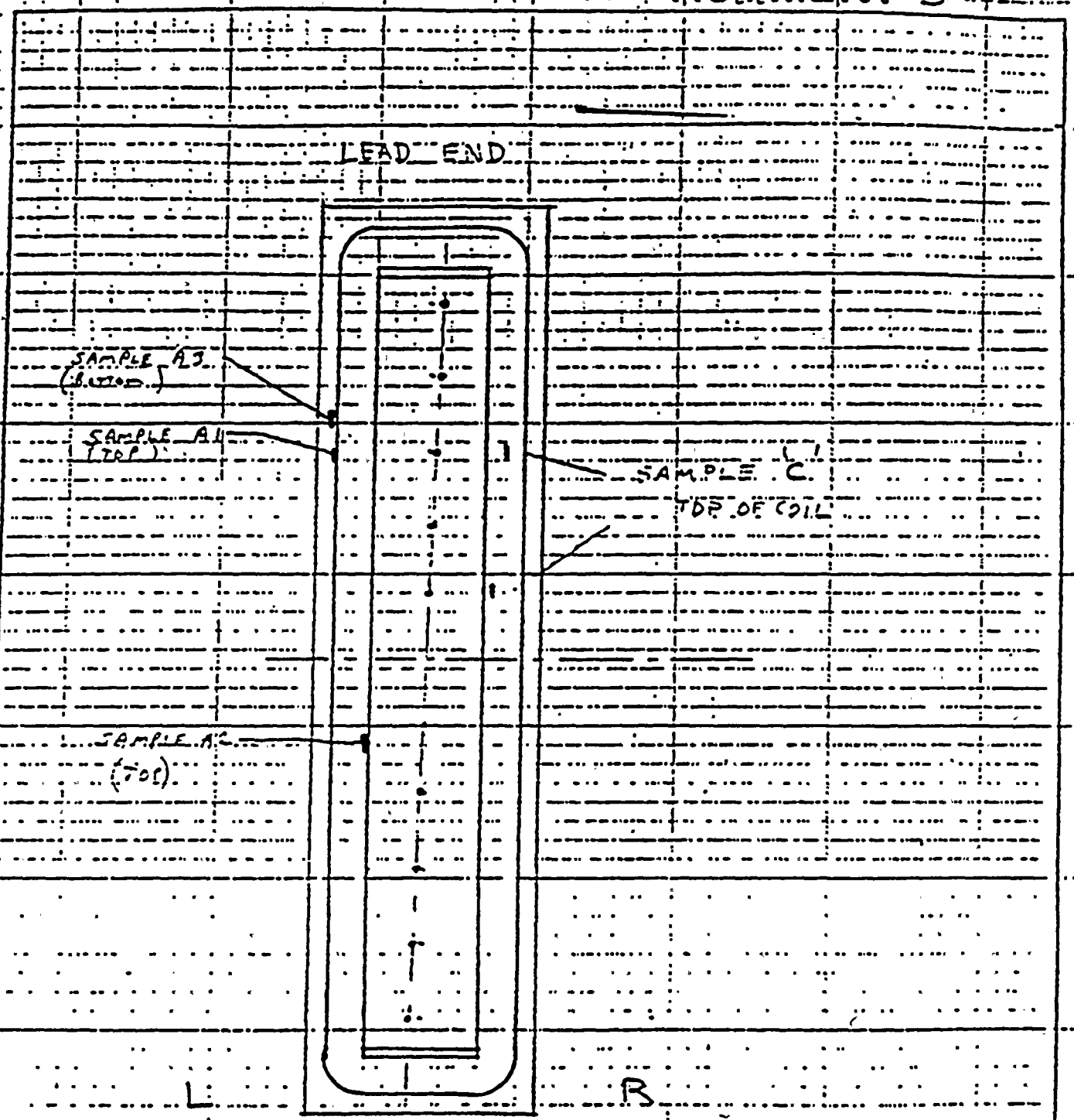
NEI PEEBLES - ELECTRIC PRODUCTS, INC.

Charles Moosbrugger

Charles Moosbrugger
Engineering Specialist

CM/jmr

Enclosures



LEFT SIDE SEPARATED

51

SUBJECT ROTOR POLE ASSEMBLY /A-64665-50
LOCATION OF RESIN SAMPLES

S.O. NO. 17609964
ID. NO.

NEI PARSONS PEEBLES—ELECTRIC PRODUCTS, INC.
1725 CLARKSTONE ROAD • CLEVELAND, OHIO 44112

BY CJM DATE 12/8/86
REVISION DATE
SHEET NO. OF

ATTACHMENT-E

Reichhold Chemicals, Inc.
Sterling Group
Route 65
Sewickley Pennsylvania 15143

REICHHOLD

January 13, 1987

Mr. R. A. Rossman
Manager of Materials
NEI Peebles - Electric Products, INc.
17045 Euclid Ave
Cleveland, OH 44112

Dear Mr. Rossman:

In accordance with the request of your Purchase Order No. 14935, we have performed Thermal Gravametic GRAVIMETRIC Analysis (TGA), determined filler content of the samples and compared these results with a freshly made batch of D-111A Polyester Compound.

Conclusions of analytical study:

	TGA Index	% Filler
Standard (D-111A made in Laboratory)	163.5	26.35
Resin Sample A 1	163.5	29.85
Resin Sample B	162.6	33.35
Resin Sample C	164.5	29.90

Comparison of the TGA indexes, shape of curve and filler content indicates a very high probability that Samples A 1, B & C are cured specimens of D-111A.

