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Chopper Locomotive Demonstration Program Phase II

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Final Report

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16. Abstract

Abstract E44 Chopper Locomotive

An E44 electric locomotive of 5000 hp, 6 axles and 6 motors was used as a test bed to evaluate full scale use of 6 separate high power DC to DC choppers for propulsion.

The normal phase control rectifier equipment was removed and replaced by a DC link at 2000 volts as the source of energy to the choppers. The choppers were then free to operate at any optimum frequency rather than being tied to the catenary frequency. Catenary power fed the link on a continuous basis thus providing a line power factor very close to unity (95%).

The project was a joint venture ofthe Federal Railroad Administration, Conrail and The General Electric Company. The old phase controlled electronics was removed at the Erie plant of General Electric and replaced by 6 choppers with the necessary ancillary equipment. The new propulsion system was matched to the normal E44 performance. The ability to operate in multiple with other diesel locomotives was also provided.

The objective of this project was to demonstrate that modern power electronics could be applied to an electric locomotive. Tests showed that all of the advantages available from this method of propulsion i.e. high efficiency, high power factor and smooth control can be achieved.

17. Key Words	18. Distribution Statement
Chopper Locomotive, Chopper Controls, Power Factor Electric Propulsion	

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CONTENTS

CHOPPER LOCOMOTIVE DEMONSTRATION PROGRAM

CONTRACT #DOT-FR-9027

FINAL REPORT

SECTION 1

A. INTRODUCTION

The Transportation Systems Business Operation of the General Electric Company has completed the Chopper Locomotive Demonstration Program. This report documents the E44 Chopper Locomotive tests that were performed on the GE-Erie locomotive test track, and the in-service runs pulling a Conrail trailer van train between Newark and Washington, D.C.

Please refer to the interim progress reports forwarded to the FRA during Phases I and II of this program for information on the design and fabrication of the Chopper Locomotive.

B. SUMMARY

1. Testing in Erie included motoring and dynamic braking performance, wheelslip evaluation, and measurement of the power factor,

efficiency, and psophometric current of the Chopper Locomotive, all at 25KV, 60 Hz.

2. Motoring Performance - Motoring performance was as expected per the published tractive effort vs speed curve, 41H141280. See Figure 3.1 which shows the test data plotted on this curve.

3. Dynamic Braking Performance - Dynamic braking performance was also as expected per the published braking effort vs speed curve, 41H105988. See Figure 4.1 which shows the test data plotted on this curve.

4. Wheelslip Evaluation - The individual axle control of the wheelslip system performed very well as much of the locomotive testing was done during the winter on slippery track conditions. See Figures 5.1, 5.2, 5.3, and 5.4 which show the random slipping of the various axles and the resulting correction for only the affected axle.

5. Power Factor - The measured power factor was 0.91-0.925 over the speed range which was slightly better than expected per the published power factor vs speed curve, 41H119318. See Figure 6.1 for the power factor data plotted on this curve.

6. Locomotive Efficiency - The measured locomotive efficiency was 2-5% low in the lower speed range and 2% higher at 40 MPH compared to the calculated efficiency vs speed curve shown on 41H115682. See Figure 7.1 which shows the test data plotted on the above curve.

7. Psophometric Current - Telephone interference can be specified as either psophometric current or It product. The original curve, 41H119319, was plotted as an It product, but since that time (1979) the use of psophometric current has become standard and that is what our instruments measure. Therefore, a new curve had to be drawn, 41H106104, from some existing computer runs done in 1979 and the test data is shown plotted on this curve, Figure 8.1. The resulting psophometric current was from 1-2 amps lower than expected.

8. In-Service Runs on Conrail - Two round trips were made from the South Kearny Yard in Newark, N.J. to the Potomac Yard in Washington, D.C. The Chopper Locomotive ran very well and easily outpulled the two GP38-2 diesel electric locomotives which normally pull this trailer van train.

   Some minor problems occurred, but not with the main power train, i.e., the main transformer, phase-controlled bridges, the choppers, and traction motors.

SECTION 2

ERIE TEST TRACK TESTS

A. POWER SUPPLY AND INSTRUMENTATION

All testing was done with the catenary energized at 25KV, 60 Hz. Figure 2.1 shows a simplified power circuit with some of the instrumentation used. Below is a listing of the various test instruments and their model numbers.

Instrument	Model
1. Power factor/wattmeter	Magtrol Power Analyzer Model #4612PF
2. Psophometer	Siemens Model # S44034-U2133-A702
3. Potential transformer (PT)	General Electric JVS150 Catalog #766X30G5
4. Non-inductive shunt	Co-axial shunt with a resistance of 0.0002485 ohms

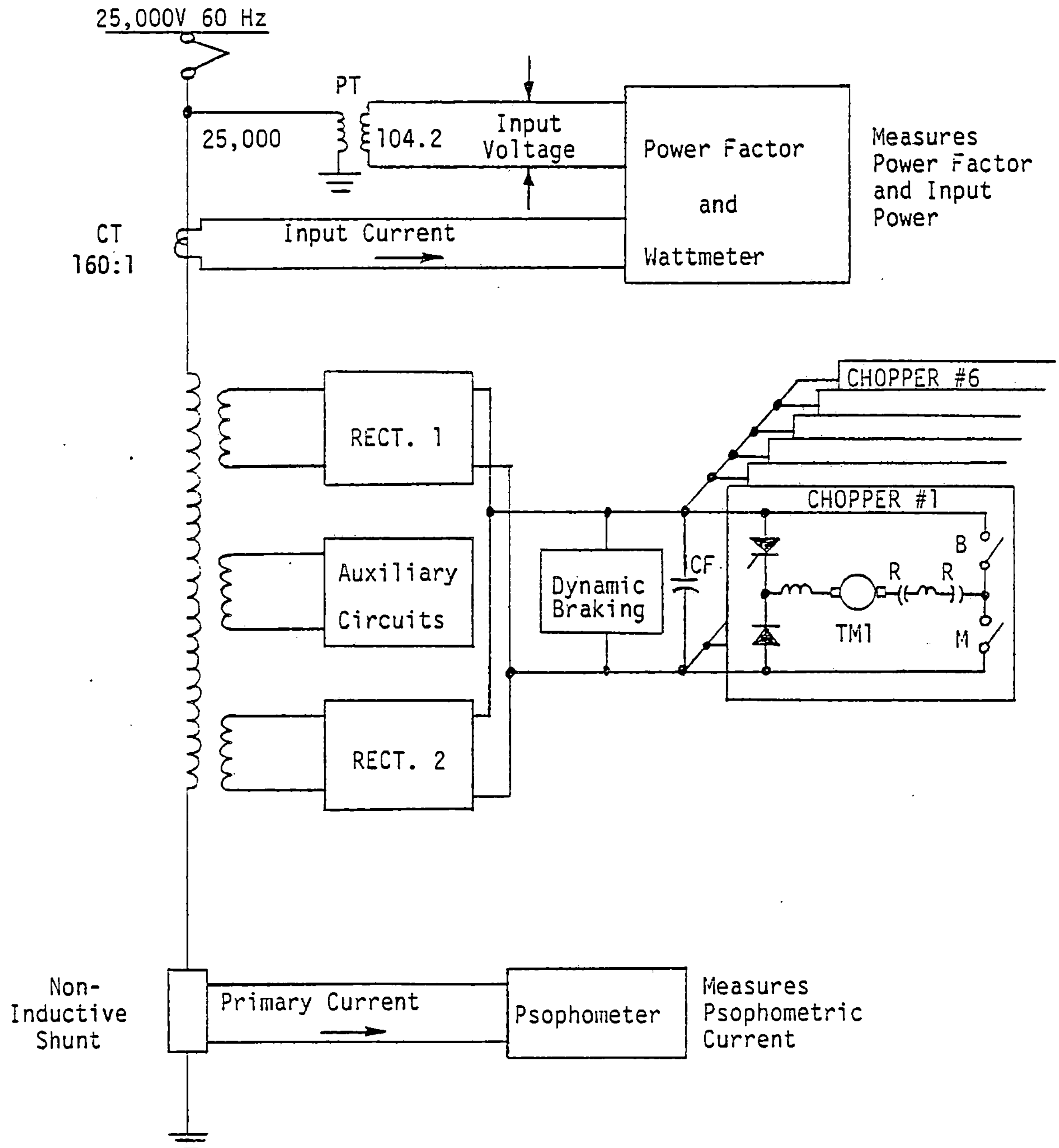
5. Current transformer (CT) — Part of the main transformer which feeds the primary overcurrent relay.

6. Brush recorder — Gould 8 channel brush Model #481

B. TEST CONSIST

Two diesel-electric locomotives were used to simulate a train by operating them in dynamic braking for the Chopper motoring tests, and in motoring for the Chopper dynamic braking tests. Test runs were made with the Chopper Locomotive in either N8 motoring or dynamic braking at 10, 20, 30, and 40 MPH, which was the maximum speed allowed for a six axle electric locomotive on the Erie Test Track.

FIGURE 2.1 - SIMPLIFIED POWER CIRCUIT SHOWING THE INSTRUMENTATION USED



SECTION 3

MOTORING PERFORMANCE

A. TEST SET-UP

Each traction motor current, the DC filter voltage, and locomotive speed were recorded on the Gould 8 channel brush recorder. These signals were taken from test points on the front of the electronic control cards.

B. TEST RESULTS

Figure 3.1 shows the published tractive effort/speed curve, 41H141280, with the four data points at 10, 20, 30, and 40 MPH plotted. The function generator card which puts out the traction motor current reference to the choppers was designed to have a steeper slope in the 0-20 MPH range which results in the currents at 10 and 20 MPH being slightly less than the motor capability.

C. FIGURE 3.2-MOTORING AND DYNAMIC BRAKING DATA

This chart shows the data taken from the brush recorder charts. Each run was at a specified speed and each of the six traction motor currents were shown with the average of those six currents and the resulting tractive effort or braking effort for the dynamic braking runs.

D. <u>FIGURE 3.3-NOTCH 8 ACCELERATION FROM STOP</u>

Typical N8 run from standstill. Note axle 4 wheelslips.

E. <u>FIGURE 3.4-TWO N8 ACCELERATION RUNS</u>

F. <u>FIGURE 3.5-RUNS 6 AND 7 - 10 MPH MOTORING</u>

Note some wheelslip activity and 300V volts peak to peak ripple on the filter voltage. This 10 Hz ripple is caused by the resonant frequency of the line filter reactors and filter capacitors and is most noticeable at the higher chopper current ranges.

