EPA-420-R-86-101

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September 29, 1986

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SUBJECT: Final Report for Work Assignment No. 20, Contract 68-03-3192, "Catalyst Evaluation," SwRI Project 03-7774-020.

This Work Assignment has been intended to evaluate the condition of catalysts and oxygen sensors removed from in-use vehicles. The catalysts and oxygen sensors were removed from In-Use Technology Assessment program vehicles by EPA. The converters represented monolith technologies and both single and multiple beds. Catalysts used by several different manufacturers were included in the evaluation, and they included both oxidation and/or three-way catalyst types.

This letter report, along with the included data, is intended to be the final report of the results from the catalyst and oxygen sensor evaluation testing. It includes all the results from the "on-engine" evaluations (including converter light-off times and converter efficiencies); and all results from the laboratory analyses by whole converter x-ray, B.E.T. surface area, x-ray fluorescence, proton induced x-ray emission (PIXE), x-ray diffraction, and scanning electron microscopy (SEM). Twelve oxygen sensors (8 whole and 4 partial tips) were evaluated for leakage rate, voltage output, sensor response time, cold light-off time, B.E.T. surface area, and electron spectroscopy for chemical analysis (ESCA) of exterior elements. Only a brief discussion of the analytical procedure, and no discussion of the trends observed in the evaluation of each catalyst, is included. A total of 42 converters (29 whole and 11 partial samples) were examined. A list of the converters evaluated in the program is presented in Table 1. Of the 42 converters, 9 were evaluated "on-engine" only, 7 received laboratory analysis only, 7 were quality assurance samples for the laboratory, 2 were quality assurance for the engine, and 17 were examined using all of the analytical procedures. A detailed description of the laboratory analytical procedure is presented in the final reports for Work Assignments No. 10 and 17 of Contract 68-03-3162 (with the exception of PIXE and ESCA) and the parameters for the "on-engine" evaluations are presented in Table 2.

TABLE 1. LIST OF CATALYSTS FOR EVALUATION

Converter or Biscuit Number	Make	Engine Family	Type of Catalyst
A3/1037-A	Ford	1.6AP/EAC	dual biscuit 3-way + Ox
A81/0270-1	Ford	3.3GQ/EAC	single biscuit 3-way
A87/0479-2-A	Chrsyler	BCR1.7V2HJ1	dual biscuit Ox + Ox
A154/0392-A	Ford	CFM1.6V2GKC2	dual biscuit 3-way + Ox
A155/0979-1-A	Chrysler	CCR2.2V2HFL1	dual biscuit 3-way + Ox
A160/0656-1	Ford	CFM3.3V1GXF9	single biscuit 3-way
A180/0094	Nissan	CNS2.8V5FAF4	single biscuit 3-way
A193/0908	Chrysler	DCR2.2V2HAC3	dual biscuit 3-way + Ox
A214/0681-A	Ford	CFM5.0V2HDF8	dual biscuit 3-way + Ox
A218/0045	Nissan	CNS2.8V5FAF1	single biscuit 3-way
A218/0045X	Nissan	CNS2.8V5FAF1	single biscuit 3-way
A218/0068	Nissan	CNS2.8V5FAF1	single biscuit 3-way
A220/0392	GM	D4G3.8V2NEA3	dual biscuit 3-way + Ox
A220/0810	GM	D4G3.8V2NEA3	dual biscuit 3-way + Ox
A221/0152	Chrysler	DCR2.2V2HAC3	dual biscuit 3-way + Ox
A221/0198	Chrysler	DCR2.2V2HAC3	dual biscuit 3-way + Ox
A221/0204	Chrysler	DCR2.2V2HAC3	dual biscuit 3-way + Ox
A221/0310	Chrysler	DCR2.2V2HAC3	dual biscuit 3-way + Ox
A221/0447	Chrysler	DCR2.2V2HAC3	dual biscuit 3-way + Ox
A230/0177X	GM	D1G2.0V5XAJ4	dual biscuit 3-way + 3-way
A230/0636X	GM	D1G2.0V5XAJ4	dual biscuit 3-way + 3-way
A240/0016L	Ford	DFM1.6V2GDK6	dual biscuit 3-way + Ox
A240/0102	Ford	DFM1.6V2GDK6	dual biscuit 3-way + Ox
A240/0141L	Ford	DFM1.6V2GDK6	dual biscuit 3-way + Ox
A240/0153	Ford	DFM1.6V2GDK6	dual biscuit 3-way + Ox
A240/0334L	Ford	DFM1.6V2GDK6	dual biscuit 3-way + Ox
A249/0169-1	Chrysler	DCR5.2V2HAP9	single biscuit 3-way
A249/0169-2	Chrysler	DCR5.2V2HAP9	single biscuit 3-way
A249/0169-3	Chrysler	DCR5.2V2HAP9	dual biscuit 3-way + Ox
A249/0486-1	Chrysler	DCR5.2V2HAP9	single biscuit 3-way
A249/0486-2	Chrysler	DCR5.2V2HAP9	single biscuit 3-way
A249/0486-3	Chrysler	DCR5.2V2HAP9	dual biscuit 3-way + Ox
A254/0031	Toyota	DTY2.4V5FBB2	dual biscuit 3-way
A254/0037	Toyota	DTY2.4V5FBB2	dual biscuit 3-way
A254/0191	Toyota	DTY2.4V5FBB2	dual biscuit 3-way
A254/0275	Toyota	DTY2.4V5FBB2	dual biscuit 3-way
A280/0001L	Chrysler	ECR2.2V2HAC4	dual biscuit 3-way + Ox
A155/0941-1	Chrysler	CCR2.2V2HFL1	dual biscuit 3-way + Ox
A155/0941-2	Chrysler	CCR2.2V2HFL1	dual biscuit Ox + Ox
A207/0101	Chrysler	CCR1.7V2HBF7	triple biscuit 3-way + 3-way + Ox
A215/0201R	Ford	CFM5.0V5HEF0	dual biscuit 3-way + Ox
EPA 1174R	GM	D1G2.8H2NNA9	dual biscuit 3-way + OX

TABLE 2. PARAMETERS FOR CONVERSION EFFICIENCY AND LIGHT-OFF TIMES

I. Light-Off times

1. Engine speed = 1800 $\pm$ 20 rpm
2. Purge catalyst before starting - cool to 100-110°F
3. Exhaust flow rate through catalyst - Engine Family Displacement
4. Air injected upstream
5. Temperature of exhaust at catalyst face = 730 $\pm$ 30°F
6. Exhaust concentration settings

   5.0 $\pm$ 0.1% O_2
   2.0 $\pm$ 0.1% CO

7. Sample for 600 seconds

II. Conversion Efficiency

1. Engine speed = 1800 $\pm$ 20 rpm
2. Temperature of exhaust at catalyst face = 730 $\pm$ 30°F (controlled by engine load)
3. Engine Exhaust Emission levels at 14.7 A/F ratio: HC = 1500 $\pm$ 200 ppm and NO_x = 1600 $\pm$ 200 ppm
4. Exhaust flow rate through catalyst - Dependent on Engine Family Displacement
5. Air/Fuel ratio increments of 0.2 from 14.1 to 15.3
6. Injected O_2 - set at 10% dilution of exhaust ($\frac{\text{Carbon in}}{\text{Carbon out}}$ = 1.1)

   a. 3-way (no air injected)
   b. 3-way + Ox (air injected to Ox catalyst

III. Gaseous Emission Instrumentation

Inlet	
HC FID	0-5000 ppm
CO NDIR	0-3 and 0-6%
NO_x CI	0-1000 and 0-2500 ppm
O_2	0-25%
CO_2 NDIR	0-6 and 0-16%
Gas Temp.	0-500°C Strip, -100 to +1595°F Digital

Outlet	
HC	0-500, 0-100 and 0-5000 ppm
CO (low)	0-500 ppm
CO (high)	0-3 and 0-6%
NO_x	0-1000 and 0-2500 ppm
Gas Temp.	0-500°C Strip, -100 to +1595°F Digital

IV. Number of Cylinders Required for "On-Engine" Evaluation

Converter Number	Number of Cylinders
A193/0908	4
A220/0392	5
A220/0810	5
A221/0152	4
A221/0198	4
A221/0204	4
A221/0310	4
A221/0447	4
A230/0177X	3
A230/0636X	3
A240/0016L	3
A240/0102	3
A240/0141L	3
A240/0153	3
A240/0334L	3
A249/0169-1	4
A249/0169-2	4
A249/0169-3	8
A249/0486-1	4
A249/0486-2	4
A249/0486-3	8
A254/0031	4
A254/0037	4
A254/0191	4
A254/0275	4
A254/0001L	4

V. Engine Displacement by Cylinders

Cylinders Used	Engine size, liters (CID)
8	5.7 (350)
7	5.0 (305)
6	4.3 (262)
5	3.6 (220)
4	2.9 (177)
3	2.1 (128)
2	1.4 (85)

I. Converter Efficiency and Light-Off Times

Before testing each converter for converter efficiency and light-off times, a whole converter x-ray radiograph was obtained. The radiographs served three major purposes: 1) to determine internal structural damage from overheating and external shock or impact, 2) shadowing due to the presence of lead or other deposits, and 3) to assist in the opening of the container without damaging the biscuits. In general, the radiographs did not provide a significant amount of quantitative data. A negative image was obtained for each radiograph, and there was less film exposure where the density of the material was greatest. These negatives were transformed to positives for clarity, and they are shown in Appendix A.

The converter efficiency data for hydrocarbons, carbon monoxide, and oxides of nitrogen are summarized in Tables 3 through 5. The data for each individual test are included as Appendix B. All converters were tested at air/fuel ratios from 14.1 to 15.3 in 0.2 increments. Three-way only catalysts were tested with no injected air, and three-way + O_x catalysts were tested with the air injected to the oxidation catalyst. The injected air flow was set to simulate a 10 percent dilution of the total exhaust flow.

After the converter efficiency tests were completed, each converter was cooled by injecting air upstream of the converter with the exhaust bypassing the converter. The exhaust concentration was then set to 2.0±0.1% CO and 5.0±0.1% O_2. The oxygen concentration was obtained in the exhaust by injecting air. A specially-designed diverter valve was activated to switch the exhaust flow to the converter. The light-off times were monitored for each converter and are presented in Tables 6 through 8. The data for the individual tests are presented in Appendix B.

Converter A240/0204 was tested with the flow going in the opposite direction from the converter design (i.e., oxidation biscuit as inlet and air going to 3-way biscuit). The error was not discovered until after the converter had been cut open. For this reason, the converter could not be retested with the proper flow. It should be noted that even with the incorrect direction of exhaust flow, the percent reductions for hydrocarbons and carbon monoxide were only slightly lower than similar converters, and the percent reduction for the oxides of nitrogen was about half. The light-off times were longer than all of the other converters except A240/0102 and A193/0908, which were both determined to be overheated. The data are included in the summary table and Appendix B, but the emission results cannot be used for correlation with the "on-vehicle" emission tests.

II. Laboratory Analysis

The laboratory analysis of the catalyst samples consisted of whole converter x-ray, BET surface area, x-ray fluorescence, PIXE, x-ray diffraction, and SEM. The catalyst samples were examined as follows:

1. Only whole converters were examined by whole converter x-ray radiographs.

TABLE 3. STEADY-STATE CONVERTER EFFICIENCY SUMMARY HYDROCARBONS

Converter Number	Make	Type	Percent Reduction at Nominal A/F Ratio 14.1	14.3	14.5	14.7	14.9	15.1	15.3
A193/0908	Chrysler	DCR2.2V2HAC3	36.6	39.2	47.1	88.8	89.4	88.9	89.1
A220/0392	GM	D4G3.8V2NEA3	89.4	90.3	89.6	92.0	92.0	90.9	91.7
A220/0810	GM	D4G3.8V2NEA3	87.4	87.5	87.1	90.0	88.4	87.5	85.7
A221/0152	Chrysler	DCR2.2V2HAC3	68.2	87.2	89.2	91.2	91.7	91.4	90.6
A221/0198	Chrysler	DCR2.2V2HAC3	73.3	67.4	90.0	90.0	91.4	91.8	91.7
A221/0204*	Chrysler	DCR2.2V2HAC3	66.6	65.5	65.8	75.0	87.5	89.6	90.4
A221/0310	Chrysler	DCR2.2V2HAC3	57.6	75.6	65.4	89.7	91.2	92.2	91.1
A221/0447	Chrysler	DCR2.2V2HAC3	90.3	90.7	91.2	91.2	90.8	91.7	92.3
A230/0177X	GM	D1G2.0V5XAJ4	54.5	95.0	94.6	93.5	95.3	94.9	93.8
A230/0636X	GM	D1G2.0V5XAJ4	47.0	93.8	92.6	94.4	95.6	94.7	93.8
A240/0016L	Ford	DFM1.6V2GDK6	81.9	89.5	92.0	92.8	92.0	91.8	93.0
A240/0102	Ford	DFM1.6V2GDK6	27.6	27.1	25.4	24.5	32.0	36.1	42.4
A240/0141L	Ford	DFM1.6V2GDK6	83.1	85.7	87.3	89.5	88.0	87.2	87.8
A240/0153	Ford	DFM1.6V2GDK6	77.6	86.6	87.9	89.1	90.0	88.6	88.9
A240/0334L	Ford	DFM1.6V2GDK6	75.7	90.2	92.6	94.0	93.5	92.7	93.8
A249/0169-1	Chrysler	DCR5.2V2HAP9	51.8	89.0	91.4	90.9	90.0	89.6	88.7
A249/0169-2	Chrysler	DCR5.2V2HAP9	42.1	75.7	86.2	85.7	86.2	87.9	85.2
A249/0169-3	Chrysler	DCR5.2V2HAP9	63.6	76.2	86.5	91.2	90.6	88.9	89.1
A249/0486-1	Chrysler	DCR5.2V2HAP9	51.0	71.8	81.3	82.8	84.8	83.9	82.1
A249/0486-2	Chrysler	DCR5.2V2HAP9	44.4	64.7	82.5	82.8	84.0	82.8	82.1
A249/0486-3	Chrysler	DCR5.2V2HAP9	84.7	92.2	91.8	92.6	92.6	90.0	90.3
A254/0031	Toyota	DTY2.4V5FBB2	95.2	80.5	94.9	97.1	97.0	96.0	96.2
A254/0037	Toyota	DTY2.4V5FBB2	46.2	94.0	96.5	97.4	95.7	94.9	94.8
A254/0191	Toyota	DTY2.4V5FBB2	96.5	80.2	97.2	97.1	95.4	95.7	95.4
A254/0275	Toyota	DTY2.4V5FBB2	73.7	98.7	95.8	96.1	97.0	95.0	55.2
A280/0001L	Chrysler	ECR2.2V2HAC4	66.0	66.3	62.8	88.0	88.4	90.6	90.3

*Tested with exhaust flow in opposite direction from converter design

TABLE 4. STEADY-STATE CONVERTER EFFICIENCY SUMMARY CARBON MONOXIDE

Converter Number	Make	Type	Percent Reduction at Nominal A/F Ratio 14.1	14.3	14.5	14.7	14.9	15.1	15.3
A193/0908	Chrysler	DCR2.2V2HAC3	34.3	37.4	44.1	98.0	98.8	99.4	99.6
A220/0392	GM	D4G3.8V2NEA3	98.3	98.2	99.0	99.6	99.5	99.6	99.4
A220/0810	GM	D4G3.8V2NEA3	94.3	98.2	99.0	98.8	99.5	99.6	99.5
A221/0152	Chrysler	DCR2.2V2HAC3	81.3	94.8	98.2	98.6	99.4	99.5	99.4
A221/0198	Chrysler	DCR2.2V2HAC3	84.6	83.6	94.1	93.3	98.6	98.2	99.4
A221/0204*	Chrysler	DCR2.2V2HAC3	84.1	82.9	84.6	90.5	96.2	99.0	98.9
A221/0310	Chrysler	DCR2.2V2HAC3	82.8	92.2	88.5	96.9	98.7	96.7	98.2
A221/0447	Chrysler	DCR2.2V2HAC3	95.0	98.4	98.9	99.7	99.6	99.5	99.4
A230/0177X	GM	D1G2.0V5XAJ4	51.3	96.1	99.6	99.3	99.4	99.4	99.3
A230/0636X	GM	D1G2.0V5XAJ4	44.2	99.0	99.5	99.5	99.5	99.3	99.3
A240/0016L	Ford	DFM1.6V2GDK6	94.3	99.4	99.6	99.5	99.4	99.4	99.3
A240/0102	Ford	DFM1.6V2GDK6	19.0	18.5	13.1	23.5	30.8	42.9	56.0
A240/0141L	Ford	DFM1.6V2GDK6	93.1	98.8	99.2	99.2	98.9	99.1	98.8
A240/0153	Ford	DFM1.6V2GDK6	91.4	98.8	98.7	99.2	99.2	99.3	99.5
A240/0334L	Ford	DFM1.6V2GDK6	90.1	99.3	99.5	99.6	99.5	99.3	98.9
A249/0169-1	Chrysler	DCR5.2V2HAP9	42.4	95.4	94.0	98.0	98.6	98.3	98.2
A249/0169-2	Chrysler	DCR5.2V2HAP9	29.3	58.0	87.6	85.4	92.2	95.0	98.9
A249/0169-3	Chrysler	DCR5.2V2HAP9	76.2	81.0	91.4	93.2	95.0	95.2	94.3
A249/0486-1	Chrysler	DCR5.2V2HAP9	42.5	62.1	79.5	93.9	94.0	97.3	96.7
A249/0486-2	Chrysler	DCR5.2V2HAP9	44.3	57.7	91.8	93.7	96.6	93.8	94.7
A249/0486-3	Chrysler	DCR5.2V2HAP9	84.1	93.5	91.6	94.6	97.4	96.4	99.1
A254/0031	Toyota	DTY2.4V5FBB2	89.4	55.6	86.7	99.8	99.7	99.7	99.6
A254/0037	Toyota	DTY2.4V5FBB2	42.5	81.8	99.8	99.8	99.7	99.6	99.6
A254/0191	Toyota	DTY2.4V5FBB2	87.9	57.1	99.8	99.8	99.7	99.7	99.7
A254/0275	Toyota	DTY2.4V5FBB2	49.6	99.3	99.8	99.9	99.7	99.7	99.8
A280/0001L	Chrysler	ECR2.2V2HAC4	86.9	87.9	85.9	96.7	97.9	98.6	98.4

*Tested with exhaust flow in opposite direction from converter design

TABLE 5. STEADY-STATE CONVERTER EFFICIENCY SUMMARY
OXIDES OF NITROGEN

Converter Number	Make	Type	Percent Reduction at Nominal A/F Ratio 14.1	14.3	14.5	14.7	14.9	15.1	15.3
A193/0908	Chrysler	DCR2.2V2HAC3	29.1	29.7	33.4	40.0	35.2	25.6	23.4
A220/0392	GM	D4G3.8V2NEA3	57.4	63.8	56.6	38.8	36.1	35.9	34.0
A220/0810	GM	D4G3.8V2NEA3	32.9	36.5	38.9	41.4	33.4	26.1	28.0
A221/0152	Chrysler	DCR2.2V2HAC3	41.2	64.3	53.0	34.5	25.4	16.7	14.0
A221/0198	Chrysler	DCR2.2V2HAC3	28.2	22.9	55.8	57.6	33.9	33.4	25.5
A221/0204*	Chrysler	DCR2.2V2HAC3	13.5	13.3	14.4	19.3	23.4	20.4	15.9
A221/0310	Chrysler	DCR2.2V2HAC3	19.8	37.7	37.6	37.5	31.0	35.9	25.0
A221/0447	Chrysler	DCR2.2V2HAC3	43.9	34.1	22.0	16.0	13.3	13.3	12.7
A230/0177X	GM	D1G2.0V5XAJ4	78.8	92.9	57.1	23.3	14.5	13.2	14.8
A230/0636X	GM	D1G2.0V5XAJ4	78.1	98.5	60.5	33.4	16.8	12.9	15.0
A240/0016L	Ford	DFM1.6V2GDK6	73.6	85.7	77.9	51.0	33.9	28.2	29.0
A240/0102	Ford	DFM1.6V2GDK6	24.3	23.2	22.9	22.6	22.1	21.7	20.4
A240/0141L	Ford	DFM1.6V2GDK6	62.0	68.4	50.0	30.3	28.7	22.1	20.0
A240/0153	Ford	DFM1.6V2GDK6	65.0	60.2	73.1	46.8	34.5	25.6	22.1
A240/0334L	Ford	DFM1.6V2GDK6	88.1	88.5	57.4	35.5	29.3	22.8	19.6
A249/0169-1	Chrysler	DCR5.2C2HAP9	91.0	69.8	43.6	18.5	11.1	11.5	8.3
A249/0169-2	Chrysler	DCR5.2C2HAP9	89.4	89.5	76.8	39.7	25.8	18.9	11.7
A249/0169-3	Chrysler	DCR5.2C2HAP9	45.4	69.0	58.0	38.2	27.0	20.9	17.9
A249/0486-1	Chrysler	DCR5.2C2HAP9	85.9	84.3	68.7	26.6	18.5	17.8	13.3
A249/0486-2	Chrysler	DCR5.2C2HAP9	83.3	84.6	41.6	25.4	21.9	19.5	13.8
A249/0486-3	Chrysler	DCR5.2C2HAP9	82.9	74.4	77.5	64.4	45.3	33.4	27.6
A254/0031	Toyota	DTY2.4V5FBB2	96.1	97.1	99.1	57.7	40.2	20.9	11.2
A254/0037	Toyota	DTY2.4V5FBB2	92.0	99.1	44.8	60.2	41.0	19.2	10.2
A254/0191	Toyota	DTY2.4V5FBB2	95.0	99.0	48.0	52.8	18.4	17.7	10.0
A254/0275	Toyota	DTY2.4V5FBB2	97.4	87.4	57.9	26.1	39.3	14.6	14.4
A280/0001L	Chrysler	ECR2.2V2HAC4	20.4	19.3	17.9	33.2	24.6	20.2	18.2

*Tested with exhaust flow in opposite direction from converter design

TABLE 6. SUMMARY OF LIGHT-OFF TIMES FOR CONVERTER RESPONSE HYDROCARBONS

Converter Number	Make	Type	Time to Reach % Reduction, sec. 20	50	80	% Reduction After 205 sec	600 sec
A193/0908	Chrysler	DCR2.2V2HAC3	87	108	132	86.7	86.7
A220/0392	GM	D4G3.8V2NEA3	36	47	68	91.2	90.3
A220/0810	GM	D4G3.8V2NEA3	41	56	338	84.4	89.7
A221/0152	Chrysler	DCR2.2V2HAC3	84	96	131	87.0	88.0
A221/0198	Chrysler	DCR2.2V2HAC3	71	86	121	86.8	89.1
A221/0204*	Chrysler	DCR2.2V2HAC3	86	113	182	85.0	88.3
A221/0310	Chrysler	DCR2.2V2HAC3	68	80	96	87.8	88.4
A221/0447	Chrysler	DCR2.2V2HAC3	25	38	63	90.6	90.3
A230/0177X	GM	D1G2.0V5XAJ4	20	24	42	93.0	93.1
A230/0636X	GM	D1G2.0V5XAJ4	16	28	43	91.1	91.4
A240/0016L	Ford	DFM1.6V2GDK6	31	38	50	88.3	88.7
A240/0102	Ford	DFM1.6V2GDK6	141	172	NA	69.7	75.7
A240/0141L	Ford	DFM1.6V2GDK6	33	43	64	85.7	87.1
A240/0153	Ford	DFM1.6V2GDK6	28	48	70	89.9	90.9
A240/0334L	Ford	DFM1.6V2GDK6	33	39	50	89.8	90.3
A249/0169-1	Chrysler	DCR5.2V2HAP9	22	30	67	80.0	83.0
A249/0169-2	Chrysler	DCR5.2V2HAP9	42	55	NA	74.6	77.3
A249/0169-3	Chrysler	DCR5.2V2HAP9	20	28	54	88.1	89.0
A249/0486-1	Chrysler	DCR5.2V2HAP9	22	43	NA	62.5	73.0
A249/0486-2	Chrysler	DCR5.2V2HAP9	28	46	128	81.1	83.0
A249/0486-3	Chrysler	DCR5.2V2HAP9	18	30	46	93.3	92.0
A254/0031	Toyota	DTY2.4V5FBB2	27	32	45	94.3	95.4
A254/0037	Toyota	DTY2.4V5FBB2	34	40	54	93.5	94.7
A254/0191	Toyota	DTY2.4V5FBB2	27	34	48	94.8	94.7
A254/0275	Toyota	DTY2.4V5FBB2	22	36	51	95.5	96.2
A280/0001L	Chrysler	ECR2.2V2HAC4	57	72	110	89.6	89.1

*Tested with exhaust flow in opposite direction from converter design

TABLE 7. SUMMARY OF LIGHT-OFF TIMES FOR CONVERTER RESPONSE CARBON MONOXIDE

Converter Number	Make	Type	Time to Reach % Reduction, sec. 20	50	80	% Reduction After 205 sec	600 sec
A193/0908	Chrysler	DCR2.2V2HAC3	90	105	123	99.0	99.0
A220/0392	GM	D4G3.8V2NEA3	34	42	58	99.8	99.9
A220/0810	GM	D3G3.8V2NEA3	45	50	54	99.9	99.9
A221/0152	Chrysler	DCR2.2V2HAC3	77	86	102	99.0	99.5
A221/0198	Chrysler	DCR2.2V2HAC3	66	76	92	99.7	99.9
A221/0204*	Chrysler	DCR2.2V2HAC3	82	100	130	99.0	99.5
A221/0310	Chrysler	DCR2.2V2HAC3	65	74	82	99.5	99.6
A221/0447	Chrysler	DCR2.2V2HAC3	20	29	42	99.6	99.5
A230/0177X	GM	D2G2.0V5XAJ4	16	20	28	99.9	99.9
A230/0636X	GM	D2G2.0V5XAJ4	26	32	38	99.9	99.9
A240/0016L	Ford	DFM1.6V2GDK6	28	42	48	99.9	99.9
A240/0102	Ford	DFM1.6V2GDK6	117	156	182	94.5	98.6
A240/0141L	Ford	DFM1.6V2GDK6	30	40	46	99.8	100
A240/0153	Ford	DFM1.6V2GDK6	35	44	55	99.8	99.9
A240/0334L	Ford	DFM1.6V2GDK6	35	40	48	99.8	99.9
A249/0169-1	Chrysler	DCR5.2V2HAP9	20	25	35	96.5	96.5
A249/0169-2	Chrysler	DCR5.2V2HAP9	38	45	60	94.9	94.3
A249/0169-3	Chrysler	DCR5.2V2HAP9	18	26	40	99.6	99.8
A249/0486-1	Chrysler	DCR5.2V2HAP9	22	30	47	94.4	94.4
A249/0486-2	Chrysler	DCR5.2V2HAP9	30	40	55	95.4	96.0
A249/0486-3	Chrysler	DCR5.2V2HAP9	16	26	35	99.8	99.9
A254/0031	Toyota	DTY2.4V5FBB2	25	30	39	99.9	99.9
A254/0037	Toyota	DTY2.4V5FBB2	32	38	49	99.9	99.9
A254/0191	Toyota	DTY2.4V5FBB2	29	34	48	99.9	99.9
A254/0275	Toyota	DTY2.4V5FBB2	21	32	46	99.9	99.9
A280/0001L	Chrysler	ECR2.2V2HAC4	57	78	93	98.5	99.0

*Tested with exhaust flow in opposite direction from converter design

TABLE 8. SUMMARY OF LIGHT-OFF TIMES FOR CONVERTER RESPONSE OXIDES OF NITROGEN

Converter Number	Make	Type	Time to Reach % Reduction, sec. 20	50	80	% Reduction After 205 sec	600 sec
A193/0908	Chrysler	DCR2.2V2HAC3	NA	NA	NA	2.6	3.4
A220/0392	GM	D4G3.8V2NEA3	ND	ND	ND	ND	ND
A220/0810	GM	D4G3.8V2NEA3	NA	NA	NA	6.8	1.4
A221/0152	Chrysler	DCR2.2V2HAC3	82	NA	NA	6.0	1.2
A221/0198	Chrysler	DCR2.2V2HAC3	60	NA	NA	7.5	5.3
A221/0204*	Chrysler	DCR2.2V2HAC3	NA	NA	NA	10.3	5.0
A221/0310	Chrysler	DCR2.2V2HAC3	70	NA	NA	4.2	4.4
A221/0447	Chrysler	DCR2.2V2HAC3	NA	NA	NA	2.2	0.4
A230/0177X	GM	D1G2.0V5XAJ4	18	NA	NA	8.3	7.5
A230/0636X	GM	D1G2.0V5XAJ4	NA	NA	NA	5.1	3.3
A240/0016L	Ford	DFM1.6V2GDK6	24	NA	NA	8.5	6.8
A240/0102	Ford	DFM1.6V2GDK6	NA	NA	NA	9.7	7.0
A240/0141L	Ford	DFM1.6V2GDK6	26	NA	NA	8.8	7.1
A240/0153	Ford	DFM1.6V2GDK6	29	NA	NA	10.7	7.6
A240/0334L	Ford	DFM1.6V2GDK6	40	NA	NA	5.9	4.0
A249/0169-1	Chrysler	DCR5.2V2HAP9	NA	NA	NA	0.5	0.9
A249/0169-2	Chrysler	DCR5.2V2HAP9	35	NA	NA	8.7	4.0
A249/0169-3	Chrysler	DCR5.2V2HAP9	NA	NA	NA	6.9	3.6
A249/0486-1	Chrysler	DCR5.2V2HAP9	26	NA	NA	5.3	2.5
A249/0486-2	Chrysler	DCR5.2V2HAP9	27	NA	NA	6.4	5.4
A249/0486-3	Chrysler	DCR5.2V2HAP9	NA	NA	NA	1.7	0.6
A254/0031	Toyota	DTY2.4V5FBB2	24	NA	NA	2.2	3.7
A254/0037	Toyota	DTY2.4V5FBB2	30	NA	NA	6.7	4.0
A254/0191	Toyota	DTY2.4V5FBB2	28	NA	NA	3.3	3.5
A254/0275	Toyota	DTY2.4V5FBB2	30	NA	NA	3.8	0.9
A280/0001L	Chrysler	ECR2.2V2HAC4	NA	NA	NA	6.8	7.5

NA - Not Achieved
ND - Not Determined
*Tested with exhaust flow in opposite direction from converter design

2. The whole converters were weighed with and without any heat shields, photographed, and then carefully cut to expose the catalyst material. All catalyst samples were visually inspected, weighed, and photographed. Photographs of the front face of each biscuit were taken.

3. The sectioning procedure for monolith catalyst samples is shown in Figure 1.

    a. Each biscuit was cut in half along a row of cells from the front face to the rear face.

    b. Two strips were then cut from the entire length of the center of the biscuit. These samples were the bulk samples for x-ray diffraction and surface area.

    c. The two halves were then cut in half again to form quarters. Opposite quarters were ground to 400 mesh to prepare samples for x-ray fluorescence and PIXE.

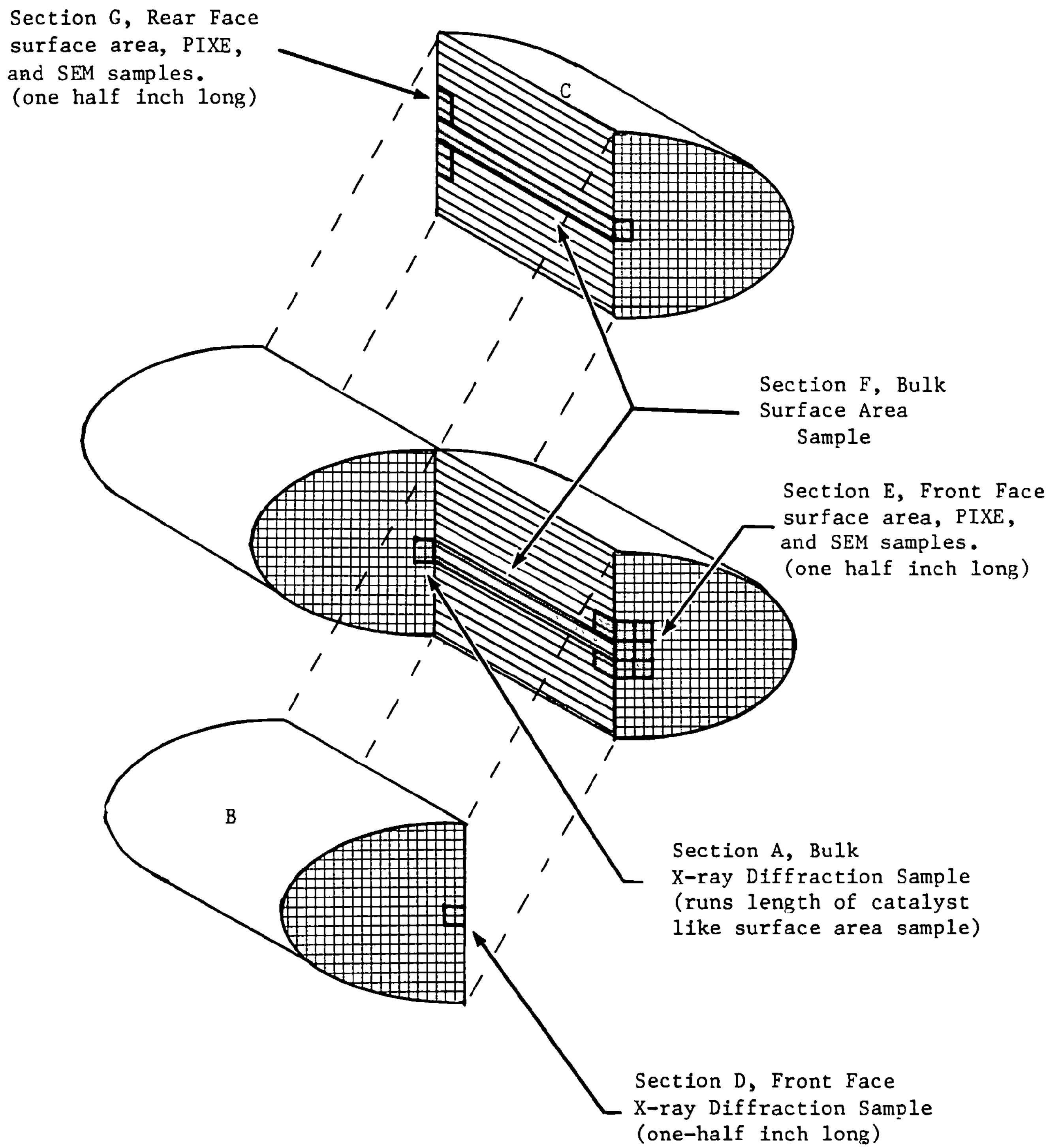
    d. From the upstream quarter, about one half inch of the entire front face was removed. This sample was cut into small cubes to prepare samples for x-ray diffraction, surface area, and SEM. The remainder was ground to 400 mesh for PIXE.

    e. About one half inch of the entire rear face was removed from the downstream quarter to prepare samples for surface area and SEM. Small cubes were cut for each of these samples. The remainder was ground to 400 mesh for PIXE.

    f. A total of ten samples were taken from the upstream biscuit and five from the downstream biscuit. The sample identification code is presented in Table 9; and a detailed description of the sample selection and preparation criteria is shown in Table 10. Partial biscuits for laboratory analysis only were treated in a similar manner.

For the purpose of identifying the converters analyzed in this program, each converter was designated with the seven or eight digit EPA identification code. In the event of a dual-converter vehicle (example A155/0941), the converters were also identified -1 and -2 after the EPA identification code. The upstream converter was labeled "-1," and the downstream converter "-2." In the case of the A249 class converters, one of the three-way converters was labeled "-1" and the other was labeled "-2." The downstream three-way + Ox converter was labeled "-3." Once the converters were opened, the upstream biscuit was labeled "A," and the downstream biscuit was labeled "B." The term "biscuit" is used to refer to each individual piece of ceramic honeycomb material in a converter.

The weights of the various samples were determined in several stages. All of the whole converters were weighed whole (both with and without the heat shield if present), and each biscuit was weighed after opening. All of the



Sections B and C are combined and ground to a powder for elemental analysis

Figure 1. Sectioning Procedure for Monolith Catalyst Samples

TABLE 9. SUMMARY OF SAMPLE IDENTIFICATION CODE

Test Procedures[a]	Front Substrate Front Face	Front Substrate Rear Face	Second Substrate Front Face	Monolith Bulk Sample[b]
BET Surface Area	E	G	E	F
X-Ray Diffraction (conversion of gamma- to alpha-alumina)	D			A
Proton Induced X-Ray Emission (total noble metal and poison concentrations)	H	I		C
Scanning Electron Microscopy, Dot-Mapping, and the SEM-EDX Spectrum	E	G		
X-Ray Fluorescence				C

[a]Letters indicate sample identification for analysis from Figure 1.
[b]One bulk sample shall be taken from each biscuit in each can.

TABLE 10. DETAILED SAMPLE SELECTION AND PREPARATION CRITERIA FOR VARIOUS ANALYTICAL PROCEDURES

		Number of Sample					
Section[a]	Sample[b]	Front Biscuit	Rear Biscuit	Location	Type	Size	Analysis
A	A	1	1	Bulk	whole length (strip)	1/4"x1/4"x length	X-ray Diffraction
B&C	C	2	2	Bulk	ground to 400 mesh	10 g	PIXE and XRF
D	D	1	0	Front Face	cube	1/4"x1/4"x1/2"	X-ray Diffraction
E	E	2	1	Front Face	cube	1/4"x1/4"x1/2"	Surface Area & SEM
F	F	1	1	Bulk	whole length (strip)	1/4"x1/4"x length	Surface Area
G	G	2[c]	0	Rear Face	cube	1/4"x1/4"x1/2"	Surface Area & SEM
E	H	1	0	Front Face	ground to 400 mesh	entire front 1/2"	PIXE
G	I	1	0	Rear Face	ground to 400 mesh	entire rear 1/2"	PIXE

[a]Section refers to section on Figure 1

[b]Sample letters indicate sample identification for analysis

[c]Sample to be conducted on selected samples (A218/0045X, A220/0392, A221/0447, A230/0177X, A240/0016L, and A249/0169-1)

partial samples were weighed, but these weights are only a determination of the amount of sample received. In order to do additional calculations on these converters, the weights of the biscuits before the samples were taken must be known or estimated. All of the weights are presented in Table 11.

The specific surface areas of the whole length for each biscuit were measured with a Micromeritics Flowsorb II dynamic surface area analyzer using the multipoint analysis technique. This analysis was conducted "in-house" during this Work Assignment. The advantages for "in-house" analysis include a stricter control of the analytical procedures, ease of repeating questionable samples, and assurance that the analysis is performed on a sample that represents the entire length of the biscuit. Losses in surface area are due to thermal degradation and/or plugging of the sub-microscopic pores with metals and other deposits. A loss in the active surface area results in the reduction of contact between exhaust gases and the catalyst material. A low surface area generally indicates converter overheating. Conversely, a normal surface area does not necessarily indicate a normal catalyst, because the deposits can increase the apparent surface area while covering the surface and preventing contact with the exhaust gases. The specific surface areas are presented in Table 12. The plots for the BET equation versus the relative pressure for each converter are included in Appendix C.

X-ray diffraction analysis of the samples was used to determine the crystal structure of the alumina. Gamma-alumina and several other very similar alumina structures are the original crystal structures used in the alumina washcoat. When a catalyst containing these types of alumina is overheated (temperatures greater than 1000°C), the crystal structure changes to the alpha-alumina form. This conversion in crystal structure can trap the active metals and change the active surface area of the catalyst. The Debye-Scherrer powder x-ray diffraction technique was used to determine the alumina crystal structure. This technique is well suited for the analysis of monolith catalysts because of the small quantities of sample required. In the case of monolith catalysts, the alumina is deposited as a thin wash-coat on the surface of the ceramic substrate. The alumina can be scraped off carefully and analyzed. The x-rays are diffracted by the various crystalline compounds within the sample. Each crystalline compound has a characteristic diffraction pattern. Amorphous compounds do not result in a diffraction pattern. These patterns are compared to known compounds in a Powder Data File for identification. Table 13 lists the alumina crystal structure of each sample and any other crystalline compounds observed in the samples.

A section of the front face portion of each converter was examined with an SEM at 500X, 2500X, and 5000X magnification. A spectrum was recorded at 2500X. The surface concentrations of silicon, phosphorous, sulfur, lead, calcium, and manganese were normalized to aluminum and presented in Table 14. At 5000X magnification, dot maps of aluminum, silicon, phosphorous, sulfur, zinc and lead were taken and included in Appendix D with individual spectra. In the cases where the concentration of the element was less than twice the background, no dot map was taken.

One sample from the rear face of a representative catalyst for six of the engine families was taken for comparison purposes with the SEM and dot mapping. The specific catalyst was selected on the basis of three criteria:

TABLE 11. CONVERTER WEIGHTS

Converter Number	Whole Converters, lbs		Biscuit Weights, g	
	With Heat Shield	Without Heat Shield	Upstream (A)	Downstream (B)
A160/0656-1	--	--	528.6[b]	--
A180/0094	--	--	ND[a]	--
A193/0908	--	9.41	1074.2	427.8
A214/0681-A	--	--	373.8[b]	--
A218/0045	--	--	388.0	--
A218/0045X	--	--	405.1	--
A218/0068	--	--	370.0	--
A220/0392	11.42	10.38	923.0	608.1
A220/0810	11.85	10.86	901.7	628.3
A221/0152	9.96	9.50	1071.5	452.6
A221/0198	--	9.65		
A221/0204	--	9.70	1143.7	480.9
A221/0310	--	9.53		
A221/0447	--	9.68	1095.0	472.7
A230/0177X	--	9.47	801.2	655.6
A230/0636X	11.37	9.53	799.5	648.3
A240/0016L	--	8.20	353.9	512.9
A240/0102	--	8.27	393.5	537.2
A240/0141L	9.71	8.13	392.1	504.6
A240/0153	--	8.26	428.0	550.8
A240/0334L	9.78	8.23	399.8	580.5
A249/0169-1	--	6.57	804.6	--
A249/0169-2	--	7.14	832.0	--
A249/0169-3	--	12.41	740.9	1366.3
A249/0486-1	--	6.60		
A249/0486-2	--	6.78		
A249/0486-3	--	12.59		
A254/0031	--	12.82		
A254/0037	--	9.65		
A254/0191	--	11.58		
A254/0275	--	9.66		
A280/0001L	9.69	9.21	1120.5	443.1
A155/0941-1	11.00[c]	10.52[c]	ND	ND
A155/0941-2	7.19[c]	5.71[c]	ND	ND
A207/0101	11.69[c]	11.09[c]	ND	ND

[a]No Data
[b]Partial sample, total biscuit weight not available
[c]Converter weights obtained in Work Assignment 31, Contract 68-03-3162

TABLE 12. CATALYST SPECIFIC SURFACE AREA

Biscuit Number	Specific, m^2/g Front Face (E)	Rear Face (G)	Bulk (F)	Total for Bulk Sample, m^2
A180/0094	19.4	18.8	22.3	ND[a]
A193/0908-A	11.2	8.8	2.7	2,900
A193/0908-B	5.1	--	3.4	1,500
A218/0046	14.0	17.3	16.7	ND
A218/0045X	12.7	18.0	16.8	ND
A218/0068	13.7	18.2	18.3	ND
A220/0392-A	16.8	19.4	17.3	16,000
A220/0392-B	12.2	--	14.5	8,800
A220/0810-A	13.9	11.2	4.7	4,200
A220/0810-B	13.5	--	9.4	5,900
A221/0152-A	9.3	12.2	10.4	11,100
A221/0152-B	12.1	--	8.6	3,900
A221/0204-A	5.4	11.2	3.0	3,400
A221/0204-B	8.2	--	6.3	3,000
A221/0447-A	12.9	10.0	4.8	5,300
A221/0447-B	9.6	--	8.0	3,800
A230/0177X-A	14.8	17.1	21.4	17,100
A230/0177X-B	18.6	--	14.3	9,400
A230/0636X-A	12.7	13.2	10.6	8,500
A230/0636X-B	13.7	--	11.2	7,300
A240/0016L-A	21.5	21.5	22.8	8,100
A240/0016L-B	17.5	--	17.4	8,900
A240/0102-A	8.3	2.7	1.8	700
A240/0102-B	12.8	--	2.4	1,300
A240/0141L-A	17.8	20.0	18.7	7,300
A240/0141L-B	12.3	--	9.7	4,900

TABLE 12 (CONT'D). CATALYST SPECIFIC SURFACE AREA

	Specific, m^2/g			
Biscuit Number	Front Face (E)	Rear Face (G)	Bulk (F)	Total for Bulk Sample, m^2
A240/0153-A	26.6	8.4	20.1	8,600
A240/0153-B	13.7	--	13.6	7,500
A240/0334L-A	22.9	19.4	19.9	8,000
A240/0334L-B	18.8	--	8.6	5,000
A249/0169-1	7.8	10.2	6.8	5,500
A249/0169-2	13.4	8.9	2.2	1,800
A249/0169-3-A	7.9	6.6	4.8	3,600
A249/0169-3-B	3.8	--	1.5	2,000
A280/0001L-A	7.5	9.2	5.1	5,700
A280/0001L-B	18.8	--	7.0	3,100
A155/0941-1-A	7.6	6.0	3.6	4,500[b]
A155/0941-1-B	8.8	--	6.9	4,100[b]
A155/0941-2-A	4.4	6.5	3.1	1,500[b]
A155/0941-2-B	7.3	--	4.1	2,100[b]
A207/0101-A	5.2	9.4	6.2	3,900[c]
A207/0101-B	7.8	--	2.7	2,000[c]
A207/0101-C	11.0	--	2.1	1,300[c]

[a]Partial biscuit, no total weight available
[b]Total surface area based on biscuit weights of converter A155/0926.
[c]Total surface area based on biscuit weights of converter average of A207/0025 and A207/0054.

TABLE 13. ALUMINA CRYSTAL STRUCTURE

	Alumina Crystal Structure	
Biscuit Number	Bulk Sample	Front Face
A180/0094	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with possible NiO	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with (Al, Fe)$(PO_3)_3$, and possible $AlPO_4$ and other Fe or Zn phosphates
A193/0908-A	mixture of α and θ alumina with CeO_2	no alumina detected, mostly $AlPO_4$ and possible CeO_2
A193/0908-B	mostly α alumina	
A218/0045	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with possible NiO	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with (Al, Fe)$(PO_3)_3$, and possible $AlPO_4$ and other Fe phosphates
A218/0045X	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with possible NiO	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with (Al, Fe)$(PO_3)_3$, and possible $AlPO_4$ and other Fe phosphates
A218/0068	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with possible NiO	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with (Al, Fe)$(PO_3)_3$, and possible $AlPO_4$ and other Fe phosphates and NiO
A220/0392-A	mostly γ/θ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with NiO and CeO_2 or ZnS	mostly γ/θ alumina with traces of CeO_2 or ZnS and $AlPO_4$
A220/0392-B	mostly γ/θ alumina	
A220/0810-A	mostly α alumina with spinel cubic Ni or $MgAl_2O_4$	mostly γ/θ alumina with trace of α, NiO, $AlPO_4$ and other possible phosphates
A220/0810-B	mostly γ/θ alumina	
A221/0152-A	mostly θ alumina with CeO_2	mostly θ alumina with possible CeO_2 and $AlPO_4$
A221/0152-B	mostly θ alumina	
A221/0204-A	mostly θ alumina with some α and CeO_2	mostly θ alumina with CeO_2 and possible $AlPO_4$
A221/0204-B	mostly θ alumina with possible unknown phosphate	

TABLE 13 (CONT'D). ALUMINA CRYSTAL STRUCTURE

Biscuit Number	Alumina Crystal Structure: Bulk Sample	Alumina Crystal Structure: Front Face
A240/0334L-A	mostly Υ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with NiO and CeO_2	mostly Υ alumina NiO and possible CeO_2, Ni or $MgAlO_4$ and $AlPO_4$
A240/0334L-B	mostly α with some θ alumina and CeO_2	
A249/0169-1	mostly θ alumina	mostly θ alumina with $AlPO_4$ and possible CeO_2
A249/0169-2	mostly θ alumina and possible CeO_2	mostly θ alumina with CeO_2 and possible unknown phosphates
A249/0169-3-A	mostly Υ alumina with CeO_2	mostly Υ alumina with CeO_2 and $PbSO_4$
A249/0169-3-B	mostly α alumina with trace of Υ/θ alumina	
A280/0001L-A	mostly θ alumina with CeO_2 and possible Spinel $MgAl_2O_4$	mostly Υ/θ alumina with CeO_2 and possible $AlPO_4$ or other unknown phosphates
A280/0016L-B	mostly Υ/θ alumina with possible Spinel $MgAl_2O_4$	
A155/0941-1-A	mostly Υ/θ alumina with CeO_2	mostly Υ/θ alumina with $AlPO_4$ and CeO_2
A155/0941-1-B	mostly Υ/θ alumina	
A155/0941-2-A	mostly Υ/θ alumina	mostly Υ/θ alumina with Fe_2O_3 and possible $FePO_4$ and $AlPO_4$
A155/0941-2-B	mostly Υ/θ alumina	
A207/0101-A	mostly Υ/θ alumina with $AlPO_4$ and CeO_2	mostly Υ/θ alumina with CeO_2
A207/0101-B	mostly Υ/θ alumina	
A207/0101-C	mostly Υ/θ alumina with possible CeO_2	

TABLE 13 (CONT'D). ALUMINA CRYSTAL STRUCTURE

Biscuit Number	Alumina Crystal Structure	
	Bulk Sample	Front Face
A221/0447-A	mostly θ alumina with CeO_2	mostly θ alumina with CeO_2
A221/0447-B	mostly θ alumina with possible $PbSO_4$	
A230/0177X-A	mostly γ/θ alumina with CeO_2 or ZnS	mostly γ/θ alumina with $AlPO_4$
A230/0177X-B	mostly γ/θ alumina with CeO_2	
A230/0636X-A	mostly γ/θ alumina with $AlPO_4$	mostly γ/θ alumina with $AlPO_4$
A230/0636X-B	mostly γ/θ alumina with CeO_2	
A240/0016L-A	mostly γ alumina with NiO and possible CeO_2 or ZnS and spinel cubic Ni or $MgAl_2O_4$	mostly γ alumina with possible CeO_2 and $AlPO_4$ or other unknown phosphates
A240/0016L-B	mostly γ alumina with CeO_2 or ZnS and possible Ni or $MgAl_2O_4$	
A240/0102-A	mostly α alumina and trace of γ/θ alumina with Mullite ($Al_6Si_2O_{13}$), NiO, $AlPO_4$ spinel cubic Ni or or $MgAl_2O_4$ and possible CeO_2 or ZnS	trace of γ/θ alumina with spinel cubic Ni or Mg Al_2O_4, NiO, $AlPO_4$ and possible trace of CeO_2
A240/0102-B	mostly α alumina with Mullite ($Al_6Si_2O_{13}$), Spinel ($MgAl_2O_4$), and possible CeO_2 or ZnS	
A240/0141L-A	mostly γ/θ alumina with NiO and possible spinel cubic Ni or Mg Al_2O_4 and CeO_2 or ZnS	mostly γ/θ alumina with NiO
A240/0141L-B	mostly γ/θ alumina with CeO_2	
A240/0153-A	mostly γ alumina and/or spinel cubic Ni or $MgAl_2O_4$ with NiO and CeO_2 or ZnS and possible trace of $AlPO_4$	mostly γ alumina and CeO_2
A240/0153-B	mostly γ alumina and possible trace of $AlPO_4$	

TABLE 14. SURFACE ATOMIC RATIO OF ELEMENTS NORMALIZED TO ALUMINUM

Sample Number	Normalized Atomic Ratios					
	P	S	Ca	Mn	Pb	Si
A180/0094	17.40	0.21	3.61	1.24	82.64	0.25
A193/0908	3.09	2.80	0.54	0.36	1.55	2.84
A218/0045	15.06	2.04	4.08	0.91	42.56	2.26
A218/0045X	11.44	15.65	2.48	0.75	34.38	10.17
A218/0045X*	0.20	0.01	0.04	--	0.09	0.02
A218/0068	49.54	2.89	11.04	1.23	155.73	3.42
A220/0392	3.34	2.09	0.77	0.08	5.17	2.23
A220/0392*	0.12	0.02	0.01	--	0.03	0.02
A220/0810	11.45	0.68	2.95	0.10	8.15	0.80
A221/0152	10.90	24.96	2.58	5.20	19.51	24.36
A221/0204	12.64	1.55	2.41	0.24	14.88	1.94
A221/0447	2.08	3.01	0.28	0.12	13.07	3.22
A221/0447*	0.03	0.04	0.003	--	0.02	0.06
A230/0177X	0.56	0.37	0.09	0.05	0.27	0.42
A230/0177X*	0.05	0.03	0.01	--	0.02	0.05
A230/0636X	1.68	0.23	0.23	0.08	3.09	0.27
A240/0016L	2.40	0.61	0.35	--	8.58	0.72
A240/0016L*	0.45	1.00	0.04	--	0.87	0.12
A240/0102	3.47	1.20	1.01	0.08	3.42	1.33
A240/0141L	6.12	37.62	0.85	4.03	6.20	30.63
A240/0152	1.71	0.10	0.13	0.27	1.15	0.11
A240/0334L	0.74	0.41	0.03	0.03	1.46	0.45
A249/0169-1	1.48	0.58	0.08	0.05	1.08	0.54
A249/0169-1*	0.05	0.01	0.01	--	0.04	0.02
A249/0169-2	1.76	4.04	0.10	0.12	1.83	3.56
A249/0169-3	1.29	0.41	0.87	--	14.60	0.56
A280/0001L	9.04	2.19	2.27	1.68	3.60	2.49
A155/0941-1	2.64	0.60	0.67	0.51	0.70	0.64
A155/0941-2	0.72	0.52	0.21	0.07	2.26	0.62
A207/0101	0.35	0.07	0.01	0.07	0.03	0.08

*Rear Face of A biscuit for comparison within each engine family

1. condition of the converter as observed with the whole converter x-ray

2. visual integrity of the biscuits upon removal from the container (i.e., no melting, plugging, or excess discoloration)

3. results of the converter efficiency and light-off times

These criteria were used because the results from the surface area, PIXE, x-ray fluorescence, and x-ray diffraction were not available before the samples had to be submitted for SEM analysis. The best samples for each of the six engine families selected on the basis of these criteria were:

A218/0045X	A220/0392	A221/0447
A230/0177X	A240/0016L	A249/0169-1

The six rear face samples were submitted for SEM at three magnifications (500X, 2500X, 5000X), normalized surface concentrations for Si, P, S, Pb, Ca, and Mn, and dot mapping at 5000X. These data are also included in Table 14 and Appendix D.

Proton induced x-ray emission (PIXE) was used to determine the concentrations of noble metals and the accumulation of poisons. The elements of concern were phosphorus (P), sulfur (S), calcium (Ca), manganese (Mn), zinc (Zn), lead (Pb), platinum (Pt), palladium (Pd), rhodium (Rh), and nickel (Ni). The elements P, S, Ca, Mn, Zn, and Pb are poisons or contaminants. They are derived from engine wear, dirt deposits, oil, fuel, and other sources. The noble metals are Pt, Pd, and Rh, and they perform the function of "cleaning up" the exhaust. Nickel was found in some converters, and is reportedly present to enhance the catalytic activity. Aluminum and silicon are major constituents of the support material and were not quantitatively determined. The weight percentages of each element are included in Table 15. Where the concentration of an element was at the detection limit of the analytical procedure, the word "trace" was used, and an asterisk (*) was used to identify those elements with concentrations below the detection limit.

In addition to PIXE, a sample from the bulk of each biscuit was analyzed by x-ray fluorescence. This technique uses x-rays as the incident radiation rather than protons to cause the characteristic x-rays to fluoresce for each element. This was the technique used in all previous work assignments. This analysis was included as a means of comparing the two analytical techniques and as a comparison to previous work assignments. The correlation between the two procedures will be discussed in a subsequent section. The data are summarized in Table 16 and the individual results are included in Appendix E.

III. Oxygen Sensor Evaluation

In addition to catalyst evaluation, oxygen sensors were also examined in this work assignment. A total of 12 oxygen sensors were evaluated in this program (8 "on-engine" and 4 partial tips plus one reference for laboratory analysis). A list of oxygen sensors evaluated is presented in Table 17, and a list of evaluations and test parameters is included in Table 18. All "on-engine" tests were compared to a new Ford sensor, which served as a reference.

TABLE 15. ELEMENTAL ANALYSIS OF NOBLE METALS AND POISONS BY PIXE

Biscuit Number	Sample Location	Weight Percent										Others
		P	S	Ca	Mn	Ni	Zn	Rh	Pd	Pt	Pb	
A180/0094	Bulk	0.54±0.03	*	0.11±0.01	0.02±0.002	7.56±0.08	0.17±0.003	0.13±0.01	trace	0.59±0.01	0.56±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	2.24±0.05	*	0.21±0.01	0.04±0.002	4.33±0.04	0.61±0.01	0.07±0.01	*	0.34±0.01	1.82±0.02	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.07±0.02	0.13±0.02	0.10±0.01	0.01±0.001	4.59±0.05	0.05±0.001	0.10±0.01	trace	0.37±0.01	0.07±0.003	Na, Mg, Al, Si, Cl, K, Ti, Fe, Ce
A193/0908-A	Bulk	1.58±0.05	0.15±0.02	0.20±0.01	0.03±0.001	0.02±0.0004	0.27±0.003	0.03±0.003	*	0.24±0.003	0.16±0.002	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	3.74±0.07	*	0.30±0.01	0.09±0.002	0.02±0.001	0.82±0.01	0.02±0.003	*	0.18±0.003	0.65±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.39±0.03	0.19±0.02	0.19±0.01	0.01±0.001	0.02±0.005	0.17±0.002	0.02±0.003	*	0.22±0.003	0.04±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
A193/0908-B	Bulk	0.19±0.02	0.19±0.02	0.15±0.01	0.01±0.0003	0.01±0.0001	0.15±0.001	*	0.38±0.01	0.01±0.0004	0.17±0.002	Na, Mg, Al, Si, K, Ti, Fe, Ce
A218/0045	Bulk	0.30±0.03	0.23±0.02	0.10±0.01	trace	6.04±0.06	0.08±0.002	0.11±0.01	trace	0.45±0.01	0.17±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	2.10±0.06	*	0.25±0.01	0.02±0.002	3.66±0.04	0.67±0.01	0.06±0.01	*	0.28±0.01	1.23±0.02	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.15±0.03	0.18±0.02	0.13±0.01	0.01±0.001	4.61±0.05	0.08±0.02	0.07±0.01	trace	0.34±0.01	0.10±0.003	Na, Mg, Al, Si, K, Ti, Fe, Ce
A218/0045X	Bulk	0.63±0.04	*	0.08±0.01	trace	5.07±0.05	0.10±0.002	0.09±0.01	*	0.41±0.01	0.33±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	2.92±0.07	*	0.27±0.01	0.02±0.002	3.53±0.04	1.02±0.01	0.07±0.01	*	0.29±0.01	2.32±0.03	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.25±0.04	0.17±0.02	0.12±0.01	trace	3.15±0.03	0.07±0.001	0.07±0.01	*	0.25±0.004	0.10±0.002	Na, Mg, Al, Si, K, Ti, Fe, Ce
A218/0068	Bulk	0.48±0.03	*	0.11±0.01	0.01±0.002	6.53±0.07	0.19±0.003	0.08±0.01	*	0.51±0.01	0.68±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	1.38±0.04	*	0.17±0.01	0.01±0.001	2.30±0.02	0.45±0.01	0.03±0.01	trace	0.18±0.003	1.37±0.02	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.18±0.02	0.24±0.02	0.07±0.01	trace	4.75±0.05	0.05±0.001	0.07±0.01	trace	0.38±0.01	0.11±0.003	Na, Mg, Al, Si, K, Ti, Fe, Ce
A220/0392-A	Bulk	1.40±0.05	0.60±0.03	0.10±0.01	*	5.14±0.05	0.19±0.003	0.04±0.01	0.12±0.01	0.10±0.003	0.22±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	Front Face	2.92±0.07	0.45±0.03	0.20±0.01	0.02±0.002	3.97±0.04	0.60±0.01	0.03±0.01	0.09±0.01	0.07±0.004	0.64±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	Rear Face	0.21±0.03	0.72±0.03	0.04±0.01	*	4.27±0.04	0.04±0.001	0.04±0.01	0.10±0.01	0.10±0.003	0.04±0.002	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A220/0392-B	Bulk	0.12±0.79	0.79±0.03	0.10±0.01	*	0.02±0.003	0.08±0.001	*	0.15±0.004	0.39±0.004	0.05±0.001	Mg, Al, Si, K, Ti, Fe, Ce
A220/0810-A	Bulk	2.00±0.06	0.46±0.02	0.25±0.01	0.01±0.002	3.93±0.04	0.61±0.01	0.04±0.01	0.12±0.01	0.10±0.004	0.38±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	Front Face	4.77±0.09	*	0.61±0.02	0.02±0.002	3.94±0.04	2.15±0.02	trace	0.08±0.01	0.08±0.004	1.25±0.02	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	Rear Face	0.68±0.04	0.93±0.03	0.29±0.01	*	4.42±0.05	0.45±0.01	0.03±0.01	0.11±0.01	0.11±0.004	0.13±0.004	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A220/0810-B	Bulk	0.59±0.04	0.99±0.03	0.21±0.01	0.01±0.0003	0.01±0.0002	0.20±0.002	*	0.12±0.004	0.32±0.003	0.14±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A221/0152-A	Bulk	1.85±0.05	*	0.17±0.01	0.14±0.002	0.01±0.001	0.42±0.004	0.04±0.01	*	0.34±0.01	0.52±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	3.33±0.06	*	0.28±0.01	0.28±0.003	0.02±0.001	1.07±0.01	0.02±0.004	*	0.19±0.003	1.13±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.35±0.03	0.29±0.02	0.12±0.01	0.03±0.001	0.01±0.003	0.12±0.001	0.03±0.003	*	0.30±0.004	0.16±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A221/0152-B	Bulk	0.16±0.02	0.25±0.02	0.15±0.01	0.04±0.001	*	0.14±0.001	*	0.39±0.01	0.01±0.0004	0.32±0.003	Mg, Al, Si, K, Ti, Fe, Ce

TABLE 15 (CONT'D). ELEMENTAL ANALYSIS OF NOBLE METALS AND POISONS BY PIXE

Biscuit Number	Sample Location	Weight Percent										
		P	S	Ca	Mn	Ni	Zn	Rh	Pd	Pt	Pb	Others
A221/0204-A	Bulk	3.34±0.08	*	0.40±0.01	0.01±0.001	0.01±0.0004	1.15±0.01	0.01±0.003	*	0.21±0.003	0.33±0.004	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	5.23±0.09	0.03±0.01	0.78±0.02	0.01±0.002	0.02±0.001	3.11±0.03	0.01±0.004	*	0.16±0.004	0.92±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.70±0.04	0.14±0.02	0.17±0.01	*	0.01±0.0002	0.21±0.002	0.02±0.003	*	0.20±0.002	0.06±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A221/0204-B	Bulk	0.83±0.04	0.43±0.02	0.40±0.01	0.01±0.003	0.01±0.0002	0.66±0.01	*	0.54±0.01	0.04±0.001	0.38±0.004	Mg, Al, Si, K, Ti, Fe, Ce
A221/0447-A	Bulk	0.91±0.04	*	0.13±0.01	0.01±0.001	0.01±0.0003	0.19±0.002	0.04±0.004	*	0.34±0.004	0.69±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	2.37±0.05	*	0.17±0.01	0.03±0.001	0.01±0.0005	0.53±0.01	0.02±0.004	*	0.21±0.003	2.10±0.02	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.17±0.03	0.36±0.02	0.09±0.01	*	*	0.09±0.001	0.02±0.003	*	0.26±0.003	0.19±0.003	Na, Mg, Al, Si, K, Ti, Fe, Ce
A221/0047-B	Bulk	0.08±0.02	0.29±0.02	0.11±0.01	0.01±0.0003	*	0.08±0.001	*	0.50±0.01	0.01±0.0005	0.63±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
A230/0177X-A	Bulk	1.10±0.04	0.28±0.02	0.10±0.01	0.04±0.002	0.01±0.001	0.21±0.003	0.03±0.01	0.18±0.01	0.30±0.01	0.32±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	2.10±0.06	*	0.29±0.01	0.08±0.002	0.03±0.001	0.85±0.01	trace	0.10±0.01	0.24±0.004	0.81±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.09±0.02	0.13±0.02	0.08±0.01	0.01±0.001	0.01±0.0004	0.04±0.001	0.03±0.004	0.11±0.01	0.24±0.003	0.05±0.001	Mg, Al, Si, K, Ti, Fe, Ce
A230/0177X-B	Bulk	*	0.27±0.01	0.06±0.01	0.01±0.001	0.01±0.0004	0.05±0.001	0.04±0.005	0.15±0.01	0.31±0.004	0.05±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A230/0636X-A	Bulk	0.92±0.04	*	0.12±0.01	0.01±0.001	0.02±0.001	0.22±0.002	0.04±0.001	0.13±0.01	0.30±0.004	0.48±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	2.72±0.05	*	0.32±0.01	0.04±0.002	0.04±0.001	0.72±0.01	0.02±0.004	0.10±0.01	0.23±0.004	1.19±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.11±0.02	0.07±0.01	0.06±0.01	0.01±0.001	0.01±0.0005	0.04±0.001	0.03±0.01	0.10±0.01	0.21±0.003	0.06±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A230/0636X-B	Bulk	0.07±0.02	0.29±0.01	0.06±0.01	0.01±0.001	0.01±0.0004	0.07±0.001	0.05±0.005	0.20±0.01	0.32±0.004	0.08±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A240/0016L-A	Bulk	0.67±0.04	0.48±0.02	0.07±0.01	*	7.09±0.07	0.17±0.002	0.04±0.01	trace	0.20±0.004	0.71±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	1.11±0.05	*	0.10±0.01	*	6.18±0.06	0.33±0.004	0.03±0.01	*	0.17±0.004	1.22±0.02	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.43±0.03	0.41±0.02	0.07±0.01	*	6.92±0.07	0.10±0.002	0.04±0.01	trace	0.18±0.004	0.49±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
A240/0016L-B	Bulk	0.21±0.03	0.73±0.03	0.13±0.01	trace	0.13±0.001	0.14±0.001	trace	0.12±0.01	0.17±0.002	0.40±0.004	Na, Mg, Al, Si, K, Ti, Fe, Ce
A240/0102-A	Bulk	2.74±0.06	0.17±0.02	0.16±0.01	0.02±0.001	4.62±0.05	0.06±0.01	0.07±0.02	0.06±0.02	0.14±0.004	0.30±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	3.11±0.06	*	1.74±0.01	0.02±0.001	4.64±0.05	0.61±0.01	trace	trace	0.13±0.004	0.32±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	1.03±0.04	0.13±0.01	0.10±0.01	0.01±0.001	3.71±0.04	0.15±0.002	0.03±0.01	0.02±0.005	0.11±0.002	0.08±0.003	Mg, Al, Si, K, Ti, Fe, Ce
A240/0102-B	Bulk	0.70±0.04	0.23±0.02	0.20±0.01	0.01±0.001	0.03±0.001	0.36±0.003	*	0.10±0.005	0.14±0.002	0.14±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A240/0141L-A	Bulk	0.45±0.03	0.21±0.02	0.06±0.01	0.07±0.002	6.35±0.06	0.11±0.002	0.05±0.02	0.07±0.02	0.19±0.004	0.17±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	0.81±0.03	*	0.08±0.01	0.10±0.002	4.33±0.04	0.20±0.002	trace	trace	0.12±0.003	0.28±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.22±0.02	0.24±0.02	0.04±0.01	0.02±0.002	6.06±0.06	0.03±0.001	0.04±0.01	0.03±0.01	0.17±0.004	0.17±0.003	Mg, Al, Si, K, Ti, Fe, Ce
A240/0141L-B	Bulk	0.24±0.03	0.39±0.03	0.05±0.01	0.03±0.001	0.02±0.0005	0.05±0.001	*	0.10±0.01	0.15±0.002	0.06±0.001	Mg, Al, Si, K, Ti, Fe, Ce
A240/0153-A	Bulk	1.40±0.04	0.36±0.02	0.07±0.01	0.08±0.003	7.27±0.07	0.20±0.003	0.04±0.01	trace	0.18±0.01	0.54±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	1.81±0.05	*	0.10±0.01	0.16±0.003	7.15±0.07	0.45±0.01	trace	*	0.19±0.01	1.17±0.02	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.87±0.04	0.33±0.02	0.06±0.01	0.06±0.002	6.46±0.07	0.10±0.002	0.03±0.01	trace	0.16±0.004	0.28±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
A240/0153-B	Bulk	0.34±0.03	0.52±0.03	0.10±0.01	0.05±0.001	0.73±0.01	0.15±0.001	0.01±0.002	0.13±0.01	0.17±0.002	0.16±0.002	Na, Mg, Al, Si, K, Ti, Fe, Ce

TABLE 15 (CONT'D). ELEMENTAL ANALYSIS OF NOBLE METALS AND POISONS BY PIXE

Biscuit Number	Sample Location	Weight Percent										
		P	S	Ca	Mn	Ni	Zn	Rh	Pd	Pt	Pb	Others
A240/0334L-A	Bulk	0.38±0.03	0.53±0.02	0.03±0.01	trace	7.83±0.08	0.04±0.002	0.05±0.01	*	0.21±0.01	0.17±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	0.73±0.05	0.59±0.03	0.04±0.01	0.01±0.002	7.08±0.07	0.08±0.002	0.04±0.01	*	0.19±0.01	0.31±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.15±0.02	0.37±0.02	0.04±0.01	trace	5.91±0.06	0.02±0.001	0.03±0.01	trace	0.16±0.004	0.08±0.003	Na, Mg, Al, Si, K, Ti, Fe, Ce
A240/0334L-B	Bulk	*	0.35±0.02	0.09±0.01	*	0.12±0.001	0.02±0.0004	*	0.10±0.004	0.14±0.001	0.05±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
A249/0169-1	Bulk	0.56±0.03	*	0.12±0.01	0.02±0.001	0.04±0.001	0.09±0.001	0.08±0.004	trace	0.52±0.01	0.31±0.003	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	1.43±0.04	*	0.13±0.01	0.04±0.01	0.04±0.001	0.20±0.002	0.05±0.004	trace	0.38±0.004	0.59±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.13±0.02	*	0.01±0.001	0.01±0.001	0.04±0.001	0.01±0.001	0.05±0.003	trace	0.35±0.004	0.24±0.03	Na, Mg, Al, Si, K, Ti, Fe, Ce
A249/0169-2	Bulk	0.65±0.02	*	0.10±0.004	0.02±0.001	0.01±0.0003	0.01±0.001	0.06±0.003	trace	0.37±0.004	0.16±0.002	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	1.78±0.04	*	0.13±0.01	0.05±0.001	0.01±0.0004	0.21±0.002	0.04±0.004	*	0.33±0.004	0.85±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.10±0.02	*	0.10±0.01	*	0.01±0.0003	0.02±0.0005	0.04±0.004	*	0.30±0.003	0.03±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
A249/0169-3	Bulk	0.11±0.02	0.48±0.02	0.14±0.01	0.01±0.001	0.01±0.0003	0.08±0.001	0.06±0.004	trace	0.37±0.004	0.53±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	0.23±0.03	*	0.21±0.01	0.03±0.002	0.03±0.001	0.31±0.003	0.05±0.01	*	0.40±0.01	1.88±0.02	Na, Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	*	0.37±0.02	0.14±0.01	*	0.01±0.0003	0.04±0.001	0.06±0.004	*	0.41±0.01	0.14±0.002	Na, Mg, Al, Si, K, Ti, Fe, Ce
A249/0169-3-B	Bulk	*	0.27±0.02	0.01±0.001	0.01±0.0003	0.01±0.0002	0.02±0.0004	*	0.90±0.01	trace	0.09±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
A280/0001L-A	Bulk	1.62±0.05	*	0.23±0.01	0.19±0.002	0.01±0.0003	0.55±0.01	0.02±0.003	*	0.23±0.003	0.25±0.003	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	4.20±0.08	*	0.48±0.02	0.44±0.01	0.02±0.001	1.67±0.02	0.02±0.004	*	0.19±0.004	0.72±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.28±0.03	0.16±0.02	0.09±0.01	0.04±0.001	0.01±0.0002	0.09±0.001	0.02±0.002	*	0.21±0.002	0.07±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
A280/0001L-B	Bulk	0.22±0.03	0.28±0.02	0.15±0.01	0.05±0.001	trace	0.19±0.002	*	0.45±0.01	0.01±0.001	0.22±0.002	Na, Mg, Al, Si, K, Ti, Fe, Ce
A155/0941-1-A	Bulk	1.36±0.05	*	0.17±0.01	0.06±0.002	0.01±0.0004	0.24±0.002	0.03±0.004	*	0.27±0.003	0.23±0.003	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	3.56±0.08	*	0.37±0.01	0.14±0.002	0.02±0.0004	0.79±0.01	0.02±0.003	*	0.23±0.003	0.77±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.23±0.03	*	0.12±0.01	0.01±0.001	0.01±0.0003	0.08±0.001	0.02±0.003	*	0.26±0.003	0.07±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A155/0941-1-B	Bulk	0.16±0.03	*	0.15±0.01	0.02±0.0003	*	0.13±0.001	*	*	0.18±0.002	0.18±0.002	Mg, Al, Si, K, Ti, Fe
A155/0941-2-A	Bulk	0.43±0.03	0.92±0.03	0.48±0.01	0.04±0.001	0.01±0.0002	0.41±0.004	*	*	0.17±0.002	0.42±0.004	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	0.53±0.04	0.52±0.03	0.31±0.01	0.04±0.001	*	0.29±0.003	*	*	0.17±0.002	0.67±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.17±0.03	0.57±0.02	0.10±0.01	0.01±0.0003	*	0.05±0.001	*	*	0.14±0.001	0.13±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
A155/0941-2-B	Bulk	0.16±0.03	0.34±0.02	0.13±0.01	0.01±0.0003	0.01±0.0002	0.10±0.001	*	*	0.14±0.001	0.06±0.001	Mg, Al, Si, K, Ti, Fe
A207/0101-A	Bulk	1.04±0.05	*	0.08±0.01	0.18±0.002	0.01±0.0004	0.22±0.002	0.04±0.004	*	0.37±0.004	0.40±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Front Face	1.83±0.05	*	0.12±0.01	0.34±0.004	0.02±0.001	0.56±0.01	0.03±0.004	*	0.36±0.01	0.99±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	Rear Face	0.43±0.03	*	0.07±0.01	0.08±0.002	0.01±0.0004	0.06±0.001	0.04±0.004	*	0.35±0.004	0.08±0.002	Mg, Al, Si, K, Ti, Fe, Ce
A207/0101-B	Bulk	0.10±0.03	0.22±0.02	0.05±0.01	0.01±0.0003	0.01±0.0002	0.03±0.0005	*	0.32±0.01	*	0.06±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
A207/0101-C	Bulk	0.29±0.03	*	0.09±0.01	0.08±0.001	0.01±0.0003	0.05±0.001	0.03±0.003	*	0.33±0.004	0.04±0.001	Mg, Al, Si, K, Ti, Fe, Ce

TABLE 16. ELEMENTAL ANALYSIS OF NOBLE METALS AND POISONS BY X-RAY FLUORESCENCE

Biscuit Number	Weight Percent of Elements								
	P	S	Ca	Mn	Ni	Zn	Pt	Pb	Others
A180/0094	0.65±0.03	0.26±0.01	0.13±0.01	0.01±0.001	6.65±0.33	0.16±0.01	0.56±0.03	0.53±0.03	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A193/0908-A	1.54±0.08	0.21±0.01	0.23±0.01	0.03±0.002	0.01±0.001	0.31±0.02	0.25±0.01	0.18±0.01	Mg, Al, Si, K, Ti, Fe, Ce
A193/0908-B	0.14±0.01	0.22±0.01	0.16±0.01	0.01±0.001	*	0.15±0.01	0.01±0.001	0.19±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
A218/0045	0.27±0.01	0.29±0.02	0.10±0.01	*	5.32±0.27	0.07±0.004	0.43±0.02	0.15±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A218/0045X	0.57±0.03	0.16±0.01	0.10±0.005	*	4.50±0.023	0.09±0.005	0.38±0.02	0.30±0.02	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A218/0068	0.78±0.04	0.34±0.02	0.17±0.01	0.01±0.001	6.24±0.31	0.25±0.01	0.52±0.03	0.77±0.04	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A220/0392-A	1.39±0.07	0.77±0.04	0.11±0.01	*	4.67±0.23	0.19±0.01	0.10±0.01	0.24±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A220/0392-B	0.10±0.01	0.89±0.04	0.17±0.01	0.01±0.001	0.02±0.001	0.08±0.004	0.35±0.02	0.04±0.002	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A220/0810-A	2.03±0.10	0.54±0.03	0.30±0.02	0.01±0.001	3.63±0.18	0.64±0.03	0.10±0.01	0.44±0.02	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A220/0810-B	0.48±0.02	1.15±0.06	0.20±0.01	0.01±0.001	0.02±0.001	0.25±0.01	0.37±0.02	0.17±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A221/0152-A	1.68±0.08	0.23±0.01	0.16±0.01	0.12±0.01	0.01±0.001	0.40±0.02	0.31±0.002	0.51±0.03	Mg, Al, Si, K, Ti, Fe, Ce
A221/0152-B	0.16±0.01	0.27±0.01	0.13±0.01	0.03±0.002	*	0.13±0.01	*	0.29±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A221/0204-A	2.78±0.14	0.11±0.01	0.41±0.02	0.01±0.001	0.01±0.001	0.16±0.06	0.20±0.01	0.35±0.02	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A221/0204-B	0.37±0.02	0.29±0.01	0.24±0.01	*	*	0.36±0.02	0.02±0.001	0.24±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A221/0447-A	0.93±0.05	0.38±0.02	0.11±0.01	0.02±0.001	0.01±0.001	0.20±0.01	0.32±0.02	0.72±0.04	Mg, Al, Si, K, Ti, Fe, Ce
A221/0447-B	0.09±0.01	0.29±0.01	0.10±0.005	0.01±0.001	*	0.07±0.003	0.01±0.001	0.56±0.03	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A230/0177X-A	0.92±0.05	0.33±0.02	0.18±0.01	0.04±0.003	0.01±0.001	0.24±.01	0.28±0.01	0.36±0.02	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A230/0177X-B	0.06±0.004	0.38±0.02	0.09±0.005	0.01±0.001	0.01±0.001	0.05±0.003	0.30±0.02	0.04±0.002	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A230/0636X-A	0.87±0.04	0.21±0.01	0.14±0.01	0.01±0.001	0.02±0.001	0.22±0.01	0.28±0.01	0.48±0.02	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A230/0636X-B	0.08±0.005	0.37±0.02	0.08±0.004	*	0.01±0.001	0.08±0.004	0.33±0.02	0.07±0.004	Mg, Al, Si, K, Ti, Fe, Ce
A240/0016L-A	0.72±0.04	0.66±0.03	0.08±0.004	*	7.39±0.37	0.19±0.01	0.23±0.01	0.81±0.04	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A240-0016L-B	0.26±0.01	0.96±0.05	0.10±0.01	0.01±0.001	0.13±0.01	0.14±0.01	0.17±0.01	0.41±0.02	Mg, Al, Si, K, Ti, Fe, Ba, Ce

TABLE 16 (CONT'D). ELEMENTAL ANALYSIS OF NOBLE METALS AND POISONS BY X-RAY FLUORESCENCE

Biscuit Number	Weight Percent of Elements								
	P	S	Ca	Mn	Ni	Zn	Pt	Pb	Others
A240/0102-A	2.33±0.12	0.15±0.01	0.18±0.01	0.01±0.001	3.57±0.18	0.49±0.02	0.11±0.01	0.25±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A240/0102-B	0.63±0.03	0.29±0.01	0.22±0.01	0.01±0.001	0.04±0.002	0.40±0.02	0.14±0.01	0.16±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A240/0141L-A	0.43±0.02	0.26±0.01	0.08±0.004	0.03±0.002	5.92±0.30	0.10±0.01	0.18±0.01	0.15±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A240/0141L-B	0.18±0.01	0.48±0.02	0.07±0.004	0.04±0.002	0.03±0.001	0.06±0.003	0.16±0.01	0.07±0.004	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A240/0153-A	1.40±0.07	0.44±0.02	0.08±0.004	0.04±0.002	0.01±0.001	0.21±0.01	0.19±0.01	0.59±0.03	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A240/0153-B	0.28±0.01	0.63±0.03	0.10±0.01	0.04±0.003	0.68±0.03	0.15±0.01	0.17±0.01	0.17±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A240/0334L-A	0.33±0.02	0.61±0.03	0.05±0.003	*	0.01±0.01	0.05±0.002	0.22±0.01	0.19±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A240/0334L-B	0.06±0.003	0.46±0.02	0.07±0.004	*	0.13±0.01	0.02±0.001	0.16±0.01	0.05±0.003	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A249/0169-1	0.50±0.03	0.13±0.01	0.10±0.01	0.02±0.002	0.04±0.002	0.09±0.005	0.50±0.03	0.31±0.02	Mg, Al, Si, K, Ti, Fe, Ce
A249/0169-2	0.53±0.03	0.04±0.002	0.11±0.01	0.02±0.001	0.01±0.001	0.06±0.003	0.36±0.02	0.17±0.01	Mg, Al, Si, K, Ti, Fe, Ce
A249/0169-3-A	0.10±0.01	0.65±0.03	0.15±0.01	0.02±0.001	0.01±0.001	0.10±0.01	0.47±0.02	0.68±0.03	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A249/0169-3-B	0.04±0.002	0.34±0.02	0.09±0.005	0.01±0.001	0.01±0.001	0.03±0.001	*	0.10±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
A280/0001L-A	1.55±0.08	0.15±0.01	0.25±0.01	0.14±0.01	0.01±0.001	0.61±0.03	0.23±0.01	0.28±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A280/0001L-B	0.18±0.01	0.27±0.01	0.14±0.01	0.04±0.003	*	0.18±0.01	0.01±0.001	0.22±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A155/0941-1-A	1.14±0.06	0.06±0.004	0.20±0.01	0.06±0.004	0.01±0.001	0.28±0.01	0.28±0.01	0.26±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A155/0941-1-B	0.12±0.01	0.11±0.01	0.18±0.01	0.02±0.001	*	0.16±0.01	0.21±0.01	0.21±0.01	Mg, Al, Si, K, Ti, Fe, Ce
A155/0941-2-A	0.26±0.01	0.78±0.04	0.41±0.02	0.03±0.002	0.01±0.0004	0.39±0.02	0.15±0.01	0.41±0.02	Na, Mg, Al, Si, K, Ti, Fe, Ce
A155-0941-2-B	0.09±0.01	0.39±0.02	0.17±0.01	0.01±0.001	0.01±0.001	0.12±0.01	0.17±0.01	0.07±0.004	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
A207/0101-A	0.88±0.04	0.10±0.01	0.10±0.01	0.18±0.01	0.01±0.001	0.26±0.01	0.39±0.02	0.45±0.02	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A207/0101-B	0.16±0.01	0.05±0.004	0.11±0.01	0.08±0.004	0.01±0.001	0.06±0.003	0.36±0.02	0.03±0.002	Mg, Al, Si, K, Ti, Fe, Ba, Ce
A207/0101-C	0.04±0.003	0.24±0.01	0.07±0.004	0.01±0.001	0.01±0.0004	0.04±0.02	*	0.07±0.004	Mg, Al, Si, K, Ti, Fe, Ce

* below the detection limit

TABLE 17. LIST OF OXYGEN SENSORS FOR EVALUATION

Sensor Number	Make	Engine Family	Condition
A220/0660	GM	D4G3.8V2NEA3	whole sensor element
A220/0810	GM	D4G3.8V2NEA3	whole sensor element
A221/0146	Chrysler	DCR2.2V2HAC3	whole sensor element
A221/0310	Chrysler	DCR2.2V2HAC3	whole sensor element
A230/0177	GM	D1G2.0V5XAJ4	whole sensor element
A230/0649X	GM	D1G2.0V5HAJ4	whole sensor element
A249/0064	Chrysler	DCR5.2V2HAP9	whole sensor element
A251/0467	GM	D2G1.8V5TDGX	whole sensor element
A180/0094	Nissan	CNS2.8V5FAF4	partial tip only
A218/0045	Nissan	CNS2.8V5FAF1	partial tip only
A218/0045X	Nissan	CNS2.8V5FAF1	partial tip only
A218/0068	Nissan	CNS2.8V5FAF1	partial tip only

TABLE 18. O_2 SENSOR EVALUATION

1. Leak-Down Check

   a. Prepare leak-down chamber
   b. Attach O_2 sensor
   c. Pressurize with air to 10" Hg
   d. Monitor the leak-down rate on a strip chart recorder

2. Engine Evaluation

   a. Light-Off

      (1) Mount O_2 sensor onto exhaust generator (370°C)
      (2) Warm engine to set temperature and switch exhaust to sensor
      (3) Determine "light-off" time by recording the sensor voltage

   b. Voltage Output

      (1) Monitor voltage output on strip chart as A/F ratio stepwise changes from 14 to 16 at 370°C
      (2) Repeat at another exhaust temperature (590°C)

   c. Repsonse Time

      (1) Measure response time for instananeous shift in A/F ratio from 14 to 16 and then 16 to 14 (change from 200 millivolts to 600 millivolts) at 370°C.
      (2) Repeat at another exhaust temperature (590°C).

3. Laboratory Analysis

   a. Disassemble
   b. Conduct surface area analysis
   c. Submit for ESCA of exterior metals and poisons

A leak-down rate chamber was prepared to determine the leakage rate of each of the sensors. The internal volume of the chamber was measured at 3220 ml. A pressure transducer mounted on one end was connected to a strip chart recorder. The chamber was pressurized to an internal pressure of 10"Hg and the leakage rate was determined after 15 minutes. The leakage rate for each sensor is reported in Table 19.

Cold "light-off" times for all the oxygen sensors were determined using exhaust gas from an engine mounted on a dynamometer test stand. The sensors initially started at room temperature and were heated by the exhaust gases to approximately 370°C. The times for the sensors to begin to respond and the exhaust temperatures are presented in Table 20.

The response times of all the sensors were determined at 370°C and 590°C. The response times were measured following an instantaneous switch from a rich to a lean air/fuel ratio and again from lean to rich. The response times for each sensor are recorded in Tables 21 and 22.

The voltage outputs at various air/fuel ratios and two exhaust temperatures (370°C and 590°C) were also determined. These data are presented in Tables 23 and 24. The air/fuel ratio was slowly changed from rich to lean in a stepwise manner. The voltage output of each sensor was recorded as a function of the air/fuel ratio. These data can be used to determine the air/fuel ratio at which the sensor will send a signal to change from rich to lean.

The specific surface area of each sensor tip was determined with the same technique used for the catalyst samples. The results are included in Table 25. One important note is that the results for surface areas of sensor tips using the multipoint technique are about 4 to 6 times greater than with the singlepoint technique which was used in previous work assignments. The cause of the lower values is the result of a negative peak which follows the desorption peak. The negative peak is probably due to the larger thermal mass of the sensor tips. The area under the negative peak was not accounted for in the singlepoint analysis in the previous work assignments and resulted in lower reported values. The plots for the BET equation versus the relative pressure for each sensor tip are included in Appendix F.

The exterior surfaces of the oxygen sensor tips were examined with ESCA. This is a quantitative technique capable of determining the concentration of all elements except hydrogen and helium above about 0.1 atom percent in the sample. The depth of penetration is about 100 Å into the sample. The elements detected included carbon (C), oxygen (O), aluminum (Al), magnesium (Mg), calcium (Ca), silicon (Si), chlorine (Cl), sulfur (S), phosphorous (P), lead (Pb), nitrogen (N), zinc (Zn), sodium (Na), chromium (Cr), and iron (Fe). The sensor tip consists of a yttrium impregnated zirconium dioxide ceramic with a thin platinum coating covered by an exterior spinel coating. The spinel coating is composed of magnesium, aluminum, and oxygen. The exteriors of the sensor tips contained many of the same elements that are found in the catalysts as poisons. The weight percentages of the various elements detected are presented in Table 26. The individual spectra are included in Appendix G. It should be noted that a significant amount of carbon and oxygen was found on the surface and that very little magnesium and aluminum were detected. This

TABLE 19. LEAKAGE RATE FOR OXYGEN SENSORS

Sensor Number	Temperature. °F		Pressure, "Hg		Leakage Rate SCIM*
	Initial	Final	Initial	Final	
A220/0660	76	76	10.18	10.14	0.02
A220/0810	76	76	10.20	10.12	0.04
A221/0146	76	75	10.20	10.11	0.03
A221/0310	76	75	10.20	10.14	0.02
A230/0177	75	75	10.14	9.44	0.30
A230/0649X	76	76	10.20	9.84	0.16
A249/0064	76	76	10.18	10.00	0.08
A251/0467	76	75	10.18	8.12	0.88
Reference	75	75	10.18	10.12	0.03

*SCIM - Standard cubic inches per minute

TABLE 20. O_2 SENSOR EVALUATION - LIGHT-OFF TIMES AT 370°C

Sensor Number	A/F Ratio	Final Voltage, mV	Temperature, °F Initial*	Temperature, °F Final**	Light-Off Times, Sec. Initial*	Light-Off Times, Sec. Final**
A220/0660	14.04	680	512	642	26	244
A220/0810	14.04	645	547	665	52	341
A221/0146	14.02	690	543	670	34	274
A221/0310	14.02	855	555	695	46	386
A230/0177	14.04	565	512	645	26	260
A230/0649	14.02	735	570	713	60	476
A249/0064	14.02	770	555	704	46	437
A271/0467	14.04	315	547	660	50	311
Reference[a]	14.02	780	515	650	20	204
Reference[b]	14.04	775	512	655	25	306

*Initial temperature is temperature where sensor begins to respond.
Initial time is time when sensor begins to respond.
**Final temperature is temperature where sensor reached 90% of final response.
Final time is time to reach 90% of final response

TABLE 21. O_2 SENSOR EVALUATION - RESPONSE TIME AT 370°C

Sensor Number	Response Time to Maximum Response, sec.		Response Time Between 600-200 mV, sec.		Limiting Voltages mV	
	Rich to Lean	Lean to Rich	Rich to Lean	Lean to Rich	Rich	Lean
A221/0146	7	16	2.1	2.8	880	35
A249/0064	3	11	0.2	0.2	850	30
A221/0310	37	37	2.2	16.6	870	35
A230/0649X	1	3	0.2	0.2	780	45
Reference Test 1[a]	1	3	0.2	0.6	800	35
A230/0177	1	1	--[c]	--[c]	460	0
A251/0467	23	13	--[c]	--[c]	430	60
A220/0660	7	1	0.5	0.2	730	0
A220/0810	1	2	0.6	0.2	660	0
Reference Test 2[b]	12	1	0.8	0.2	920	70

[a]Test 1 with sensors A221/0146, A249/0064, A221/0310, A230/0649X
[b]Test 2 with sensors A230/0177, A251/0467, A220/0660. A220/0810
[c]600 mV not achieved

TABLE 22. O_2 SENSOR EVALUATION - RESPONSE TIME AT 590°C

Sensor Number	Response Time to Maximum Response, sec.		Response Time Between 600-200 mV, sec.		Limiting Voltages mV	
	Rich to Lean	Lean to Rich	Rich to Lean	Lean to Rich	Rich	Lean
A221/0146	1	2	--	0.2	570	0
A249/0064	23	17	7.7	6.0	810	10
A221/0310	9	4	1.6	2.6	820	90
A230/0649X	10	27	2.9	8.8	800	55
Reference Test 1[a]	9	1	0.6	0.2	910	80
A230/0177	1	6	0.2	0.3	810	45
A251/0467	29	46	4.1	34.2	630	80
A220/0660	5	2	0.2	0.2	800	40
A220/0810	1	6	0.2	0.2	880	45
Reference Test 2[b]	0.5	2	0.2	0.2	830	40

[a]Test 1 with sensors A221/0146, A249/0064, A221/0310, A230/0649X
[b]Test 2 with sensors A230/0177, A251/0467, A220/0660. A220/0810

TABLE 23. O_2 SENSOR EVALUATION - VOLTAGE OUTPUT VERSUS AIR/FUEL RATIO AT 370°C

A/F Ratio	Voltage Output, mV				
	A221/0146	A249/0064	A221/0310	A230/0649X	Reference
14.21	880	870	890	820	800
14.51	700	600	600	500	600
14.56	700	600	600	500	600
14.66	130	170	180	150	250
14.75	90	80	100	90	100
14.98	70	60	80	70	90
15.48	45	40	40	65	70
16.47	35	30	35	45	35

A/F Ratio	Voltage Output, mV				
	A230/0177	A251/0467	A220/0660	A220/0810	Reference
13.98	410	425	670	635	940
14.49	370	410	670	630	920
14.61	370	370	680	620	915
14.68	370	330	670	550	910
14.81	250	200	500	350	900
14.92	120	140	400	240	885
15.48	20	60	100	80	190
16.23	0	25	70	70	90

TABLE 24. O_2 SENSOR EVALUATION - VOLTAGE OUTPUT VERSUS AIR/FUEL RATIO AT 590°C

A/F Ratio	Voltage Output, mV				
	A221/0146	A249/0064	A221/0310	A230/0649X	Reference
14.16	550	810	810	780	925
14.54	510	740	760	680	910
14.63	480	670	700	600	890
14.73	250	270	220	250	870
14.83	180	60	160	130	730
14.98	150	60	140	120	650
15.43	100	20	100	55	250
16.07	20	10	75	40	20

A/F Ratio	Voltage Output, mV				
	A230/0177	A251/0467	A220/0660	A220/0810	Reference
14.18	820	700	820	820	850
14.45	650	580	--	500	700
14.57	550	540	500	450	500
14.81	150	180	140	100	180
14.73	220	250	210	160	250
14.98	140	130	120	90	150
15.41	60	90	75	60	60
16.26	30	65	45	50	40

TABLE 25. SPECIFIC SERVICE AREA OF OXYGEN SENSORS

Sensor Number	Specific Surface Area, m^2/g	Surface Area, m^2
A220/0660	1.8	7.4
A220/0810	0.7	2.5
A221/0146	1.3	3.9
A221/0310	1.8	5.4
A230/0177	1.2	4.7
A230/0649X	1.5	5.7
A249/0064	1.8	5.1
A251/0467	1.0	4.2
A180/0094	3.5	*
A218/0045	4.5	*
A218/0045X	3.6	*
A218/0068	3.1	*
New Chrysler	3.0	8.7

* - partial sample, no total weight available

TABLE 26. ELEMENTAL ANALYSIS OF EXTERIOR SURFACE OF OXYGEN SENSORS BY ESCA

Sensor Number	Weight Percent of Element														
	C	O	Al	Mg	Ca	Si	Cl	S	P	Pb	N	Zn	Na	Cr	Fe
A220/0660	66	21	--	1.6	0.8	2.9	--	--	2.5	0.3	1.6	--	2.5	--	--
A220/0810	61	24	--	3.1	0.8	1.4	--	1.4	2.6	0.1	0.9	--	4.6	--	--
A221/0146	67	21	--	5.1	--	2.8	--	--	2.3	0.5	0.7	--	0.7	--	--
A221/0310	60	22	--	3.1	--	9.2	--	--	2.4	0.6	1.7	--	0.8	--	--
A230/0177	56	27	--	2.0	1.6	4.8	--	0.8	4.0	0.5	--	1.5	2.7	--	--
A230/0649X	56	26	--	2.0	0.8	9.0	--	--	2.2	0.6	--	--	2.8	0.2	0.2
A249/0064	77	18	--	--	--	2.1	--	0.7	0.5	0.2	1.4	--	--	--	--
A251/0467	51	26	--	4.0	--	12	--	--	2.7	0.4	--	--	3.3	--	--
A180/0094	34	41	--	--	--	--	--	2.2	5.1	7.6	--	4.7	5.6	--	--
A218/0045	84	13	--	--	--	--	--	--	--	0.4	--	--	2.1	--	--
A218/0045X	42	35	2.0	5.0	--	2.6	--	--	6.8	2.6	--	--	4.4	--	--
A218/0068	82	15	--	--	--	--	--	--	1.5	0.8	--	--	1.3	--	--
New Chrysler	13	39	27	14	2.0	2.4	0.6	1.2	--	--	--	--	--	--	--

indicates that each tip was covered with a layer at least 100Å thick of exhaust products. The new Chrysler sensor tip was mostly magnesium, aluminum, and oxygen, with a smaller amount of carbon and detectable levels of calcium, silicon, chlorine, and sulfur. A correlation between the exterior elements and the operation of the sensors was not performed.

IV. Quality Assurance and Correlation

In an effort to assure the quality of the experimental results for the "on-engine" evaluation, a number of steps were taken. Two converters were selected to undergo three repeat tests each for converter efficiency and light-off times. These converters were A215/0201R and EPA 1174R. The test results for the quality assurance program are summarized in Tables 27 through 32, and the data for the individual quality assurance tests are included with the individual results for all of the converters in Appendix H. An average range and percent range were calculated for each converter. In general, the repeatability of the engine and analytical system was good except at rich air/fuel ratios. A plot of the time versus percent reduction in the exhaust concentration for the three repeat tests from each converter is shown in Figures 2 through 6 for the light-off tests. The average value for the test results was calculated and is also included on each plot.

The Micromeritics Flowsorb II dynamic surface area analyzer was set up to analyze the catalyst samples "in-house." Two NBS Standard Reference Materials and seven standards from Duke Scientific Corporation were used to establish the instrument operating range, linearity, and confidence in the analytical procedure. In this work assignment, the surface areas were determined with a multipoint technique. The standards were analyzed using this technique, and the results are presented in Table 33. In general, the standards repeated within the published confidence limits for the entire range of standards (0.62 m^2/g to 265 m^2/g).

In this work assignment, a new analytical technique was applied to catalyst samples. This technique was PIXE. In an attempt to correlate the results from previous work assignment with this work assignment, several steps were taken. They included a comparison of SwRI x-ray fluorescence, EPA/RTP x-ray fluorescence, x-ray fluorescence at Surface Science Laboratories (SSL), and PIXE by Elemental Analysis Corp. The ten samples were selected to undergo a multitude of correlation tests which included:

1. submission of five samples to all laboratories
2. submission of samples previously analyzed by Ford to EPA/RTP and PIXE
3. Independent analysis of all samples by wet chemistry (WC)/direct coupled plasma (DCP)
4. submission of SwRI standards to EPA/RTP, SSL, and PIXE.

The data for each of the correlation samples are included in Table 34. Samples A3/1037-A, A81/0270-1, A87/0479-2-A, A154/0392-A, and A155/0979-1-A were

TABLE 27. STEADY-STATE CONVERTER EFFICIENCY SUMMARY FOR QUALITY ASSURANCE HYDROCARBONS

Converter Number	Converter Type	Test	Percent Reduction at Nominal A/F Ratio 14.1	14.3	14.5	14.7	14.9	15.1	15.3
A215/0201R	3-Way + Ox	1	88.2	91.9	92.6	91.9	92.3	92.2	91.1
		2	84.9	86.1	90.9	90.3	93.1	92.3	91.3
		3	86.6	87.3	91.7	93.3	92.4	91.3	92.8
		Avg.	86.8	88.4	91.7	91.8	92.6	91.9	91.7
		Range	3.3	5.8	1.7	3.0	0.8	1.0	1.7
		% Range	3.8	6.6	1.9	3.3	0.9	1.1	1.9
EPA 1174R	3-Way + Ox	1	86.0	89.2	92.2	92.8	91.9	90.9	89.5
		2	85.7	86.7	89.8	90.5	92.8	91.5	90.0
		3	84.8	87.7	91.0	91.4	90.6	91.3	90.7
		Avg.	85.5	87.9	91.0	91.6	91.8	91.2	90.1
		Range	1.2	2.5	2.4	2.3	2.2	0.6	1.2
		% Range	1.4	2.8	2.6	2.5	2.4	0.7	1.3

TABLE 28. STEADY-STATE CONVERTER EFFICIENCY SUMMARY FOR QUALITY ASSURANCE CARBON MONOXIDE

Converter Number	Converter Type	Test	Percent Reduction at Nominal A/F Ratio 14.1	14.3	14.5	14.7	14.9	15.1	15.3
A215/0201R	3-Way + Ox	1	98.0	99.6	99.5	99.5	99.4	99.4	99.2
		2	98.4	98.9	99.6	99.6	99.5	99.4	99.3
		3	99.2	99.2	99.6	99.8	99.7	99.6	99.6
		Avg.	98.5	99.2	99.6	99.6	99.5	99.5	99.4
		Range	1.2	0.7	0.1	0.3	0.3	0.2	0.4
		% Range	1.2	0.7	0.1	0.3	0.3	0.2	0.4
EPA 1174R	3-Way + Ox	1	96.4	99.6	99.5	99.6	99.4	99.2	99.1
		2	98.5	99.1	99.7	99.7	99.6	99.5	99.6
		3	94.8	99.5	99.7	99.7	99.6	99.5	99.7
		Avg.	96.6	99.4	99.6	99.7	99.5	99.4	99.5
		Range	3.7	0.5	0.2	0.1	0.2	0.3	0.6
		% Range	3.8	0.5	0.2	0.1	0.2	0.3	0.6

TABLE 29. STEADY-STATE CONVERTER EFFICIENCY SUMMARY FOR QUALITY ASSURANCE OXIDES OF NITROGEN

Converter Number	Converter Type	Test	Percent Reduction at Nominal A/F Ratio 14.1	14.3	14.5	14.7	14.9	15.1	15.3
A215/0201R	3-Way + Ox	1	75.6	71.6	71.6	48.0	28.2	21.8	19.9
		2	57.4	68.8	77.9	47.5	34.4	29.0	24.9
		3	73.1	72.0	44.2	32.9	28.8	26.6	25.1
		Avg.	68.7	70.8	62.7	42.8	30.5	25.8	23.3
		Range	18.2	3.2	33.7	15.1	6.2	7.2	5.2
		% Range	26	4.5	53	35	20	28	22
EPA 1174R	3-Way + Ox	1	63.8	78.6	63.2	50.3	32.9	23.7	21.3
		2	47.0	71.7	67.3	42.9	31.6	24.1	24.7
		3	49.0	73.1	71.0	43.0	29.6	23.9	20.4
		Avg.	53.3	74.5	67.2	45.4	31.4	23.9	22.1
		Range	16.8	6.9	7.8	7.4	3.3	0.4	4.3
		% Range	32	9.3	12	16	10	1.7	20

TABLE 30. LIGHT-OFF TIMES FOR QUALITY ASSURANCE OF CONVERTER RESPONSE HYDROCARBONS

Converter Number	Converter Type	Test	Time to Reach % Reduction, Sec. 20	50	80	Percent Reduction After 205 sec	600 sec
A215/0201R	3-Way + Ox	1	26	36	54	88.7	88.0
		2	27	30	52	86.8	88.7
		3	28	35	52	87.3	88.5
		Avg.	27	34	53	87.6	88.4
		Range	2	6	2	1.9	0.7
		% Range	7.4	1.8	3.8	2.2	0.8
EPA 1174R	3-Way + Ox	1	55	63	89	91.0	88.7
		2	40	48	66	92.0	91.5
		3	48	54	75	91.2	91.2
		Avg.	48	55	77	91.4	90.5
		Range	15	15	23	1.0	2.8
		% Range	31	27	30	1.1	3.1

TABLE 31. LIGHT-OFF TIMES FOR QUALITY ASSURANCE OF CONVERTER RESPONSE CARBON MONOXIDE

Converter Number	Converter Type	Test	Time to Reach % Reduction, Sec. 20	50	80	Percent Reduction After 205 sec	600 sec
A215/0201R	3-Way + Ox	1	21	30	38	99.8	99.8
		2	20	30	37	99.8	99.8
		3	22	30	36	99.8	99.8
		Avg.	21	30	37	99.8	99.8
		Range	2	0	2	0	0
		% Range[a]	9.5	0	5.4	0	0
EPA 1174R	3-Way + Ox	1	48	57	66	99.8	99.9
		2	38	42	50	99.0	100.0
		3	41	48	55	99.8	99.9
		Avg.	42	49	57	99.5	99.9
		Range	10	15	16	0.8	0.1
		% Range[a]	24	31	28	0.8	0.1

[a]% Range = (max - min/avg)x100

TABLE 32. LIGHT-OFF TIMES FOR QUALITY ASSURANCE OF CONVERTER RESPONSE OXIDES OF NITROGEN

Converter Number	Converter Type	Test	Time to Reach % Reduction, Sec. 20	50	80	Percent Reduction After 205 sec	600 sec
A215/0201R	3-Way + Ox	1	25	NA	NA	4.2	5.2
		2	24	NA	NA	8.4	6.9
		3	30	NA	NA	7.0	5.2
		Avg.	26	--	--	6.5	5.8
		Range	6	--	--	4.2	1.7
		% Range	23	--	--	65	29
EPA 1174R	3-Way + Ox	1	32	50	NA	6.8	5.8
		2	25	40	NA	7.4	8.3
		3	29	45	NA	3.3	0.5
		Avg.	29	45	--	5.8	4.9
		Range	7	10	--	4.1	7.8
		% Range	24	22	--	71	159

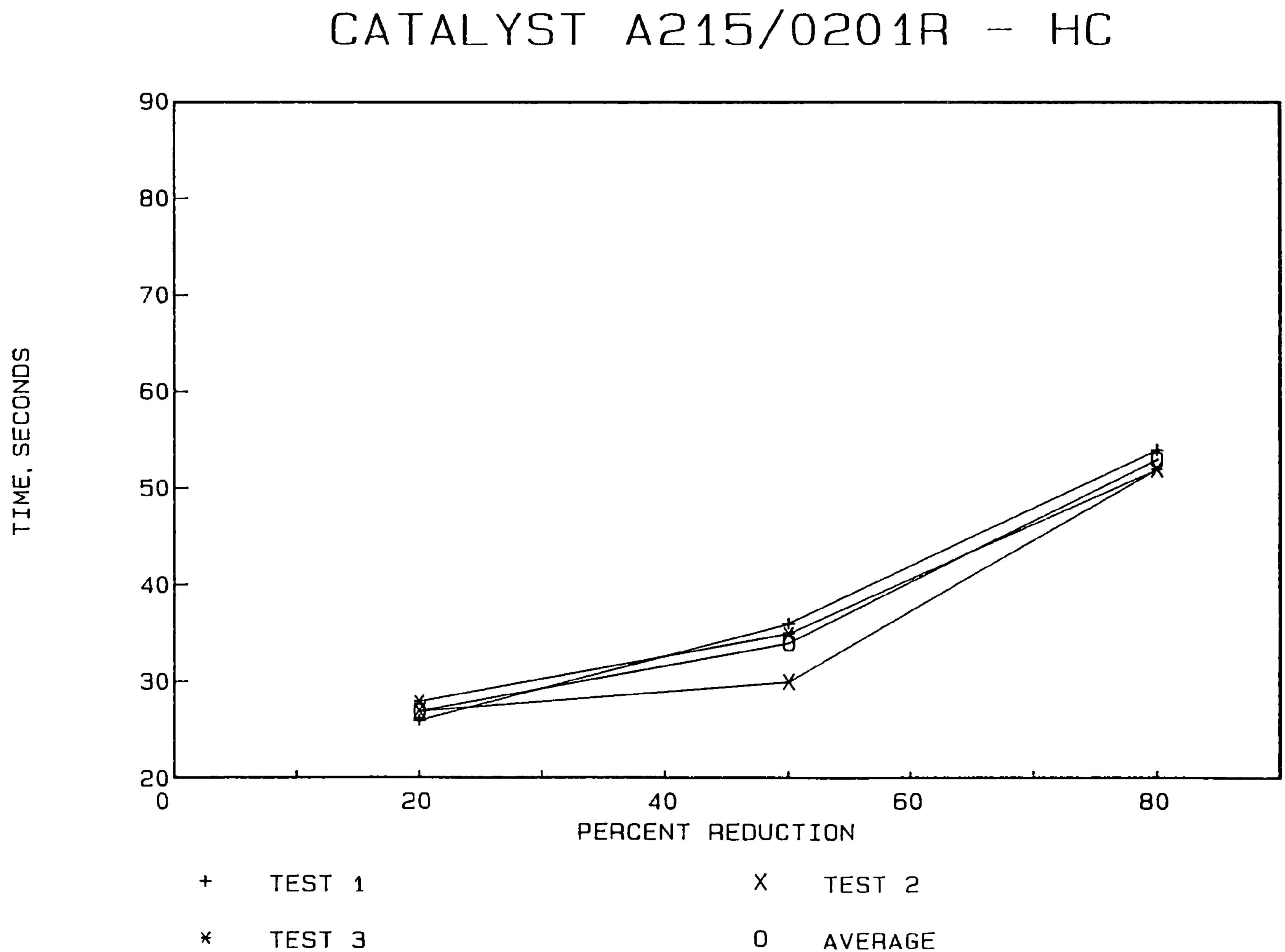


Figure 2. Percent reduction of HC from the light-off test for Converter A215/0201R

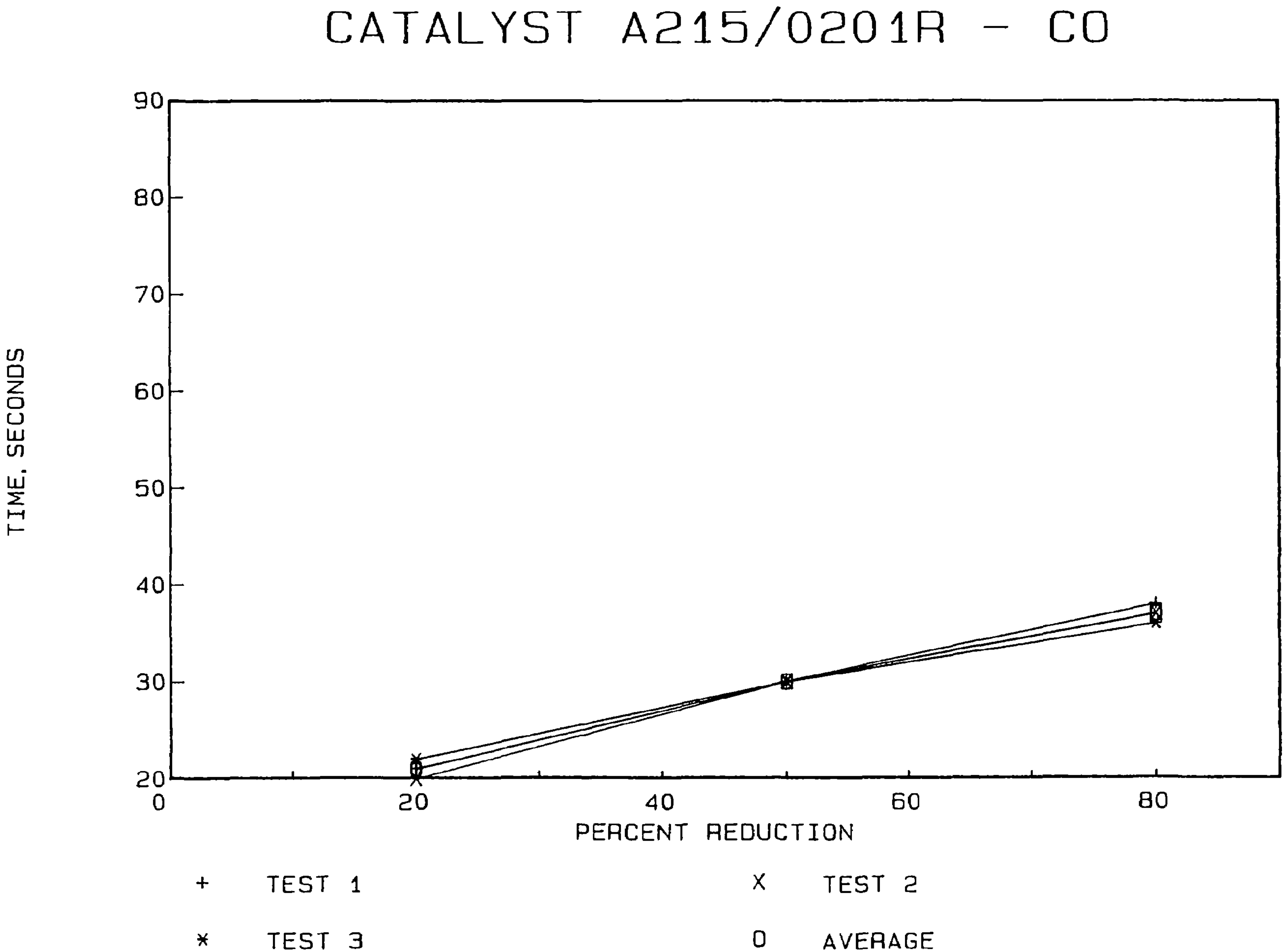


Figure 3. Percent reduction of CO from the light-off test for Converter A215/0201R

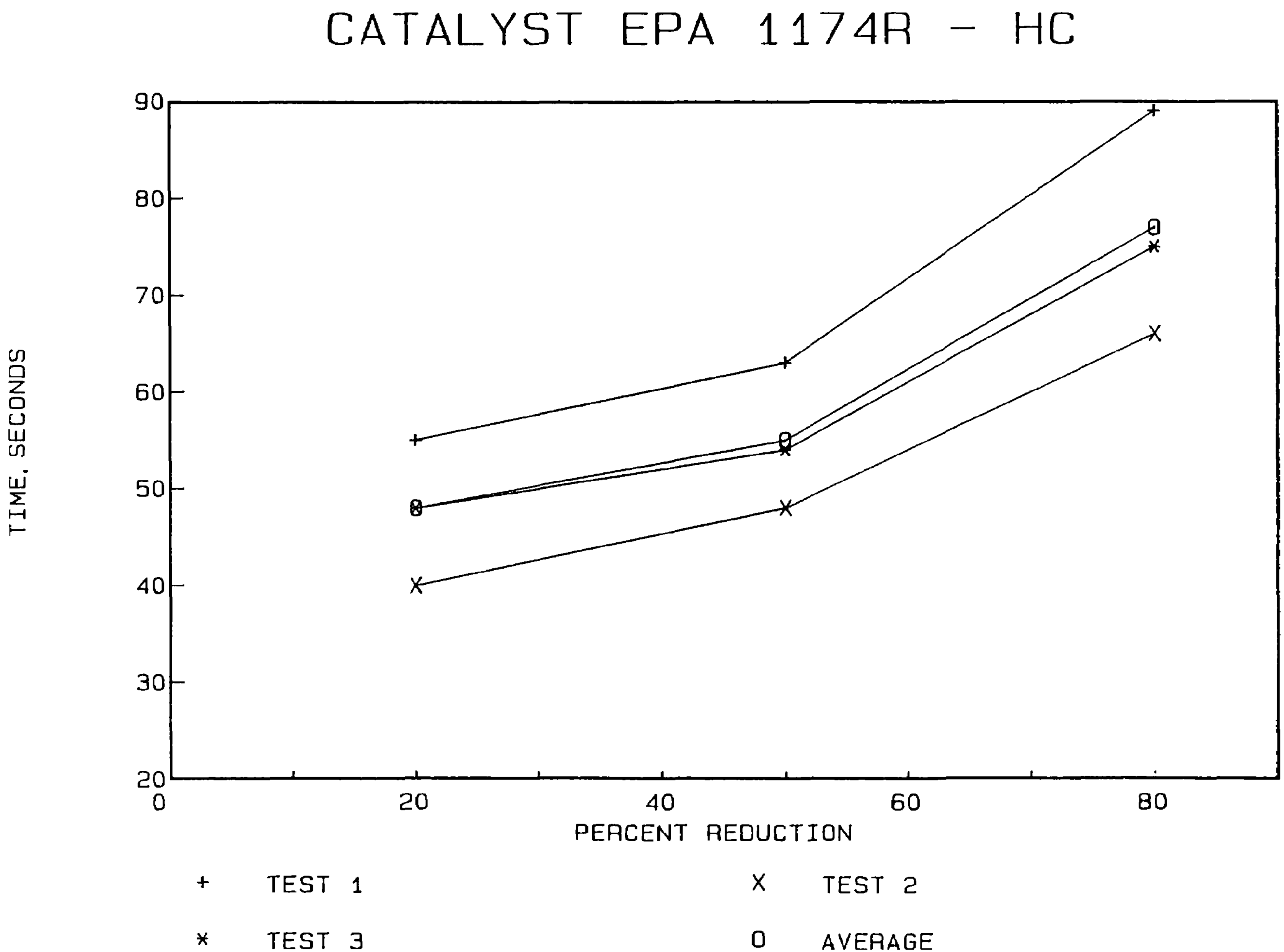


Figure 4. Percent reduction of HC from the light-off test for Converter EPA 1174R

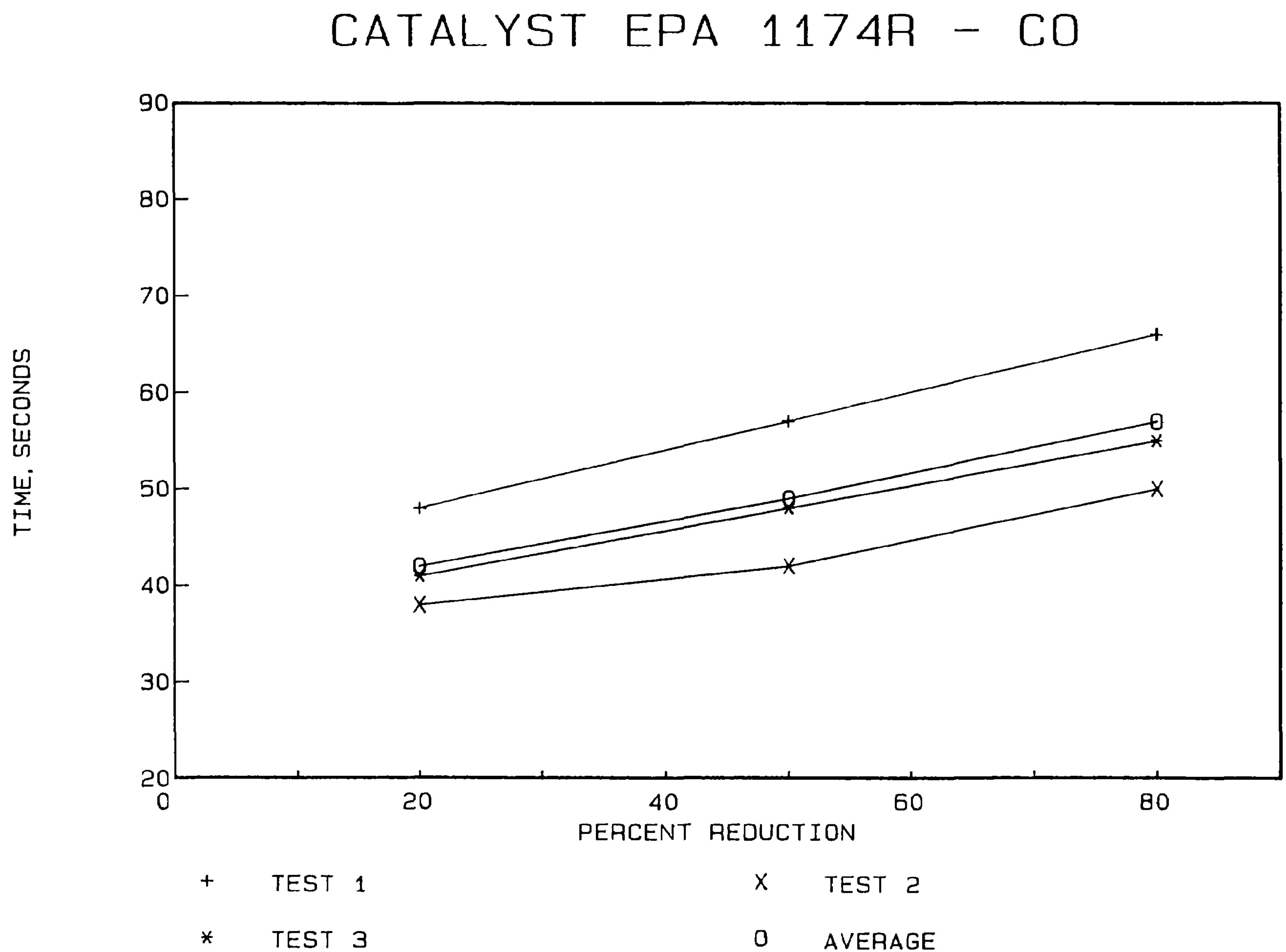


Figure 5. Percent reduction of CO from the light-off test for Converter EPA 1174R

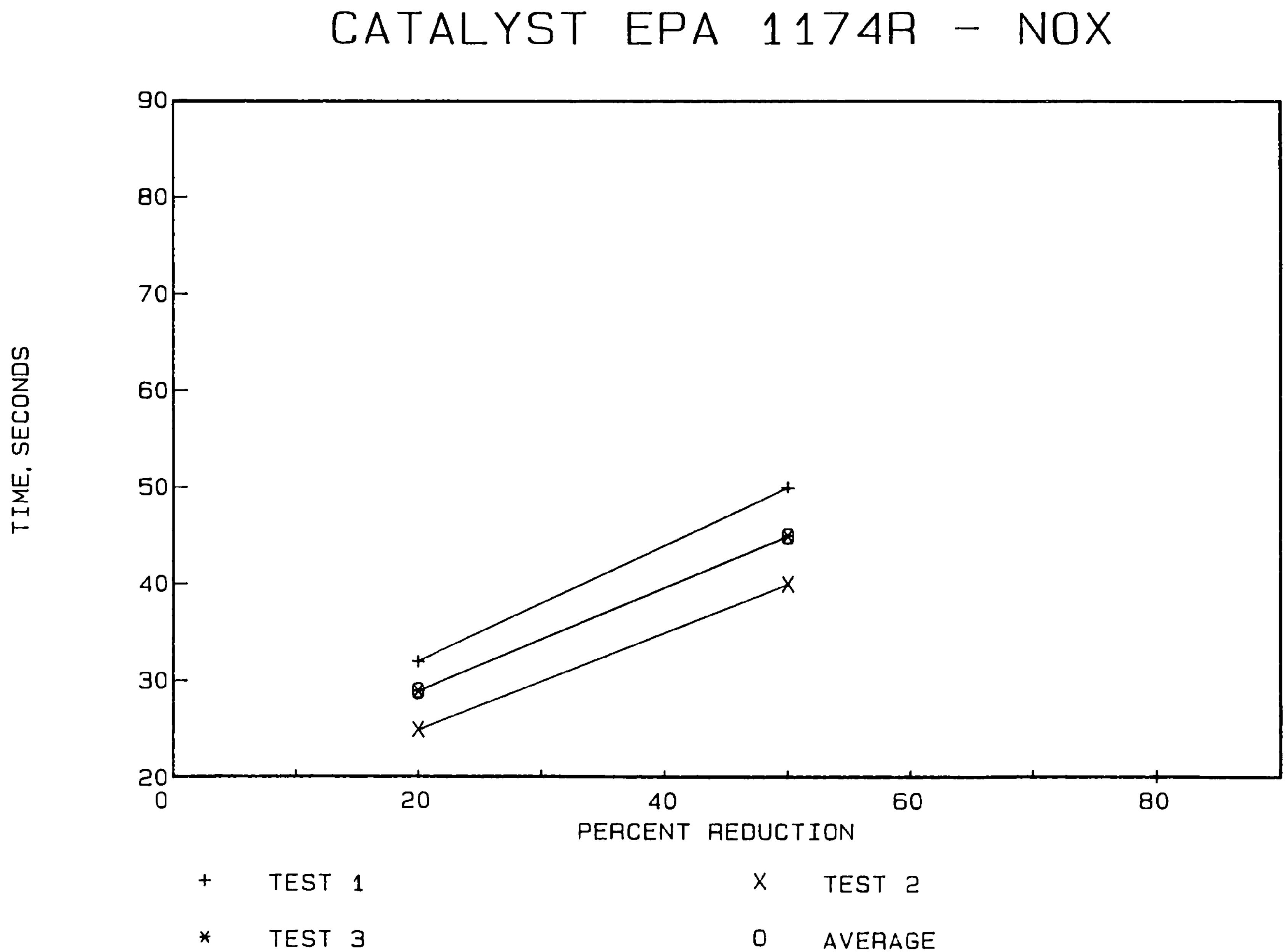


Figure 6. Percent reduction of NO_x from the light-off test for Converter EPA 1174R

TABLE 33. QUALITY ASSURANCE OF SURFACE AREA STANDARDS

Standard Composition	Standard Surface Area, m^2/g	Measured Surface Area, m^2/g	Percent Difference
Zinc oxide	0.62±0.04	0.84	35.5
Alpha alumina	0.78 NBS	1.07	37.2
Alumina	3.04±0.25	3.41	12.2
		3.56	17.1
		3.58	17.8
Titanium dioxide	7.05±0.7	7.28	3.3
		8.05	14.2
Alumina	14.0±0.6	16.2	15.7
		14.4	2.9
		13.2	-5.7
Graphitized Carbon Black	71.3 NBS	80.4	12.8
		78.7	10.4
Alumina	81.4±6.2	85.6	5.2
Alumina	265±11	260	-1.9

TABLE 34. CORRELATION OF SEVERAL SAMPLES BY DIFFERENT ANALYTICAL TECHNIQUES AND LABORATORIES

Technique	Sample Number	Weight Percent of Elements										
		P	S	Ca	Mn	Ni	Zn	Pb	Pt	Pd	Rh	Others
PIXE	A3/1037-A	0.96±0.04	*	0.09±0.01	0.01±0.001	3.13±0.03	0.12±0.001	0.01±0.003	0.12±0.002	0.01±0.003	0.02±0.004	Mg, Al, Si, K, Ti, Fe, Ce
	A81/0270-1	0.53±0.03	*	0.13±0.01	0.06±0.002	4.24±0.04	0.28±0.003	1.62±0.02	0.32±0.01	0.01±0.005	0.05±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A87/0479-2-A	*	0.15±0.02	0.16±0.01	0.02±0.001	0.04±0.001	0.09±0.001	0.23±0.003	*	0.43±0.01	trace	Na, Mg, Al, Si, K, Ti, Fe, Ce
	A154/0392-A	1.05±0.05	0.24±0.02	0.08±0.001	0.02±0.002	4.43±0.05	0.14±0.002	0.53±0.01	0.13±0.003	0.01±0.004	0.04±0.01	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A155/0979-1-A	0.45±0.03	*	0.10±0.01	0.01±0.001	0.01±0.0003	0.01±0.001	0.25±0.003	0.25±0.003	0.003±0.001	0.03±0.002	Mg, Al, Si, Cl, K, Ti, Fe, Ce
	A160/0656-1-A[a]	0.81±0.03	*	0.20±0.01	0.08±0.001	0.25±0.002	0.30±0.003	0.82±0.01	0.02±0.001	*	trace	Mg, Al, Si, K, Ti, Fe, Ce
	A160/0656-1-A[b]	3 49±0.07	*	0.51±0.02	0.33±0.004	2.92±0.03	1.08±0.01	2.78±0.03	0.25±0.01	trace	0.03±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	A160/0656-1-C[a]	0.56±0.03	*	0.08±0.01	0.04±0.001	0.56±0.01	0.07±0.001	0.09±0.002	0.04±0.001	trace	0.01±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
	A160/0656-1-C[b]	0.56±0.04	*	0.11±0.01	0.05±0.001	2.41±0.02	0.07±0.001	0.12±0.002	0.19±0.003	*	0.02±0.003	Na, Mg, Al, Si, K, Ti, Fe, Ce
	A160/0656-1-B[a]	0.20±0.02	*	0.07±0.01	0.02±0.001	0.73±0.01	0.02±0.0004	0.02±0.001	0.06±0.001	*	0.01±0.001	Na, Mg, Al, Si, K, Ti, Fe, Ce
	A160/0656-1-B[b]	0.26±0.03	*	0.10±0.01	0.04±0.001	..83±0.03	0.04±0.001	0.13±0.003	0.24±0.003	*	0.02±0.004	Na, Mg, Al, Si, K, Ti, Fe, Ce
	A214/0681-A-A[a]	1.11±0.03	*	0 17±0.01	0.01±0.001	2.92±0.03	0.19±0.002	0.34±0.01	0.07±0.002	trace	0.02±0.004	Mg, Al, Si, K, Ti, Fe, Ce
	A214/0681-A-A[b]	2.09±0.05	*	0.31±0.01	0.03±0.002	6.23±0.06	0.43±0.01	0.79±0.01	0.16±0.01	*	0.04±0.01	Mg, Al, Si, K, Ti, Fe, Ce
	A214/0681-A-C[a]	0.30±0.02	*	0.06±0.01	trace	1.44±0.01	0.01±0.0005	0.02±0.001	0.03±0.001	*	0.01±0.003	Na, Mg, Al, Si, K, Ti, Fe, Ce
	A214/0681-A-C[b]	1.08±0.05	*	0.12±0.01	0.01±0.001	4.70±0.05	0.06±0.001	0.01±0.003	0.11±0.003	trace	0.03±0.01	Na, Mg, Al, Si, K, Ti, Fe, Ce
	A214/0681-A-B[b]	0.31±0.03	*	0.08±0.01	trace	2.62±0.03	0.03±0.001	0.05±0.002	0.06±0.002	*	0.01±0.003	Na, Mg, Al, Si, K, Ti, Fe, Ce
SwRI-XRF	A3/1037-A	0.72	0.04	0.07	*	1.84	0.05	0.06	0.18	*	trace	Large Ti, Ce & Fe
	A81/0270-1	0.18	0.31	0.06	0.02	1.54	0.11	0.59	0.37	*	trace	Large Ti, Ce & Fe
	A87/0479-2-A	*	0.26	0 06	0.01	0.02	trace	0.12	*	0.45	*	Ti, large Fe
	A154/0392-A	0.52	0.52	0.03	*	1.66	0.03	0.24	0.17	0.08	*	Large Ti, Ce & Fe
	A155/0979-1-A	0.04	*	0.03	*	0 02	0.04	0.12	*	*	*	Ti, large Ce & Fe
EPA/RTP-XRF	A3/1037-A	0.97±0.05	0.05±0.004	0.09±0.005	0.01±0.001	2.85±0.14	0.12±0.01	0 10±0.01	0 12±0.01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A81/0270-1	0.68±0.03	0.20±0.01	0.14±0.01	0.04±0.002	3.44±0.17	0.27±0.01	1.60±0.08	0.29±0.01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A87/0479-2-A	0.06±0.004	0.18±0.01	0.17±0.01	0.03±0.002	0.04±0.002	0.08±0.004	0.22±0.01	*	ND	ND	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A154/0392-A	1.07±0.05	0.35±0 01	0.07±0.004	0.01±0.001	4.11±0.21	0.14±0.001	0.55±0.03	0 12±0.01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A155/0979-1-A	0.43±0.02	0.04±0.003	0.08±0.004	0.01±0.001	0.01±0.001	0.07±0.004	0.21±0.01	0 21±0.01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A160/0656-1-A	3.33±0.17	*	0.55±0.03	0.19±0.01	2.16±0.11	0.98±0.05	2.76±0.14	0 22±0.01	ND	ND	Na, Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A160/0656-1-C	0.61±0.03	*	0.17±0.01	0.05±0.003	3.47±0.17	0 10±0.01	0.18±0.01	0.29±0.01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A160/0656-1-B	0.21±0.01	*	0.12±0.01	0.02±0 002	2 87±0.14	0 05±0.002	0.14±0.01	0 25±0.01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A214/0681-A-A	1.92±0.10	0.03±0.003	0 34±0.02	0 02±0.001	6.02±0.30	0.40±0.02	0 78±0.04	0.17±0 01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A214/0681-A-C	0.80±0.04	*	0.13±0.01	*	3.89±0.19	0.05±0.003	0.09±0 005	0.10±0 01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce
	A214/0681-A-B	0.51±0.03	0.01±0.002	0 13±0.01	*	5.07±0.25	0.06±0.003	0.12±0 01	0 13±0 01	ND	ND	Mg, Al, Si, K, Ti, Fe, Ba, Ce

TABLE 34 (CONT'D). CORRELATION OF SEVERAL SAMPLES BY DIFFERENT ANALYTICAL TECHNIQUES AND LABORATORIES

Technique	Sample Number	Weight Percent of Elements										Others
		P	S	Ca	Mn	Ni	Zn	Pb	Pt	Pd	Rh	
LEDOUX	A3/1037-A	0.69	0.02	ND	ND	ND	0.11	0.09	0.11	*	0.02	moisture 0.56%
	A81/0270-1	0.61	0.10	ND	ND	ND	0.31	1.64	0.24	*	0.02	moisture 0.51%
	A87/0479-2-A	0.04	0.09	ND	ND	ND	0.11	0.13	*	0.23	*	moisture 0.14%
	A154/0392-A	0.64	0.21	ND	ND	ND	0.10	0.36	0.10	*	0.02	moisture 0.91%
	A155/0979-1-A	0.19	0.02	ND	ND	ND	0.04	0.12	0.10	*	0.01	moisture 0.09%
	A160/0656-1-A	1.87	0.01	ND	ND	ND	0.61	1.84	0.07	*	trace	
	A160/0656-1-C	0.18	0.01	ND	ND	ND	0.03	0.05	0.05	*	trace	
	A160/0656-1-B	0.08	0.01	ND	ND	ND	0.02	0.05	0.06	*	trace	
	A214-0681-A-A	0.66	0.01	ND	ND	ND	0.16	0.32	0.05	*	0.01	
	A214/0681-A-C	0.33	0.01	ND	ND	ND	0.02	0.03	0.04	*	0.01	
	A214/0681-A-B	0.09	0.01	ND	ND	ND	0.01	0.02	0.01	*	*	
SSL-XRF	A3/1037-A	ND	0.16	ND	ND	8.87	0.27	0.22	0.05	ND	ND	Ce
	A81/0270-1	ND	0.83	ND	ND	10.07	0.49	2.65	0.26	ND	ND	Ce
	A87/0479-2-A	ND	1.18	ND	ND	0.12	0.13	0.40	*	ND	ND	Ce
	A154/0398-A	ND	1.43	ND	ND	10.02	0.27	0.84	*	ND	ND	Ce
	A155/0979-1-A	ND	*	ND	ND	0.04	0.20	0.61	0.26	ND	ND	Ce

[a]Ford prepared pellet
[b]SwRI prepared powder sample from same location in biscuit as Ford pellet
ND - not determined with this analytical procedure
* - below the detection limit
trace - at the detection limit

analyzed in Work Assignment No. 26, EPA Contract 68-03-3162, by x-ray fluorescence at SwRI. A silver tube was employed to analyze all of the elements except palladium (Pd) and rhodium (Rh). A gold tube was used for these two elements. Additional samples were taken from each biscuit and submitted for analysis by x-ray fluorescence (EPA/RTP and SSL), PIXE, and WX/DCP. The EPA/RTP x-ray fluorescence unit used a chromium tube. Two more catalysts which were analyzed by Ford were also submitted to each of these laboratories except SSL because adequate sample was not available. These catalysts were A160/0656-1 and A214/0681. With these two catalysts, Ford took core samples from the front face, middle, and rear face of the biscuit. The additional samples were taken from the same location used by Ford. As another comparison, the actual pellet samples prepared by Ford were also submitted for PIXE. No data were available for the Ford analyzed pellets.

The standards prepared by SwRI in previous work assignments were submitted to EPA/RTP, SSL, and PIXE. The concentrations of the SwRI standards are included in Table 35. Standards #1 through #4 were submitted to EPA/RTP for analysis as unknowns. The actual versus measured values for the four SwRI standards analyzed by EPA/RTP are presented in Table 36. The standards submitted to SSL were used to establish the fundamental parameters program. In this case the program was called EXACT. Standard HB was used for fundamental parameters calibration and then analyzed as an unknown along with HA, HC, and HD. Standard #5 was used for fundamental parameters calibration and then analyzed as an unknown along with A1, B1, and #6. The results are included in Table 37. With PIXE, standards #1 through #3 were submitted as unknowns to determine the precision and accuracy of the technique. The results by PIXE are included in Table 38. All standards were not submitted to all laboratories because of the limited time available to complete the analyses and return the standards.

In Work Assignment Nos. 26 and 31, EPA Contract 68-03-3162, the exterior surfaces of the oxygen sensor tips were analyzed by x-ray fluorescence. This technique resulted in relative concentrations with no means of determining actual concentrations due to the lack of appropriate standards. In this work assignment, ESCA was employed to examine the exterior surface concentrations on the sensor tips. ESCA is a standardless technique. The only limitation is the depth of penetration (about 100Å), The depth of penetration for x-ray fluorescence is between 2 and 200 microns, depending on the element. Heavier atomic weight elements have larger penetration. This limitation is reduced by the fact that the majority of the elements of concern should be located near the exterior surface of the sample. A limitation for x-ray fluorescence is that only elements with atomic weights above sodium can be detected. Elements such as carbon, nitrogen, and oxygen cannot be detected with x-ray fluorescence. ESCA is capable of detecting all elements except hydrogen and helium. Another question that needed to be answered was presence of uneven distribution of the elements on the sensor tip. This question could only be answered by ESCA because very small sampling areas on the surface are used. Sensor tip A218/0045 was examined at nine different locations to determine if the elements were evenly distributed. It should be noted that A218/0045 was a partial sensor tip (one side only). The tip was examined at five locations down the axis of the tip from the rounded (closed) end to the cut (open) end of the sensor tip and at four locations around the

TABLE 35. WEIGHT PERCENTAGES OF ELEMENTS IN SwRI STANDARDS

	Weight Percent of Elements in Standard												
Element	#1	#2	#3	#4	#5	#6	A1	B1	HA	HB	HC	HD	Honeycomb Blank
Al	15.89	15.87	15.80	21.09	15.89	10.60	15.86	15.88	--	--	--	--	--
Si	0.03	0.05	0.09	--	0.95	5.51	13.99	14.01	--	--	--	--	--
Fe	--	--	--	--	--	--	0.31	0.17	--	--	--	--	--
P	0.12	--	0.27	--	0.54	--	--	--	--	--	--	--	--
S	1.01	--	0.31	--	--	1.91	--	--	0.35	0.63	--	1.01	--
Ni	0.16	0.09	0.25	--	3.18	0.88	--	0.47	0.19	1.03	--	--	--
Zn	0.17	0.03	0.08	--	--	--	0.38	0.12	0.20	0.11	0.14	0.02	--
Mn	0.04	0.14	0.38	--	--	--	--	--	--	--	--	--	--
Ca	0.02	0.08	0.05	--	--	--	--	--	--	--	--	--	--
Ce	--	0.17	--	--	--	--	--	0.58	1.15	1.10	--	--	--
Ti	--	--	--	--	--	--	0.13	--	--	--	0.27	0.10	--
Pt	0.12	0.20	0.30	--	0.80	--	--	--	0.02	0.05	0.04	0.03	--
Pb	0.92	0.05	0.18	--	2.72	--	--	--	0.09	0.14	0.49	--	--
Honeycomb	--	--	--	--	--	--	--	--	80	80	80	80	90

TABLE 36. CORRELATION OF SwRI STANDARD BY EPA/RTP

Element		Weight Percentages of Elements in Standards			
		#1	#2	#3	#4
Al	Actual	15.89	15.87	15.80	21.09
	Measured	15.65±0.78	16.34±0.81	16.18±0.81	21.02±1.05
Si	Actual	0.03	0.05	0.09	*
	Measured	*	trace	0.01±0.003	*
P	Actual	0.12	*	0.27	*
	Measured	0.10±0.01	trace	0.24±0.01	trace
S	Actual	1.01	*	0.31	*
	Measured	1.06±0.05	trace	0.33±0.02	trace
Ca	Actual	0.02	0.08	0.05	*
	Measured	0.03±0.002	0.10±0.01	0.06±0.003	0.01±0.001
Mn	Actual	0.04	0.14	0.38	*
	Measured	0.03±0.002	0.12±0.01	0.31±0.02	trace
Ni	Actual	0.16	0.09	0.25	*
	Measured	0.12±0.01	0.07±0.004	0.21±0.01	*
Zr	Actual	0.17	0.03	0.08	*
	Measured	0.17±0.01	0.03±0.002	0.09±0.002	trace
Pt	Actual	0.12	0.20	0.30	*
	Measured	0.03±0.002	0.03±0.002	0.08±0.004	*
Pb	Actual	0.92	0.05	0.18	*
	Measured	0.69±0.03	0.04±0.002	0.15±0.01	*

* - below the detection limit
trace - at detection limit

TABLE 37. CORRELATION OF SwRI STANDARD BY SSL

Element		Weight Percent of Elements in Standards							
		HA	HB[a]	HC	HD	A1	B1	#5	#6
S	Actual	0.35	0.63	*	1.01	*	*	*	1.91
	Measured	0.30	0.63	*	0.69	0.43	0.41	*	1.97
Ti	Actual	*[b]	*	0.27	0.10	0.13	*	*	*
	Measured	*	*	0.27	0.10	0.15	*	*	*
Ni	Actula	0.19	1.03	*	*	*	0.47	3.18	0.88
	Measured	0.16	1.03	*	*	*	0.66	3.18	0.74
Zn	Actual	0.20	0.11	0.14	0.02	0.38	0.12	*	*
	Measured	0.18	0.11	0.07	*	0.36	0.15	*	*
Ce	Actual	1.15	1.10	*	*	*	0.58	*	*
	Measured	0.96	1.10	*	*	*	0.32	*	*
Pt	Actual	0.02	0.05	0.04	0.03	*	*	0.80	*
	Measured	0.05	0.05	0.03	0.02	0.02	0.01	0.80	*
Pb	Actual	0.09	0.14	0.49	*	*	*	2.72	*
	Measured	0.09	0.14	0.27	*	*	*	2.72	*
Al	Actual	*	*	*	*	15.89	10.60	15.86	15.88
	Measured	*	*	*	*	15.89	10.45	9.18	9.78
Si	Actual	*	*	*	*	0.95	5.51	13.99	14.01
	Measured	*	*	*	*	0.95	2.40	45.37	45.08
P	Actual	*	*	*	*	0.54	*	*	*
	Measured	*	*	*	*	0.54	0.09	·0.07	0.02

[a]Standard HB was used to establish fundamental parameters
[b]None present and none detected

TABLE 38. CORRELATION OF SwRI STANDARD BY PIXE

Element		Weight Percentages of Elements in Standards #1	#2	#3	#4
Al	Actual	15.89	15.87	15.80	21.09
	Measured	16.0±0.19	17.0±0.21	17.4±0.21	22.1±0.27
Si	Actual	0.03	0.05	0.09	*
	Measured	trace	trace	0.03±0.01	trace
P	Actual	0.12	*	0.27	*
	Measured	0.11±0.01	*	0.26±0.01	*
S	Actual	1.01	*	0.31	*
	Measured	0.58±0.01	*	0.15±0.01	*
Ca	Actual	0.02	0.08	0.05	*
	Measured	0.03±0.002	0.10±0.003	0.07±0.004	0.01±0.001
Mn	Actual	0.04	0.14	0.38	*
	Measured	0.04±0.0005	0.13±0.001	0.43±0.004	*
Ni	Actual	0.16	0.09	0.25	*
	Measured	0.14±0.001	0.09±0.001	0.25±0.002	*
Zn	Actual	0.17	0.03	0.08	*
	Measured	0.16±0.001	0.03±0.0004	0.08±0.001	*
Pt	Actual	0.12	0.20	0.30	*
	Measured	0.06±0.001	0.08±0.001	0.14±0.002	*
Pb	Actual	0.92	0.05	0.18	*
	Measured	0.71±0.01	0.04±0.001	0.16±0.002	*

* - below the detection limit
trace - at detection limit

circumference of the mid point of the sensor tip. The locations are illustrated in Figure 7 and the elemental concentrations are shown in Table 39. In general, there was an even distribution of elements over the entire surface except near the rounded or closed end of the sensor tip, Visually, the sensor tip was black near the cut or open end, indicating carbonaceous deposits, and changes to a light brown at the rounded end, indicating the spinel coating. Carbon and oxygen are the major components with trace amounts of other elements scattered across the tip. Magnesium was detected in two of the three locations with the carbon concentration less than 80%. The presence of magnesium indicates that the carbon layer was much thinner at this location (less than 100A), and the depth of penetration was into the spinel coating. The sampling location for all of the remaining sensor tips was near the mid point of the long axis and at a typical location around the circumference. The ESCA spectra of each location are presented in Appendix I.

V. Summary

In summary, a total of 42 catalysts were examined for converter efficiency and light-off times, whole converter x-ray, x-ray fluorescence, x-ray diffraction, SEM with dot mapping, PIXE, and B.E.T. surface area analysis. Of these 42 catalysts, 29 were whole converters and 11 were partial catalyst samples. Nine converters were evaluated "on-engine" only, 7 received laboratory analysis only, and 17 were examined "on-engine" and by laboratory analysis. In addition, 12 oxygen sensors were evaluated for one or more of the following: screening tests (light-off, voltage response, and voltage output), surface area analysis, and ESCA for elements on the sensor exterior.

This letter report is a compilation of all of the data available at the time of submittal, and is intended to serve as the final report of the results for the program. We hope that the results from these catalyst evaluations will help to answer some of the EPA questions about relationships between catalyst efficiency and catalyst condition. Please contact us if there are additional questions, or if we can be of further assistance.

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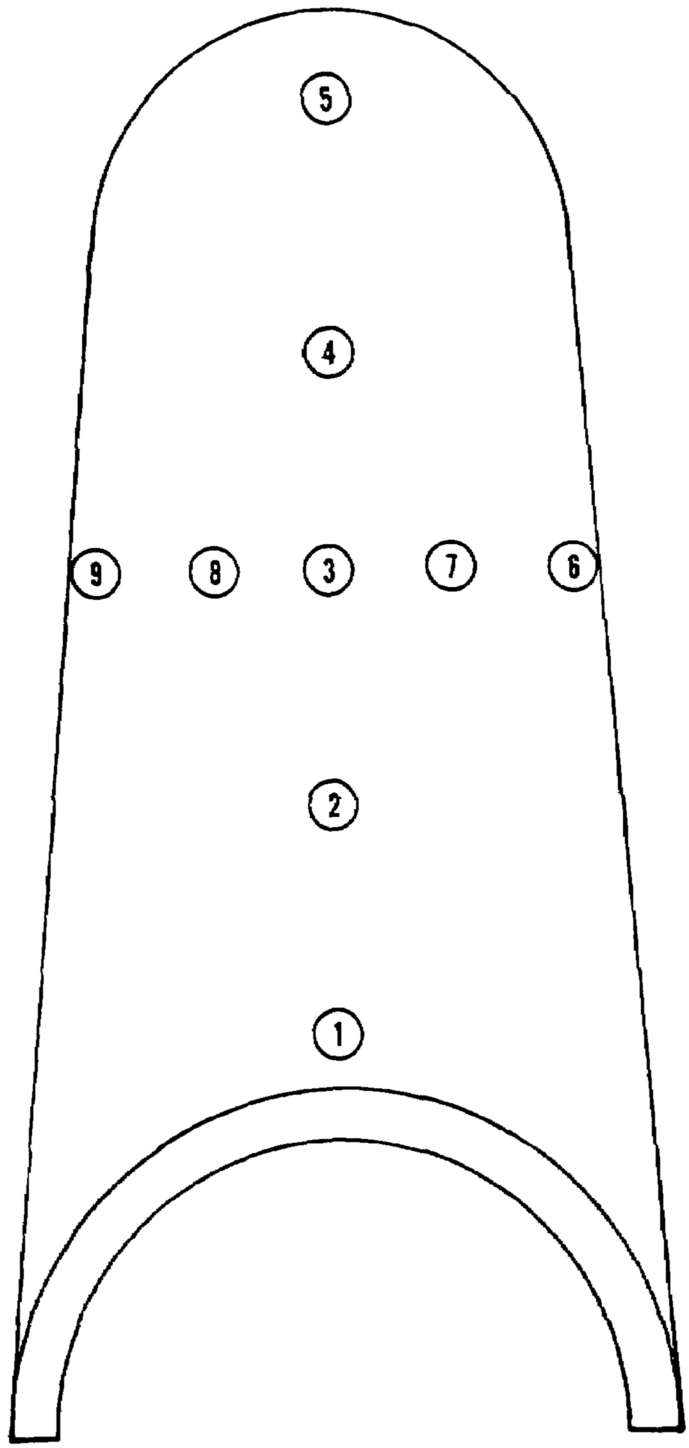


Figure 7. Sample location for Sensor Tip A218/0045

TABLE 39. ELEMENTAL CONCENTRATION AT SEVERAL LOCATIONS ON SENSOR TIP A218/0045

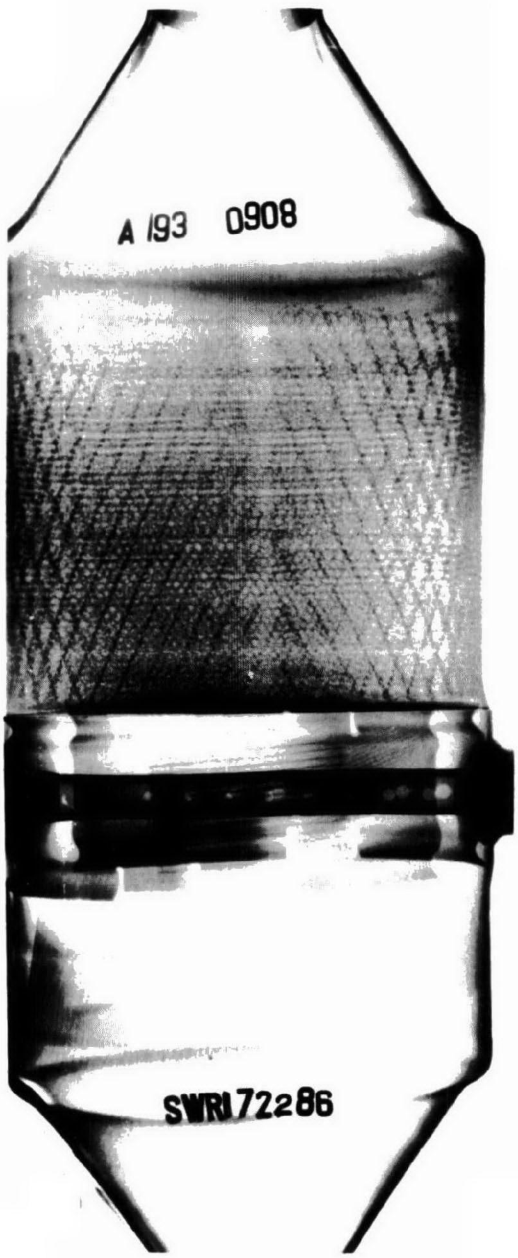
Location	Weight Percent of Elements									
	C	O	Na	Pb	Mg	P	Ca	B	N	S
1	86	11	1.1	0.4	1.0	--	--	--	--	--
2	87	13	--	0.4	--	--	--	--	--	--
3	84	13	2.1	0.4	--	--	--	--	--	--
4	74	16	--	1.0	3.3	--	--	5.3	--	--
5	78	17	1.4	1.0	--	1.8	0.2	--	--	--
6	86	13	--	0.4	--	0.6	--	--	0.4	--
7	84	14	--	0.7	--	1.2	--	--	--	0.5
8	73	18	1.4	1.5	3.8	2.3	--	--	--	--
9	83	15	0.7	0.7	--	0.9	--	--	--	--

1 - closest to cut end (open) of sensor tip
2 - 75% of total length from closed end of sensor tip
3 - halfway between cut end and closed end of sensor tip
4 - 25% of total length from closed end of sensor tip
5 - closest to closed end of sensor tip
6 - far right of location 3
7 - right center of location 3
8 - left center of location 3
9 - far left of location 3

APPENDIX A

WHOLE CATALYST X-RAY RADIOGRAPHS

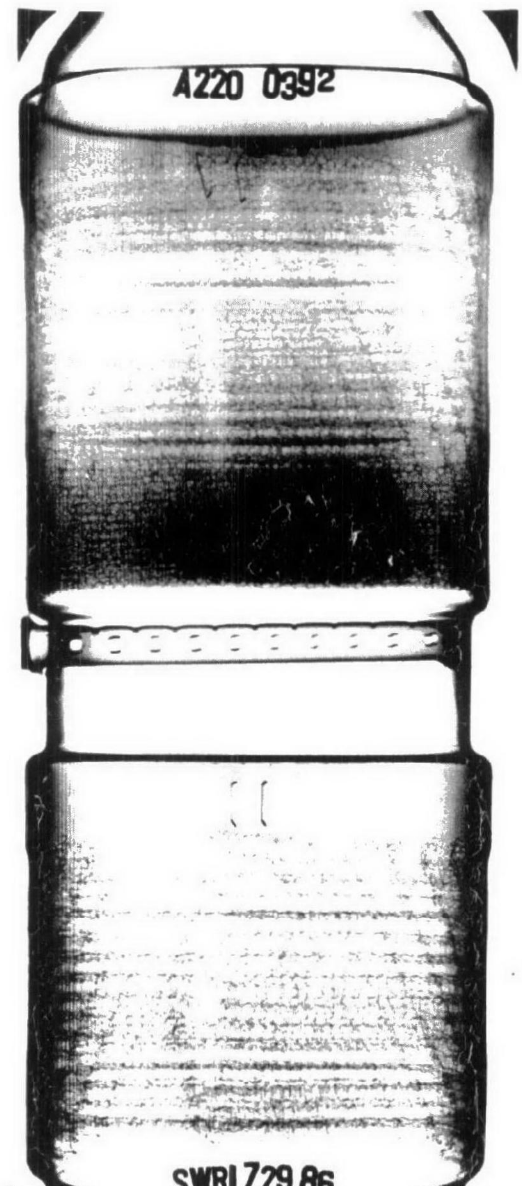
INLET



OUTLET

Figure A-1. X-Ray Radiograph of A193/0908

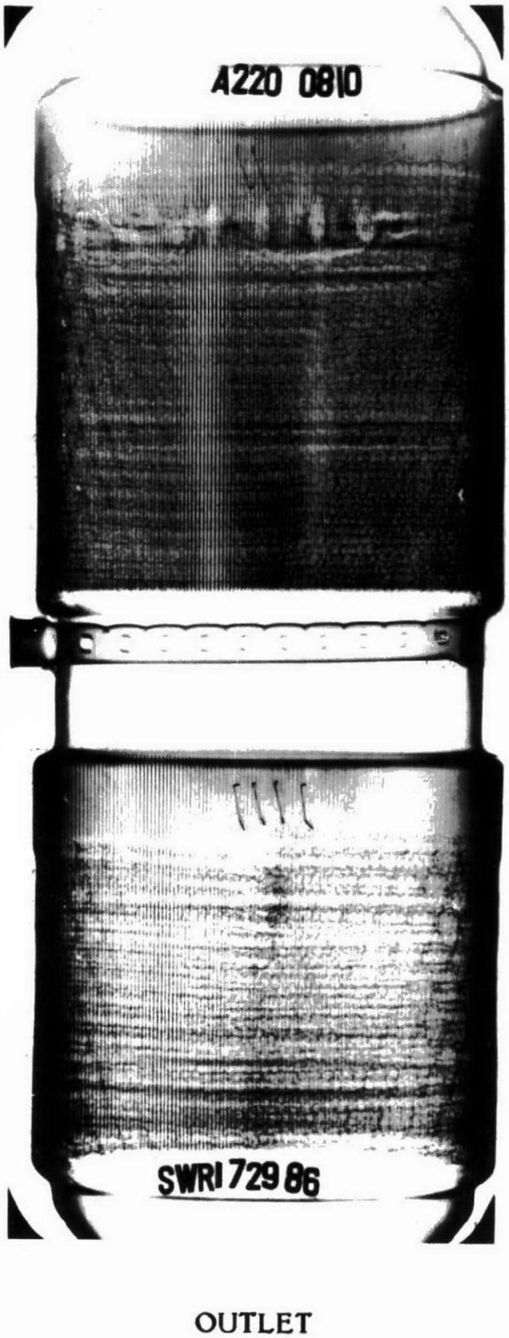
INLET



OUTLET

Figure A-2. X-Ray Radiograph of A220/0392

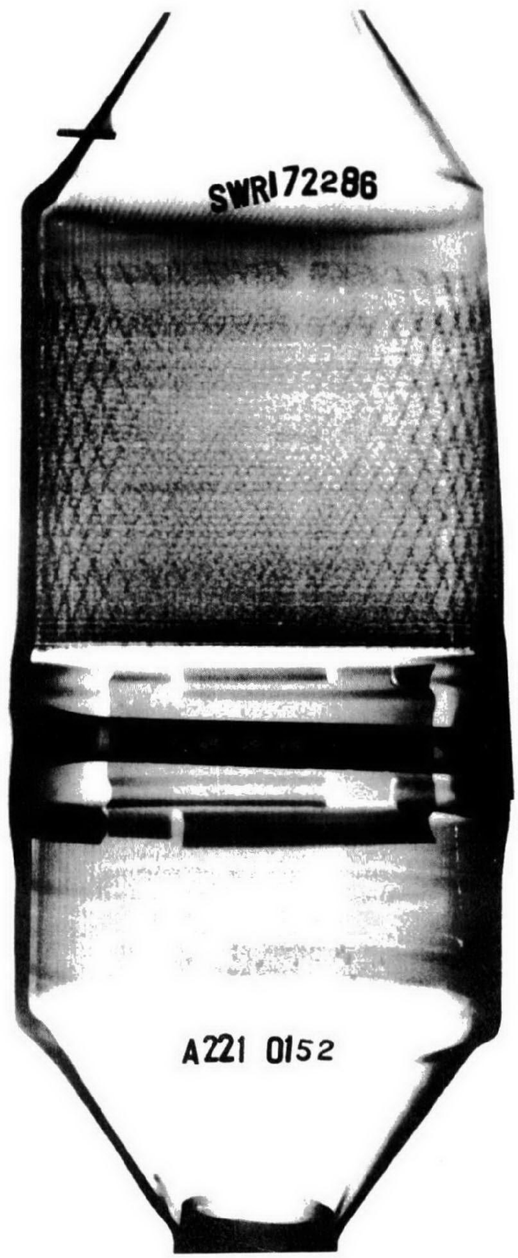
INLET



OUTLET

Figure A-3. X-Ray Radiograph of A220/0810

INLET



OUTLET

Figure A-4. X-Ray Radiograph of A221/0152

INLET

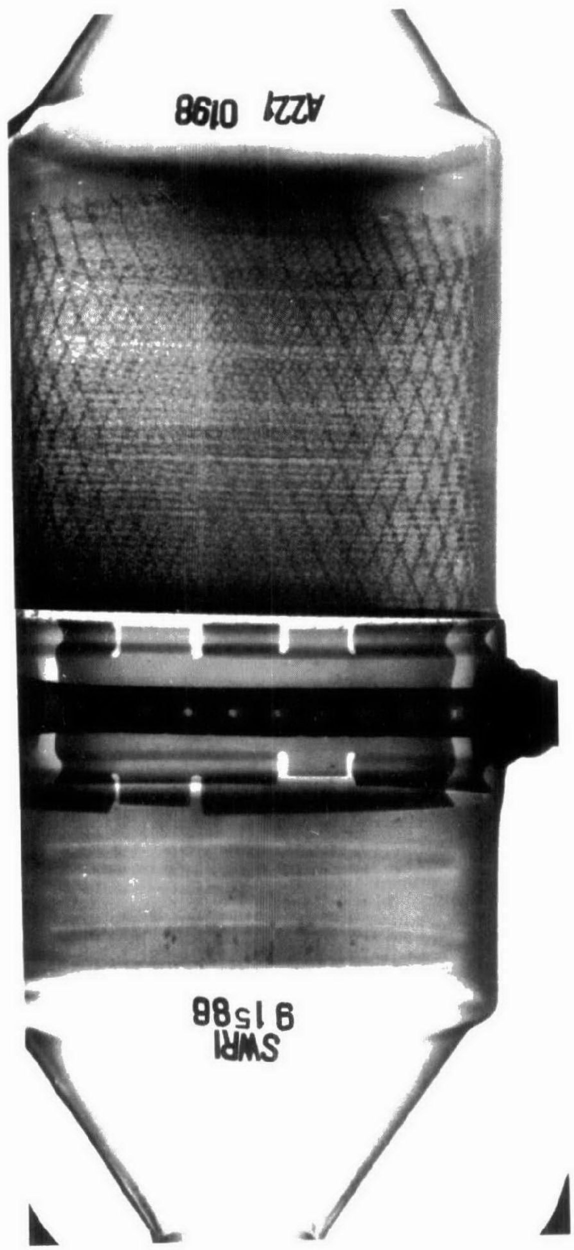


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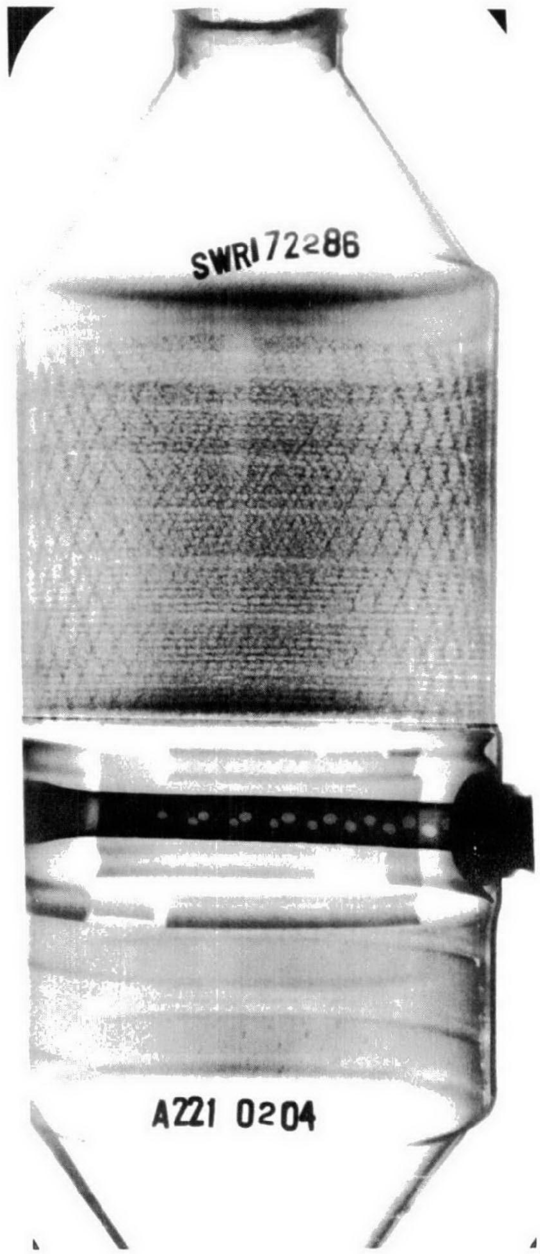
Figure A-5. X-Ray Radiograph of A221/0198

INLET



OUTLET

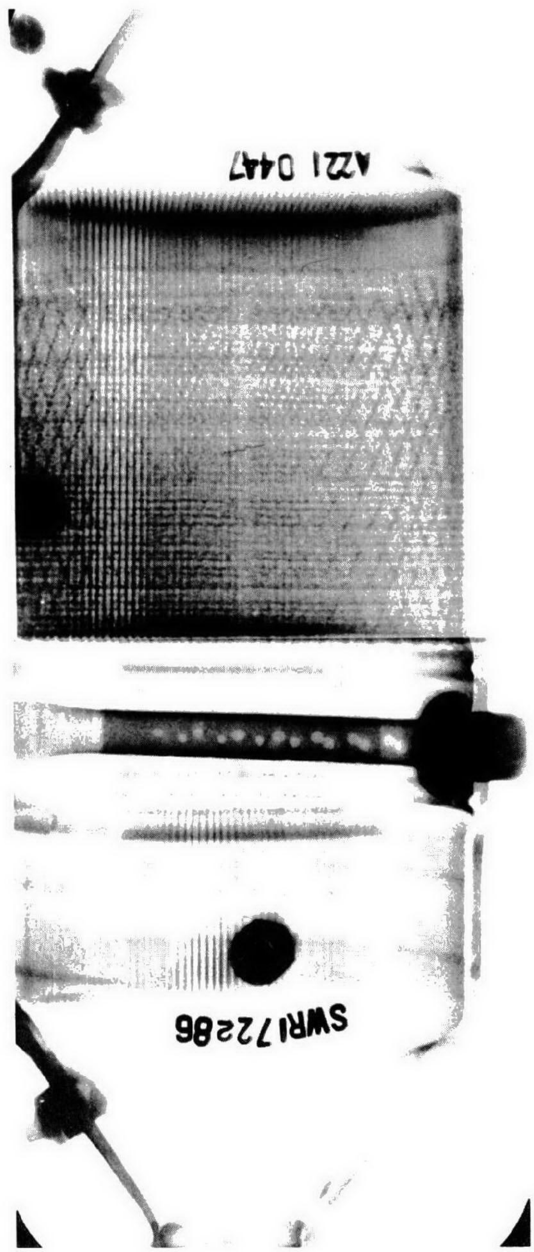
Figure A-6. X-Ray Radiograph of A221/0204

INLET

OUTLET

Figure A-7. X-Ray Radiograph of A221/0310

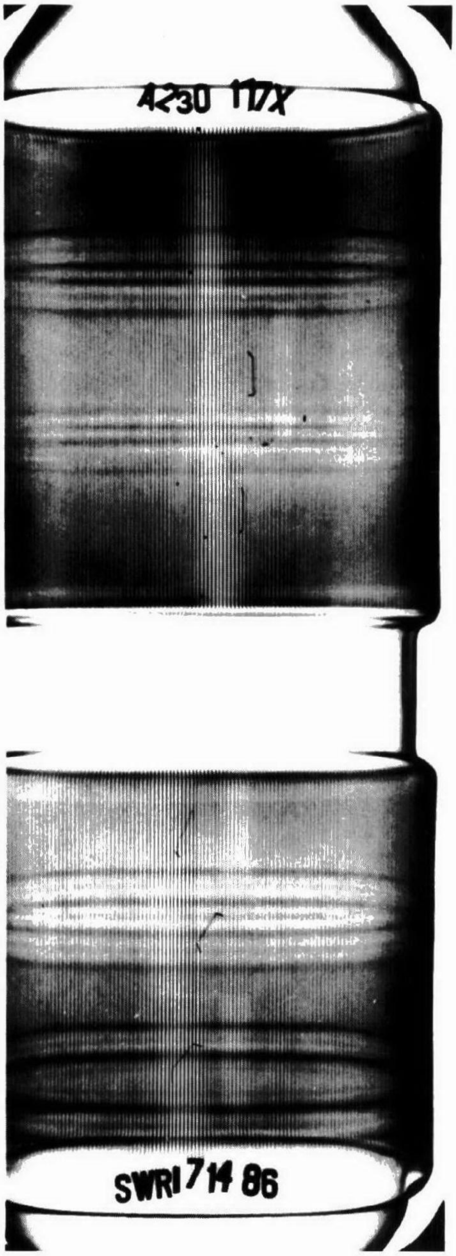
INLET



OUTLET

Figure A-8. X-Ray Radiograph of A221/0447

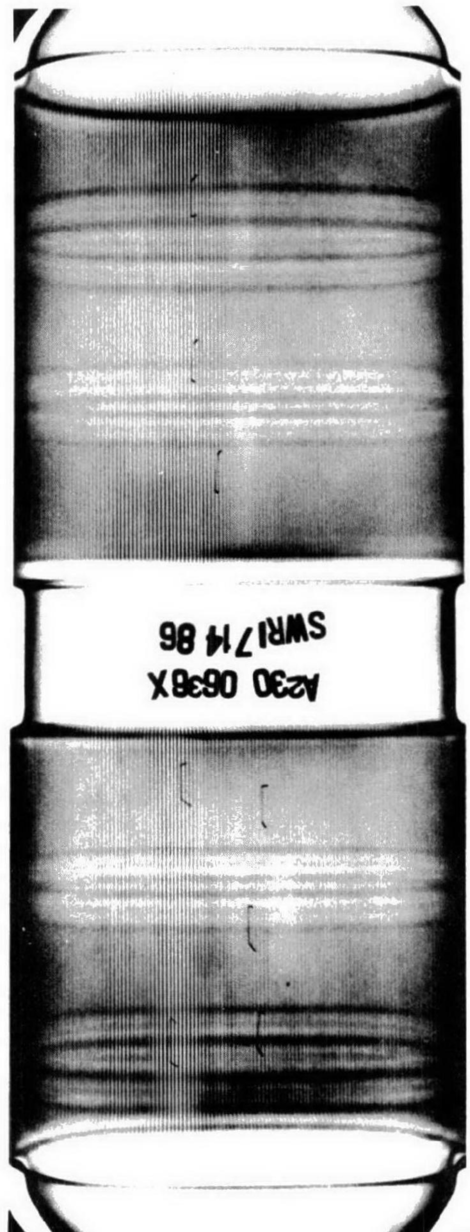
INLET



OUTLET

Figure A-9. X-Ray Radiograph of A230/0177X

INLET



OUTLET

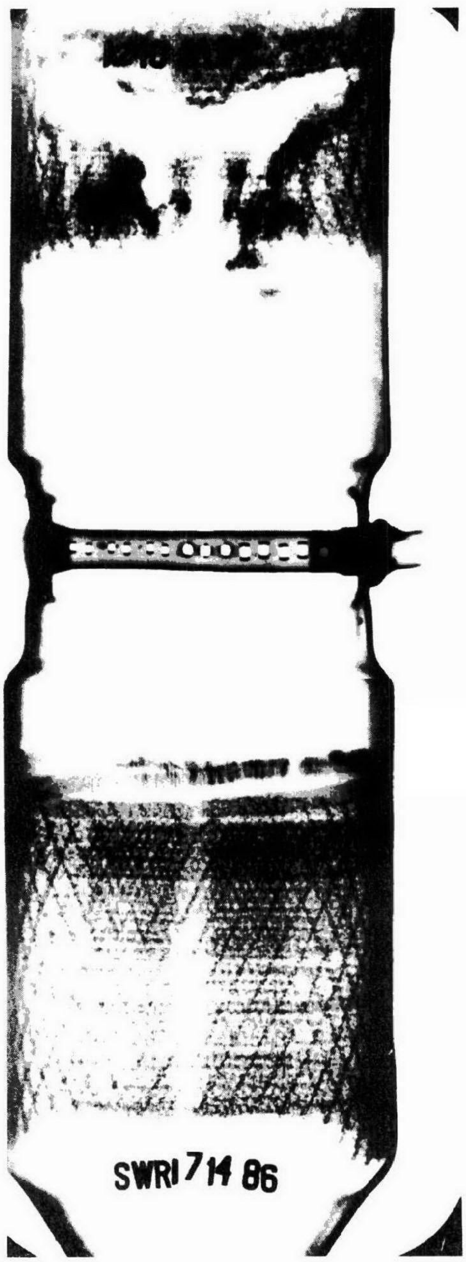
Figure A-10. X-Ray Radiograph of A230/0636X

INLET

OUTLET

Figure A-11. X-Ray Radiograph of A240/0016L

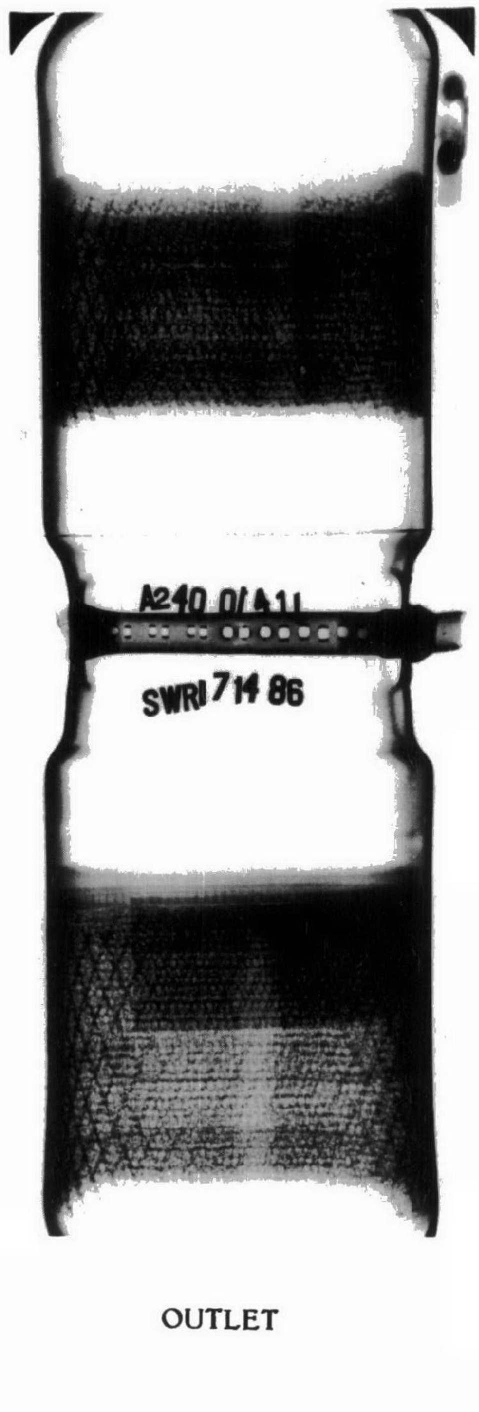
INLET



OUTLET

Figure A-12. X-Ray Radiograph of A240/0102

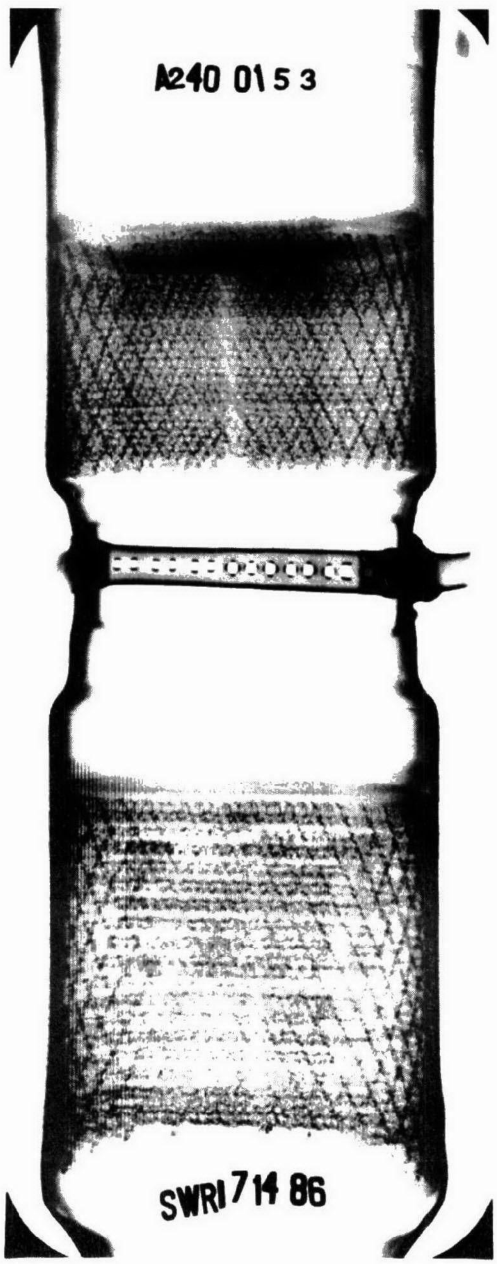
INLET



OUTLET

Figure A-13. X-Ray Radiograph of A240/0141L

INLET



OUTLET

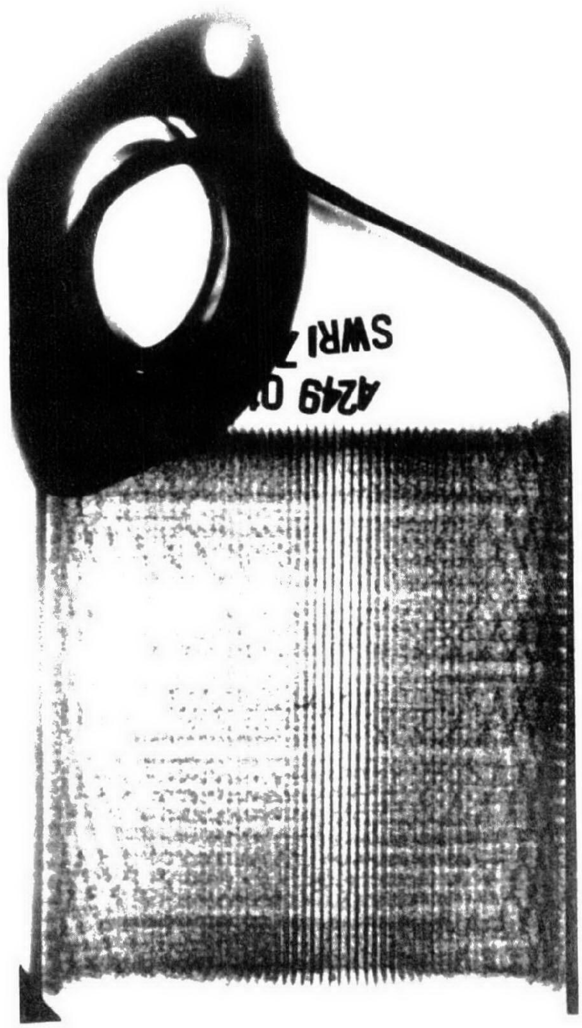
Figure A-14. X-Ray Radiograph of A240/0153

INLET

OUTLET

Figure A-15. X-Ray Radiograph of A240/0334L

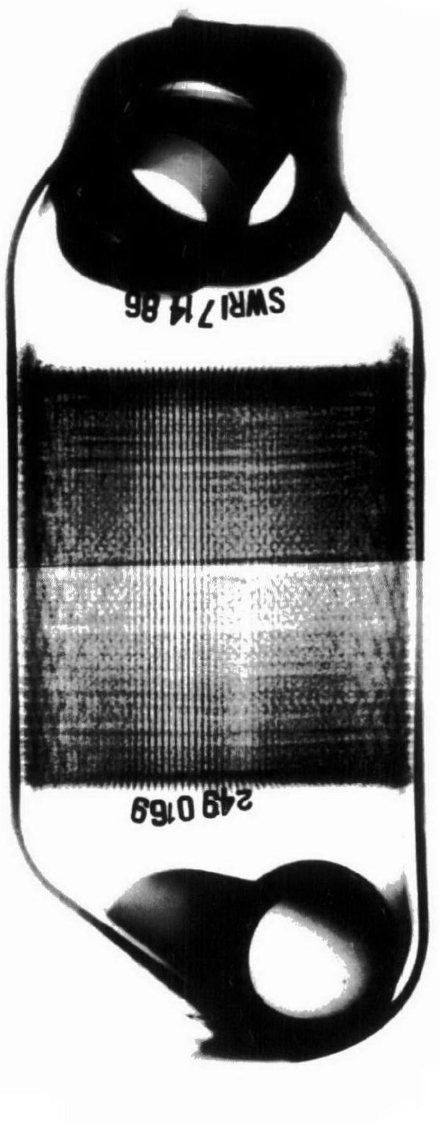
INLET



OUTLET

Figure A-16. X-Ray Radiograph of A249/0169-1

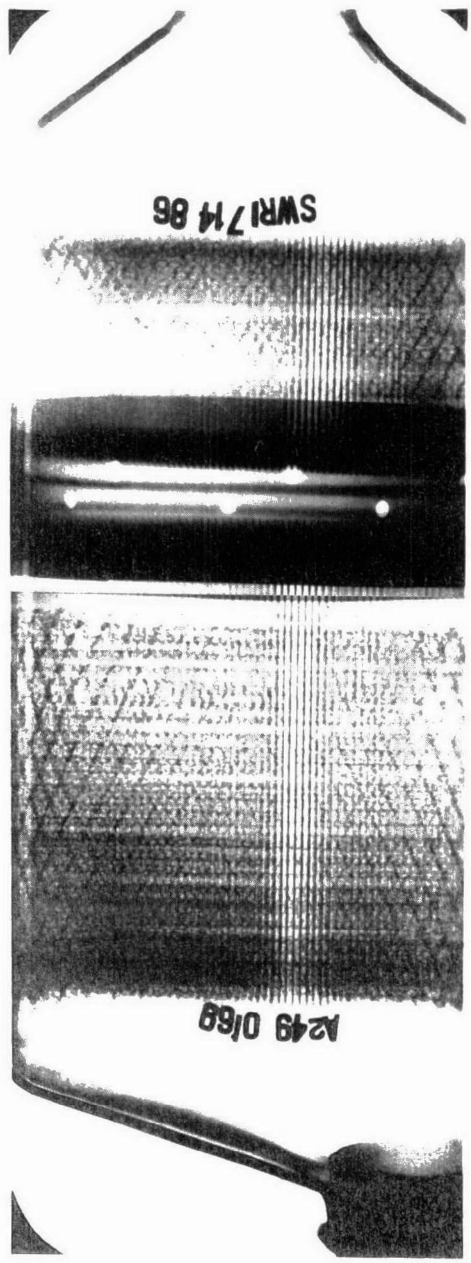
INLET



OUTLET

Figure A-17. X-Ray Radiograph of A249/0169-2

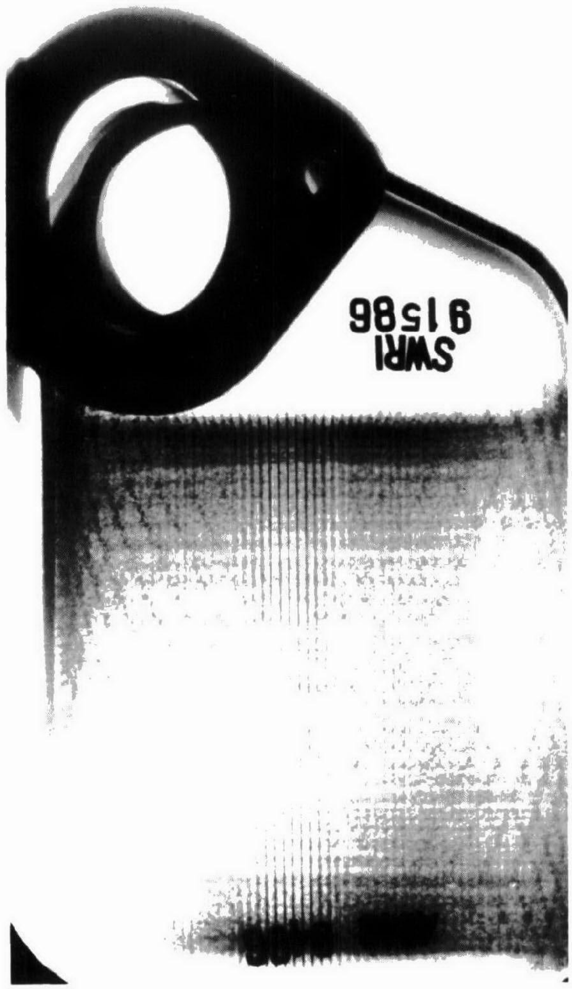
INLET



OUTLET

Figure A-18. X-Ray Radiograph of A249/0169-3

INLET



OUTLET

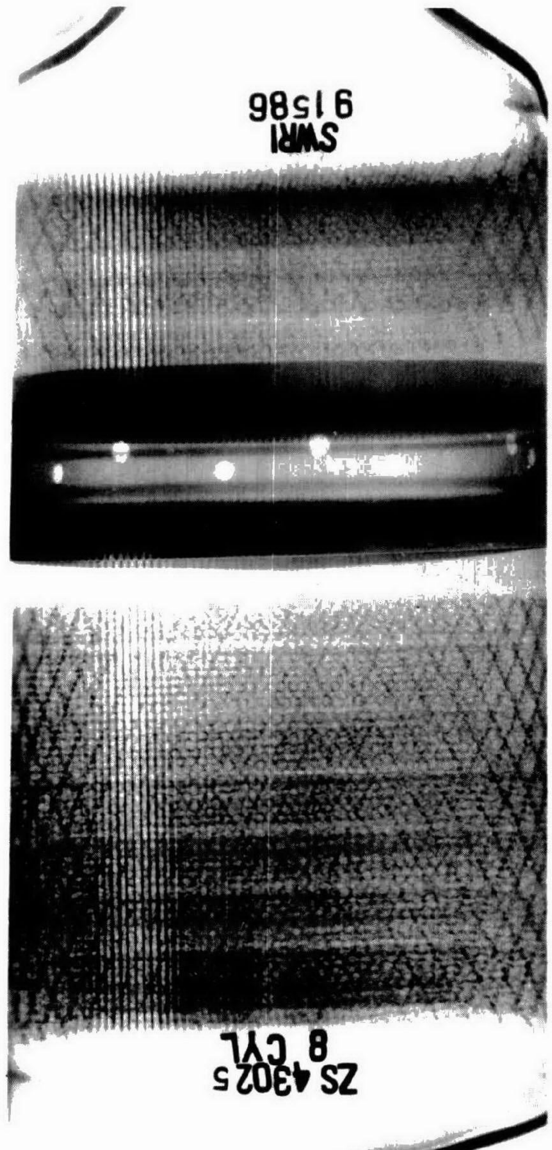
Figure A-19. X-Ray Radiograph of A249/0486-1

INLET

OUTLET

Figure A-20. X-Ray Radiograph of A249/0486-2

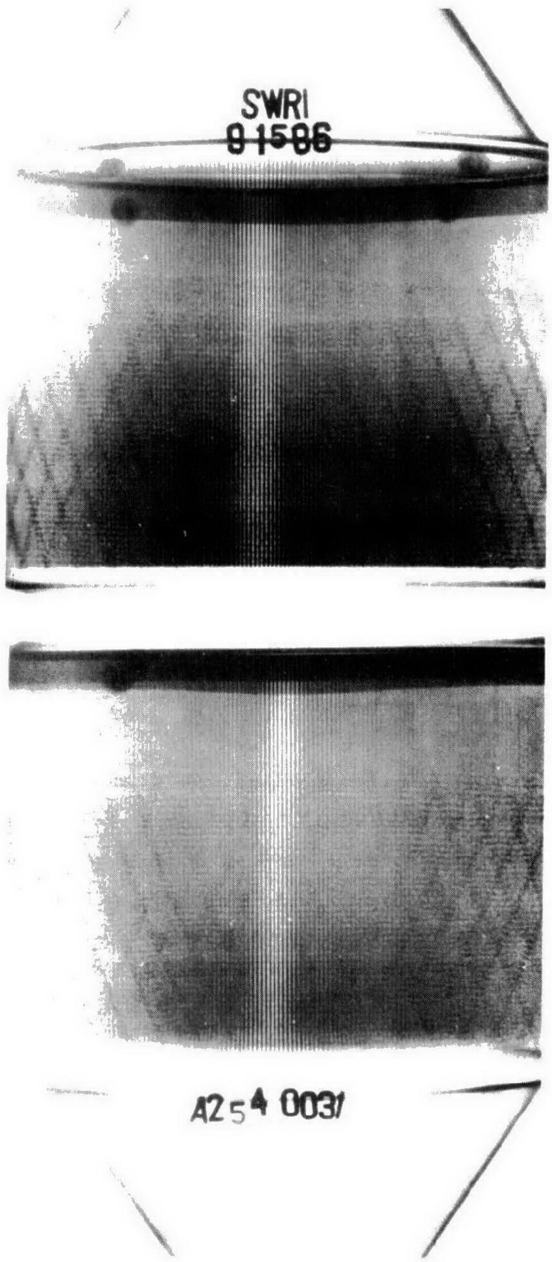
INLET



OUTLET

Figure A-21. X-Ray Radiograph of A249/0486-3

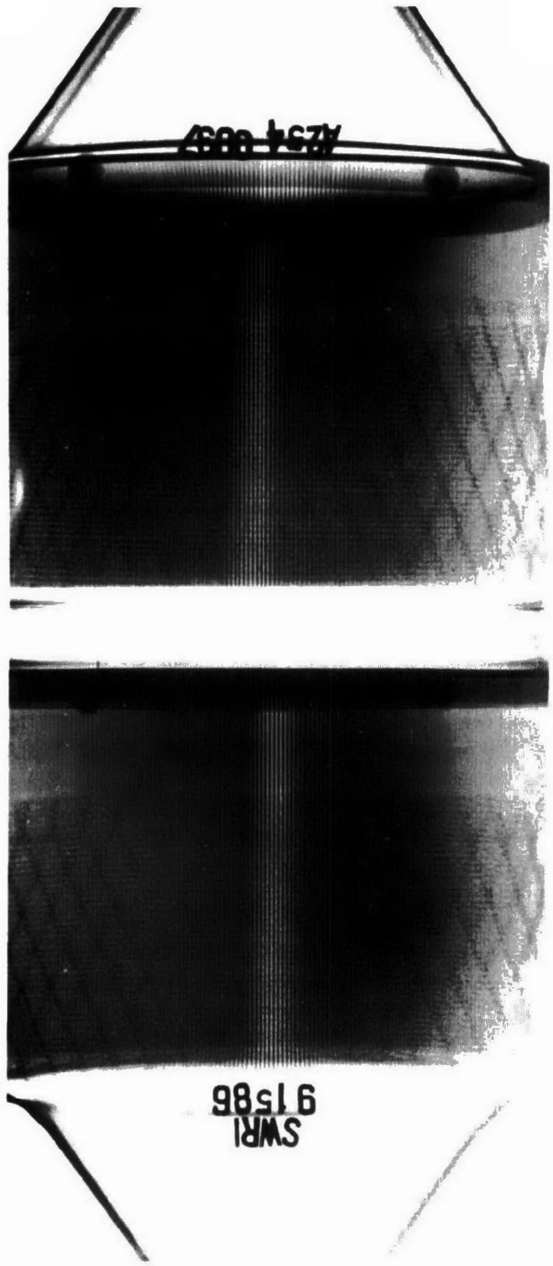
INLET



OUTLET

Figure A-22. X-Ray Radiograph of A254/0031

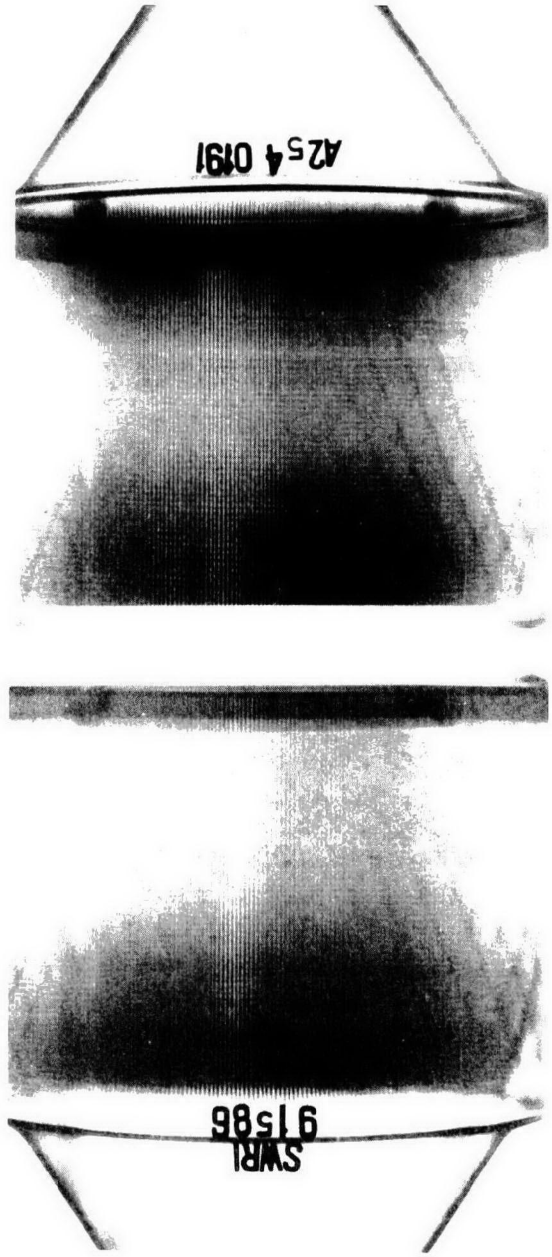
INLET



OUTLET

Figure A-23. X-Ray Radiograph of A254/0037

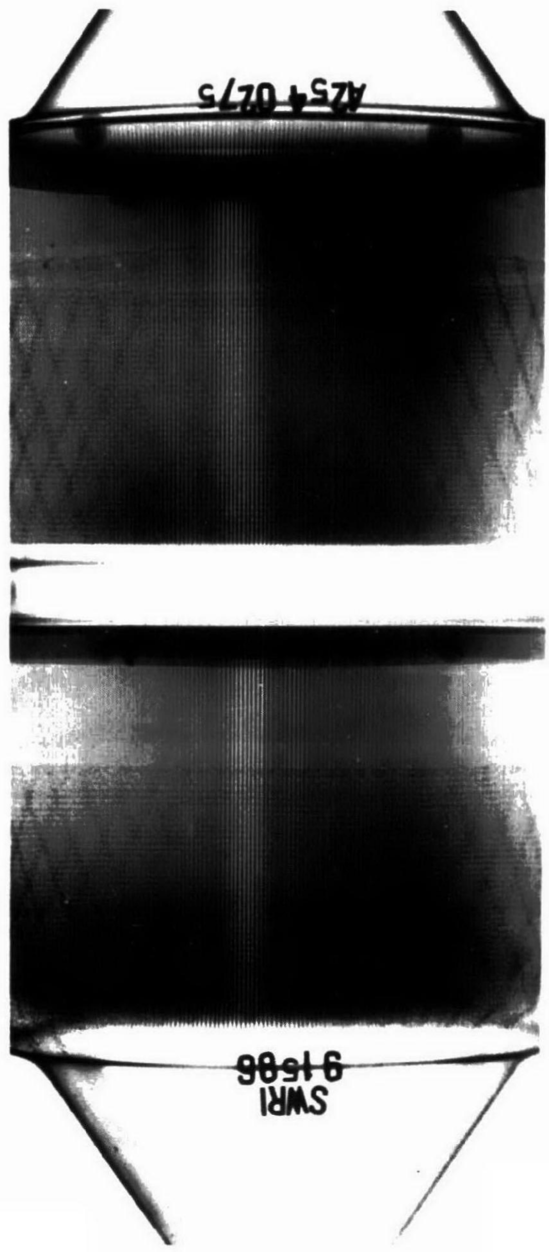
INLET



OUTLET

Figure A-24. X-Ray Radiograph of A254/0191

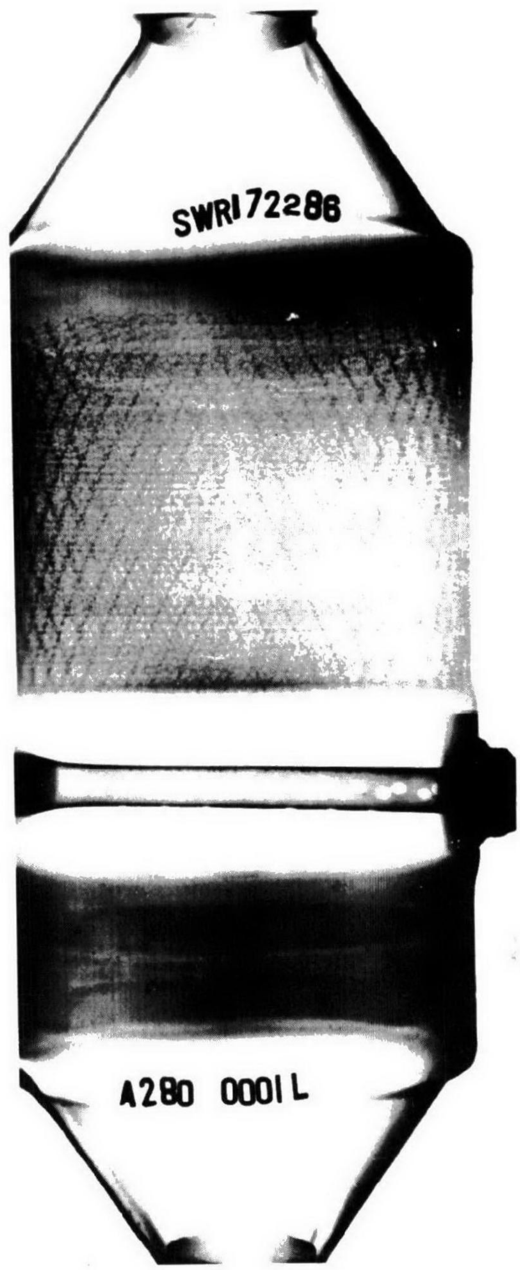
INLET



OUTLET

Figure A-25. X-Ray Radiograph of A254/0275

INLET



OUTLET

Figure A-26. X-Ray Radiograph of A280/0001L

APPENDIX B

ON-ENGINE CONVERTER EFFICIENCIES AND LIGHT-OFF TIMES

TABLE B-1. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A193/0908

A/F Ratio	Sample Location	Converter Efficiency Data					
		HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.08	Inlet	2524	2.10	1270	1.08	12.89	740
	Outlet	1600	1.38	900			682
	CE %	36.6	34.3	29.1			
14.29	Inlet	2424	1.74	1370	1.13	13.02	746
	Outlet	1475	1.09	963			661
	CE %	39.2	37.4	29.7			
14.47	Inlet	2174	1.43	1446	1.18	13.02	748
	Outlet	1150	0.80	963			665
	CE %	47.1	44.1	33.4			
14.72*	Inlet	1774	0.98	1395	1.28	13.29	748
	Outlet	200	0.02	837			706
	CE %	88.8	98.0	40.0			
14.94	Inlet	1649	0.84	1446	1.38	13.43	748
	Outlet	175	0.01	973			712
	CE %	89.4	98.8	35.2			
15.10	Inlet	1349	0.73	1446	1.58	13.43	747
	Outlet	150	0.004	1076			688
	CE %	88.9	99.4	25.6			
15.29	Inlet	1149	0.66	1471	1.63	13.29	749
	Outlet	125	0.003	1126			668
	CE %	89.1	99.6	23.4			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM		Intake Air		Exhaust		Bar. in. Hg
				Engine	Injected	°F	in. H_2O Vac	°F	in. H_2O	
14.08	1810	16.6	21.1	46.8	2.49	97	0.7	961	5.5	29.17
14.29	1809	16.6	21.0	46.6	2.48	99	0.7	969	5.5	29.16
14.47	1809	16.6	20.8	46.5	2.47	99	0.7	973	5.5	29.15
14.72	1806	16.8	19.6	45.5	2.47	99	0.65	977	5.5	29.15
14.94	1807	16.8	19.6	45.4	2.42	99	0.65	977	5.5	29.14
15.10	1804	16.8	19.5	45.0	2.41	100	0.65	980	5.5	29.12
15.29	1804	16.8	19.2	45.0	2.41	100	0.65	981	5.5	29.11

* - HC and NO_x not within tolerances at 14.7 air fuel ratio

TABLE B-2. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A193/0908

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	2224	87		
	CO	1.99	90		
	NO_x	1760	NA		
50	HC	2224	108		
	CO	1.99	105		
	NO_x	1760	NA		
80	HC	2224	132		
	CO	1.99	123		
	NO_x	1760	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	2249	300	86.7			
	CO	2.02	0.02	99.0			
	NO_x	1760	1714	2.6			
at 600 sec	HC	2249	300	86.7			
	CO	2.04	0.02	99.0			
	NO_x	1735	1676	3.4			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	12.6	36.6	65.6	9.61	106	1.1	1036	14.3	29.09