TGA Charts are attached for your use and reference.

We have enclosed the original and one copy of our Invoice No. 1101-10388, covering the reported analysis

If you have any additional questions, do not hesitate to contact us.

Very truly yours,

Donald E. Campbell
Product Manager

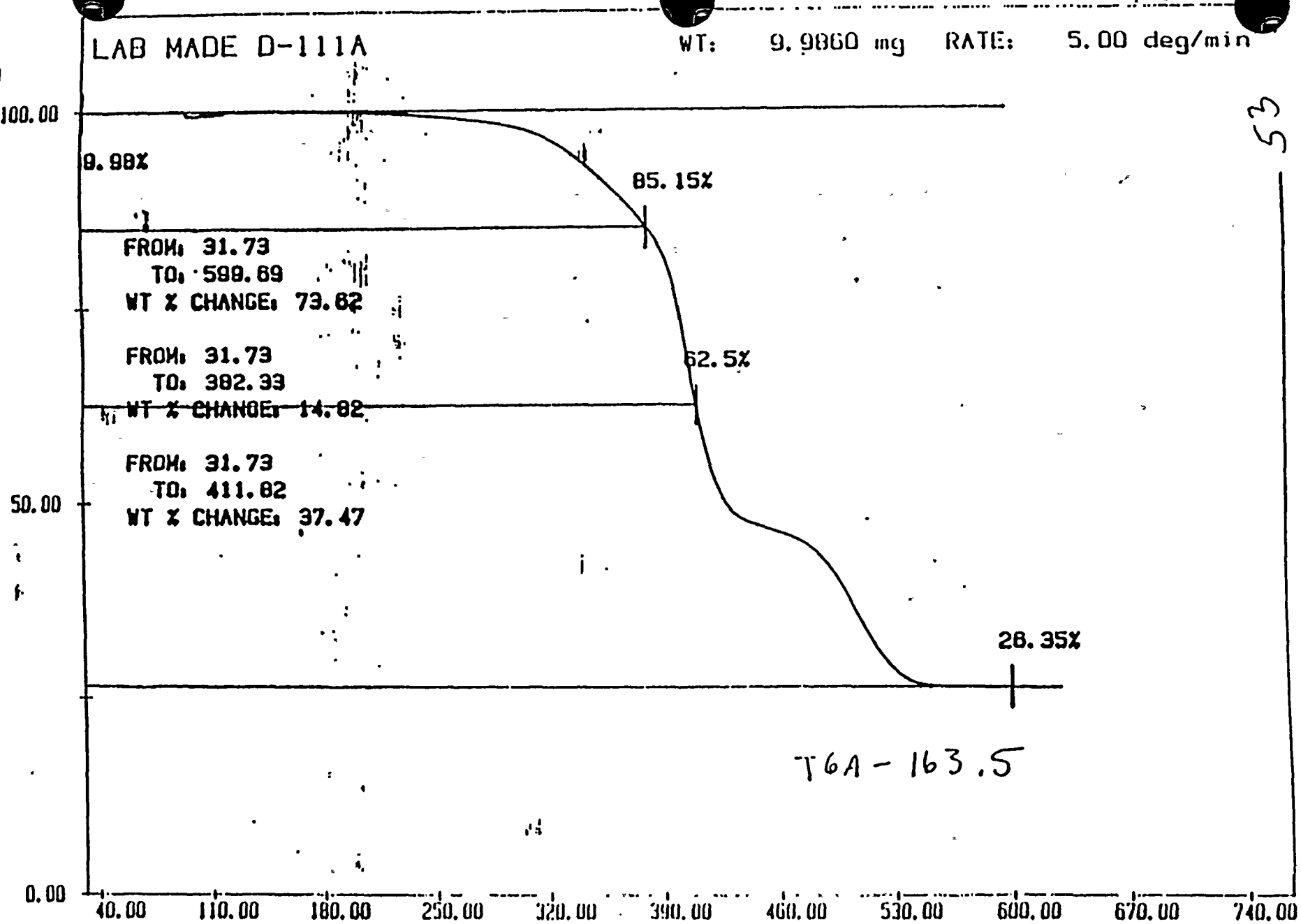
DEC/rmn
Enclosures

52

Tel (412) 766-7600
TWX. 7106683877

ATTACHMENT-E

53



TGA - 163.5

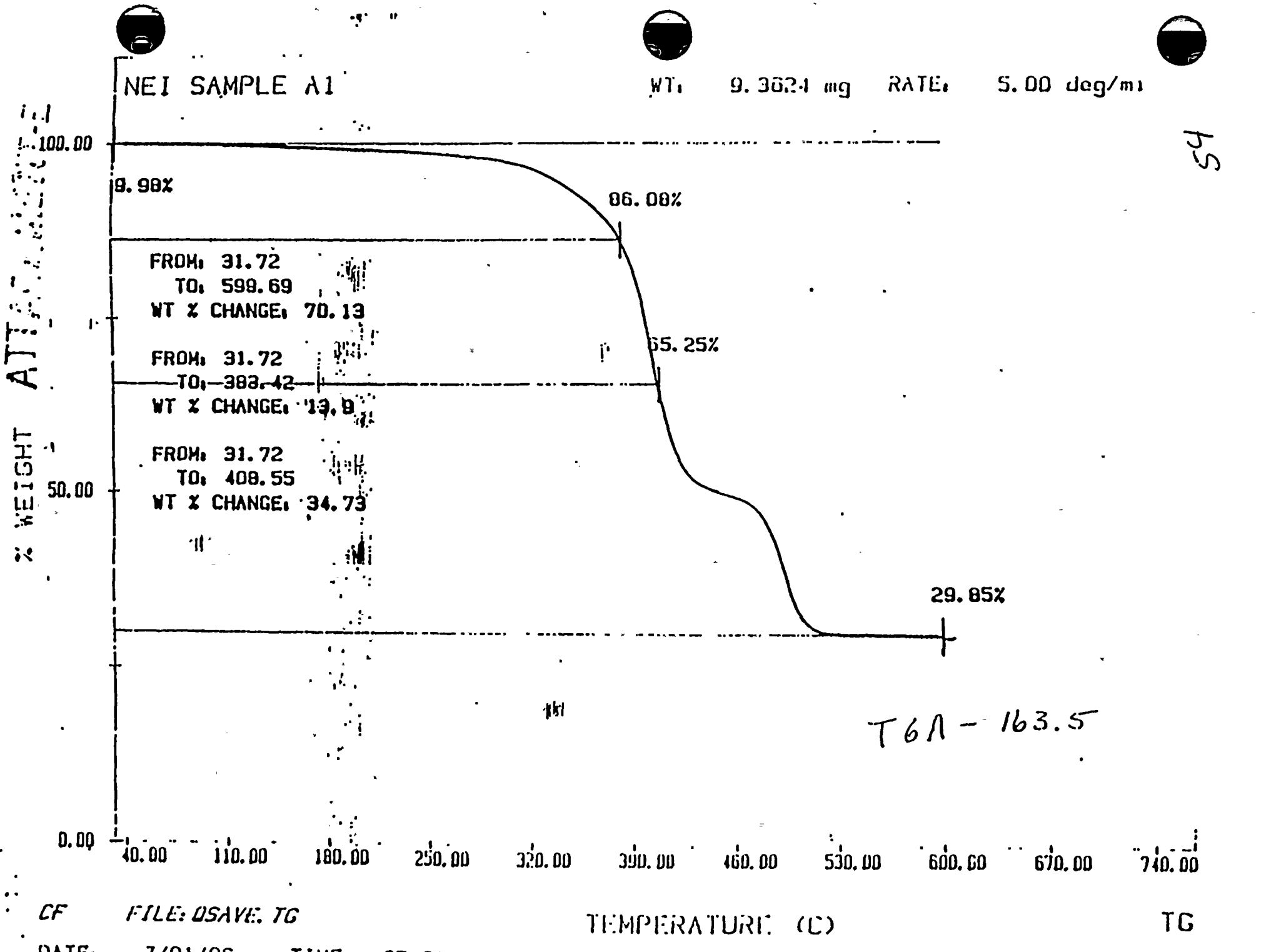
CF: FILE: QSAVE. TG

TG

DATE: 7/01/07 TIME: 09: 2