G. <u>FIGURE 3.6-RUN 3 - 20 MPH MOTORING</u>

Note much wheelslip activity up to about 15 MPH

H. <u>FIGURE 3.7-RUN 1 - 30 MPH MOTORING</u>

I. <u>FIGURE 3.8-RUN 2 - 40 MPH MOTORING</u>

J. <u>FIGURE 3.9-RUN 4 - 40 MPH MOTORING</u>

K. <u>FIGURE 3.10-RUNS 13 AND 14 - 10 MPH MOTORING WITH POWER FACTOR CORRECTION FILTERS CONNECTED</u>

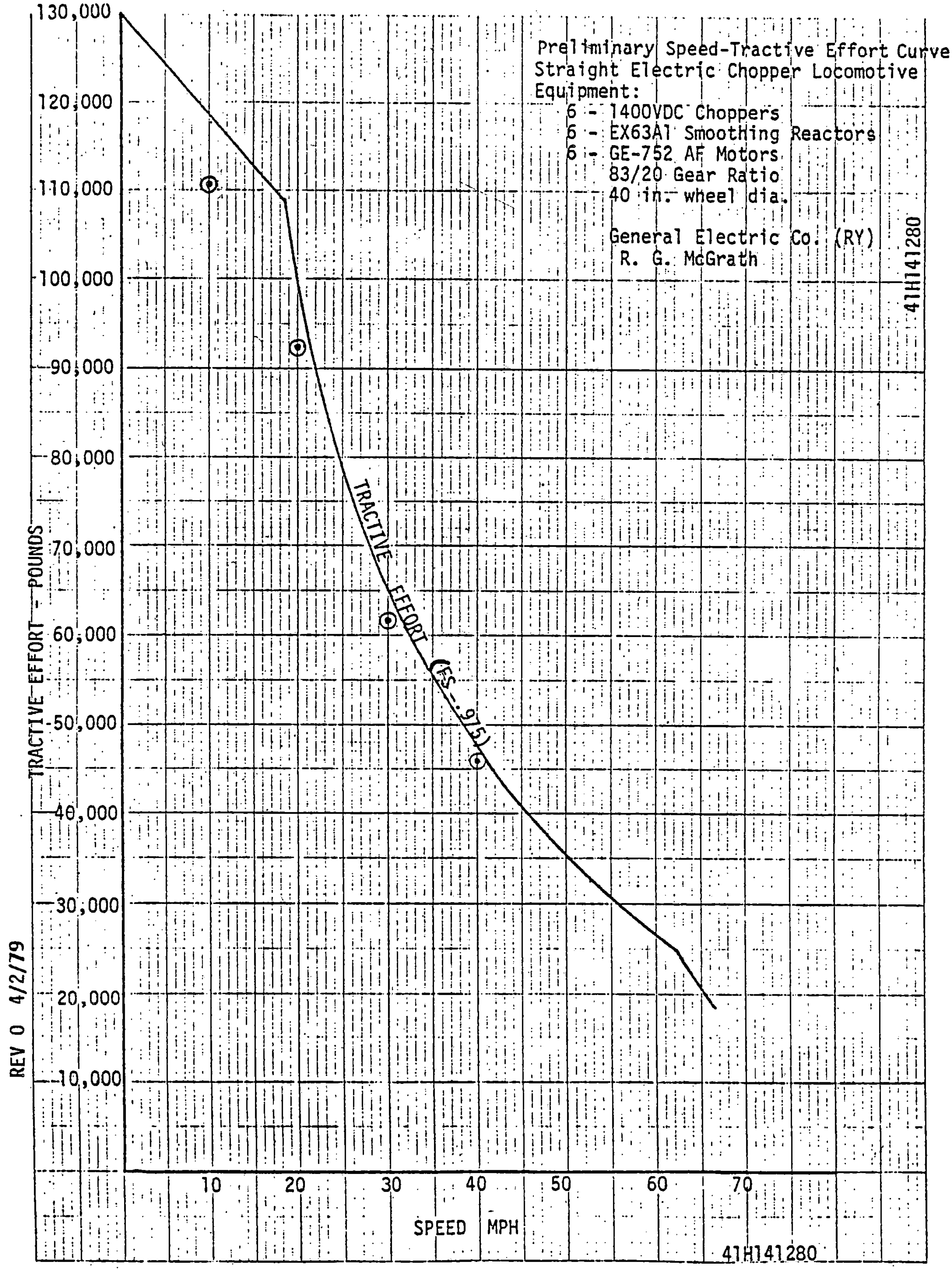
This set of runs was made with the power factor correction filters connected across the two traction windings of the main transformer.

L. <u>FIGURE 3.11-RUNS 10 AND 11 - 20 MPH MOTORING WITH POWER FACTOR CORRECTION FILTERS CONNECTED</u>

M. <u>FIGURE 3.12-RUNS 8 AND 9 - 30 MPH MOTORING WITH POWER FACTOR CORRECTION FILTERS CONNECTED</u>

N. <u>FIGURE 3.13-RUNS 15 AND 12 - 40 MPH MOTORING WITH POWER FACTOR CORRECTION FILTERS CONNECTED</u>

FIGURE 3.1 - TRACTIVE EFFORT VS SPEED CURVE



RUN #	SPEED (MPH)	TRACTION MOTOR CURRENT 1	2	3	4	5	6	AVG.	TRACTIVE EFFORT(#)	MAGTROL READINGS I (AMPS)	V (VOLTS)	WATTS	POW. FACTOR	PSOPHOMETER (MV)
		MOTORING RUNS												
1	30	880	880	880	910	860	940	892	61.9K	1.418	102.4	124.87	0.867	3.6
2	40	700	720	700	720	640	760	707	45.5K	1.32	102.9	118.2	0.868	3.5
3	20	1200	1180	1200	1240	1220	1270	1218	92.1K	1.52	101.4	131.5	0.857	3.6
4	40	720	730	720	740	650	750	718	46.5K	1.364	102.2	119.12	0.865	3.5
5		RUN NO GOOD												
6	10	1400	1390	1380	1450	1410	1440	1412	111.0K	1.00	103.2	88.2	0.860	2.9
7	10	1390	1380	1380	1450	1410	1430	1407	110.5K	0.96	103.4	89.25	0.851	2.9
8	30	920	900	910	940	940	940	925	64.9K	1.395	103.5	131.25	0.912	3.5
9	30	920	880	910	900	940	950	917	64.1K	1.388	103.3	127.25	0.918	3.5
10	20	1200	1190	1190	1250	1220	1240	1215	91.8K	1.42	102.3	133.5	0.911	3.5
11		RUN NO GOOD												
12	40	720	720	710	730	660	740	713	46.0K	1.30	103.4	123.0	0.915	3.5
13	10	1400	1400	1360	1420	1400	1420	1400	109.8K	0.915	104.6	90.2	0.929	2.5
14	10	1390	1430	1360	1440	1400	1420	1407	110.5K	0.915	104.6	91.5	0.927	2.6
15	40	720	700	700	720	720	740	717	46.4K	1.321	103.6	126.6	0.915	3.5
		DYNAMIC BRAKING RUNS												
16	10	860	860	840	880	880	880	867	67.2K					
17	20	800	800	800	820	820	840	813	63.0K					
18	30	605	580	590	620	620	630	608	46.5K					
19	40	485	480	480	505	500	500	492	36.8K					
20	10	840	840	840	880	860	900	860	66.6K					
21	20	810	810	810	820	820	860	822	63.7K					
22	30	560	580	600	620	620	650	605	46.3K					
23	40	400	420	480	500	500	500	467	34.0K					

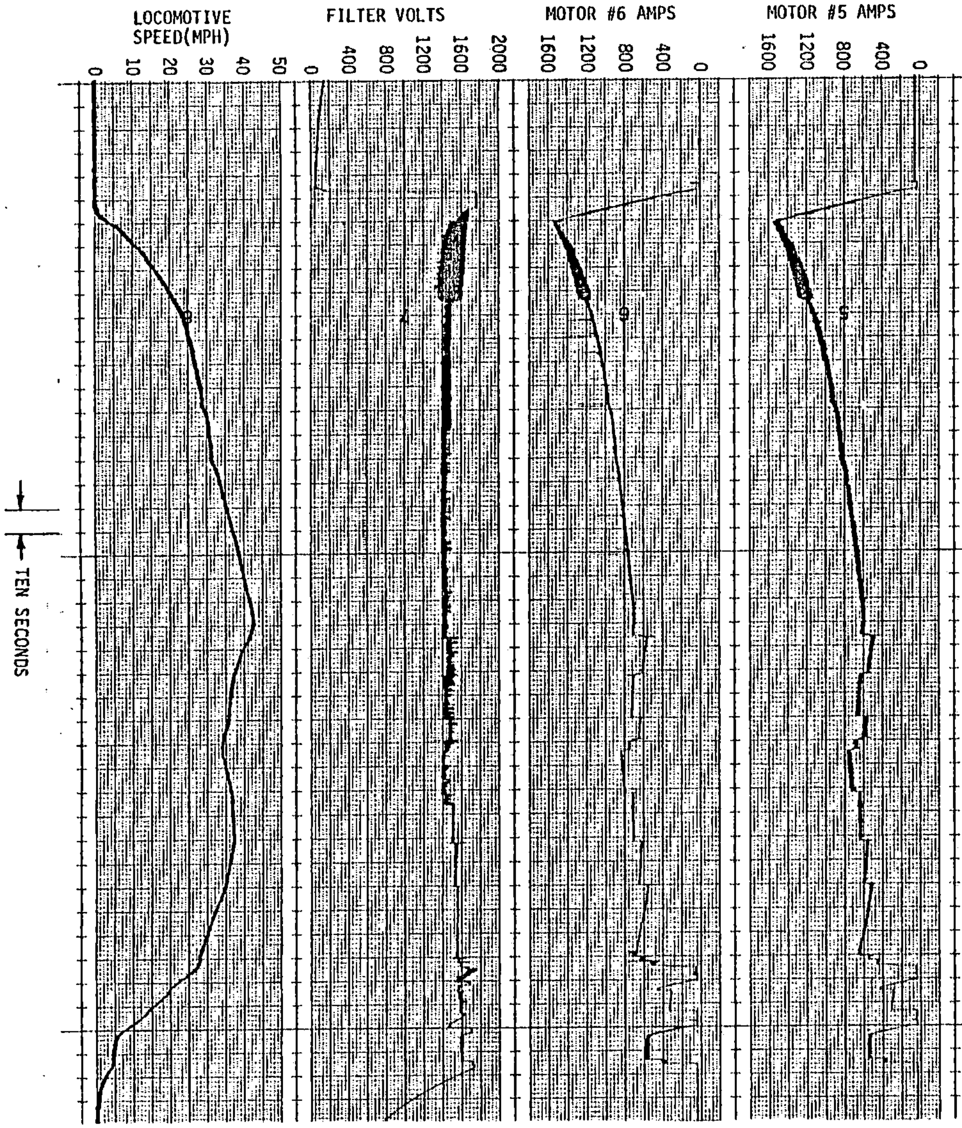

LOCOMOTIVE SPEED(MPH)
0 10 20 30 40 50
FILTER VOLTS
0 400 800 1200 1600 2000
MOTOR #6 AMPS
1600 1200 800 400 0
MOTOR #5 AMPS
1600 1200 800 400 0
TEN SECONDS