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-3. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A220/0392

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.14	Inlet	1649	1.19	1257	0.68	14.12	700
	Outlet	175	0.02	535			756
	CE %	89.4	98.3	57.4			
14.35	Inlet	1549	1.13	1408	0.68	14.12	704
	Outlet	150	0.02	510			736
	CE %	90.3	98.2	63.8			
14.52	Inlet	1449	0.95	1408	0.83	13.98	705
	Outlet	150	0.01	611			710
	CE %	89.6	99.0	56.6			
14.68*	Inlet	1249	0.68	1408	0.98	14.12	709
	Outlet	100	0.003	862			680
	CE %	92.0	99.6	38.8			
14.88	Inlet	1249	0.57	1408	1.13	14.12	710
	Outlet	100	0.003	900			660
	CE %	92.0	99.5	36.1			
15.18	Inlet	1099	0.47	1383	1.28	14.12	711
	Outlet	100	0.002	887			643
	CE %	90.9	99.6	35.9			
15.26	Inlet	900	0.35	1307	1.48	14.12	710
	Outlet	75	0.002	862			623
	CE %	91.7	99.4	34.0			

Engine Operation Data

A/F	Speed	Man Vac	Power	Air Flow, SCFM		Intake Air		Exhaust		Bar.
Ratio	rpm	in. Hg	Hp obs	Engine	Injected	°F	in. H_2O Vac	°F	in. H_2O	in. Hg
14.14	1796	16.8	20.3	46.3	2.51	98	0.7	ND	6	29.05
14.35	1794	16.7	20.1	46.3	2.51	97	0.7	ND	6	29.05
14.52	1796	16.7	19.8	46.1	2.50	98	0.7	ND	6	29.06
14.68	1795	16.7	19.6	46.1	2.51	97	0.7	ND	6	29.06
14.88	1793	16.7	19.1	46.3	2.52	97	0.7	ND	6	29.06
15.08	1796	16.8	19.0	46.3	2.54	97	0.65	ND	6	29.07
[illegible].26	1793	16.8	18.5	46.3	2.56	96	0.65	ND	6	29.07

*HC not within tolerance at 14.7 air/fuel ratio

TABLE B-4. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A220/0392

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1649	36		
	CO	2.02	34		
	NO_x	1383	ND		
50	HC	1649	47		
	CO	2.02	42		
	NO_x	1383	ND		
80	HC	1649	68		
	CO	2.02	58		
	NO_x	1383	ND		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1699	150	91.2			
	CO	2.02	.003	99.8			
	NO_x	1408	ND	ND			
at 600 sec	HC	1549	150	90.3			
	CO	1.99	.002	99.9			
	NO_x	1408	ND	ND			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1807	13.2	35.1	64.8	9.06	98	1.07	ND	15	29.06

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %
ND: No Data

TABLE B-5. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE UNIT A220/0810

A/F Ratio	Sample Location	Converter Efficiency Data HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.08	Inlet	1749	1.57	1509	0.63	13.84	728
	Outlet	220	0.09	1013			821
	CE %	87.4	94.3	32.9			
14.32	Inlet	1599	1.13	1634	0.78	13.84	731
	Outlet	200	0.02	1038			758
	CE %	87.5	98.2	36.5			
14.50	Inlet	1549	0.98	1659	0.88	14.12	721
	Outlet	200	0.01	1013			729
	CE %	87.1	99.0	38.9			
14.65	Inlet	1499	0.84	1685	0.98	14.12	730
	Outlet	150	0.01	988			712
	CE %	90.0	98.8	41.4			
14.85	Inlet	1299	0.65	1710	1.18	14.12	735
	Outlet	150	0.003	1138			693
	CE %	88.4	99.5	33.4			
15.07	Inlet	1199	0.47	1710	1.38	13.84	733
	Outlet	150	0.002	1264			665
	CE %	87.5	99.6	26.1			
15.26	Inlet	1049	0.42	1685	1.48	13.98	733
	Outlet	150	0.002	1214			655
	CE %	85.7	99.5	28.0			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.08	1805	16.2	23.0	49.3	2.79	93	0.7	ND	8	29.15
14.32	1805	16.2	22.7	49.6	2.79	93	0.7	ND	8	29.15
14.50	1805	16.2	22.6	49.3	2.79	93	0.7	ND	8	29.16
14.65	1804	16.2	22.4	49.3	2.79	93	0.7	ND	8	29.16
14.85	1803	16.25	22.2	49.3	2.79	93	0.7	ND	8	29.16
15.07	1802	16.25	21.8	49.2	2.79	92	0.7	ND	8	29.17
15.26	1802	16.25	21.6	49.2	2.79	92	0.7	ND	8	29.17

TABLE B-6. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A220/0810

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
50	HC	1599	34		
	CO	2.10	21		
	NO_x	1307	38		
80	HC	1599	41		
	CO	2.10	37		
	NO_x	1307	NA		
90	HC	1599	56		
	CO	2.10	43		
	NO_x	1307	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1599	250	84.4			
	CO	1.99	0.002	99.9			
	NO_x	1383	1289	6.8			
at 600 sec	HC	1699	175	89.7			
	CO	1.99	0.002	99.9			
	NO_x	1333	1314	1.4			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1801	12.7	37.7	67.7	11.46	93	1.12	ND	16	29.12

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-7. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A221/0152

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.06	Inlet	2199	1.55	1295	0.73	13.56	742
	Outlet	700	0.29	762			785
	CE %	68.2	81.3	41.2			
14.30	Inlet	1949	1.36	1358	0.83	13.70	743
	Outlet	250	0.07	485			772
	CE %	87.2	94.8	64.3			
14.45	Inlet	1849	1.08	1458	0.88	13.84	743
	Outlet	200	0.02	686			728
	CE %	89.2	98.2	53.0			
14.67	Inlet	1699	0.73	1471	1.03	13.98	745
	Outlet	150	0.01	963			710
	CE %	91.2	98.6	34.5			
14.90	Inlet	1499	0.56	1458	1.18	13.98	745
	Outlet	125	0.003	1088			680
	CE %	91.7	99.4	25.4			
15.06	Inlet	1449	0.42	1458	1.33	13.98	745
	Outlet	125	0.002	1214			665
	CE %	91.4	99.5	16.7			
15.26	Inlet	1324	0.37	1383	1.43	13.98	744
	Outlet	125	0.002	1189			649
	CE %	90.6	99.4	14.0			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.06	1800	16.6	20.9	45.9	3.17	96	0.65	964	4.5	29.22
14.30	1800	16.6	20.8	45.9	3.17	95	0.65	966	4.5	29.22
14.45	1800	16.6	20.7	46.1	3.17	95	0.65	971	4.5	29.23
14.67	1800	16.6	20.7	46.1	3.17	95	0.65	976	4.5	29.23
14.90	1800	16.6	20.5	46.1	3.17	95	0.65	979	4.5	29.24
15.06	1800	16.6	20.2	46.2	3.17	94	0.65	981	4.5	29.24
15.26	1800	16.6	19.8	46.2	3.17	94	0.65	980	4.5	29.25

TABLE B-8. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A221/0152

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 1 730° Converter Inlet	Test 1 730° Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	2499	84		
	CO	2.06	77		
	NO_x	1634	82		
50	HC	2499	96		
	CO	2.06	86		
	NO_x	1634	NA		
80	HC	2499	131		
	CO	2.06	102		
	NO_x	1634	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	2499	325	87.0			
	CO	1.99	0.02	99.0			
	NO_x	1584	1489	6.0			
at 600 sec	HC	2499	300	88.0			
	CO	2.06	0.01	99.5			
	NO_x	1609	1589	1.2			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	12.8	37.5	66.7	9.45	95	1.1	1052	9.7	29.18

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-9. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A221/0198

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.08	Inlet	2349	1.62	1584	0.73	13.56	723
	Outlet	625	0.25	1138			847
	CE %	73.3	84.6	28.2			
14.32	Inlet	2149	1.28	1672	0.88	13.56	716
	Outlet	700	0.21	1289			776
	CE %	67.4	83.6	22.9			
14.52	Inlet	1999	1.01	1722	1.03	13.56	714
	Outlet	200	0.06	762			793
	CE %	90.0	94.1	55.8			
14.68	Inlet	1999	0.89	1735	1.08	13.84	725
	Ou			736			785
	CE			57.6			
14.89	In			1760	1.23	13.84	703
	Ou			1163			719
	CE			33.9			
15.10	In			1710	1.48	13.56	740
	Ou			1138			709
	CE			33.4			
15.25	In			1697	1.63	13.56	704
	Ou			1264			678
	CE			25.5			

ıtion Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Injected	Intake Air: °F	in. H_2O Vac	Exhaust: °F	in. H_2O	Bar. in. Hg
14.08	1808	14.5	31.3	57.9	3.4	87	0.95	1020	9.0	29.33
14.32	1809	14.4	31.2	57.9	3.4	88	0.95	1020	9.0	29.33
14.52	1810	14.5	31.1	57.7	3.4	89	0.95	1025	9.0	29.33
14.68	1808	14.5	30.4	57.2	3.4	89	0.95	1028	9.0	29.33
14.89	1809	14.4	30.6	57.7	3.4	88	1.0	1024	9.0	29.33
15.10	1807	14.5	29.9	57.6	3.5	88	1.0	1041	9.0	29.34
15.25	1807	14.5	30.0	57.6	3.5	89	1.0	1028	9.0	29.34

C not within tolerance at 14.7 air/fuel ratio

TABLE B-10. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A221/0198

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1799	71		
	CO	1.91	66		
	NO_x	1219	60		
50	HC	1799	86		
	CO	1.91	76		
	NO_x	1219	NA		
80	HC	1799	121		
	CO	1.91	92		
	NO_x	1219	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1899	250	86.8			
	CO	1.88	.005	99.7			
	NO_x	1257	1163	7.5			
at 600 sec	HC	1924	210	89.1			
	CO	1.86	.002	99.9			
	NO_x	1282	1214	5.3			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1810	12.95	40.7	67.2	9.4	84	1.1	1071	14	29.32

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-11. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A221/0204

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.14	Inlet	2324	1.45	1244	0.73	13.43	743
	Outlet	775	0.23	1076			781
	CE %	66.6	84.1	13.5			
14.29	Inlet	2249	1.17	1299	0.78	13.70	745
	Outlet	775	0.20	1126			754
	CE %	65.5	82.9	13.3			
14.47	Inlet	2049	0.91	1345	0.88	13.70	747
	Outlet	700	0.14	1151			719
	CE %	65.8	84.6	14.4			
14.75*	Inlet	1799	0.63	1333	1.13	13.70	749
	Outlet	450	0.06	1076			695
	CE %	75.0	90.5	19.3			
14.91	Inlet	1599	0.53	1320	1.13	13.84	749
	Outlet	200	0.02	1013			689
	CE %	87.5	96.2	23.4			
15.08	Inlet	1449	0.41	1320	1.28	13.70	749
	Outlet	150	0.004	1050			671
	CE %	89.6	99.0	20.4			
15.28	Inlet	1299	0.36	1219	1.43	13.70	750
	Outlet	125	0.004	1025			661
	CE %	90.4	98.9	15.9			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.14	1800	17.0	18.6	42.9	2.52	105	0.6	956	4.5	29.11
14.29	1800	17.0	18.4	42.7	2.52	105	0.6	957	4.5	29.11
14.47	1800	17.0	18.2	43.0	2.52	106	0.6	963	4.5	29.10
14.75	1800	17.0	18.1	43.0	2.52	106	0.6	968	4.5	29.10
14.91	1800	17.0	17.7	43.0	2.52	106	0.6	969	4.5	29.10
15.08	1800	17.0	17.6	42.8	2.52	106	0.6	971	4.5	29.10
15.28	1800	17.0	17.3	42.8	2.52	106	0.6	975	4.5	29.10

*HC + NO_x not within tolerances at 14.7 air/fuel ratio

TABLE B-12. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A221/0204

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	2349	86		
	CO	2.01	82		
	NO_x	1609	NA		
50	HC	2349	113		
	CO	2.01	100		
	NO_x	1609	NA		
80	HC	2349	182		
	CO	2.01	130		
	NO_x	1609	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	2399	360	85.0			
	CO	2.06	0.02	99.0			
	NO_x	1647	1477	10.3			
at 600 sec	HC	2349	275	88.3			
	CO	2.06	0.01	99.5			
	NO_x	1634	1552	5.0			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
2% CO, 5% O_2										
1	1809	12.8	37.8	67.8	9.88	97	1.15	1042	10.3	29.19

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-13. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A221/0310

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.07	Inlet	2474	1.74	1295	0.73	13.84	701
	Outlet	1050	0.30	1038			744
	CE %	57.6	82.8	19.8			
14.30	Inlet	2049	1.28	1383	0.83	13.84	746
	Outlet	500	0.10	862			777
	CE %	75.6	92.2	37.7			
14.49	Inlet	1949	1.13	1421	0.98	13.84	709
	Outlet	675	0.13	887			703
	CE %	65.4	88.5	37.6			
14.69*	Inlet	1949	0.98	1421	1.03	13.98	720
	Outlet	200	0.03	887			714
	CE %	89.7	96.9	37.6			
14.86	Inlet	1699	0.76	1395	1.23	13.84	724
	Outlet	150	0.01	963			694
	CE %	91.2	98.7	31.0			
15.07	Inlet	1599	0.60	1383	1.48	13.84	728
	Outlet	125	0.02	887			685
	CE %	92.2	96.7	35.9			
15.25	Inlet	1399	0.55	1383	1.58	13.84	730
	Outlet	125	0.01	1038			672
	CE %	91.1	98.2	25.0			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.07	1805	15.2	28.5	53.6	2.8	91	0.9	1008	8.0	29.33
14.30	1804	15.3	28.0	53.0	2.8	92	0.8	1030	8.0	29.33
14.49	1805	15.2	28.3	52.9	2.8	92	0.8	1010	8.0	29.33
14.69	1804	15.2	27.7	53.1	2.8	93	0.9	1034	8.0	29.33
14.86	1806	15.2	27.3	53.2	2.8	94	0.9	1037	8.0	29.32
15.07	1801	15.2	27.0	53.0	2.8	95	0.9	1037	8.0	29.32
15.25	1797	15.2	26.6	53.0	2.8	95	0.9	1037	8.0	29.31

C not within tolerances at 14.7 air/fuel ratio

TABLE B-14. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF UNIT A221/0310

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	2199	68		
	CO	1.99	65		
	NO_x	1370	70		
50	HC	2199	80		
	CO	1.99	74		
	NO_x	1370	NA		
80	HC	2199	96		
	CO	1.99	82		
	NO_x	1370	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	2249	275	87.8			
	CO	2.01	0.01	99.5			
	NO_x	1345	1289	4.2			
at 600 sec	HC	2149	250	88.4			
	CO	2.02	0.01	99.6			
	NO_x	1282	1226	4.4			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
2% CO, 5% O_2										
1	1809	12.9	39.2	67.1	9.1	86	1.15	1067	13	29.33

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-15. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A221/0447

A/F Ratio	Sample Location	HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
		Converter Efficiency Data					
14.07	Inlet	2324	1.60	1358	0.63	13.70	738
	Outlet	225	0.08	762			855
	CE %	90.3	95.0	43.9			
14.27	Inlet	2149	1.25	1421	1.23	13.84	748
	Outlet	200	0.02	937			796
	CE %	90.7	98.4	34.1			
14.46	Inlet	1999	0.92	1458	0.88	13.98	727
	Outlet	175	0.01	1138			737
	CE %	91.2	98.9	22.0			
14.70	Inlet	1699	0.66	1446	1.08	13.98	749
	Outlet	150	0.002	1214			720
	CE %	91.2	99.7	16.0			
14.87	Inlet	1624	0.47	1458	1.18	14.12	718
	Outlet	150	0.002	1264			705
	CE %	90.8	99.6	13.3			
15.08	Inlet	1499	0.40	1471	1.38	13.98	743
	Outlet	125	0.002	1276			695
	CE %	91.7	99.5	13.3			
15.28	Inlet	1299	0.35	1433	1.53	13.84	756
	Outlet	100	0.002	1251			685
	CE %	92.3	99.4	12.7			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.07	1800	16.5	21.4	47.1	3.21	94	0.7	950	6	29.24
14.27	1800	16.6	21.3	47.0	3.21	95	0.7	962	6	29.24
14.46	1799	16.6	21.0	47.0	3.22	95	0.7	933	6	29.24
14.70	1799	16.5	20.5	46.8	3.21	96	0.7	967	6	29.23
14.87	1800	16.6	20.4	46.8	3.22	96	0.7	931	6	29.23
15.08	1797	16.6	19.9	46.8	3.21	97	0.7	963	6	29.23
15.28	1798	16.6	19.6	46.6	3.21	97	0.7	971	6	29.23

TABLE B-16. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF UNIT A221/0447

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1999	25		
	CO	1.97	20		
	NO_x	1446	NA		
50	HC	1999	38		
	CO	1.97	29		
	NO_x	1446	NA		
80	HC	1999	63		
	CO	1.97	42		
	NO_x	1446	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	2399	225	90.6			
	CO	2.28[2]	0.01	99.6			
	NO_x	1421	1389	2.2			
at 600 sec	HC	2574	250	90.3			
	CO	2.18[2]	0.01	99.5			
	NO_x	1408	1402	0.4			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
2% CO, 5% O_2										
1	1812	13.5	35.4	65.6	9.13	86	1.1	1026	10.2	29.23

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %
(2) After 167 sec CO not maintained within 2.0 ± 0.1%

TABLE B-17. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A230/0177X

		Converter Efficiency Data					
A/F Ratio	Sample Location	HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.11	Inlet	1649	1.13	1571	0.44	13.84	715
	Outlet	750	0.55	333			658
	CE %	54.5	51.3	78.8			
14.33	Inlet	1499	0.77	1634	0.53	13.98	716
	Outlet	75	0.03	116			685
	CE %	95.0	96.1	92.9			
14.50	Inlet	1399	0.69	1659	0.63	13.98	717
	Outlet	75	0.003	711			695
	CE %	94.6	99.6	57.1			
14.75*	Inlet	1149	0.42	1697	0.88	13.98	719
	Outlet	75	0.003	1302			659
	CE %	93.5	99.3	23.3			
14.89	Inlet	1074	0.35	1684	0.98	13.84	719
	Outlet	50	0.002	1439			646
	CE %	95.3	99.4	14.5			
15.07	Inlet	974	0.31	1672	1.13	13.98	718
	Outlet	50	0.002	1452			639
	CE %	94.9	99.4	13.2			
15.27	Inlet	800	0.28	1571	1.48	13.84	716
	Outlet	50	0.002	1339			629
	CE %	93.8	99.3	14.8			

Engine Operation Data

A/F	Speed	Man Vac	Power	Air Flow, SCFM		Intake Air		Exhaust		Bar.
Ratio	rpm	in. Hg	Hp obs	Engine	Injected	°F	in. H_2O Vac	°F	in. H_2O	in. Hg
14.11	1807	16.35	23.9	51.2	--	90	0.8	969	4.5	29.18
14.33	1807	16.35	23.8	51.0	--	91	0.8	974	4.5	29.18
14.50	1804	16.35	23.6	50.8	--	92	0.8	976	4.5	29.18
14.75	1806	16.35	23.1	50.6	--	93	0.8	978	4.5	29.17
14.89	1806	16.35	22.7	50.6	--	93	0.8	980	4.5	29.17
15.07	1807	16.35	22.5	50.4	--	94	0.8	980	4.5	29.16
15.27	1810	16.35	22.3	50.3	--	94	0.8	977	4.5	29.16

*HC not within tolerance at 14.7 air/fuel ratio

TABLE B-18. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF UNIT A230/ 0177X

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1424	20		
	CO	1.99	16		
	NO_x	1307	18		
50	HC	1424	24		
	CO	1.99	20		
	NO_x	1307	NA		
80	HC	1424	42		
	CO	1.99	28		
	NO_x	1307	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1424	100	93.0			
	CO	2.08	.002	99.9			
	NO_x	1282	1176	8.3			
at 600 sec	HC	1449	100	93.1			
	CO	2.10	.0008	100			
	NO_x	1244	1151	7.5			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	10.15	51.1	85.0	11.13	83	1.5	1086	14.2	29.18

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-19. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A230/0636X

A/F Ratio	Sample Location	Converter Efficiency Data HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.15	Inlet	1699	1.13	1634	0.28	13.84	710
	Outlet	900	0.63	358			689
	CE %	47.0	44.2	78.1			
14.35	Inlet	1599	0.95	1710	0.35	13.84	714
	Outlet	100	0.01	26			702
	CE %	93.8	99.0	98.5			
14.49	Inlet	1349	0.65	1735	0.50	13.84	714
	Outlet	100	0.003	686			701
	CE %	92.6	99.5	60.5			
14.66	Inlet	1349	0.55	1760	0.58	13.84	716
	Outlet	75	0.003	1189			681
	CE %	94.4	99.5	33.4			
14.89	Inlet	1149	0.40	1760	0.74	13.56	717
	Outlet	50	0.002	1464			662
	CE %	95.6	99.5	16.8			
15.15	Inlet	950	0.30	1710	1.15	13.29	717
	Outlet	50	0.002	1489			653
	CE %	94.7	99.3	12.9			
15.33	Inlet	800	0.25	1634	1.15	13.29	716
	Outlet	50	0.002	1389			638
	CE %	93.8	99.3	15.0			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.15	1800	16.3	23.7	50.0	--	99	0.75	965	4.9	29.11
14.35	1800	16.3	23.5	49.8	--	100	0.75	969	4.9	29.11
14.49	1800	16.35	23.1	49.8	--	100	0.75	970	4.9	29.11
14.66	1800	16.35	23.0	49.8	--	100	0.75	970	4.9	29.11
14.89	1800	16.35	22.4	49.7	--	101	0.75	971	4.9	29.11
15.15	1800	16.35	22.2	49.5	--	102	0.75	971	4.5	29.11
15.33	1800	16.35	21.7	49.5	--	102	0.75	969	4.5	29.11

TABLE B-20. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A230/0636X

Time to Reach % Reduction	Emission(1)	Converter Efficiency Data: Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1449	16		
	CO	1.99	26		
	NO_x	1383	NA		
50	HC	1449	28		
	CO	1.99	32		
	NO_x	1383	NA		
80	HC	1449	43		
	CO	1.99	38		
	NO_x	1383	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1399	125	91.1			
	CO	2.06	0.002	99.9			
	NO_x	1358	1289	5.1			
at 600 sec	HC	1449	125	91.4			
	CO	1.99	0.002	99.9			
	NO_x	1333	1289	3.3			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
2% CO, 5% O_2										
1	1808	9.5	52.0	84.7	11.20	94	1.5	1093	16.0	29.13

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-21. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE UNIT A240/0016L

		Converter Efficiency Data					
A/F Ratio	Sample Location	HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.17	Inlet	1799	1.22	1596	0.48	14.41	701
	Outlet	325	0.07	422			671
	CE %	81.9	94.3	73.6			
14.30	Inlet	1674	0.92	1710	0.58	14.41	701
	Outlet	175	0.005	244			652
	CE %	89.5	99.4	85.7			
14.48	Inlet	1574	0.81	1735	0.68	14.56	702
	Outlet	125	0.003	384			626
	CE %	92.0	99.6	77.9			
14.66	Inlet	1399	0.60	1710	0.78	14.41	701
	Outlet	100	0.003	837			597
	CE %	92.8	99.5	51.0			
14.88	Inlet	1249	0.47	1685	1.08	14.27	702
	Outlet	100	0.003	1113			580
	CE %	92.0	99.4	33.9			
15.05	Inlet	1099	0.35	1672	1.23	14.12	701
	Outlet	90	0.002	1201			565
	CE %	91.8	99.4	28.2			
15.28	Inlet	1074	0.29	1622	1.38	14.12	702
	Outlet	75	0.002	1151			556
	CE %	93.0	99.3	29.0			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.07	1807	16.45	23.1	49.1	2.45	103	0.8	953	5	29.17
14.30	1809	16.45	23.0	49.0	2.47	105	0.8	955	5	29.17
14.48	1808	16.45	22.8	49.0	2.47	104	0.8	957	5	29.17
14.66	1805	16.5	22.5	49.0	2.50	105	0.8	960	5	29.17
14.88	1806	16.5	22.2	49.1	2.53	104	0.8	960	5	29.17
15.05	1806	16.5	21.7	49.1	2.52	106	0.8	956	5	29.17
15.28	1808	16.5	21.0	49.0	2.54	107	0.8	956	5	29.17

TABLE B-22. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A240/0016L

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1549	31		
	CO	1.95	28		
	NO_x	1395	24		
50	HC	1549	38		
	CO	1.95	42		
	NO_x	1395	NA		
80	HC	1549	50		
	CO	1.95	48		
	NO_x	1395	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1624	190	88.3			
	CO	1.99	0.001	99.9			
	NO_x	1395	1276	8.5			
at 600 sec	HC	1549	175	88.7			
	CO	2.02	0.001	99.9			
	NO_x	1383	1289	6.8			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	10.22	49.9	81.5	10.71	104	1.45	1082	14.0	29.19

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-23. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A240/0102

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.14	Inlet	1899	1.16	1521	0.48	14.12	701
	Outlet	1375	0.94	1151			509
	CE %	27.6	19.0	24.3			
14.32	Inlet	1749	0.81	1597	0.63	14.12	701
	Outlet	1275	0.66	1226			504
	CE %	27.1	18.5	23.2			
14.54	Inlet	1574	0.61	1622	0.78	14.12	704
	Outlet	1175	0.53	1251			506
	CE %	25.4	13.1	22.9			
14.72	Inlet	1424	0.51	1634	0.88	14.12	705
	Outlet	1075	0.39	1264			508
	CE %	24.5	23.5	22.6			
14.88	Inlet	1249	0.39	1622	1.03	14.12	705
	Outlet	850	0.27	1264			511
	CE %	32.0	30.8	22.1			
15.07	Inlet	1174	0.35	1597	1.18	13.98	706
	Outlet	750	0.20	1251			516
	CE %	36.1	42.9	21.7			
15.28	Inlet	999	0.25	1509	1.48	13.98	706
	Outlet	575	0.11	1201			517
	CE %	42.4	56.0	20.4			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.14	1802	16.5	22.2	47.8	2.53	106	0.8	946	5	29.06
14.32	1798	16.5	21.8	47.8	2.53	106	0.75	951	5	29.06
14.54	1802	16.5	21.7	48.0	2.53	106	0.8	953	5	29.06
14.72	1800	16.5	21.6	48.0	2.53	106	0.8	955	5	29.06
14.88	1801	16.55	21.2	47.7	2.53	106	0.75	954	5	29.06
15.07	1803	16.55	20.9	47.9	2.53	105	0.75	954	5	29.06
15.28	1800	16.55	20.6	47.6	2.53	104	0.75	954	5	29.06

TABLE B-24. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A240/0102

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1574	141		
	CO	1.97	117		
	NO_x	1370	NA		
50	HC	1574	172		
	CO	1.97	156		
	NO_x	1370	NA		
80	HC	1574	NA		
	CO	1.97	182		
	NO_x	1370	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1649	500	69.7			
	CO	2.01	0.11	94.5			
	NO_x	1358	1226	9.7			
at 600 sec	HC	1649	400	75.7			
	CO	2.08	0.03	98.6			
	NO_x	1345	1251	7.0			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
2% CO, 5% O_2										
1	1807	10.2	50.5	81.9	10.64	104	1.5	1067	15	29.06

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-25. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE UNIT A240/0141L

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.13	Inlet	1924	1.16	1509	0.48	14.12	702
	Outlet	325	0.08	573			674
	CE %	83.1	93.1	62.0			
14.31	Inlet	1749	0.87	1571	0.58	14.12	702
	Outlet	250	0.01	497			648
	CE %	85.7	98.8	68.4			
14.53	Inlet	1574	0.60	1597	0.73	14.27	704
	Outlet	200	0.005	799			613
	CE %	87.3	99.2	50.0			
14.70	Inlet	1424	0.47	1597	0.83	14.12	705
	Outlet	150	0.004	1113			596
	CE %	89.5	79.2	30.3			
14.90	Inlet	1249	0.36	1597	1.08	14.12	705
	Outlet	150	0.004	1138			572
	CE %	88.0	98.9	28.7			
15.10	Inlet	1174	0.32	1509	1.28	14.12	704
	Outlet	150	0.003	1176			563
	CE %	87.2	99.1	22.1			
15.25	Inlet	1024	0.26	1471	1.43	13.84	703
	Outlet	125	0.003	1176			554
	CE %	87.8	98.8	20.0			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.13	1806	16.6	22.2	48.2	2.05	102	0.8	949	5.5	29.12
14.31	1804	16.6	22.0	47.9	2.07	103	0.8	953	5.5	29.12
14.53	1805	16.6	21.7	47.9	2.09	103	0.7	954	5.5	29.13
14.70	1805	16.6	21.5	47.8	2.08	102	0.7	955	5.5	29.13
14.90	1804	16.6	21.1	48.0	2.11	102	0.7	955	5.5	29.13
15.10	1806	16.6	20.9	48.0	2.14	102	0.7	953	5.5	29.13
.25	1805	16.6	20.4	48.0	2.14	102	0.7	952	5.5	29.13

TABLE B-26. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A240/0141L

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1574	33		
	CO	2.04	30		
	NO_x	1345	26		
50	HC	1574	43		
	CO	2.04	40		
	NO_x	1345	NA		
80	HC	1574	64		
	CO	2.04	46		
	NO_x	1345	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1574	225	85.7			
	CO	2.08	0.005	99.8			
	NO_x	1345	1226	8.8			
at 600 sec	HC	1549	200	87.1			
	CO	2.10	0.004	99.8			
	NO_x	1320	1226	7.1			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
2% CO, 5% O_2										
1	1801	9.2	54.5	86.7	11.19	100	1.6	1102	16	29.10

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-27. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE UNIT A240/0153

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.10	Inlet	1899	1.17	1458	0.44	13.98	700
	Outlet	425	0.10	510			666
	CE %	77.6	91.4	65.0			
14.29	Inlet	1674	0.81	1534	0.58	13.98	700
	Outlet	225	0.01	611			633
	CE %	86.6	98.8	60.2			
14.45	Inlet	1649	0.70	1571	0.63	13.98	701
	Outlet	200	0.009	422			616
	CE %	87.9	98.7	73.1			
14.70	Inlet	1374	0.50	1597	0.83	13.98	701
	Outlet	150	0.004	850			586
	CE %	89.1	99.2	46.8			
14.85	Inlet	1249	0.37	1546	1.13	13.98	702
	Outlet	125	0.003	1013			574
	CE %	90.0	99.2	34.5			
15.07	Inlet	1099	0.29	1496	1.18	13.98	704
	Outlet	125	0.002	1113			558
	CE %	88.6	99.3	25.6			
15.33	Inlet	900	0.22	1446	1.48	13.84	702
	Outlet	100	0.001	1126			546
	CE %	88.9	99.5	22.1			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.10	1804	16.6	22.4	48.6	1.84	103	0.7	950	4.5	29.11
14.29	1804	16.6	22.0	48.3	1.85	104	0.7	953	4.5	29.11
14.45	1804	16.6	21.9	48.3	1.84	104	0.7	956	4.5	29.11
14.70	1805	16.6	21.4	48.2	1.85	104	0.7	957	4.5	29.10
14.85	1804	16.7	21.1	48.2	1.85	104	0.7	959	4.5	29.10
15.07	1803	16.7	20.9	48.2	1.85	103	0.7	961	4.2	29.09
-.33	1803	16.7	20.4	48.2	1.84	104	0.7	958	4.2	29.09

TABLE B-28. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A240/0153

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1924	28		
	CO	1.99	35		
	NO_x	1345	29		
50	HC	1924	48		
	CO	1.99	44		
	NO_x	1345	NA		
80	HC	1924	70		
	CO	1.99	55		
	NO_x	1345	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1974	200	89.9			
	CO	1.99	0.003	99.8			
	NO_x	1358	1213	10.7			
at 600 sec	HC	1924	175	90.9			
	CO	1.99	0.002	99.9			
	NO_x	1395	1289	7.6			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	10.5	49.6	81.9	10.77	96	1.5	1074	40.0	29.13

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-29. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A240/0334L

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.14	Inlet	1649	1.01	1509	0.44	14.12	700
	Outlet	400	0.10	180			627
	CE %	75.7	90.1	88.1			
14.35	Inlet	1524	0.74	1571	0.58	14.27	701
	Outlet	150	0.005	180			618
	CE %	90.2	99.3	88.5			
14.54	Inlet	1349	0.56	1609	0.68	14.27	700
	Outlet	100	0.003	686			597
	CE %	92.6	99.5	57.4			
14.70*	Inlet	1249	0.47	1609	0.83	14.27	703
	Outlet	75	0.002	1038			584
	CE %	94.0	99.6	35.5			
14.86	Inlet	1149	0.39	1609	0.98	14.27	705
	Outlet	75	0.002	1138			570
	CE %	93.5	99.5	29.3			
15.09	Inlet	1024	0.28	1571	1.18	14.12	705
	Outlet	75	0.002	1213			559
	CE %	92.7	99.3	22.8			
15.28	Inlet	800	0.18	1446	1.63	13.84	704
	Outlet	50	0.002	1163			550
	CE %	93.8	98.9	19.6			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.14	1798	16.6	22.3	48.5	2.78	103	0.8	956	5	29.23
14.35	1797	16.6	22.0	48.4	2.77	102	0.8	960	5	29.23
14.54	1798	16.7	21.8	48.4	2.78	102	0.8	963	5	29.24
14.70	1799	16.6	21.8	48.4	2.78	102	0.8	964	5	29.24
14.86	1795	16.7	21.2	48.4	2.77	102	0.8	963	5	29.23
15.09	1792	16.7	21.0	48.4	2.78	102	0.8	963	5	29.23
15.28	1793	16.7	20.7	48.4	2.77	102	0.8	961	5	29.23

*HC not within tolerance at 14.7 air/fuel ratio

TABLE B-30. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A240/0334L

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1549	33		
	CO	1.91	35		
	NO_x	1395	40		
50	HC	1549	39		
	CO	1.91	40		
	NO_x	1395	NA		
80	HC	1549	50		
	CO	1.91	48		
	NO_x	1395	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1574	160	89.8			
	CO	1.99	0.003	99.8			
	NO_x	1383	1302	5.9			
at 600 sec	HC	1549	150	90.3			
	CO	2.02	0.002	99.9			
	NO_x	1383	1327	4.0			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	10.3	50.0	81.6	10.72	99	1.5	1080	15	29.22

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-31. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A 249/0169-1

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.07	Inlet	2074	2.12	1571	0.93	13.70	730
	Outlet	1000	1.22	142			785
	CE %	51.8	42.4	91.0			
14.33	Inlet	2049	1.75	1647	1.03	13.84	730
	Outlet	225	0.08	497			795
	CE %	89.0	95.4	69.8			
14.47	Inlet	2024	1.34	1773	1.13	13.70	733
	Outlet	175	0.08	1000			809
	CE %	91.4	94.0	43.6			
14.68	Inlet	1649	1.01	1597	1.28	14.12	716
	Outlet	150	0.02	1302			744
	CE %	90.9	98.0	18.5			
14.91	Inlet	1499	0.70	1634	1.43	14.12	725
	Outlet	150	0.01	1452			717
	CE %	90.0	98.6	11.1			
15.13	Inlet	1449	0.60	1597	1.53	13.84	730
	Outlet	150	0.01	1414			697
	CE %	89.6	98.3	11.5			
15.25	Inlet	1324	0.55	1597	1.63	13.98	728
	Outlet	150	0.01	1464			688
	CE %	88.7	98.2	8.3			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.07	1800	16.0	24.0	49.9	--	100	0.8	--	4.5	29.31
14.33	1800	16.0	23.9	49.5	--	100	0.8	--	4.5	29.30
14.47	1800	16.0	23.8	49.4	--	101	0.8	--	4.5	29.29
14.68	1800	16.4	21.8	49.4	--	100	0.7	--	4.0	29.29
14.91	1800	16.4	21.4	49.4	--	101	0.7	--	4.0	29.29
15.13	1800	16.5	21.1	49.4	--	101	0.6	--	4.0	29.29
15.25	1800	16.5	21.2	49.3	--	102	0.7	--	4.0	29.29

TABLE B-32. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A 249/0169-1

Converter Efficiency Data

Time to Reach % Reduction	Emission (1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1799	22		
	CO	1.99	20		
	NO_x	1320	N/A		
50	HC	1799	30		
	CO	1.99	25		
	NO_x	1320	N/A		
80	HC	1799	67		
	CO	1.99	35		
	NO_x	1320	N/A		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1749	350	80.0			
	CO	1.99	0.07	96.5			
	NO_x	1345	1338	0.5			
at 600 sec	HC	1799	306	83.0			
	CO	2.01	0.07	96.5			
	NO_x	1345	1333	0.9			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	13.3	36.8	65.2	8.21	95	1.1	--	7.5	29.31

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-33. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE UNIT A 249/0169-2

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.08	Inlet	1899	1.88	1333	0.83	13.16	723
	Outlet	1100	1.33	142			732
	CE %	42.1	29.3	89.4			
14.27	Inlet	1749	1.57	1358	0.93	13.16	718
	Outlet	425	0.66	142			764
	CE %	75.7	58.0	89.5			
14.47	Inlet	1624	1.29	1433	0.98	13.43	740
	Outlet	225	0.16	333			761
	CE %	86.2	87.6	76.8			
14.65	Inlet	1574	1.10	1471	1.13	13.29	720
	Outlet	225	0.16	887			727
	CE %	85.7	85.4	39.7			
14.85	Inlet	1449	0.77	1534	1.33	13.29	732
	Outlet	200	0.06	1138			733
	CE %	86.2	92.2	25.8			
15.13	Inlet	1449	0.60	1559	1.48	13.29	731
	Outlet	175	0.03	1264			699
	CE %	87.9	95.0	18.9			
15.26	Inlet	1349	0.47	1559	1.58	13.43	742
	Outlet	200	0.005	1377			708
	CE %	85.2	98.9	11.7			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM		Intake Air		Exhaust		Bar. in. Hg
				Engine	Injected	°F	in. H_2O Vac	°F	in. H_2O	
14.08	1801	15.7	25.0	51.4	--	102	0.8	--	5	29.13
14.27	1798	15.7	24.7	51.2	—	103	0.8	--	5	29.13
14.47	1799	15.75	24.5	51.0	--	104	0.8	—	5	29.12
14.65	1793	15.7	24.3	51.0	--	104	0.8	—	5	29.11
14.85	1795	15.7	24.2	51.0	--	104	0.8	--	5	29.10
15.13	1792	15.7	23.8	50.7	--	104	0.8	--	5	29.10
15.26	1791	15.7	23.6	50.7	--	104	0.8	—	5	29.10

TABLE B-34. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A249/0169-2

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1599	42		
	CO	1.99	38		
	NO_x	1219	35		
50	HC	1599	55		
	CO	1.99	45		
	NO_x	1219	NA		
80	HC	1599	NA		
	CO	1.99	60		
	NO_x	1219	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1674	425	74.6			
	CO	2.14	0.11	94.9			
	NO_x	1219	1113	8.7			
at 600 sec	HC	1650	375	77.3			
	CO	1.94	0.11	94.3			
	NO_x	1264	1213	4.0			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	13.37	36.3	64.6	8.77	98	1.07	—	9.8	29.19

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-35. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT 249/0169-3

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.06	Inlet	2199	1.81	1257	0.68	13.84	718
	Outlet	800	0.43	686			831
	CE %	63.6	76.2	45.4			
14.32	Inlet	2099	1.47	1483	0.78	14.12	748
	Outlet	500	0.28	459			856
	CE %	76.2	81.0	69.0			
14.50	Inlet	1849	1.04	1509	0.98	14.12	726
	Outlet	250	0.09	634			796
	CE %	86.5	91.4	58.0			
14.67	Inlet	1699	0.73	1559	1.08	14.27	722
	Outlet	150	0.05	963			760
	CE %	91.2	93.2	38.2			
14.89	Inlet	1599	0.60	1559	1.23	14.41	717
	Outlet	150	0.03	1138			725
	CE %	90.6	95.0	27.0			
15.09	Inlet	1349	0.42	1534	1.38	14.12	716
	Outlet	150	0.02	1214			703
	CE %	88.9	95.2	20.9			
15.31	Inlet	1149	0.35	1509	1.68	14.12	729
	Outlet	125	0.02	1239			721
	CE %	89.1	94.3	17.9			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.06	1800	16.75	20.4	46.2	4.98	100	0.7	871	--	29.17
14.32	1802	16.75	20.3	46.1	4.97	102	0.75	931	--	29.17
14.50	1800	16.75	20.2	46.2	4.95	101	0.75	880	--	29.17
14.67	1801	16.8	20.1	46.4	5.09	101	0.7	878	--	29.17
14.89	1799	16.75	19.7	46.4	5.09	101	0.7	879	--	29.17
15.09	1797	16.8	19.2	46.4	5.09	101	0.7	878	--	29.17
15.31	1799	16.75	18.9	46.3	5.08	101	0.7	884	--	29.17

TABLE B-36. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT 249/0169-3

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	2099	20		
	CO	2.06	18		
	NO_x	1157	N/A		
50	HC	2099	28		
	CO	2.06	26		
	NO_x	1157	N/A		
80	HC	2099	54		
	CO	2.06	40		
	NO_x	1157	N/A		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	2099	250	88.1			
	CO	2.06	0.008	99.6			
	NO_x	1169	1088	6.9			
at 600 sec	HC	2049	225	89.0			
	CO	2.06	0.005	99.8			
	NO_x	1207	1163	3.6			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1802	15.4	25.6	54.1	14.15	102	0.8	939	--	29.19

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-37. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A249/0486-1

A/F Ratio	Sample Location	Converter Efficiency Data HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.08	Inlet	2549	1.67	1458	0.78	13.84	728
	Outlet	1250	0.96	206			678
	CE %	51.0	42.5	85.9			
14.35	Inlet	1949	1.40	1471	0.98	13.84	726
	Outlet	550	0.53	231			691
	CE %	71.8	62.1	84.3			
14.53	Inlet	1874	1.22	1471	1.13	13.84	723
	Outlet	350	0.25	460			691
	CE %	81.3	79.5	68.7			
14.69	Inlet	1749	0.99	1483	1.23	13.84	722
	Outlet	300	0.06	1088			673
	CE %	82.8	93.9	26.6			
14.87	Inlet	1649	0.84	1521	1.38	13.70	724
	Outlet	250	0.05	1239			652
	CE %	84.8	94.0	18.5			
15.10	Inlet	1524	0.73	1521	1.53	13.84	727
	Outlet	250	0.02	1251			641
	CE %	83.6	97.3	17.8			
15.26	Inlet	1399	0.60	1458	1.73	13.84	725
	Outlet	250	0.02	1264			620
	CE %	82.1	96.7	13.3			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.08	1799	14.9	29.5	54.1	--	95	0.95	1020	7	29.25
14.35	1798	15.0	29.2	54.3	--	95	0.95	1017	7	29.25
14.53	1800	15.0	28.8	54.0	--	95	0.95	1018	7	29.24
14.69	1800	15.0	28.9	54.0	--	95	0.95	1022	7	29.24
14.87	1800	15.0	28.3	54.0	--	95	0.95	1027	7	29.24
15.10	1800	15.0	28.2	54.0	--	95	0.95	1028	7	29.24
[illegible].26	1800	15.0	27.8	54.0	--	95	0.95	1030	7	29.24

TABLE B-38. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A249/0486-1

Converter Efficiency Data

Time to Reach % Reduction	Emission (1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1849	22		
	CO	1.95	22		
	NO_x	1295	26		
50	HC	1849	43		
	CO	1.95	30		
	NO_x	1295	NA		
80	HC	1849	NA		
	CO	1.95	47		
	NO_x	1295	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1799	675	62.5			
	CO	1.95	0.11	94.4			
	NO_x	1295	1226	5.3			
at 600 sec	HC	1849	500	73.0			
	CO	1.97	0.11	94.4			
	NO_x	1257	1226	2.5			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1809	12.8	39.2	66.7	9.1	91	1.2	1068	13	29.26

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-39. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A249/0486-2

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.12	Inlet	2249	1.67	1383	0.83	13.84	727
	Outlet	1250	0.93	231			588
	CE %	44.4	44.3	83.3			
14.30	Inlet	2124	1.42	1421	0.93	13.84	725
	Outlet	750	0.60	219			605
	CE %	64.7	57.7	84.6			
14.48	Inlet	1999	1.22	1433	0.98	14.12	723
	Outlet	850	0.10	837			621
	CE %	82.5	91.8	41.6			
14.68*	Inlet	1749	0.95	1458	1.18	14.12	727
	Outlet	300	0.06	1088			597
	CE %	82.8	93.7	25.4			
14.85	Inlet	1724	0.87	1458	1.28	14.12	725
	Outlet	275	0.03	1138			588
	CE %	84.0	96.6	21.9			
15.05	Inlet	1599	0.65	1509	1.48	14.12	726
	Outlet	275	0.04	1214			566
	CE %	82.8	93.8	19.5			
15.25	Inlet	1399	0.57	1408	1.68	14.12	727
	Outlet	250	0.03	1214			558
	CE %	82.1	94.7	13.8			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.12	1800	15.3	28.4	51.8	--	92	0.9	1015	5.5	29.22
14.30	1800	15.3	28.4	51.8	--	92	0.9	1017	5.5	29.22
14.48	1800	15.3	28.1	51.8	--	92	0.9	1023	5.5	29.22
14.68	1800	15.3	27.5	51.8	--	92	0.9	1027	5.5	29.22
14.85	1800	15.3	27.6	51.8	--	92	0.9	1028	5.5	29.22
15.05	1800	15.3	27.4	51.8	--	92	0.9	1028	5.5	29.22
15.25	1800	15.3	26.9	51.8	--	92	0.9	1026	5.5	29.22

C not within tolerance at 14.7 air/fuel ratio

TABLE B-40. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A249/0486-2

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1974	28		
	CO	1.91	30		
	NO_x	1270	27		
50	HC	1974	46		
	CO	1.91	40		
	NO_x	1270	NA		
80	HC	1974	128		
	CO	1.91	55		
	NO_x	1270	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	2249	425	81.1			
	CO	1.95	0.09	95.4			
	NO_x	1270	1189	6.4			
at 600 sec	HC	2349	400	83.0			
	CO	1.99	0.08	96.0			
	NO_x	1270	1201	5.4			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	13.6	36.0	61.3	10.3	90	1.1	1062	7.9	29.21

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-41. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A249/0486-3

A/F Ratio	Sample Location	Converter Efficiency Data HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.13	Inlet	2124	1.45	1647	0.73	13.43	759
	Outlet	325	0.23	282			896
	CE %	84.7	84.1	82.9			
14.30	Inlet	1924	1.23	1697	0.83	13.56	755
	Outlet	150	0.08	434			893
	CE %	92.2	93.5	74.4			
14.45	Inlet	1824	1.07	1710	0.93	13.56	756
	Outlet	150	0.09	384			863
	CE %	91.8	91.6	77.5			
14.66	Inlet	1699	0.92	1785	1.03	13.56	752
	Outlet	125	0.05	636			847
	CE %	92.6	94.6	64.4			
14.85	Inlet	1699	0.76	1848	1.23	13.56	747
	Outlet	125	0.02	1013			837
	CE %	92.6	97.4	45.2			
15.13	Inlet	1499	0.55	1860	1.48	13.43	749
	Outlet	150	0.02	1239			803
	CE %	90.0	96.4	33.4			
15.26	Inlet	1449	0.46	1835	1.63	13.43	749
	Outlet	140	0.004	1339			785
	CE %	90.3	99.1	27.0			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.13	1800	15.9	25.2	49.6	4.0	94	0.8	922	14.9	29.21
14.30	1800	15.9	25.2	49.6	4.0	94	0.8	925	14.7	29.21
14.45	1800	15.8	25.2	49.8	4.0	93	0.8	914	14.5	29.21
14.66	1800	15.8	25.2	49.8	4.0	93	0.8	908	14.5	29.21
14.85	1800	15.8	25.2	49.8	4.0	93	0.8	908	14.4	29.21
15.13	1800	15.8	25.2	49.8	4.0	94	0.8	910	14.3	29.19
15.26	1800	15.8	25.1	49.8	4.0	94	0.8	910	14.4	29.19

TABLE B-42. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A249/0486-3

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1874	18		
	CO	1.95	16		
	NO_x	1056	NA		
50	HC	1874	30		
	CO	1.95	26		
	NO_x	1056	NA		
80	HC	1874	46		
	CO	1.95	35		
	NO_x	1056	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1874	125	93.3			
	CO	1.99	0.003	99.8			
	NO_x	1081	1063	1.7			
at 600 sec	HC	1874	150	92.0			
	CO	1.86	0.002	99.9			
	NO_x	1095	1088	0.6			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	16.0	29.6	49.6	11.0	90	0.8	969	17.9	29.24

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-43. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A254/0031

A/F Ratio	Sample Location	Converter Efficiency Data HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.14	Inlet	2099	1.70	1320	0.83	13.70	756
	Outlet	100	0.18	52			951
	CE %	95.2	89.4	96.1			
14.33	Inlet	2049	1.53	1345	0.93	13.70	743
	Outlet	400	0.68	39			843
	CE %	80.5	55.6	97.1			
14.48	Inlet	1949	1.28	1433	1.03	13.70	738
	Outlet	100	0.17	13			827
	CE %	94.9	86.7	99.1			
14.68*	Inlet	1724	0.95	1446	1.18	13.84	748
	Outlet	50	.002	611			810
	CE %	97.1	99.8	57.7			
14.95	Inlet	1649	0.77	1483	1.33	13.84	741
	Outlet	50	.002	887			774
	CE %	97.0	99.7	40.2			
15.07	Inlet	1499	0.65	1471	1.43	13.98	738
	Outlet	60	.002	1163			749
	CE %	96.0	99.7	20.9			
15.30	Inlet	1299	0.50	1395	1.68	13.84	743
	Outlet	50	.002	1239			726
	CE %	96.2	99.6	11.2			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.14	1800	14.9	28.8	54.0	--	90	0.9	1040	9.0	29.14
14.33	1800	14.9	28.4	54.0	--	90	0.9	1041	9.0	29.14
14.48	1800	14.9	28.0	54.0	--	90	0.9	1044	9.0	29.14
14.68	1800	14.9	27.8	54.1	--	89	0.9	1051	9.0	29.12
14.95	1800	14.9	27.6	54.1	--	89	0.9	1049	9.0	29.12
15.07	1800	14.9	27.3	54.1	--	89	0.9	1049	9.0	29.12
15.30	1800	14.9	27.0	53.8	--	89	0.9	1049	9.0	29.12

*HC not within tolerances at 14.7 air/fuel ratio

TABLE B-44. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A254/0031

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1749	27		
	CO	1.93	25		
	NO_x	1106	24		
50	HC	1749	32		
	CO	1.93	30		
	NO_x	1106	NA		
80	HC	1749	45		
	CO	1.93	39		
	NO_x	1106	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1749	100	94.3			
	CO	1.88	.002	99.9			
	NO_x	1383	1352	2.2			
at 600 sec	HC	1849	85	95.4			
	CO	1.82	.001	99.9			
	NO_x	1169	1126	3.7			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	13.5	36.8	61.4	8.4	89	1.1	1066	12.5	29.10

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-45. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A254/0037

A/F Ratio	Sample Location	Converter Efficiency Data HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.09	Inlet	2324	1.81	1295	0.83	13.70	727
	Outlet	1250	1.04	103			841
	CE %	46.2	42.5	92.0			
14.31	Inlet	2099	1.32	1395	1.03	13.84	732
	Outlet	125	0.24	13			886
	CE %	94.0	81.8	99.1			
14.49	Inlet	2149	1.01	1471	1.03	13.98	744
	Outlet	75	0.002	812			871
	CE %	96.5	99.8	44.8			
14.66*	Inlet	1949	0.95	1471	1.18	13.84	730
	Outlet	50	0.002	586			873
	CE %	97.4	99.8	60.2			
14.89	Inlet	1749	0.74	1546	1.33	13.98	725
	Outlet	75	0.002	912			825
	CE %	95.7	99.7	41.0			
15.13	Inlet	1475	0.55	1534	1.53	13.84	730
	Outlet	75	0.002	1239			778
	CE %	94.9	99.6	19.2			
15.28	Inlet	1449	0.47	1534	1.68	13.84	731
	Outlet	75	0.002	1377			767
	CE %	94.8	99.6	10.2			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.09	1800	15.45	27.1	50.3	—	95	0.8	990	8.0	29.13
14.31	1800	15.45	27.0	50.4	—	93	0.8	1010	8.0	29.12
14.49	1800	15.45	26.8	50.6	—	93	0.8	1014	8.0	29.12
14.66	1800	15.45	26.6	50.6	—	93	0.8	1017	8.0	29.13
14.89	1800	15.45	26.3	50.6	—	93	0.8	995	8.0	29.13
15.13	1800	15.45	26.4	50.6	—	92	0.8	1014	8.0	29.14
15.28	1800	15.45	25.8	50.6	—	92	0.8	1017	8.0	29.14

TABLE B-46. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A254/0037

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1849	34		
	CO	1.99	32		
	NO_x	1383	30		
50	HC	1849	40		
	CO	1.99	38		
	NO_x	1383	NA		
80	HC	1849	54		
	CO	1.99	49		
	NO_x	1383	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1924	125	93.5			
	CO	1.91	0.002	99.9			
	NO_x	1408	1314	6.7			
at 600 sec	HC	1899	100	94.7			
	CO	1.90	0.002	99.9			
	NO_x	1383	1327	4.0			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	13.0	83.4	63.5	10.4	93	1.2	1059	13.6	29.13

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-47. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE UNIT A254/0191

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.06	Inlet	2149	1.74	1307	0.83	13.29	728
	Outlet	75	0.21	65			923
	CE %	96.5	87.9	95.0			
14.30	Inlet	2024	1.47	1333	0.93	13.29	744
	Outlet	400	0.63	13			853
	CE %	80.2	57.1	99.0			
14.48	Inlet	1824	1.11	1345	1.08	13.43	733
	Outlet	50	0.002	699			858
	CE %	97.2	99.8	48.0			
14.74*	Inlet	1749	0.87	1395	1.23	13.43	744
	Outlet	50	0.002	661			829
	CE %	97.1	99.8	52.6			
14.87	Inlet	1649	0.74	1395	1.28	13.43	730
	Outlet	75	0.002	1138			818
	CE %	95.4	99.7	18.4			
15.07	Inlet	1524	0.65	1383	1.38	13.56	748
	Outlet	65	0.002	1138			793
	CE %	95.7	99.7	17.7			
15.26	Inlet	1099	0.66	1433	1.63	13.29	702
	Outlet	50	0.002	1289			711
	CE %	95.4	99.7	10.0			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.06	1800	15.0	28.8	51.9	—	100	0.9	1037	9.0	29.04
14.30	1800	15.0	28.6	51.9	—	100	0.9	1043	8.5	29.04
14.48	1800	15.0	27.9	52.1	—	100	0.9	1045	8.5	29.04
14.74	1800	15.0	27.7	52.1	—	99	0.9	1050	8.5	29.04
14.87	1800	15.0	27.7	52.3	—	99	0.9	1050	8.5	29.04
15.07	1800	15.0	27.4	52.4	--	99	0.9	1054	8.5	29.04
15.26	1800	15.0	27.0	52.4	--	97	0.9	1044	8.5	29.04

.C and NO_x not within tolerances at 14.7 air/fuel ratio

TABLE B-48. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A254/0191

Time to Reach % Reduction	Emission[1]	Converter Efficiency Data: Test 1[2] Converter Inlet	Test 1[2] Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1974	27		
	CO	1.81	29		
	NO_x	1295	28		
50	HC	1974	34		
	CO	1.81	34		
	NO_x	1295	NA		
80	HC	1974	48		
	CO	1.81	44		
	NO_x	1295	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1924	100	94.8			
	CO	1.79	0.002	99.9			
	NO_x	1307	1264	3.3			
at 600 sec	HC	1899	100	94.7			
	CO	1.84	0.001	99.9			
	NO_x	1270	1226	3.5			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
2% CO, 5% O_2										
1	1800	12.6	39.8	65.6	8.1	100	1.2	1100	14.0	29.04

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %
(2) CO not within tolerances throughout test

TABLE B-49. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A254/0275

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.15	Inlet	1999	1.43	1496	0.83	12.89	727
	Outlet	525	0.72	39			820
	CE %	73.7	49.6	97.4			
14.30	Inlet	1899	1.37	1534	0.93	13.02	737
	Outlet	25	0.01	193			890
	CE %	98.7	99.3	87.4			
14.45	Inlet	1824	1.10	1571	0.98	13.02	711
	Outlet	75	0.002	661			831
	CE %	95.9	99.8	57.9			
14.73	Inlet	1649	0.81	1710	1.18	13.02	743
	Outlet	65	0.001	1264			853
	CE %	96.1	99.9	26.1			
14.87	Inlet	1649	0.73	1710	1.23	12.89	749
	Outlet	50	0.002	1038			842
	CE %	97.0	99.7	39.3			
15.06	Inlet	1499	0.60	1509	1.38	12.63	702
	Outlet	75	0.002	1289			754
	CE %	95.0	99.7	14.6			
15.26	Inlet	1324	0.50	1710	1.58	12.76	738
	Outlet	60	0.001	1464			779
	CE %	55.2	99.8	14.4			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.15	1798	14.5	30.7	55.6	--	99	1.0	1040	8	29.09
14.30	1798	14.5	30.6	55.4	--	100	1.0	1047	8	29.08
14.45	1796	14.5	30.4	55.4	--	100	1.0	1028	8	29.08
14.73	1795	14.5	30.0	55.2	--	100	1.0	1040	8	29.07
14.87	1795	14.5	29.8	55.2	--	100	1.0	1066	8	29.07
15.06	1797	14.6	30.1	54.8	--	101	1.0	1027	8	29.06
15.26	1797	14.6	29.2	54.8	--	102	1.0	1054	8	29.06

TABLE B-50. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A254/0275

Converter Efficiency Data

Time to Reach % Reduction	Emission (1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1924	22		
	CO	2.01	21		
	NO_x	1345	30		
50	HC	1924	36		
	CO	2.01	32		
	NO_x	1345	NA		
80	HC	1924	51		
	CO	2.01	46		
	NO_x	1345	NA		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1999	90	95.5			
	CO	2.04	0.002	99.9			
	NO_x	1320	1270	3.8			
at 600 sec	HC	1974	75	96.2			
	CO	1.90	0.002	99.9			
	NO_x	1370	1358	0.9			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	12.9	38.2	64.4	8.9	88	1.1	1060	15.1	29.19

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE B-51. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A 280/0001 L

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.13	Inlet	2424	1.53	1383	0.78	13.56	727
	Outlet	825	0.20	1101			764
	CE %	66.0	86.9	20.4			
14.25	Inlet	2374	1.32	1395	0.73	13.70	749
	Outlet	800	0.16	1126			764
	CE %	66.3	87.9	19.3			
14.46	Inlet	2149	0.99	1433	0.83	13.84	737
	Outlet	800	0.14	1176			705
	CE %	62.8	85.9	17.9			
14.70*	Inlet	1874	0.61	1685	0.98	13.98	753
	Outlet	225	0.02	1126			694
	CE %	88.0	96.7	33.2			
14.87	Inlet	1724	0.48	1710	1.08	13.98	748
	Outlet	200	0.01	1289			670
	CE %	88.4	97.9	24.6			
15.05	Inlet	1599	0.37	1710	1.25	13.98	756
	Outlet	150	0.005	1364			664
	CE %	90.6	98.6	20.2			
15.25	Inlet	1549	0.31	1697	1.38	13.98	756
	Outlet	150	0.005	1389			665
	CE %	90.3	98.4	18.2			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.13	1798	17.2	17.6	41.7	2.25	112	0.6	940	4	29.12
14.25	1799	17.2	17.7	41.7	2.24	113	0.6	974	4	29.12
14.46	1799	17.2	17.5	41.6	2.28	114	0.6	961	4	29.12
14.70	1800	17.1	17.6	41.6	2.26	112	0.6	982	4	29.06
14.87	1800	17.1	17.6	41.5	2.26	113	0.6	979	4	29.06
15.05	1800	17.1	17.2	41.4	2.26	114	0.6	985	4	29.06
15.25	1800	17.1	17.1	41.4	2.26	114	0.6	985	4	29.06

.C not within tolerances at 14.7 air/fuel ratio

TABLE B-52. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A 280/0001 L

Converter Efficiency Data

Time to Reach % Reduction	Emission(1)	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	2674	57		
	CO	1.99	57		
	NO_x	1685	N/A		
50	HC	2674	72		
	CO	1.99	78		
	NO_x	1685	N/A		
80	HC	2674	110		
	CO	1.99	93		
	NO_x	1685	N/A		

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	2899	300	89.6			
	CO	2.02	0.03	98.5			
	NO_x	1685	1571	6.8			
at 600 sec	HC	2749	300	89.1			
	CO	2.01	0.02	99.0			
	NO_x	1685	1559	7.5			

Engine Operation Data

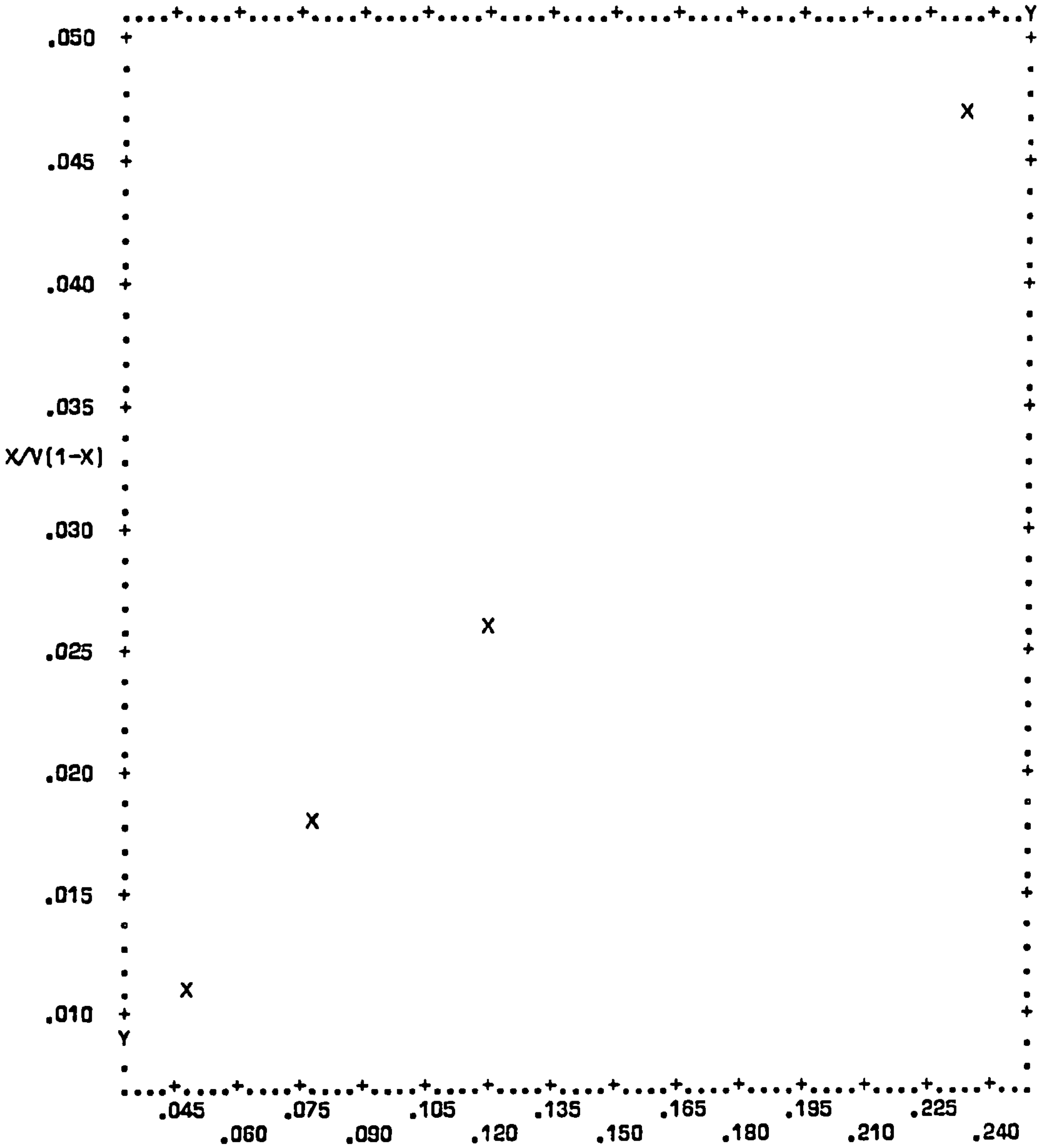
Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1798	13.1	36.0	63.9	9.31	98	1.1	1066	10.5	29.09

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

APPENDIX C

BET EQUATION VERSUS RELATIVE PRESSURE

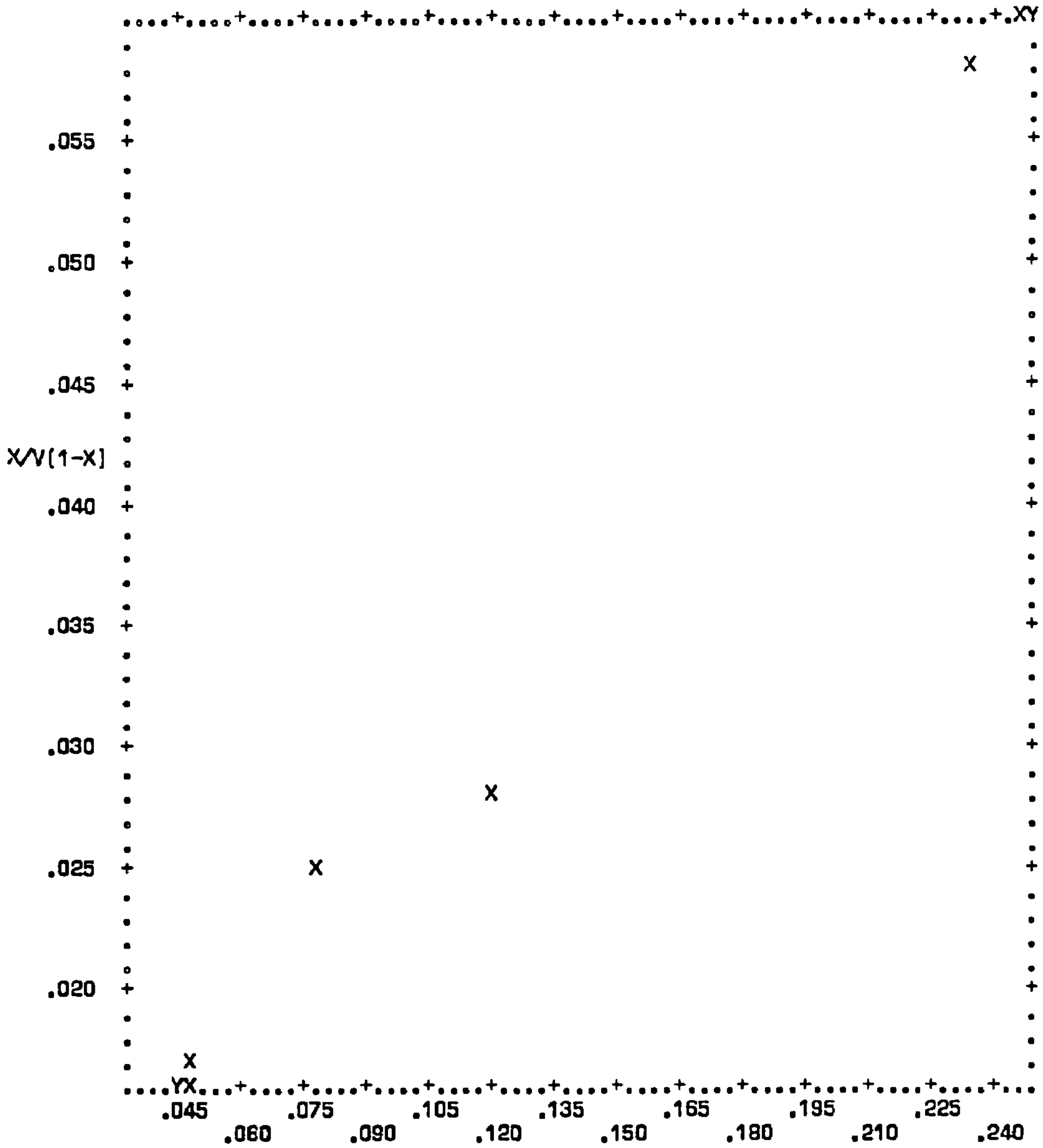
PAGE 4 CONVERTER SURFACE AREA ANALYSIS A180/0094 SAMPLE F




```
N=    4
COR= .9996                                P/PO

    MEAN     ST.DEV.     REGRESSION LINE      RES.MS.
X   .11992    .08084   X= 5.1876*Y-.01363     693E-8
Y   .02574    .01558   Y= .19283*X+ .00264    257E-9

VARIABLE    1  P/PO      VERSUS VARIABLE  2  X/V        SYMBOL=X

CPU TIME USED        .970 SECONDS
```

Figure C-1. Plot of BET equation versus relative pressure for Converter A180/0094 - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A180/0094 SAMPLE E



N= 4
COR= .9907

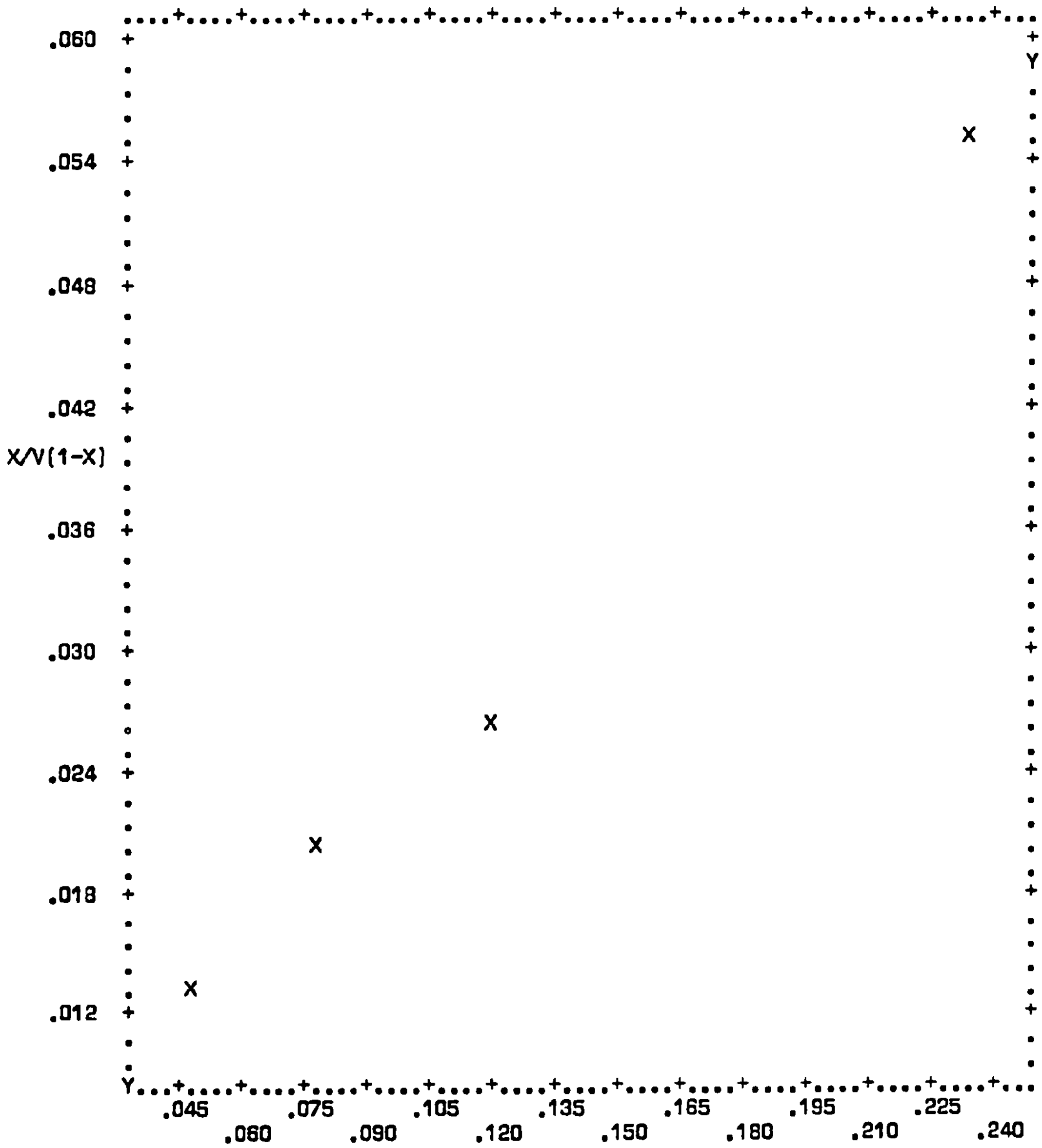
	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 4.5033*Y-.02437	182E-6
Y	.03204	.01778	Y= .21793*X+ .00591	882E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .925 SECONDS

Figure C-2. Plot of BET equation versus relative pressure for Converter A180/0094 - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A180/0094 SAMPLE G



N= 4
COR= .9972

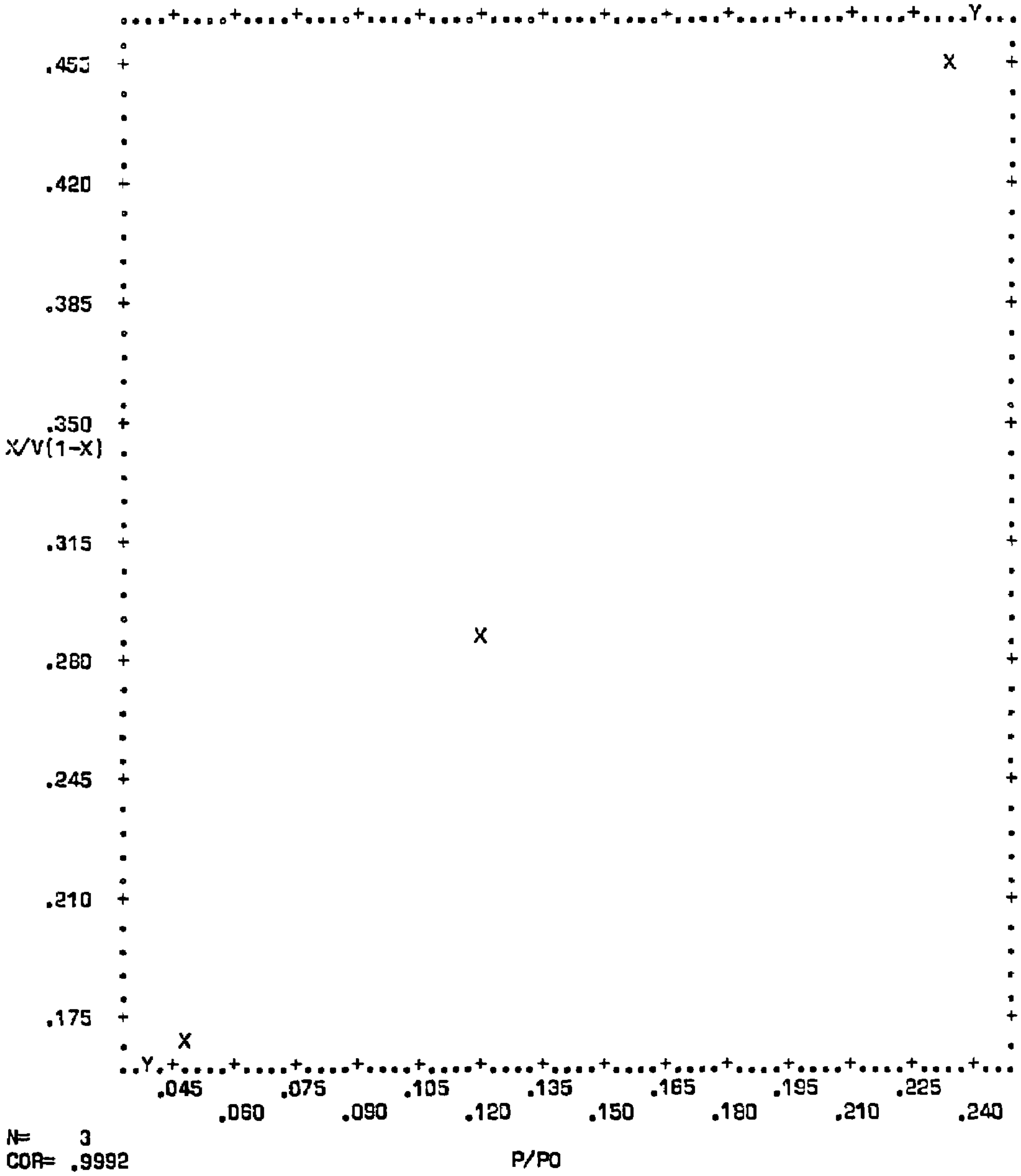
P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 4.3014*Y-.00313	540E-7
Y	.02861	.01874	Y= .23120*X+ 881E-6	290E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .987 SECONDS

Figure C-3. Plot of BET equation versus relative pressure for Converter A180/0094 - Rear Face

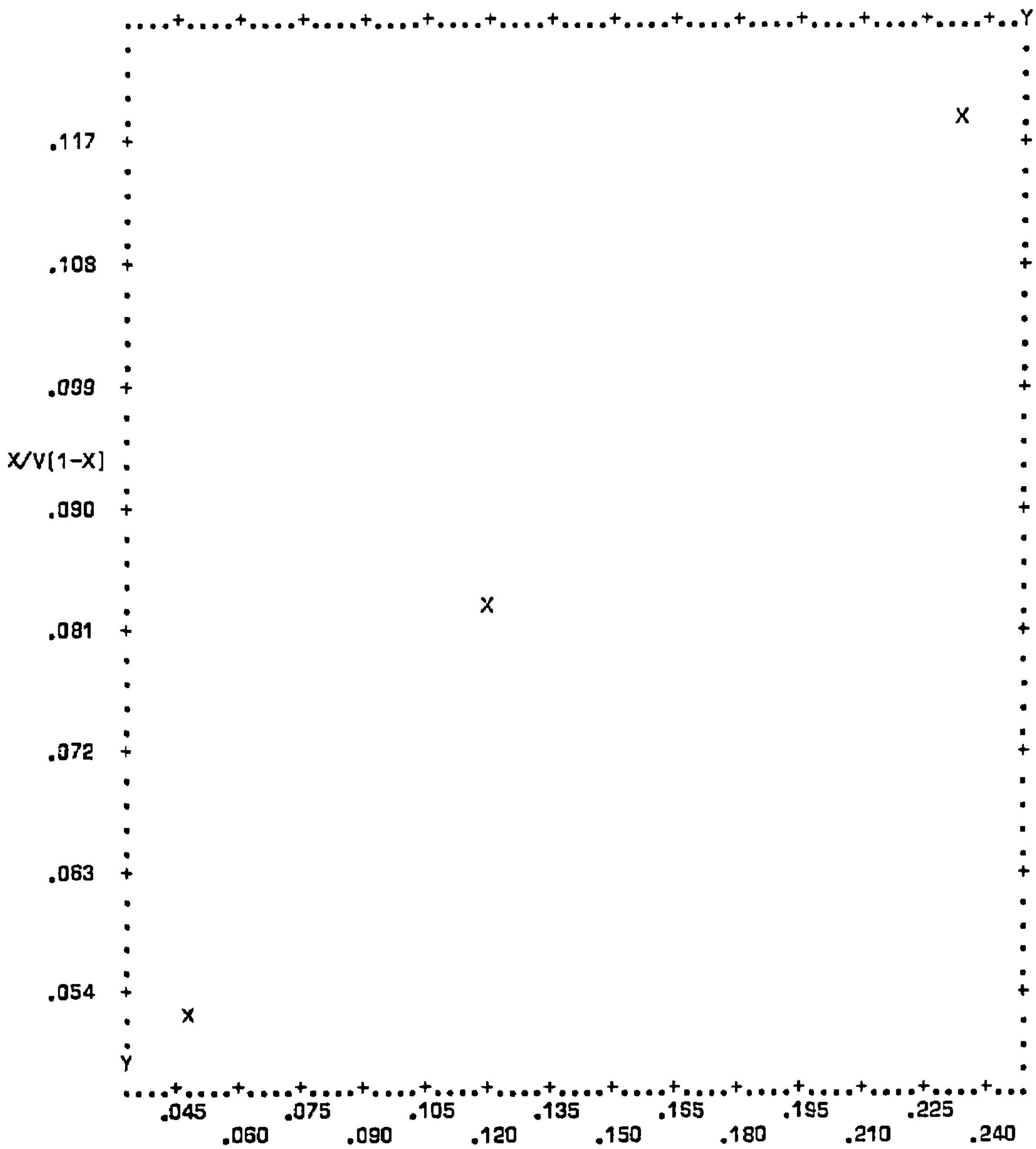


N= 3
COR= .9992

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09332	X= .65324*Y-.06537	283E-7
Y	.30434	.14275	Y= 1.5283*X+ .10040	662E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-4. Plot of BET equation versus relative pressure for Converter A193/0908-A - Bulk



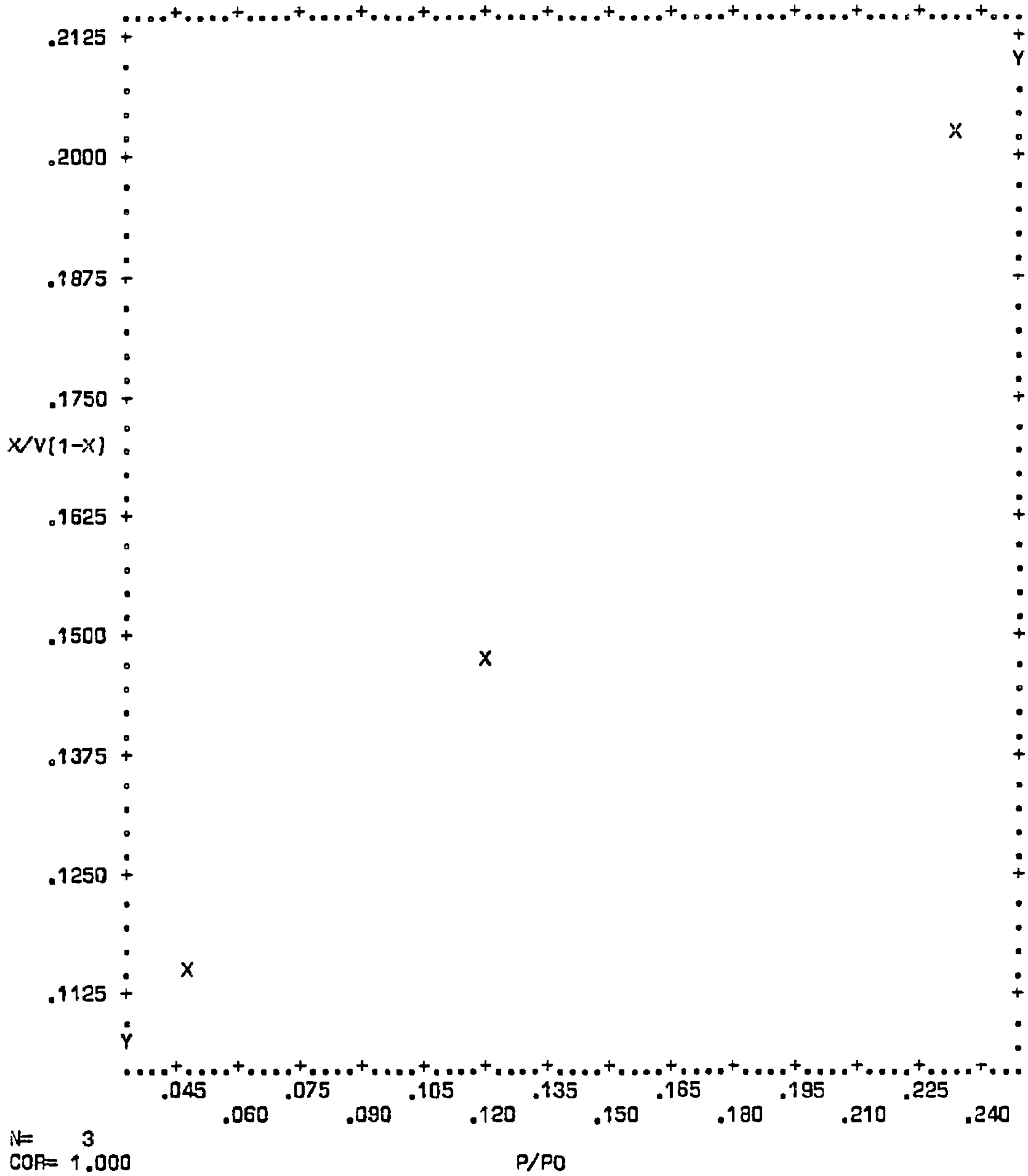
N= 3
COR= .9952 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 2.8161*Y-.10451	168E-6
Y	.08449	.03298	Y= .35168*X+ .03757	210E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-5. Plot of BET equation versus relative pressure for Converter A193/0908-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A193/0908-A SAMPLE G



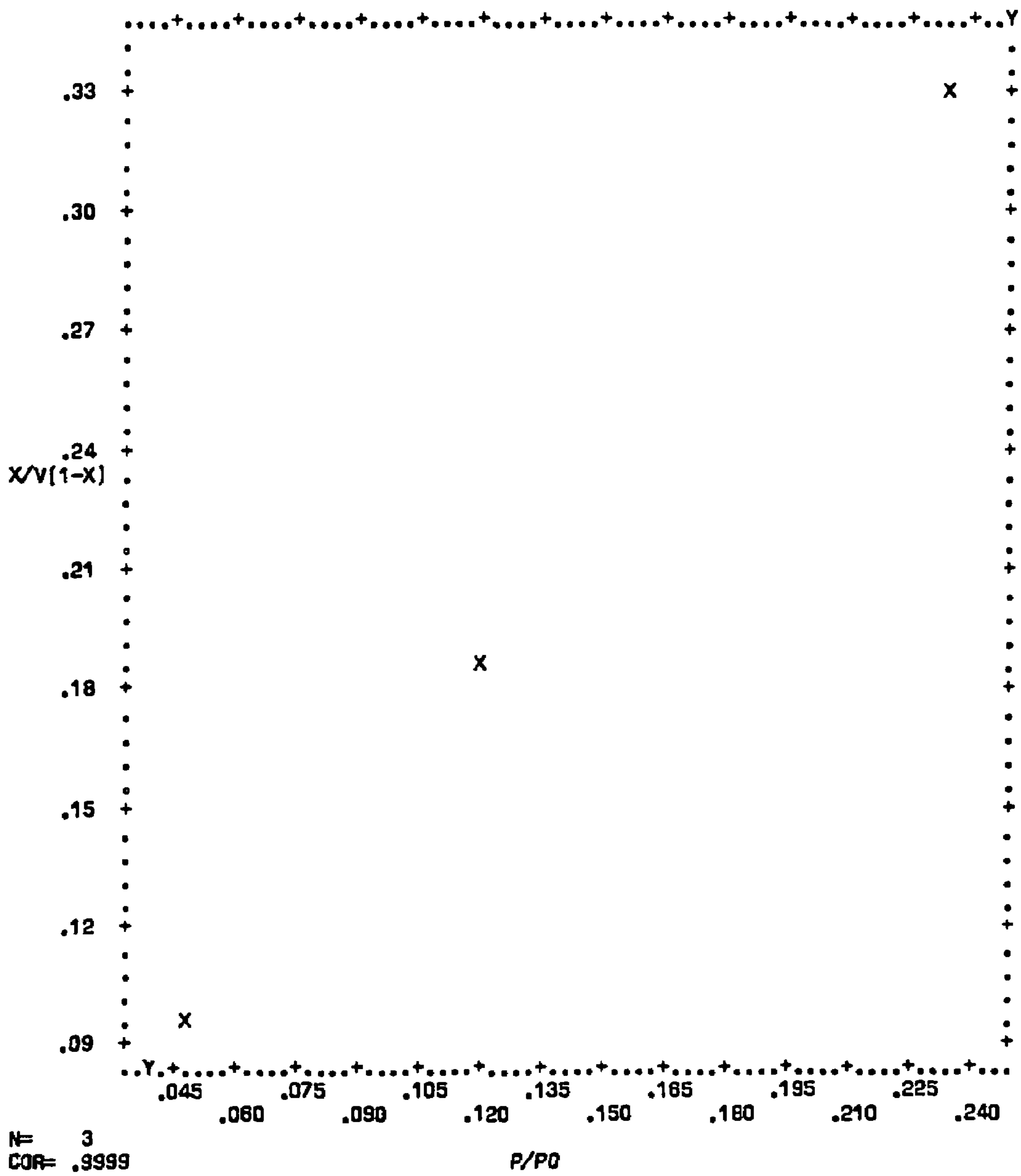
N= 3
COR= 1.000

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13342	.09331	X= 2.1176*Y-.19443	721E-9
Y	.15482	.04406	Y= .47220*X+ .09182	161E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-6. Plot of BET equation versus relative pressure for Converter A193/0908-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A193/0908-B SAMPLE F



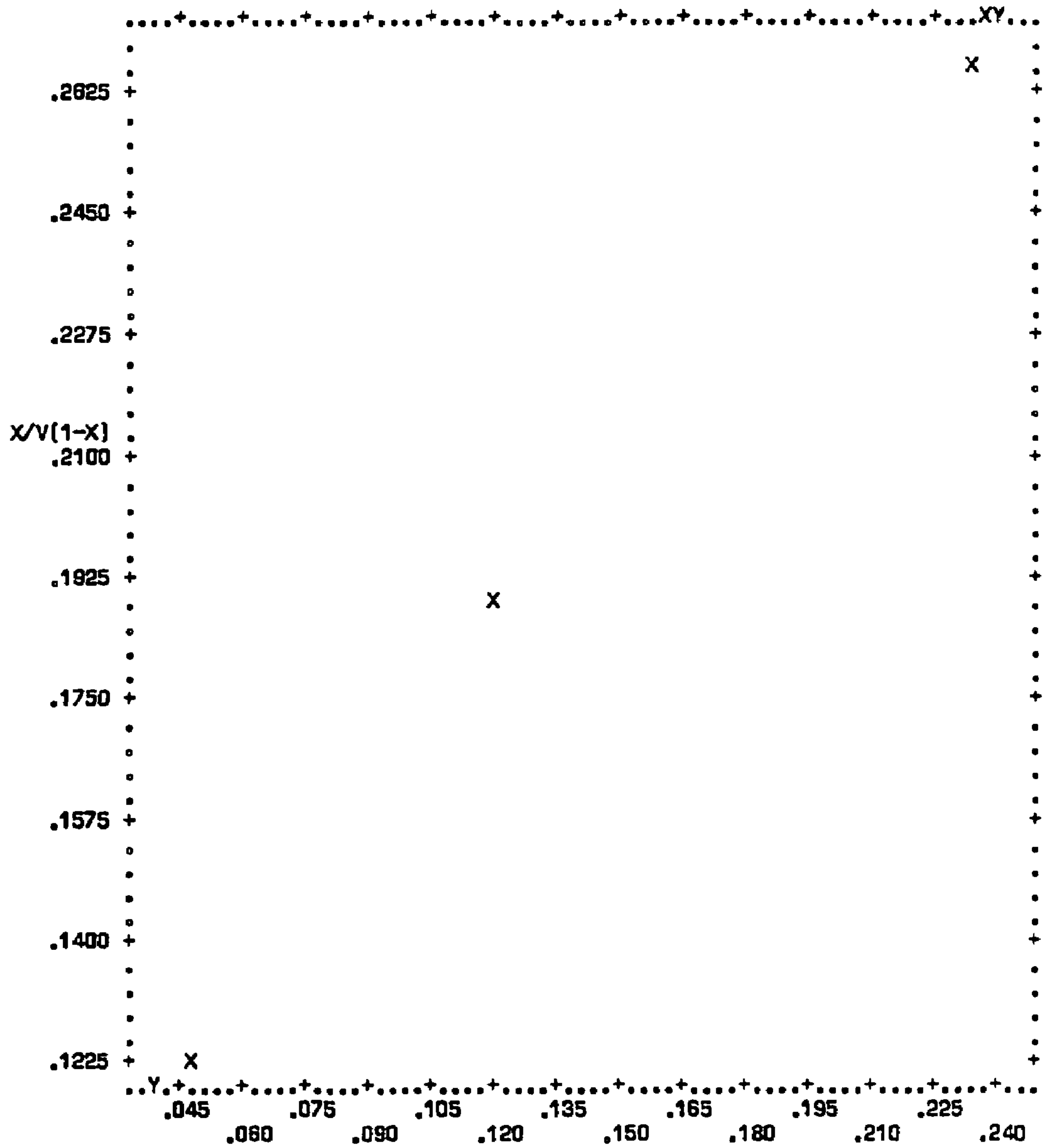
N= 3
COR= .9999

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= .79383*Y-.02799	176E-8
Y	.20334	.11754	Y= 1.2598*X+ .03527	280E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-7. Plot of BET equation versus relative pressure for Converter A193/0908-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A193/0908-B SAMPLE E



N= 3
COR= .9961

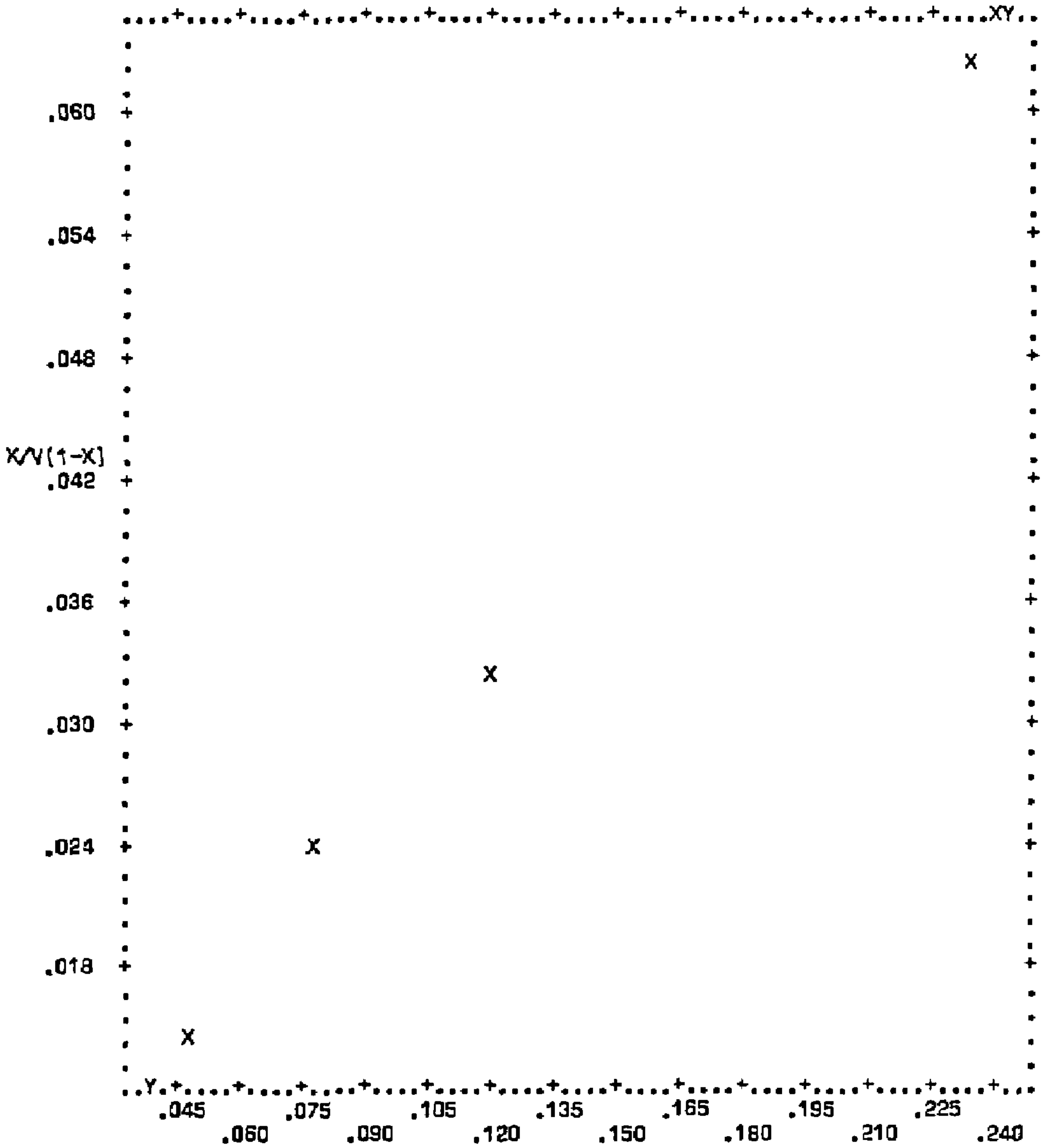
P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 1.2970*Y-.11578	138E-6
Y	.18214	.07166	Y= .76497*X+ .09007	805E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-8. Plot of BET equation versus relative pressure for Converter A193/0908-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A218/0045 SAMPLE F



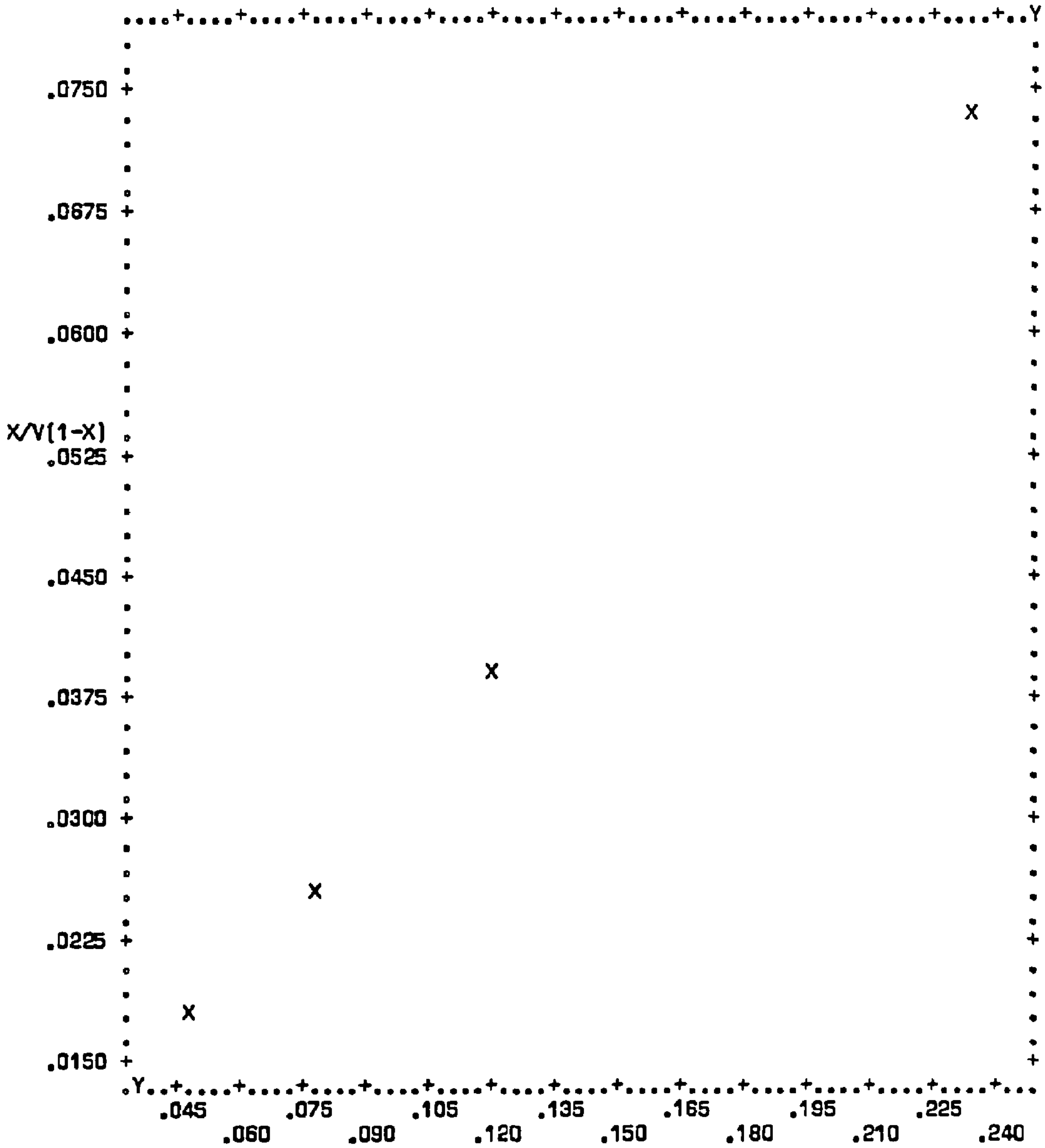
N= 4
COR= .9995 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.8554*Y-.00838	961E-8
Y	.03328	.02096	Y= .25912*X+ .00220	646E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-9. Plot of BET equation versus relative pressure for Converter A218/0045 - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A218/0045 SAMPLE E



N= 4
COR= .9999 P/PO

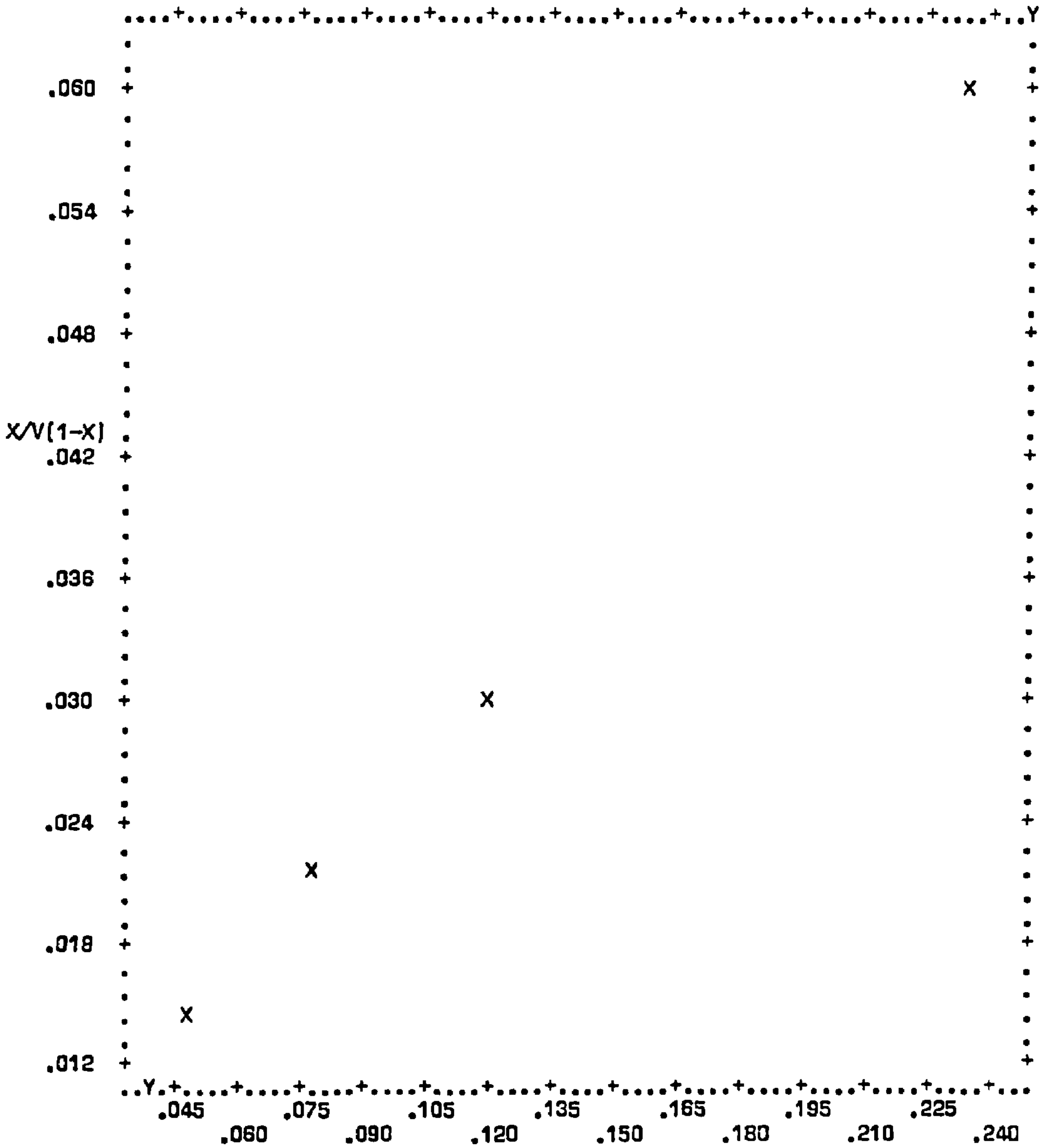
	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.2458*Y-.00667	221E-8
Y	.03900	.02490	Y= .30802*X+ .00206	210E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .937 SECONDS

Figure C-10. Plot of BET equation versus relative pressure for Converter A218/0045 - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A218/0045 SAMPLE G



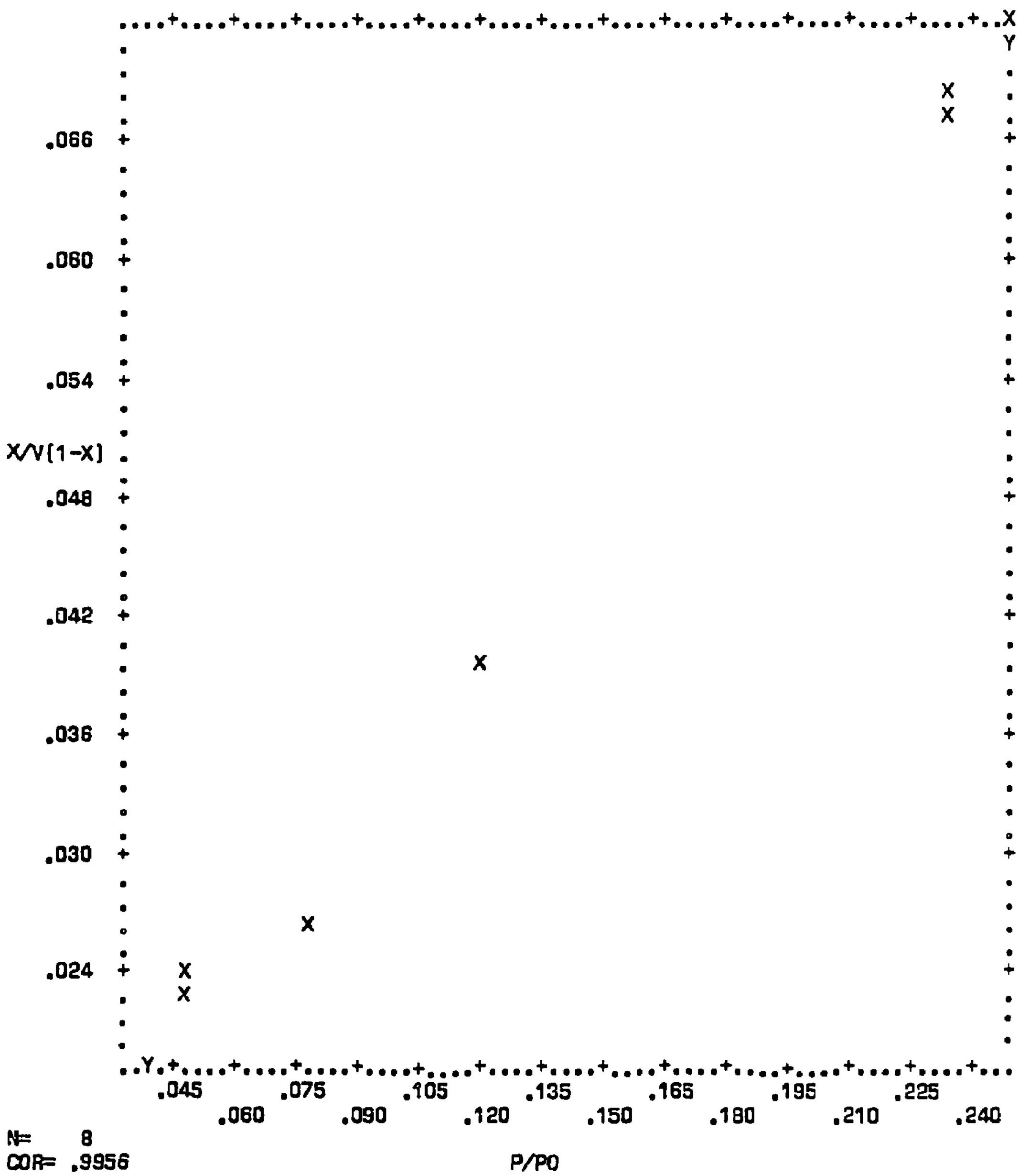
N= 4
COR= .9985

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.9831*Y-.00524	289E-7
Y	.03142	.02027	Y= .25032*X+ .00140	182E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .925 SECONDS

Figure C-11. Plot of BET equation versus relative pressure for Converter A218/0045 - Rear Face



N= 8
COR= .9956

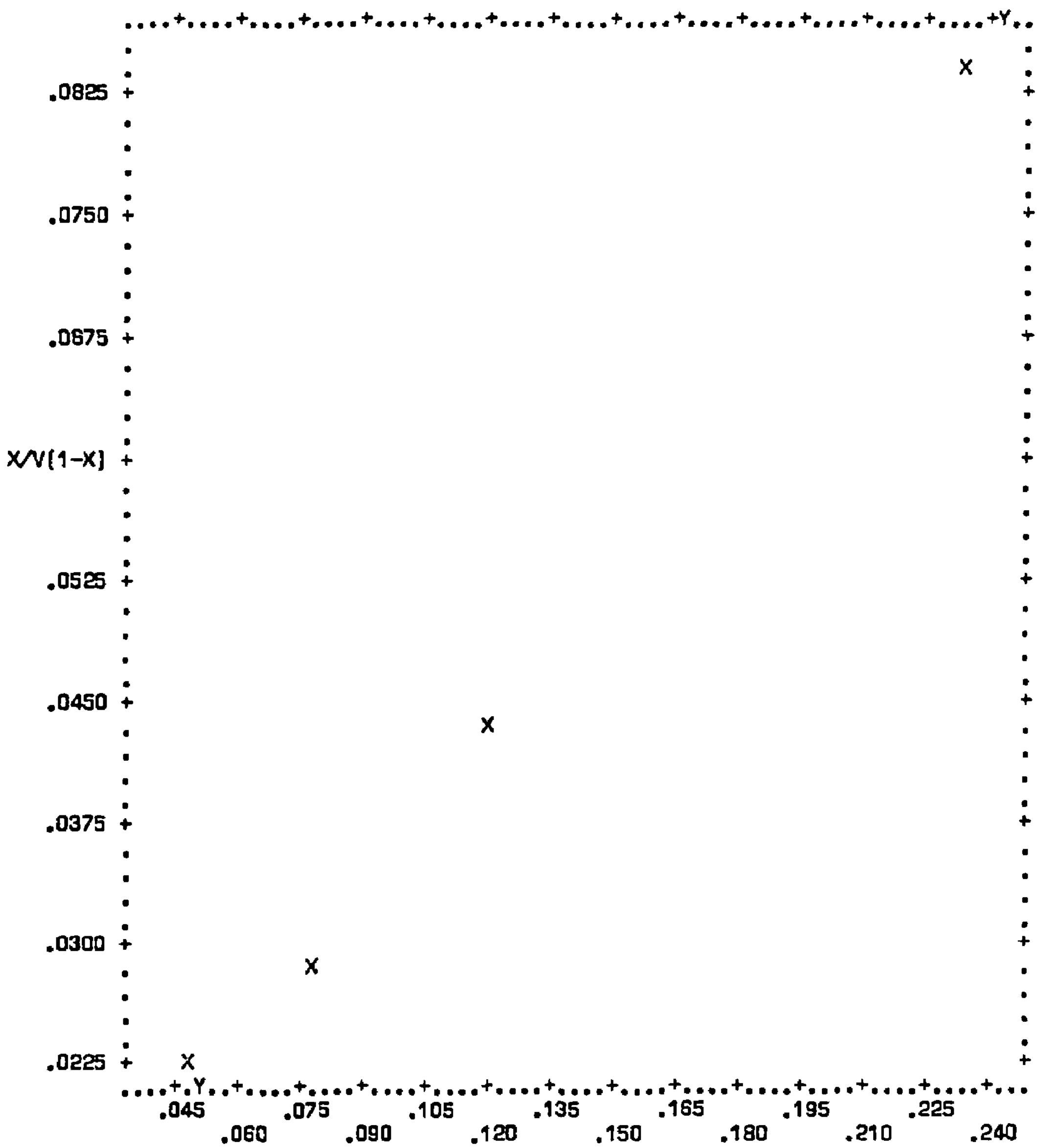
	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11993	.07485	X= 3.9828*Y-.03646	580E-7
Y	.03927	.01871	Y= .24885*X+ .00942	363E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .944 SECONDS

Figure C-12. Plot of BET equation versus relative pressure for Converter A218/0045X - Bulk

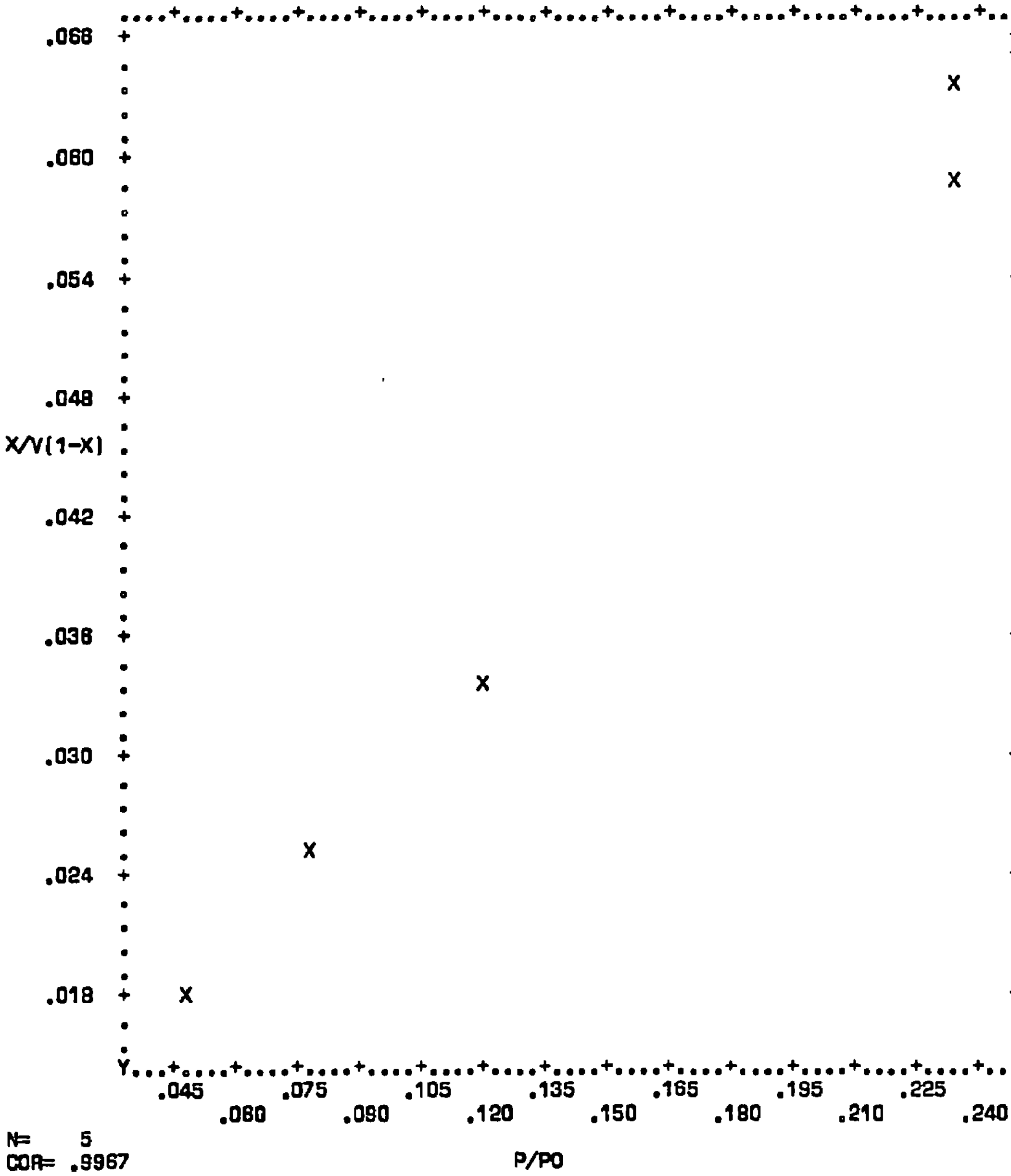
PAGE 4 CONVERTER SURFACE AREA ANALYSIS A218/0045X SAMPLE E




```
N=    4
COR= .9984                                     P/PO

    MEAN     ST.DEV.    REGRESSION LINE    RES.MS.
X   .11992   .08084  X= 2.9336*Y-.01129    319E-7
Y   .04473   .02751  Y= .33976*X+ .00398   370E-8

VARIABLE    1  P/PO     VERSUS VARIABLE  2  X/V        SYMBOL=X

CPU TIME USED        .935 SECONDS
```

Figure C-13. Plot of BET equation versus relative pressure for Converter A218/0045X - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A218/0045X-G



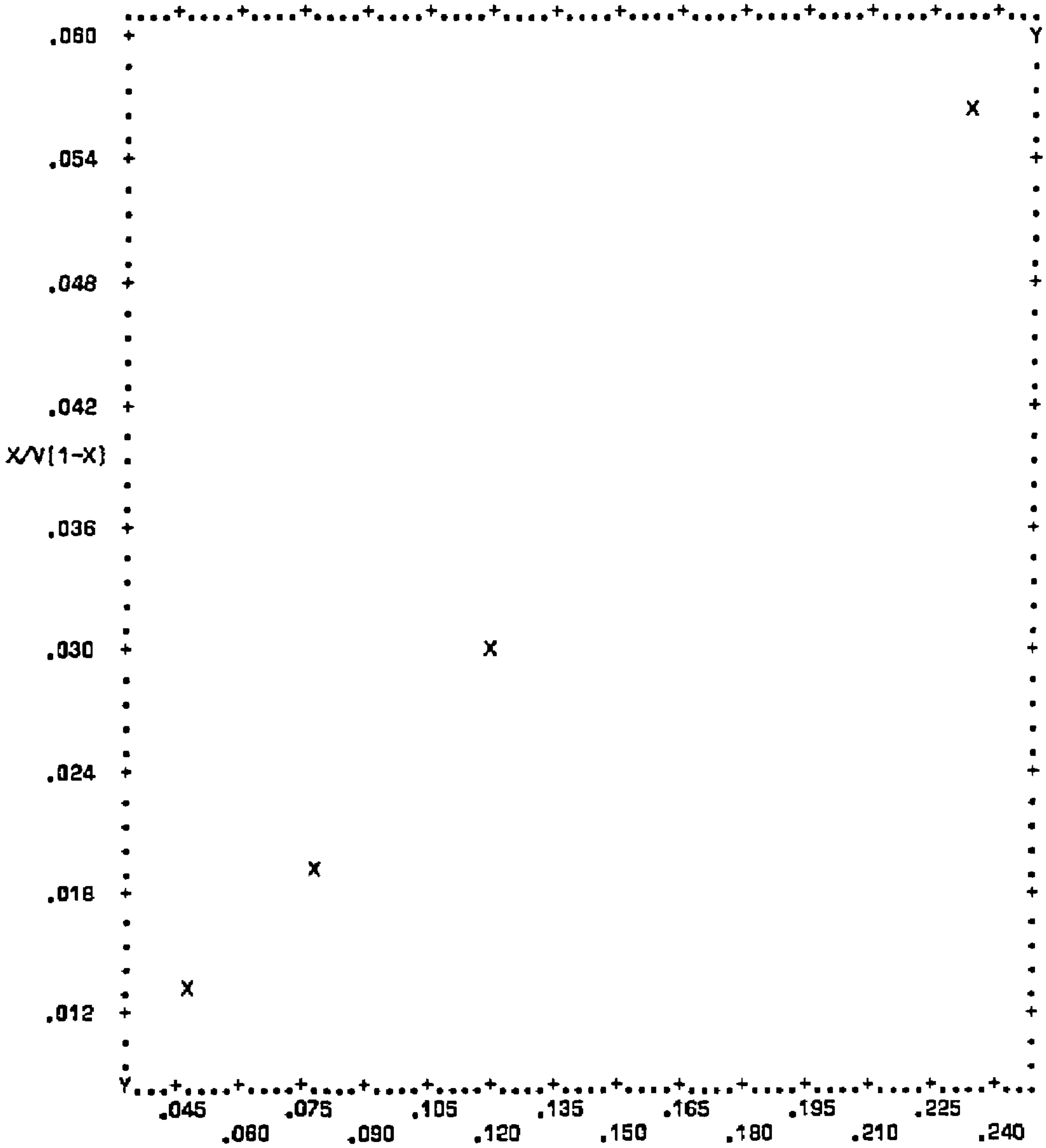
N= 5
COR= .9967

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.14261	.08645	X= 4.2148*Y-.02624	847E-7
Y	.04006	.02044	Y= .23572*X+ .00645	362E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-14. Plot of BET equation versus relative pressure for Converter A218/0045X - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A218/0068 SAMPLE F



N= 4
COR= .9998 P/PO

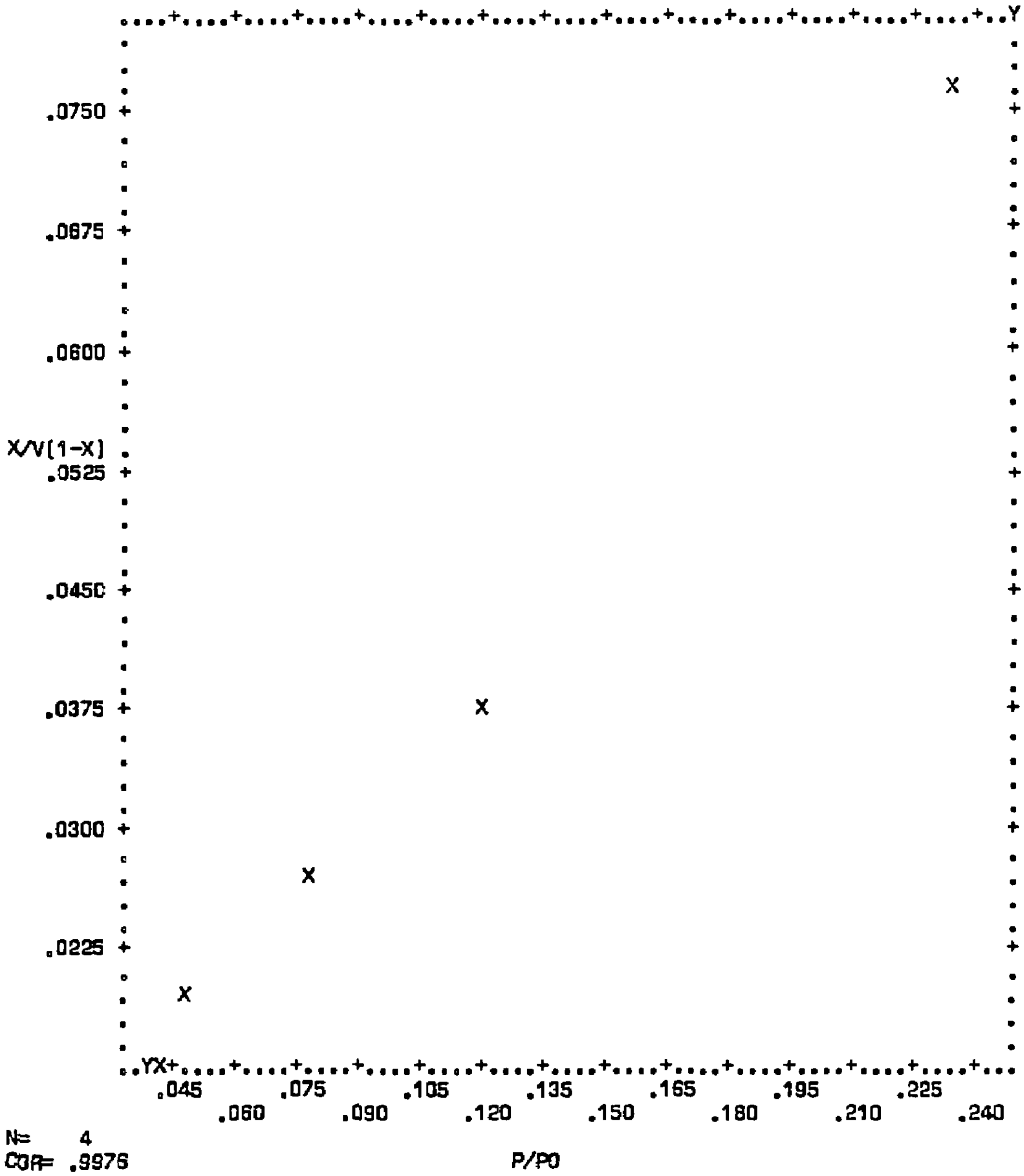
	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 4.2163*Y-.00453	397E-8
Y	.02952	.01917	Y= .23708*X+ .00109	223E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .965 SECONDS

Figure C-15. Plot of BET equation versus relative pressure for Converter A218/0068 - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A218/0068 SAMPLE E



N= 4
COR= .9976

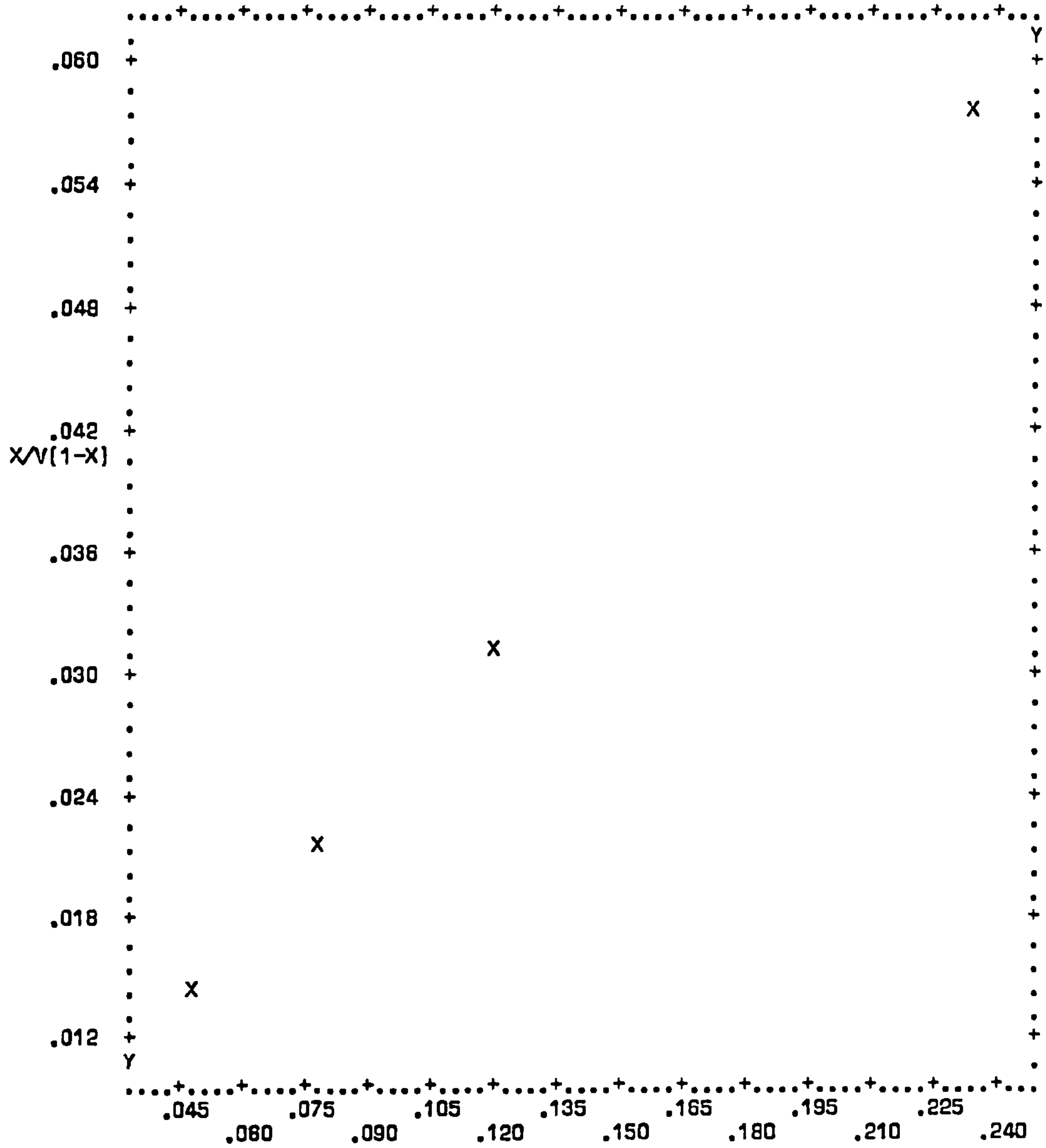
	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11993	.08085	X= 3.1492*Y-.00667	461E-7
Y	.04020	.02561	Y= .31605*X+ .00230	463E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .903 SECONDS

Figure C-16. Plot of BET equation versus relative pressure for Converter A218/0068 - Front Face

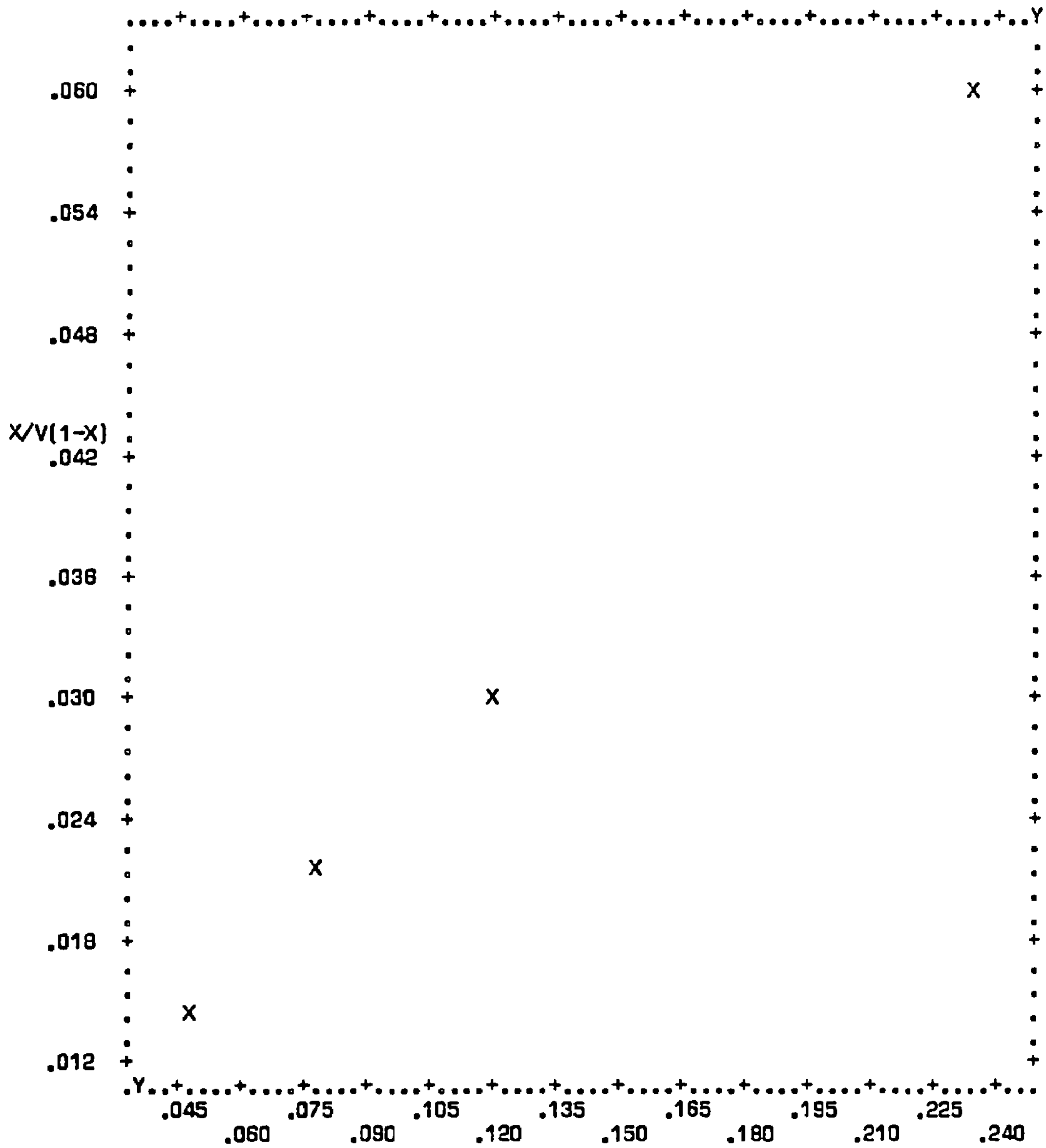
PAGE 4 CONVERTER SURFACE AREA ANALYSIS A218/0068 SAMPLE G




```
N=    4
COR= .9999                              P/PO

     MEAN     ST.DEV.    REGRESSION LINE     RES.MS.
X   .11992    .08084  X= 4.2455*Y-.01331     184E-8
Y   .03138    .01904  Y= .23550*X+ .00314    102E-9

VARIABLE    1  P/PO     VERSUS VARIABLE  2  X/V        SYMBOL=X

CPU TIME USED         .955 SECONDS
```

Figure C-17. Plot of BET equation versus relative pressure for Converter A218/0068 - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A220/0392-1 SAMPLE F



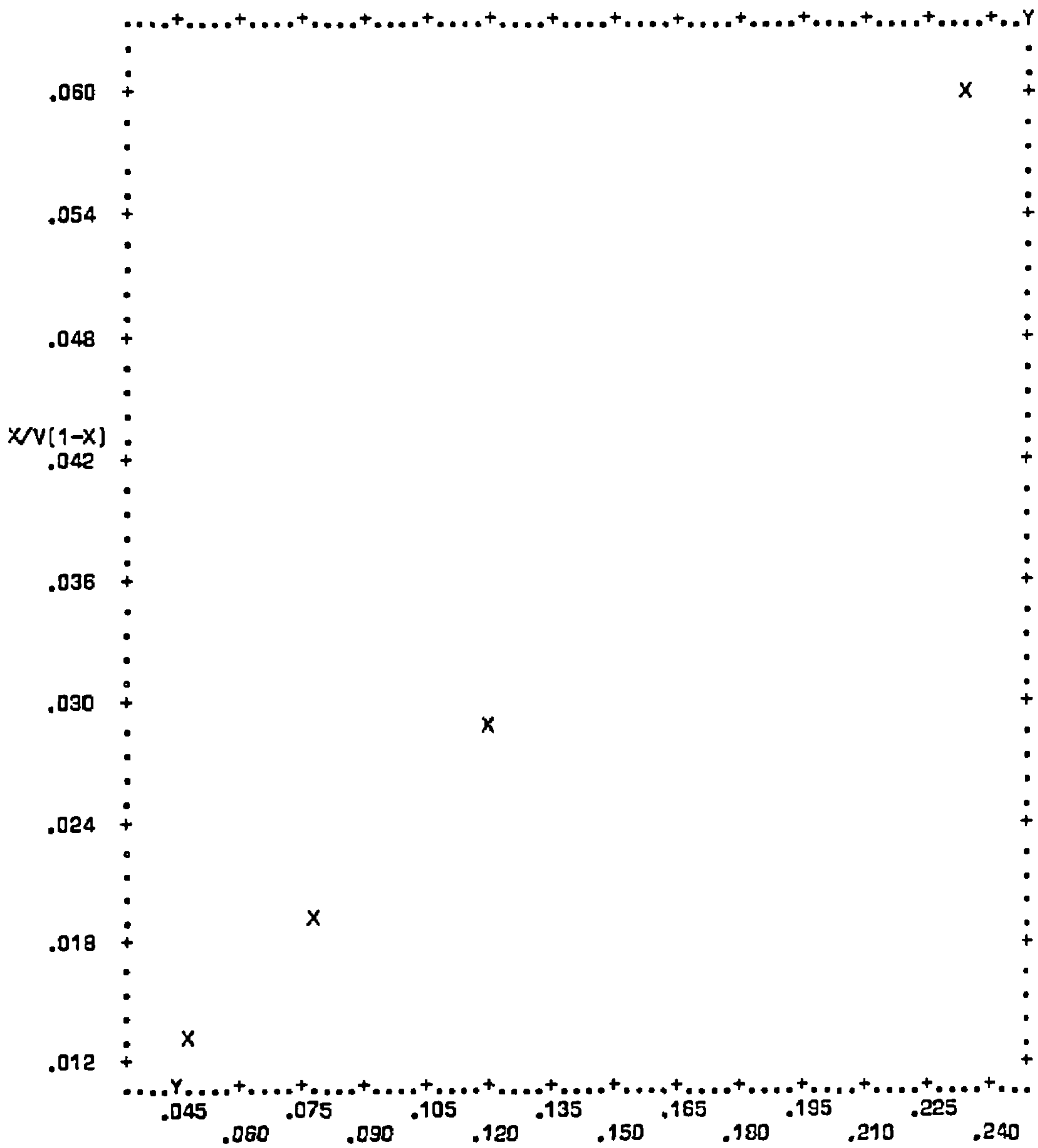
N= 4
COR= .9996 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.9898*Y-.00601	768E-8
Y	.03156	.02025	Y= .25045*X+ .00153	482E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-18. Plot of BET equation versus relative pressure for Converter A220/0392-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A220/0392-A SAMPLE E



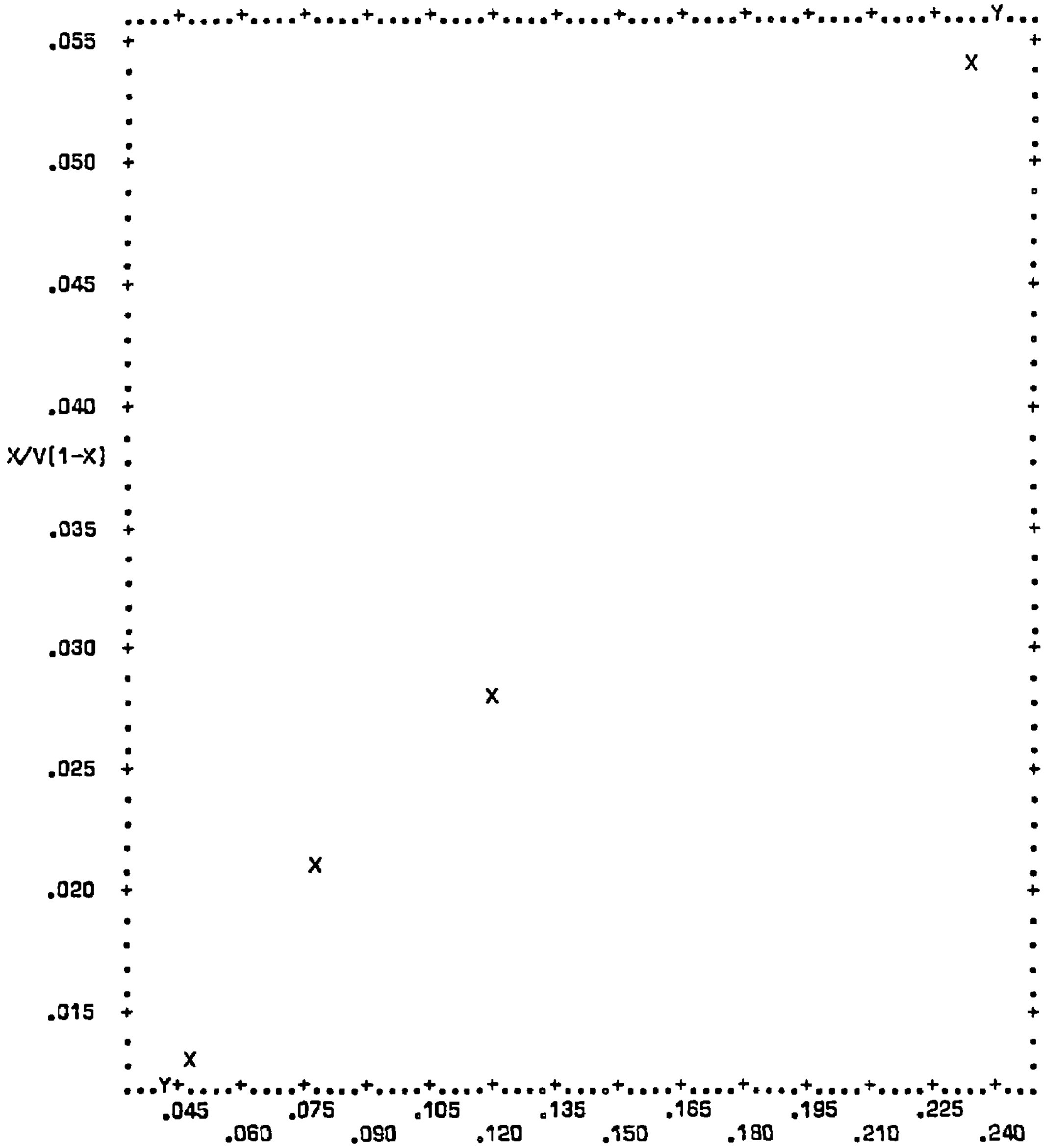
N= 4
COR= .9983

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.8500*Y+ .00264	334E-7
Y	.03046	.02096	Y= .25886*X-580E-6	225E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-19. Plot of BET equation versus relative pressure for Converter A220/0392-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A220/0392-A SAMPLE G



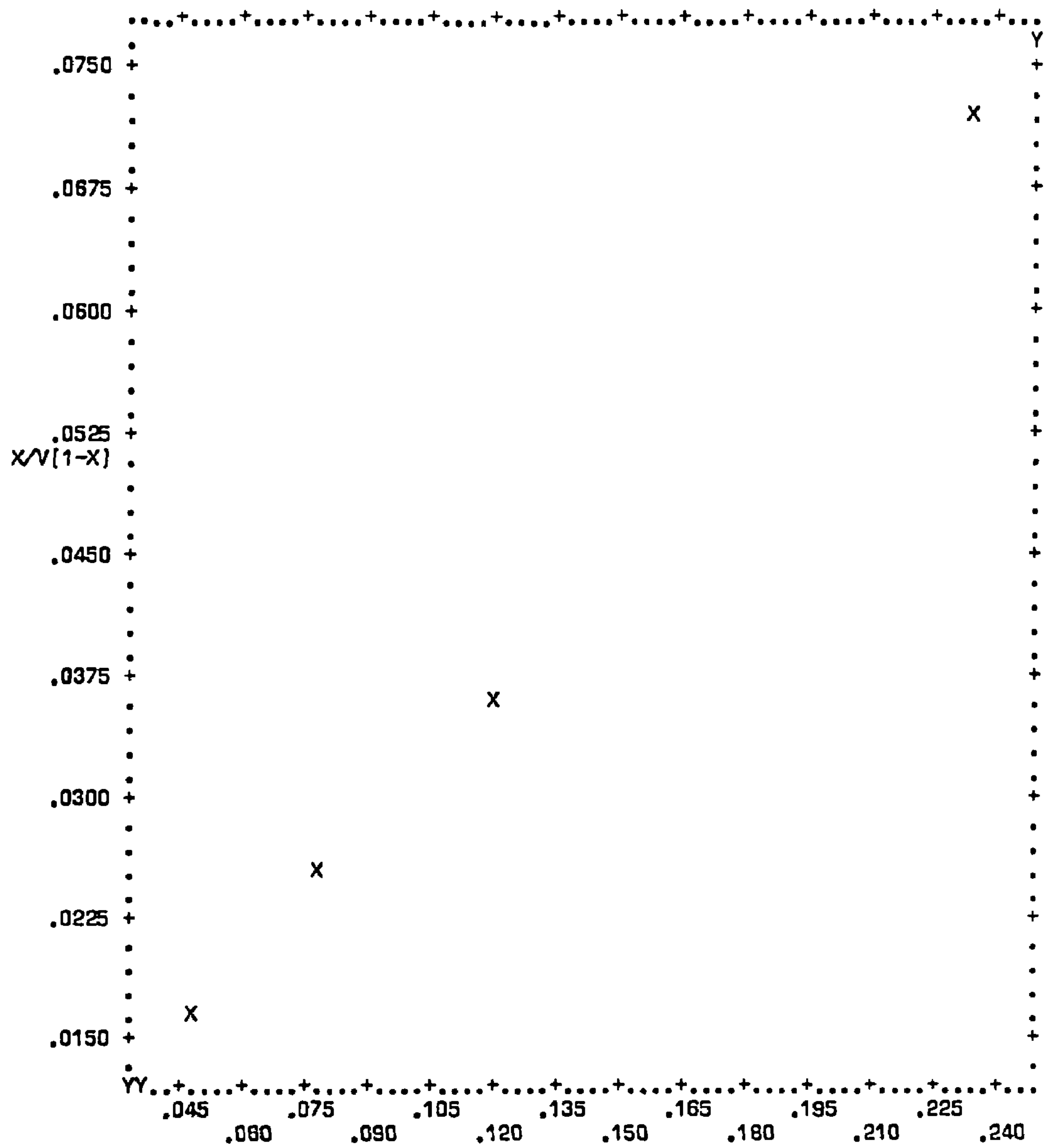
N= 4
COR= .9993 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 4.5012*Y-.01123	132E-7
Y	.02914	.01795	Y= .22186*X+ .00253	651E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-20. Plot of BET equation versus relative pressure for Converter A220/0392-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A220/0392-6 SAMPLE F



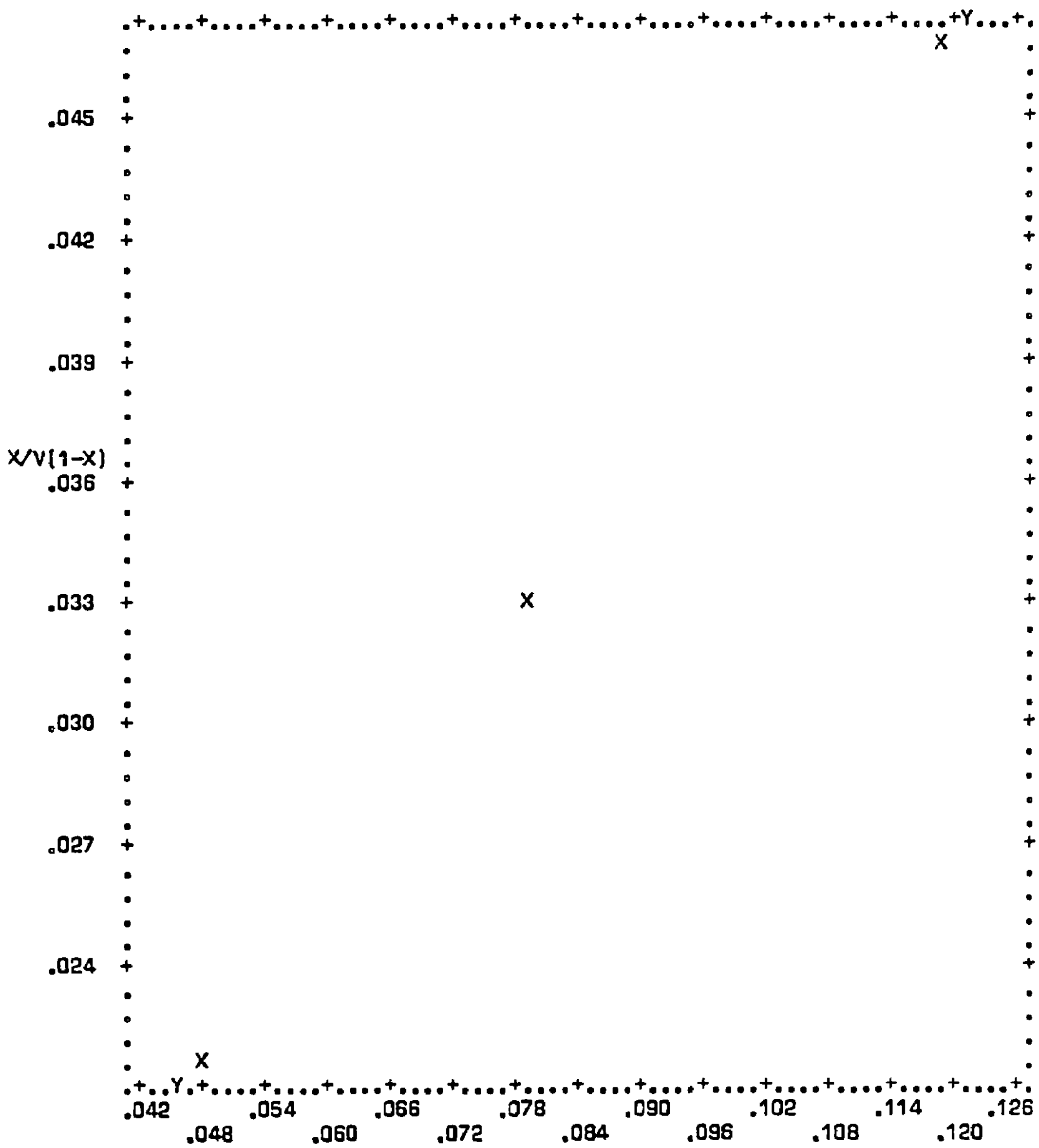
N= 4
COR= .9994 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.3348*Y-.00488	122E-7
Y	.03742	.02423	Y= .29949*X+ .00151	109E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-21. Plot of BET equation versus relative pressure for Converter A220/0392-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A220/0392-B SAMPLE E

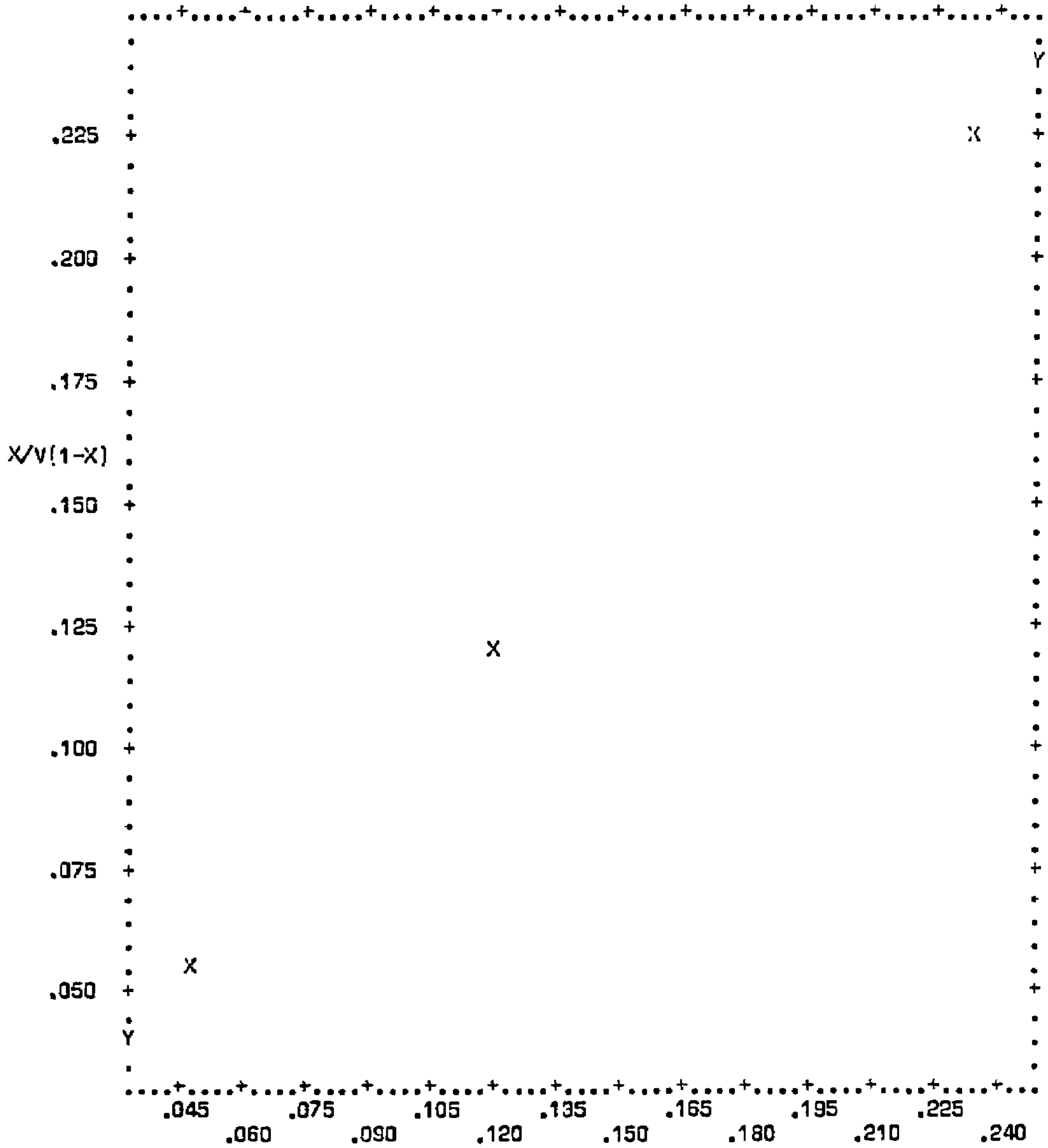


N= 3
COR= .9999

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.08214	.03517	X= 2.8273*Y-.01330	411E-9
Y	.03376	.01244	Y= .35364*X+ .00471	51E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-22. Plot of BET equation versus relative pressure for Converter A220/0392-B - Front Face



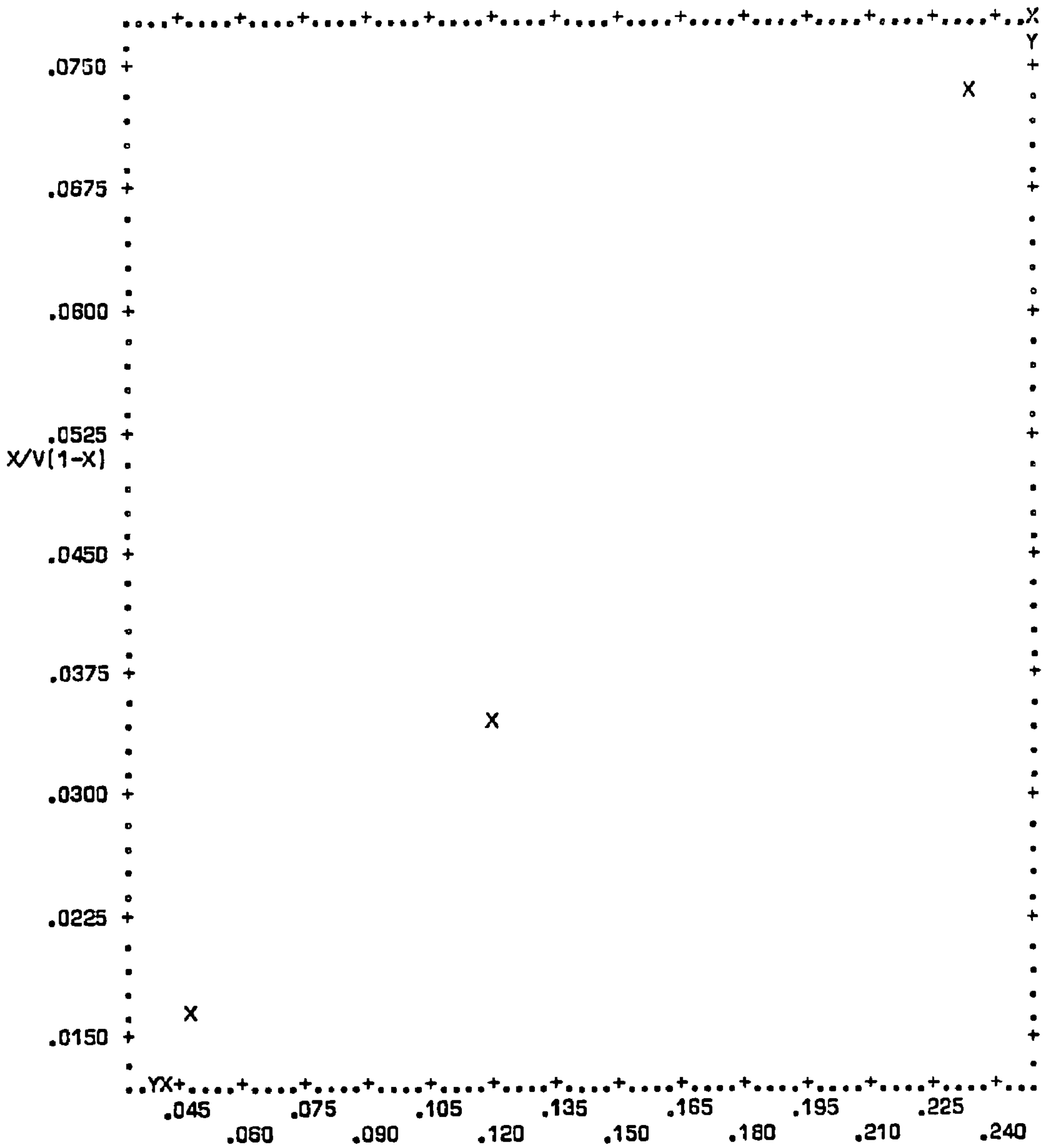
N= 3
COR= .9999 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.0888*Y-.01103	246E-8
Y	.13342	.08570	Y= .91832*X+ .01088	207E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-23. Plot of BET equation versus relative pressure for Converter A220/0810-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A 220/0810XX1-A SAMPLE E



N= 3
COR= .9970

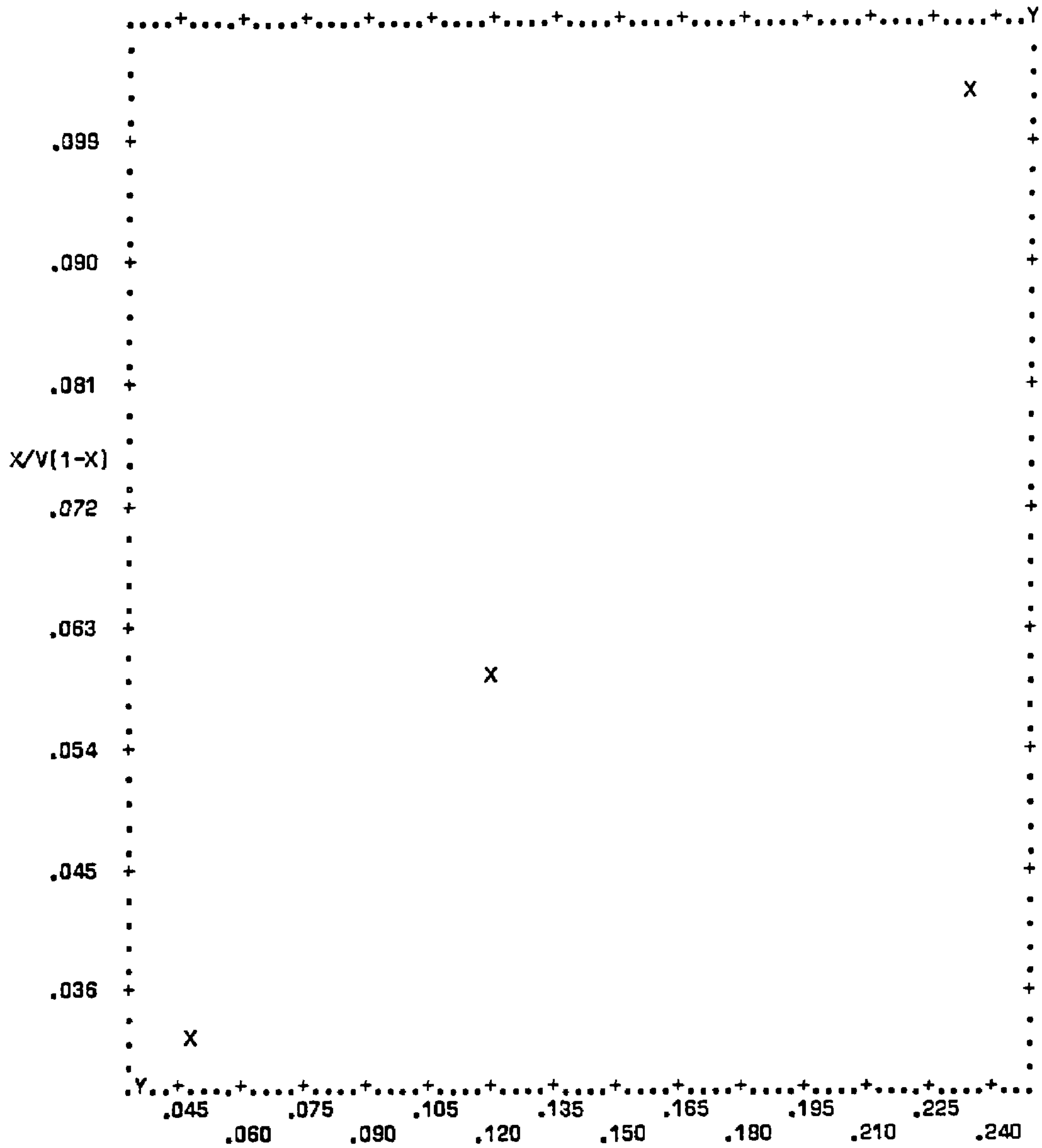
P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 3.1878*Y+ .00237	105E-6
Y	.04111	.02918	Y= .31180*X-489E-6	103E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-24. Plot of BET equation versus relative pressure for Converter A220/0810-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A220/0810XX1-A SAMPLE G

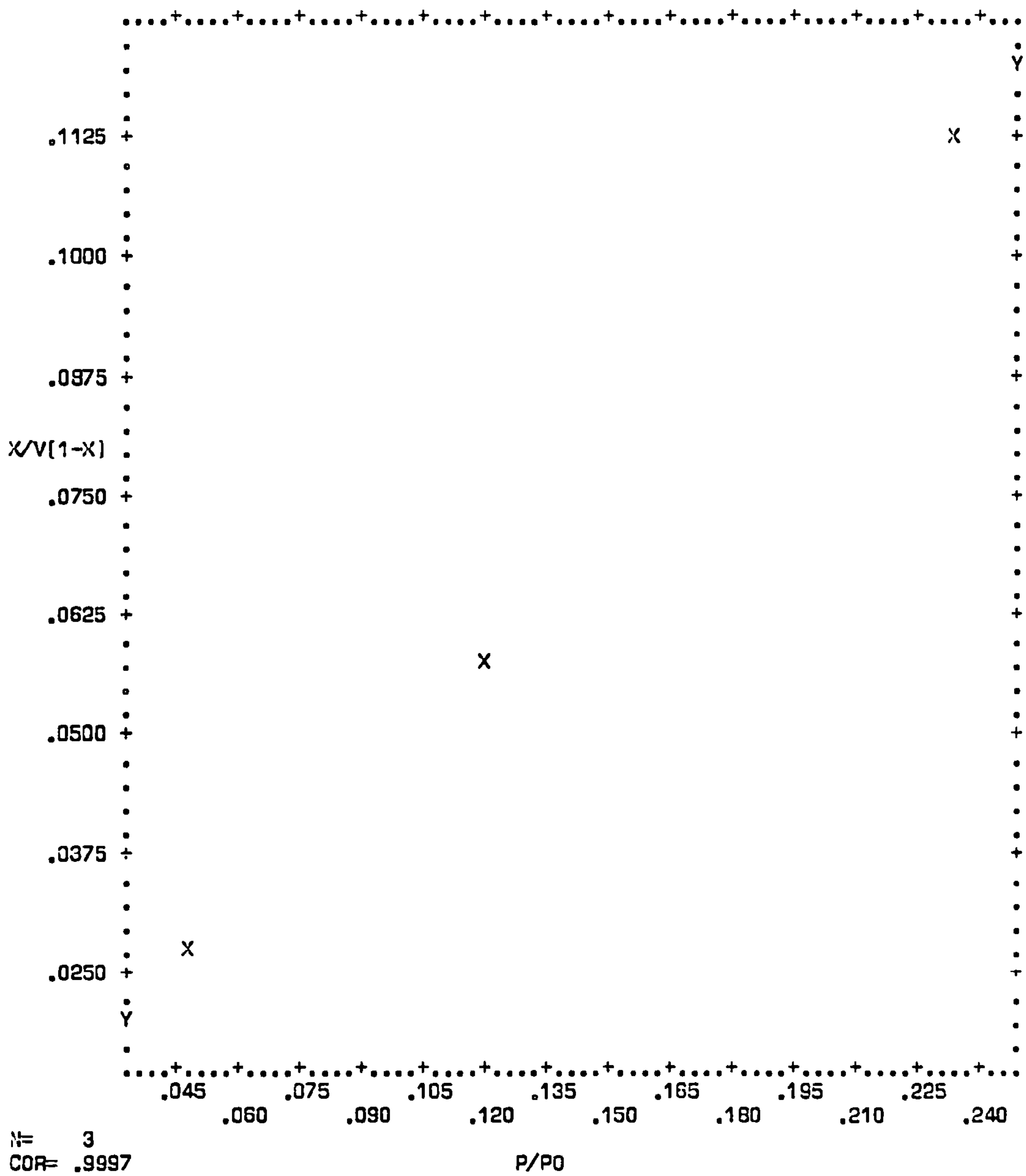


N= 3
COR= 1.000 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 2.6912*Y-.04122	154E-8
Y	.06490	.03467	Y= .37155*X+ .01532	213E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-25. Plot of BET equation versus relative pressure for Converter A220/0810-A - Rear Face



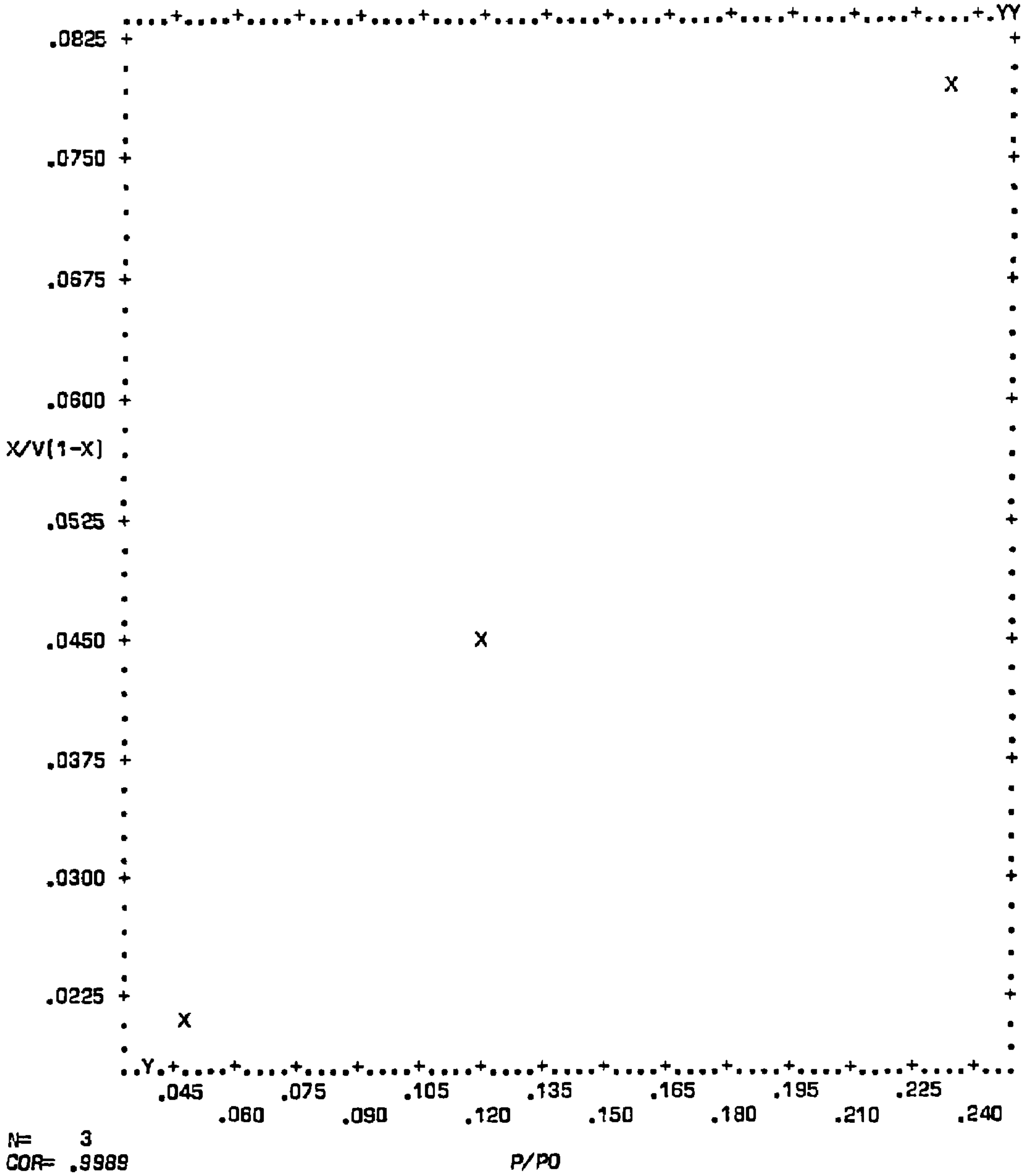
N= 3
COR= .9997

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 2.1820*Y-.01124	945E-8
Y	.06630	.04276	Y= .45804*X+ .00518	198E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-26. Plot of BET equation versus relative pressure for Converter A220/0810-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A220/0810XX1-B SAMPLE E



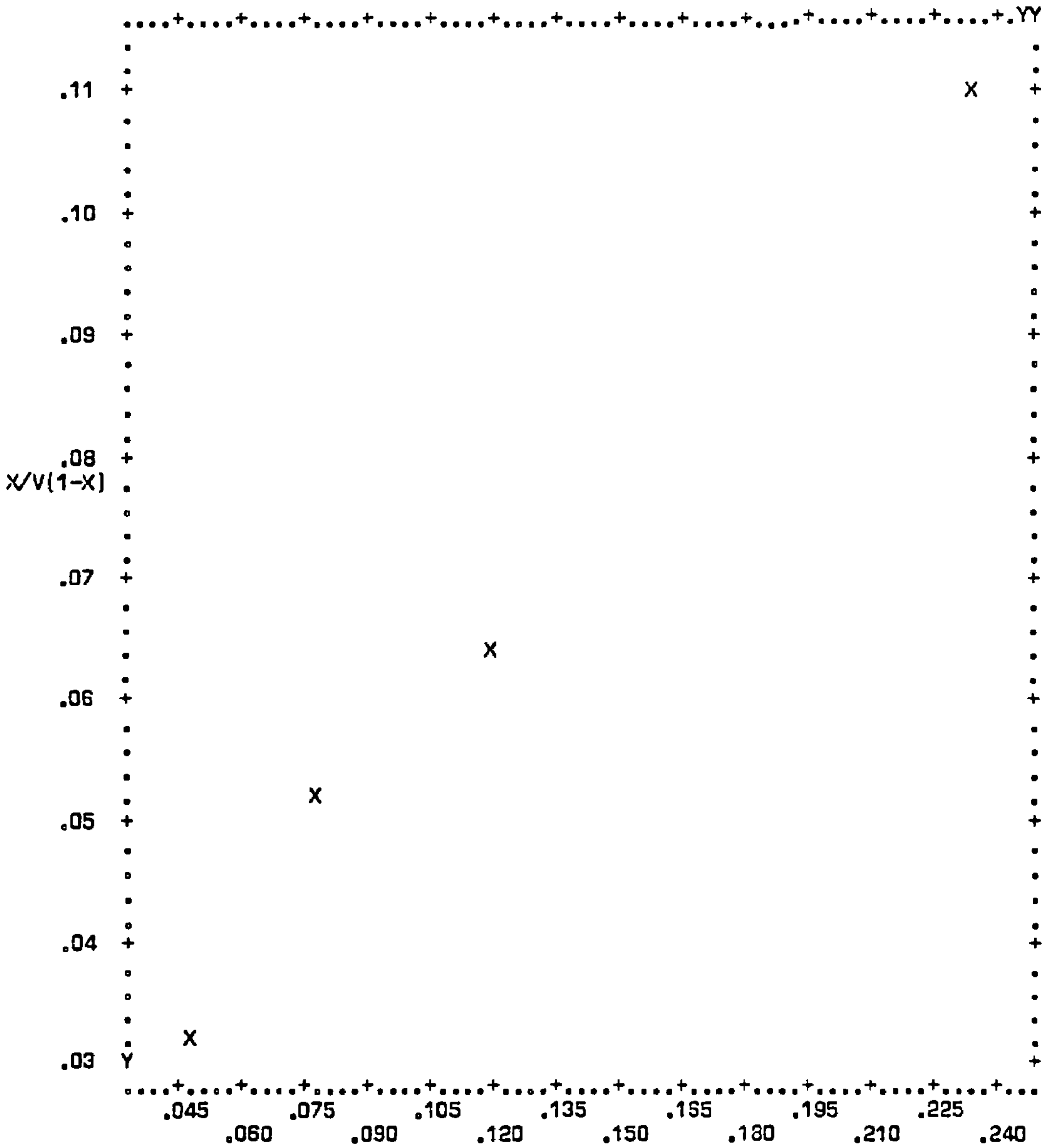
N= 3
COR= .9989

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 3.1584*Y-.01891	387E-7
Y	.04823	.02951	Y= .31592*X+ .00608	387E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-27. Plot of BET equation versus relative pressure for Converter A220/0810-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0152-A SAMPLE F



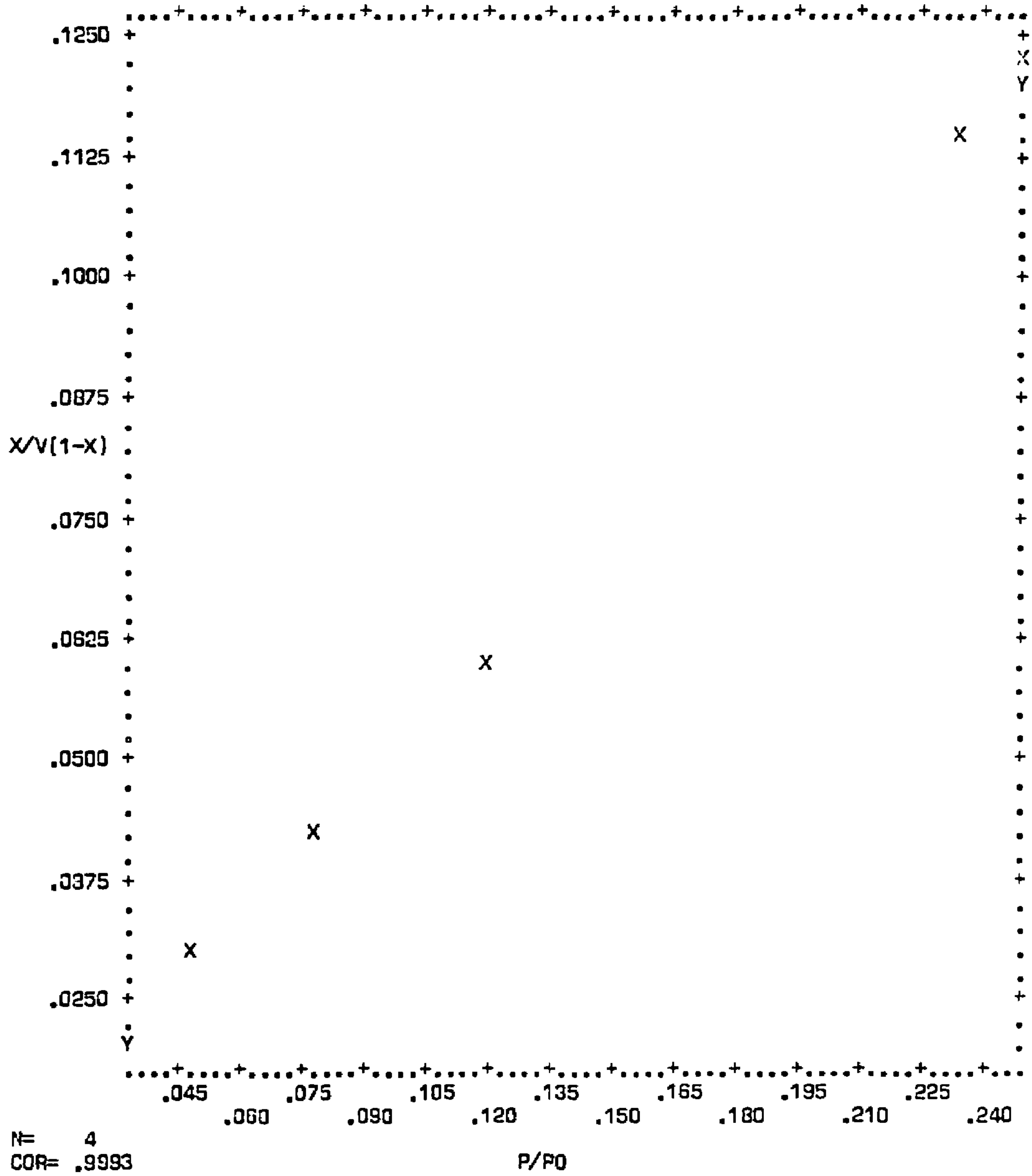
N= 4
COR= .9950 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11994	.08085	X= 2.4564*Y-.03872	977E-7
Y	.06459	.03275	Y= .40305*X+ .01625	160E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-28. Plot of BET equation versus relative pressure for Converter A221/0152-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0152-A SAMPLE E



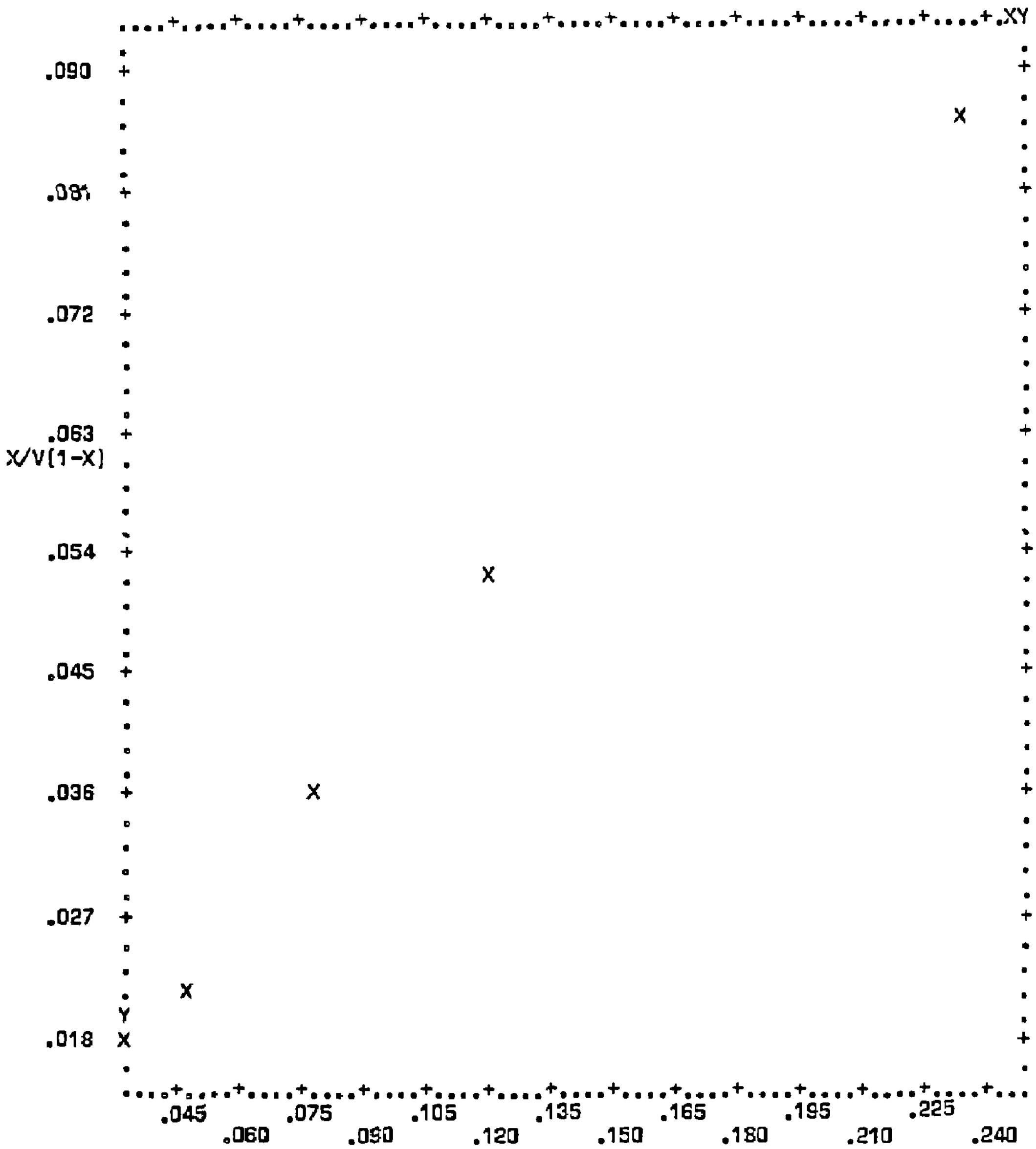
N= 4
COR= .9993

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.1556*Y-.01239	132E-7
Y	.06138	.03748	Y= .46329*X+ .00582	283E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-29. Plot of BET equation versus relative pressure for Converter A221/0152-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0152-A SAMPLE G



N= 4
COR= .9946

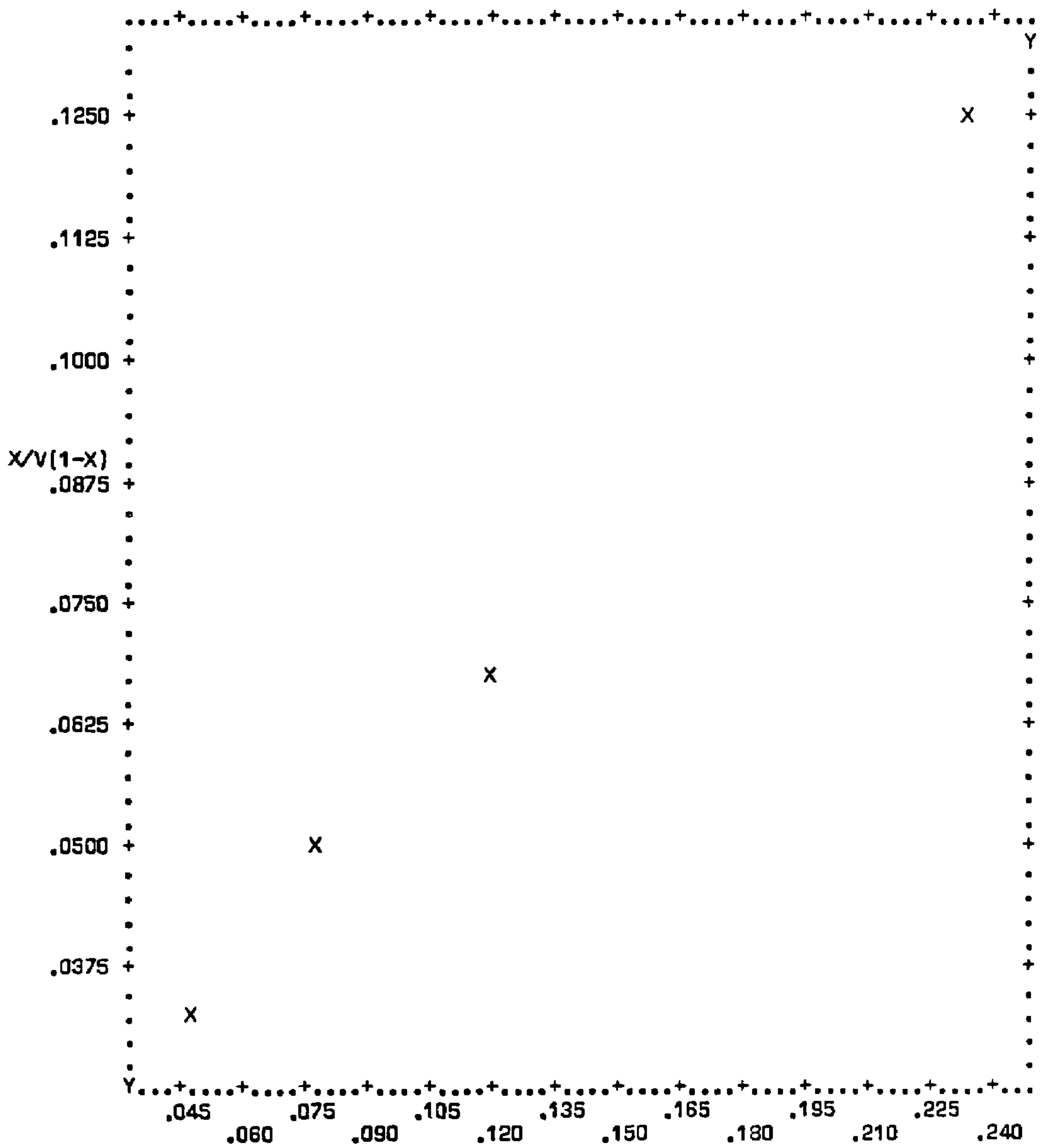
P/P0

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.3442*Y-.02006	105E-6
Y	.04922	.02827	Y= .34783*X+ .00750	128E-7

VARIABLE 1 P/P0 VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-30. Plot of BET equation versus relative pressure for Converter A221/0152-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0152-B SAMPLE F



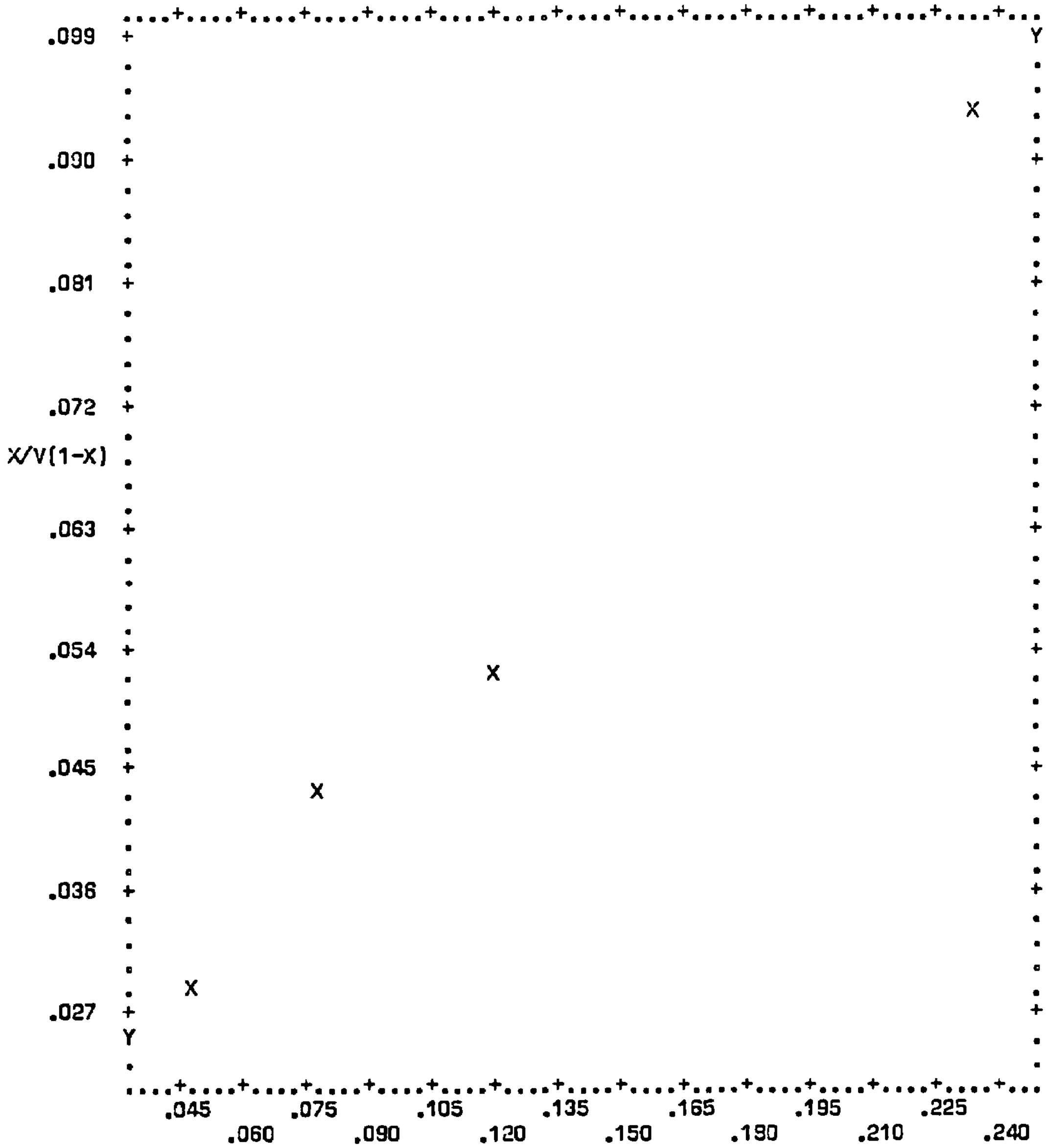
N= 4
COR= 1.000 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.0145*Y-.01792	636E-9
Y	.06842	.04013	Y= .49636*X+ .00890	157E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-31. Plot of BET equation versus relative pressure for Converter A221/0152-B - Bulk

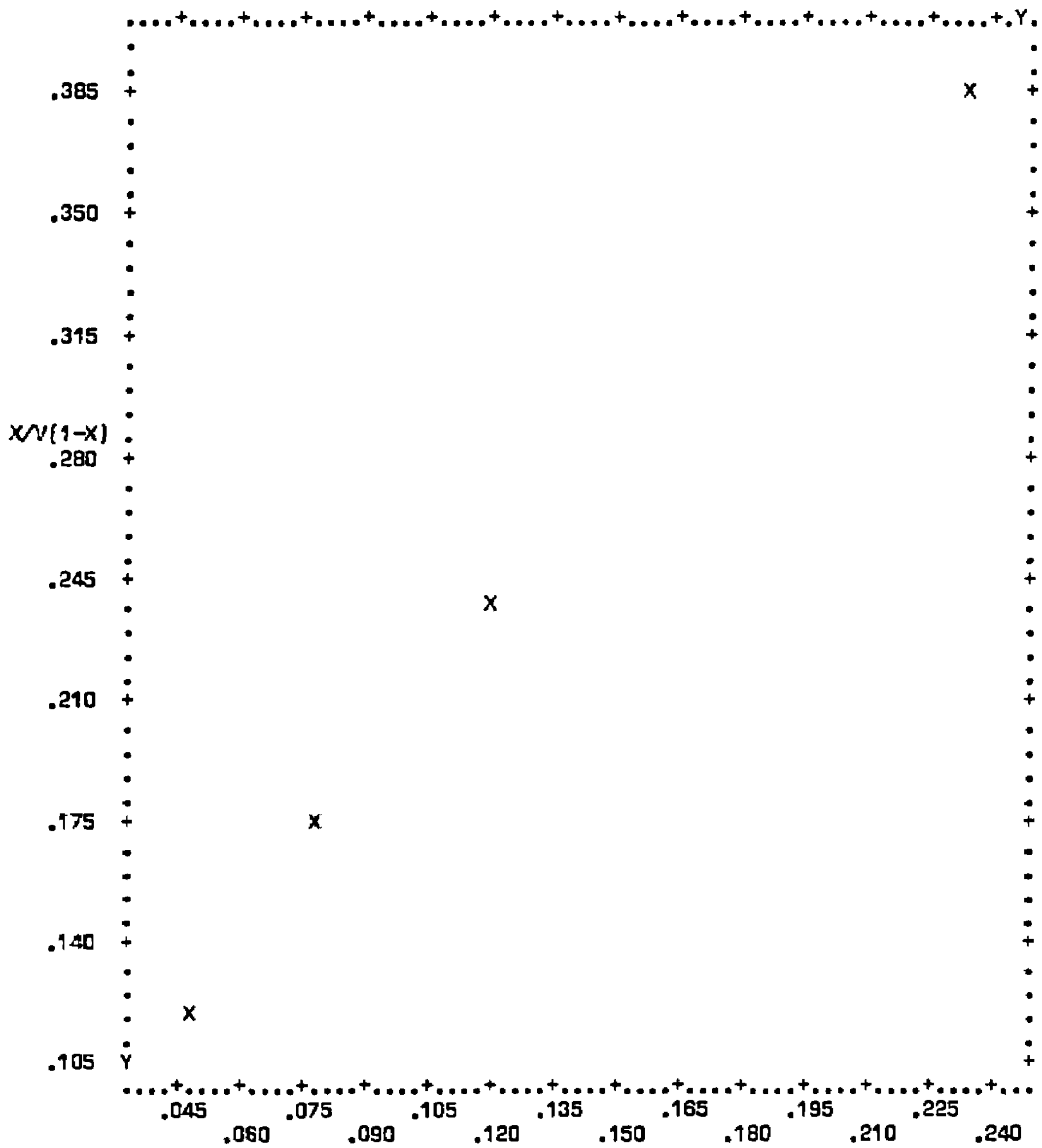
PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0152-B SAMPLE E




```
N=    4
COR= .9983

     MEAN     ST.DEV.    REGRESSION LINE      RES.MS.
X   .11993   .08085   X= 2.8636*Y-.03669    335E-7
Y   .05469   .02819   Y= .34802*X+ .01296   407E-8

VARIABLE   1  P/PO    VERSUS VARIABLE  2  X/V      SYMBOL=X
```

Figure C-32. Plot of BET equation versus relative pressure for Converter A221/0152-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0204-A SAMPLE F

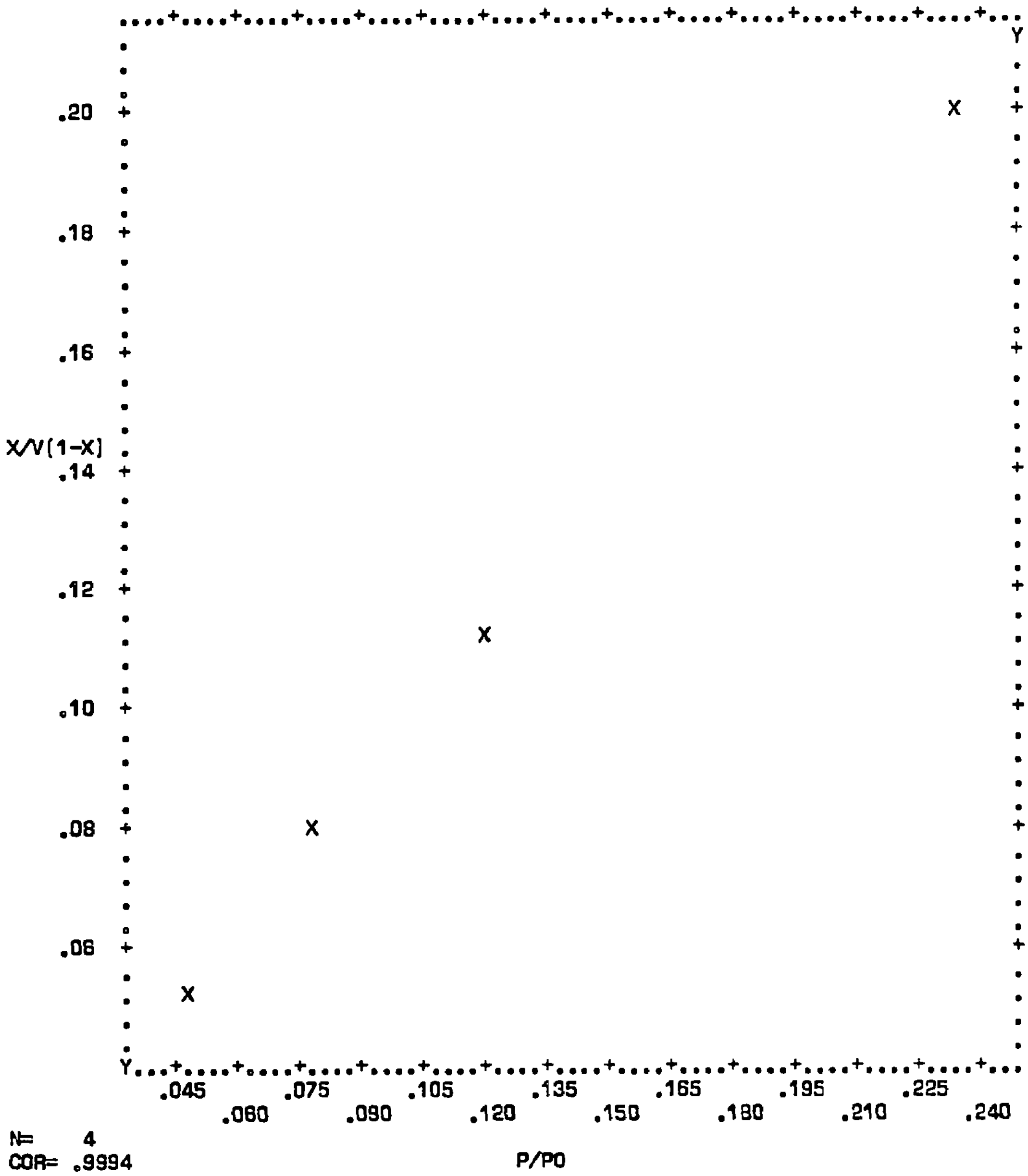


N= 4
COR= .9971 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= .71053*Y-.04340	570E-7
Y	.22986	.11345	Y= 1.3992*X+ .06207	112E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-33. Plot of BET equation versus relative pressure for Converter A221/0204-A - Bulk