PERKIN-ELMER

al Analysis



CF FILE: DSAVE.TG

DATE: 7/01/06 TIME: 07:20

TG

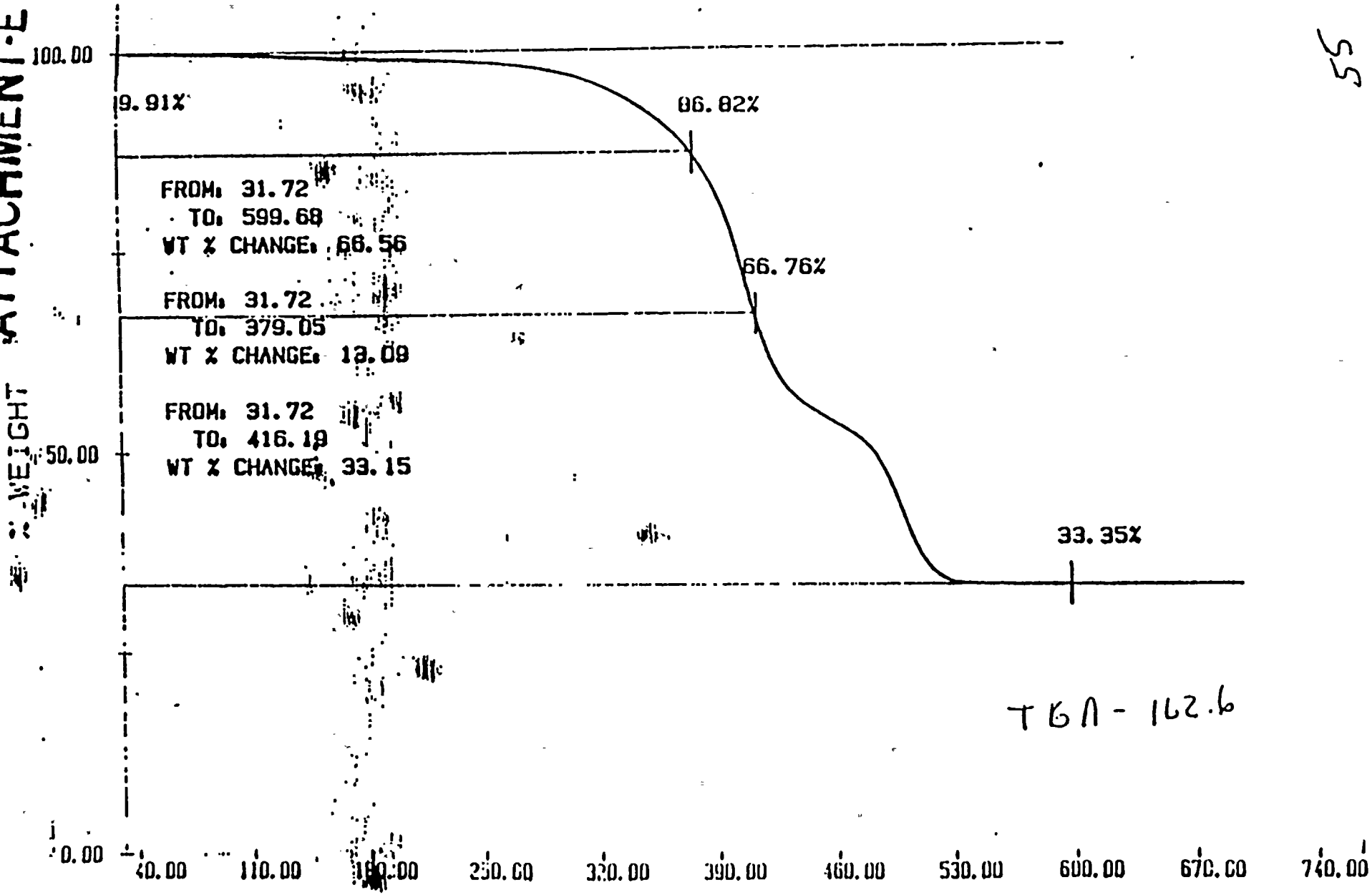
PERKIN-ELMER

al Analysis

54

ATTACHMENT-E

55



TGA - 162.6

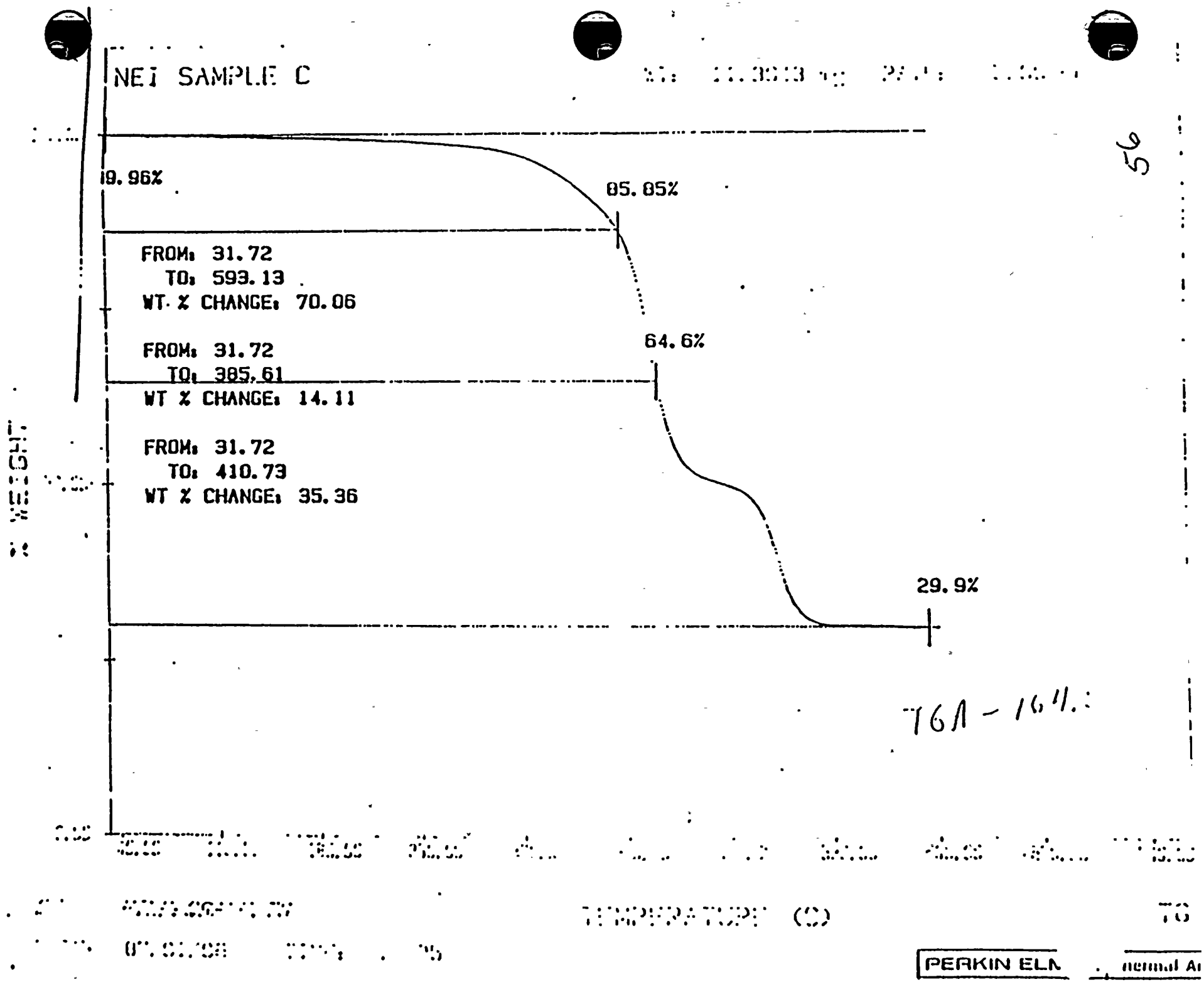
CF FILE: QSAVE. TG.