FIGURE 3.3 - NOTCH 8 ACCELERATION FROM STOP

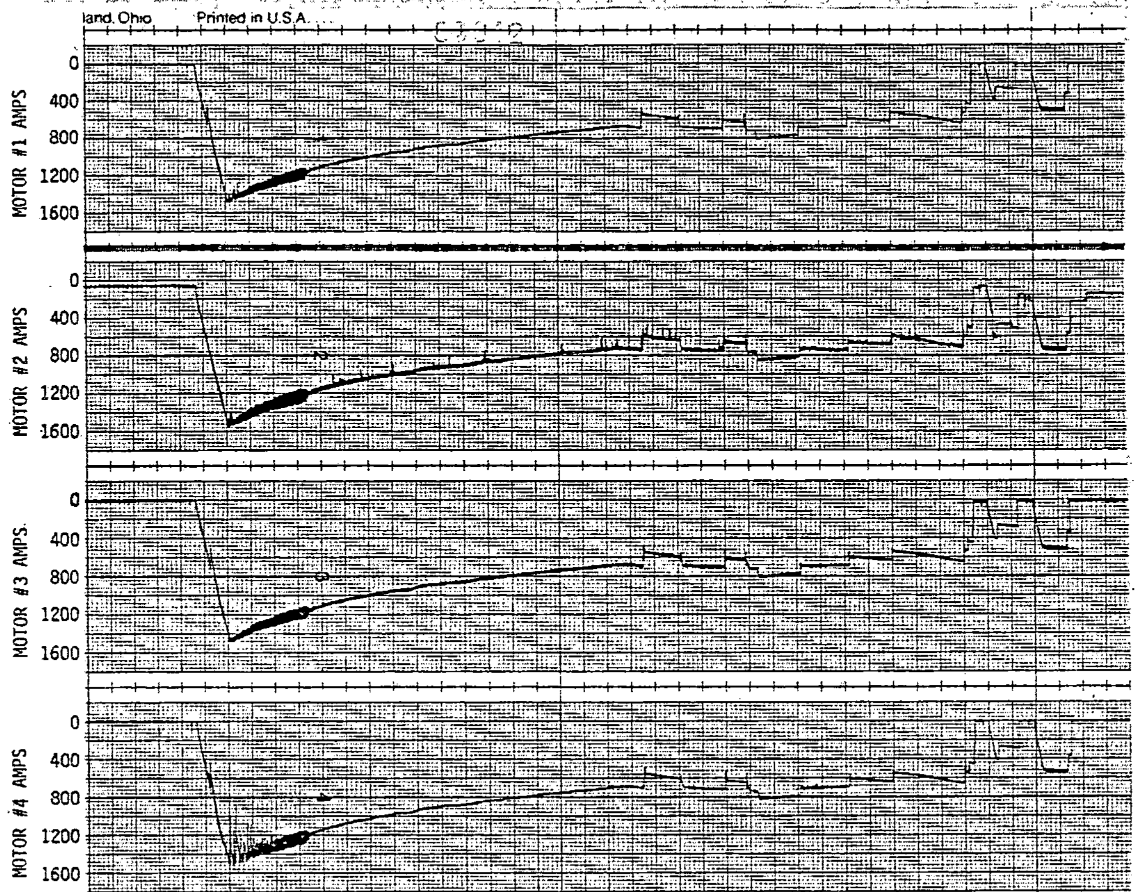
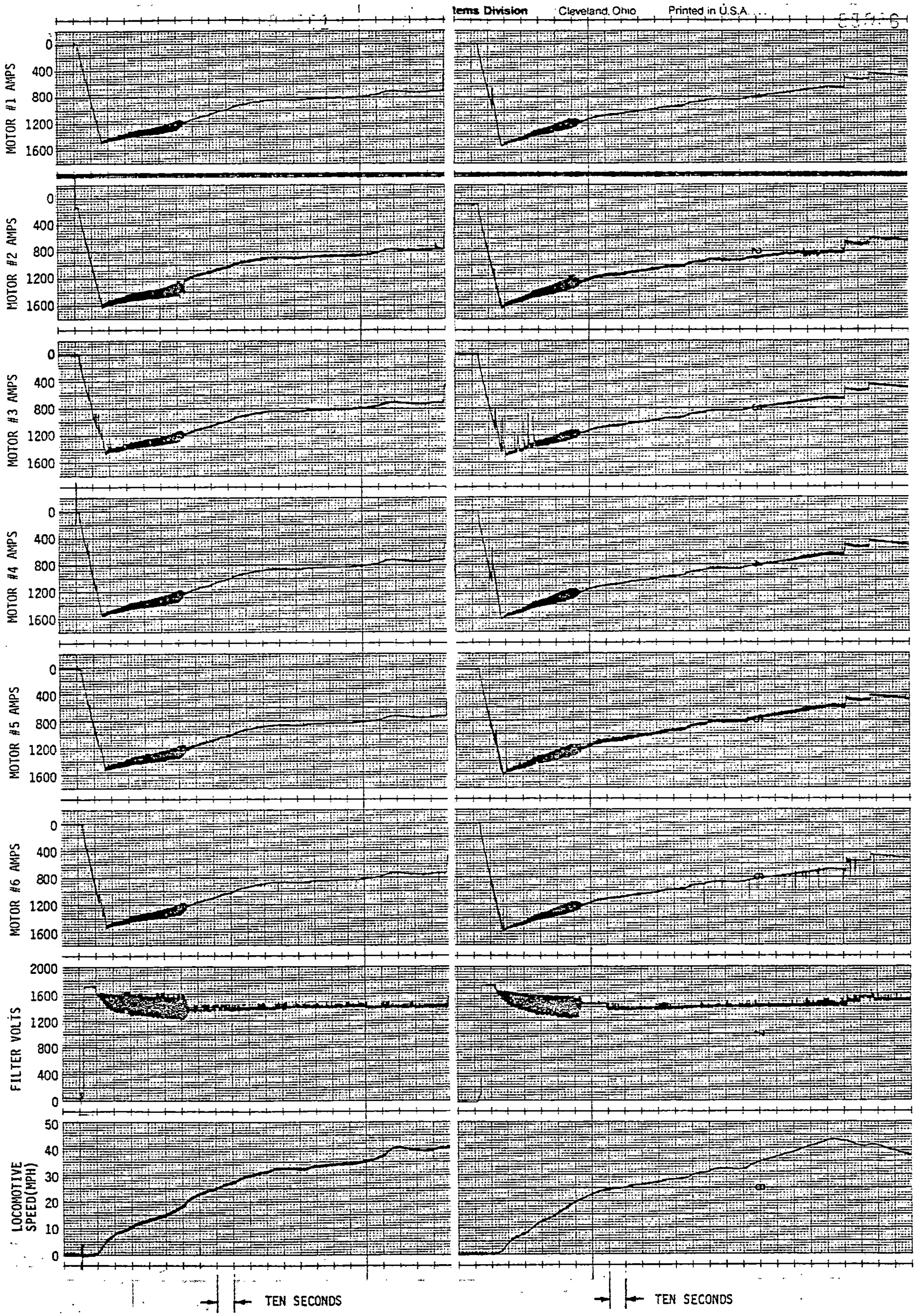


FIGURE 3.4 - TWO NOTCH 8 ACCELERATION RUNS



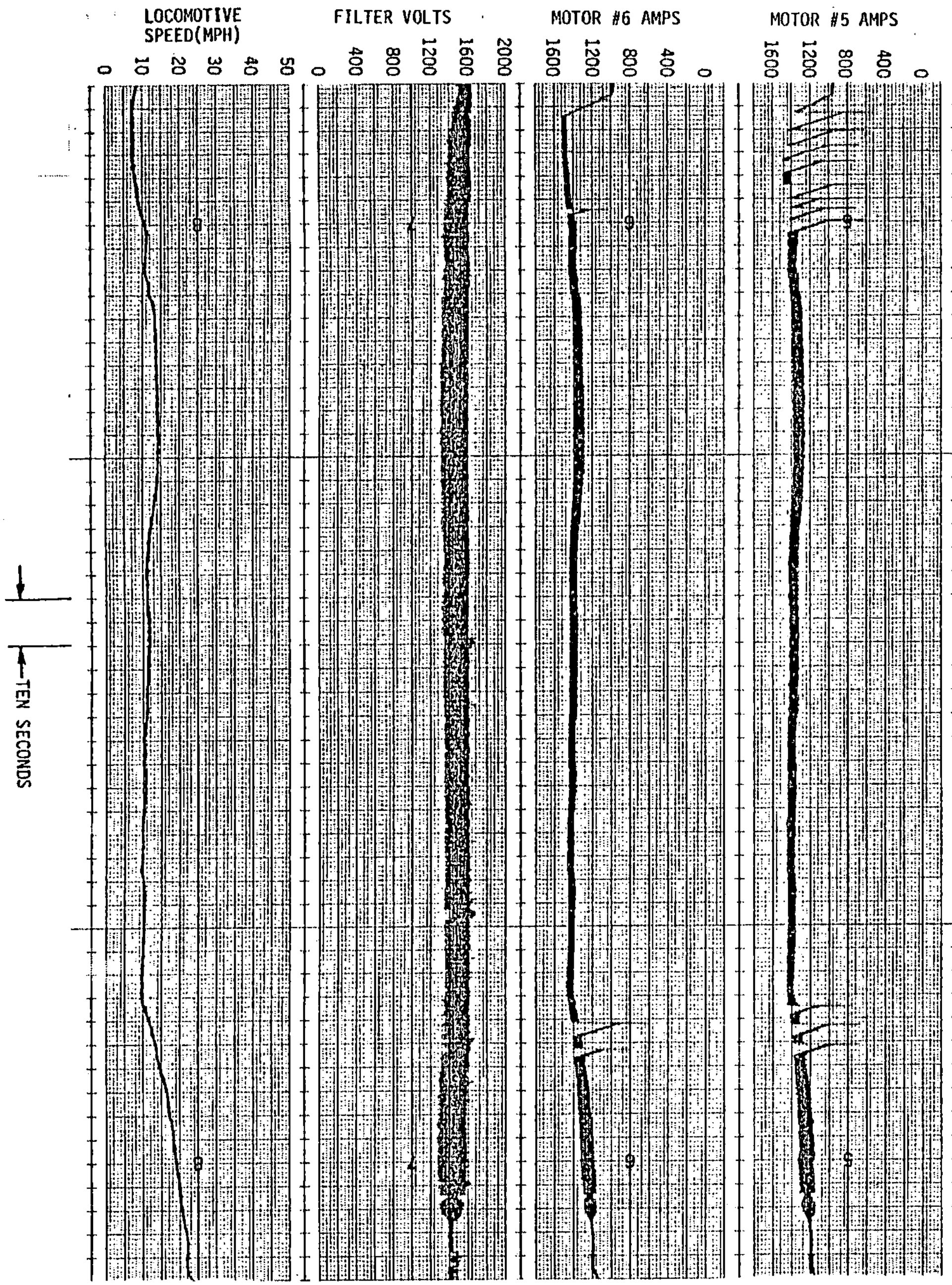
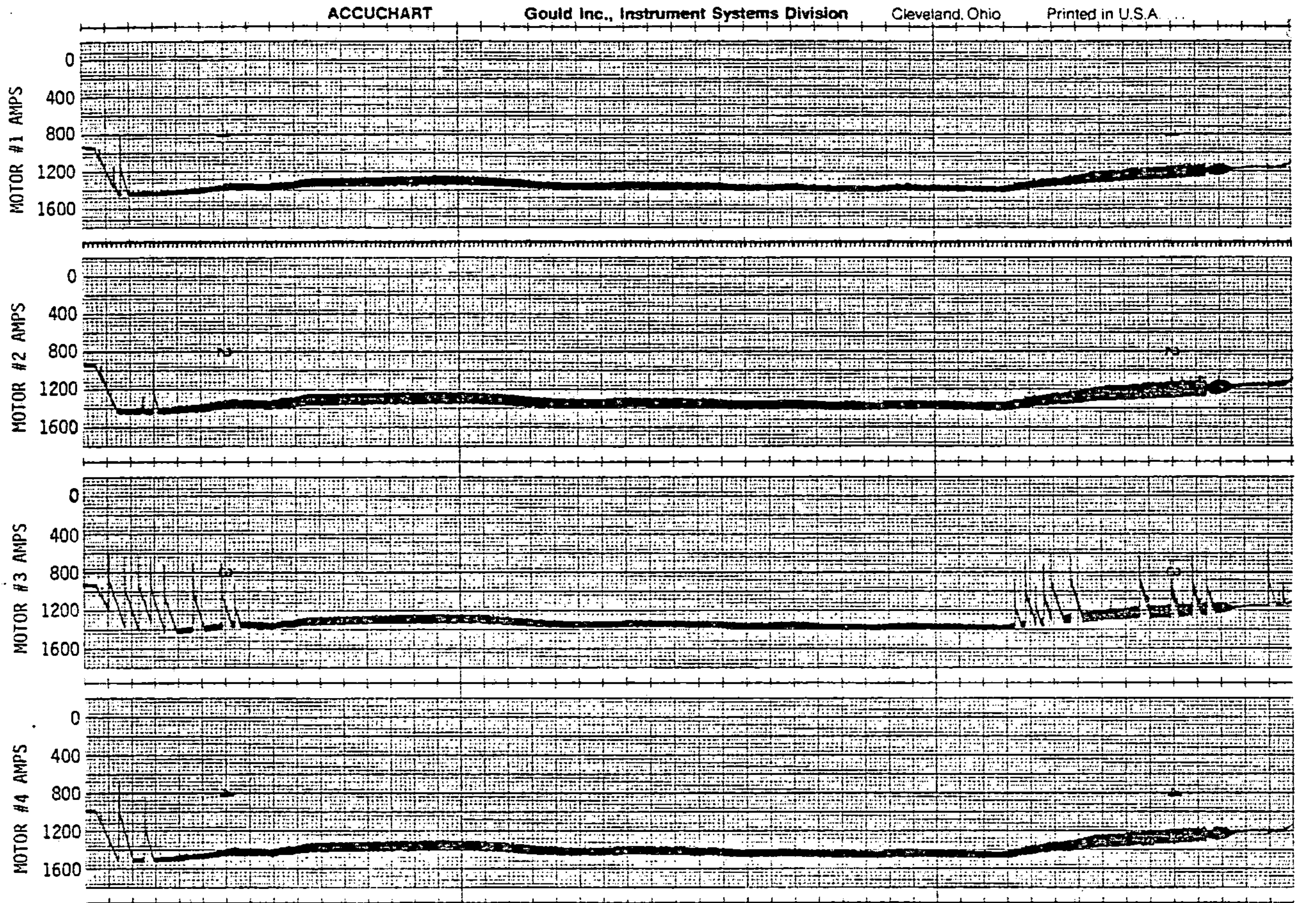

LOCOMOTIVE SPEED(MPH)
0 10 20 30 40 50
FILTER VOLTS
0 400 800 1200 1600 2000
MOTOR #6 AMPS
1600 1200 800 400 0
MOTOR #5 AMPS
1600 1200 800 400 0
TEN SECONDS