N= 4
COR= .9994

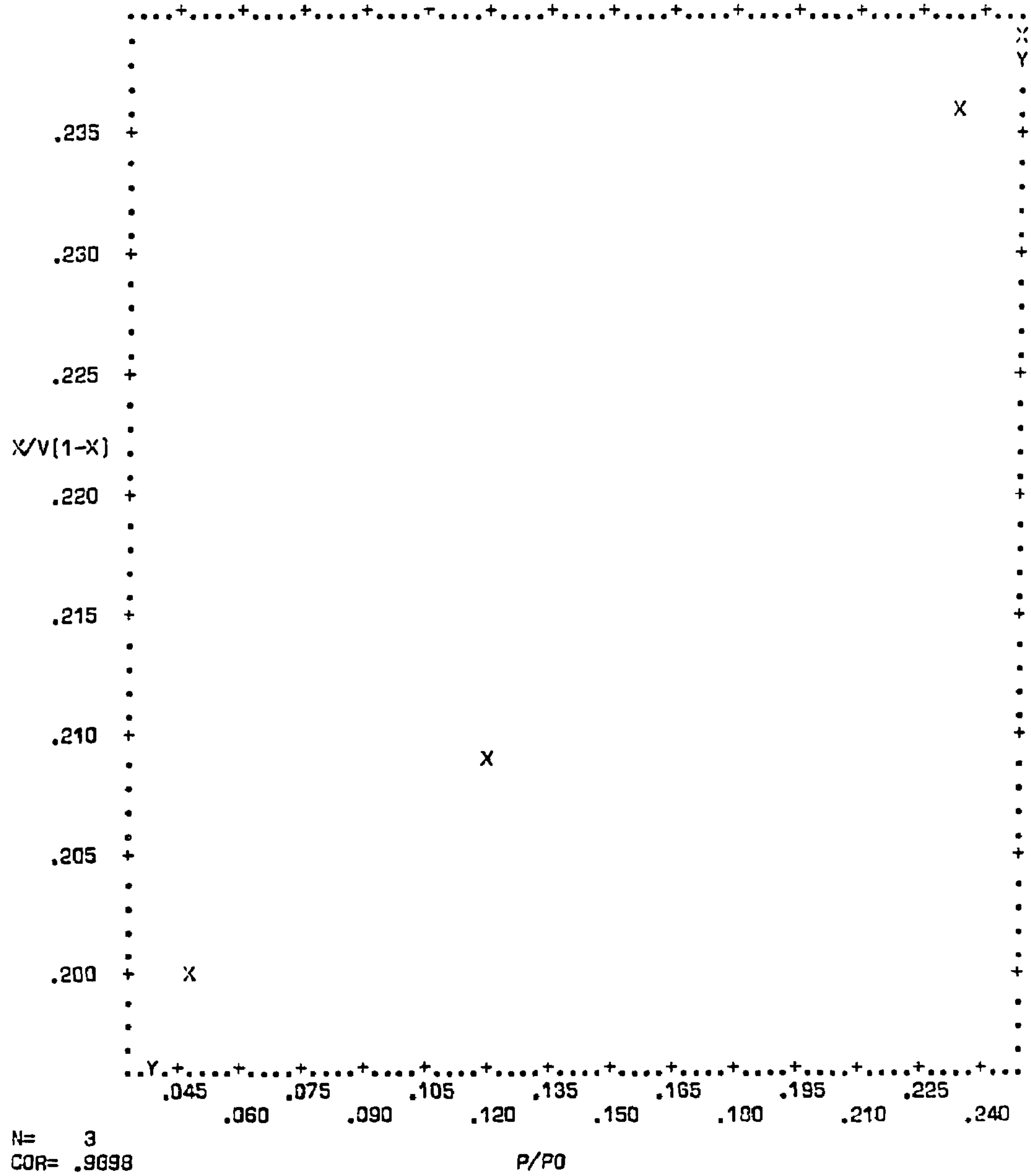
	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 1.2628*Y-.01895	119E-7
Y	.10998	.06399	Y= .79102*X+ .01512	747E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .956 SECONDS

Figure C-34. Plot of BET equation versus relative pressure for Converter A221/0204-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0204-A SAMPLE G



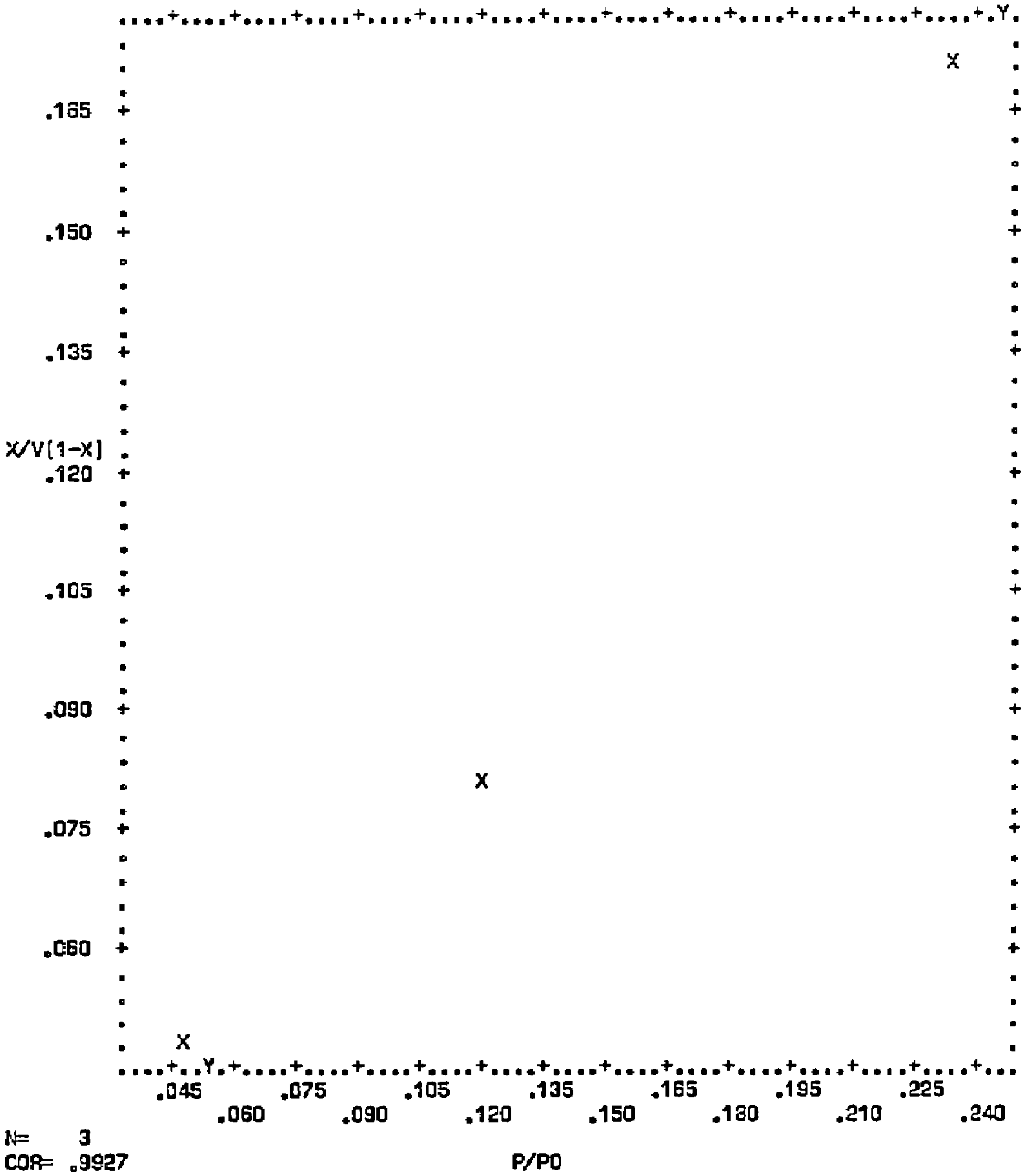
N= 3
COR= .9698

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09333	X= 4.8750*Y-.91590	354E-6
Y	.21525	.01895	Y= .20096*X+ .13843	146E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-35. Plot of BET equation versus relative pressure for Converter A221/0204-A - Rear Face

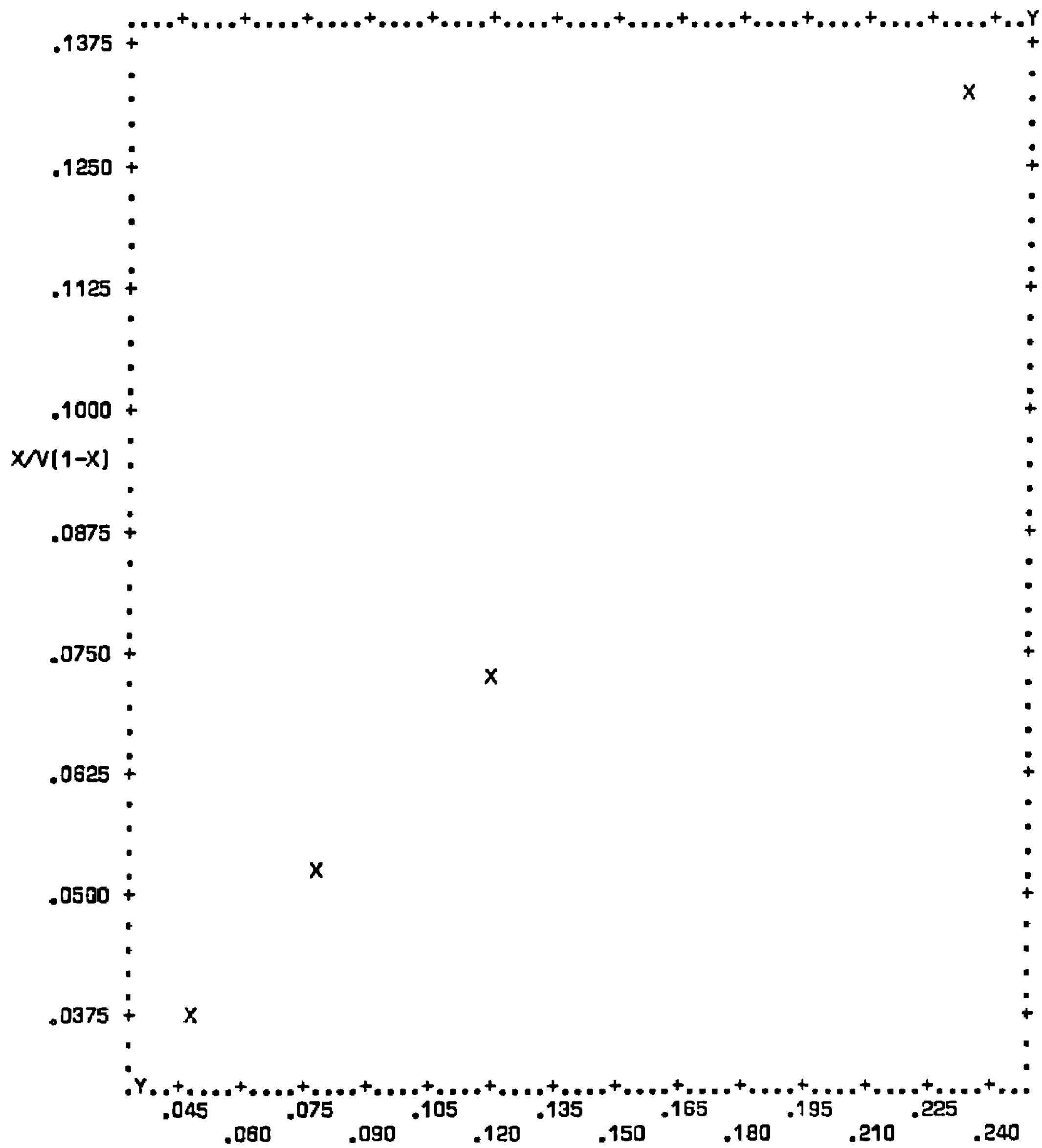
PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0204-B SAMPLE F




```
N=    3
COR= .9927

    MEAN    ST.DEV.    REGRESSION LINE      RES.MS.
X   .13344   .09332   X= 1.4406*Y-.01047    252E-6
Y   .09989   .06431   Y= .68410*X+ .00861   120E-6

VARIABLE    1  P/PO     VERSUS VARIABLE  2  X/V       SYMBOL=X
```

Figure C-36. Plot of BET equation versus relative pressure for Converter A221/0204-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0204-B SAMPLE E

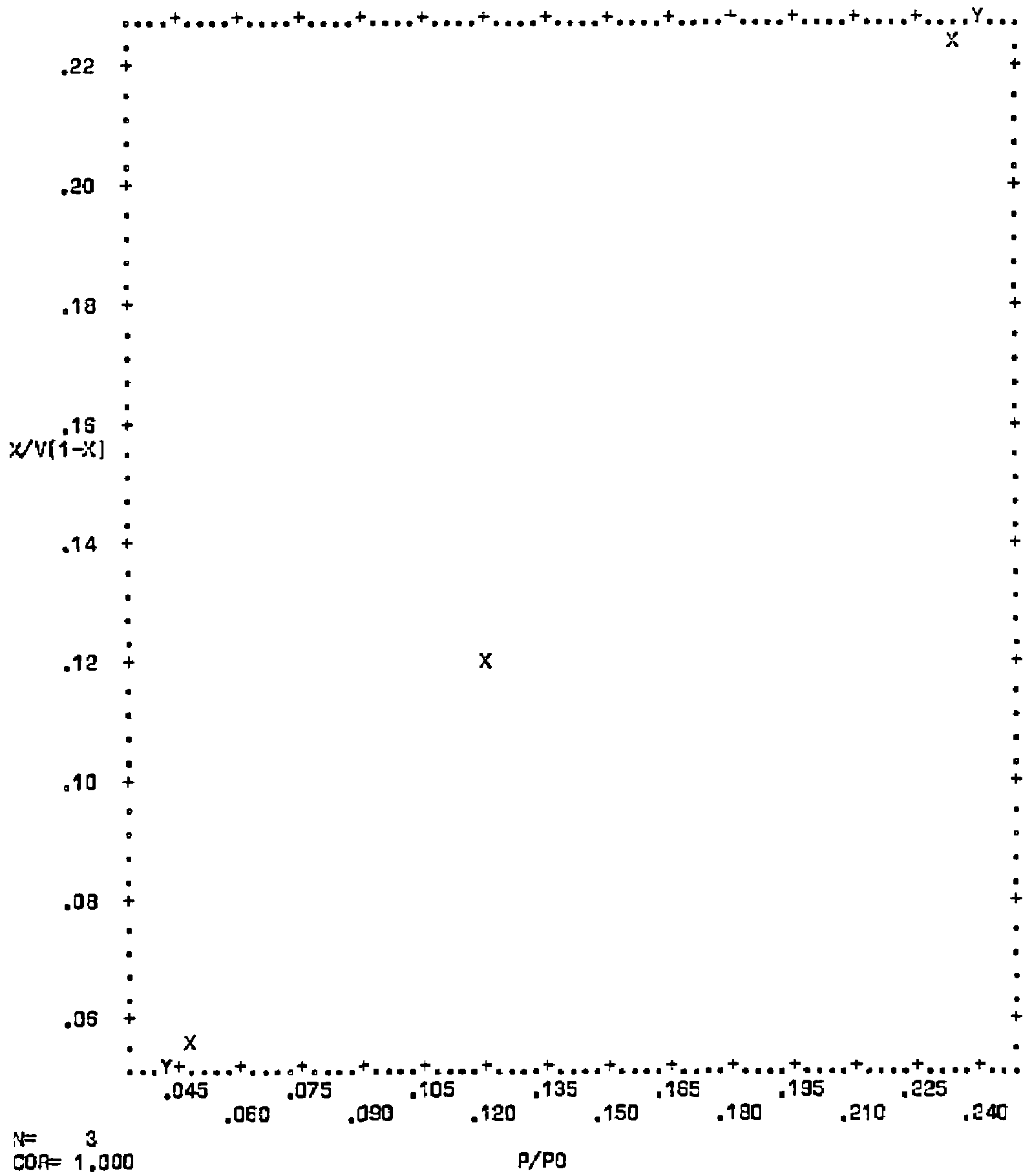


N= 4
COR= .9999

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 1.9229*Y-.02114	113E-8
Y	.07336	.04204	Y= .52000*X+ .01100	305E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-37. Plot of BET equation versus relative pressure for Converter A221/0204-B - Front Face



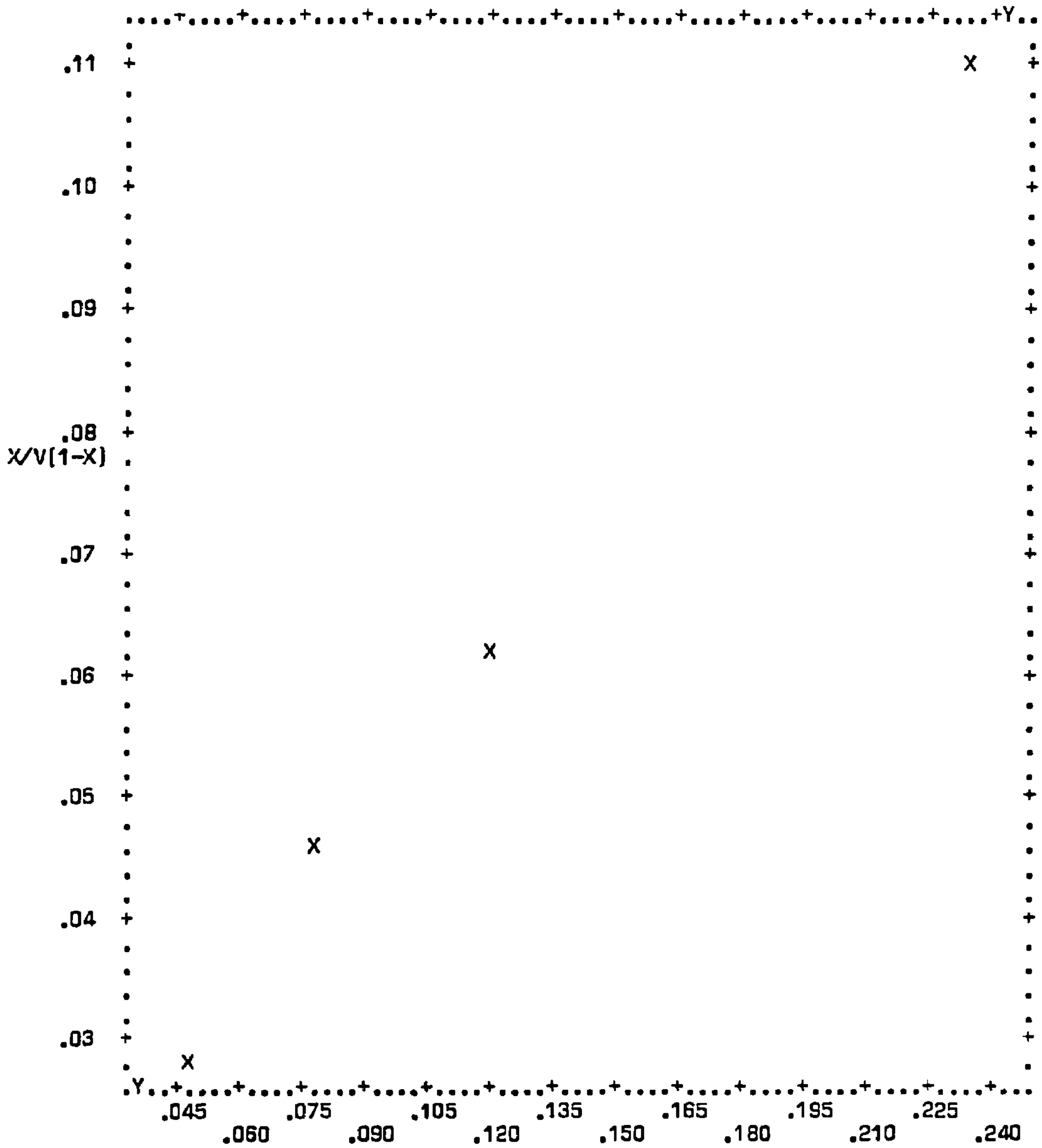
N= 3
COR= 1.000

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.1175*Y-.01498	32E-10
Y	.13281	.08351	Y= .89489*X+ .01340	26E-10

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-38. Plot of BET equation versus relative pressure for Converter A221/0447-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0447-A SAMPLE E

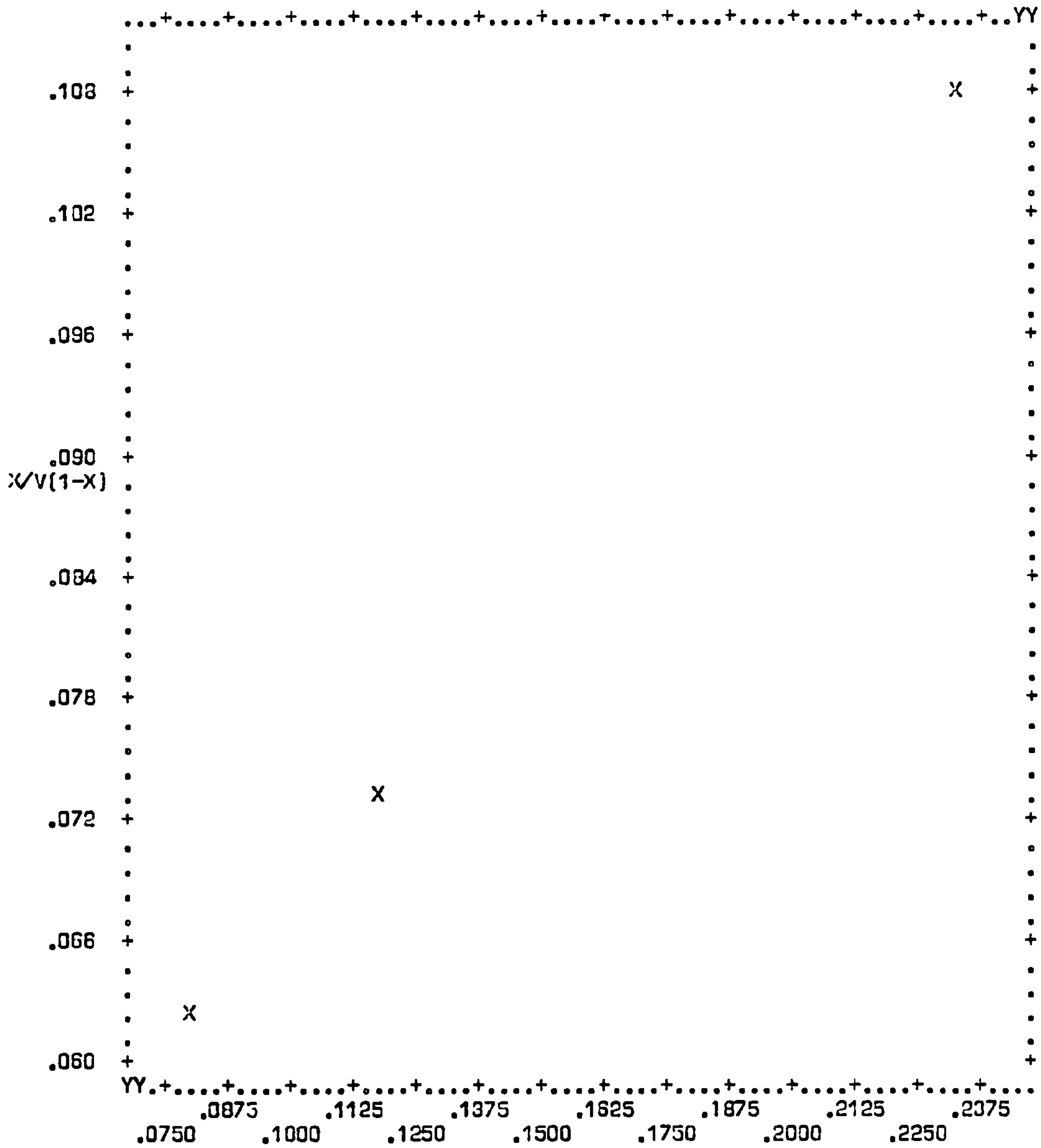


N= 4
COR= .9980 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.3321*Y-.02401	398E-7
Y	.06171	.03459	Y= .42705*X+ .01050	730E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-39. Plot of BET equation versus relative pressure for Converter A221/0447-A - Front Face



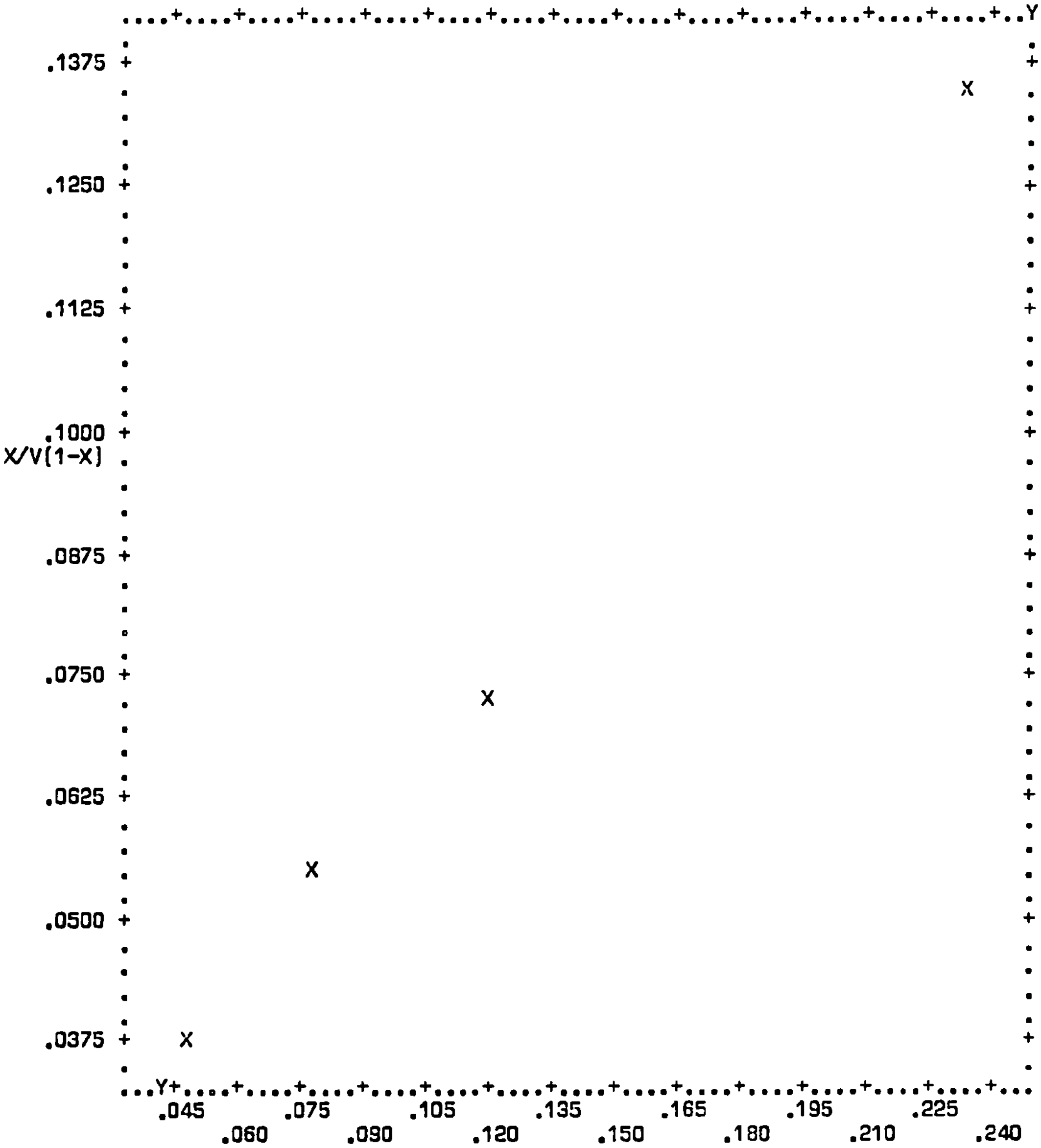
N= 3
COR= 1.000 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.14376	.07997	X= 3.3471*Y-.12752	971E-9
Y	.08105	.02389	Y= .29874*X+ .03810	87E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-40. Plot of BET equation versus relative pressure for Converter A221/0447-A - Rear Face

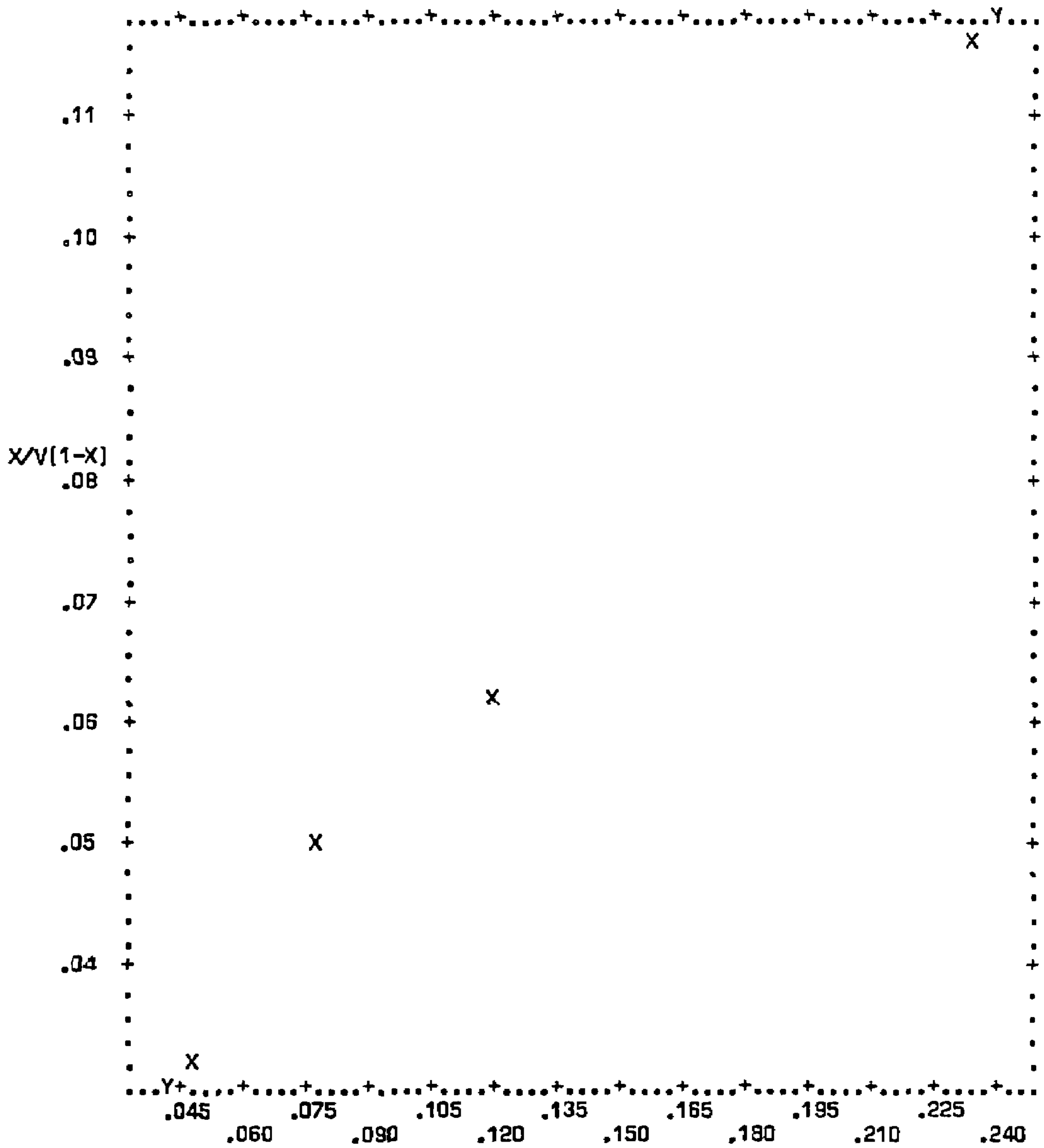
PAGE 4 CONVERTER SURFACE AREA ANALYSIS A221/0447-B SAMPLE F



N= 4
COR= .9996 P/PO

```
    MEAN     ST.DEV.    REGRESSION LINE     RES.MS.
X   .11992   .08084   X= 1.8812*Y-.02026    790E-8
Y   .07452   .04296   Y= .53116*X+ .01082   223E-8

VARIABLE    1  P/PO      VERSUS VARIABLE  2  X/V        SYMBOL=X
```

Figure C-41. Plot of BET equation versus relative pressure for Converter A221/0447-B - Bulk



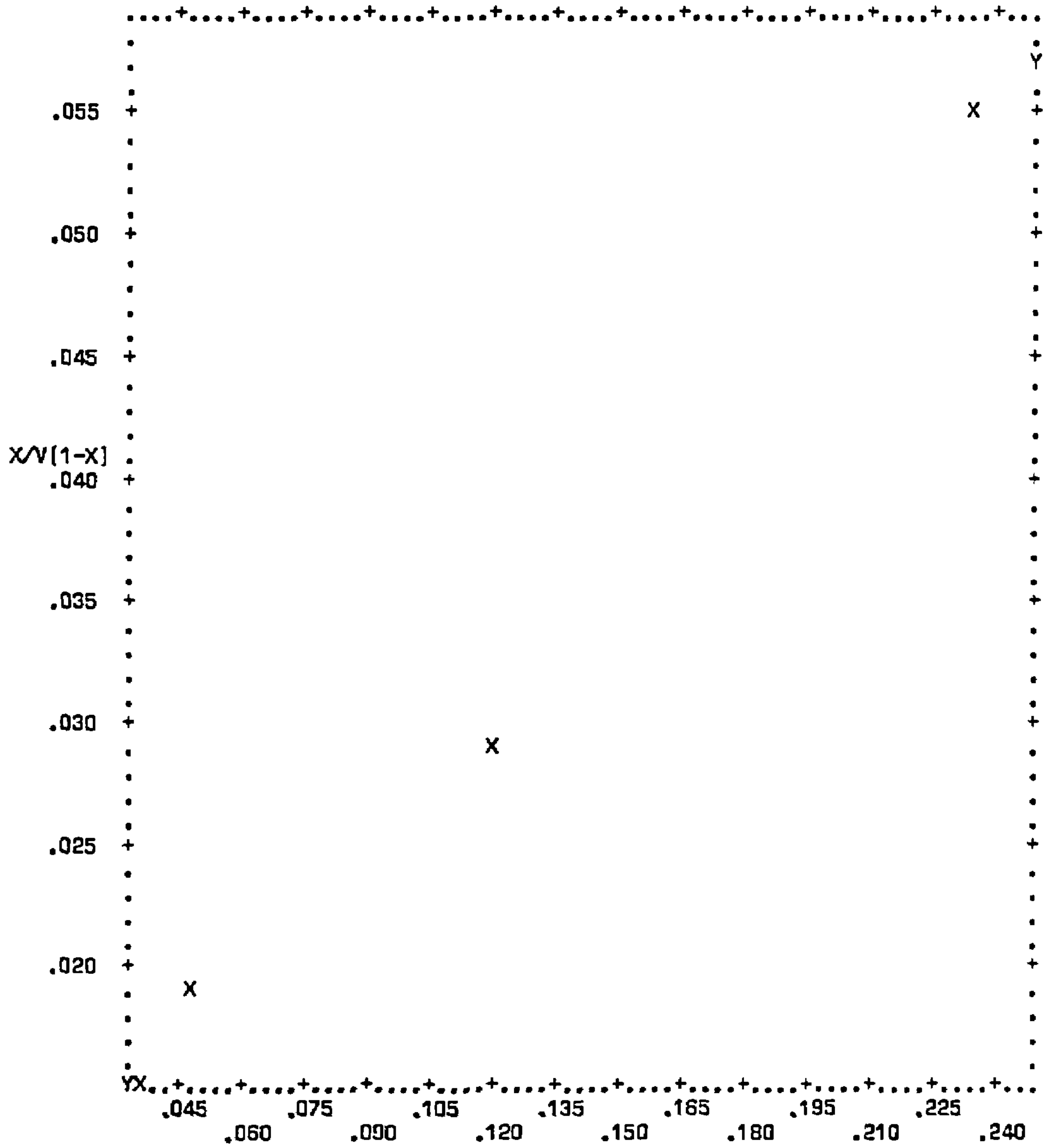
N= 4
COR= .9983

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.2481*Y-.02516	331E-7
Y	.06453	.03590	Y= .44332*X+ .01137	653E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-42. Plot of BET equation versus relative pressure for Converter A221/0447-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A230/0177X-A SAMPLE F



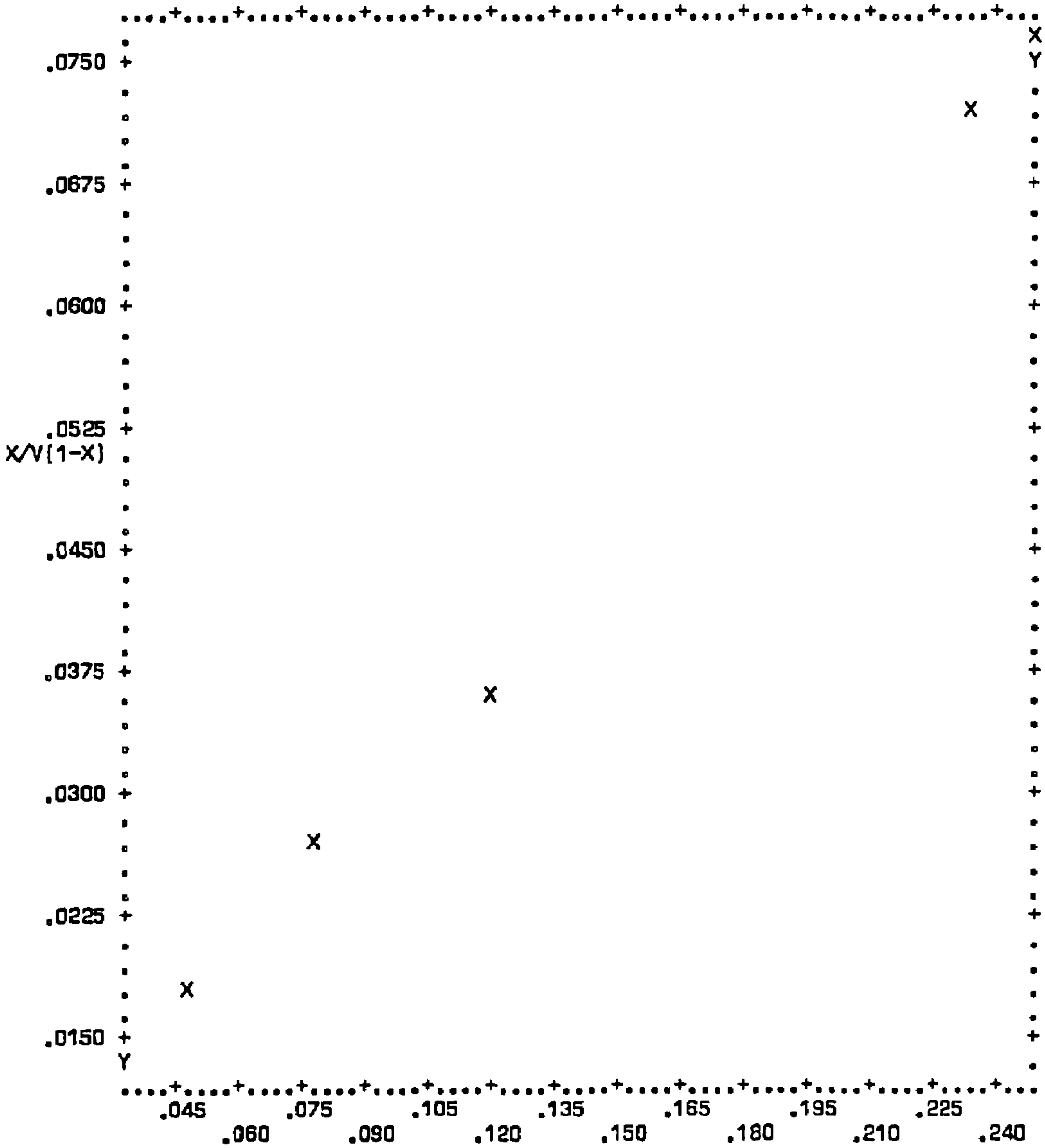
N= 3
COR= .9922

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13342	.09331	X= 5.0328*Y-.03964	269E-6
Y	.03439	.01840	Y= .19563*X+ .00829	105E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-43. Plot of BET equation versus relative pressure for Converter A230/0177X-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A230/0177X-A SAMPLE E



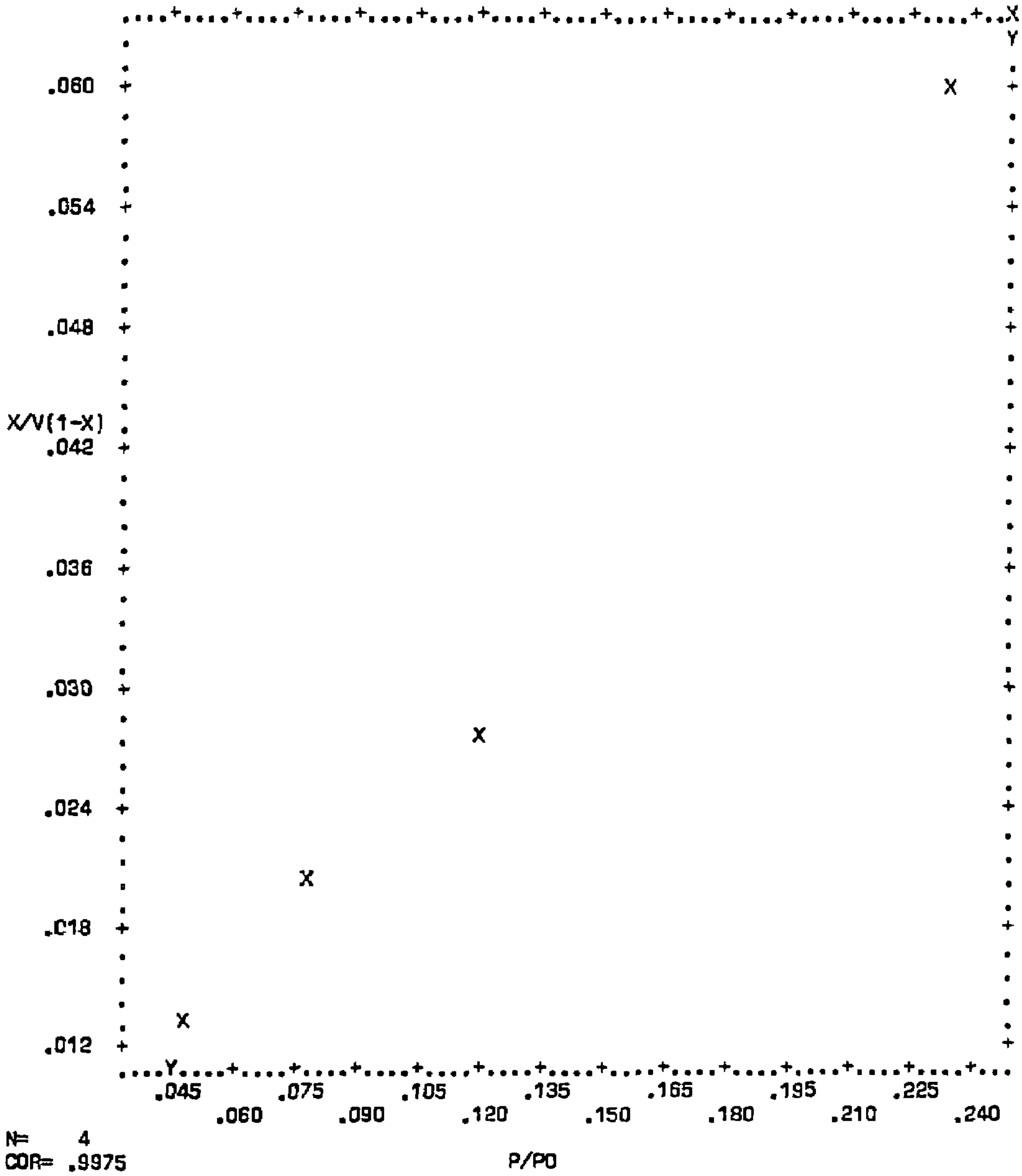
N= 4
COR= .9993 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.4277*Y-.01077	140E-7
Y	.03813	.02357	Y= .29133*X+ .00319	119E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-44. Plot of BET equation versus relative pressure for Converter A230/0177X-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A230/0177X-A SAMPLE G

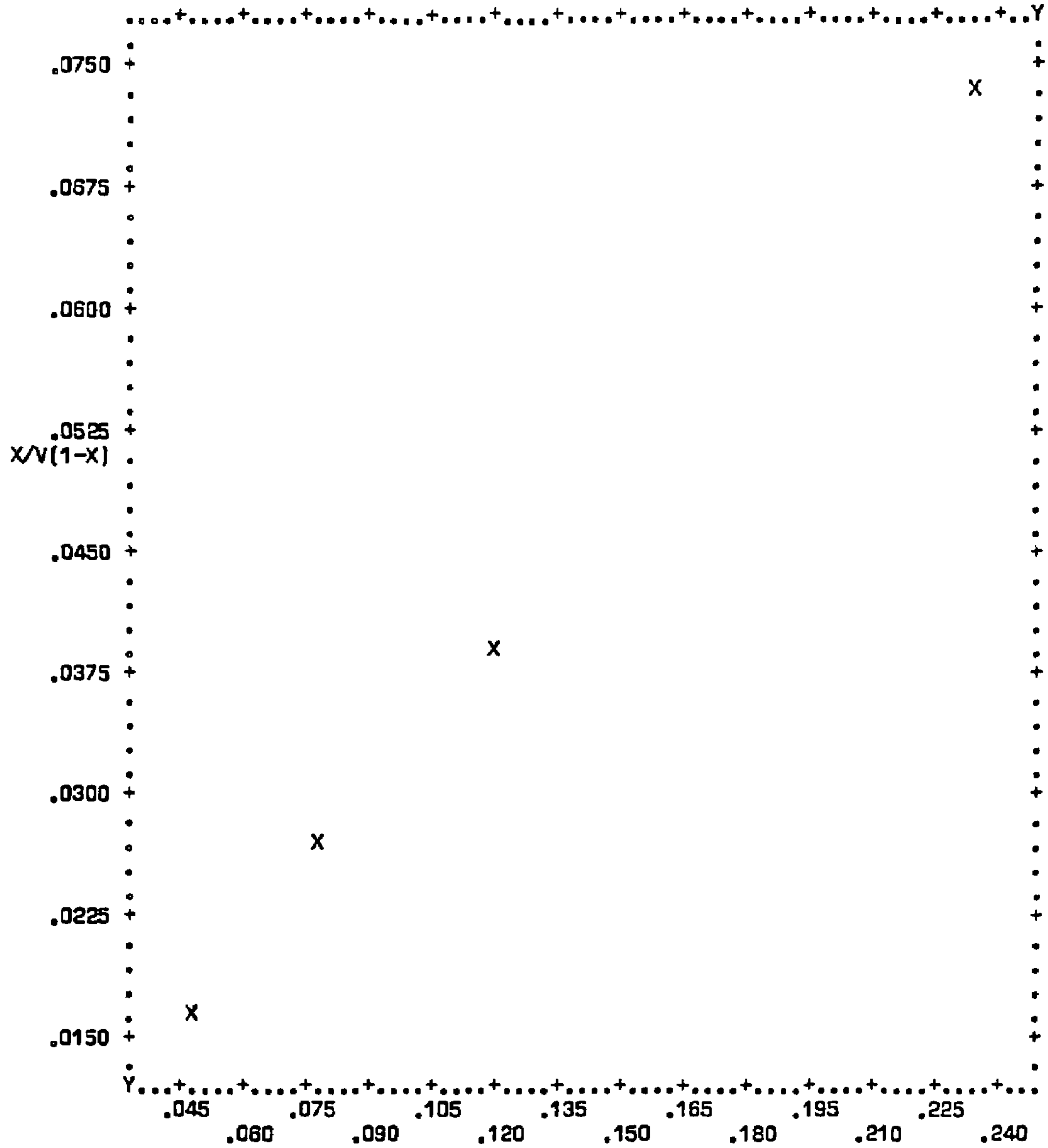


N= 4
COR= .9975

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.9088*Y+ .00230	496E-7
Y	.03011	.02064	Y= .25467*X-434E-6	323E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-45. Plot of BET equation versus relative pressure for Converter A230/0177X-A - Rear Face

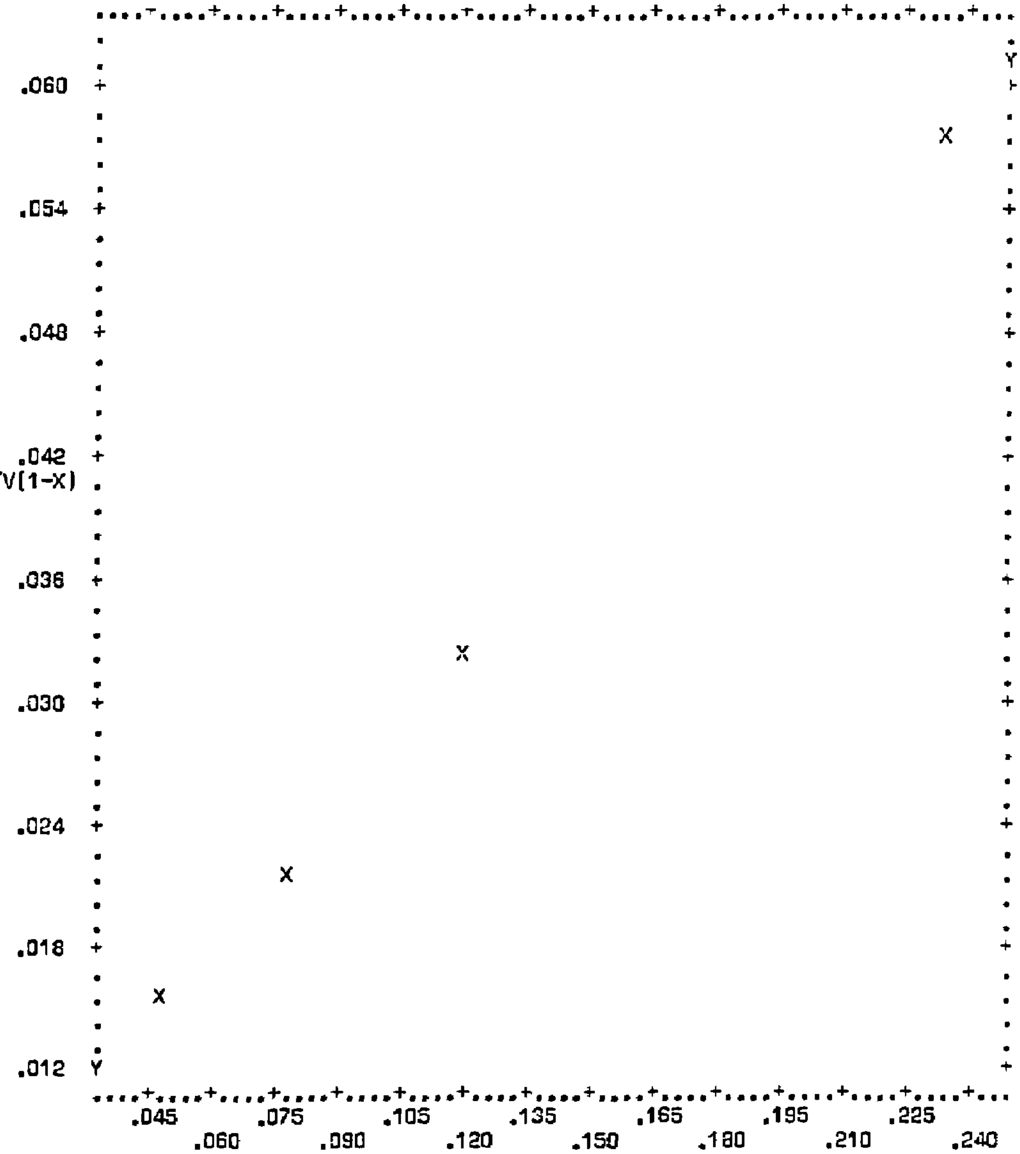


N= 4
COR= .9998 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.3019*Y-.00847	403E-8
Y	.03888	.02448	Y= .30273*X+ .00258	370E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-46. Plot of BET equation versus relative pressure for Converter A230/0177X-B - Bulk

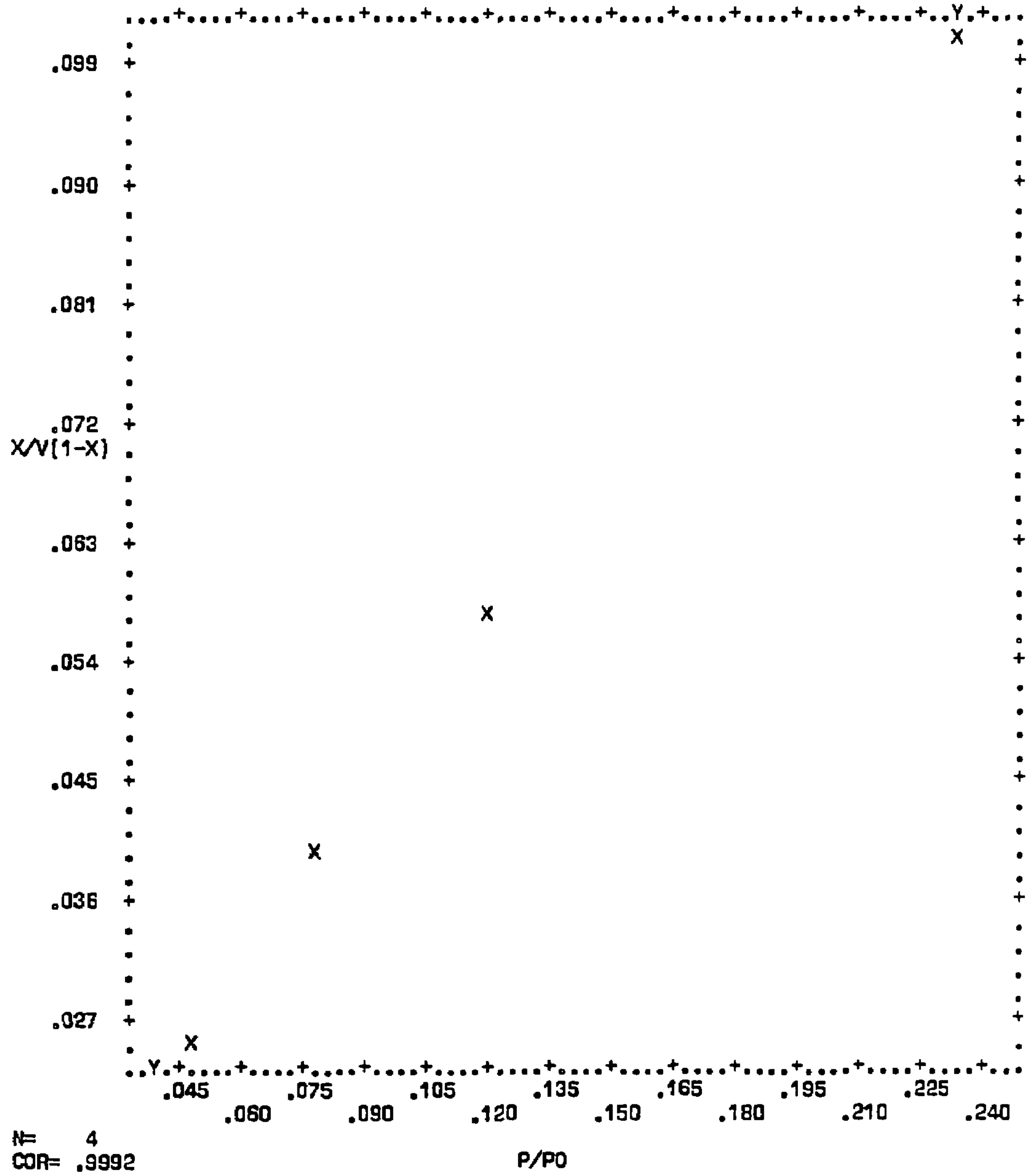


N= 4
COR= .9998

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 4.3493*Y-.01758	475E-8
Y	.03161	.01858	Y= .22979*X+ .00406	251E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-47. Plot of BET equation versus relative pressure for Converter A230/0177X-B - Front Face



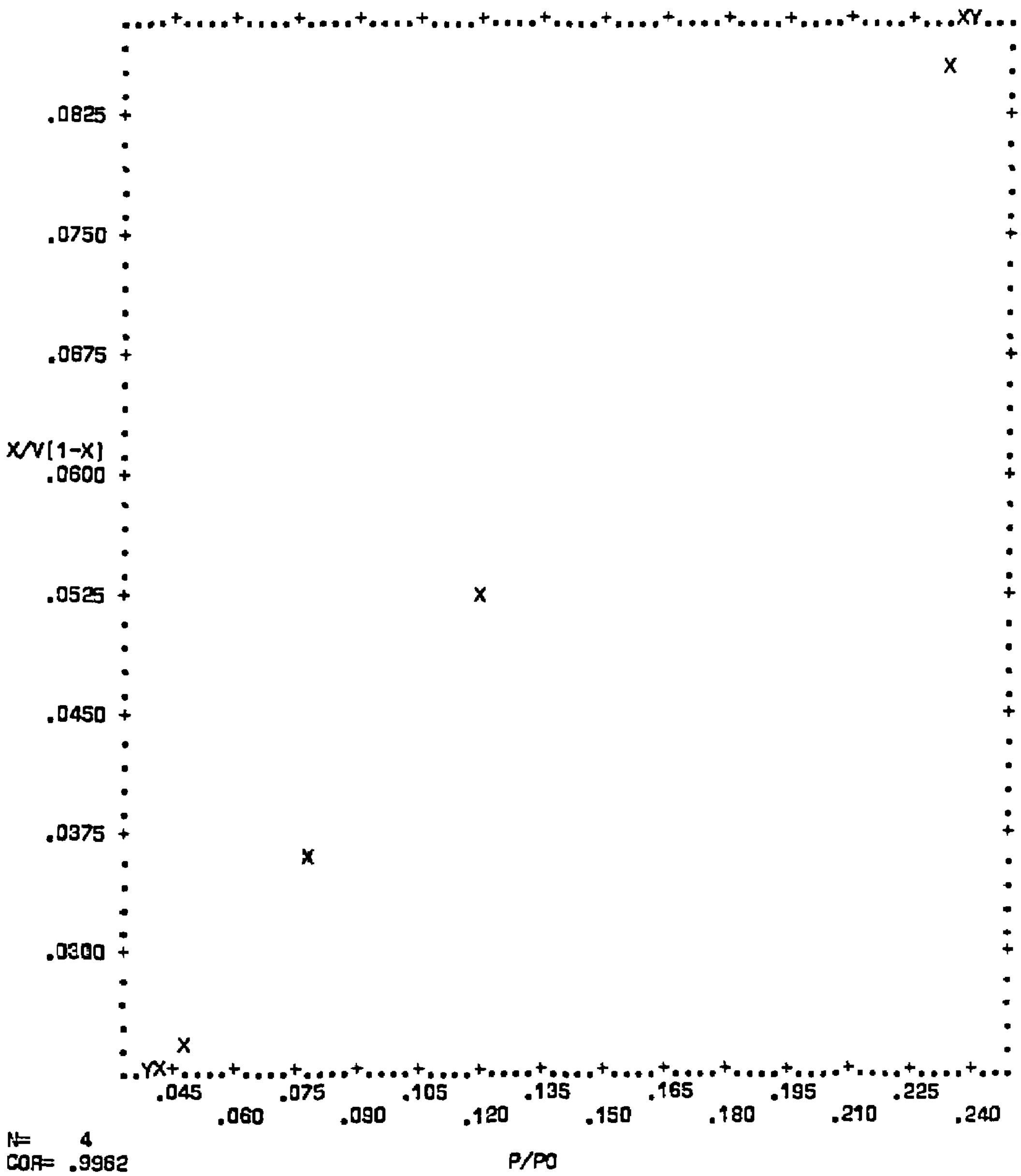
N= 4
COR= .9992

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.4679*Y-.01817	150E-7
Y	.05595	.03273	Y= .40458*X+ .00743	245E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-48. Plot of BET equation versus relative pressure for Converter A230/0636X-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A230/0636X-A SAMPLE E



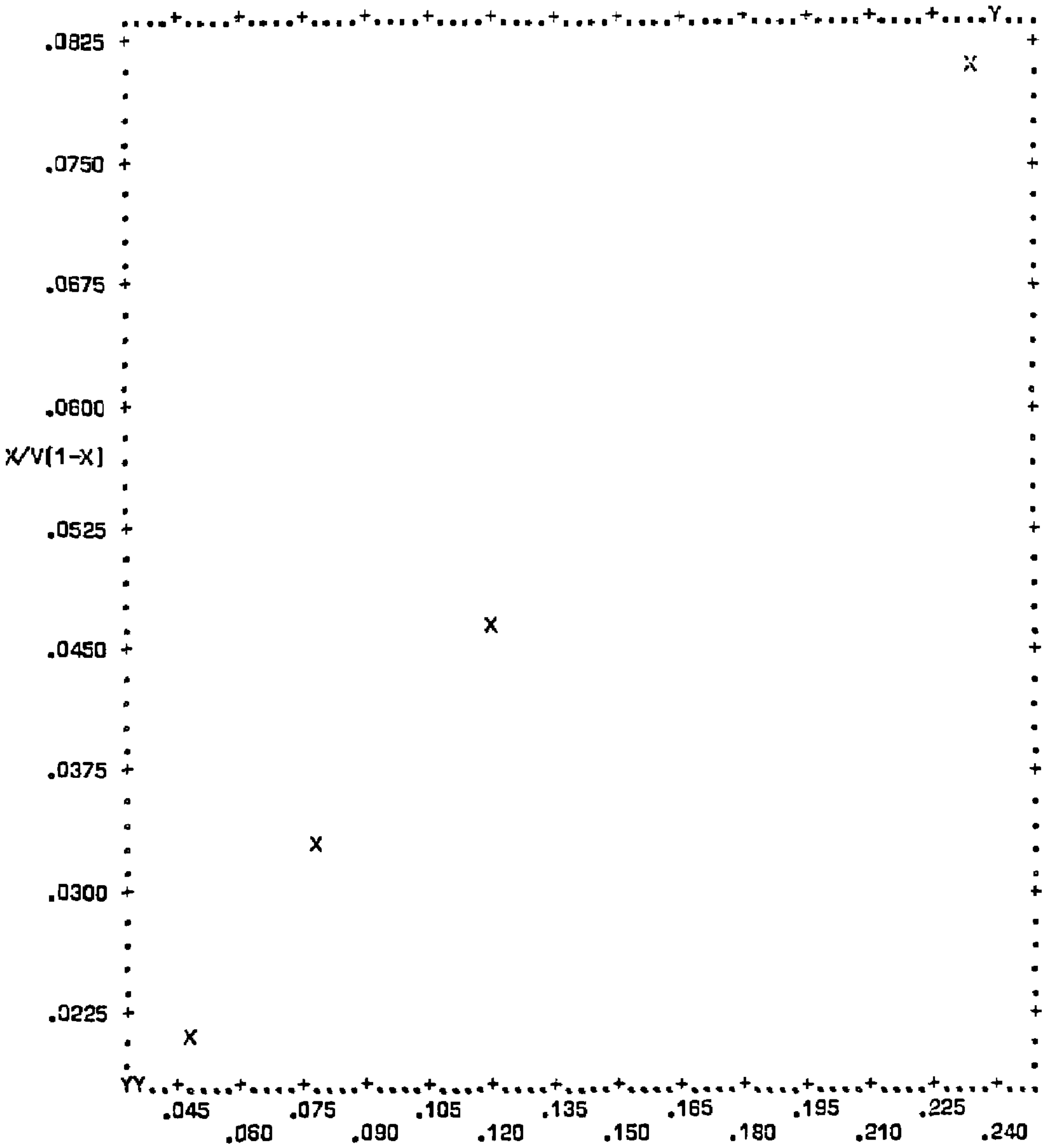
N= 4
COR= .9962

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.9814*Y-.02620	736E-7
Y	.04901	.02701	Y= .33290*X+ .00909	821E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-49. Plot of BET equation versus relative pressure for Converter A230/0636X-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A230/0636X-A SAMPLE 6



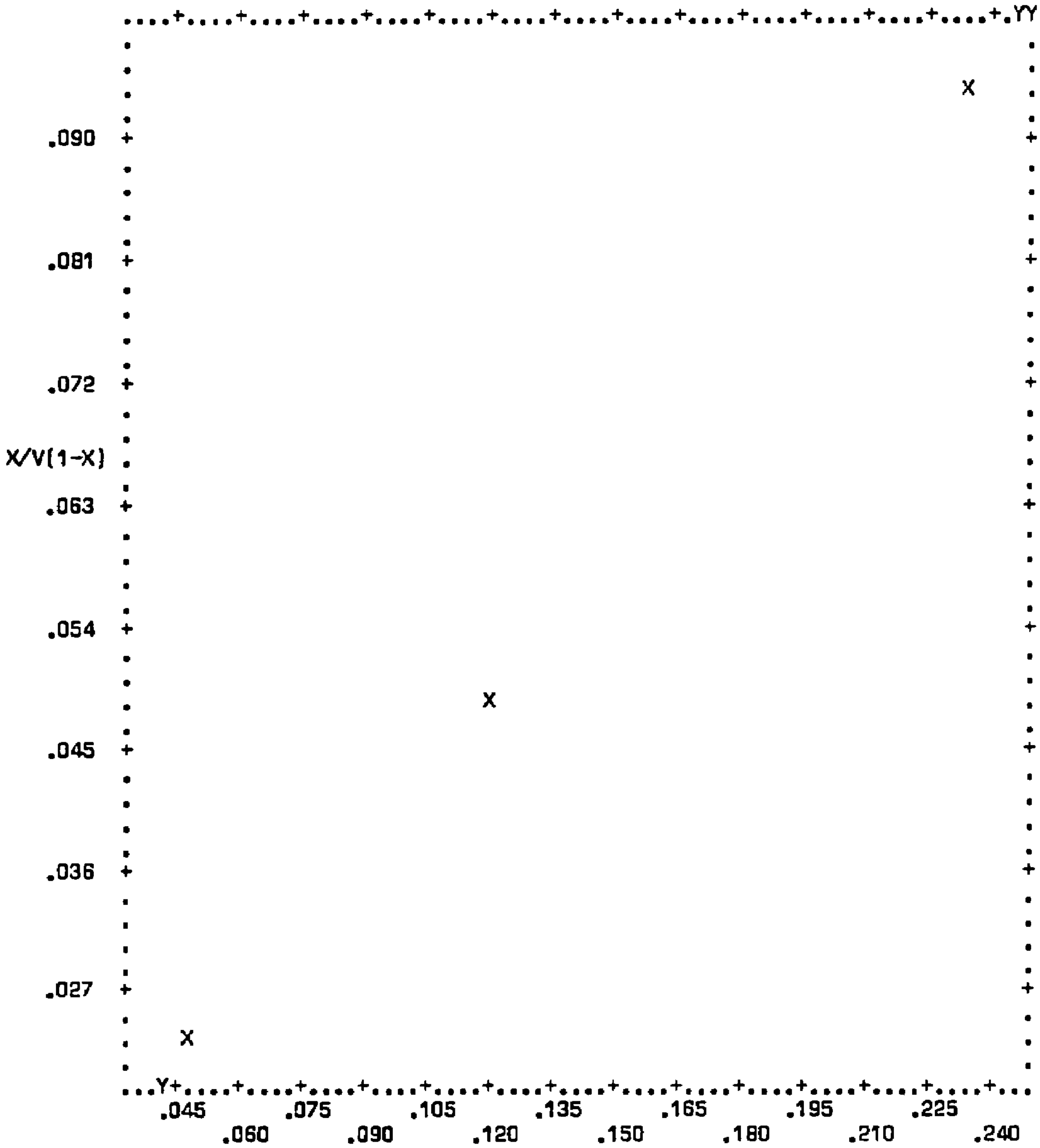
N= 4
COR= .9993 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.1035*Y-.02058	145E-7
Y	.04527	.02603	Y= .32174*X+ .00669	150E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-50. Plot of BET equation versus relative pressure for Converter A230/0636X-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A230/0636X-B SAMPLE F

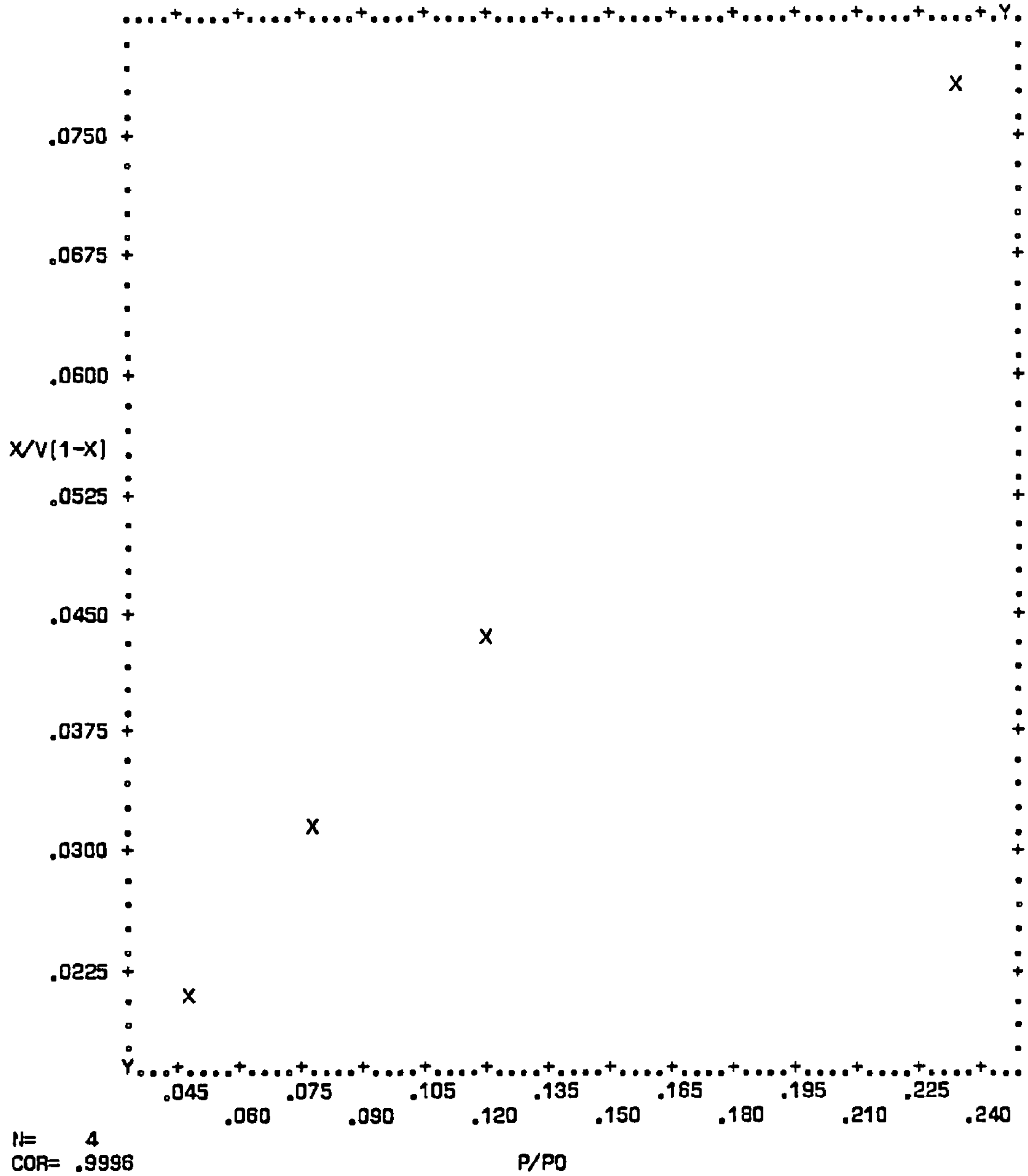


N= 3
COR= .9994 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 2.5834*Y-.00905	195E-7
Y	.05515	.03610	Y= .38665*X+ .00356	293E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-51. Plot of BET equation versus relative pressure for Converter A230/0636X-B - Bulk



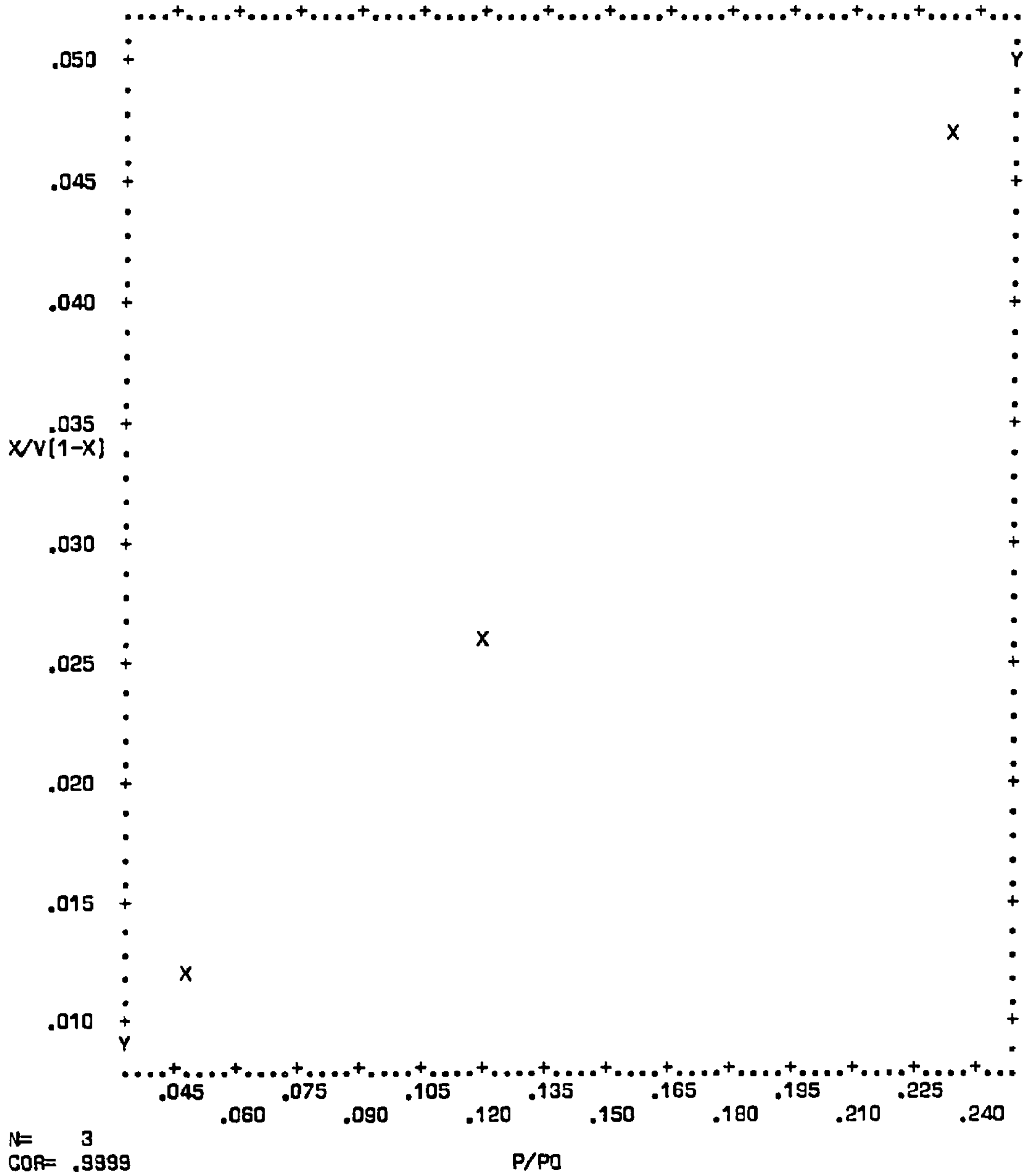
N= 4
COR= .9996

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.2140*Y-.02033	744E-8
Y	.04363	.02514	Y= .31090*X+ .00635	719E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-52. Plot of BET equation versus relative pressure for Converter A230/0636X-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0016L-A SAMPLE F



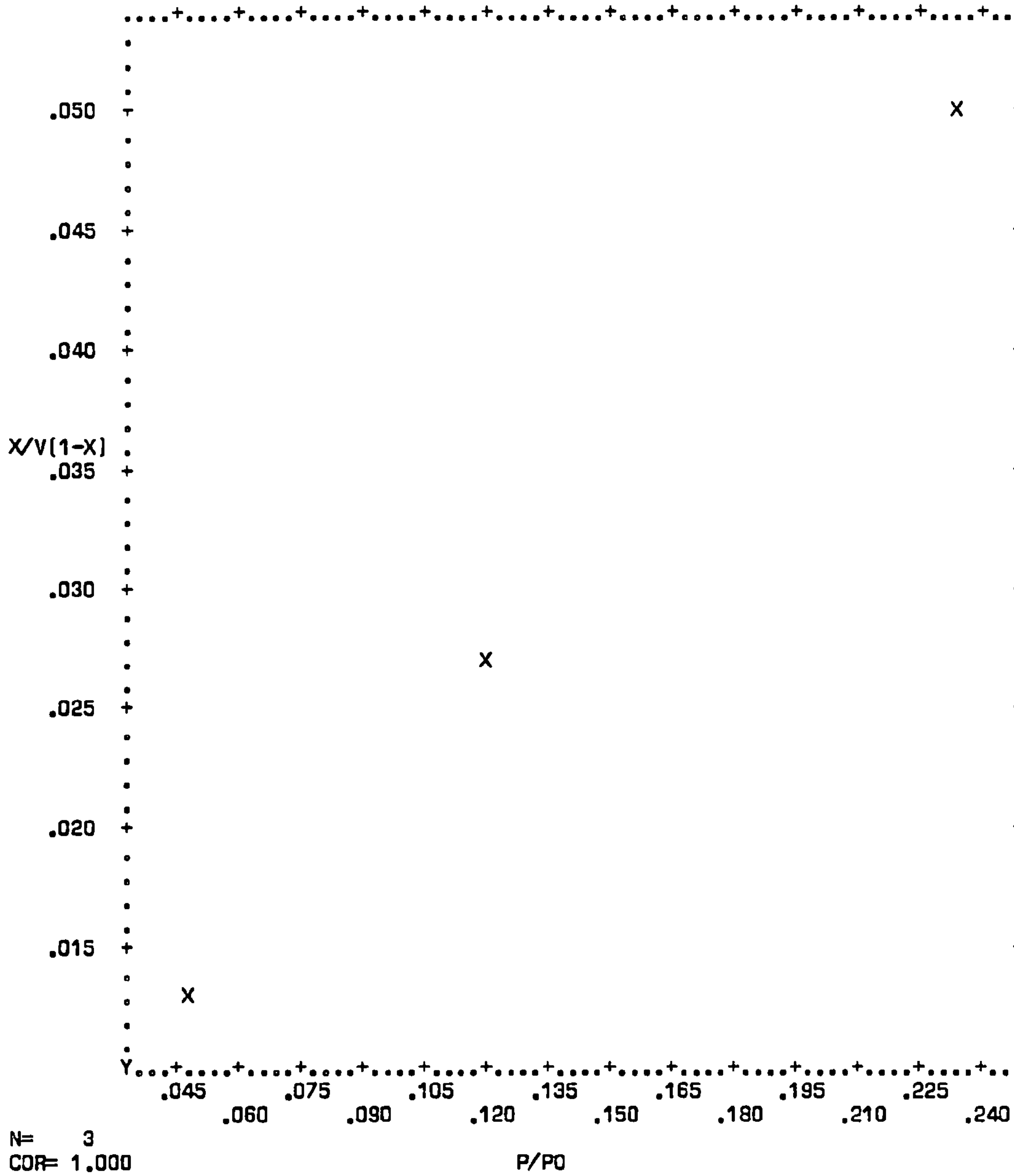
N= 3
COR= .9999

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09333	X= 5.3220*Y-.01621	490E-8
Y	.02812	.01753	Y= .18785*X+ .00305	173E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-53. Plot of BET equation versus relative pressure for Converter A240/0016L-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0016L-A SAMPLE E



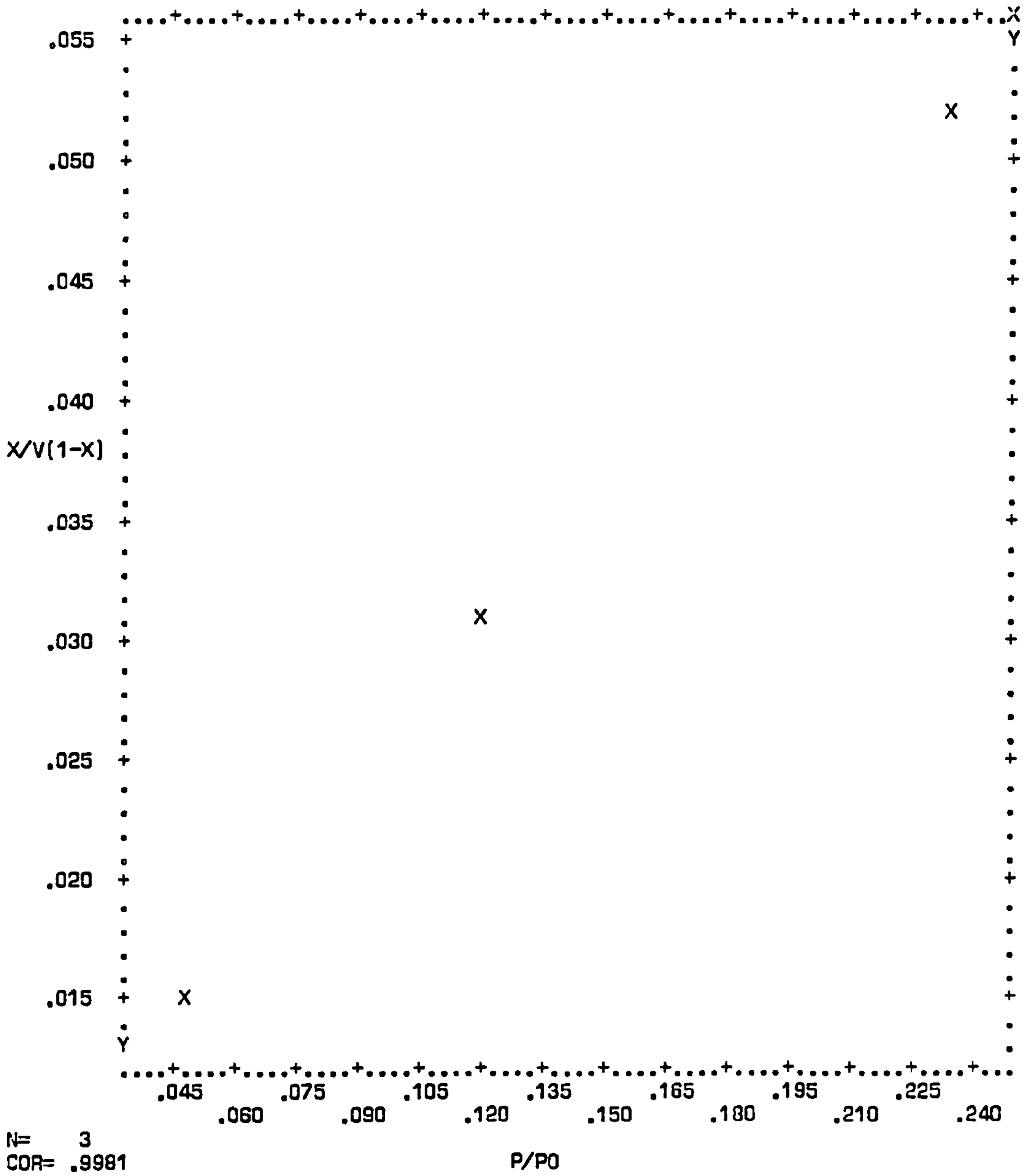
N= 3
COR= 1.000

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09332	X= 5.0348*Y-.01881	215E-9
Y	.03024	.01854	Y= .19861*X+ .00374	85E-10

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-54. Plot of BET equation versus relative pressure for Converter A240/0016L-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0016L-A SAMPLE G



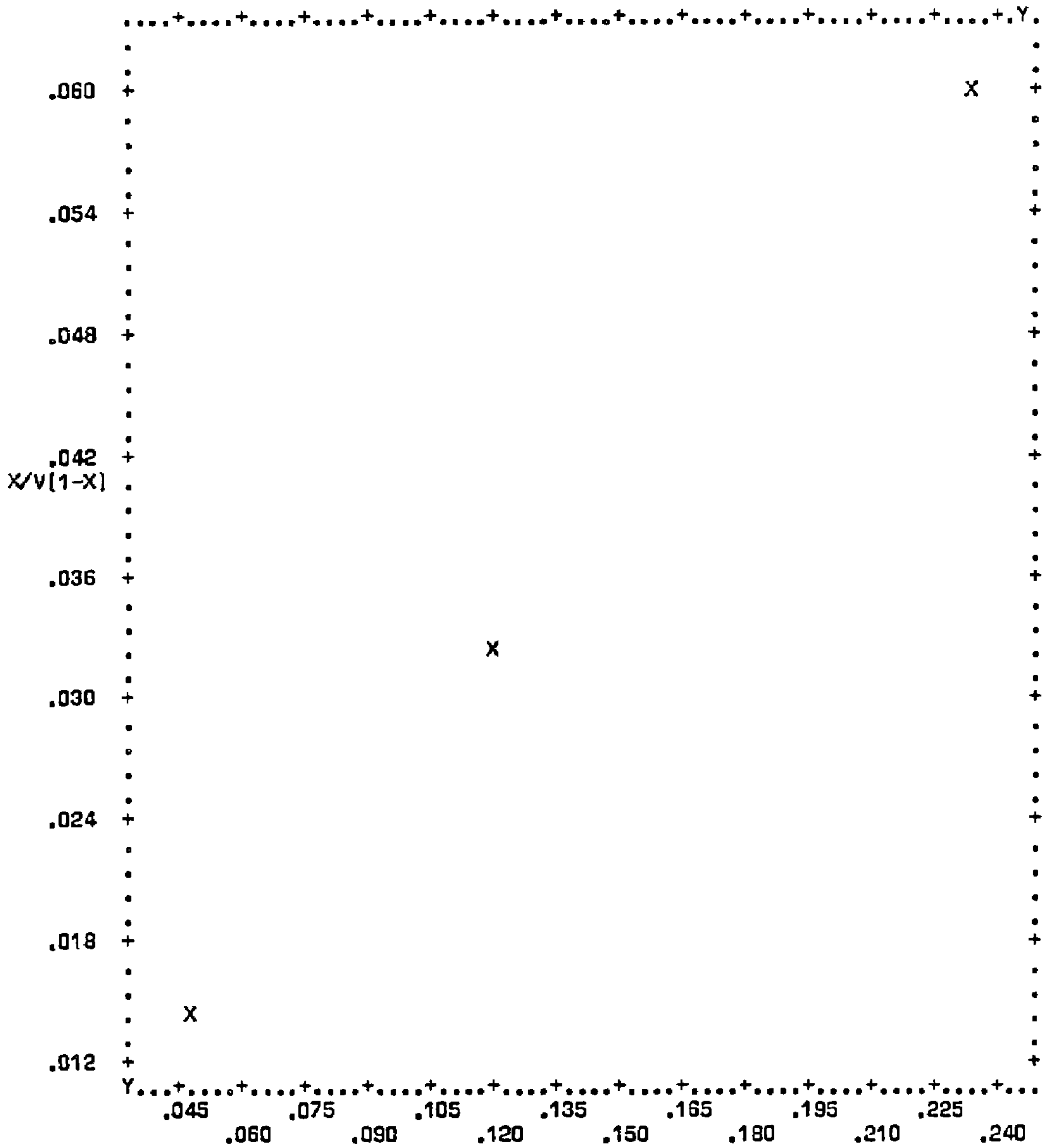
N= 3
COR= .9981

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13345	.09332	X= 5.0974*Y-.03400	673E-7
Y	.03285	.01827	Y= .19542*X+ .00677	258E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-55. Plot of BET equation versus relative pressure for Converter A240/0016L-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0016L-B SAMPLE F



N= 3
COR= .9998

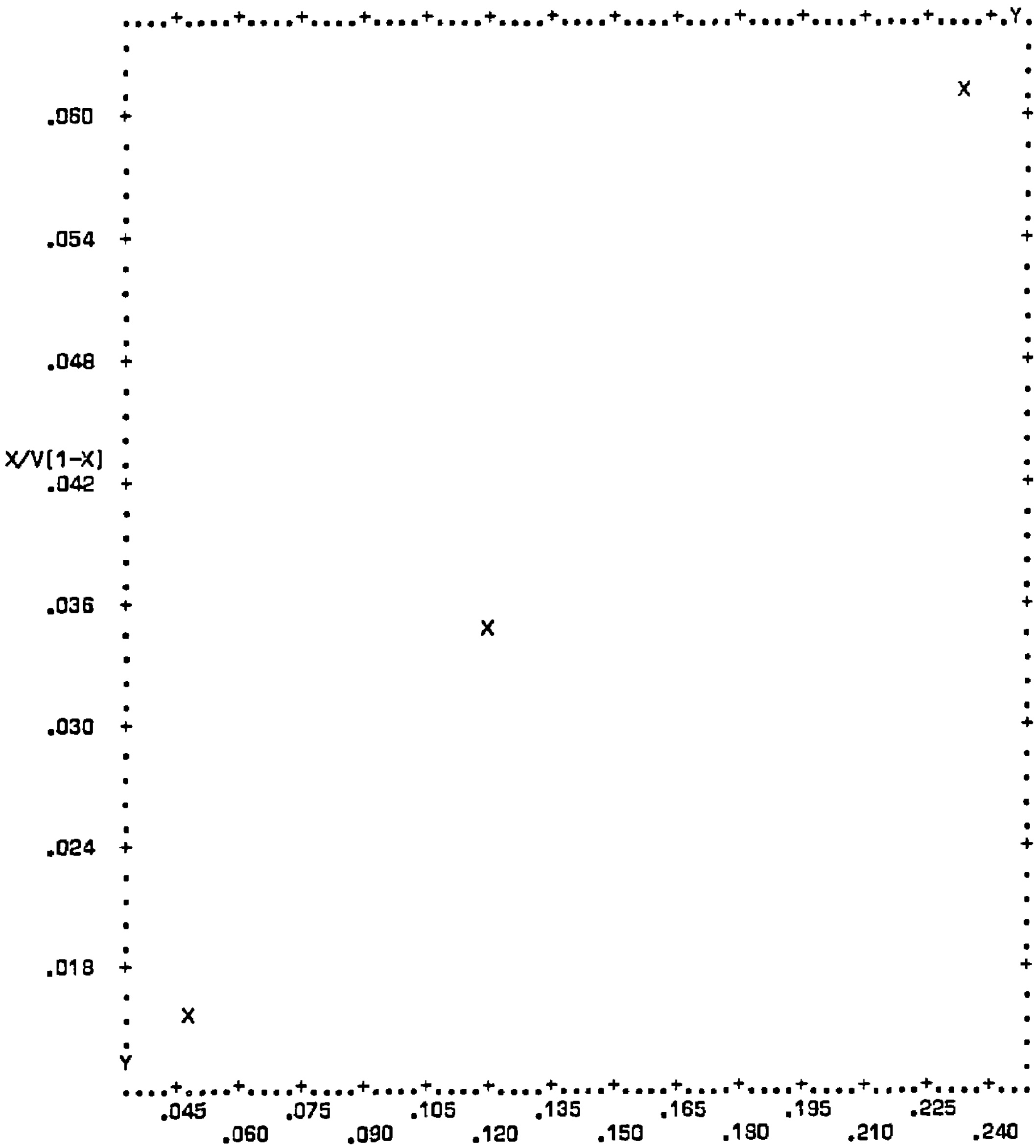
P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13345	.09332	X= 4.0447*Y-.01218	766E-8
Y	.03600	.02307	Y= .24713*X+ .00302	468E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-56. Plot of BET equation versus relative pressure for Converter A240/0016L-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0016L-B SAMPLE E

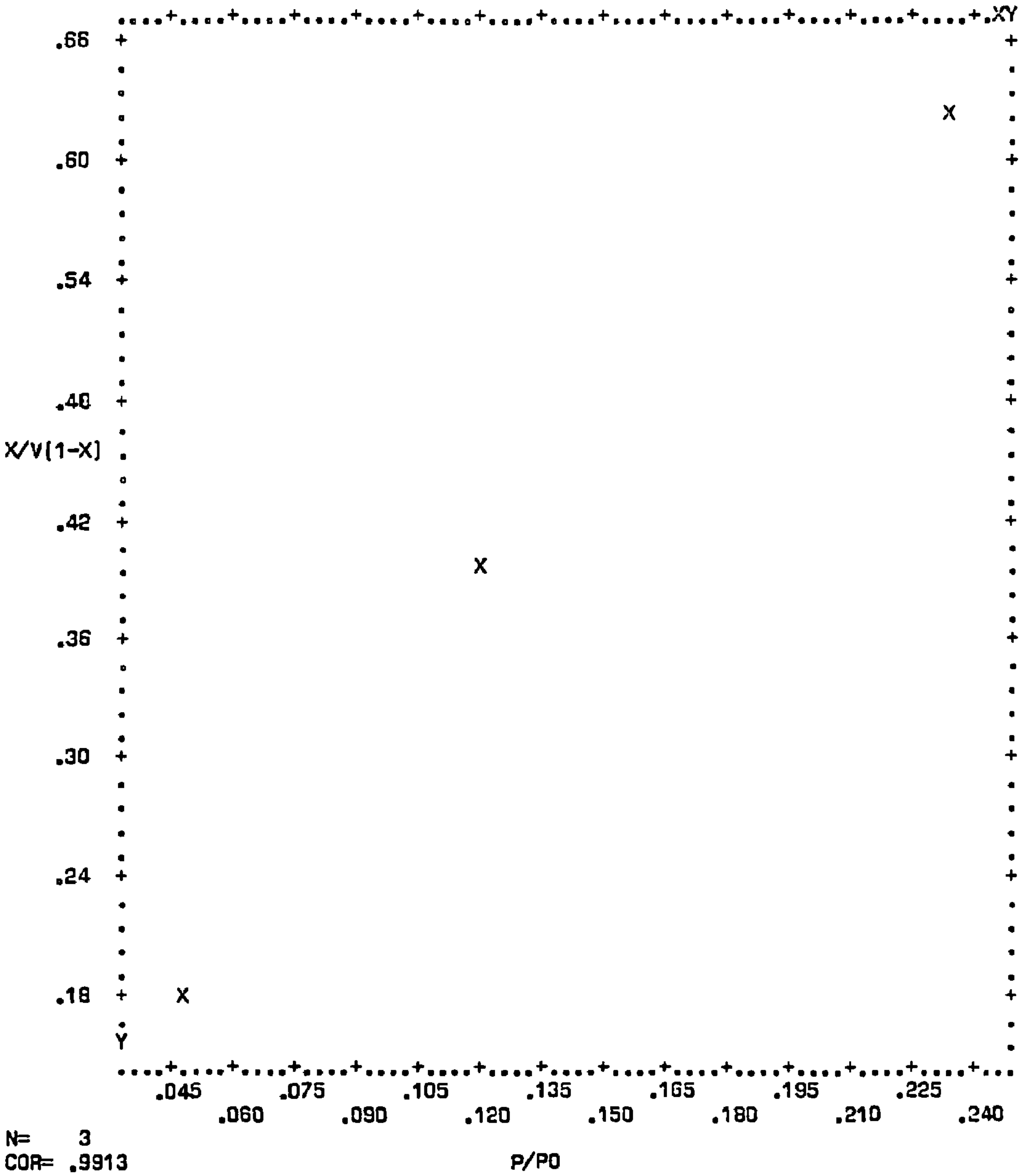


N= 3
COR= .9992 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13345	.09332	X= 4.0929*Y-.01979	293E-7
Y	.03744	.02278	Y= .24392*X+ .00489	175E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-57. Plot of BET equation versus relative pressure for Converter A240/0016L-B - Front Face



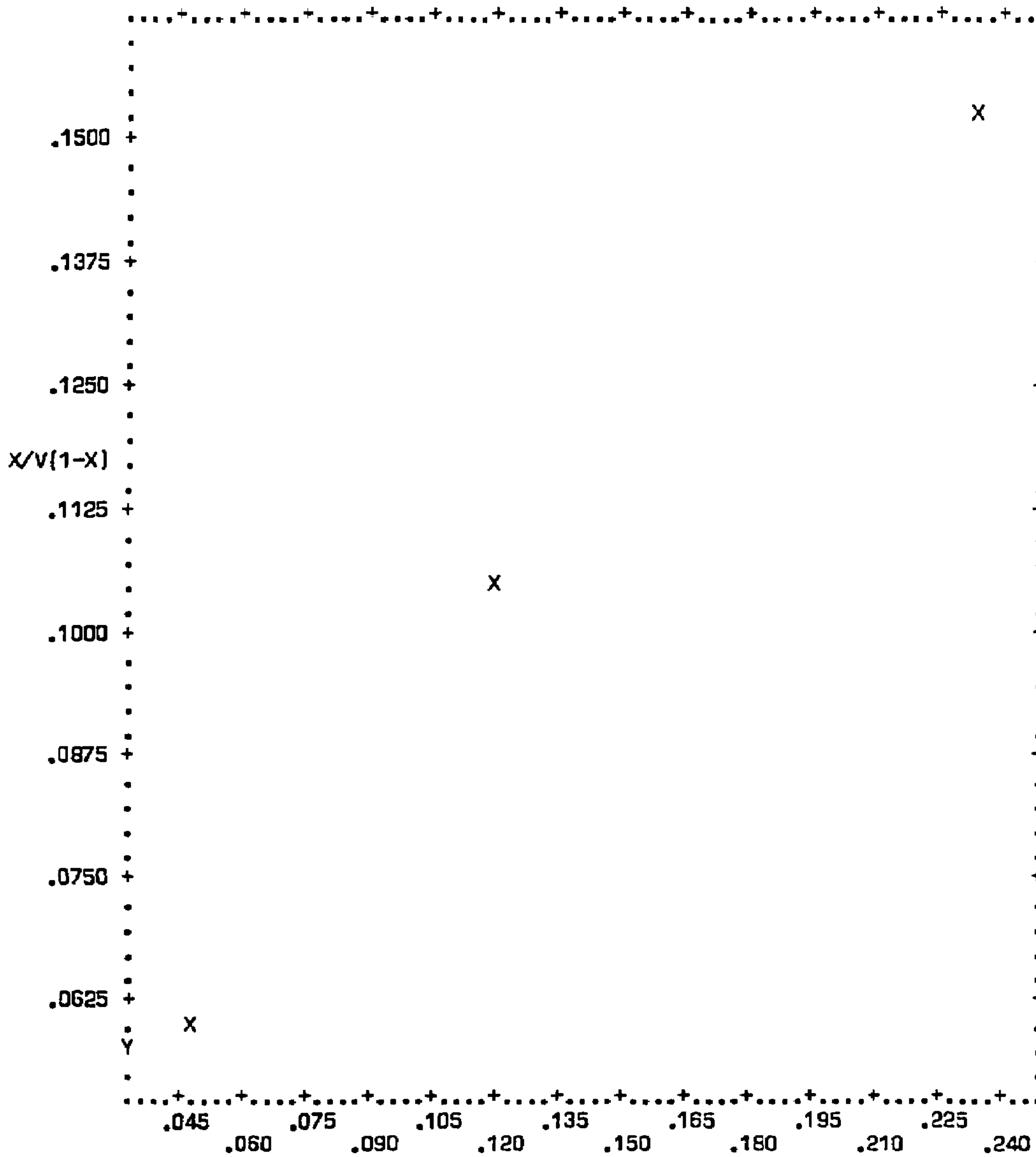
N= 3
COR= .9913

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= .41316*Y-.03174	303E-6
Y	.39976	.22388	Y= 2.3783*X+ .08243	.00174

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-58. Plot of BET equation versus relative pressure for Converter A240/0102-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/C102-A SAMPLE E



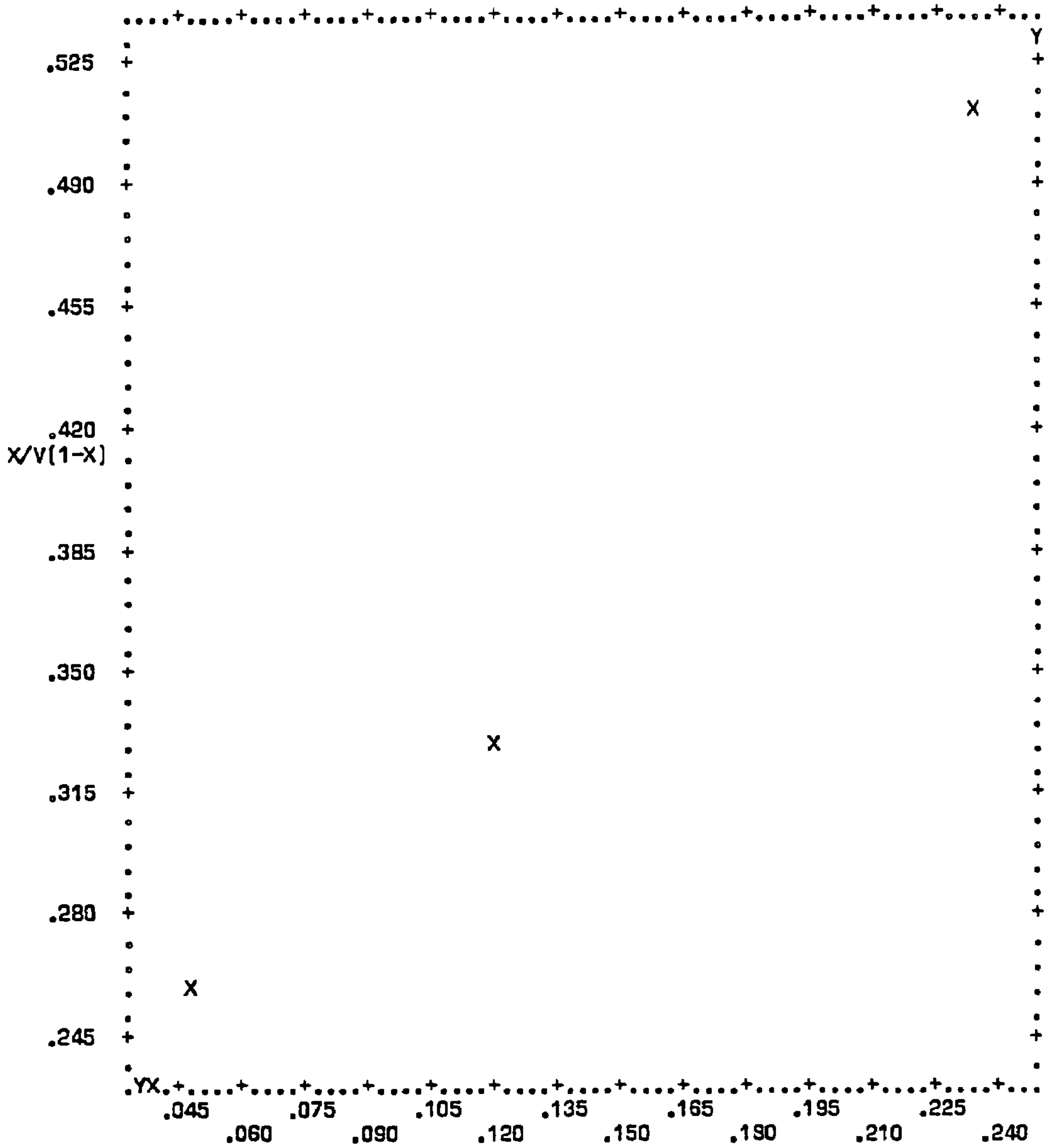
N= 3
COR= .9911

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13342	.09331	X= 2.0333*Y-.08201	309E-6
Y	.10595	.04548	Y= .48307*X+ .04150	735E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-59. Plot of BET equation versus relative pressure for Converter A240/0102-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0102-A SAMPLE G



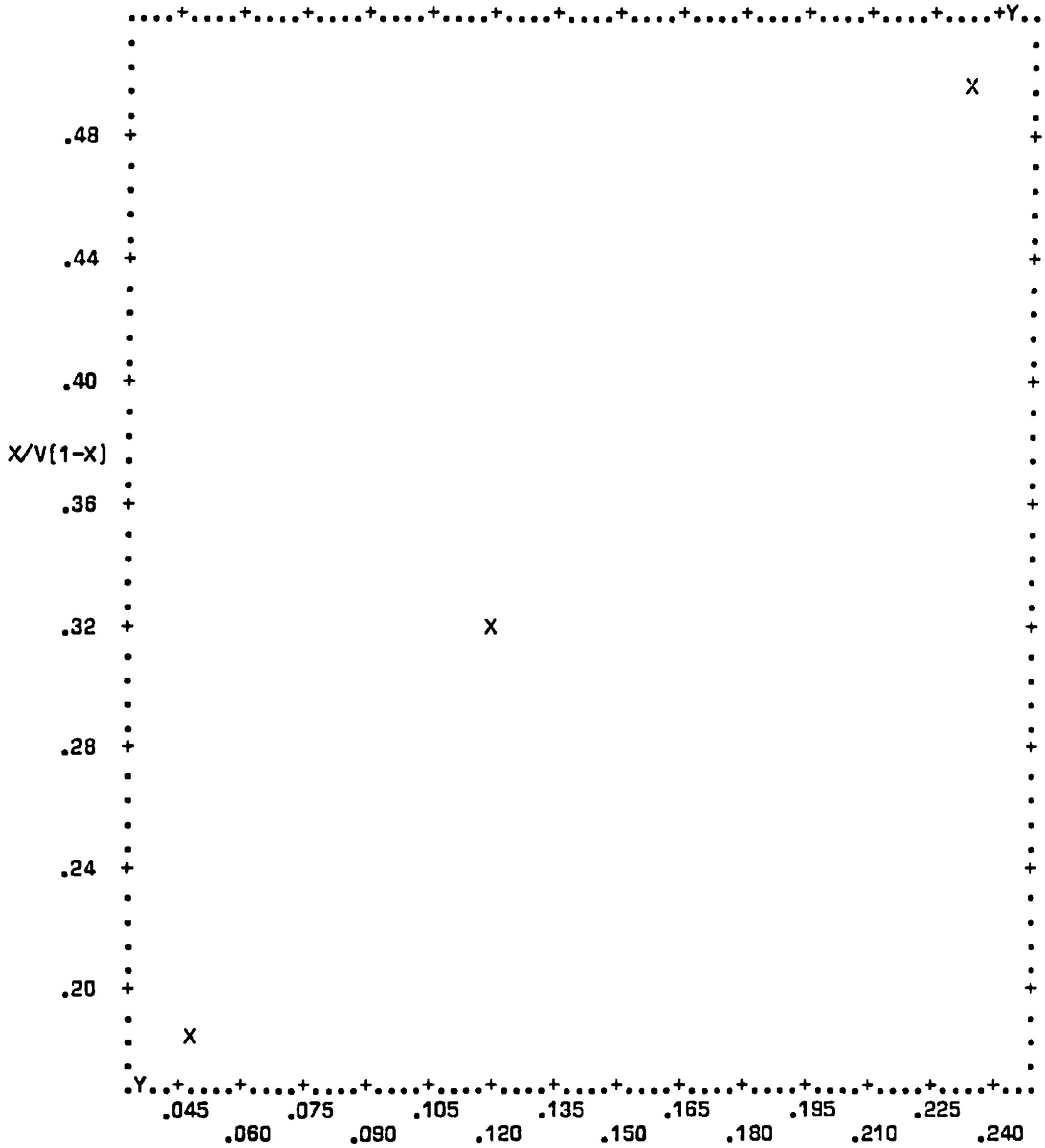
N= 3
COR= .9931 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= .69963*Y-.12320	241E-6
Y	.36681	.13245	Y= 1.4095*X+ .17874	486E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-60. Plot of BET equation versus relative pressure for Converter A240/0102-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0102-B SAMPLE F



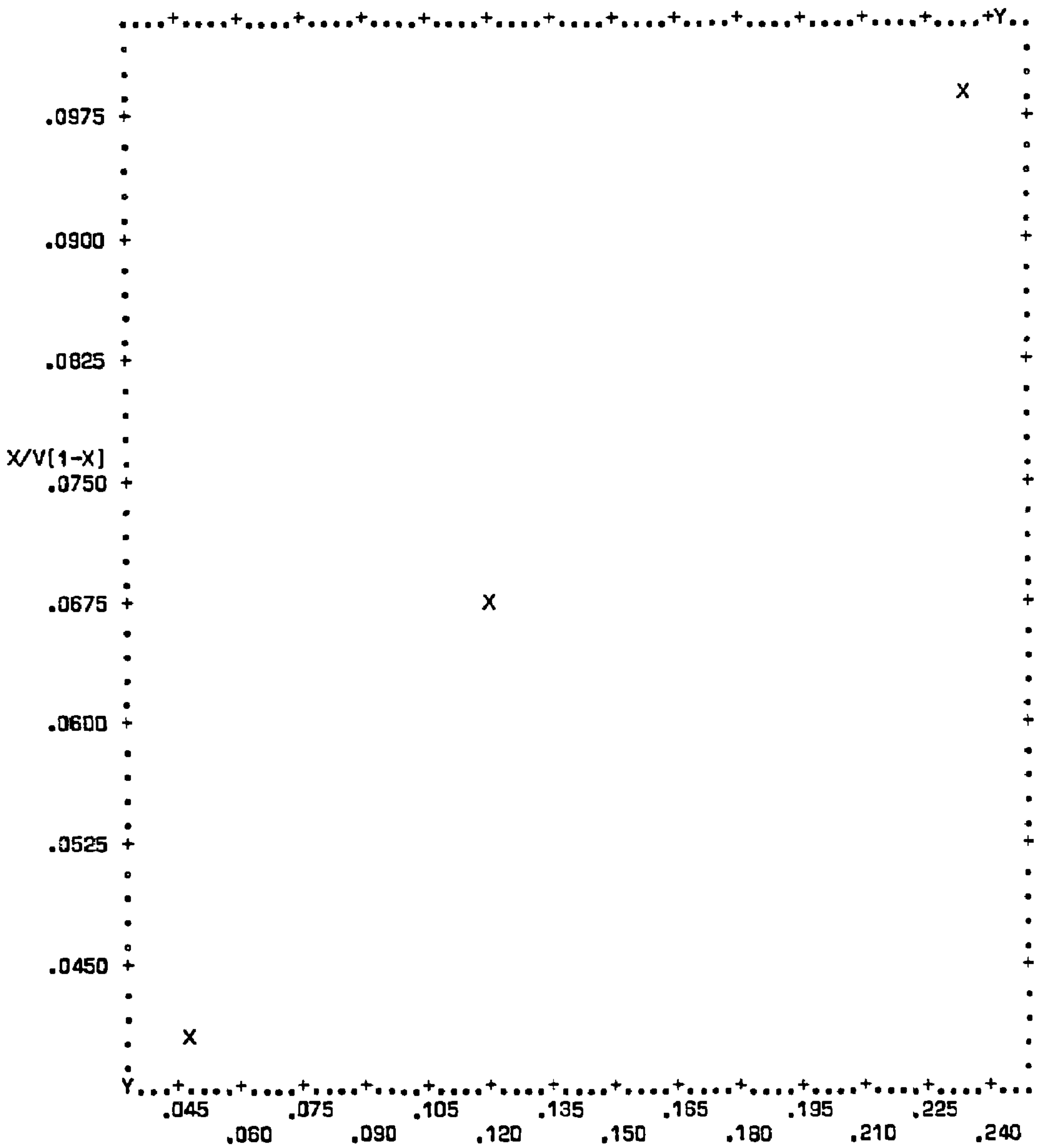
N= 3
COR= .9985 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= .58450*Y-.06074	512E-7
Y	.33220	.15942	Y= 1.7058*X+ .10458	149E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-61. Plot of BET equation versus relative pressure for Converter A240/0102-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0102-B SAMPLE E



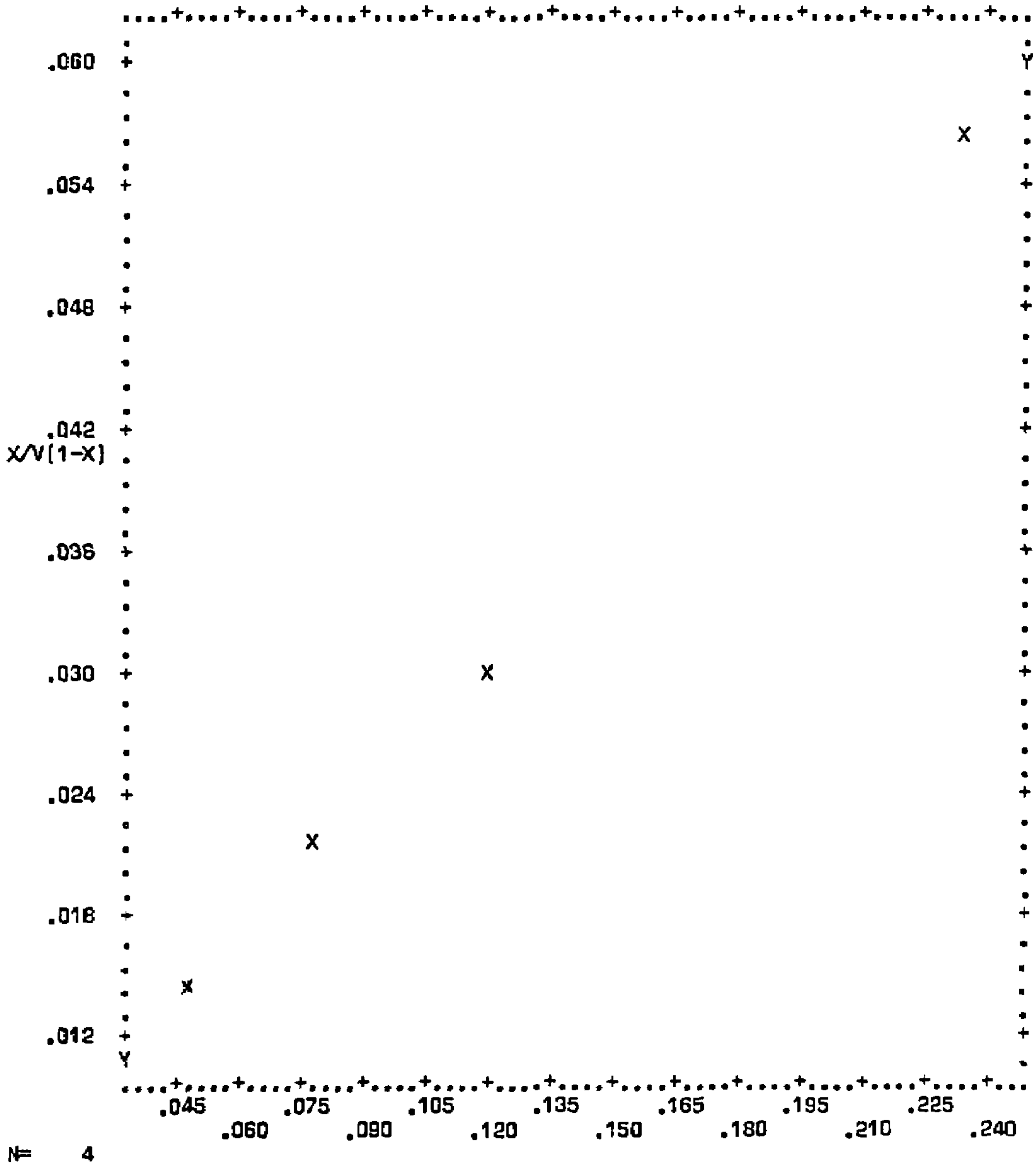
N= 3
COR= .9949

P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13342	.09331	X= 3.1814*Y-.08610	176E-6
Y	.06900	.02918	Y= .31115*X+ .02749	172E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-62. Plot of BET equation versus relative pressure for Converter A240/0102-B - Front Face



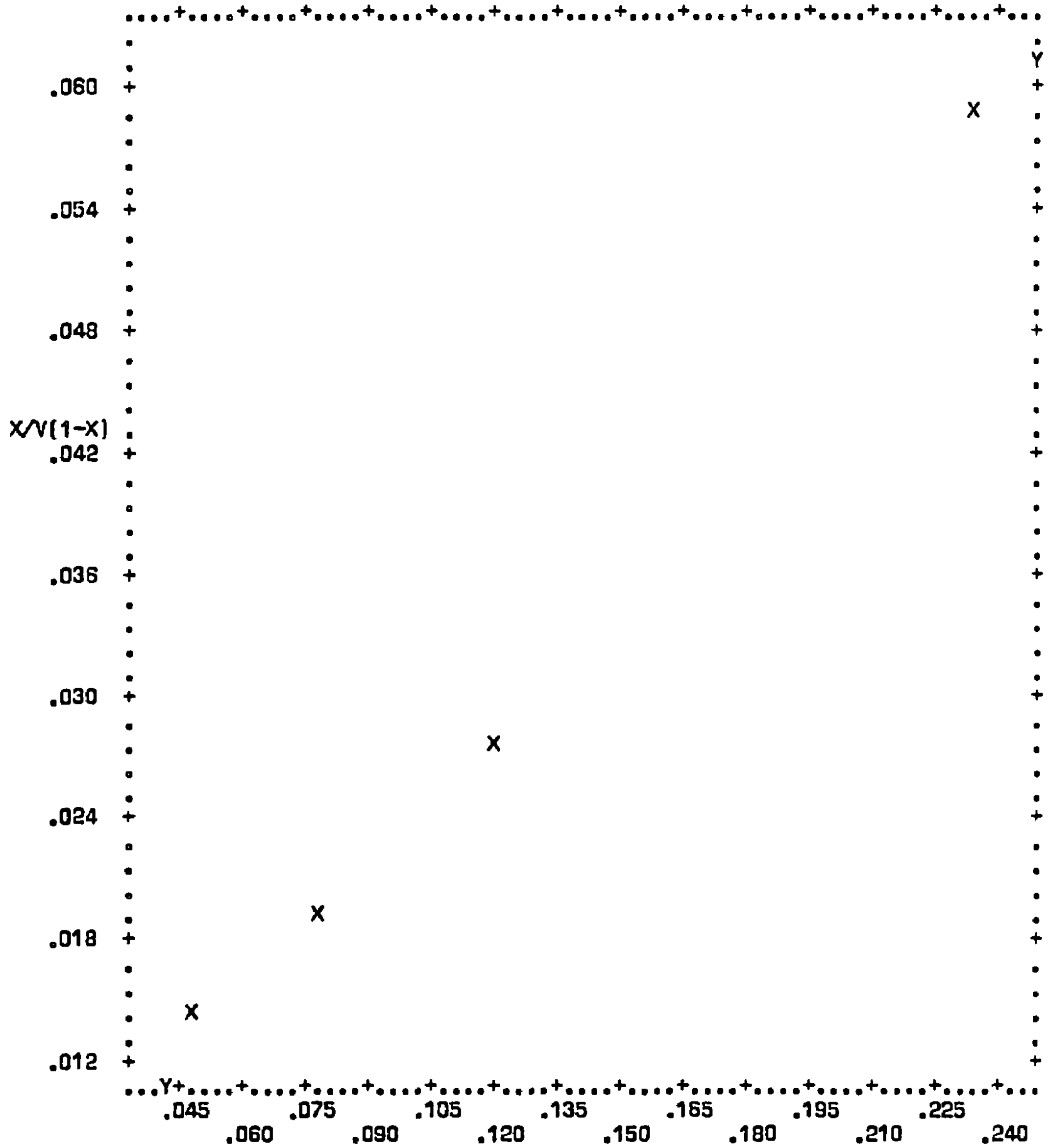
N= 4
COR= .9999

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 4.3451*Y-.01357	116E-8
Y	.03072	.01860	Y= .23012*X+ .00313	62E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-63. Plot of BET equation versus relative pressure for Converter A240/0141L-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0141L-A SAMPLE E

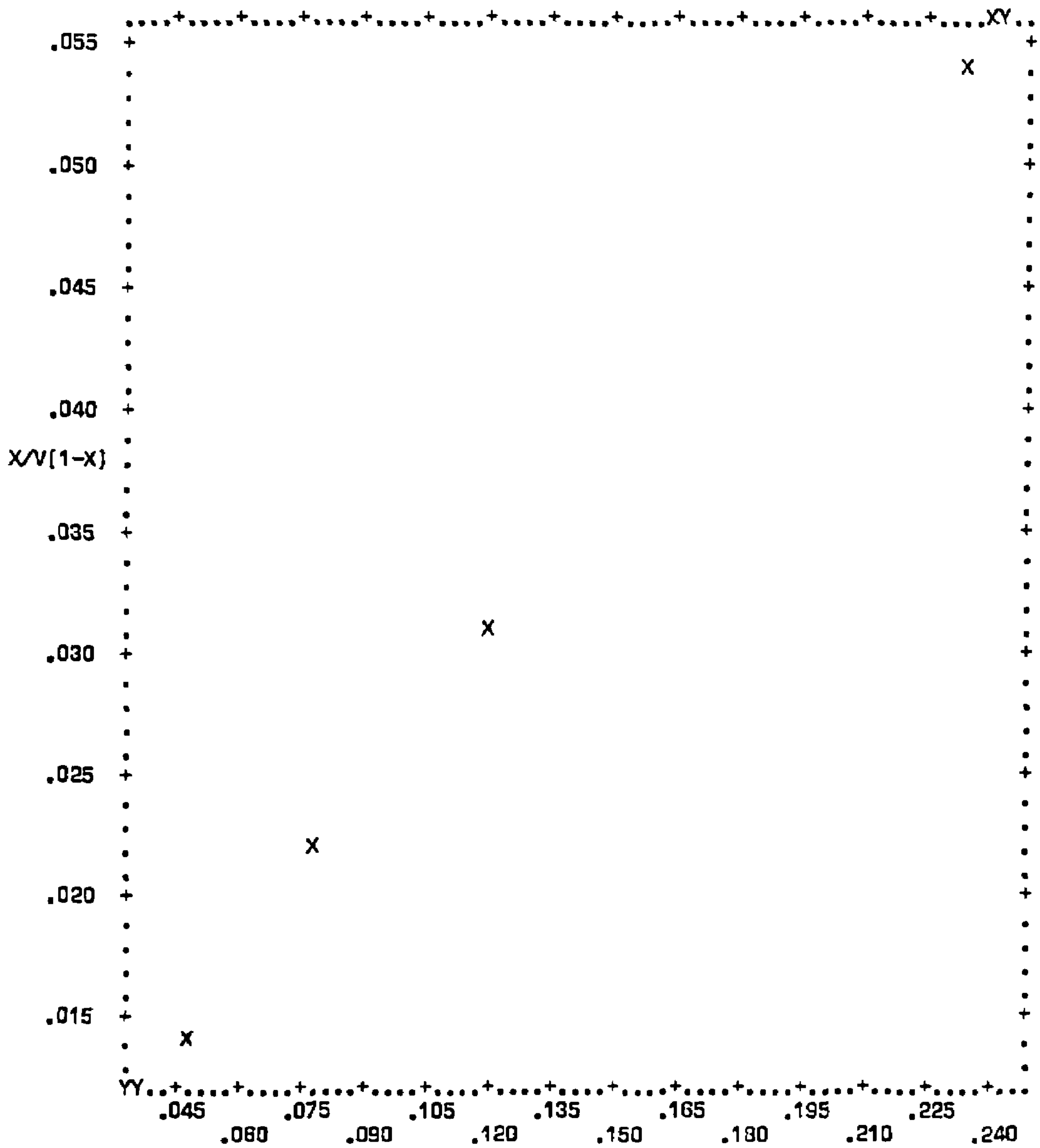


N= 4
COR= .9974

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 4.0616*Y-.00198	502E-7
Y	.03001	.01985	Y= .24495*X+ 638E-8	303E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-64. Plot of BET equation versus relative pressure for Converter A240/0141L-A - Front Face

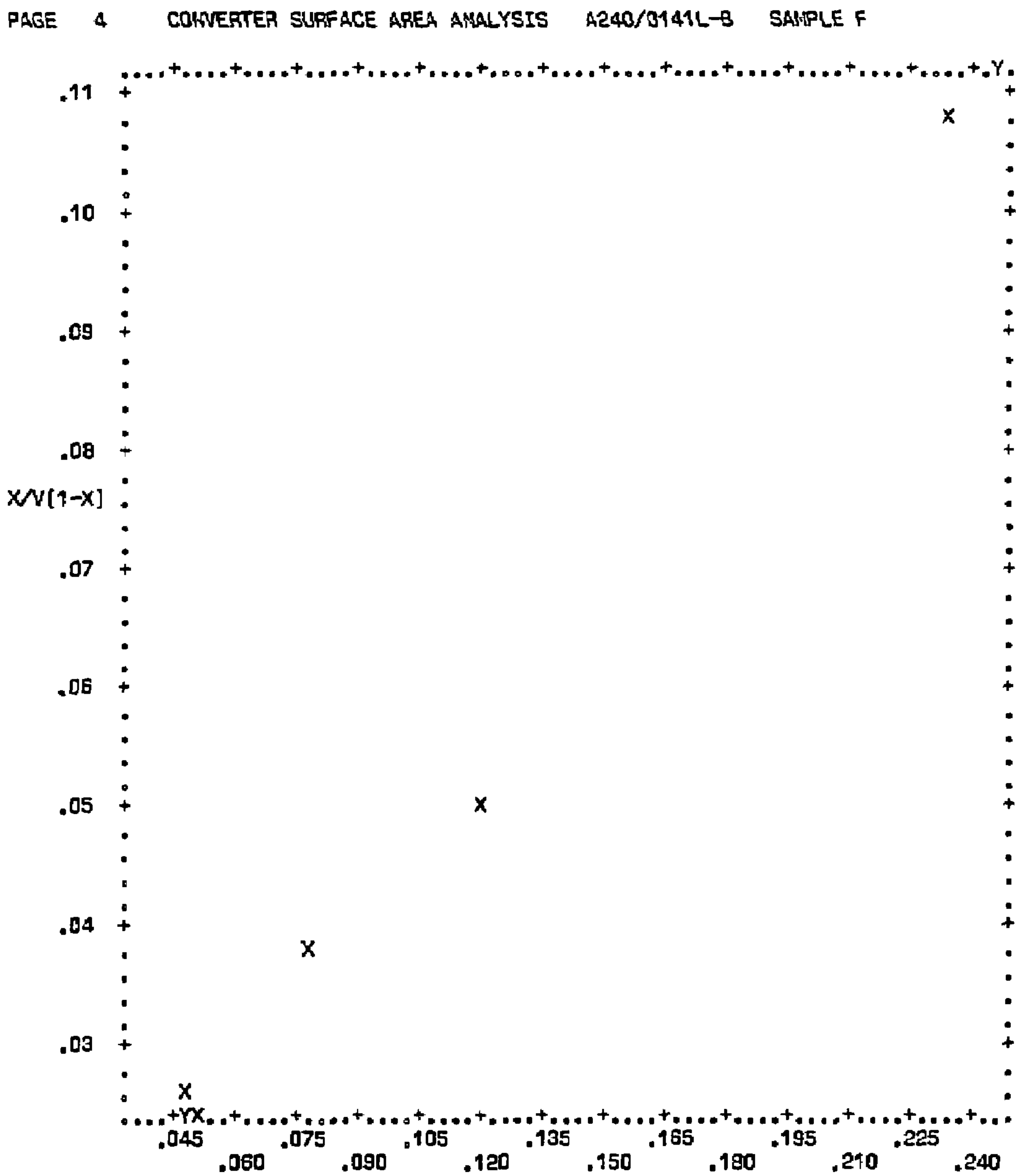


N= 4
COR= .9986 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 4.6837*Y-.02085	272E-7
Y	.03006	.01724	Y= .21291*X+ .00452	124E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-65. Plot of BET equation versus relative pressure for Converter A240/0141L-A - Rear Face



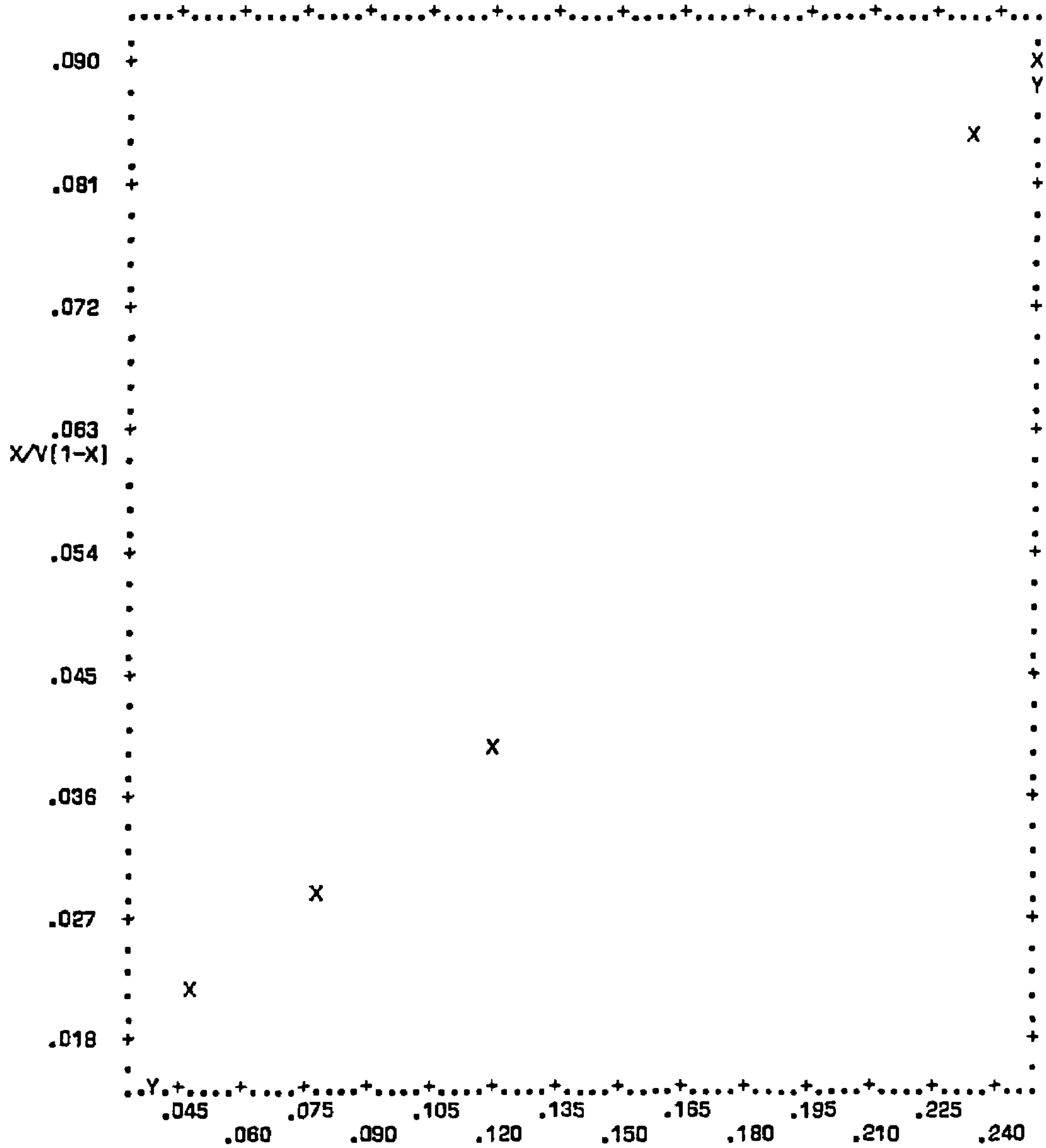
N= 4
COR= .9973

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.2287*Y-.00368	523E-7
Y	.05546	.03618	Y= .44631*X+ .00194	105E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-66. Plot of BET equation versus relative pressure for Converter A240/0141L-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0141L-B SAMPLE E



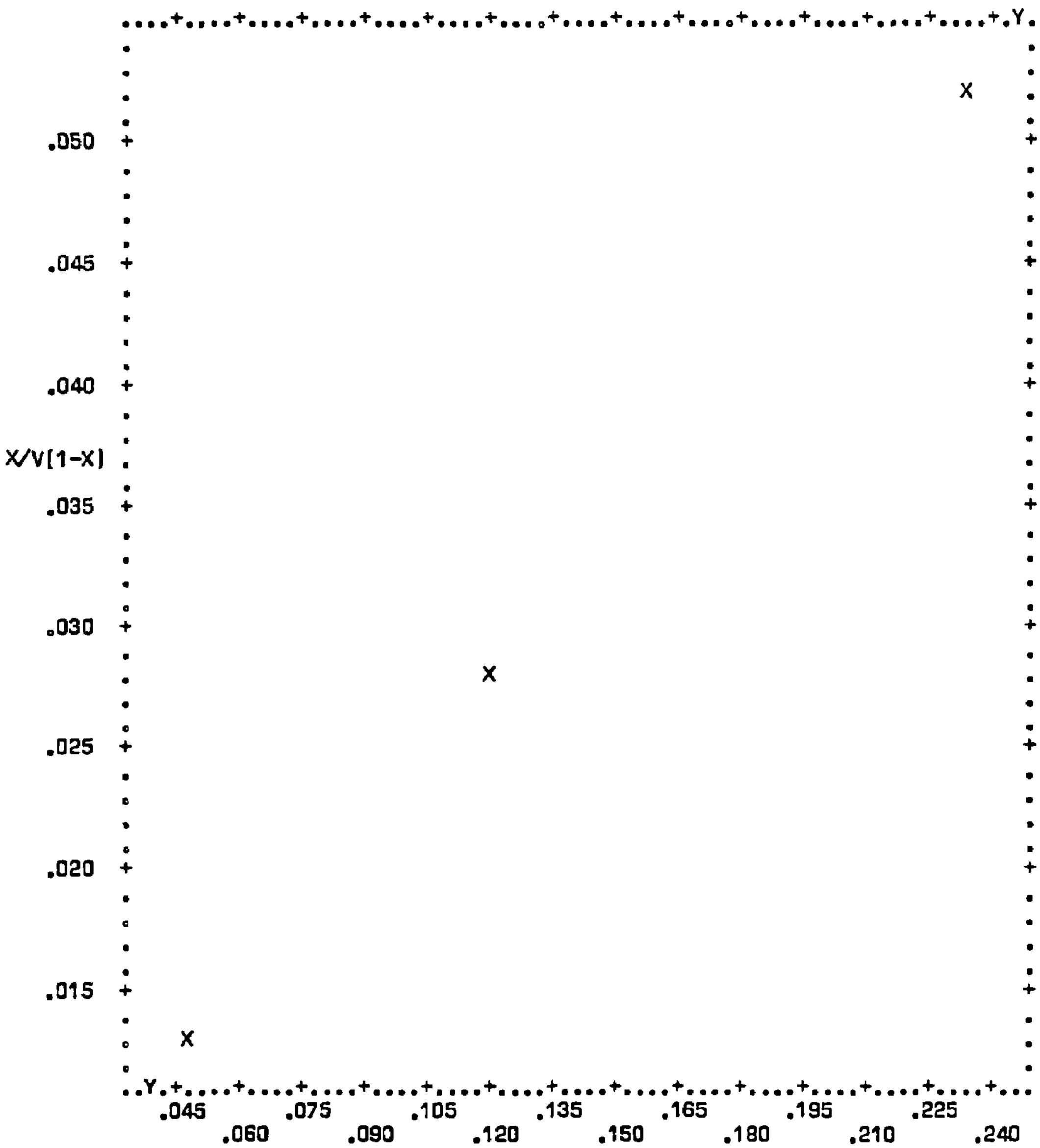
N= 4
COR= .9962 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 2.8189*Y-.00245	749E-7
Y	.04341	.02857	Y= .35203*X+ .00120	936E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-67. Plot of BET equation versus relative pressure for Converter A240/0141L-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0153-A SAMPLE F



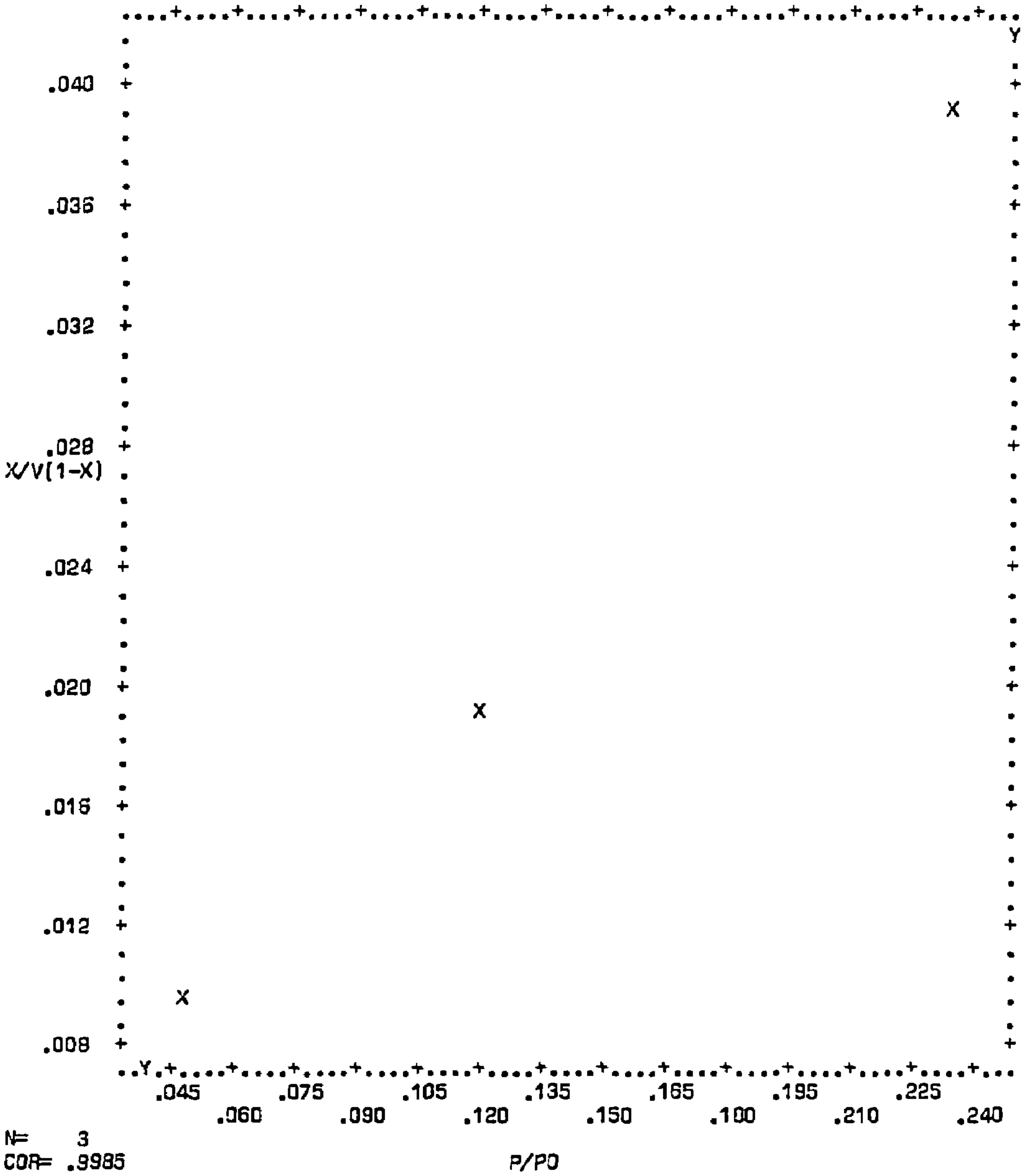
N= 3
COR= .9997 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13342	.09331	X= 4.6613*Y-.01147	924E-8
Y	.03108	.02001	Y= .21442*X+ .00247	425E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-68. Plot of BET equation versus relative pressure for Converter A240/0153-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0153-A SAMPLE E



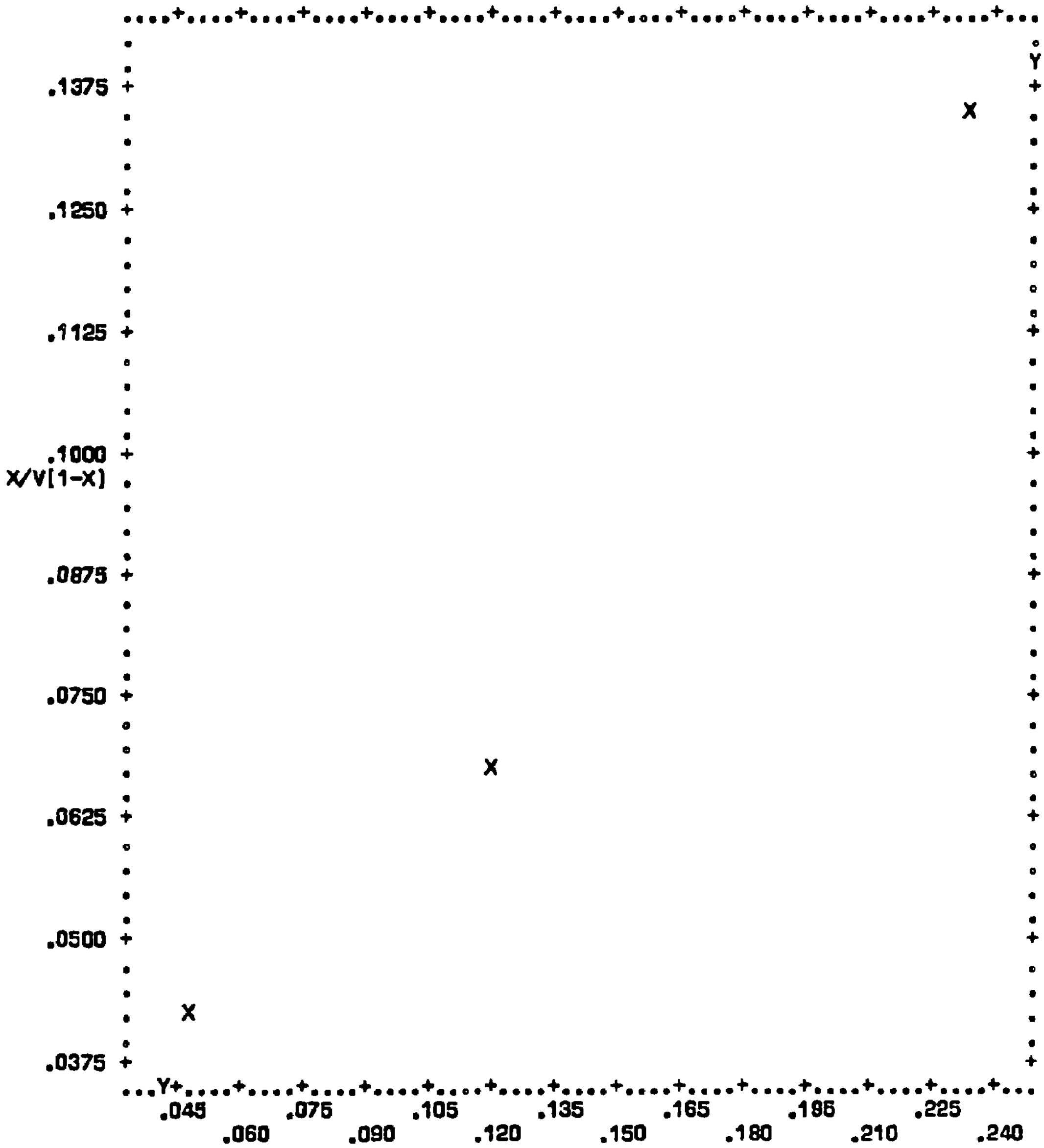
N= 3
COR= .9985

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 6.1407*Y-.00574	506E-7
Y	.02266	.01517	Y= .16238*X+ .00100	134E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-69. Plot of BET equation versus relative pressure for Converter A240/0153-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0153-A SAMPLE G

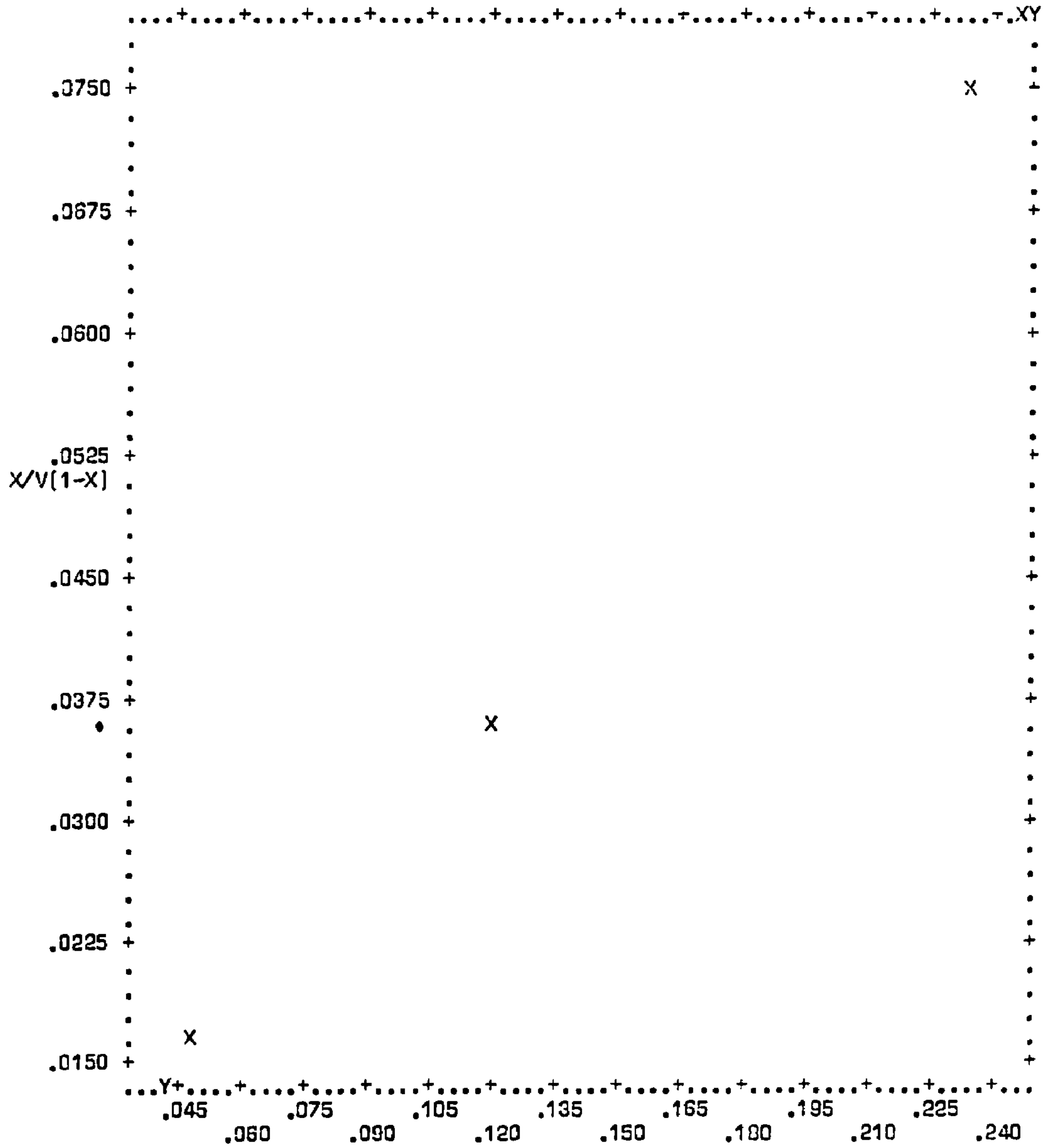


N= 3
COR= .9922

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09332	X= 1.9494*Y-.02486	272E-6
Y	.08120	.04750	Y= .50496*X+ .01382	704E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-70. Plot of BET equation versus relative pressure for Converter A240/0153-A - Rear Face



N= 3

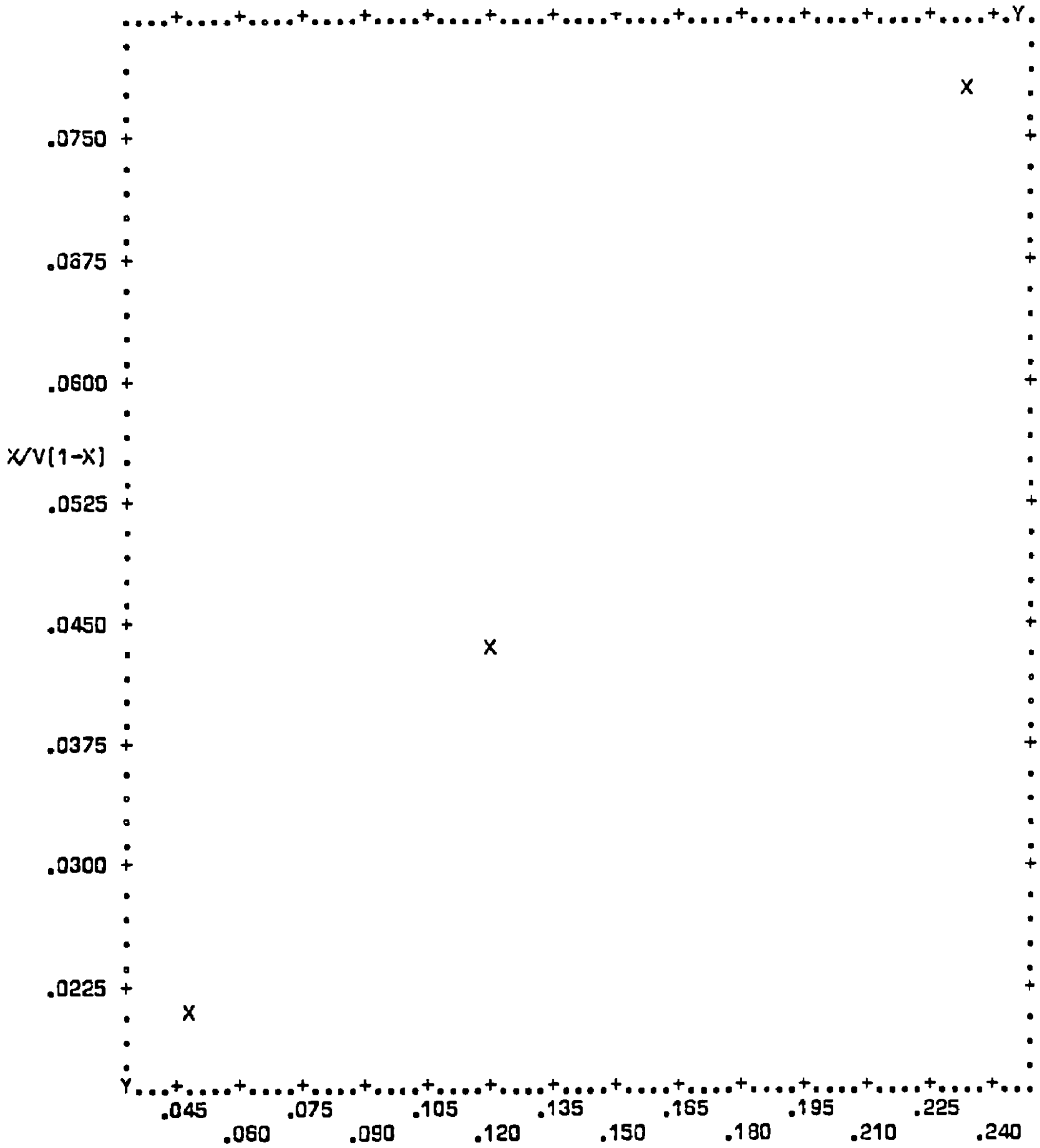
COR= .9989 P/P0

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 3.1224*Y-813E-6	389E-7
Y	.04299	.02985	Y= .31955*X+ 356E-6	399E-8

VARIABLE 1 P/P0 VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-71. Plot of BET equation versus relative pressure for Converter A240/0153-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0153-B SAMPLE E



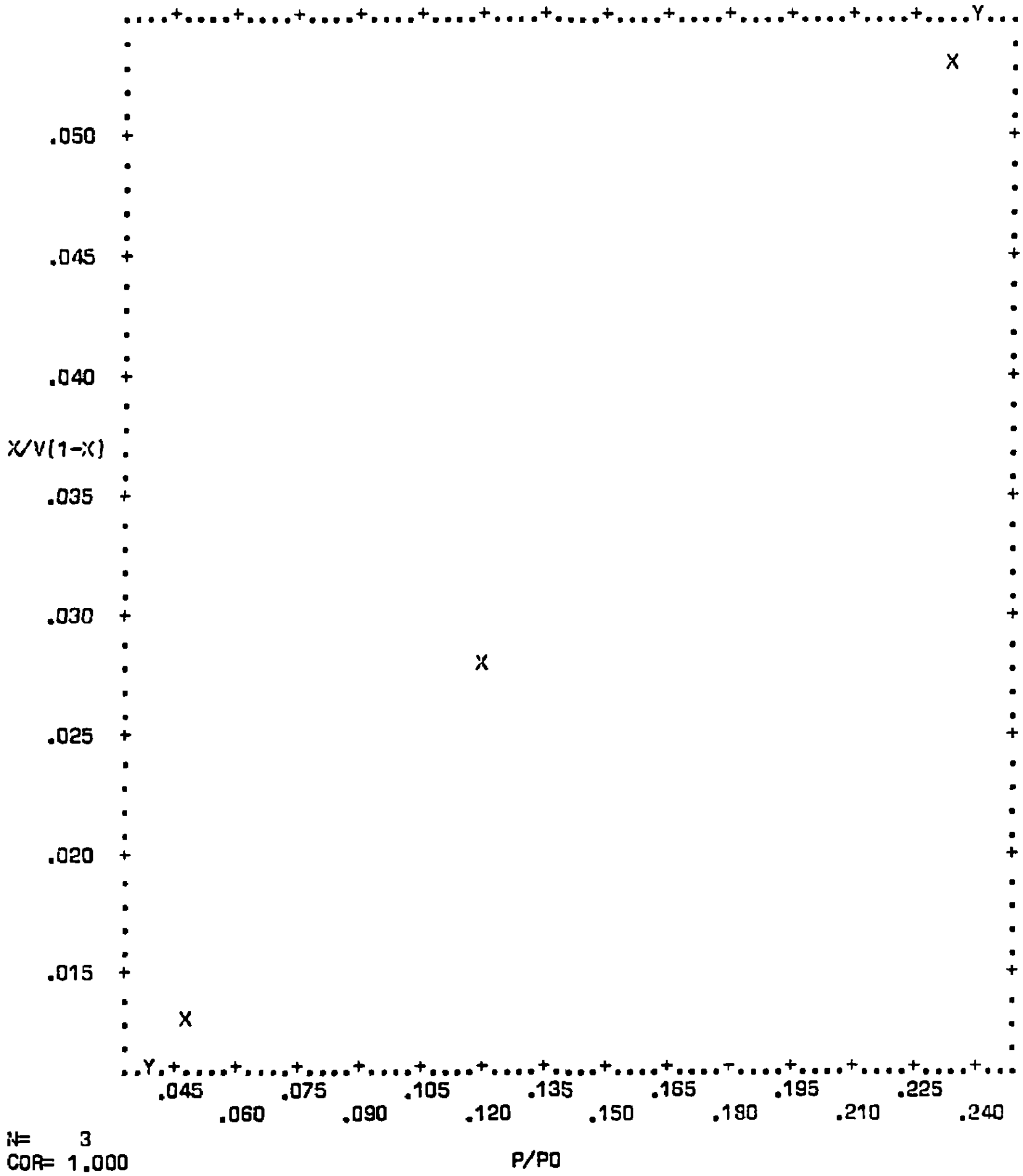
N= 3
COR= .9995

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 3.2124*Y-.01937	179E-7
Y	.04757	.02903	Y= .31097*X+ .00607	173E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-72. Plot of BET equation versus relative pressure for Converter A240/0153-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A240/0334L-A SAMPLE F

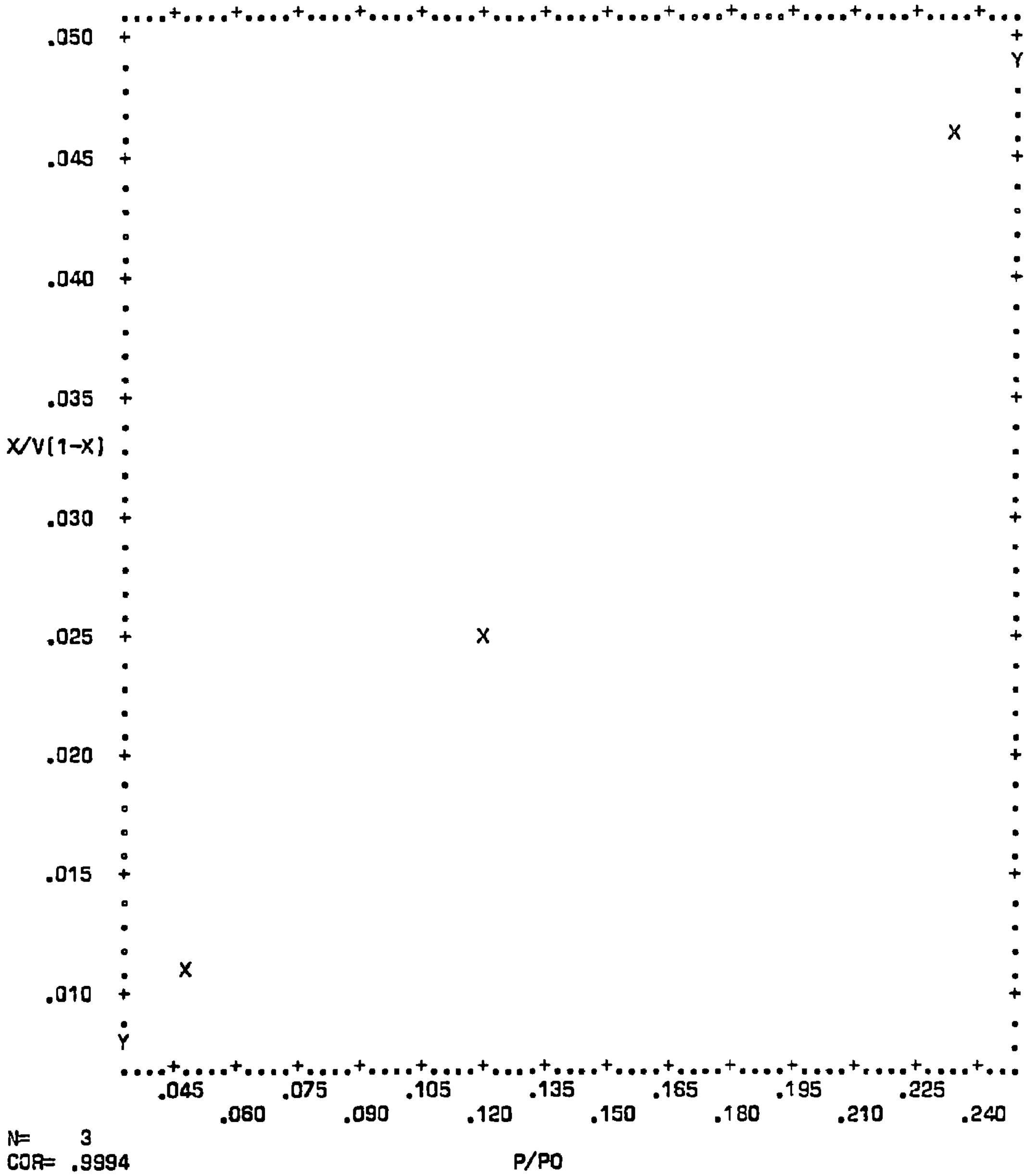


N= 3
COR= 1.000

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 4.6215*Y-.01313	165E-8
Y	.03171	.02019	Y= .21636*X+ .00284	77E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-73. Plot of BET equation versus relative pressure for Converter A240/0334L-A - Bulk



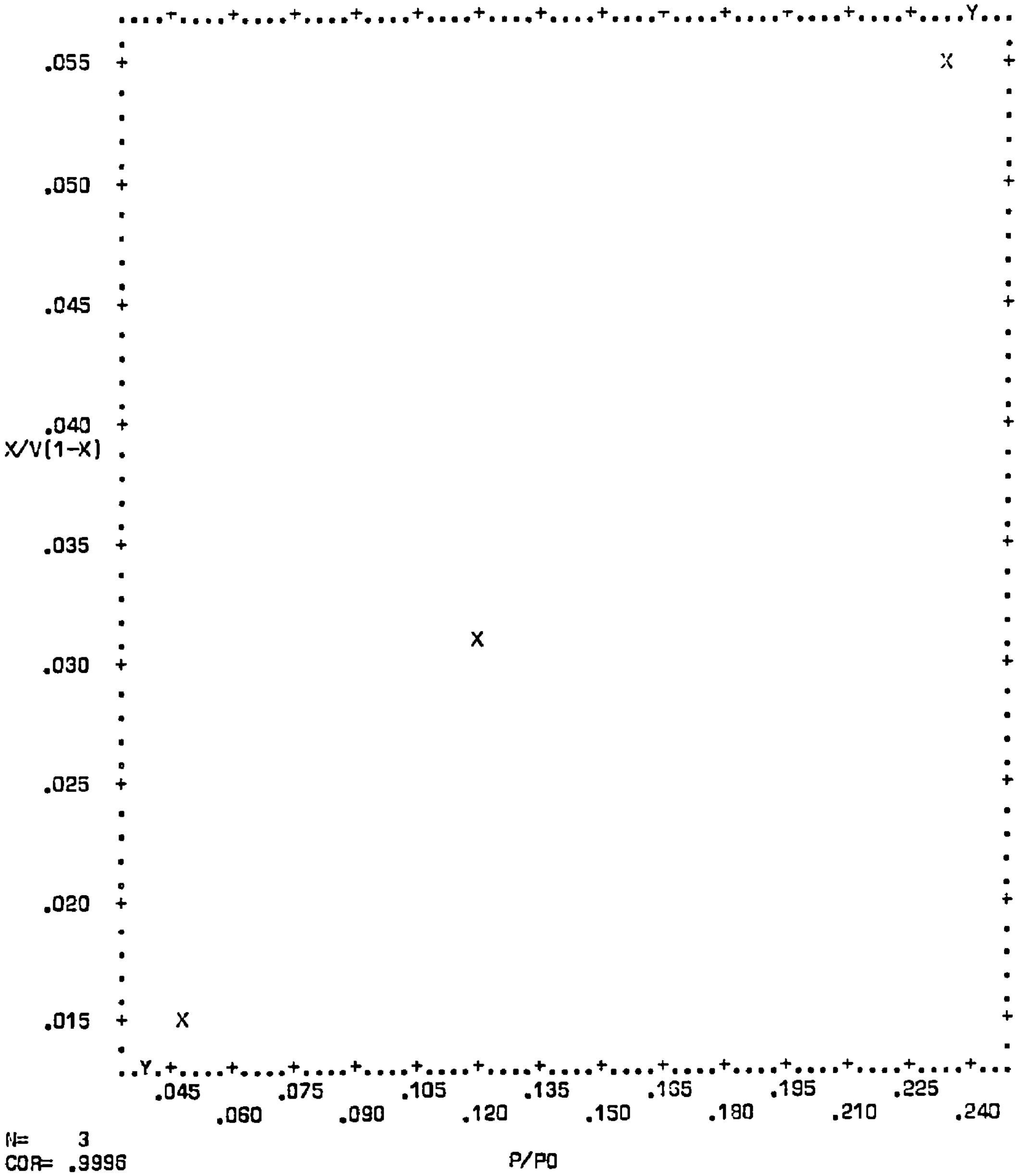
N= 3
COR= .9994

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 5.3153*Y-.01037	196E-7
Y	.02705	.01755	Y= .18792*X+ .00198	694E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-74. Plot of BET equation versus relative pressure for Converter A240/0334L-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS 1240/0334L-A SAMPLE G

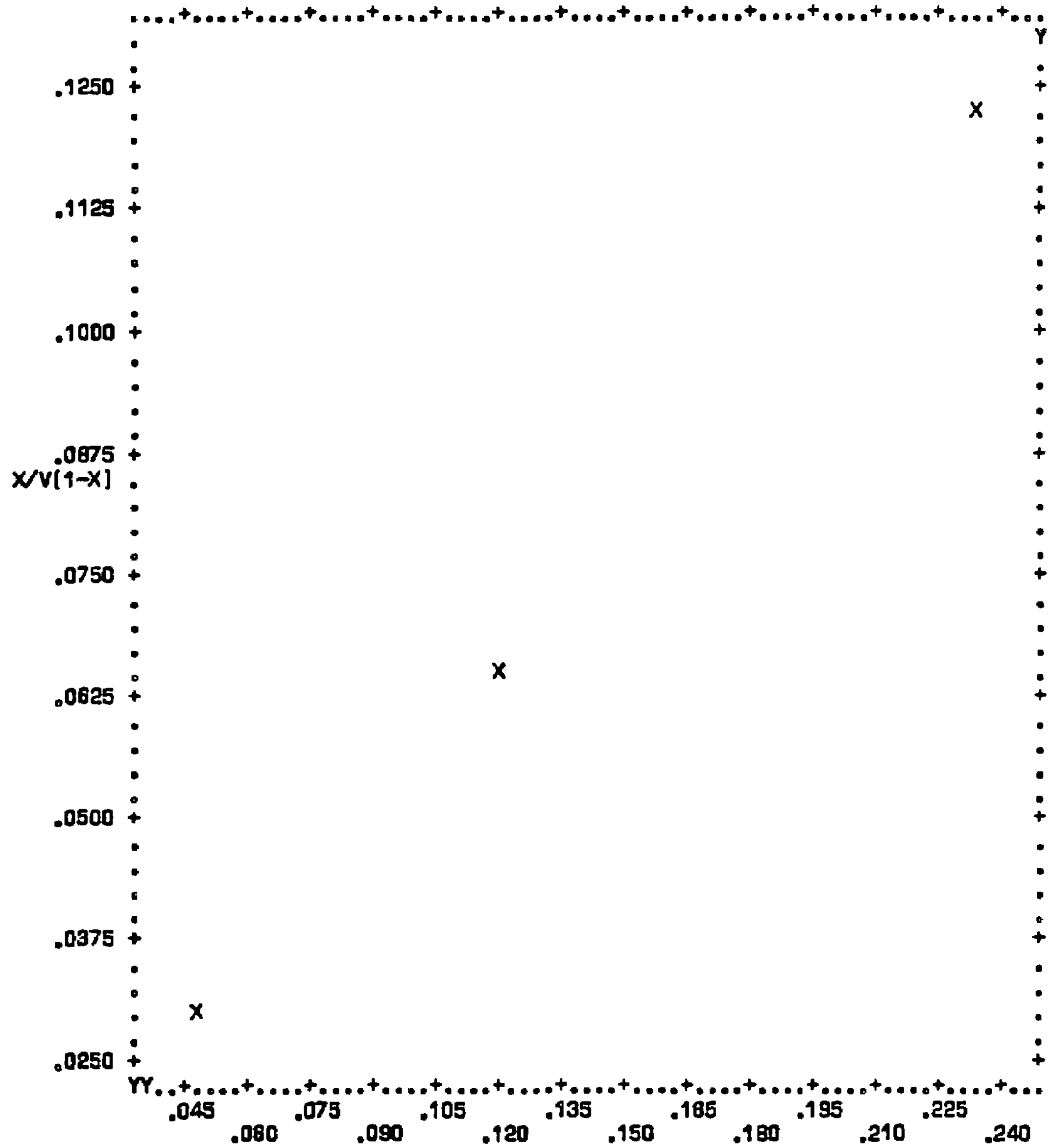


N= 3
COR= .9996

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 4.5296*Y-.01925	147E-7
Y	.03371	.02059	Y= .22059*X+ .00427	717E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-75. Plot of BET equation versus relative pressure for Converter A240/0334L-A - Rear Face

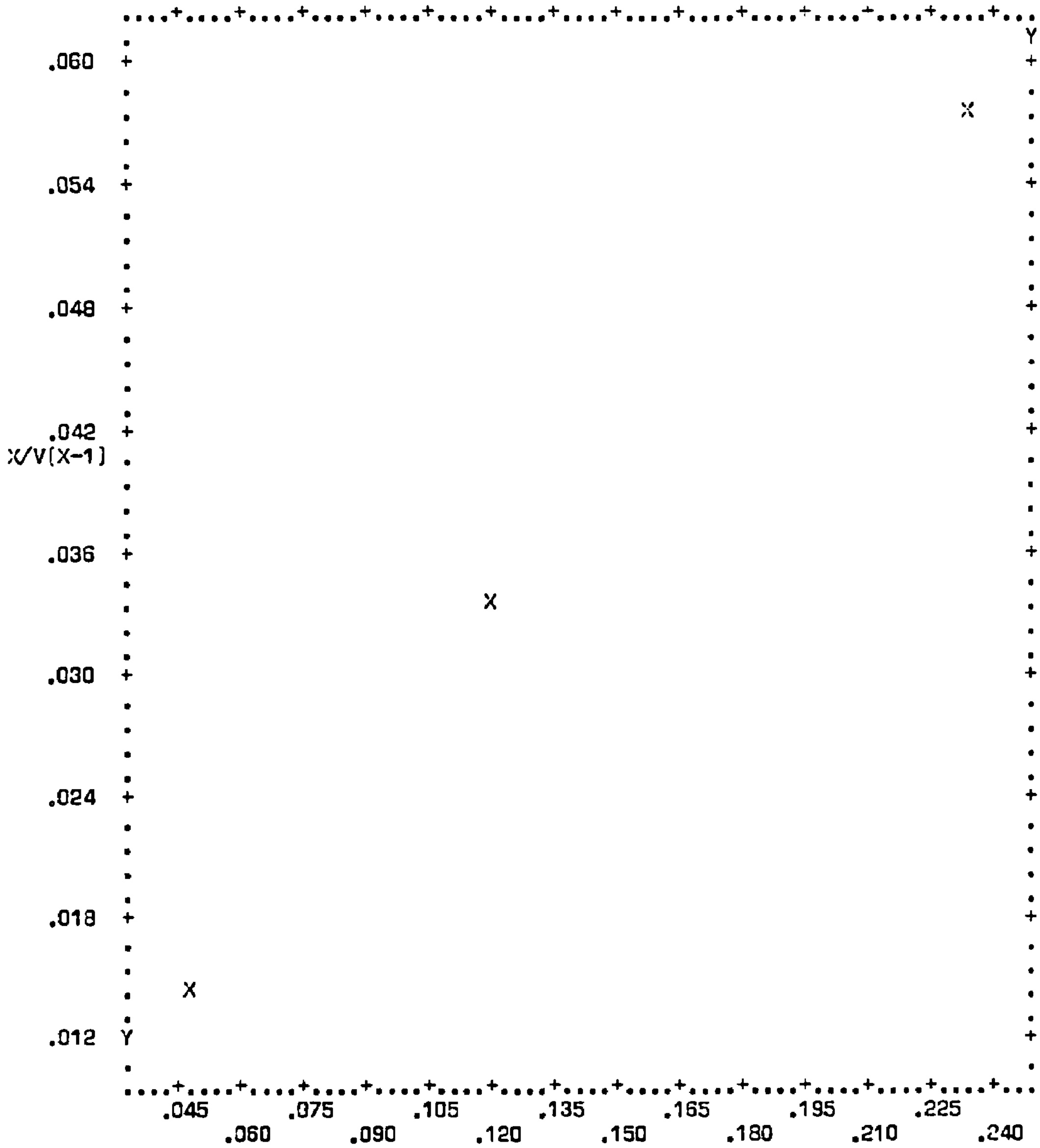


N= 3
COR= 1.000

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09332	X= 1.9867*Y-.00992	674E-9
Y	.07216	.04697	Y= .50332*X+ .00500	171E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-76. Plot of BET equation versus relative pressure for Converter A240/0334L-B - Bulk



N= 3
COR= .9971

P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09332	X= 4.3664*Y-.02081	103E-6
Y	.03533	.02131	Y= .22767*X+ .00495	535E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-77. Plot of BET equation versus relative pressure for Converter A240/0334L-B - Front Face

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PAGE   4     CONVERTER SURFACE AREA ANALYSIS  A249/0169-1  F
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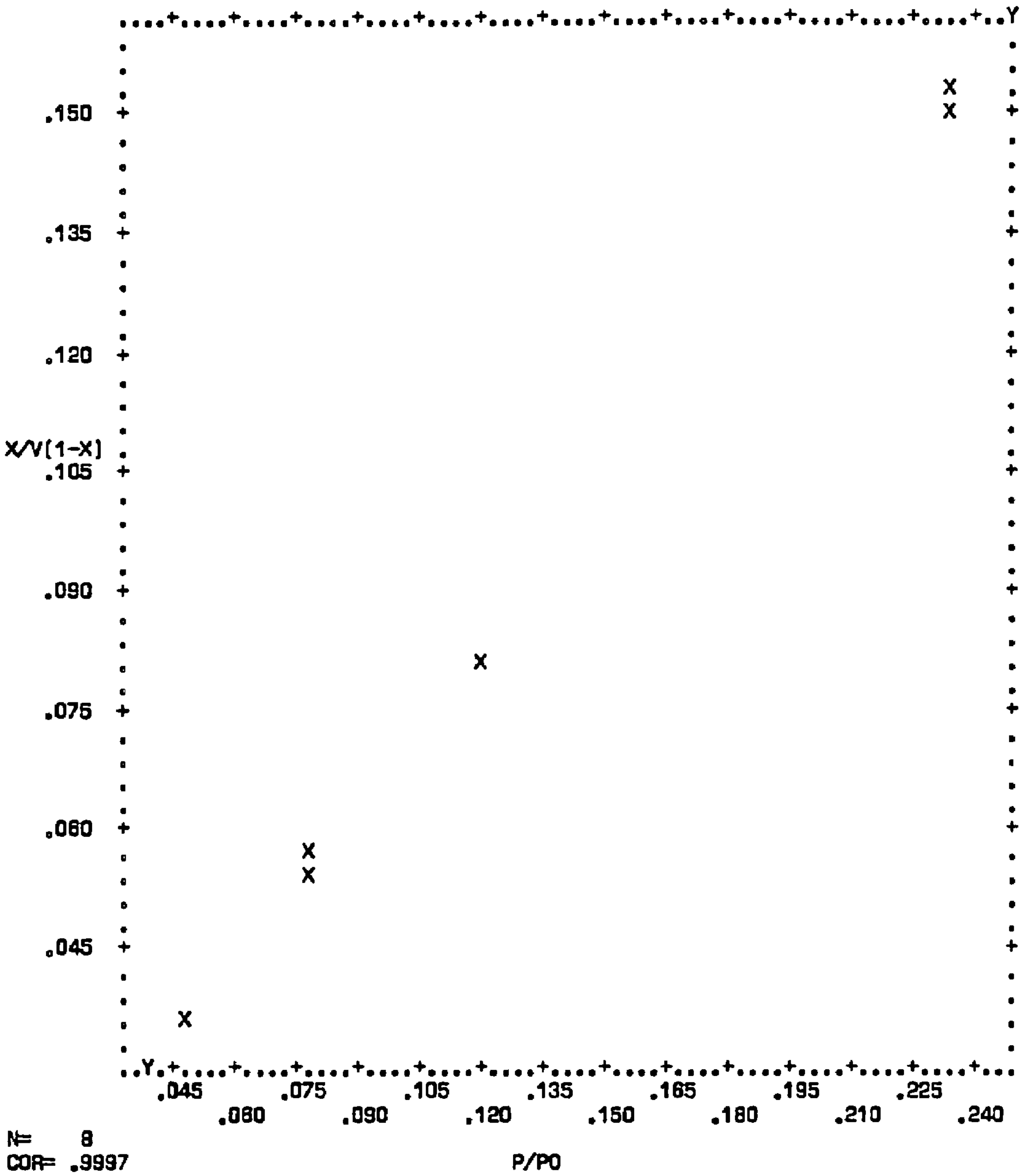


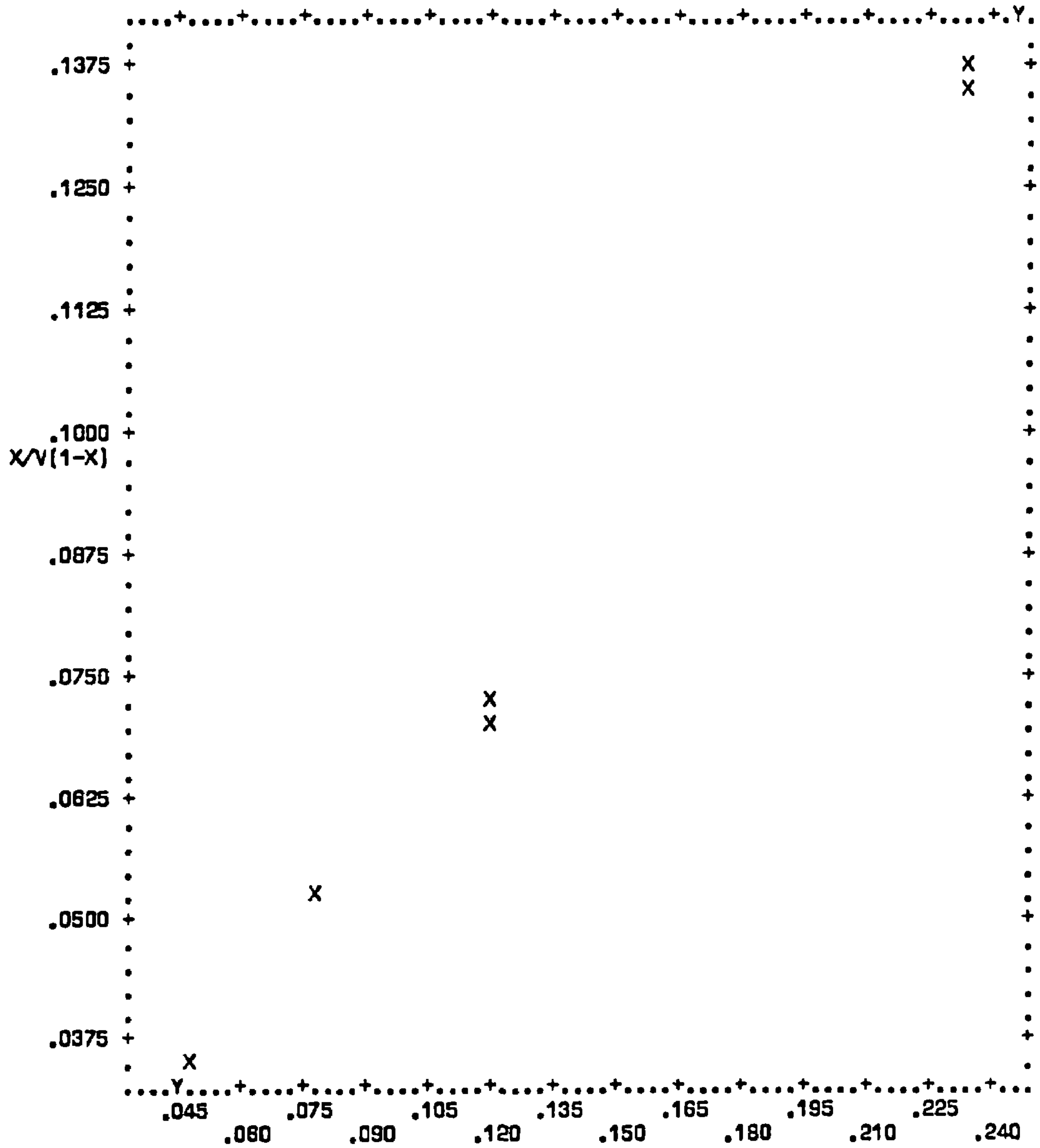

```
N=    8
COR= .9997

    MEAN     ST.DEV.    REGRESSION LINE    RES.MS.
X   .11992   .07485  X= 1.5883*Y-.00943    346E-8
Y   .08144   .04711  Y= .62926*X+ .00598   137E-8

VARIABLE    1  P/PO     VERSUS VARIABLE  2  X/V        SYMBOL=X
```

Figure C-78. Plot of BET equation versus relative pressure for Converter A249/0169-1 - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS



N= 7
COR= .9994 P/PO

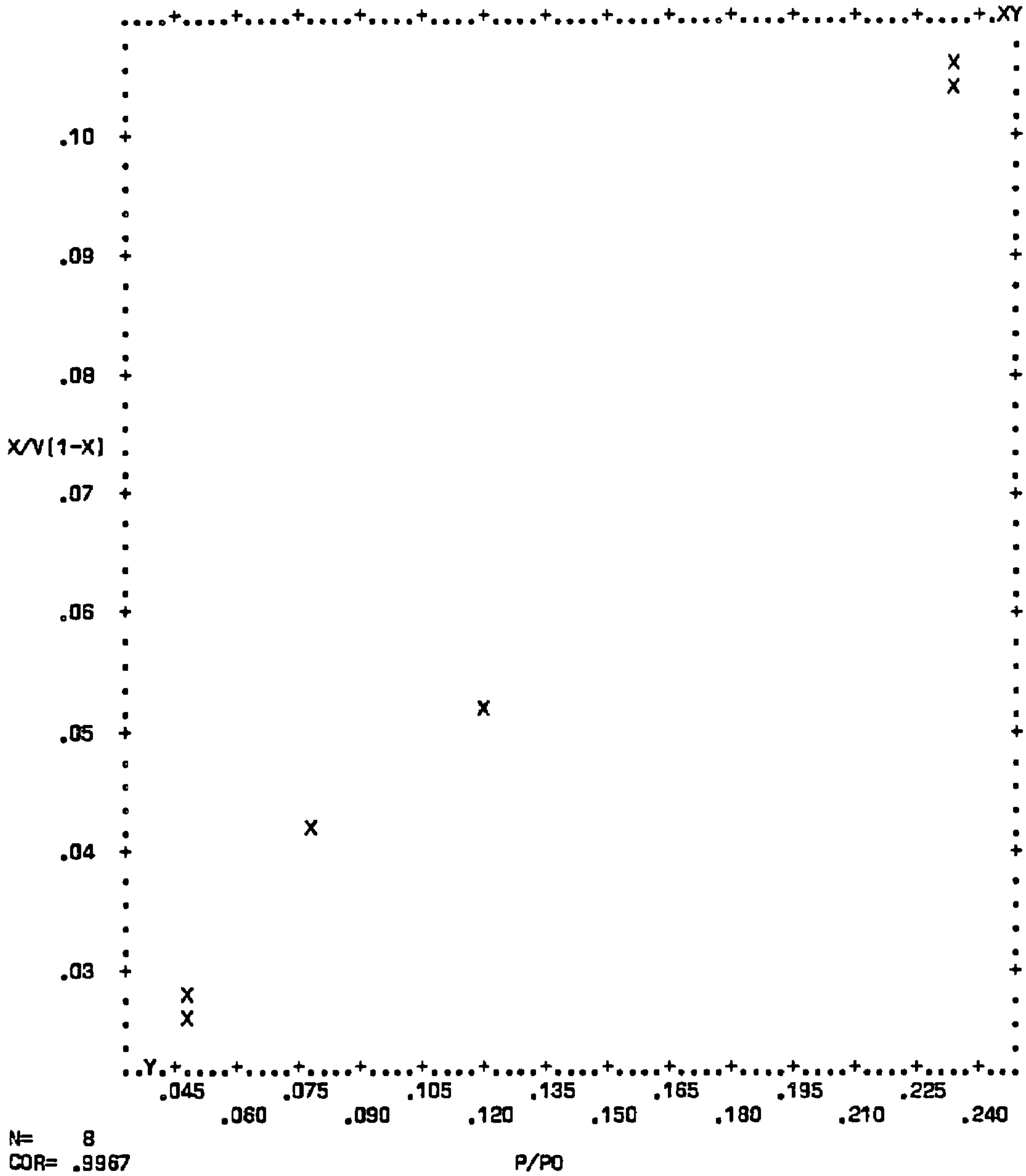
	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13015	.07458	X= 1.8221*Y-.01457	840E-8
Y	.07942	.04090	Y= .54812*X+ .00809	253E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED .942 SECONDS

Figure C-79. Plot of BET equation versus relative pressure for Converter A249/0169-1 - Front Face

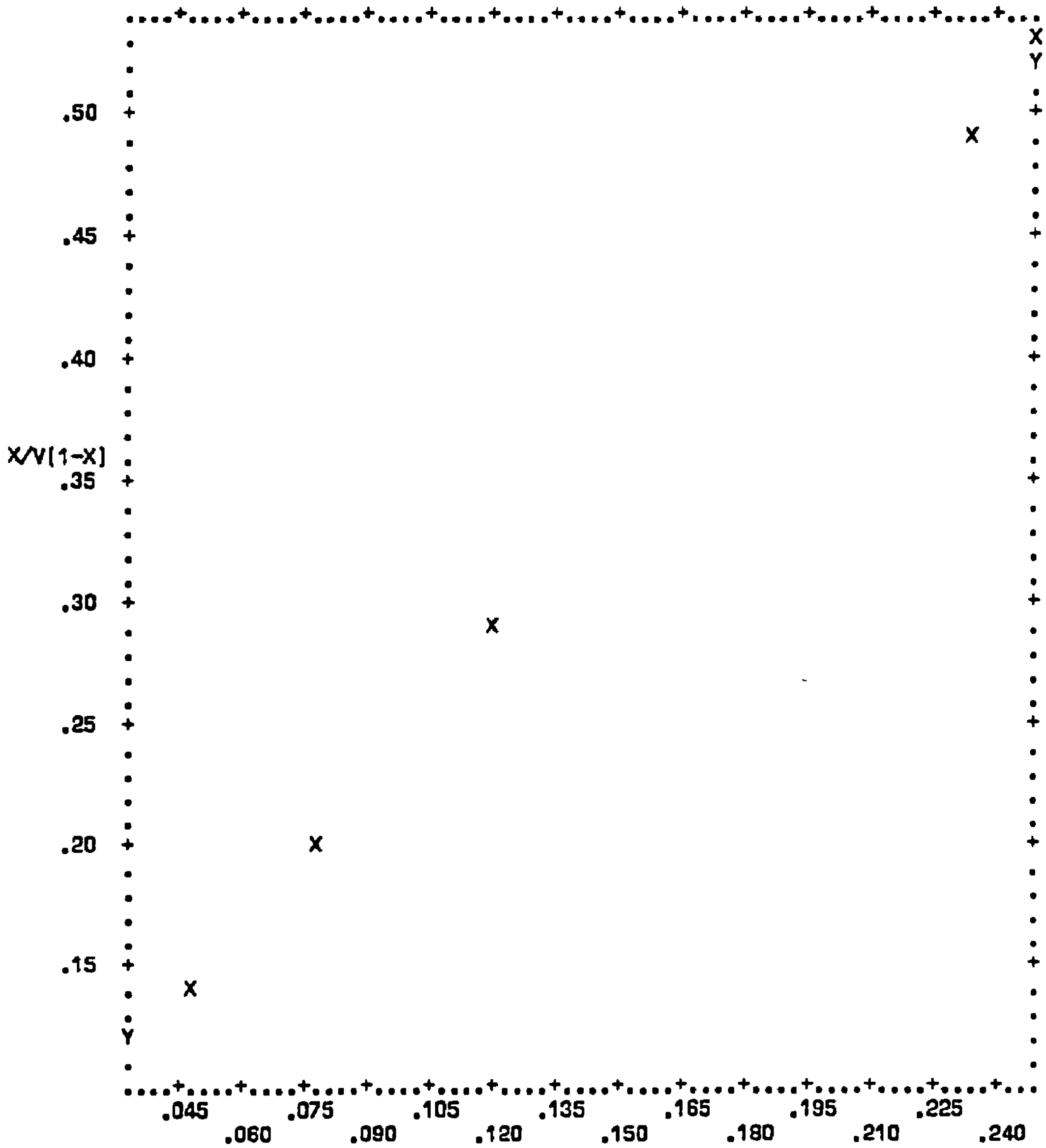
PAGE 4 CONVERTER SURFACE AREA ANALYSIS A249/0169-1 G



N= 8
COR= .9967

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11993	.07485	X= 2.3736*Y-.01368	435E-7
Y	.05629	.03143	Y= .41849*X+ .00610	767E-8

Figure C-80. Plot of BET equation versus relative pressure for Converter A249/0169-1 - Rear Face



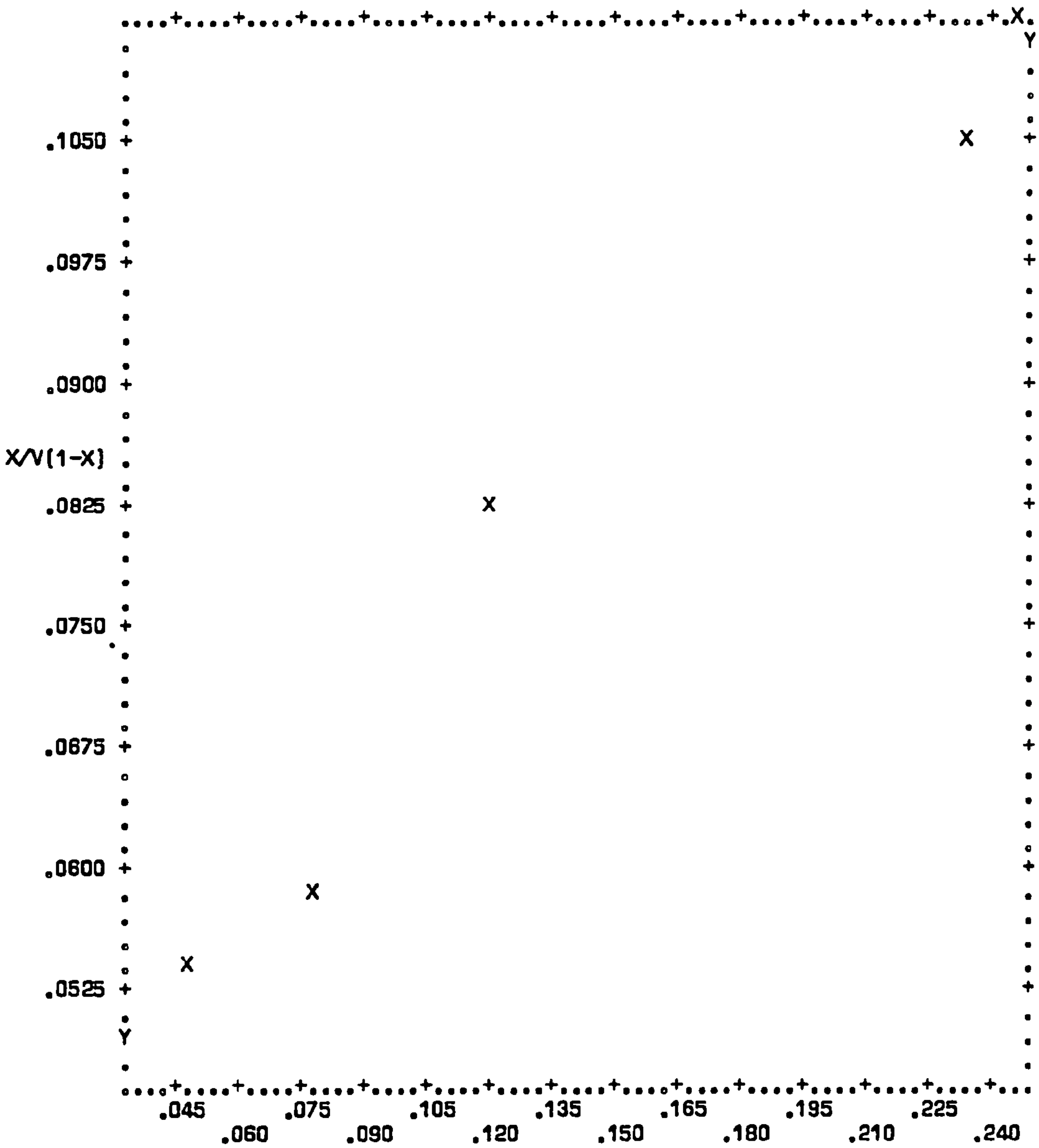
N= 4
COR= .9981 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11994	.08085	X= .52890*Y-.02891	378E-7
Y	.26143	.15258	Y= 1.8835*X+ .05554	134E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-81. Plot of BET equation versus relative pressure for Converter A249/0169-2 - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A-249/0169-2 SAMPLE E



N= 4
COR= .9736 P/PO

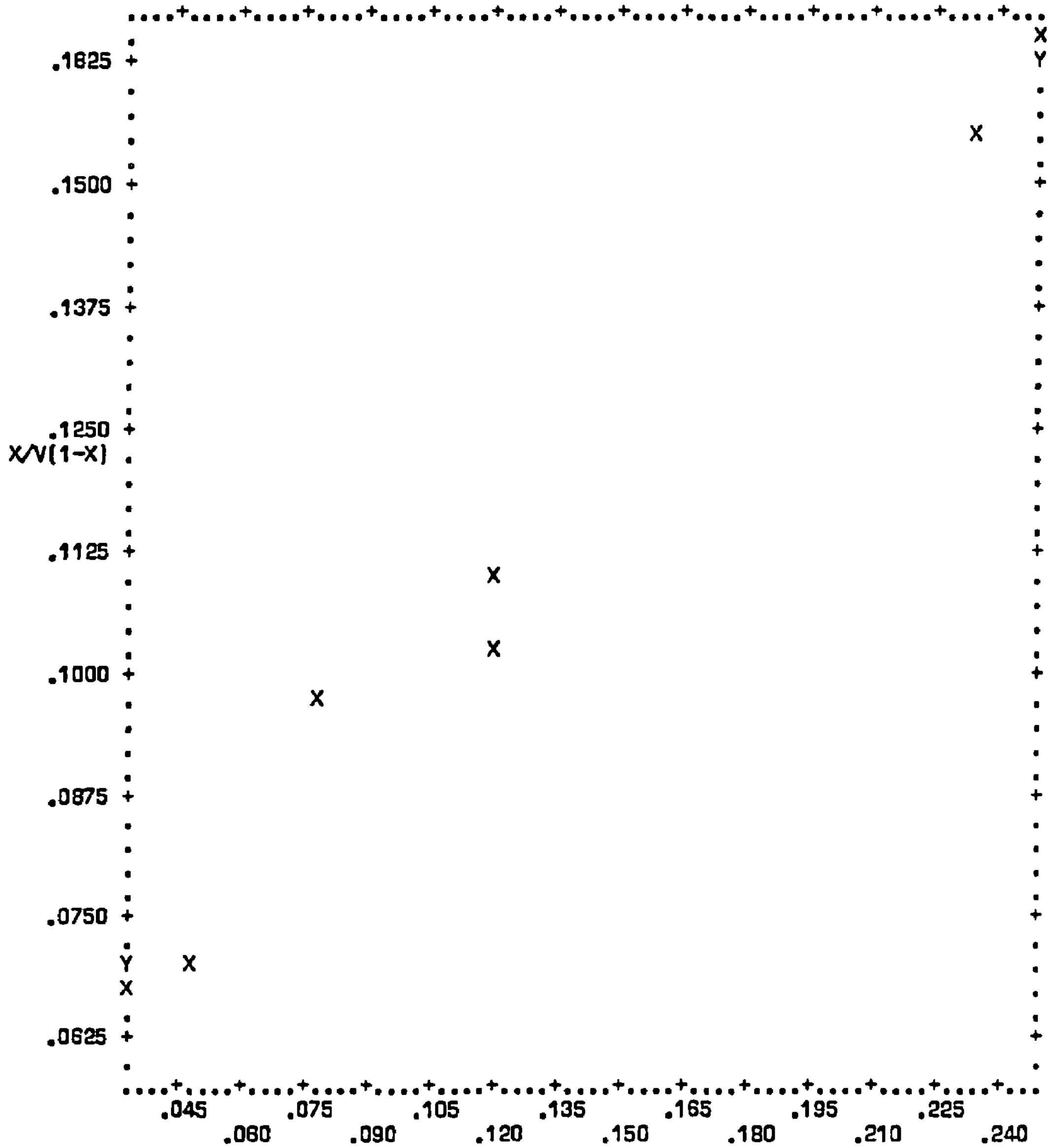
	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 3.3262*Y-.12926	511E-6
Y	.07491	.02388	Y= .28497*X+ .04074	438E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

CPU TIME USED 1.000 SECONDS

Figure C-82. Plot of BET equation versus relative pressure for Converter A249/0169-2 - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A249/0169-2 SAMPLE G



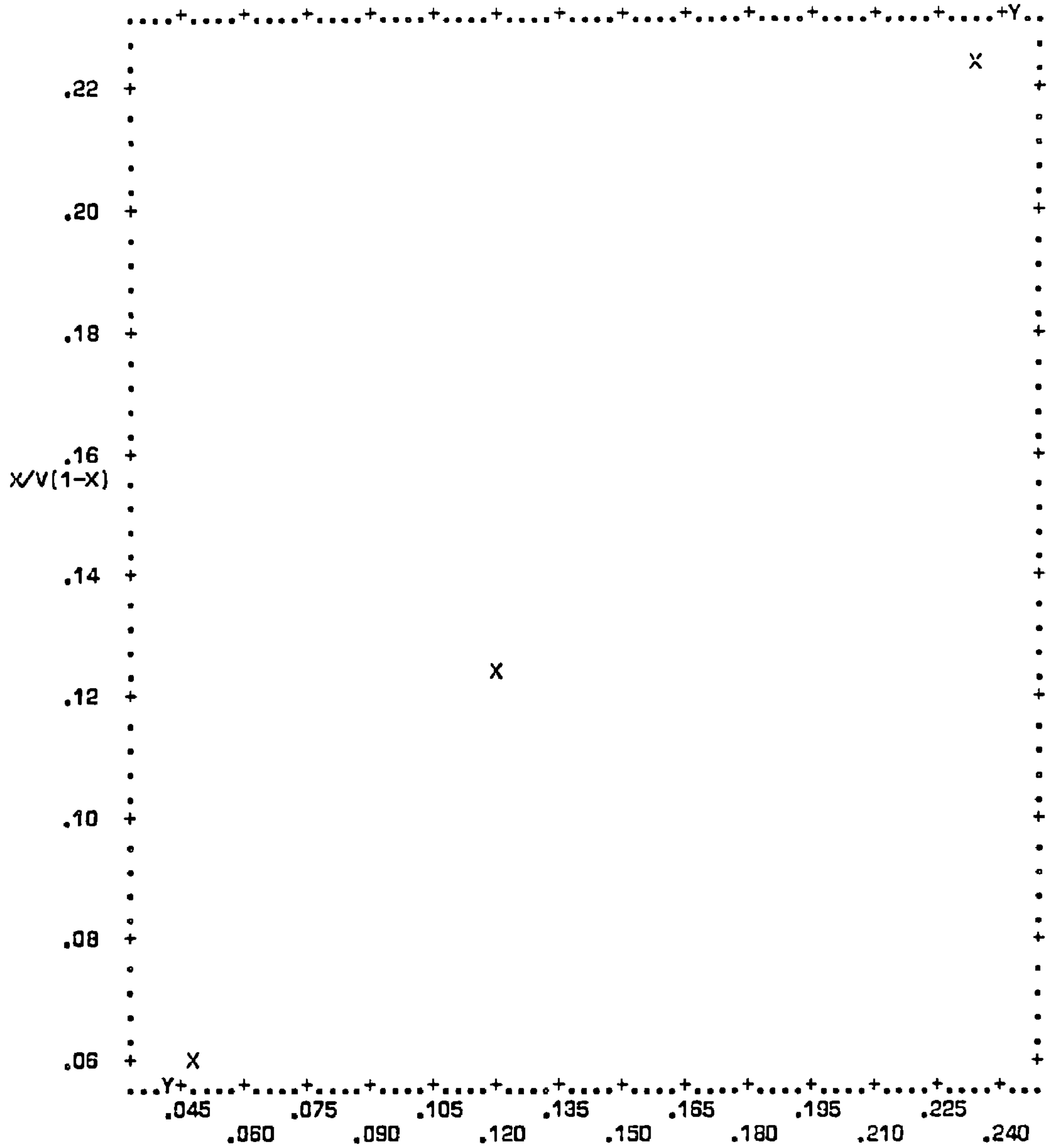
N= 5
COR= .9806 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11966	.07002	X= 2.2234*Y-.11759	251E-6
Y	.10670	.03088	Y= .43246*X+ .05496	489E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-83. Plot of BET equation versus relative pressure for Converter A249/0169-2 - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A249/0169-3-A SAMPLE F