TG

DA 87/01/06 TIME: 09:

PERKIN ELM. .nal Analy

ATTACHMENT-E



56

76A - 164.3

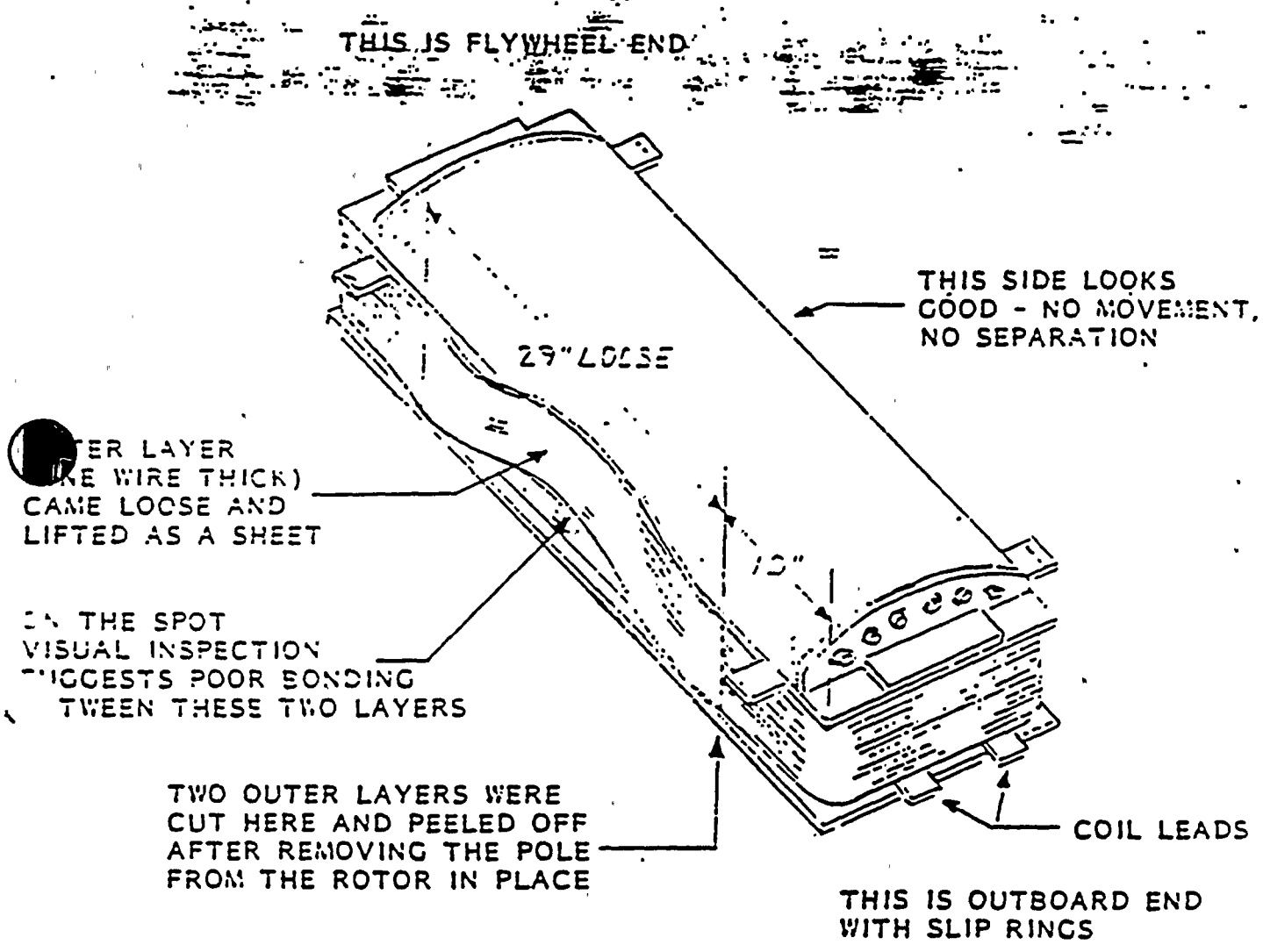
ATTACHMENT-F

SERVICE REPORT

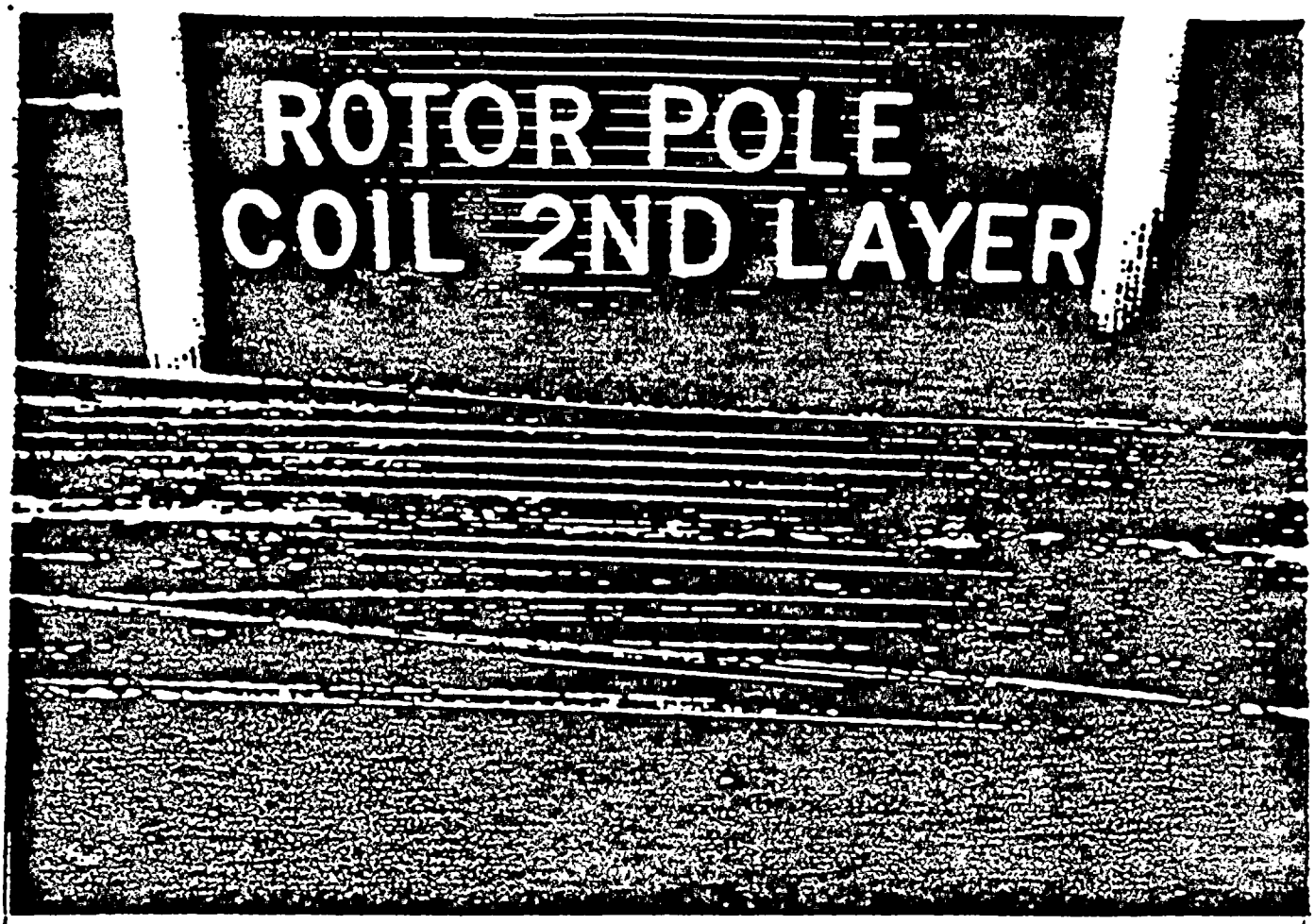
F-1063

Sketch of the failed rotor pole coil, Serial Number 17609966

Date of service: 11-18-86 thru 12-8-86 Service Engineer: F. Lamcha



Note: Bottom washer was removed in G.E. Repair Shop. Inspection from the bottom indicates voids and spaces all around, more noticeable on the ends. Two outer layers were cut and peeled off intact as sheets. Wires did not separate.