FIGURE 3.5 - RUNS 6 AND 7 - 10 MPH MOTORING



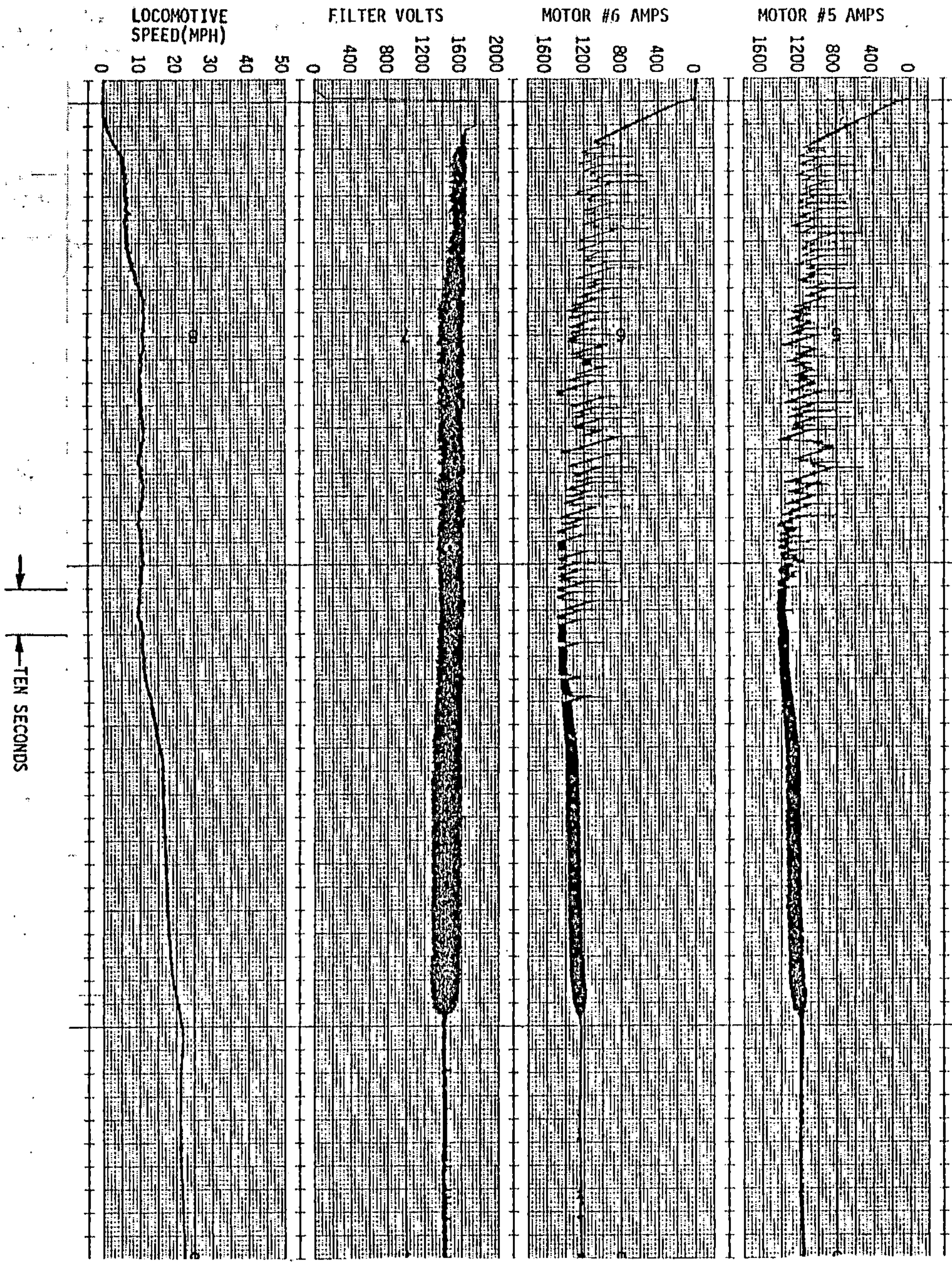
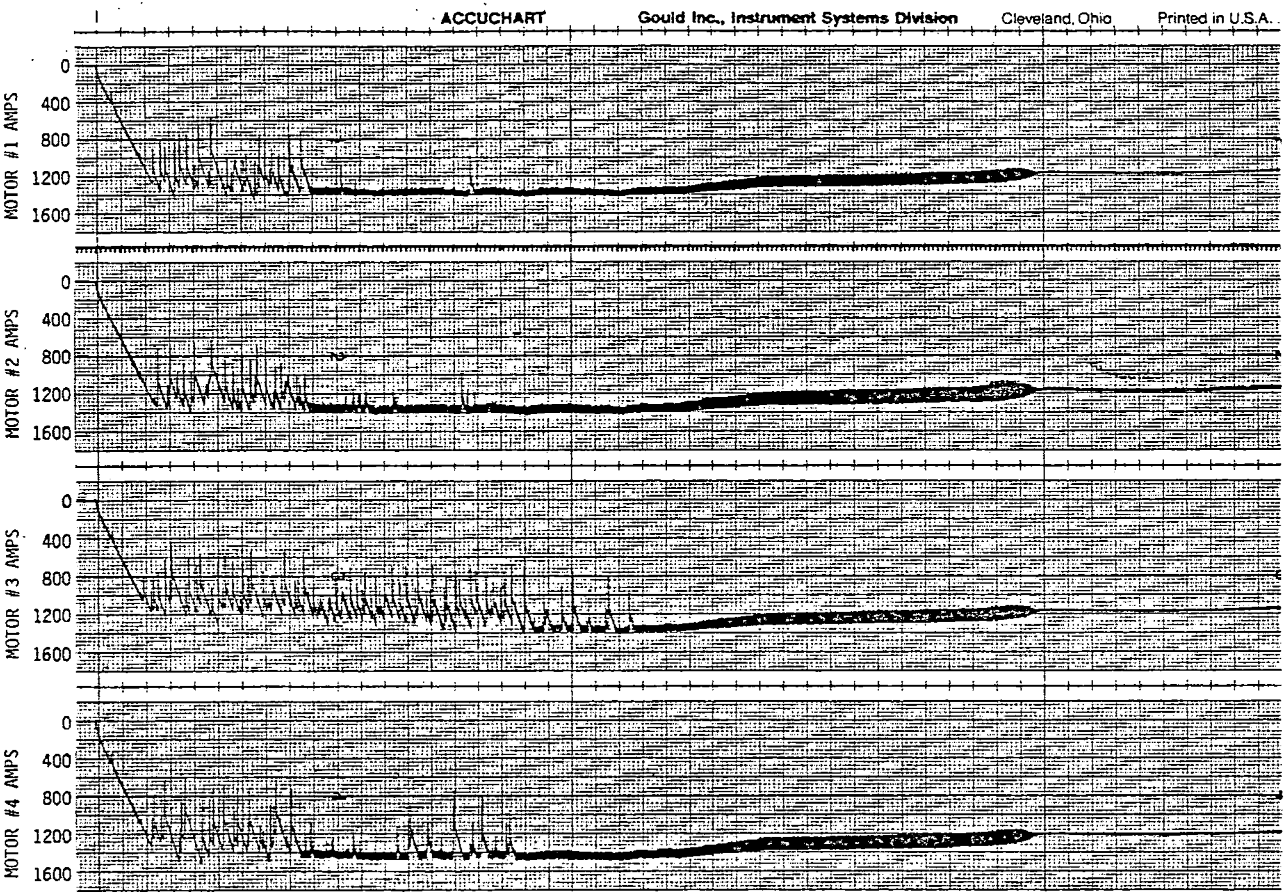
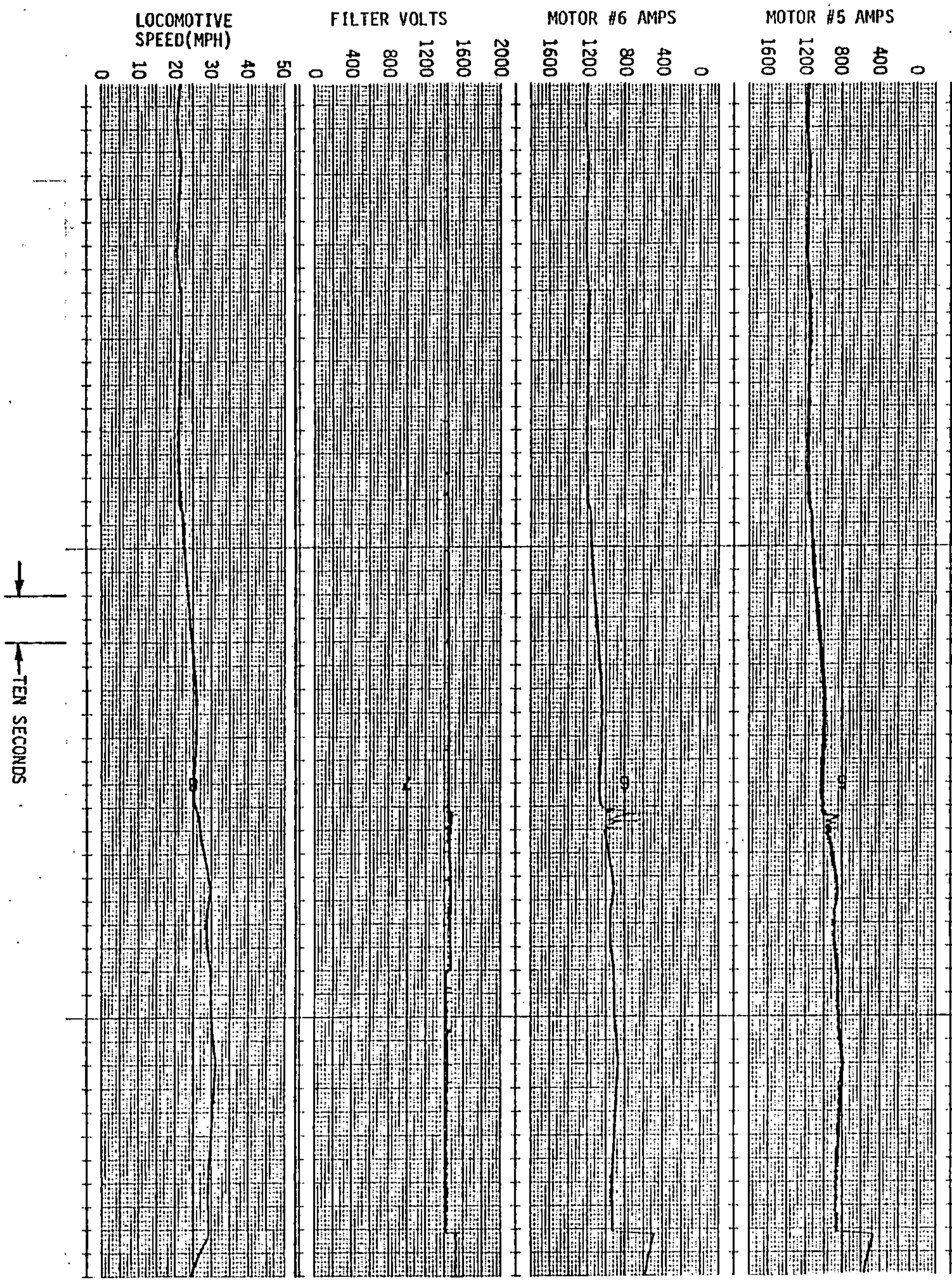

LOCOMOTIVE SPEED(MPH)
0
10
20
30
40
50
FILTER VOLTS
0
400
800
1200
1600
2000
MOTOR #6 AMPS
1600
1200
800
400
0
MOTOR #5 AMPS
1600
1200
800
400
0
TEN SECONDS