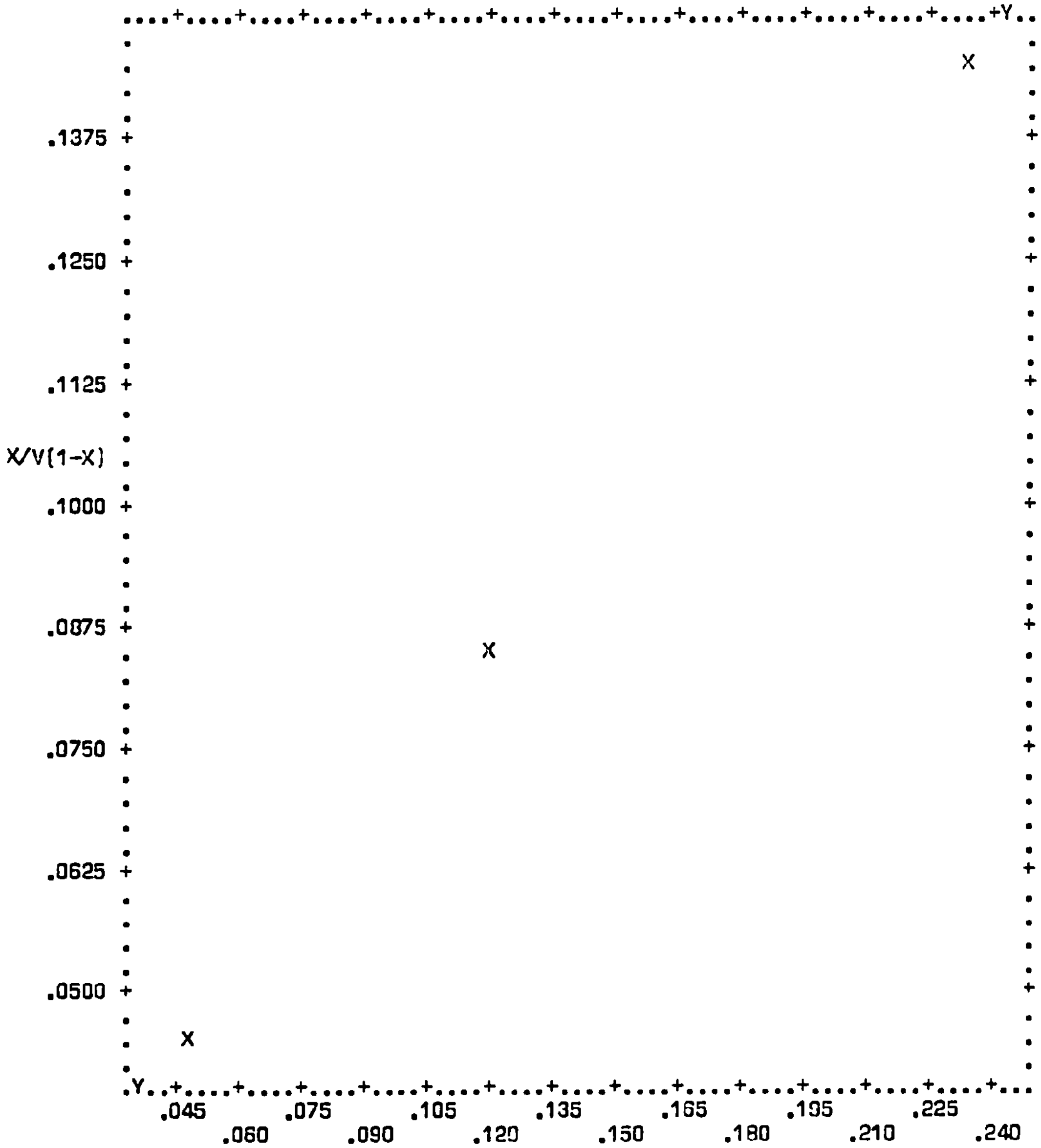
N= 3
COR= .9999 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.1308*Y-.02075	178E-8
Y	.13635	.08252	Y= .88424*X+ .01837	139E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-84. Plot of BET equation versus relative pressure for Converter A249/0169-3-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A249/0169-3-A SAMPLE 3



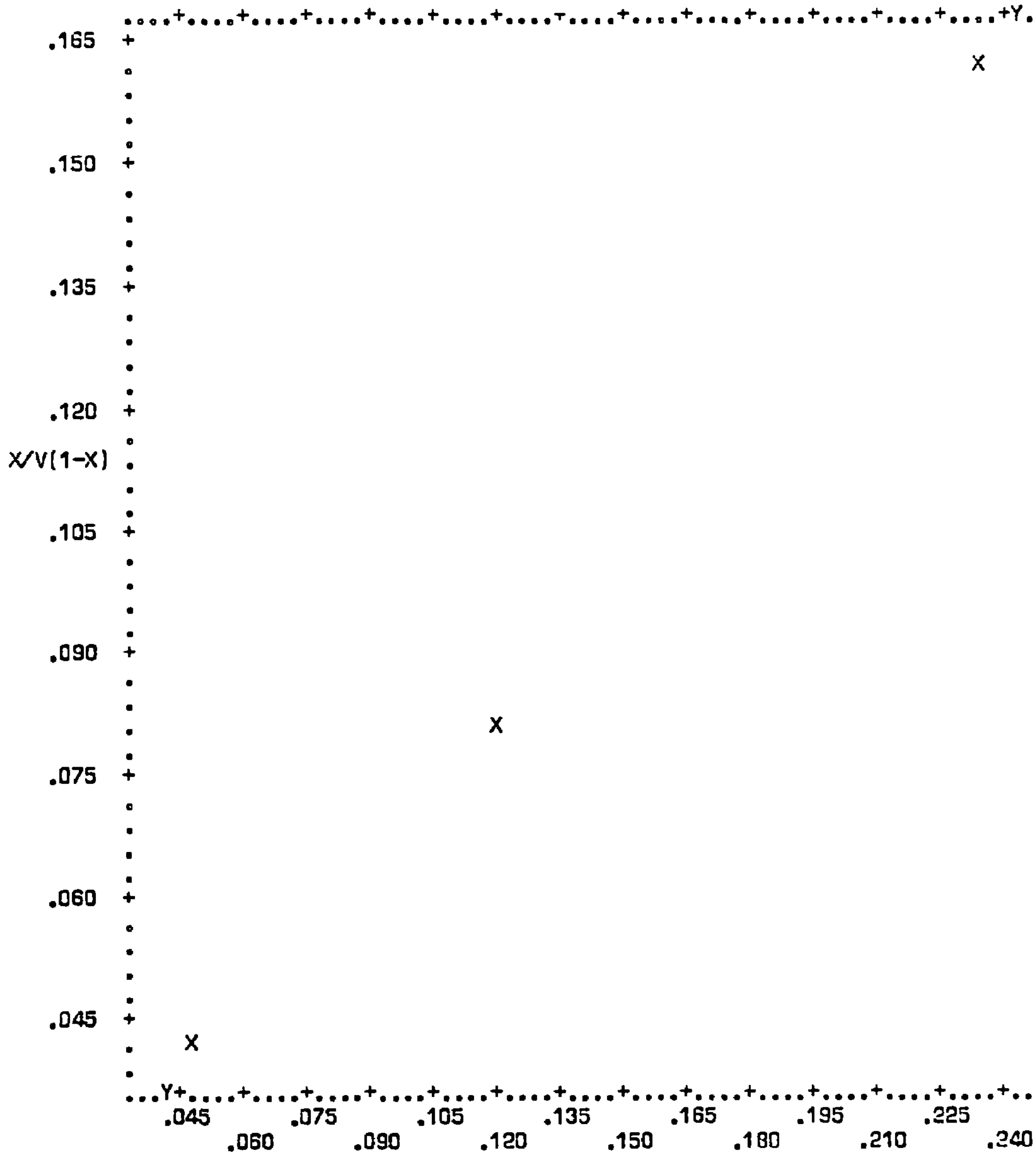
N= 3
COR= .9996 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 1.8810*Y-.03885	151E-7
Y	.09159	.04959	Y= .53118*X+ .02071	425E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-85. Plot of BET equation versus relative pressure for Converter A249/0169-3-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A249/0169-3-A SAMPLE S



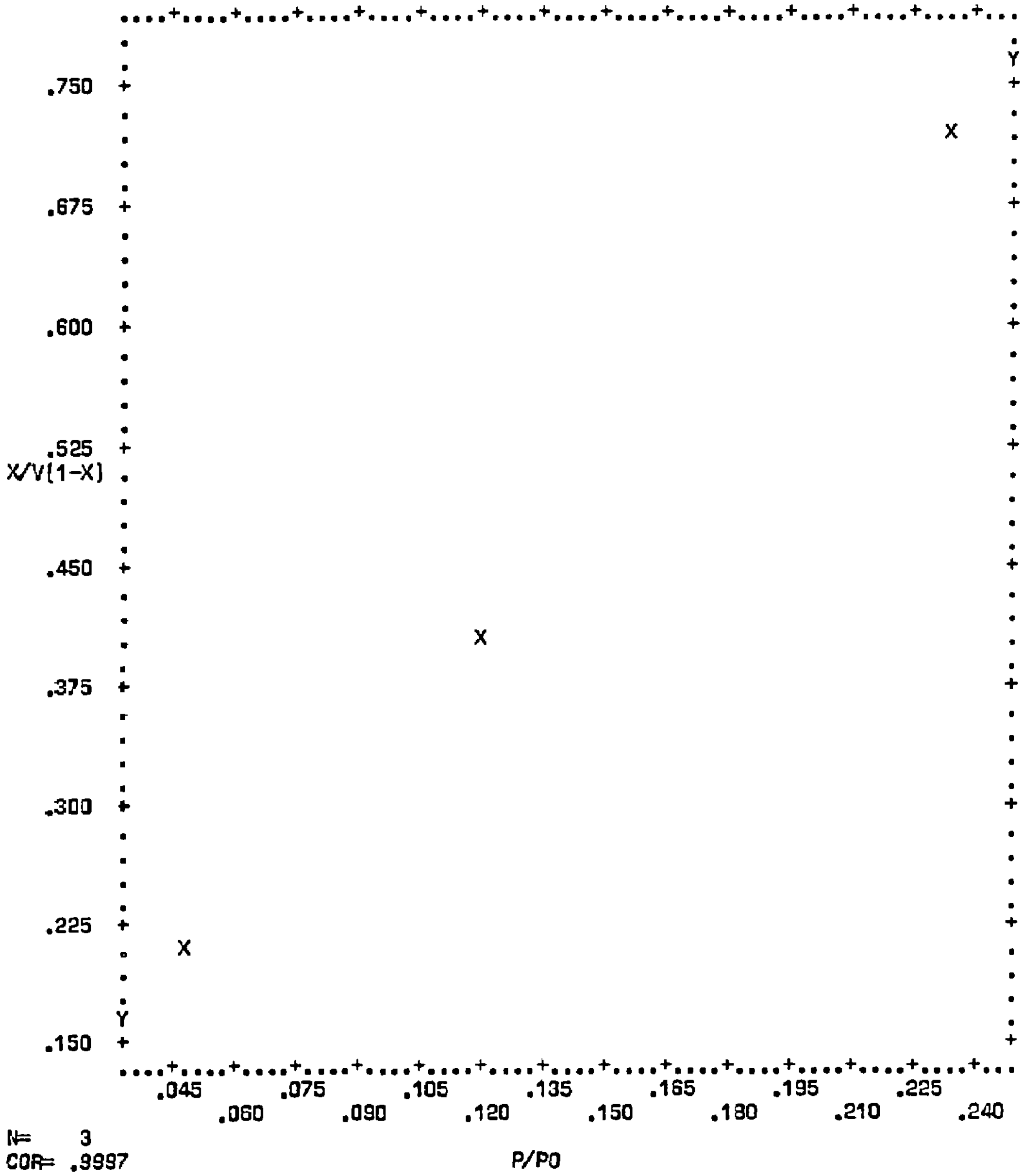
N= 3
COR= .9981

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.5271*Y-.01353	652E-7
Y	.09623	.06099	Y= .65237*X+ .00919	278E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-86. Plot of BET equation versus relative pressure for Converter A249/0169-3-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A249/0119-3-B SAMPLE F



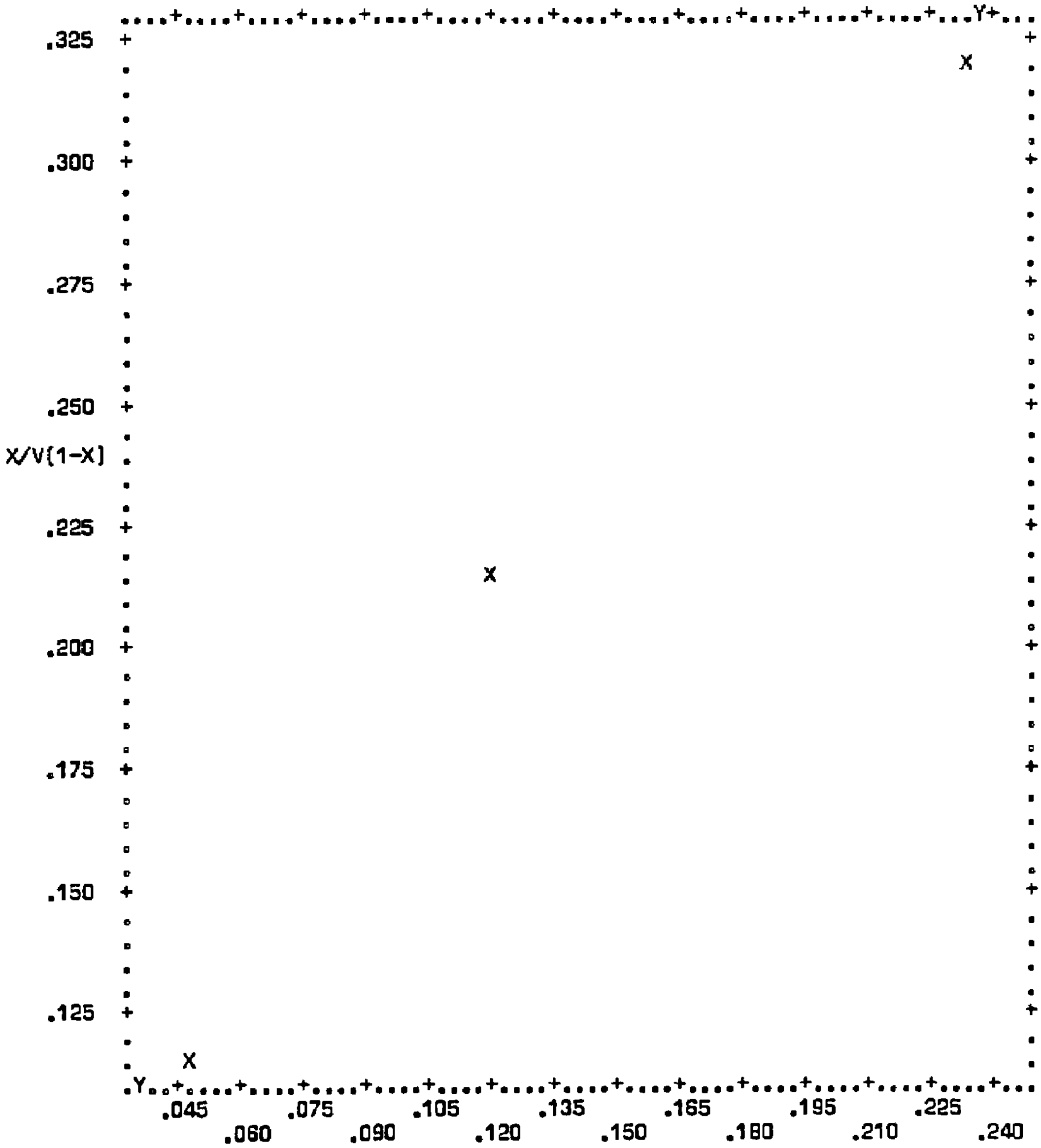
N= 3
COR= .9997

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09333	X= .36154*Y-.02791	103E-7
Y	.44630	.25806	Y= 2.7643*X+ .07743	788E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-87. Plot of BET equation versus relative pressure for Converter A249/0169-3-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A249/0169-3-B SAMPLE E



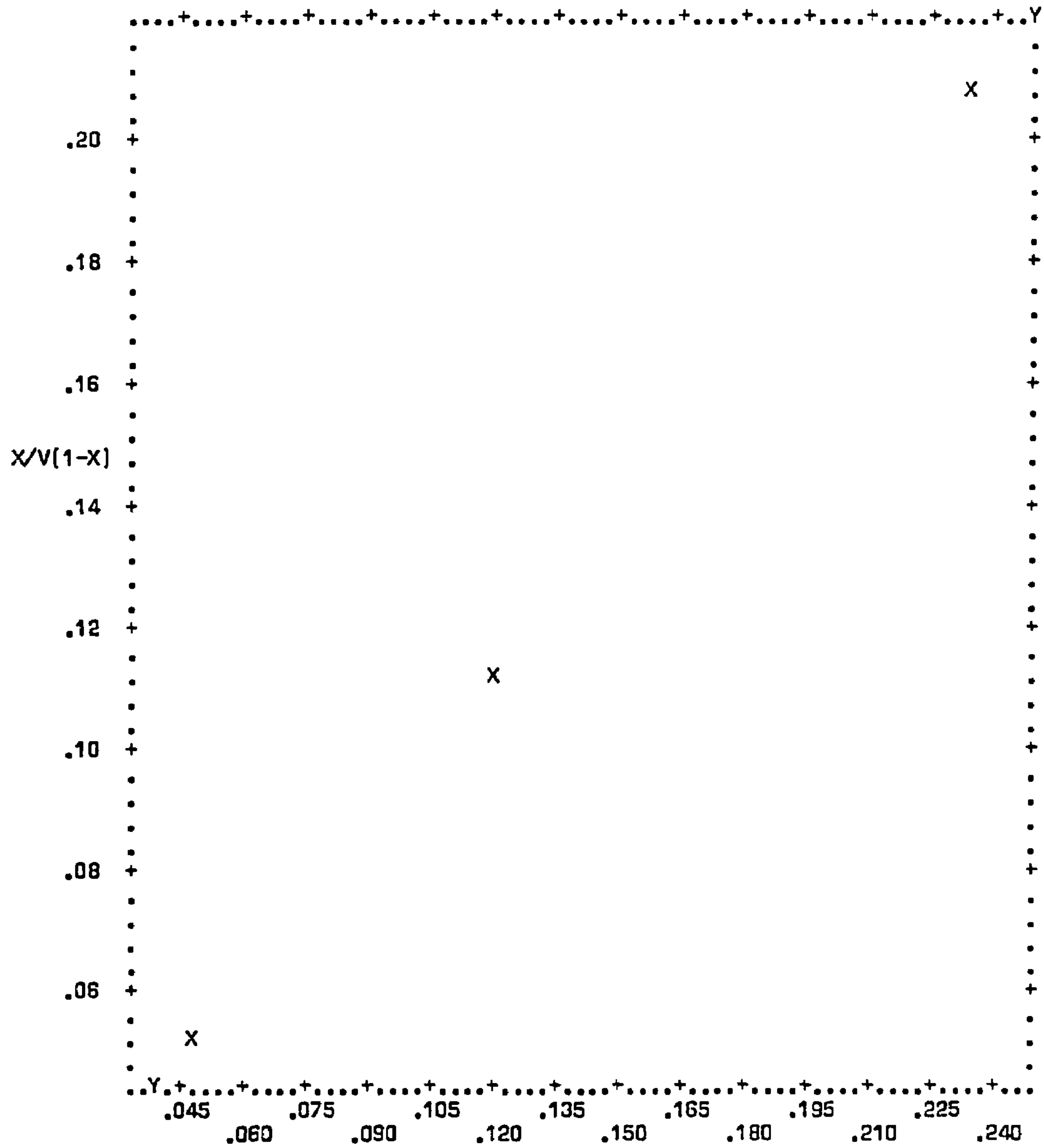
N= 3
COR= .9916

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09332	X= .90445*Y-.06203	292E-6
Y	.21612	.10231	Y= 1.0871*X+ .07105	351E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-88. Plot of BET equation versus relative pressure for Converter A249/0169-3-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A280/0001L-A SAMPLE F



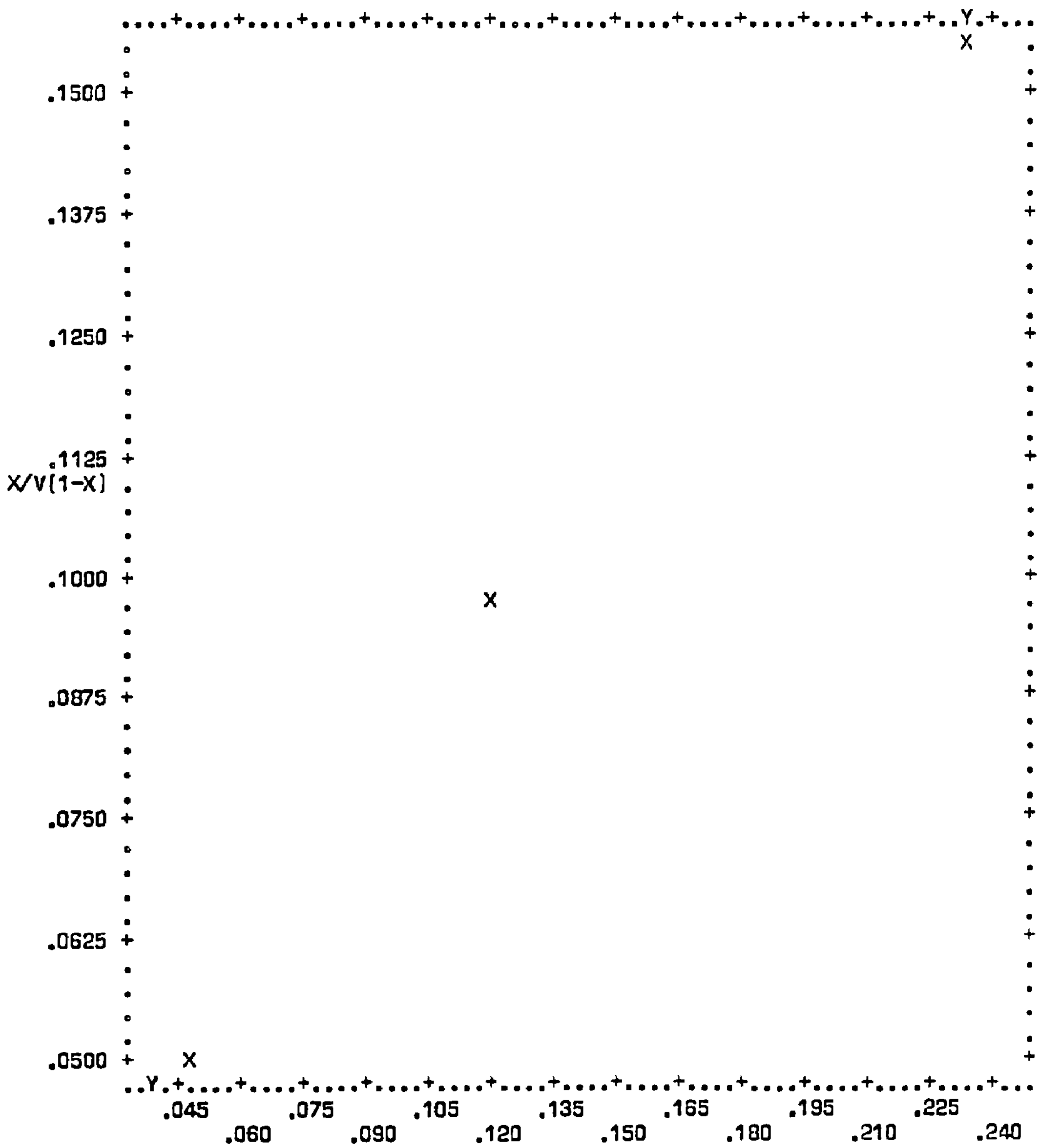
N= 3
COR= 1.000 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.1962*Y-.01348	444E-9
Y	.12282	.07801	Y= .83599*X+ .01127	310E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-89. Plot of BET equation versus relative pressure for Converter A280/0001L-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A280/001L-A SAMPLE E



N= 3
COR= .9958

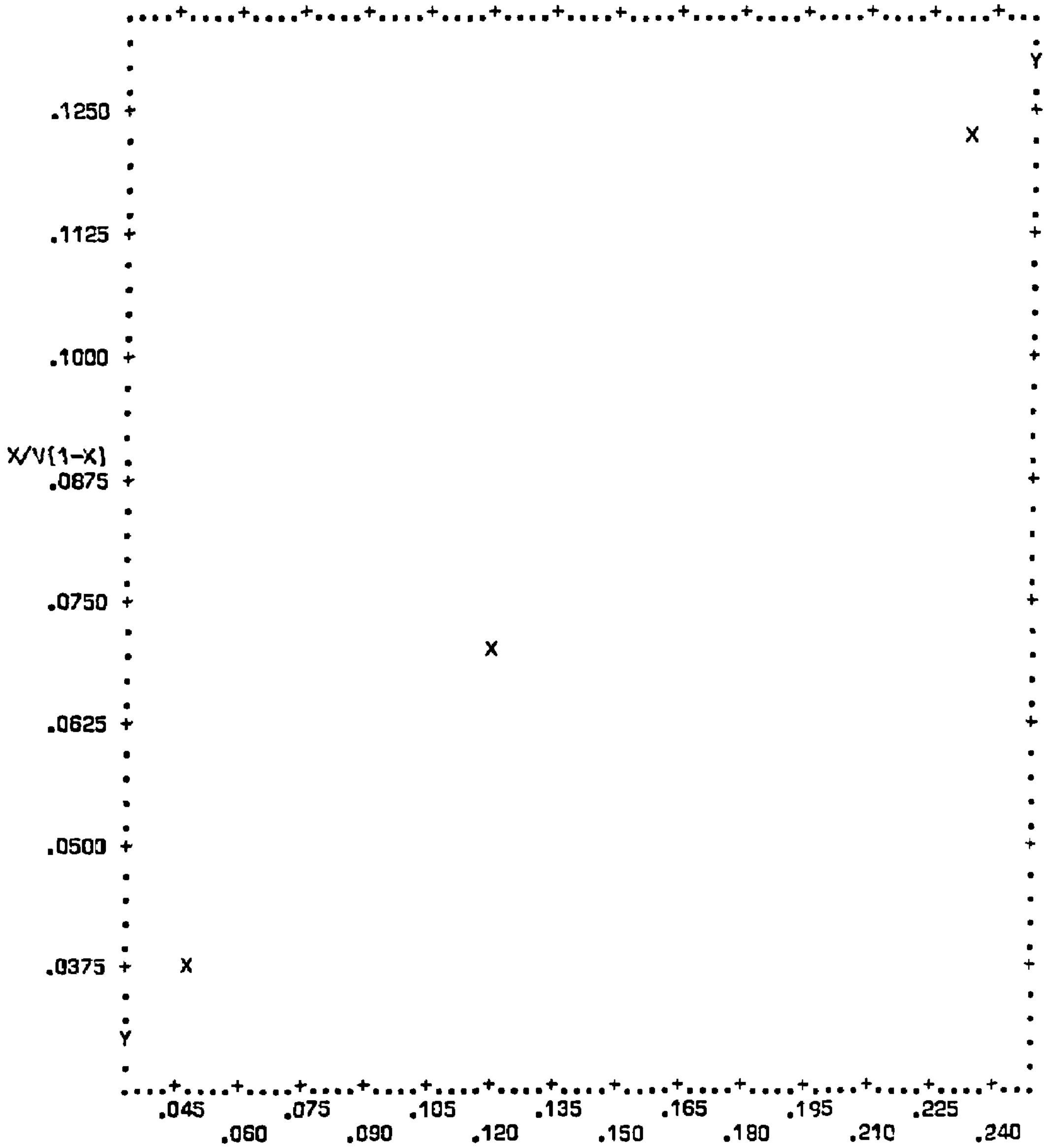
P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.7807*Y-.04626	146E-6
Y	.10091	.05219	Y= .55698*X+ .02661	457E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-90. Plot of BET equation versus relative pressure for Converter A280/0001L-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A280/0001L-A SAMPLE G



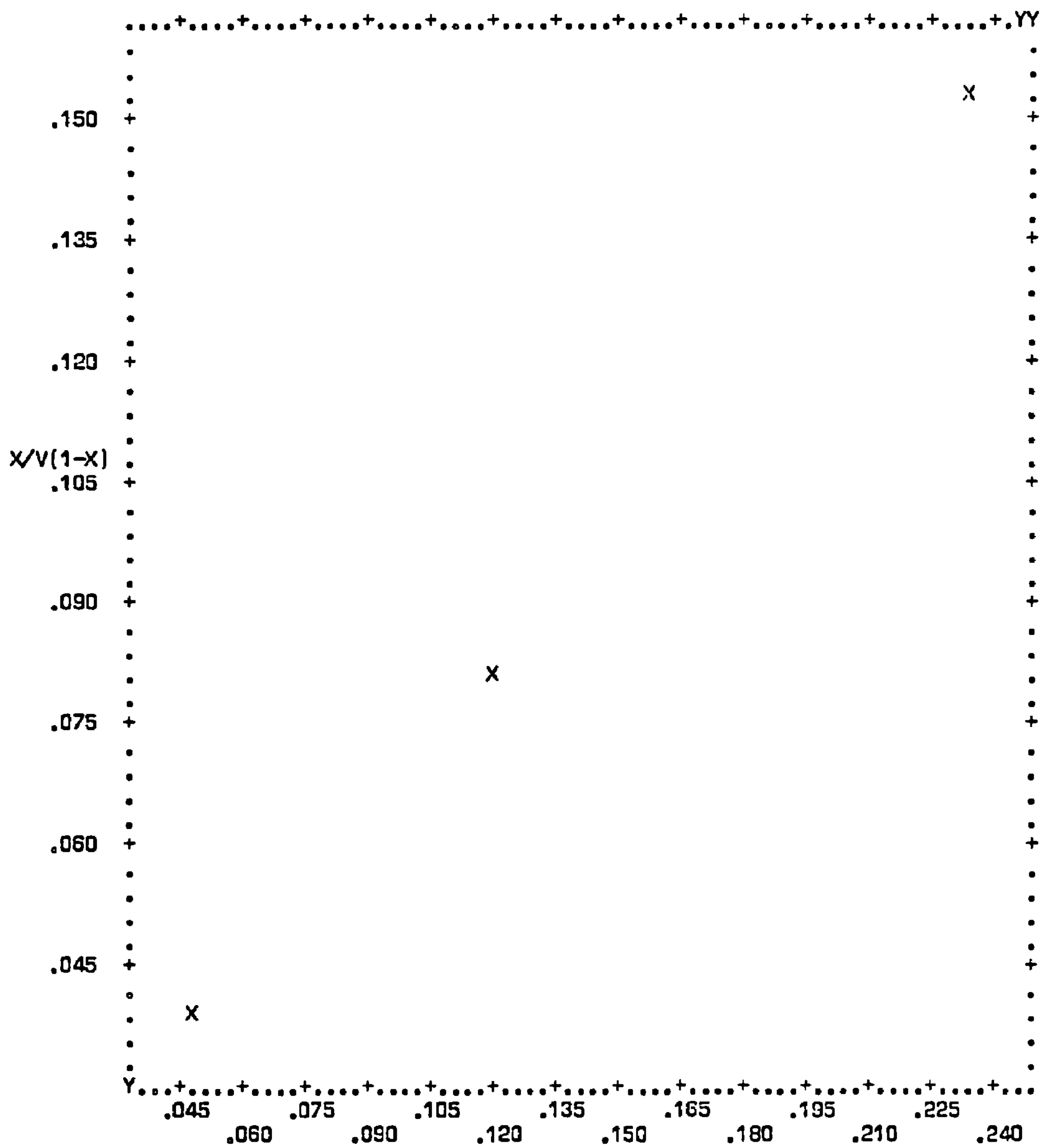
N= 3
COR= .9999

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 2.1873*Y-.03475	434E-8
Y	.07689	.04266	Y= .45708*X+ .01590	907E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-91. Plot of BET equation versus relative pressure for Converter A280/0001L-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A280/001L-B SAMPLE F



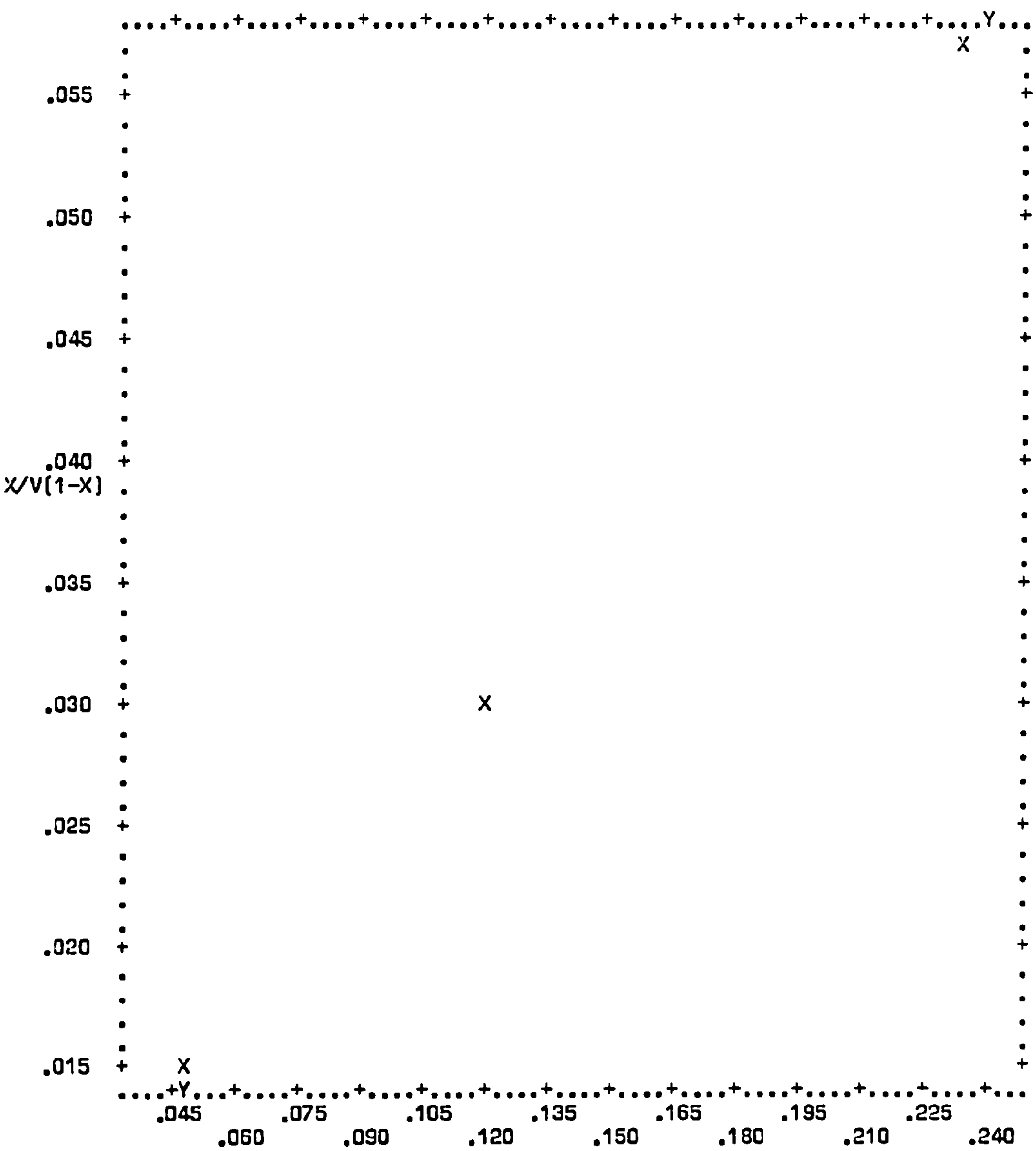
N= 3
COR= .9998

P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.6227*Y-.01566	659E-8
Y	.08188	.05750	Y= .61602*X+ .00968	250E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-92. Plot of BET equation versus relative pressure for Converter A280/0001L-B - Bulk



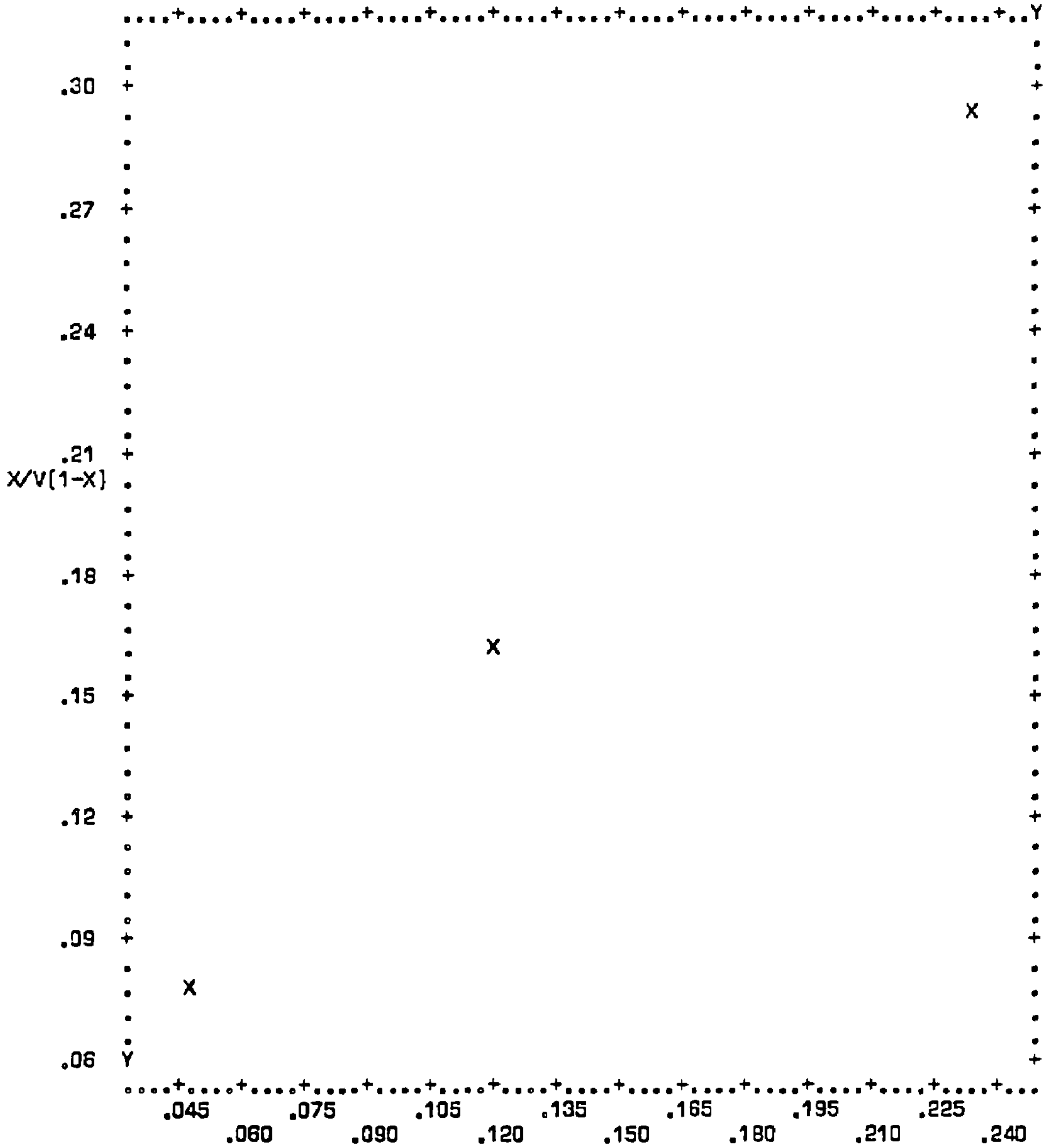
N= 3
COR= .9999 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09332	X= 4.3901*Y-.01449	494E-8
Y	.03370	.02125	Y= .22772*X+ .00331	256E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-93. Plot of BET equation versus relative pressure for Converter A280/0001L-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A155/0941-1-A SAMPLE F



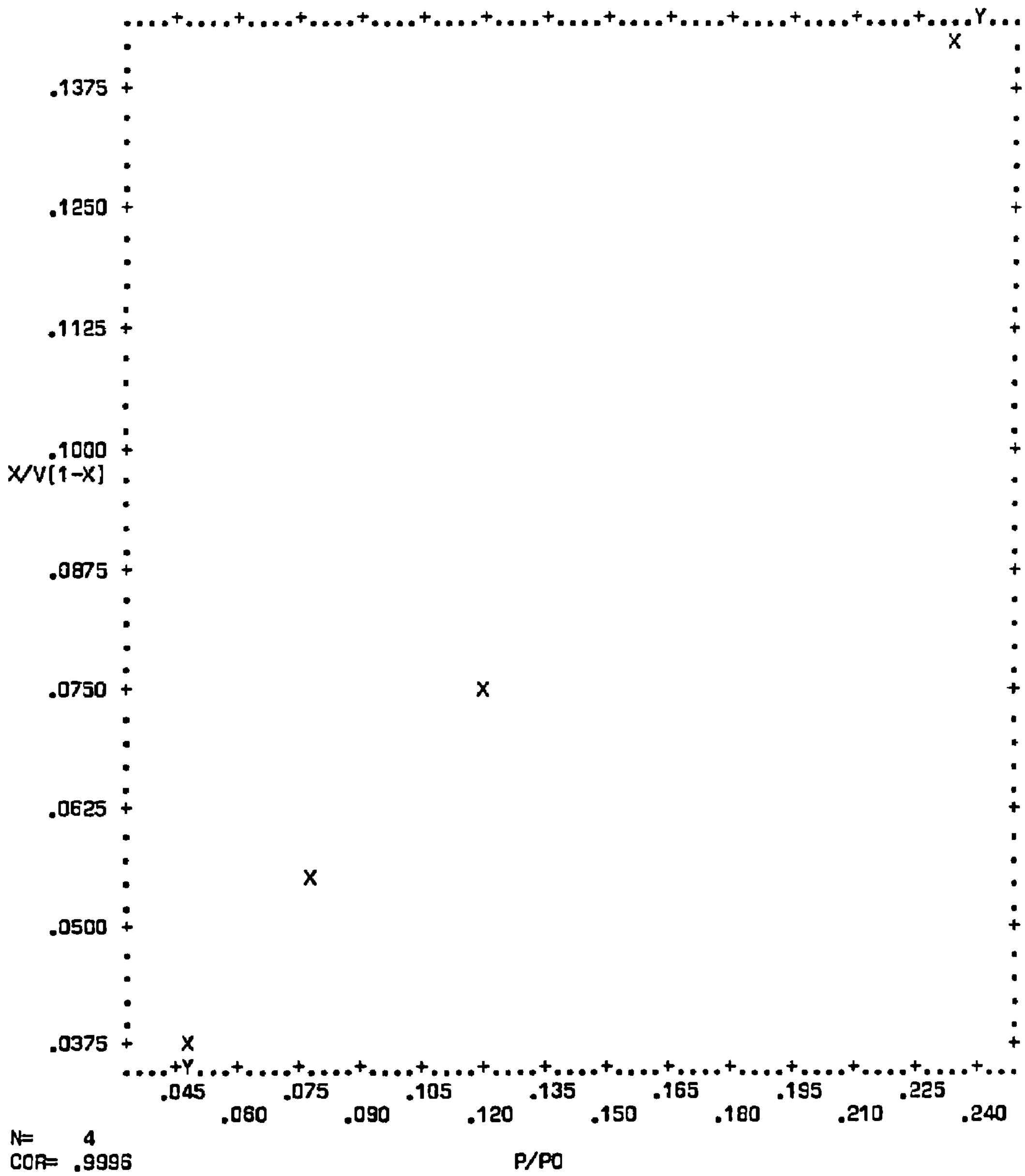
N= 3
COR= 1.000 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= .84540*Y-.01769	116E-9
Y	.17875	.11038	Y= 1.1829*X+ .02093	163E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-94. Plot of BET equation versus relative pressure for Converter A155/0941-1-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A155/0941-1-A SAMPLE E



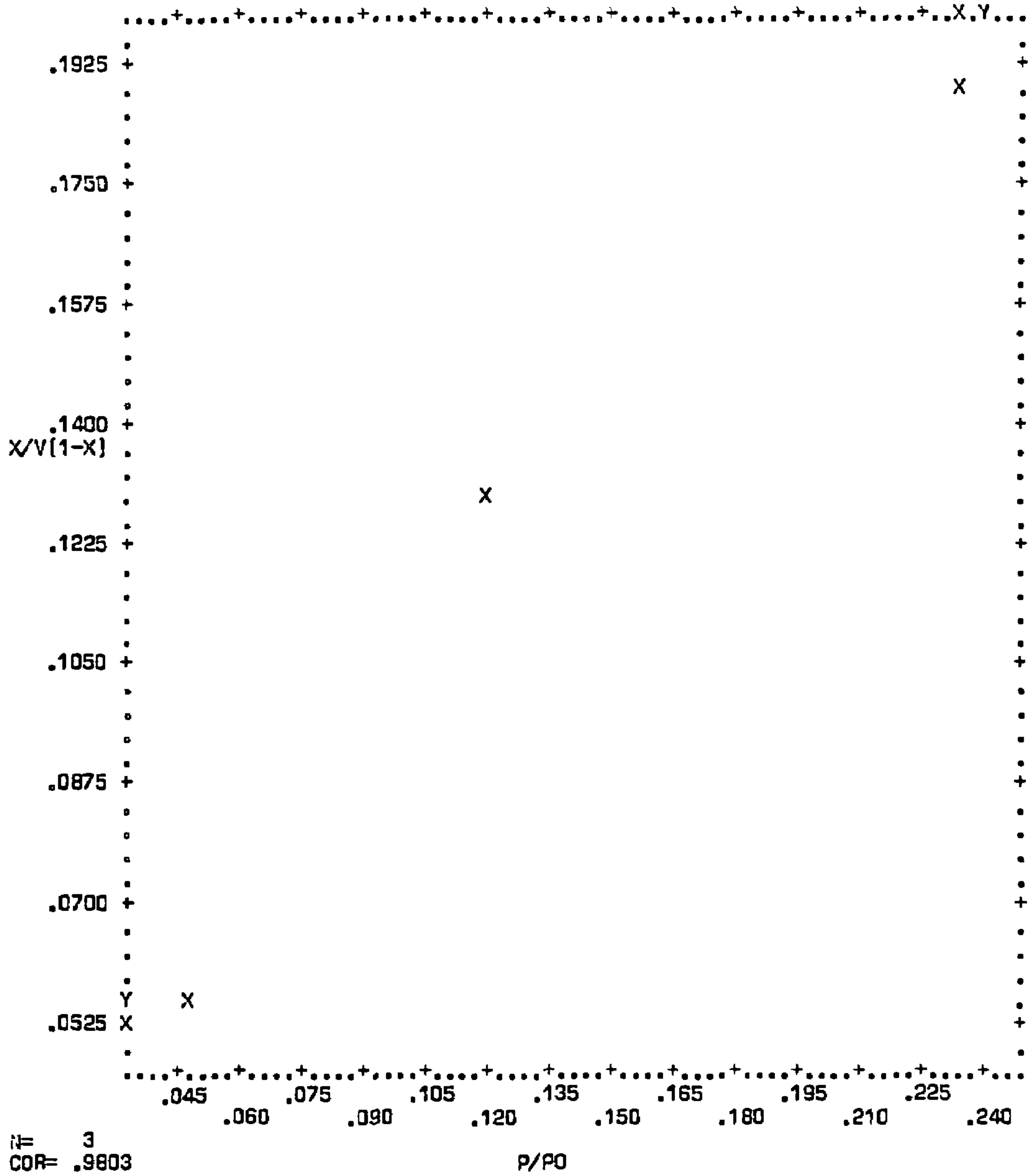
N= 4
COR= .9996

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 1.7650*Y-.01515	736E-8
Y	.07653	.04579	Y= .56614*X+ .00864	236E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-95. Plot of BET equation versus relative pressure for Converter A155/0941-1-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A155/0941-1-A SAMPLE G



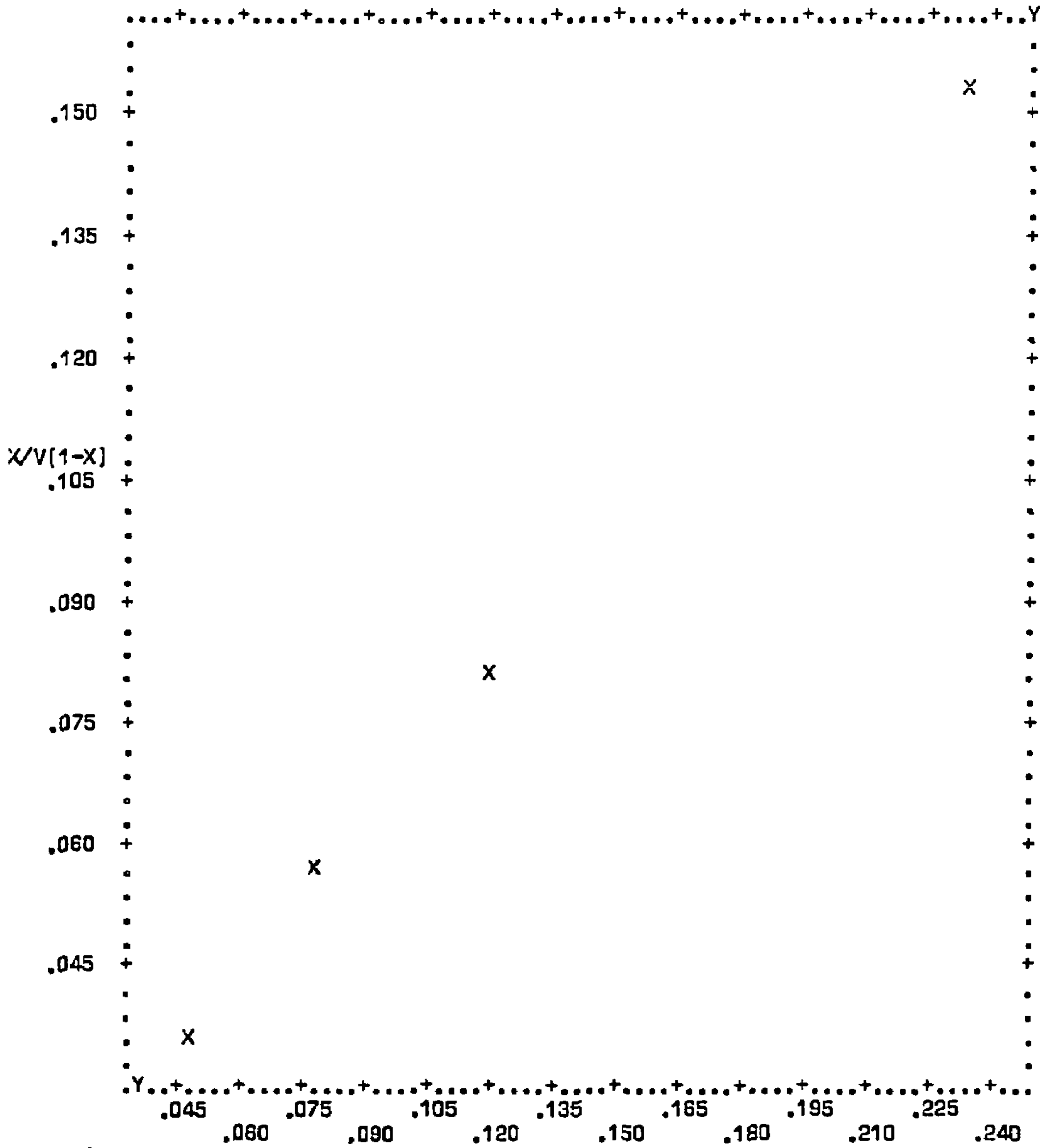
N= 3
COR= .9803

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 1.3813*Y-.04055	681E-6
Y	.12596	.06622	Y= .69567*X+ .03314	343E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-96. Plot of BET equation versus relative pressure for Converter A155/0941-1-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A230/0636X-8 SAMPLE F

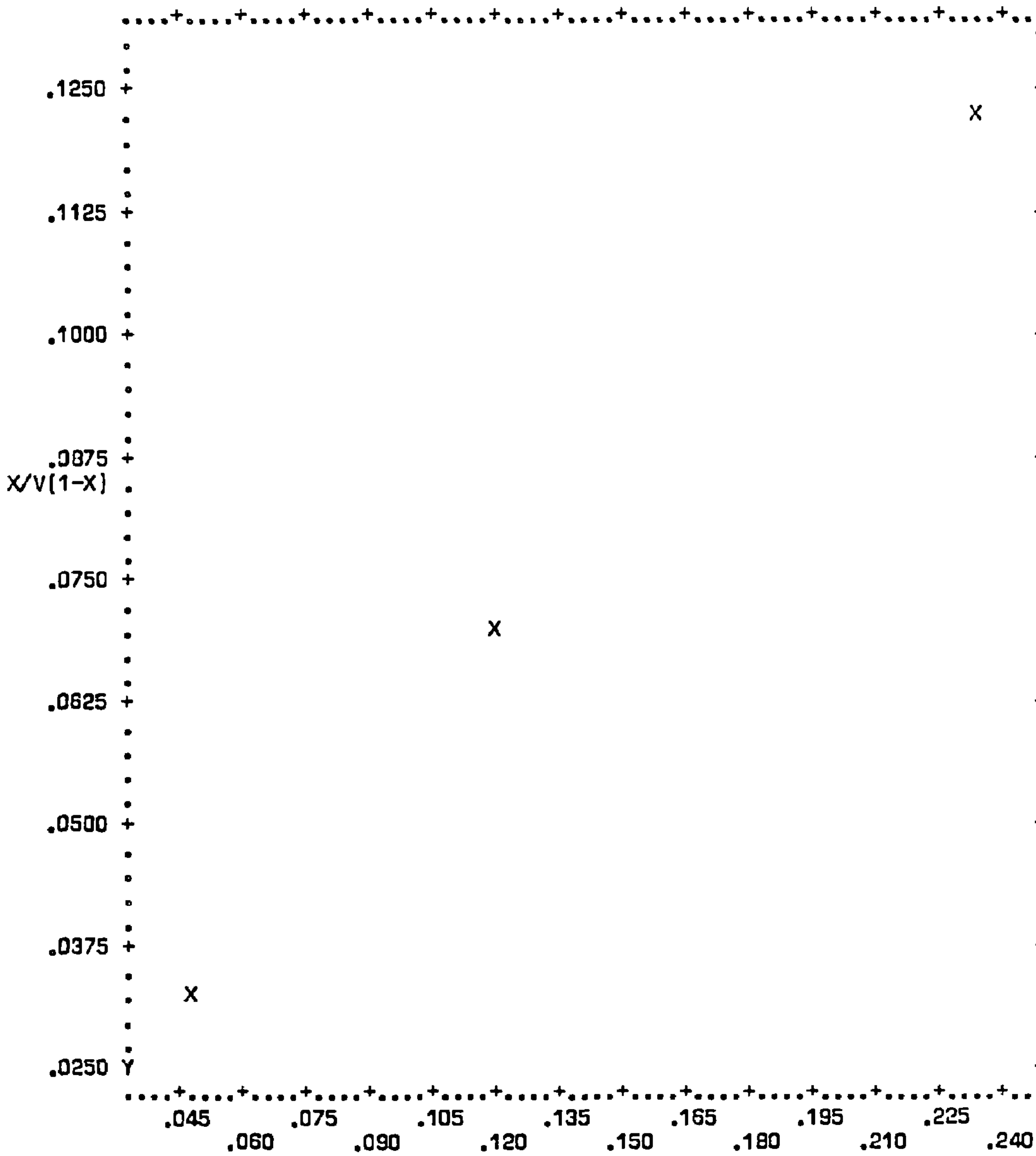


N= 4
COR= .9997 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 1.6064*Y-.01156	497E-8
Y	.08185	.05031	Y= .62219*X+ .00724	193E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-97. Plot of BET equation versus relative pressure for Converter A155/0941-1-B - Bulk



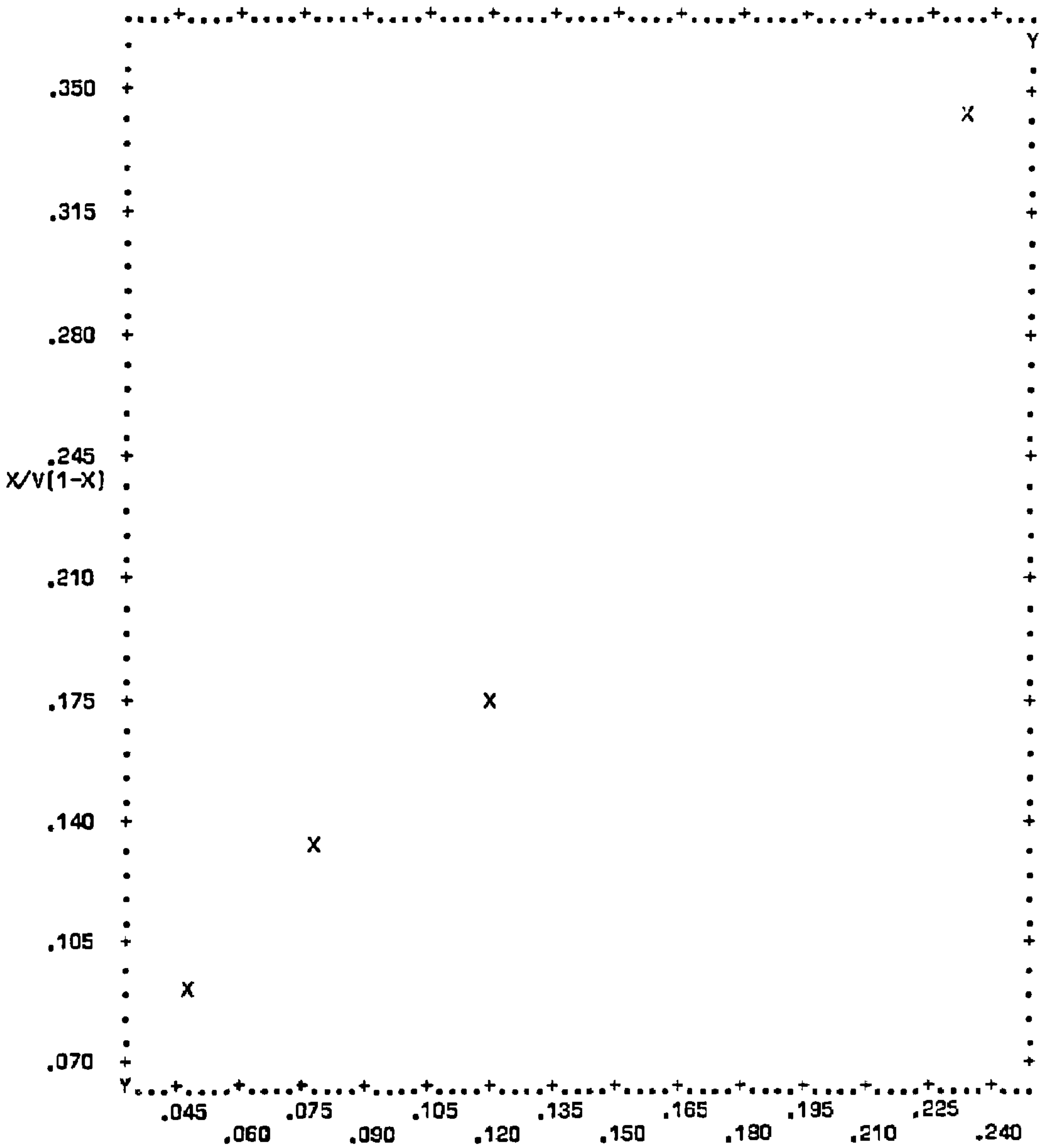
N= 3
COR= .9985

P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13342	.09331	X= 2.0612*Y-.02057	524E-7
Y	.07471	.04520	Y= .48370*X+ .01017	123E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-98. Plot of BET equation versus relative pressure for Converter A155/0941-1-B - Front Face



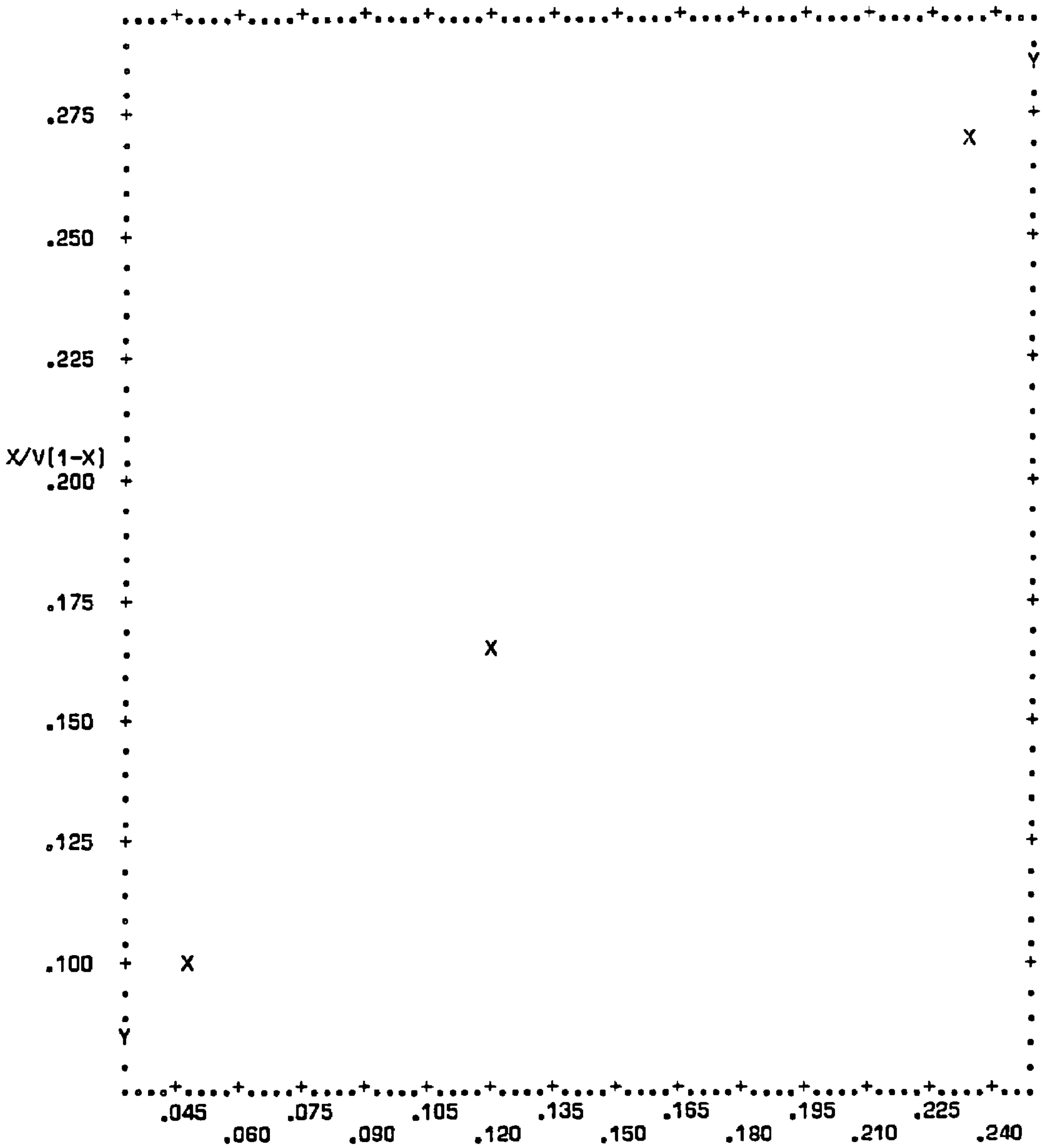
N= 4
COR= .9991 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= .72320*Y-.01324	181E-7
Y	.18413	.11168	Y= 1.3802*X+ .01862	345E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-99. Plot of BET equation versus relative pressure for Converter A155/0941-2-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A155/0941-2-A SAMPLE E



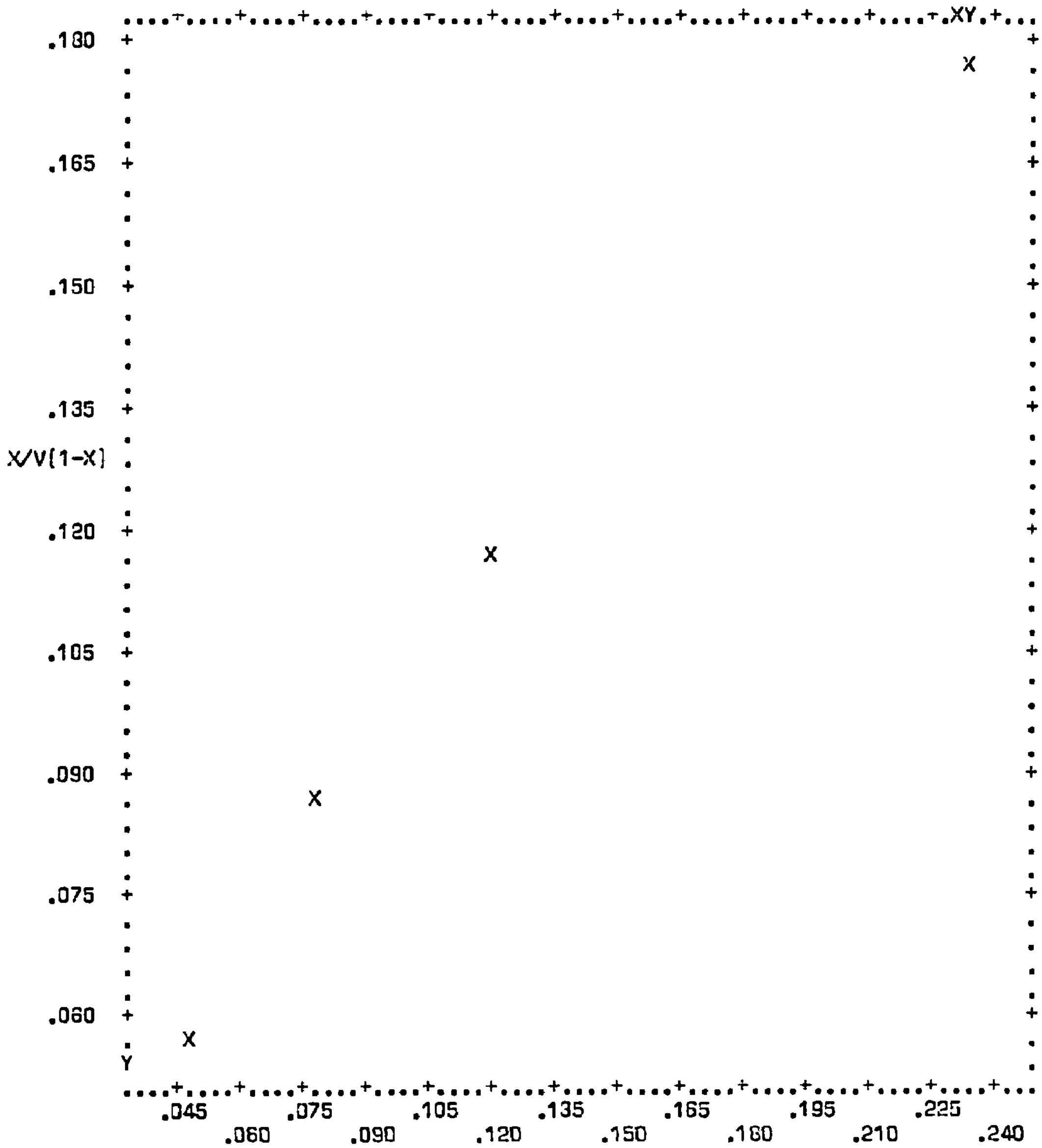
N= 3
COR= 1.000 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 1.0755*Y-.05863	62E-10
Y	.17858	.08676	Y= .92981*X+ .05452	53E-10

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-100. Plot of BET equation versus relative pressure for Converter A155/0941-2-A - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A155/0941-2-A SAMPLE G



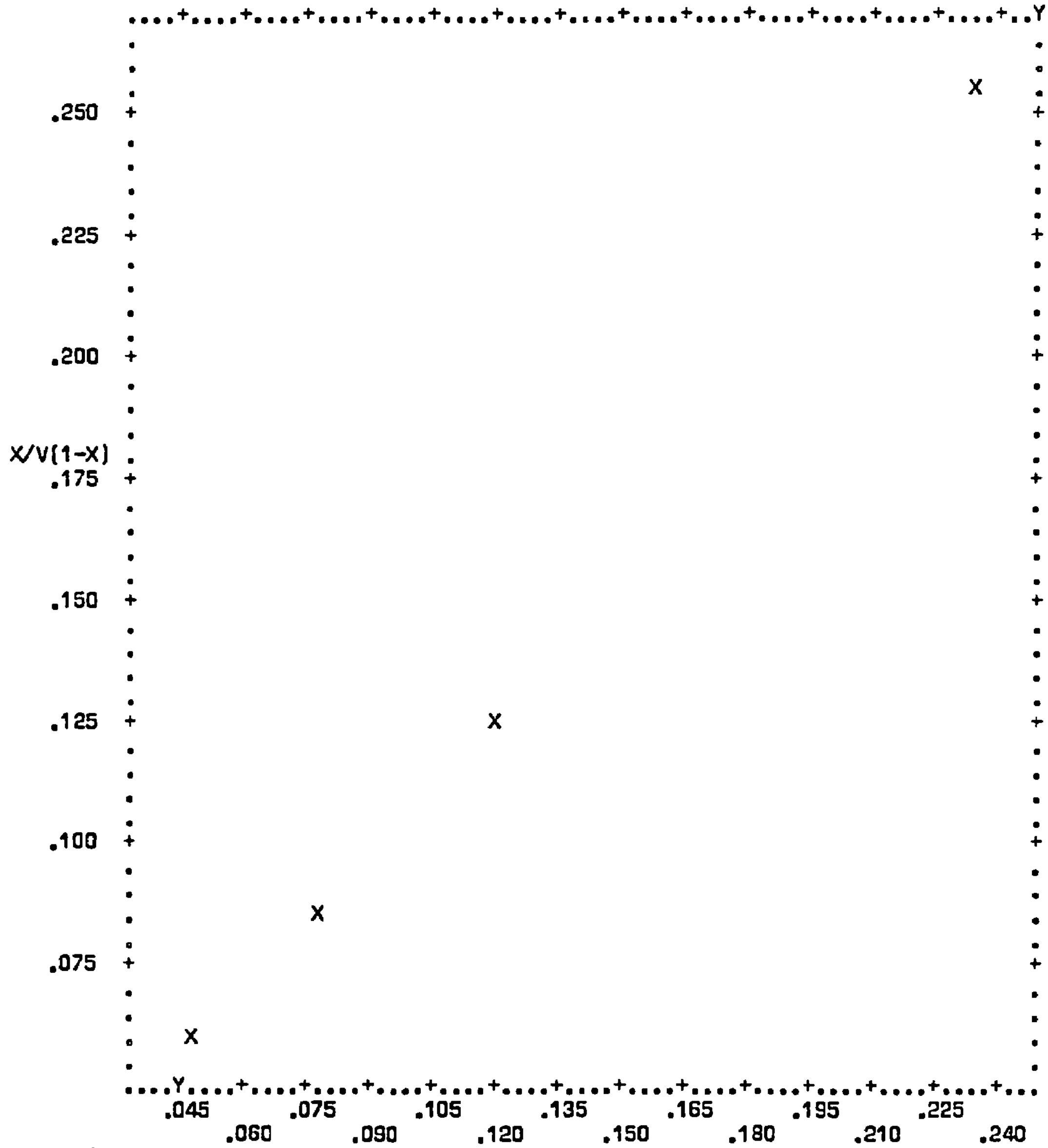
N= 4
COR= .9890 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= 1.5330*Y-.04866	215E-6
Y	.10997	.05215	Y= .63602*X+ .03346	895E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-101. Plot of BET equation versus relative pressure for Converter A155/0941-2-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A155/0941-2-B SAMPLE F



N= 4
COR= .9989

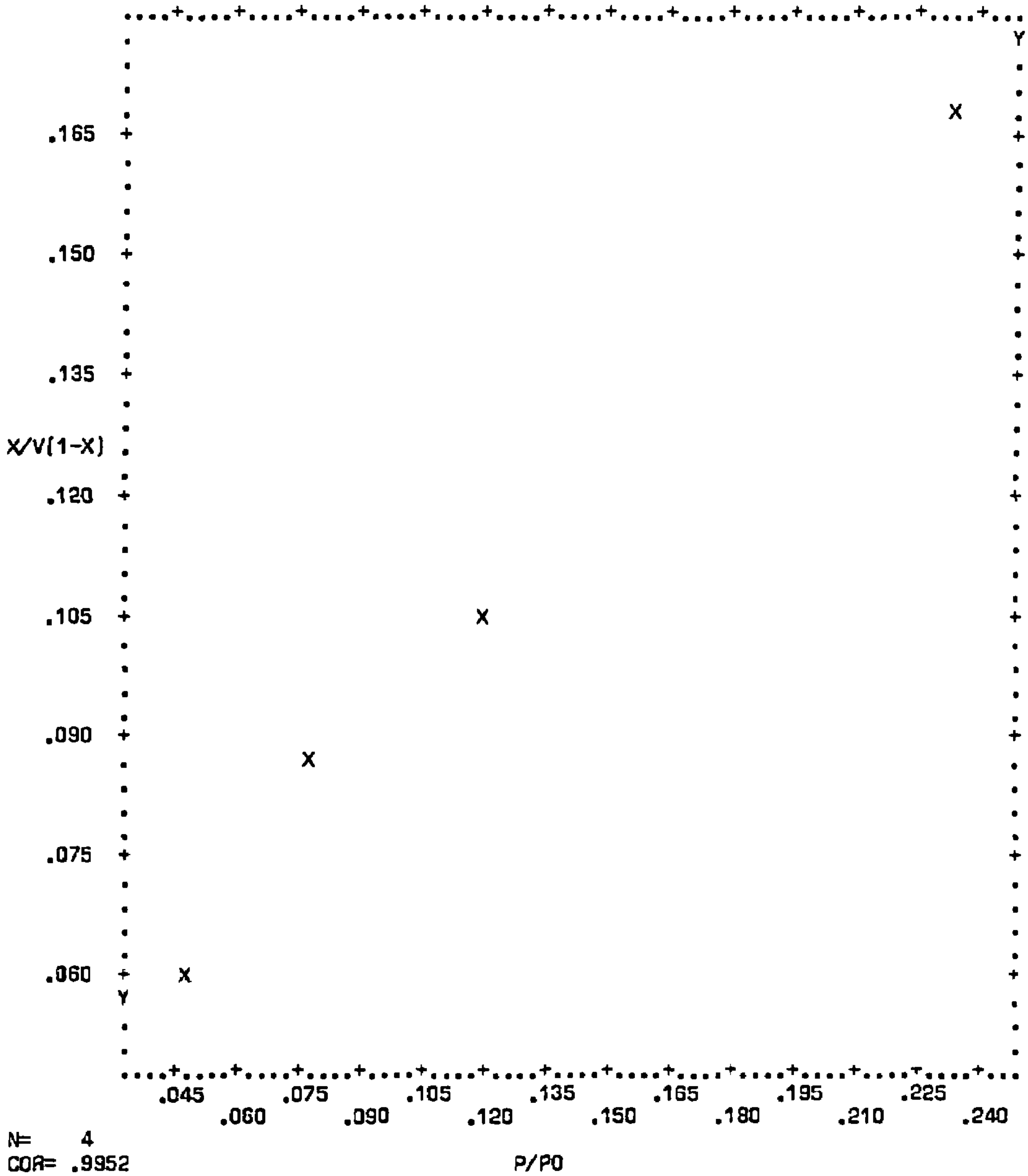
P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11991	.08083	X= .93768*Y-.00287	214E-7
Y	.13095	.08611	Y= 1.0641*X+ .00334	242E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-102. Plot of BET equation versus relative pressure for Converter A155/0941-2-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A155/0941-2-B SAMPLE E



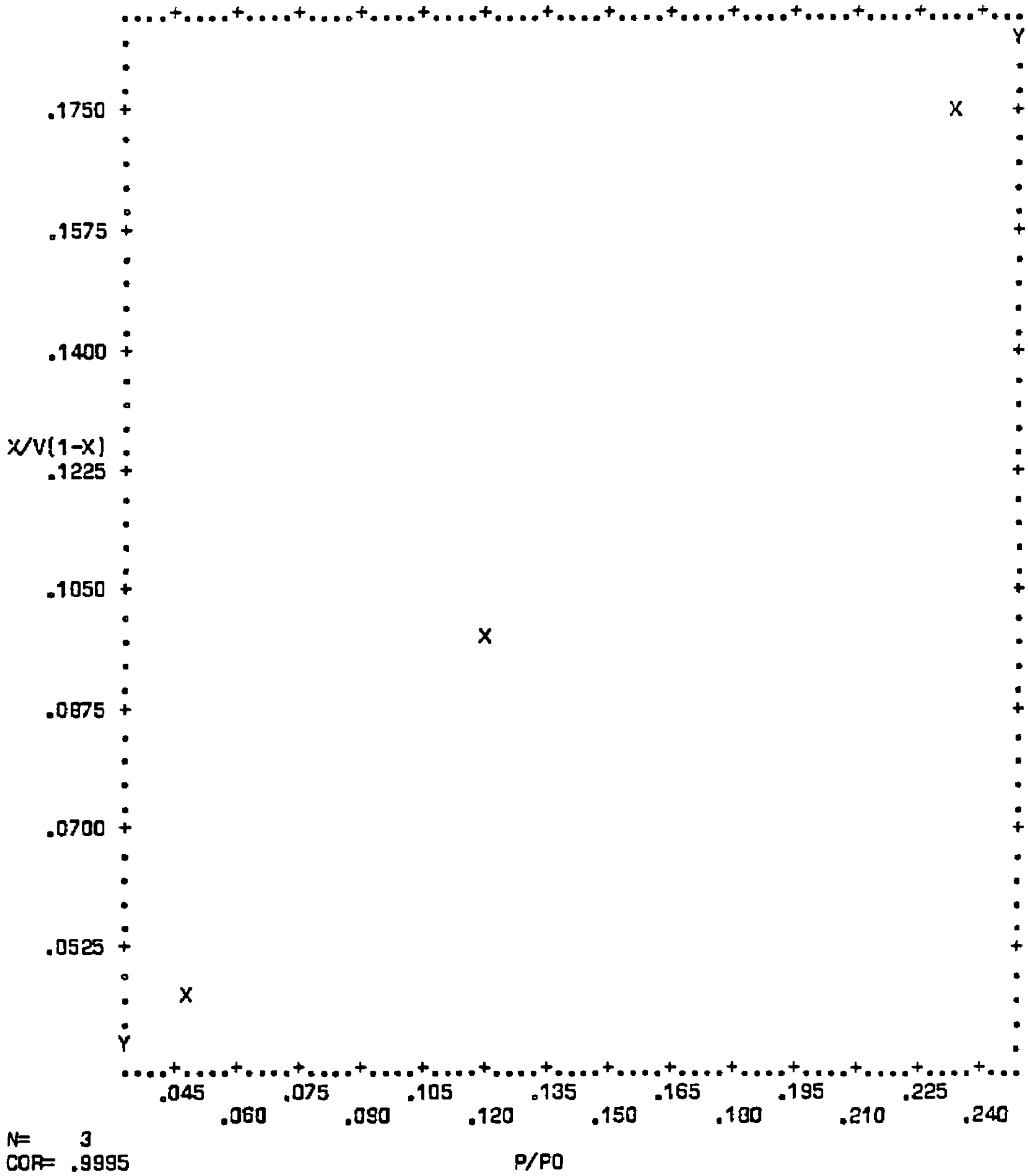
N= 4
COR= .9952

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11993	.08085	X= 1.7720*Y-.06606	931E-7
Y	.10496	.04541	Y= .55896*X+ .03792	294E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-103. Plot of BET equation versus relative pressure for Converter A155/0941-2-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A207/0101-A SAMPLE F



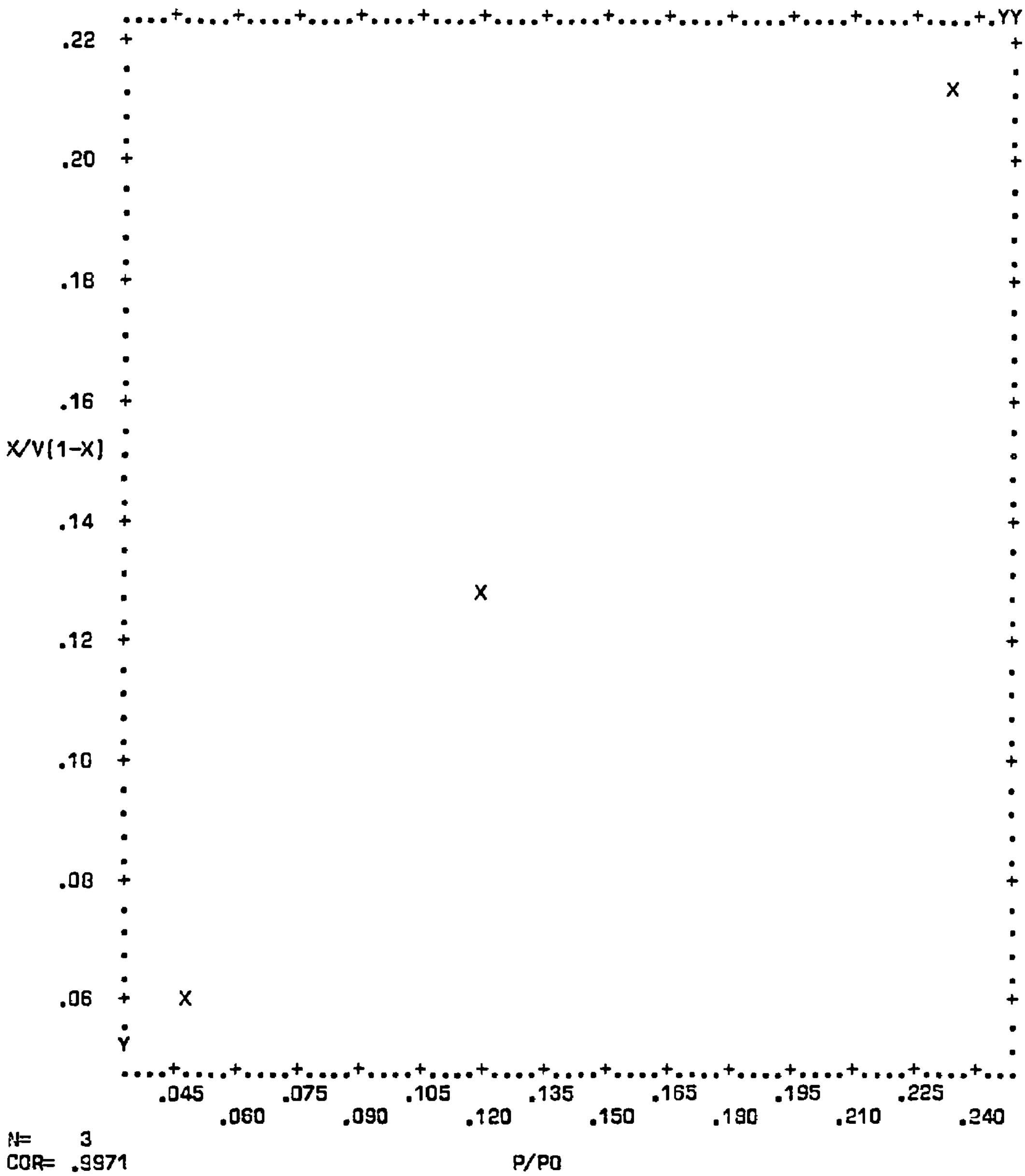
N= 3
COR= .9995

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.4538*Y-.02150	169E-7
Y	.10657	.06416	Y= .63717*X+ .01488	799E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-104. Plot of BET equation versus relative pressure for Converter A207/0101-A - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A207/0101-A SAMPLE E

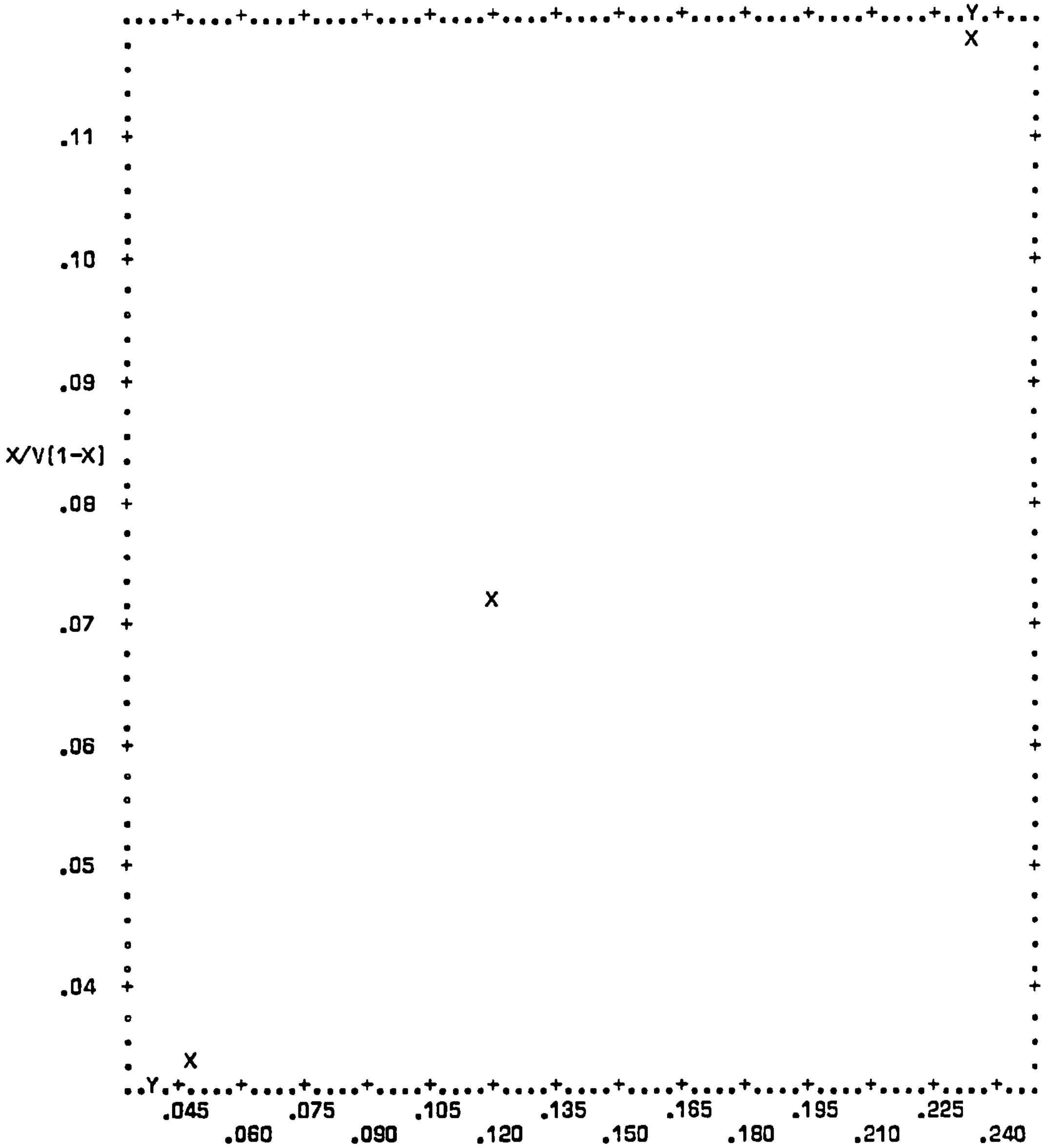


N= 3
COR= .9971

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 1.2313*Y-.02941	101E-6
Y	.13225	.07557	Y= .80744*X+ .02451	665E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-105. Plot of BET equation versus relative pressure for Converter A207/0101-A - Front Face



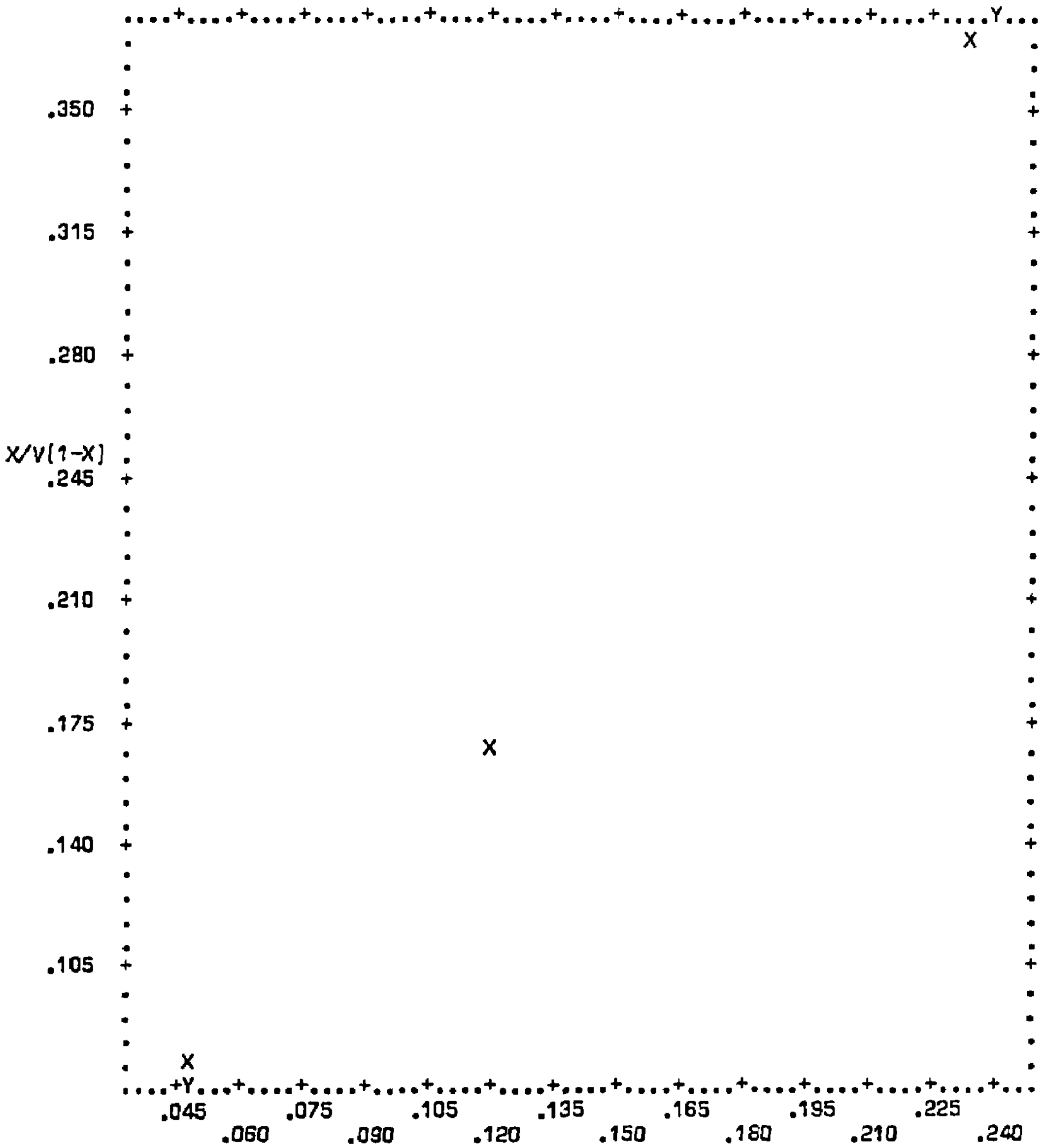
N= 3
COR= .9970 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 2.2249*Y-.03290	104E-6
Y	.07471	.04182	Y= .44677*X+ .01510	209E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-106. Plot of BET equation versus relative pressure for Converter A207/0101-A - Rear Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A207/0101-B SAMPLE F



N= 3

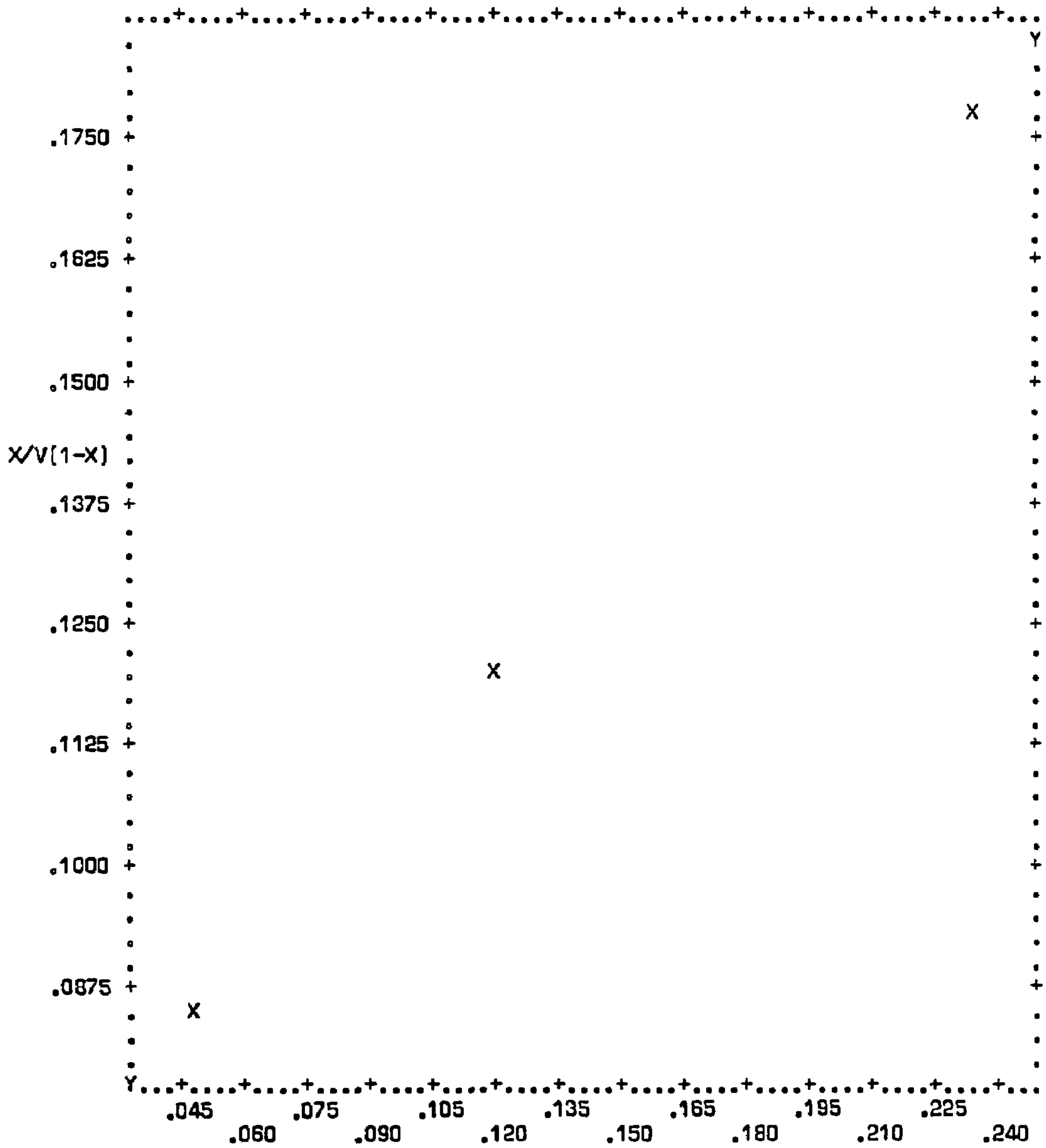
COR= .9969 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= .61963*Y+ .00475	106E-6
Y	.20767	.15014	Y= 1.6040*X-.00636	275E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-107. Plot of BET equation versus relative pressure for Converter A207/0101-B - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A207/0101-B SAMPLE E



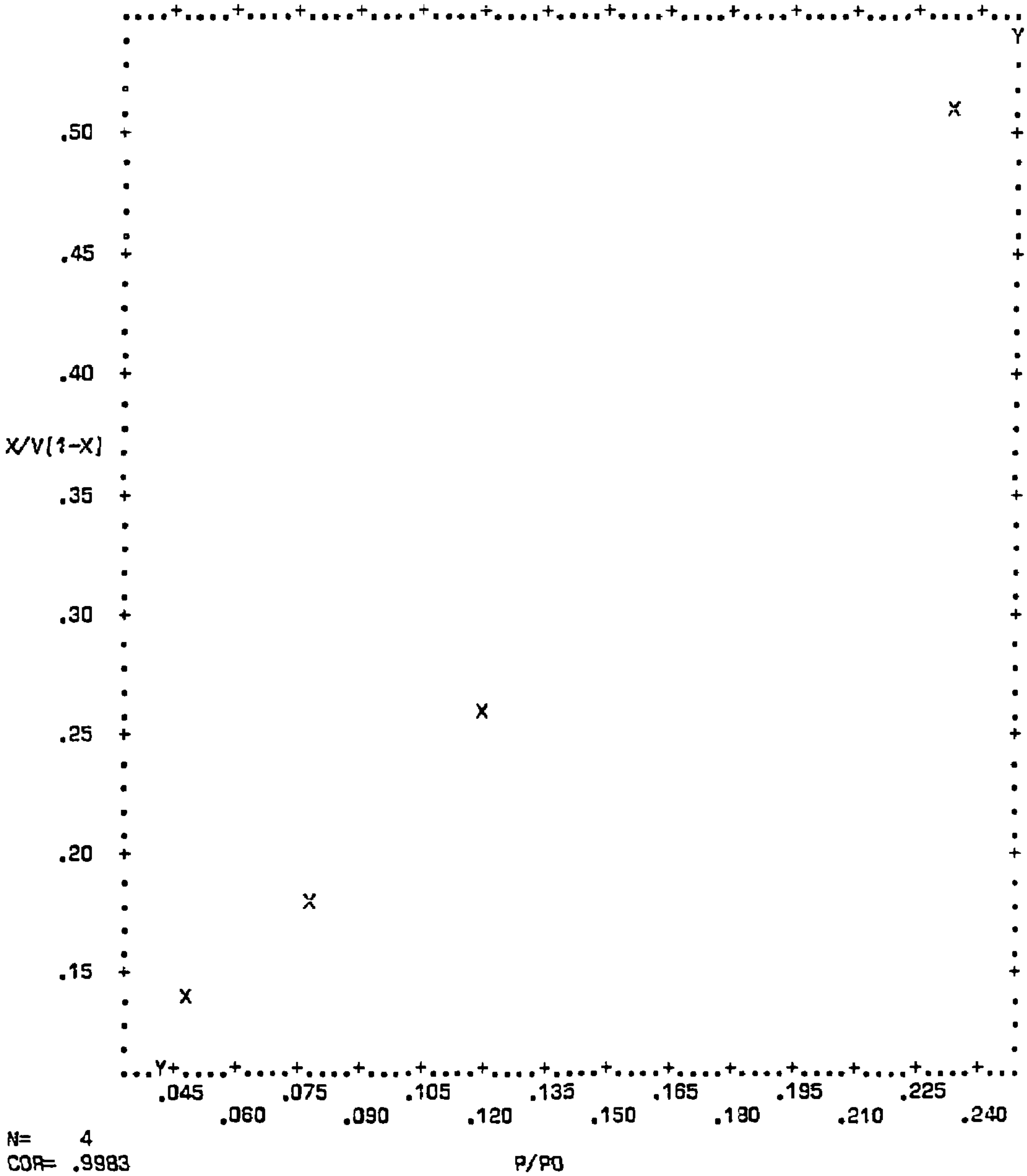
N= 3
COR= 1.000 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 2.0053*Y-.12264	54E-9
Y	.12770	.04654	Y= .49369*X+ .06116	13E-9

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-108. Plot of BET equation versus relative pressure for Converter A207/0101-B - Front Face

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A207/0101-C SAMPLE F



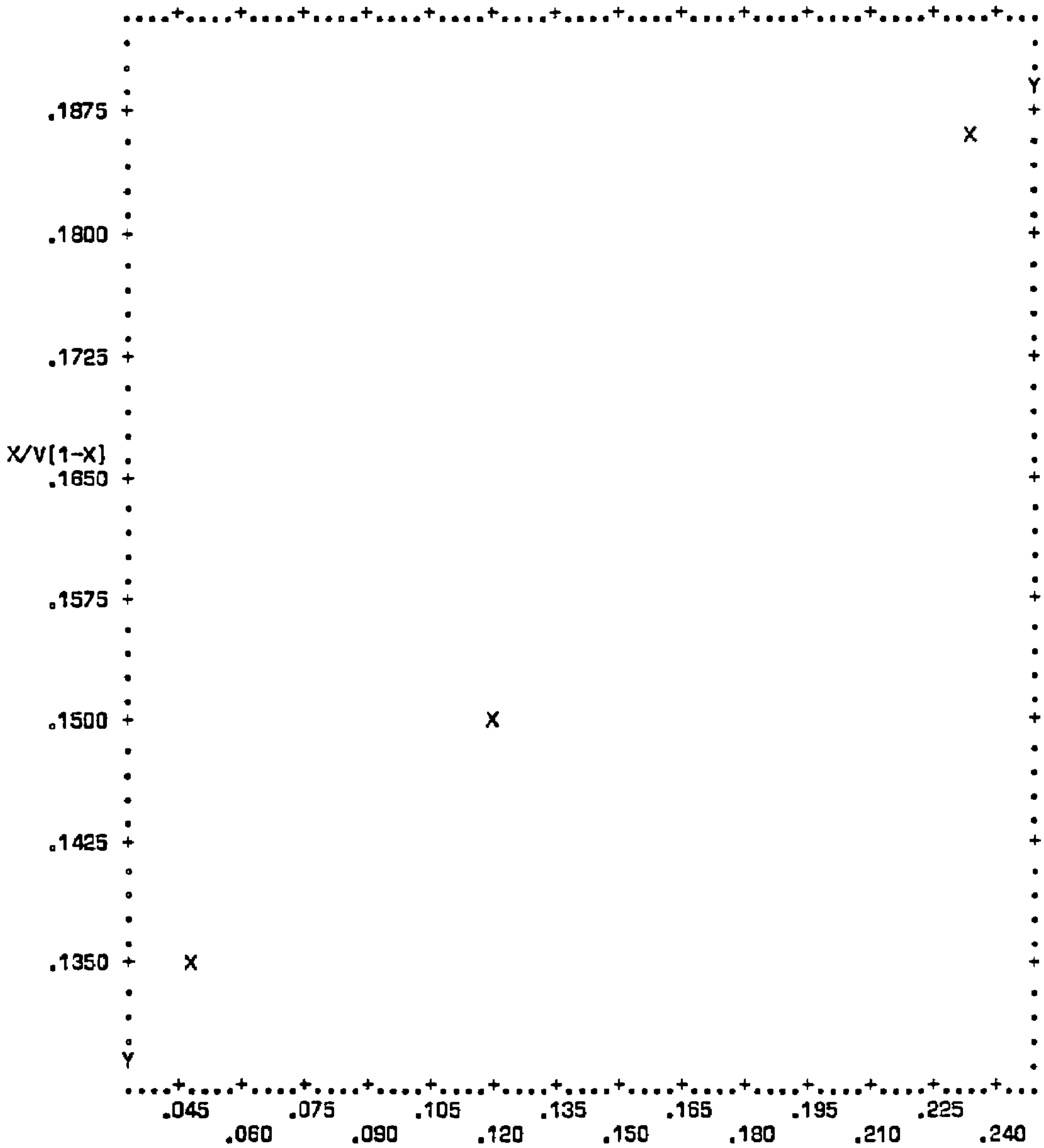

```
N=    4
COR= .9983

     MEAN    ST.DEV.    REGRESSION LINE       RES.MS.
X   .11992   .08084   X= .48443*Y-.01239      337E-7
Y   .27313   .16660   Y= 2.0572*X+ .02643     143E-6

VARIABLE    1  P/PO     VERSUS VARIABLE  2  X/V       SYMBOL=X
```

Figure C-109. Plot of BET equation versus relative pressure for Converter A207/0101-C - Bulk

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A207/0101-C SAMPLE E



N= 3

COR= .9932 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= 3.5581*Y-.42564	237E-6
Y	.15713	.02605	Y= .27722*X+ .12014	185E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure C-110. Plot of BET equation versus relative pressure for Converter A207/0101-C - Front Face

APPENDIX D

SCANNING ELECTRON MICROSCOPE MICROGRAPHS AND DOT MAPS

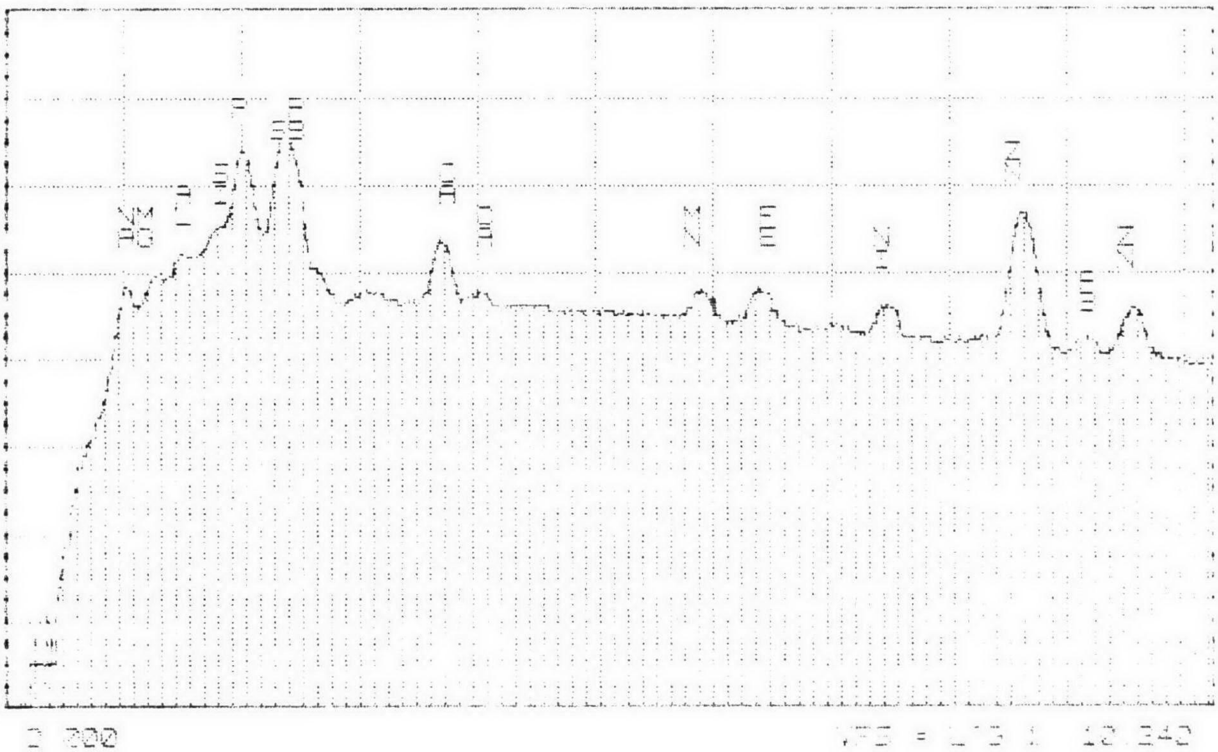


Figure D-1. SEM/EDX Spectrum of Converter A180/0094

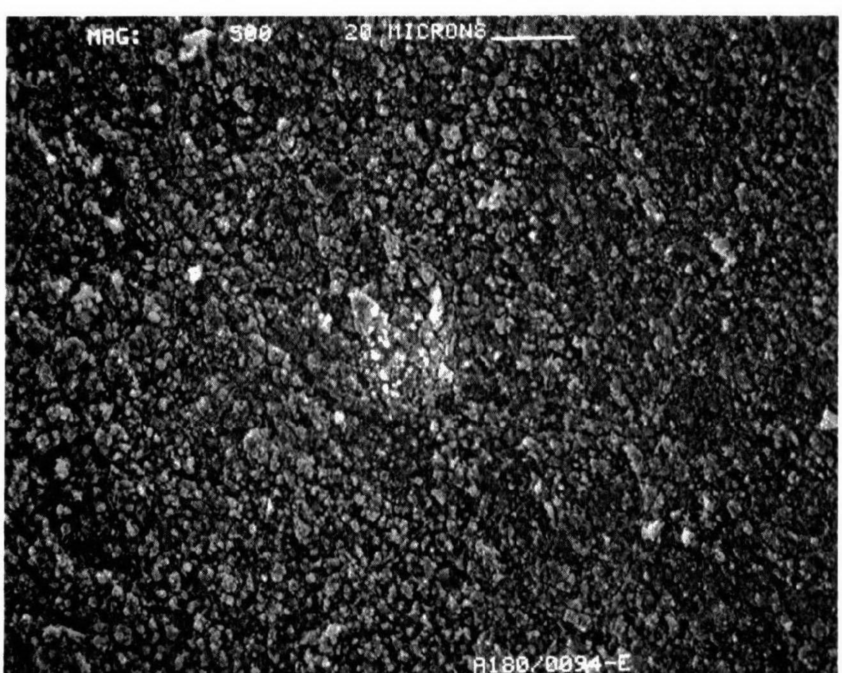


Figure D-2. Scanning Electron Micrograph at X500 of Converter A180/0094

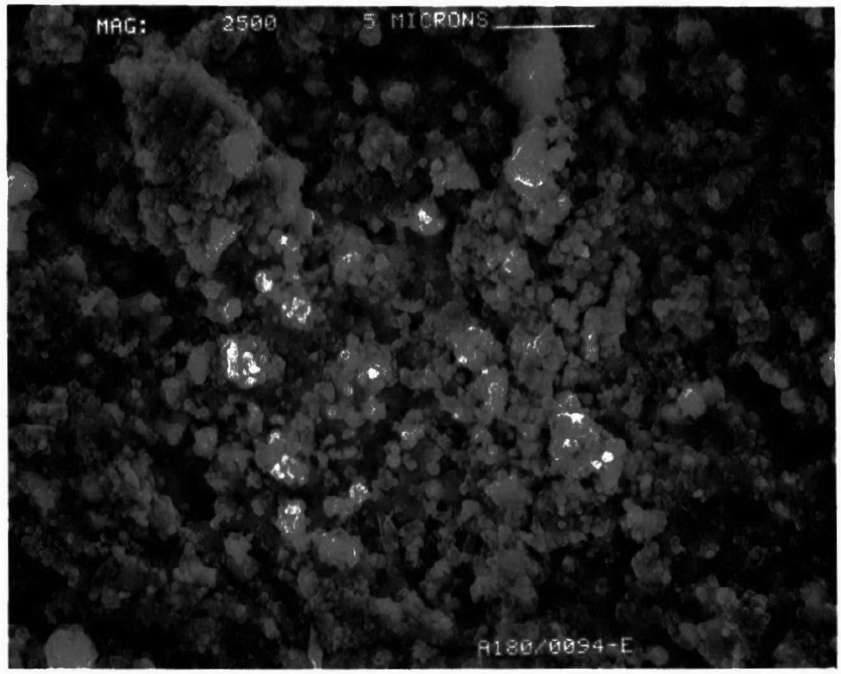


Figure D-3. Scanning Electron Micrograph at X2500 of Converter A180/0094

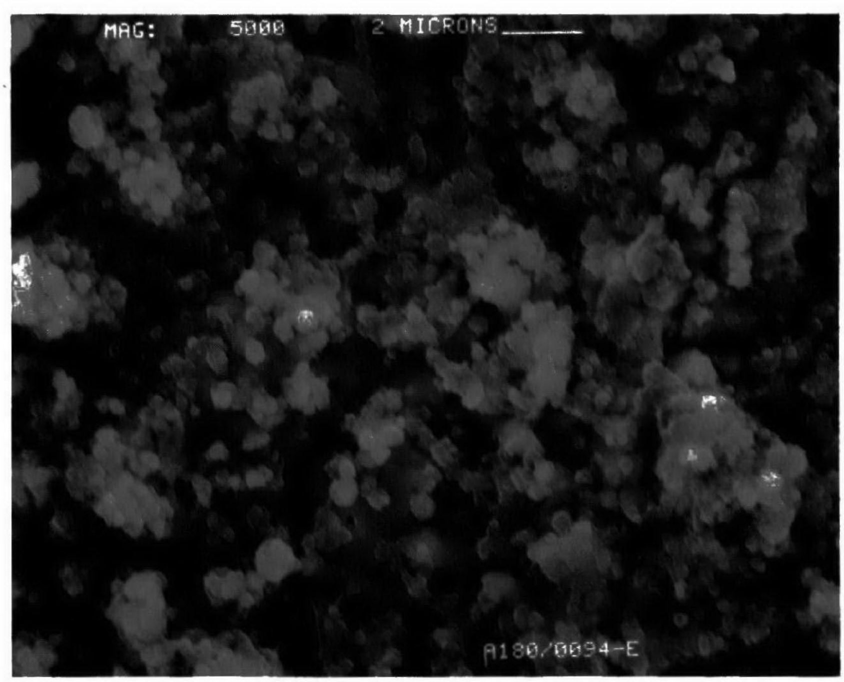


Figure D-4. Scanning Electron Micrograph at X5000 of Converter A180/0094

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE TO LOW FOR ADEQUATE MAPPING

Figure D-5. Aluminum Dot Map at X5000 of Converter A180/0094

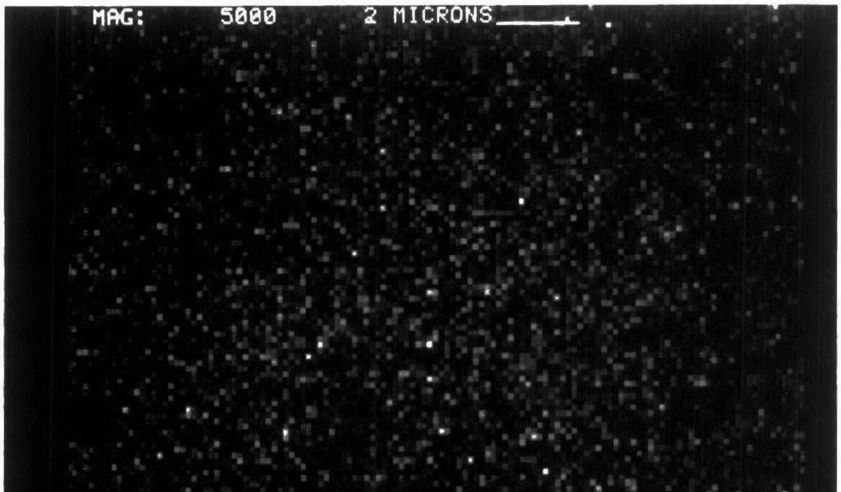


Figure D-6. Silicon Dot Map at X5000 of Converter A180/0094

Figure D-7. Lead Dot Map at X5000 of Converter A180/0094

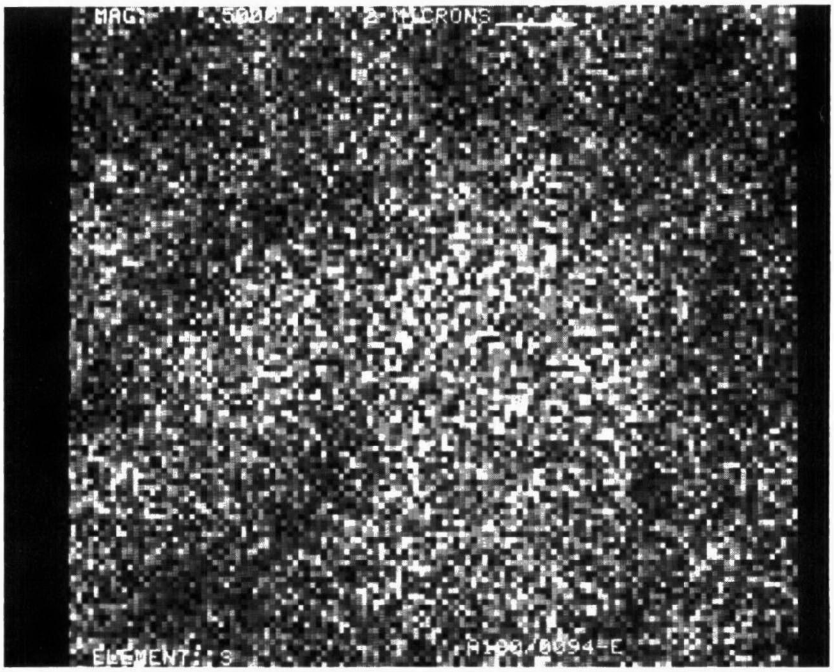


Figure D-8. Sulfur Dot Map at X5000 of Converter A180/0094

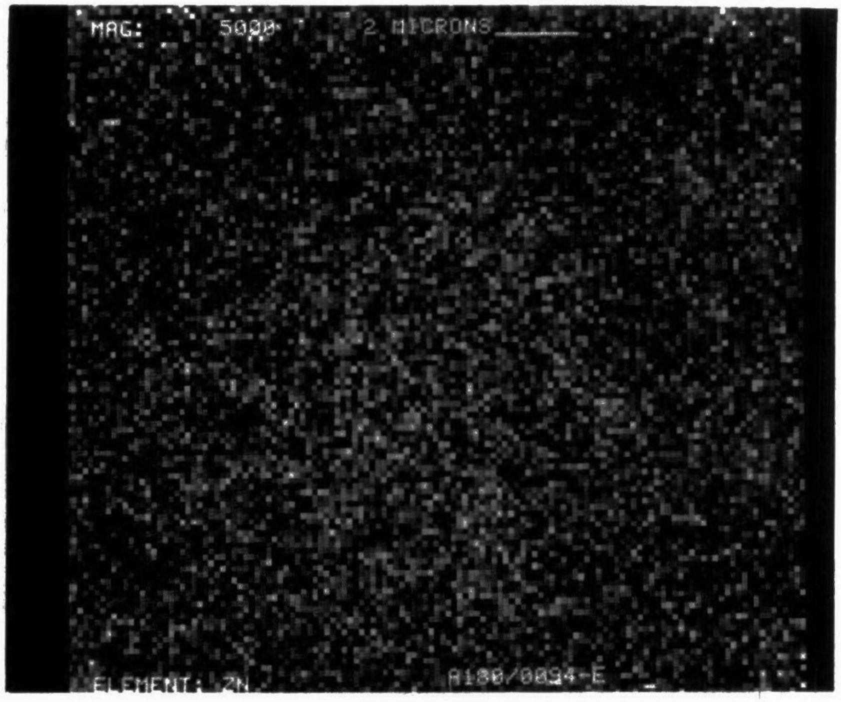


Figure D-9. Zinc Dot Map at X5000 of Converter A180/0094

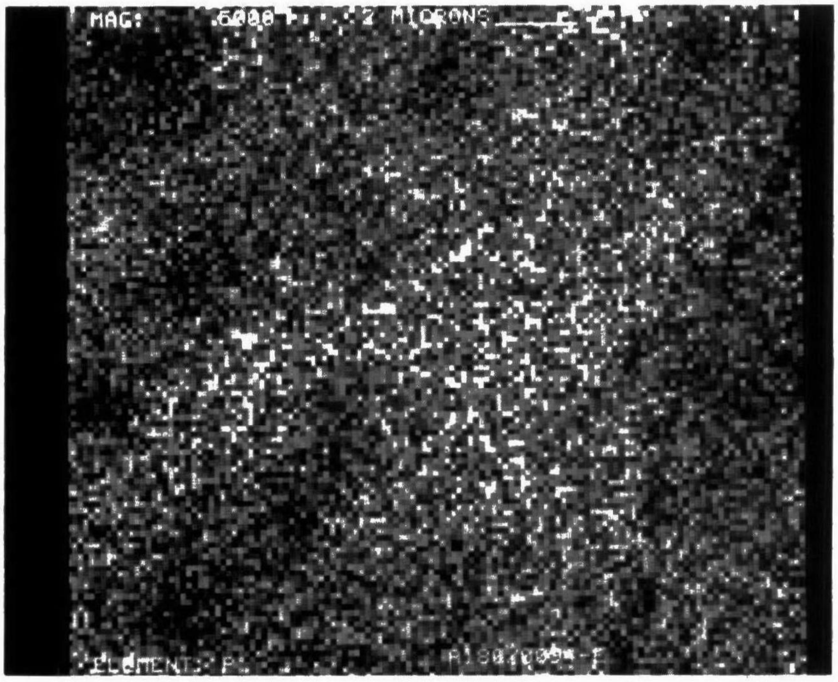


Figure D-10. Phosphorus Dot Map at X5000 of Converter A180/0094

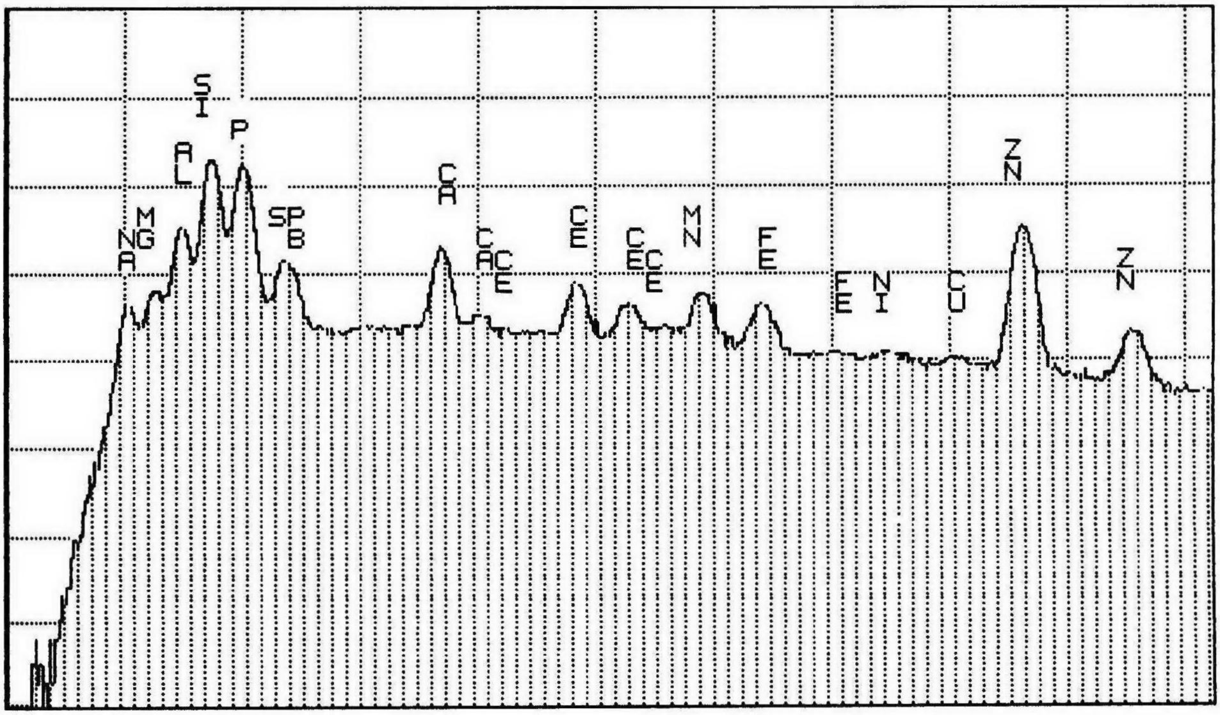


Figure D-11. SEM/EDX Spectrum of Converter A193/0908

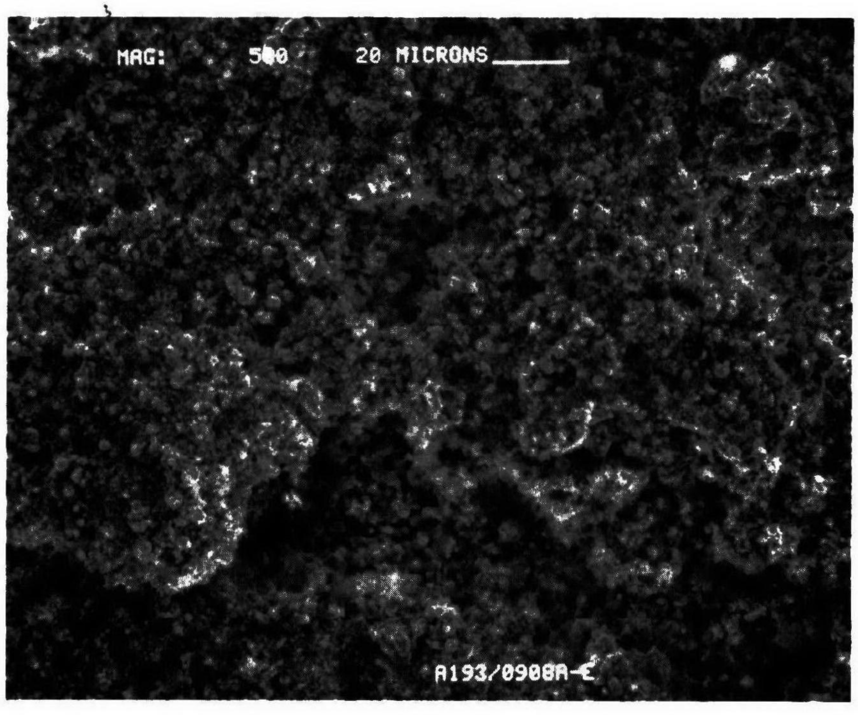


Figure D-12. Scanning Electron Micrograph at X500 of Converter A193/0908

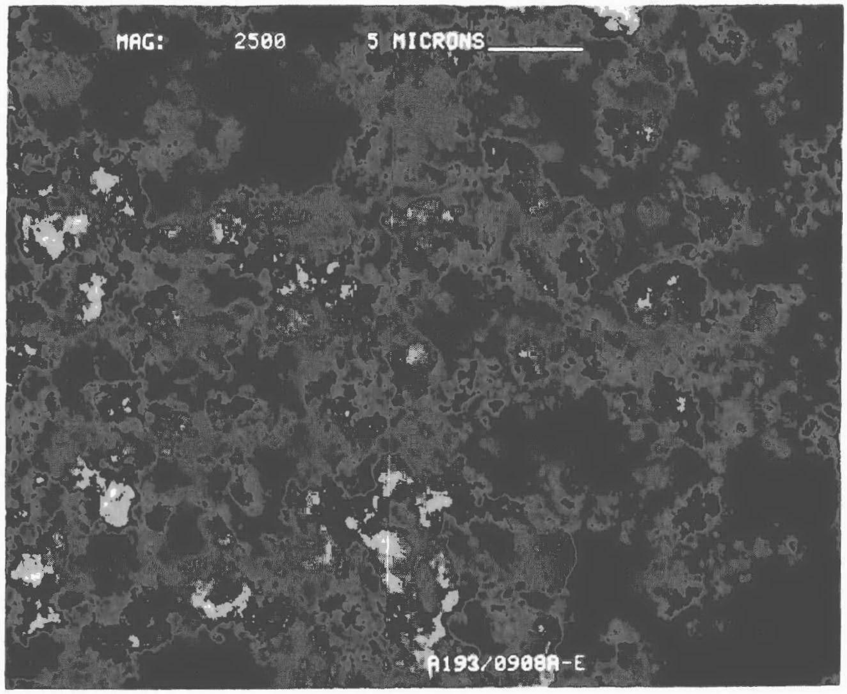


Figure D-13. Scanning Electron Micrograph at X2500 of Converter A193/0908

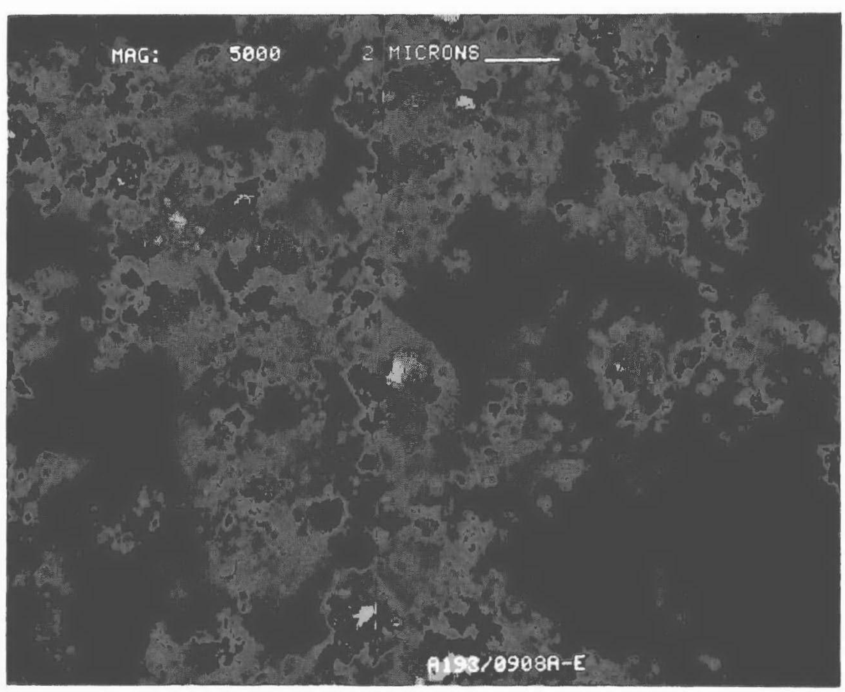


Figure D-14. Scanning Electron Micrograph at X5000 of Converter A193/0908

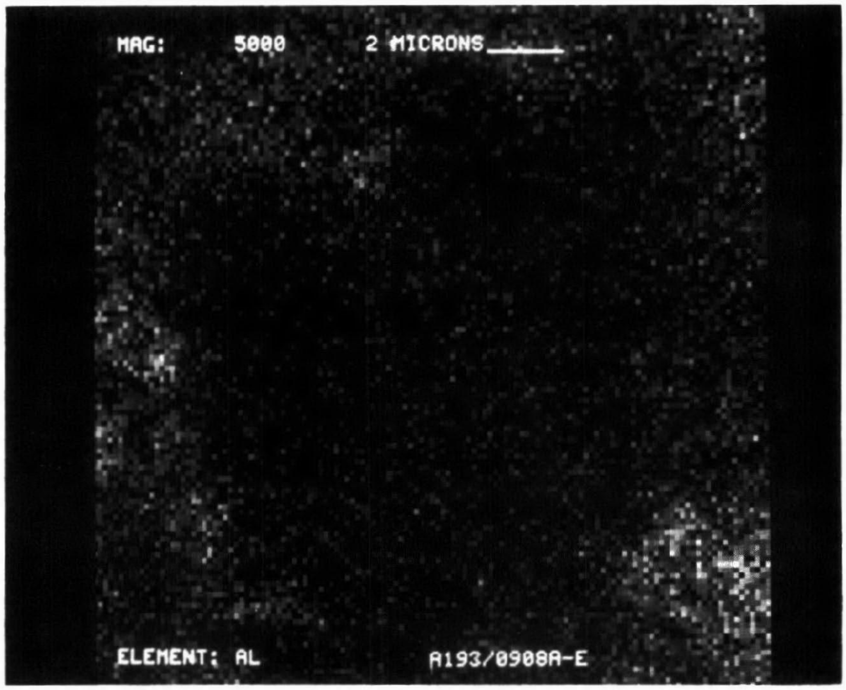


Figure D-15. Aluminum Dot Map at X5000 of Converter A193/0908

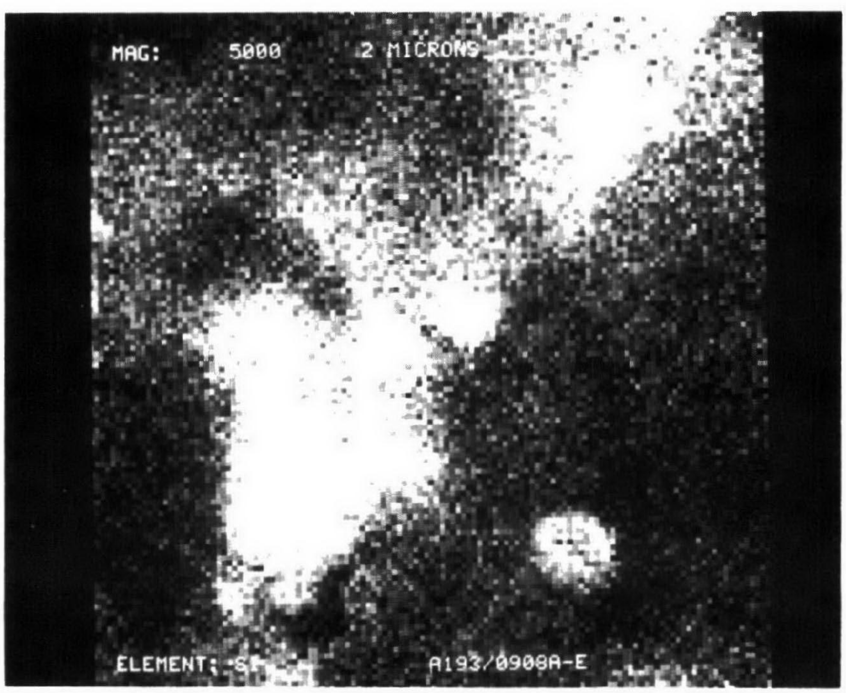


Figure D-16. Silicon Dot Map at X5000 of Converter A193/0908

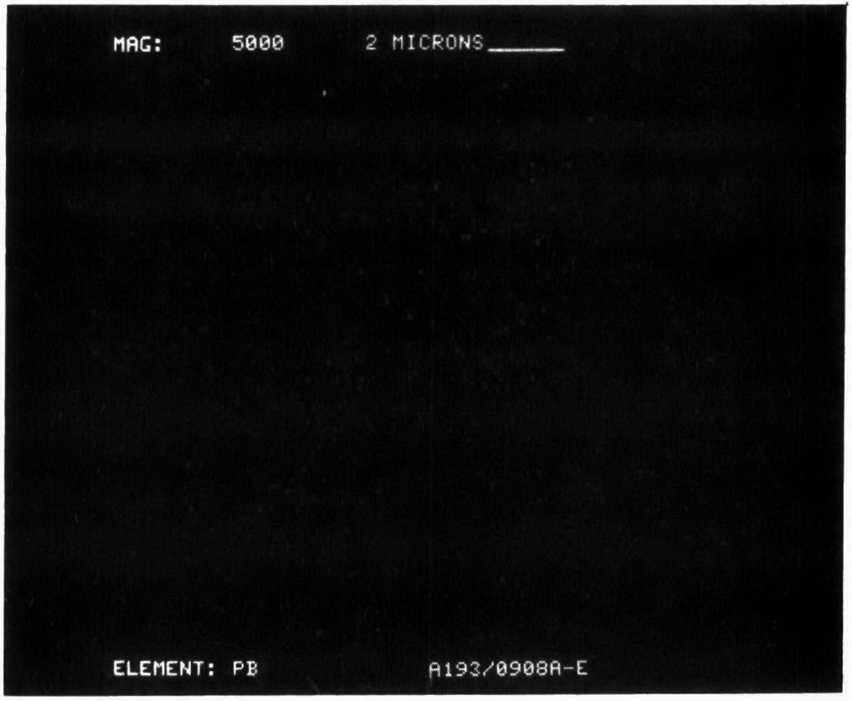


Figure D-17. Lead Dot Map at X5000 of Converter A193/0908

Figure D-18. Sulfur Dot Map at X5000 of Converter A193/0908

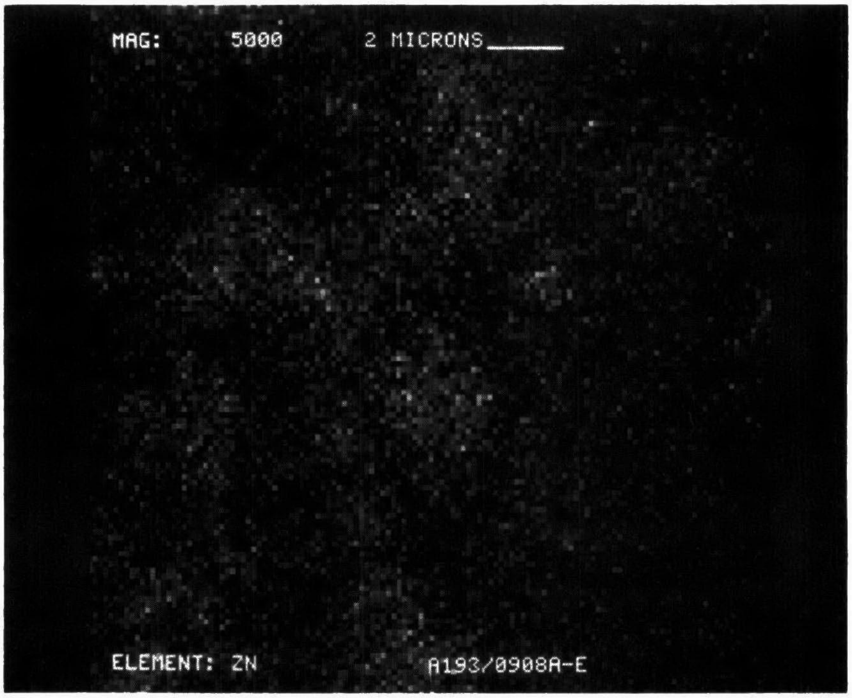


Figure D-19. Zinc Dot Map at X5000 of Converter A193/0908

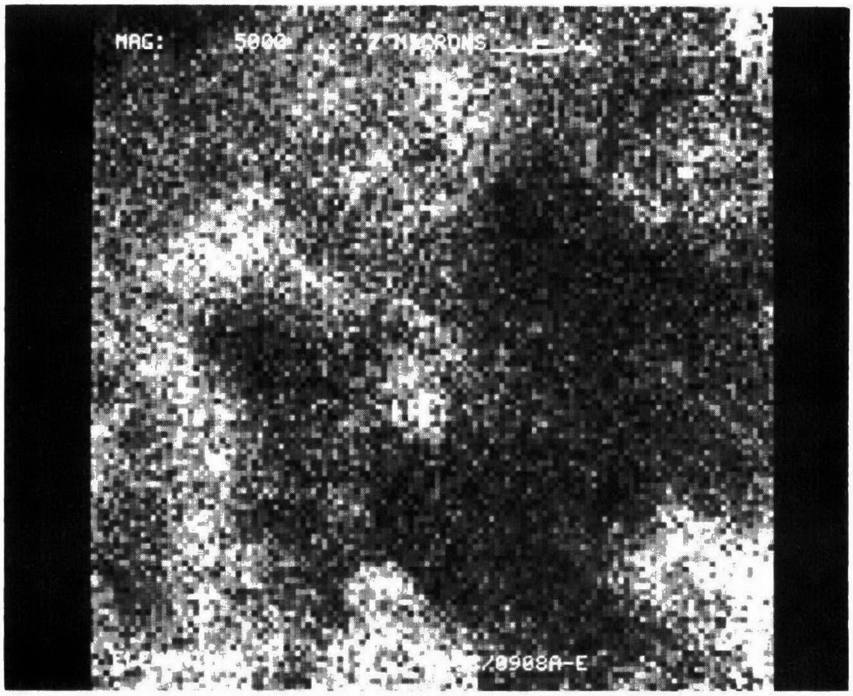


Figure D-20. Phosphorus Dot Map at X5000 of Converter A193/0908

NO VISUAL REPRESENTATIVE OF SPECTRUM TAKEN AT 2500X MAGNIFICATION

Figure D-21. SEM/EDX Spectrum of Converter A218/0045

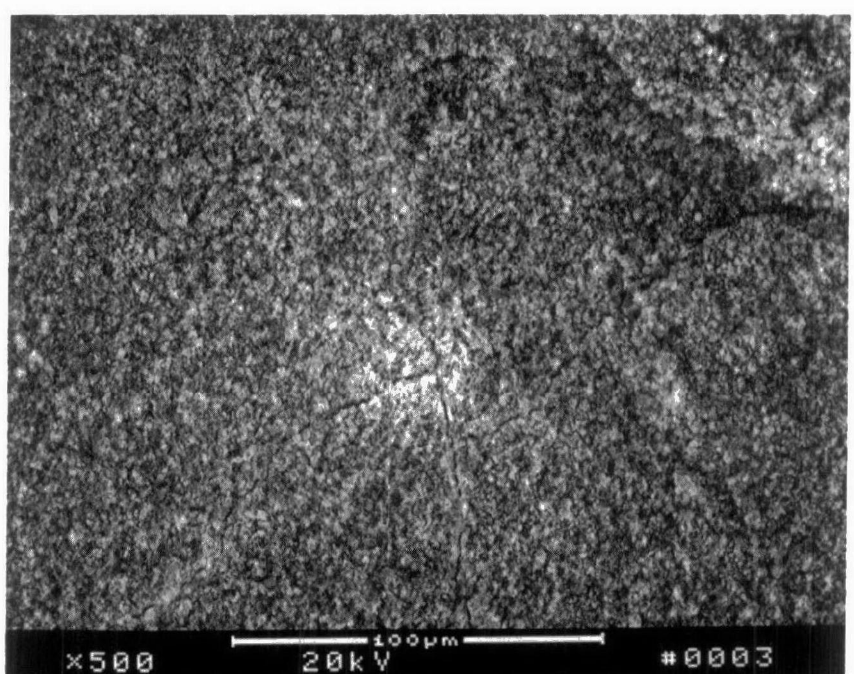


Figure D-22. Scanning Electron Micrograph at X500 of Converter A218/0045

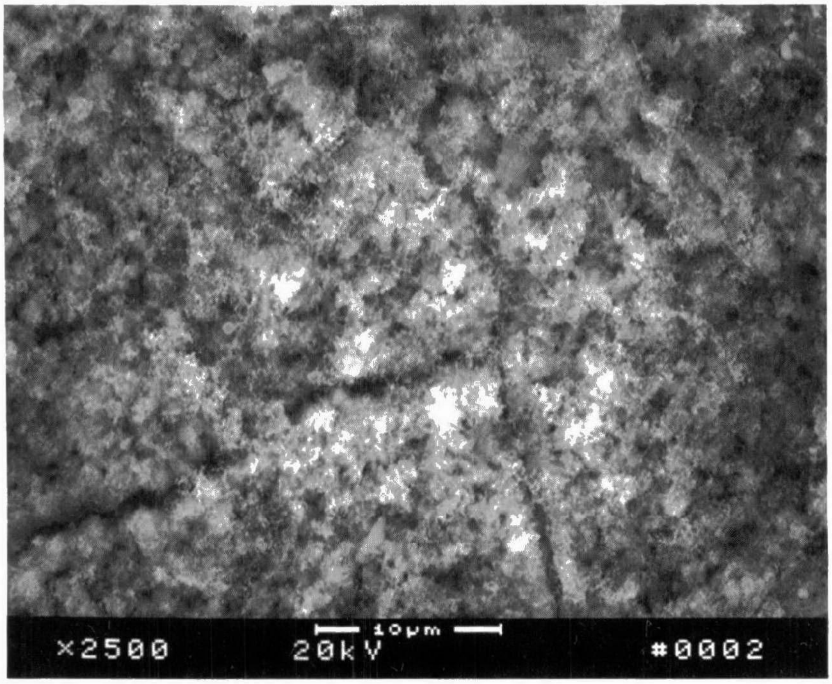


Figure D-23. Scanning Electron Micrograph at X2500 of Converter A218/0045

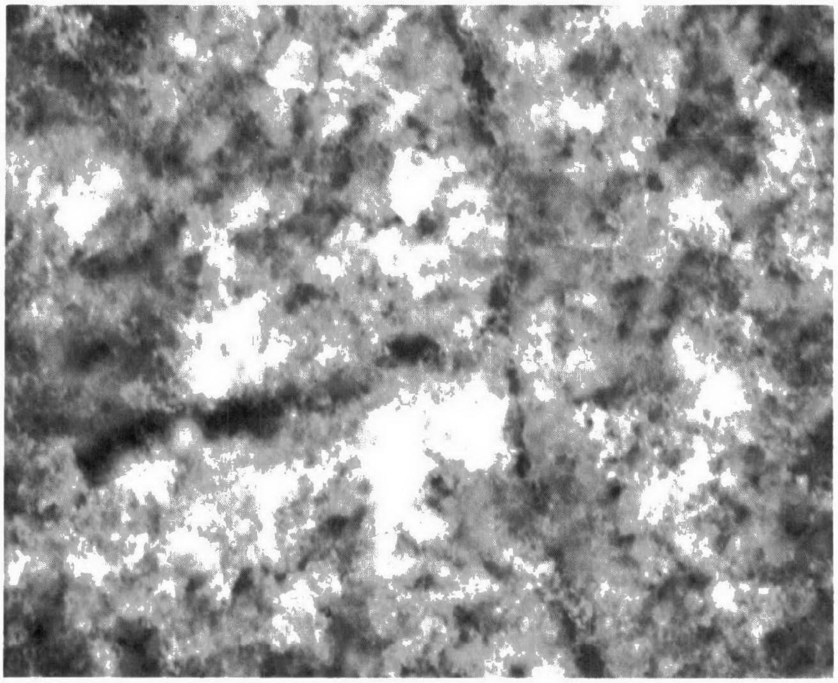


Figure D-24. Scanning Electron Micrograph at X5000 of Converter A218/0045

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE TO LOW FOR ADEQUATE MAPPING

Figure D-25. Aluminum Dot Map at X5000 of Converter A218/0045

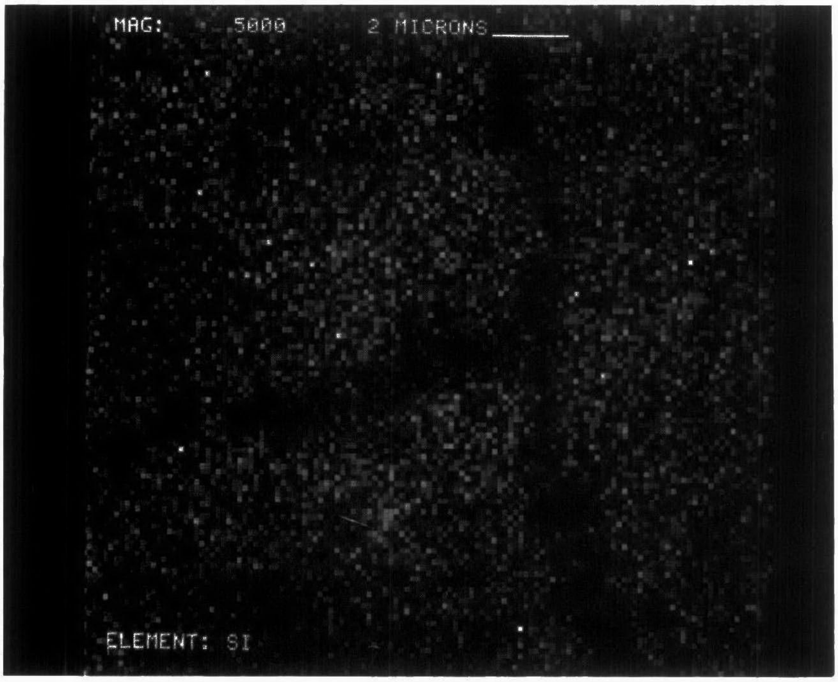


Figure D-26. Silicon Dot Map at X5000 of Converter A218/0045

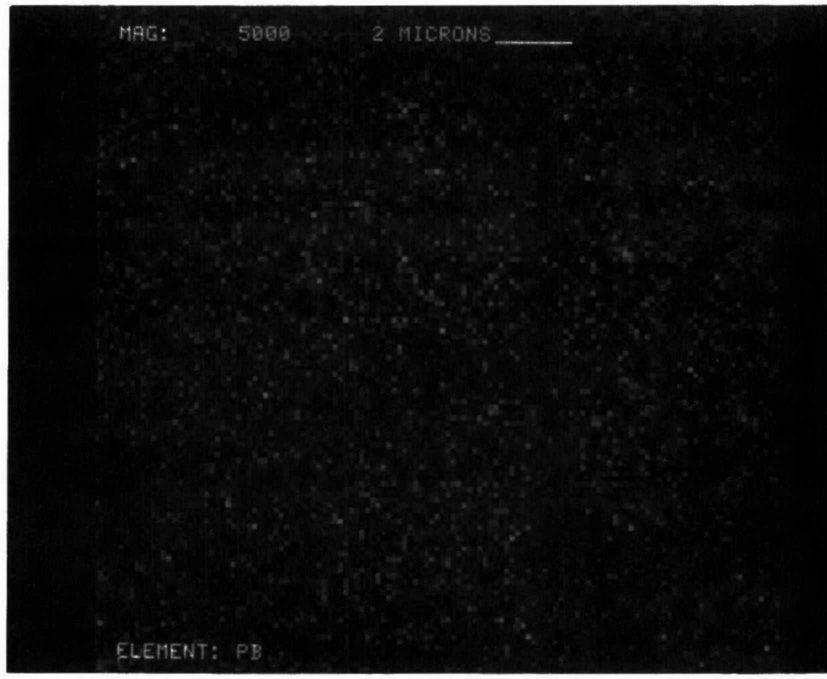


Figure D-27. Lead Dot Map at X5000 of Converter A218/0045

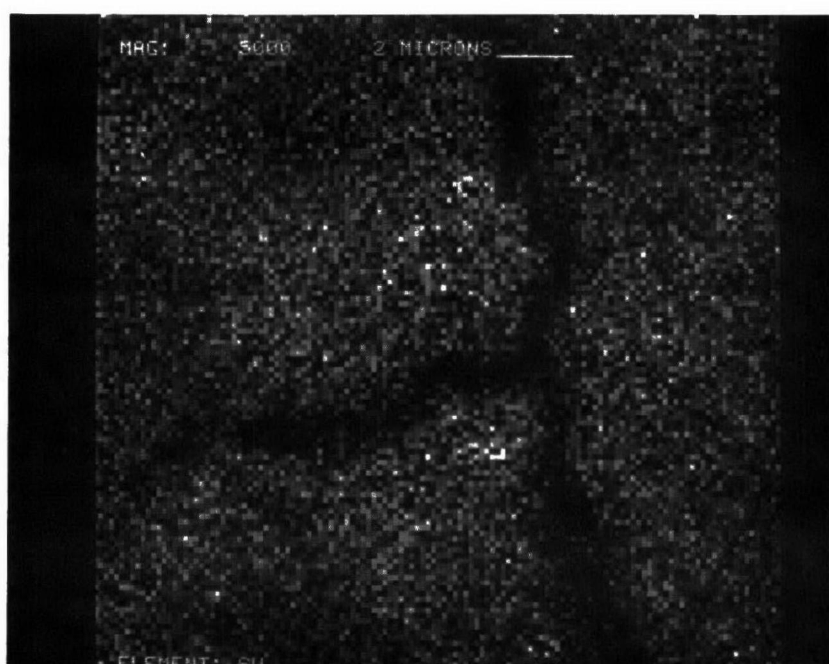


Figure D-28. Sulfur Dot Map at X5000 of Converter A218/0045

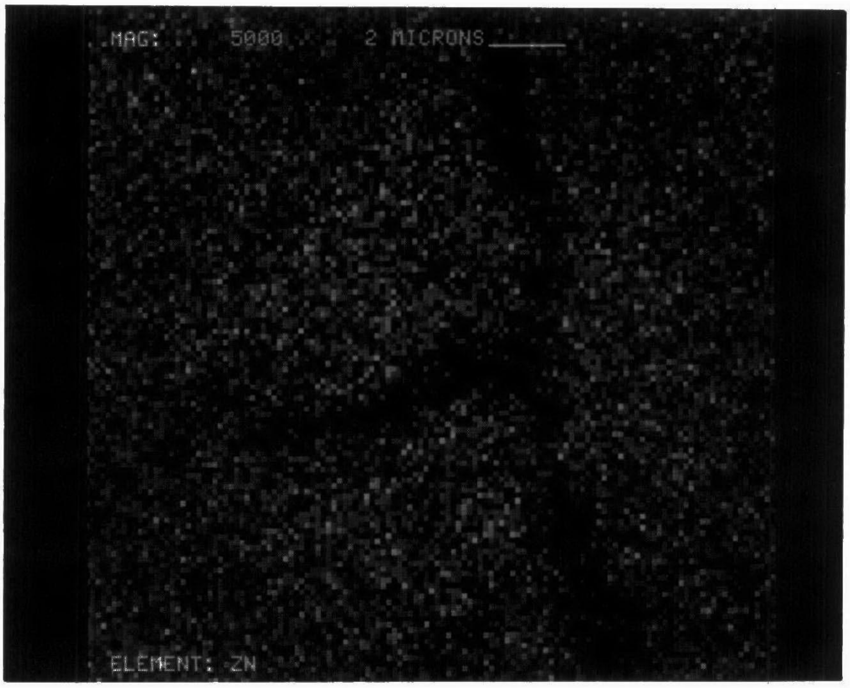


Figure D-29. Zinc Dot Map at X5000 of Converter A218/0045

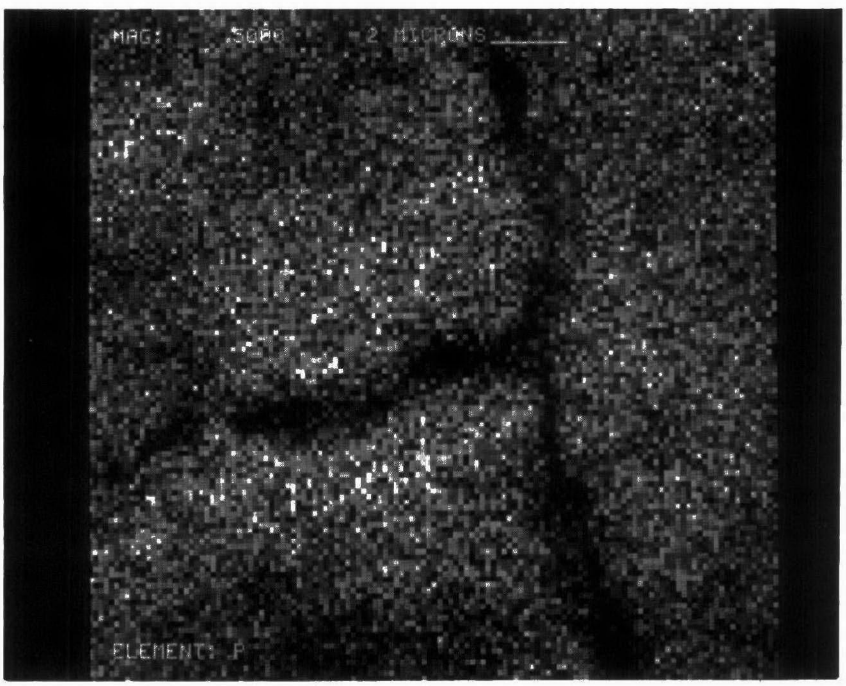


Figure D-30. Phosphorus Dot Map at X5000 of Converter A218/0045

NO VISUAL REPRESENTATIVE OF SPECTRUM TAKEN AT 2500X MAGNIFICATION

Figure D-31. SEM/EDX Spectrum of Converter A218/0045X

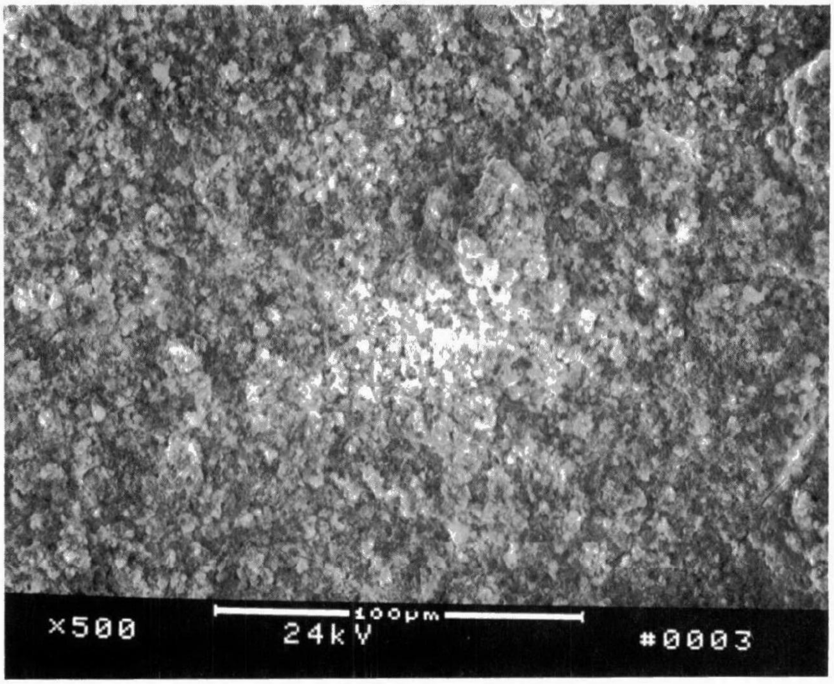


Figure D-32. Scanning Electron Micrograph at X500 of Converter A218/0045X

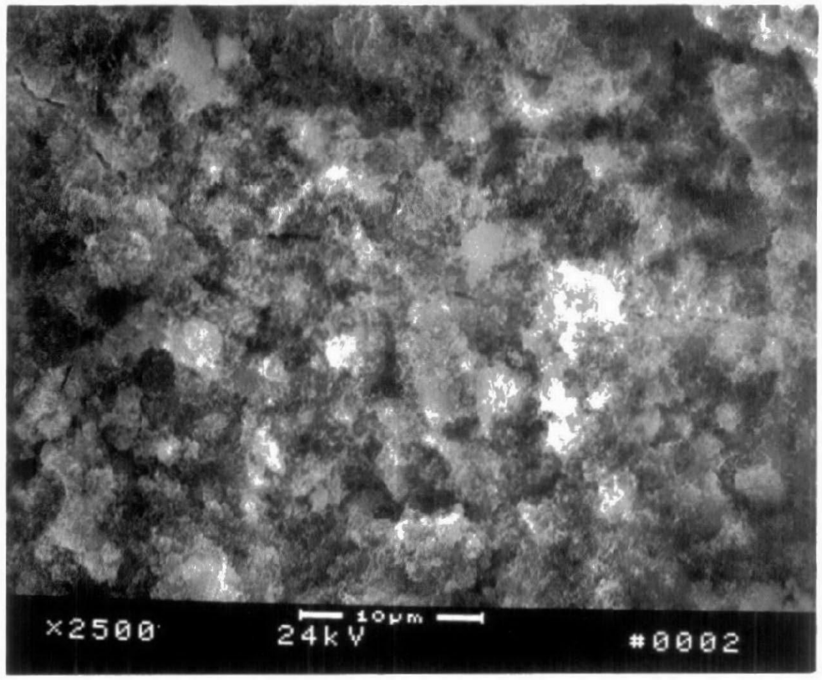


Figure D-33. Scanning Electron Micrograph at X2500 of Converter A218/0045X

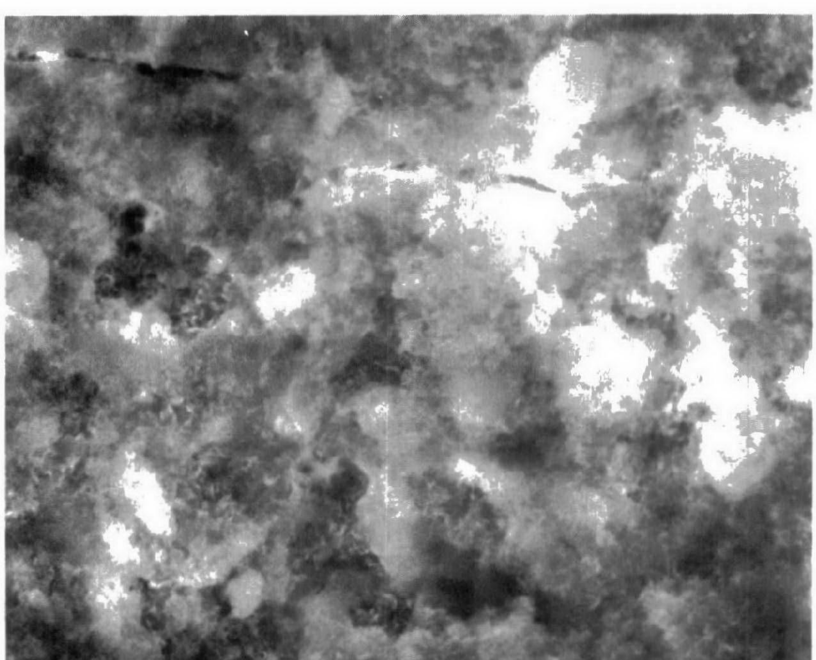


Figure D-34. Scanning Electron Micrograph at X5000 of Converter A218/0045X

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE TO LOW FOR ADEQUATE MAPPING

Figure D-35. Aluminum Dot Map at X5000 of Converter A218/0045X

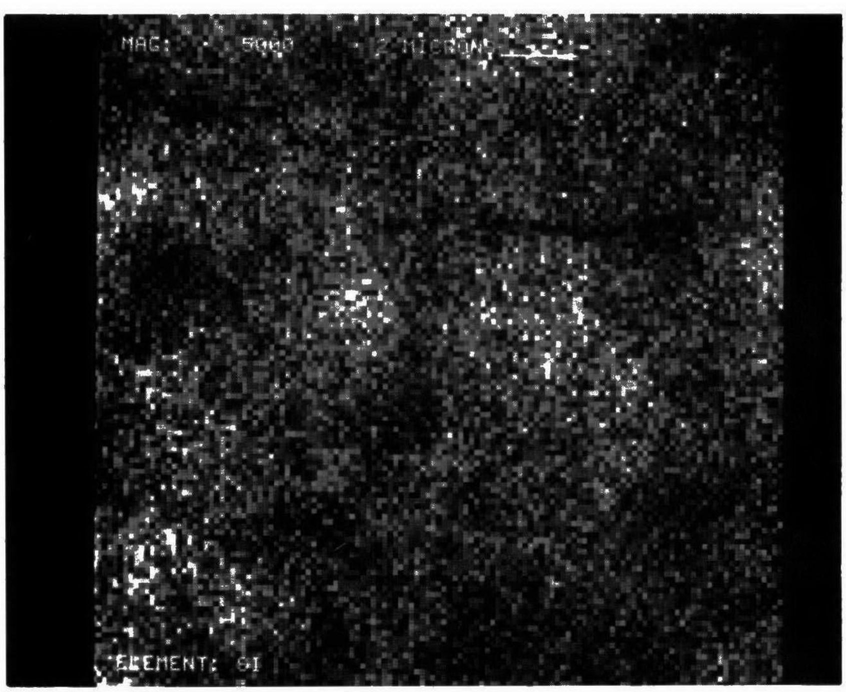


Figure D-36. Silicon Dot Map at X5000 of Converter A218/0045X

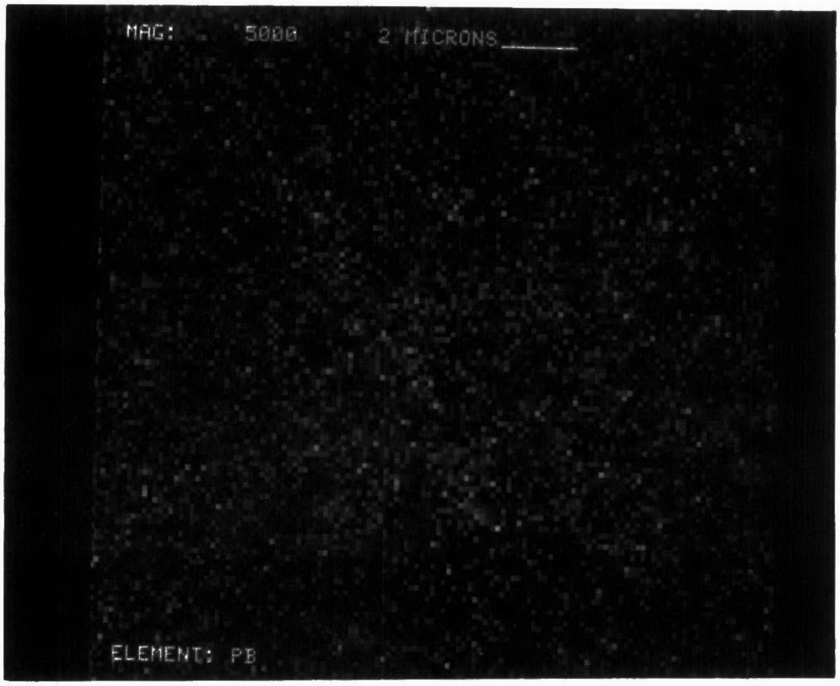


Figure D-37. Lead Dot Map at X5000 of Converter A218/0045X

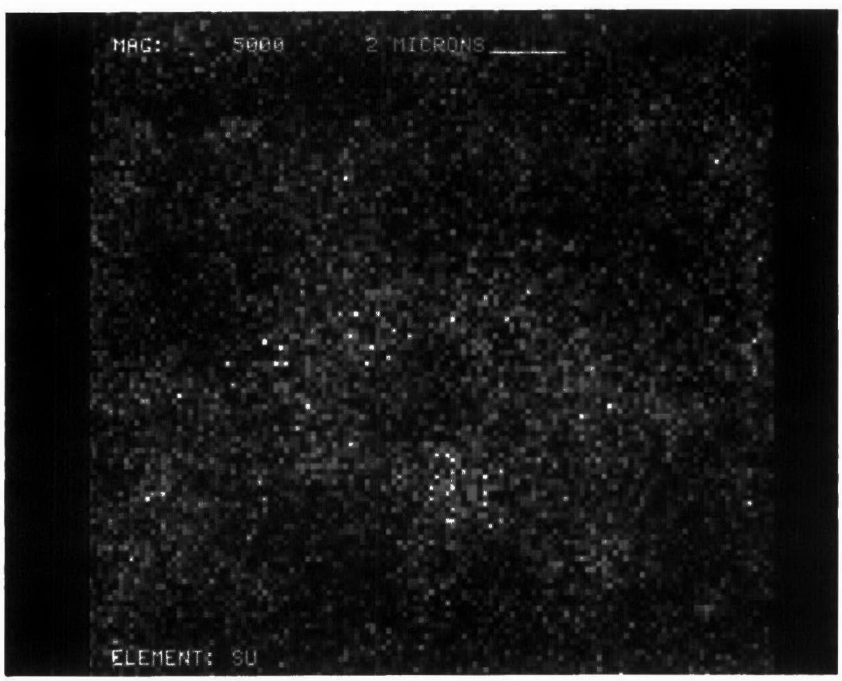


Figure D-38. Sulfur Dot Map at X5000 of Converter A218/0045X

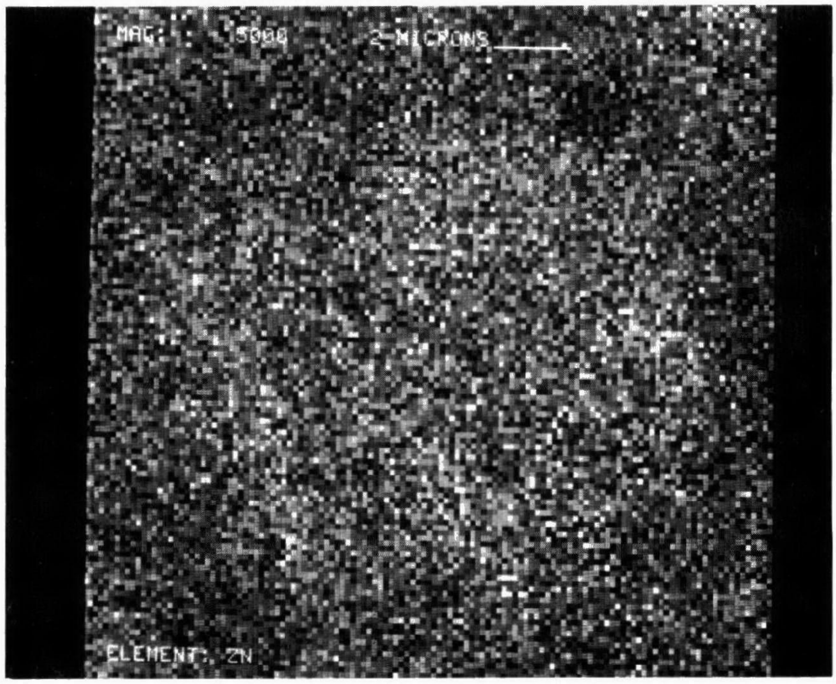


Figure D-39. Zinc Dot Map at X5000 of Converter A218/0045X

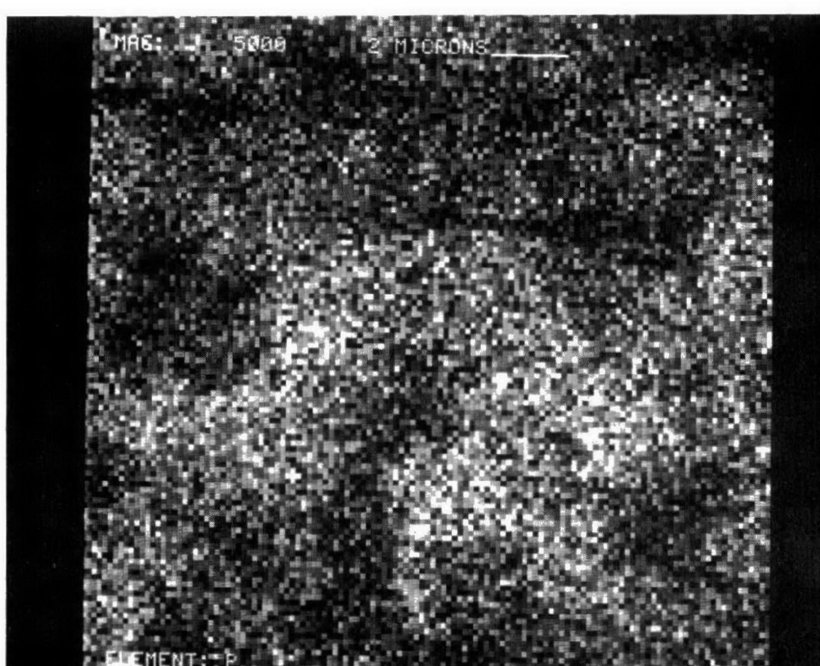


Figure D-40. Phosphorus Dot Map at X5000 of Converter A218/0045X

NO VISUAL REPRESENTATIVE OF SPECTRUM TAKEN
AT 2500X MAGNIFICATION

Figure D-41. SEM/EDX Spectrum of Converter A218/0068

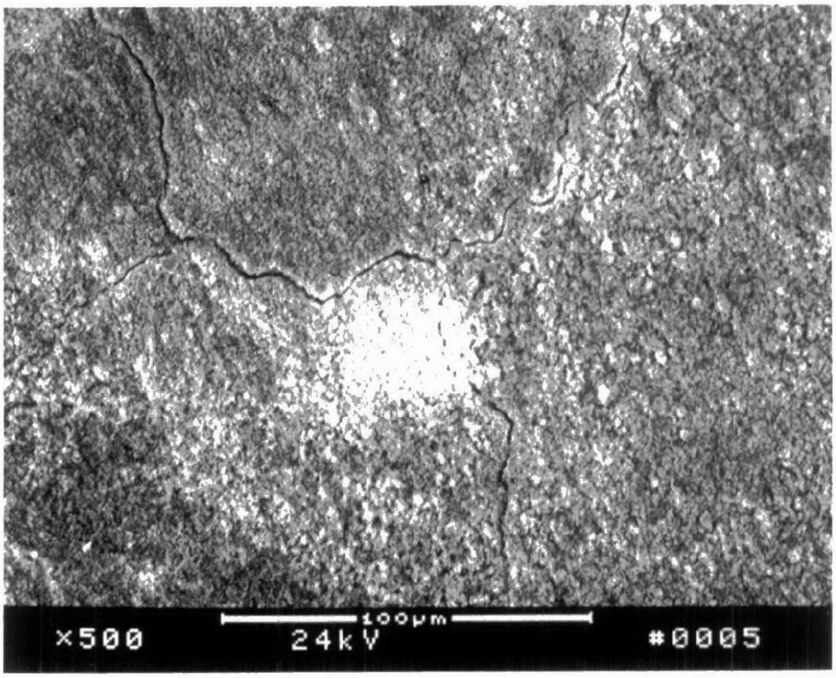


Figure D-42. Scanning Electron Micrograph at X500 of Converter A218/0068

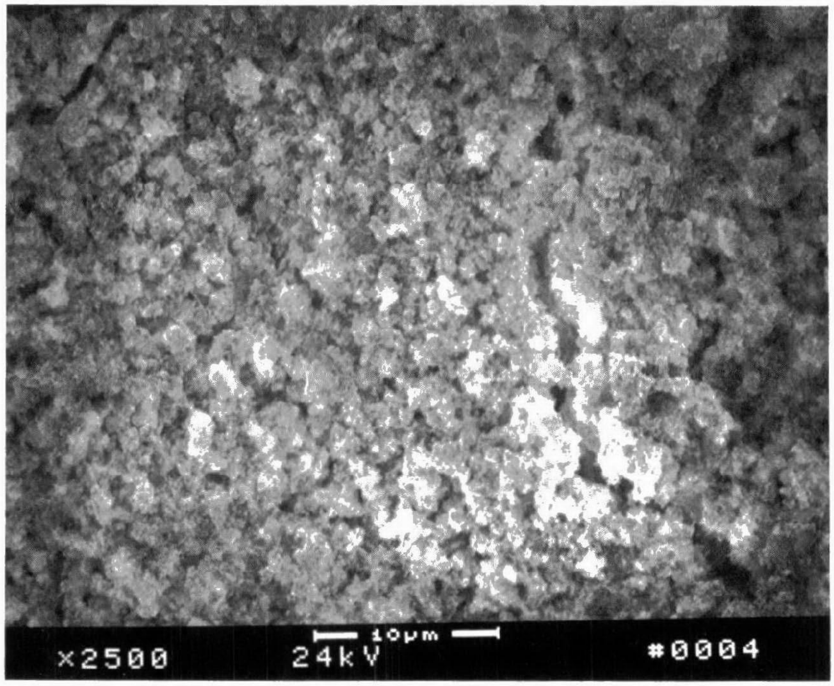


Figure D-43. Scanning Electron Micrograph at X2500 of Converter A218/0068

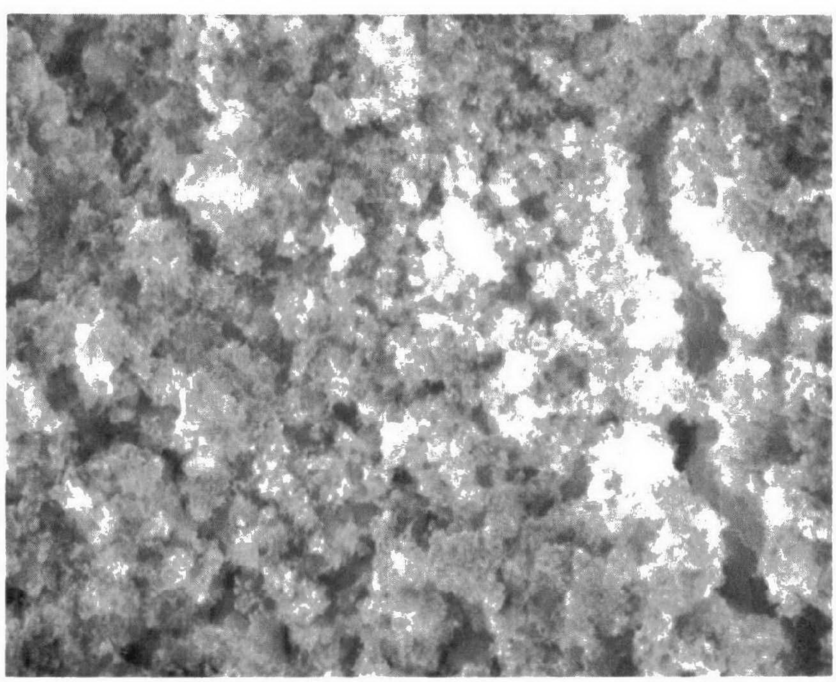


Figure D-44. Scanning Electron Micrograph at X5000 of Converter A218/0068

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE TO LOW FOR ADEQUATE MAPPING

Figure D-45. Aluminum Dot Map at X5000 of Converter A218/0068

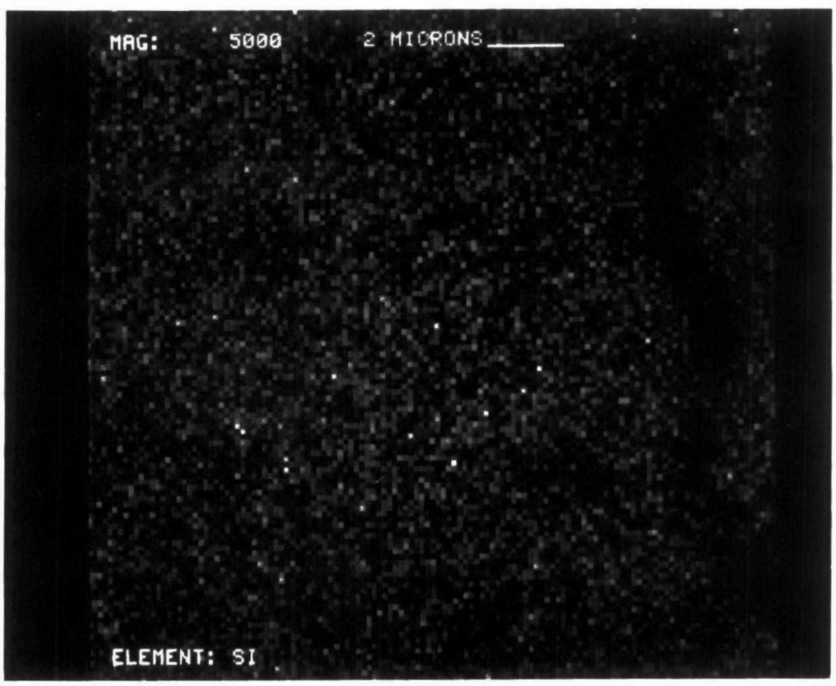


Figure D-46. Silicon Dot Map at X5000 of Converter A218/0068

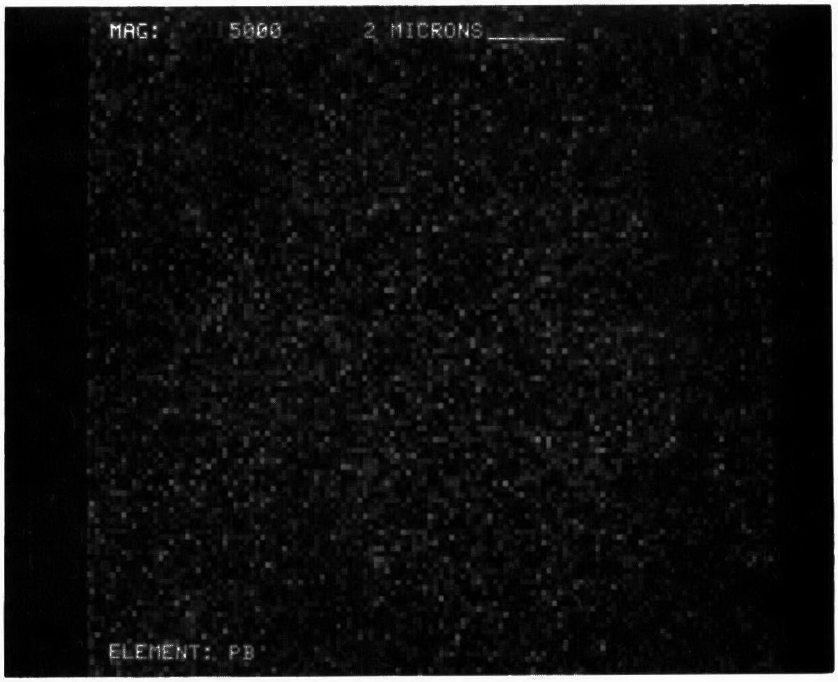


Figure D-47. Lead Dot Map at X5000 of Converter A218/0068

Figure D-48. Sulfur Dot Map at X5000 of Converter A218/0068

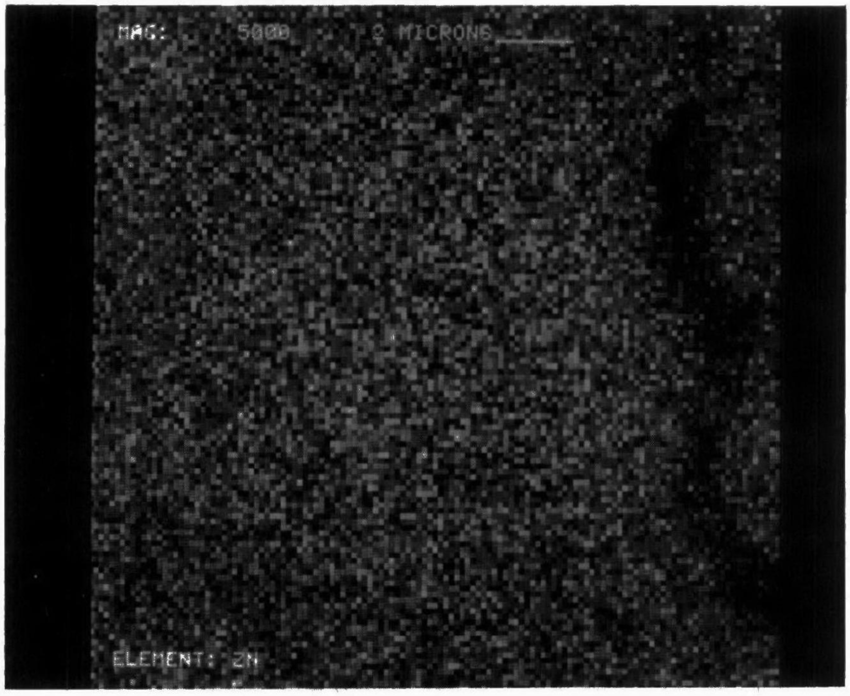


Figure D-49. Zinc Dot Map at X5000 of Converter A218/0068

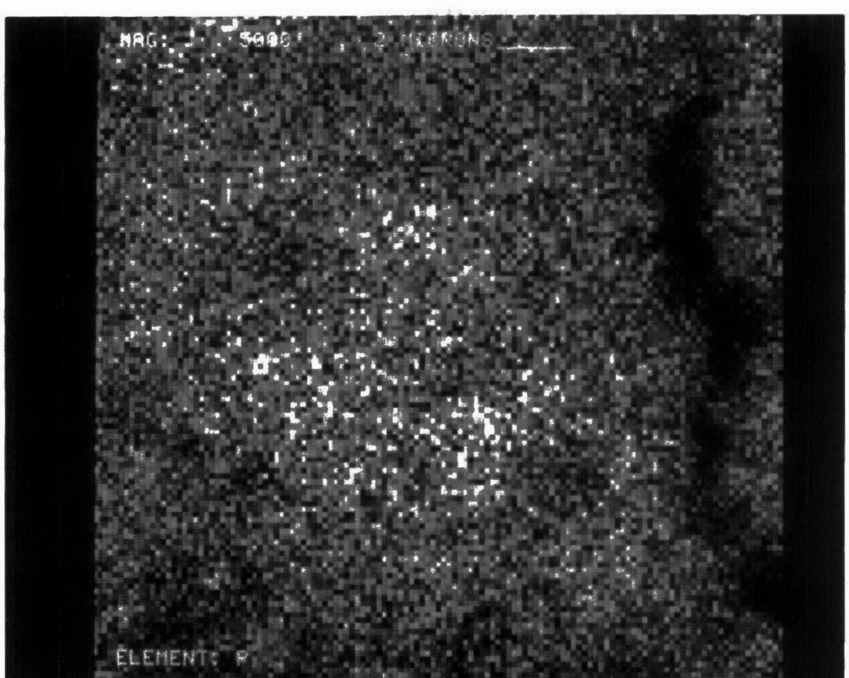


Figure D-50. Phosphorus Dot Map at X5000 of Converter A218/0068

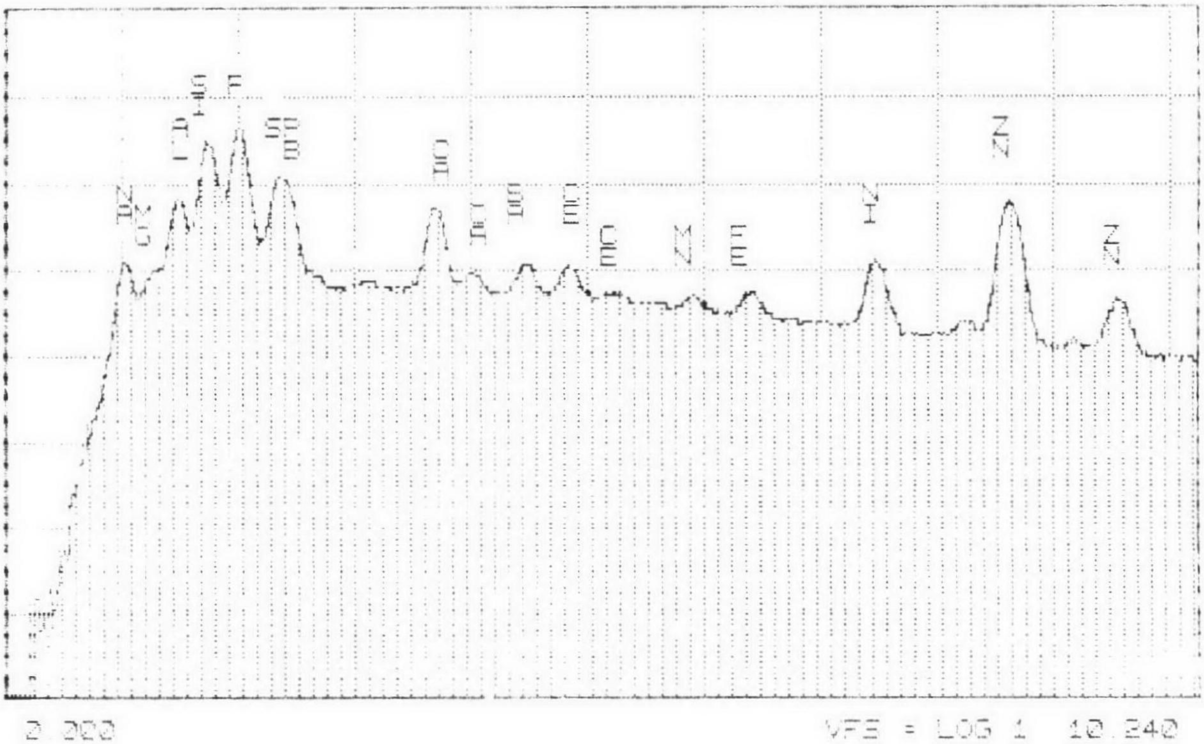


Figure D-51. SEM/EDX Spectrum of Converter A220/0392

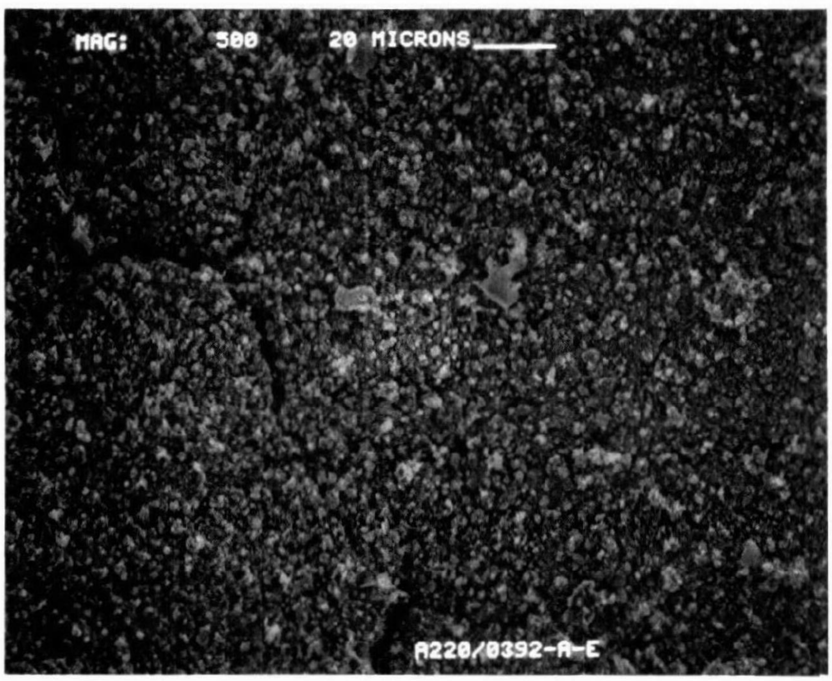


Figure D-52. Scanning Electron Micrograph at X500 of Converter A220/0392

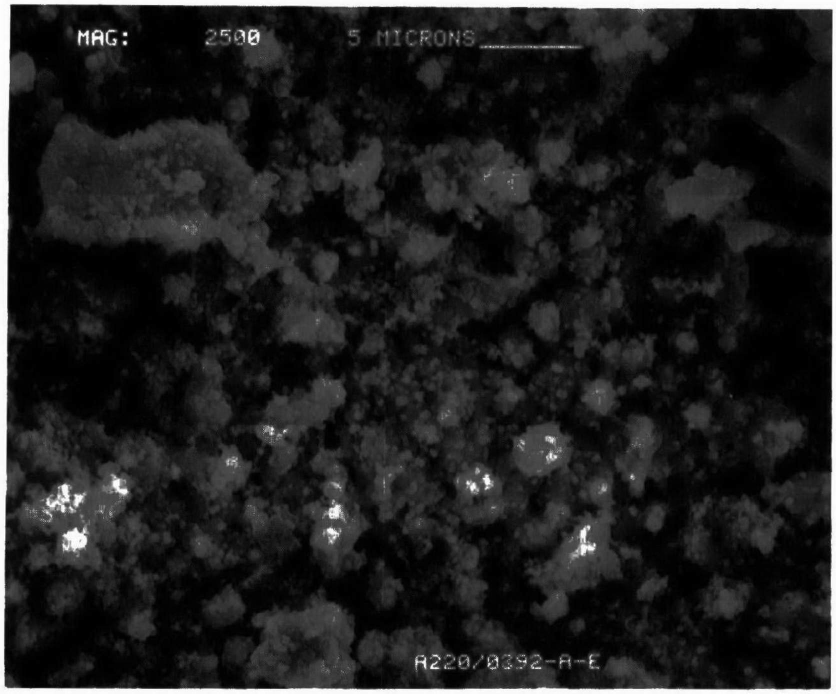


Figure D-53. Scanning Electron Micrograph at X2500 of Converter A220/0392

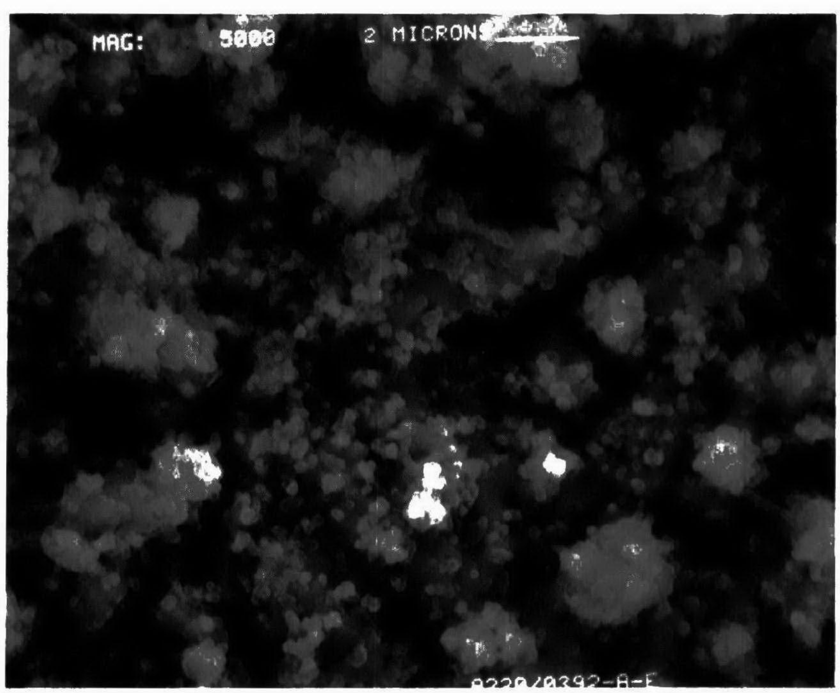


Figure D-54. Scanning Electron Micrograph at X5000 of Converter A220/0392

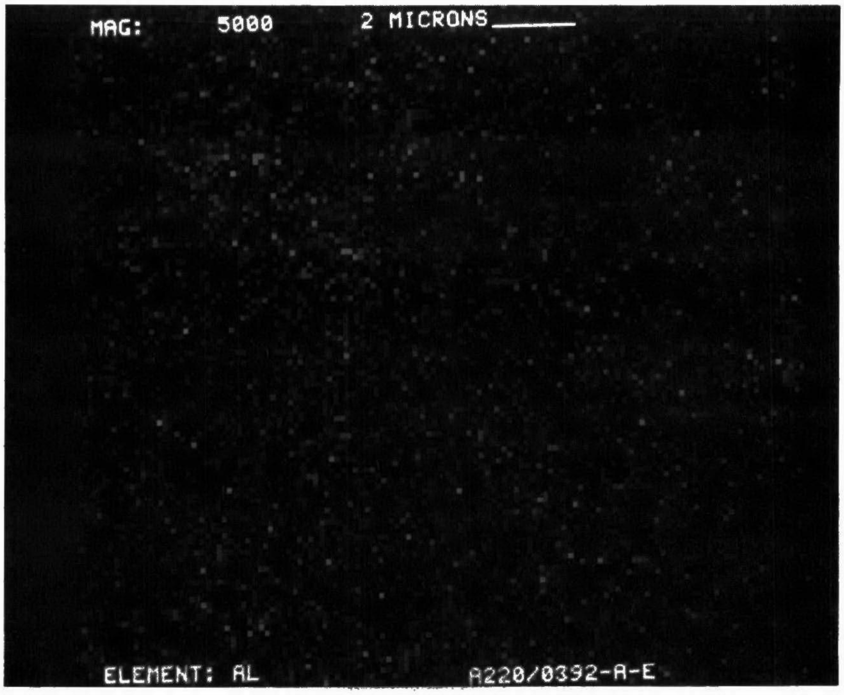


Figure D-55. Aluminum Dot Map at X5000 of Converter A220/0392

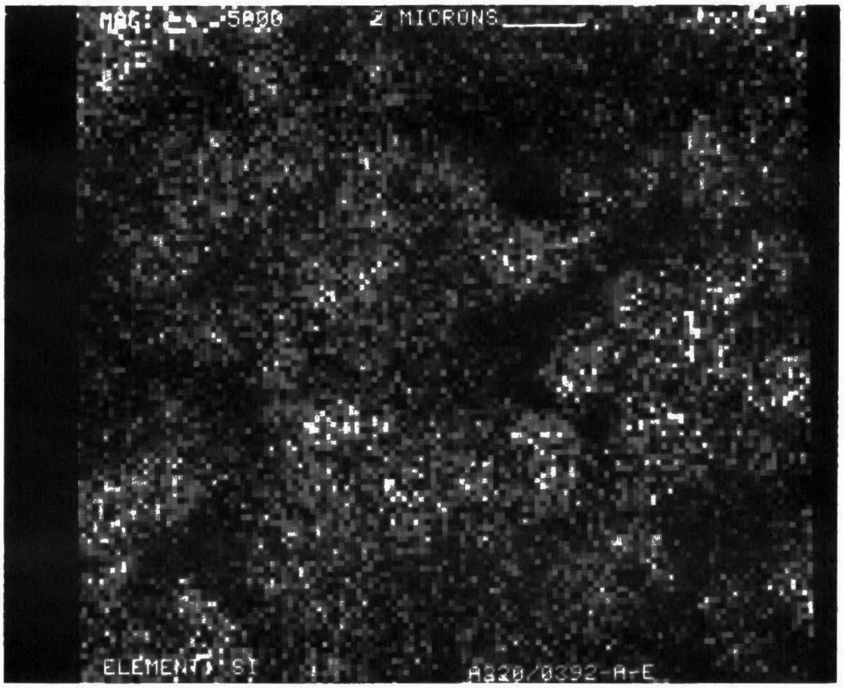


Figure D-56. Silicon Dot Map at X5000 of Converter A220/0392

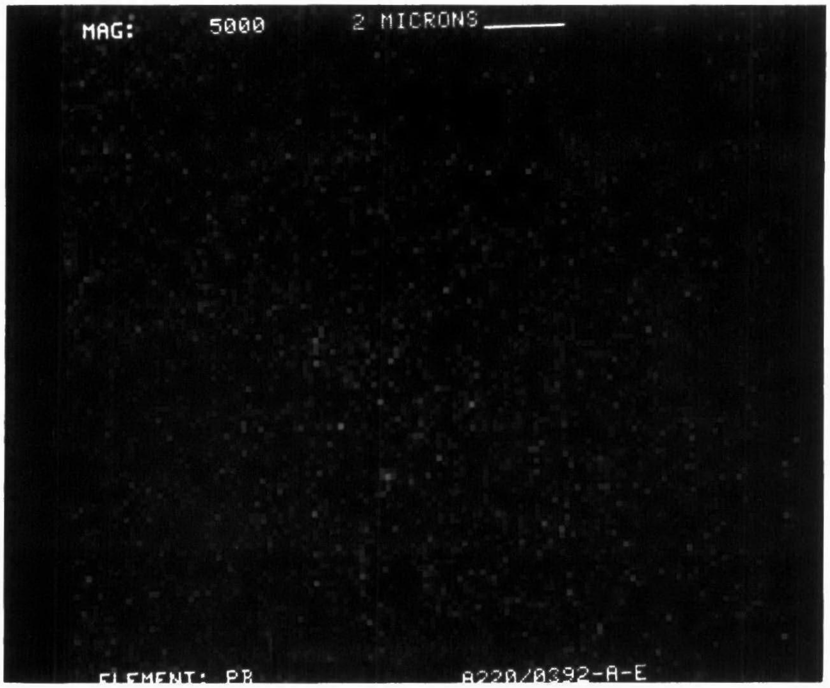


Figure D-57. Lead Dot Map at X5000 of Converter A220/0392

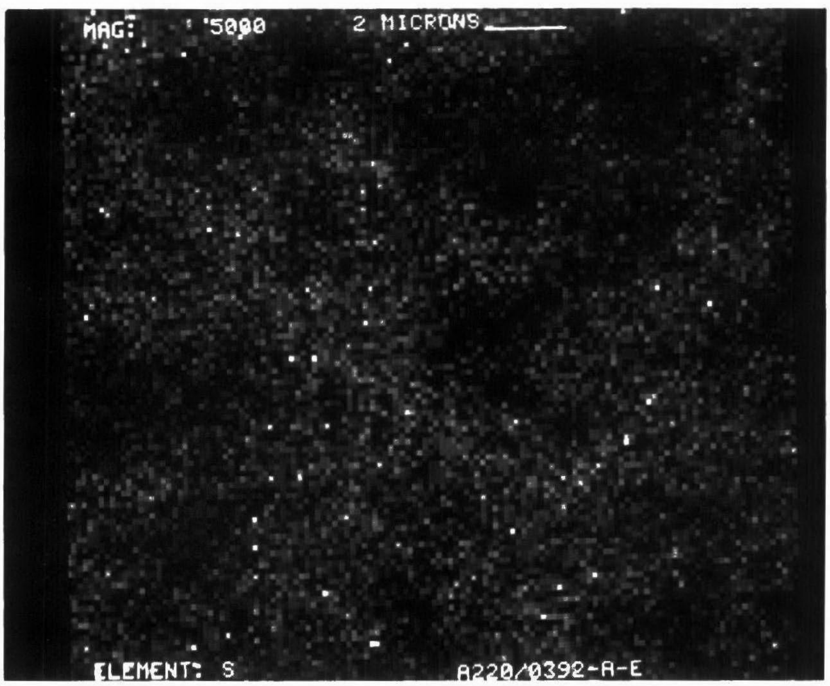


Figure D-58. Sulfur Dot Map at X5000 of Converter A220/0392

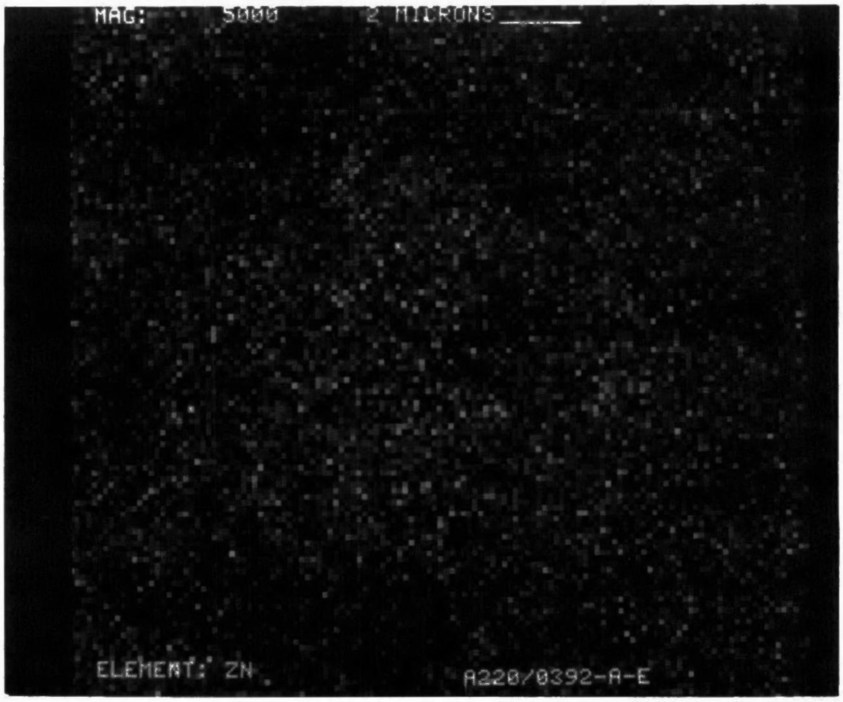


Figure D-59. Zinc Dot Map at X5000 of Converter A220/0392

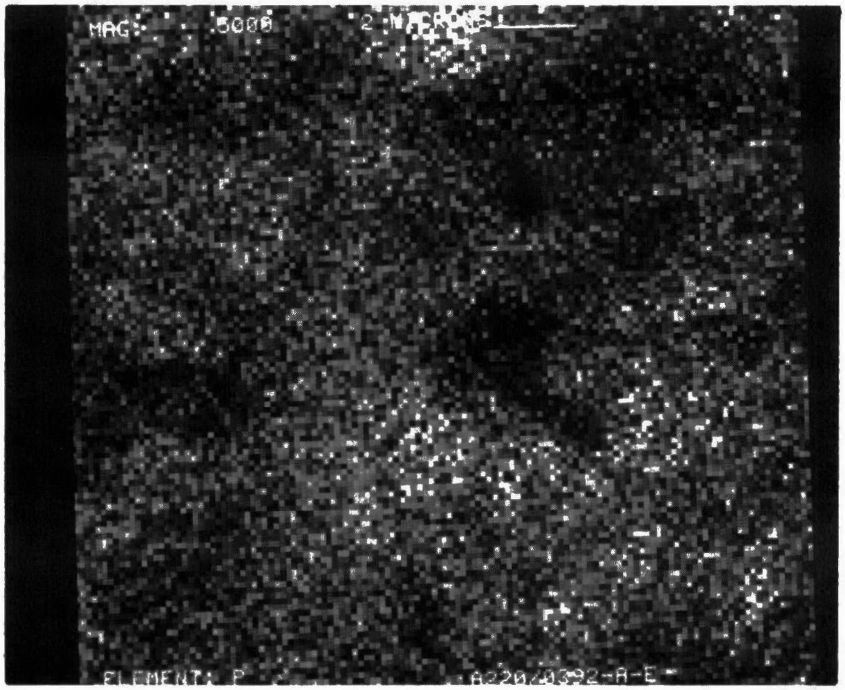


Figure D-60. Phosphorus Dot Map at X5000 of Converter A220/0392

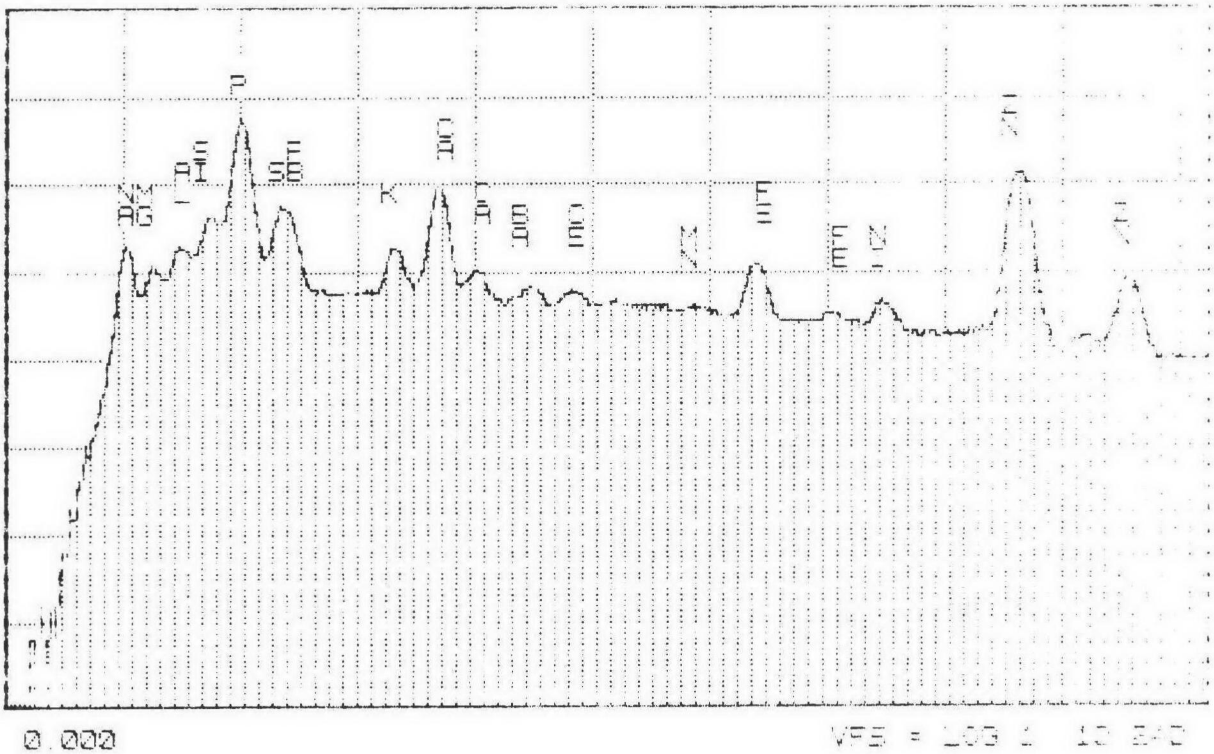


Figure D-61. SEM/EDX Spectrum of Converter A220/0810

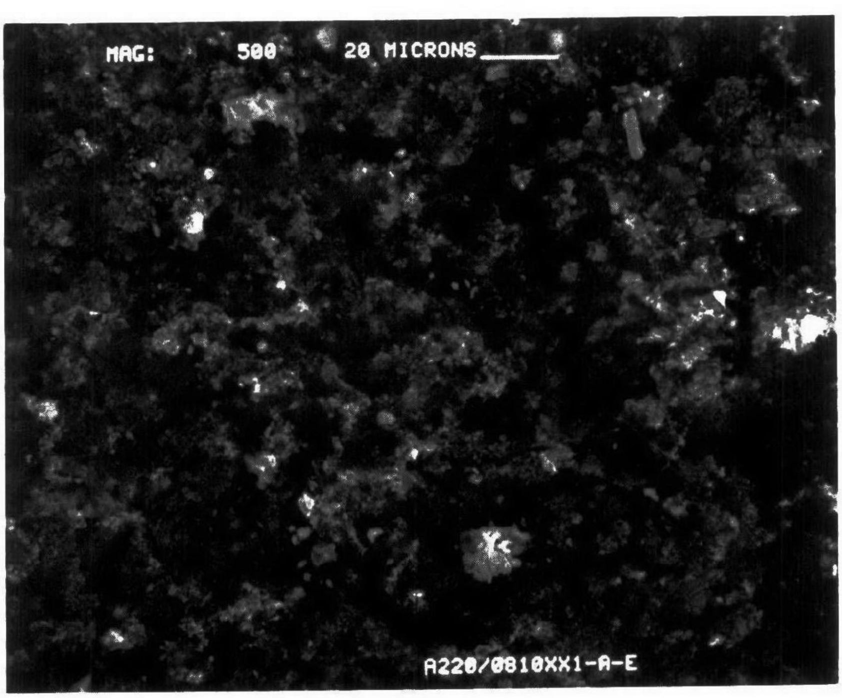


Figure D-62. Scanning Electron Micrograph at X500 of Converter A220/0810

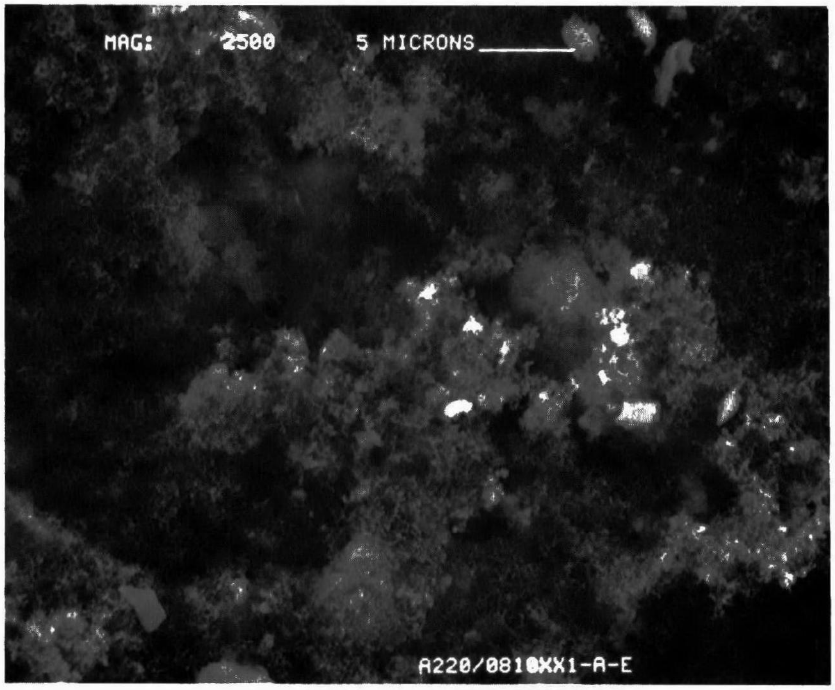


Figure D-63. Scanning Electron Micrograph at X2500 of Converter A220/0810

Figure D-64. Scanning Electron Micrograph at X5000 of Converter A220/0810

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE
TO LOW FOR ADEQUATE MAPPING