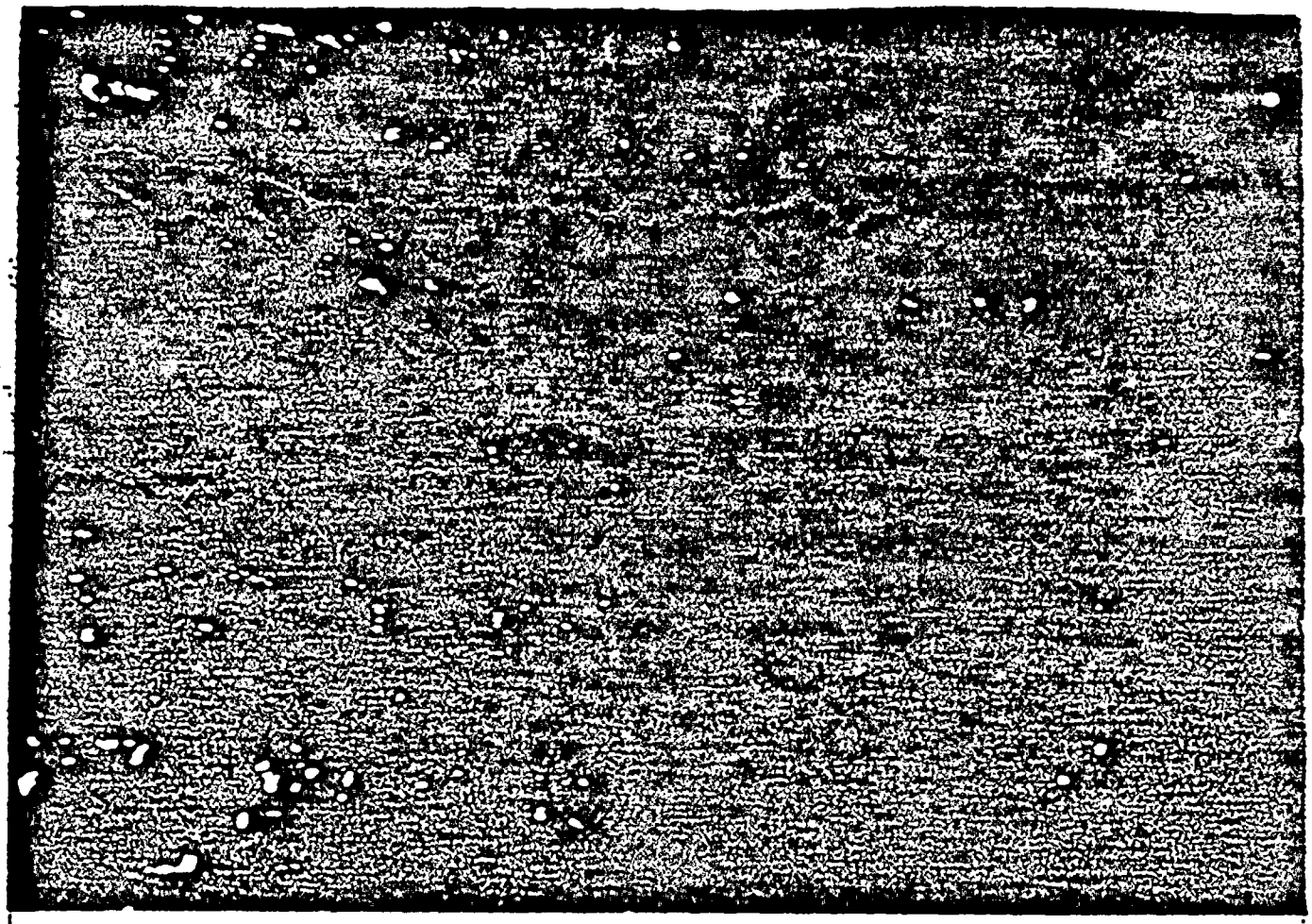


Photograph No. 1. (approximately 1/2 actual size)

General view of the 2nd layer of the wire-wound rotor pole (received separated from the 1st layer and from the rest of the rotor pole coil but with individual turns still bonded) showing the beginning of the area of failure (appearing as a darker spot) under the letter "C" which becomes wider and