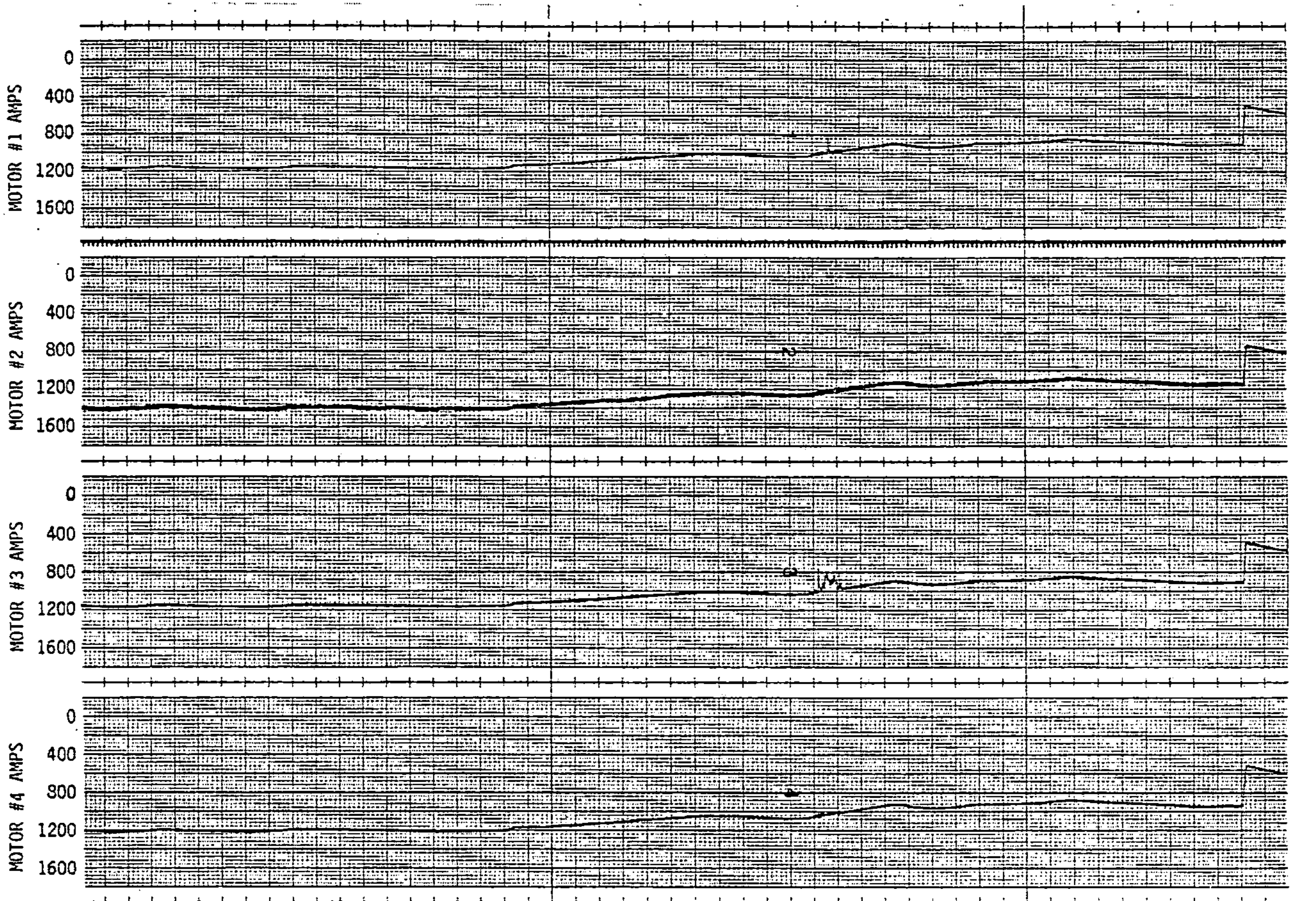
FIGURE 3.6 - RUN 3 - 20 MPH MOTORING





LOCOMOTIVE SPEED(MPH)
0 10 20 30 40 50
FILTER VOLTS
0 400 800 1200 1600 2000
MOTOR #6 AMPS
1600 1200 800 400 0
MOTOR #5 AMPS
1600 1200 800 400 0
TEN SECONDS

FIGURE 3.7 - RUN 1 - 30 MPH MOTORING



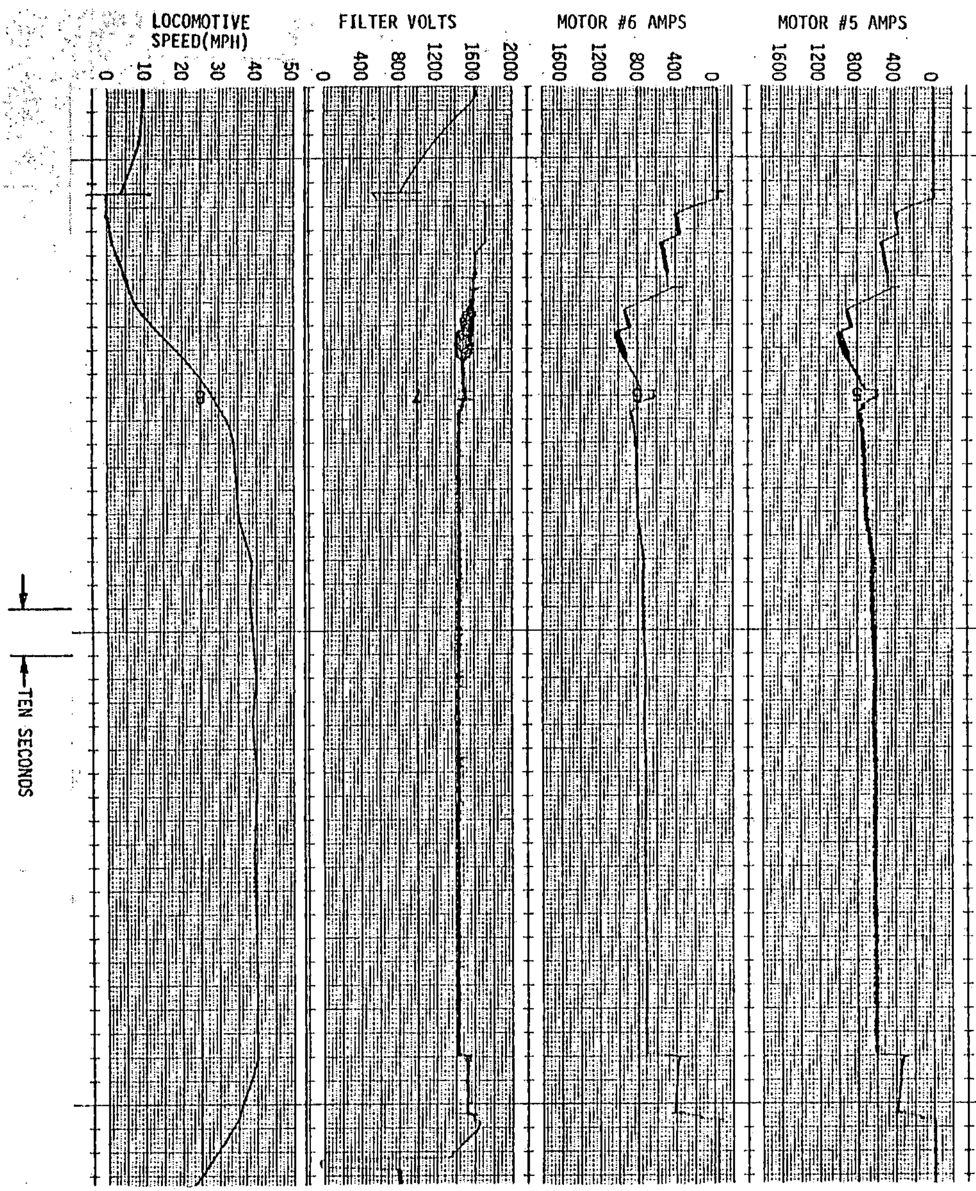
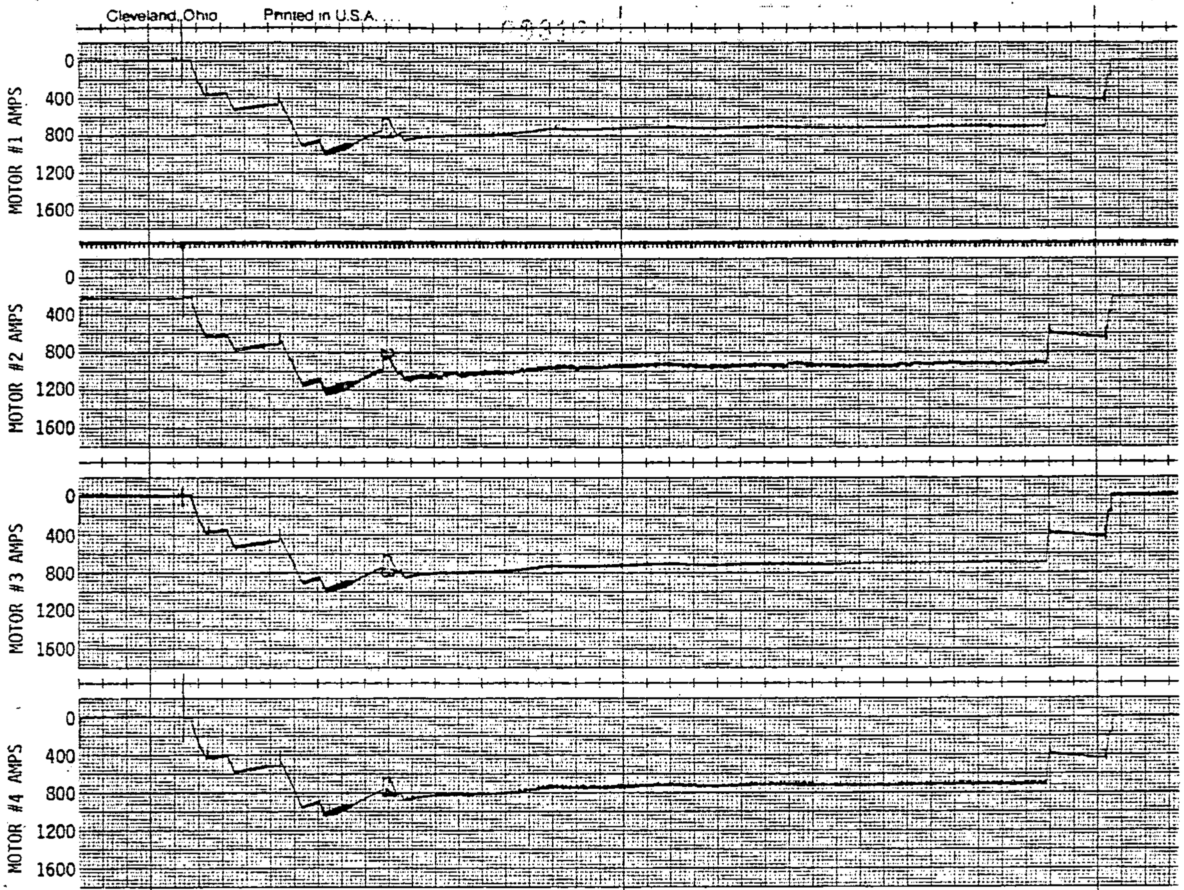
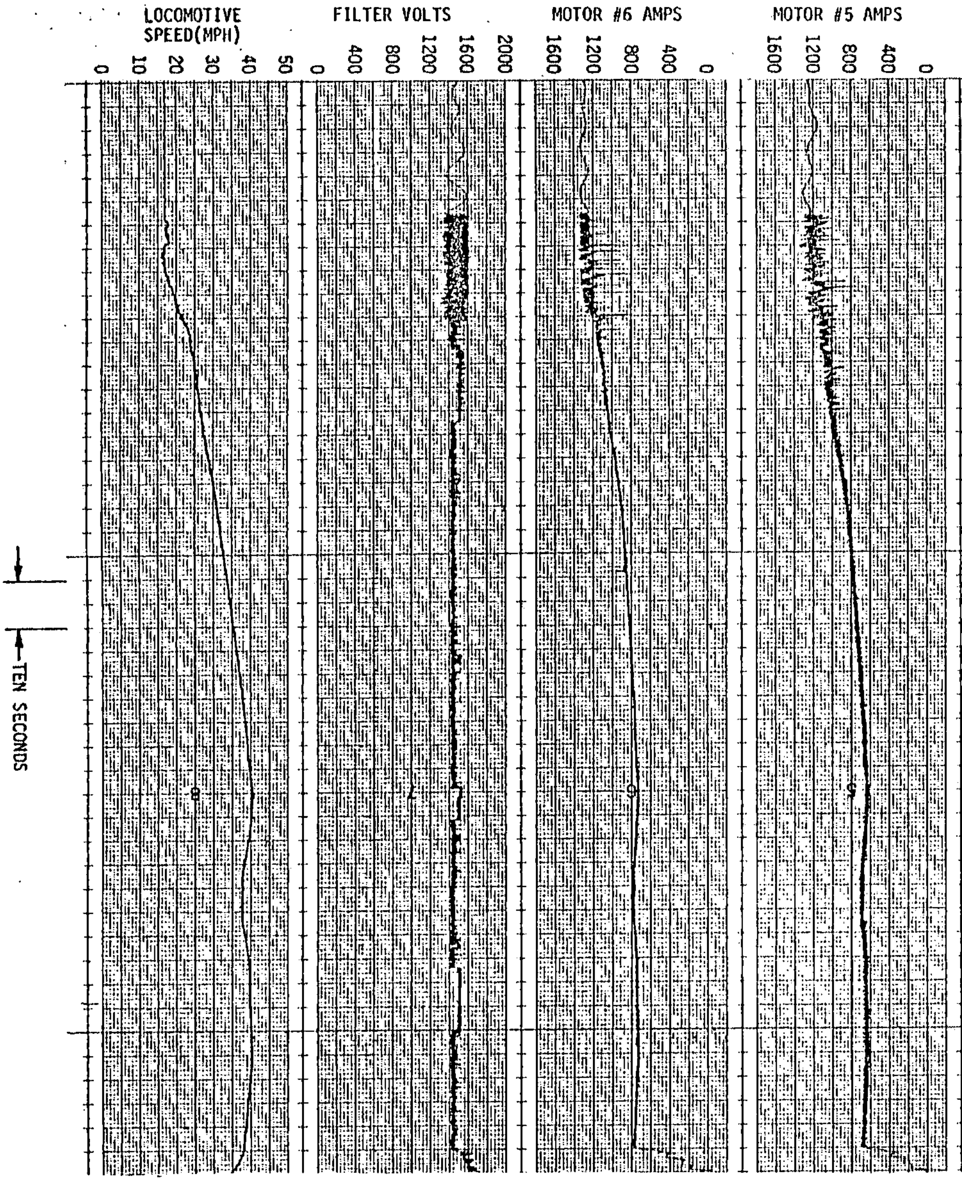