Figure D-65. Aluminum Dot Map at X5000 of Converter A220/0810

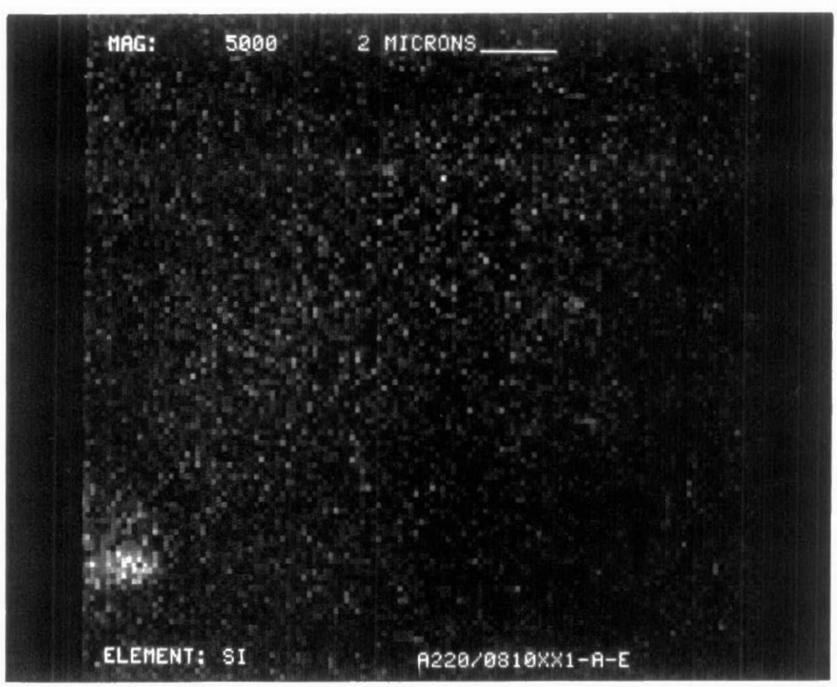


Figure D-66. Silicon Dot Map at X5000 of Converter A220/0810

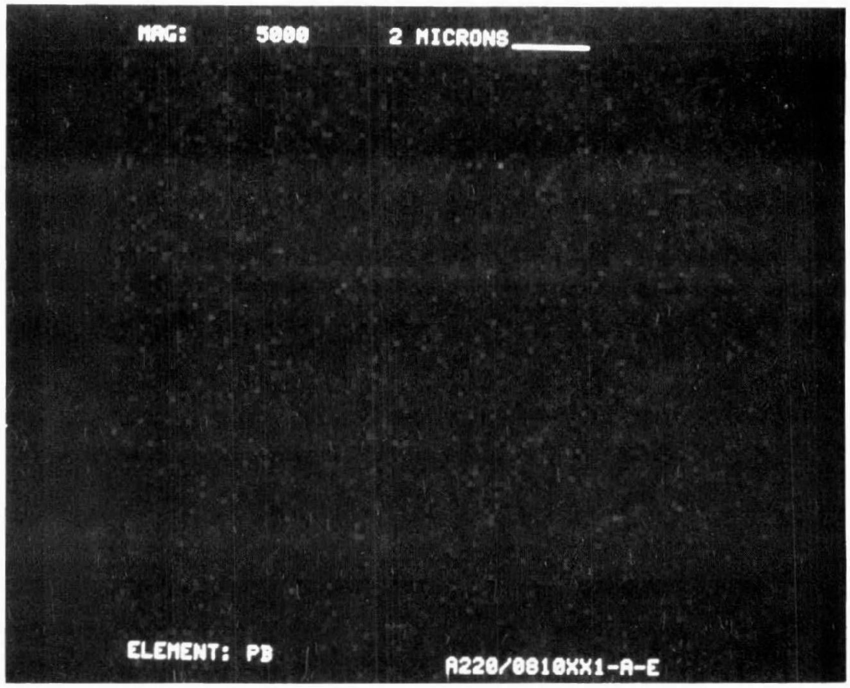


Figure D-67. Lead Dot Map at X5000 of Converter A220/0810

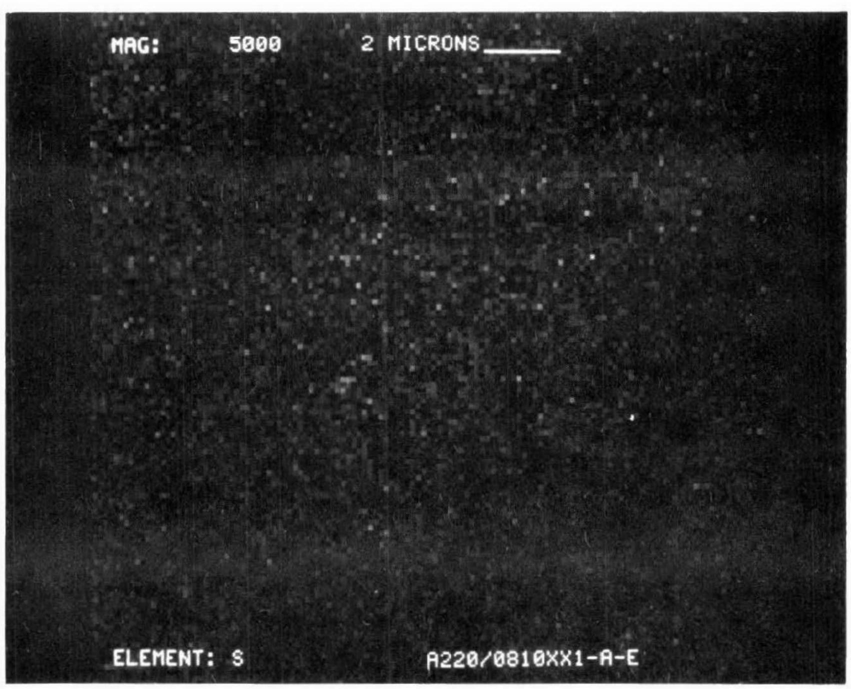


Figure D-68. Sulfur Dot Map at X5000 of Converter A220/0810

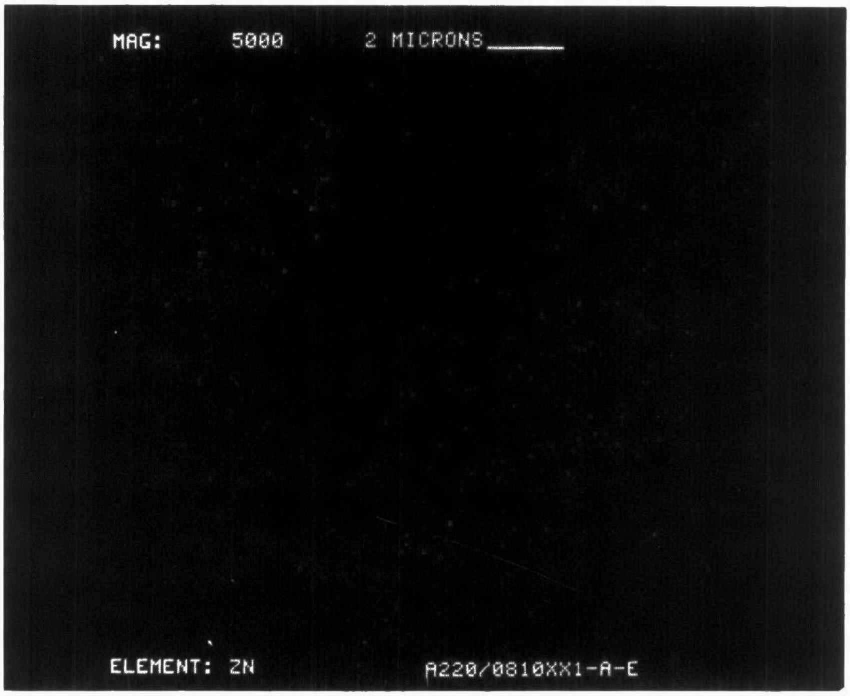


Figure D-69. Zinc Dot Map at X5000 of Converter A220/0810

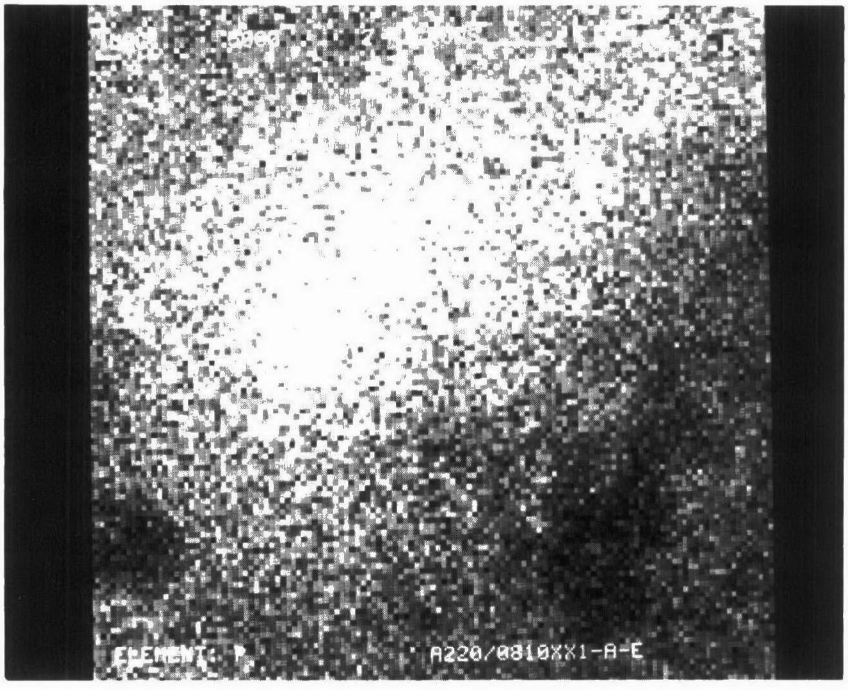


Figure D-70. Phosphorus Dot Map at X5000 of Converter A220/0810

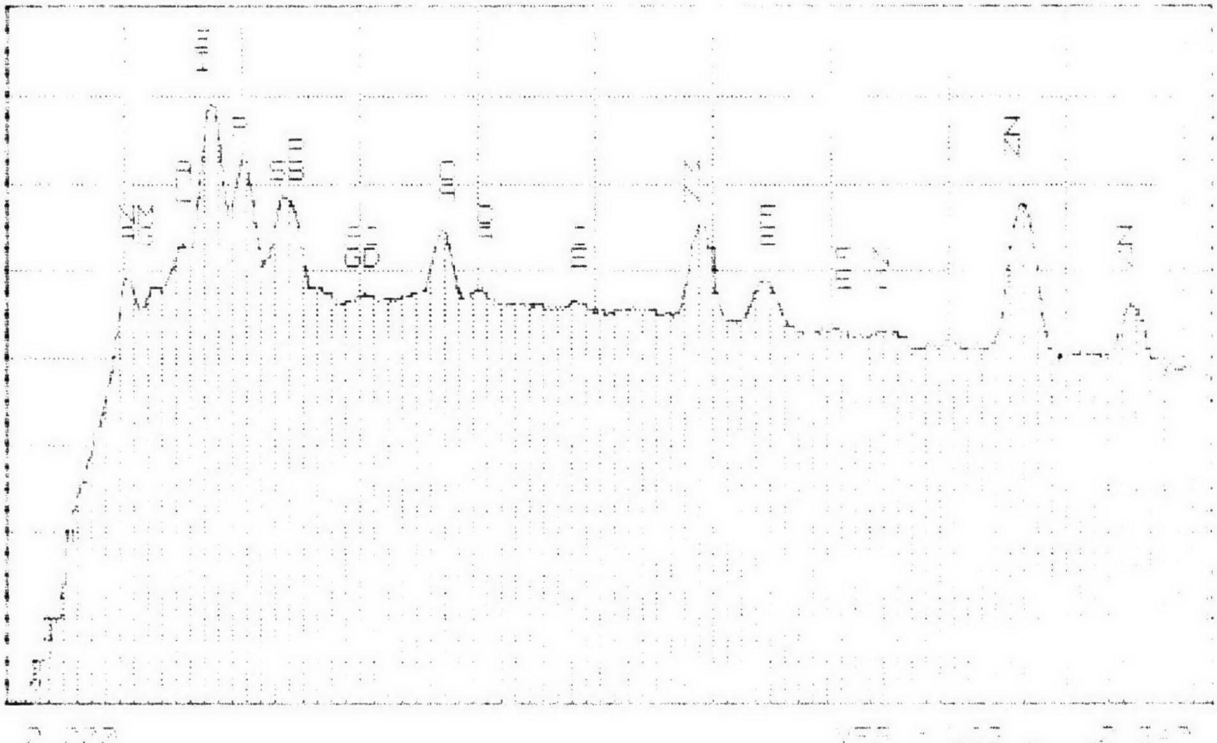


Figure D-71. SEM/EDX Spectrum of Converter A221/0152

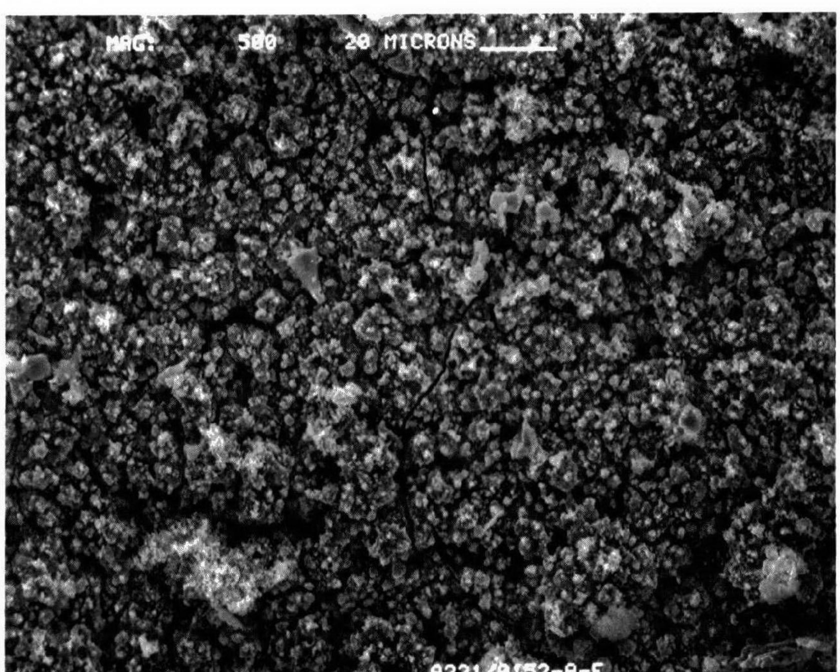


Figure D-72. Scanning Electron Micrograph at X500 of Converter A221/0152

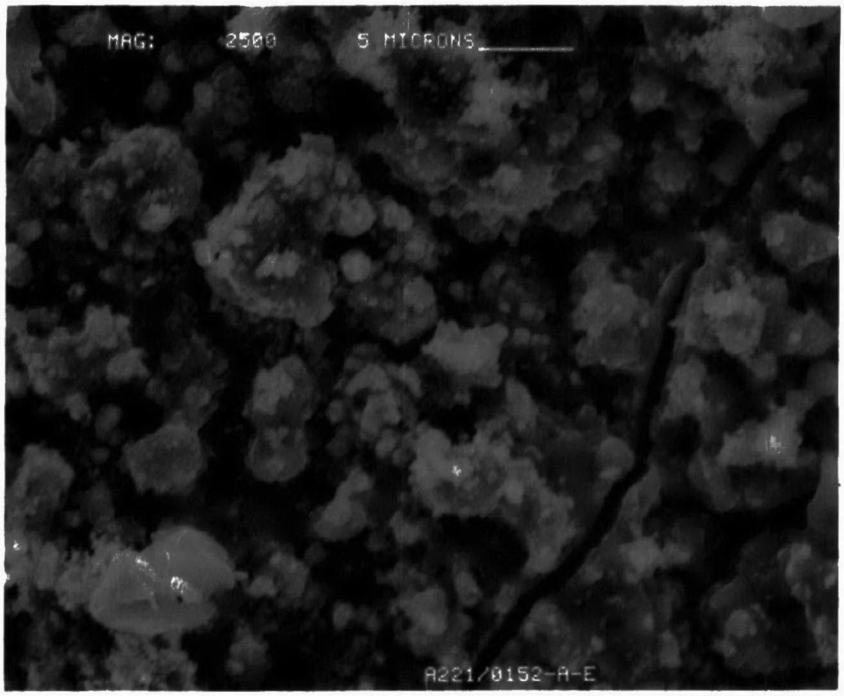


Figure D-73. Scanning Electron Micrograph at X2500 of Converter A221/0152

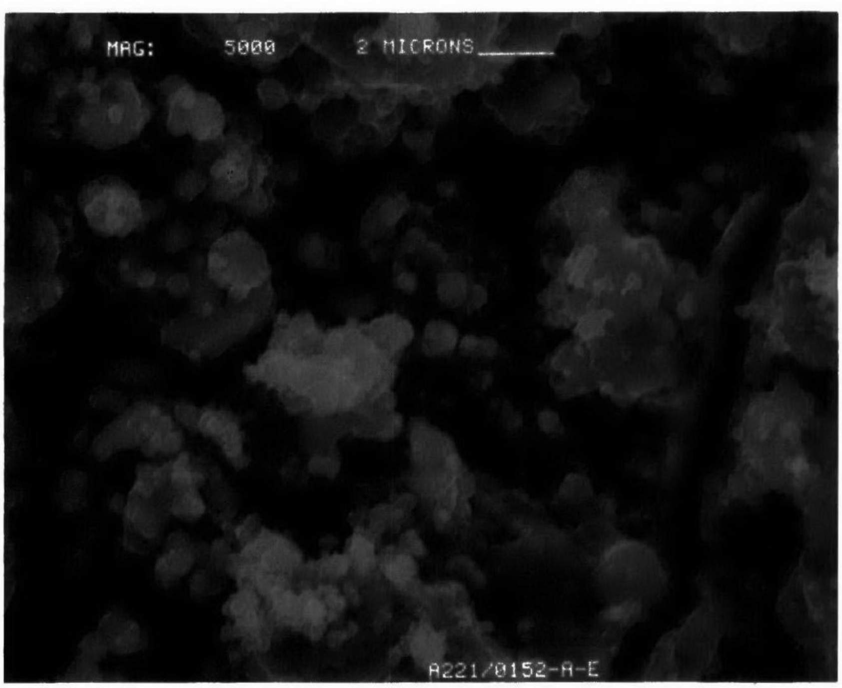


Figure D-74. Scanning Electron Micrograph at X5000 of Converter A221/0152

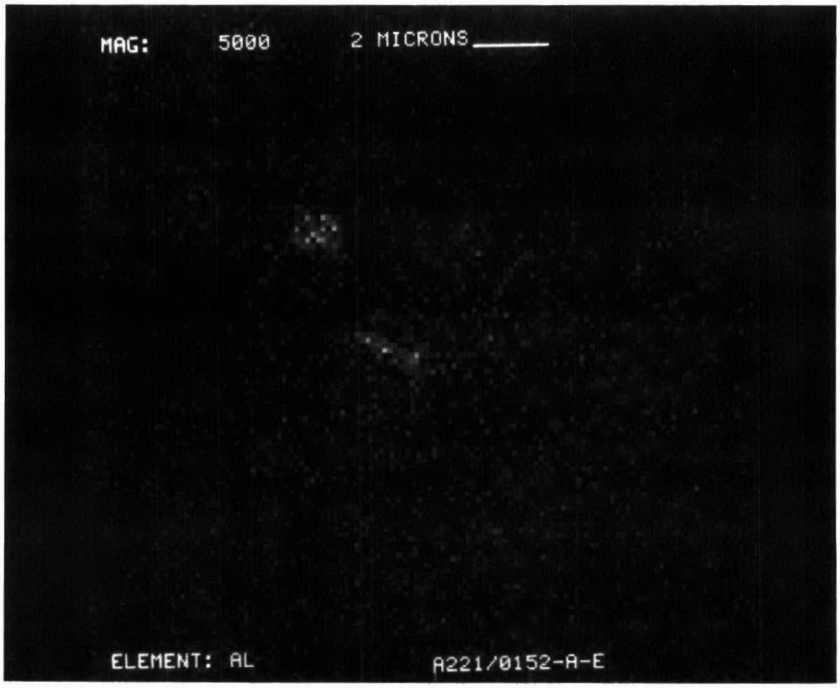


Figure D-75. Aluminum Dot Map at X5000 of Converter A221/0152

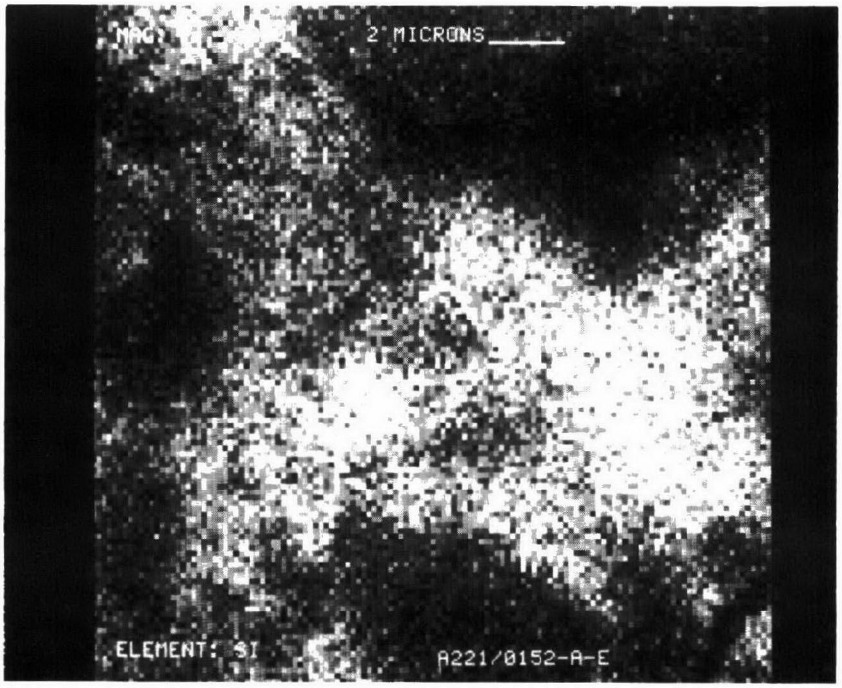


Figure D-76. Silicon Dot Map at X5000 of Converter A221/0152

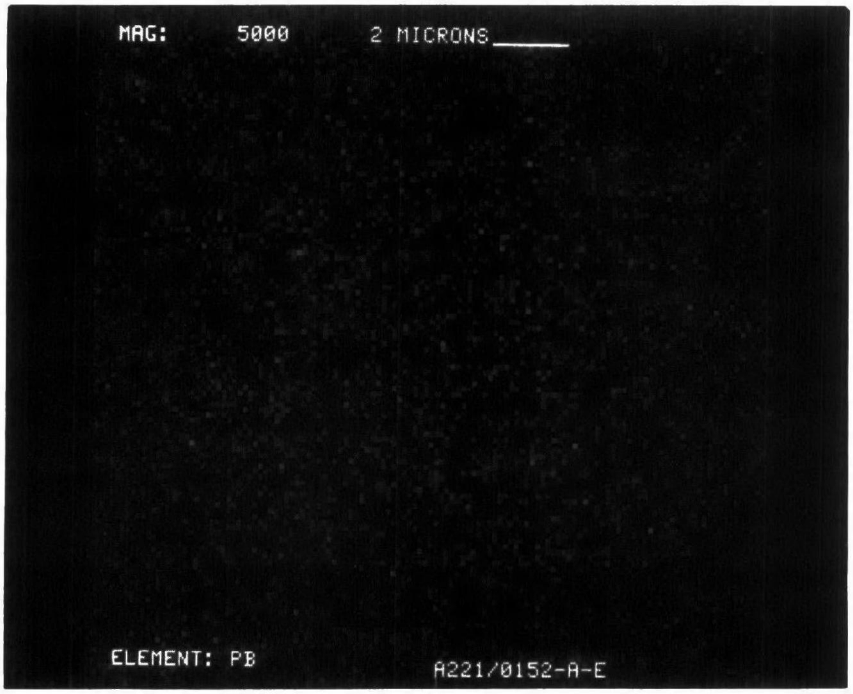


Figure D-77. Lead Dot Map at X5000 of Converter A221/0152

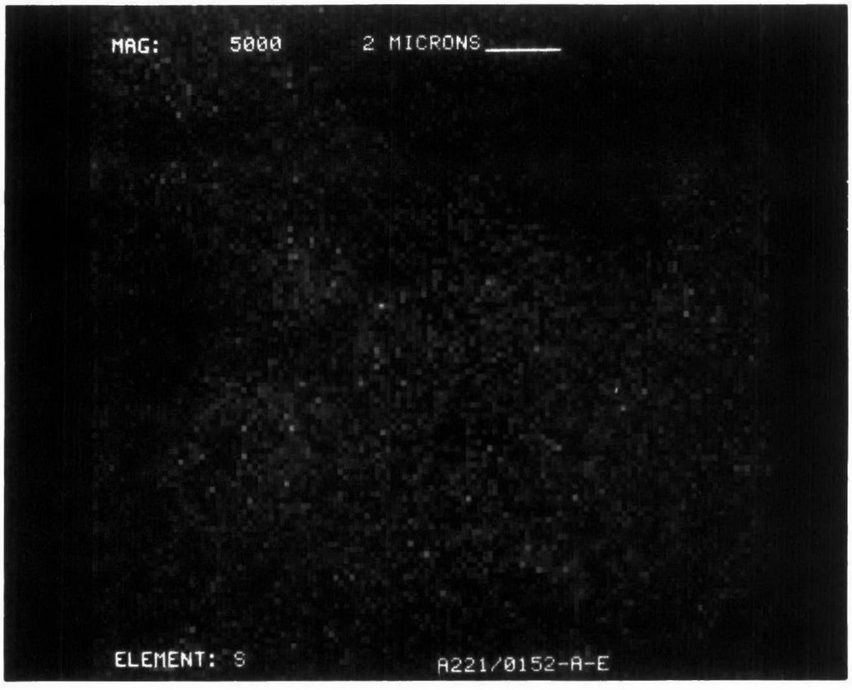


Figure D-78. Sulfur Dot Map at X5000 of Converter A221/0152

Figure D-79. Zinc Dot Map at X5000 of Converter A221/0152

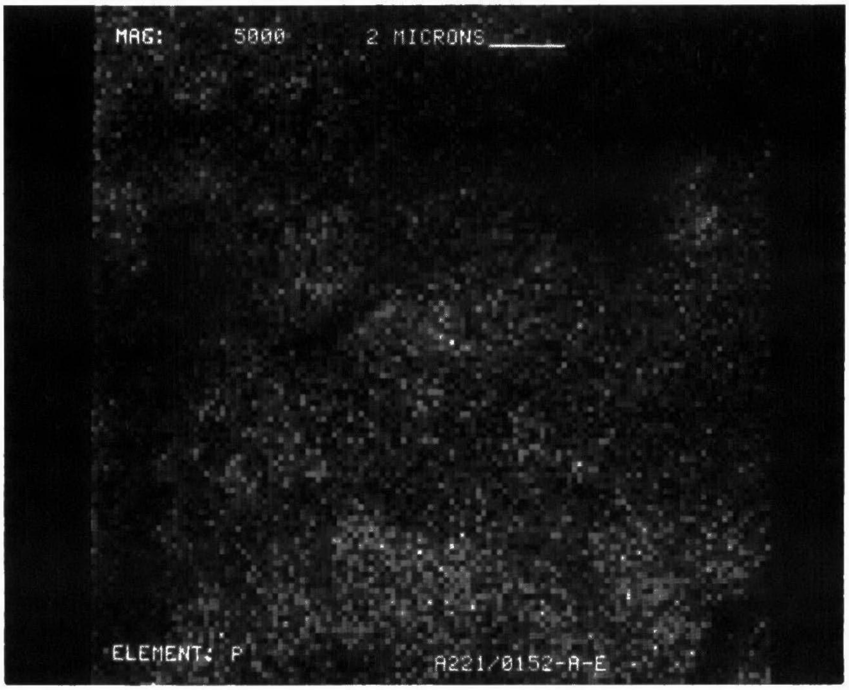


Figure D-80. Phosphorus Dot Map at X5000 of Converter A221/0152

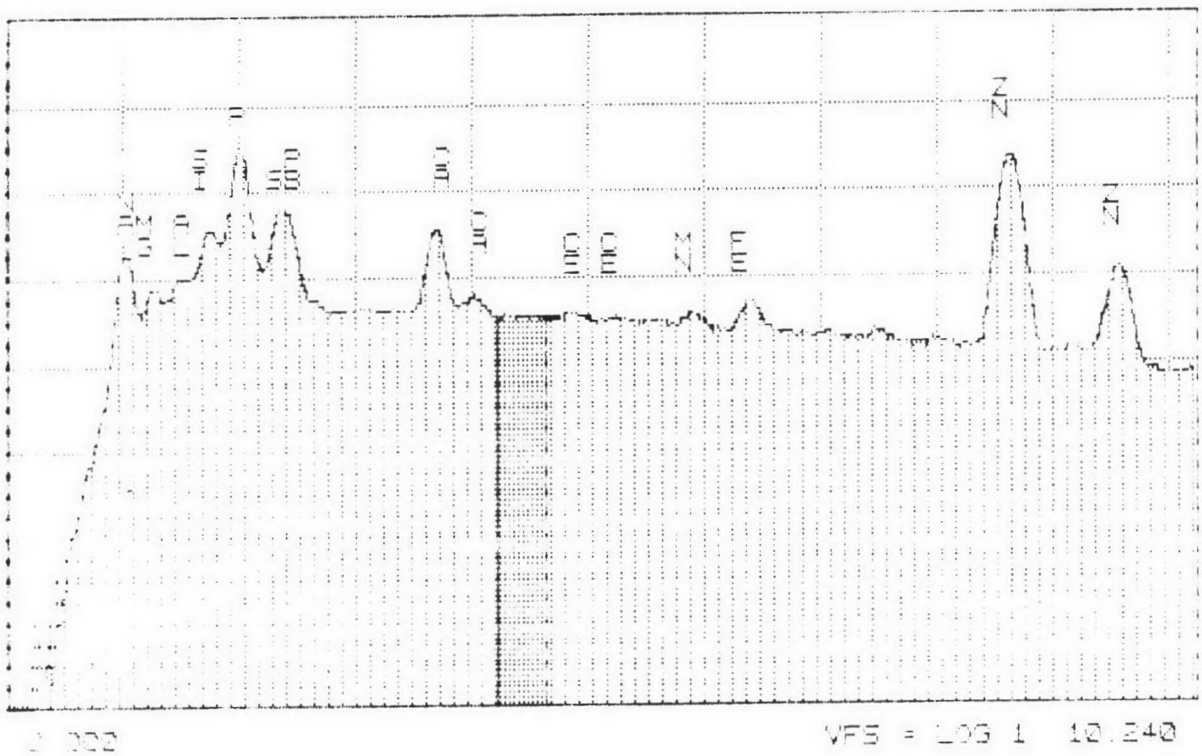


Figure D-81. SEM/EDX Spectrum of Converter A221/0204

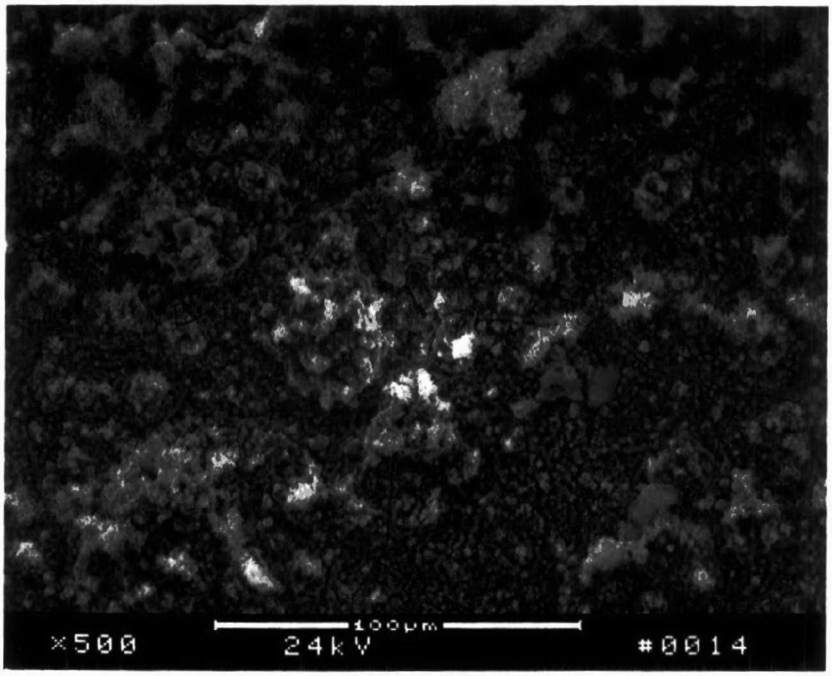


Figure D-82. Scanning Electron Micrograph at X500 of Converter A221/0204

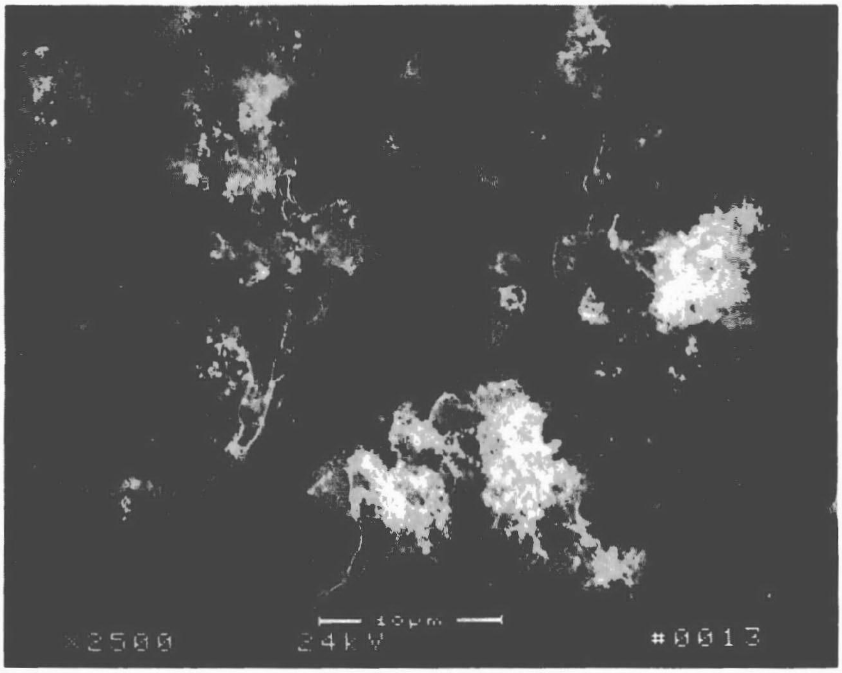


Figure D-83. Scanning Electron Micrograph at X2500 of Converter A221/0204

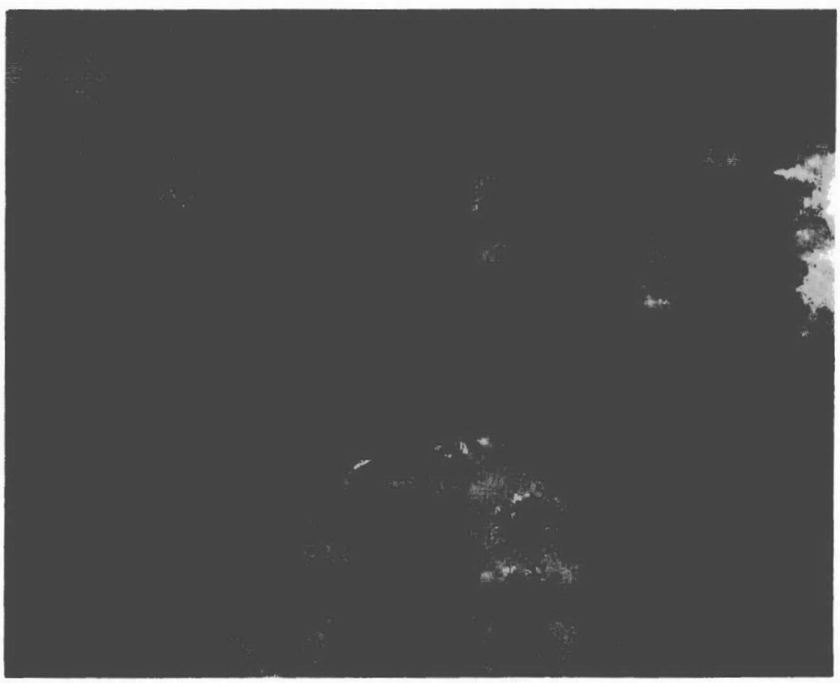


Figure D-84. Scanning Electron Micrograph at X5000 of Converter A221/0204

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE TO LOW FOR ADEQUATE MAPPING

Figure D-85. Aluminum Dot Map at X5000 of Converter A221/0204

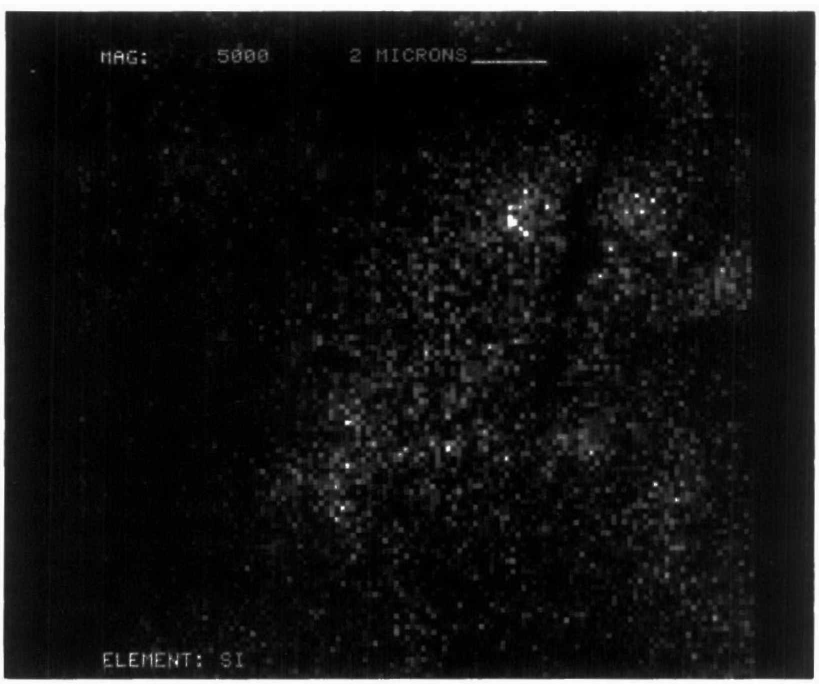


Figure D-86. Silicon Dot Map at X5000 of Converter A221/0204

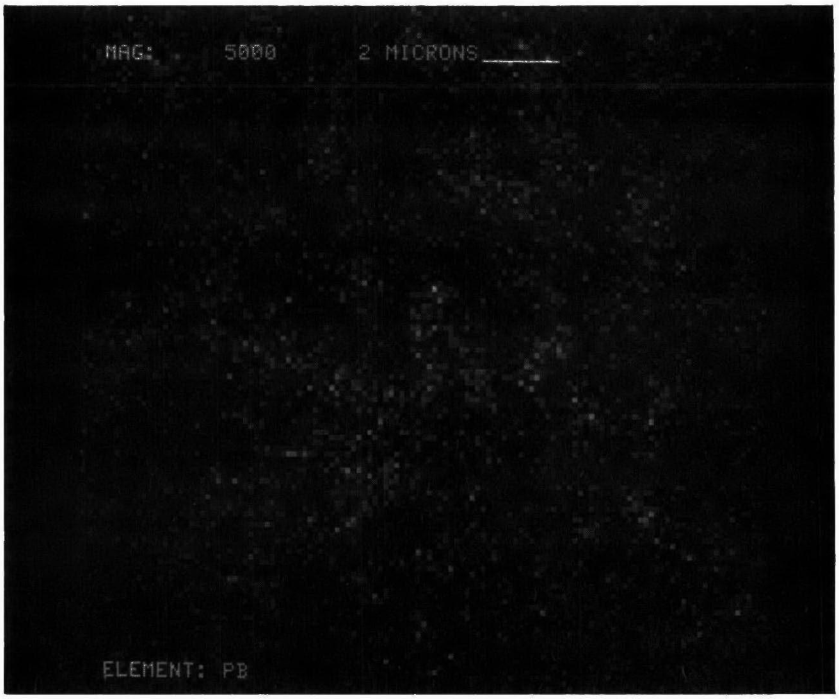


Figure D-87. Lead Dot Map at X5000 of Converter A221/0204

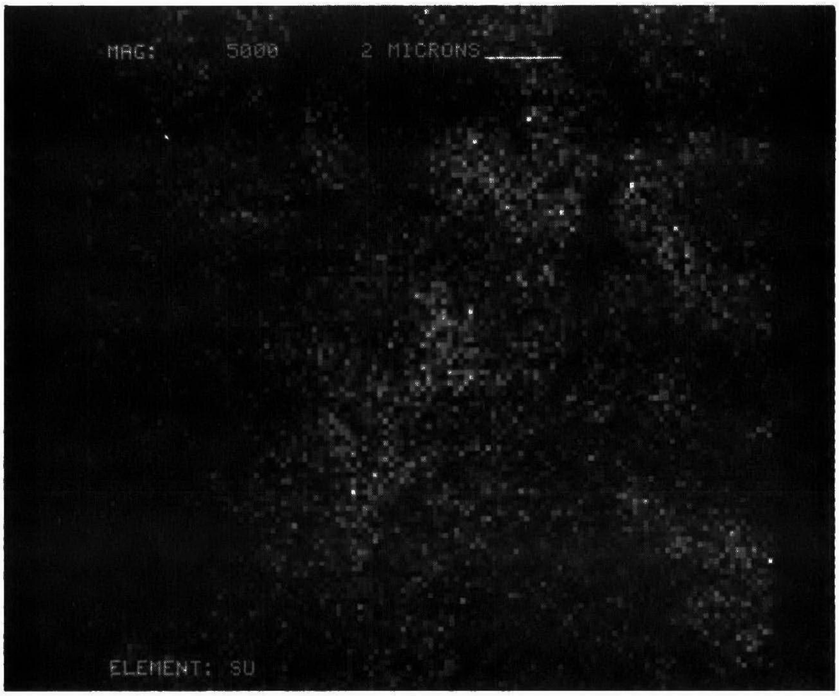


Figure D-88. Sulfur Dot Map at X5000 of Converter A221/0204

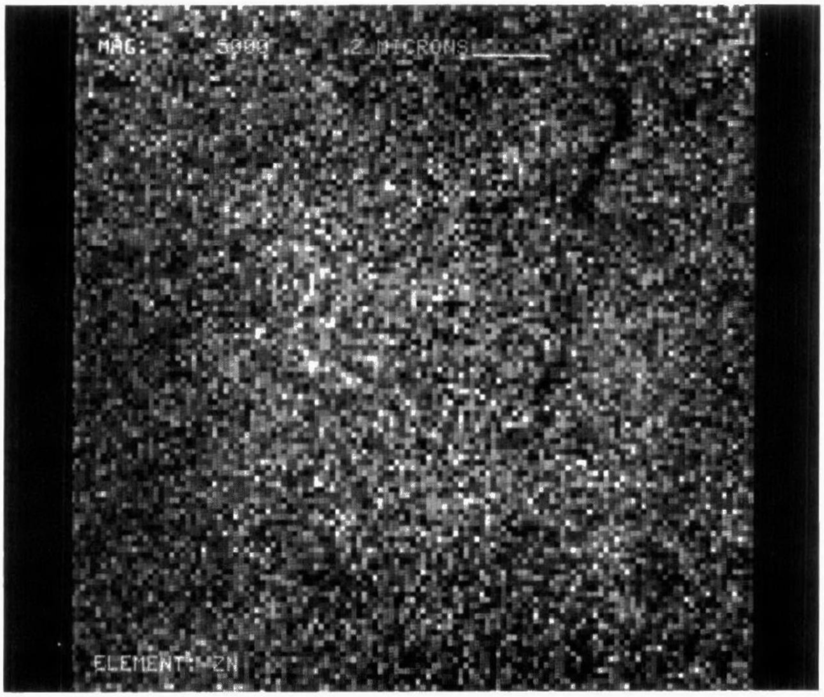


Figure D-89. Zinc Dot Map at X5000 of Converter A221/0204

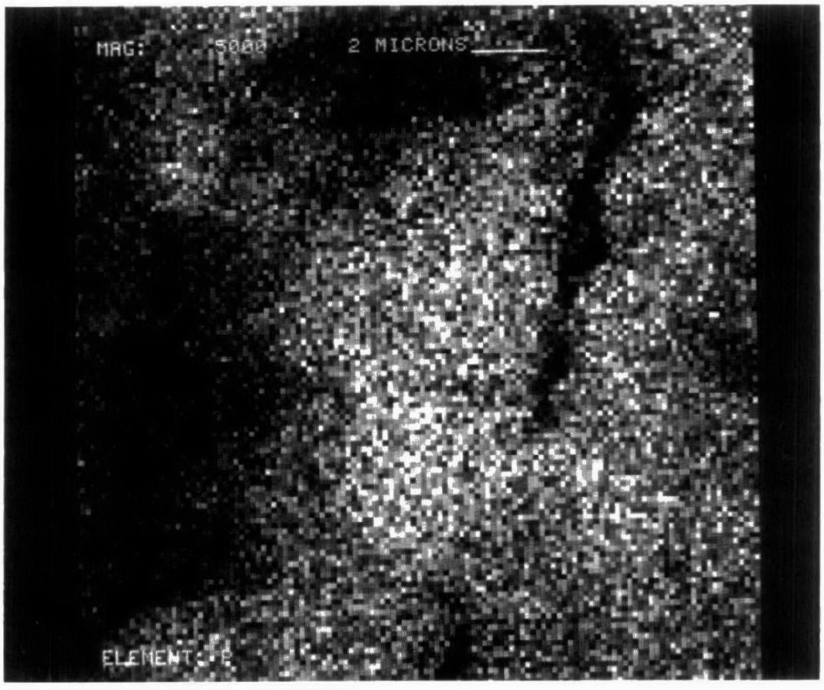


Figure D-90. Phosphorus Dot Map at X5000 of Converter A221/0204

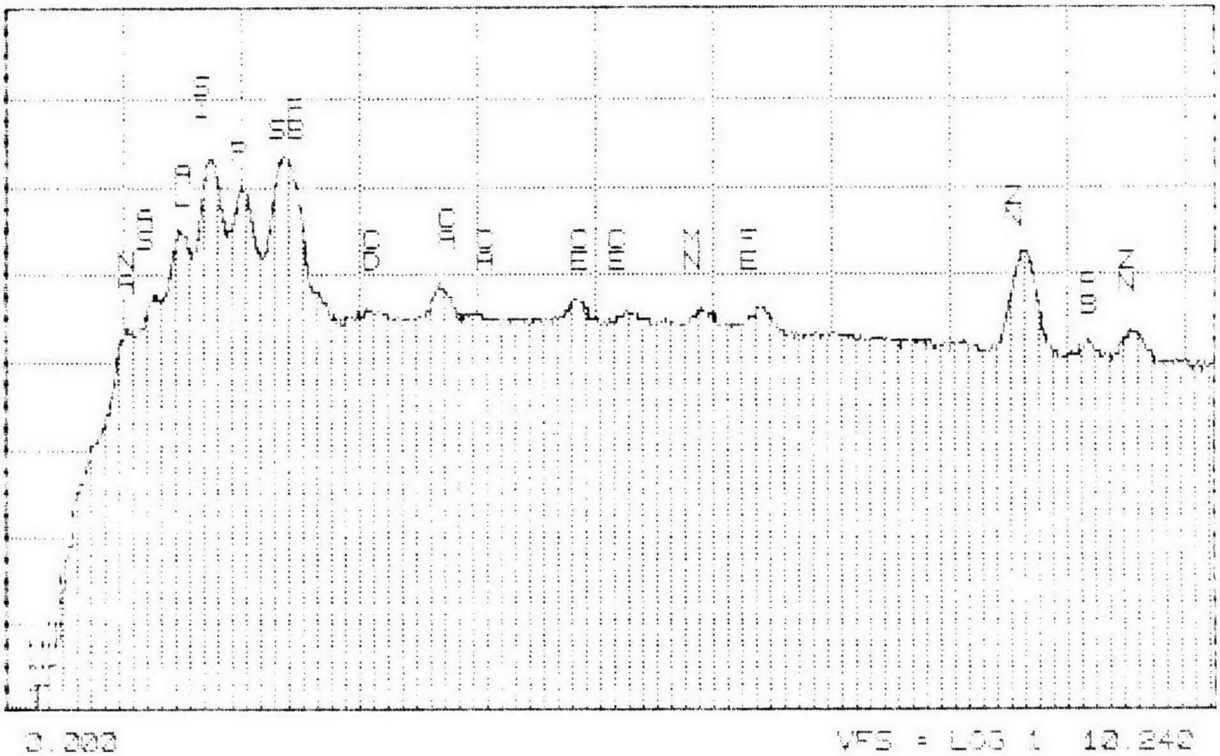


Figure D-91. SEM/EDX Spectrum of Converter A221/0447

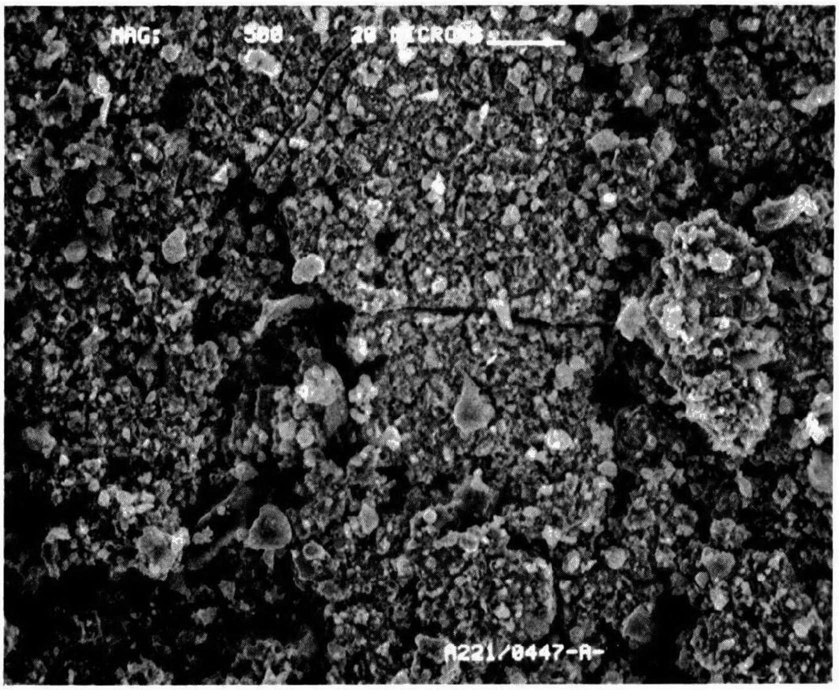


Figure D-92. Scanning Electron Micrograph at X500 of Converter A221/0447

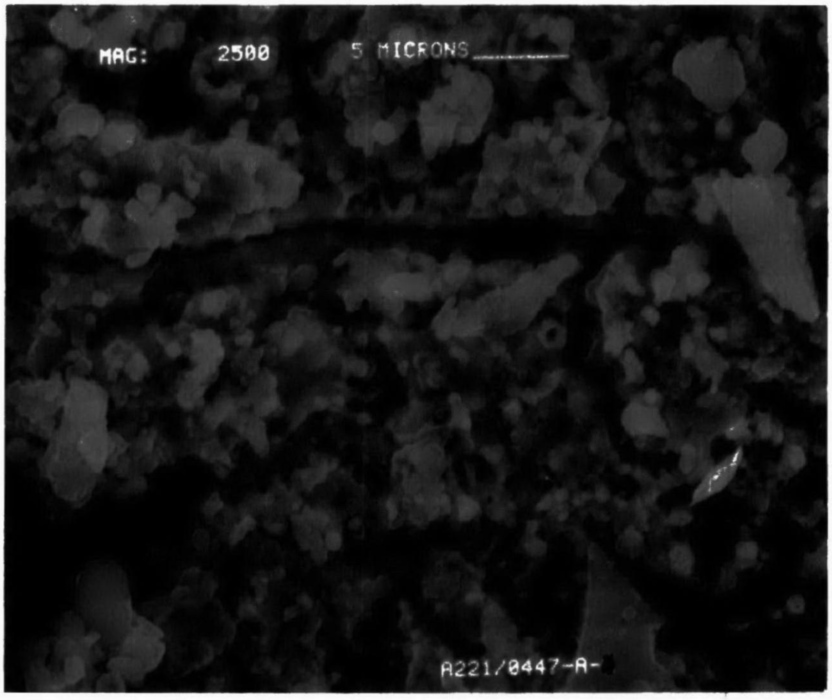


Figure D-93. Scanning Electron Micrograph at X2500 of Converter A221/0447

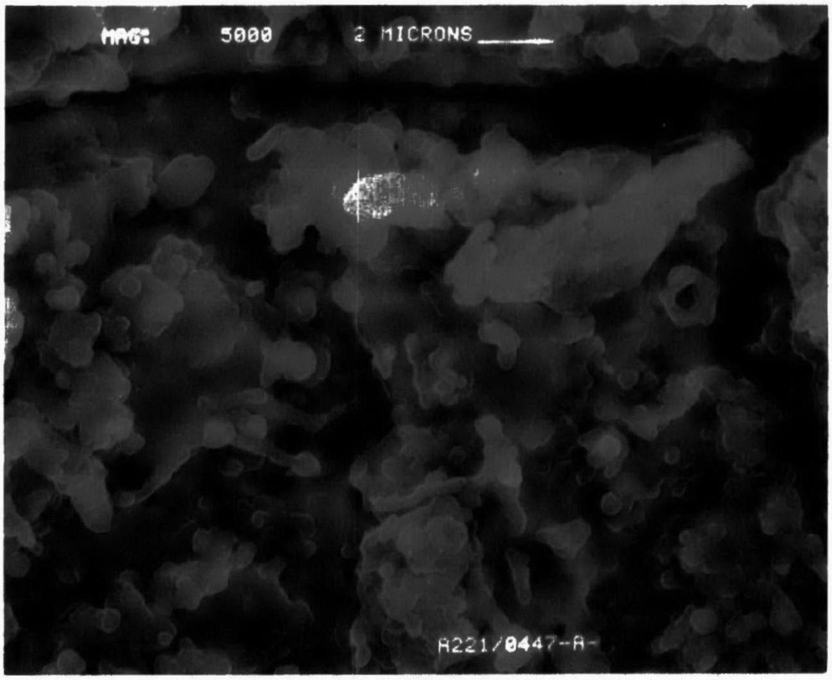


Figure D-94. Scanning Electron Micrograph at X5000 of Converter A221/0447

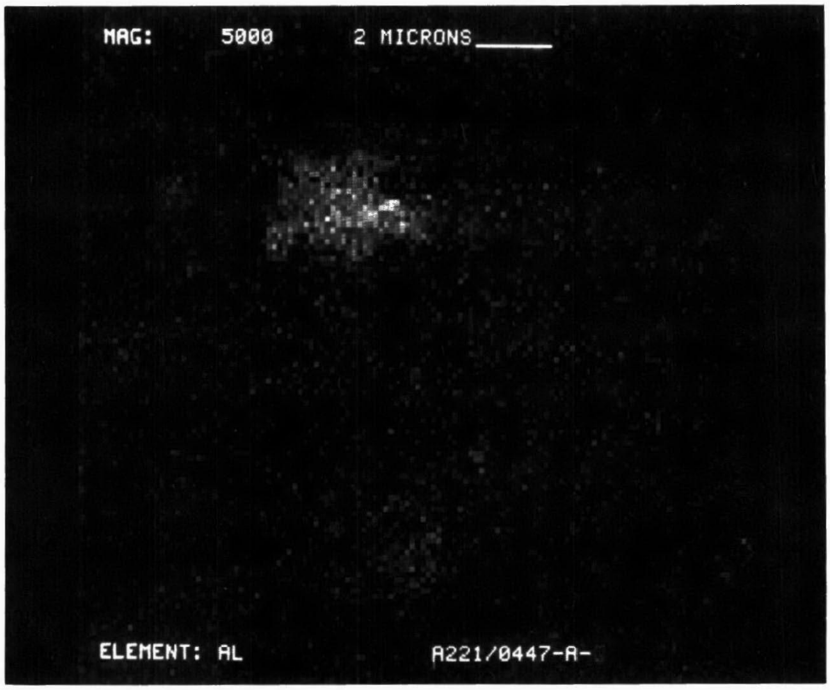


Figure D-95. Aluminum Dot Map at X5000 of Converter A221/0447

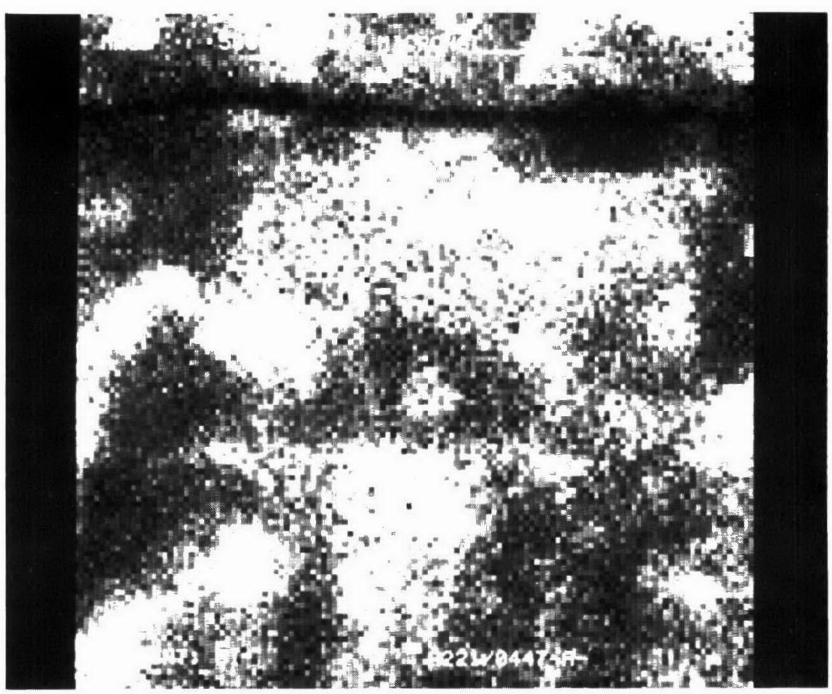


Figure D-96. Silicon Dot Map at X5000 of Converter A221/0447

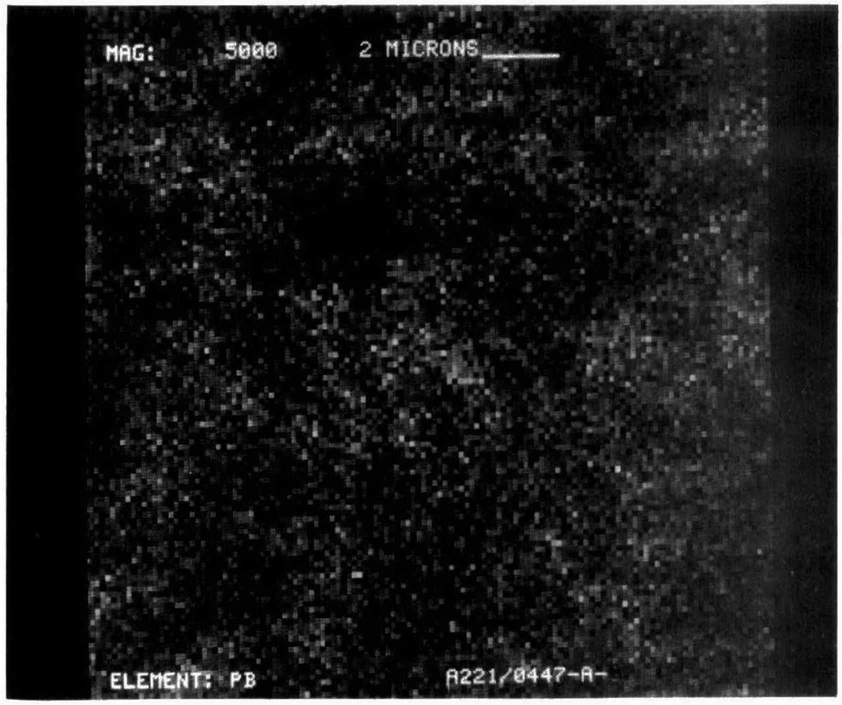


Figure D-97. Lead Dot Map at X5000 of Converter A221/0447

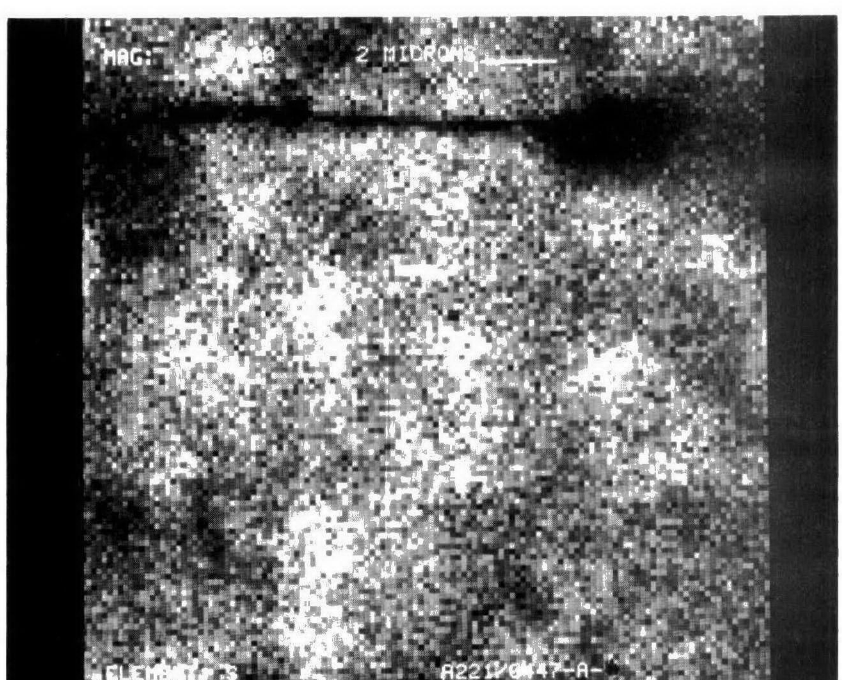


Figure D-98. Sulfur Dot Map at X5000 of Converter A221/0447

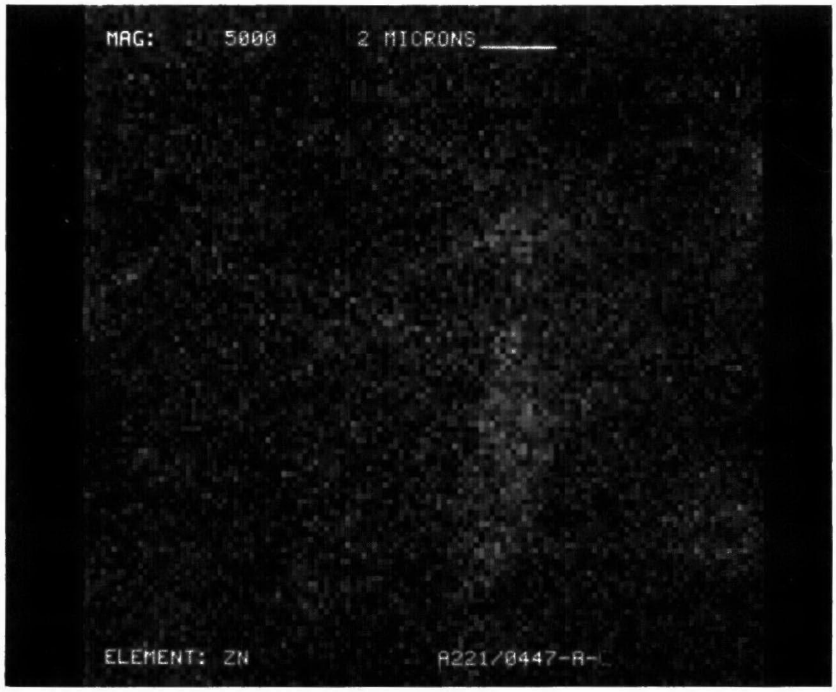


Figure D-99. Zinc Dot Map at X5000 of Converter A221/0447

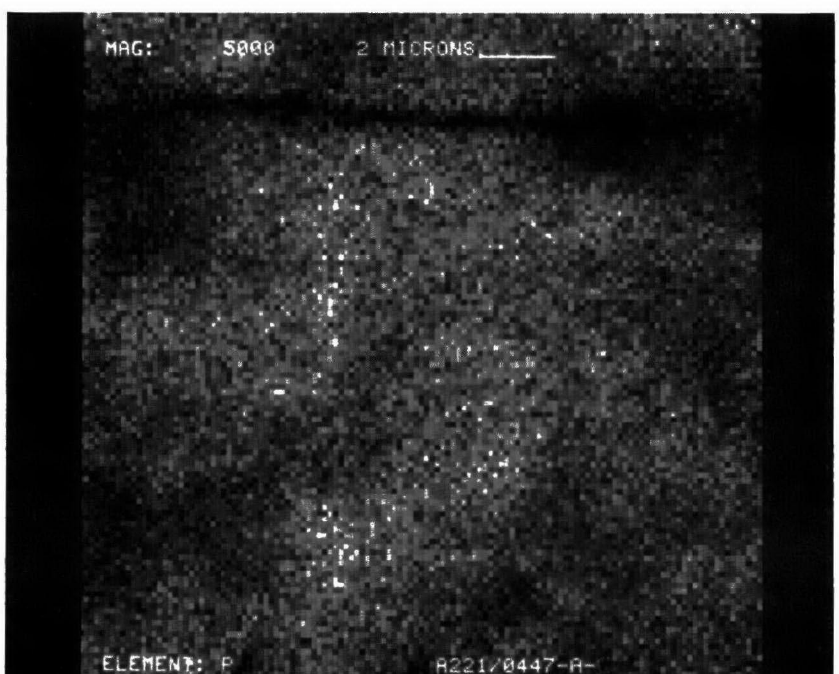


Figure D-100. Phosphorus Dot Map at X5000 of Converter A221/0447

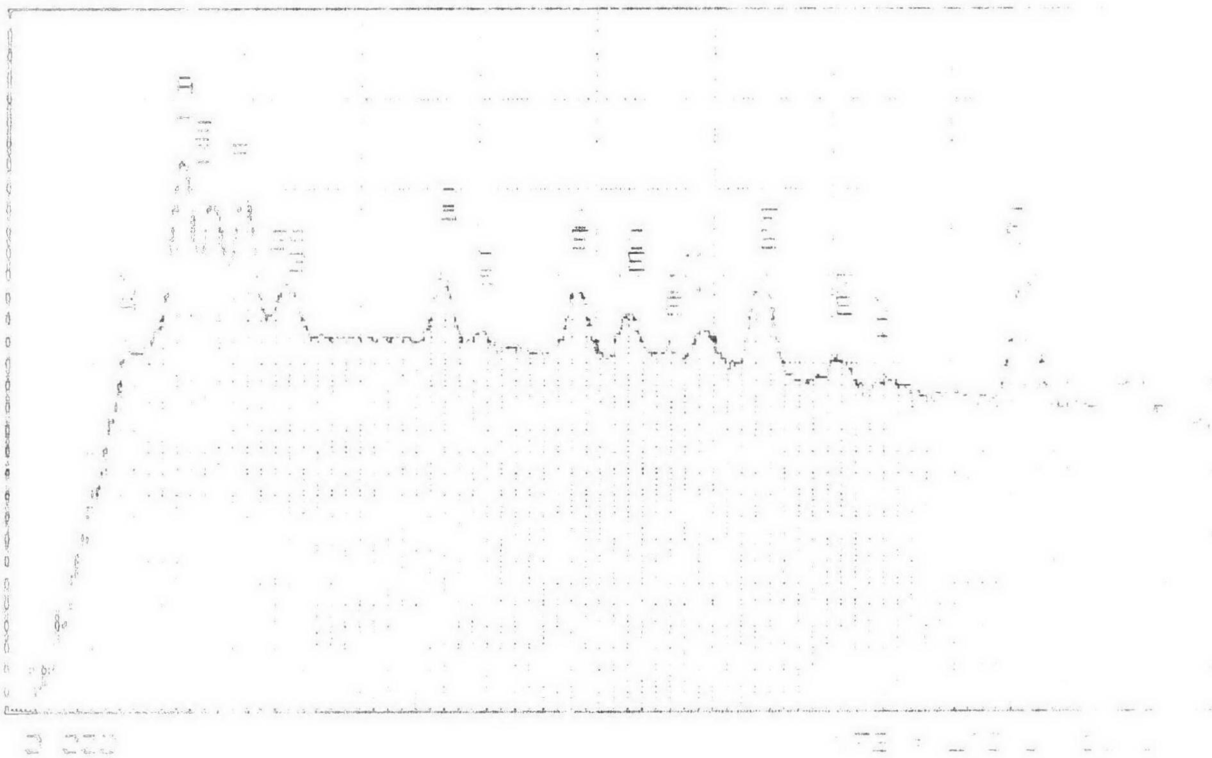


Figure D-101. SEM/EDX Spectrum of Converter A230/0177X

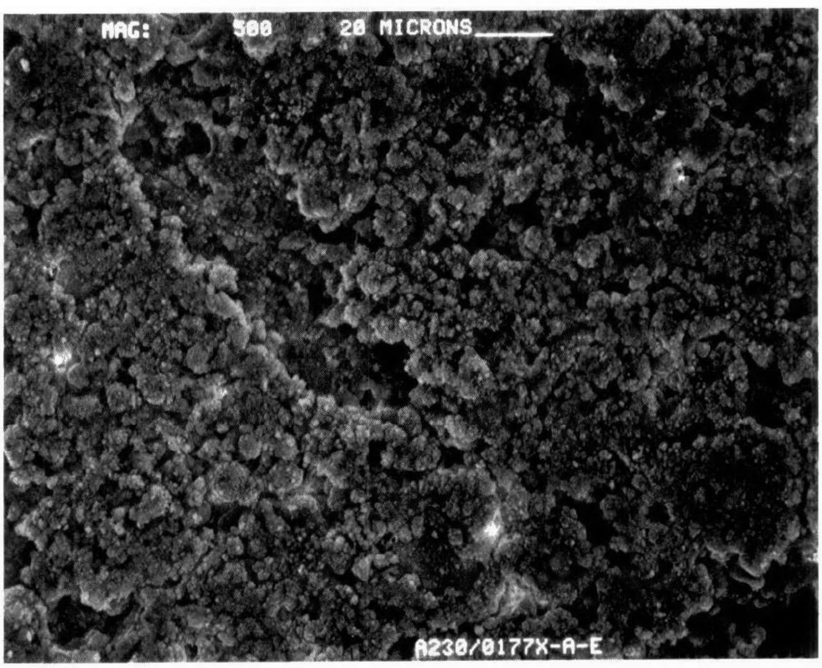


Figure D-102. Scanning Electron Micrograph at X500 of Converter A230/0177X

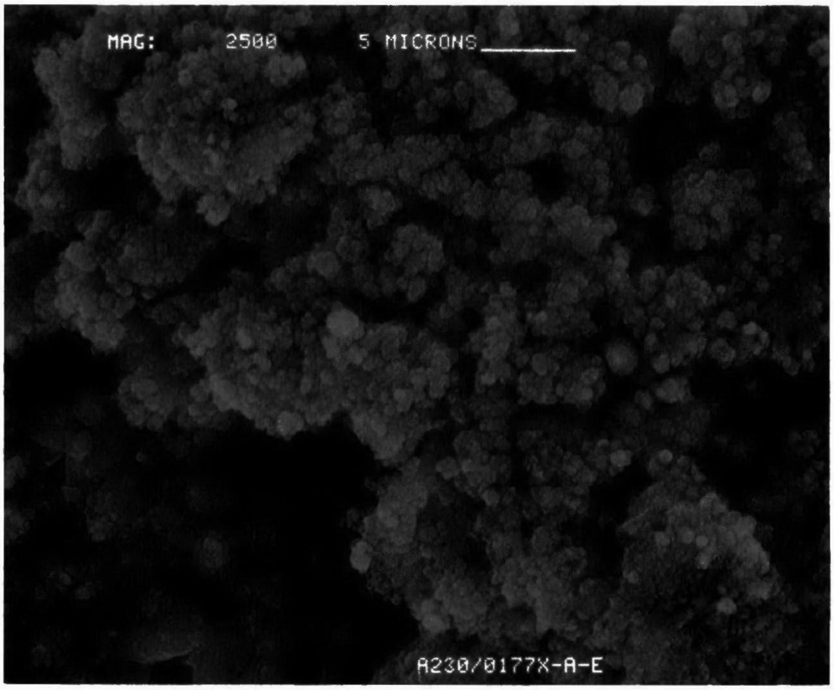


Figure D-103. Scanning Electron Micrograph at X2500 of Converter A230/0177X

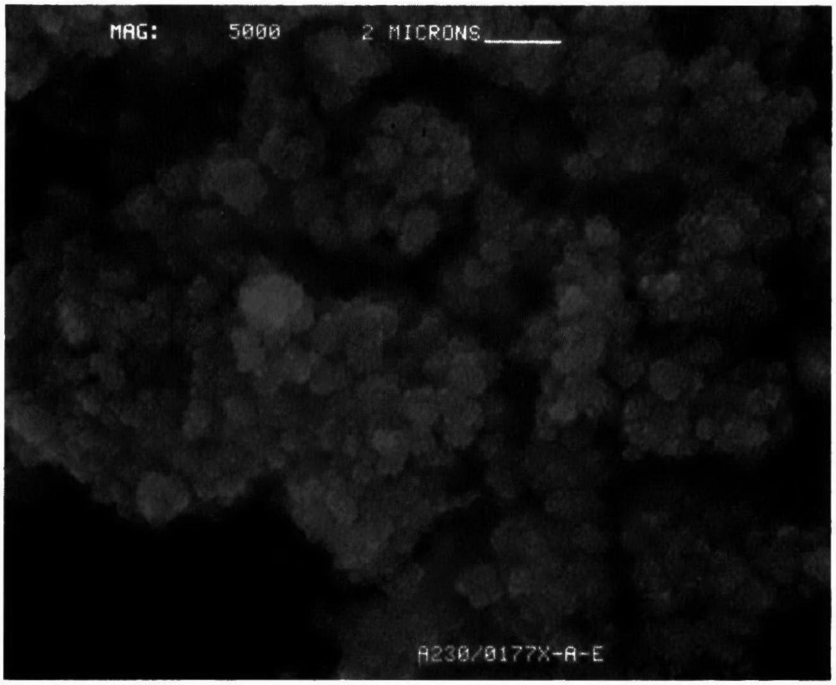


Figure D-104. Scanning Electron Micrograph at X5000 of Converter A230/0177X

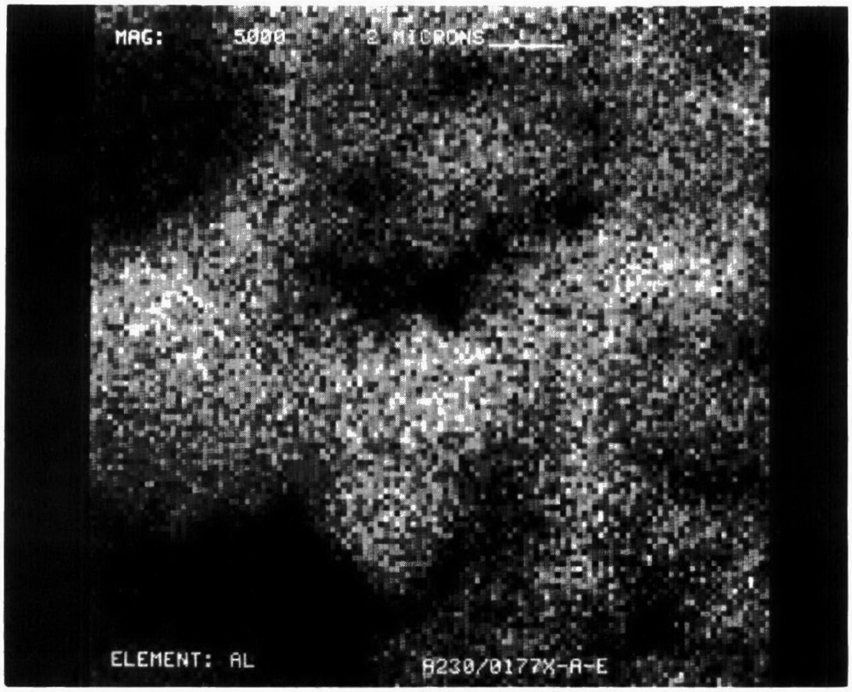


Figure D-105. Aluminum Dot Map at X5000 of Converter A230/0177X

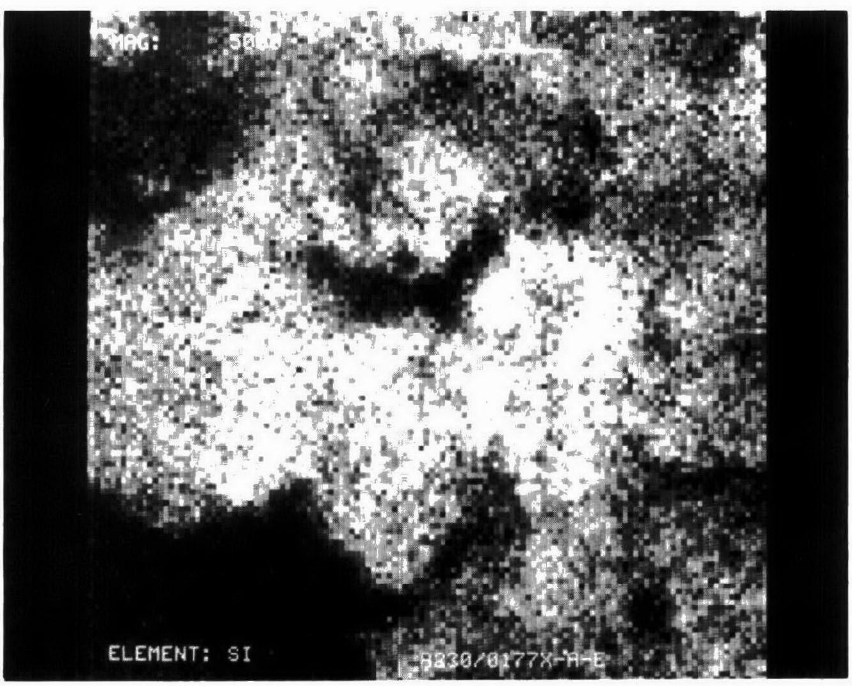


Figure D-106. Silicon Dot Map at X5000 of Converter A230/0177X

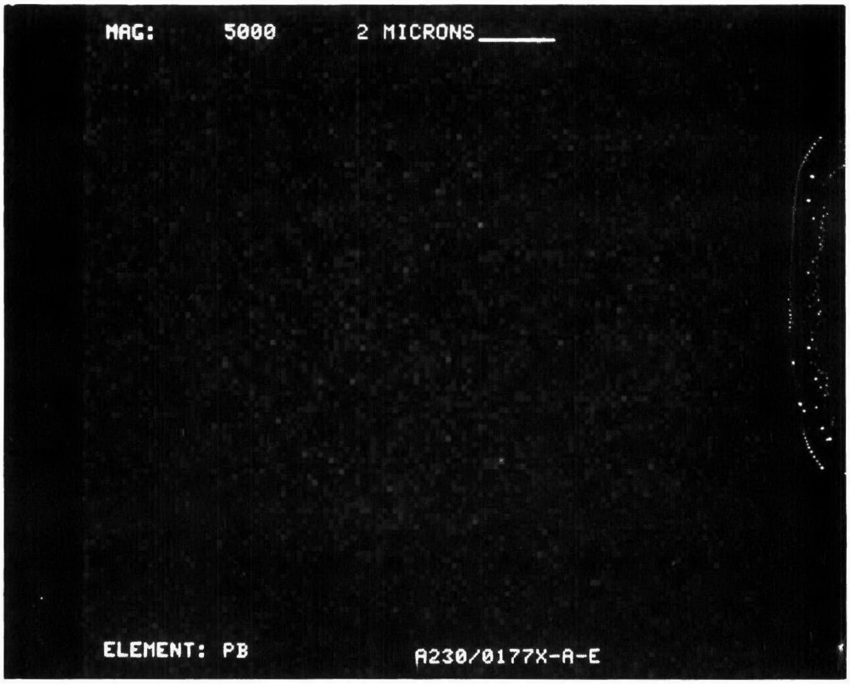


Figure D-107. Lead Dot Map at X5000 of Converter A230/0177X

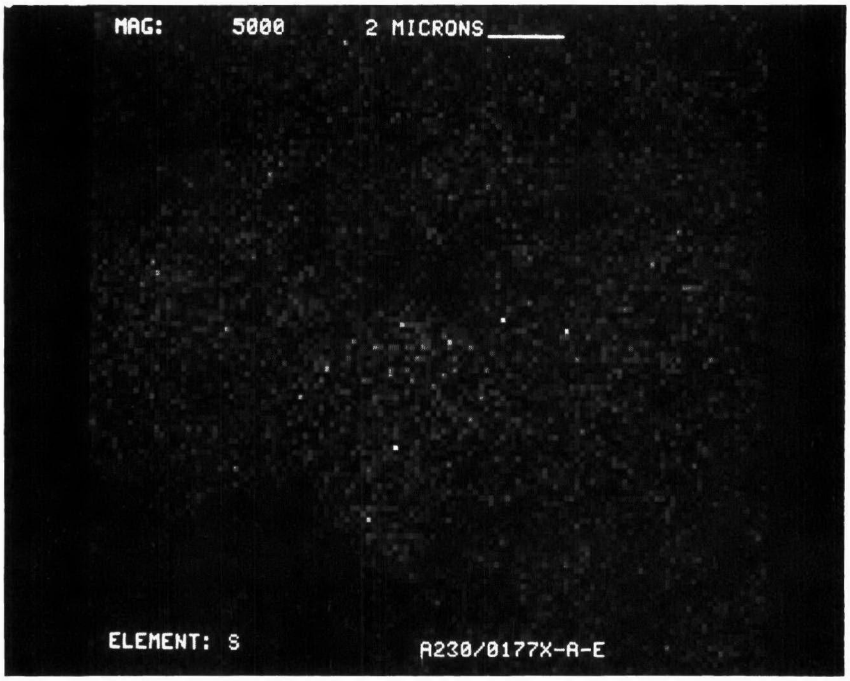


Figure D-108. Sulfur Dot Map at X5000 of Converter A230/0177X

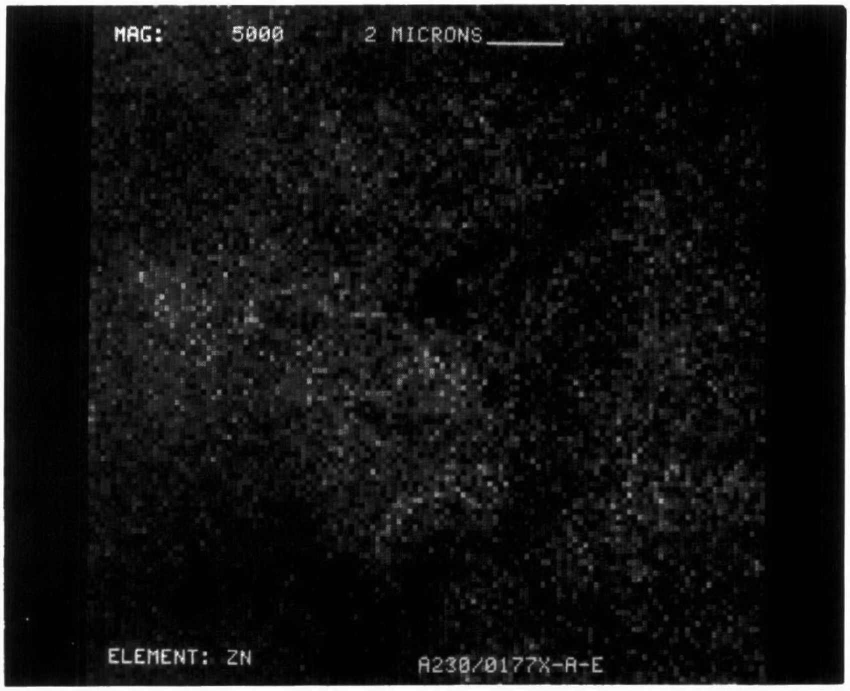


Figure D-109. Zinc Dot Map at X5000 of Converter A230/0177X

Figure D-110. Phosphorus Dot Map at X5000 of Converter A230/0177X

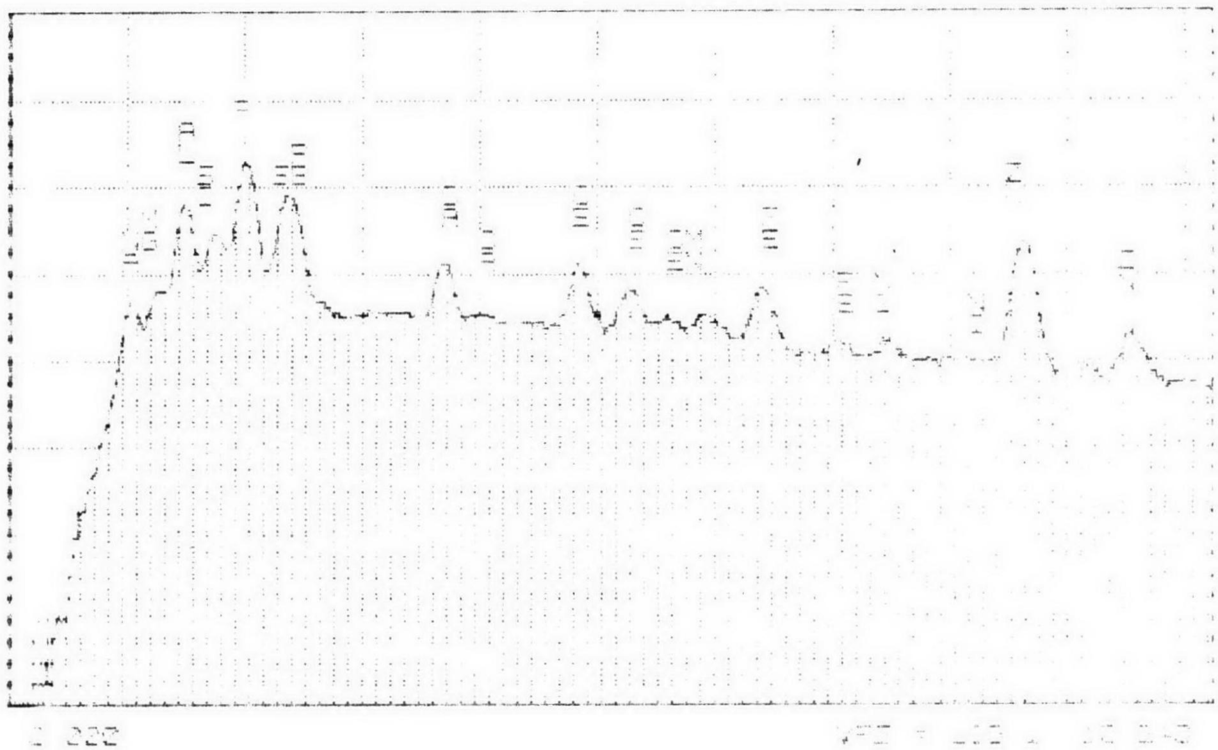


Figure D-111. SEM/EDX Spectrum of Converter A230/0636X

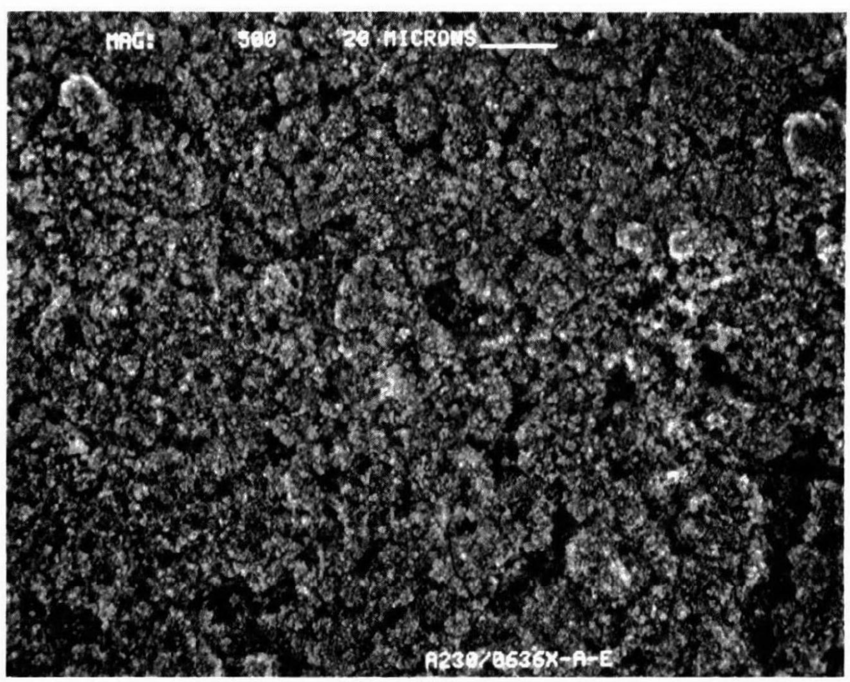


Figure D-112. Scanning Electron Micrograph at X500 of Converter A230/0636X

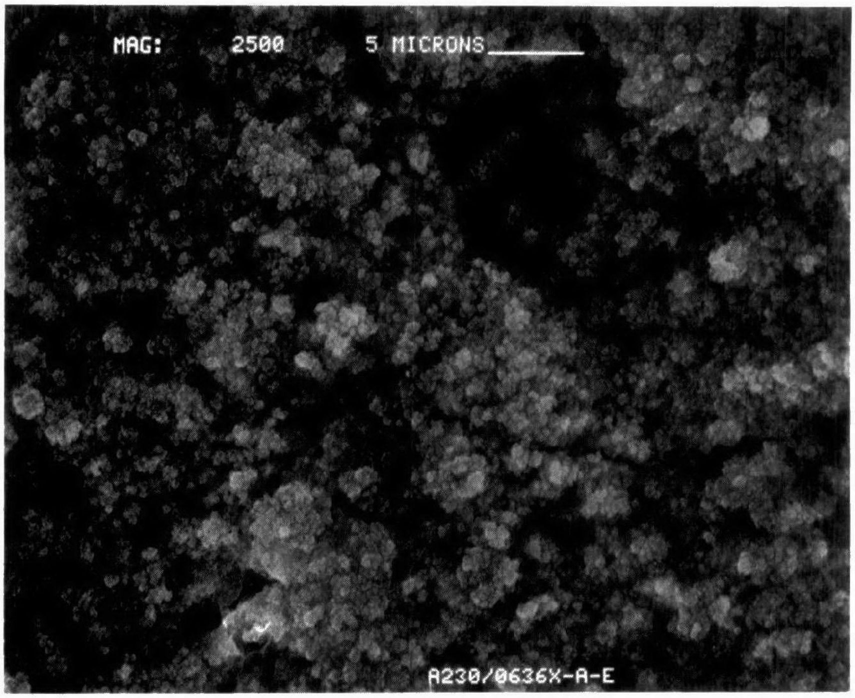


Figure D-113. Scanning Electron Micrograph at X2500 of Converter A230/0636X

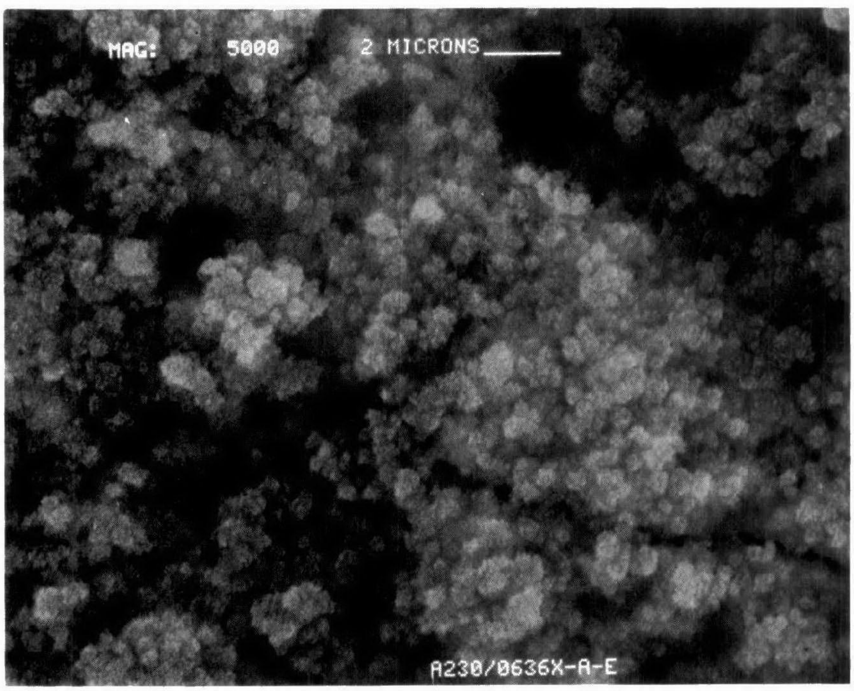


Figure D-114. Scanning Electron Micrograph at X5000 of Converter A230/0636X

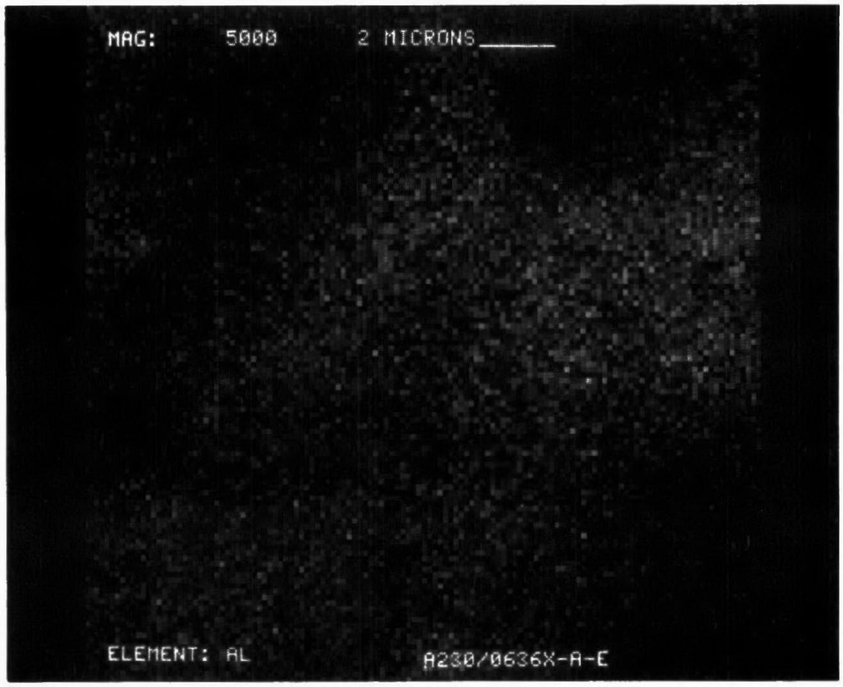


Figure D-115. Aluminum Dot Map at X5000 of Converter A230/0636X

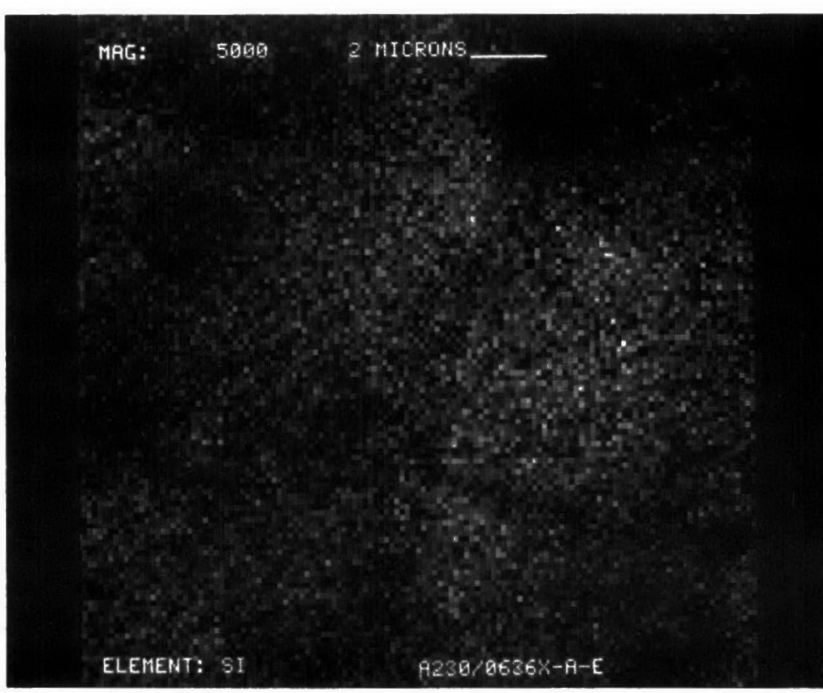


Figure D-116. Silicon Dot Map at X5000 of Converter A230/0636X

Figure D-117. Lead Dot Map at X5000 of Converter A230/0636X

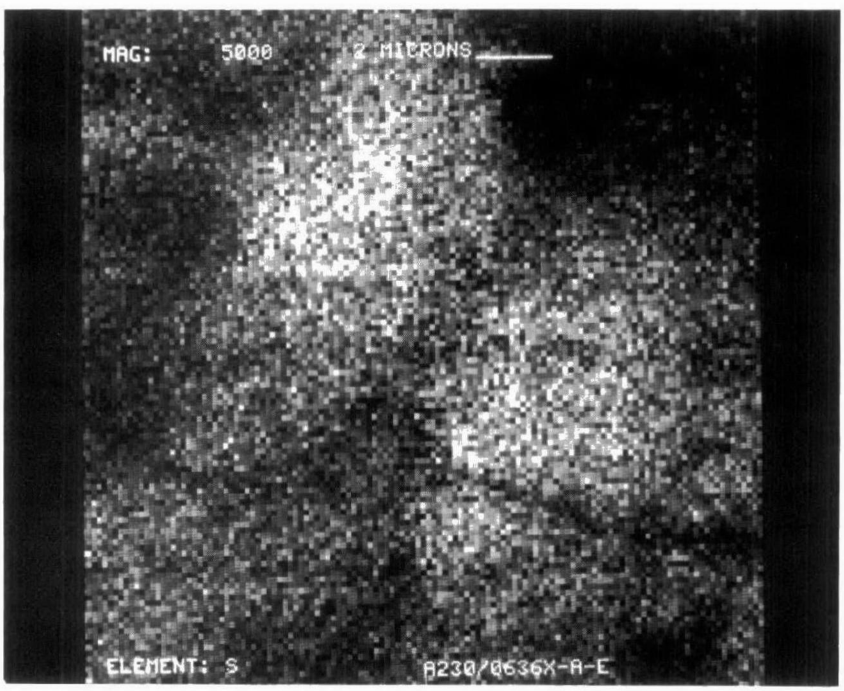


Figure D-118. Sulfur Dot Map at X5000 of Converter A230/0636X

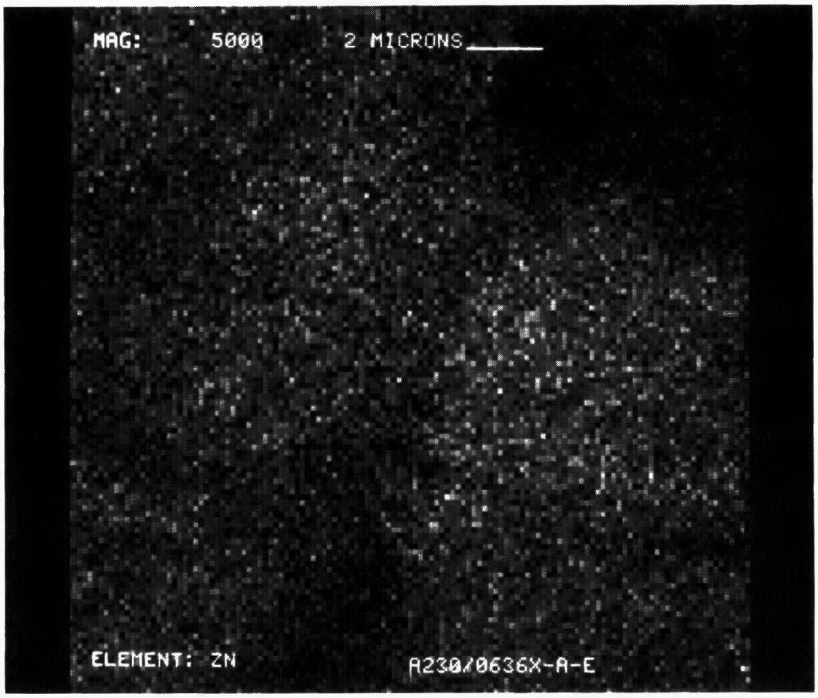


Figure D-119. Zinc Dot Map at X5000 of Converter A230/0636X

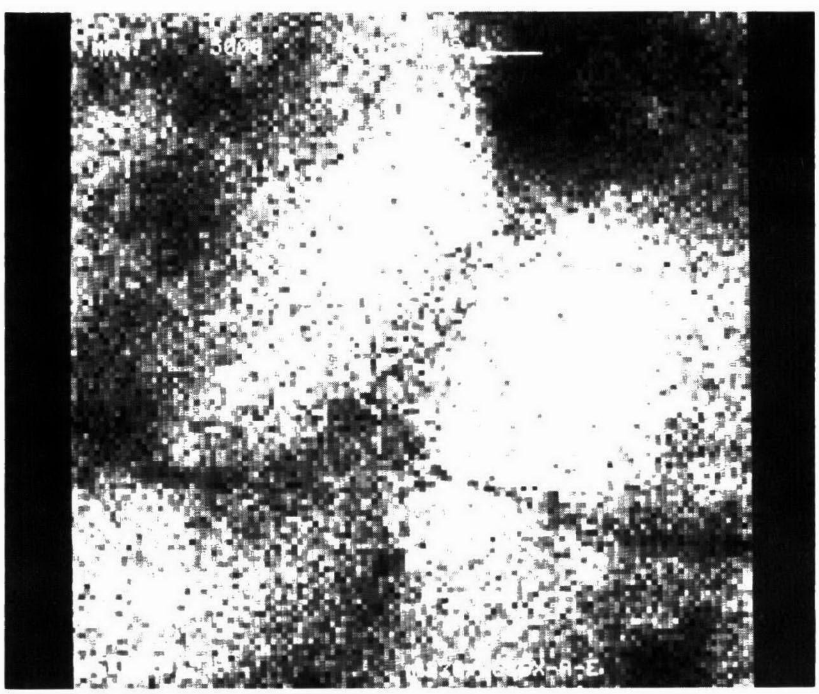


Figure D-120. Phosphorus Dot Map at X5000 of Converter A230/0636X

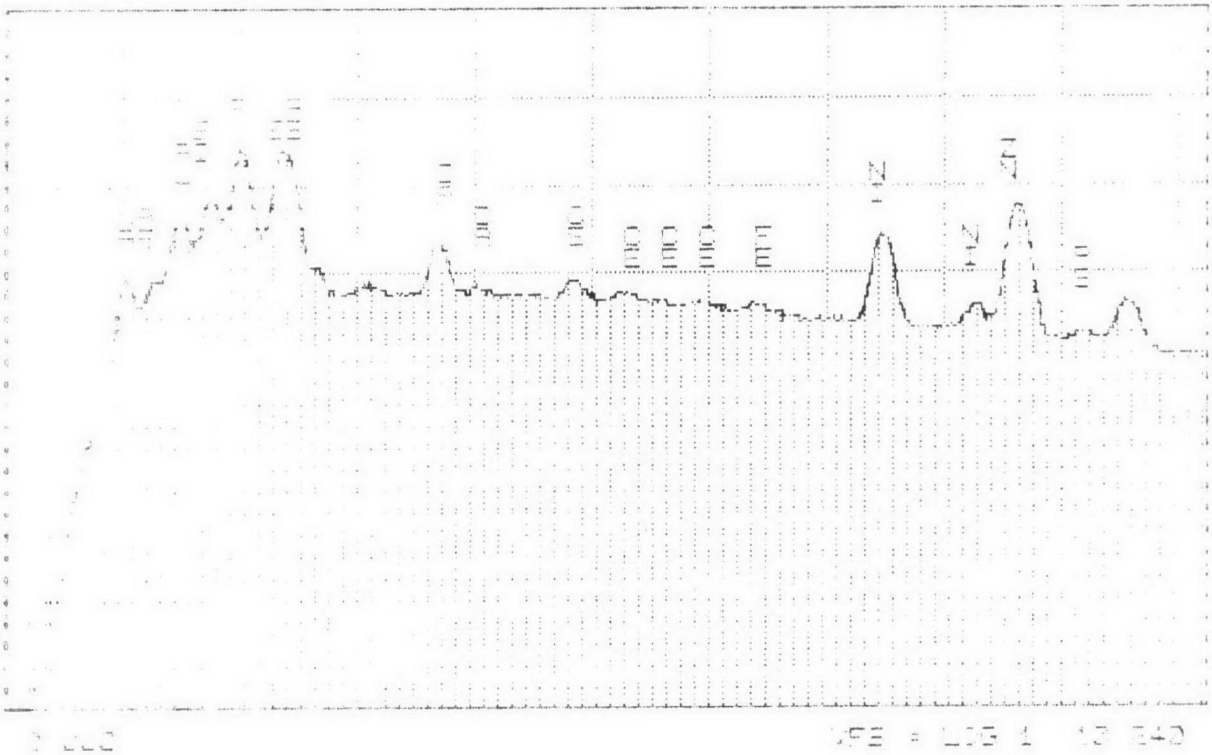


Figure D-121. SEM/EDX Spectrum of Converter A240/0016L

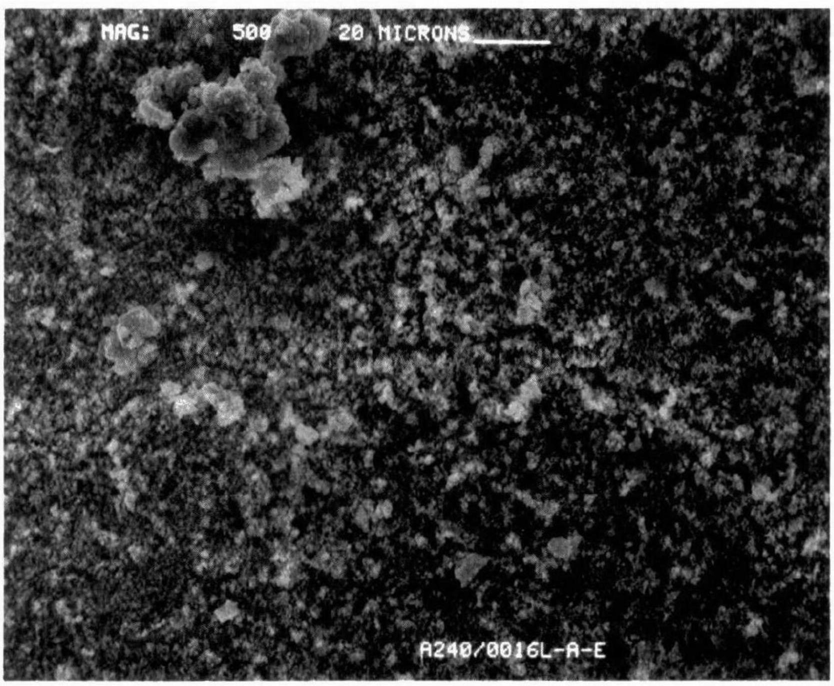


Figure D-122. Scanning Electron Micrograph at X500 of Converter A240/0016L

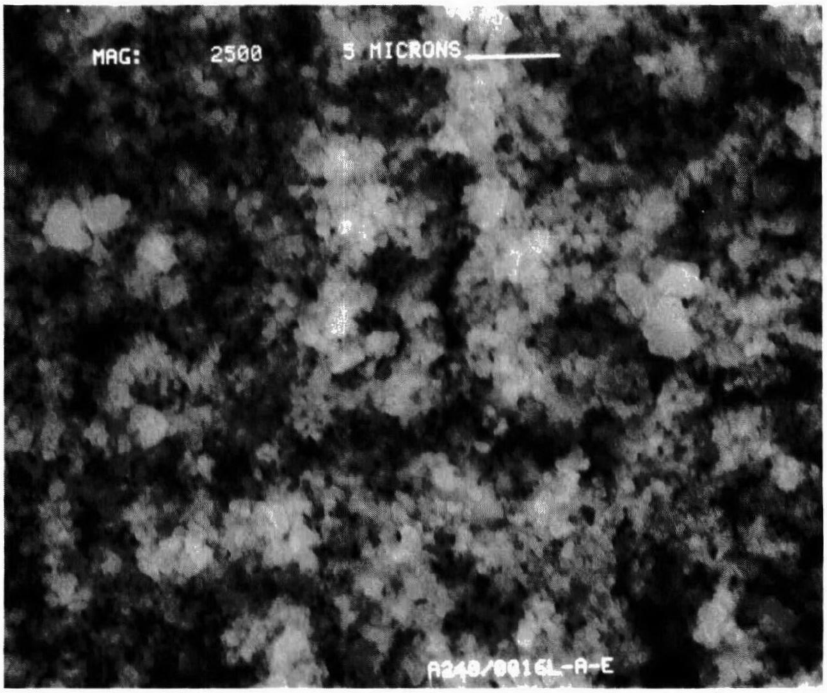


Figure D-123. Scanning Electron Micrograph at X2500 of Converter A240/0016L

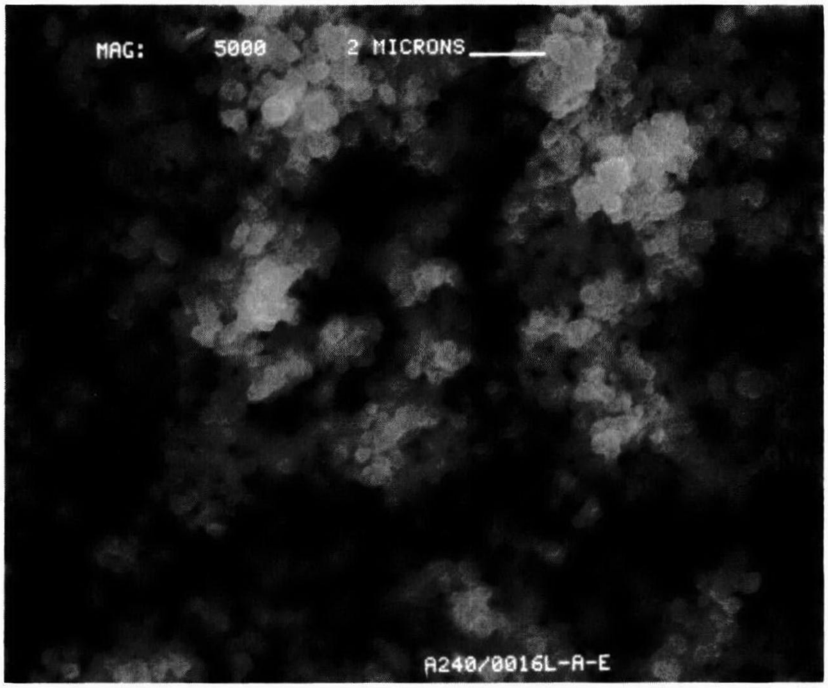


Figure D-124. Scanning Electron Micrograph at X5000 of Converter A240/0016L

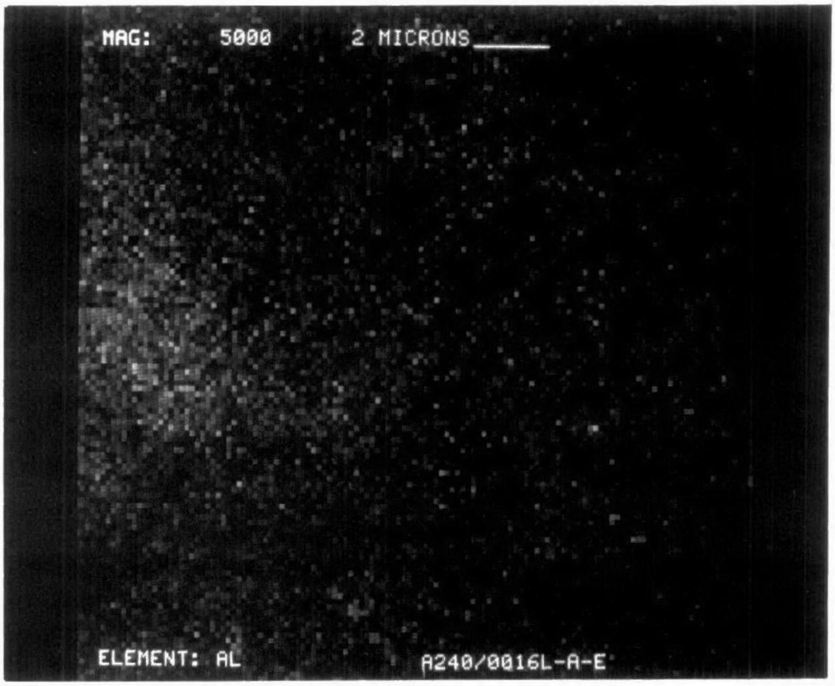


Figure D-125. Aluminum Dot Map at X5000 of Converter A240/0016L

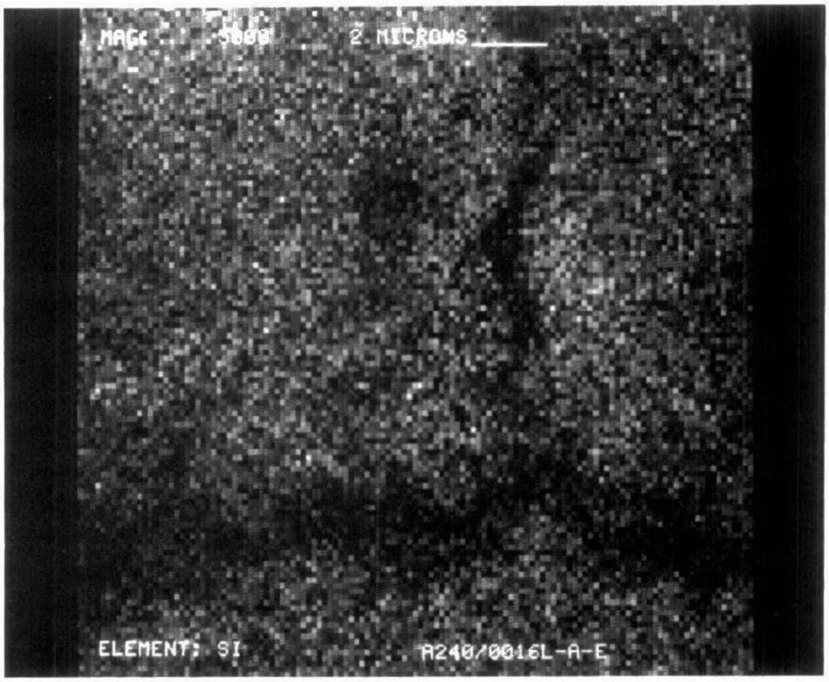


Figure D-126. Silicon Dot Map at X5000 of Converter A240/0016L

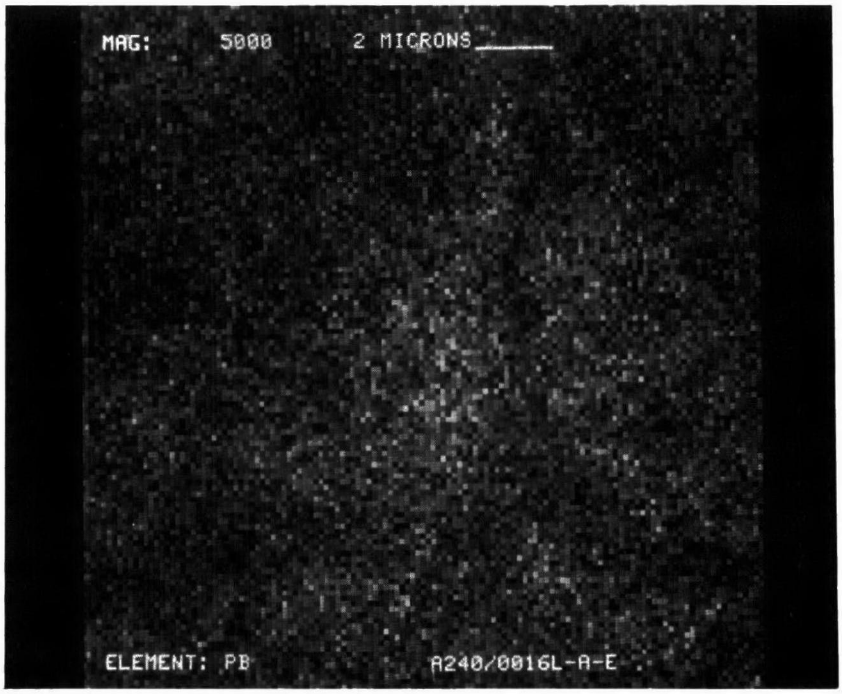


Figure D-127. Lead Dot Map at X5000 of Converter A240/0016L

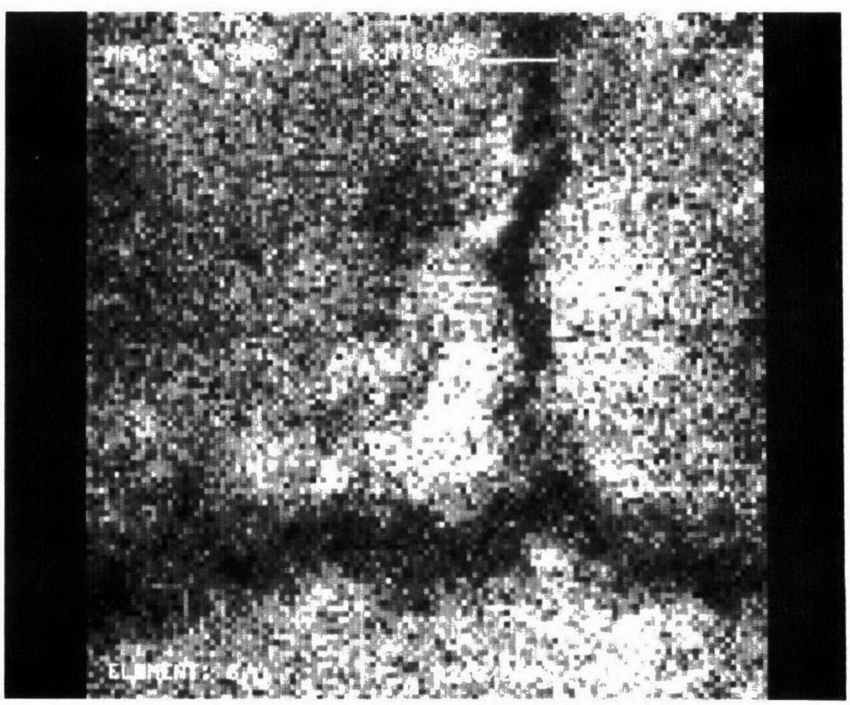


Figure D-128. Sulfur Dot Map at X5000 of Converter A240/0016L

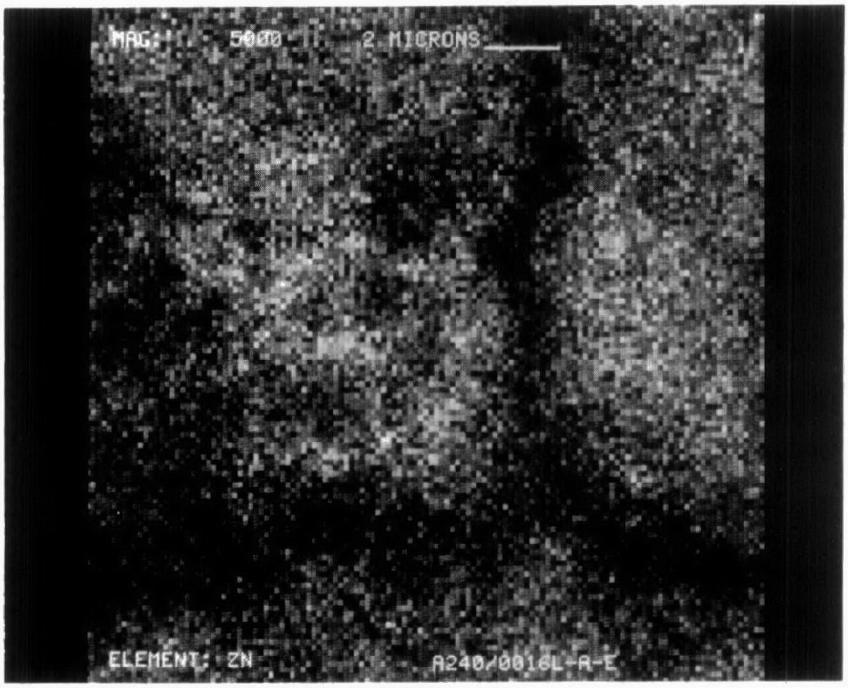


Figure D-129. Zinc Dot Map at X5000 of Converter A240/0016L

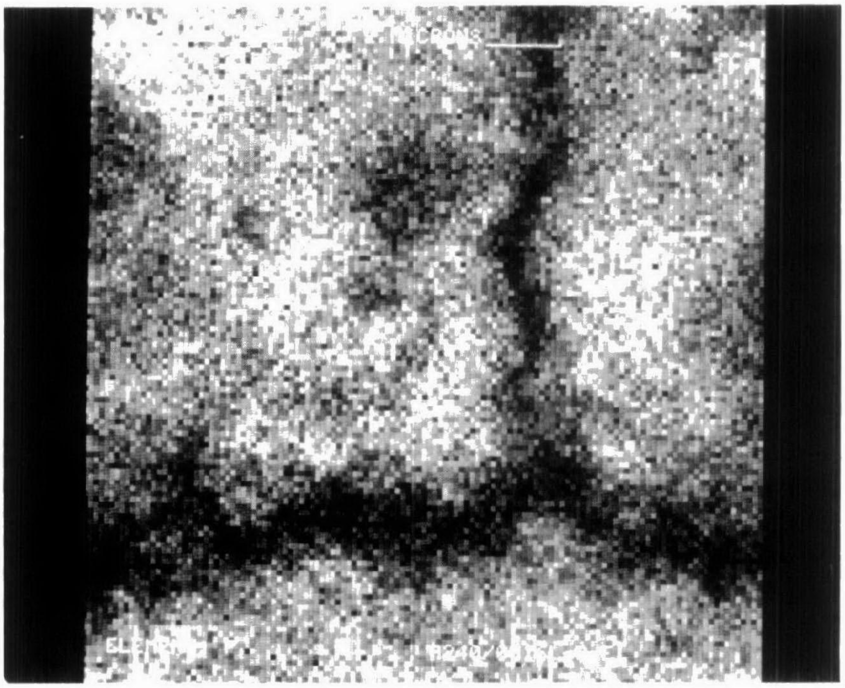


Figure D-130. Phosphorus Dot Map at X5000 of Converter A240/0016L

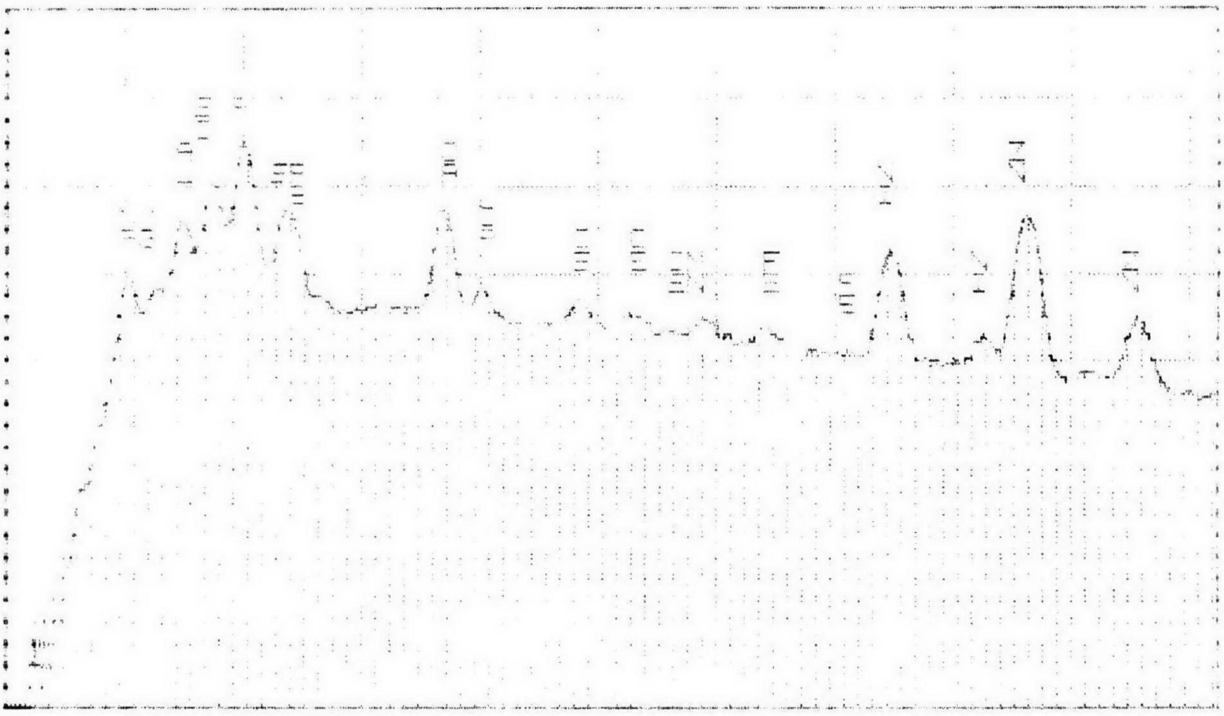


Figure D-131. SEM/EDX Spectrum of Converter A240/0102

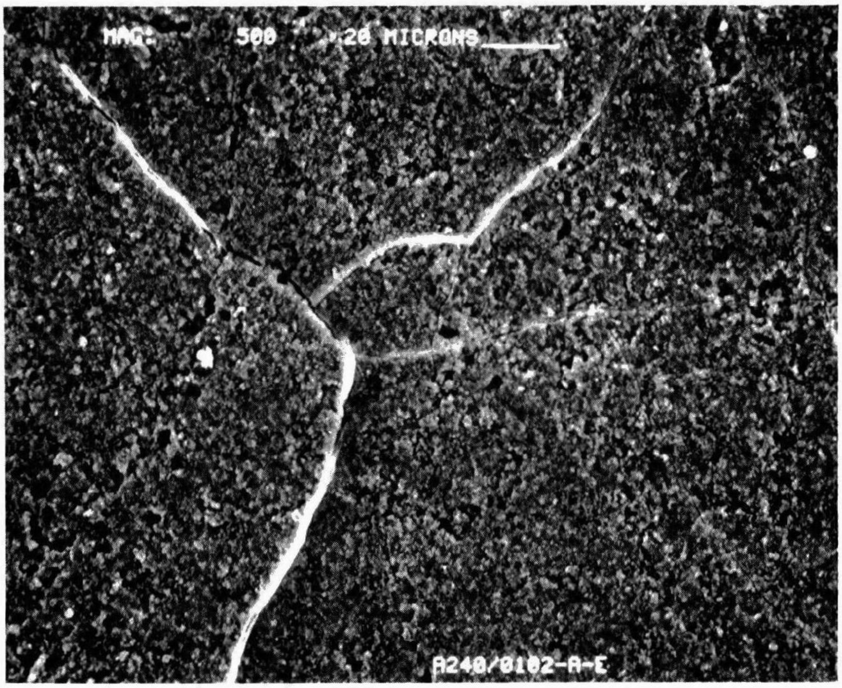


Figure D-132. Scanning Electron Micrograph at X500 of Converter A240/0102

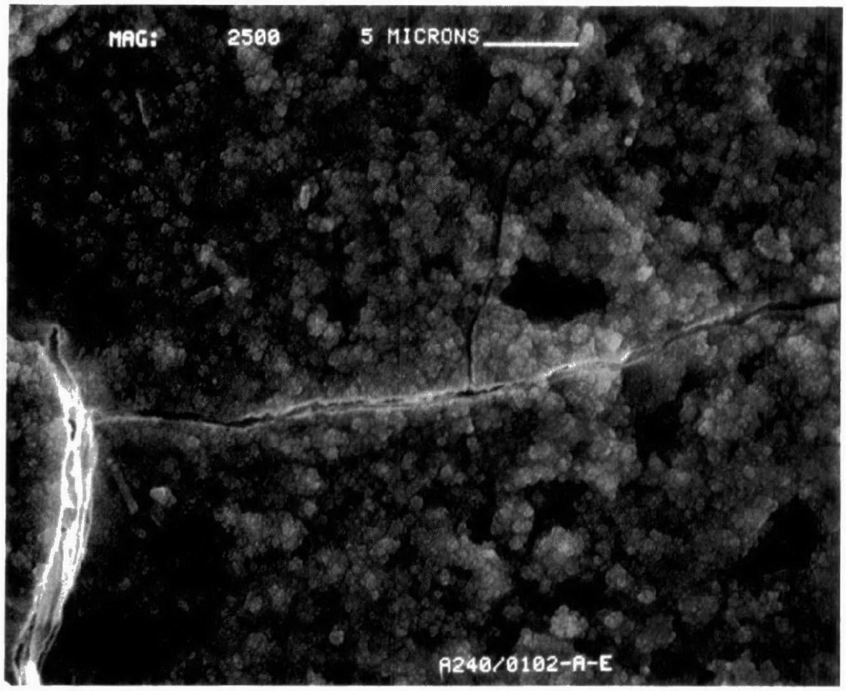


Figure D-133. Scanning Electron Micrograph at X2500 of Converter A240/0102

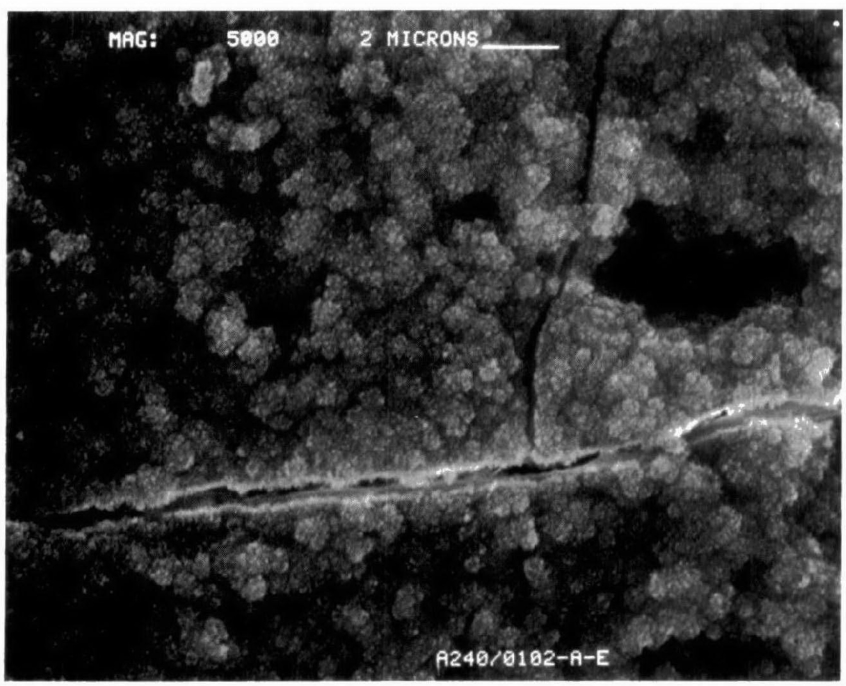


Figure D-134. Scanning Electron Micrograph at X5000 of Converter A240/0102

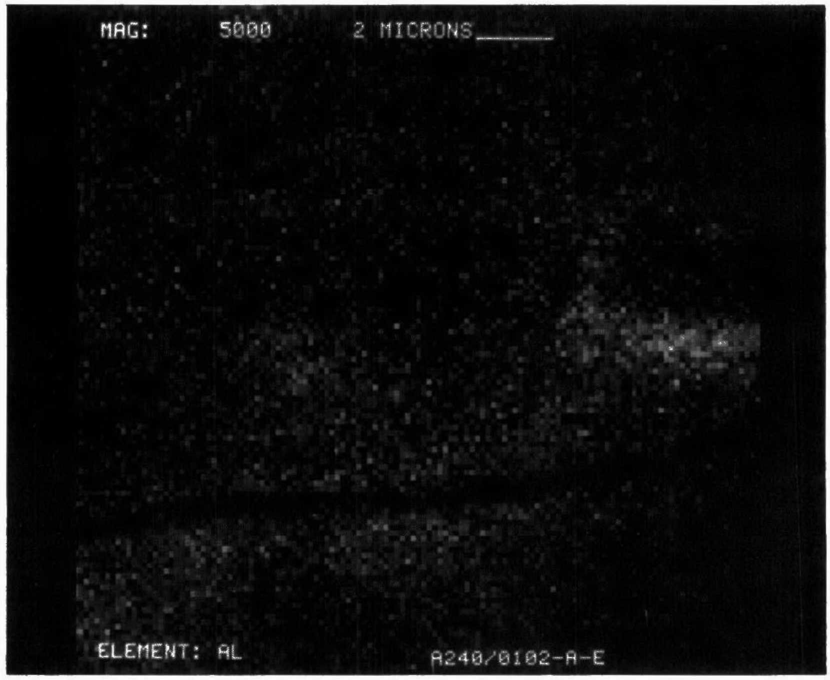


Figure D-135. Aluminum Dot Map at X5000 of Converter A240/0102

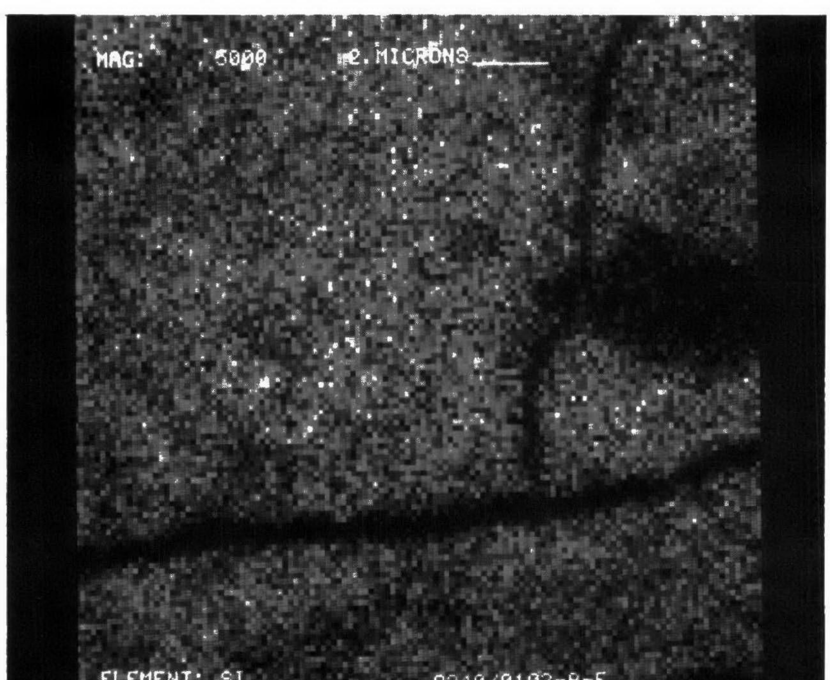


Figure D-136. Silicon Dot Map at X5000 of Converter A240/0102

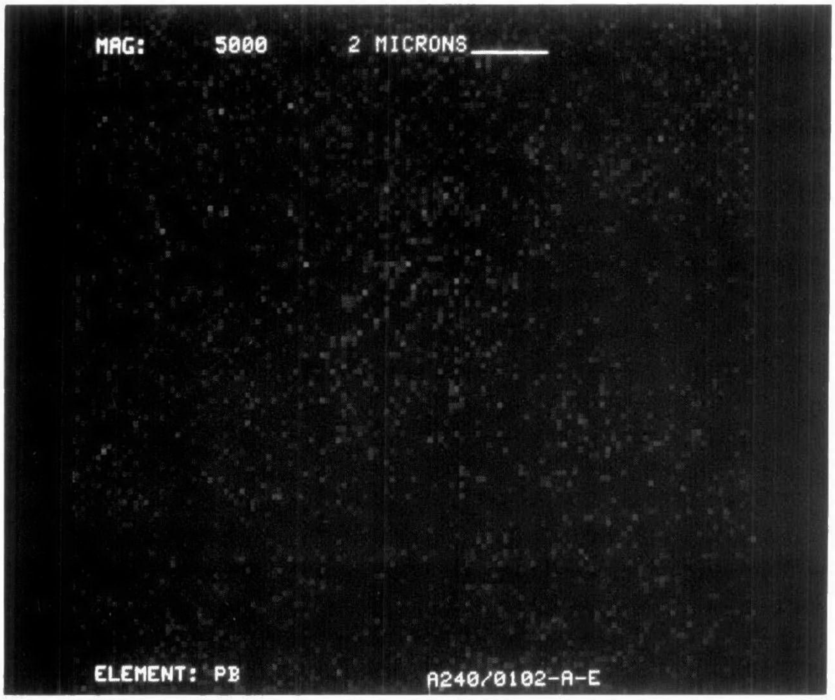


Figure D-137. Lead Dot Map at X5000 of Converter A240/0102

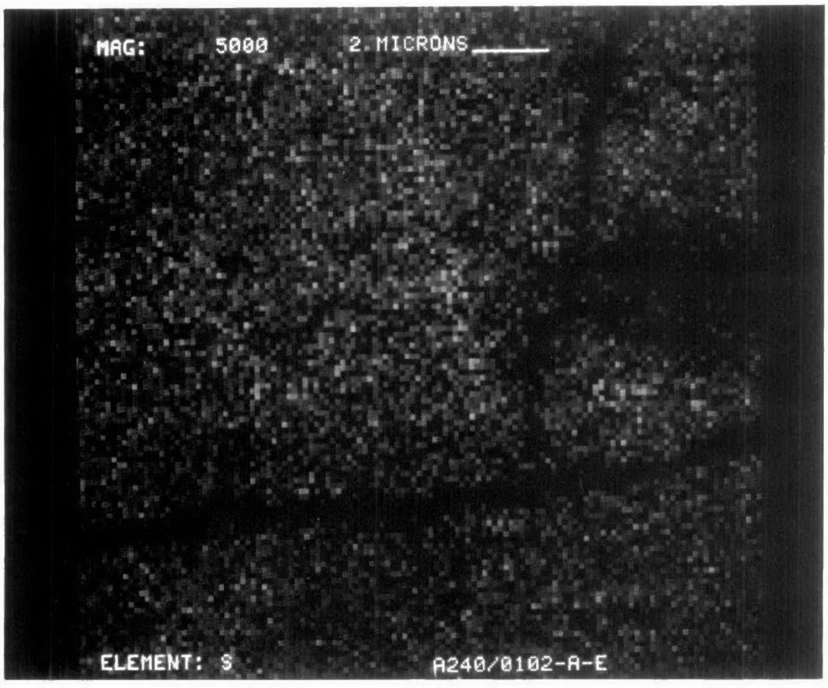


Figure D-138. Sulfur Dot Map at X5000 of Converter A240/0102

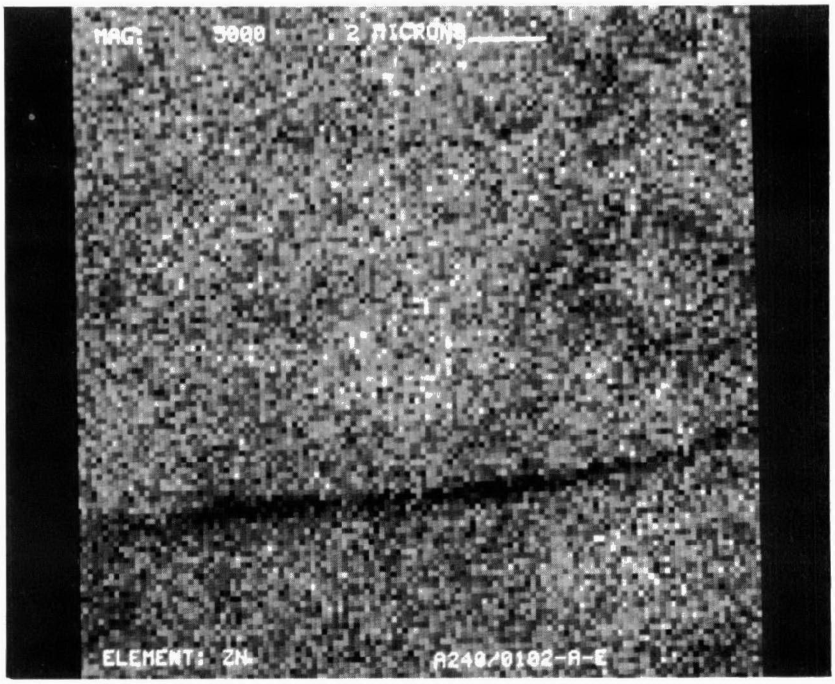


Figure D-139. Zinc Dot Map at X5000 of Converter A240/0102

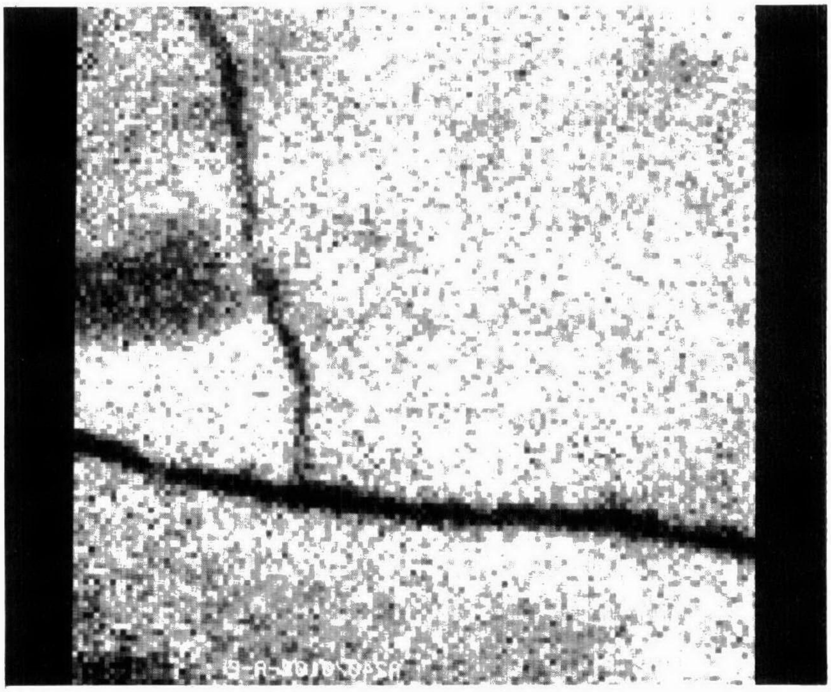


Figure D-140. Phosphorus Dot Map at X5000 of Converter A240/0102

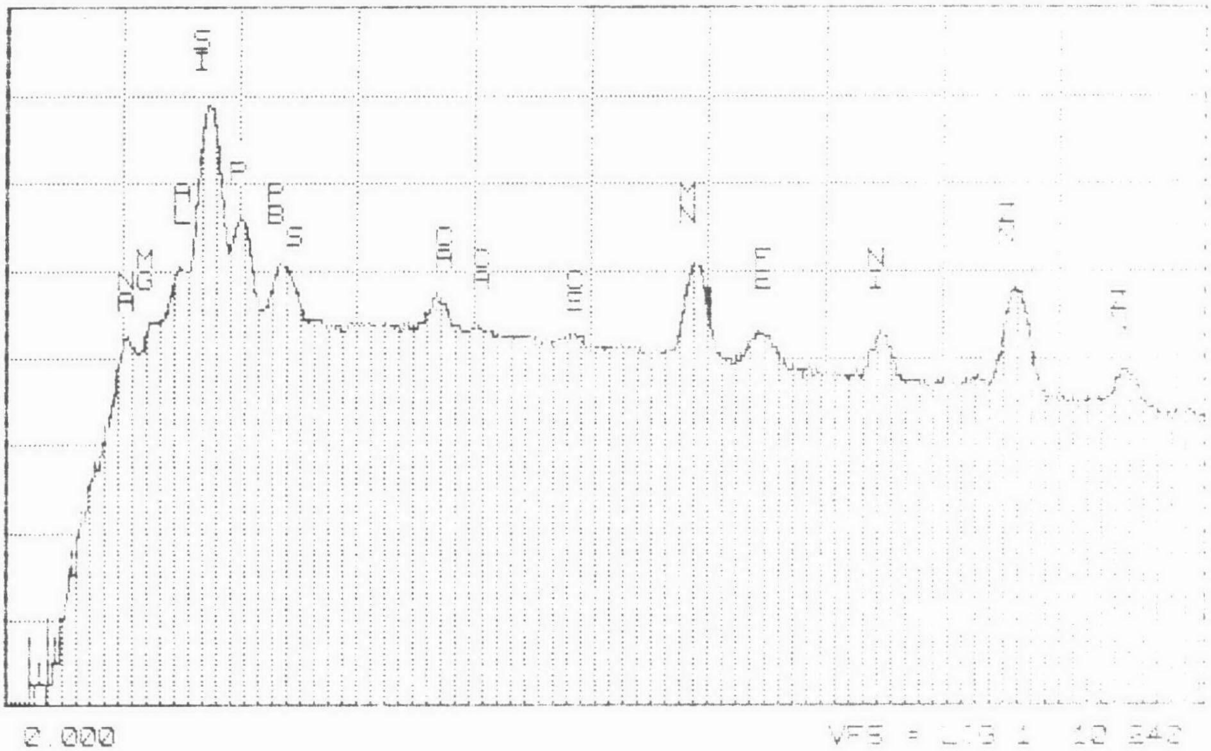


Figure D-141. SEM/EDX Spectrum of Converter A240/0141L

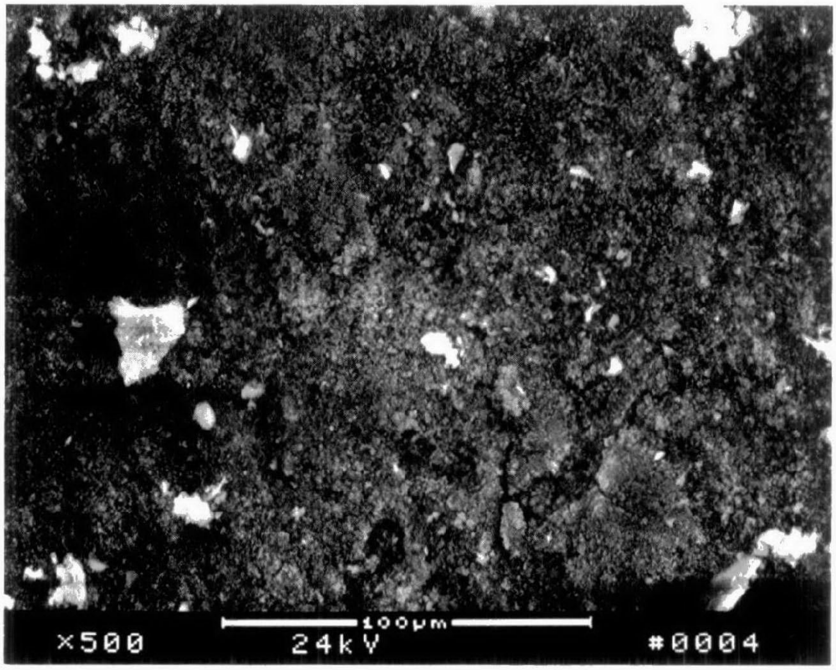


Figure D-142. Scanning Electron Micrograph at X500 of Converter A240/0141L

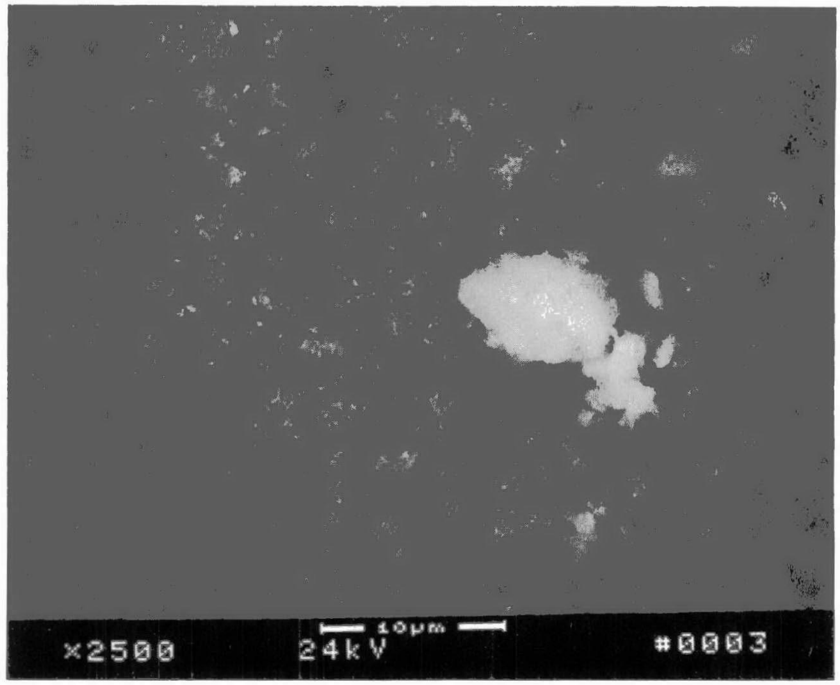


Figure D-143. Scanning Electron Micrograph at X2500 of Converter A240/0141L

Figure D-144. Scanning Electron Micrograph at X5000 of Converter A240/0141L

Figure D-145. Aluminum Dot Map at X5000 of Converter A240/0141L

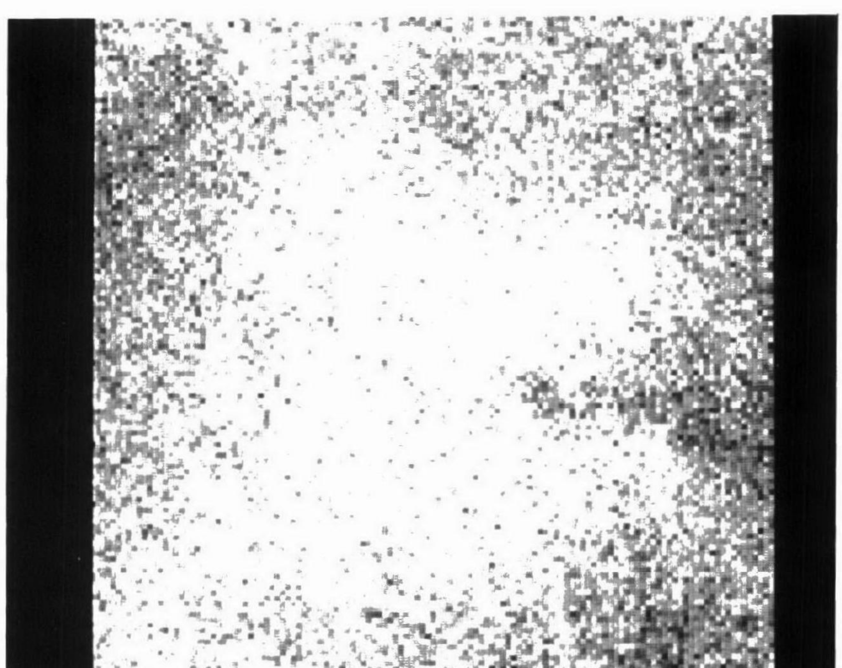


Figure D-146. Silicon Dot Map at X5000 of Converter A240/0141L

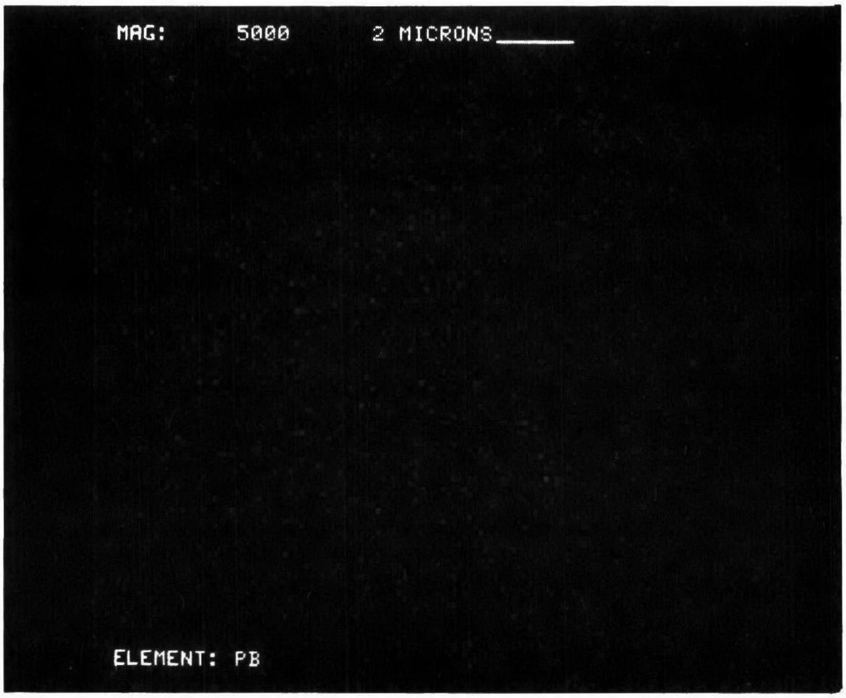


Figure D-147. Lead Dot Map at X5000 of Converter A240/0141L

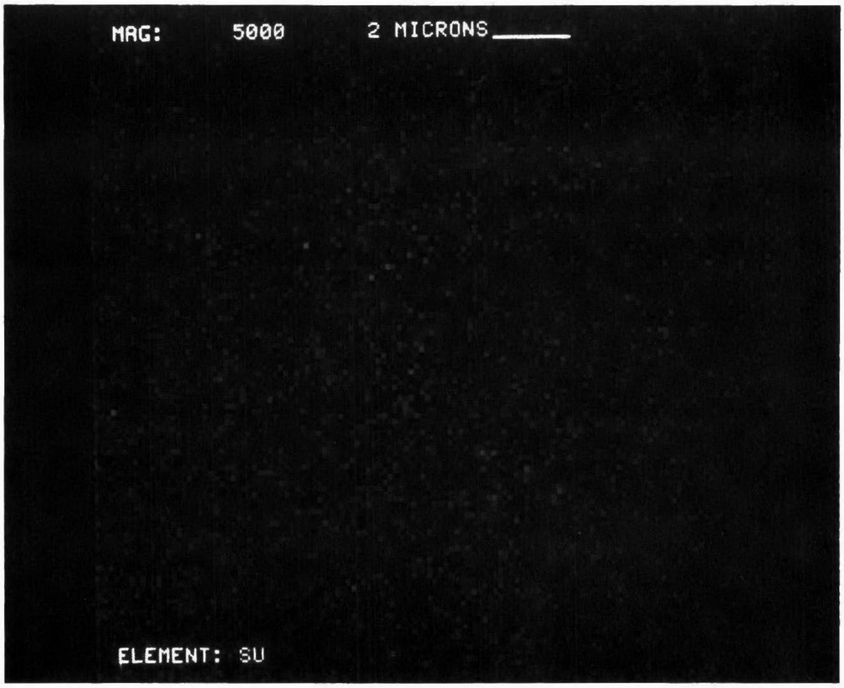


Figure D-148. Sulfur Dot Map at X5000 of Converter A240/0141L

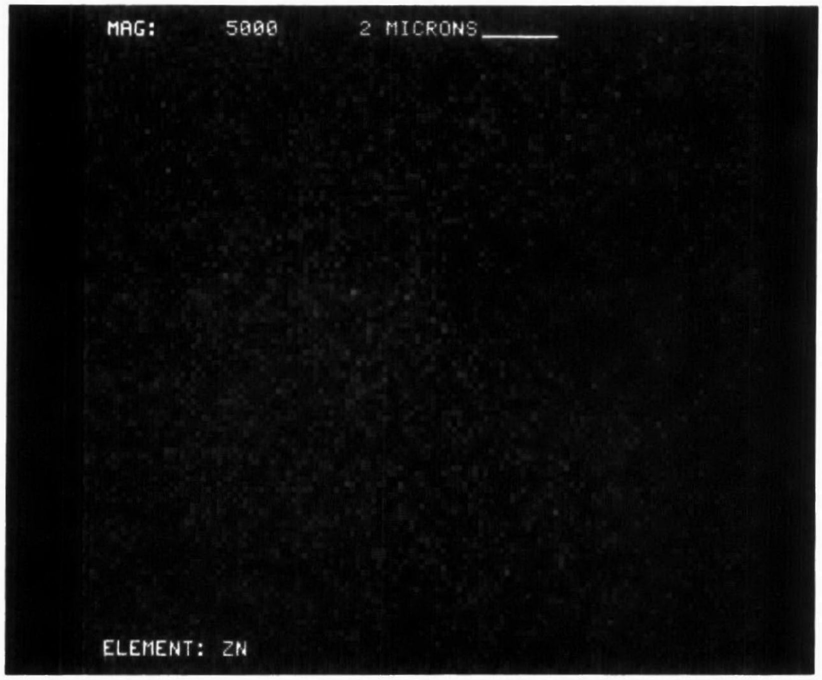


Figure D-149. Zinc Dot Map at X5000 of Converter A240/0141L

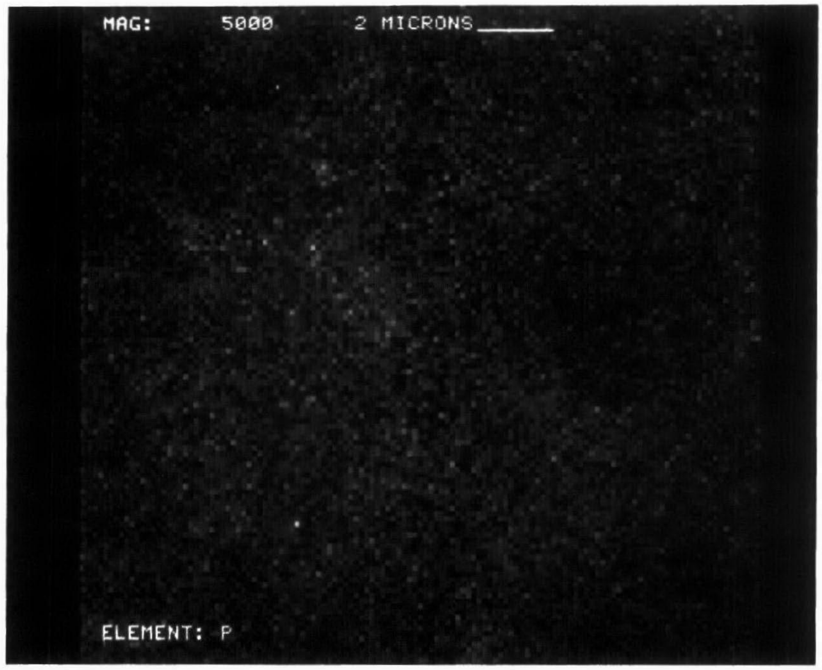


Figure D-150. Phosphorus Dot Map at X5000 of Converter A240/0141L

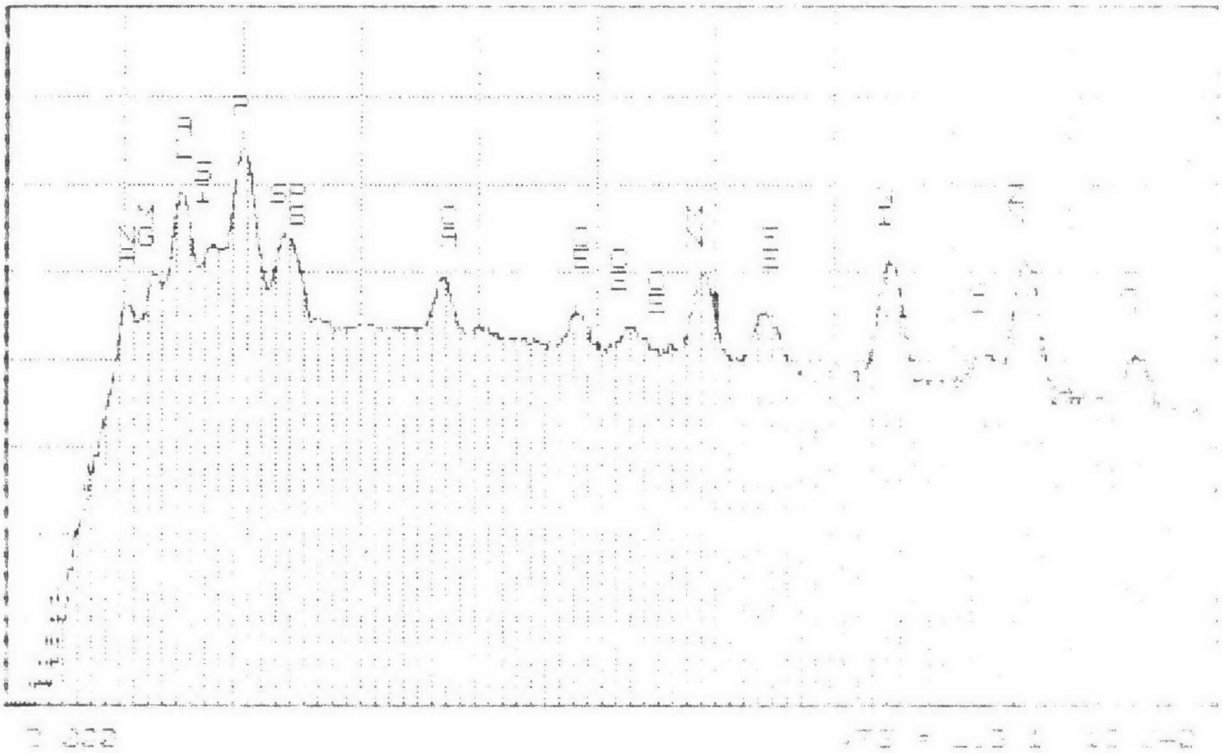


Figure D-151. SEM/EDX Spectrum of Converter A240/0153

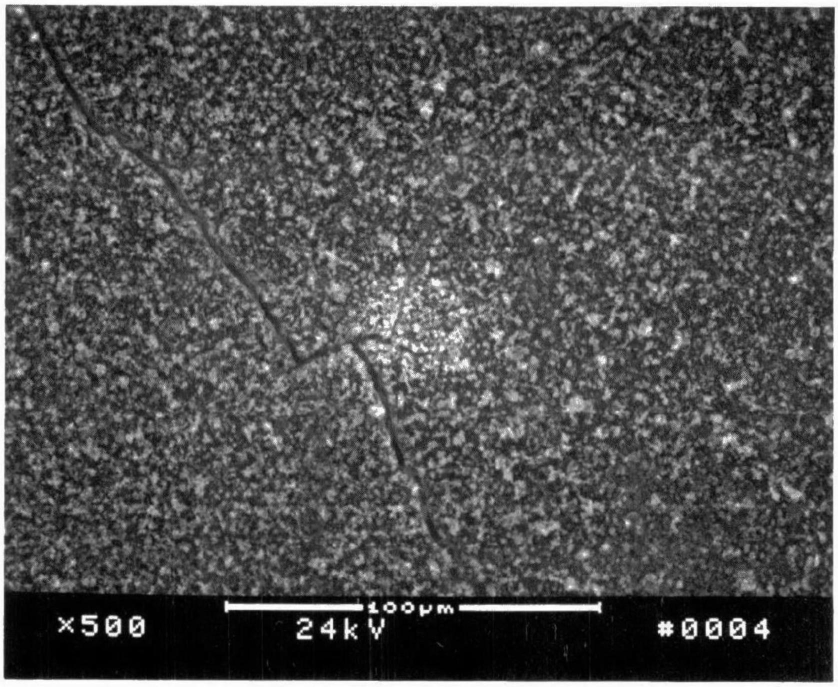


Figure D-152. Scanning Electron Micrograph at X500 of Converter A240/0153

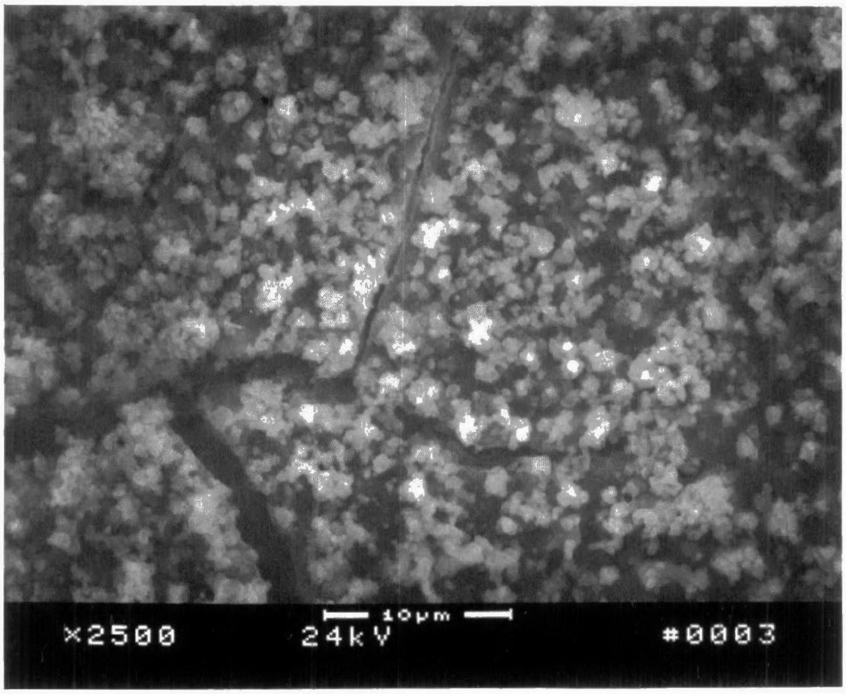


Figure D-153. Scanning Electron Micrograph at X2500 of Converter A240/0153

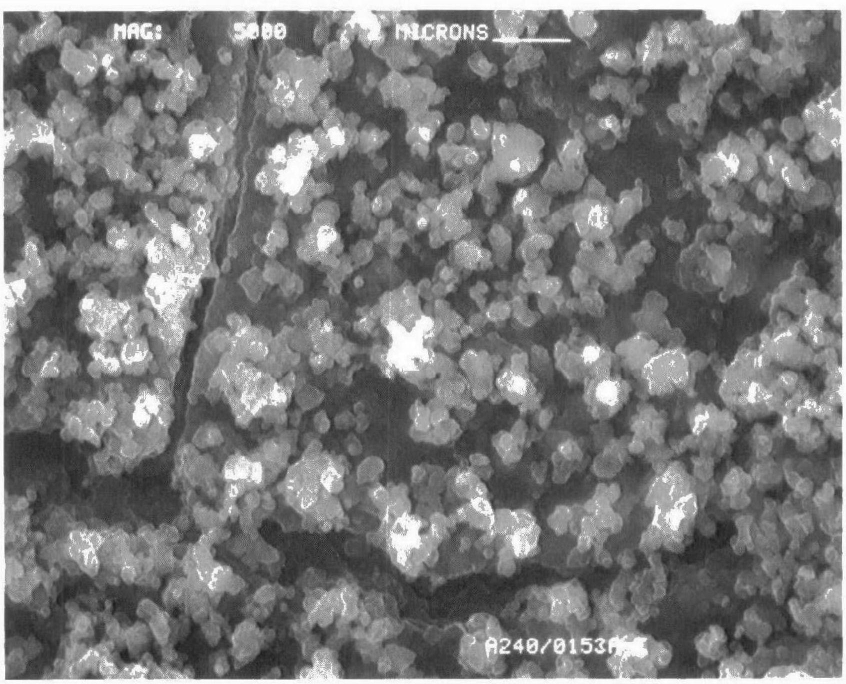


Figure D-154. Scanning Electron Micrograph at X5000 of Converter A240/0153

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE
TO LOW FOR ADEQUATE MAPPING

Figure D-155. Aluminum Dot Map at X5000 of Converter A240/0153

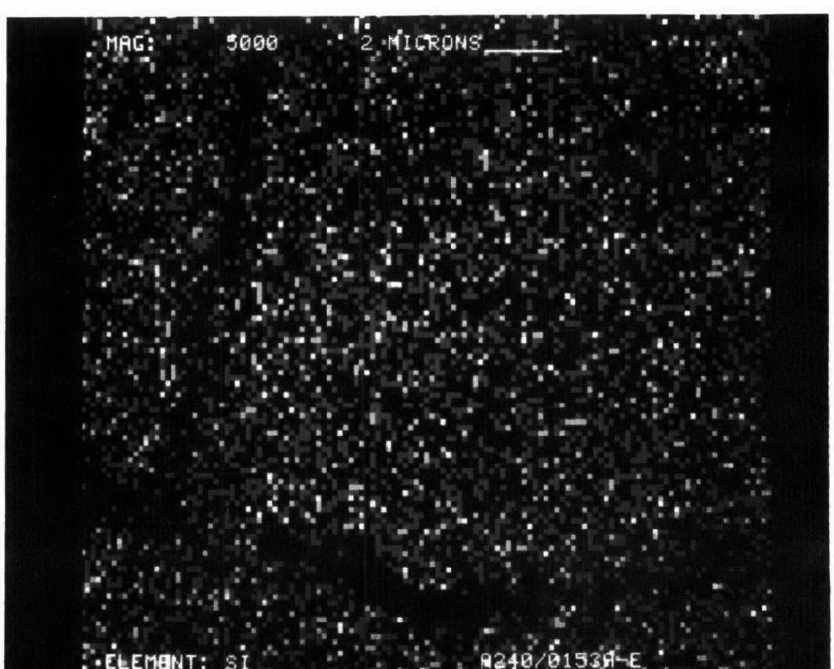


Figure D-156. Silicon Dot Map at X5000 of Converter A240/0153

Figure D-157. Lead Dot Map at X5000 of Converter A240/0153

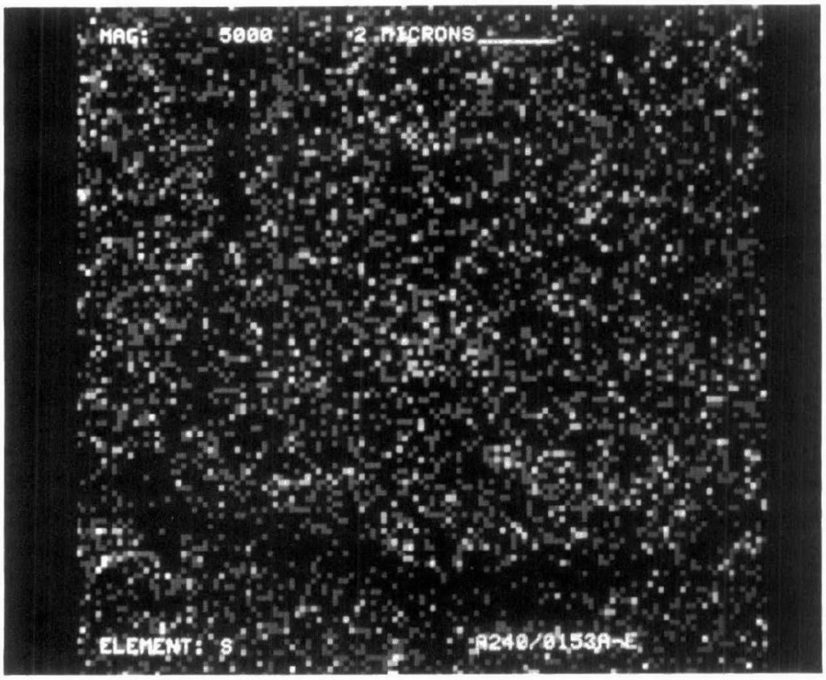


Figure D-158. Sulfur Dot Map at X5000 of Converter A240/0153

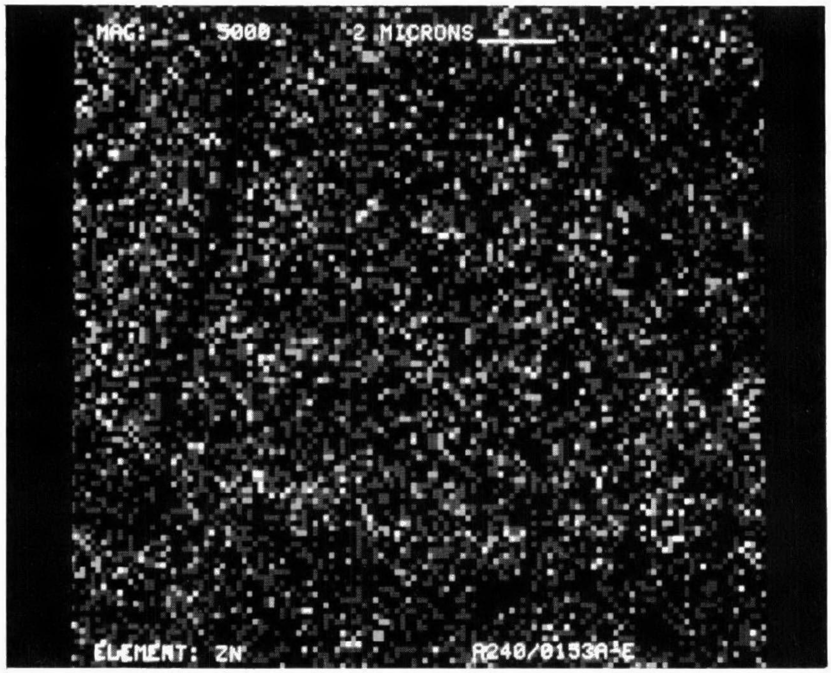


Figure D-159. Zinc Dot Map at X5000 of Converter A240/0153

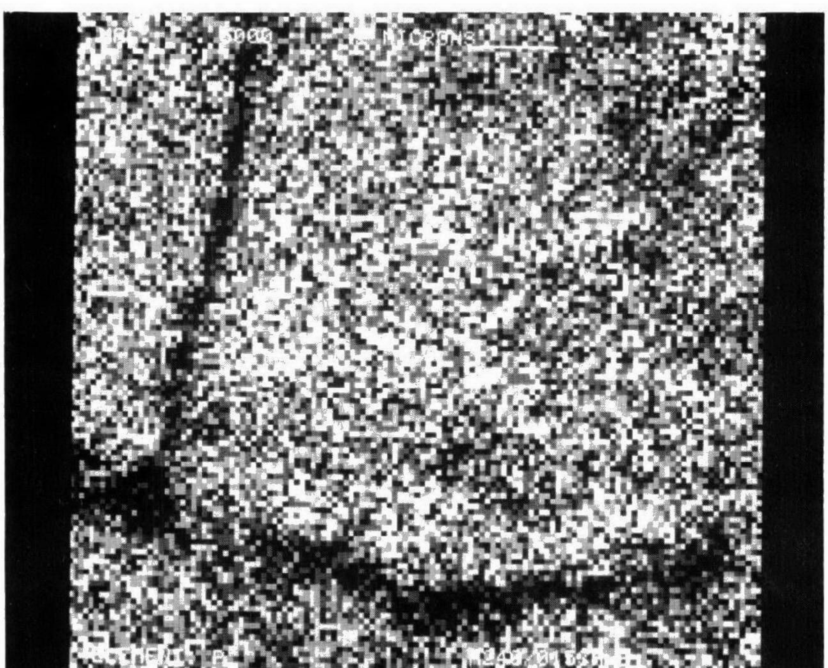


Figure D-160. Phosphorus Dot Map at X5000 of Converter A240/0153

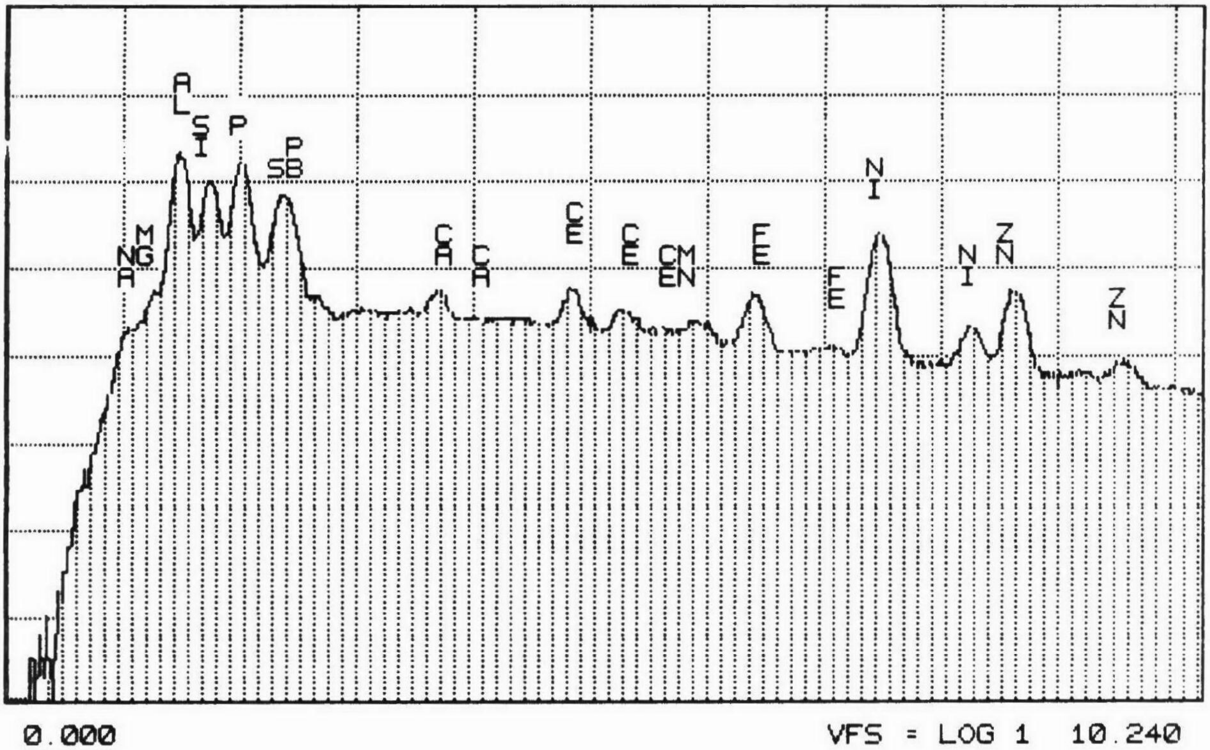


Figure D-161. SEM/EDX Spectrum of Converter A240/0334L

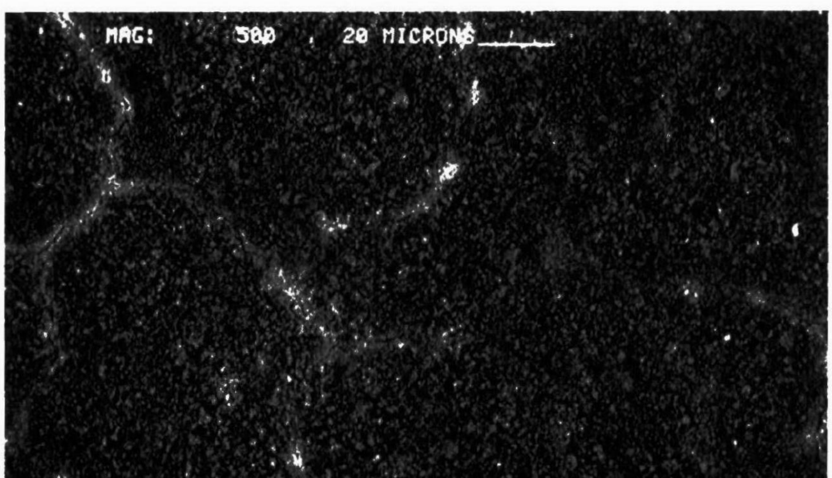


Figure D-162. Scanning Electron Micrograph at X500 of Converter A240/0334L

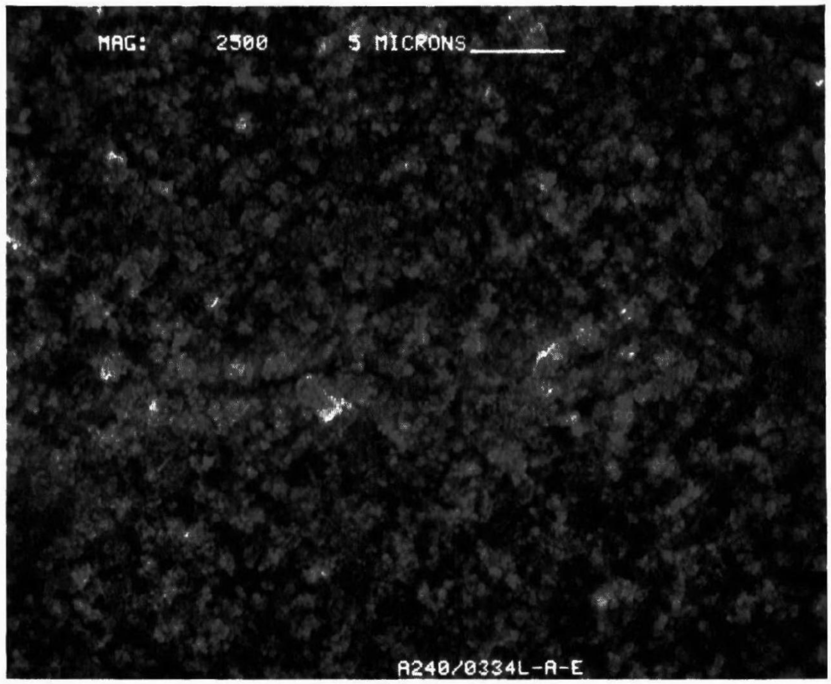


Figure D-163. Scanning Electron Micrograph at X2500 of Converter A240/0334L

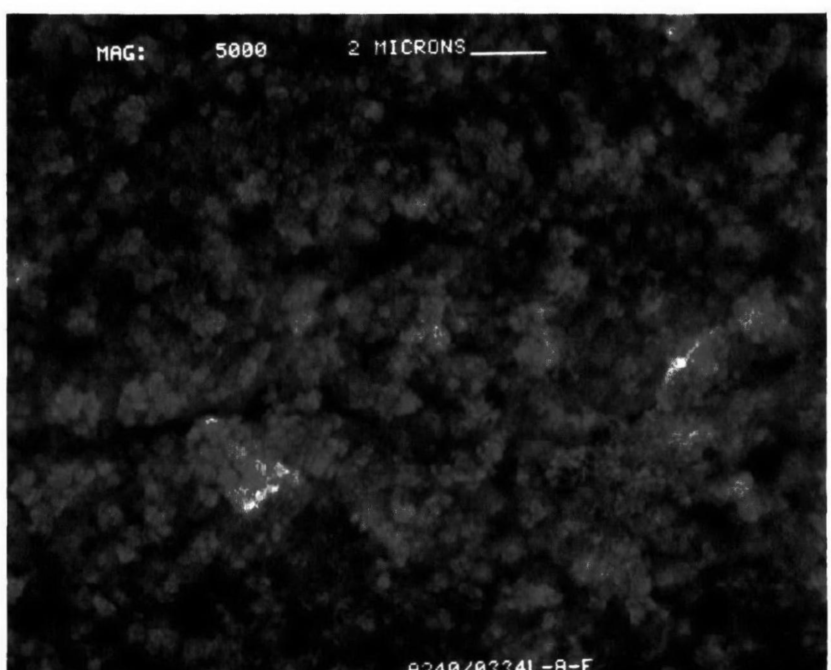


Figure D-164. Scanning Electron Micrograph at X5000 of Converter A240/0334L

Figure D-165. Aluminum Dot Map at X5000 of Converter A240/0334L

Figure D-166. Silicon Dot Map at X5000 of Converter A240/0334L

Figure D-167. Lead Dot Map at X5000 of Converter A240/0334L

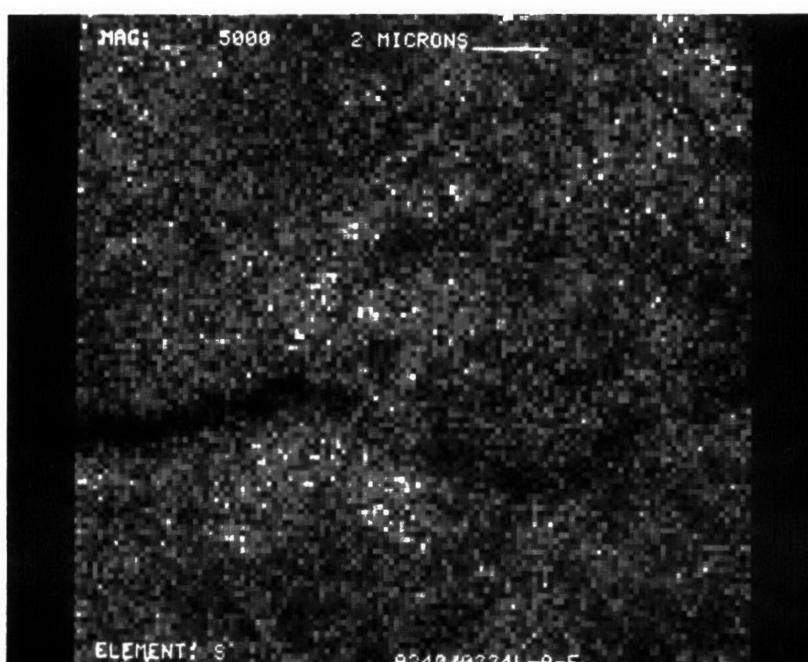


Figure D-168. Sulfur Dot Map at X5000 of Converter A240/0334L

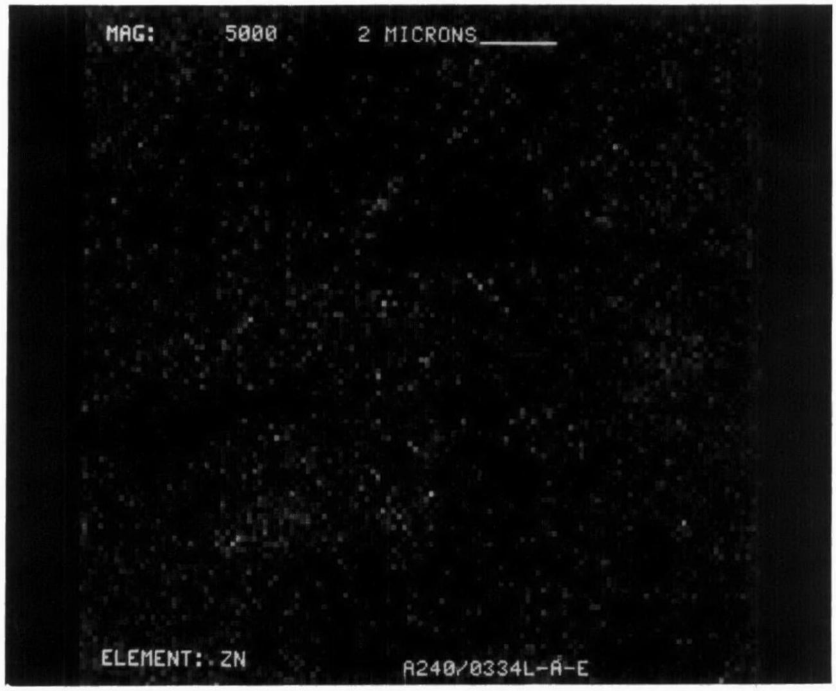


Figure D-169. Zinc Dot Map at X5000 of Converter A240/0334L

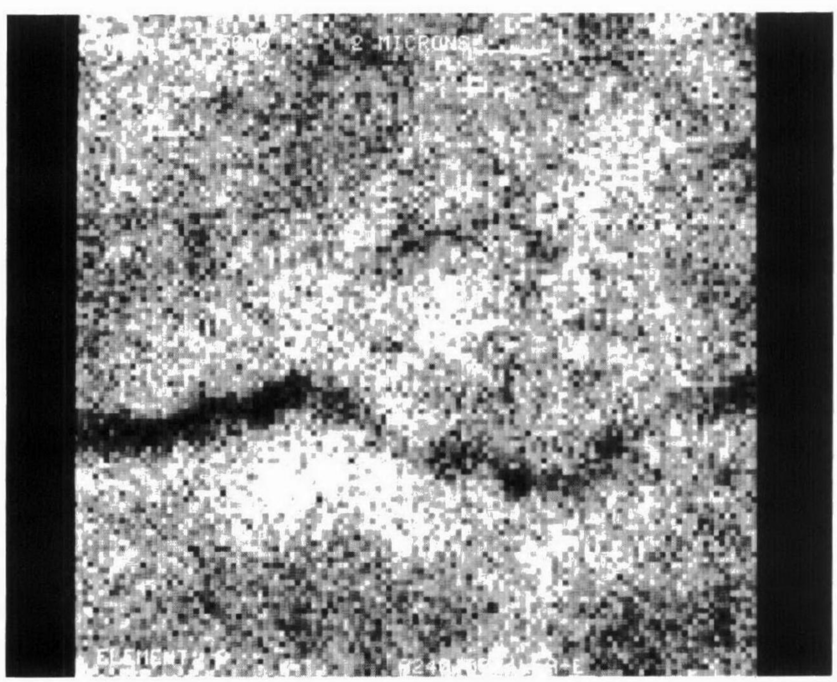


Figure D-170. Phosphorus Dot Map at X5000 of Converter A240/0334L

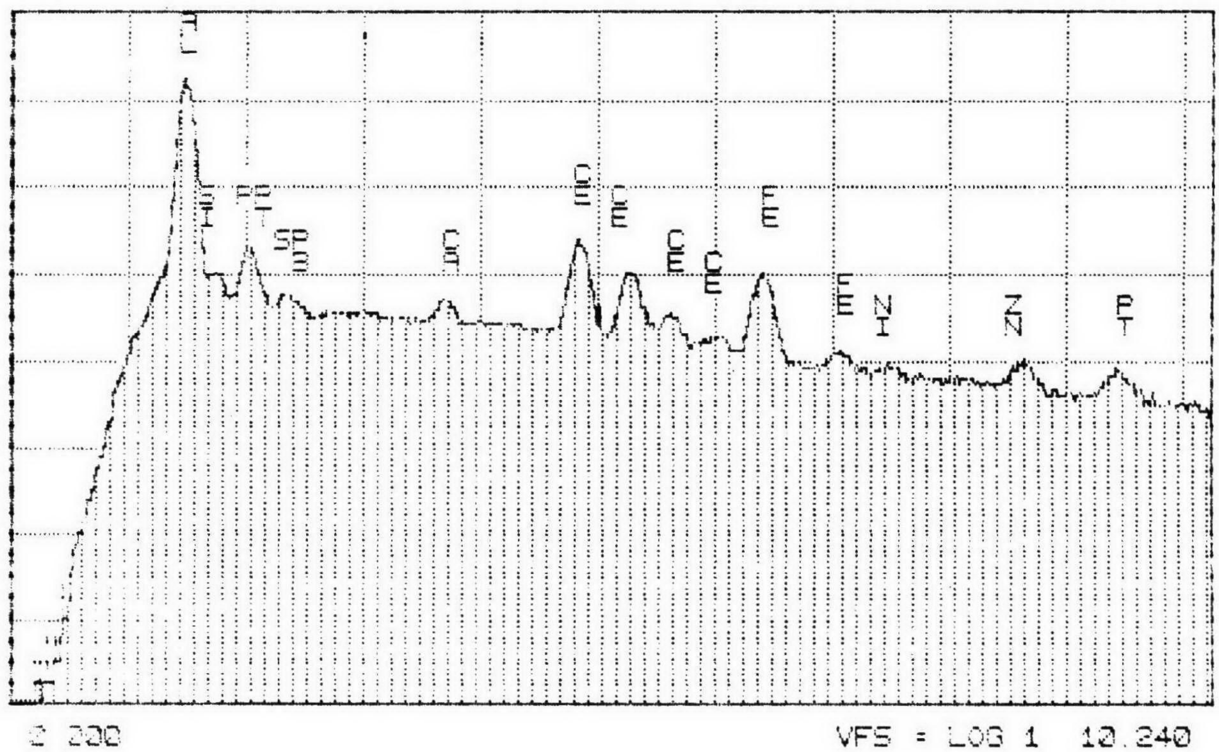


Figure D-171. SEM/EDX Spectrum of Converter A249/0169-1

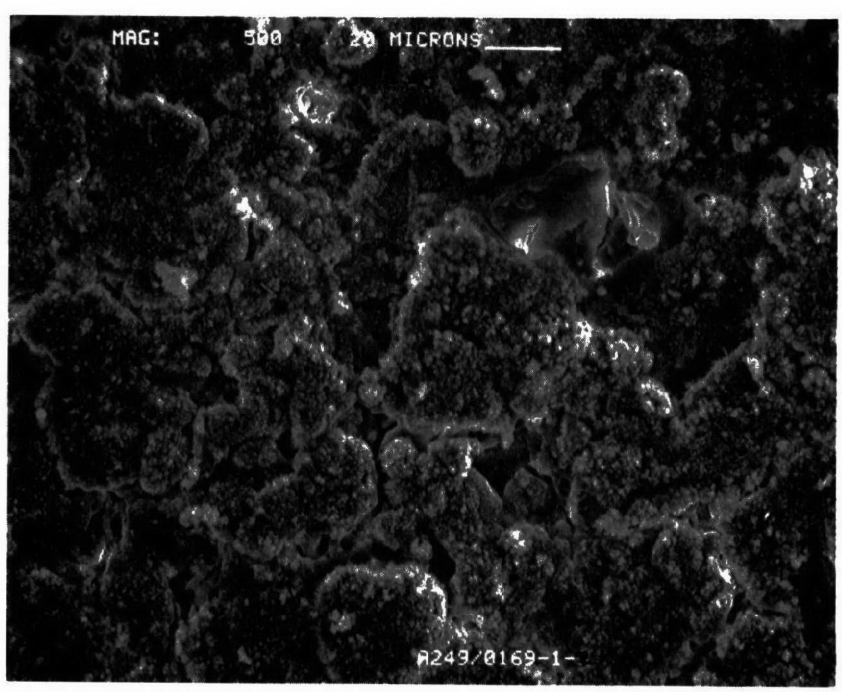


Figure D-172. Scanning Electron Micrograph at X500 of Converter A249/0169-1

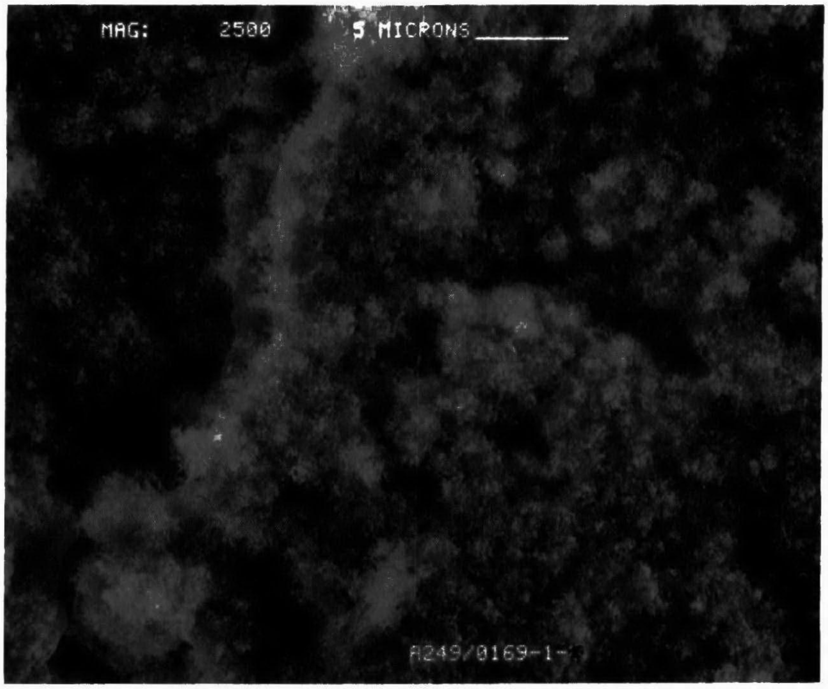


Figure D-173. Scanning Electron Micrograph at X2500 of Converter A249/0169-1

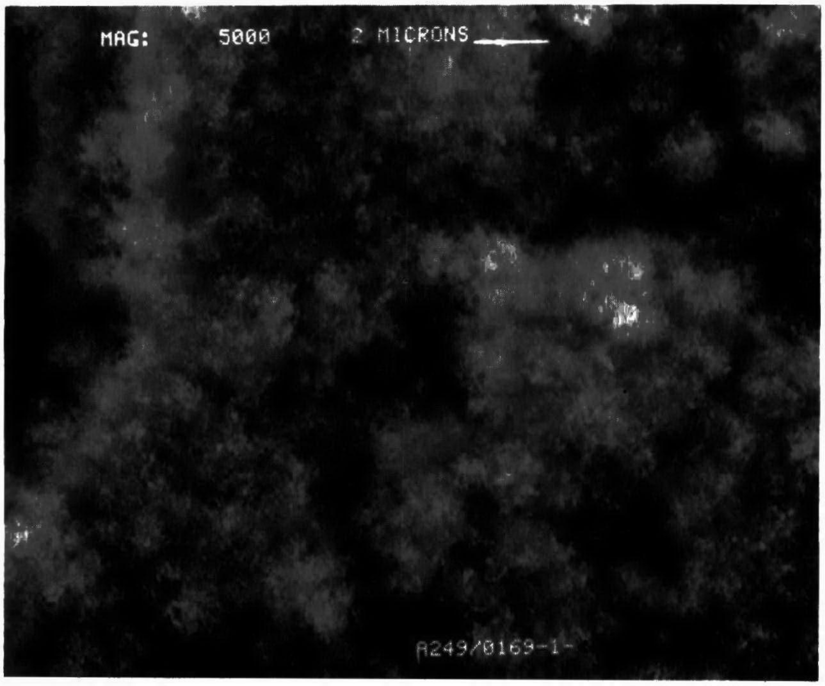


Figure D-174. Scanning Electron Micrograph at X5000 of Converter A249/0169-1

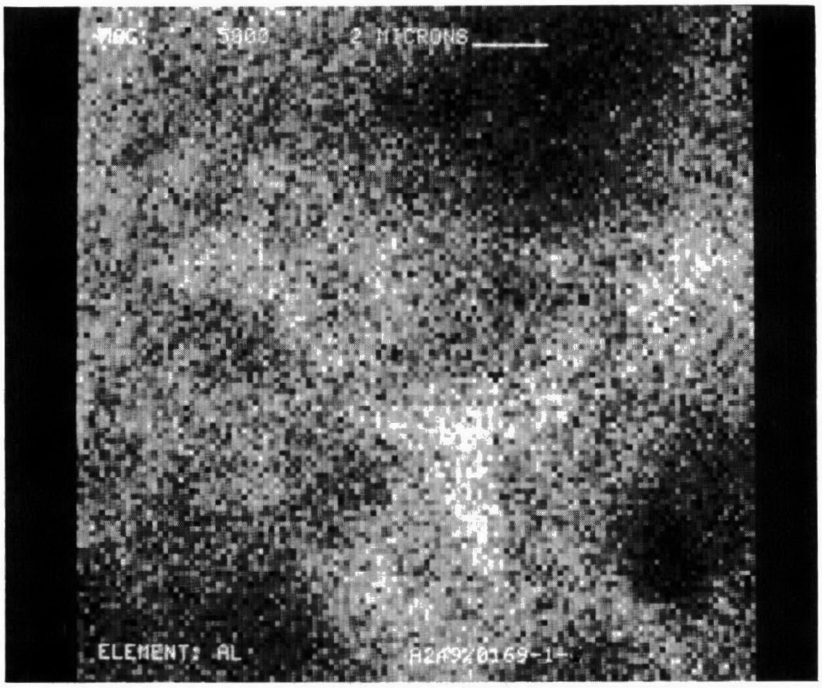


Figure D-175. Aluminum Dot Map at X5000 of Converter A249/0169-1

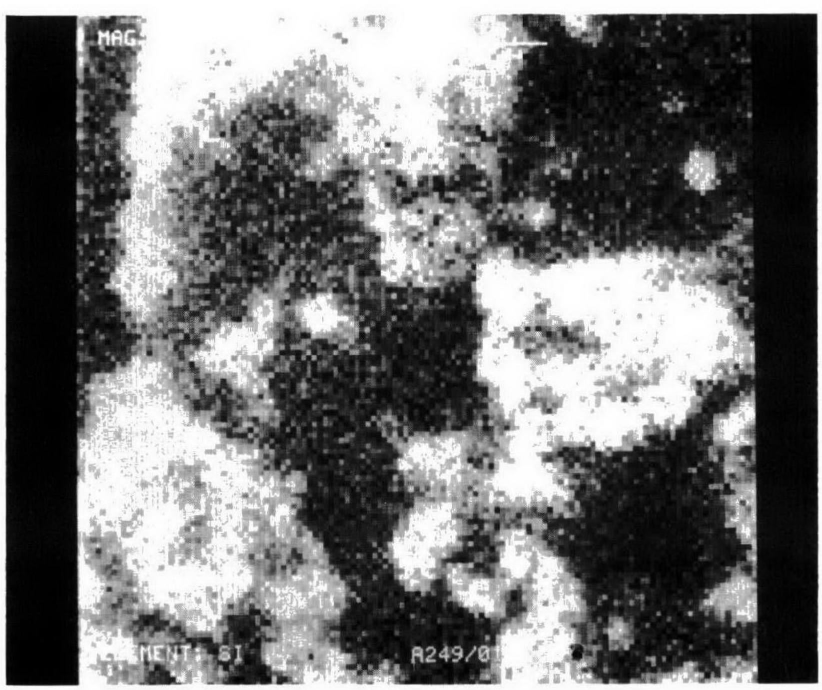


Figure D-176. Silicon Dot Map at X5000 of Converter A249/0169-1

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE TO LOW FOR ADEQUATE MAPPING