wider towards the right side of the picture (towards the center of pole).

58

SUBJECT ENGINEERING LABORATORY RECORD	S.O. NO 17609966 and 969 ID NO W-1037
NEI PEEBLES—ELECTRIC PRODUCTS, INC. 17945 EUCLID AVENUE • CLEVELAND, OHIO 44112	BY CJM, JVP Date 1-26 to Date 1-30 1987 SHEET NO 1 OF 4

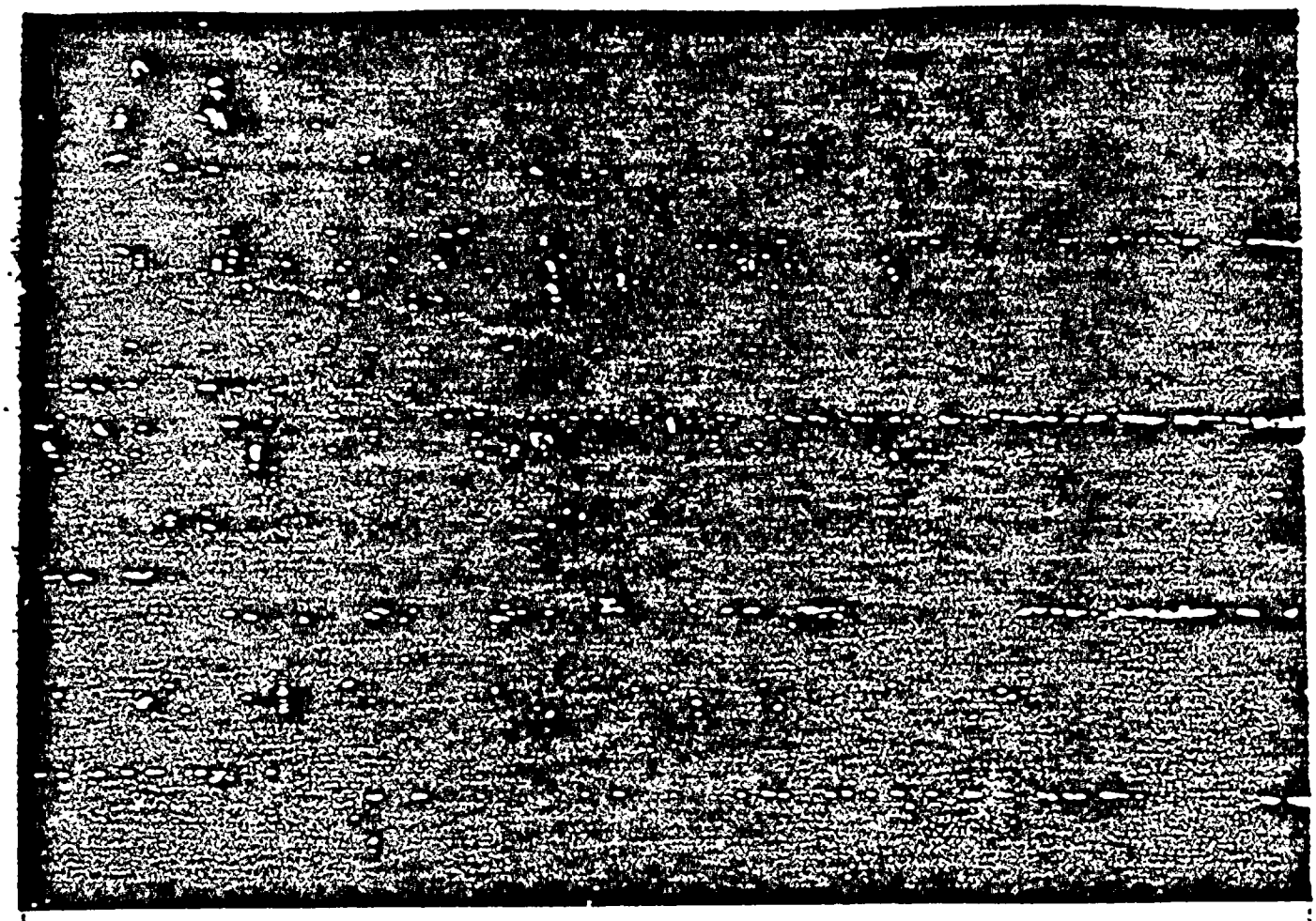


Photograph No. 2. (approximately 5 times actual size)