LOCOMOTIVE SPEED(MPH)
0 10 20 30 40 50
FILTER VOLTS
0 400 800 1200 1600 2000
MOTOR #6 AMPS
1600 1200 800 400 0
MOTOR #5 AMPS
1600 1200 800 400 0
TEN SECONDS

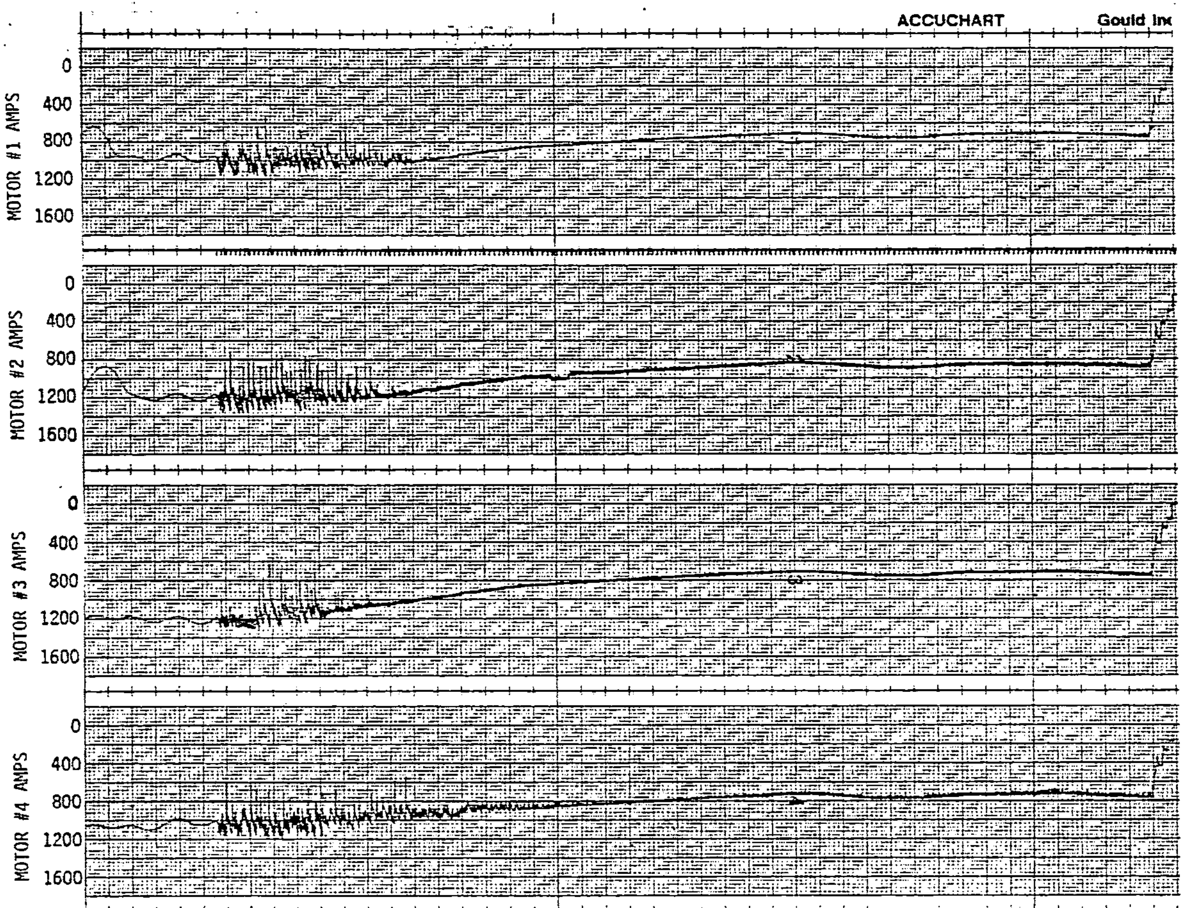
FIGURE 3.8 - RUN 2 - 40 MPH MOTORING





LOCOMOTIVE SPEED(MPH)
0
10
20
30
40
50
FILTER VOLTS
0
400
800
1200
1600
2000
MOTOR #6 AMPS
1600
1200
800
400
0
MOTOR #5 AMPS
1600
1200
800
400
0
TEN SECONDS

FIGURE 3.9 - RUN 4 - 40 MPH MOTORING



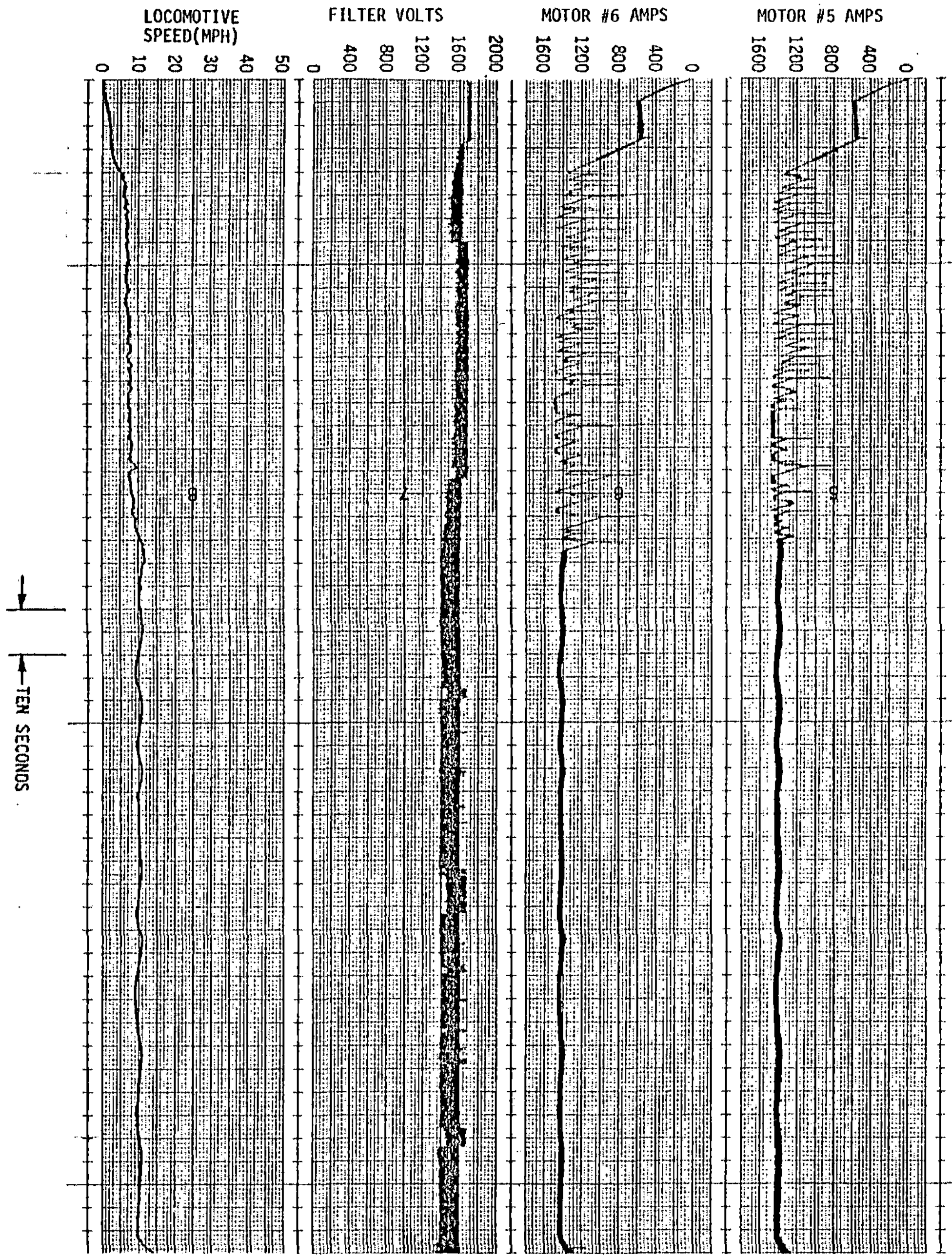
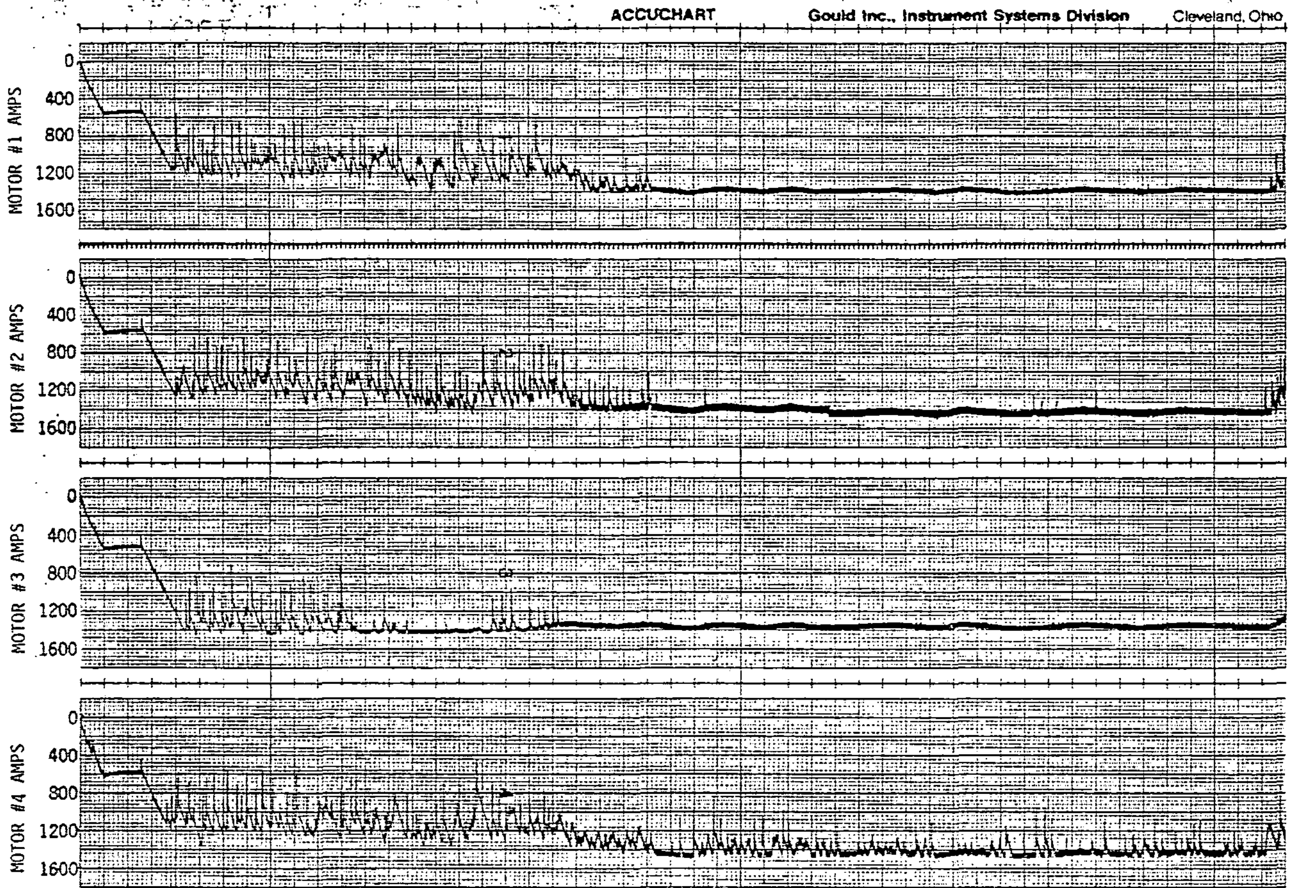