Figure D-177. Lead Dot Map at X5000 of Converter A249/0169-1

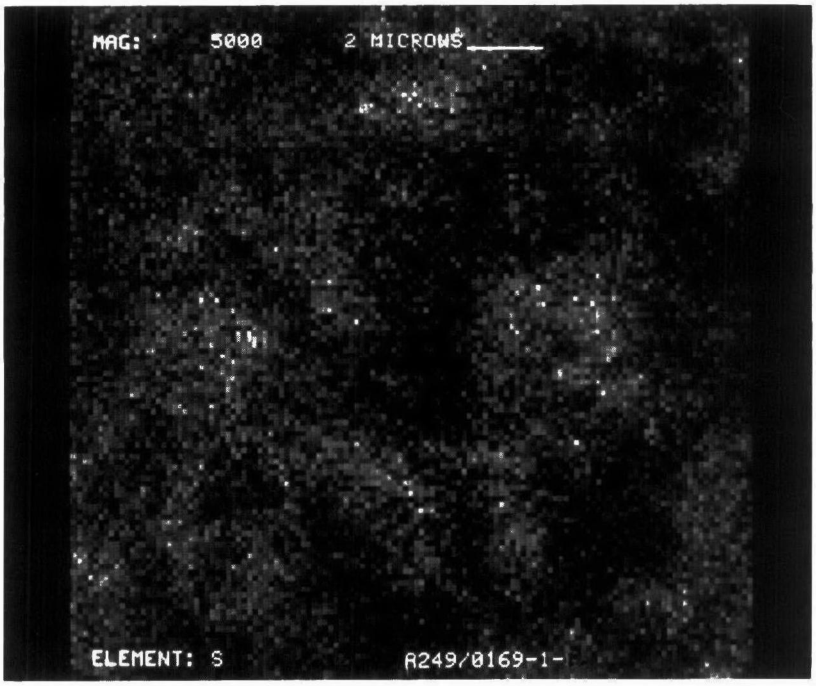


Figure D-178. Sulfur Dot Map at X5000 of Converter A249/0169-1

Figure D-179. Zinc Dot Map at X5000 of Converter A249/0169-1

Figure D-180. Phosphorus Dot Map at X5000 of Converter A249/0169-1

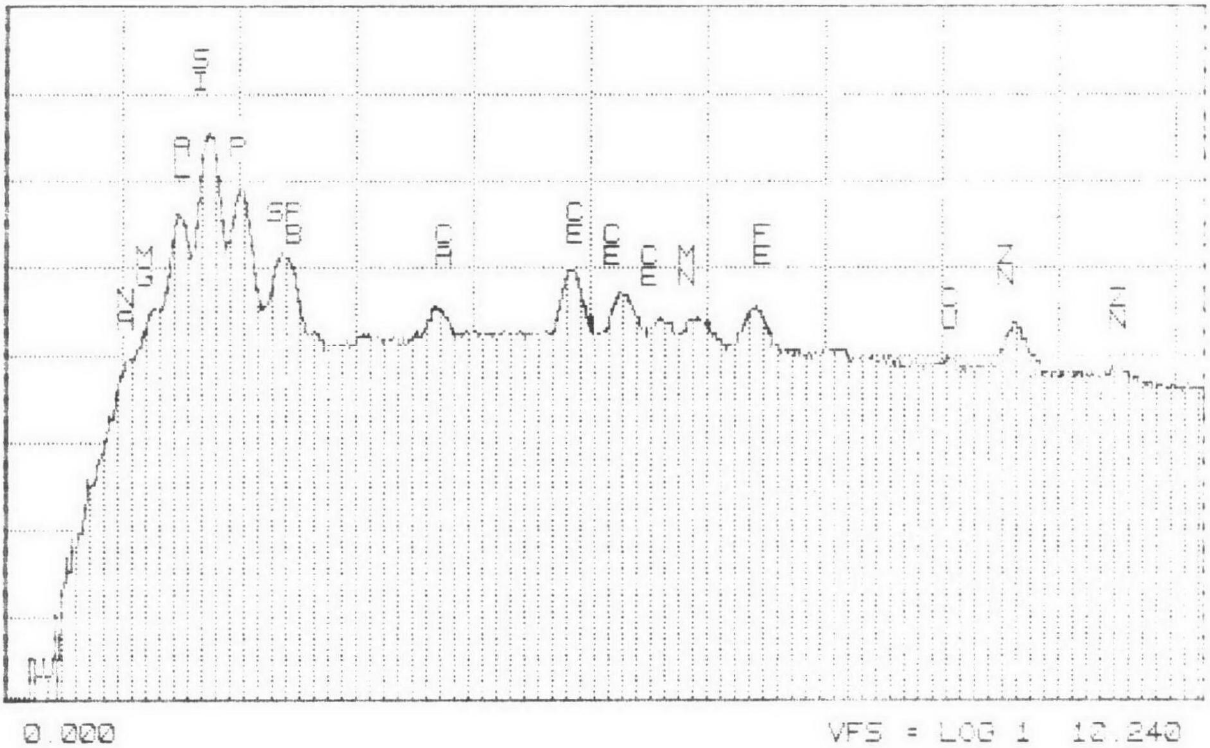


Figure D-181. SEM/EDX Spectrum of Converter A249/0169-2

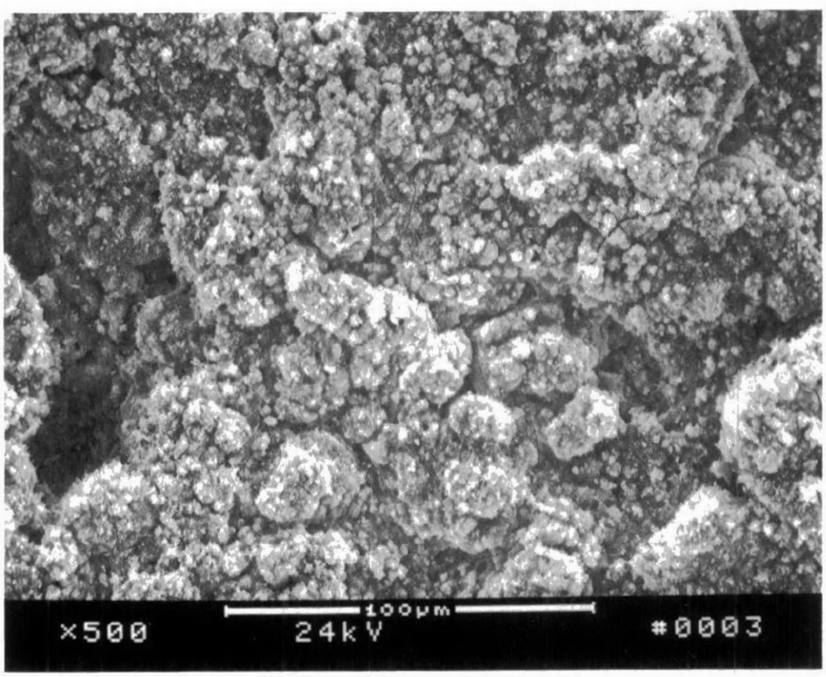


Figure D-182. Scanning Electron Micrograph at X500 of Converter A249/0169-2

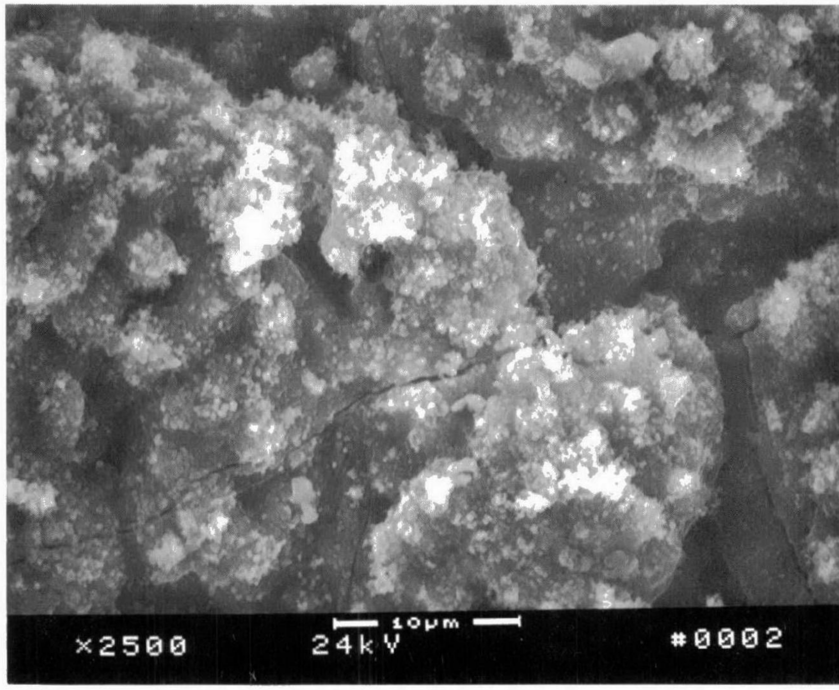


Figure D-183. Scanning Electron Micrograph at X2500 of Converter A249/0169-2

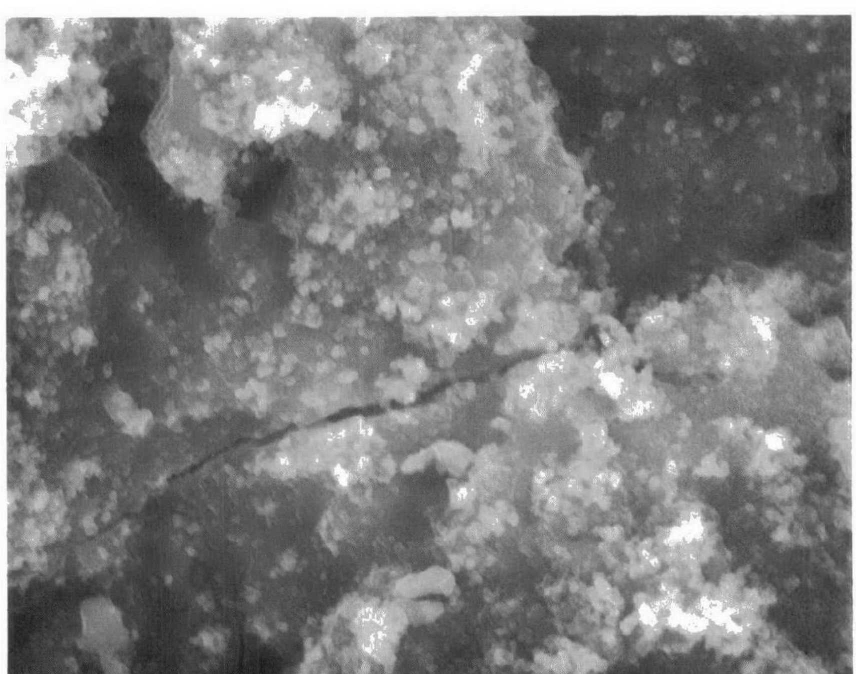


Figure D-184. Scanning Electron Micrograph at X5000 of Converter A249/0169-2

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE TO LOW FOR ADEQUATE MAPPING

Figure D-185. Aluminum Dot Map at X5000 of Converter A249/0169-2

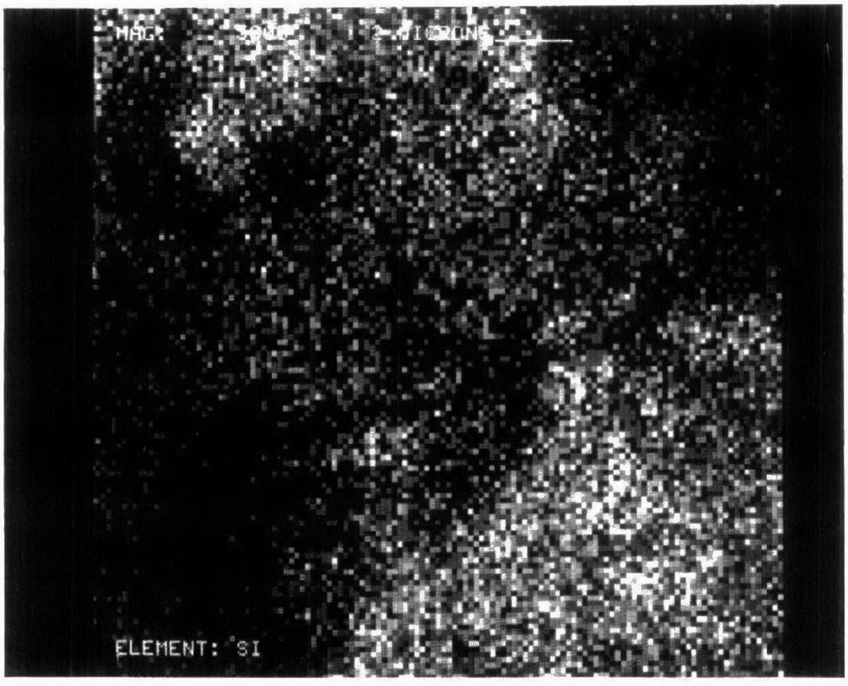


Figure D-186. Silicon Dot Map at X5000 of Converter A249/0169-2

Figure D-187. Lead Dot Map at X5000 of Converter A249/0169-2

Figure D-188. Sulfur Dot Map at X5000 of Converter A249/0169-2

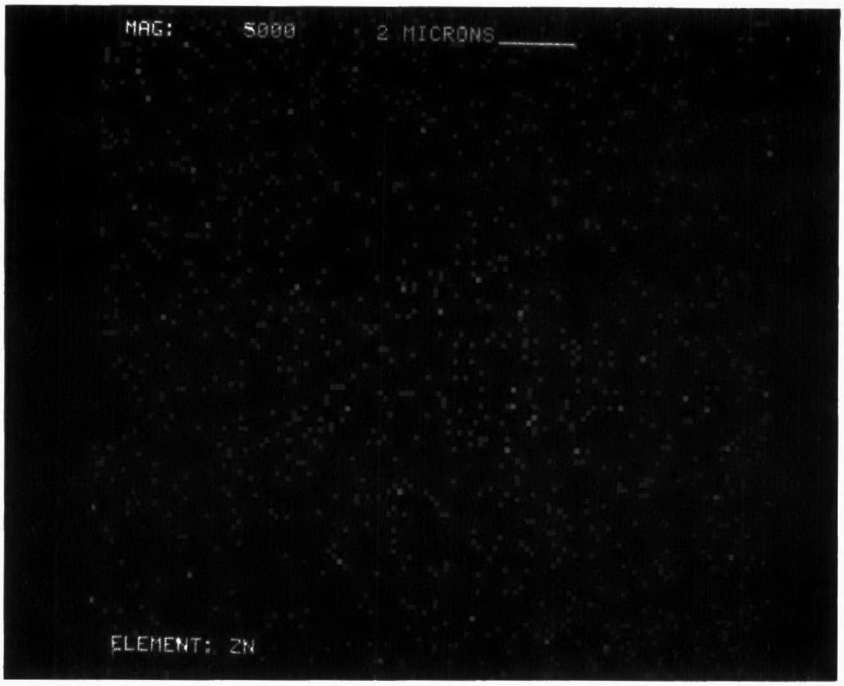


Figure D-189. Zinc Dot Map at X5000 of Converter A249/0169-2

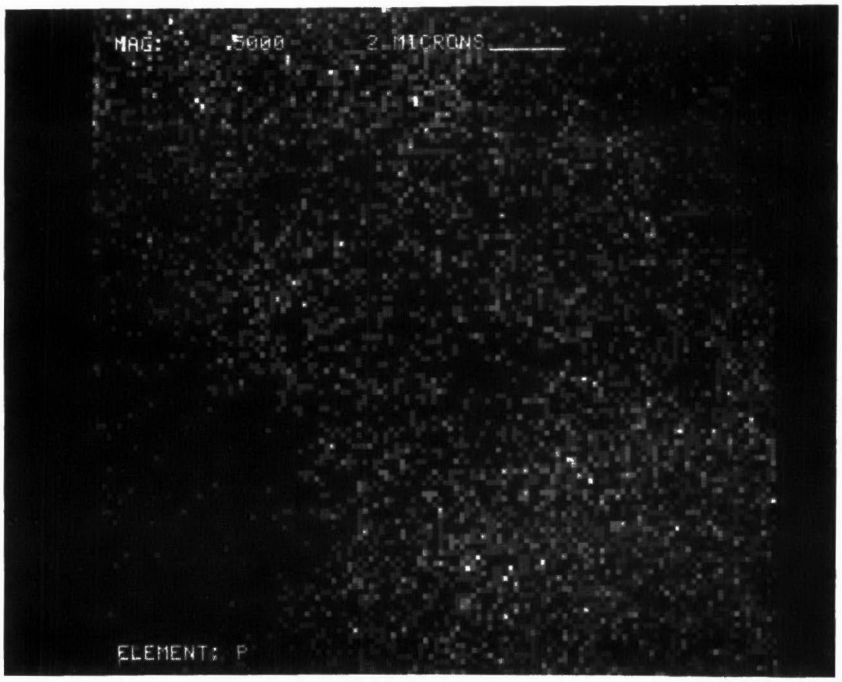


Figure D-190. Phosphorus Dot Map at X5000 of Converter A249/0169-2

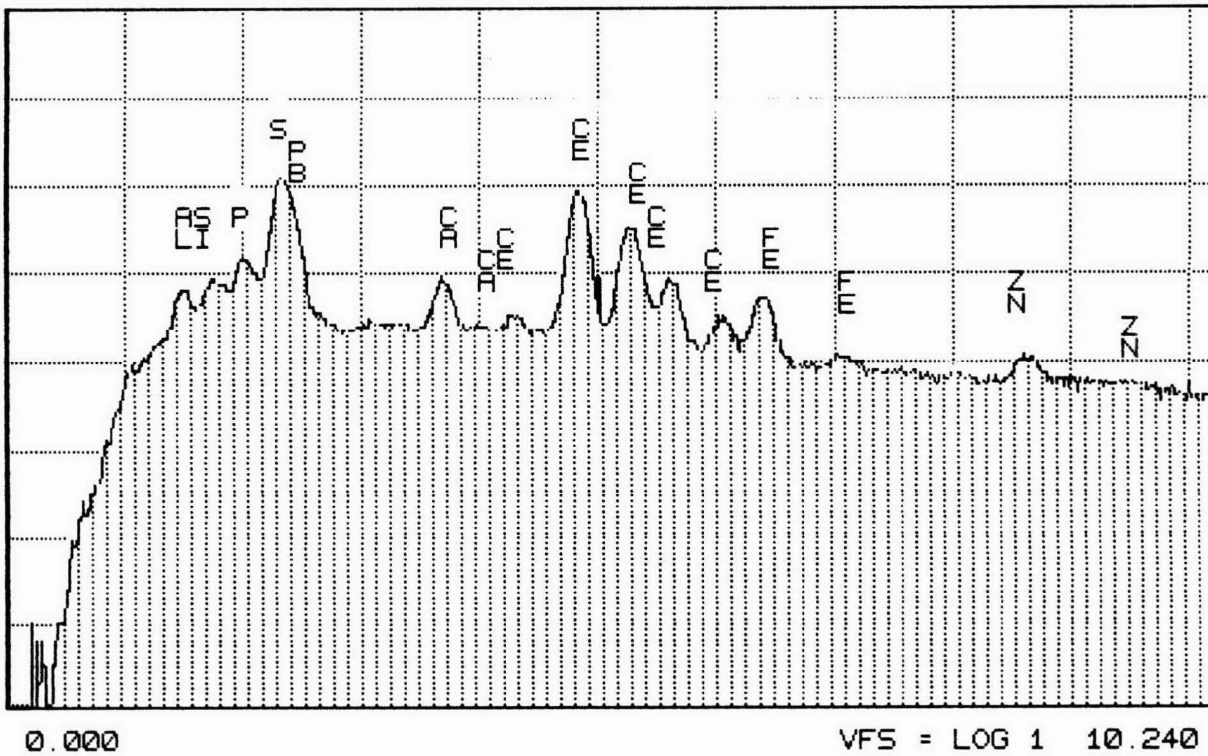


Figure D-191. SEM/EDX Spectrum of Converter A249/0169-3

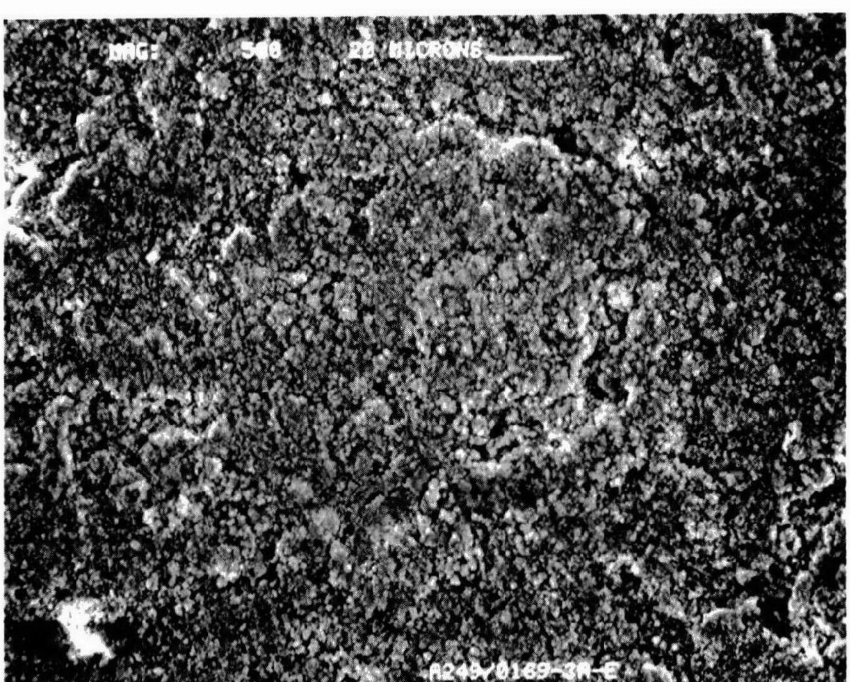


Figure D-192. Scanning Electron Micrograph at X500 of Converter A249/0169-3

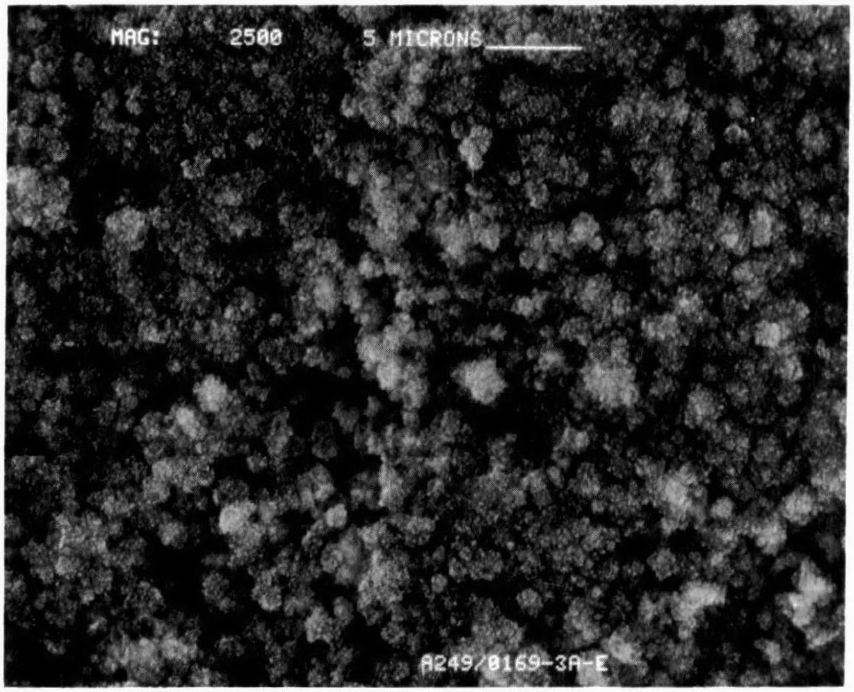


Figure D-193. Scanning Electron Micrograph at X2500 of Converter A249/0169-3

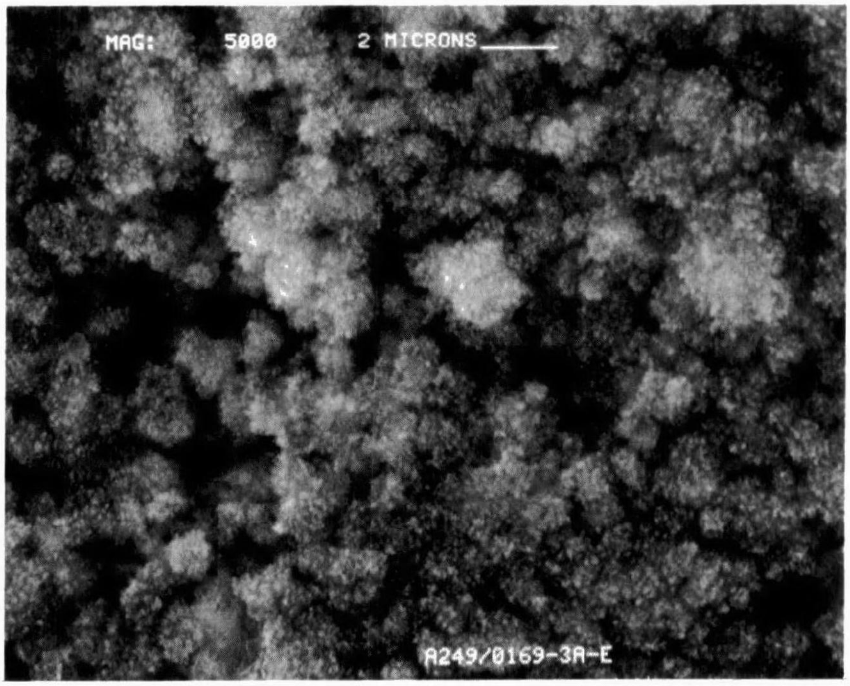


Figure D-194. Scanning Electron Micrograph at X5000 of Converter A249/0169-3

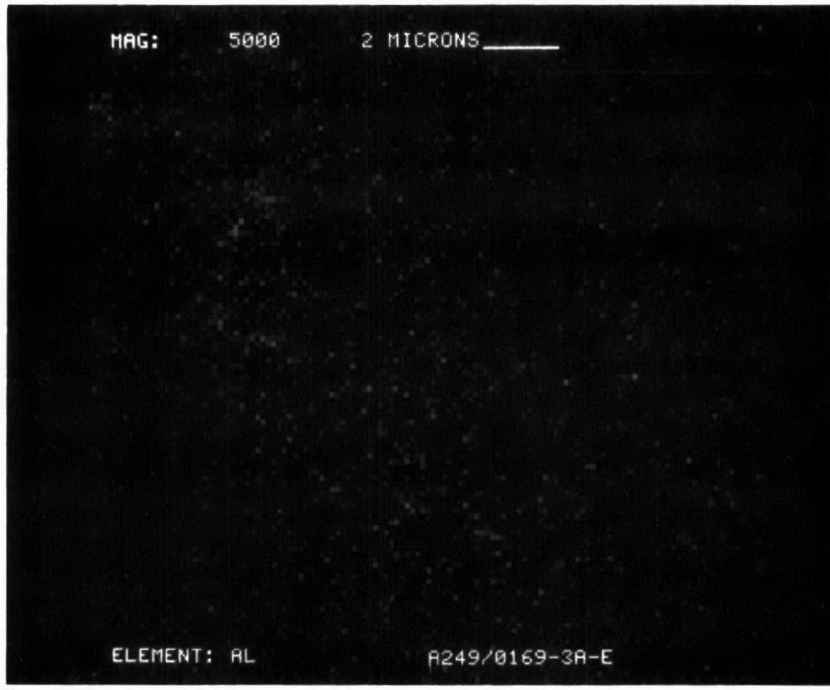


Figure D-195. Aluminum Dot Map at X5000 of Converter A249/0169-3

Figure D-196. Silicon Dot Map at X5000 of Converter A249/0169-3

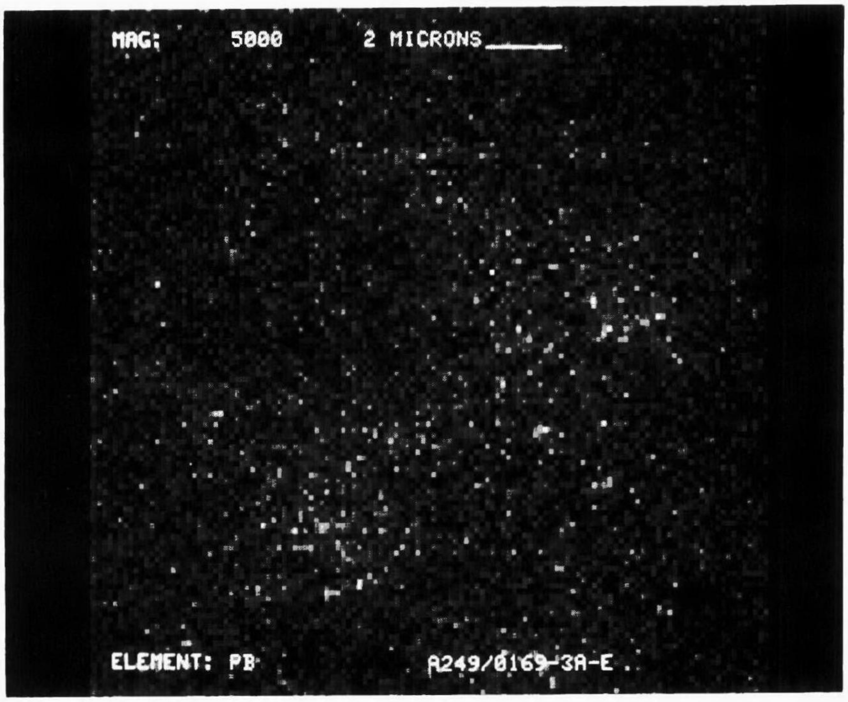


Figure D-197. Lead Dot Map at X5000 of Converter A249/0169-3

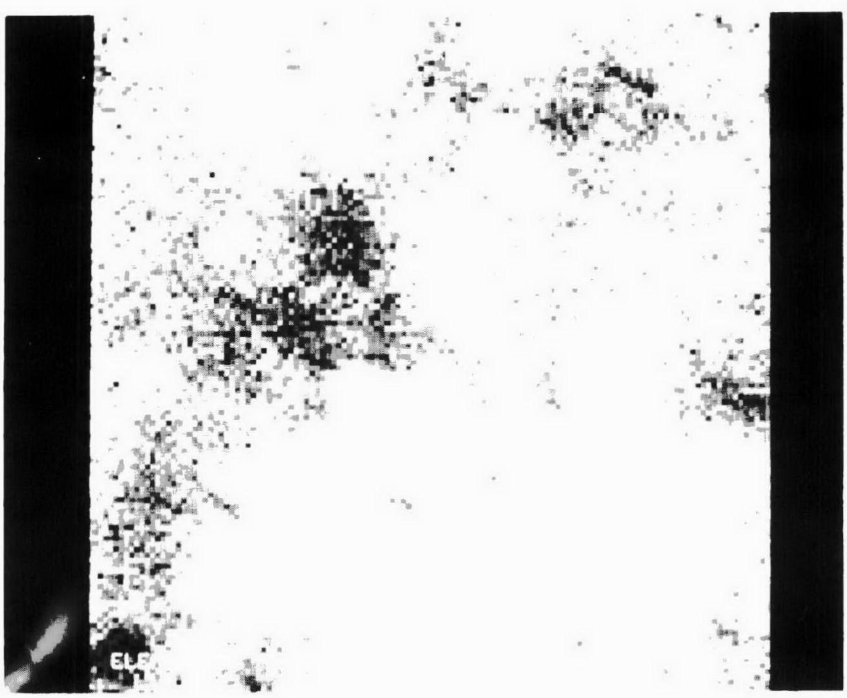


Figure D-198. Sulfur Dot Map at X5000 of Converter A249/0169-3

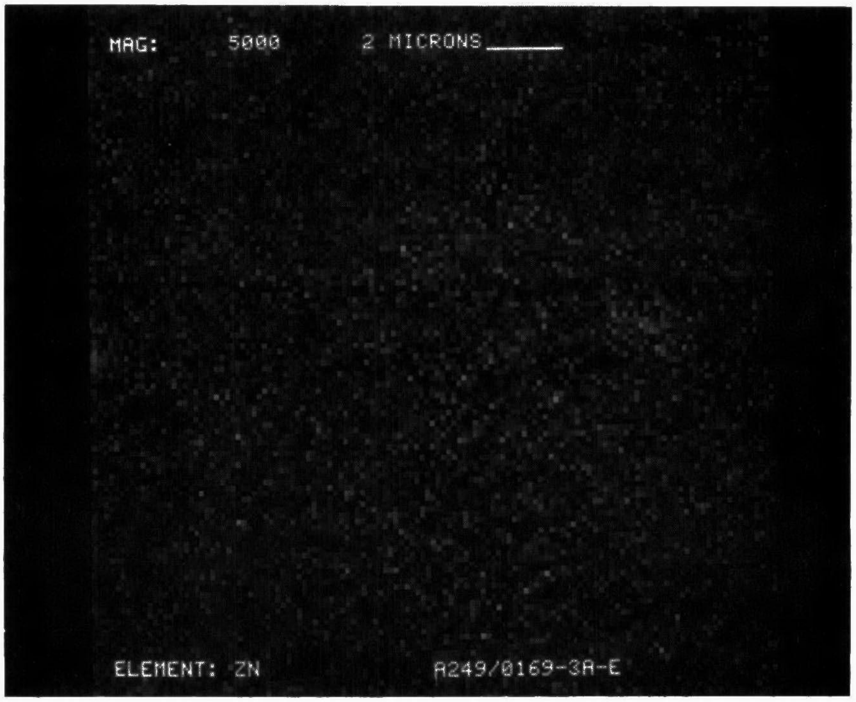


Figure D-199. Zinc Dot Map at X5000 of Converter A249/0169-3

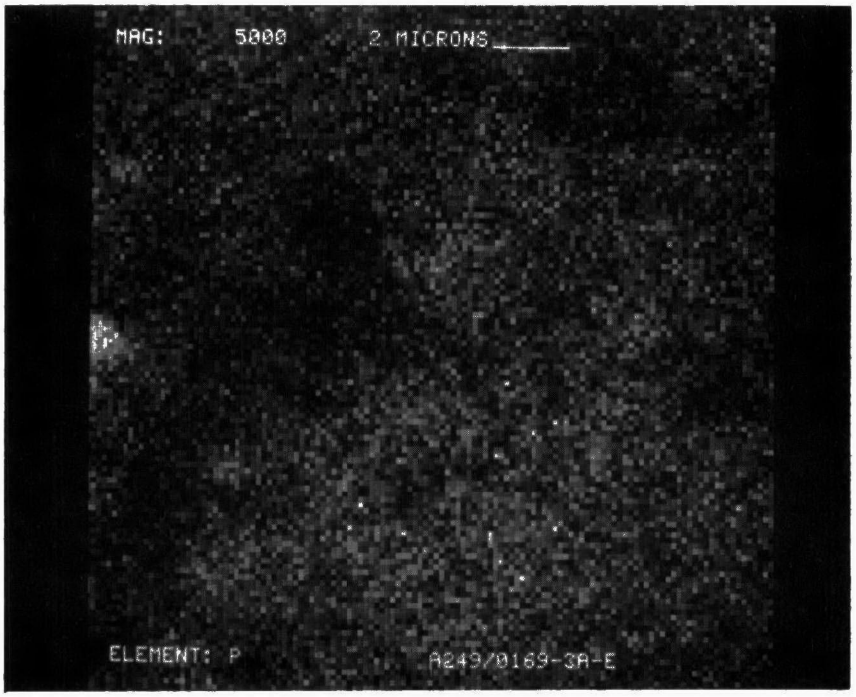


Figure D-200. Phosphorus Dot Map at X5000 of Converter A249/0169-3

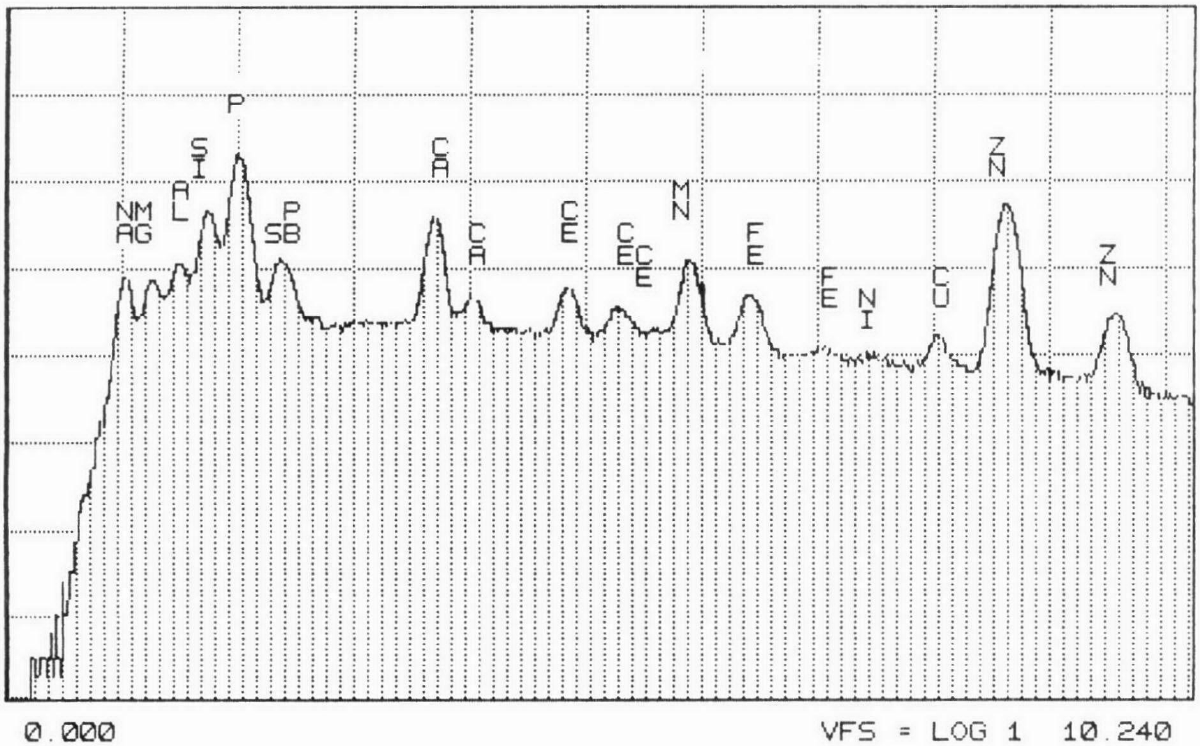


Figure D-201. SEM/EDX Spectrum of Converter A280/0001L

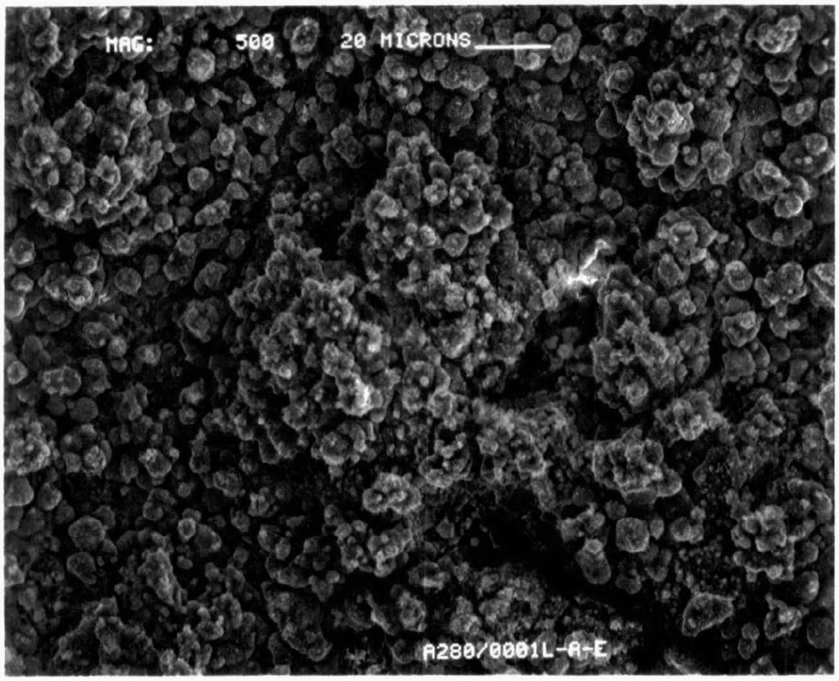


Figure D-202. Scanning Electron Micrograph at X500 of Converter A280/0001L

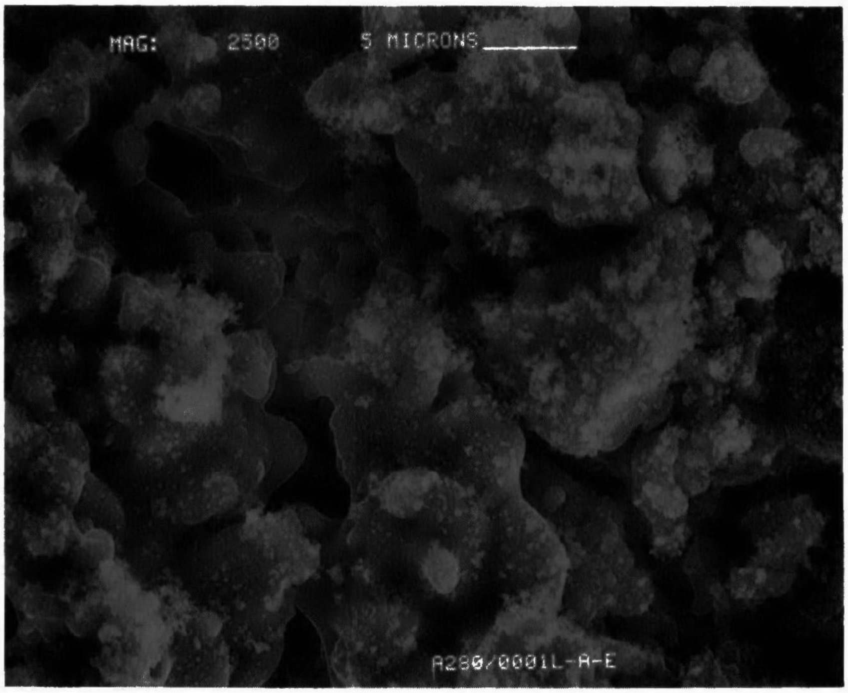


Figure D-203. Scanning Electron Micrograph at X2500 of Converter A280/0001L

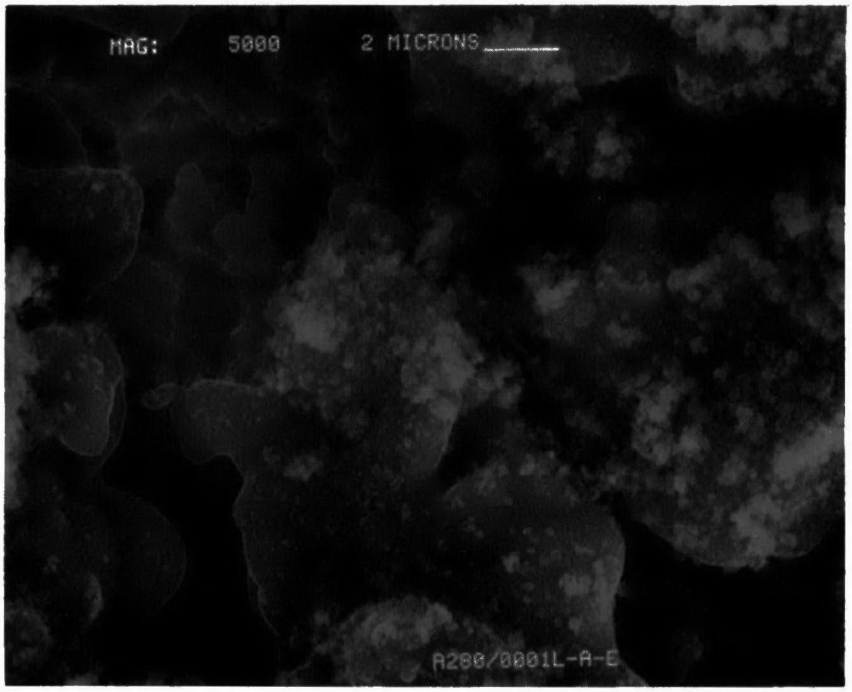


Figure D-204. Scanning Electron Micrograph at X5000 of Converter A280/0001L

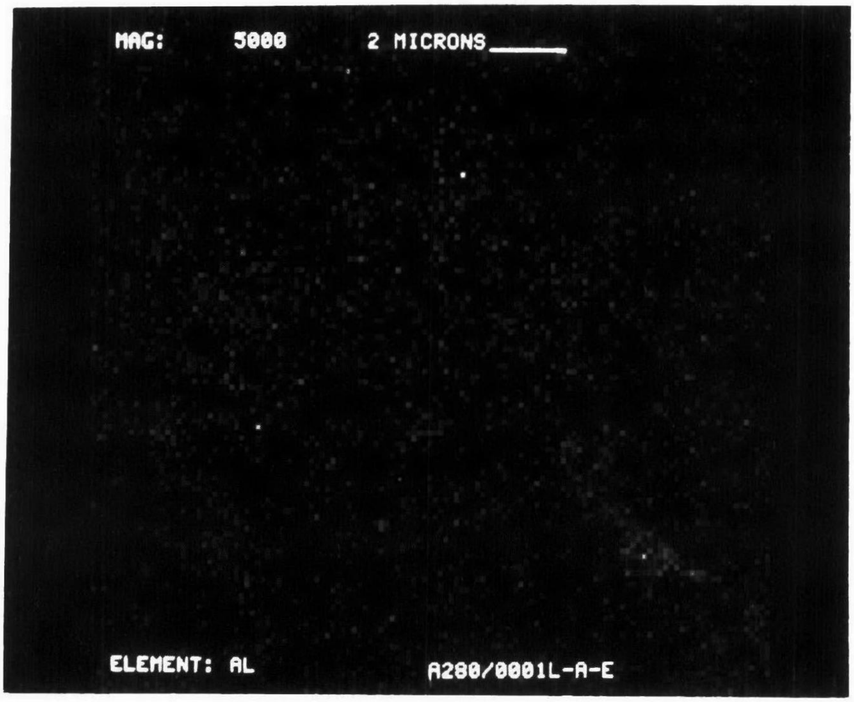


Figure D-205. Aluminum Dot Map at X5000 of Converter A280/0001L

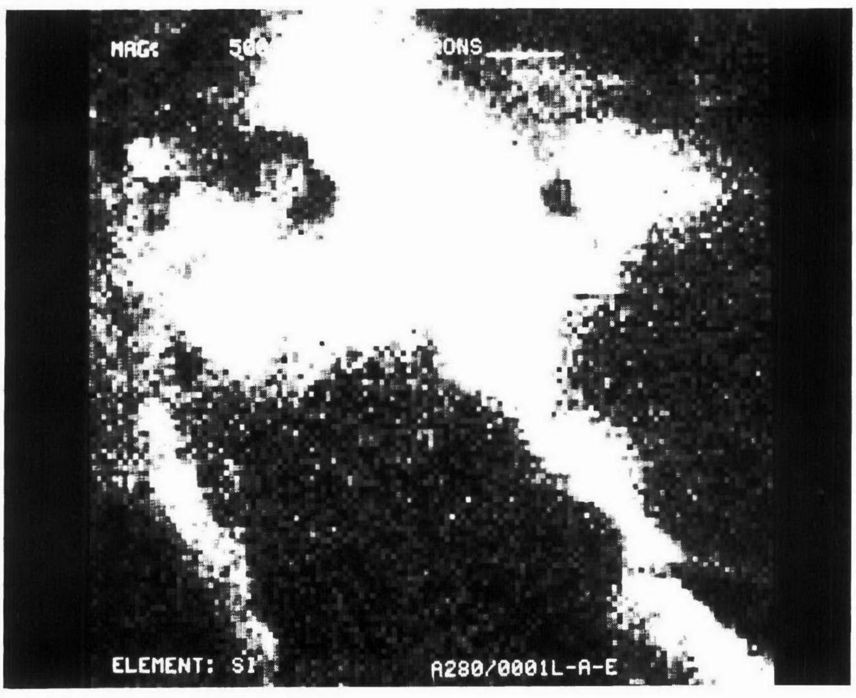


Figure D-206. Silicon Dot Map at X5000 of Converter A280/0001L

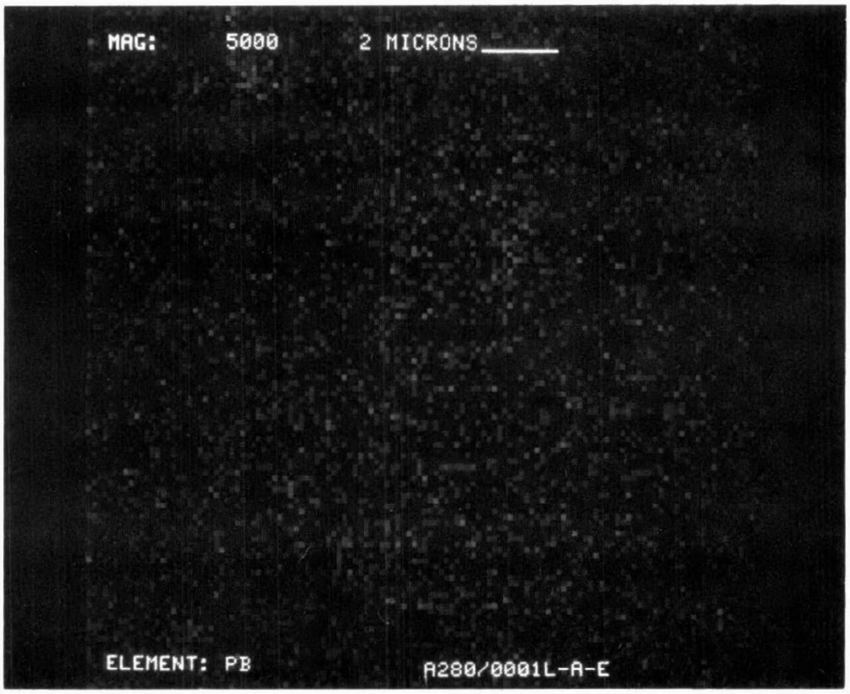


Figure D-207. Lead Dot Map at X5000 of Converter A280/0001L

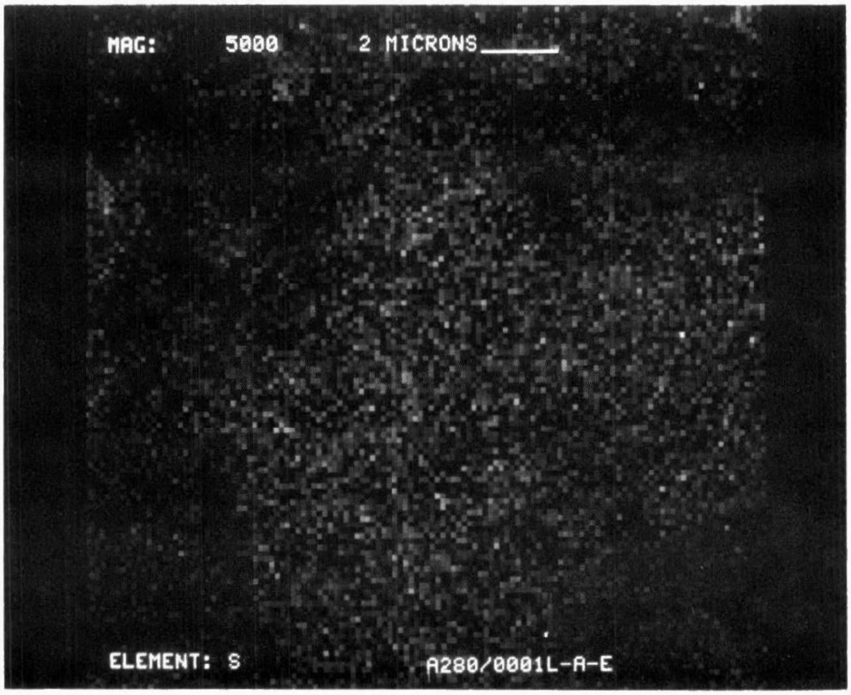


Figure D-208. Sulfur Dot Map at X5000 of Converter A280/0001L

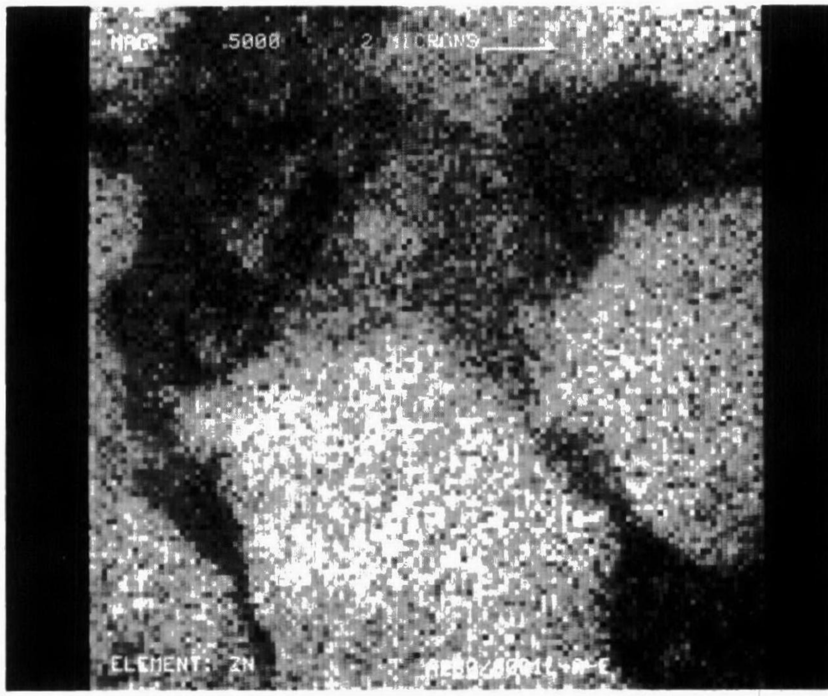


Figure D-209. Zinc Dot Map at X5000 of Converter A280/0001L

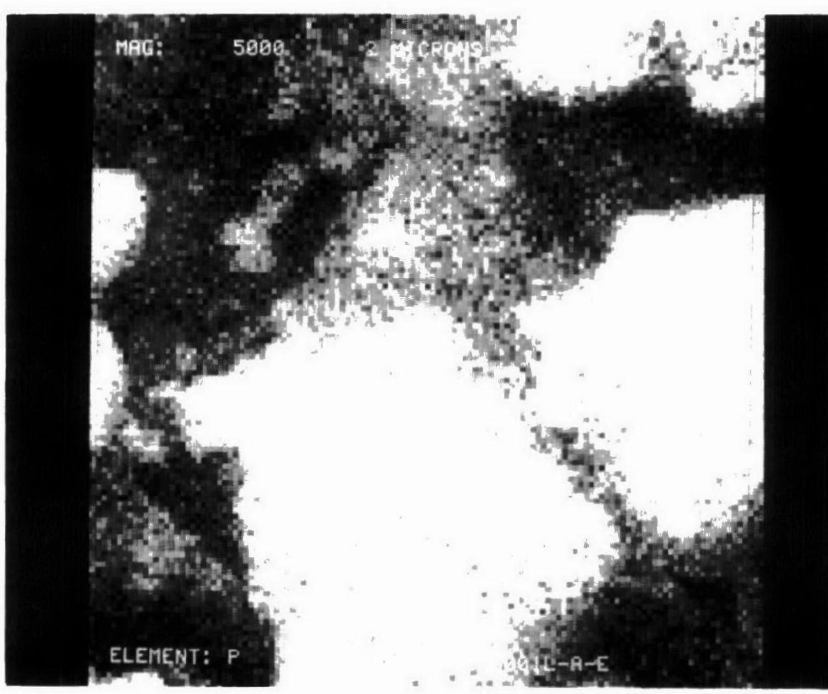


Figure D-210. Phosphorus Dot Map at X5000 of Converter A280/0001L

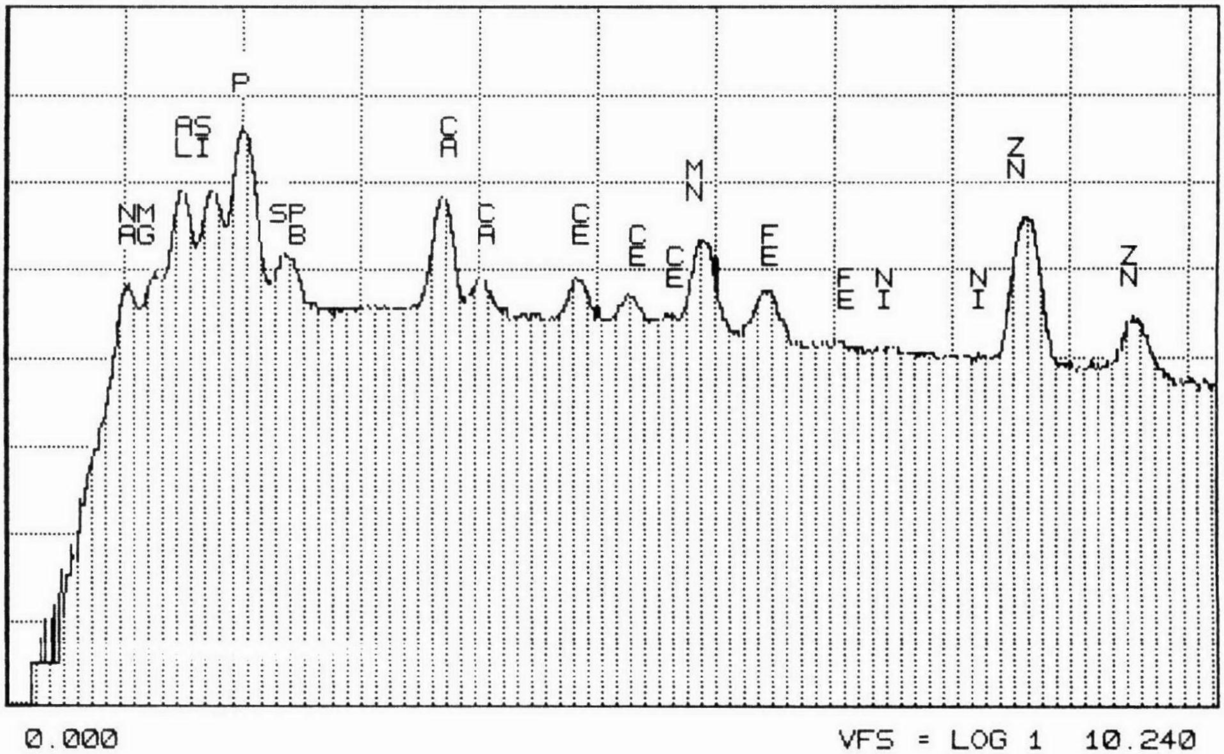


Figure D-211. SEM/EDX Spectrum of Converter A155/0941-1

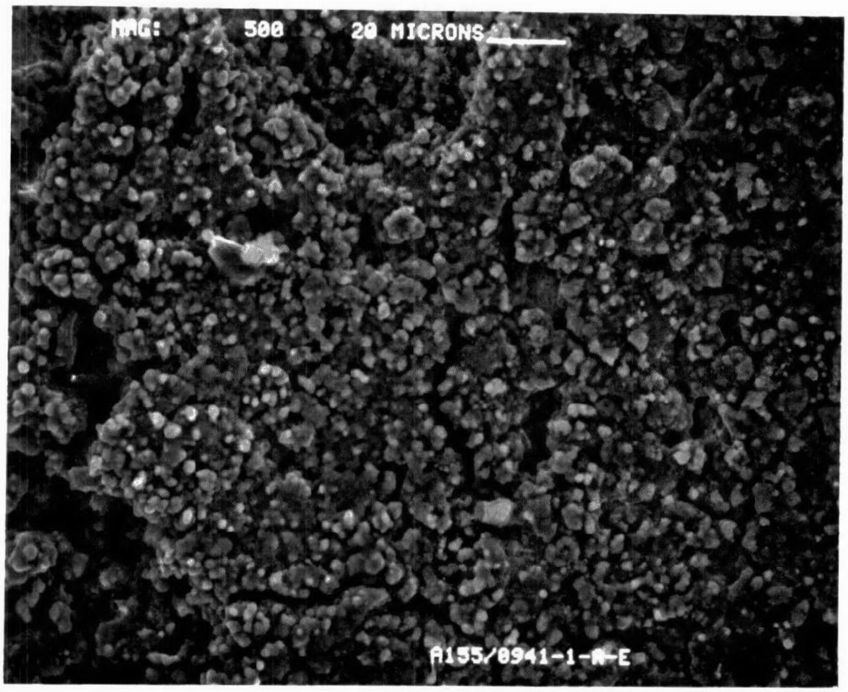


Figure D-212. Scanning Electron Micrograph at X500 of Converter A155/0941-1

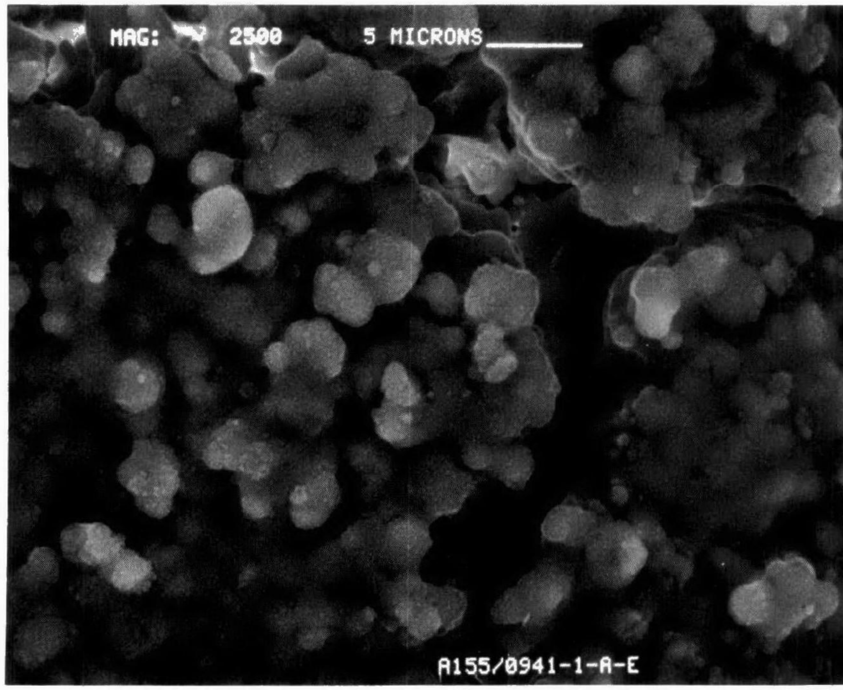


Figure D-213. Scanning Electron Micrograph at X2500 of Converter A155/0941-1

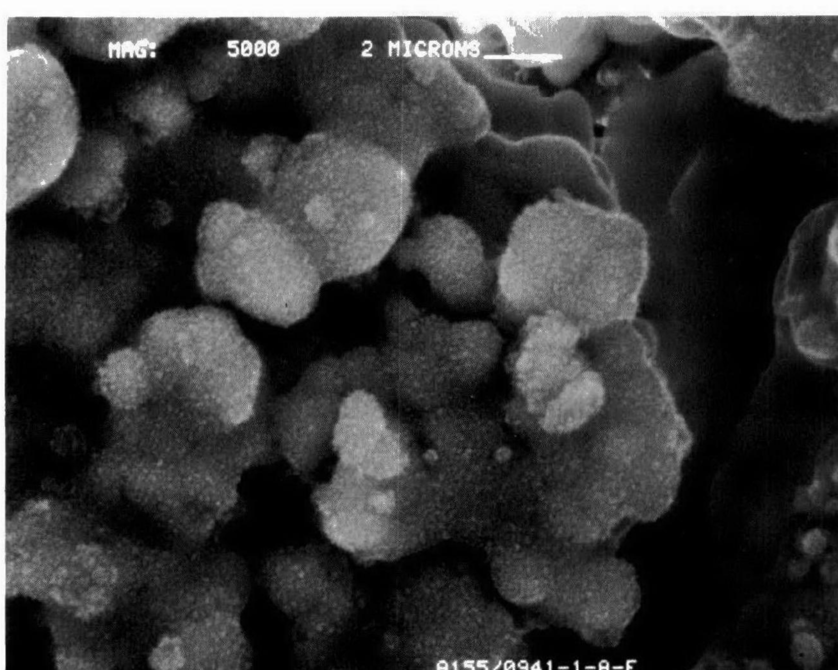


Figure D-214. Scanning Electron Micrograph at X5000 of Converter A155/0941-1

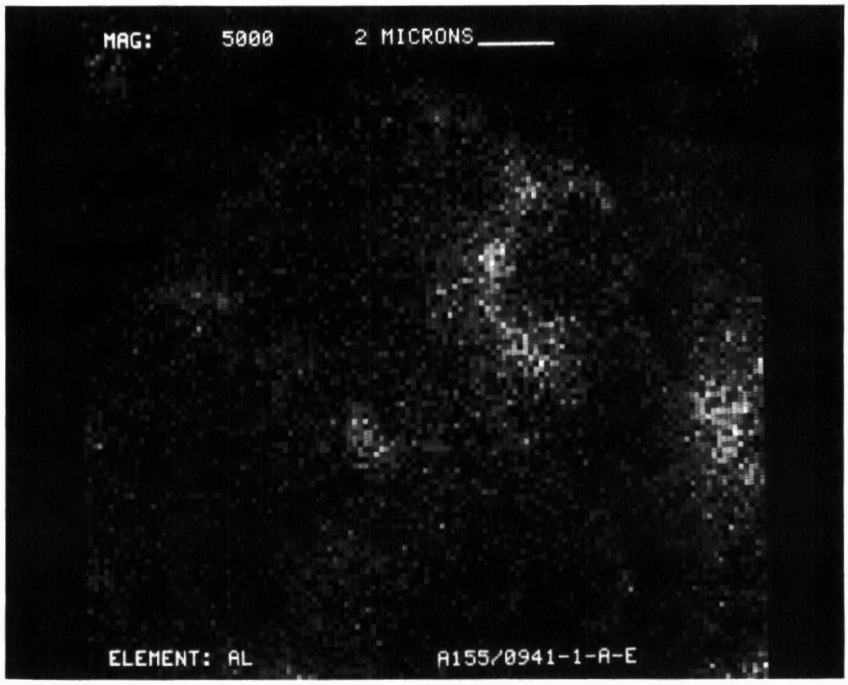


Figure D-215. Aluminum Dot Map at X5000 of Converter A155/0941-1

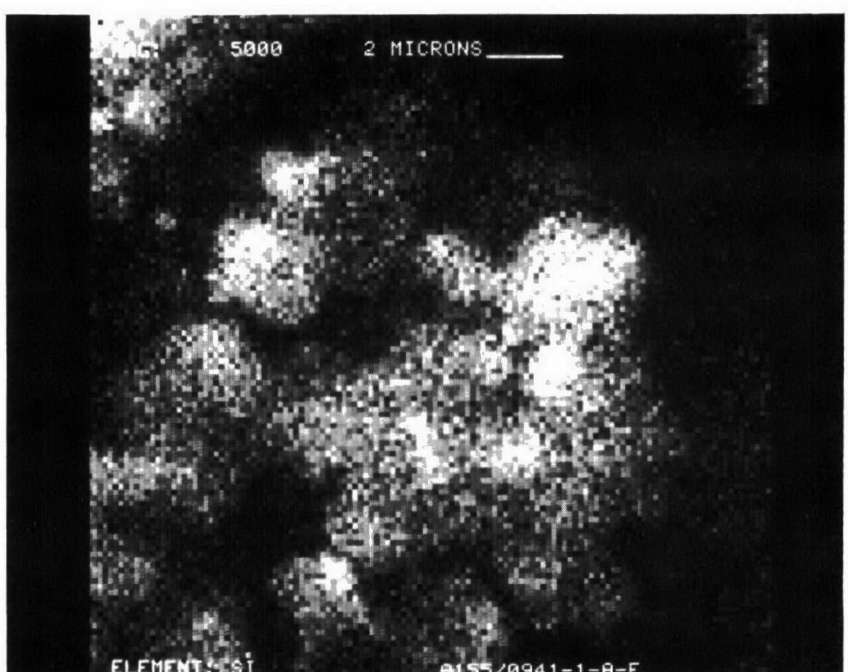


Figure D-216. Silicon Dot Map at X5000 of Converter A155/0941-1

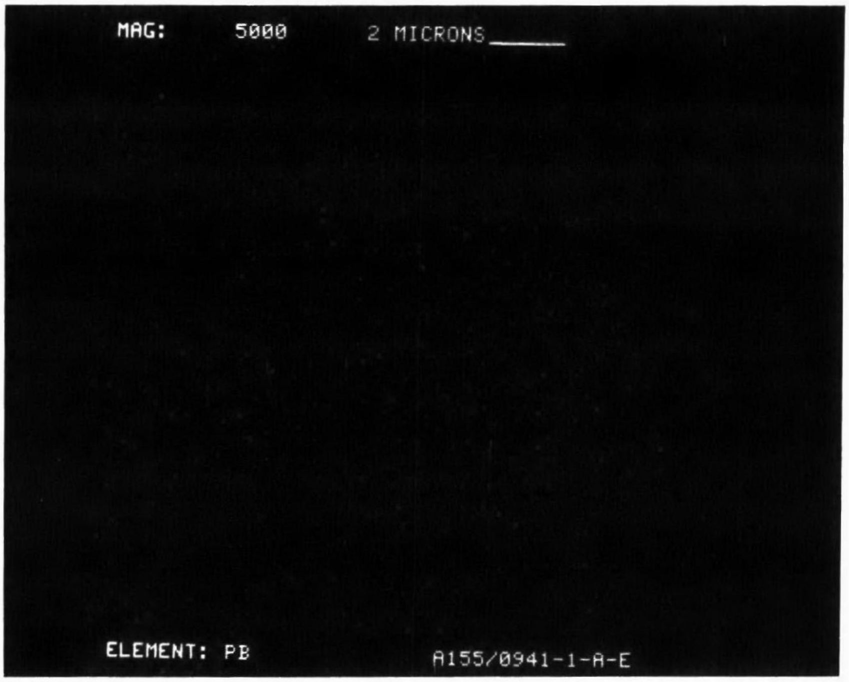


Figure D-217. Lead Dot Map at X5000 of Converter A155/0941-1

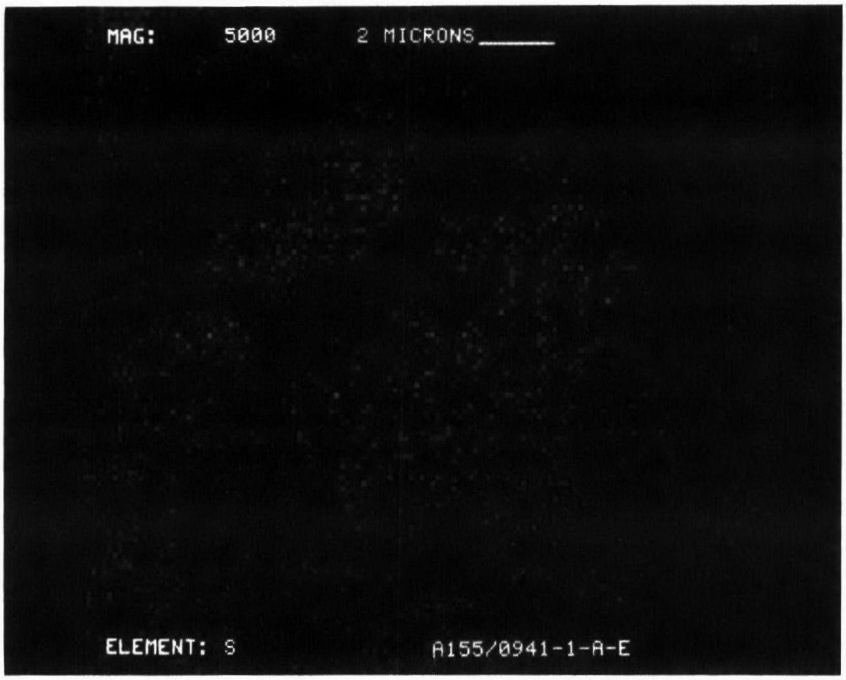


Figure D-218. Sulfur Dot Map at X5000 of Converter A155/0941-1

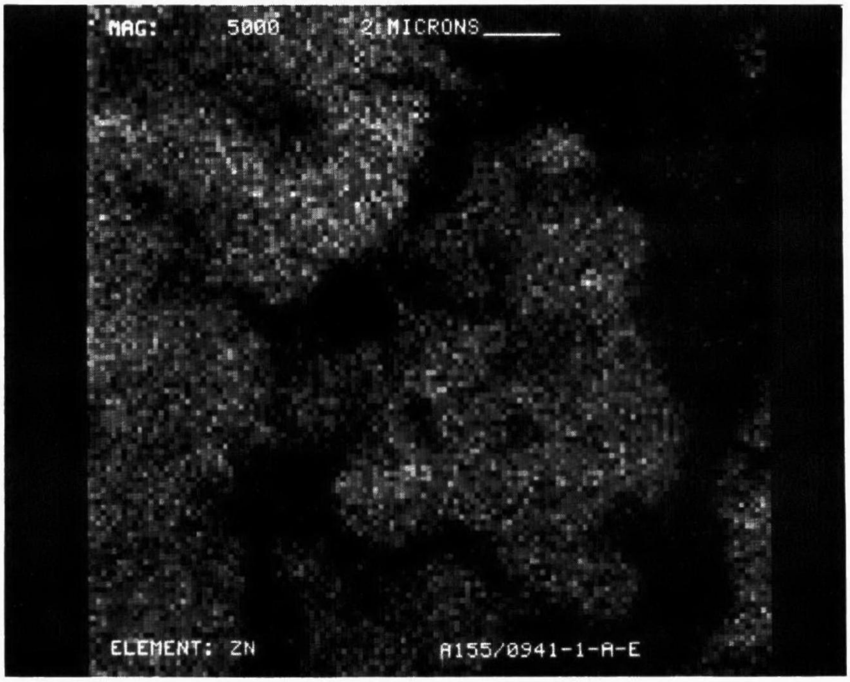


Figure D-219. Zinc Dot Map at X5000 of Converter A155/0941-1

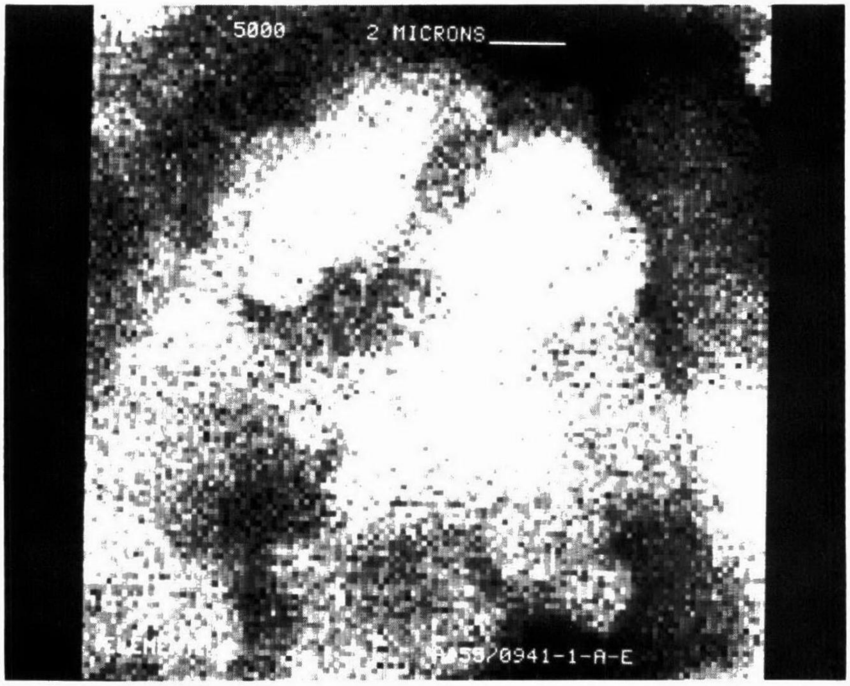


Figure D-220. Phosphorus Dot Map at X5000 of Converter A155/0941-1

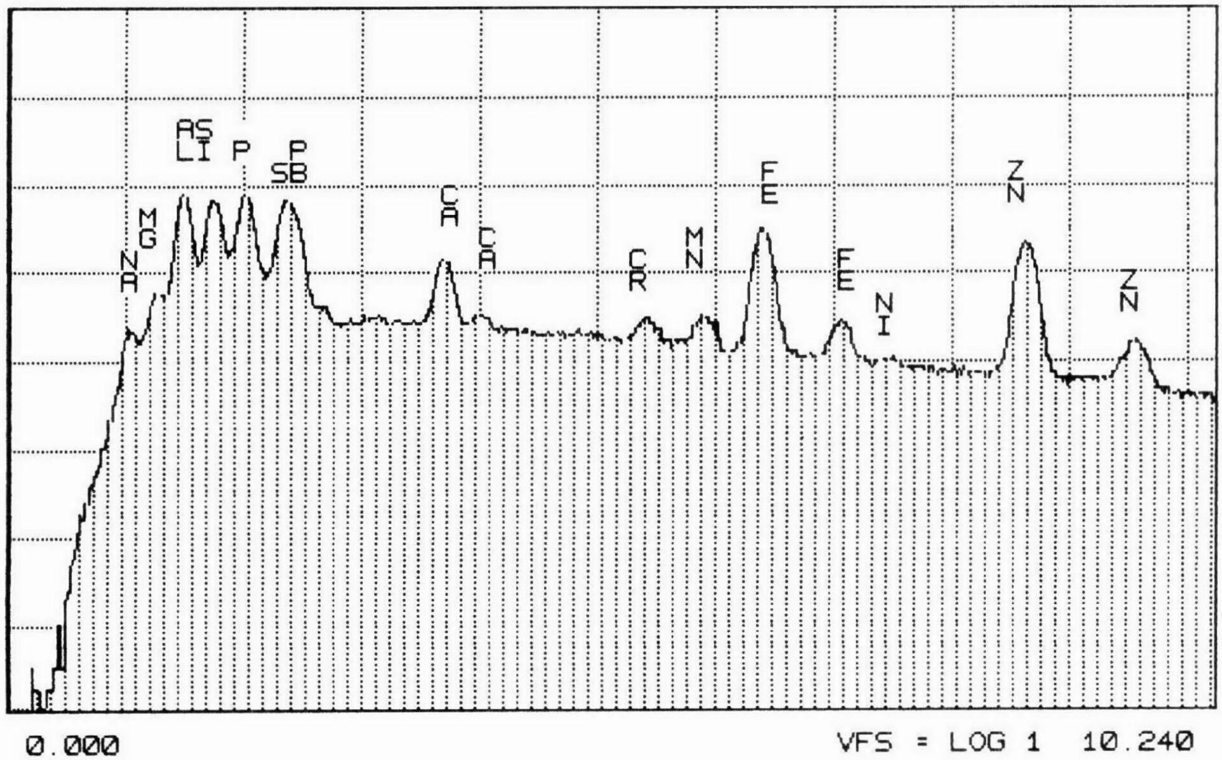


Figure D-221. SEM/EDX Spectrum of Converter A155/0941-2

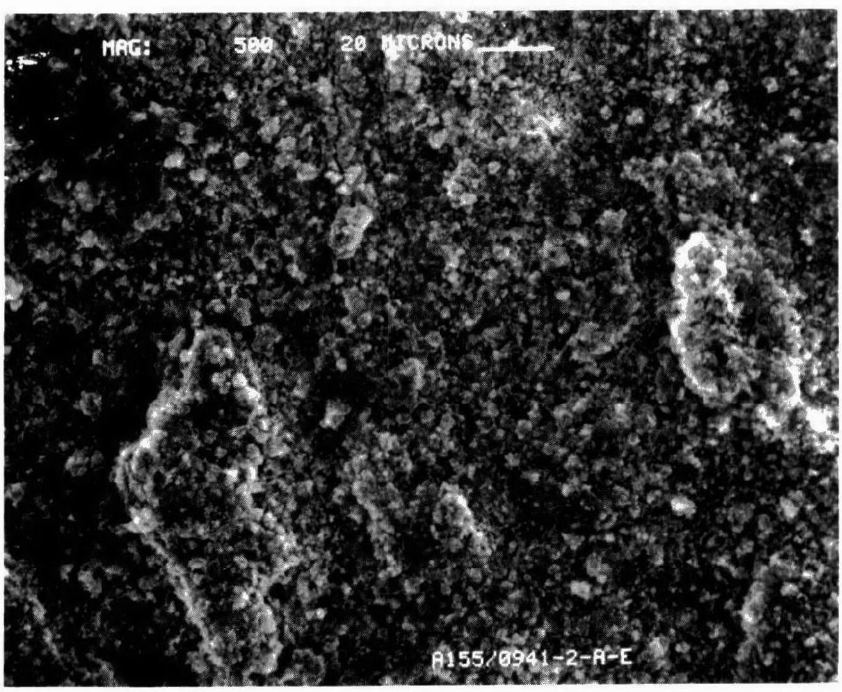


Figure D-222. Scanning Electron Micrograph at X500 of Converter A155/0941-2

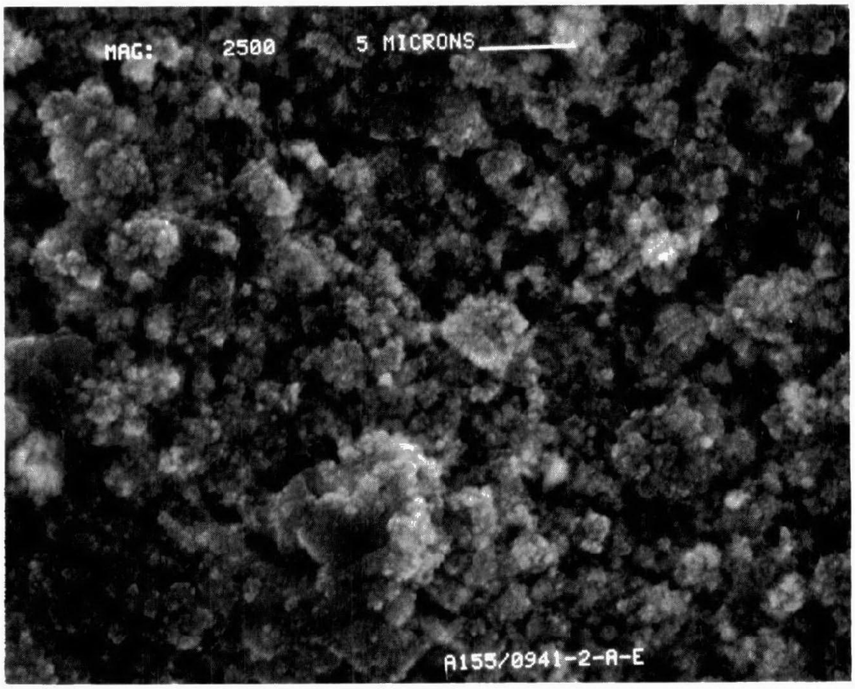


Figure D-223. Scanning Electron Micrograph at X2500 of Converter A155/0941-2

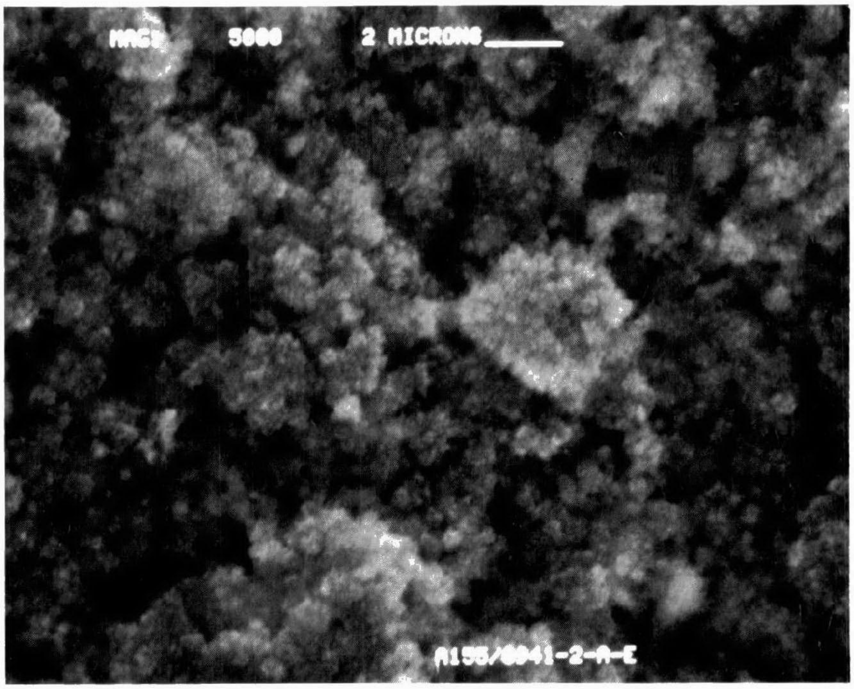


Figure D-224. Scanning Electron Micrograph at X5000 of Converter A155/0941-2

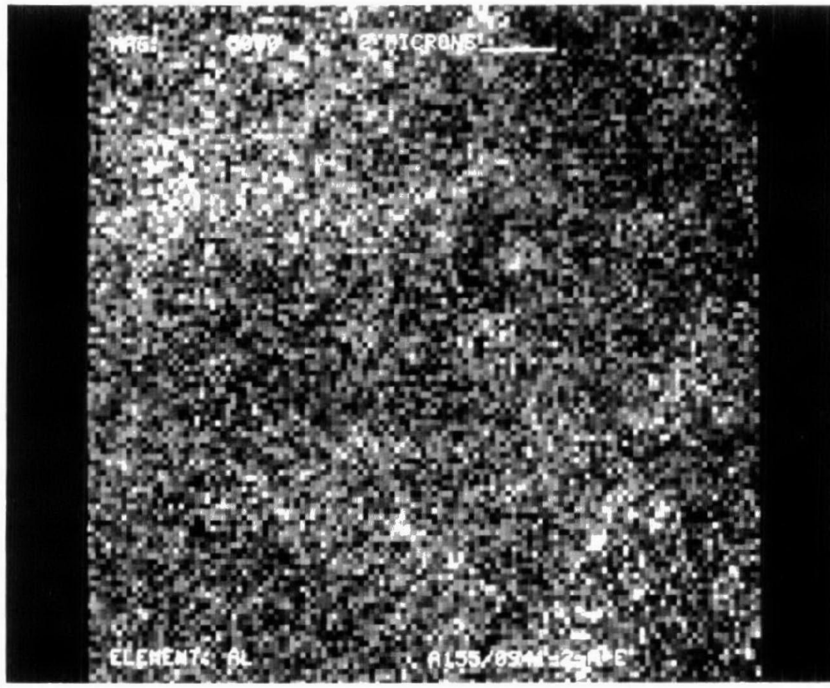


Figure D-225. Aluminum Dot Map at X5000 of Converter A155/0941-2

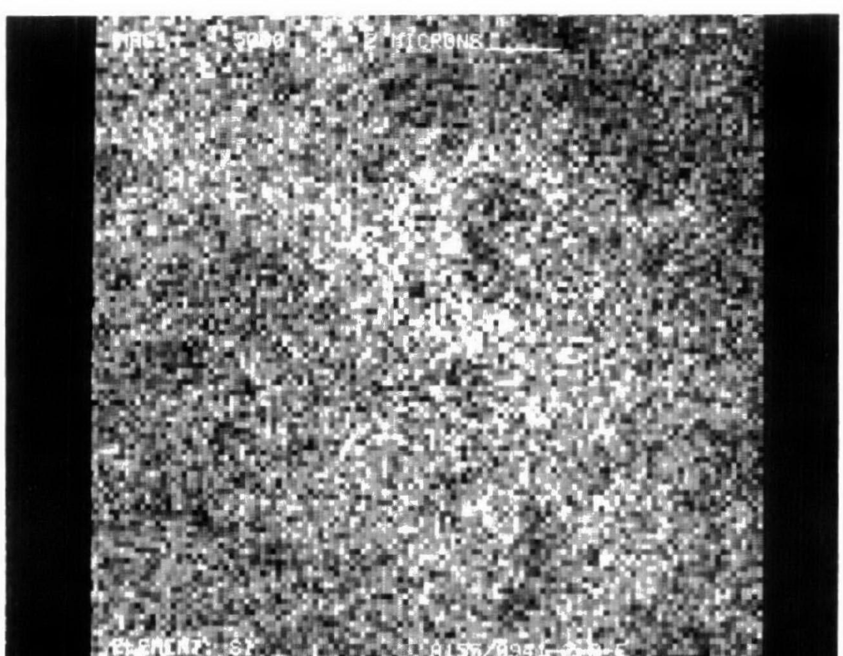


Figure D-226. Silicon Dot Map at X5000 of Converter A155/0941-2

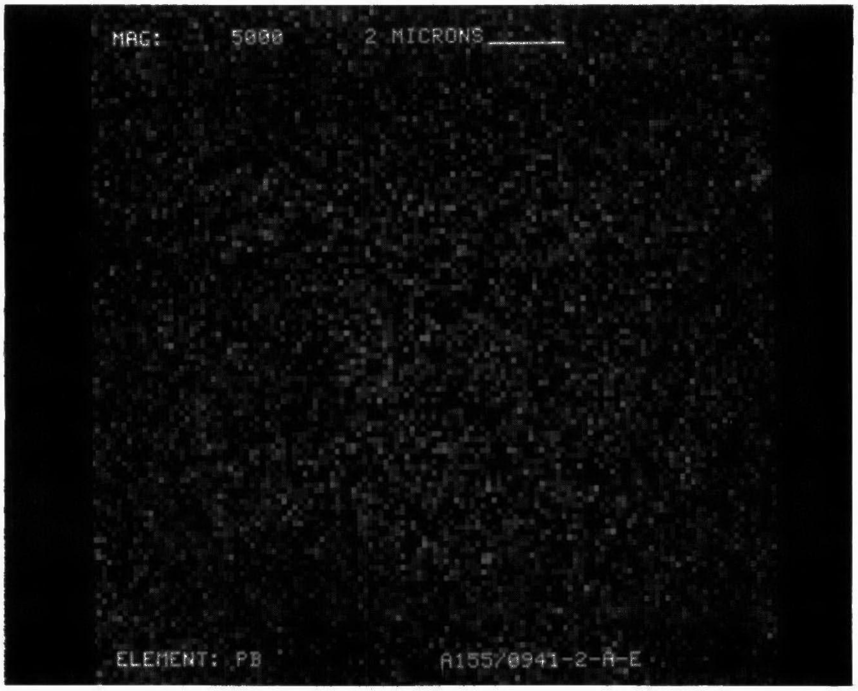


Figure D-227. Lead Dot Map at X5000 of Converter A155/0941-2

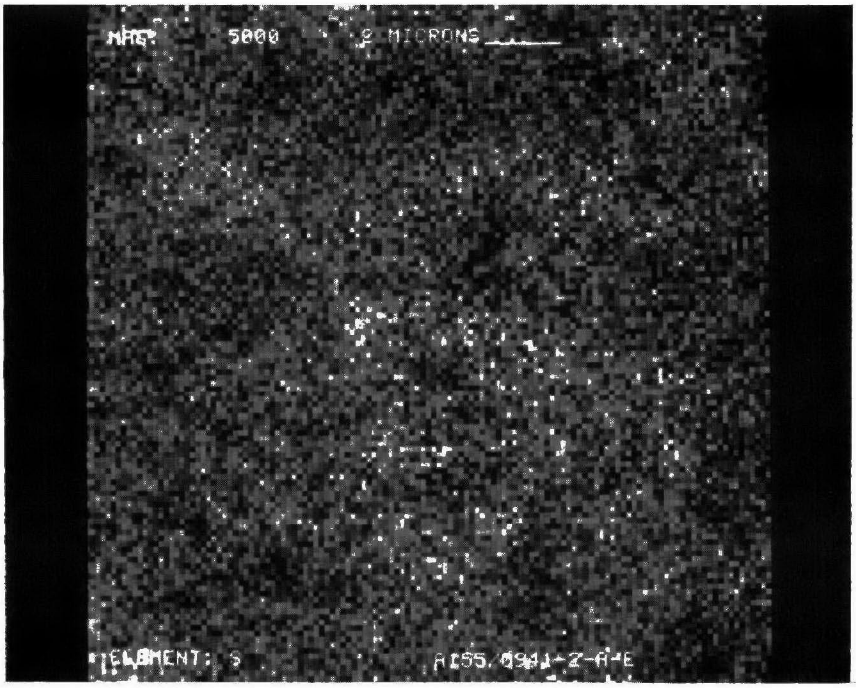


Figure D-228. Sulfur Dot Map at X5000 of Converter A155/0941-2

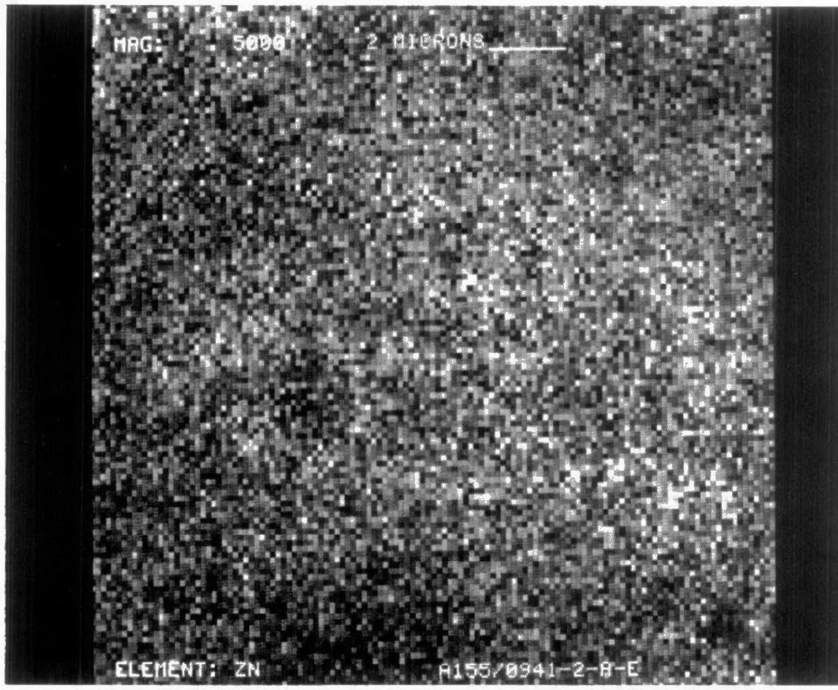


Figure D-229. Zinc Dot Map at X5000 of Converter A155/0941-2

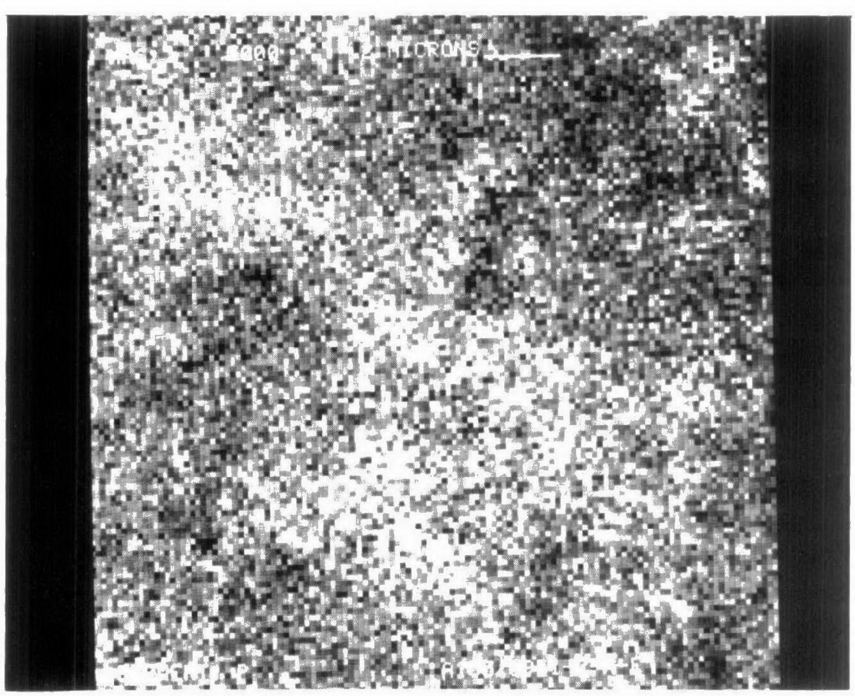


Figure D-230. Phosphorus Dot Map at X5000 of Converter A155/0941-2

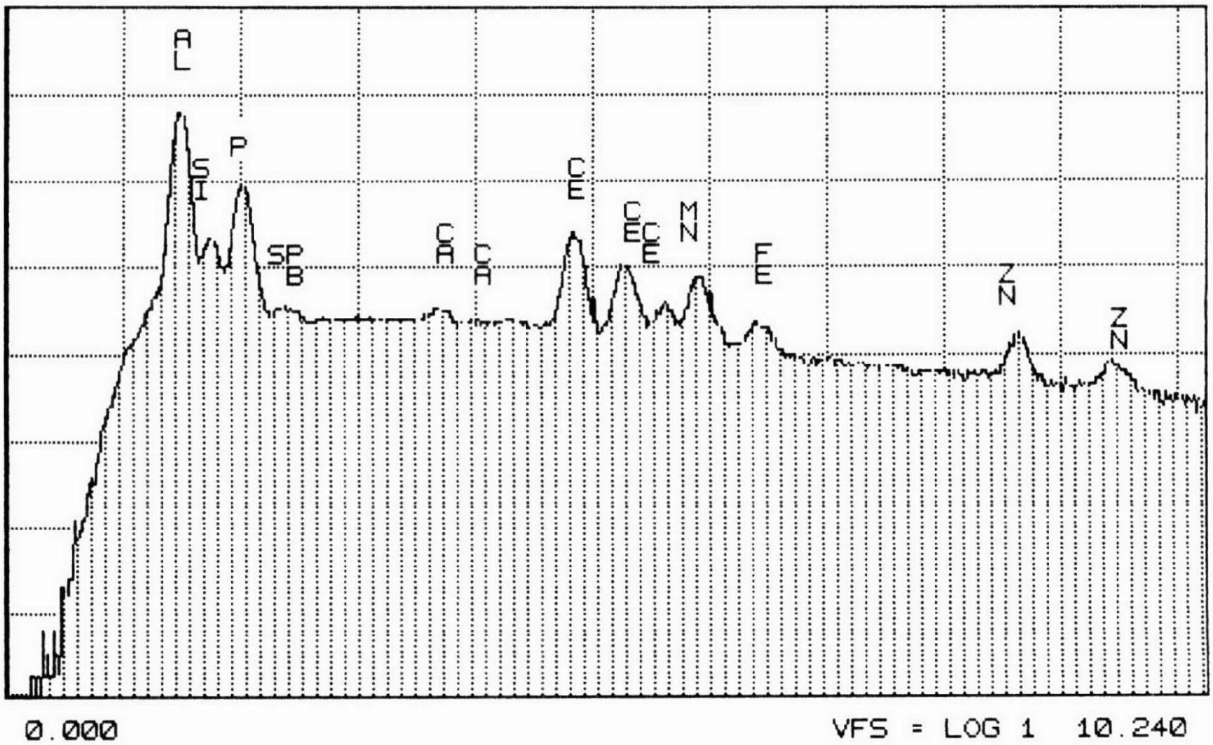


Figure D-231. SEM/EDX Spectrum of Converter A207/0101

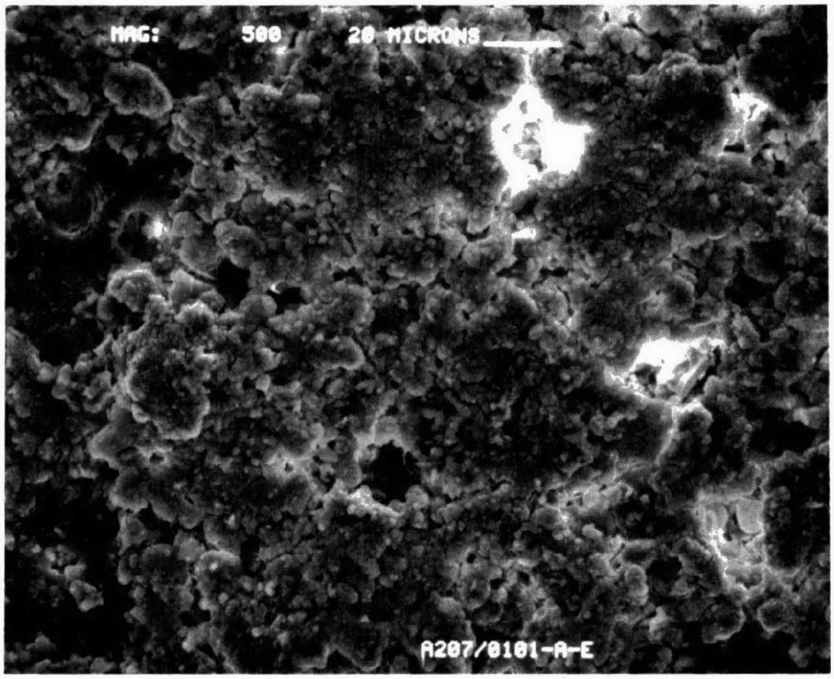


Figure D-232. Scanning Electron Micrograph at X500 of Converter A207/0101

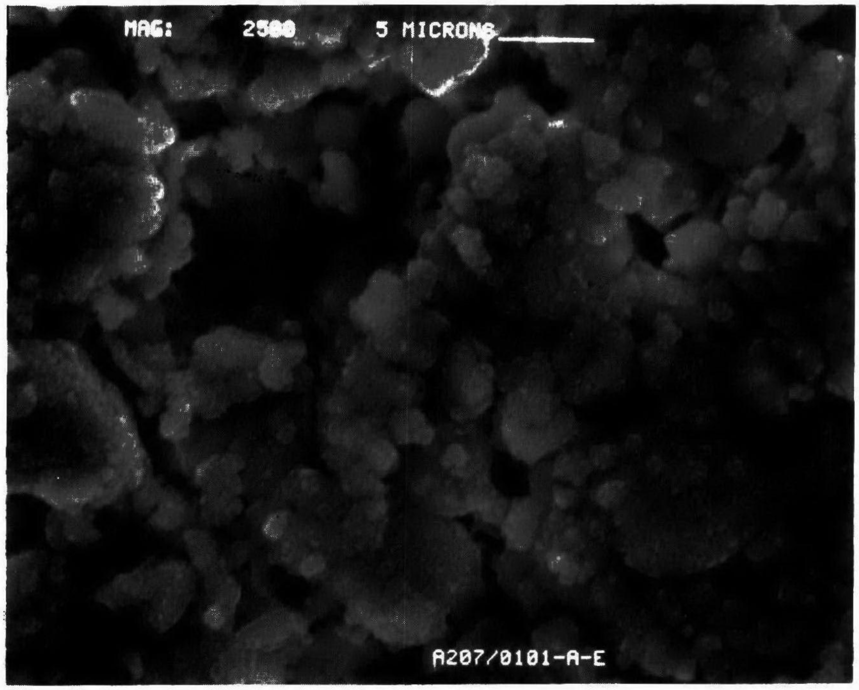


Figure D-233. Scanning Electron Micrograph at X2500 of Converter A207/0101

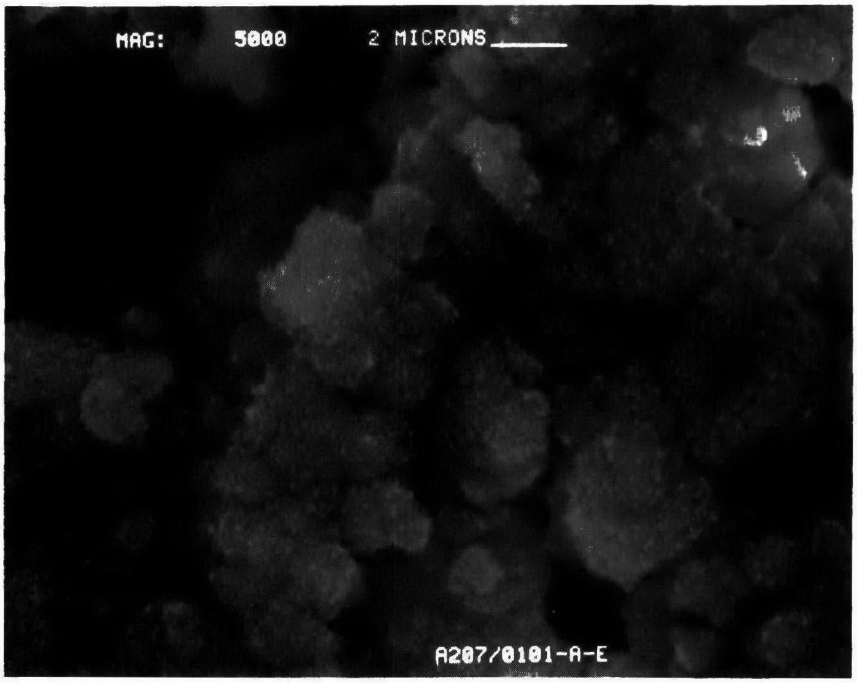


Figure D-234. Scanning Electron Micrograph at X5000 of Converter A207/0101

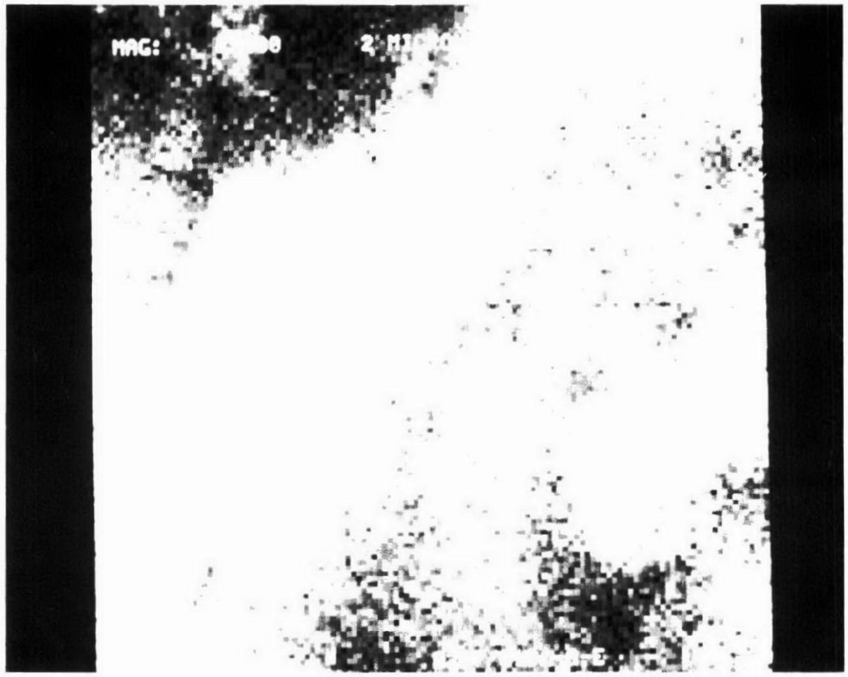


Figure D-235. Aluminum Dot Map at X5000 of Converter A207/0101

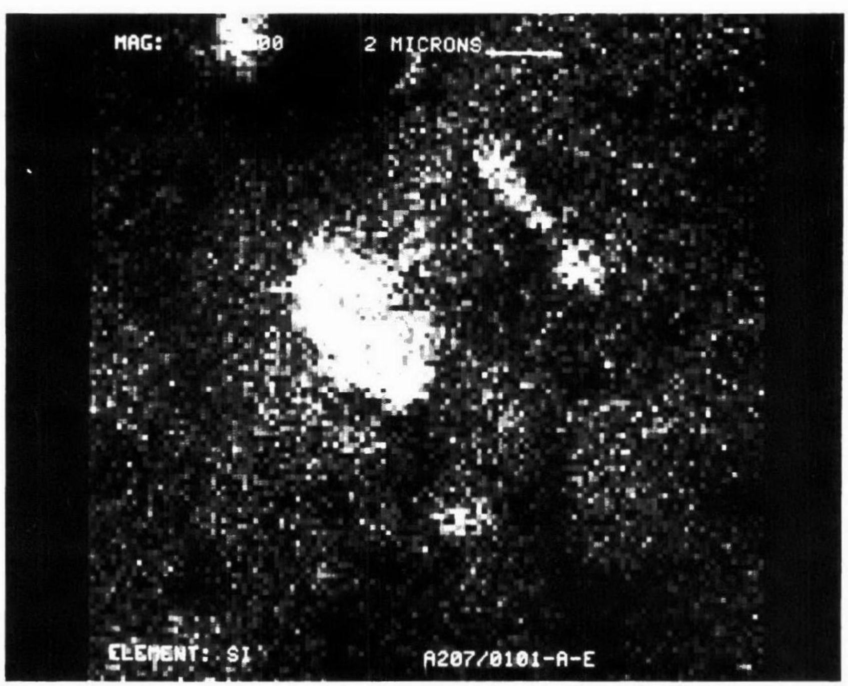


Figure D-236. Silicon Dot Map at X5000 of Converter A207/0101

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE
TO LOW FOR ADEQUATE MAPPING

Figure D-237. Lead Dot Map at X5000 of Converter A207/0101

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE
TO LOW FOR ADEQUATE MAPPING

Figure D-238. Sulfur Dot Map at X5000 of Converter A207/0101

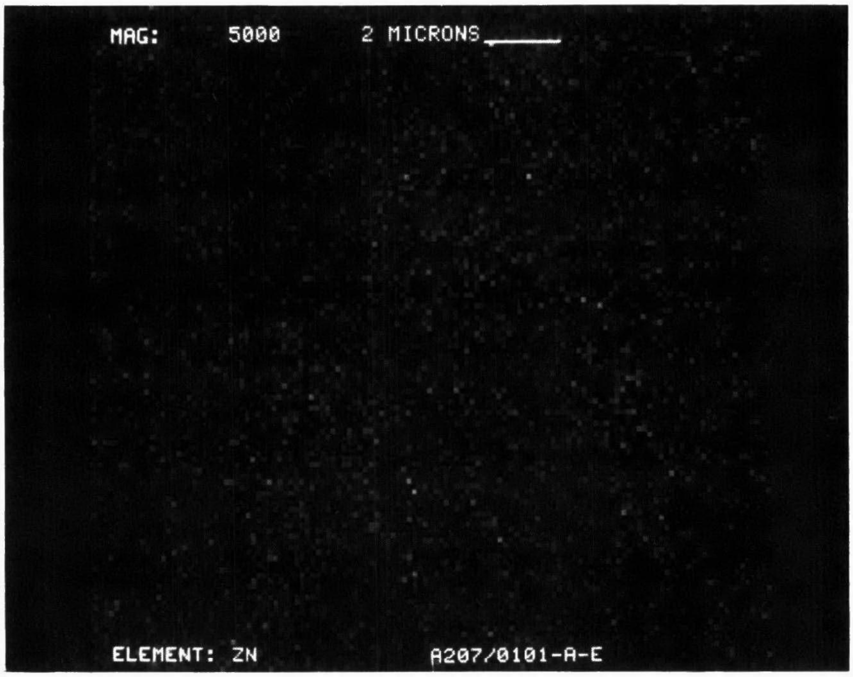


Figure D-239. Zinc Dot Map at X5000 of Converter A207/0101

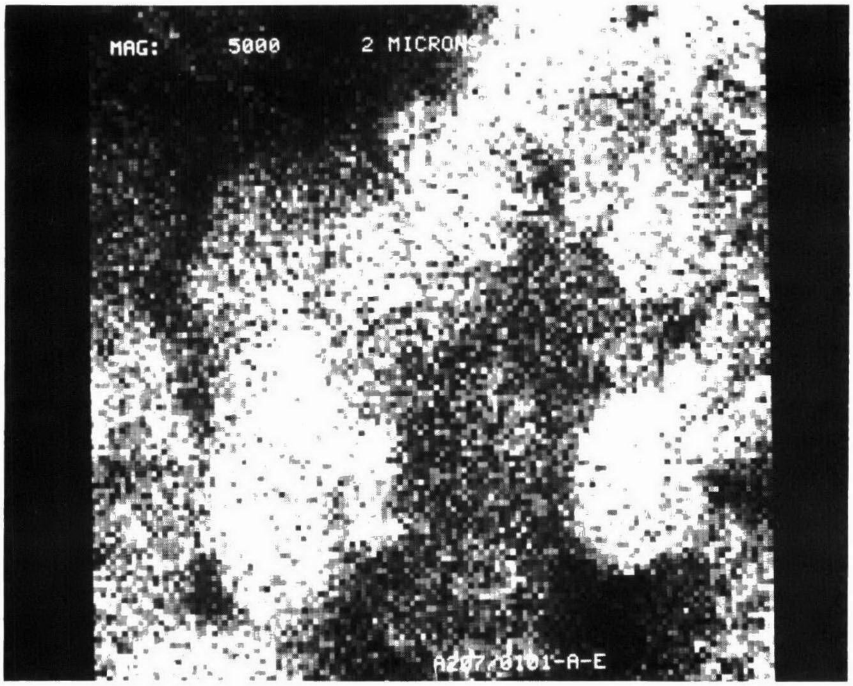


Figure D-240. Phosphorus Dot Map at X5000 of Converter A207/0101

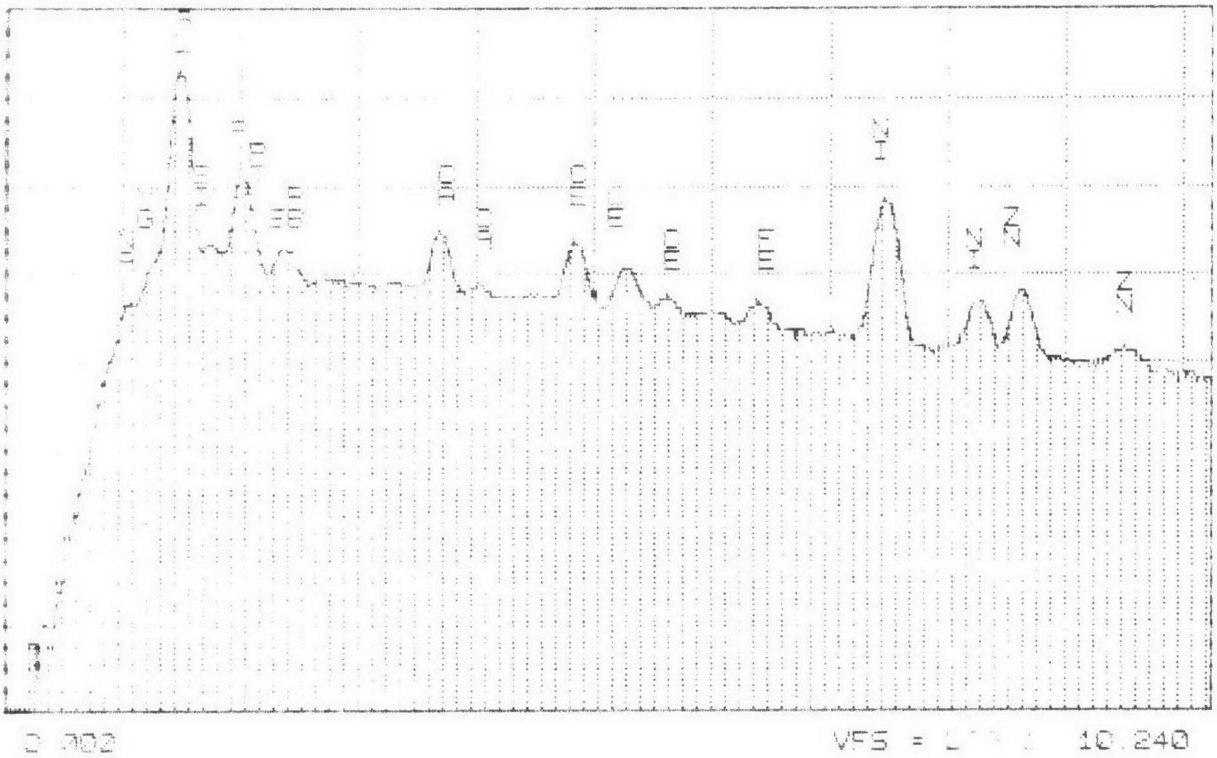


Figure D-241. SEM/EDX Spectrum of Converter A218/0045X-Rear Face

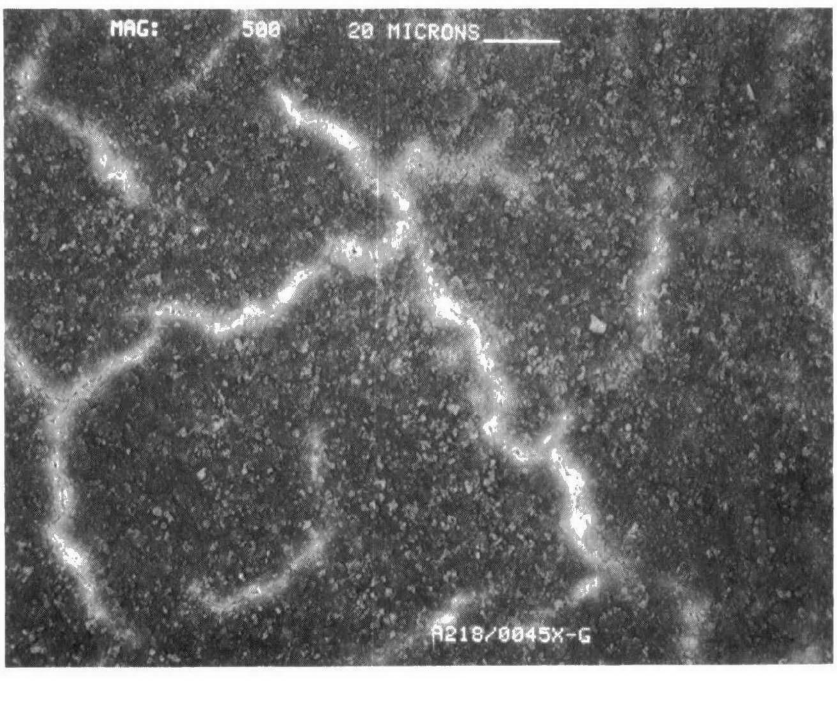


Figure D-242. Scanning Electron Micrograph at X500 of Converter A218/0045X-Rear Face

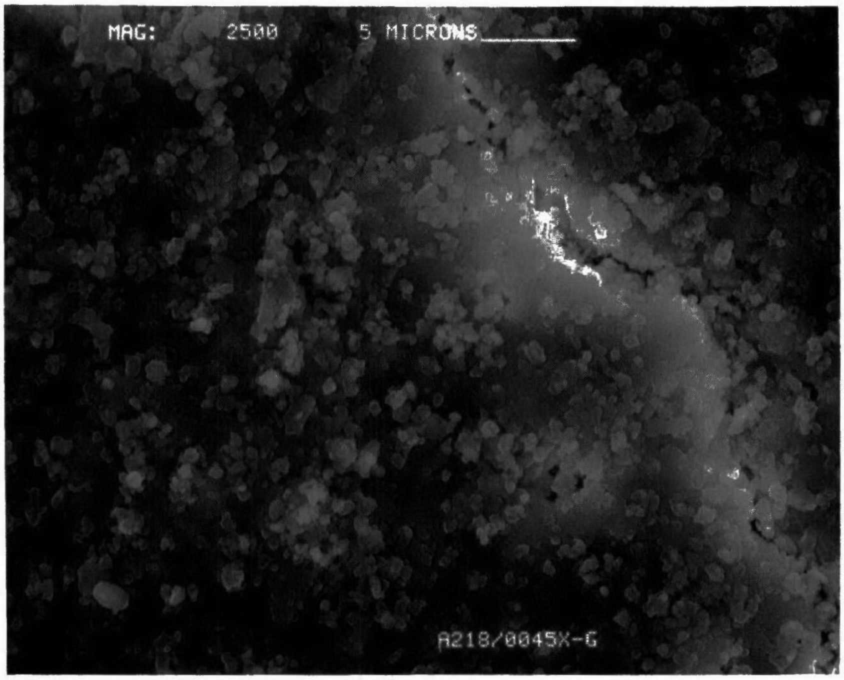


Figure D-243. Scanning Electron Micrograph at X2500 of Converter A218/0045X-Rear Face

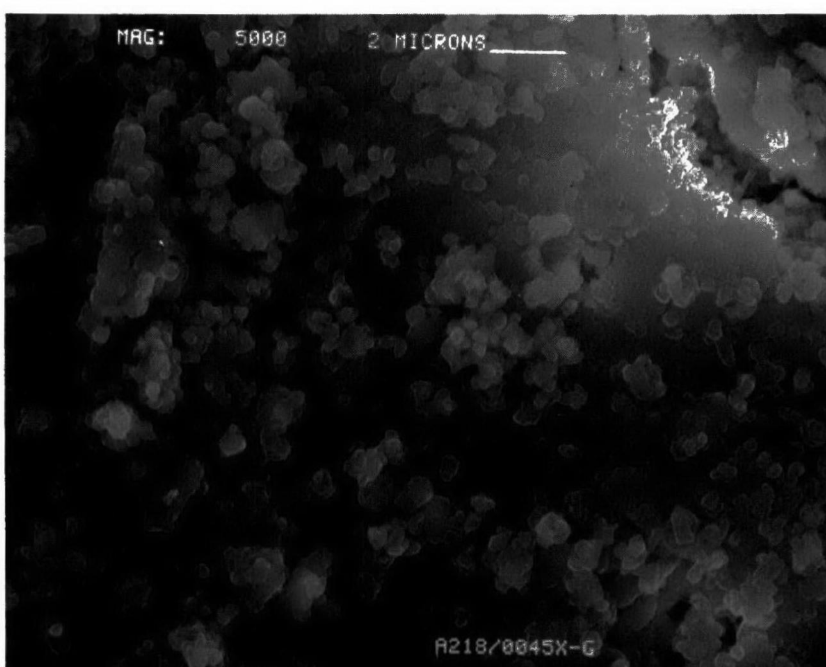


Figure D-244. Scanning Electron Micrograph at X5000 of Converter A218/0045X-Rear Face

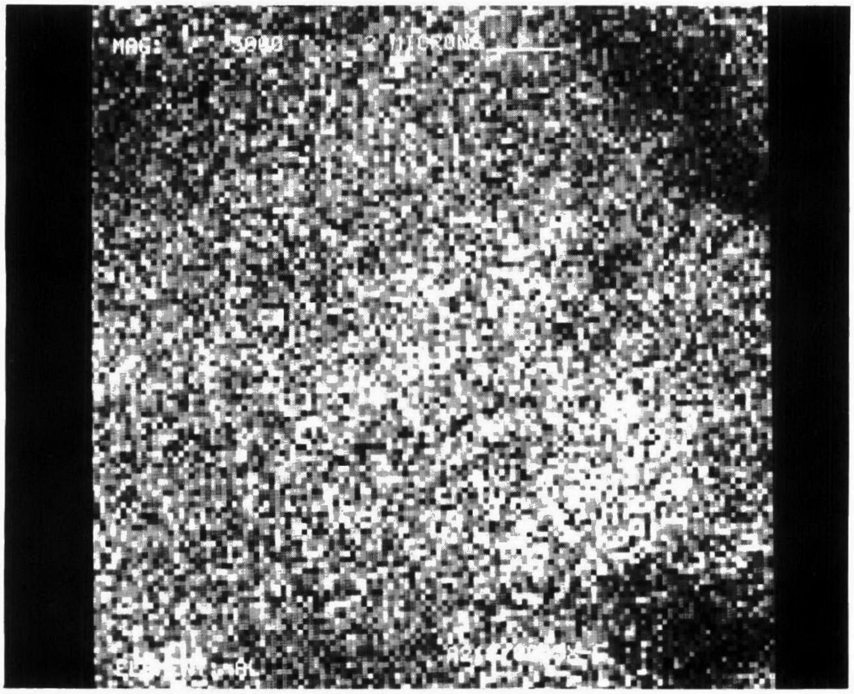


Figure D-245. Aluminum Dot Map at X5000 of Converter A218/0045X-Rear Face

Figure D-246. Silicon Dot Map at X5000 of Converter A218/0045X-Rear Face

Figure D-247. Lead Dot Map at X5000 of Converter A218/0045X-Rear Face

Figure D-248. Sulfur Dot Map at X5000 of Converter A218/0045X-Rear Face

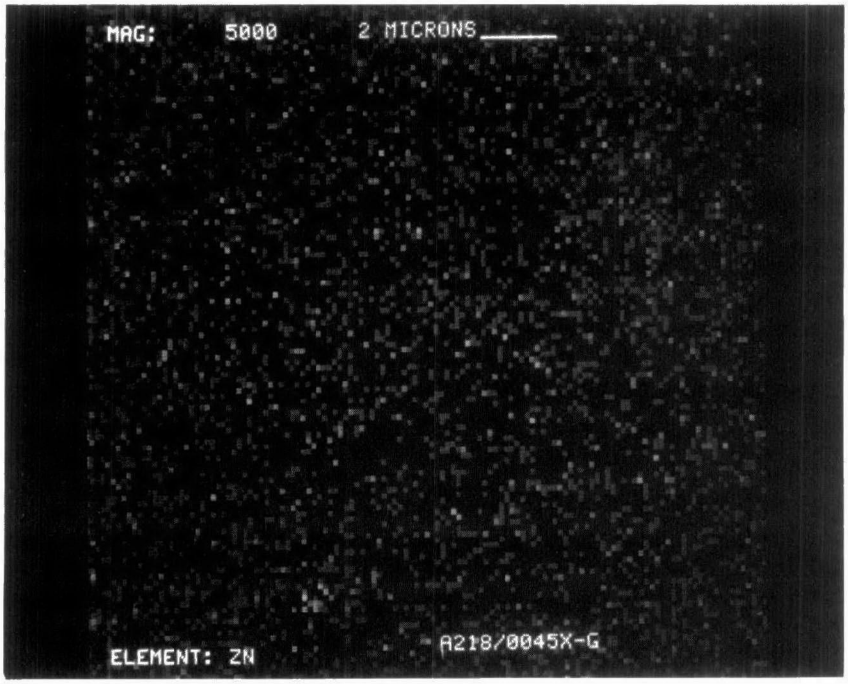


Figure D-249. Zinc Dot Map at X5000 of Converter A218/0045X-Rear Face

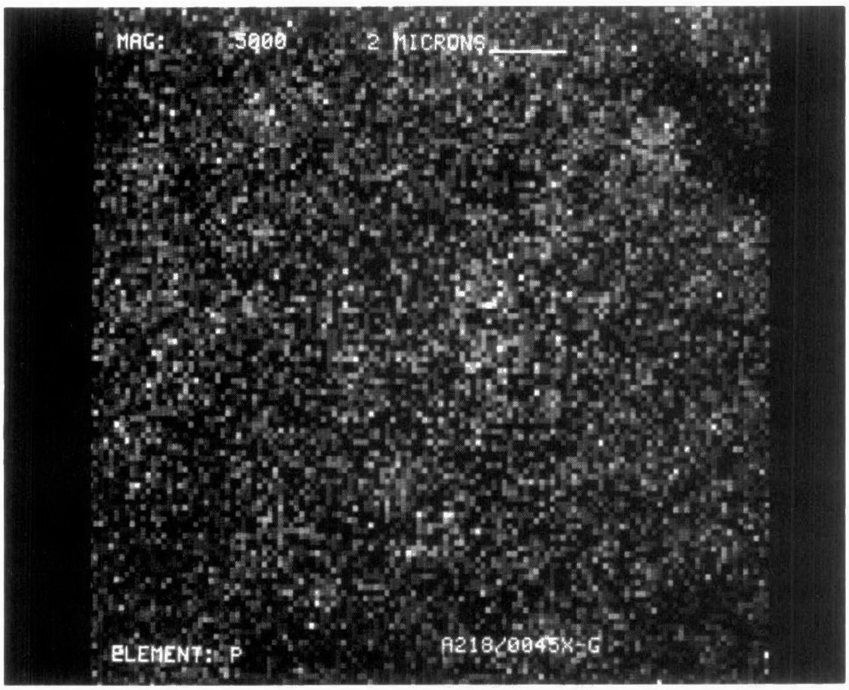


Figure D-250. Phosphorus Dot Map at X5000 of Converter A218/0045X-Rear Face

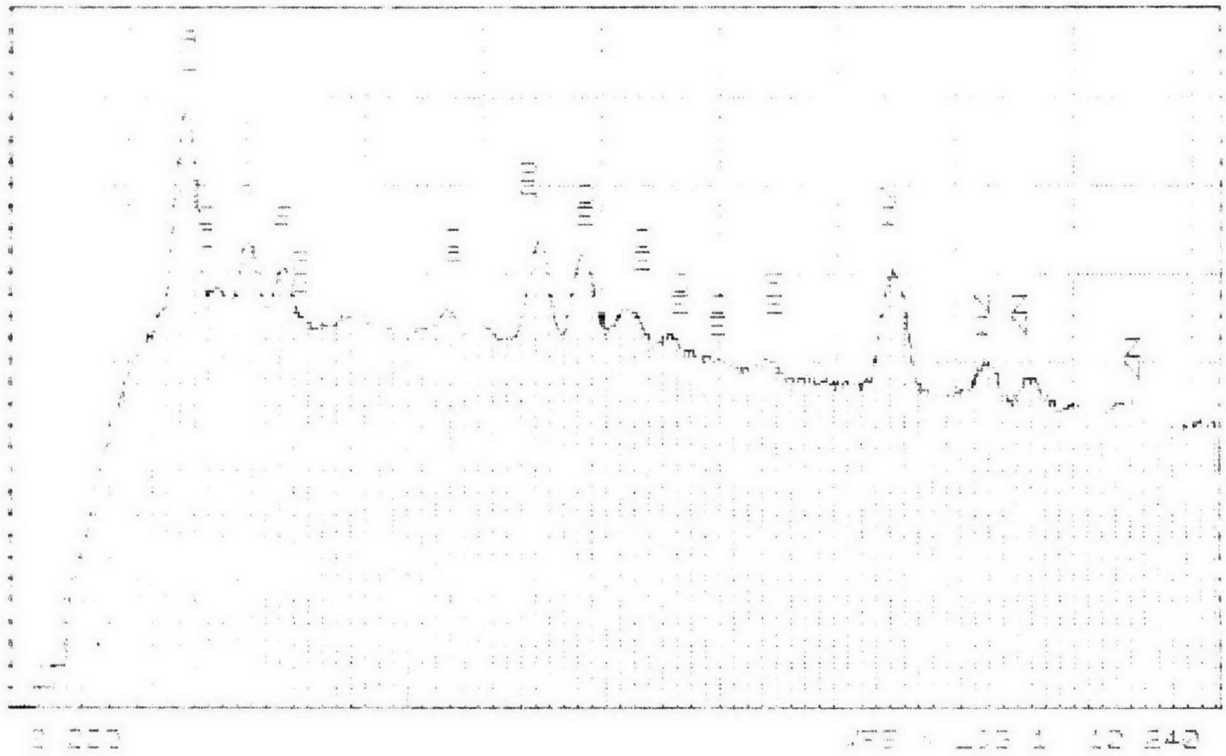


Figure D-251. SEM/EDX Spectrum of Converter A220/0392-Rear Face

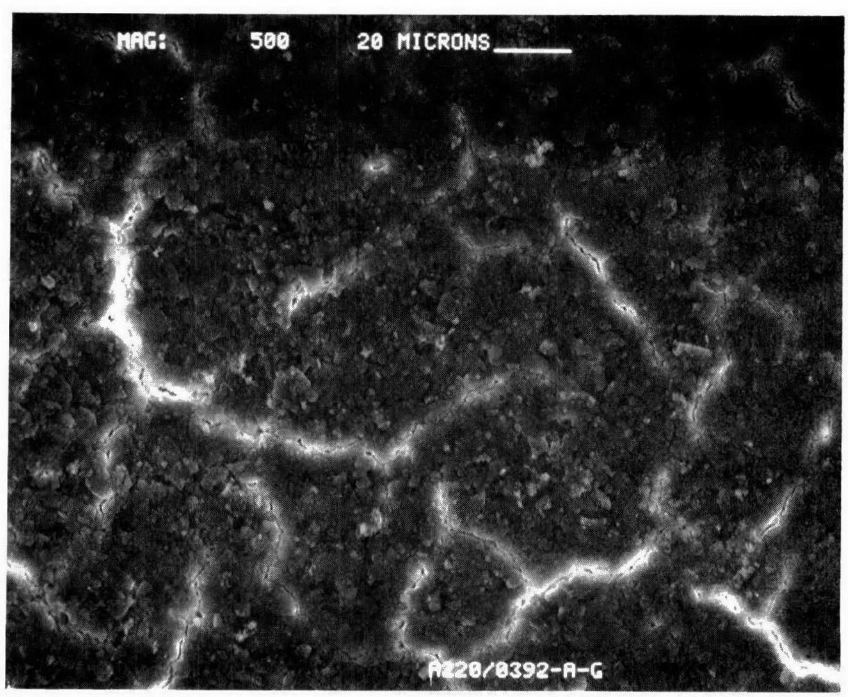


Figure D-252. Scanning Electron Micrograph at X500 of Converter A220/0392-Rear Face

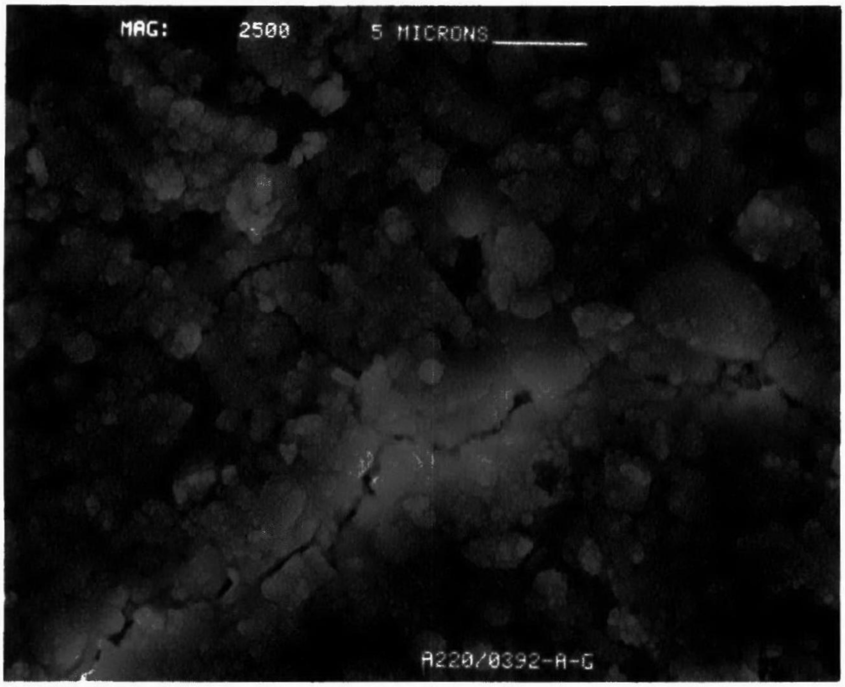


Figure D-253. Scanning Electron Micrograph at X2500 of Converter A220/0392-Rear Face

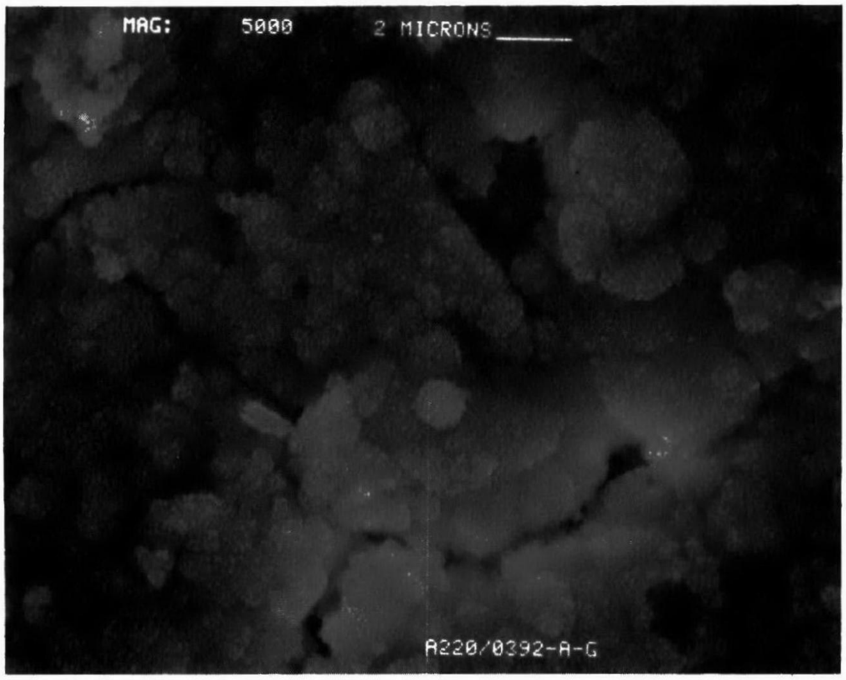


Figure D-254. Scanning Electron Micrograph at X5000 of Converter A220/0392-Rear Face

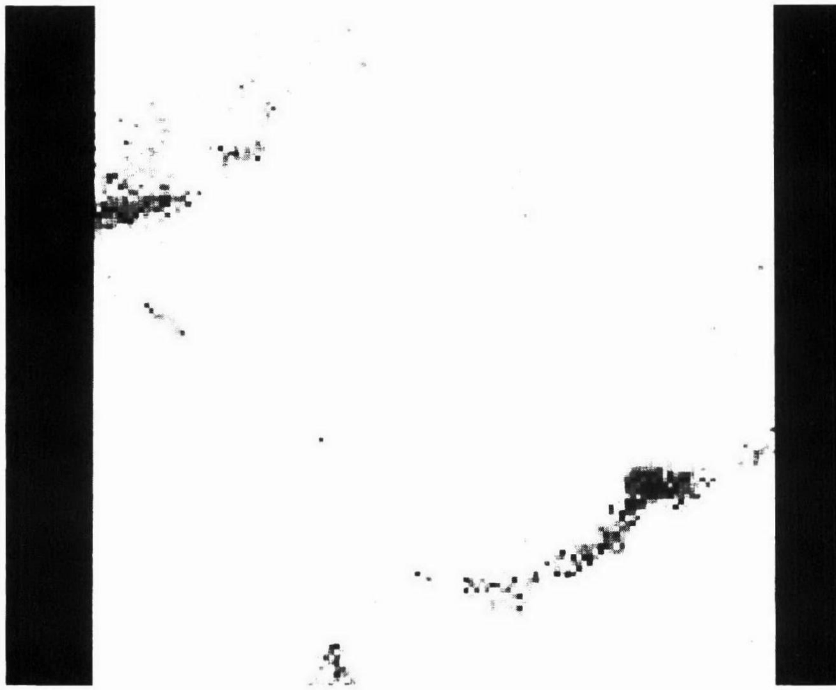


Figure D-255. Aluminum Dot Map at X5000 of Converter A220/0392-Rear Face

Figure D-256. Silicon Dot Map at X5000 of Converter A220/0392-Rear Face

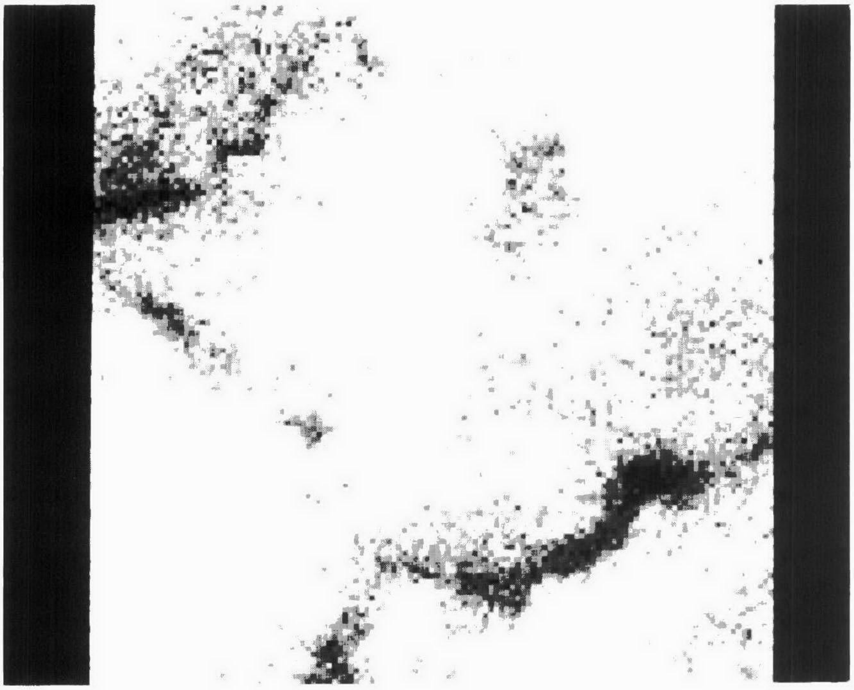


Figure D-257. Lead Dot Map at X5000 of Converter A220/0392-Rear Face

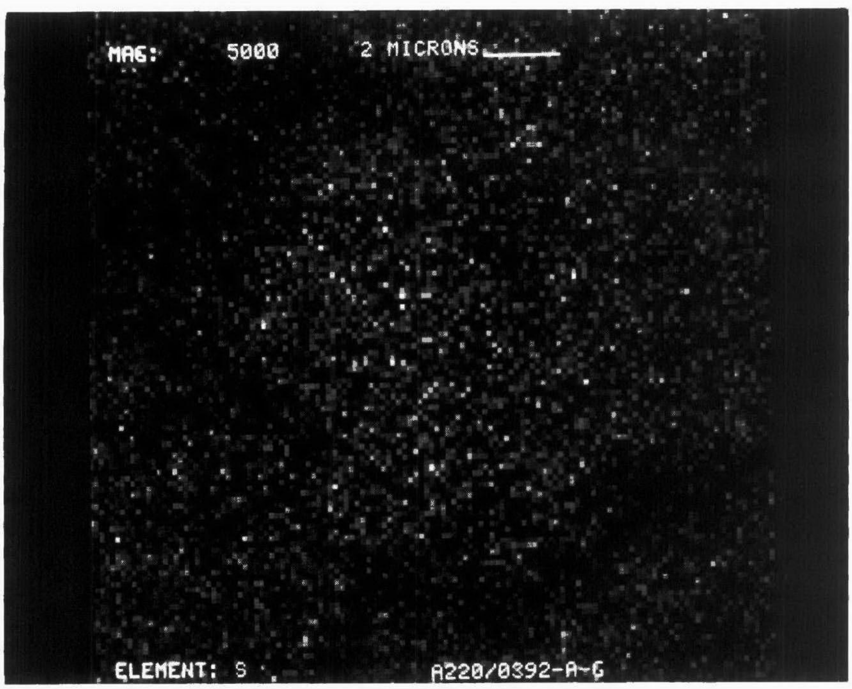


Figure D-258. Sulfur Dot Map at X5000 of Converter A220/0392-Rear Face

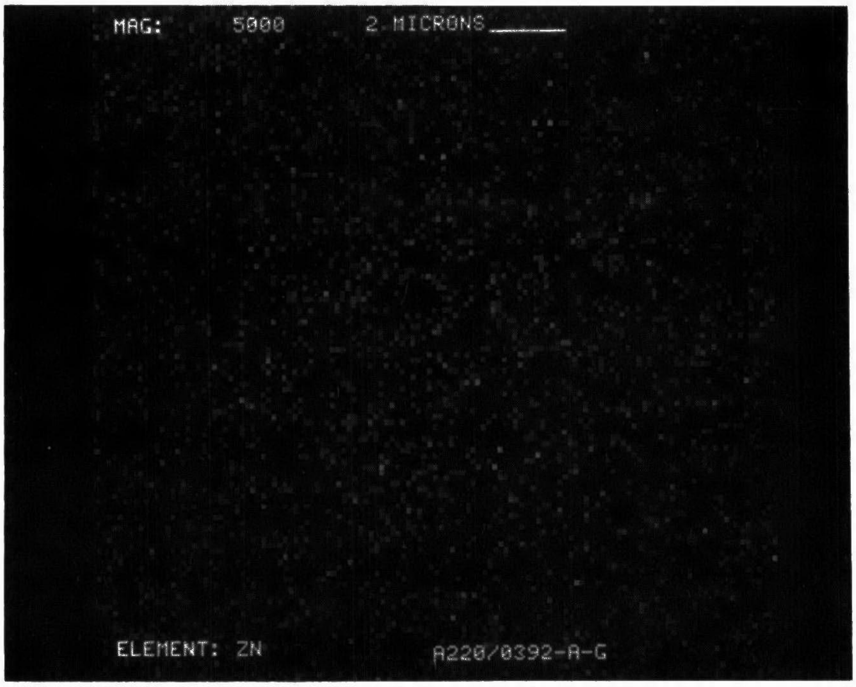


Figure D-259. Zinc Dot Map at X5000 of Converter A220/0392-Rear Face

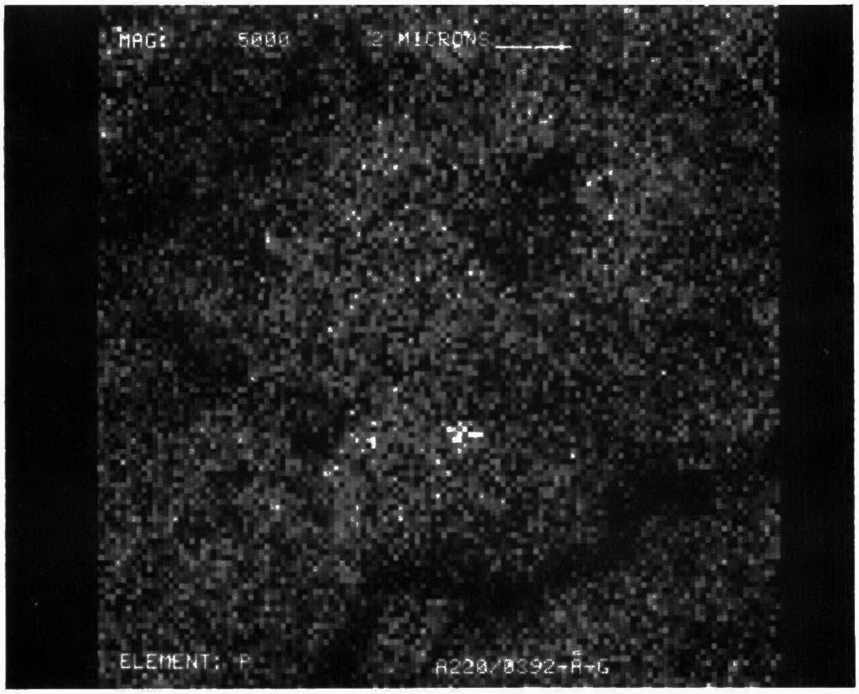


Figure D-260. Phosphorus Dot Map at X5000 of Converter A220/0392-Rear Face

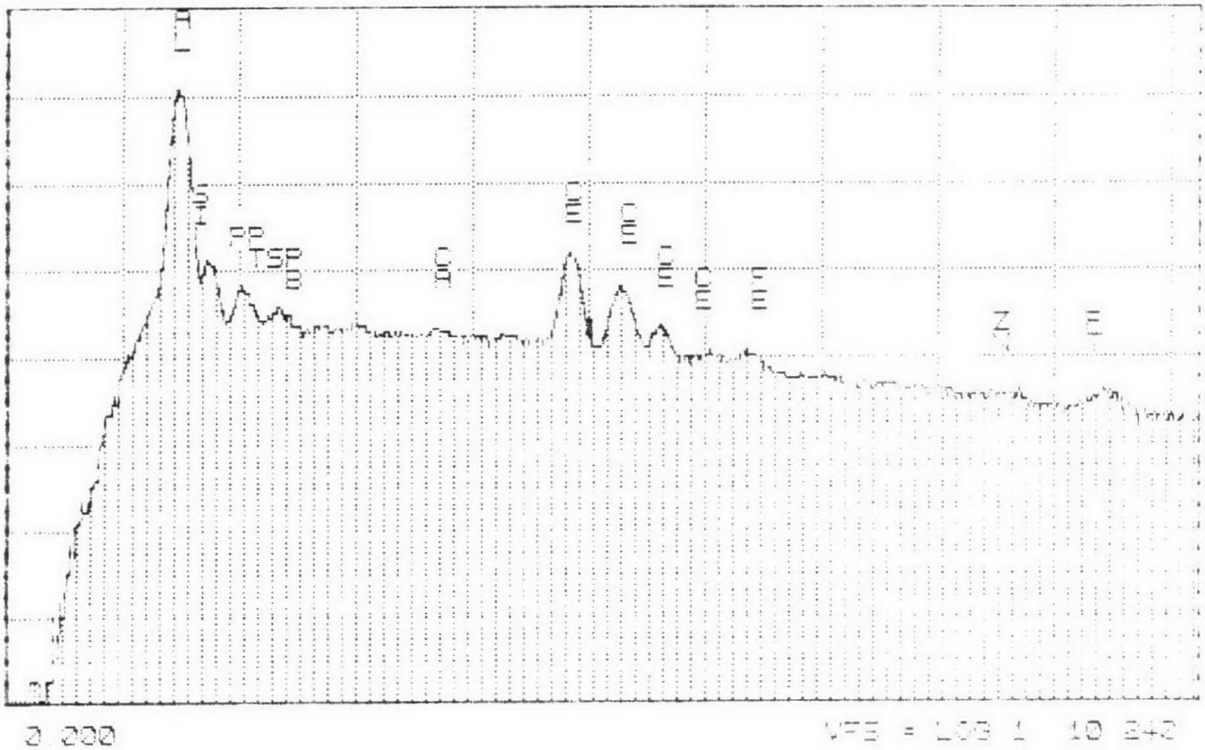


Figure D-261. SEM/EDX Spectrum of Converter A221/0447-Rear Face

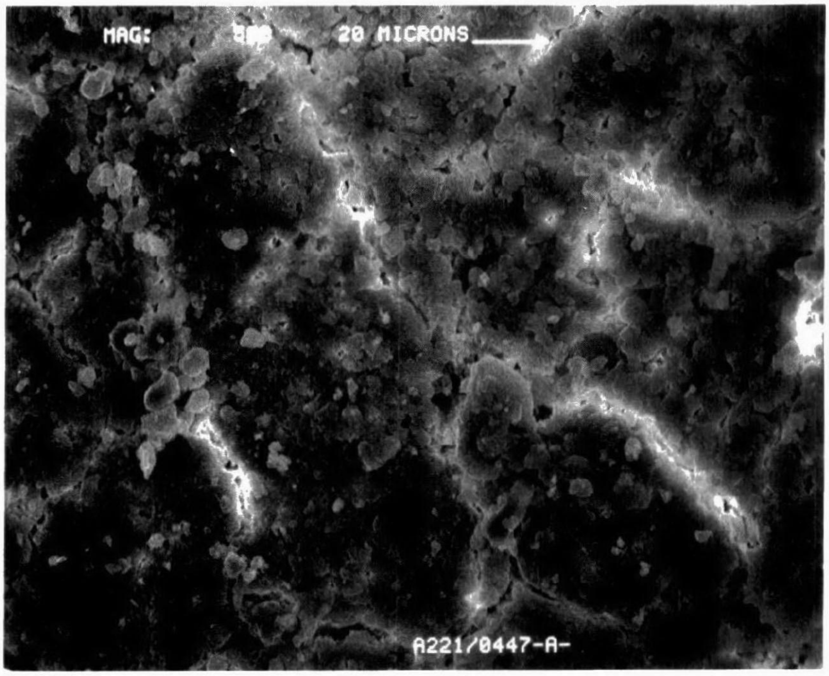


Figure D-262. Scanning Electron Micrograph at X500 of Converter A221/0447-Rear Face

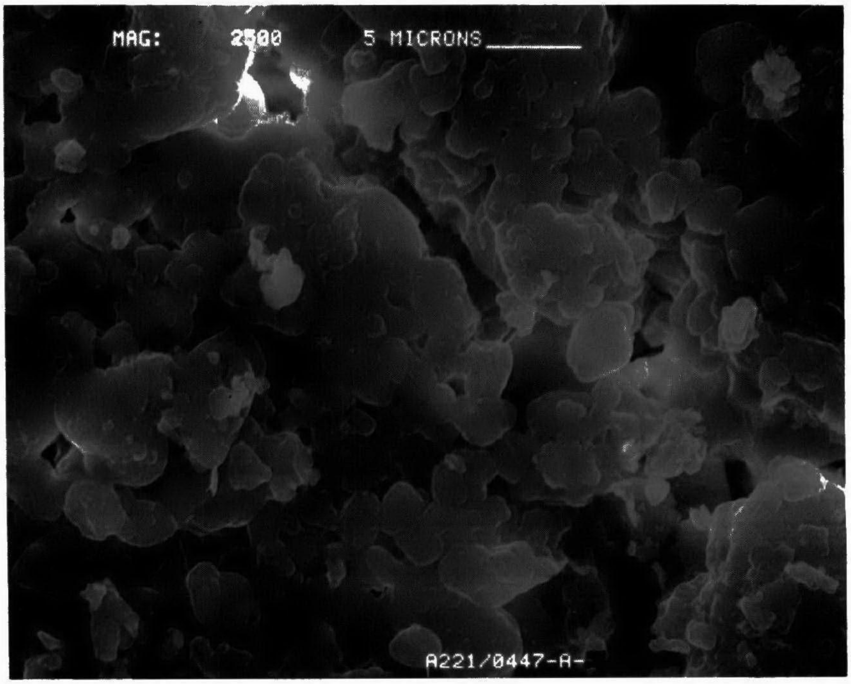


Figure D-263. Scanning Electron Micrograph at X2500 of Converter A221/0447-Rear Face

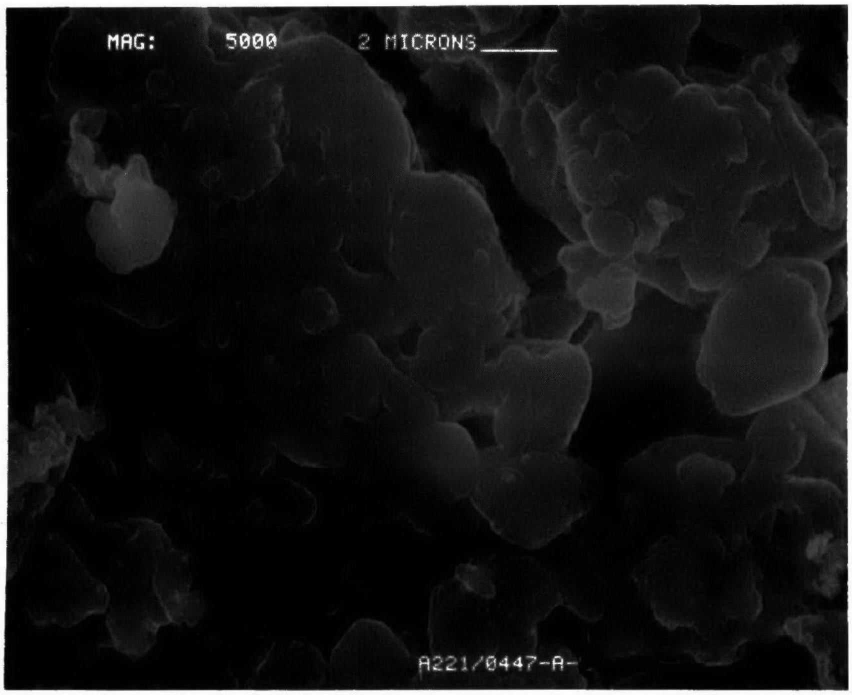


Figure D-264. Scanning Electron Micrograph at X5000 of Converter A221/0447-Rear Face

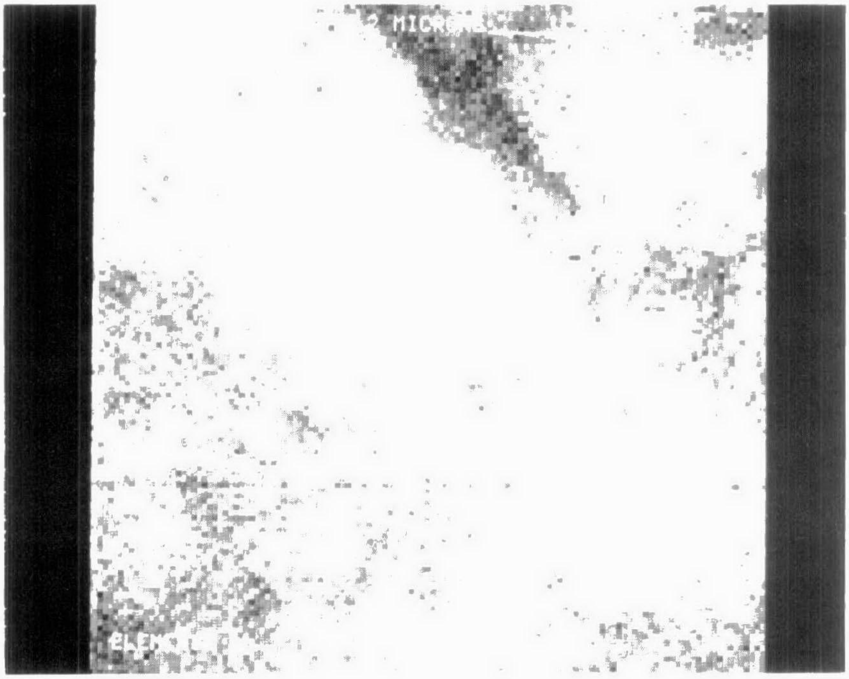


Figure D-265. Aluminum Dot Map at X5000 of Converter A221/0447-Rear Face

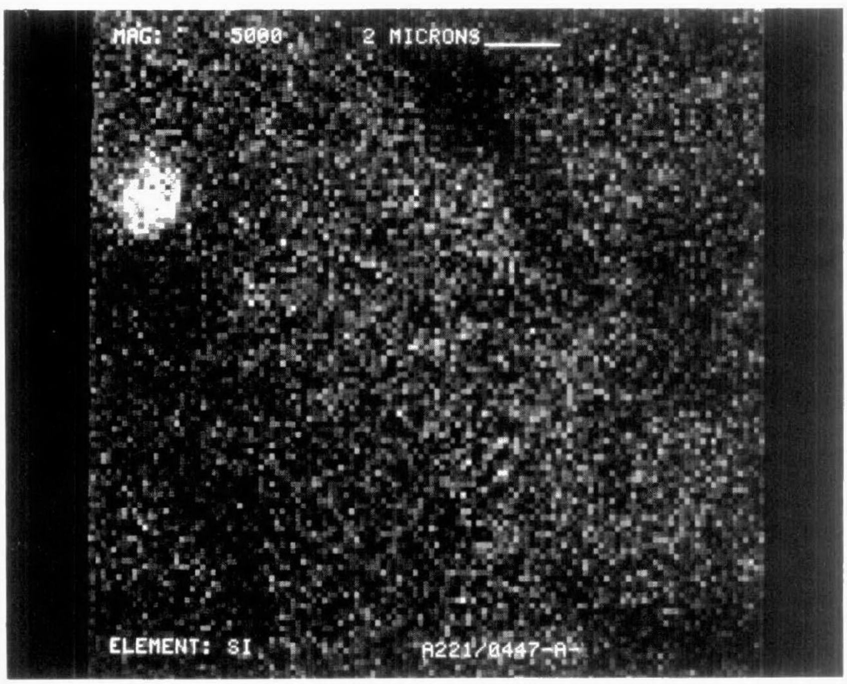


Figure D-266. Silicon Dot Map at X5000 of Converter A221/0447-Rear Face

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE
TO LOW FOR ADEQUATE MAPPING

Figure D-267. Lead Dot Map at X5000 of Converter A221/0447-Rear Face

Figure D-268. Sulfur Dot Map at X5000 of Converter A221/0447-Rear Face

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE
TO LOW FOR ADEQUATE MAPPING

Figure D-269. Zinc Dot Map at X5000 of Converter A221/0447-Rear Face

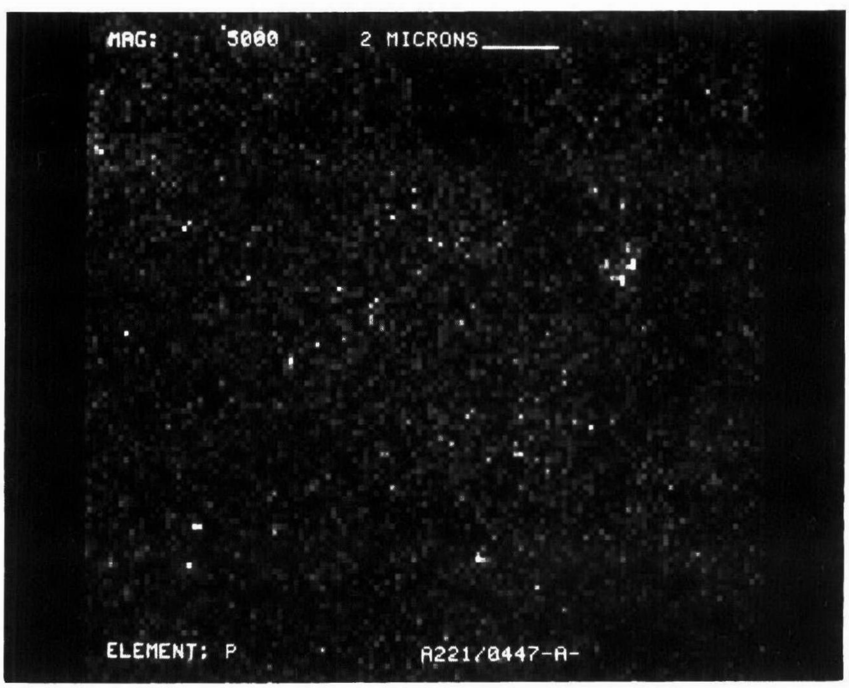


Figure D-270. Phosphorus Dot Map at X5000 of Converter A221/0447-Rear Face

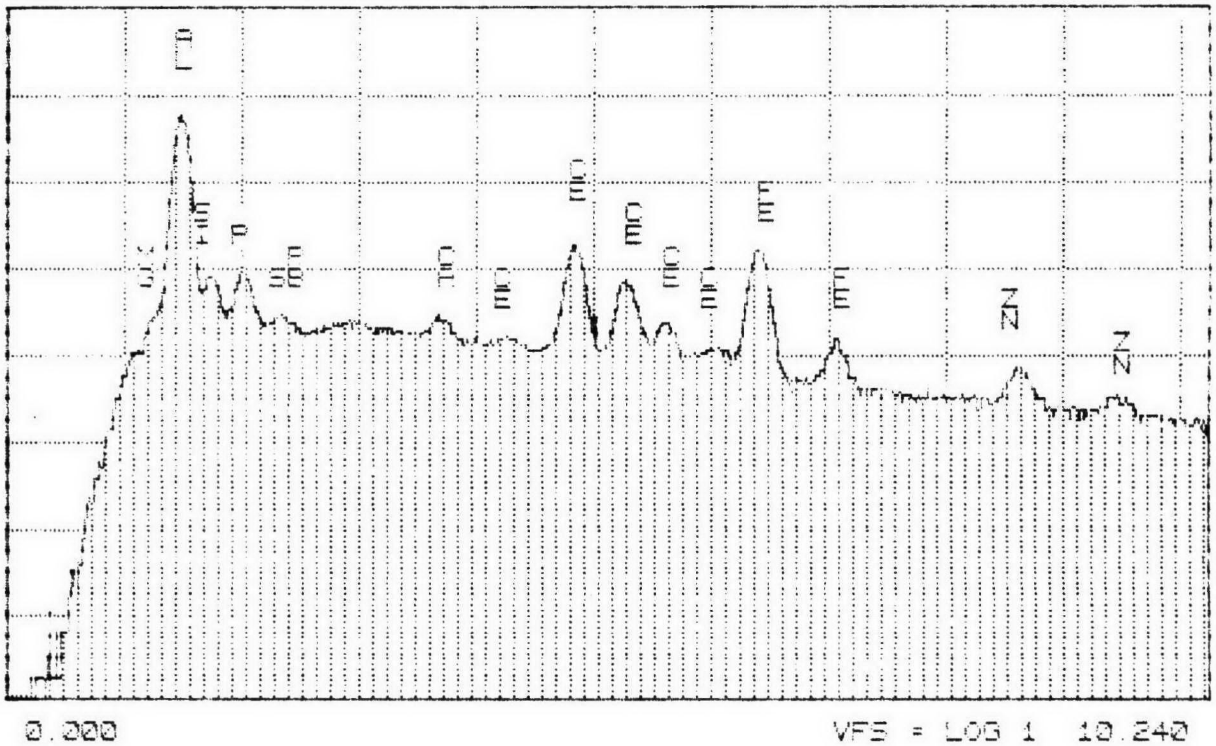


Figure D-271. SEM/EDX Spectrum of Converter A230/0177X-Rear Face

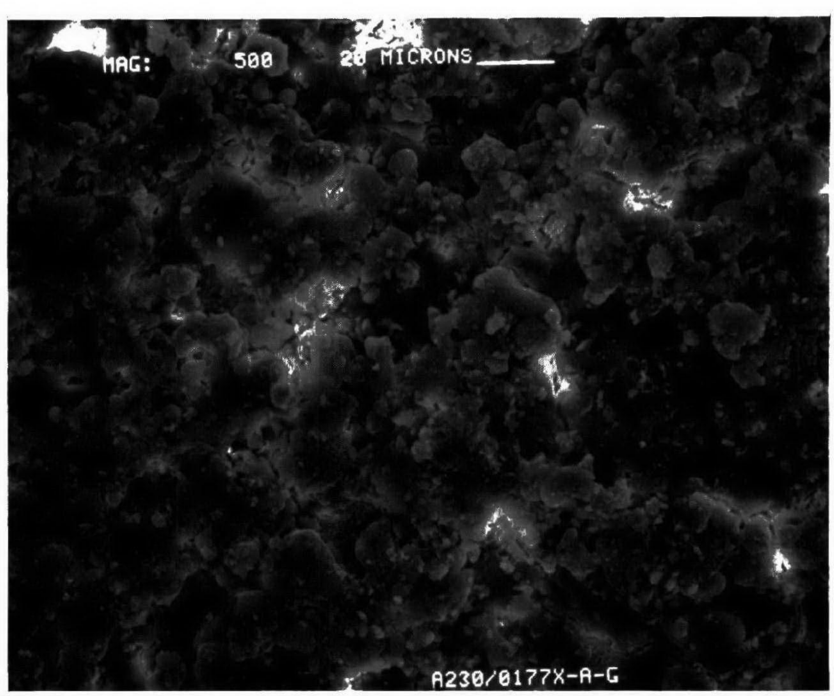


Figure D-272. Scanning Electron Micrograph at X500 of Converter A230/0177X-Rear Face

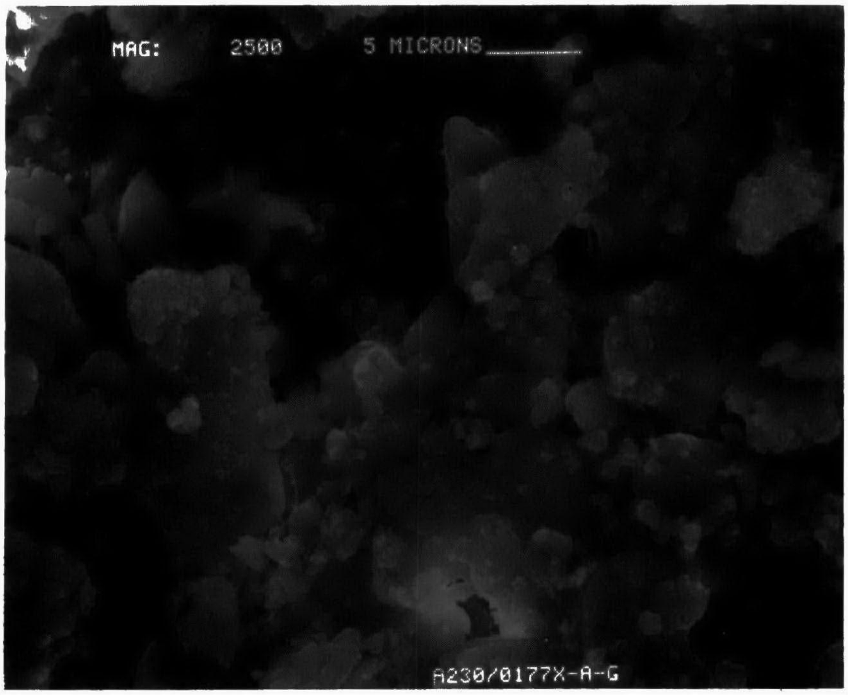


Figure D-273. Scanning Electron Micrograph at X2500 of Converter A230/0177X-Rear Face

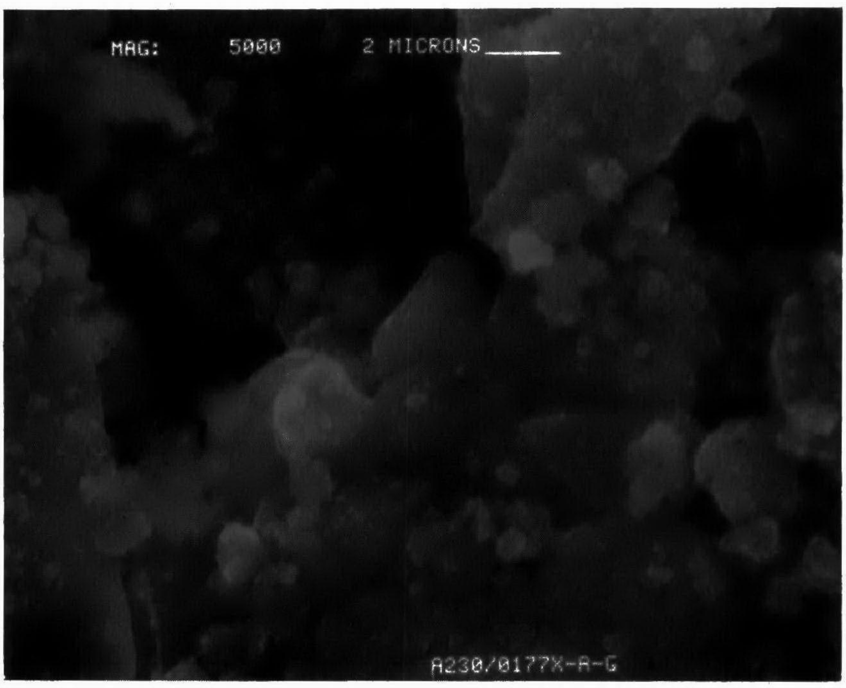


Figure D-274. Scanning Electron Micrograph at X5000 of Converter A230/0177X-Rear Face

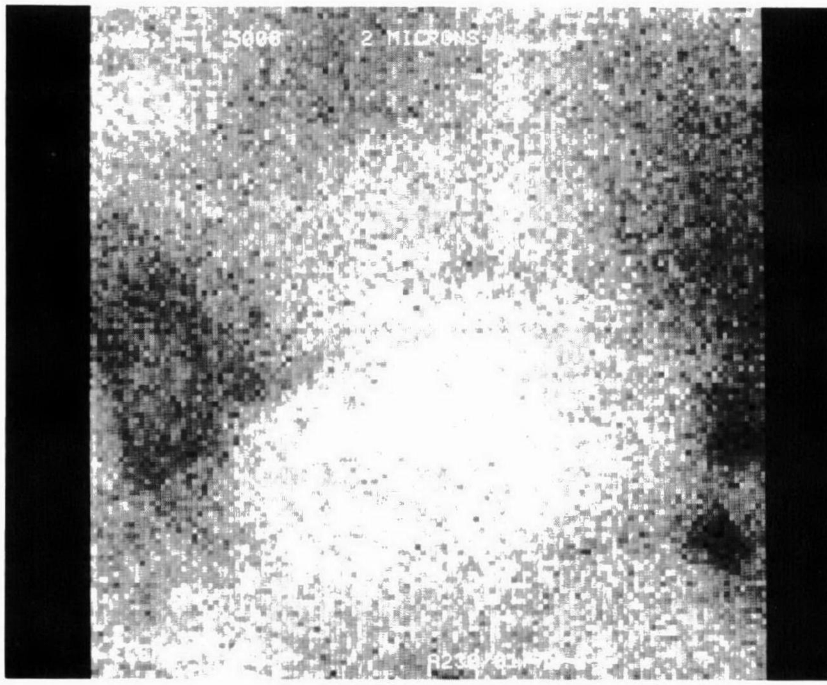


Figure D-275. Aluminum Dot Map at X5000 of Converter A230/0177X-Rear Face

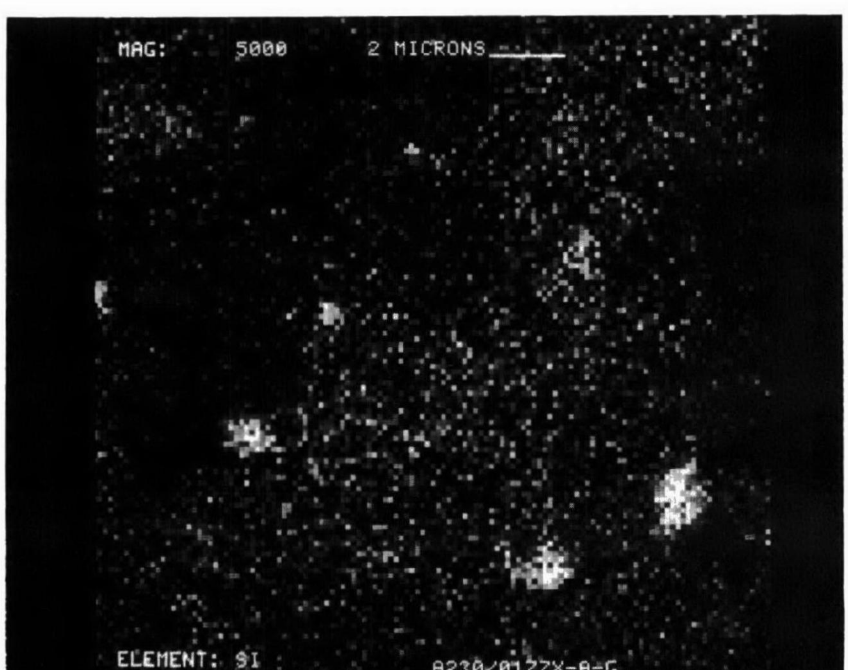


Figure D-276. Silicon Dot Map at X5000 of Converter A230/0177X-Rear Face

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE TO LOW FOR ADEQUATE MAPPING

Figure D-277. Lead Dot Map at X5000 of Converter A230/0177X-Rear Face

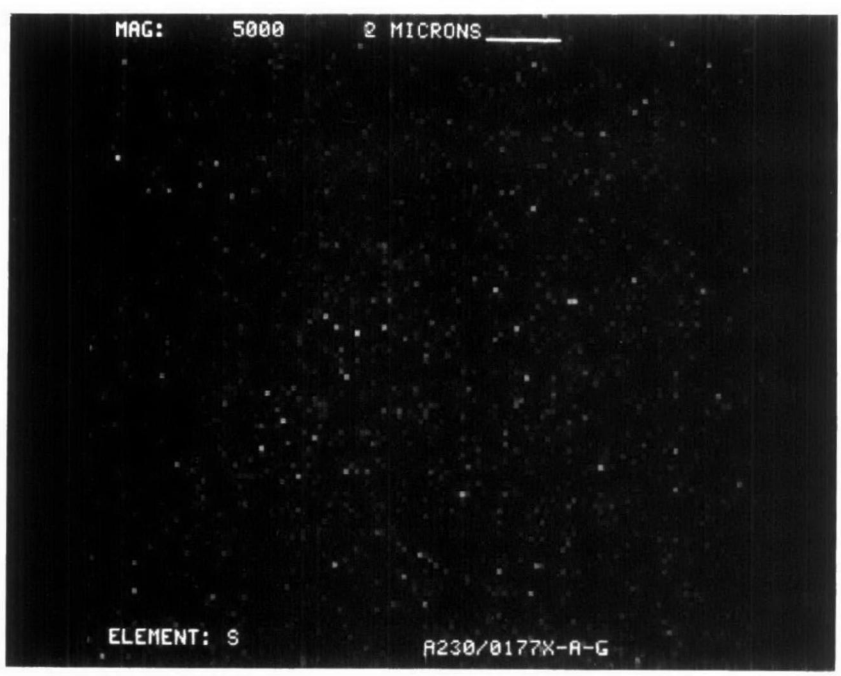


Figure D-278. Sulfur Dot Map at X5000 of Converter A230/0177X-Rear Face

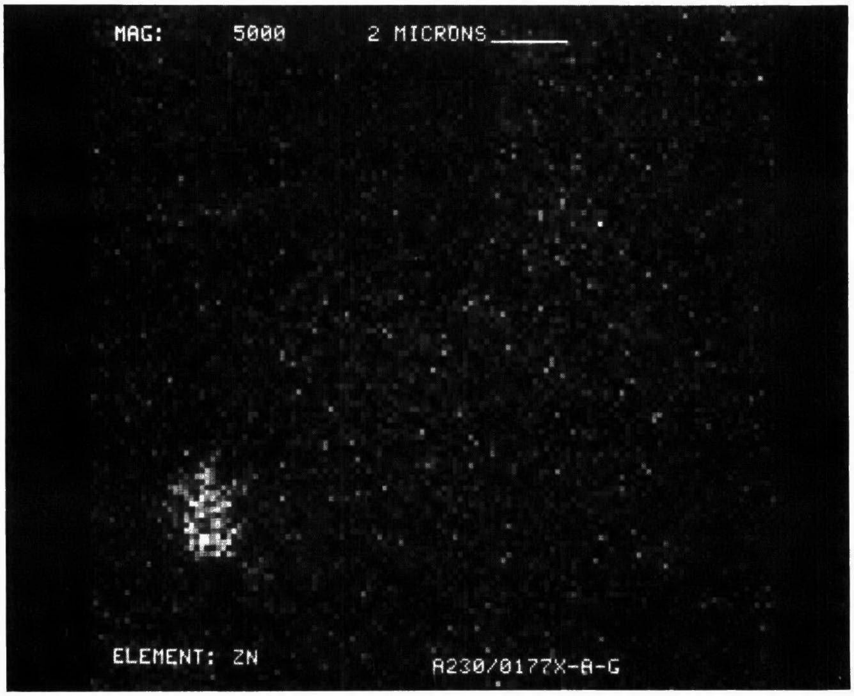


Figure D-279. Zinc Dot Map at X5000 of Converter A230/0177X-Rear Face

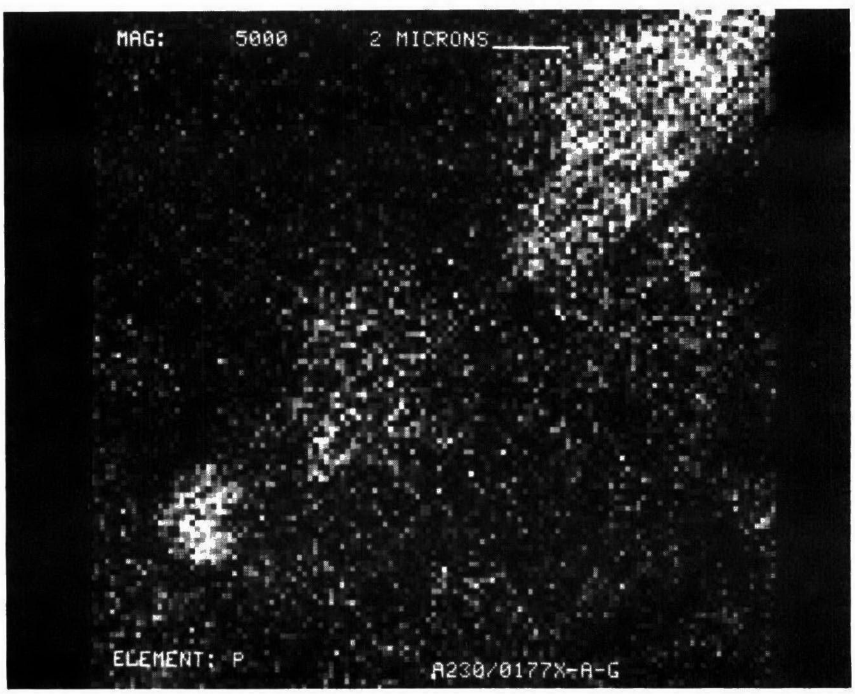


Figure D-280. Phosphorus Dot Map at X5000 of Converter A230/0177X-Rear Face

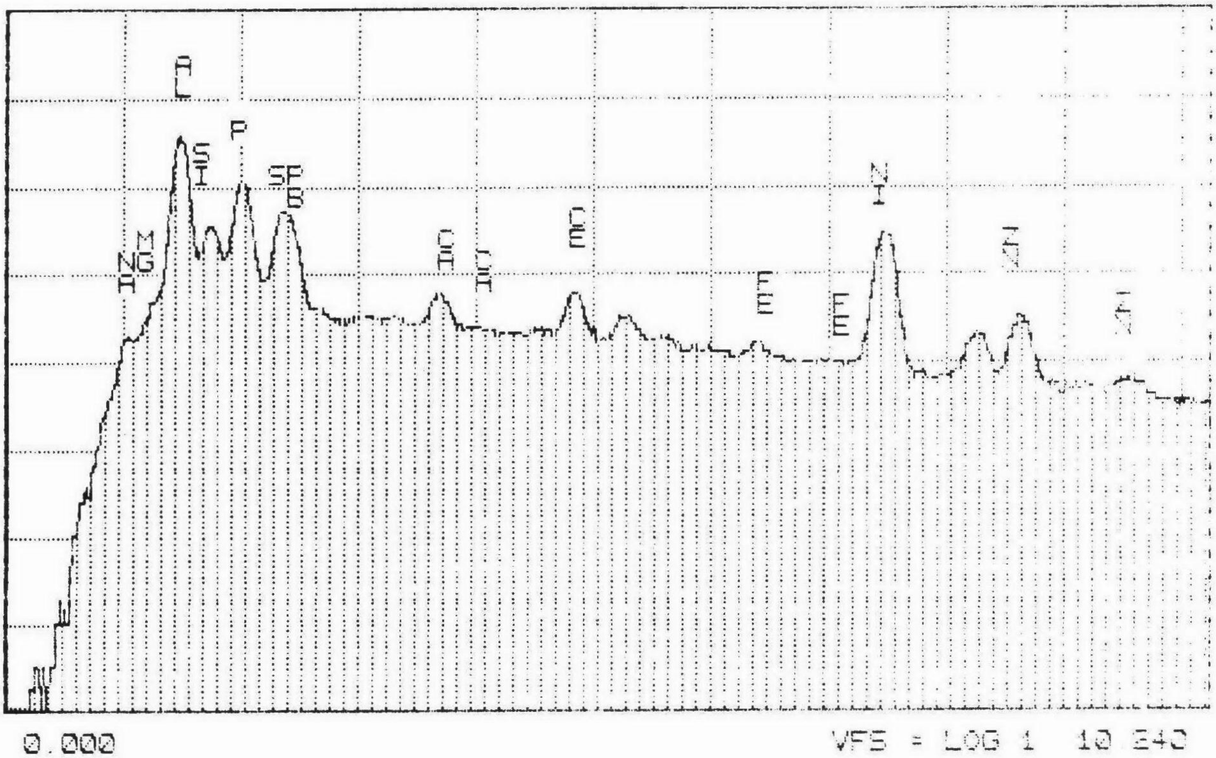


Figure D-281. SEM/EDX Spectrum of Converter A240/0016L-Rear Face

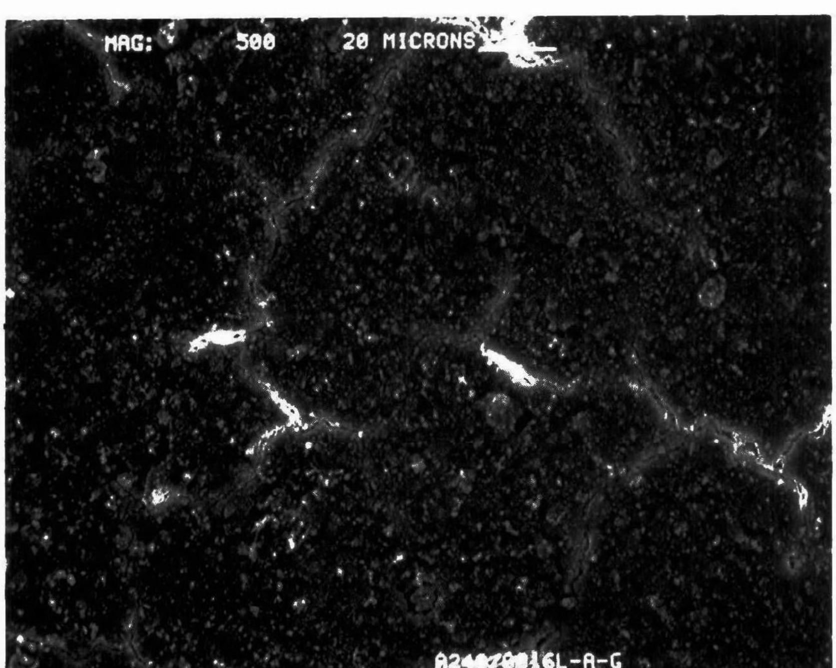


Figure D-282. Scanning Electron Micrograph at X500 of Converter A240/0016L-Rear Face