Magnified view of a 1 x 1.5 in. area located under the numeral "2" in Photograph No. 1 showing a nearly total lack of bond between the outside of the 2nd layer and the inside of the 1st layer (removed). Note the "smooth" appearance of the fibrous wire covering where the resin was diluted. Also note "pinhead" formation in the areas adjacent to poorly bonded contact imprints resulting from driving out volatiles during the cure. This view is typical of approximately 30% of the total area of failure interspersed in the background typified by Photograph No. 3.

59

SUBJECT ENGINEERING LABORATORY RECORD	S.O. NO 17609966 and 965 I.O. NO W-1037
NEI PEEBLES—ELECTRIC PRODUCTS, INC. 17045 EUCLID AVENUE • CLEVELAND OHIO 44112	BY CJM/JVP Date 1-26 to Date 1-30 1987 SHEET NO 2 OF 4



Photograph No. 3 (approximately 5 times actual size)

Magnified view of a 1 x 1.5 in. area located under the letters "AY" in Photograph No. 1 showing a nearly total lack of bond between the outside of the 2nd layer and the inside of the 1st layer (removed) even though a relatively uniform contact over a wide area was established. Note the "smooth" appearance of the fibrous wire covering and "scabbed over" contact areas which did not bond. Note also the same "pinhead" formation in the vicinity of contact imprints as observed in Photograph No. 2. This view is typical of the general appearance of the area of failure and forms a background in which spots depicted by Photograph No. 2 are randomly distributed. General appearance of the failure area changes into that typified by Photograph No. 4 on both ends of the pole.

60

SUBJECT ENGINEERING LABORATORY RECORD	SO NO 17609966 and 969 ID NO W-1037
NEI PEEBLES—ELECTRIC PRODUCTS, INC. 17045 EUCLID AVENUE • CLEVELAND, OHIO 44112	BY CJM/JVP Date 1-26 to Date 1-30 1987 SHEET NO 3 OF 4

STAND / FREQUENCY / ANGER TEST RM

ATTACHMENT

PE	KVA OR HP	KW	VOLTS	AMPS	PHASES	CYCLES	RPM	PF	FRAME	DUTY

ELECTRIC PRODUCTS DIVISION
PORTEC, INC.
1725 Clarkstone Road Cleveland, Ohio 44112

TEST PER IEEE NO. 115 . PARAGRAPH | TYPE | CONTRACT

MOTOR												GENERATOR										
												PHASE 1		PHASE 2		PHASE 3		OUTPUT		FIELD		~
												VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	KW	PF	VOLTS	AMPS	
				25% OVERSPEED FOR 5 MINUTES - & MECHANICAL BALANCE - METHOD 2																	45.01	
				VIBRATION																		
		STUB END		OPP. END								x25		x25		x25				x1	x3	RPM
HORIZ.		.0016		.0007								167		167		167				36.5	31.3	
VERT.		.0011		.0004																		600
AXIAL		.0012		.001																		
HORIZ		.0008		.0004		5 MINUTES						167		167		167				28	22.5	
VERT.		.0005		.0004																		750
AXIAL		.0005		.0003																		
HORIZ		.002		.0006								167		167		167				36.8	30.7	
VERT.	0	.0009		.0008																		600
AXIAL		.0013		.0009																		

THERE WAS NO EXCESSIVE NOISE OR VIBRATION DURING THE TEST AND NO EVIDENCE OF INJURY OR CHANGE IN ANY PART AFTER SHUTDOWN

DIRECT AXIS TRANSIENT & SUBTRANSIENT REACTANCES & TIME CORRESPONDING TIME CONSTANTS BY OSCILLOGRAPH.

	x25	x2000	x25	x2000	x25	x2000			x1	x2	
Before Short	167.5	0	167.5	0	167.5	0			36.5	45.2	600
During Short	—	.30	—	.30	—	.30			35.5	46.5	600
After Short	162	0	162	0	162	0			36.5	45.5	600

TESTED BY ALK DATE 12-7-77 CHECKED SG CERTIFIED WITNESSED DATE

Photograph No. 4 (approximately 5 times the actual size)

Magnified view of a 1 x 1.5 in. area located outside the field of Photograph No. 1 showing the typical appearance of either end of the area of failure where a more normal bond begins to become evident. There are still some signs of resin dilution to the left but "brittle fracture" of the resin layer is becoming noticeable to the right even though the bonding still lacks uniformity. Note the presence of "craze lines" where a relatively good bond was broken while the 1st layer was being "peeled off" from the coil. Also note a few "pinheads" still evident next to the void zones indicating some presence of a solvent before and during the cure.

62

SUBJECT ENGINEERING LABORATORY RECORD	SO NO 17609966 and 969 ID NO W-1037
NEI PEEBLES—ELECTRIC PRODUCTS, INC. 17045 EUCLID AVENUE • CLEVELAND OHIO 44112	BY CJM·JVP Date 1-26 to Date 1-30 1987 SHEET NO 4 OF 4

ATTACHED