LOCOMOTIVE SPEED(MPH)
0
10
20
30
40
50
FILTER VOLTS
0
400
800
1200
1600
2000
MOTOR #6 AMPS
1600
1200
800
400
0
MOTOR #5 AMPS
1600
1200
800
400
0
TEN SECONDS

FIGURE 3.10 – RUNS 13 AND 14 – 10 MPH MOTORING WITH POWER FACTOR CORRECTION FILTERS CONNECTED



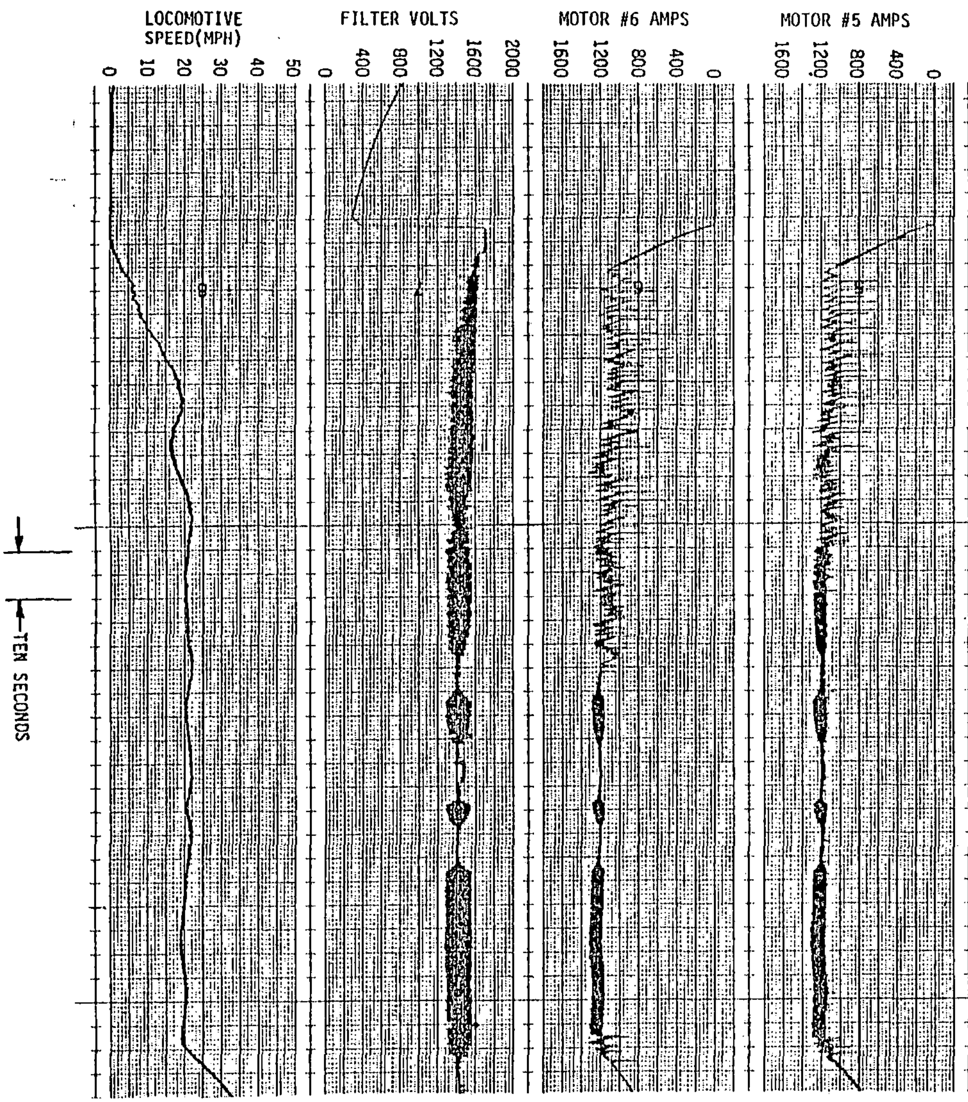
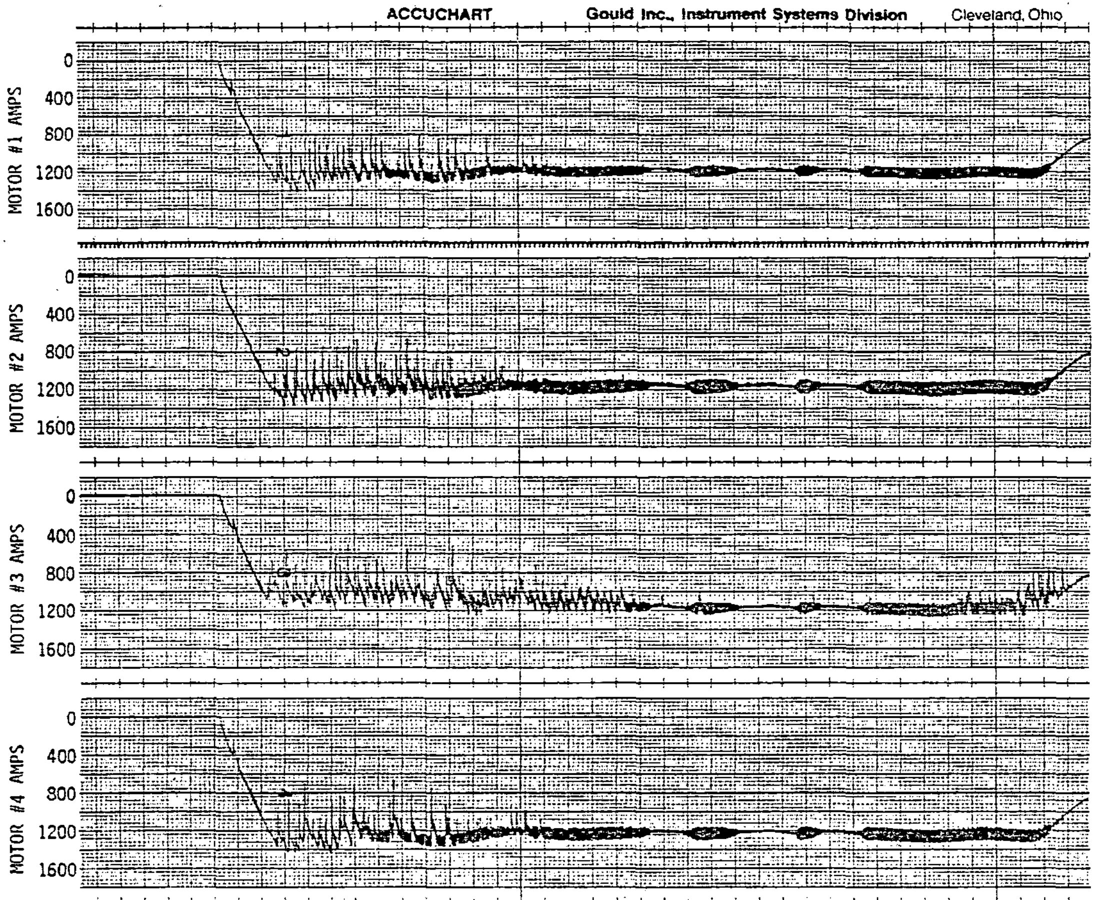

LOCOMOTIVE SPEED(MPH)
FILTER VOLTS
MOTOR #6 AMPS
MOTOR #5 AMPS
0
10
20
30
40
50
400
800
1200
1600
2000
TEN SECONDS

FIGURE 3.11 - RUNS 10 AND 11 - 20 MPH MOTORING WITH POWER FACTOR CORRECTION FILTERS CONNECTED




LOCOMOTIVE SPEED(MPH)
0 10 20 30 40 50
FILTER VOLTS
0 400 800 1200 1600 2000
MOTOR #6 AMPS
1600 1200 800 400 0
MOTOR #5 AMPS
1600 1200 800 400 0
TEN SECONDS

FIGURE 3.12 - RUNS 8 AND 9 - 30 MPH MOTORING WITH POWER FACTOR CORRECTION FILTERS CONNECTED

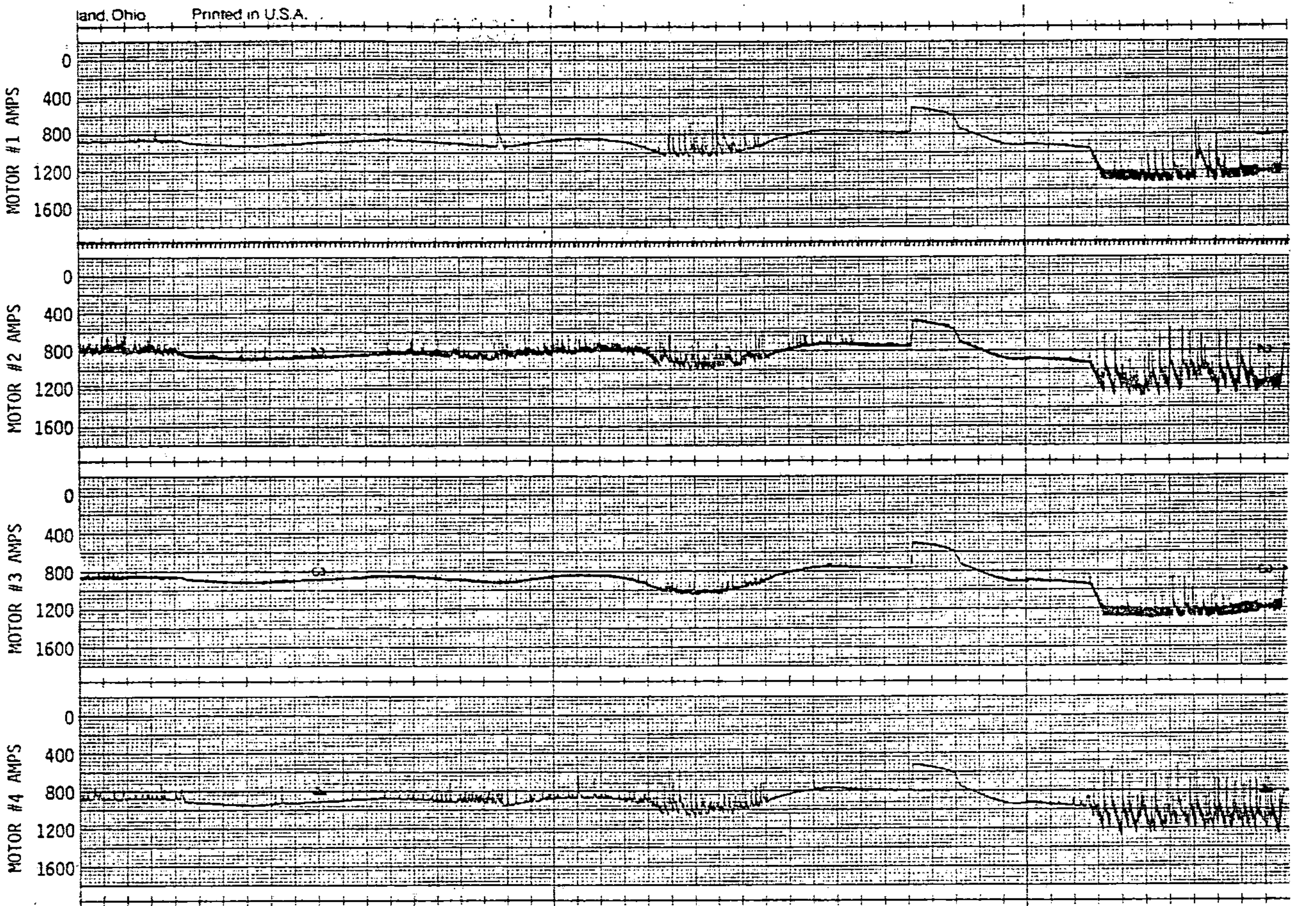
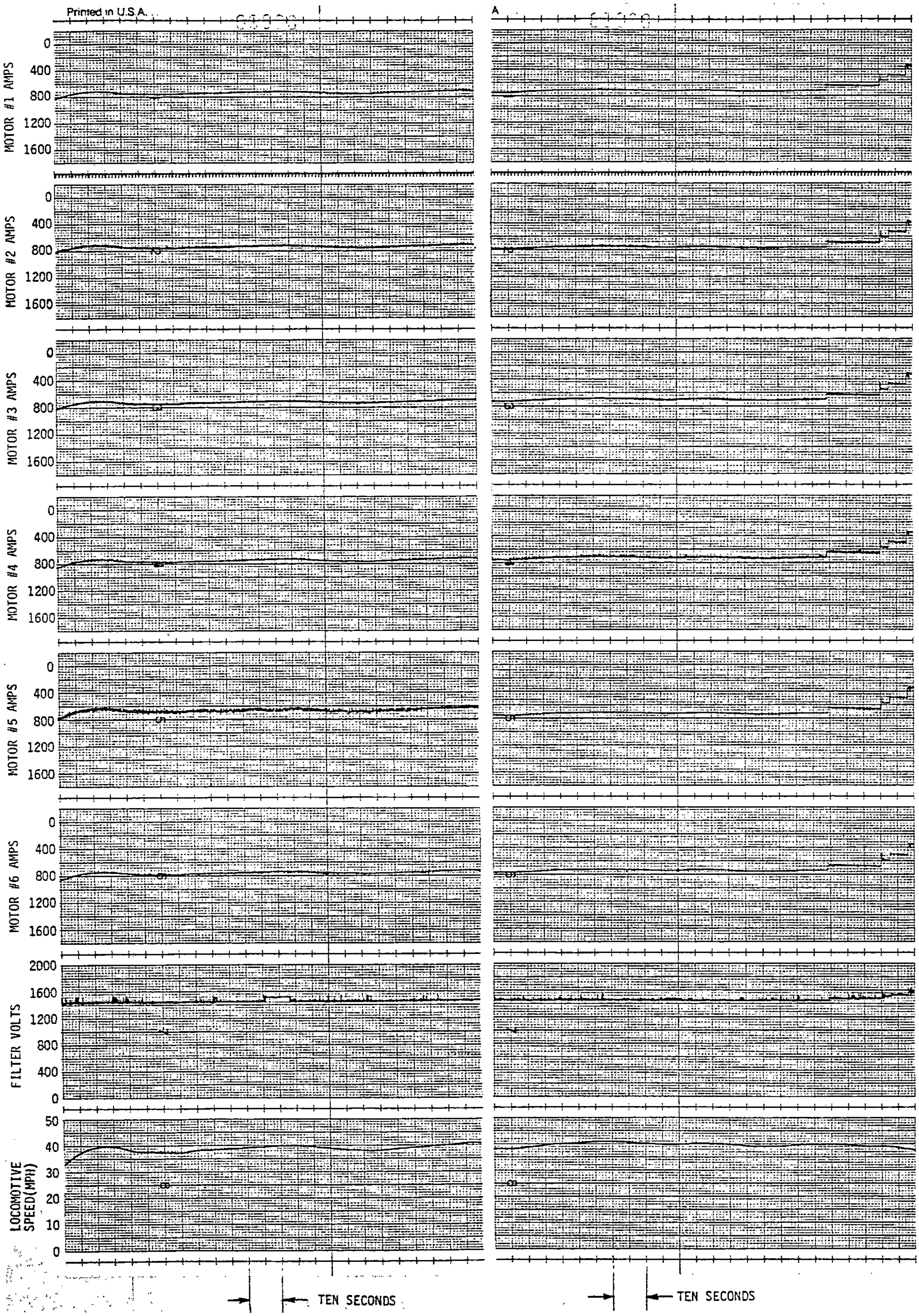