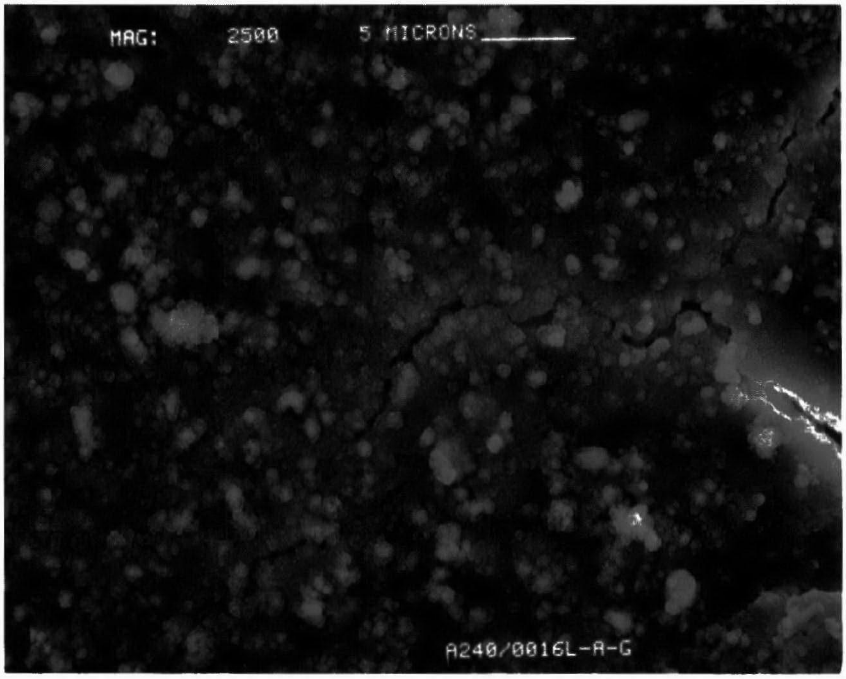


Figure D-283. Scanning Electron Micrograph at X2500 of Converter A240/0016L-Rear Face

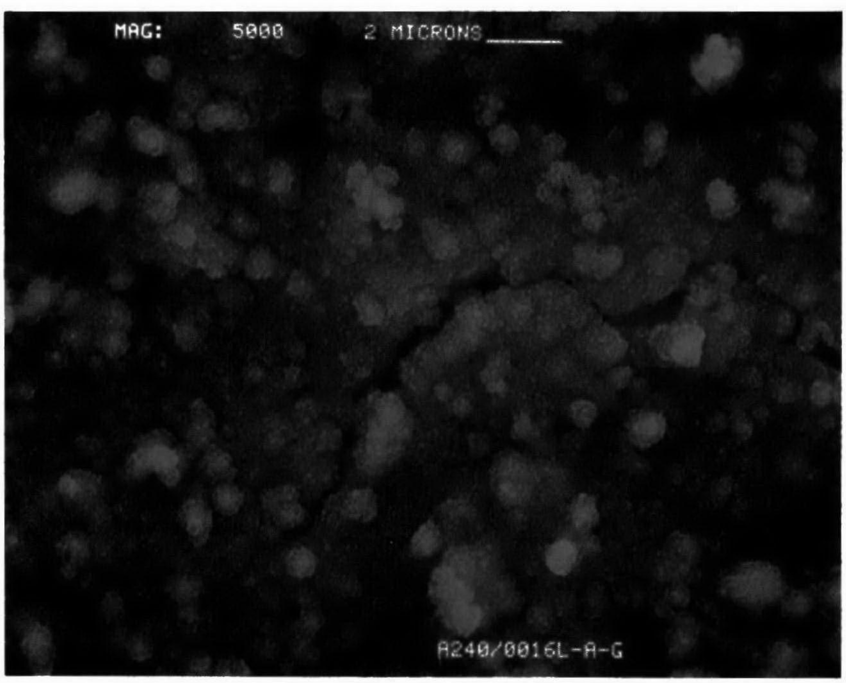


Figure D-284. Scanning Electron Micrograph at X5000 of Converter A240/0016L-Rear Face

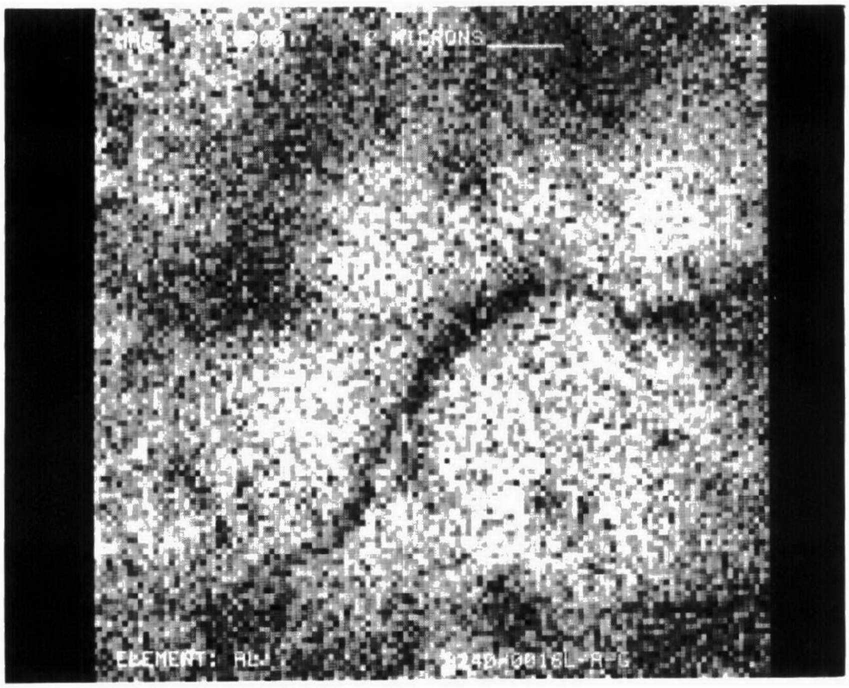


Figure D-285. Aluminum Dot Map at X5000 of Converter A240/0016L-Rear Face

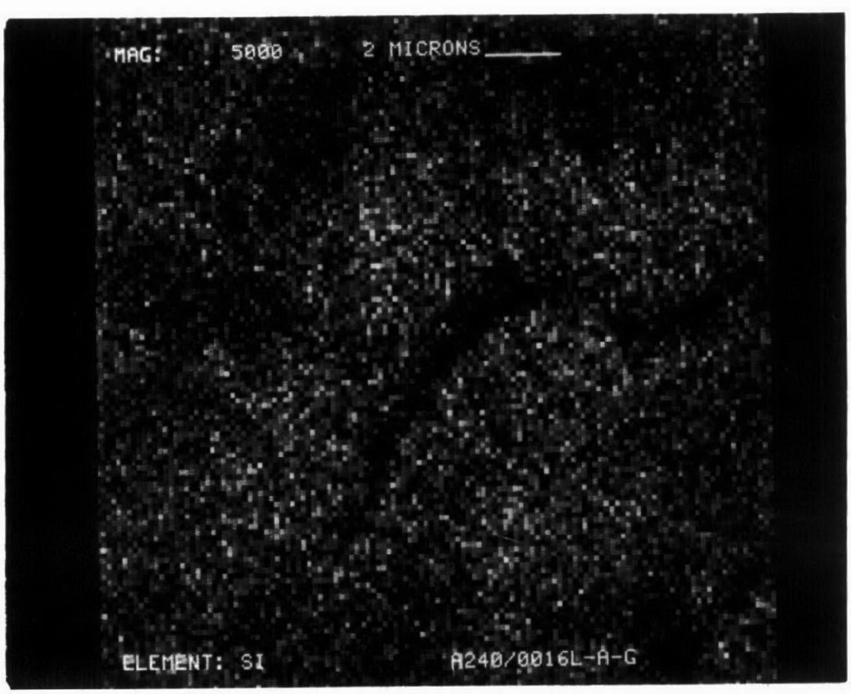


Figure D-286. Silicon Dot Map at X5000 of Converter A240/0016L-Rear Face

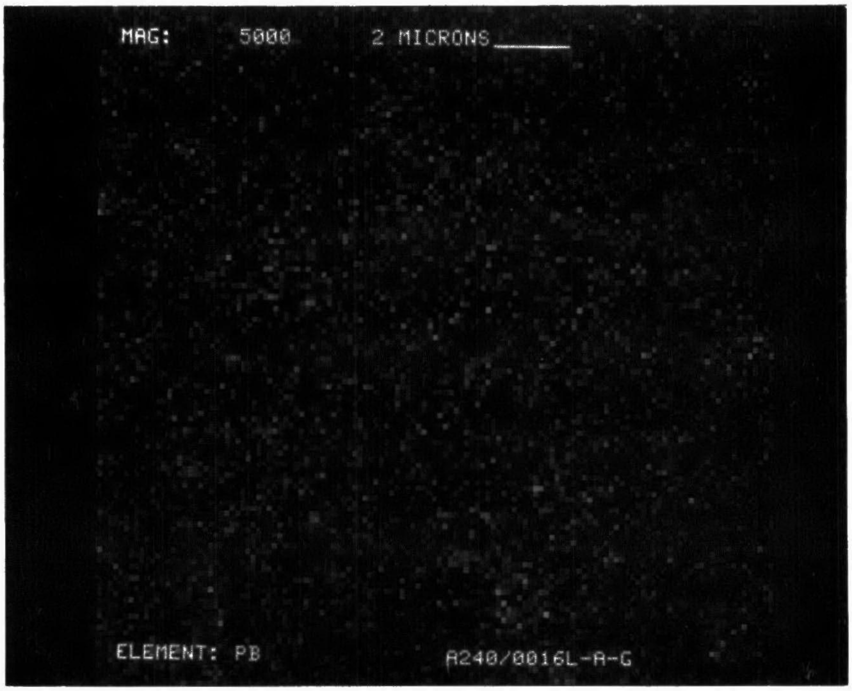


Figure D-287. Lead Dot Map at X5000 of Converter A240/0016L-Rear Face

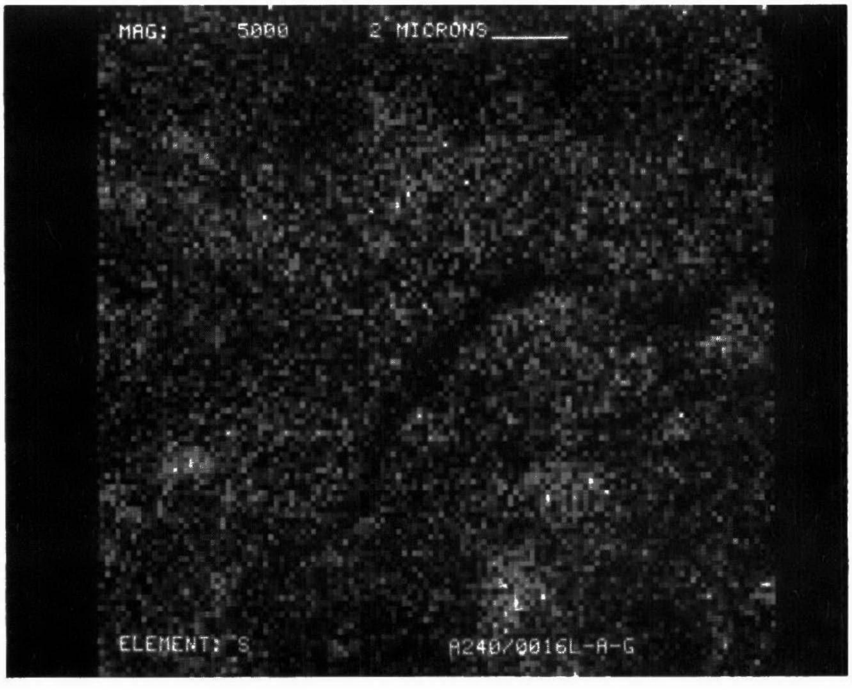


Figure D-288. Sulfur Dot Map at X5000 of Converter A240/0016L-Rear Face

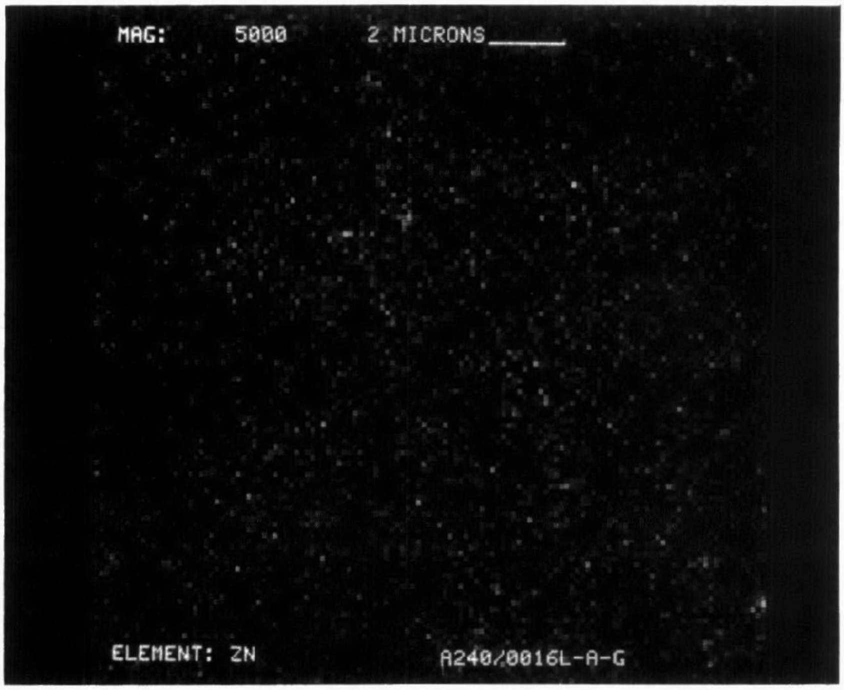


Figure D-289. Zinc Dot Map at X5000 of Converter A240/0016L-Rear Face

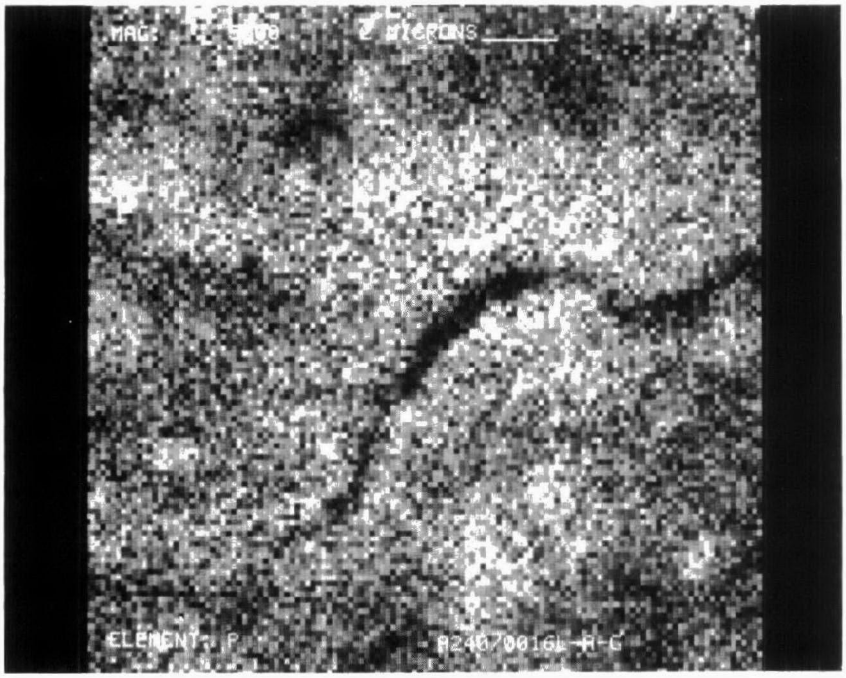


Figure D-280. Phosphorus Dot Map at X5000 of Converter A240/0016L-Rear Face

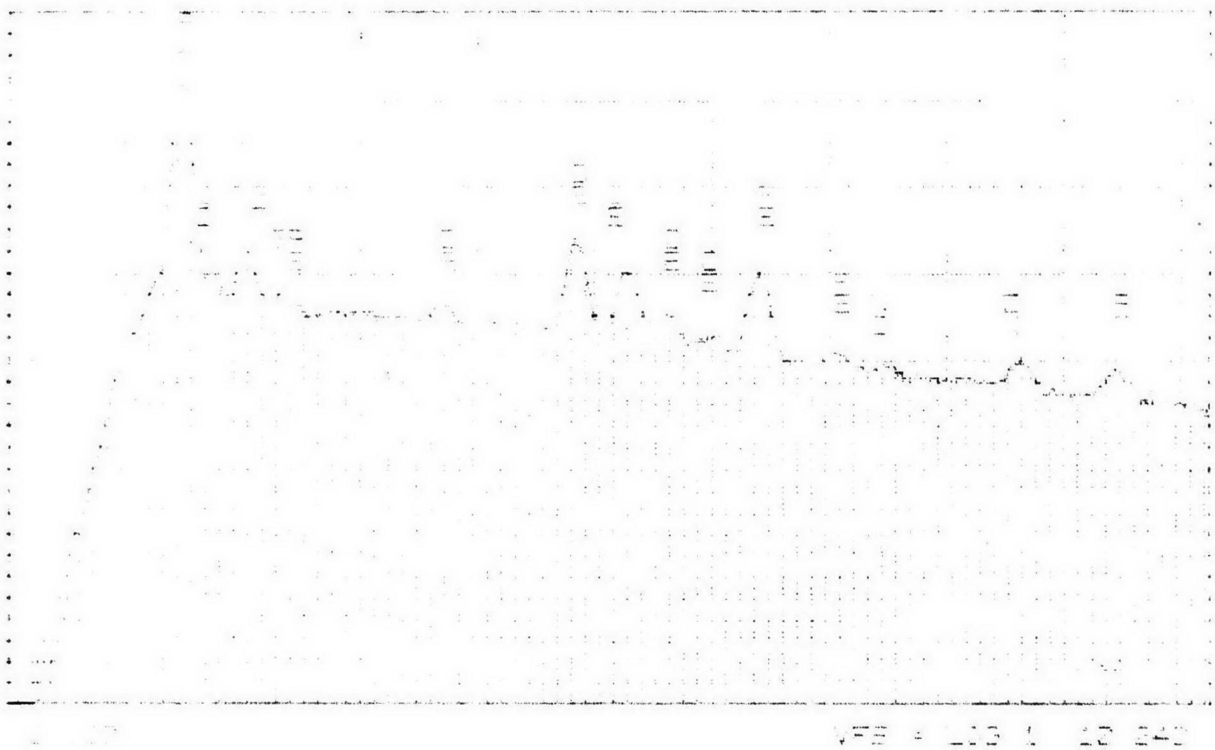


Figure D-281. SEM/EDX Spectrum of Converter A249/0169-1-Rear Face

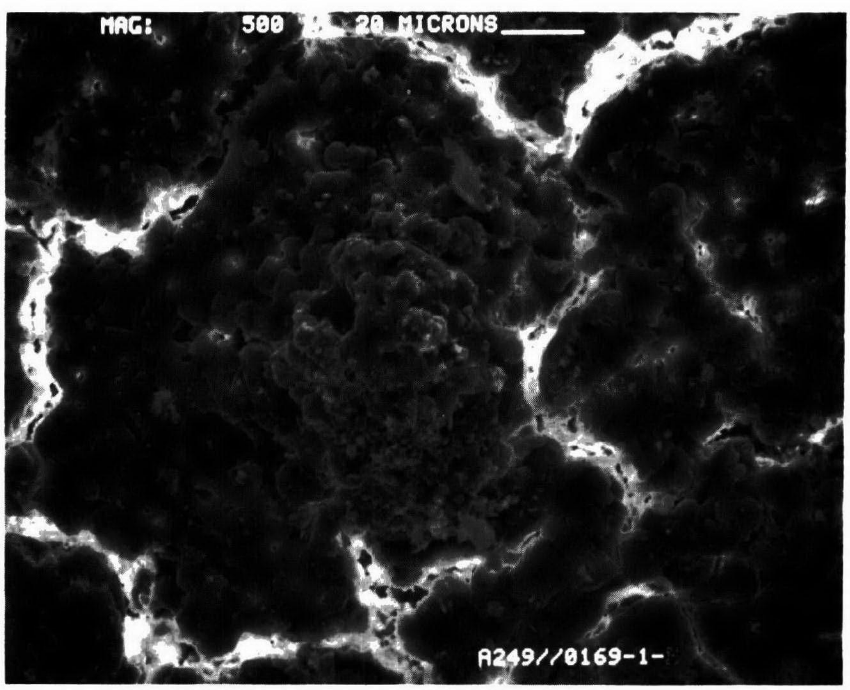


Figure D-282. Scanning Electron Micrograph at X500 of Converter A249/0169-1-Rear Face

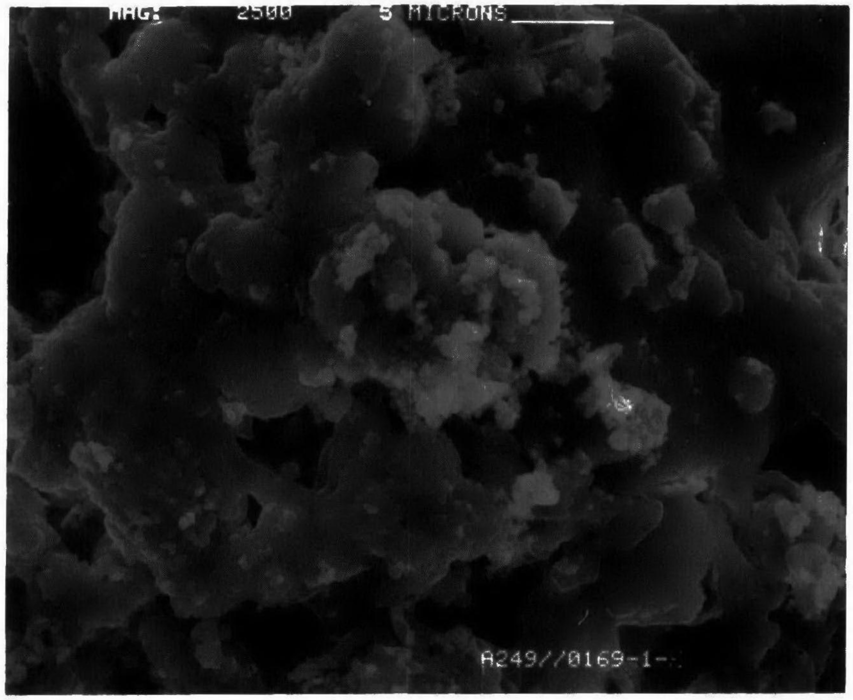


Figure D-283. Scanning Electron Micrograph at X2500 of Converter A249/0169-1-Rear Face

Figure D-284. Scanning Electron Micrograph at X5000 of Converter A249/0169-1-Rear Face

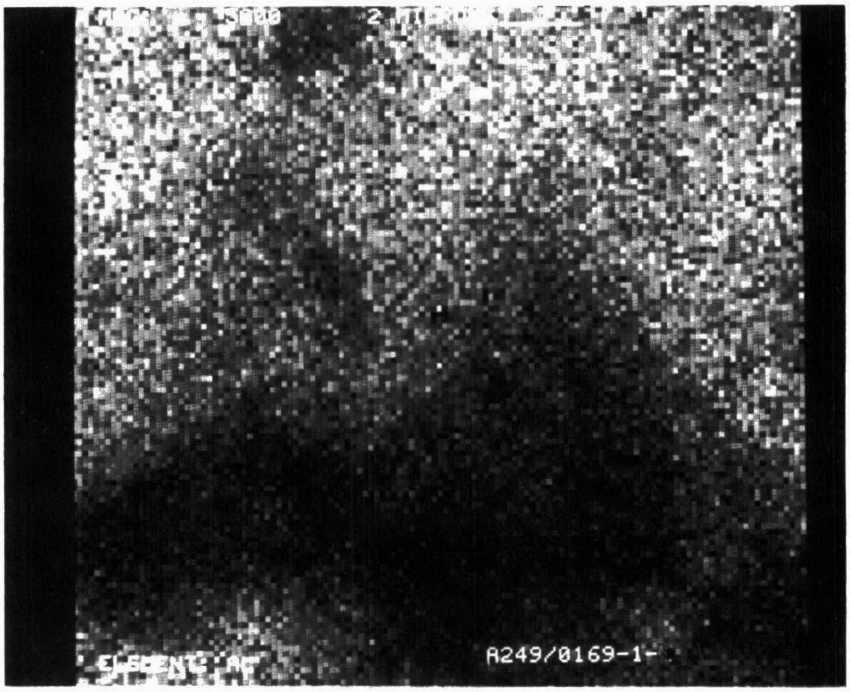


Figure D-285. Aluminum Dot Map at X5000 of Converter A249/0169-1-Rear Face

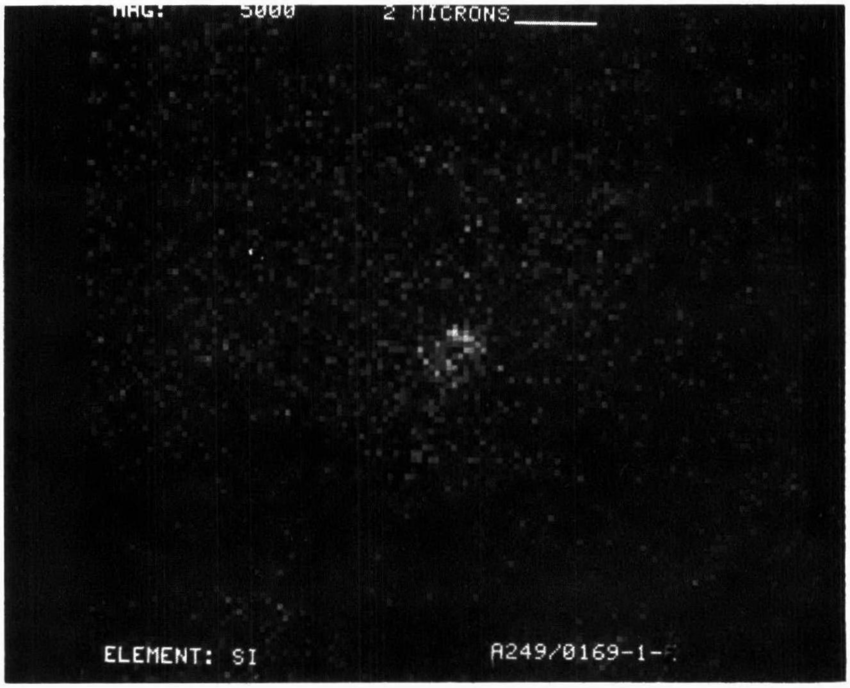


Figure D-286. Silicon Dot Map at X5000 of Converter A249/0169-1-Rear Face

NO DOT MAP BECAUSE ELEMENT CONCENTRATION IN SAMPLE
TO LOW FOR ADEQUATE MAPPING

Figure D-287. Lead Dot Map at X5000 of Converter A249/0169-1-Rear Face

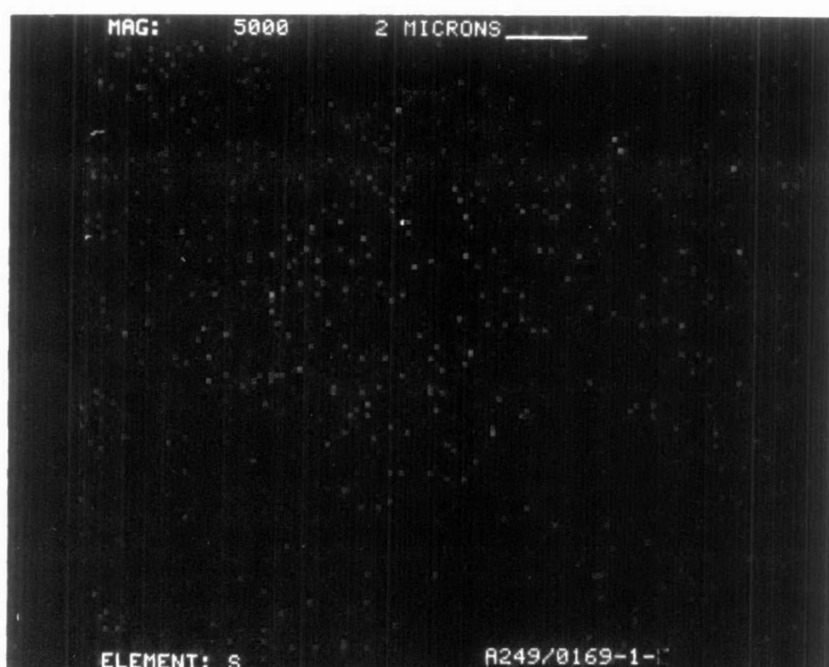


Figure D-288. Sulfur Dot Map at X5000 of Converter A249/0169-1-Rear Face

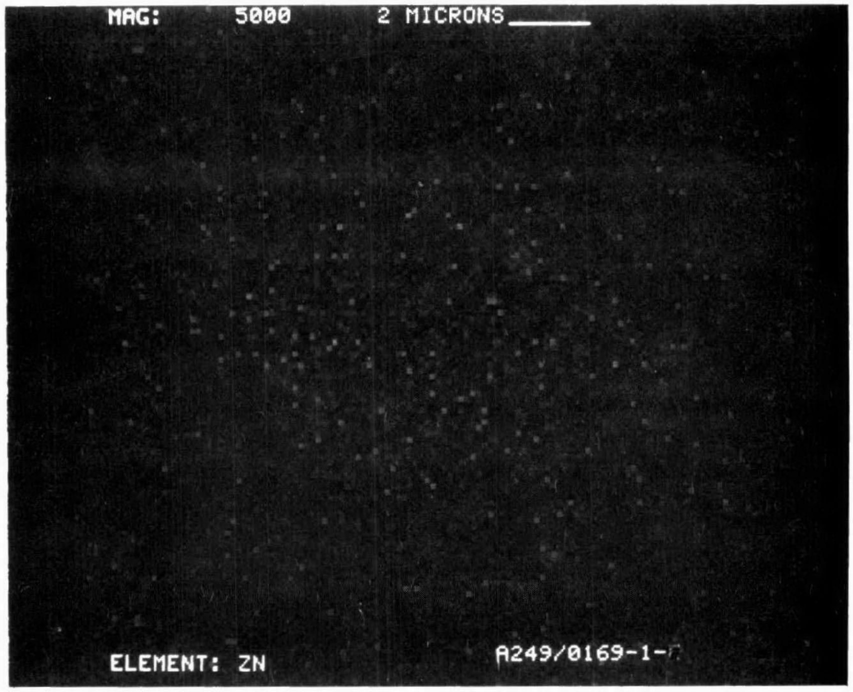


Figure D-289. Zinc Dot Map at X5000 of Converter A249/0169-1-Rear Face

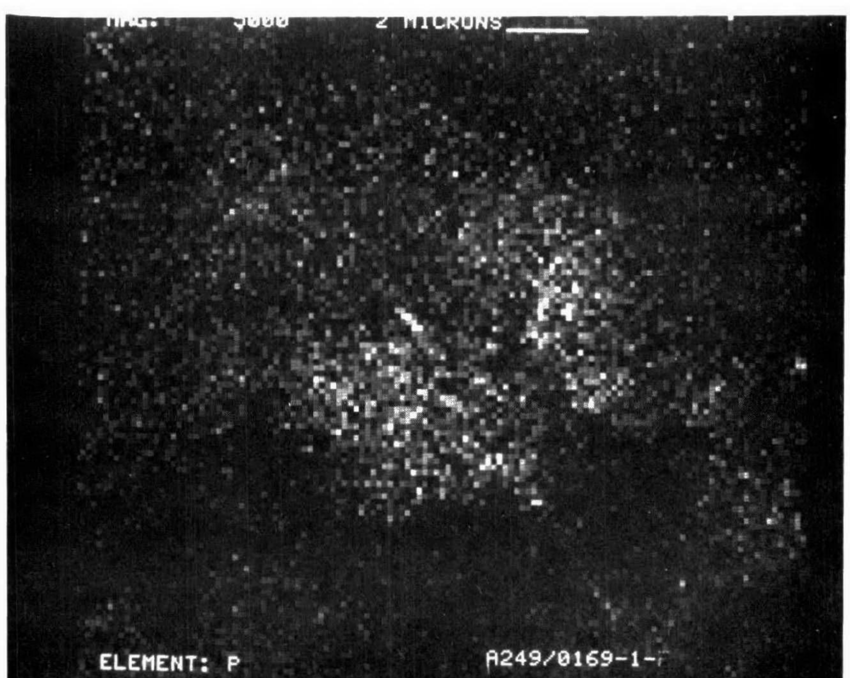


Figure D-290. Phosphorus Dot Map at X5000 of Converter A249/0169-1-Rear Face

APPENDIX E

ELEMENTAL CONCENTRATIONS OF METALS AND POISONS FOR BULK SAMPLE BY X-RAY FLUORESCENCE

RUN DESCRIPTION: SWRIAC - CONTAMINATED AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 07/25/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 7
SAMPLE ID: A3/1037-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.028111	.468695E-01	+-	.283433E-01
MG		.224739E-02	3.64507	+-	.183289
AL		.329636E-01	21.7605	+-	1.08924
SI		.47881E-02	15.4452	+-	.77329
P		.422422E-03	.970743	+-	.493443E-01
S		.225447E-02	.507564E-01	+-	.351864E-02
CL	X	.110531E-02	-.433473E-03	+-	.27628E-04
K		.35356E-03	.543237E-01	+-	.275754E-02
CA		.201825E-03	.092765	+-	.477257E-02
TI		.185483E-03	.315891	+-	.158987E-01
V	X	.562998E-03	-.492077E-02	+-	.307396E-03
CR		.613348E-03	.653832E-02	+-	.774751E-03
MN		.36683E-03	.806205E-02	+-	.73523E-03
FE		.421514E-03	.180416	+-	.916715E-02
CO		.43145E-03	.225638E-02	+-	.397698E-03
NI		.569168E-03	2.8533	+-	.142765
CU		.4236E-03	.16194E-02	+-	.420266E-03
ZN		.325708E-03	.115913	+-	.586646E-02
SE	X	.33718E-03	-.181065E-02	+-	.213346E-02
BR	X	.346862E-02	-.233834E-02	+-	.117197E-03
SR	X	.522621E-02	-.311009E-02	+-	.156062E-03
MO	X	.938197E-02	-.298445E-02	+-	.149349E-03
CD		.182716E-03	.639604E-03	+-	.145376E-03
SN	D	.144164E-02	.266082E-02	+-	.983194E-03
SB	X	.643098E-03	-.186891E-04	+-	.307098E-04
BA		.513732E-03	.69383E-02	+-	.617128E-03
CE		.190713E-02	.878206	+-	.044771
PT		.883359E-03	.119897	+-	.618404E-02
PB		.8911E-03	.101251	+-	.523334E-02

TOTAL DETECTED BY XRF = 46.6598

RUN DESCRIPTION: SWRIAC - CONTAMINATED AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 07/25/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 8
SAMPLE ID: A81/0270-1-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.372687E-01	.439457E-01	+-	.374086E-01
MG		.301901E-02	3.43254	+-	.172761
AL		.439037E-01	21.9392	+-	1.0986
SI		.582322E-02	14.4563	+-	.723894
P		.48503E-03	.682506	+-	.349387E-01
S		.259103E-02	.197654	+-	.104244E-01
CL	X	.131148E-02	-.624289E-04	+-	.389918E-05
K		.420917E-03	.578896E-01	+-	.294472E-02
CA		.218119E-03	.136238	+-	.695678E-02
TI		.241516E-03	.296854	+-	.149575E-01
V	X	.826312E-03	-.677051E-02	+-	.487197E-03
CR		.709378E-03	.628039E-02	+-	.799916E-03
MN		.517524E-03	.398204E-01	+-	.237243E-02
FE		.485612E-03	.234229	+-	.118799E-01
CO		.495259E-03	.199022E-02	+-	.416106E-03
NI		.667116E-03	3.4358	+-	.171905
CU		.496353E-03	.488562E-02	+-	.561622E-03
ZN		.393089E-03	.269934	+-	.135753E-01
SE	X	.481703E-03	-.547095E-02	+-	.436607E-02
BR	X	.516787E-02	-.417361E-02	+-	.209176E-03
SR	X	.795027E-02	-.121193E-01	+-	.608369E-03
MO	X	.142591E-01	.119187E-03	+-	.142591E-01
CD	X	.218101E-03	-.823182E-03	+-	.876638E-04
SN		.155268E-02	.560191E-02	+-	.128052E-02
SB	X	.687593E-03	.491175E-03	+-	.366033E-03
BA		.683349E-03	.844366	+-	.425488E-01
CE		.285613E-02	1.04486	+-	.532206E-01
PT		.112842E-02	.292347	+-	.148193E-01
PB		.127567E-02	1.6083	+-	.805689E-01

TOTAL DETECTED BY XRF = 49.0315

RUN DESCRIPTION: SWRIAC - CONTAMINATED AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 07/25/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 9
SAMPLE ID: A87/0479-2-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.234913E-01	.368077E-01	+-	.243941E-01
MG		.189003E-02	4.74012	+-	.237935
AL		.282132E-01	20.322	+-	1.01715
SI		.436612E-02	18.0195	+-	.901974
P		.4064E-03	.606109E-01	+-	.00376
S		.213721E-02	.180174	+-	.947636E-02
CL	X	.105066E-02	-.226613E-02	+-	.152958E-03
K		.337735E-03	.355647E-01	+-	.182746E-02
CA		.187277E-03	.16961	+-	.861447E-02
TI		.158809E-03	.101874	+-	.519628E-02
V	X	.514094E-03	.289976E-03	+-	.249754E-04
CR		.71925E-03	.305622E-01	+-	.221558E-02
MN		.527999E-03	.172369E-01	+-	.001333
FE		.444842E-03	.653063	+-	.328278E-01
CO	D	.309638E-03	.874511E-03	+-	.136625E-03
NI		.274084E-03	.424528E-01	+-	.221139E-02
CU		.257453E-03	.632386E-02	+-	.441243E-03
ZN		.25917E-03	.790681E-01	+-	.400609E-02
SE	X	.261117E-03	.632878E-04	+-	.41237E-02
BR	X	.271882E-02	-.485226E-03	+-	.243044E-04
SR	X	.410016E-02	-.317568E-02	+-	.15923E-03
MO	X	.766378E-02	-.432342E-02	+-	.216316E-03
CD		.174147E-03	.86148E-03	+-	.134452E-03
SN	X	.132399E-02	-.736997E-03	+-	.546495E-03
SB	X	.582908E-03	.161232E-03	+-	.216919E-03
BA		.448133E-03	.228779E-02	+-	.388144E-03
CE		.139605E-02	.150967E-01	+-	.22601E-02
PT	D	.713619E-03	.102543E-02	+-	.257469E-03
PB		.718973E-03	.2198	+-	.110889E-01

TOTAL DETECTED BY XRF = 44.7849

RUN DESCRIPTION: SWRIAC - CONTAMINATED AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 07/25/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 10
SAMPLE ID: A154/0392-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.332801E-01	-.401736E-01	+-	.320326E-02
MG		.267606E-02	3.5352	+-	.177869
AL		.394413E-01	23.6118	+-	1.18202
SI		.542682E-02	13.6394	+-	.683055
P		.455311E-03	1.07861	+-	.547461E-01
S		.24434E-02	.359869	+-	.183992E-01
CL	X	.12175E-02	-.178392E-02	+-	.116469E-03
K		.389174E-03	.496227E-01	+-	.253038E-02
CA		.217519E-03	.772937E-01	+-	.400529E-02
TI		.237296E-03	.333584	+-	.167895E-01
V	X	.816239E-03	-.869176E-02	+-	.603865E-03
CR		.662026E-03	.464034E-02	+-	.649799E-03
MN		.463583E-03	.119479E-01	+-	.972252E-03
FE		.448556E-03	.141838	+-	.725258E-02
CO		.509297E-03	.003025	+-	.503412E-03
NI		.726323E-03	4.11694	+-	.205966
CU	X	.520107E-03	-.910637E-03	+-	.455359E-04
ZN		.378102E-03	.142387	+-	.720375E-02
SE	X	.411655E-03	-.147395E-02	+-	.197676E-02
BR	X	.442704E-02	-.224128E-02	+-	.112348E-03
SR	X	.672582E-02	-.374688E-02	+-	.188048E-03
MO	X	.119902E-01	.365865E-02	+-	.119916E-01
CD	D	.201481E-03	.481487E-03	+-	.680639E-04
SN	D	.153018E-02	.319811E-02	+-	.116657E-02
SB	X	.65869E-03	.481285E-03	+-	.37163E-03
BA		.659966E-03	.969035	+-	.487691E-01
CE		.274423E-02	1.08568	+-	.552066E-01
PT		.105866E-02	.122243	+-	.634912E-02
PB		.110467E-02	.545111	+-	.274116E-01

TOTAL DETECTED BY XRF = 49.8319

RUN DESCRIPTION: SWRIAC - CONTAMINATED AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 07/25/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 11
SAMPLE ID: A155/0979-1-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.280253E-01	.399987E-01	+-	.281909E-01
MG		.228131E-02	4.88277	+-	.245134
AL		.336337E-01	19.3436	+-	.968456
SI		.486124E-02	18.1095	+-	.906494
P		.441297E-03	.432202	+-	.224291E-01
S		.233934E-02	.364231E-01	+-	.303848E-02
CL	X	.115032E-02	-.265386E-02	+-	.179192E-03
K		.368942E-03	.022071	+-	.11802E-02
CA		.176706E-03	.784042E-01	+-	.405752E-02
TI		.181066E-03	.106434	+-	.542808E-02
V	X	.627205E-03	-.495725E-04	+-	.464368E-05
CR		.105631E-02	.370789E-02	+-	.690441E-03
MN		.661593E-03	.891392E-02	+-	.10224E-02
FE		.649767E-03	.320952	+-	.162583E-01
CO	D	.347324E-03	.405977E-03	+-	.133492E-03
NI		.315247E-03	.807585E-02	+-	.567648E-03
CU	D	.299484E-03	.807583E-03	+-	.294462E-03
ZN		.301382E-03	.700984E-01	+-	.356976E-02
SE	X	.334413E-03	-.331894E-02	+-	.252482E-02
BR	X	.350486E-02	-.253965E-02	+-	.127231E-03
SR	X	.529211E-02	-.229242E-02	+-	.11495E-03
MO	X	.947405E-02	-.329934E-03	+-	.165089E-04
CD	X	.190147E-03	-.640285E-04	+-	.267619E-04
SN	D	.12487E-02	.175325E-02	+-	.779652E-03
SB	D	.544119E-03	.717976E-03	+-	.448784E-03
BA		.51374E-03	.224694E-02	+-	.417338E-03
CE		.222799E-02	1.79424	+-	.906904E-01
PT		.841566E-03	.214913	+-	.108918E-01
PB		.876344E-03	.214322	+-	.108383E-01

TOTAL DETECTED BY XRF = 45.6926

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A-
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 5
SAMPLE ID: A160/0656-A-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.383249E-01	.12193	+-	.392707E-01
MG		.312815E-02	3.50157	+-	.176204
AL		.444242E-01	18.7491	+-	.93923
SI		.561527E-02	13.3479	+-	.668382
P		.476937E-03	3.33039	+-	.167303
S	X	.263018E-02	-.783389E-03	+-	.410873E-03
CL	X	.135031E-02	.780535E-03	+-	.135116E-02
K		.433643E-03	.530458E-01	+-	.270737E-02
CA		.251653E-03	.552095	+-	.277558E-01
TI		.221969E-03	.277492	+-	.139941E-01
V	X	.61709E-03	-.387702E-02	+-	.257032E-03
CR		.699903E-03	.100021E-01	+-	.106233E-02
MN		.501483E-03	.193972	+-	.100625E-01
FE		.458103E-03	.334672	+-	.168981E-01
CO		.400326E-03	.185502E-02	+-	.316414E-03
NI		.524059E-03	2.1683	+-	.108511
CU		.441039E-03	.948827E-02	+-	.681735E-03
ZN		.431576E-03	.982537	+-	.491967E-01
SE	X	.493997E-03	-.452525E-02	+-	.522876E-02
BR	X	.546769E-02	-.49918E-02	+-	.250148E-03
SR	X	.84803E-02	-.191869E-01	+-	.963246E-03
MO	X	.152985E-01	-.426718E-02	+-	.213617E-03
CD	X	.226357E-03	-.411199E-04	+-	.323767E-05
SN		.17976E-02	.692957E-02	+-	.103122E-02
SB	X	.80661E-03	.500783E-03	+-	.444782E-03
BA		.632828E-03	.467392E-02	+-	.553188E-03
CE		.219616E-02	.605405	+-	.312777E-01
PT		.10863E-02	.221001	+-	.011232
PB		.134361E-02	2.75808	+-	.138057

TOTAL DETECTED BY XRF = 47.2304

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 6
SAMPLE ID: A160/0656-A-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.282482E-01	.362361E-01	+-	.283881E-01
MG		.226127E-02	4.06421	+-	.204244
AL		.332233E-01	21.3761	+-	1.07004
SI		.483151E-02	16.073	+-	.80469
P		.425735E-03	.213455	+-	.114596E-01
S	X	.224785E-02	.470793E-03	+-	.136452E-02
CL	X	.110201E-02	-.210453E-02	+-	.140192E-03
K		.352927E-03	.616539E-01	+-	.312148E-02
CA		.202607E-03	.121581	+-	.621251E-02
TI		.186394E-03	.347035	+-	.174558E-01
V	X	.573645E-03	-.586619E-02	+-	.360497E-03
CR		.56244E-03	.506523E-02	+-	.677319E-03
MN		.405048E-03	.245114E-01	+-	.155839E-02
FE		.400935E-03	.258337	+-	.130589E-01
CO		.427681E-03	.192241E-02	+-	.356407E-03
NI		.569936E-03	2.86703	+-	.143451
CU	X	.415875E-03	-.110035E-02	+-	.550223E-04
ZN		.318071E-03	.480049E-01	+-	.247997E-02
SE	X	.360497E-03	-.379602E-02	+-	.246752E-02
BR	X	.350693E-02	-.299091E-02	+-	.149905E-03
SR	X	.529589E-02	-.326758E-02	+-	.163966E-03
MO	X	.945944E-02	-.247984E-02	+-	.124098E-03
CD	X	.182492E-03	-.102967E-03	+-	.735187E-04
SN	D	.144937E-02	.398873E-02	+-	.107985E-02
SB	X	.64904E-03	-.215739E-04	+-	.316229E-04
BA		.528842E-03	.387756E-02	+-	.418541E-03
CE		.190974E-02	.680426	+-	.348842E-01
PT		.890935E-03	.250692	+-	.012699
PB		.918966E-03	.144286	+-	.736682E-02

TOTAL DETECTED BY XRF = 46.5814

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 7
SAMPLE ID: A160/0656-A-C

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.294802E-01	.537912E-01	+-	.297657E-01
MG		.235851E-02	3.62929	+-	.182522
AL		.348354E-01	22.9379	+-	1.14816
SI		.499993E-02	14.37	+-	.719558
P		.429234E-03	.614588	+-	.315307E-01
S	X	.228235E-02	-.221775E-02	+-	.135189E-03
CL	X	.112094E-02	-.271838E-02	+-	.184417E-03
K		.358847E-03	.595898E-01	+-	.301965E-02
CA		.204278E-03	.174138	+-	.884118E-02
TI		.190666E-03	.313043	+-	.015757
V	X	.567627E-03	-.663872E-02	+-	.424097E-03
CR		.55749E-03	.596005E-02	+-	.708515E-03
MN		.372915E-03	.474795E-01	+-	.268363E-02
FE		.405471E-03	.225714	+-	.114251E-01
CO		.450826E-03	.211936E-02	+-	.392628E-03
NI		.623197E-03	3.46753	+-	.173481
CU	X	.444117E-03	-.861747E-03	+-	.430912E-04
ZN		.34278E-03	.104108	+-	.528151E-02
SE	X	.380941E-03	-.387646E-02	+-	.224006E-02
BR	X	.372204E-02	-.289584E-02	+-	.145151E-03
SR	X	.562921E-02	-.321861E-02	+-	.161532E-03
MO	X	.100428E-01	-.182695E-02	+-	.914301E-04
CD	D	.185788E-03	.274266E-03	+-	.759901E-04
SN		.145475E-02	.552016E-02	+-	.113779E-02
SB	X	.645588E-03	.414534E-03	+-	.311666E-03
BA		.5364E-03	.375052E-02	+-	.424373E-03
CE		.185994E-02	.828457	+-	.422714E-01
PT		.940974E-03	.287875	+-	.145666E-01
PB		.973004E-03	.177511	+-	.903239E-02

TOTAL DETECTED BY XRF = 47.3086

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 4
SAMPLE ID: A180/0094

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.03571	-.125579E-01	+-	.970268E-03
MG		.285185E-02	1.02753	+-	.525301E-01
AL		.459168E-01	36.9861	+-	1.85076
SI		.641961E-02	4.25416	+-	.214028
P		.471893E-03	.65282	+-	.334523E-01
S		.253453E-02	.262898	+-	.136182E-01
CL	X	.126724E-02	-.865604E-03	+-	.550556E-04
K		.406861E-03	.388166E-01	+-	.200141E-02
CA		.235399E-03	.130166	+-	.66517E-02
TI		.195361E-03	.127439	+-	.648241E-02
V	X	.59193E-03	-.327717E-02	+-	.322476E-03
CR		.530143E-03	.362076E-02	+-	.434131E-03
MN		.382029E-03	.102318E-01	+-	.8168E-03
FE		.44157E-03	.698046E-01	+-	.364034E-02
CO		.571084E-03	.922746E-02	+-	.791786E-03
NI		.887584E-03	6.64608	+-	.332439
CU	X	.612056E-03	-.249957E-02	+-	.12499E-03
ZN		.428528E-03	.16154	+-	.817511E-02
SE	X	.520259E-03	-.735117E-02	+-	.295013E-02
BR	X	.503349E-02	-.414475E-02	+-	.207831E-03
SR	X	.767701E-02	-.655166E-02	+-	.32908E-03
MO	X	.136697E-01	.225157E-04	+-	.136697E-01
CD		.210409E-03	.82492E-03	+-	.107818E-03
SN		.167116E-02	.683305E-02	+-	.146626E-02
SB	D	.735519E-03	.102883E-02	+-	.577377E-03
BA		.541685E-03	.145919E-01	+-	.108323E-02
CE		.188283E-02	1.76707	+-	.891901E-01
PT		.121167E-02	.562526	+-	.028348
PB		.128903E-02	.531977	+-	.267831E-01

TOTAL DETECTED BY XRF = 53.2653

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 9
SAMPLE ID: A193/0908-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.310358E-01	.464211E-01	+-	.312283E-01
MG		.253648E-02	3.77225	+-	.189639
AL		.383835E-01	24.4871	+-	1.2257
SI		.540704E-02	14.2934	+-	.715754
P		.46142E-03	1.54264	+-	.779671E-01
S		.24928E-02	.209802	+-	.110131E-01
CL	X	.123235E-02	-.175766E-02	+-	.114671E-03
K		.394399E-03	.279588E-01	+-	.147034E-02
CA		.196147E-03	.225567	+-	.114213E-01
TI		.185589E-03	.108776	+-	.555051E-02
V	X	.641736E-03	.159696E-03	+-	.148632E-04
CR		.140209E-02	.846731E-02	+-	.127021E-02
MN		.736098E-03	.343003E-01	+-	.230546E-02
FE		.768814E-03	.466191	+-	.235447E-01
CO	X	.389265E-03	.22608E-03	+-	.749188E-04
NI		.344028E-03	.145567E-01	+-	.883688E-03
CU		.346613E-03	.106296E-01	+-	.68764E-03
ZN		.37138E-03	.308553	+-	.154965E-01
SE	X	.387419E-03	-.396003E-02	+-	.290271E-02
BR	X	.414553E-02	-.322678E-02	+-	.161696E-03
SR	X	.626471E-02	-.530305E-02	+-	.266048E-03
MO	X	.111976E-01	.425469E-02	+-	.111996E-01
CD	X	.204126E-03	-.22876E-04	+-	.110652E-04
SN	D	.139203E-02	.255531E-02	+-	.673423E-03
SB	X	.6086E-03	.773417E-04	+-	.160941E-03
BA	D	.52466E-03	.151807E-02	+-	.3524E-03
CE		.238449E-02	3.13797	+-	.15793
PT		.956515E-03	.248185	+-	.125787E-01
PB		.10053E-02	.182283	+-	.927041E-02

TOTAL DETECTED BY XRF = 49.1291

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 10
SAMPLE ID: A193/0908-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.231039E-01	.991649E-01	+-	.242701E-01
MG		.186236E-02	4.56295	+-	.22906
AL		.282223E-01	22.0921	+-	1.10563
SI		.443152E-02	17.2391	+-	.862969
P		.406962E-03	.135877	+-	.756918E-02
S		.214466E-02	.221512	+-	.115078E-01
CL	X	.001055	-.213222E-02	+-	.143249E-03
K		.339605E-03	.539643E-01	+-	.273804E-02
CA		.186063E-03	.156059	+-	.793791E-02
TI		.166188E-03	.127926	+-	.649987E-02
V	X	.515151E-03	-.285165E-03	+-	.226856E-04
CR		.112892E-02	.112347E-01	+-	.173909E-02
MN		.546367E-03	.116608E-01	+-	.106732E-02
FE		.45398E-03	.534029	+-	.268767E-01
CO	X	.312673E-03	-.168234E-03	+-	.566272E-04
NI		.26384E-03	.458221E-02	+-	.384822E-03
CU		.257308E-03	.340546E-02	+-	.327297E-03
ZN		.268527E-03	.152953	+-	.769742E-02
SE	X	.262475E-03	-.740961E-04	+-	.887958E-03
BR	X	.270851E-02	-.617204E-03	+-	.309158E-04
SR	X	.407074E-02	-.217161E-02	+-	.108879E-03
MO	X	.742619E-02	-.264292E-02	+-	.132233E-03
CD		.175025E-03	.667755E-03	+-	.122268E-03
SN	X	.133052E-02	.113247E-02	+-	.453435E-03
SB	X	.599395E-03	.784764E-04	+-	.969674E-04
BA	D	.479999E-03	.830399E-03	+-	.217235E-03
CE		.195099E-02	.220775E-01	+-	.256718E-02
PT		.713367E-03	.009354	+-	.754298E-03
PB		.720785E-03	.187015	+-	.945317E-02

TOTAL DETECTED BY XRF = 45.6265

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 8
SAMPLE ID: A214/0681-A-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.347651E-01	-.433592E-01	+-	.347262E-02
MG		.277321E-02	2.20424	+-	.111372
AL		.415036E-01	27.6342	+-	1.38315
SI		.563593E-02	8.64632	+-	.433445
P		.446722E-03	1.91546	+-	.965677E-01
S		.242137E-02	.025206	+-	.265982E-02
CL	X	.120643E-02	-.519103E-03	+-	.328784E-04
K		.385632E-03	.583692E-01	+-	.296272E-02
CA		.224716E-03	.338637	+-	.170711E-01
TI		.190743E-03	.218566	+-	.110367E-01
V	X	.574771E-03	-.437725E-02	+-	.312665E-03
CR		.494719E-03	.493091E-02	+-	.563837E-03
MN		.328258E-03	.150424E-01	+-	.001025
FE		.397175E-03	.158739	+-	.80667E-02
CO		.532371E-03	.651783E-02	+-	.64592E-03
NI		.809981E-03	6.01593	+-	.30092
CU		.580801E-03	.105959E-01	+-	.811886E-03
ZN		.428026E-03	.395065	+-	.198398E-01
SE	X	.447105E-03	-.307573E-02	+-	.344561E-02
BR	X	.463538E-02	-.291236E-02	+-	.146028E-03
SR	X	.707268E-02	-.739147E-02	+-	.37122E-03
MO	X	.126241E-01	-.335396E-03	+-	.167882E-04
CD		.200567E-03	.65896E-03	+-	.752273E-04
SN		.15905E-02	.852782E-02	+-	.126276E-02
SB	D	.697653E-03	.133021E-02	+-	.543393E-03
BA		.536236E-03	.428915E-02	+-	.503796E-03
CE		.182542E-02	1.13587	+-	.576145E-01
PT		.112244E-02	.166756	+-	.857213E-02
PB		.116873E-02	.780717	+-	.392027E-01

TOTAL DETECTED BY XRF = 49.746

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 9
SAMPLE ID: A214/0681-A-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.304665E-01	-.193024E-01	+-	.156452E-02
MG		.242157E-02	3.22832	+-	.162519
AL		.358372E-01	24.4719	+-	1.22489
SI		.005125	12.5916	+-	.630668
P		.427432E-03	.508779	+-	.262347E-01
S	D	.226593E-02	.620481E-02	+-	.220449E-02
CL	X	.111202E-02	-.970307E-03	+-	.62507E-04
K		.355403E-03	.708133E-01	+-	.357719E-02
CA		.214005E-03	.12653	+-	.645949E-02
TI		.192224E-03	.291234	+-	.146647E-01
V	X	.536401E-03	-.509239E-02	+-	.322535E-03
CR		.480538E-03	.442845E-02	+-	.546515E-03
MN		.320973E-03	.348254E-02	+-	.459442E-03
FE		.367738E-03	.130587	+-	.66556E-02
CO		.49403E-03	.559877E-02	+-	.586713E-03
NI		.733759E-03	5.07854	+-	.254042
CU	X	.516645E-03	-.130086E-02	+-	.650487E-04
ZN		.351981E-03	.603966E-01	+-	.310982E-02
SE	X	.374797E-03	-.204289E-02	+-	.236366E-02
BR	X	.38089E-02	-.189154E-02	+-	.948296E-04
SR	X	.574864E-02	-.277813E-02	+-	.139463E-03
MO	X	.010232	-.273368E-04	+-	.136811E-05
CD	X	.183969E-03	-.437338E-04	+-	.308187E-04
SN	D	.152126E-02	.317198E-02	+-	.100159E-02
SB	D	.672868E-03	.966594E-03	+-	.445875E-03
BA		.539268E-03	.418323E-02	+-	.462528E-03
CE		.178357E-02	.895063	+-	.455483E-01
PT		.984845E-03	.129652	+-	.670414E-02
PB		.973521E-03	.122939	+-	.633529E-02

TOTAL DETECTED BY XRF = 47.7344

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 10
SAMPLE ID: A214/0681-A-C

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.284587E-01	-.036704	+-	.303951E-02
MG		.226836E-02	3.6526	+-	.183679
AL		.336479E-01	23.3293	+-	1.16769
SI		.489967E-02	14.1676	+-	.709442
P		.422248E-03	.798698	+-	.407399E-01
S	X	.224633E-02	-.19656E-02	+-	.119999E-03
CL	X	.110042E-02	-.272358E-02	+-	.185399E-03
K		.352017E-03	.687185E-01	+-	.347269E-02
CA		.20522E-03	.125516	+-	.640943E-02
TI		.184854E-03	.317365	+-	.015972
V	X	.548897E-03	-.28799E-02	+-	.175236E-03
CR		.511297E-03	.589869E-02	+-	.686384E-03
MN		.342138E-03	.415859E-02	+-	.515144E-03
FE		.382417E-03	.147771	+-	.752287E-02
CO		.456511E-03	.454433E-02	+-	.516761E-03
NI		.646383E-03	3.89083	+-	.194647
CU	X	.461676E-03	.160351E-03	+-	.436556E-03
ZN		.337905E-03	.507304E-01	+-	.262191E-02
SE	X	.34992E-03	-.16297E-02	+-	.229524E-03
BR	X	.353415E-02	-.159258E-02	+-	.798271E-04
SR	X	.532398E-02	-.212418E-02	+-	.106602E-03
MO	X	.949722E-02	.372138E-03	+-	.949724E-02
CD	D	.182089E-03	.363463E-03	+-	.118923E-03
SN	D	.145028E-02	.283474E-02	+-	.919117E-03
SB	X	.634211E-03	.440771E-03	+-	.29542E-03
BA		.514878E-03	.401907E-02	+-	.433403E-03
CE		.183805E-02	.729837	+-	.373247E-01
PT		.920029E-03	.102544	+-	.534042E-02
PB		.918795E-03	.887953E-01	+-	.463015E-02

TOTAL DETECTED BY XRF = 47.4921

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 1
SAMPLE ID: A218/0045

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.323216E-01	-.183409E-01	+-	.145235E-02
MG		.258195E-02	2.32517	+-	.117355
AL		.400969E-01	30.9595	+-	1.54931
SI		.574986E-02	9.19206	+-	.460792
P		.450896E-03	.268419	+-	.01422
S		.240201E-02	.29161	+-	.150128E-01
CL	X	.118993E-02	.463601E-04	+-	.118993E-02
K		.38142E-03	.049022	+-	.249933E-02
CA		.219878E-03	.104459	+-	.005362
TI		.194429E-03	.22156	+-	.111851E-01
V	X	.591322E-03	-.498653E-02	+-	.362264E-03
CR		.533189E-03	.484377E-02	+-	.556522E-03
MN		.348006E-03	.355078E-02	+-	.487198E-03
FE		.421481E-03	.115114	+-	.589704E-02
CO		.522974E-03	.70019E-02	+-	.665956E-03
NI		.774356E-03	5.31679	+-	.265962
CU	X	.544458E-03	-.224602E-02	+-	.112311E-03
ZN		.383334E-03	.072689	+-	.373044E-02
SE	X	.454084E-03	-.686777E-02	+-	.323157E-02
BR	X	.432874E-02	-.335317E-02	+-	.168116E-03
SR	X	.655947E-02	-.348211E-02	+-	.174833E-03
MO	X	.011679	-.438471E-03	+-	.219458E-04
CD	D	.19716E-03	.498602E-03	+-	.122713E-03
SN		.15621E-02	.646403E-02	+-	.141605E-02
SB	D	.68847E-03	.712334E-03	+-	.456216E-03
BA		.538744E-03	.172708E-01	+-	.119039E-02
CE		.181882E-02	1.43939	+-	.727997E-01
PT		.106691E-02	.430234	+-	.217109E-01
PB		.112658E-02	.148602	+-	.762882E-02

TOTAL DETECTED BY XRF = 50.975

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 2
SAMPLE ID: A218/0045X

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.318681E-01	-.254508E-01	+-	.202815E-02
MG		.254776E-02	2.49786	+-	.125977
AL		.390445E-01	28.8406	+-	1.44336
SI		.557093E-02	10.2452	+-	.513409
P		.44584E-03	.570158	+-	.293123E-01
S		.238003E-02	.160023	+-	.855794E-02
CL	X	.11787E-02	-.697597E-03	+-	.44469E-04
K		.377949E-03	.050072	+-	.255063E-02
CA		.214541E-03	.953498E-01	+-	.490564E-02
TI		.195032E-03	.233161	+-	.117646E-01
V	X	.579589E-03	-.401901E-02	+-	.277604E-03
CR		.578387E-03	.446553E-02	+-	.564805E-03
MN		.391015E-03	.310004E-02	+-	.499189E-03
FE		.418768E-03	.167478	+-	.851501E-02
CO		.49671E-03	.605838E-02	+-	.603504E-03
NI		.716867E-03	4.50201	+-	.225216
CU	X	.506777E-03	-.909031E-03	+-	.454557E-04
ZN		.367755E-03	.917788E-01	+-	.467548E-02
SE	X	.436558E-03	-.591169E-02	+-	.305747E-02
BR	X	.420543E-02	-.289904E-02	+-	.145328E-03
SR	X	.638252E-02	-.390233E-02	+-	.195893E-03
MO	X	.113761E-01	-.918747E-04	+-	.459823E-05
CD	D	.195325E-03	.500745E-03	+-	.915354E-04
SN		.151437E-02	.72386E-02	+-	.145706E-02
SB	X	.659269E-03	.493814E-03	+-	.374567E-03
BA		.552148E-03	.191645E-01	+-	.128599E-02
CE		.19206E-02	1.28782	+-	.652337E-01
PT		.104236E-02	.381946	+-	.019287
PB		.109308E-02	.297849	+-	.150548E-01

TOTAL DETECTED BY XRF = 49.4618

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 3
SAMPLE ID: A218/0068

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.360665E-01	-.199125E-01	+-	.154085E-02
MG		.288735E-02	1.39778	+-	.071037
AL		.456802E-01	34.5353	+-	1.72823
SI		.630715E-02	5.69224	+-	.285875
P		.472418E-03	.779384	+-	.397788E-01
S		.254194E-02	.341696	+-	.175107E-01
CL	X	.127655E-02	-.41565E-03	+-	.261855E-04
K		.409834E-03	.421752E-01	+-	.216694E-02
CA		.227625E-03	.166221	+-	.845478E-02
TI		.189062E-03	.156533	+-	.793792E-02
V	X	.598581E-03	-.470276E-02	+-	.430137E-03
CR		.561515E-03	.49072E-02	+-	.556362E-03
MN		.36903E-03	.590272E-02	+-	.608463E-03
FE		.429754E-03	.100864	+-	.518798E-02
CO		.553163E-03	.790509E-02	+-	.724355E-03
NI		.848996E-03	6.24326	+-	.312294
CU	D	.604279E-03	.135191E-02	+-	.582808E-03
ZN		.434934E-03	.245869	+-	.123865E-01
SE	X	.521571E-03	-.830338E-02	+-	.375481E-02
BR	X	.507181E-02	-.367742E-02	+-	.184379E-03
SR	X	.775381E-02	-.837044E-02	+-	.42044E-03
MO	X	.138381E-01	-.358705E-03	+-	.179558E-04
CD		.212145E-03	.784348E-03	+-	.900781E-04
SN		.160245E-02	.160656E-01	+-	.193628E-02
SB	D	.693815E-03	.105963E-02	+-	.543735E-03
BA		.530522E-03	.175539E-01	+-	.122098E-02
CE		.193832E-02	1.61084	+-	.813925E-01
PT		.119667E-02	.522473	+-	.263415E-01
PB		.130292E-02	.766144	+-	.384841E-01

TOTAL DETECTED BY XRF = 52.6563

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 1
SAMPLE ID: A220/0392-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.347425E-01	.268253E-01	+-	.348017E-01
MG		.278619E-02	2.02157	+-	.102209
AL		.430505E-01	31.6057	+-	1.58171
SI		.595349E-02	7.97121	+-	.399754
P		.462389E-03	1.38986	+-	.703074E-01
S		.250552E-02	.766571	+-	.386668E-01
CL	X	.125359E-02	.221522E-03	+-	.125367E-02
K		.400452E-03	.384239E-01	+-	.198079E-02
CA		.219926E-03	.114249	+-	.585441E-02
TI		.257739E-03	.231109	+-	.116673E-01
V	X	.104774E-02	-.135684E-01	+-	.209184E-02
CR		.100757E-02	.403047E-02	+-	.786701E-03
MN		.519785E-03	.370693E-02	+-	.636086E-03
FE		.474843E-03	.135961	+-	.697338E-02
CO	X	.545891E-03	-.116278E-02	+-	.581441E-04
NI		.791722E-03	4.67625	+-	.233945
CU	X	.580956E-03	.474897E-03	+-	.551891E-03
ZN		.427585E-03	.191783	+-	.968238E-02
SE	X	.43239E-03	-.15022E-02	+-	.261123E-02
BR	X	.471419E-02	-.207665E-02	+-	.104112E-03
SR		.720503E-02	.471913E-01	+-	.746136E-02
MO	X	.128071E-01	.537802E-02	+-	.128099E-01
CD		.207493E-03	.887646E-03	+-	.148994E-03
SN	D	.155711E-02	.315535E-02	+-	.106501E-02
SB	D	.676652E-03	.924655E-03	+-	.522201E-03
BA		.728821E-03	1.72086	+-	.863713E-01
CE		.336343E-02	1.56885	+-	.793961E-01
PT		.114762E-02	.979295E-01	+-	.518137E-02
PB		.113076E-02	.235572	+-	.119732E-01

TOTAL DETECTED BY XRF = 52.8258

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 2
SAMPLE ID: A220/0392-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.227133E-01	.11301	+-	.241886E-01
MG		.181959E-02	2.36868	+-	.119294
AL		.297771E-01	32.1659	+-	1.60928
SI		.489425E-02	9.9842	+-	.500321
P		.397599E-03	.997653E-01	+-	.572359E-02
S		.212474E-02	.893393	+-	.449678E-01
CL	D	.106057E-02	.155286E-02	+-	.106488E-02
K		.343002E-03	.586465E-01	+-	.297106E-02
CA		.18514E-03	.166846	+-	.847773E-02
TI		.169885E-03	.203111	+-	.102602E-01
V	D	.512082E-03	.102047E-02	+-	.668726E-04
CR		.111816E-02	.108545E-01	+-	.173234E-02
MN		.51041E-03	.60067E-02	+-	.77408E-03
FE		.434927E-03	.301673	+-	.152619E-01
CO	X	.312679E-03	-.124101E-03	+-	.758864E-04
NI		.269385E-03	.150352E-01	+-	.860668E-03
CU		.266181E-03	.224447E-02	+-	.296809E-03
ZN		.269396E-03	.799849E-01	+-	.405296E-02
SE	X	.310793E-03	-.564144E-02	+-	.277555E-02
BR	X	.281066E-02	-.221285E-02	+-	.110845E-03
SR	X	.424221E-02	-.145048E-02	+-	.727276E-04
MO	X	.794395E-02	-.177624E-02	+-	.888716E-04
CD	D	.176704E-03	.434621E-03	+-	.151731E-03
SN	X	.13244E-02	.806672E-03	+-	.336184E-03
SB	X	.596602E-03	.122509E-03	+-	.129955E-03
BA		.478915E-03	.286466E-02	+-	.383858E-03
CE		.191221E-02	.213393E-01	+-	.252031E-02
PT		.750397E-03	.346932	+-	.174612E-01
PB		.77447E-03	.388069E-01	+-	.210316E-02

TOTAL DETECTED BY XRF = 46.8823

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 9
SAMPLE ID: A220/0810-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.344268E-01	.225344	+-	.037793
MG		.278446E-02	2.99928	+-	.151098
AL		.04152	26.3731	+-	1.32011
SI		.562479E-02	10.9045	+-	.546335
P		.457594E-03	2.02696	+-	.10216
S		.249201E-02	.540226	+-	.273767E-01
CL	X	.124418E-02	-.138581E-02	+-	.893988E-04
K		.398237E-03	.135383	+-	.680143E-02
CA		.217094E-03	.300151	+-	.151503E-01
TI		.253605E-03	.265147	+-	.133709E-01
V	X	.96966E-03	-.966265E-02	+-	.875404E-03
CR		.106325E-02	.430791E-02	+-	.868357E-03
MN		.555266E-03	.657991E-02	+-	.789795E-03
FE		.515253E-03	.498709	+-	.025108
CO		.497617E-03	.425246E-02	+-	.486708E-03
NI		.700694E-03	3.63124	+-	.181683
CU	D	.541315E-03	.871983E-03	+-	.519261E-03
ZN		.460533E-03	.639935	+-	.320822E-01
SE	X	.426121E-03	-.143817E-02	+-	.24955E-02
BR	X	.467798E-02	-.230929E-02	+-	.11577E-03
SR	D	.712195E-02	.174357E-01	+-	.658654E-02
MO	X	.126649E-01	.433948E-02	+-	.126667E-01
CD		.207031E-03	.186156E-02	+-	.202081E-03
SN		.156483E-02	.563309E-02	+-	.102876E-02
SB	X	.709798E-03	.547682E-03	+-	.257654E-03
BA		.72326E-03	1.35687	+-	.681739E-01
CE		.31442E-02	1.41366	+-	.716487E-01
PT		.109783E-02	.966916E-01	+-	.508242E-02
PB		.113645E-02	.437453	+-	.220449E-01

TOTAL DETECTED BY XRF = 51.8856

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 10
SAMPLE ID: A220/0810-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.235451E-01	.15119	+-	.259191E-01
MG		.189292E-02	2.42248	+-	.121998
AL		.306695E-01	31.5269	+-	1.57735
SI		.491436E-02	9.8473	+-	.493462
P		.399146E-03	.483975	+-	.249693E-01
S		.215317E-02	1.1543	+-	.580057E-01
CL	X	.108278E-02	-.22795E-02	+-	.153333E-03
K		.351181E-03	.153331	+-	.769481E-02
CA		.190481E-03	.19752	+-	.010014
TI		.177147E-03	.202982	+-	.102559E-01
V	D	.524451E-03	.113497E-02	+-	.746431E-04
CR		.985007E-03	.206227E-01	+-	.220913E-02
MN		.478012E-03	.673064E-02	+-	.786401E-03
FE		.447087E-03	.42393	+-	.213743E-01
CO	X	.306961E-03	.216605E-03	+-	.621608E-04
NI		.269409E-03	.172825E-01	+-	.969057E-03
CU		.27424E-03	.206908E-02	+-	.299136E-03
ZN		.290803E-03	.254489	+-	.127757E-01
SE	X	.32706E-03	-.546041E-02	+-	.259593E-02
BR	X	.298835E-02	-.210101E-02	+-	.105248E-03
SR	X	.452589E-02	-.126596E-02	+-	.634793E-04
MO	X	.008444	.217072E-03	+-	.008444
CD		.18105E-03	.859581E-03	+-	.146807E-03
SN	D	.134197E-02	.389515E-02	+-	.865346E-03
SB	X	.590305E-03	.660709E-04	+-	.336461E-04
BA		.491502E-03	.626497E-02	+-	.610431E-03
CE		.19637E-02	.183332E-01	+-	.244313E-02
PT		.77336E-03	.36752	+-	.184942E-01
PB		.829534E-03	.168971	+-	.85619E-02

TOTAL DETECTED BY XRF = 47.4321

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/28/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 5
SAMPLE ID: A221/0152-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.342318E-01	.511719E-02	+-	.342339E-01
MG		.280263E-02	3.07629	+-	.154877
AL		.424983E-01	25.7634	+-	1.28964
SI		.582147E-02	13.1466	+-	.658443
P		.484247E-03	1.67878	+-	.847795E-01
S		.262358E-02	.226814	+-	.118726E-01
CL	X	.13068E-02	-.62672E-03	+-	.396468E-04
K		.418632E-03	.311826E-01	+-	.163262E-02
CA		.188352E-03	.159619	+-	.812698E-02
TI		.193616E-03	.789237E-01	+-	.406136E-02
V	D	.642059E-03	.178844E-02	+-	.178727E-03
CR		.162387E-02	.601594E-02	+-	.102158E-02
MN		.769385E-03	.11584	+-	.637563E-02
FE		.873271E-03	.341605	+-	.173349E-01
CO	X	.416037E-03	-.675334E-04	+-	.429863E-04
NI		.363611E-03	.113681E-01	+-	.748995E-03
CU		.365551E-03	.139922E-01	+-	.851653E-03
ZN		.398741E-03	.402117	+-	.020179
SE	X	.434196E-03	-.518525E-02	+-	.346913E-02
BR	X	.472537E-02	-.422995E-02	+-	.211973E-03
SR	X	.717998E-02	-.816904E-02	+-	.409902E-03
MO	X	.128477E-01	.47915E-02	+-	.01285
CD	D	.216461E-03	.336554E-03	+-	.545681E-04
SN		.133437E-02	.72045E-02	+-	.125797E-02
SB	D	.577062E-03	.909125E-03	+-	.473072E-03
BA	D	.548213E-03	.151922E-02	+-	.40257E-03
CE		.241498E-02	3.88954	+-	.195541
PT		.103567E-02	.313118	+-	.158345E-01
PB		.112523E-02	.509901	+-	.256404E-01

TOTAL DETECTED BY XRF = 49.7769

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/28/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 6
SAMPLE ID: A221/0152-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.233088E-01	.801931E-01	+-	.240875E-01
MG		.187885E-02	4.33442	+-	.21763
AL		.286229E-01	22.8374	+-	1.1429
SI		.44943E-02	16.6189	+-	.831968
P		.408028E-03	.155338	+-	.854502E-02
S		.215317E-02	.269431	+-	.013874
CL	X	.106307E-02	-.129523E-02	+-	.847654E-04
K		.342391E-03	.401691E-01	+-	.205527E-02
CA		.192142E-03	.134115	+-	.684131E-02
TI		.168839E-03	.104937	+-	.535077E-02
V	X	.50517E-03	-.388491E-03	+-	.340962E-04
CR		.106979E-02	.819073E-02	+-	.153442E-02
MN		.498443E-03	.291612E-01	+-	.192015E-02
FE		.439187E-03	.371768	+-	.187636E-01
CO	X	.314588E-03	-.538632E-04	+-	.234803E-04
NI		.264385E-03	.372786E-02	+-	.352195E-03
CU		.261834E-03	.382313E-02	+-	.344621E-03
ZN		.259541E-03	.125486	+-	.632367E-02
SE	X	.266005E-03	-.190557E-03	+-	.628561E-02
BR	X	.274931E-02	-.650955E-03	+-	.32605E-04
SR	X	.415039E-02	-.277338E-02	+-	.139046E-03
MO	X	.770822E-02	-.269289E-02	+-	.134734E-03
CD		.176339E-03	.116582E-02	+-	.151988E-03
SN	X	.134571E-02	.447009E-03	+-	.248765E-03
SB	X	.581465E-03	.105918E-03	+-	.149767E-03
BA	D	.474902E-03	.904256E-03	+-	.249391E-03
CE		.190435E-02	.266635E-01	+-	.272416E-02
PT		.721136E-03	.496403E-02	+-	.539302E-03
PB		.726956E-03	.291126	+-	.146501E-01

TOTAL DETECTED BY XRF = 45.4419

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/28/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 1
SAMPLE ID: A221/0204-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.313375E-01	.136618	+-	.328153E-01
MG		.257874E-02	4.24317	+-	.213218
AL		.378088E-01	20.8667	+-	1.04475
SI		.516045E-02	15.0455	+-	.753299
P		.452743E-03	2.78486	+-	.140066
S		.248283E-02	.107488	+-	.610746E-02
CL	X	.122745E-02	.956558E-03	+-	.122887E-02
K		.392045E-03	.029177	+-	.152838E-02
CA		.205492E-03	.408763	+-	.205822E-01
TI		.199841E-03	.137105	+-	.696809E-02
V	X	.606623E-03	-.482809E-03	+-	.400302E-04
CR		.129411E-02	.447698E-02	+-	.845518E-03
MN		.62923E-03	.918935E-02	+-	.998878E-03
FE		.697464E-03	.376966	+-	.190613E-01
CO	X	.351218E-03	-.179541E-03	+-	.103091E-03
NI		.307566E-03	.859532E-02	+-	.586456E-03
CU		.3456E-03	.108648E-01	+-	.696433E-03
ZN		.447015E-03	1.16049	+-	.580935E-01
SE	X	.397396E-03	-.281319E-02	+-	.250361E-02
BR	X	.419652E-02	-.298596E-02	+-	.14964E-03
SR	X	.635706E-02	-.52329E-02	+-	.262558E-03
MO	X	.113504E-01	.229591E-02	+-	.011351
CD	D	.203762E-03	.226429E-03	+-	.469722E-04
SN	D	.145821E-02	.211452E-02	+-	.441888E-03
SB	X	.638875E-03	.19883E-03	+-	.298481E-03
BA		.565667E-03	.595263E-02	+-	.663092E-03
CE		.226273E-02	2.63474	+-	.132745
PT		.940828E-03	.200949	+-	.102089E-01
PB		.10384E-02	.353672	+-	.178278E-01

TOTAL DETECTED BY XRF = 48.5276

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/28/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 2
SAMPLE ID: A221/0204-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.234703E-01	.110924	+-	.248733E-01
MG		.18988E-02	4.71881	+-	.236864
AL		.028478	20.9308	+-	1.04759
SI		.439878E-02	17.5959	+-	.880793
P		.407134E-03	.371161	+-	.193571E-01
S		.215529E-02	.285053	+-	.146483E-01
CL	X	.106249E-02	-.166722E-02	+-	.110285E-03
K		.34147E-03	.313178E-01	+-	.161992E-02
CA		.187229E-03	.236181	+-	.119447E-01
TI		.172852E-03	.126759	+-	.644243E-02
V	X	.51092E-03	-.175542E-03	+-	.13944E-04
CR		.105647E-02	.71998E-02	+-	.145069E-02
MN		.482409E-03	.470966E-02	+-	.683358E-03
FE		.429179E-03	.376988	+-	.190206E-01
CO	X	.301151E-03	-.300629E-03	+-	.184815E-03
NI		.2529E-03	.431734E-02	+-	.365914E-03
CU		.265856E-03	.415525E-02	+-	.359789E-03
ZN		.293101E-03	.357015	+-	.178994E-01
SE	X	.272134E-03	-.293484E-03	+-	.186889E-02
BR	X	.277796E-02	-.886804E-03	+-	.44421E-04
SR	X	.418414E-02	-.226709E-02	+-	.113669E-03
MO	X	.76759E-02	-.149039E-02	+-	.745694E-04
CD		.176329E-03	.765035E-03	+-	.123536E-03
SN	X	.133393E-02	.113421E-02	+-	.35394E-03
SB	X	.000596	.71656E-04	+-	.137017E-03
BA		.483592E-03	.002314	+-	.3891E-03
CE		.190788E-02	.295341E-01	+-	.284395E-02
PT		.724833E-03	.197693E-01	+-	.119247E-02
PB		.743489E-03	.23779	+-	.119901E-01

TOTAL DETECTED BY XRF = 45.4515

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/28/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 3
SAMPLE ID: A221/0447-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.343293E-01	-.669095E-01	+-	.524721E-02
MG		.281911E-02	3.44077	+-	.173083
AL		.433122E-01	26.6022	+-	1.33159
SI		.005976	13.4311	+-	.672694
P		.493295E-03	.92839	+-	.472657E-01
S		.265165E-02	.376323	+-	.192516E-01
CL	X	.132877E-02	-.755075E-03	+-	.478481E-04
K		.426254E-03	.210339E-01	+-	.115181E-02
CA		.195251E-03	.105934	+-	.544467E-02
TI		.200247E-03	.861717E-01	+-	.442509E-02
V		.64557E-03	.243156E-02	+-	.225643E-03
CR		.162628E-02	.500153E-02	+-	.910327E-03
MN		.758444E-03	.181138E-01	+-	.154654E-02
FE		.867169E-03	.340497	+-	.172841E-01
CO	X	.421258E-03	-.138103E-03	+-	.100093E-03
NI		.374731E-03	.601982E-02	+-	.529459E-03
CU		.352016E-03	.516983E-02	+-	.468747E-03
ZN		.385263E-03	.195117	+-	.983031E-02
SE	X	.439454E-03	-.497212E-02	+-	.332071E-02
BR	X	.481088E-02	-.384646E-02	+-	.192738E-03
SR	X	.732698E-02	-.910863E-02	+-	.457019E-03
MO	X	.131012E-01	.620276E-02	+-	.131049E-01
CD	X	.220119E-03	-.457771E-03	+-	.863214E-04
SN	D	.139193E-02	.242178E-02	+-	.895312E-03
SB	X	.612972E-03	.519139E-03	+-	.466694E-03
BA	D	.572517E-03	.820727E-03	+-	.302202E-03
CE		.242256E-02	3.84643	+-	.193404
PT		.104952E-02	.321818	+-	.162706E-01
PB		.114028E-02	.72276	+-	.362773E-01

TOTAL DETECTED BY XRF = 50.4585

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/28/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 4
SAMPLE ID: A221/0447-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.241154E-01	.599393E-01	+-	.245447E-01
MG		.194746E-02	4.18881	+-	.210347
AL		.298916E-01	23.7904	+-	1.19057
SI		.465667E-02	16.0498	+-	.803527
P		.415796E-03	.919589E-01	+-	.535485E-02
S		.219448E-02	.28794	+-	.147956E-01
CL	X	.109062E-02	-.744668E-03	+-	.47944E-04
K		.351674E-03	.336043E-01	+-	.173436E-02
CA		.190139E-03	.969609E-01	+-	.498533E-02
TI		.17132E-03	.100948	+-	.515267E-02
V	X	.515949E-03	-.224386E-03	+-	.201185E-04
CR		.108811E-02	.775265E-02	+-	.152237E-02
MN		.511278E-03	.646101E-02	+-	.797015E-03
FE		.446544E-03	.384482	+-	.194022E-01
CO	X	.310032E-03	.163757E-03	+-	.535011E-04
NI		.271038E-03	.388565E-02	+-	.36307E-03
CU		.258468E-03	.141389E-02	+-	.268802E-03
ZN		.254996E-03	.667468E-01	+-	.339012E-02
SE	X	.277229E-03	-.452423E-03	+-	.108541E-01
BR	X	.293117E-02	-.103894E-02	+-	.520362E-04
SR	X	.445115E-02	-.435325E-02	+-	.218264E-03
MO	X	.823074E-02	-.21896E-02	+-	.109557E-03
CD	D	.180996E-03	.538631E-03	+-	.704059E-04
SN	X	.13506E-02	.986738E-04	+-	.847995E-04
SB	X	.600568E-03	-.233293E-03	+-	.116715E-01
BA		.480056E-03	.149517E-02	+-	.333952E-03
CE		.192817E-02	.291995E-01	+-	.00285
PT		.731749E-03	.879781E-02	+-	.727292E-03
PB		.77361E-03	.556157	+-	.278979E-01

TOTAL DETECTED BY XRF = 45.7673

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 3
SAMPLE ID: A230/0177X-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.330531E-01	-.280566E-01	+-	.219086E-02
MG		.267553E-02	2.64772	+-	.133453
AL		.411436E-01	28.3187	+-	1.41732
SI		.57486E-02	10.9917	+-	.550726
P		.463325E-03	.922453	+-	.469393E-01
S		.248748E-02	.330564	+-	.016954
CL	X	.123742E-02	.290373E-03	+-	.123756E-02
K		.39648E-03	.867397E-01	+-	.437458E-02
CA		.194501E-03	.178111	+-	.90464E-02
TI		.195013E-03	.210466	+-	.106339E-01
V	X	.601887E-03	.186304E-03	+-	.126566E-04
CR		.141401E-02	.515165E-02	+-	.907289E-03
MN		.752968E-03	.422678E-01	+-	.271347E-02
FE		.859435E-03	2.15787	+-	.108136
CO	X	.420712E-03	-.121381E-02	+-	.179992E-03
NI		.369737E-03	.108612E-01	+-	.733008E-03
CU		.36573E-03	.694119E-02	+-	.547017E-03
ZN		.392699E-03	.237423	+-	.119477E-01
SE	X	.422418E-03	-.463102E-02	+-	.320497E-02
BR	X	.445582E-02	-.258175E-02	+-	.129378E-03
SR	X	.675664E-02	-.301645E-02	+-	.151332E-03
MO	X	.120734E-01	.504203E-02	+-	.120761E-01
CD		.20536E-03	.491115E-02	+-	.399636E-03
SN	X	.138104E-02	.12862E-02	+-	.47099E-03
SB	X	.605367E-03	.196733E-03	+-	.143092E-03
BA		.545163E-03	.210485E-02	+-	.342969E-03
CE		.223655E-02	3.06511	+-	.154235
PT		.102963E-02	.283213	+-	.143465E-01
PB		.108583E-02	.363562	+-	.183299E-01

TOTAL DETECTED BY XRF = 49.8659

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 4
SAMPLE ID: A230/0177X-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.307949E-01	-.528962E-01	+-	.427004E-02
MG		.24893E-02	2.82186	+-	.142121
AL		.389354E-01	29.4716	+-	1.47488
SI		.564132E-02	11.3203	+-	.567172
P		.454426E-03	.584375E-01	+-	.366118E-02
S		.241209E-02	.383714	+-	.195802E-01
CL	X	.119381E-02	.14079E-03	+-	.119384E-02
K		.382909E-03	.892571E-01	+-	.449898E-02
CA		.192026E-03	.895951E-01	+-	.461844E-02
TI		.187618E-03	.233582	+-	.117873E-01
V	X	.606389E-03	.446585E-03	+-	.292744E-04
CR		.12385E-02	.463502E-02	+-	.817471E-03
MN		.775314E-03	.148389E-01	+-	.139004E-02
FE		.808482E-03	1.81516	+-	.909958E-01
CO	X	.411292E-03	-.926073E-03	+-	.150835E-03
NI		.362952E-03	.737249E-02	+-	.577094E-03
CU		.345315E-03	.213012E-02	+-	.36723E-03
ZN		.352016E-03	.494644E-01	+-	.256099E-02
SE	X	.393374E-03	-.418057E-02	+-	.248437E-02
BR	X	.407416E-02	-.278066E-02	+-	.139346E-03
SR	X	.61464E-02	-.164622E-02	+-	.8258E-04
MO	X	.110046E-01	.366996E-02	+-	.110062E-01
CD		.197849E-03	.750612E-03	+-	.191306E-03
SN	X	.138364E-02	-.504416E-03	+-	.744624E-03
SB	X	.624063E-03	-.687986E-03	+-	.344024E-04
BA		.535496E-03	.26198E-02	+-	.372588E-03
CE		.226367E-02	2.87521	+-	.144732
PT		.982379E-03	.302191	+-	.152843E-01
PB		.10079E-02	.363337E-01	+-	.208588E-02

TOTAL DETECTED BY XRF = 49.5791

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 11
SAMPLE ID: A230/0636X-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.317732E-01	-.375834E-01	+-	.296607E-02
MG		.257745E-02	3.14246	+-	.158158
AL		.395207E-01	27.0945	+-	1.35607
SI		.559085E-02	12.4795	+-	.625095
P		.460723E-03	.865923	+-	.441173E-01
S		.24676E-02	.208618	+-	.109429E-01
CL	X	.122669E-02	-.123554E-02	+-	.795283E-04
K		.39363E-03	.868248E-01	+-	.437908E-02
CA		.189966E-03	.136637	+-	.697292E-02
TI		.203455E-03	.248909	+-	.125563E-01
V	D	.611964E-03	.619965E-03	+-	.39977E-04
CR		.118678E-02	.672718E-02	+-	.105516E-02
MN		.753979E-03	.103646E-01	+-	.115783E-02
FE		.786654E-03	1.78485	+-	.894744E-01
CO	X	.399177E-03	-.100355E-02	+-	.166148E-03
NI		.364533E-03	.161319E-01	+-	.968443E-03
CU		.34841E-03	.88494E-02	+-	.612656E-03
ZN		.368992E-03	.217287	+-	.109363E-01
SE	X	.409766E-03	-.425758E-02	+-	.294348E-02
BR	X	.42828E-02	-.267492E-02	+-	.134038E-03
SR	X	.650353E-02	-.317157E-02	+-	.159098E-03
MO	X	.116337E-01	.504614E-02	+-	.116364E-01
CD	D	.203628E-03	.394845E-03	+-	.621985E-04
SN	D	.135273E-02	.305635E-02	+-	.880436E-03
SB	X	.597678E-03	.457449E-04	+-	.397969E-04
BA		.570526E-03	.186951E-02	+-	.306695E-03
CE		.228784E-02	2.52219	+-	.127093
PT		.999962E-03	.279404	+-	.014146
PB		.106661E-02	.477994	+-	.240385E-01

TOTAL DETECTED BY XRF = 49.5931

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 12
SAMPLE ID: A230/0636X-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.308893E-01	-.561784E-01	+-	.454204E-02
MG		.249508E-02	2.55721	+-	.128886
AL		.394345E-01	30.9501	+-	1.5488
SI		.573083E-02	10.2867	+-	.51551
P		.455141E-03	.832382E-01	+-	.492266E-02
S		.241819E-02	.373018	+-	.190497E-01
CL	X	.119802E-02	-.365869E-03	+-	.231387E-04
K		.384542E-03	.862335E-01	+-	.434851E-02
CA		.189836E-03	.803679E-01	+-	.415744E-02
TI		.189982E-03	.205439	+-	.103802E-01
V	D	.600538E-03	.113402E-02	+-	.762007E-04
CR		.120179E-02	.539825E-02	+-	.893241E-03
MN		.779867E-03	.295139E-02	+-	.850837E-03
FE		.817272E-03	2.04151	+-	.102313
CO	X	.398629E-03	-.123956E-02	+-	.189167E-03
NI		.362252E-03	.709691E-02	+-	.565539E-03
CU		.351204E-03	.324809E-02	+-	.403607E-03
ZN		.362069E-03	.761005E-01	+-	.388716E-02
SE	X	.404079E-03	-.570984E-02	+-	.33164E-02
BR	X	.41158E-02	-.27335E-02	+-	.136983E-03
SR	X	.62144E-02	-.887793E-03	+-	.445335E-04
MO	X	.110963E-01	.36341E-02	+-	.110978E-01
CD		.198607E-03	.811571E-03	+-	.181267E-03
SN	X	.13617E-02	.456276E-03	+-	.356235E-03
SB	X	.609377E-03	-.648001E-03	+-	.32403E-04
BA	D	.538305E-03	.129308E-02	+-	.251367E-03
CE		.231482E-02	2.78593	+-	.140261
PT		.992976E-03	.333155	+-	.168319E-01
PB		.10287E-02	.701232E-01	+-	.372144E-02

TOTAL DETECTED BY XRF = 49.9511

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 13
SAMPLE ID: A240/0016L-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.362154E-01	-.689548E-01	+-	.556122E-02
MG		.28866E-02	1.3603	+-	.691902E-01
AL		.451058E-01	33.8023	+-	1.69159
SI		.622234E-02	5.94593	+-	.29855
P		.467319E-03	.722296	+-	.369221E-01
S		.251365E-02	.663511	+-	.335217E-01
CL	X	.12686E-02	-.115579E-02	+-	.740219E-04
K		.406493E-03	.552397E-01	+-	.002811
CA		.234747E-03	.840002E-01	+-	.434453E-02
TI		.18819E-03	.181127	+-	.91667E-02
V	X	.515317E-03	-.351608E-02	+-	.262467E-03
CR		.744393E-03	.448132E-02	+-	.685653E-03
MN		.35311E-03	.283541E-02	+-	.449022E-03
FE		.404376E-03	.767218E-01	+-	.397432E-02
CO		.58498E-03	.011551	+-	.892306E-03
NI		.930034E-03	7.38831	+-	.369554
CU	X	.643088E-03	-.271831E-02	+-	.135928E-03
ZN		.43576E-03	.185426	+-	.937025E-02
SE	X	.48721E-03	-.387646E-02	+-	.340534E-02
BR	X	.502466E-02	-.279548E-02	+-	.140181E-03
SR	X	.767157E-02	-.73958E-02	+-	.371503E-03
MO	X	.013678	-.719008E-03	+-	.359926E-04
CD		.210281E-03	.142315E-02	+-	.143892E-03
SN		.167099E-02	.820513E-02	+-	.165113E-02
SB	D	.74031E-03	.962741E-03	+-	.52346E-03
BA		.527661E-03	.364214E-02	+-	.476912E-03
CE		.17808E-02	1.52972	+-	.773049E-01
PT		.119213E-02	.227038	+-	.116024E-01
PB		.126712E-02	.811373	+-	.407516E-01

TOTAL DETECTED BY XRF = 53.0664

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 14
SAMPLE ID: A240/0016L-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.276754E-01	.492795E-01	+-	.279205E-01
MG		.223904E-02	2.01405	+-	.101636
AL		.366457E-01	33.7003	+-	1.68618
SI		.554897E-02	8.56743	+-	.42954
P		.434553E-03	.25815	+-	.136888E-01
S		.232825E-02	.956494	+-	.481338E-01
CL	X	.117301E-02	-.179202E-02	+-	.117574E-03
K		.377621E-03	.531879E-01	+-	.270503E-02
CA		.185373E-03	.104368	+-	.535805E-02
TI		.184519E-03	.255945	+-	.129066E-01
V	X	.600415E-03	-.212042E-02	+-	.140364E-03
CR		.14116E-02	.100197E-01	+-	.155529E-02
MN		.642583E-03	.507577E-02	+-	.830153E-03
FE		.638204E-03	.237451	+-	.120898E-01
CO	X	.357874E-03	.215077E-03	+-	.107518E-03
NI		.337793E-03	.129461	+-	.657116E-02
CU		.325563E-03	.116354E-02	+-	.325029E-03
ZN		.319281E-03	.14208	+-	.716682E-02
SE	X	.351034E-03	-.283007E-02	+-	.28977E-02
BR	X	.371112E-02	-.184532E-02	+-	.924479E-04
SR	X	.562535E-02	-.238105E-02	+-	.119402E-03
MO	X	.101736E-01	.339594E-02	+-	.010175
CD		.194888E-03	.100077E-02	+-	.130819E-03
SN	D	.132325E-02	.179447E-02	+-	.735119E-03
SB	X	.588259E-03	-.642157E-04	+-	.112749E-03
BA		.521913E-03	.362232E-02	+-	.436612E-03
CE		.224195E-02	1.89594	+-	.958026E-01
PT		.899543E-03	.166944	+-	.851061E-02
PB		.922298E-03	.413475	+-	.207918E-01

TOTAL DETECTED BY XRF = 48.9672

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 7
SAMPLE ID: A240/0102-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.295556E-01	.127397	+-	.309949E-01
MG		.237422E-02	3.66031	+-	.184084
AL		.346801E-01	21.897	+-	1.09613
SI		.487884E-02	13.9577	+-	.698913
P		.425301E-03	2.33491	+-	.117551
S		.231885E-02	.151871	+-	.815079E-02
CL	X	.114307E-02	-.303185E-02	+-	.207707E-03
K		.365125E-03	.504433E-01	+-	.256691E-02
CA		.203732E-03	.183522	+-	.931305E-02
TI		.192719E-03	.331286	+-	.166713E-01
V	X	.51834E-03	-.369051E-02	+-	.223265E-03
CR		.810996E-03	.768741E-02	+-	.108569E-02
MN		.377024E-03	.948073E-02	+-	.796542E-03
FE		.404977E-03	.271503	+-	.137139E-01
CO		.436756E-03	.458127E-02	+-	.486038E-03
NI		.625512E-03	3.57151	+-	.178679
CU		.474548E-03	.20777E-02	+-	.474635E-03
ZN		.391267E-03	.494088	+-	.247772E-01
SE	X	.368442E-03	-.16505E-02	+-	.224266E-03
BR	X	.378162E-02	-.242999E-02	+-	.121817E-03
SR	X	.57162E-02	-.405502E-02	+-	.203547E-03
MO	X	.101895E-01	-.264427E-02	+-	.132338E-03
CD		.189174E-03	.144667E-02	+-	.183594E-03
SN		.14559E-02	.530822E-02	+-	.110731E-02
SB	X	.649955E-03	.642161E-03	+-	.412309E-03
BA		.538009E-03	.26785E-02	+-	.335229E-03
CE		.186253E-02	.854959	+-	.436052E-01
PT		.928524E-03	.11	+-	.569991E-02
PB		.973502E-03	.253303	+-	.128194E-01

TOTAL DETECTED BY XRF = 48.2831

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 8
SAMPLE ID: A240/0102-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.263934E-01	.100398	+-	.273892E-01
MG		.214483E-02	2.56082	+-	.128961
AL		.034839	32.5929	+-	1.63077
SI		.539142E-02	10.6664	+-	.534475
P		.437336E-03	.625723	+-	.321048E-01
S		.233416E-02	.289647	+-	.149076E-01
CL	X	.115521E-02	-.319075E-02	+-	.219648E-03
K		.371149E-03	.436372E-01	+-	.223163E-02
CA		.20955E-03	.221393	+-	.112099E-01
TI		.203181E-03	.292976	+-	.147591E-01
V	X	.601534E-03	.427191E-03	+-	.264945E-04
CR		.123644E-02	.011328	+-	.15841E-02
MN		.609022E-03	.102705E-01	+-	.105415E-02
FE		.630354E-03	.321769	+-	.162996E-01
CO	X	.346162E-03	.10961E-03	+-	.486073E-04
NI		.322974E-03	.382741E-01	+-	.20227E-02
CU		.318293E-03	.266728E-02	+-	.35572E-03
ZN		.346233E-03	.40156	+-	.201389E-01
SE	X	.337102E-03	-.219316E-02	+-	.234109E-02
BR	X	.354564E-02	-.177937E-02	+-	.891519E-04
SR	X	.534546E-02	-.83351E-03	+-	.417992E-04
MO	X	.956313E-02	.419264E-02	+-	.956543E-02
CD		.192003E-03	.126093E-02	+-	.18636E-03
SN	X	.147116E-02	.277731E-03	+-	.118632E-03
SB	X	.631586E-03	-.375296E-03	+-	.187665E-04
BA		.564206E-03	.18237E-02	+-	.279035E-03
CE		.227161E-02	1.76903	+-	.894561E-01
PT		.885117E-03	.144086	+-	.736734E-02
PB		.895071E-03	.159929	+-	.813751E-02

TOTAL DETECTED BY XRF = 50.2559

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 5
SAMPLE ID: A240/0141L-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.321022E-01	.268224E-01	+-	.321694E-01
MG		.254577E-02	1.78821	+-	.905276E-01
AL		.379818E-01	27.3967	+-	1.37115
SI		.546117E-02	12.2148	+-	.611874
P		.448339E-03	.432741	+-	.224527E-01
S		.238364E-02	.25601	+-	.132543E-01
CL	D	.117745E-02	.252399E-02	+-	.118728E-02
K		.376124E-03	.354044E-01	+-	.18276E-02
CA		.222543E-03	.775172E-01	+-	.401504E-02
TI		.180077E-03	.207022	+-	.010457
V	X	.488675E-03	-.360233E-02	+-	.249357E-03
CR		.734517E-03	.463918E-02	+-	.725075E-03
MN		.343777E-03	.285176E-01	+-	.16979E-02
FE		.394171E-03	.152458	+-	.775307E-02
CO		.53404E-03	.795798E-02	+-	.705911E-03
NI		.816153E-03	5.91828	+-	.296039
CU	X	.571703E-03	-.693513E-03	+-	.346788E-04
ZN		.391778E-03	.099077	+-	.504772E-02
SE	X	.416366E-03	-.258994E-02	+-	.237285E-02
BR	X	.420452E-02	-.239316E-02	+-	.119998E-03
SR	X	.635557E-02	-.384643E-02	+-	.193154E-03
MO	X	.113095E-01	-.788653E-03	+-	.394728E-04
CD		.194444E-03	.622726E-03	+-	.135626E-03
SN	D	.159426E-02	.347571E-02	+-	.124231E-02
SB	X	.71388E-03	.251746E-03	+-	.340507E-03
BA		.511634E-03	.336039E-02	+-	.432812E-03
CE		.173046E-02	1.32077	+-	.668435E-01
PT		.106923E-02	.179094	+-	.918488E-02
PB		.106564E-02	.149521	+-	.767716E-02

TOTAL DETECTED BY XRF = 50.2787

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 6
SAMPLE ID: A240/0141L-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.260451E-01	.759114E-01	+-	.266453E-01
MG		.21022E-02	1.81936	+-	.918728E-01
AL		.343796E-01	33.598	+-	1.681
SI		.541524E-02	10.6523	+-	.53378
P		.437359E-03	.177358	+-	.966355E-02
S		.23252E-02	.482734	+-	.244979E-01
CL	X	.115324E-02	-.289928E-02	+-	.197529E-03
K		.3712E-03	.559518E-01	+-	.284124E-02
CA		.193172E-03	.674386E-01	+-	.351217E-02
TI		.185616E-03	.246156	+-	.124166E-01
V	X	.581563E-03	-.213552E-03	+-	.138742E-04
CR		.143344E-02	.850255E-02	+-	.144862E-02
MN		.686424E-03	.359205E-01	+-	.236269E-02
FE		.680417E-03	.234238	+-	.119355E-01
CO	X	.368124E-03	.104904E-03	+-	.640791E-04
NI		.325745E-03	.314352E-01	+-	.168917E-02
CU		.317618E-03	.19609E-02	+-	.335988E-03
ZN		.312109E-03	.605036E-01	+-	.309493E-02
SE	X	.332107E-03	-.266461E-02	+-	.260951E-02
BR	X	.346249E-02	-.196817E-02	+-	.986066E-04
SR	X	.521174E-02	-.126345E-02	+-	.633566E-04
MO	X	.937958E-02	.323448E-02	+-	.938098E-02
CD		.191304E-03	.900293E-03	+-	.182891E-03
SN	X	.13695E-02	.175679E-03	+-	.191979E-03
SB	X	.600458E-03	-.153677E-03	+-	.34881E-03
BA		.535194E-03	.229539E-02	+-	.337624E-03
CE		.217309E-02	1.92321	+-	.971673E-01
PT		.871156E-03	.161484	+-	.823611E-02
PB		.866867E-03	.692918E-01	+-	.364123E-02

TOTAL DETECTED BY XRF = 49.705

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 15
SAMPLE ID: A240/0153-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.353802E-01	.168751E-02	+-	.353805E-01
MG		.28148E-02	1.92329	+-	.973483E-01
AL		.426562E-01	29.5794	+-	1.48043
SI		.580983E-02	7.23161	+-	.362755
P		.448861E-03	1.40016	+-	.708025E-01
S		.242905E-02	.443406	+-	.225439E-01
CL	X	.121586E-02	-.512604E-03	+-	.324553E-04
K		.388614E-03	.390121E-01	+-	.200697E-02
CA		.227766E-03	.836411E-01	+-	.432172E-02
TI		.186402E-03	.202195	+-	.102164E-01
V	X	.526523E-03	-.376447E-02	+-	.268275E-03
CR		.685544E-03	.004165	+-	.644315E-03
MN		.349945E-03	.418336E-01	+-	.235089E-02
FE		.394939E-03	.145077	+-	.738139E-02
CO		.563726E-03	.761373E-02	+-	.713407E-03
NI		.877454E-03	6.80499	+-	.340381
CU	X	.608827E-03	-.93549E-03	+-	.467787E-04
ZN		.425743E-03	.207731	+-	.104801E-01
SE	X	.45431E-03	-.338991E-02	+-	.323883E-02
BR	X	.469332E-02	-.260307E-02	+-	.130527E-03
SR	X	.71451E-02	-.690437E-02	+-	.346808E-03
MO	X	.127253E-01	-.153068E-02	+-	.766199E-04
CD		.201112E-03	.78754E-03	+-	.975332E-04
SN		.162707E-02	.668458E-02	+-	.152182E-02
SB	X	.724898E-03	.407202E-03	+-	.41539E-03
BA		.519356E-03	.43453E-02	+-	.506162E-03
CE		.180678E-02	1.41369	+-	.714811E-01
PT		.113553E-02	.193217	+-	.990305E-02
PB		.117586E-02	.591177	+-	.297348E-01

TOTAL DETECTED BY XRF = 50.324

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 16
SAMPLE ID: A240/0153-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.281179E-01	.029008	+-	.028206
MG		.226071E-02	1.82415	+-	.921849E-01
AL		.366219E-01	33.3188	+-	1.66713
SI		.549771E-02	7.34599	+-	.368472
P		.424192E-03	.279123	+-	.147259E-01
S		.22651E-02	.632321	+-	.319398E-01
CL	X	.112997E-02	-.232149E-02	+-	.155141E-03
K		.36309E-03	.455235E-01	+-	.232301E-02
CA		.192382E-03	.998751E-01	+-	.512866E-02
TI		.186045E-03	.208615	+-	.105357E-01
V	X	.583498E-03	.491407E-03	+-	.329411E-04
CR		.120281E-02	.107789E-01	+-	.146888E-02
MN		.575774E-03	.415284E-01	+-	.255348E-02
FE		.623857E-03	.295316	+-	.149633E-01
CO	D	.374993E-03	.755349E-03	+-	.2122E-03
NI		.40015E-03	.677452	+-	.339674E-01
CU		.347078E-03	.278653E-02	+-	.381688E-03
ZN		.32973E-03	.1496	+-	.754473E-02
SE	X	.343015E-03	-.25393E-02	+-	.235879E-02
BR	X	.361029E-02	-.200802E-02	+-	.100609E-03
SR	X	.545147E-02	-.290249E-02	+-	.145581E-03
MO	X	.984156E-02	.247733E-02	+-	.984234E-02
CD		.187424E-03	.850813E-03	+-	.147691E-03
SN	X	.135729E-02	.496449E-03	+-	.335526E-03
SB	X	.588316E-03	-.205084E-03	+-	.908997E-03
BA		.522387E-03	.425421E-02	+-	.498329E-03
CE		.214239E-02	1.94808	+-	.983474E-01
PT		.891454E-03	.169264	+-	.862865E-02
PB		.894409E-03	.174826	+-	.887961E-02

TOTAL DETECTED BY XRF = 47.2589

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 17
SAMPLE ID: A240/0334L-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.034432	-.214672E-01	+-	.17097E-02
MG		.272758E-02	1.6022	+-	.812875E-01
AL		.423176E-01	33.0481	+-	1.65382
SI		.596025E-02	6.30453	+-	.316468
P		.44923E-03	.334413	+-	.017514
S		.240023E-02	.61414	+-	.310489E-01
CL	X	.119703E-02	-.216108E-02	+-	.14274E-03
K		.382507E-03	.396065E-01	+-	.203526E-02
CA		.216205E-03	.529636E-01	+-	.278781E-02
TI		.182238E-03	.195933	+-	.99022E-02
V	X	.497359E-03	-.373511E-02	+-	.265514E-03
CR		.703889E-03	.387345E-02	+-	.610774E-03
MN		.304914E-03	.379082E-02	+-	.453814E-03
FE		.379182E-03	.976253E-01	+-	.500527E-02
CO		.590167E-03	.128262E-01	+-	.945873E-03
NI		.949343E-03	7.88637	+-	.394458
CU	X	.640299E-03	-.404784E-02	+-	.20241E-03
ZN		.413524E-03	.460237E-01	+-	.242173E-02
SE	X	.451979E-03	-.34255E-02	+-	.265262E-02
BR	X	.459275E-02	-.225691E-02	+-	.113188E-03
SR	X	.695543E-02	-.250404E-02	+-	.125768E-03
MO	X	.123379E-01	-.720525E-03	+-	.360665E-04
CD	X	.197779E-03	.122268E-03	+-	.418807E-04
SN		.155472E-02	.788498E-02	+-	.161277E-02
SB	X	.700916E-03	.268028E-03	+-	.326948E-03
BA		.502904E-03	.474117E-02	+-	.525487E-03
CE		.172433E-02	1.44107	+-	.728237E-01
PT		.117264E-02	.223233	+-	.114142E-01
PB		.115726E-02	.191418	+-	.978525E-02

TOTAL DETECTED BY XRF = 52.1107

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 18
SAMPLE ID: A240/0334L-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.263131E-01	-.825434E-02	+-	.654374E-03
MG		.212161E-02	2.29566	+-	.115707
AL		.346768E-01	33.1308	+-	1.65766
SI		.539085E-02	9.66139	+-	.484234
P		.429227E-03	.550477E-01	+-	.347531E-02
S		.22774E-02	.458267	+-	.02327
CL	X	.112878E-02	-.283206E-02	+-	.192902E-03
K		.362969E-03	.446449E-01	+-	.00228
CA		.180582E-03	.743951E-01	+-	.385623E-02
TI		.186241E-03	.266895	+-	.134513E-01
V		.593548E-03	.258892E-02	+-	.160188E-03
CR		.141382E-02	.825193E-02	+-	.140599E-02
MN		.630193E-03	.44555E-02	+-	.794723E-03
FE		.658007E-03	.236667	+-	.120501E-01
CO	X	.360876E-03	.227967E-03	+-	.113122E-03
NI		.331595E-03	.134837	+-	.683947E-02
CU		.313553E-03	.99705E-03	+-	.310905E-03
ZN		.301205E-03	.227661E-01	+-	.122574E-02
SE	X	.324797E-03	-.210254E-02	+-	.199684E-02
BR	X	.34081E-02	-.167859E-02	+-	.840958E-04
SR	X	.512942E-02	-.936847E-04	+-	.554669E-02
MO	X	.92887E-02	.231052E-02	+-	.928942E-02
CD	D	.187172E-03	.236506E-03	+-	.125463E-03
SN	X	.128865E-02	.962065E-03	+-	.595456E-03
SB	X	.571742E-03	-.101922E-03	+-	.250233E-03
BA		.514976E-03	.348308E-02	+-	.417038E-03
CE		.220441E-02	1.89333	+-	.956508E-01
PT		.862548E-03	.156888	+-	.800568E-02
PB		.84929E-03	.497504E-01	+-	.268469E-02

TOTAL DETECTED BY XRF = 48.5014

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 11
SAMPLE ID: A249/0169-1

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.295027E-01	-.351393E-02	+-	.272888E-03
MG		.240209E-02	4.04499	+-	.203244
AL		.362187E-01	22.9335	+-	1.14796
SI		.521227E-02	15.6484	+-	.783483
P		.451775E-03	.497384	+-	.025688
S		.240979E-02	.134015	+-	.732388E-02
CL	X	.001192	-.193387E-02	+-	.127135E-03
K		.383338E-03	.252099E-01	+-	.133457E-02
CA		.195241E-03	.100061	+-	.514348E-02
TI		.184247E-03	.873391E-01	+-	.447592E-02
V	X	.645006E-03	-.453955E-03	+-	.505386E-04
CR		.958299E-03	.830559E-02	+-	.101557E-02
MN		.637111E-03	.202331E-01	+-	.155698E-02
FE		.678945E-03	.414605	+-	.209434E-01
CO	X	.371758E-03	-.180249E-03	+-	.972512E-04
NI		.319658E-03	.397073E-01	+-	.209543E-02
CU		.308662E-03	.379951E-02	+-	.382932E-03
ZN		.319298E-03	.901104E-01	+-	.457161E-02
SE	X	.393471E-03	-.774774E-02	+-	.331554E-02
BR	X	.384912E-02	-.385107E-02	+-	.192946E-03
SR	X	.583657E-02	-.395722E-02	+-	.198474E-03
MO	X	.104596E-01	.137097E-02	+-	.104598E-01
CD	D	.197572E-03	.267866E-03	+-	.57085E-04
SN	D	.137874E-02	.281116E-02	+-	.960375E-03
SB	X	.600188E-03	.52146E-03	+-	.438432E-03
BA	D	.513169E-03	.121376E-02	+-	.333798E-03
CE		.215126E-02	1.915	+-	.967416E-01
PT		.905307E-03	.49882	+-	.250818E-01
PB		.977343E-03	.309794	+-	.156125E-01

TOTAL DETECTED BY XRF = 46.7756

RUN DESCRIPTION: SWRIC2 - CATALYST SAMPLES
DATE OF XRAY ANALYSIS: 08/08/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 12
SAMPLE ID: A249/0169-2

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.028995	.771213E-02	+-	.290011E-01
MG		.23635E-02	4.50135	+-	.22606
AL		.351021E-01	20.4243	+-	1.02251
SI		.502565E-02	17.0835	+-	.855206
P		.446751E-03	.532467	+-	.274399E-01
S		.237682E-02	.386487E-01	+-	.314718E-02
CL	X	.116954E-02	-.261152E-02	+-	.175548E-03
K		.37515E-03	.237312E-01	+-	.126129E-02
CA		.184894E-03	.109178	+-	.559644E-02
TI		.183878E-03	.101671	+-	.519055E-02
V	X	.640398E-03	-.525505E-03	+-	.527796E-04
CR		.984647E-03	.634431E-02	+-	.85141E-03
MN		.678091E-03	.211333E-01	+-	.162419E-02
FE		.719058E-03	.450807	+-	.022758
CO	X	.375652E-03	-.1691E-03	+-	.822149E-04
NI		.328408E-03	.869044E-02	+-	.604043E-03
CU		.306024E-03	.348433E-02	+-	.371283E-03
ZN		.319452E-03	.606177E-01	+-	.31021E-02
SE	X	.368757E-03	-.490685E-02	+-	.250234E-02
BR	X	.373513E-02	-.360052E-02	+-	.180403E-03
SR	X	.564527E-02	-.357583E-02	+-	.179349E-03
MO	X	.100916E-01	.178798E-02	+-	.010092
CD	X	.193514E-03	-.67801E-04	+-	.3795E-04
SN	D	.131456E-02	.367754E-02	+-	.100991E-02
SB	X	.578813E-03	.320882E-03	+-	.367122E-03
BA	D	.516758E-03	.106004E-02	+-	.295507E-03
CE		.224788E-02	2.23824	+-	.112895
PT		.884613E-03	.361121	+-	.182011E-01
PB		.924467E-03	.167827	+-	.852783E-02

TOTAL DETECTED BY XRF = 46.1378

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 11
SAMPLE ID: A249/0169-3-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.330387E-01	.322003E-01	+-	.331248E-01
MG		.271105E-02	4.33353	+-	.217711
AL		.406151E-01	22.6114	+-	1.13204
SI		.564214E-02	16.2868	+-	.815424
P		.481574E-03	.100395	+-	.580776E-02
S		.256959E-02	.645602	+-	.326398E-01
CL	D	.129081E-02	.331542E-02	+-	.130592E-02
K		.414526E-03	.337199E-01	+-	.175435E-02
CA		.202456E-03	.152923	+-	.779258E-02
TI		.192862E-03	.111988	+-	.57139E-02
V	X	.64769E-03	-.637653E-04	+-	.642096E-05
CR		.15544E-02	.161788E-01	+-	.195245E-02
MN		.740886E-03	.162607E-01	+-	.143553E-02
FE		.800853E-03	.648428	+-	.326596E-01
CO	X	.417754E-03	-.141915E-03	+-	.497765E-04
NI		.359148E-03	.108295E-01	+-	.720497E-03
CU		.339115E-03	.252887E-02	+-	.371276E-03
ZN		.355278E-03	.101584	+-	.51537E-02
SE	X	.436412E-03	-.732843E-02	+-	.353995E-02
BR	X	.455339E-02	-.447346E-02	+-	.224142E-03
SR	X	.693714E-02	-.797286E-02	+-	.400003E-03
MO	X	.124114E-01	.462981E-02	+-	.124135E-01
CD		.214168E-03	.11428E-02	+-	.128511E-03
SN	D	.145166E-02	.177603E-02	+-	.670233E-03
SB	X	.648996E-03	.312403E-03	+-	.354125E-03
BA		.539347E-03	.165955E-02	+-	.372982E-03
CE		.243727E-02	2.91948	+-	.147026
PT		.994991E-03	.467812	+-	.235537E-01
PB		.110886E-02	.684894	+-	.343762E-01

TOTAL DETECTED BY XRF = 49.1522

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/29/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 12
SAMPLE ID: A249/0169-3-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.228005E-01	.863316E-01	+-	.237237E-01
MG		.183041E-02	4.3429	+-	.218055
AL		.278311E-01	22.6219	+-	1.1321
SI		.440759E-02	16.7266	+-	.837347
P		.4022E-03	.359697E-01	+-	.248372E-02
S		.211901E-02	.344979	+-	.176161E-01
CL	X	.104312E-02	-.823902E-03	+-	.53338E-04
K		.335592E-03	.034649	+-	.178172E-02
CA		.184599E-03	.942342E-01	+-	.484554E-02
TI		.167774E-03	.134567	+-	.68307E-02
V	X	.50953E-03	-.749311E-03	+-	.590074E-04
CR		.111942E-02	.278851E-01	+-	.265036E-02
MN		.526082E-03	.783411E-02	+-	.872343E-03
FE		.449896E-03	.596227	+-	.299881E-01
CO	D	.306451E-03	.310905E-03	+-	.655388E-04
NI		.268765E-03	.101378E-01	+-	.630293E-03
CU		.261066E-03	.876237E-03	+-	.259685E-03
ZN		.249784E-03	.025581	+-	.001344
SE	X	.254708E-03	-.116434E-03	+-	.208467E-01
BR	X	.261895E-02	.413604E-04	+-	.528663E-03
SR	X	.392941E-02	-.192944E-02	+-	.967333E-04
MO	X	.72575E-02	-.38451E-02	+-	.192379E-03
CD		.172728E-03	.182363E-02	+-	.223267E-03
SN	X	.132796E-02	-.213553E-03	+-	.230913E-03
SB	X	.603948E-03	-.291573E-03	+-	.1458E-04
BA	D	.469246E-03	.105672E-02	+-	.242463E-03
CE		.191763E-02	.267609E-01	+-	.272908E-02
PT	D	.712851E-03	.159292E-02	+-	.487041E-03
PB		.701276E-03	.100521	+-	.514407E-02

TOTAL DETECTED BY XRF = 45.2227

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/28/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 7
SAMPLE ID: A280/0001L-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.311697E-01	.873034E-01	+-	.318131E-01
MG		.255583E-02	4.04322	+-	.203201
AL		.382322E-01	23.0373	+-	1.15324
SI		.534597E-02	15.0164	+-	.751889
P		.461084E-03	1.55197	+-	.784328E-01
S		.248845E-02	.147053	+-	.797379E-02
CL	X	.123031E-02	-.950421E-03	+-	.608314E-04
K		.393712E-03	.309707E-01	+-	.161594E-02
CA		.203062E-03	.249857	+-	.126359E-01
TI		.186348E-03	.101445	+-	.518399E-02
V	X	.615699E-03	-.149876E-03	+-	.145097E-04
CR	D	.155792E-02	.424009E-02	+-	.879865E-03
MN		.685269E-03	.135687	+-	.731218E-02
FE		.742143E-03	.353271	+-	.178905E-01
CO	X	.37719E-03	-.320548E-03	+-	.285826E-03
NI		.328785E-03	.82383E-02	+-	.586415E-03
CU		.345461E-03	.352325E-01	+-	.186631E-02
ZN		.396866E-03	.607458	+-	.304406E-01
SE	X	.389661E-03	-.316382E-02	+-	.246059E-02
BR	X	.416052E-02	-.293173E-02	+-	.146914E-03
SR	X	.629594E-02	-.567859E-02	+-	.284905E-03
MO	X	.112624E-01	.272031E-02	+-	.112632E-01
CD	X	.203875E-03	-.120637E-03	+-	.449921E-04
SN	D	.144297E-02	.280469E-02	+-	.698302E-03
SB	X	.633443E-03	.783653E-04	+-	.156904E-03
BA		.536316E-03	.194181E-02	+-	.410066E-03
CE		.227578E-02	2.90836	+-	.146436
PT		.956749E-03	.228477	+-	.115908E-01
PB		.101697E-02	.276343	+-	.139622E-01

TOTAL DETECTED BY XRF = 48.8276

RUN DESCRIPTION: SWRIC3 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 08/28/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 8
SAMPLE ID: A280/0001L-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.232169E-01	.782829E-01	+-	.239668E-01
MG		.187225E-02	4.43574	+-	.222699
AL		.284998E-01	22.7034	+-	1.1362
SI		.447396E-02	16.6729	+-	.834665
P		.406919E-03	.180121	+-	.978924E-02
S		.214807E-02	.274909	+-	.141448E-01
CL	X	.105886E-02	-.16621E-03	+-	.105825E-04
K		.340814E-03	.384302E-01	+-	.196931E-02
CA		.182469E-03	.141827	+-	.72263E-02
TI		.164322E-03	.121674	+-	.618729E-02
V	X	.505576E-03	.399554E-03	+-	.314748E-04
CR		.120464E-02	.635058E-02	+-	.150162E-02
MN		.513004E-03	.425703E-01	+-	.258913E-02
FE		.441499E-03	.418348	+-	.210917E-01
CO	X	.303416E-03	-.2893E-03	+-	.150098E-03
NI		.267198E-03	.263013E-02	+-	.316052E-03
CU		.261768E-03	.102692E-01	+-	.618372E-03
ZN		.2717E-03	.182703	+-	.91842E-02
SE	X	.267579E-03	-.544694E-03	+-	.772955E-02
BR	X	.273123E-02	-.397176E-03	+-	.19894E-04
SR	X	.41129E-02	-.241859E-02	+-	.121262E-03
MO	X	.759352E-02	-.218742E-02	+-	.109443E-03
CD		.175587E-03	.781184E-03	+-	.12823E-03
SN	D	.130007E-02	.131279E-02	+-	.522025E-03
SB	X	.581124E-03	.270785E-03	+-	.27972E-03
BA		.463292E-03	.168066E-02	+-	.32547E-03
CE		.188218E-02	.440806E-01	+-	.346222E-02
PT		.715139E-03	.124412E-01	+-	.88215E-03
PB		.726696E-03	.216292	+-	.109143E-01

TOTAL DETECTED BY XRF = 45.5867

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 13
SAMPLE ID: A155/0941-1-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.310284E-01	.197575E-01	+-	.310646E-01
MG		.253848E-02	4.15712	+-	.208883
AL		.379864E-01	22.4747	+-	1.12511
SI		.534703E-02	15.8872	+-	.795429
P		.464483E-03	1.14207	+-	.579421E-01
S		.249158E-02	.639782E-01	+-	.419161E-02
CL	X	.122988E-02	-.101903E-02	+-	.653148E-04
K		.393886E-03	.244972E-01	+-	.130395E-02
CA		.188926E-03	.203541	+-	.103194E-01
TI		.190095E-03	.842137E-01	+-	.43224E-02
V	X	.632204E-03	.408775E-03	+-	.431052E-04
CR	X	.191758E-02	.832046E-03	+-	.28336E-03
MN		.805713E-03	.584477E-01	+-	.35067E-02
FE		.823816E-03	.270028	+-	.137419E-01
CO	X	.392352E-03	.149086E-03	+-	.811901E-04
NI		.338454E-03	.106806E-01	+-	.700762E-03
CU		.332144E-03	.377453E-02	+-	.402951E-03
ZN		.364919E-03	.281697	+-	.141519E-01
SE	X	.385573E-03	-.426737E-02	+-	.275112E-02
BR	X	.41214E-02	-.375325E-02	+-	.188072E-03
SR	X	.623674E-02	-.33244E-02	+-	.16674E-03
MO	X	.011154	.124377E-02	+-	.111541E-01
CD	X	.203689E-03	.150997E-04	+-	.489224E-05
SN	D	.134096E-02	.15871E-02	+-	.503028E-03
SB	D	.58704E-03	.805373E-03	+-	.485156E-03
BA		.541765E-03	.433007E-02	+-	.592411E-03
CE		.238823E-02	2.99629	+-	.150844
PT		.940552E-03	.284814	+-	.144023E-01
PB		.100358E-02	.259524	+-	.013117

TOTAL DETECTED BY XRF = 48.2093

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 14
SAMPLE ID: A155/0941-1-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.235675E-01	.595647E-01	+-	.240058E-01
MG		.190422E-02	4.495	+-	.225658
AL		.289634E-01	22.4703	+-	1.12455
SI		.453082E-02	17.1829	+-	.860166
P		.413704E-03	.121318	+-	.684041E-02
S		.218317E-02	.110812	+-	.614853E-02
CL	X	.107335E-02	-.248626E-02	+-	.16869E-03
K		.345856E-03	.249214E-01	+-	.131017E-02
CA		.186132E-03	.178747	+-	.907356E-02
TI		.160637E-03	.883718E-01	+-	.452313E-02
V	X	.508881E-03	.488001E-03	+-	.44637E-04
CR		.103196E-02	.679712E-02	+-	.142806E-02
MN		.478137E-03	.191676E-01	+-	.141062E-02
FE		.43854E-03	.299023	+-	.015126
CO	X	.30318E-03	-.668162E-04	+-	.36059E-04
NI		.263158E-03	.388698E-02	+-	.356734E-03
CU		.262145E-03	.208171E-02	+-	.288792E-03
ZN		.272132E-03	.162294	+-	.816395E-02
SE	X	.295125E-03	-.315175E-02	+-	.232088E-02
BR	X	.283243E-02	-.22324E-02	+-	.111825E-03
SR	X	.427022E-02	-.292834E-02	+-	.146829E-03
MO	X	.773846E-02	-.210705E-02	+-	.105423E-03
CD	X	.178204E-03	-.407349E-04	+-	.15546E-04
SN	X	.131963E-02	-.392721E-03	+-	.233522E-03
SB	X	.584284E-03	.116584E-03	+-	.219905E-03
BA	D	.457216E-03	.116963E-02	+-	.298298E-03
CE		.193901E-02	.117412E-01	+-	.218159E-02
PT		.725046E-03	.207243	+-	.104811E-01
PB		.767655E-03	.212137	+-	.107073E-01

TOTAL DETECTED BY XRF = 45.6575

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 15
SAMPLE ID: A155/0941-2-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.249309E-01	.094168	+-	.259014E-01
MG		.201945E-02	4.88762	+-	.245326
AL		.297402E-01	19.1372	+-	.95798
SI		.443211E-02	18.0161	+-	.901781
P		.409595E-03	.260311	+-	.137948E-01
S		.218031E-02	.784225	+-	.395201E-01
CL	X	.108903E-02	-.296921E-02	+-	.204615E-02
K		.349814E-03	.421656E-01	+-	.215497E-02
CA		.195802E-03	.412897	+-	.207831E-01
TI		.175164E-03	.121765	+-	.619503E-02
V	X	.522328E-03	-.81681E-03	+-	.686537E-04
CR		.100762E-02	.167104E-01	+-	.196736E-02
MN		.523906E-03	.288019E-01	+-	.18946E-02
FE		.443553E-03	.594816	+-	.299153E-01
CO	X	.301958E-03	.568971E-04	+-	.138823E-04
NI		.266831E-03	.550166E-02	+-	.42316E-03
CU		.271134E-03	.470417E-02	+-	.384854E-03
ZN		.307199E-03	.392356	+-	.196686E-01
SE	X	.309919E-03	-.221206E-02	+-	.225755E-02
BR	X	.304675E-02	-.197387E-02	+-	.988819E-04
SR	X	.461188E-02	-.357407E-02	+-	.179232E-03
MO	X	.832575E-02	-.172027E-02	+-	.860762E-04
CD		.181388E-03	.160563E-02	+-	.176599E-03
SN	X	.138941E-02	.501939E-03	+-	.119746E-03
SB	X	.616456E-03	.613118E-03	+-	.409805E-03
BA	D	.493098E-03	.999492E-03	+-	.255343E-03
CE		.196271E-02	.247228E-01	+-	.268629E-02
PT		.756673E-03	.149785	+-	.762026E-02
PB		.819678E-03	.413384	+-	.207692E-01

TOTAL DETECTED BY XRF = 45.3898

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 16
SAMPLE ID: A155/0941-2-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA		.232025E-01	.115563	+-	.247338E-01
MG		.187147E-02	4.73861	+-	.237847
AL		.281533E-01	21.0017	+-	1.05112
SI		.438144E-02	17.6636	+-	.884184
P		.405537E-03	.873331E-01	+-	.51176E-02
S		.21434E-02	.388311	+-	.197743E-01
CL	X	.105556E-02	-.324857E-02	+-	.227768E-03
K		.339572E-03	.223923E-01	+-	.118651E-02
CA		.17917E-03	.169974	+-	.863336E-02
TI		.167535E-03	.116169	+-	.591193E-02
V	X	.5016E-03	.152974E-03	+-	.123934E-04
CR		.115895E-02	.102284E-01	+-	.170813E-02
MN		.481178E-03	.147858E-01	+-	.119517E-02
FE		.432343E-03	.413595	+-	.208539E-01
CO	X	.305179E-03	.932854E-04	+-	.303352E-04
NI		.263696E-03	.108923E-01	+-	.66159E-03
CU		.255252E-03	.183082E-02	+-	.276501E-03
ZN		.262102E-03	.117506	+-	.592557E-02
SE	X	.279047E-03	-.213558E-02	+-	.171789E-02
BR	X	.002712	-.197499E-02	+-	.989326E-04
SR	X	.407307E-02	-.310018E-02	+-	.155453E-03
MO	X	.742237E-02	-.402258E-02	+-	.201262E-03
CD	X	.174999E-03	-.168935E-04	+-	.176173E-04
SN	X	.127178E-02	-.425244E-03	+-	.2626E-03
SB	D	.563812E-03	.621262E-03	+-	.445355E-03
BA		.466401E-03	.150096E-02	+-	.312713E-03
CE		.188146E-02	.110935E-01	+-	.211084E-02
PT		.714626E-03	.167971	+-	.852123E-02
PB		.727218E-03	.747622E-01	+-	.386773E-02

TOTAL DETECTED BY XRF = 45.1284

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 17
SAMPLE ID: A207/0101-A

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.311566E-01	.197831E-01	+-	.311925E-01
MG		.254683E-02	3.86735	+-	.194385
AL		.038499	23.8203	+-	1.19237
SI		.544441E-02	15.0122	+-	.751694
P		.465687E-03	.882493	+-	.449579E-01
S		.249425E-02	.098989	+-	.571886E-02
CL	X	.123694E-02	-.13103E-02	+-	.844929E-04
K		.397287E-03	.284127E-01	+-	.14928E-02
CA		.188309E-03	.10265	+-	.527517E-02
TI		.195544E-03	.825962E-01	+-	.424156E-02
V	X	.614515E-03	.204334E-03	+-	.218167E-04
CR		.146406E-02	.696112E-02	+-	.121246E-02
MN		.752134E-03	.181423	+-	.961253E-02
FE		.742245E-03	.302197	+-	.153388E-01
CO	X	.384384E-03	.985153E-04	+-	.514932E-04
NI		.330231E-03	.137881E-01	+-	.838628E-03
CU		.328522E-03	.854324E-02	+-	.584253E-03
ZN		.355817E-03	.255256	+-	.128283E-01
SE	X	.405307E-03	-.625282E-02	+-	.334374E-02
BR	X	.417183E-02	-.373264E-02	+-	.187024E-03
SR	X	.633506E-02	-.444499E-02	+-	.222954E-03
MO	X	.113367E-01	.168971E-02	+-	.113371E-01
CD	D	.20493E-03	.371405E-03	+-	.615591E-04
SN	X	.133887E-02	.977171E-03	+-	.531728E-03
SB		.589518E-03	.005895	+-	.788077E-03
BA		.54978E-03	.19975E-02	+-	.443945E-03
CE		.230352E-02	2.57871	+-	.129954
PT		.943466E-03	.38867	+-	.195876E-01
PB		.103503E-02	.449044	+-	.225807E-01

TOTAL DETECTED BY XRF = 48.0878

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 18
SAMPLE ID: A207/0101-B

ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	X	.293243E-01	.689369E-03	+-	.293244E-01
MG		.239007E-02	4.19678	+-	.210842
AL		.362737E-01	23.5609	+-	1.17934
SI		.526084E-02	15.7774	+-	.789956
P		.454443E-03	.157427	+-	.86742E-02
S		.240585E-02	.478499E-01	+-	.351281E-02
CL	X	.118198E-02	-.266881E-02	+-	.179561E-03
K		.379201E-03	.263893E-01	+-	.139023E-02
CA		.178547E-03	.105078	+-	.539262E-02
TI		.186187E-03	.985592E-01	+-	.503614E-02
V	X	.613008E-03	.419416E-03	+-	.396125E-04
CR	D	.153089E-02	.411252E-02	+-	.907572E-03
MN		.715564E-03	.781476E-01	+-	.446852E-02
FE		.760147E-03	.30088	+-	.152735E-01
CO	X	.385498E-03	.36771E-03	+-	.143062E-03
NI		.338233E-03	.946202E-02	+-	.644639E-03
CU		.320825E-03	.447174E-02	+-	.416692E-03
ZN		.322599E-03	.590753E-01	+-	.302745E-02
SE	X	.368891E-03	-.566578E-02	+-	.289066E-03
BR	X	.378706E-02	-.372054E-02	+-	.186421E-03
SR	X	.571084E-02	-.34326E-02	+-	.172167E-03
MO	X	.102225E-01	-.123661E-03	+-	.618785E-05
CD	X	.195565E-03	-.989703E-04	+-	.109357E-04
SN	D	.127361E-02	.174561E-02	+-	.706255E-03
SB		.563777E-03	.345745E-02	+-	.648965E-03
BA		.530889E-03	.229651E-02	+-	.439257E-03
CE		.231784E-02	2.56757	+-	.129379
PT		.894959E-03	.360992	+-	.181983E-01
PB		.927784E-03	.03106	+-	.178813E-02

TOTAL DETECTED BY XRF = 47.3937

RUN DESCRIPTION: SWRIC4 AUTO CATALYSTS
DATE OF XRAY ANALYSIS: 09/11/86
SAMPLE TYPE: BRIQUETTE
SITE ID: N/A
MISCELLANEOUS INFO: NONE
SAMPLE SEQUENCE NO.: 19
SAMPLE ID: A207/0101-C

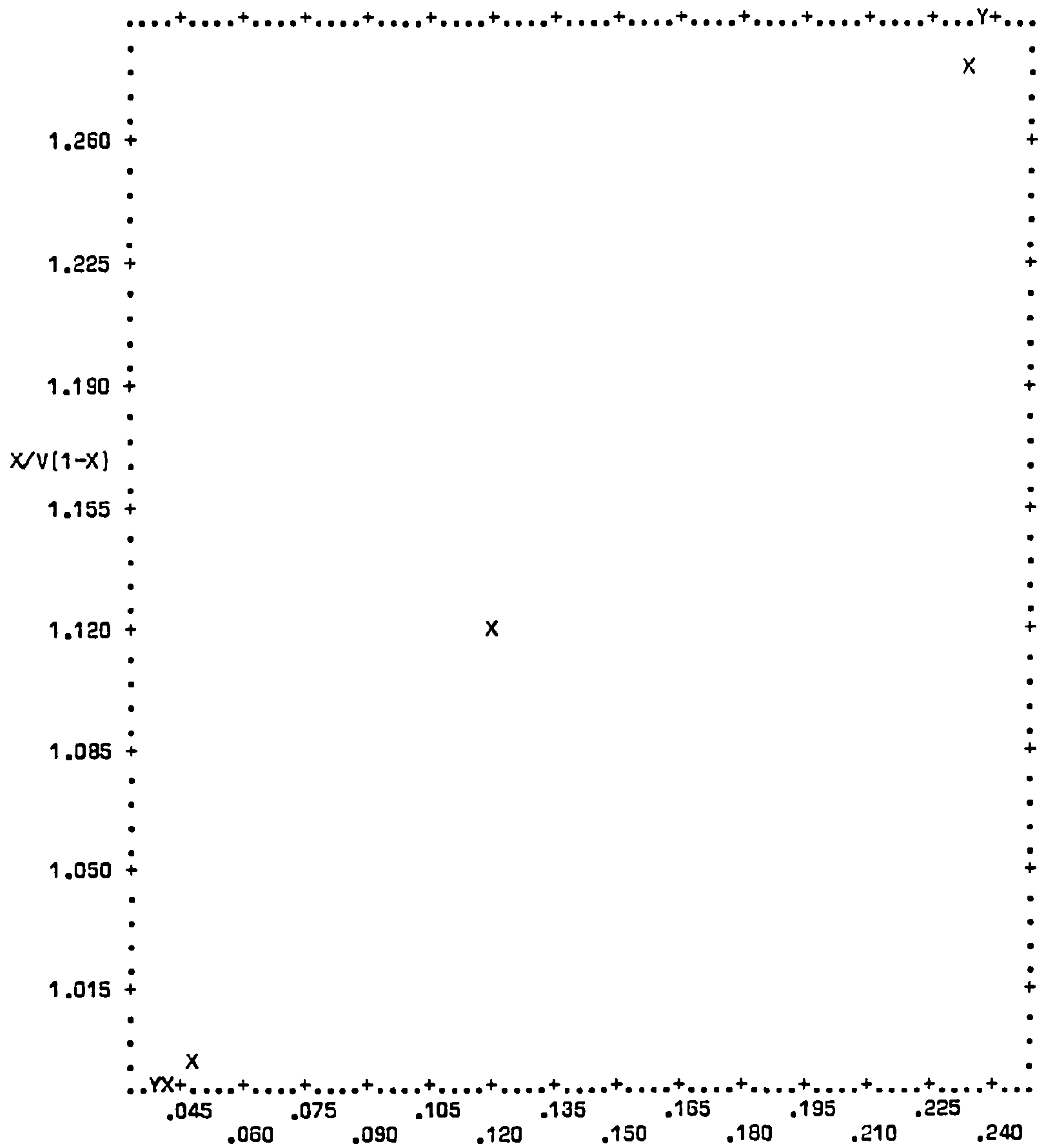
ELEMENT		DETN LIM	MASS %		2-SIGMA
NA	D	.225725E-01	.337057E-01	+-	.227302E-01
MG		.181418E-02	4.68909	+-	.235361
AL		.273807E-01	21.2686	+-	1.06444
SI		.433565E-02	18.1533	+-	.908671
P		.405358E-03	.425112E-01	+-	.28326E-02
S		.213272E-02	.243358	+-	.125845E-01
CL	X	.104662E-02	-.219913E-02	+-	.148282E-03
K		.336707E-03	.274822E-01	+-	.143175E-02
CA		.17944E-03	.073335	+-	.380128E-02
TI		.162947E-03	.102104	+-	.520778E-02
V	D	.504456E-03	.595688E-03	+-	.501805E-04
CR		.100022E-02	.168316E-01	+-	.200567E-02
MN		.525776E-03	.637755E-02	+-	.800917E-03
FE		.447803E-03	.476882	+-	.240199E-01
CO	X	.308061E-03	-.453081E-04	+-	.149846E-04
NI		.2677E-03	.58216E-02	+-	.437584E-03
CU		.252685E-03	.275611E-02	+-	.301782E-03
ZN		.255507E-03	.377591E-01	+-	.194681E-02
SE	X	.253196E-03	-.132913E-03	+-	.425703E-02
BR	X	.258613E-02	-.759935E-03	+-	.380636E-04
SR	X	.387406E-02	-.197161E-02	+-	.988457E-04
MO	X	.710896E-02	-.29436E-02	+-	.147273E-03
CD	D	.173146E-03	.406185E-03	+-	.127437E-03
SN	X	.126558E-02	-.940019E-04	+-	.115166E-03
SB	X	.554165E-03	.3455E-03	+-	.344478E-03
BA	D	.461715E-03	.112078E-02	+-	.278162E-03
CE		.190321E-02	.203215E-01	+-	.246487E-02
PT		.695657E-03	.433693E-02	+-	.630223E-03
PB		.695906E-03	.072412	+-	.375217E-02

TOTAL DETECTED BY XRF = 45.2791

APPENDIX F

BET EQUATION VERSUS RELATIVE PRESSURE FOR OXYGEN SENSORS

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A220/0660

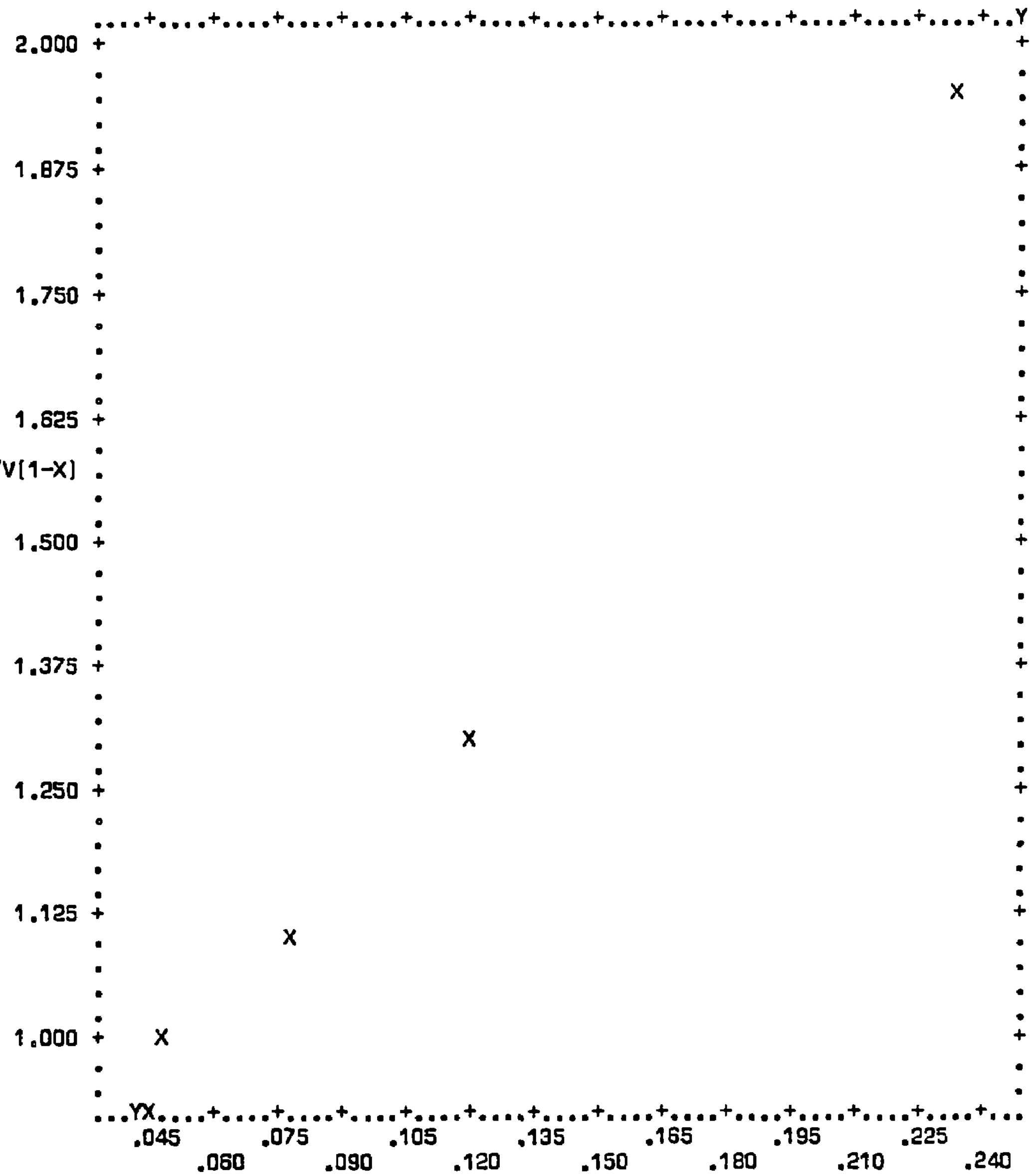


N= 3
COR= .9965

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09332	X= .63645*Y-.58704	121E-6
Y	1.1320	.14611	Y= 1.5603*X+ .92383	297E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-1. Plot of BET equation versus relative pressure for Oxygen Sensor A220/0660



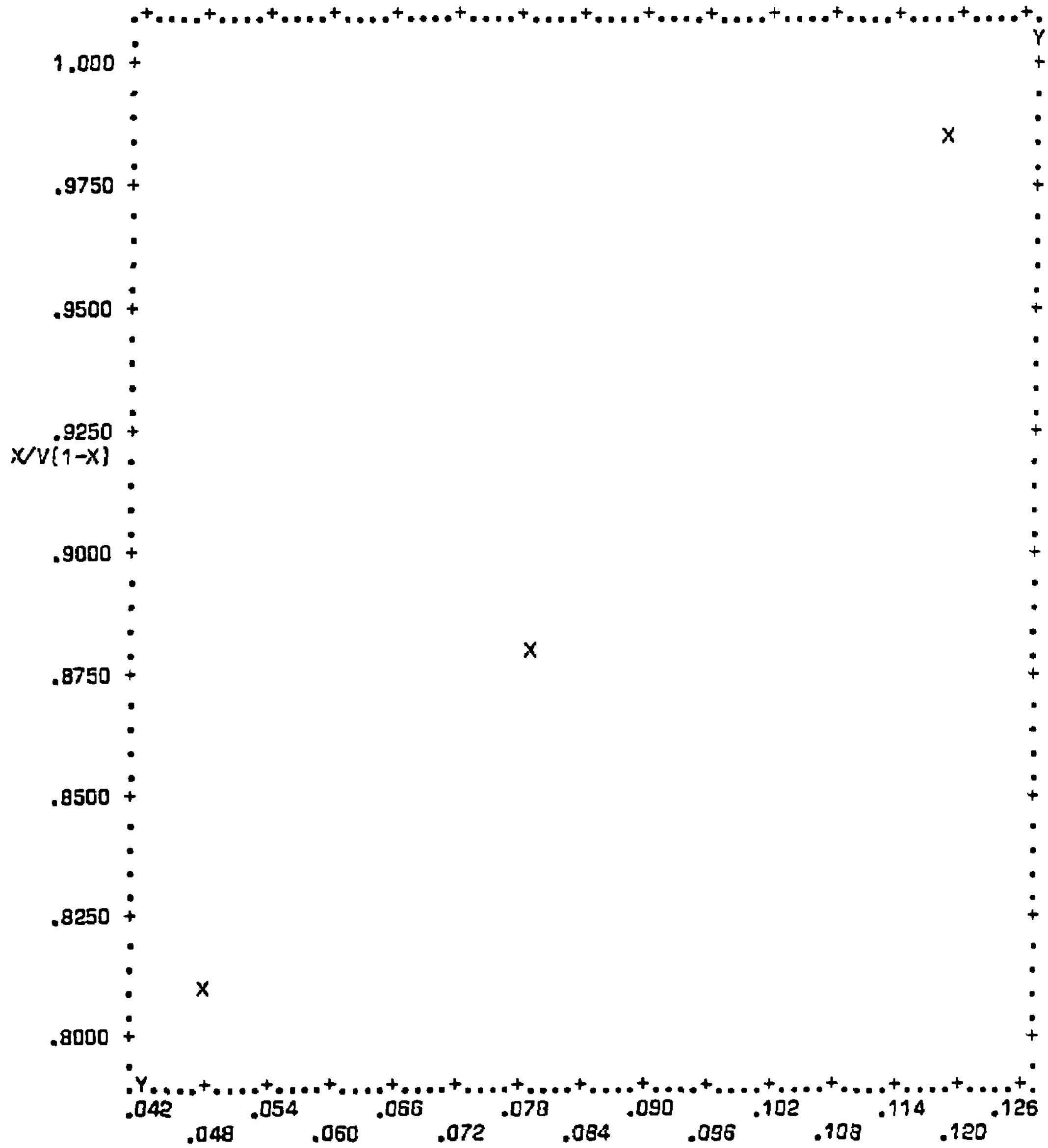
N= 4
COR= .9955 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11992	.08084	X= .18571*Y-.12808	875E-7
Y	1.3354	.43334	Y= 5.3366*X+ .69543	.00251

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-2. Plot of BET equation versus relative pressure for Oxygen Sensor A220/0810

PAGE 4 SURFACE AREA ANALYSIS A221/0146 OXYGEN SENSOR



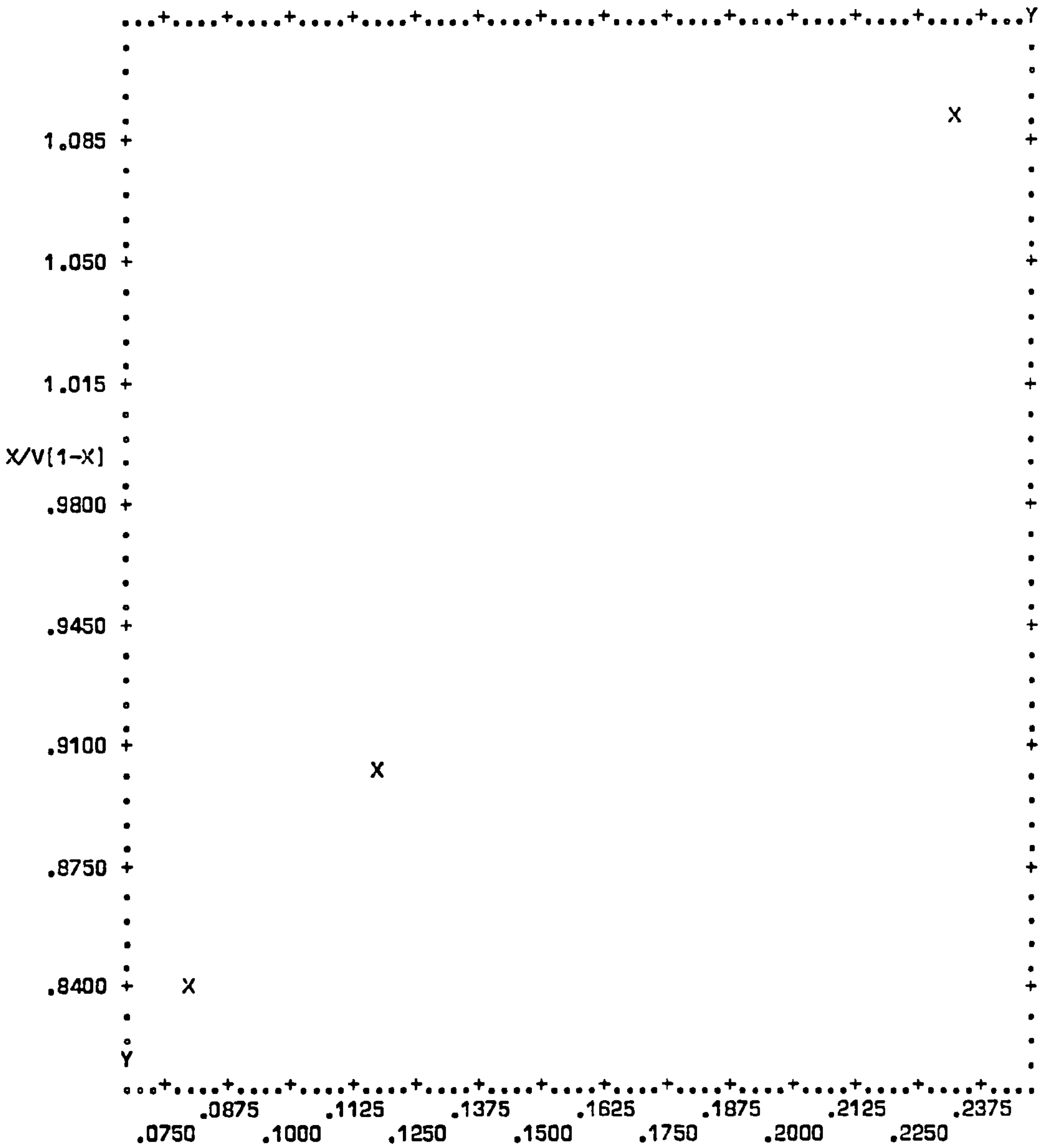
N= 3
COR= .9992

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.08214	.03510	X= .39220*Y-.26754	405E-8
Y	.89159	.08961	Y= 2.5455*X+ .68249	263E-7

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-3. Plot of BET equation versus relative pressure for Oxygen Sensor A221/0146

PAGE 4 SURFACE AREA ANALYSIS A221/0310

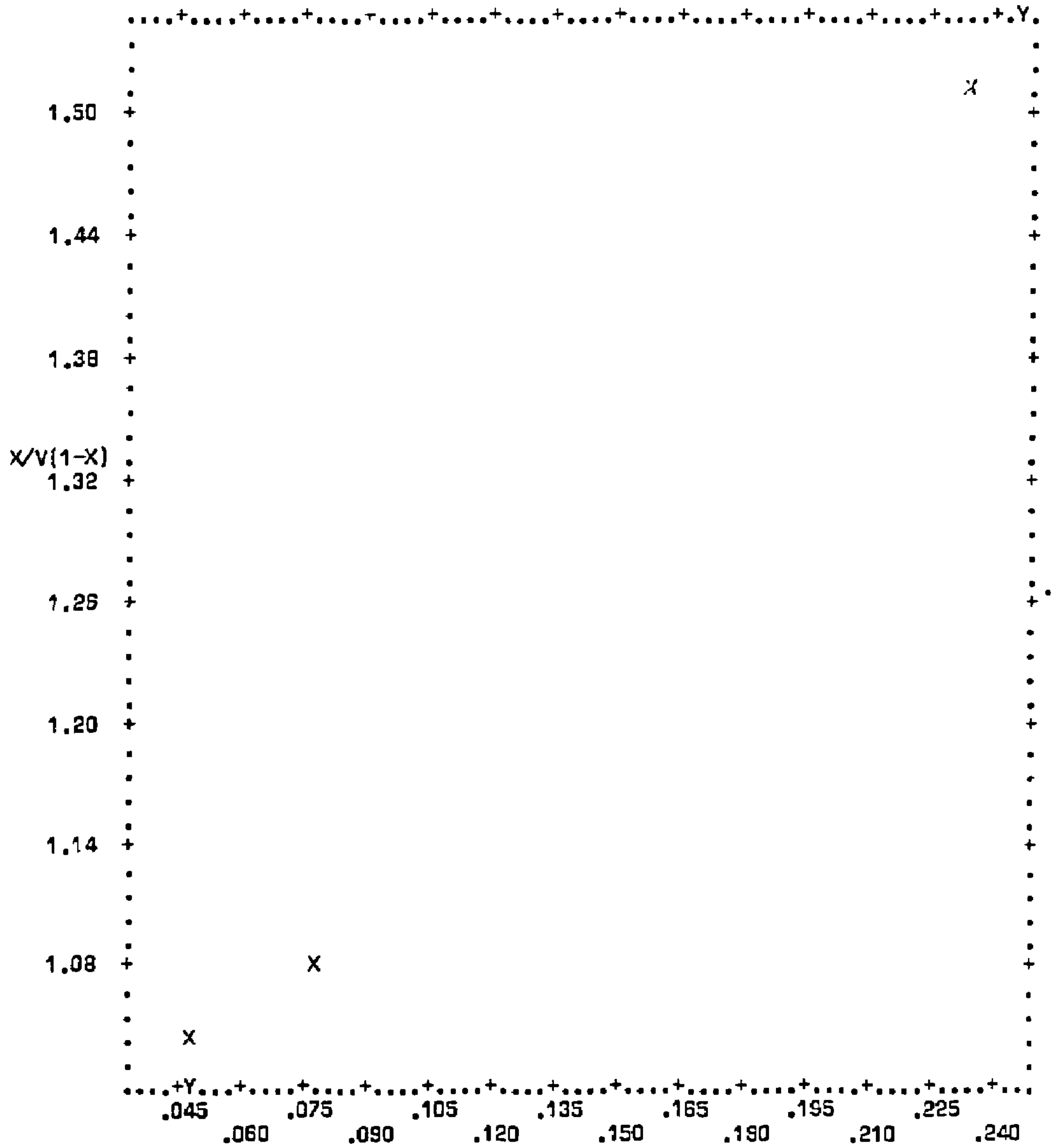


N= 3
COR= 1.000 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.14375	.07996	X= .60524*Y-.42859	704E-9
Y	.94565	.13212	Y= 1.6522*X+ .70814	192E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-4. Plot of BET equation versus relative pressure for Oxygen Sensor A221/0310

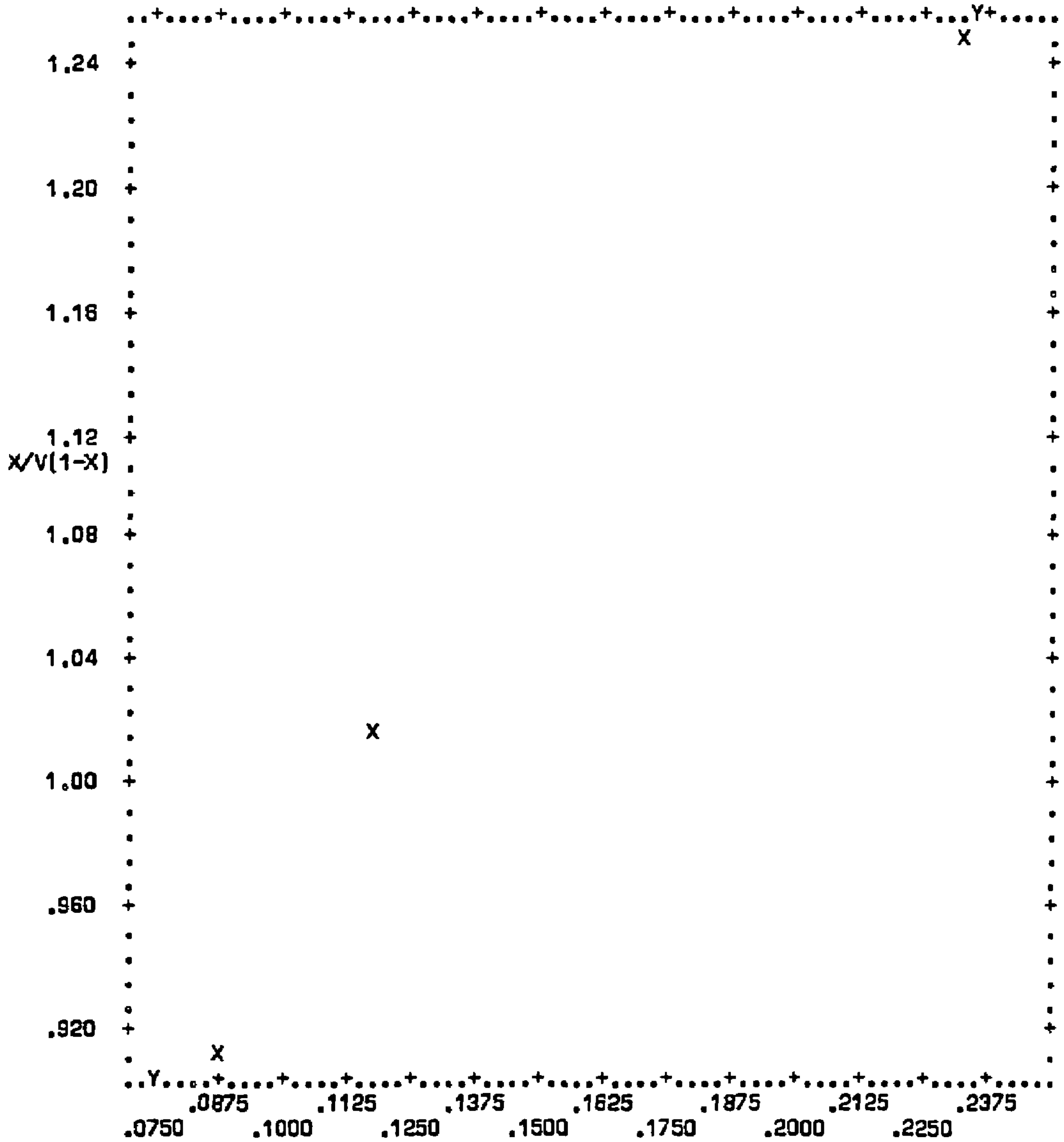


N= 3
COR= .9968 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.12036	.09901	X= .37433*Y-.33389	126E-6
Y	1.2135	.26364	Y= 2.6542*X+ .89405	096E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-5. Plot of BET equation versus relative pressure for Oxygen Sensor A230/0177



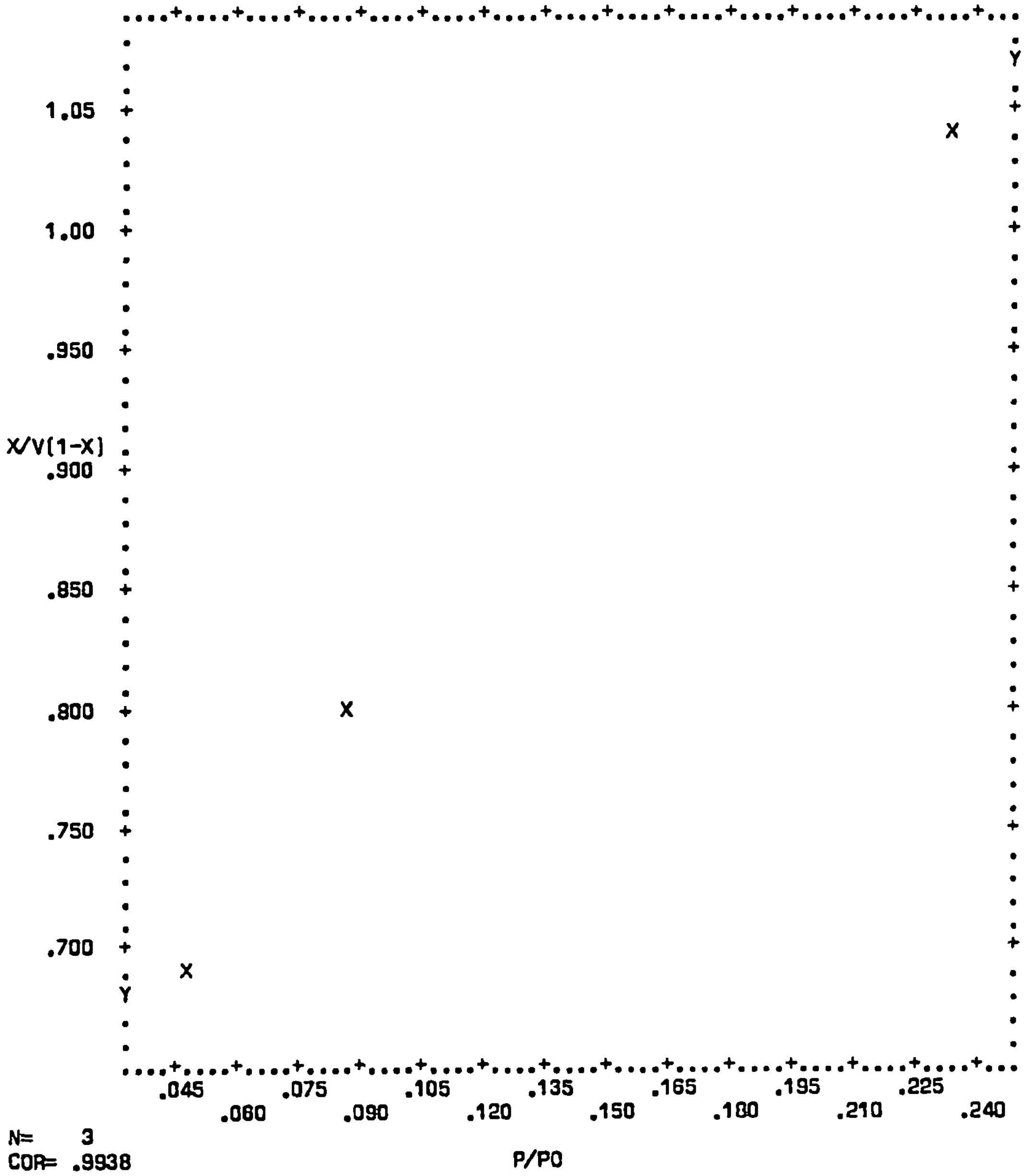
N= 3
COR= .9957 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.14623	.07703	X= .45210*Y-.33272	102E-6
Y	1.0594	.16964	Y= 2.1928*X+ .73875	497E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-6. Plot of BET equation versus relative pressure for Oxygen Sensor A230/0649X

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A249/0064



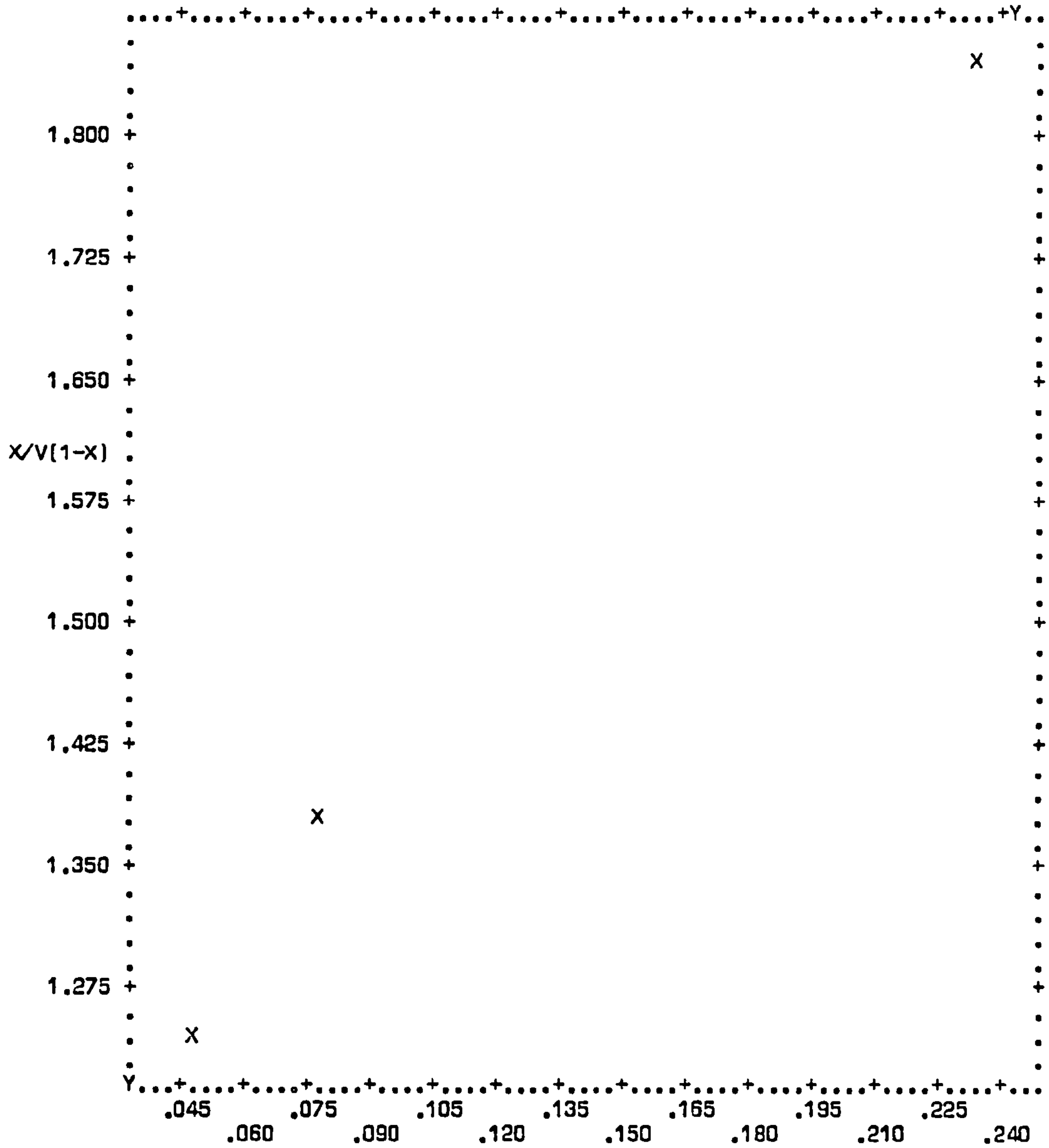
N= 3
COR= .9938

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.12283	.09754	X= .55242*Y-.34291	236E-6
Y	.84309	.17546	Y= 1.7878*X+ .62349	763E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-7. Plot of BET equation versus relative pressure for Oxygen Sensor A249/0064

PAGE 4 SURFACE AREA ANALYSIS A251/0467



N= 3
COR= .9930

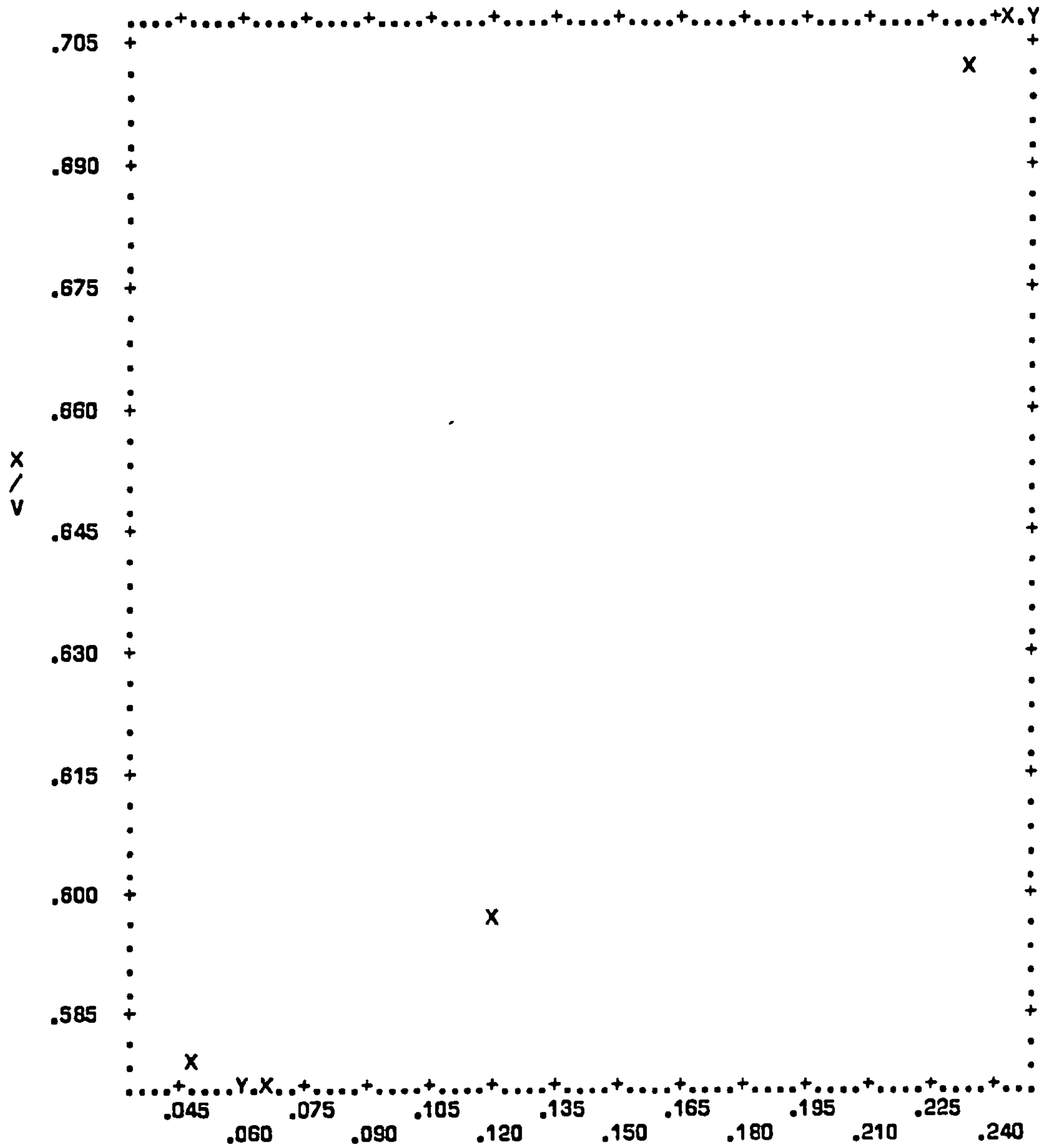
P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.12037	.09902	X= .31925*Y-.35540	772E-7
Y	1.4903	.30954	Y= 3.1200*X+ 1.1147	755E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-8. Plot of BET equation versus relative pressure for Oxygen Sensor A251/0467

PAGE 4 CONVERTER SURFACE AREA ANALYSIS A180/0094



N= 3
COR= .9657

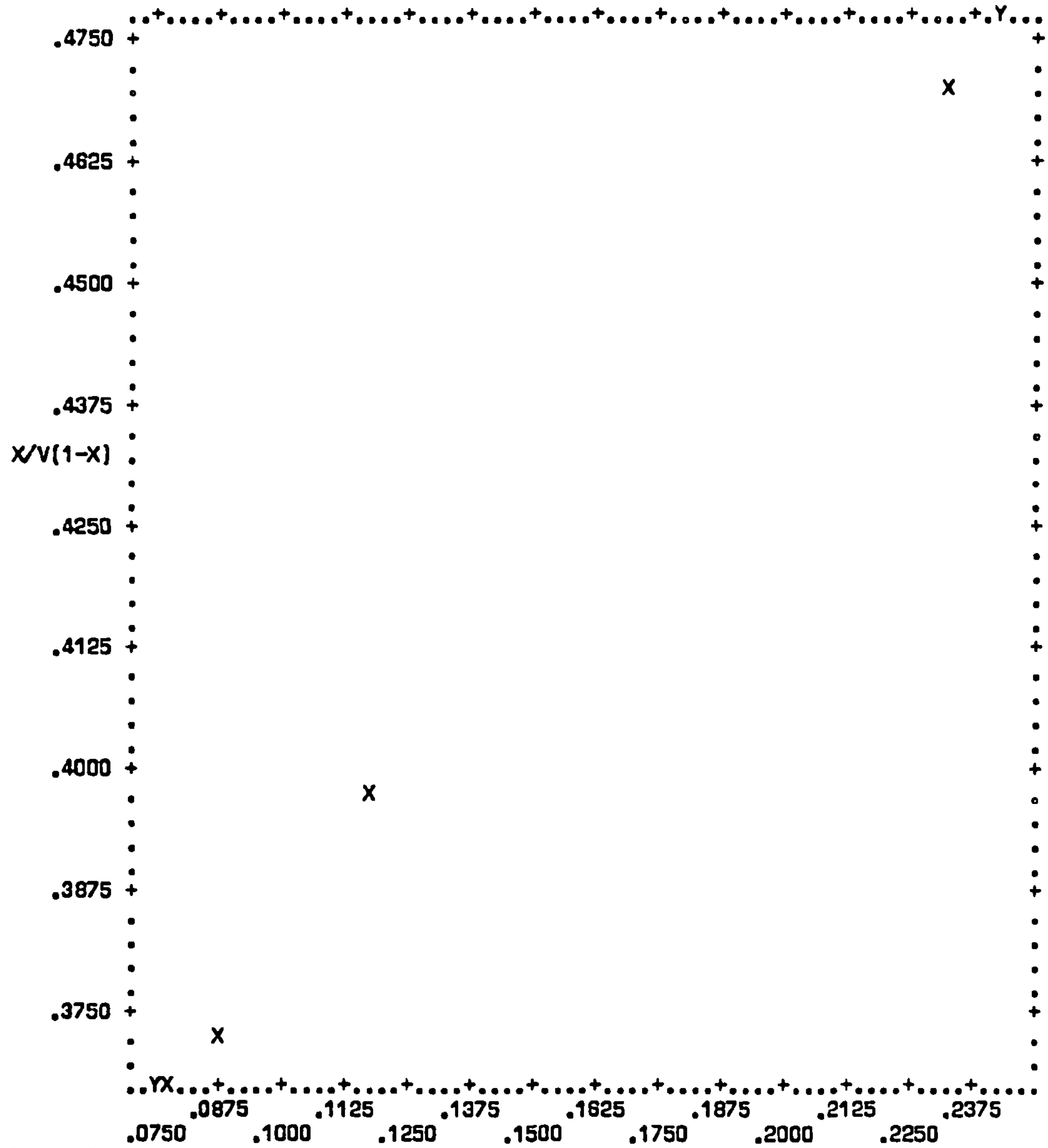
P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09333	X= 1.3429*Y-.70761	.00117
Y	.62630	.06712	Y= .69448*X+ .53362	607E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-9. Plot of BET equation versus relative pressure for Oxygen Sensor A180/0094

PAGE 4 CONVERTER SURFACE AREA ANALYSIS SAMPLE A218/0045



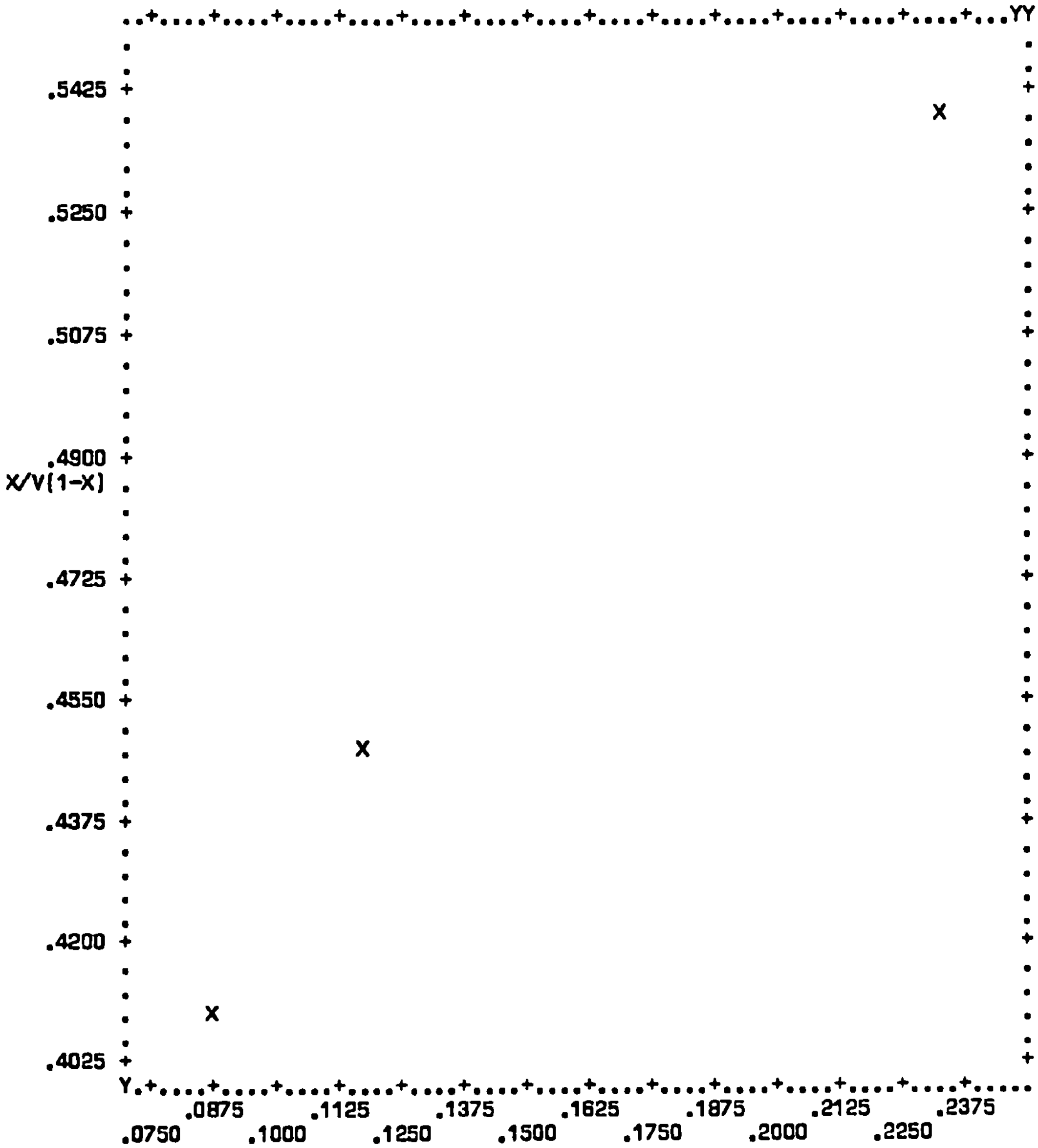
N= 3
COR= .9891 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.14624	.07703	X= 1.5174*Y-.48132	214E-7
Y	.41357	.05072	Y= .65782*X+ .31737	929E-8

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-10. Plot of BET equation versus relative pressure for Oxygen Sensor A218/0045

PAGE 4 CONVERTER SURFACE AREA ANALYSIS SAMPLE A218/0045X

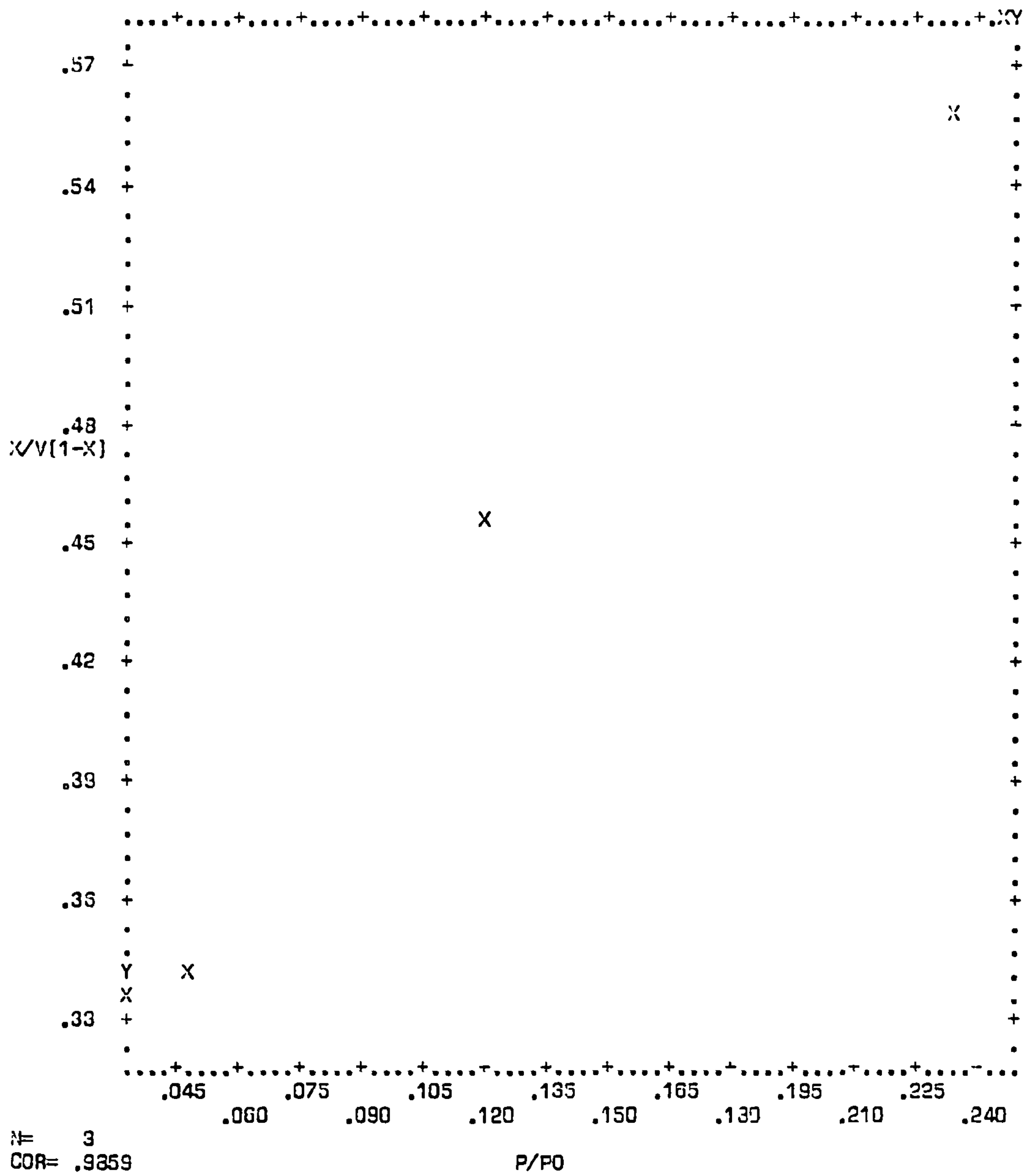


N= 3
COR= .9943 P/PO

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.14825	.07703	X= 1.1557*Y-.39169	136E-6
Y	.46548	.06827	Y= .85538*X+ .34038	101E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-11. Plot of BET equation versus relative pressure for Oxygen Sensor A218/0045X

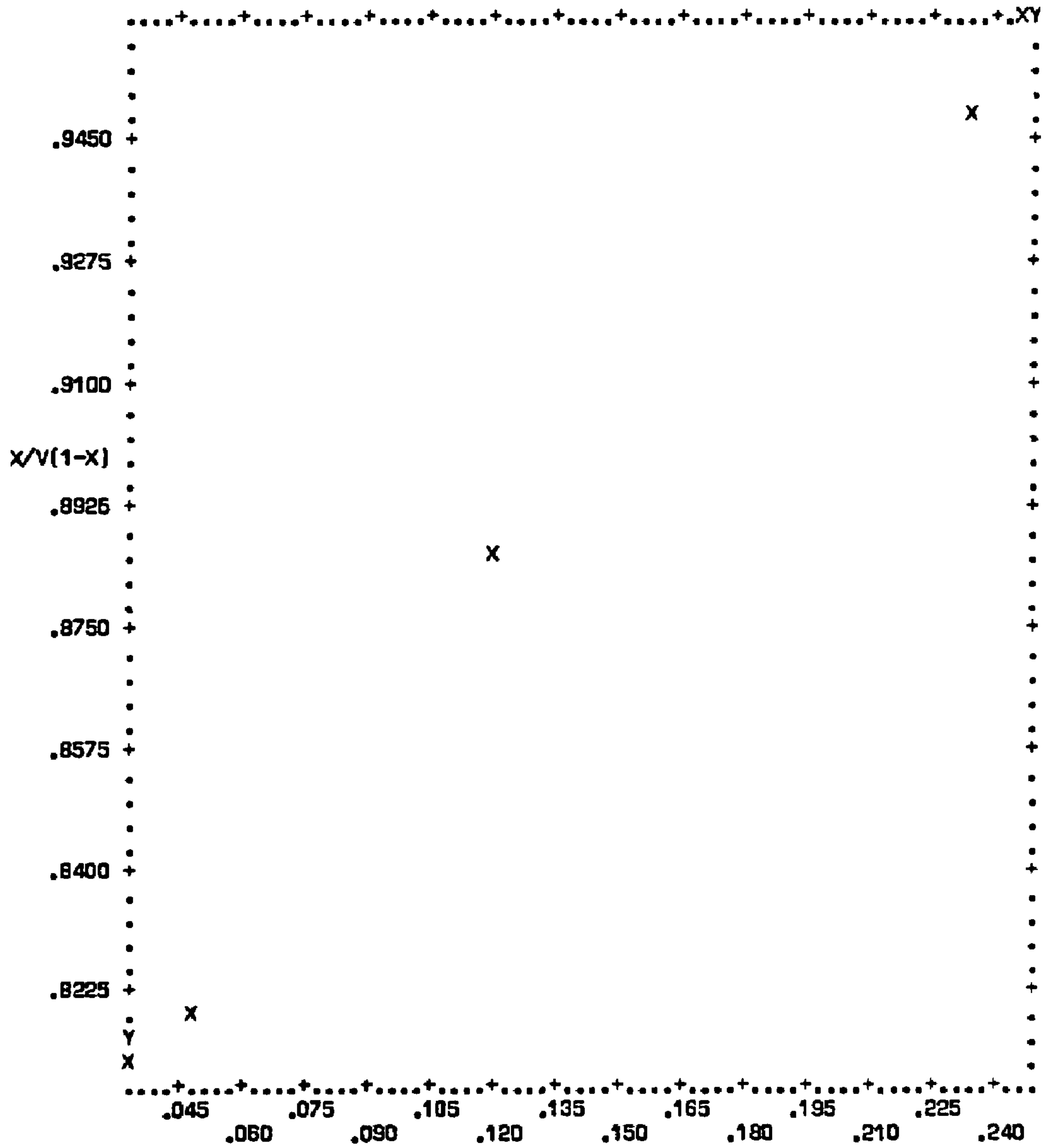


N= 3
COR= .9859

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13344	.09333	X= .87063*Y-.26046	408E-6
Y	.45243	.10568	Y= 1.1164*X+ .30346	626E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-12. Plot of BET equation versus relative pressure for Oxygen Sensor A218/0068



N= 3
COR= .9870

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13343	.09331	X= 1.4303*Y-1.1307	449E-6
Y	.88380	.06439	Y= .68110*X+ .79292	214E-6

VARIABLE 1 P/PO VERSUS VARIABLE 2 X/V SYMBOL=X

Figure F-13. Plot of BET equation versus relative pressure for New Chrysler

APPENDIX G

ESCA SPECTRA OF OXYGEN SENSOR TIP EXTERIOR SURFACE

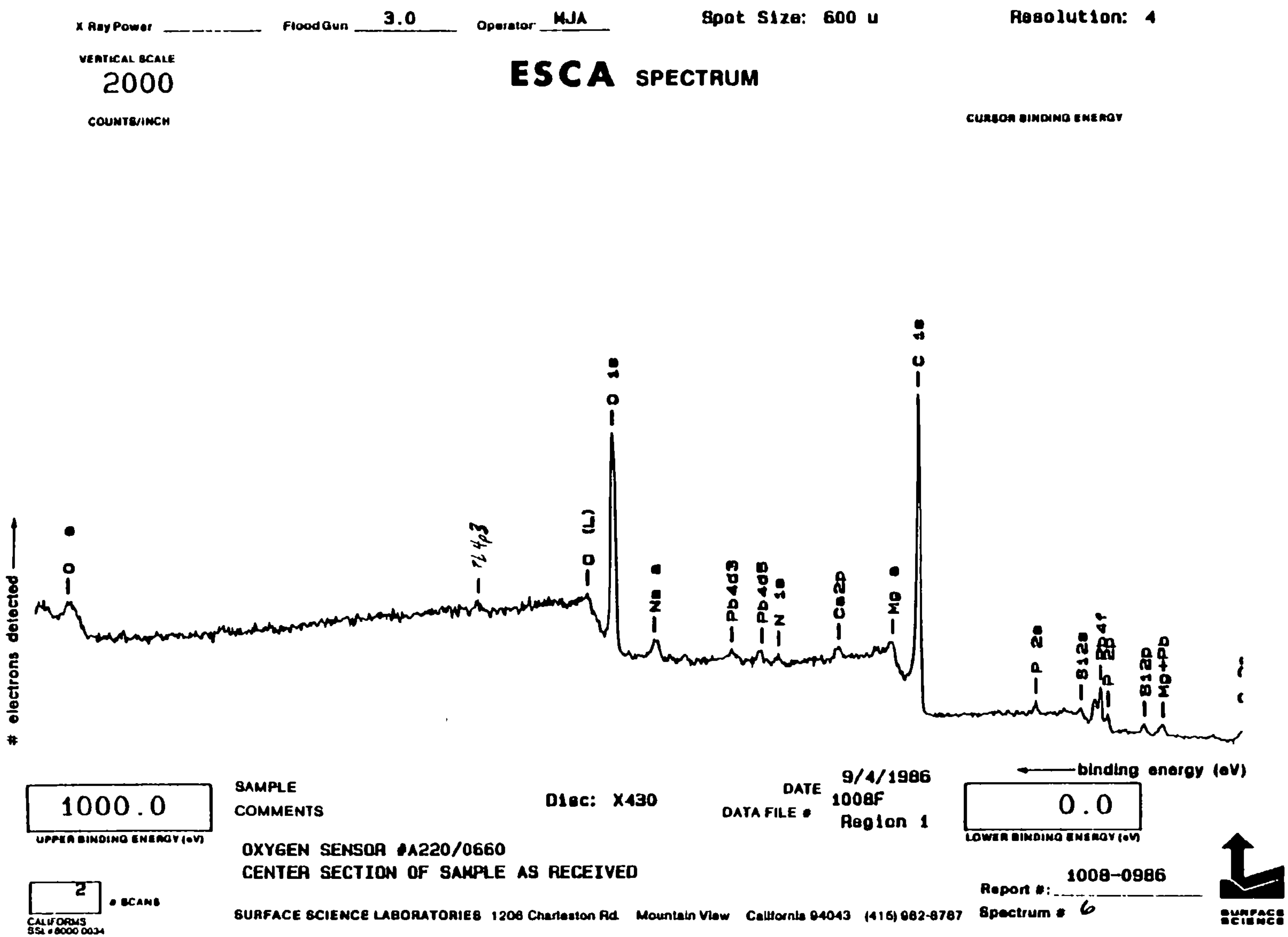


Figure G-1. ESCA Spectrum of Oxygen Sensor A220/0660 from 0 eV to 1000 eV (Exterior Surface)

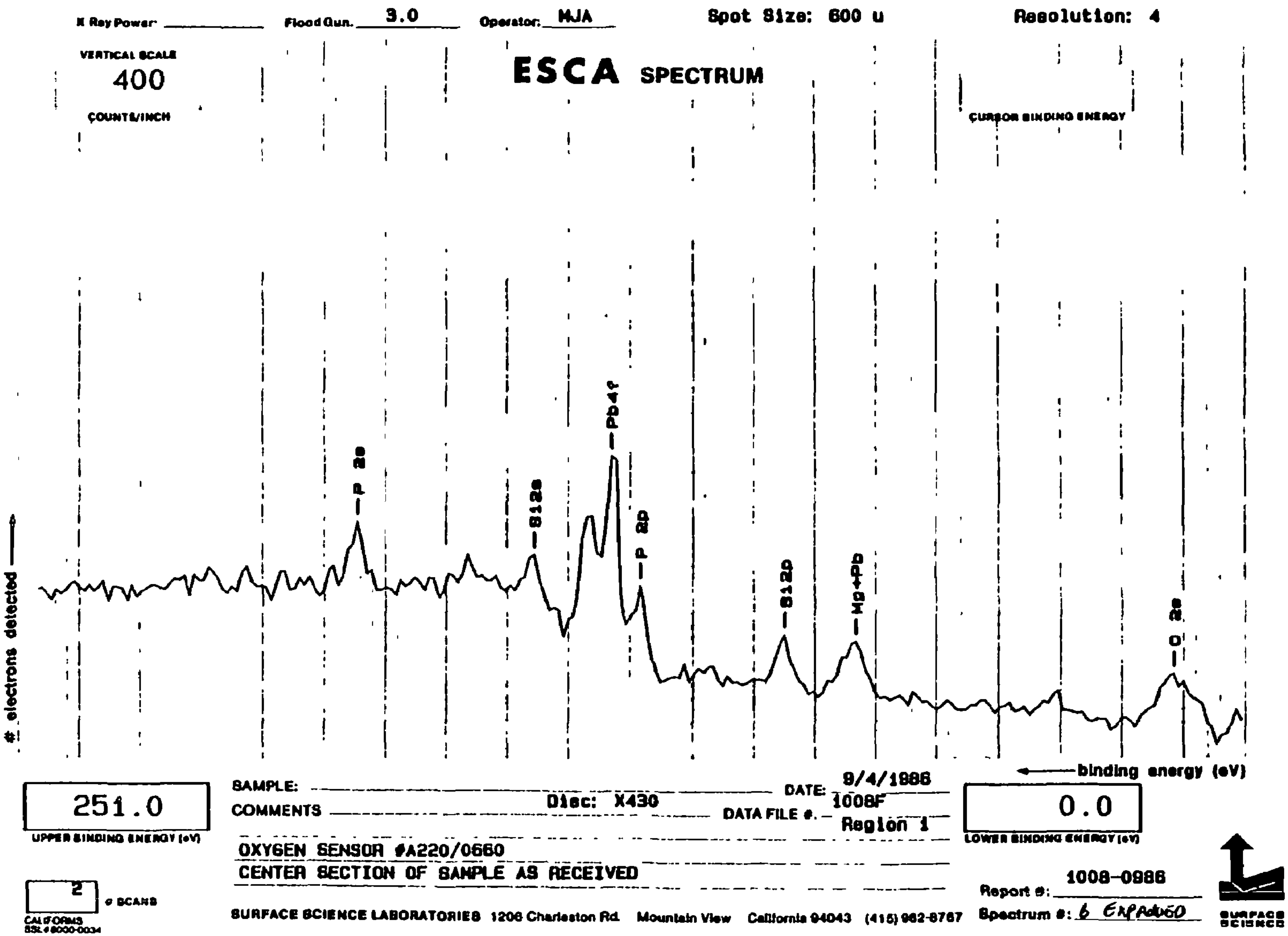


Figure G-2. ESCA Spectrum of Oxygen Sensor A220/0660 from 0 eV to eV 251 (Exterior Surface)

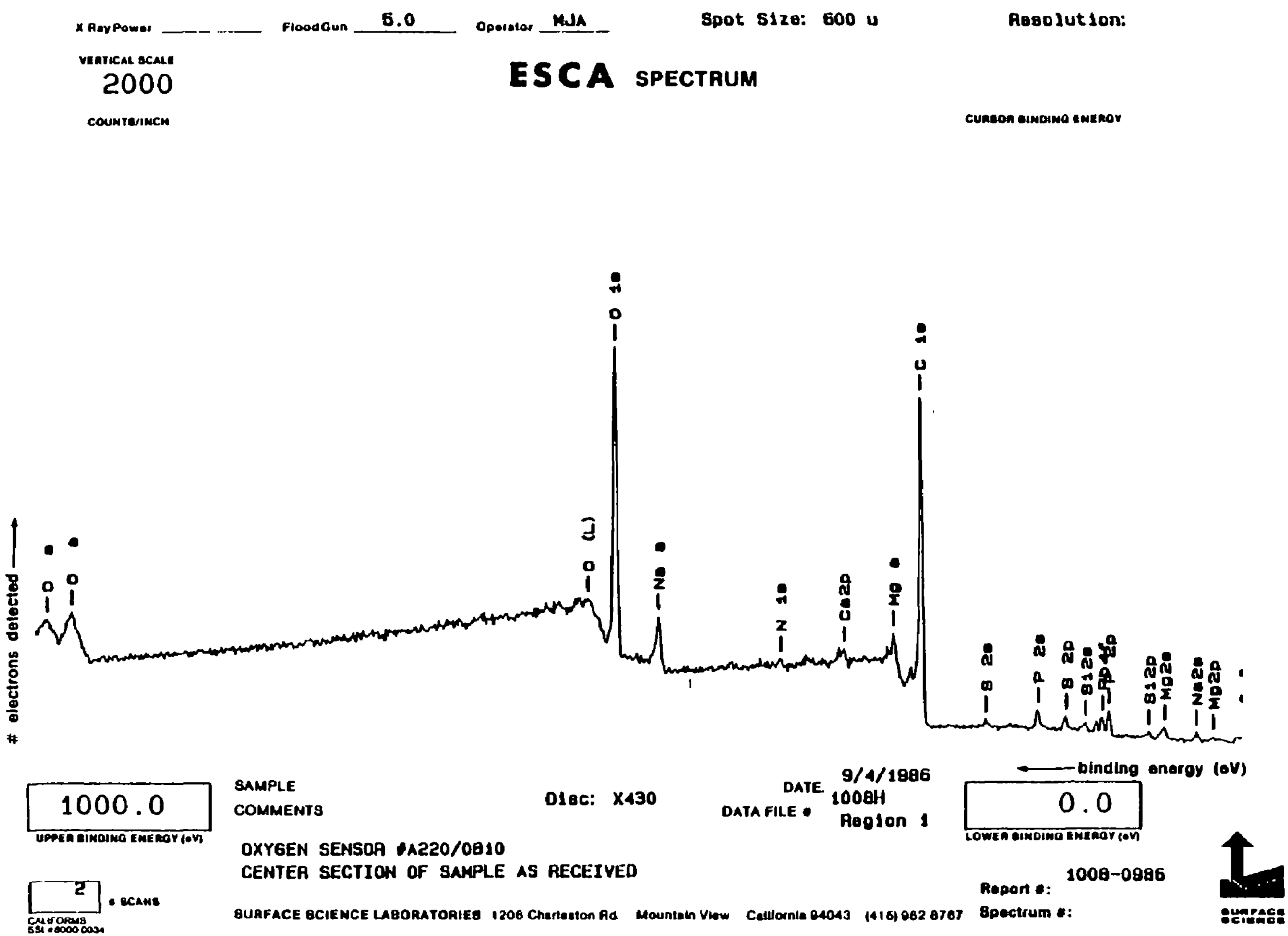


Figure G-3. ESCA Spectrum of Oxygen Sensor A220/0810 from 0 eV to 1000 eV (Exterior Surface)

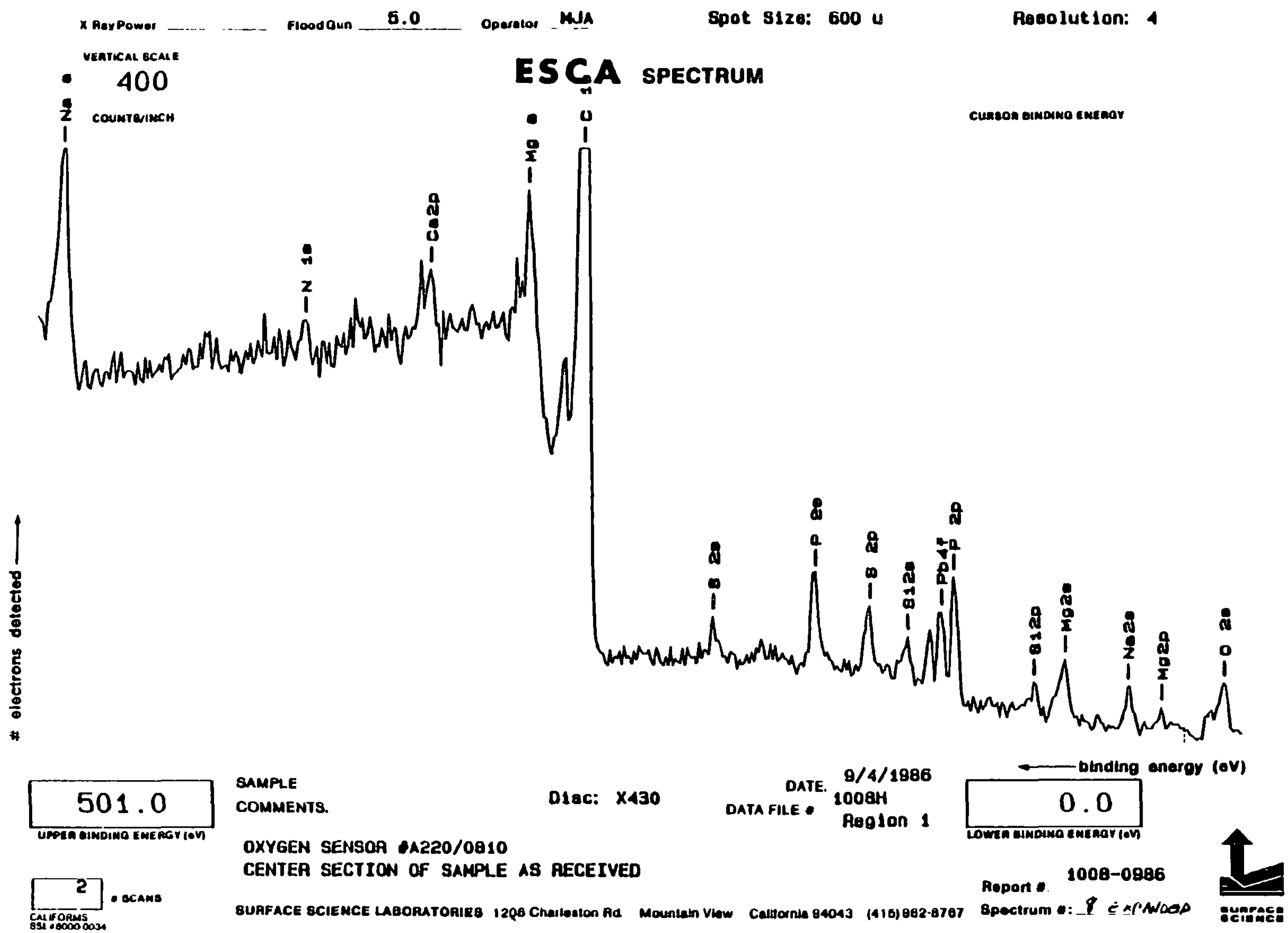


Figure G-4. ESCA Spectrum of Oxygen Sensor A220/0810 from 0 eV to 501 eV (Exterior Surface)

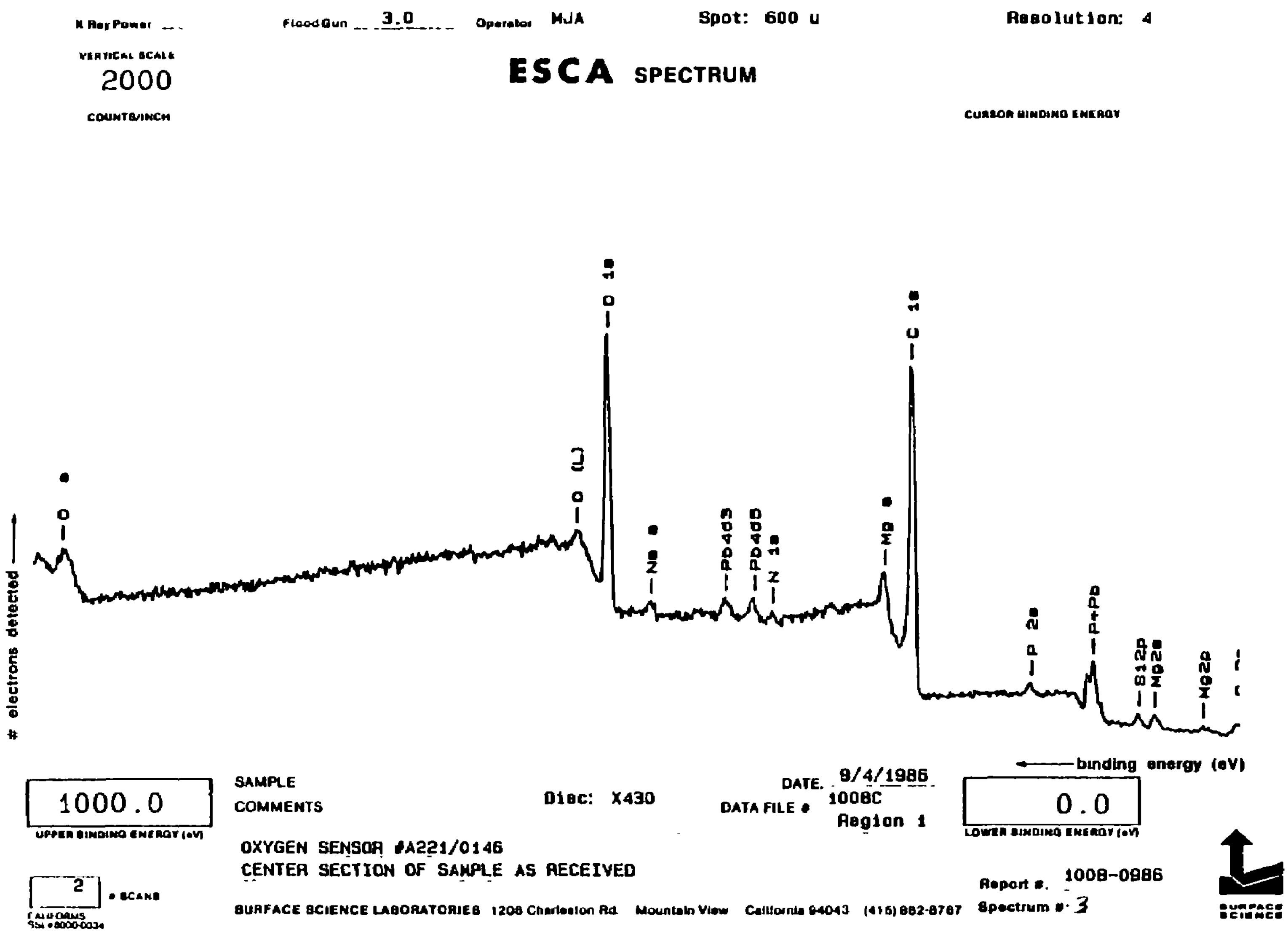


Figure G-5. ESCA Spectrum of Oxygen Sensor A221/0146 from 0 eV to 1000 eV (Exterior Surface)

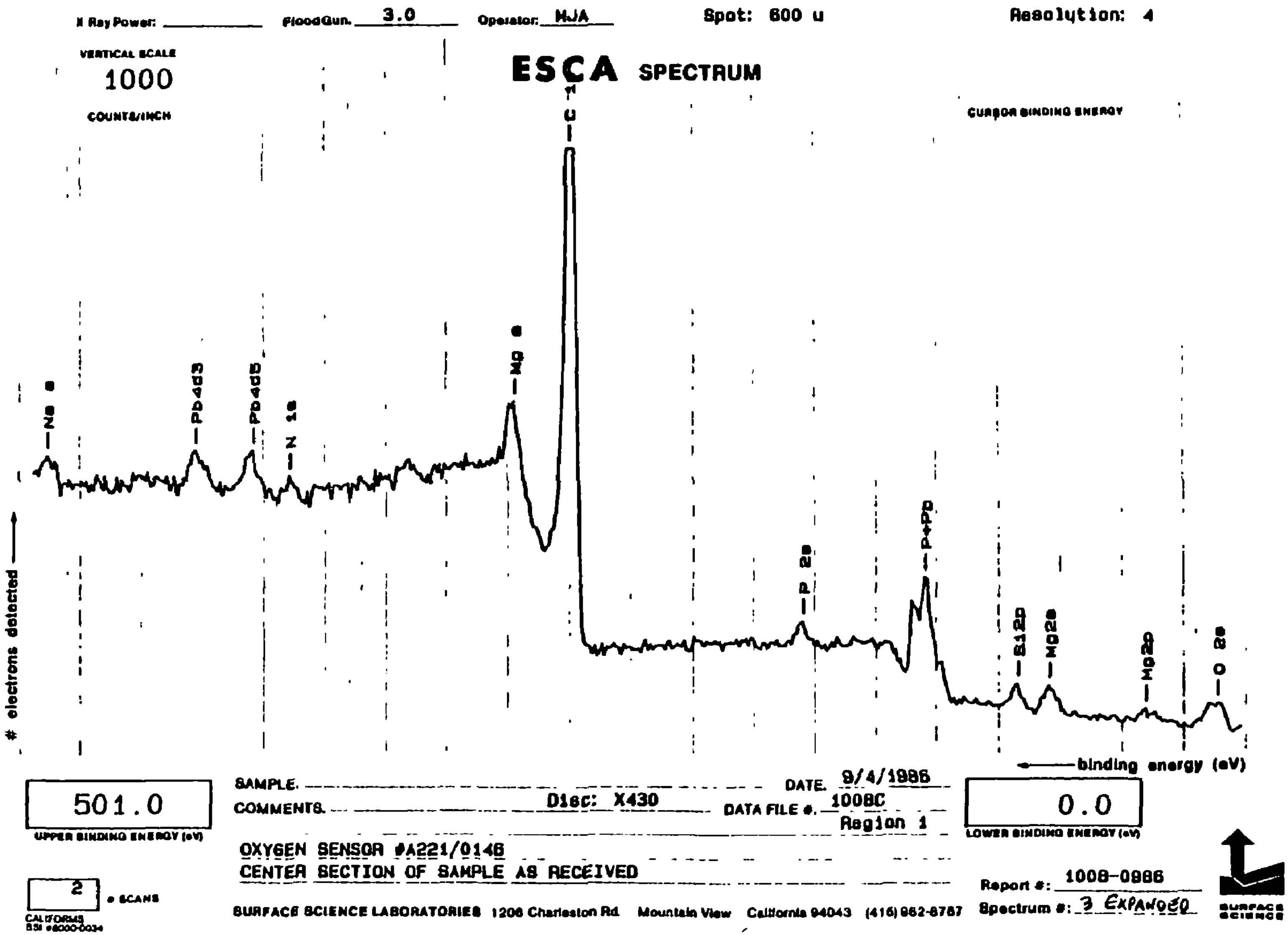


Figure G-6. ESCA Spectrum of Oxygen Sensor A221/0146 from 0 eV to 501 eV (Exterior Surface)

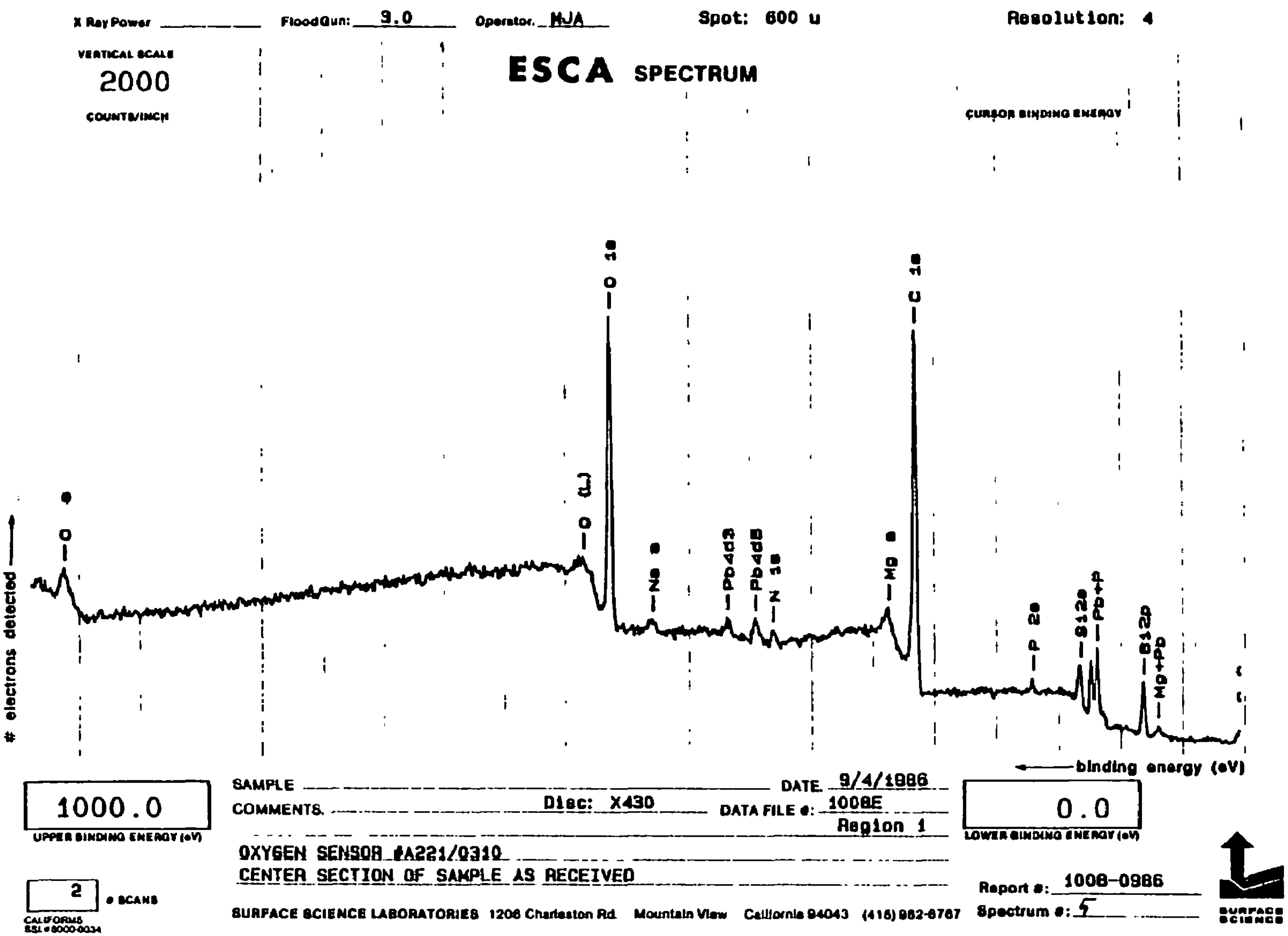


Figure G-7. ESCA Spectrum of Oxygen Sensor A221/0310 from 0 eV to 1000 eV (Exterior Surface)

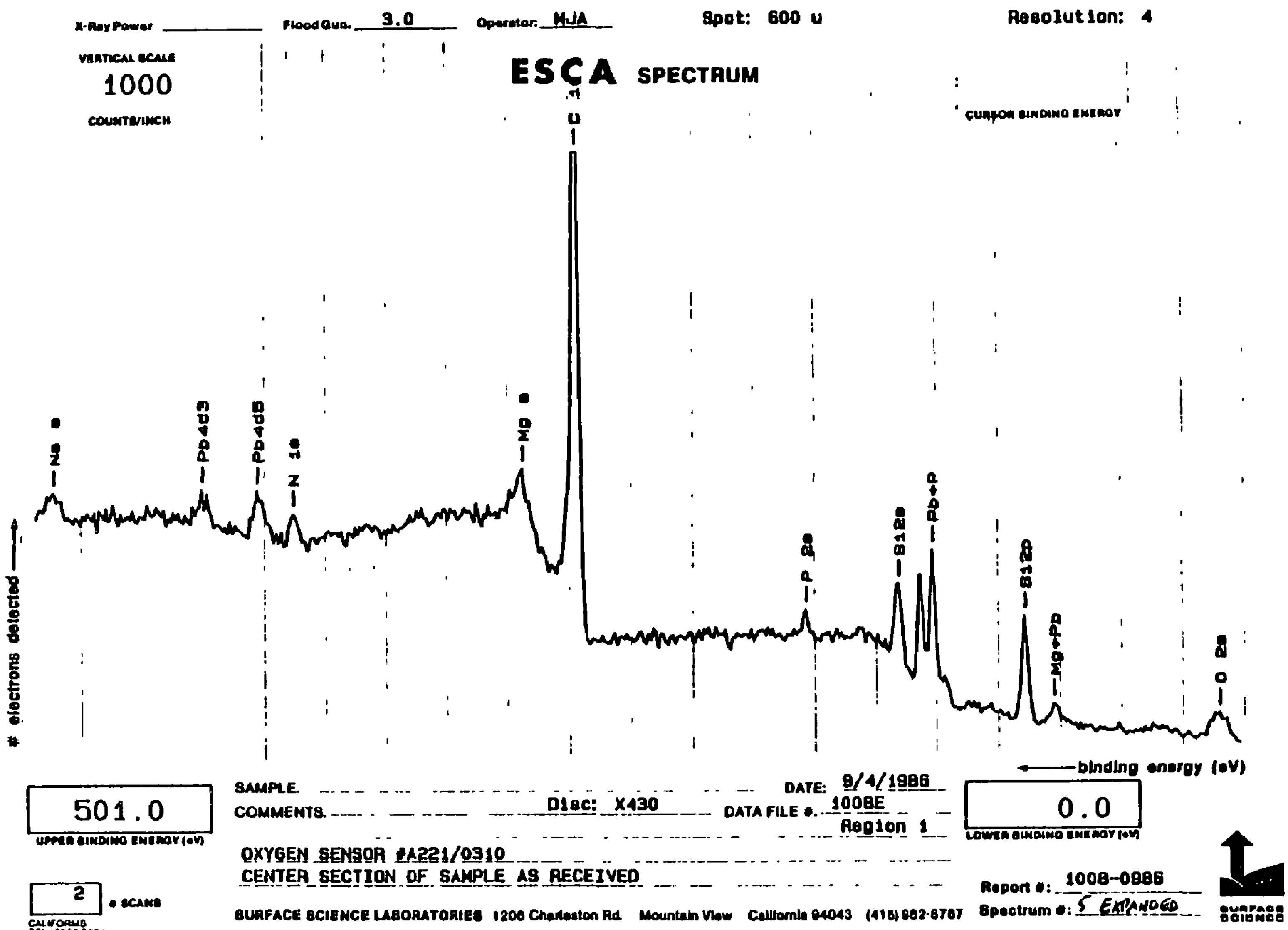


Figure G-8. ESCA Spectrum of Oxygen Sensor A221/0310 from 0 eV to 501 eV (Exterior Surface)

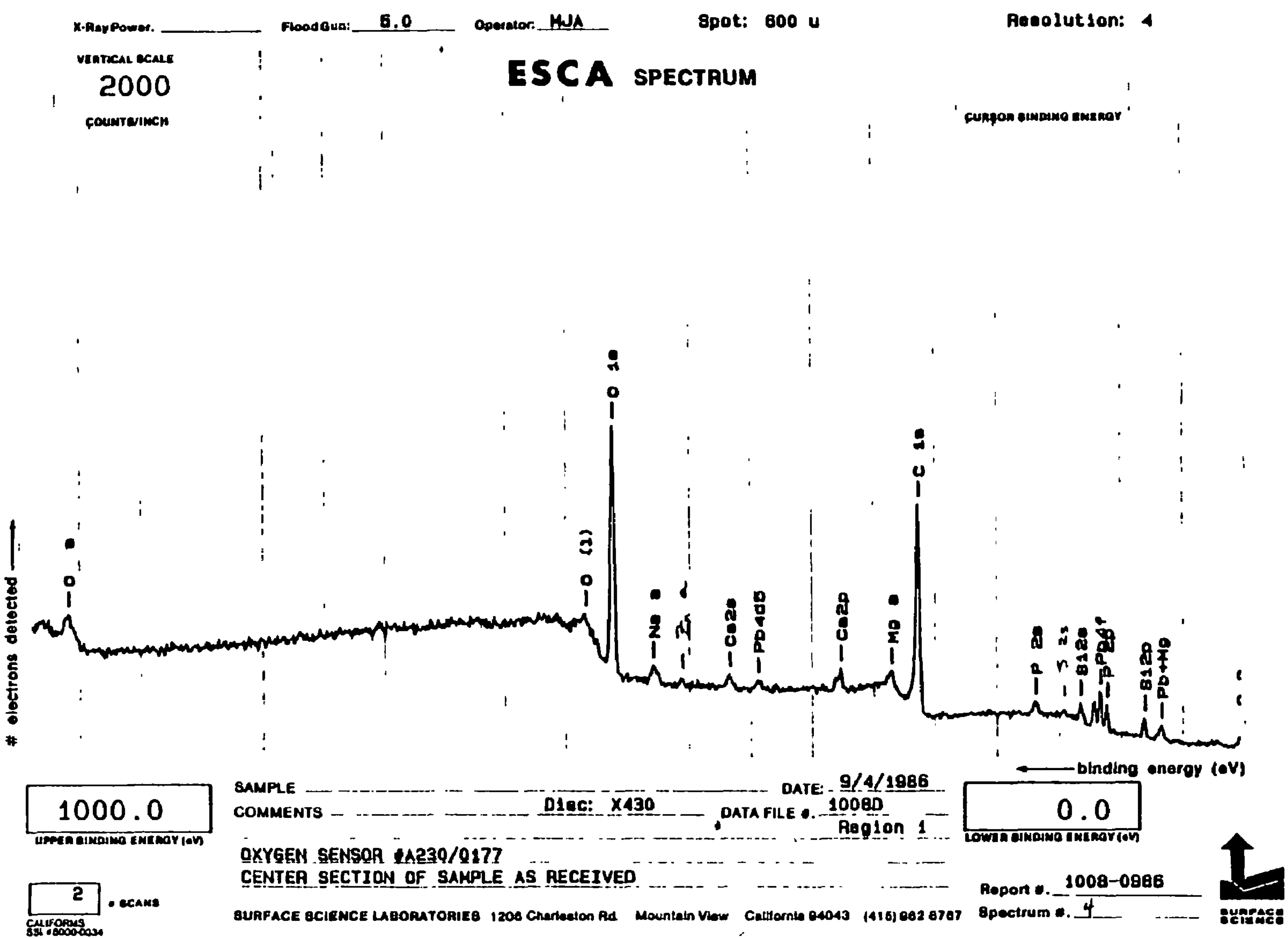


Figure G-9. ESCA Spectrum of Oxygen Sensor A230/0177 from 0 eV to 1000 eV (Exterior Surface)

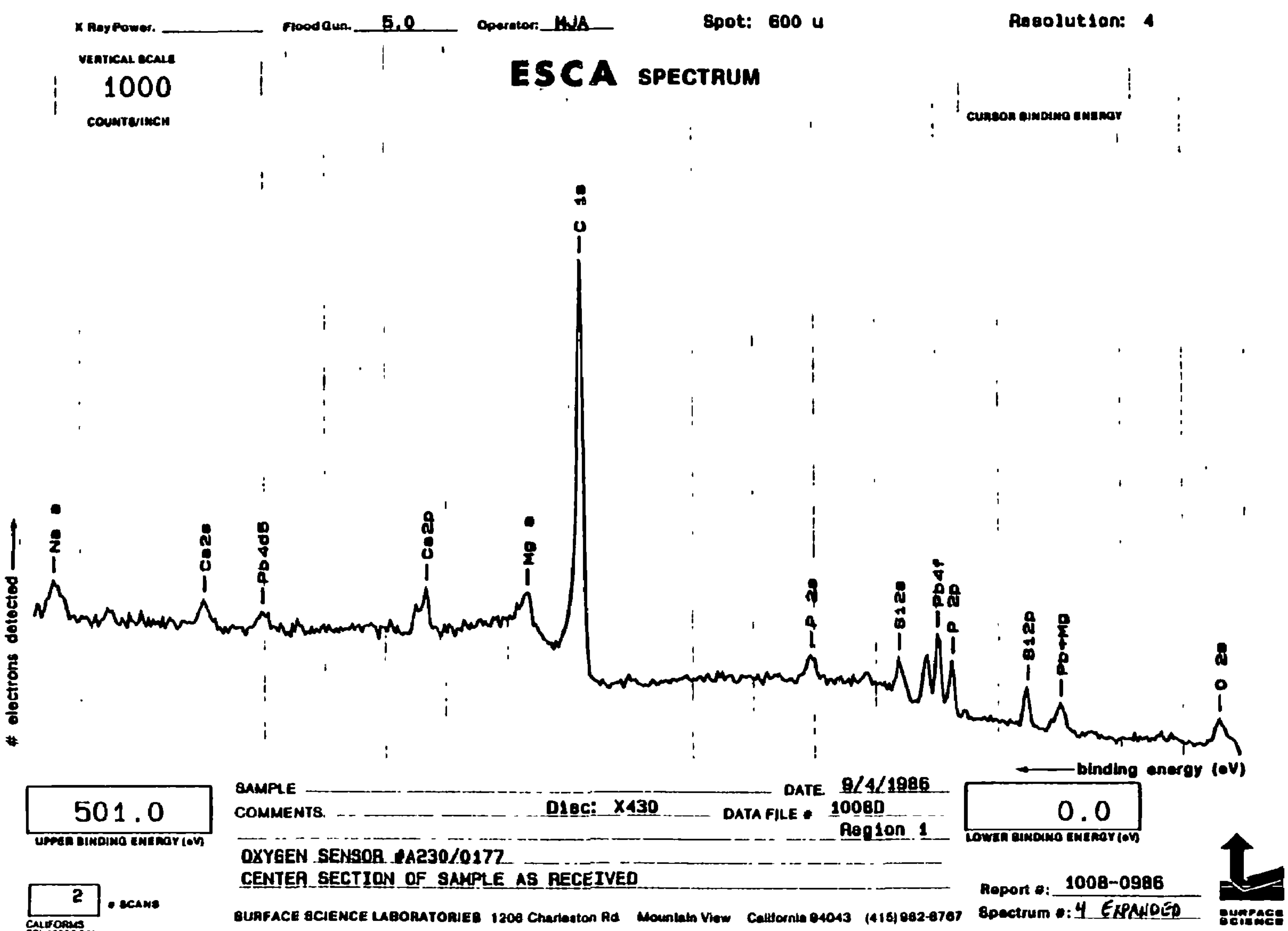


Figure G-10. ESCA Spectrum of Oxygen Sensor A230/0177 from 0 eV to 501 eV (Exterior Surface)

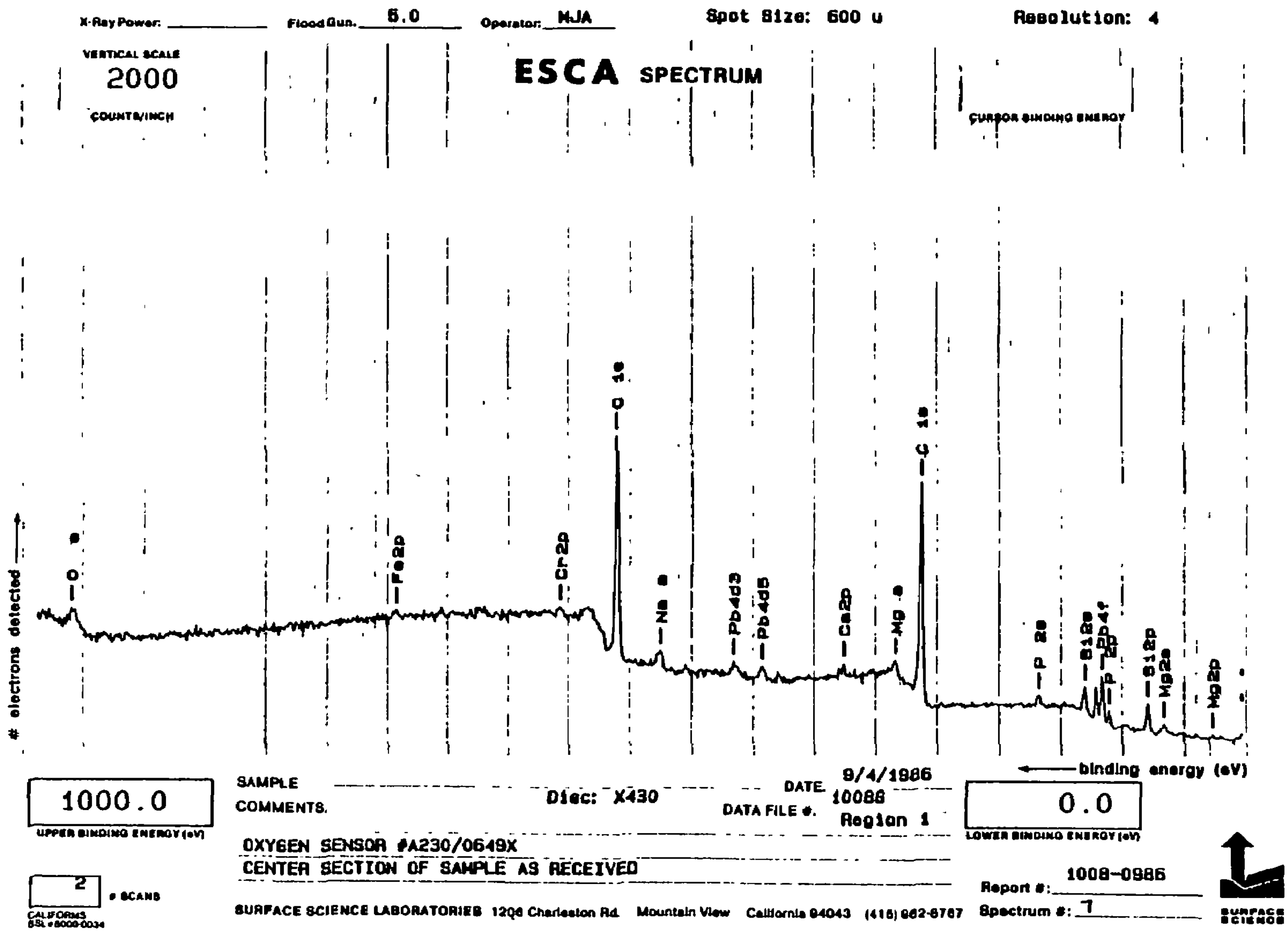


Figure G-11. ESCA Spectrum of Oxygen Sensor A230/0649X from 0 eV to 1000 eV (Exterior Surface)

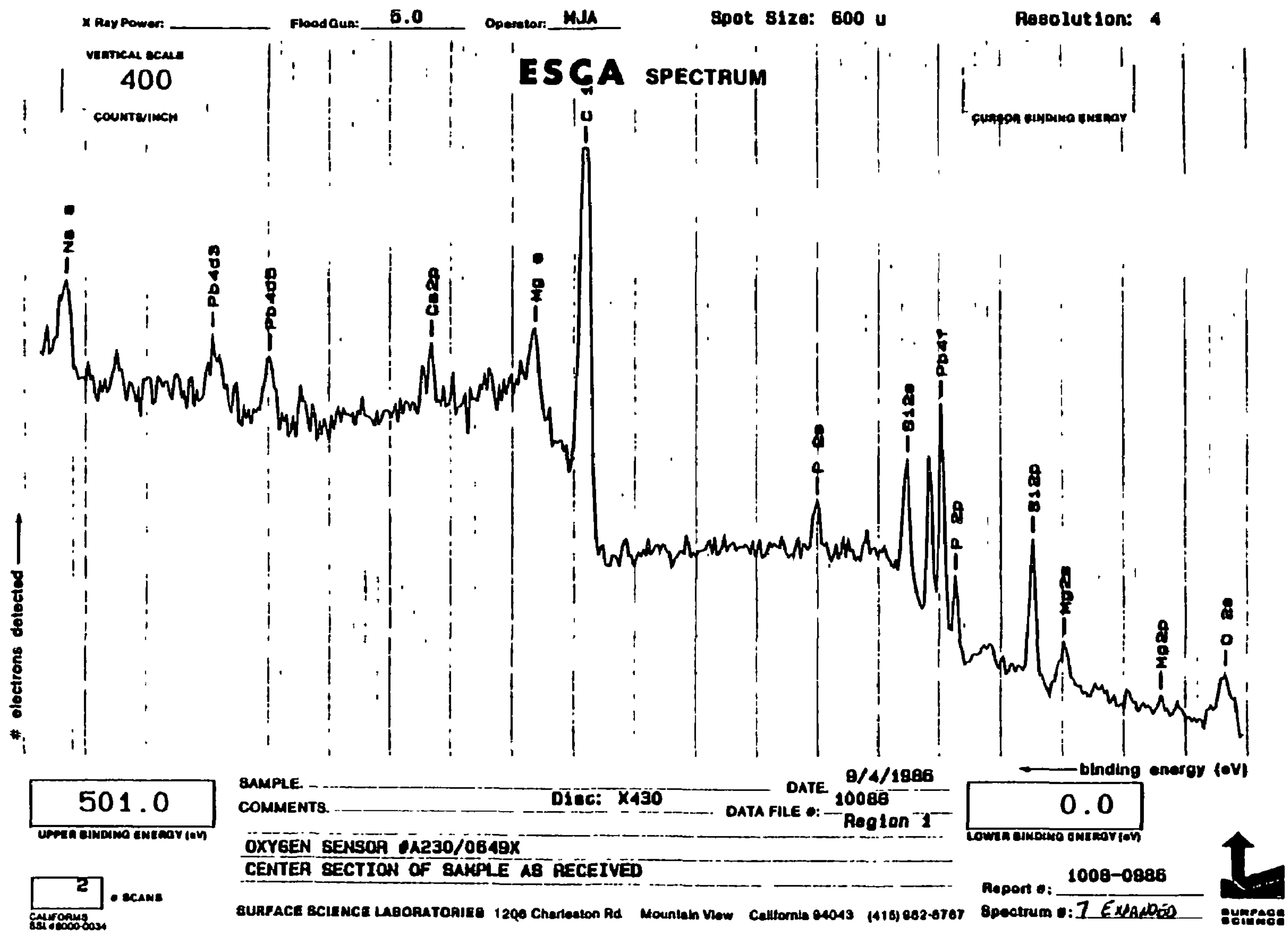


Figure G-12. ESCA Spectrum of Oxygen Sensor A230/0649X from 0 eV to 501 eV (Exterior Surface)

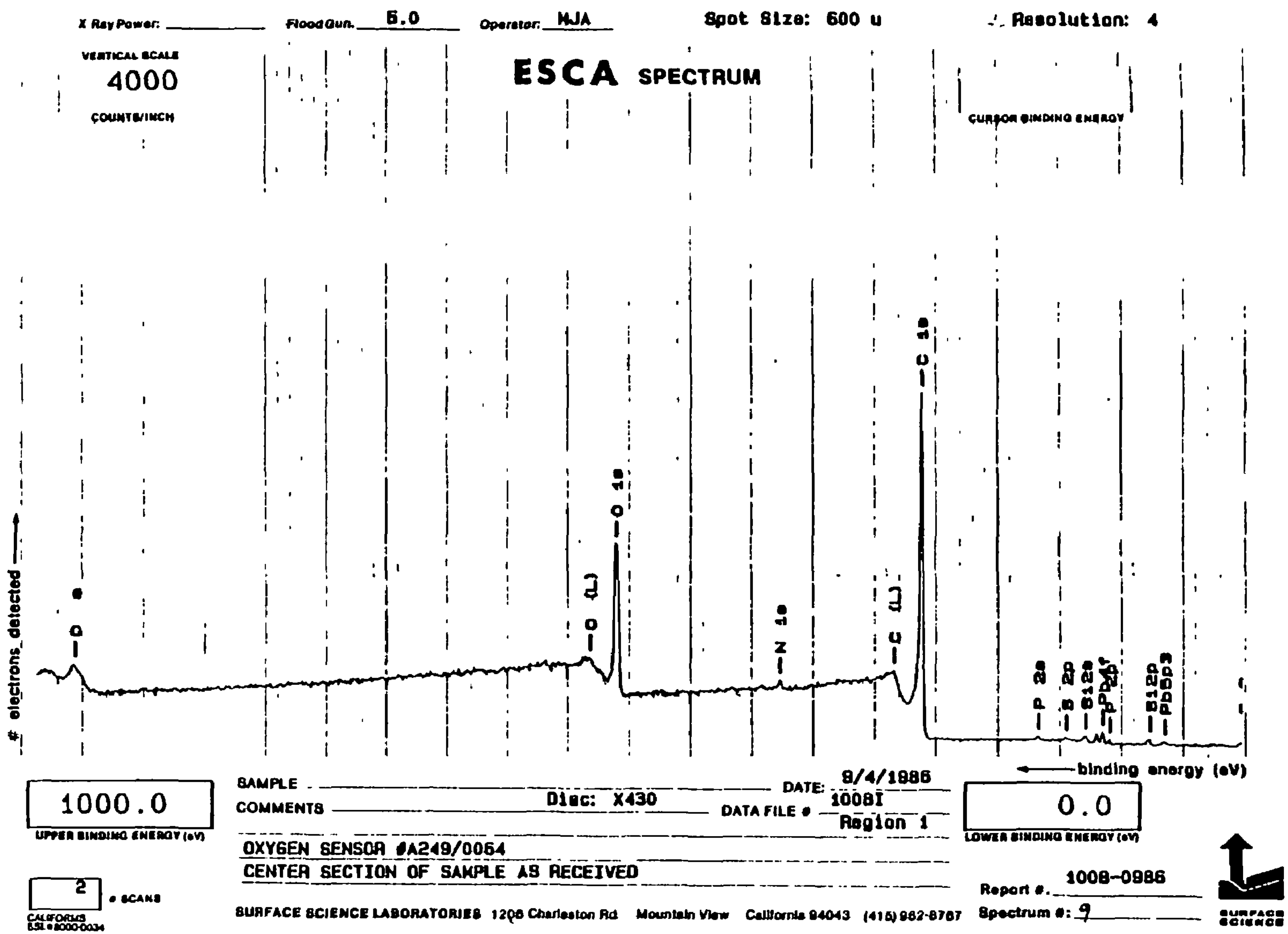


Figure G-13. ESCA Spectrum of Oxygen Sensor A249/0064 from 0 eV to 1000 eV (Exterior Surface)

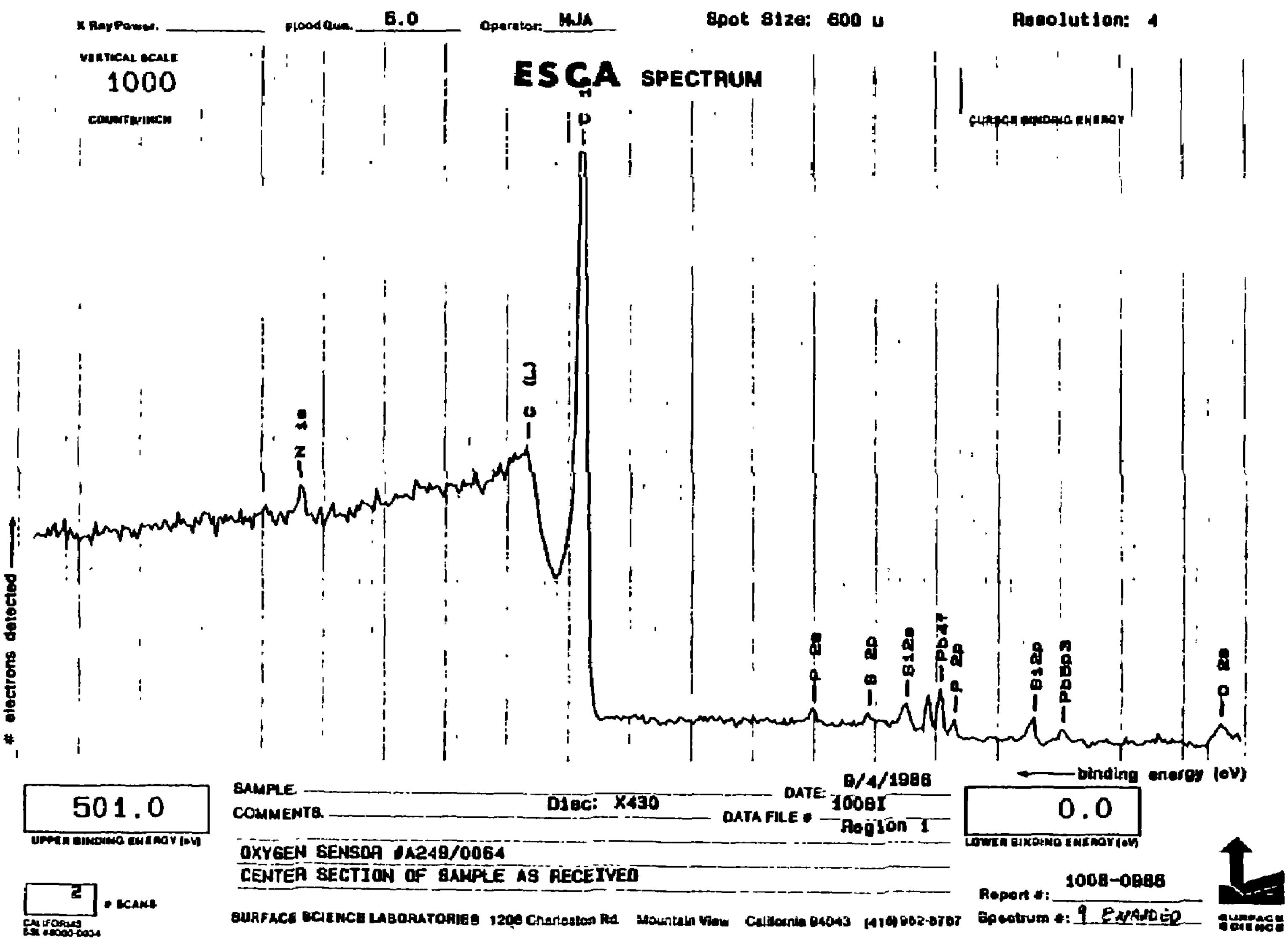


Figure G-14. ESCA Spectrum of Oxygen Sensor A249/0064 from 0 eV to 501 eV (Exterior Surface)

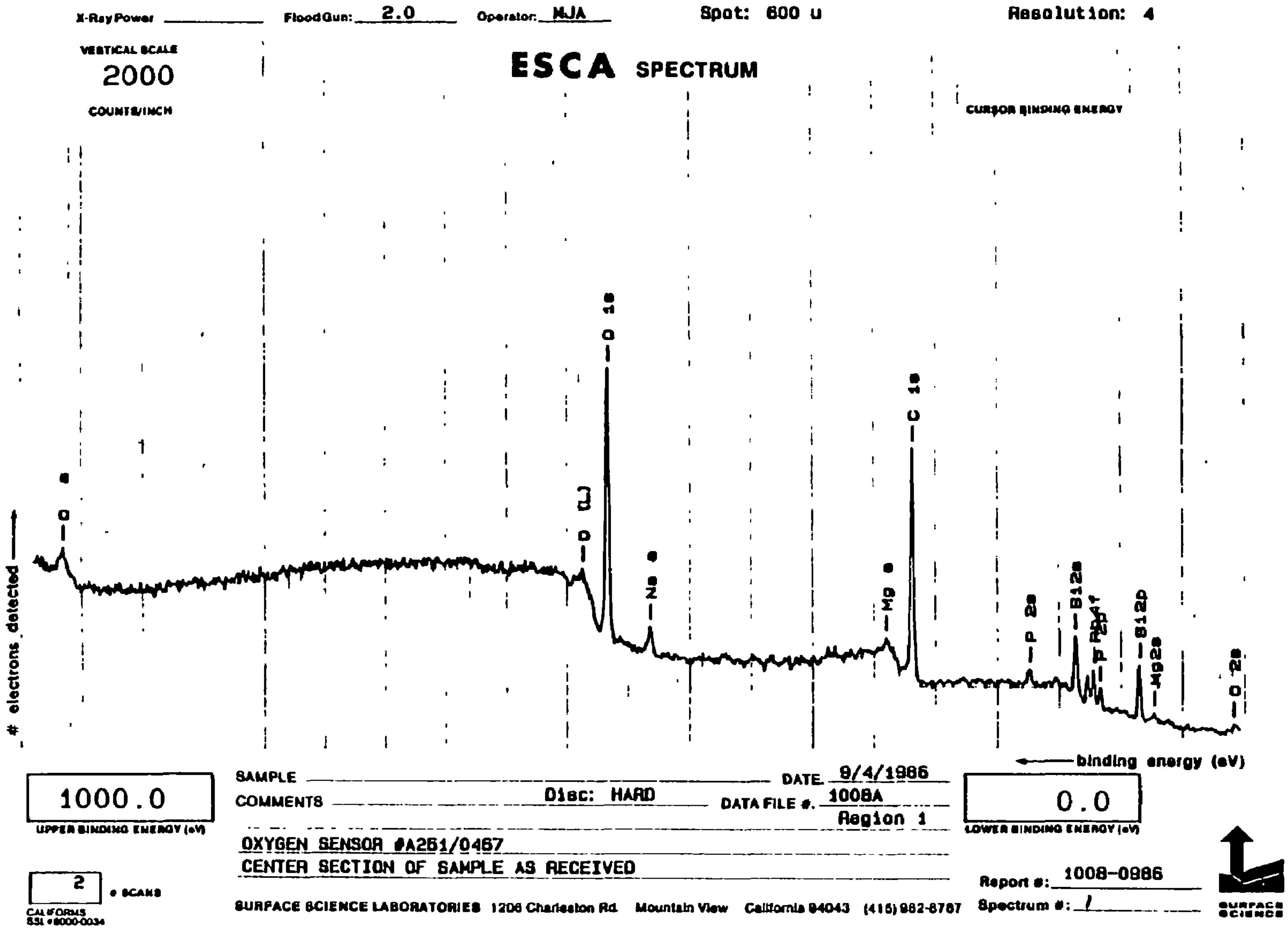


Figure G-15. ESCA Spectrum of Oxygen Sensor A251/0467 from 0 eV to 1000 eV (Exterior Surface)

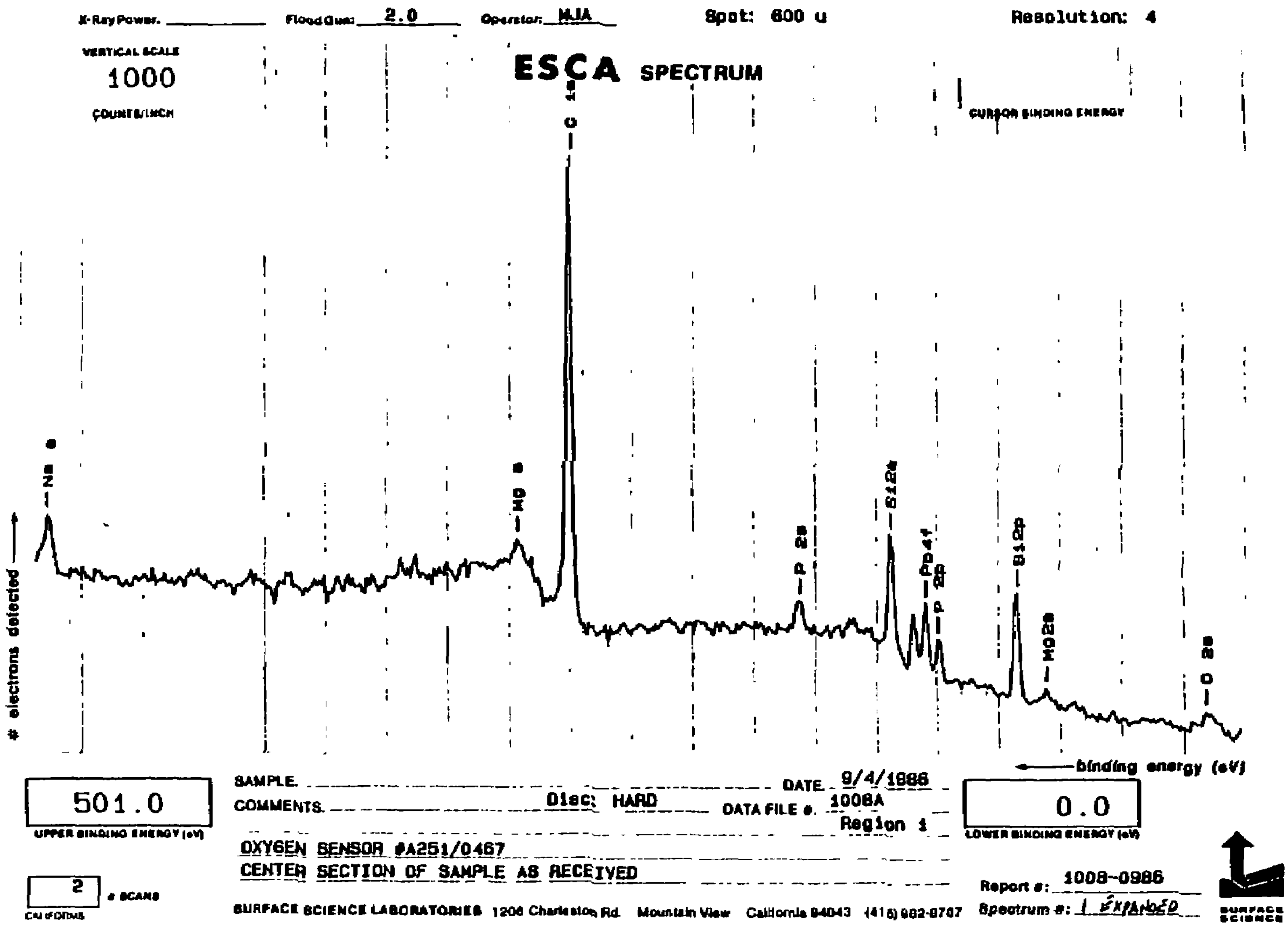


Figure G-16. ESCA Spectrum of Oxygen Sensor A251/0467 from 0 eV to 501 eV (Exterior Surface)

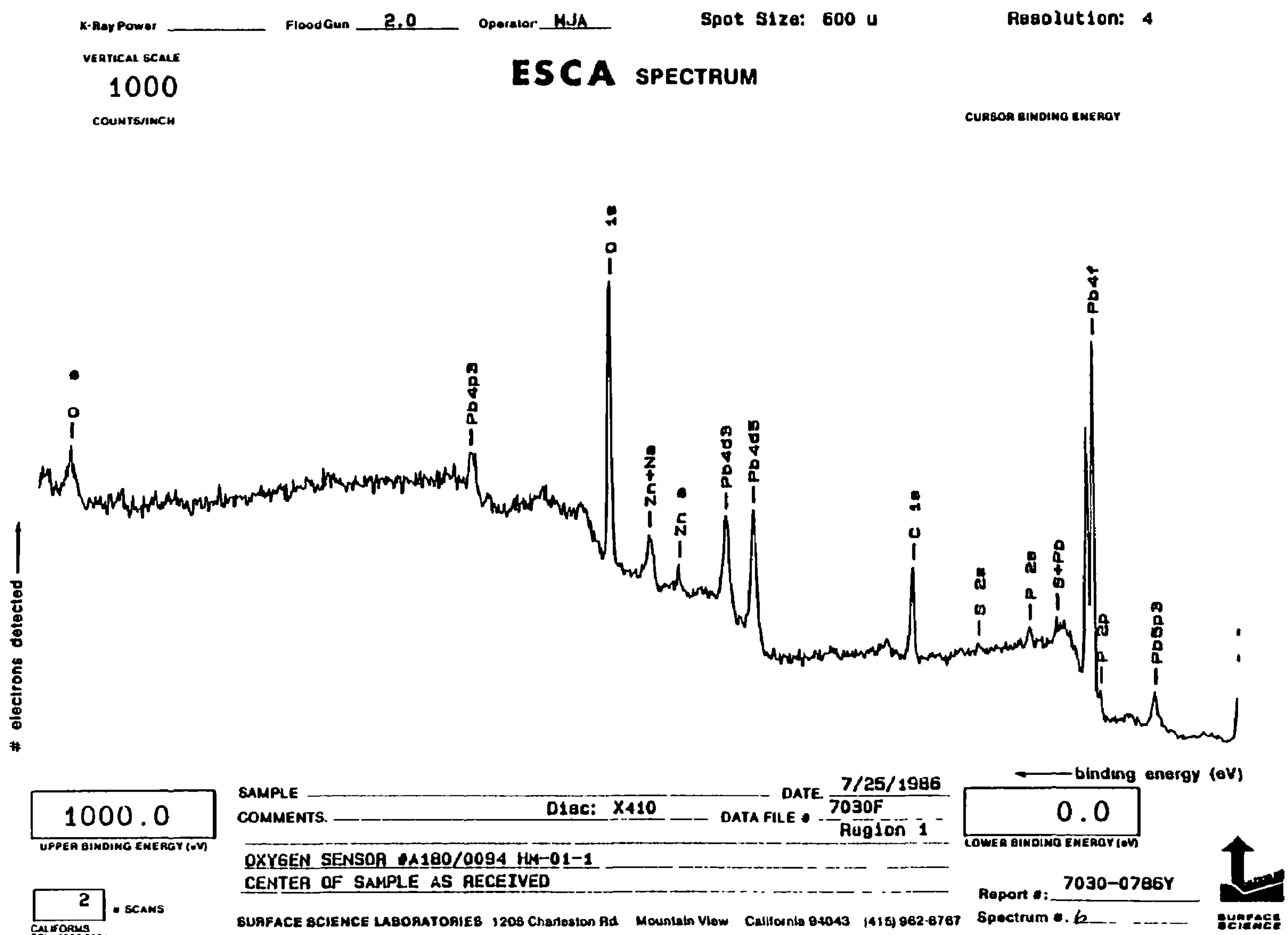


Figure G-17. ESCA Spectrum of Oxygen Sensor A180/0094 from 0 eV to 1000 eV (Exterior Surface)

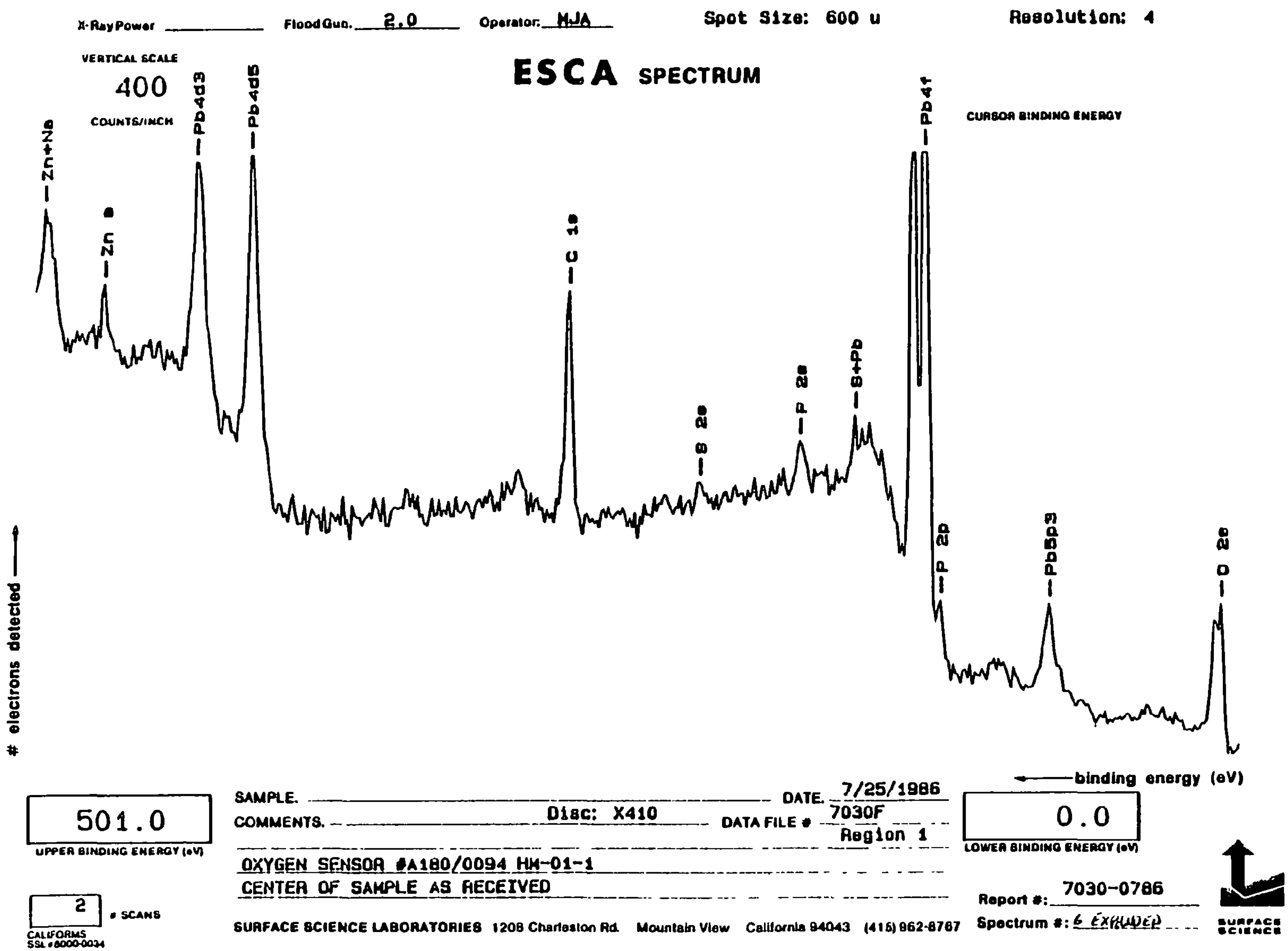


Figure G-18. ESCA Spectrum of Oxygen Sensor A180/0094 from 0 eV to 501 eV (Exterior Surface)

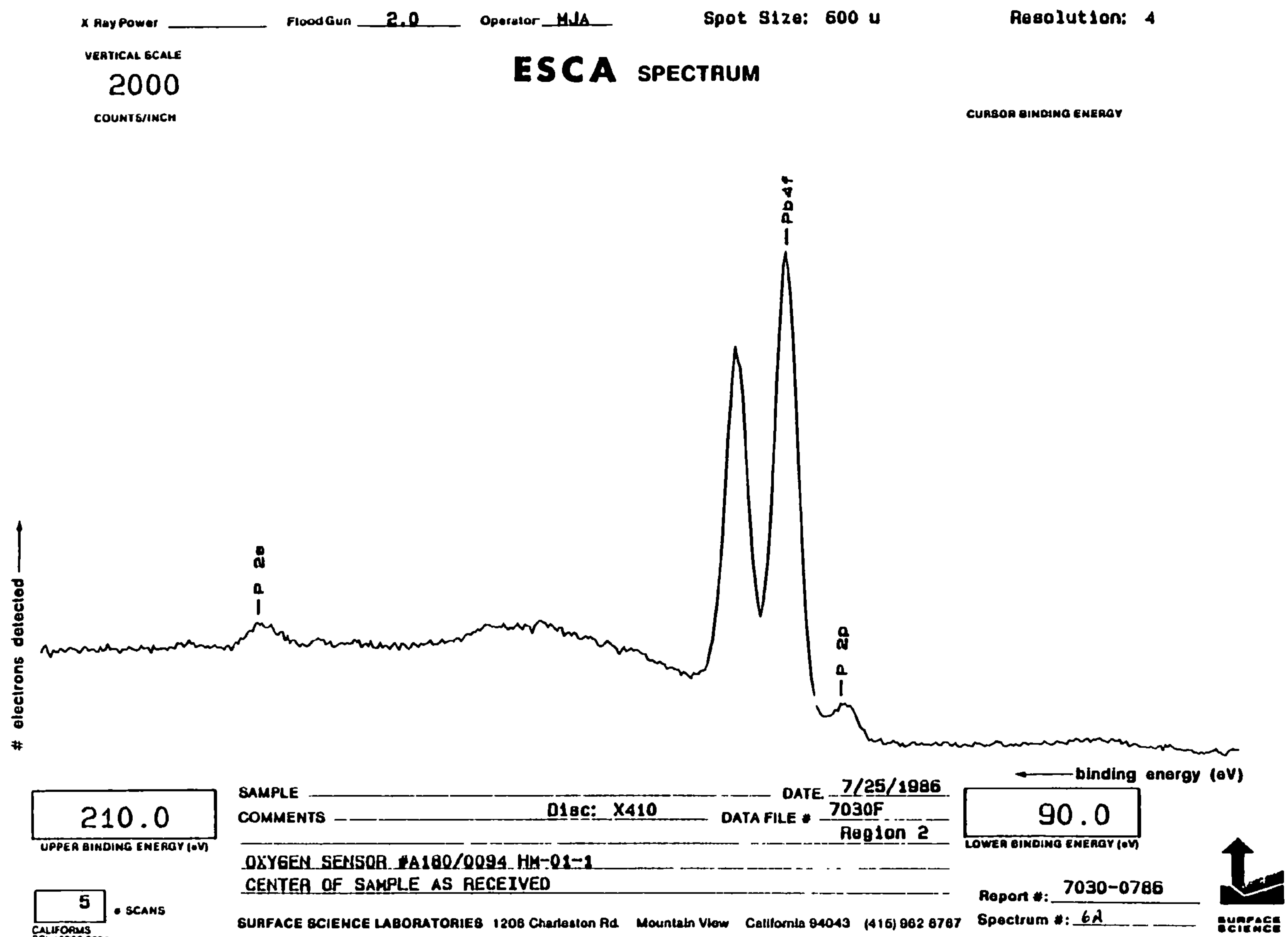


Figure G-19. ESCA Spectrum of Oxygen Sensor A180/0094 from 90 eV to 210 eV (Exterior Surface)

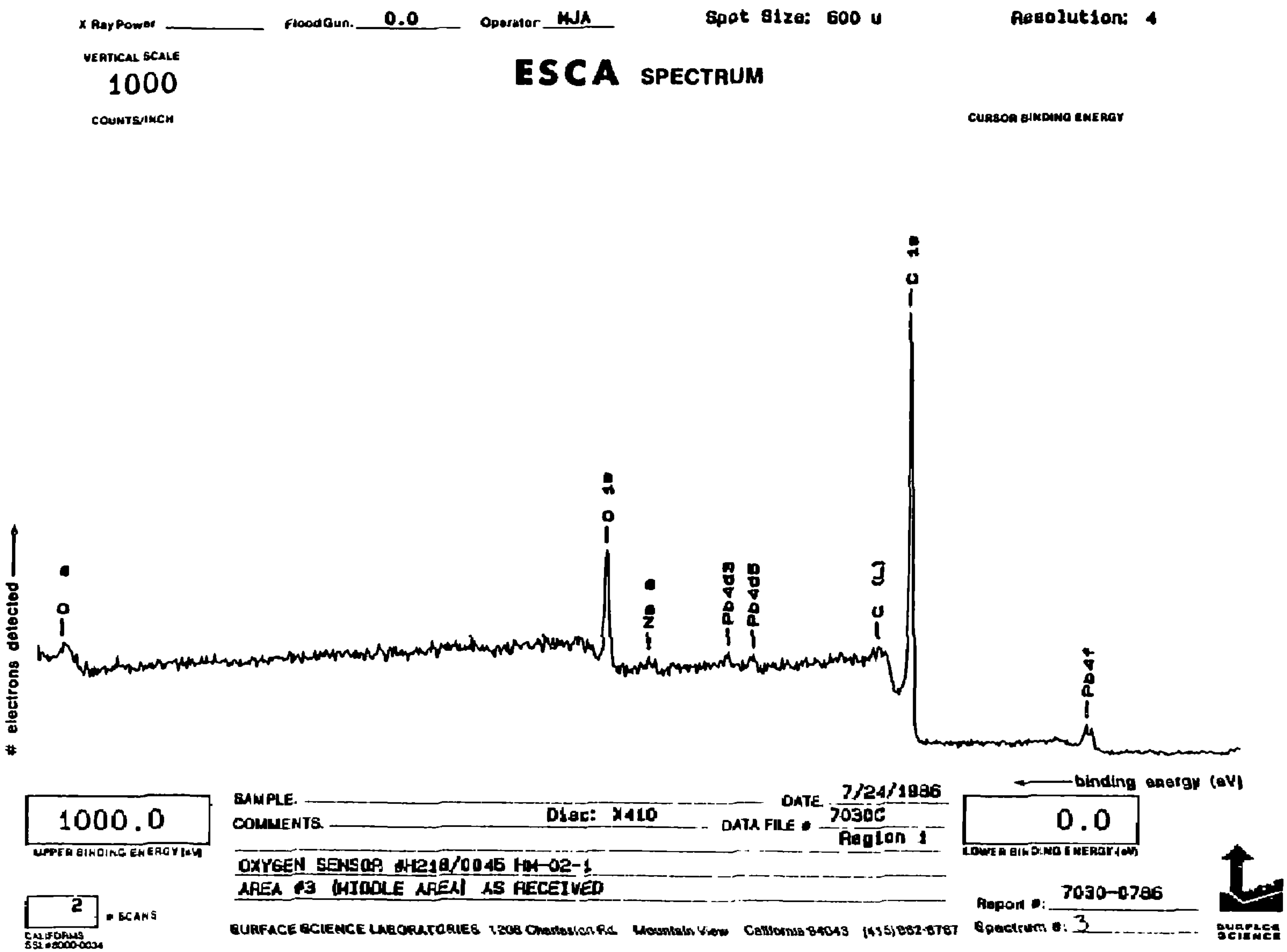


Figure G-20. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Exterior Surface)

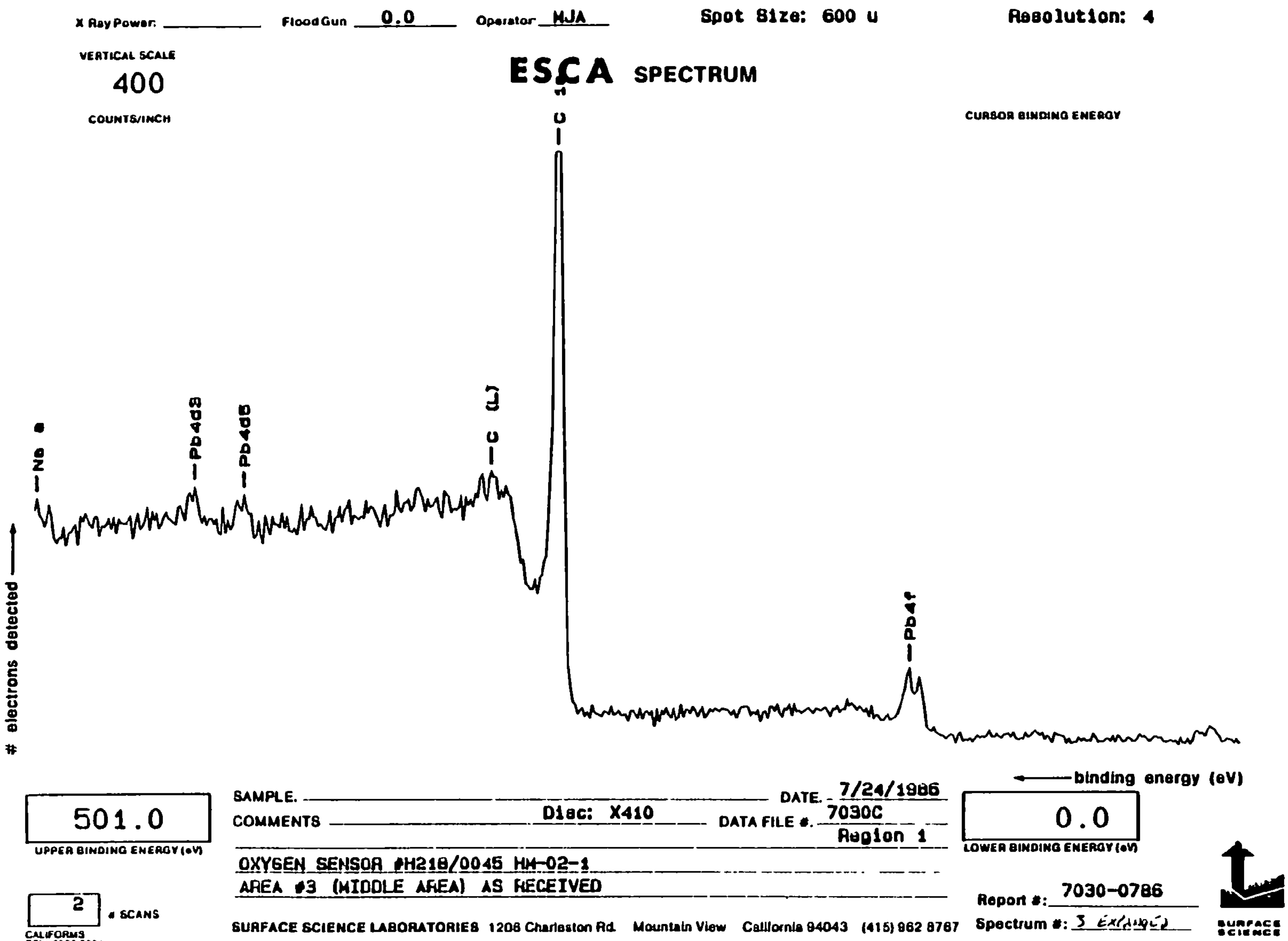


Figure G-21. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Exterior Surface)

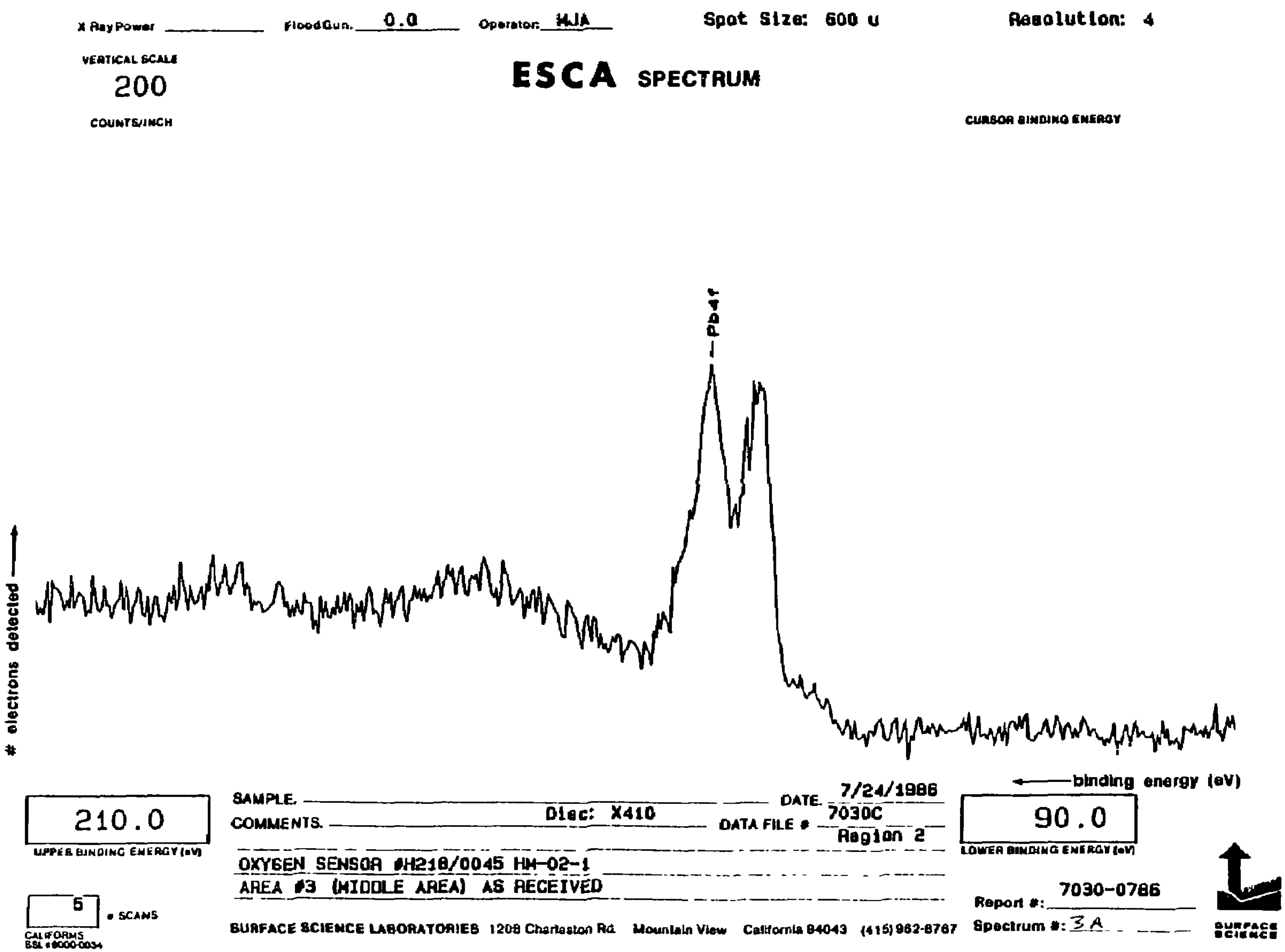


Figure G-22. ESCA Spectrum of Oxygen Sensor A218/0045 from 90 eV to 210 eV (Exterior Surface)

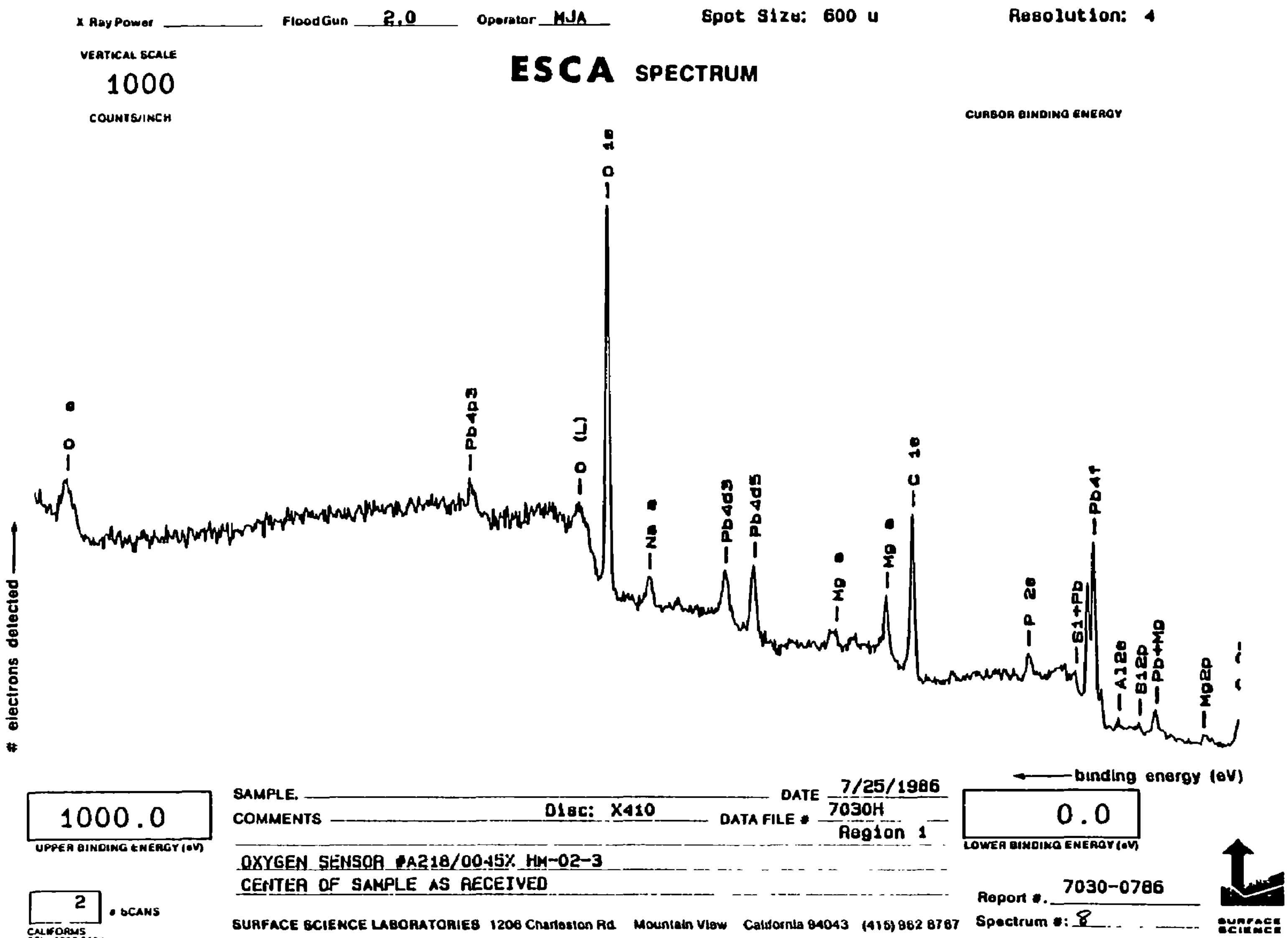


Figure G-23. ESCA Spectrum of Oxygen Sensor A218/0045X from 0 eV to 1000 eV (Exterior Surface)

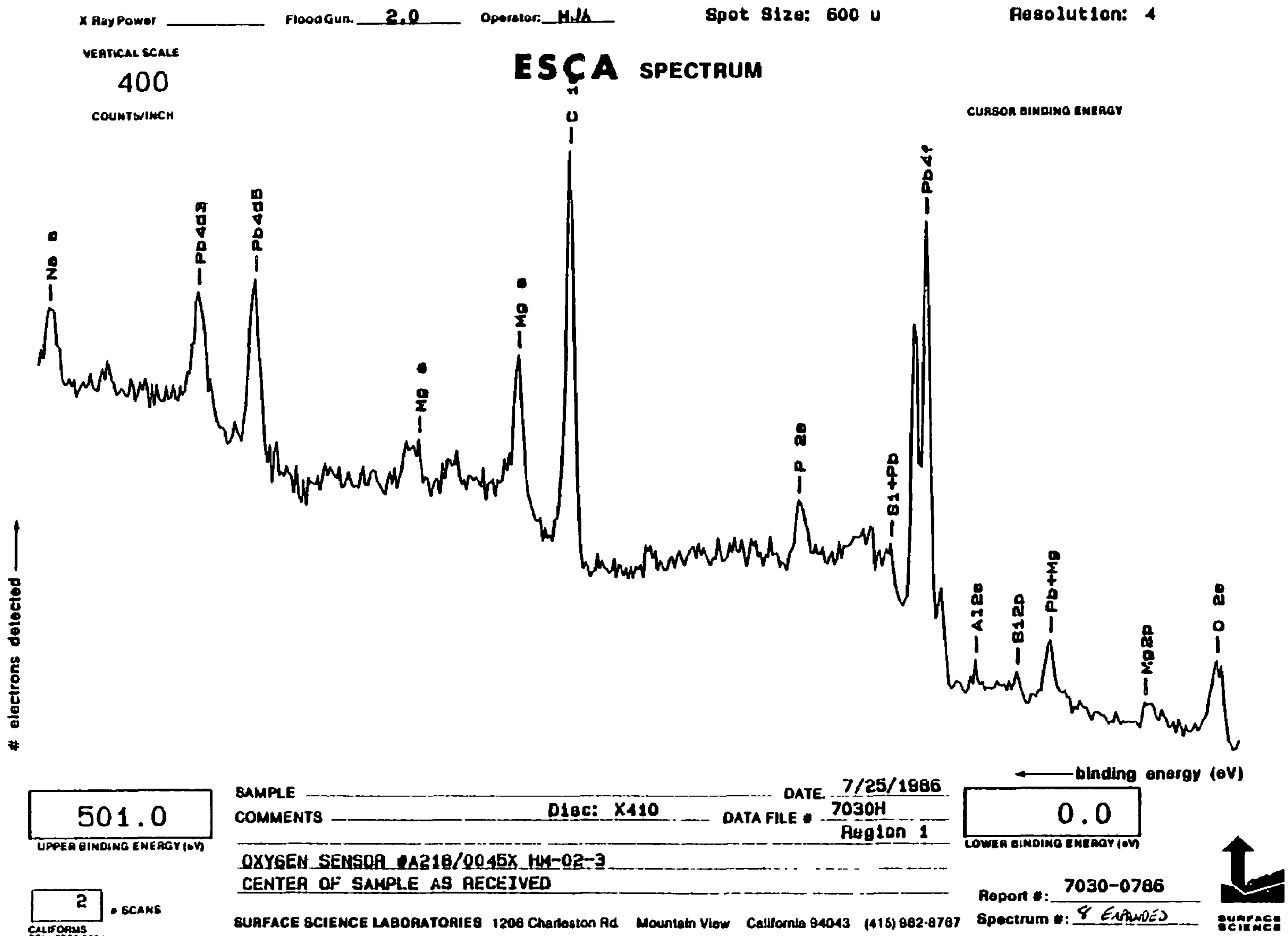


Figure G-24. ESCA Spectrum of Oxygen Sensor A218/0045X from 0 eV to 501 eV (Exterior Surface)

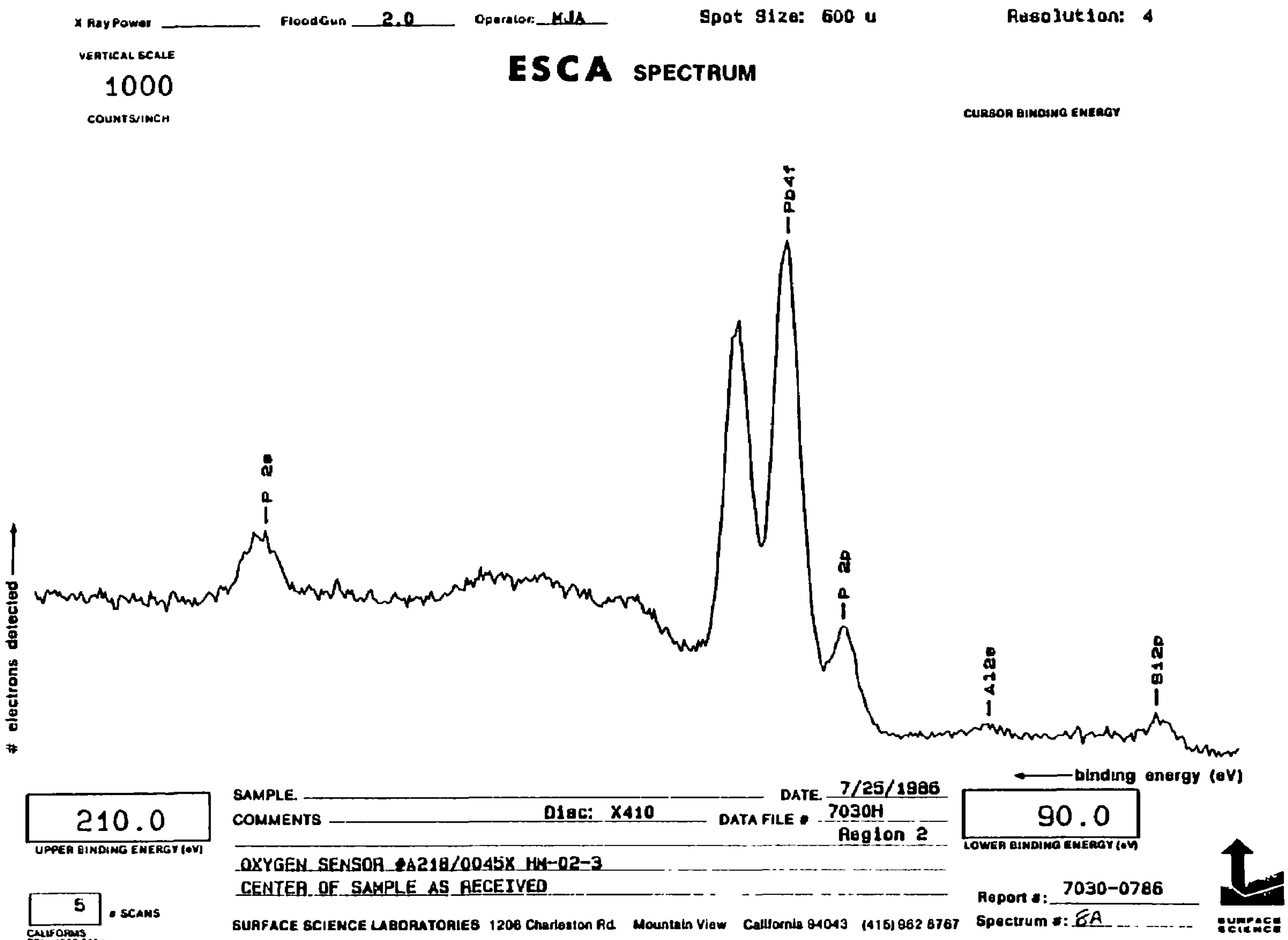


Figure G-25. ESCA Spectrum of Oxygen Sensor A218/0045X from 90 eV to 210 eV (Exterior Surface)

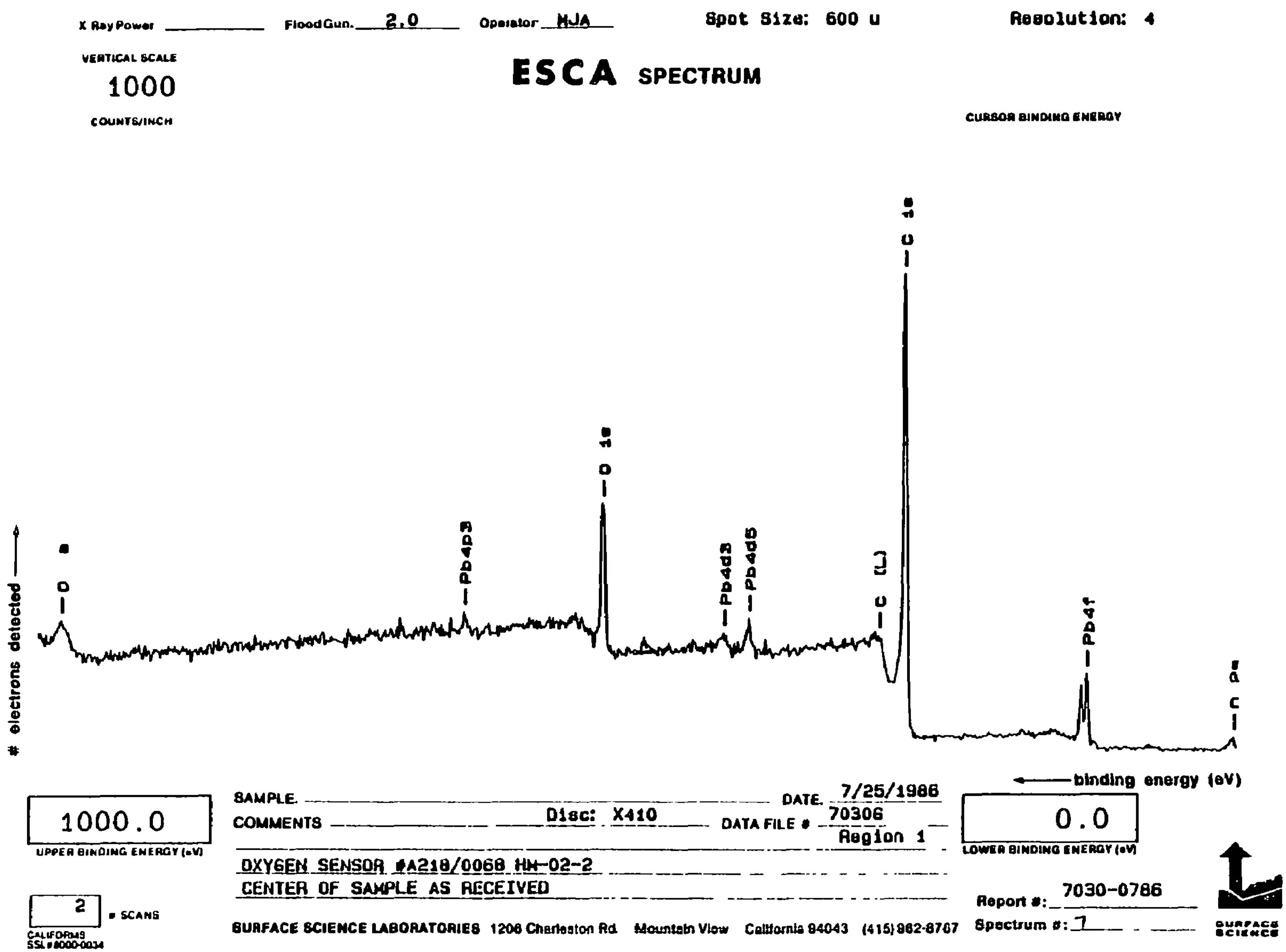


Figure G-26. ESCA Spectrum of Oxygen Sensor A218/0068 from 0 eV to 1000 eV (Exterior Surface)

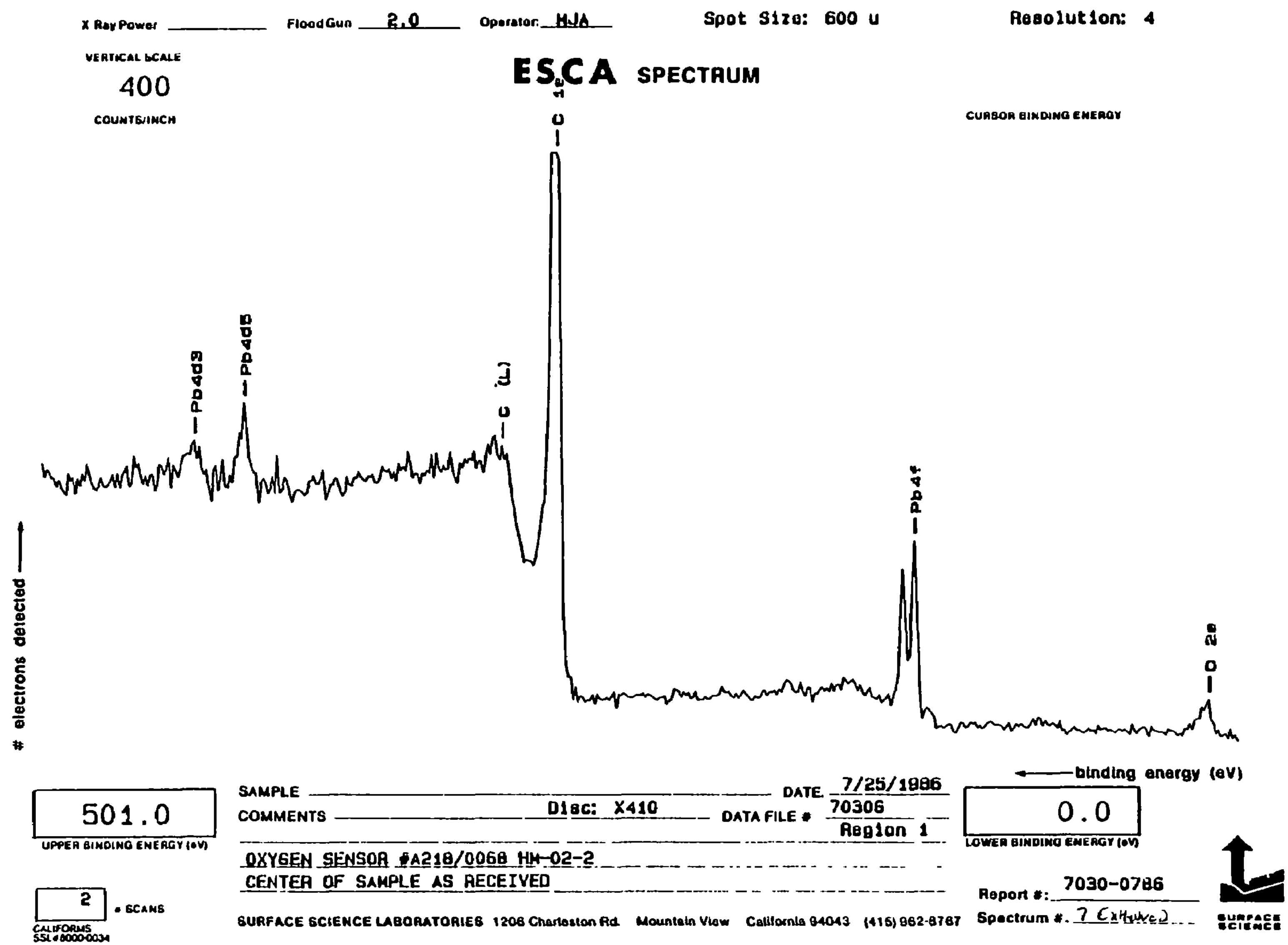


Figure G-27. ESCA Spectrum of Oxygen Sensor A218/0068 from 0 eV to 501 eV (Exterior Surface)

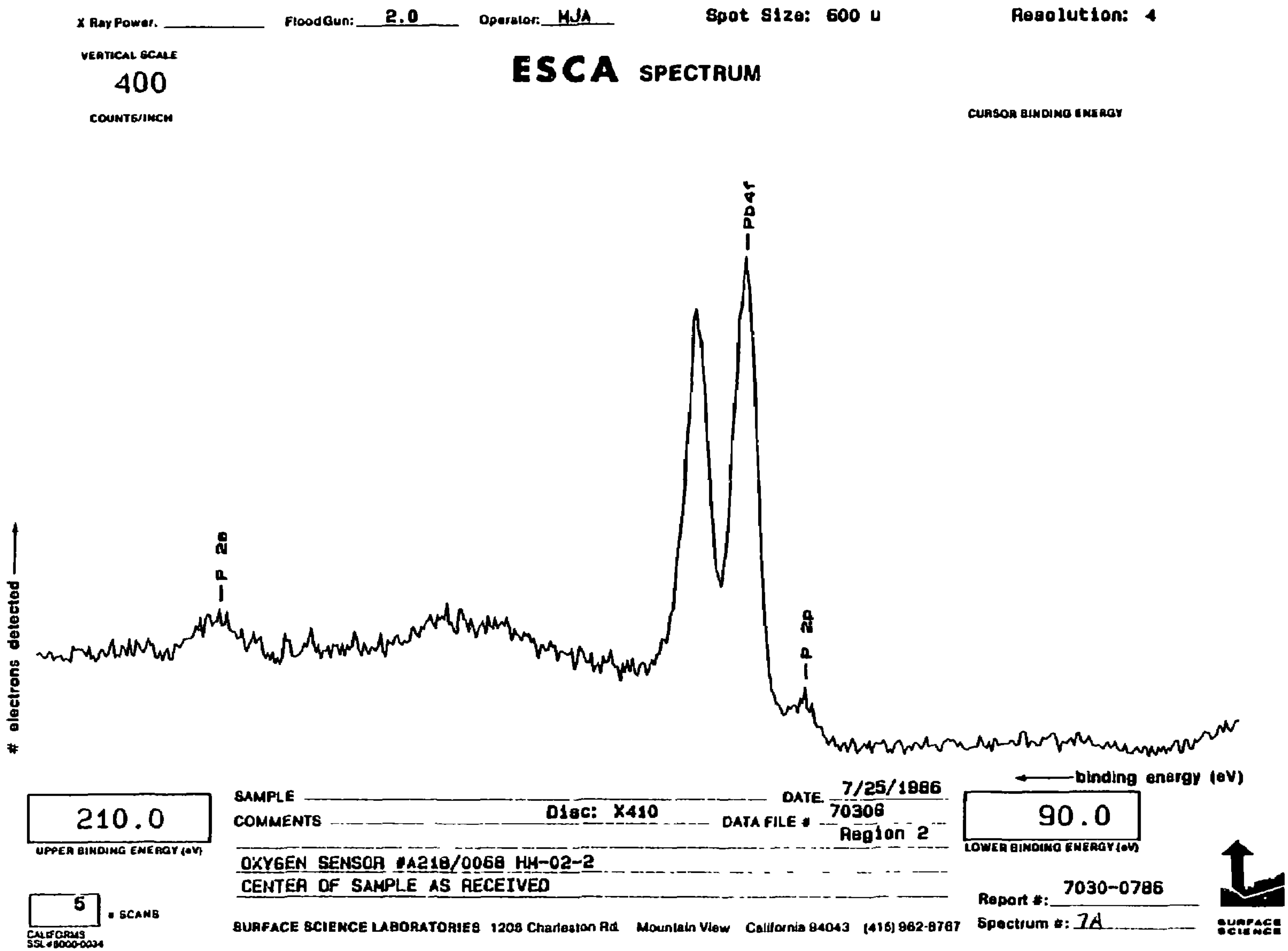


Figure G-28. ESCA Spectrum of Oxygen Sensor A218/0068 from 90 eV to 210 eV (Exterior Surface)

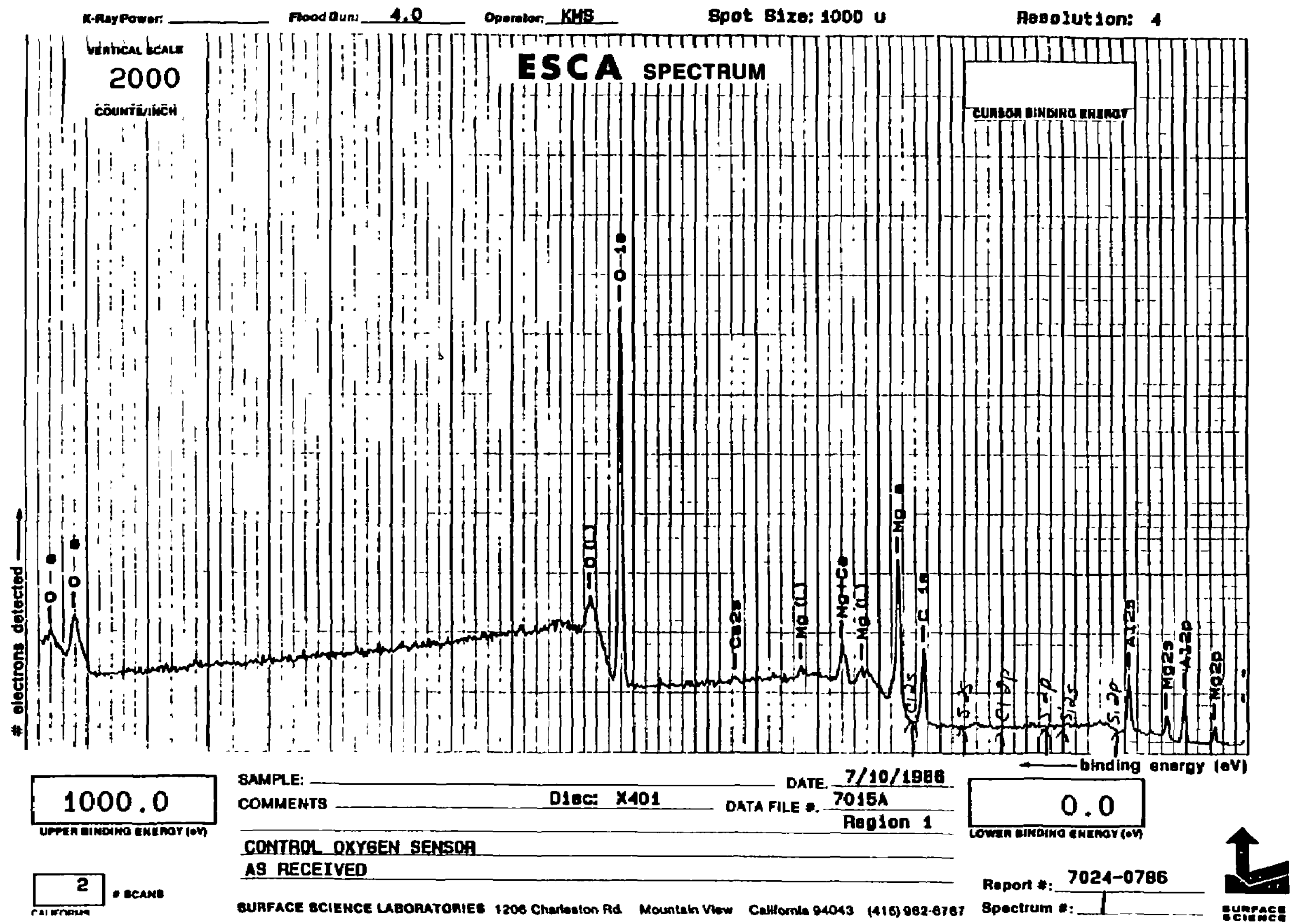


Figure G-29. ESCA Spectrum of New Chrysier Sensor 0 eV to 1000 eV (Exterior Surface)

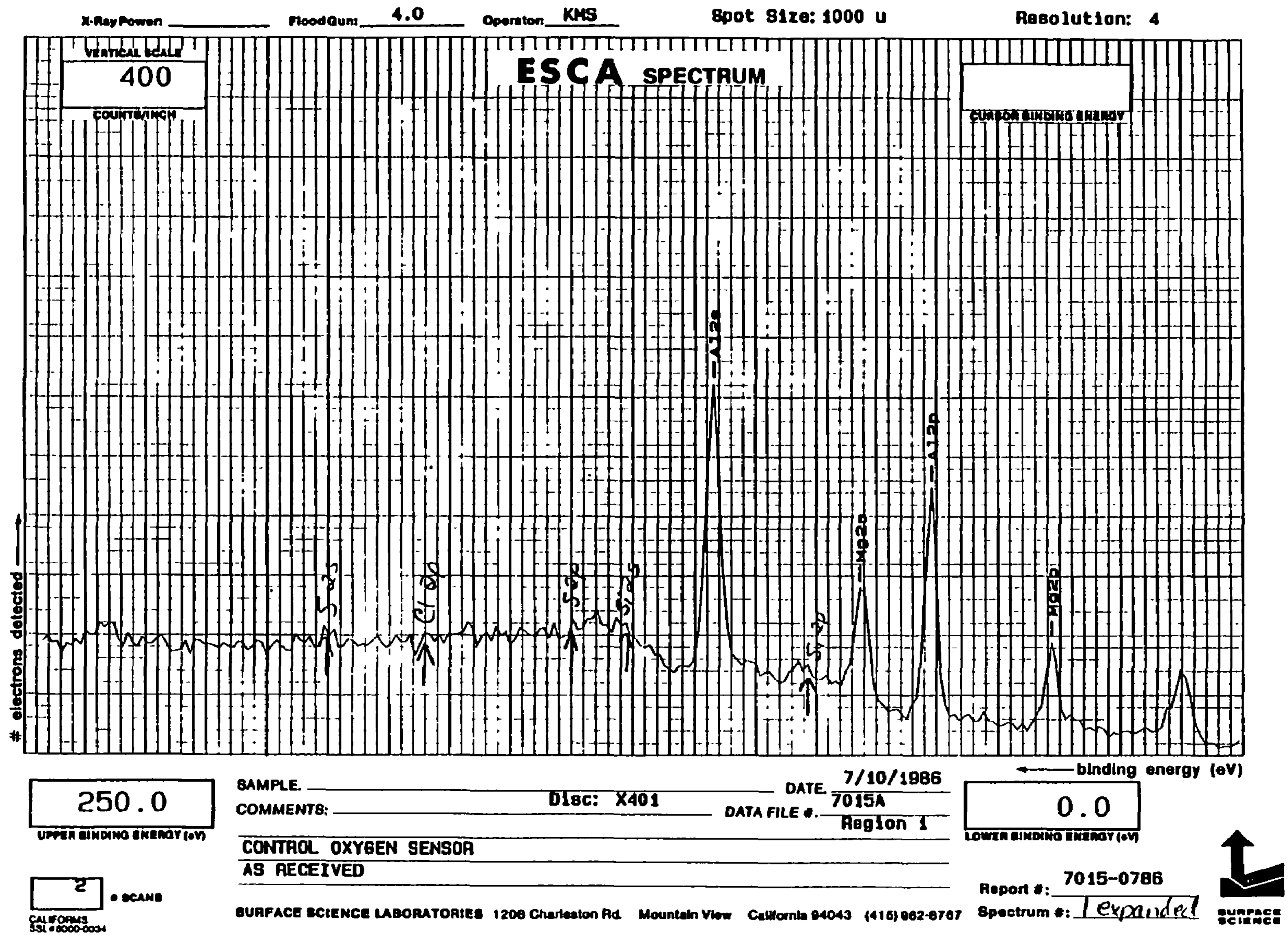


Figure G-30. ESCA Spectrum of New Chrysler Sensor from 0 eV to 250 eV (Exterior Surface)

APPENDIX H

QUALITY ASSURANCE TESTING OF ON-ENGINE CONVERTER EFFICIENCIES AND LIGHT-OFF TIMES

TABLE H-1. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A215/0201 K/G
TEST 1

A/F Ratio	Sample Location	Converter Efficiency Data HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.15	Inlet	1899	1.01	1571	0.58	14.27	707
	Outlet	225	0.02	383			710
	CE %	88.2	98.0	75.6			
14.33	Inlet	1849	0.83	1622	0.58	14.27	708
	Outlet	150	0.003	460			680
	CE %	91.9	99.6	71.6			
14.50	Inlet	1699	0.65	1622	0.73	14.27	705
	Outlet	125	0.003	460			651
	CE %	92.6	99.5	71.6			
14.66	Inlet	1549	0.57	1609	0.83	14.41	705
	Outlet	125	0.003	837			636
	CE %	91.9	99.5	48.0			
14.86	Inlet	1299	0.35	1584	1.03	14.12	705
	Outlet	100	0.002	1138			613
	CE %	92.3	99.4	28.2			
15.05	Inlet	1274	0.34	1521	1.18	14.12	705
	Outlet	100	0.002	1189			604
	CE %	92.2	99.4	21.8			
15.29	Inlet	1124	0.24	1421	1.43	13.98	705
	Outlet	100	0.002	1138			583
	CE %	91.1	99.2	19.9			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.15	1800	16.35	23.2	48.7	3.06	96	0.7	956	5.0	29.13
14.33	1800	16.35	23.1	48.9	3.06	96	0.7	959	5.0	29.13
14.50	1800	16.35	22.8	48.9	3.06	96	0.7	962	5.0	29.13
14.66	1800	16.35	22.7	48.9	3.06	96	0.7	962	5.0	29.14
14.86	1800	16.35	22.5	48.9	3.20	95	0.7	962	5.0	29.14
15.05	1800	16.35	22.2	49.1	3.19	95	0.7	964	5.0	29.15
15.29	1800	16.4	21.4	49.1	3.19	95	0.7	963	5.0	29.15

TABLE H-2. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A215/0201 K/G
TEST 2

A/F Ratio	Sample Location	Converter Efficiency Data HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.11	Inlet	1850	1.22	1609	0.39	13.84	706
	Outlet	300	0.02	686			725
	CE %	83.8	98.4	57.4			
14.27	Inlet	1799	0.92	1634	0.58	13.84	708
	Outlet	250	0.01	510			690
	CE %	86.1	98.9	68.8			
14.48	Inlet	1649	0.68	1735	0.68	14.12	710
	Outlet	150	0.003	384			659
	CE %	90.9	99.6	77.9			
14.66	Inlet	1549	0.55	1785	0.78	13.84	710
	Outlet	150	0.002	937			634
	CE %	90.3	99.6	47.5			
14.86	Inlet	1449	0.42	1735	0.98	13.84	712
	Outlet	150	0.002	1138			619
	CE %	89.6	99.5	34.4			
15.05	Inlet	1299	0.35	1710	1.18	13.56	712
	Outlet	100	0.002	1214			603
	CE %	92.3	99.4	29.0			
15.27	Inlet	1149	0.28	1584	1.43	13.56	711
	Outlet	100	0.002	1189			590
	CE %	91.3	99.3	24.9			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.11	1805	16.3	24.4	51.0	3.23	96	0.8	964	4.9	29.32
14.27	1805	16.3	24.3	50.8	3.23	96	0.8	966	4.9	29.32
14.48	1805	16.3	23.9	50.8	3.31	97	0.8	969	4.9	29.31
14.66	1805	16.3	23.8	50.9	3.31	97	0.8	970	4.9	29.31
14.86	1805	16.3	23.5	50.9	3.31	97	0.8	971	4.9	29.30
15.05	1805	16.3	23.2	50.9	3.31	97	0.8	971	4.9	29.30
15.27	1805	16.3	22.8	50.6	3.36	97	0.8	969	4.9	29.29

TABLE H-3. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT A215/0201 K/G
TEST 3

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.14	Inlet	1874	1.22	1521	0.48	14.12	702
	Outlet	250	0.01	409			708
	CE %	86.6	99.2	73.1			
14.32	Inlet	1974	1.19	1509	0.48	14.12	702
	Outlet	250	0.01	422			714
	CE %	87.3	99.2	72.0			
14.50	Inlet	1499	0.48	1672	0.73	14.12	702
	Outlet	125	0.002	962			631
	CE %	91.7	99.6	42.4			
14.67	Inlet	1499	0.53	1622	0.83	14.12	701
	Outlet	100	0.001	1088			628
	CE %	93.3	99.8	32.9			
14.87	Inlet	1324	0.39	1634	1.03	13.98	702
	Outlet	100	0.001	1163			605
	CE %	92.4	99.7	28.8			
15.14	Inlet	1149	0.28	1584	1.33	13.98	702
	Outlet	100	0.001	1163			578
	CE %	91.3	99.6	26.6			
15.27	Inlet	1049	0.22	1571	1.43	13.98	702
	Outlet	75	0.001	1176			576
	CE %	92.8	99.6	25.1			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.14	1800	16.55	22.5	48.5	3.10	100	0.8	953	4.9	29.22
14.32	1800	16.55	22.6	48.4	3.10	101	0.8	955	4.9	29.22
14.50	1800	16.55	22.3	48.4	3.21	102	0.8	959	4.9	29.21
14.67	1800	16.55	22.0	48.2	3.20	102	0.8	959	4.9	29.21
14.87	1800	16.55	21.5	48.2	3.20	102	0.8	959	4.5	20.20
15.14	1800	16.55	21.0	48.2	3.20	102	0.8	959	4.5	29.20
15.27	1800	16.55	21.1	48.3	3.20	102	0.8	959	4.5	29.19

TABLE H-4. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A215/0201 K/Ç
TESTS 1 AND 2

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1724	26	1699	27
	CO	1.99	21	2.06	20
	NO_x	1307	25	1096	24
50	HC	1724	36	1699	30
	CO	1.99	30	2.06	30
	NO_x	1307	NA	1096	NA
80	HC	1724	54	1699	52
	CO	1.99	38	2.06	37
	NO_x	1307	NA	1096	NA

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1774	200	88.7	1699	225	86.8
	CO	1.95	.003	99.8	2.06	0.003	99.8
	NO_x	1320	1264	4.2	1408	1289	8.4
at 600 sec	HC	1674	200	88.0	1775	200	88.7
	CO	1.97	0.003	99.8	2.02	0.003	99.8
	NO_x	1320	1251	5.2	1370	1276	6.9

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
1	1800	10.55	48.2	80.6	10.31	97	1.4	1083	14.2	29.10
2	1800	10.35	50.3	83.3	10.81	91	1.5	1087	14.2	29.34

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE H-5. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT A215/0201R
TEST 3

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 3 Converter Inlet	Test 3 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1549	28		
	CO	2.04	22		
	NO_x	1307	30		
50	HC	1549	35		
	CO	2.04	30		
	NO_x	1307	NA		
80	HC	1549	52		
	CO	2.04	36		
	NO_x	1307	NA		

Converter Response

Efficiency %	Emission	Test 3 Converter In	Test 3 Converter Out	Test 3 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1574	200	87.3			
	CO	2.01	0.004	99.8			
	NO_x	1345	1251	7.0			
at 600 sec	HC	1524	175	88.5			
	CO	1.99	0.003	99.8			
	NO_x	1307	1234	5.2			

Engine Operation Data

Test No.	Speed rpm	Man Vac in.Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in.H_2O Vac	Exhaust °F	Exhaust in.H_2O	Bar. in. Hg
				2% CO, 5% O_2						
3	1800	10.1	51.1	84.0	11.1	97	1.5	1083	14.5	29.25

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE H-6. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT EPA 1174R
TEST 1

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.15	Inlet	2149	1.37	1546	0.63	13.70	714
	Outlet	300	0.05	560			777
	CE %	86.0	96.4	63.8			
14.26	Inlet	2074	1.16	1609	0.68	13.84	715
	Outlet	225	0.005	345			754
	CE %	89.2	99.6	78.6			
14.48	Inlet	1924	0.84	1659	0.83	13.98	717
	Outlet	150	0.004	611			709
	CE %	92.2	99.5	63.2			
14.68*	Inlet	1724	0.70	1685	0.93	13.98	718
	Outlet	125	0.003	837			683
	CE %	92.8	99.6	50.3			
14.85	Inlet	1549	0.55	1697	1.08	13.98	719
	Outlet	125	0.003	1138			660
	CE %	91.9	99.4	32.9			
15.05	Inlet	1374	0.40	1672	1.23	13.98	719
	Outlet	125	0.003	1276			641
	CE %	90.9	99.2	23.7			
15.25	Inlet	1300	0.35	1622	1.48	13.84	718
	Outlet	137	0.003	1276			621
	CE %	89.5	99.1	21.3			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.15	1800	16.1	24.3	50.1	1.88	100	0.7	957	5.0	29.18
14.26	1800	16.1	24.0	50.0	1.90	99	0.7	959	5.0	29.18
14.48	1800	16.1	23.6	50.0	1.90	99	0.7	961	5.0	29.19
14.68	1800	16.1	23.6	49.8	1.93	99	0.7	964	5.0	29.19
14.85	1800	16.15	23.2	49.8	1.95	99	0.7	964	5.0	29.19
15.05	1800	16.15	23.0	49.8	1.98	98	0.7	965	5.0	29.19
15.25	1800	16.15	22.8	49.8	1.98	98	0.7	964	5.0	29.19

*HC not within tolerances at 14.7 air/fuel ratio

TABLE H-7. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT EPA 1174R
TEST 2

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.09	Inlet	2099	1.37	1295	0.63	14.12	701
	Outlet	300	0.02	686			753
	CE %	85.7	98.5	47.0			
14.31	Inlet	1874	1.13	1358	0.73	14.27	702
	Outlet	250	0.01	384			716
	CE %	86.7	99.1	71.7			
14.46	Inlet	1699	0.87	1408	0.83	14.41	704
	Outlet	174	0.003	460			687
	CE %	89.8	99.7	67.3			
14.66	Inlet	1574	0.68	1421	0.93	14.41	706
	Outlet	150	0.002	812			659
	CE %	90.5	99.7	42.9			
14.91	Inlet	1399	0.51	1408	1.13	14.41	707
	Outlet	100	0.002	963			633
	CE %	92.8	99.6	42.9			
15.06	Inlet	1174	0.37	1433	1.28	14.27	707
	Outlet	100	0.002	1088			614
	CE %	91.5	99.5	24.1			
15.34	Inlet	999	0.25	1345	1.63	13.98	705
	Outlet	100	0.001	1013			599
	CE %	90.0	99.6	24.7			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
14.09	1799	16.6	21.9	47.1	1.69	104	0.75	949	5.0	29.21
14.31	1796	16.6	21.7	46.6	1.72	106	0.75	953	5.0	29.21
14.46	1796	16.6	21.5	46.8	1.72	105	0.75	956	5.0	29.20
14.66	1797	16.65	21.2	46.6	1.75	105	0.7	960	5.0	29.20
14.91	1794	16.65	20.7	46.6	1.77	106	0.7	962	5.0	29.20
15.06	1798	16.65	20.7	46.5	1.77	106	0.7	963	5.0	29.19
15.34	1793	16.65	20.0	46.5	1.77	106	0.7	962	5.0	29.1

TABLE H-8. CATALYTIC CONVERTER EFFICIENCY - STEADY-STATE
UNIT EPA 1174R
TEST 3

A/F Ratio	Sample Location	Converter Efficiency Data: HC ppm	CO %	NO_x ppm	O_2 %	CO_2 %	Temp. °F
14.08	Inlet	1974	1.53	1395	0.63	13.70	700
	Outlet	300	0.08	711			761
	CE %	84.8	94.8	49.0			
14.29	Inlet	1824	1.11	1471	0.73	13.84	701
	Outlet	225	0.006	396			703
	CE %	87.7	99.5	73.1			
14.48	Inlet	1674	0.91	1496	0.83	13.98	703
	Outlet	150	0.003	434			675
	CE %	91.0	99.7	71.0			
14.72	Inlet	1449	0.60	1534	0.98	14.12	703
	Outlet	125	0.002	875			642
	CE %	91.4	99.7	43.0			
14.94	Inlet	1324	0.47	1546	1.13	14.12	703
	Outlet	125	0.002	1088			618
	CE %	90.6	99.6	29.6			
15.09	Inlet	1149	0.37	1496	1.33	13.98	704
	Outlet	100	0.002	1138			599
	CE %	91.3	99.5	23.9			
15.27	Inlet	1074	0.30	1446	1.63	13.98	703
	Outlet	100	0.001	1151			590
	CE %	90.7	99.7	20.4			

Engine Operation Data

A/F Ratio	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM: Engine	Air Flow, SCFM: Injected	Intake Air: °F	Intake Air: in. H_2O Vac	Exhaust: °F	Exhaust: in. H_2O	Bar. in. Hg
14.08	1799	16.55	22.1	47.0	1.96	109	0.75	943	5.0	29.13
14.29	1798	16.55	21.9	46.7	1.98	109	0.75	948	5.0	29.12
14.48	1795	16.6	21.7	46.7	1.99	109	0.75	951	5.0	29.12
14.72	1794	16.6	21.3	46.7	2.00	109	0.75	952	5.0	29.12
14.94	1793	16.6	21.0	46.5	2.00	110	0.75	953	5.0	29.12
15.09	1791	16.6	20.6	46.5	2.00	110	0.75	953	5.0	29.11
[illegible]	1792	16.6	20.1	46.3	2.00	110	0.75	954	5.0	29.11

TABLE H-9. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT EPA 1174R
TESTS 1 AND 2

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 1 Converter Inlet	Test 1 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1649	55	1774	40
	CO	1.91	48	2.01	38
	NO_x	1408	32	1320	25
50	HC	1649	63	1774	48
	CO	1.91	57	2.01	42
	NO_x	1408	50	1320	40
80	HC	1649	89	1774	66
	CO	1.91	66	2.01	50
	NO_x	1408	NA	1320	NA

Converter Response

Efficiency %	Emission	Test 1 Converter In	Test 1 Converter Out	Test 1 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1647	150	91.0	1899	150	92.1
	CO	2.06	0.003	99.8	2.08	.002	99.0
	NO_x	1383	1289	6.8	1270	1176	7.4
at 600 sec	HC	1549	175	88.7	1774	150	91.5
	CO	1.99	0.001	99.9	2.12	.001	100.0
	NO_x	1408	1327	5.8	1282	1176	8.3

Engine Operation Data

Test No.	Speed rpm	Man Vac in. Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in. H_2O Vac	Exhaust °F	Exhaust in. H_2O	Bar. in. Hg
				2% CO, 5% O_2						
1	1800	10.9	46.7	77.2	2.14	104	1.4	1071	12.2	29.06
2	1810	11.25	45.6	75.6	9.65	104	1.35	1069	12	29.22

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

TABLE H-10. CATALYTIC CONVERTER EFFICIENCY - LIGHT-OFF
UNIT EPA 1174R
TEST 3

Converter Efficiency Data

Time to Reach % Reduction	Emission[1]	Test 3 Converter Inlet	Test 3 Time Sec.	Test 2 Converter Inlet	Test 2 Time Sec.
20	HC	1749	48		
	CO	2.06	41		
	NO_x	1358	40		
50	HC	1749	54		
	CO	2.06	48		
	NO_x	1358	45		
80	HC	1749	75		
	CO	2.06	55		
	NO_x	1358	NA		

Converter Response

Efficiency %	Emission	Test 3 Converter In	Test 3 Converter Out	Test 3 CE %	Test 2 Converter In	Test 2 Converter Out	Test 2 CE %
at 205 sec	HC	1699	1500	91.2			
	CO	1.95	0.003	99.8			
	NO_x	1333	1289	3.3			
at 600 sec	HC	1699	150	91.2			
	CO	2.18	0.002	99.9			
	NO_x	1245	1239	0.5			

Engine Operation Data

Test No.	Speed rpm	Man Vac in Hg	Power Hp obs	Air Flow, SCFM Engine	Air Flow, SCFM Injected	Intake Air °F	Intake Air in H_2O Vac	Exhaust °F	Exhaust in H_2O	Bar. in Hg
				2% CO, 5% O_2						
3	1796	10.8	47.1	77.1	9.60	106	1.4	1070	12	29.17

NA: Not Achieved
(1) HC and NO_x are ppm, CO is %

APPENDIX I

ESCA SPECTRA OF OXYGEN SENSOR TIPS AT VARIOUS LOCATIONS

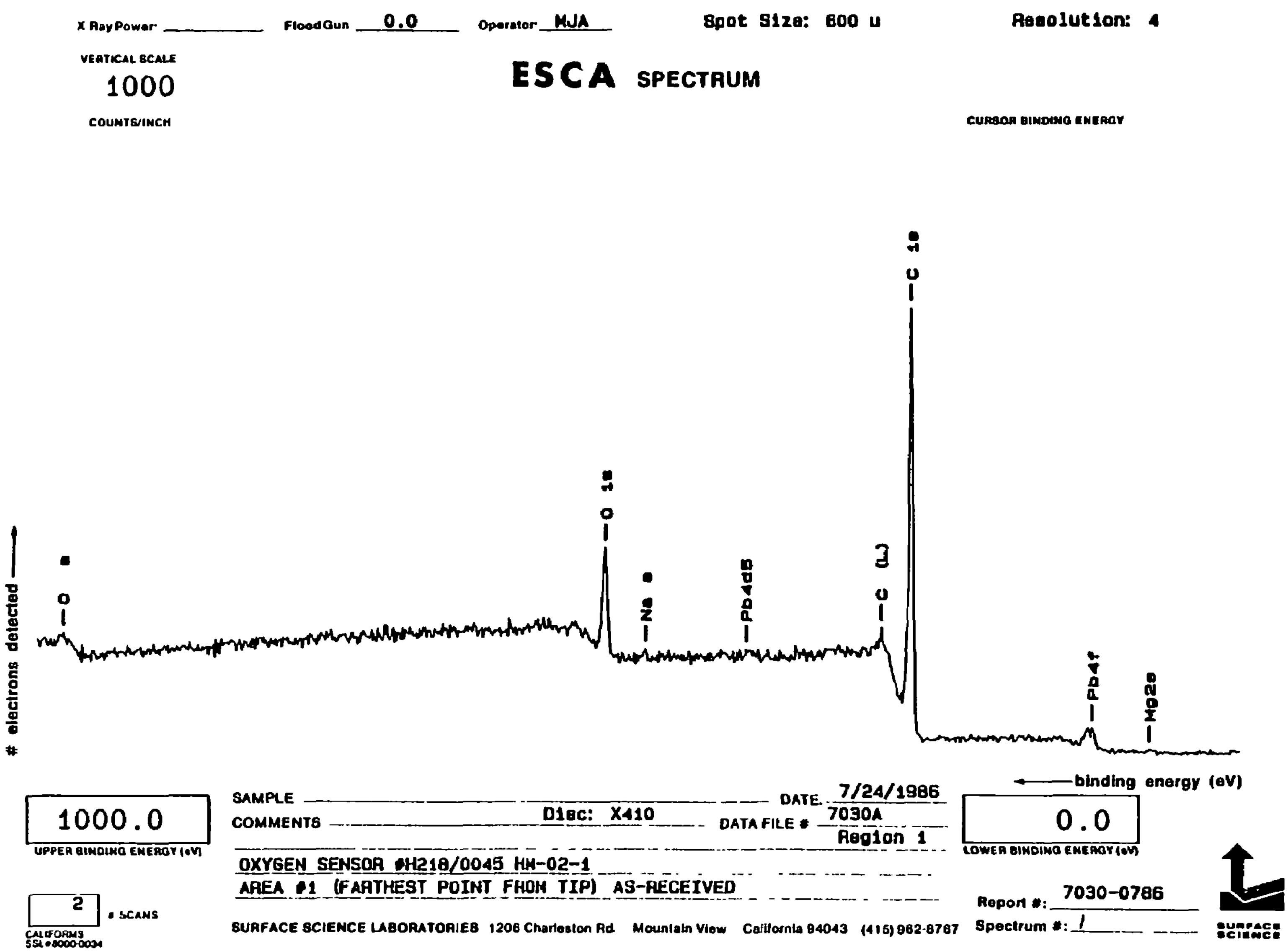


Figure I-1. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 1)

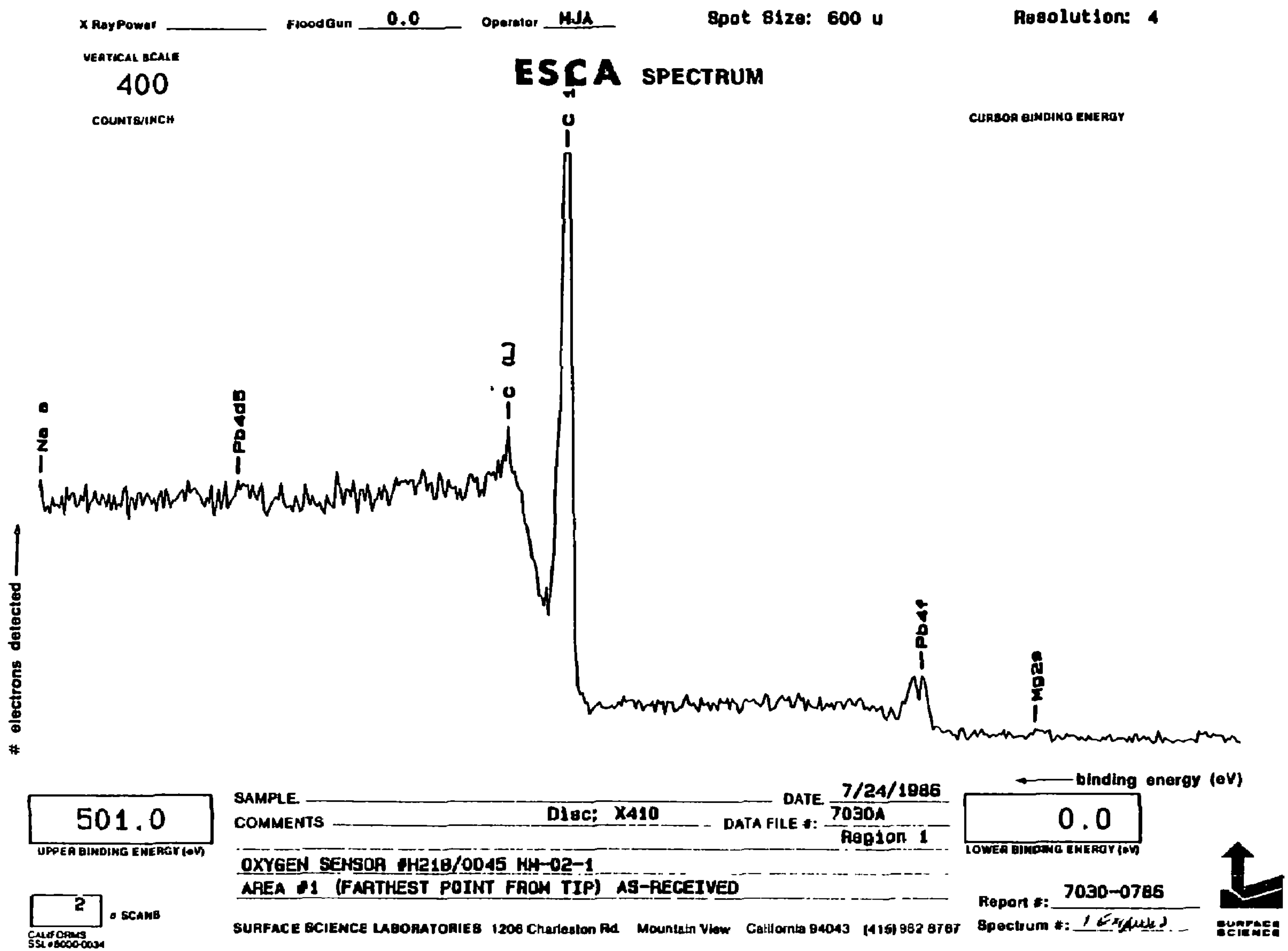


Figure I-2. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Location 1)

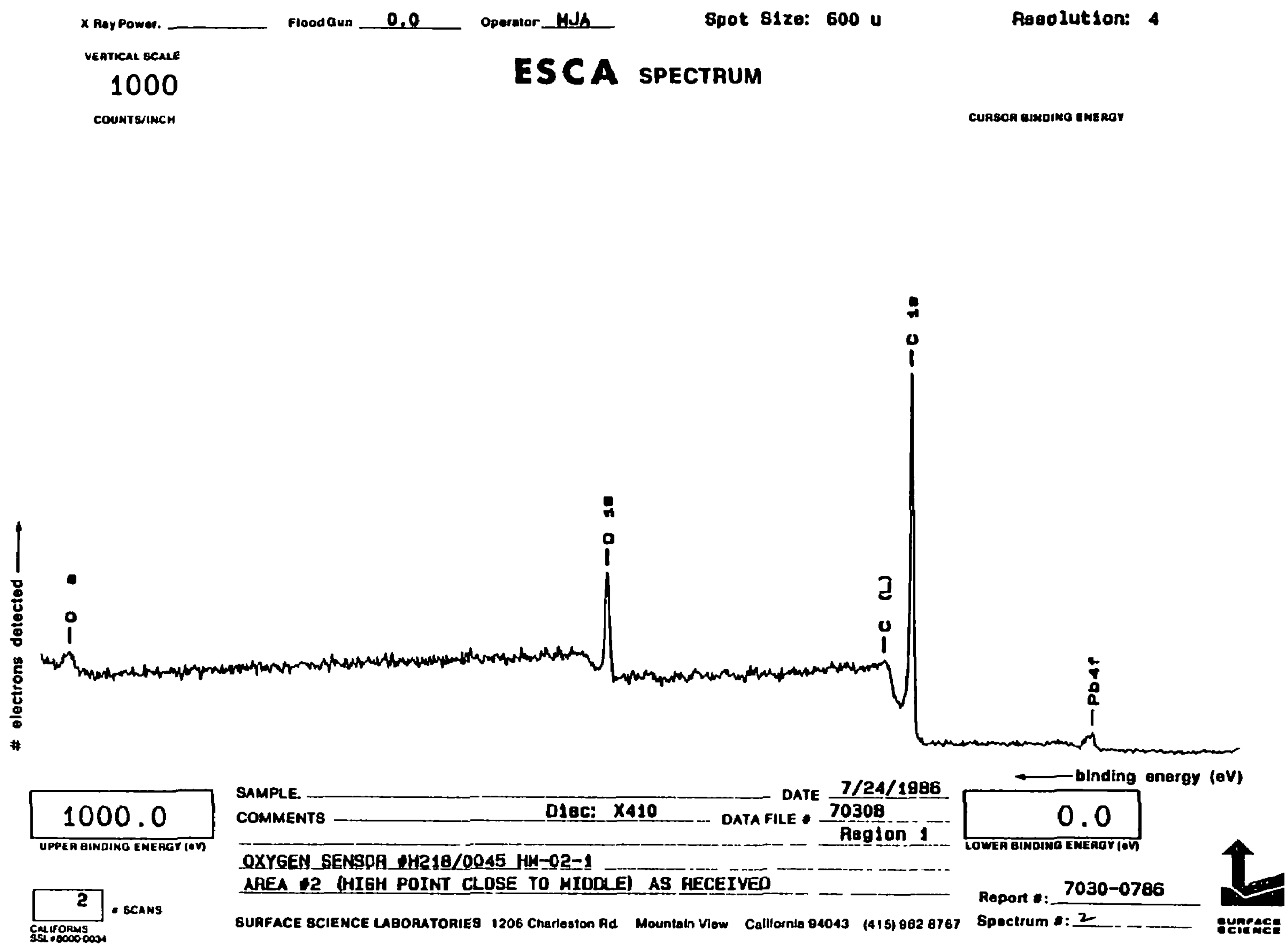


Figure I-3. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 2)

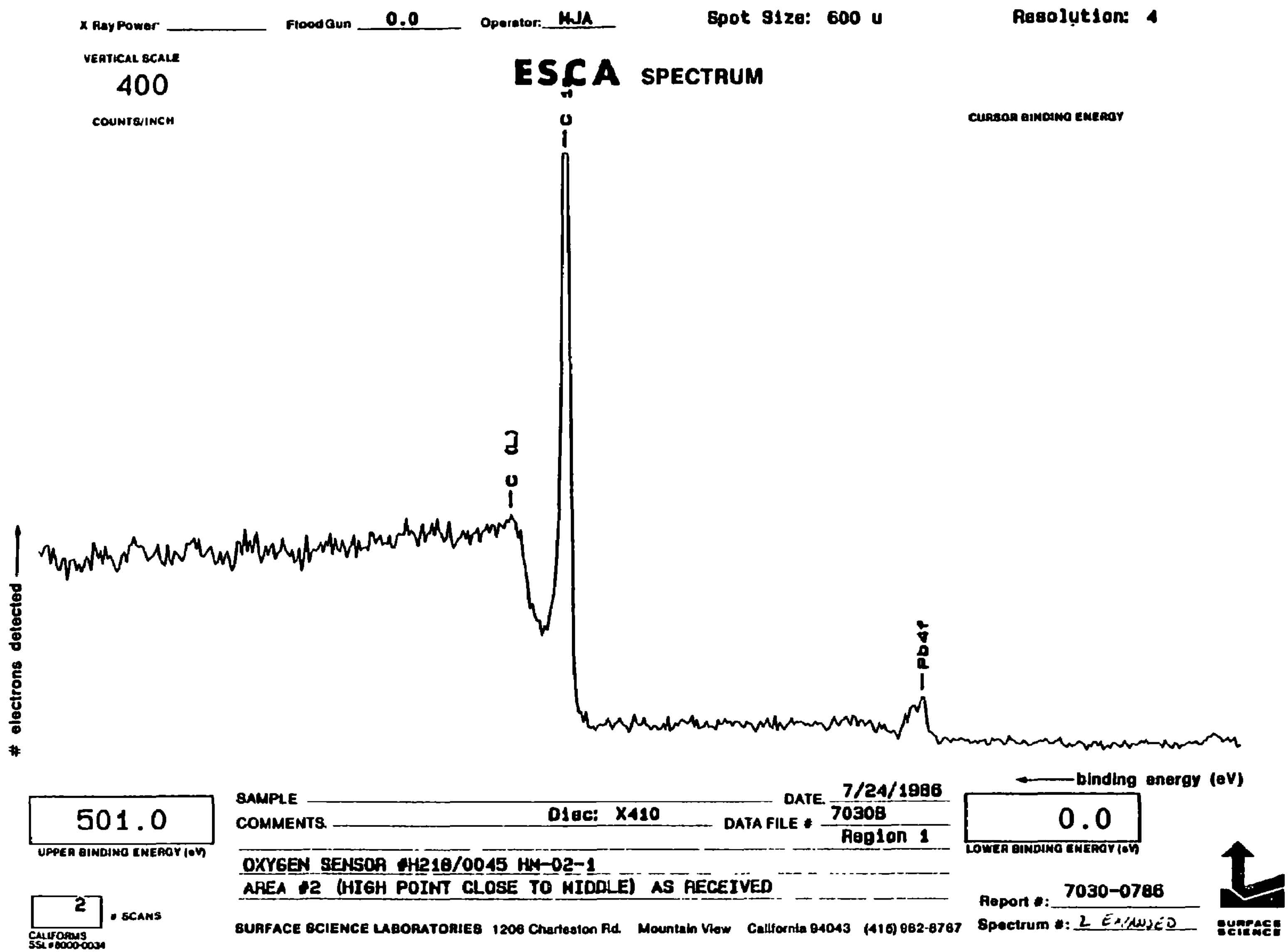


Figure I-4. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Location 2)

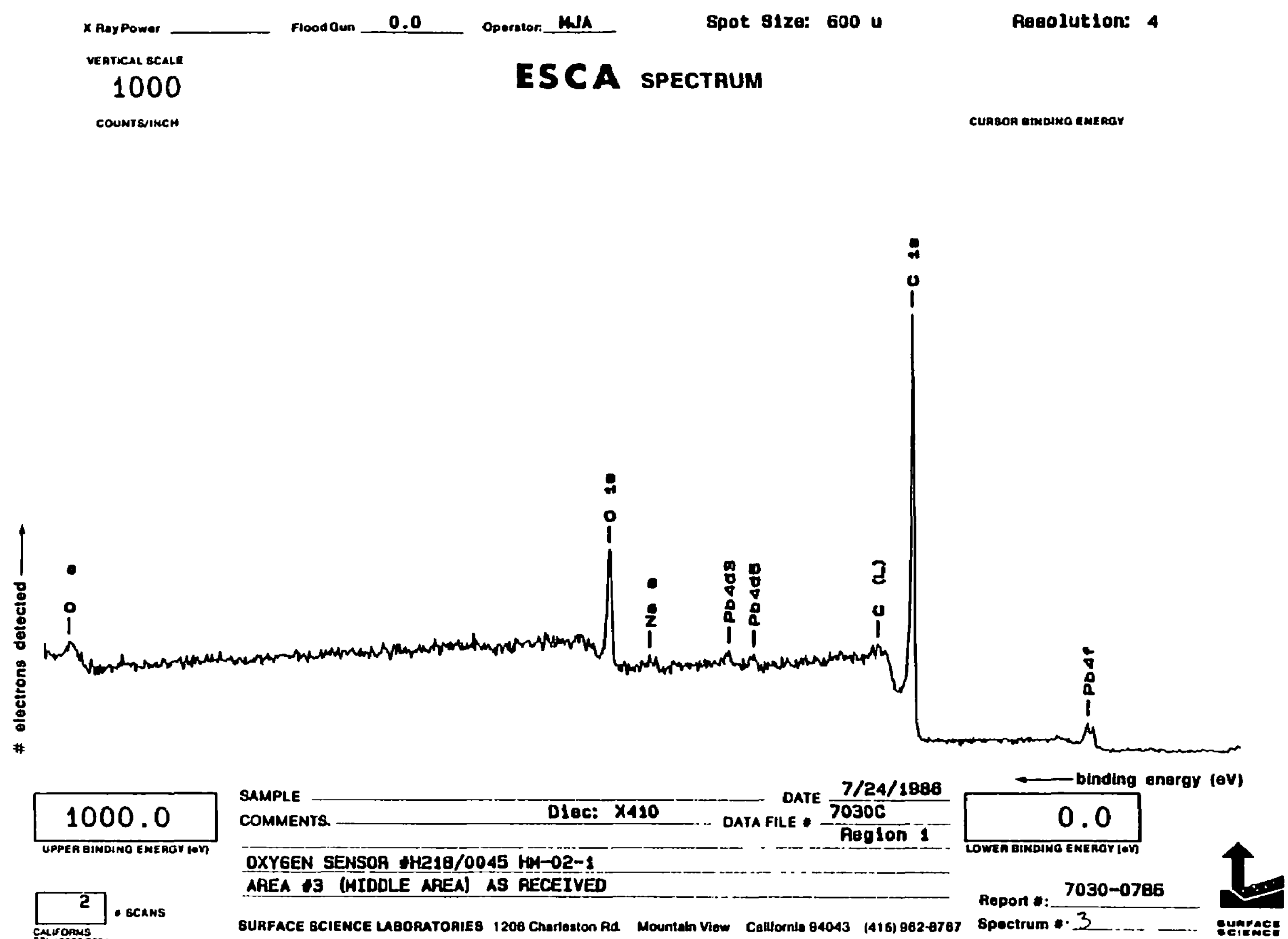


Figure I-5. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 3)

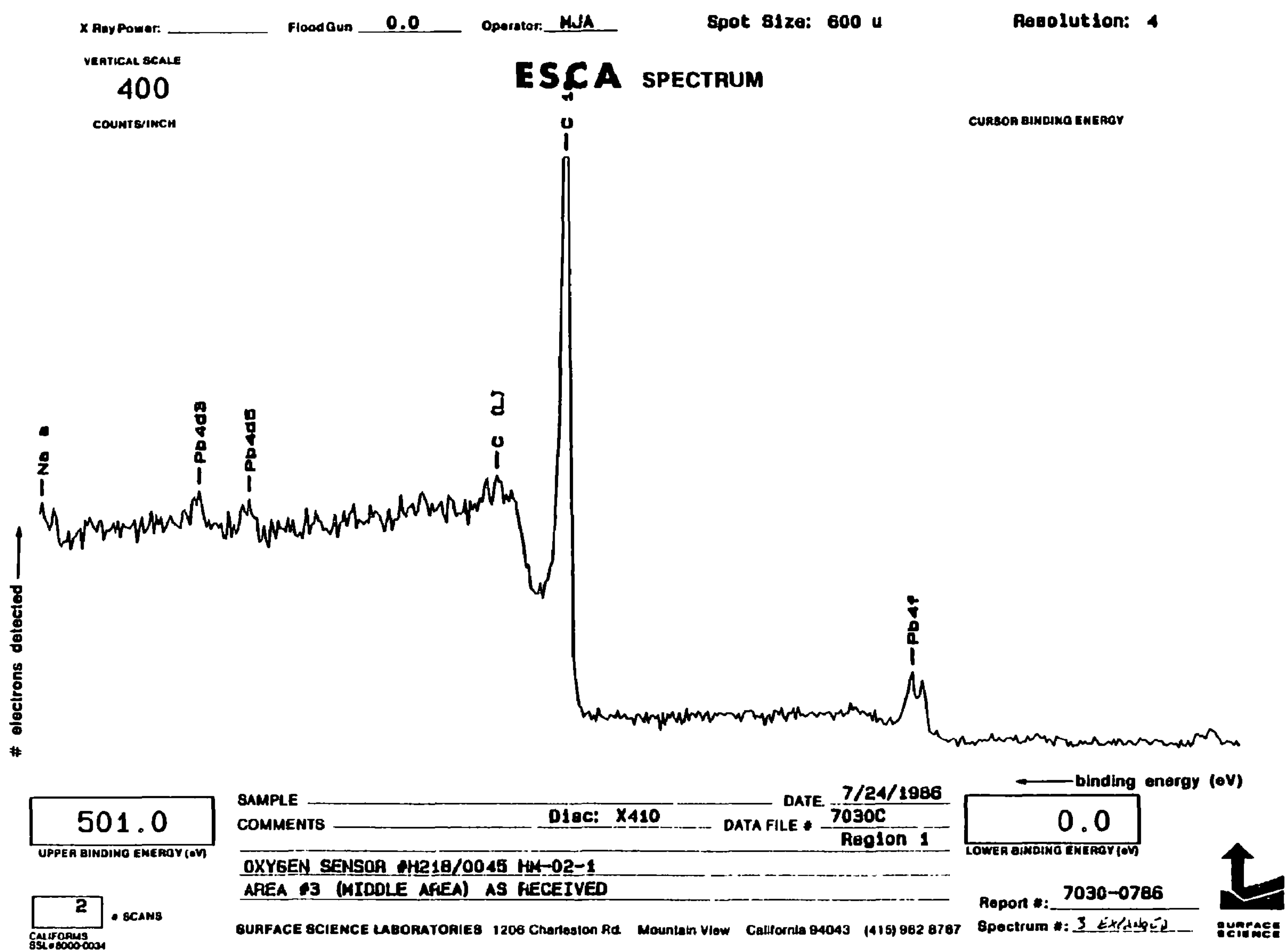


Figure I-6. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Location 3)

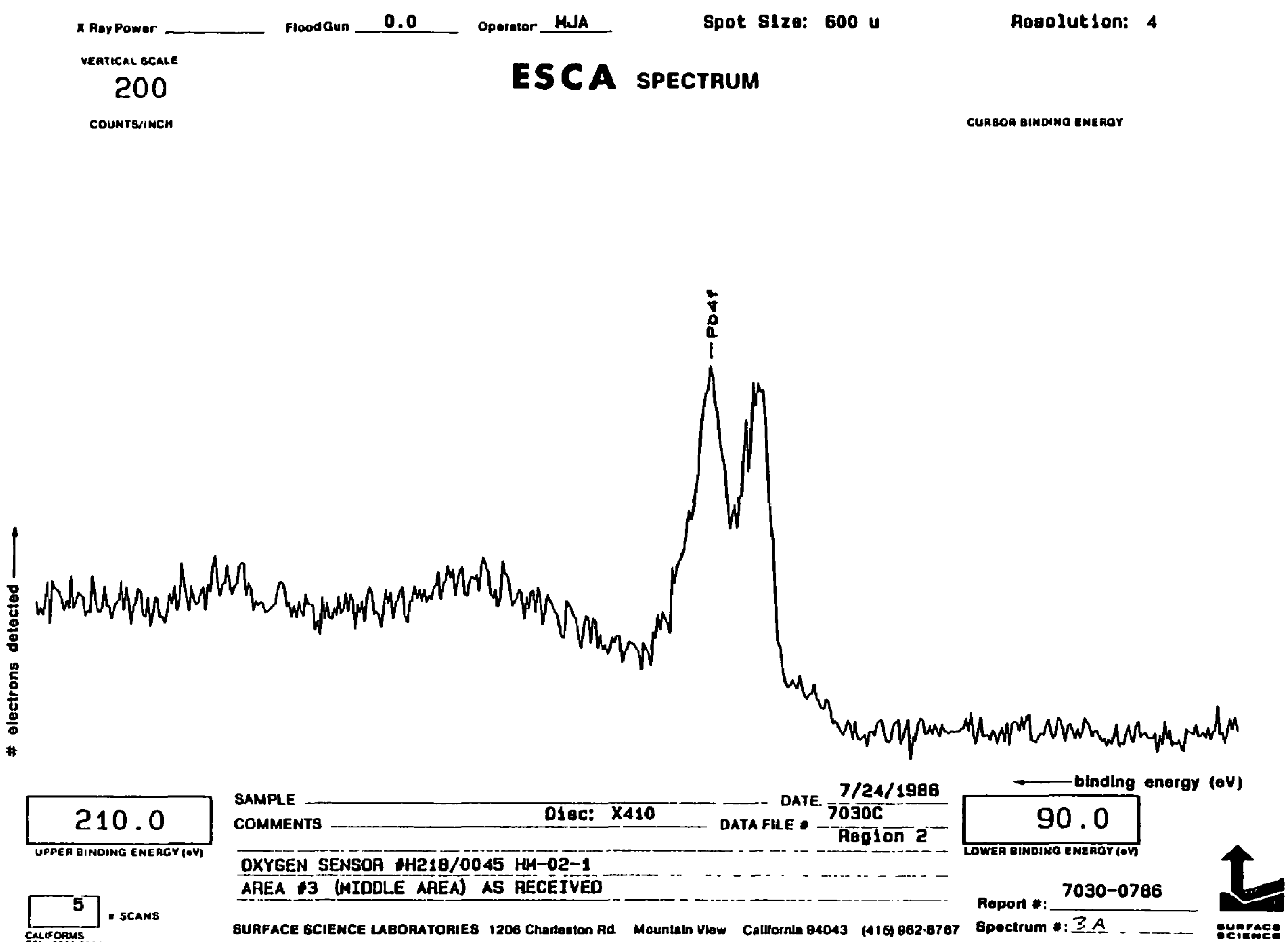


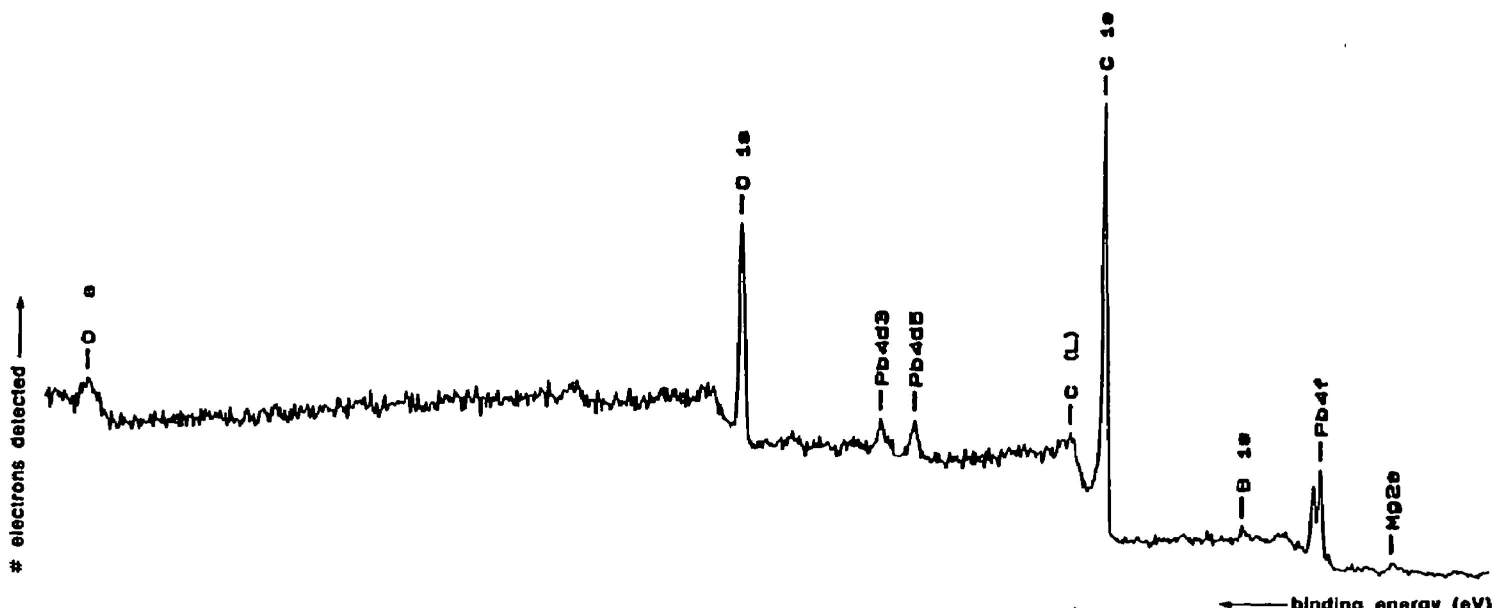
Figure I-7. ESCA Spectrum of Oxygen Sensor A218/0045 from 90 eV to 210 eV (Location 3)

X Ray Power ________ Flood Gun. 3.0 Operator MJA Spot Size: 600 u Resolution: 4

VERTICAL SCALE 1000 COUNTS/INCH

ESCA SPECTRUM

CURSOR BINDING ENERGY



1000.0 UPPER BINDING ENERGY (eV)

SAMPLE ________ DATE: 7/24/1986

COMMENTS Disc: X410 DATA FILE # 70300 Region 1

0.0 LOWER BINDING ENERGY (eV)

OXYGEN SENSOR #H218/0045 HM-02-1

AREA #4 (CLOSE TO TIP ON COLOR BORDER) AS RECEIVED

2 # SCANS

CALIFORMS SSL #8000-0034

Report #: 7030-0786

SURFACE SCIENCE LABORATORIES 1206 Charleston Rd. Mountain View California 94043 (415) 962-8767

Spectrum #: 4

SURFACE SCIENCE

Figure I-8. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 4)

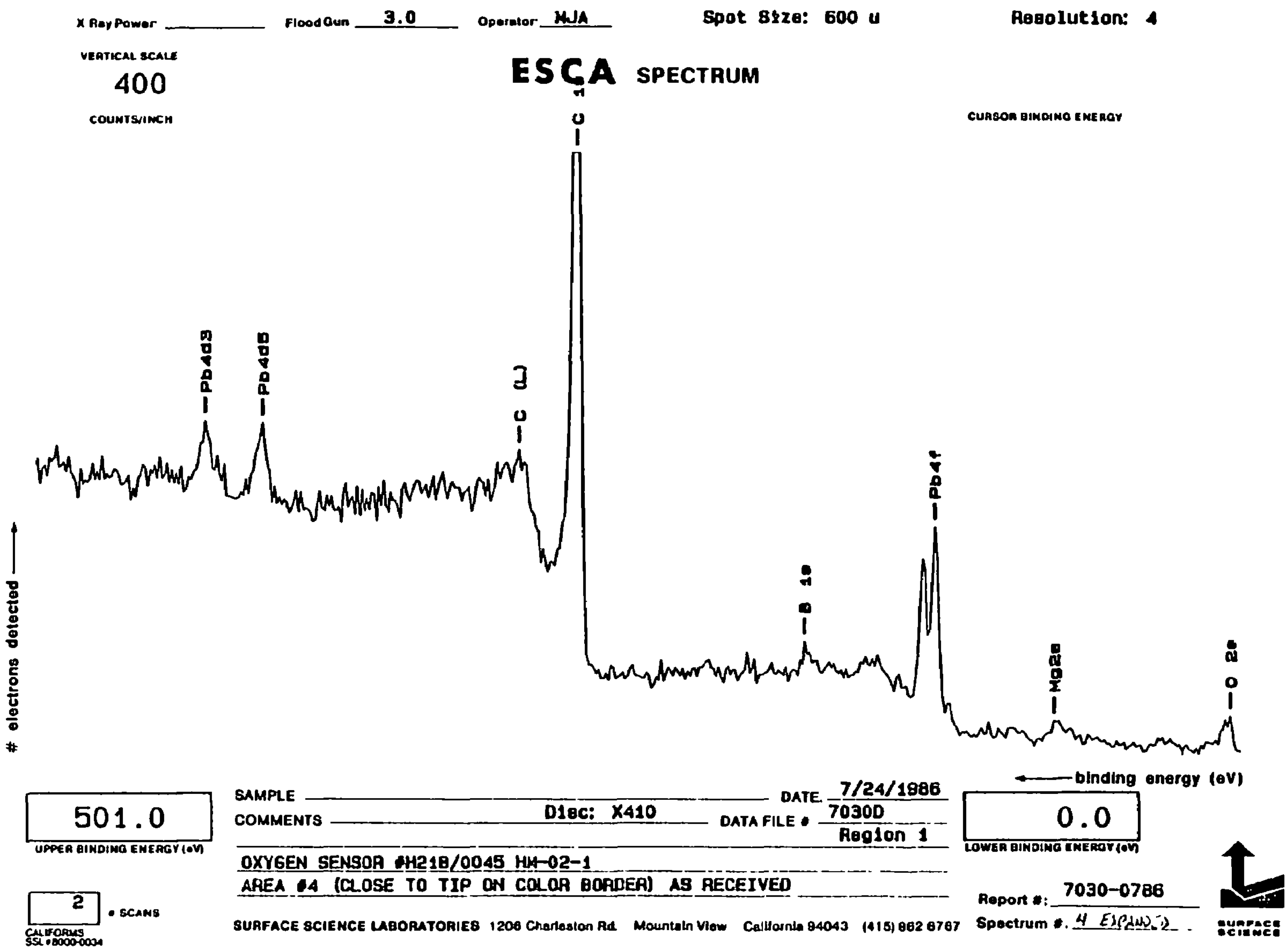


Figure I-9. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Location 4)

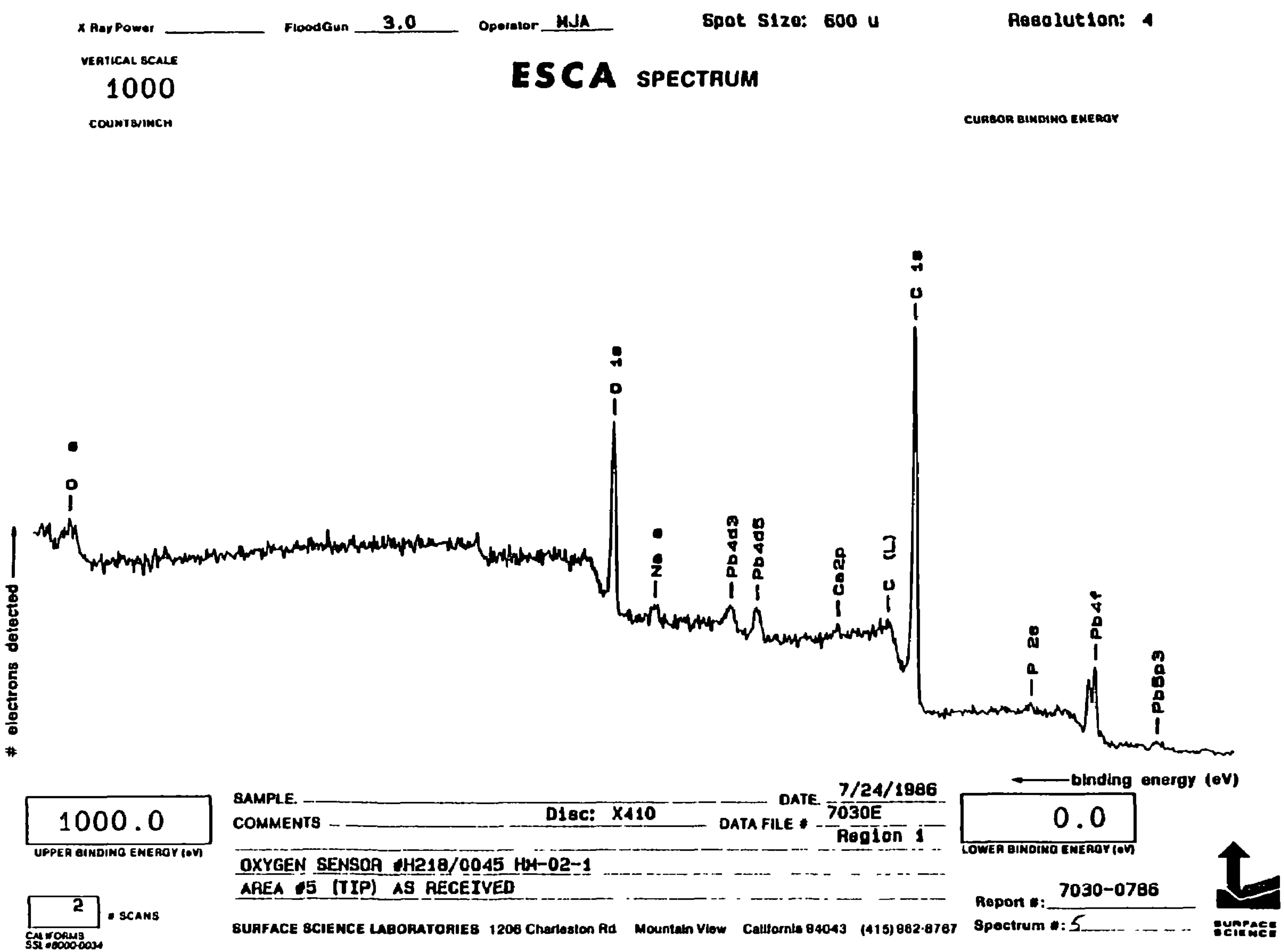


Figure I-10. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 5)

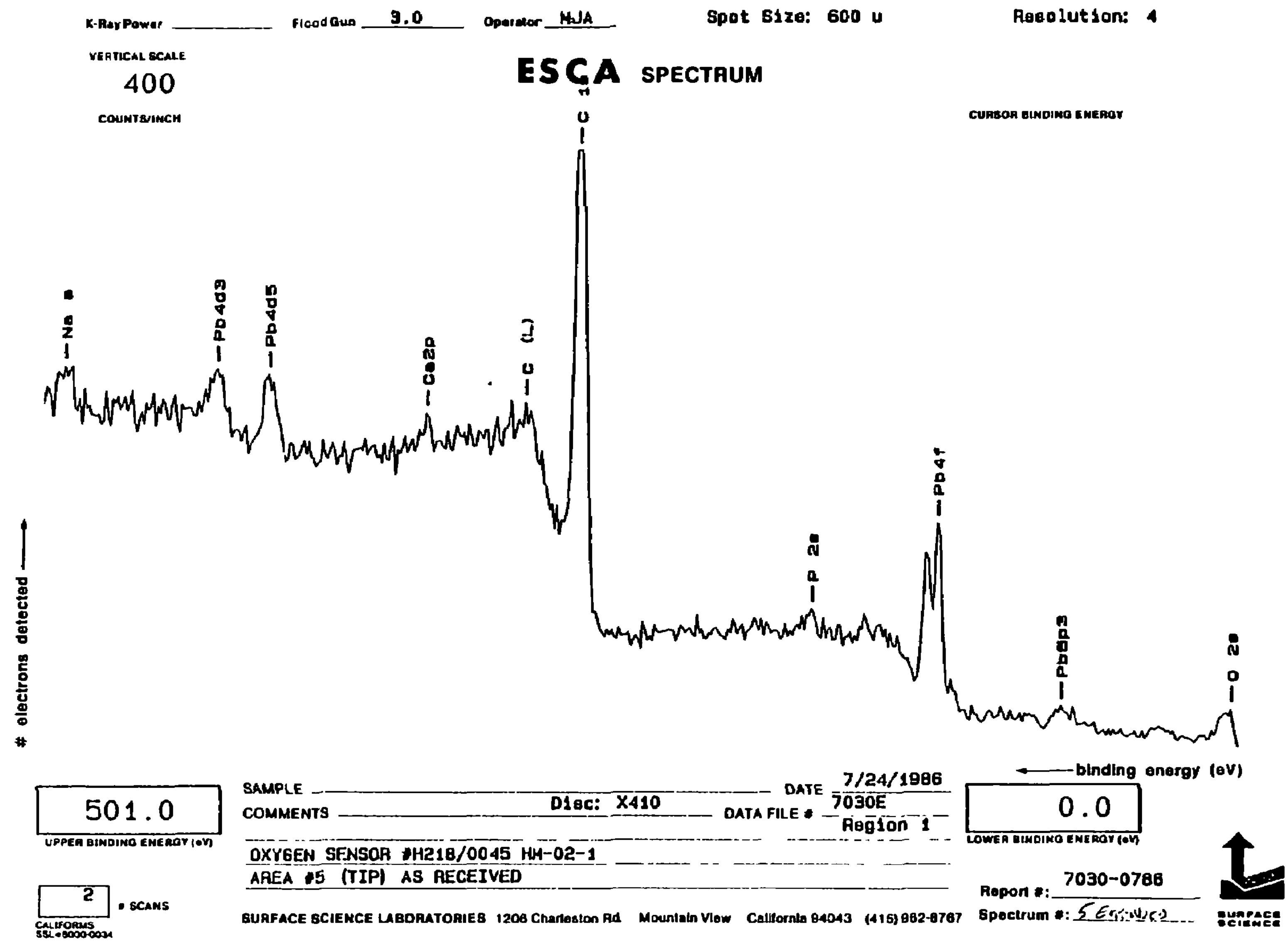


Figure I-11. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Location 5)

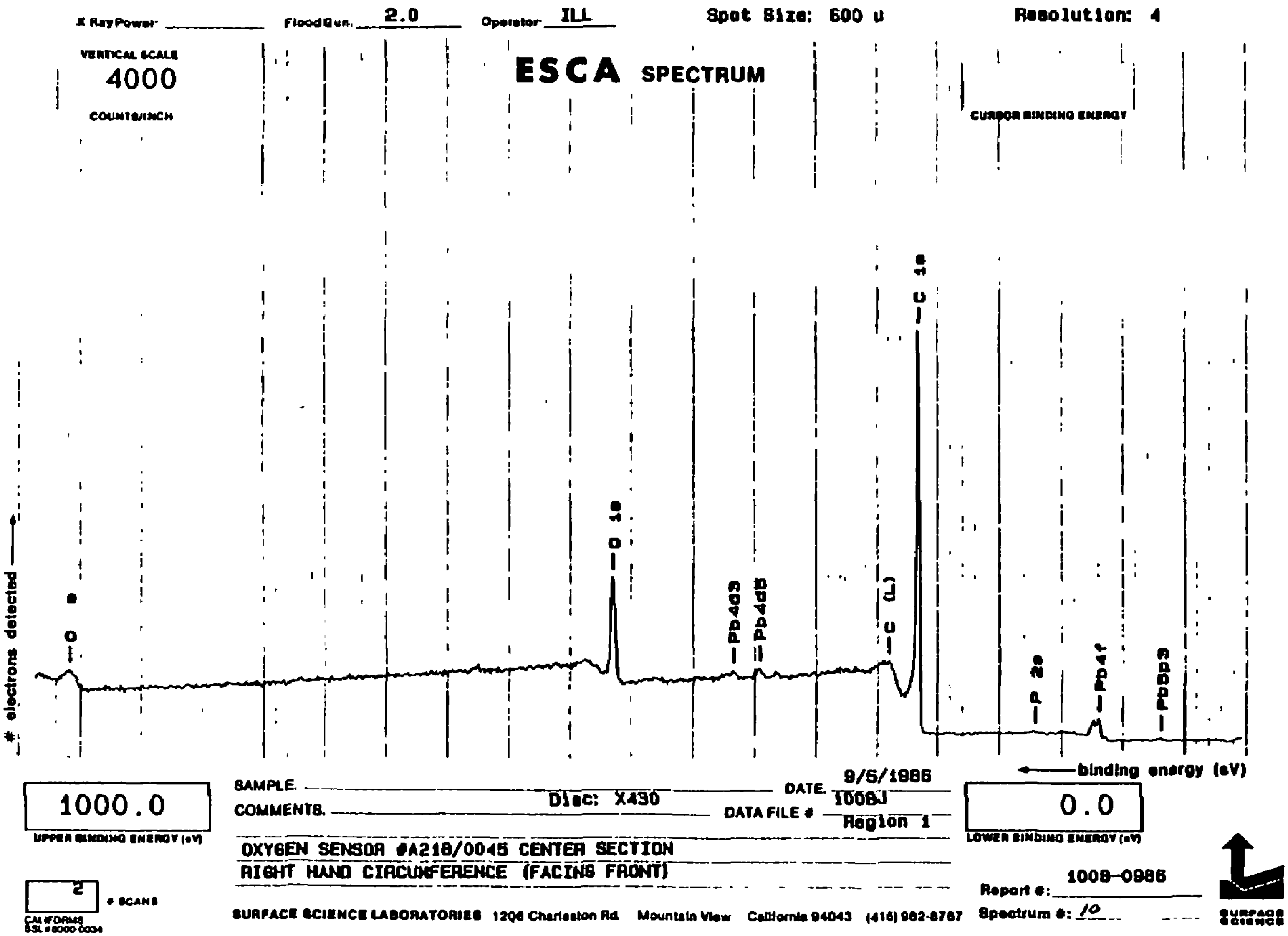


Figure I-12. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 6)

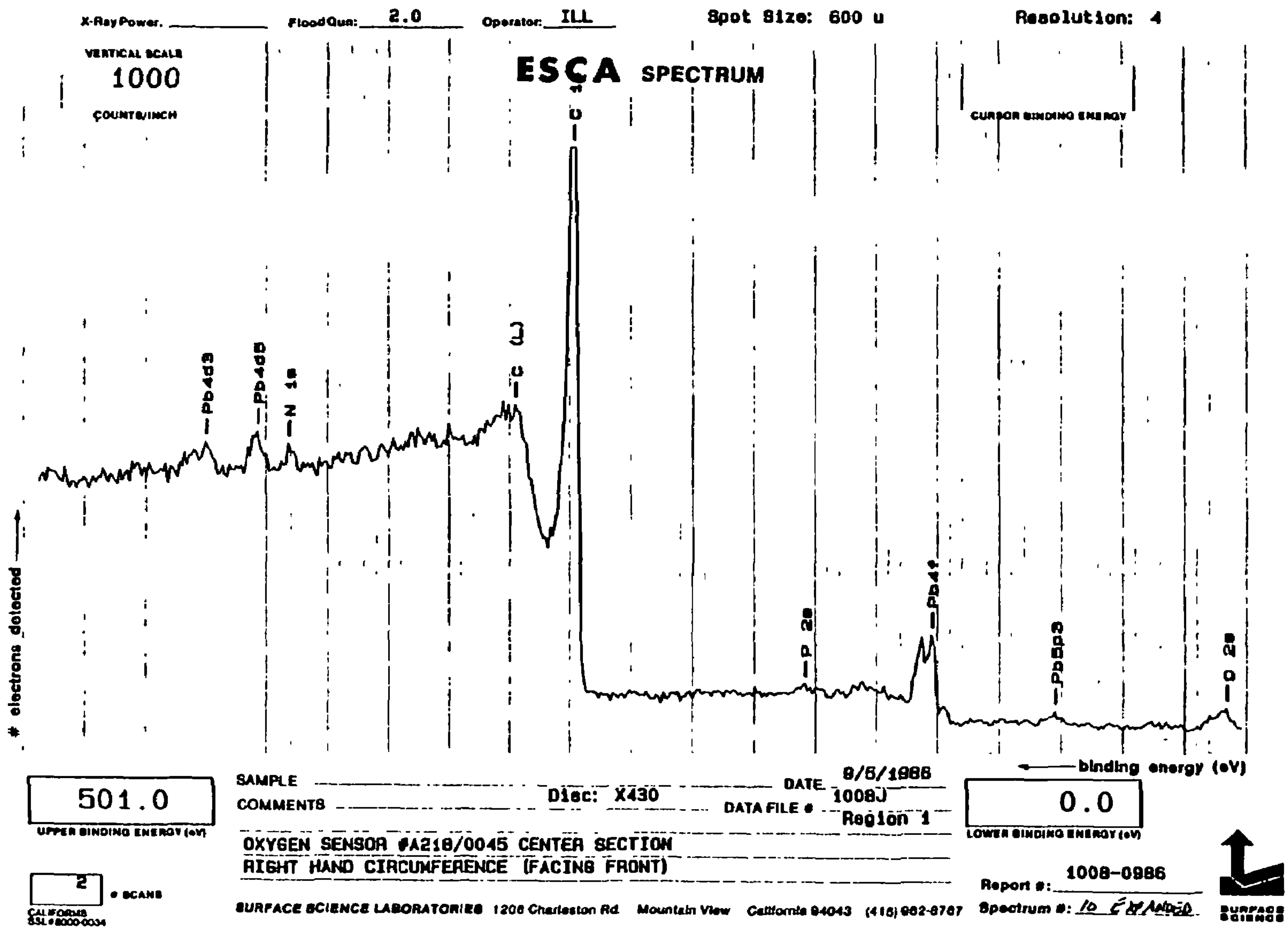


Figure I-13. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Location 6)

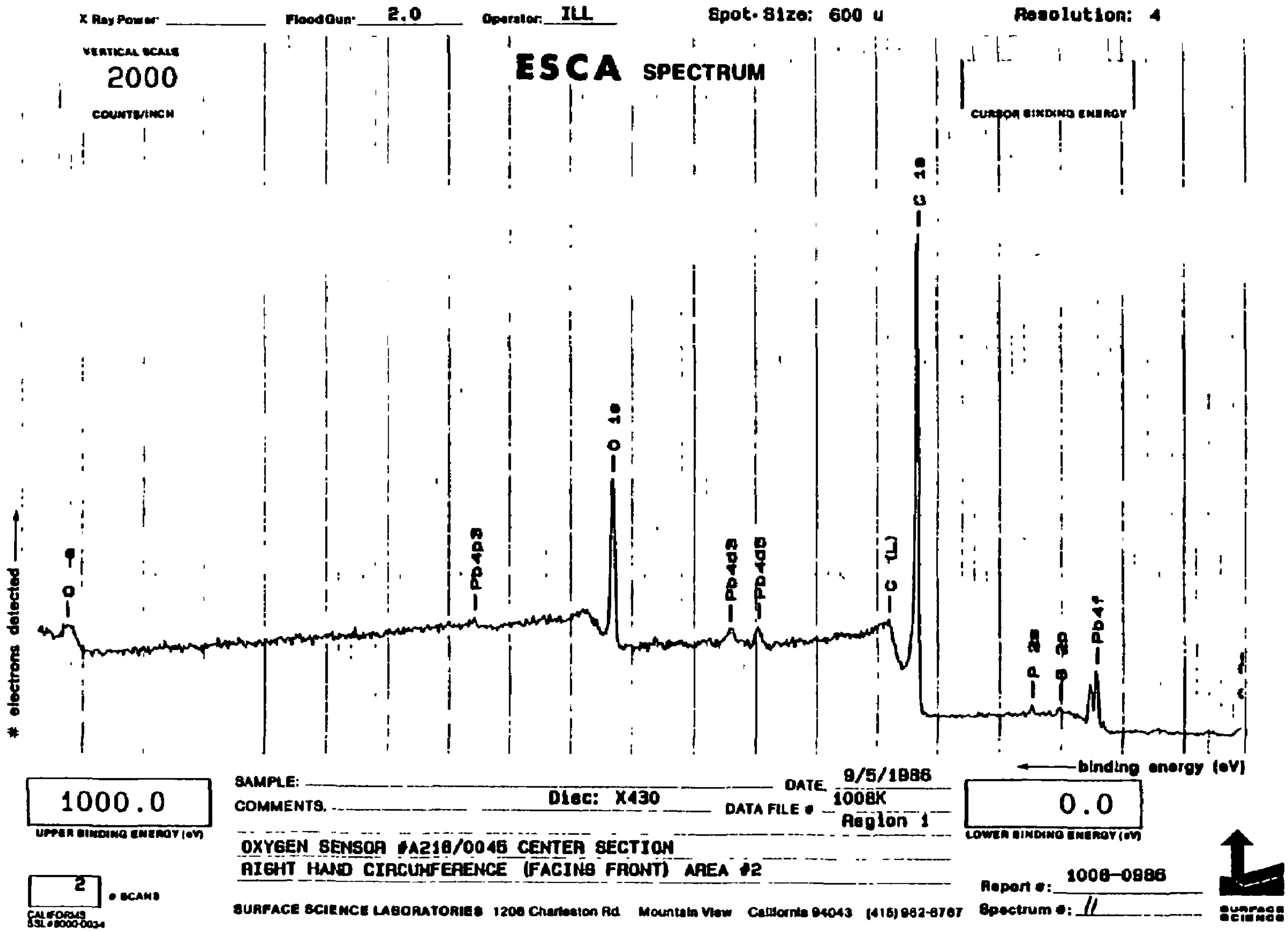


Figure I-14. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 7)

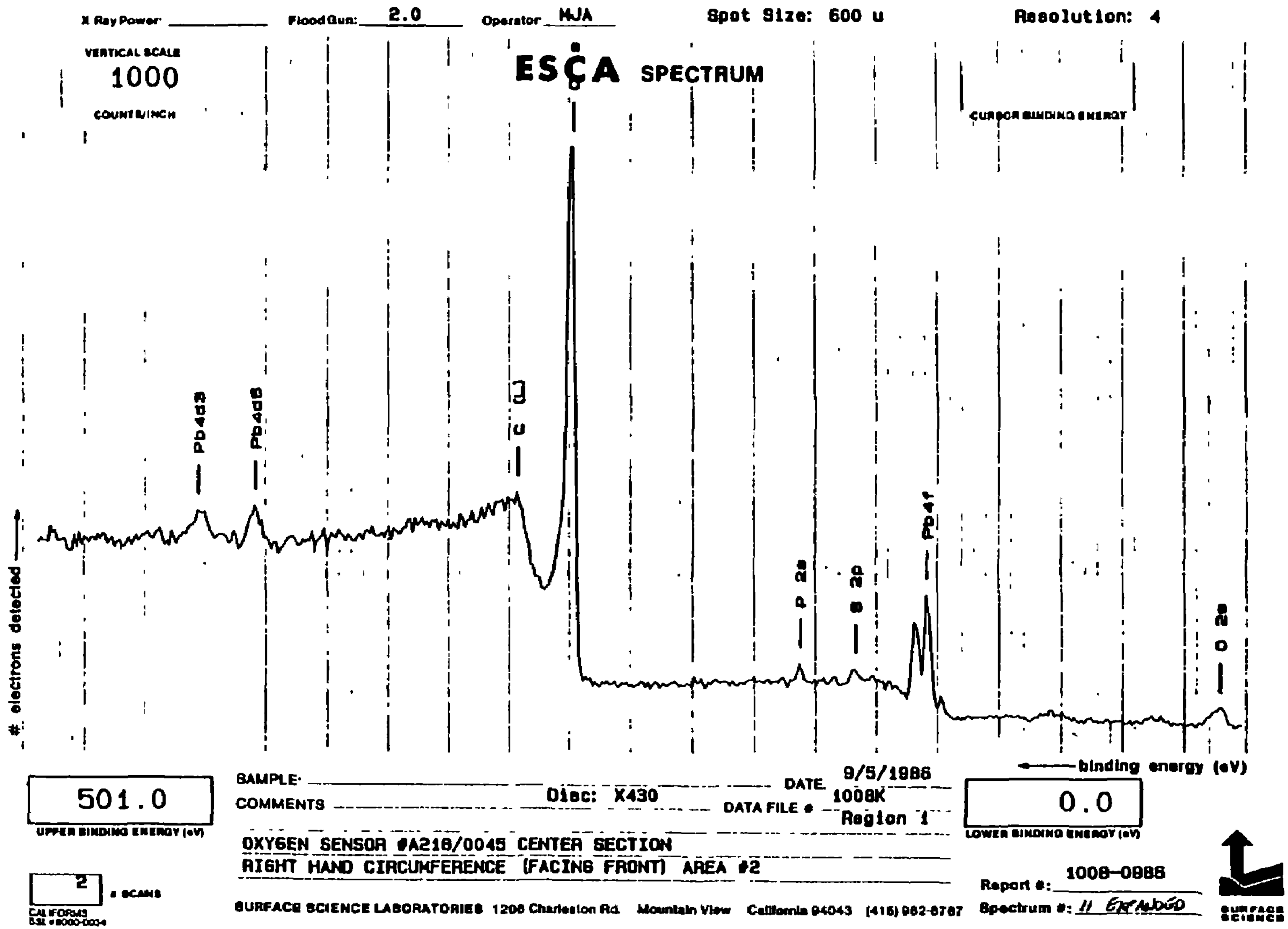


Figure I-15. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Location 7)

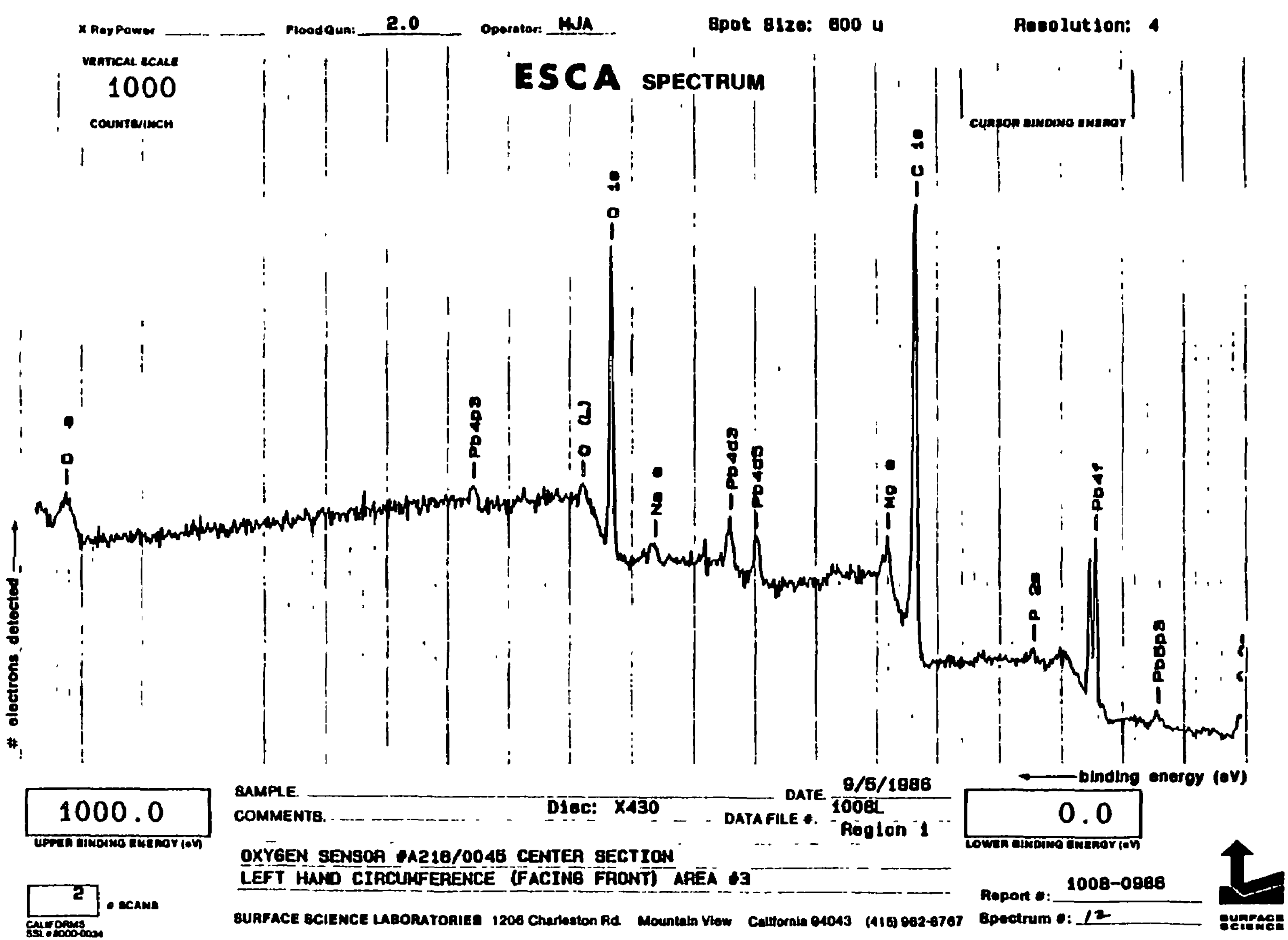


Figure I-16. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 8)

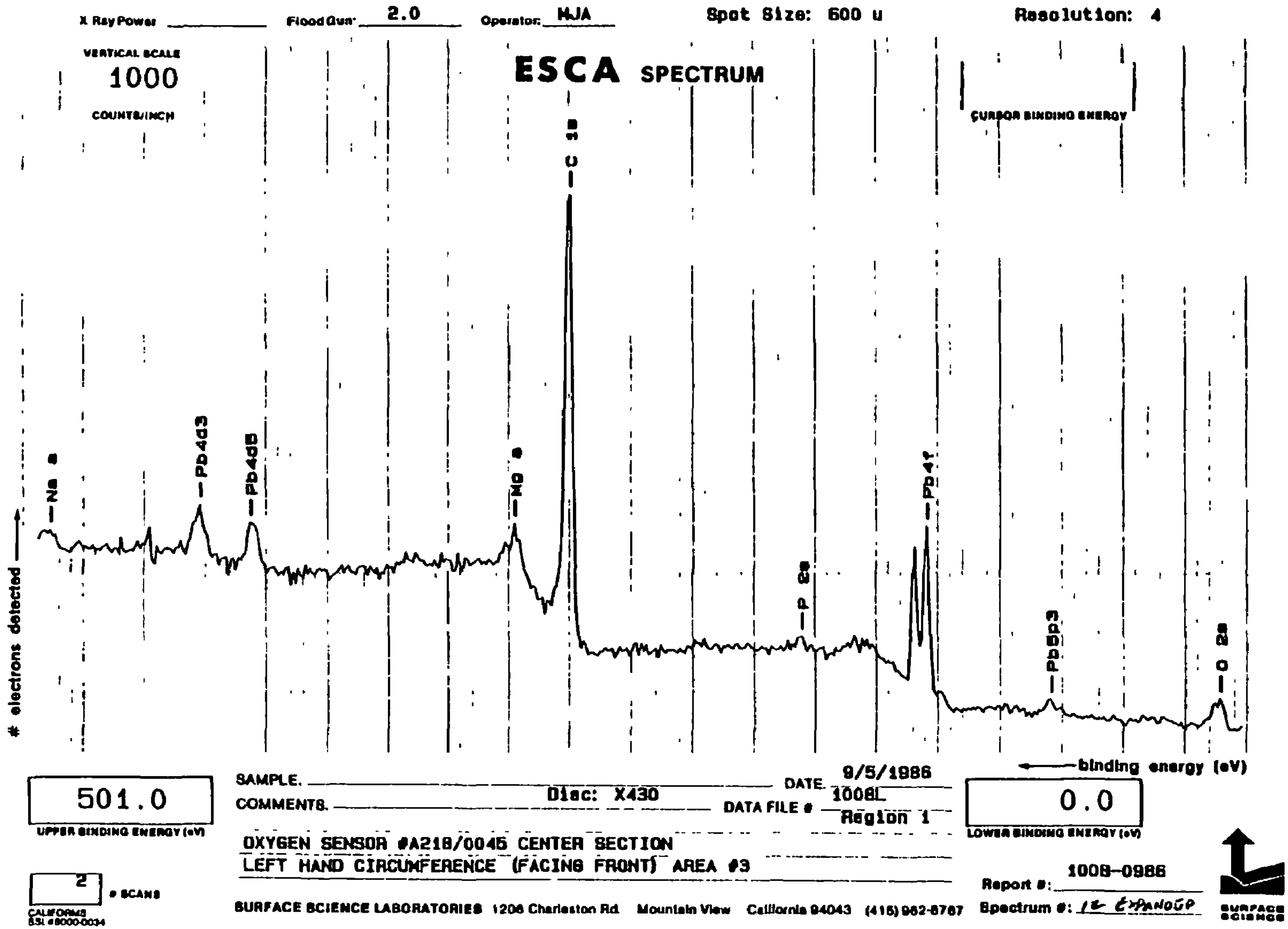


Figure I-17. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 501 eV (Location 8)

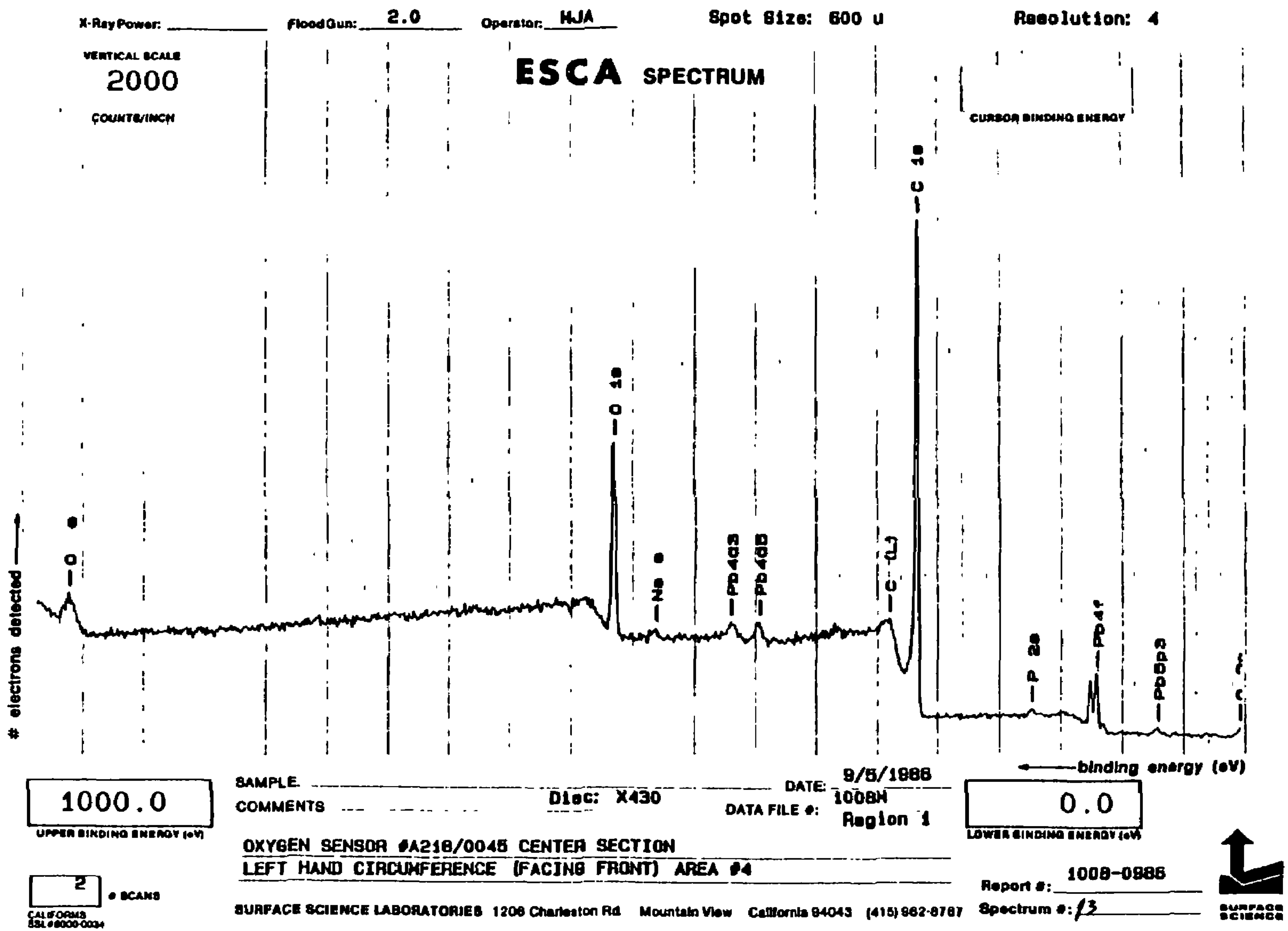


Figure I-18. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 1000 eV (Location 9)

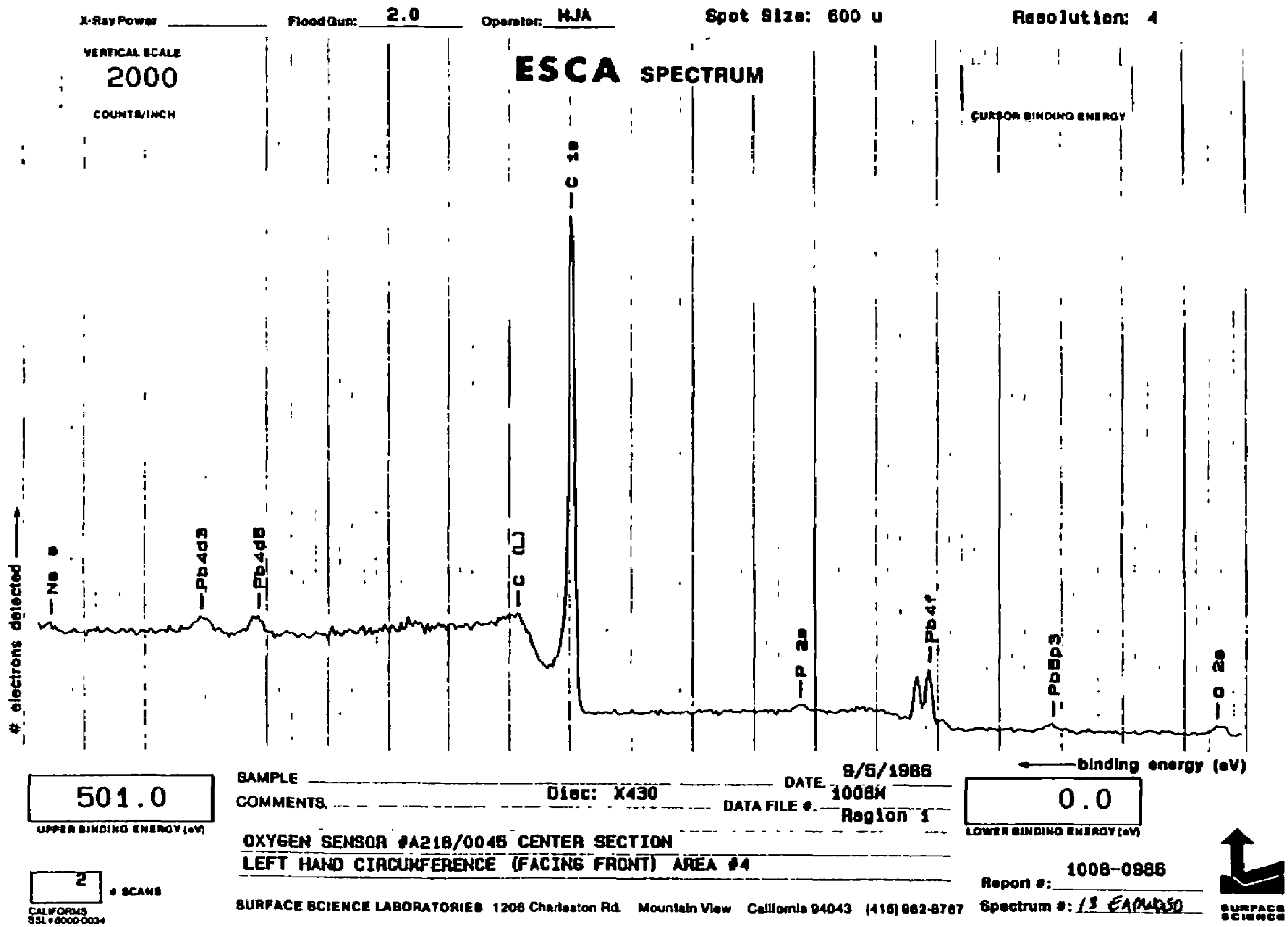


Figure I-19. ESCA Spectrum of Oxygen Sensor A218/0045 from 0 eV to 510 eV (Location 9)