FIGURE 3.13 - RUNS 15 AND 12 - 40 MPH MOTORING WITH POWER FACTOR CORRECTION FILTERS CONNECTED



SECTION 4

DYNAMIC BRAKING PERFORMANCE

A. TEST SET-UP

Test set-up was the same as for the motoring test.

B. TEST RESULTS

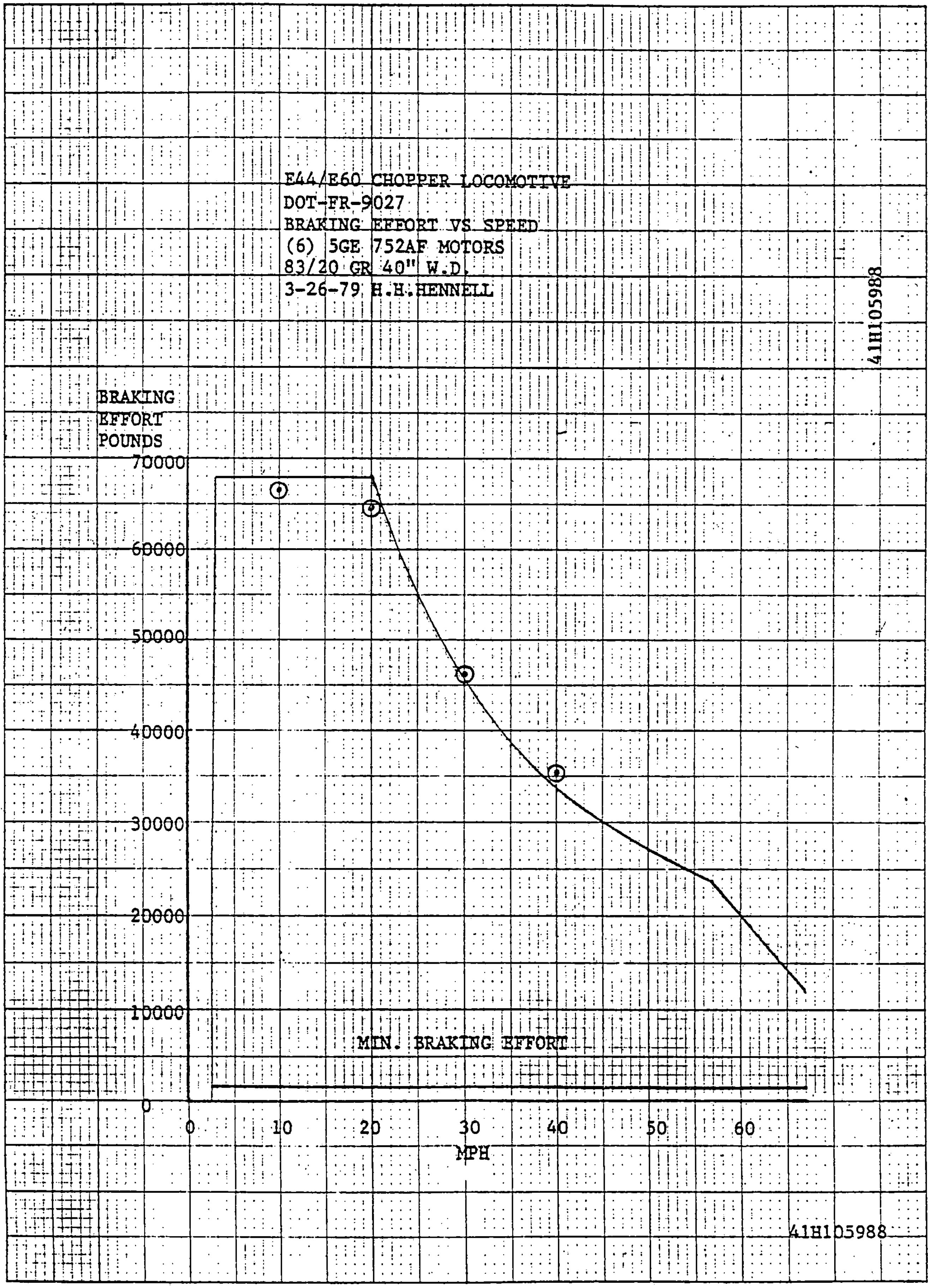
Figure 4.1 show the published braking effort vs speed curve, 41H105988, with the four data points at 10, 20, 30, and 40 MPH plotted.

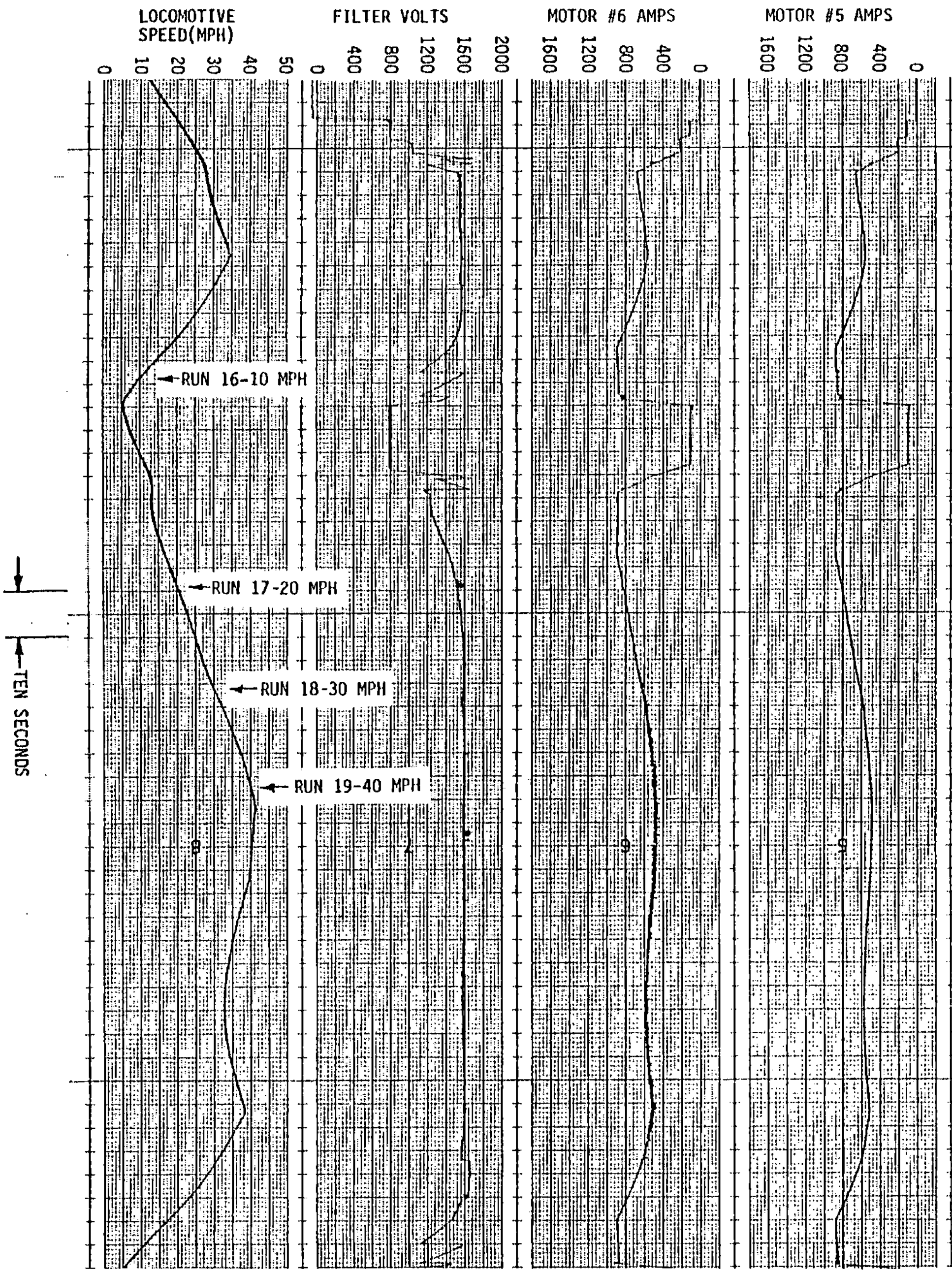
C. FIGURE 4.2-RUNS 16, 17, 19, AND 19 - DYNAMIC BRAKING FROM 10-40 MPH

Note that the filter voltage is maintained at a minimum of 800 volts by the phase controlled bridges as this is the minimum at which the choppers will work. As motor current increases, the filter voltage increase above 800 and the bridges phase off. As motor current varies, the filter voltage varies and is controlled between 1100 and 1700 by two steps of braking grid resistance.

D. FIGURE 4.3-RUNS 20, 21, 22, AND 24 - DYNAMIC BRAKING FOR 10, 20, 30, AND 40 MPH

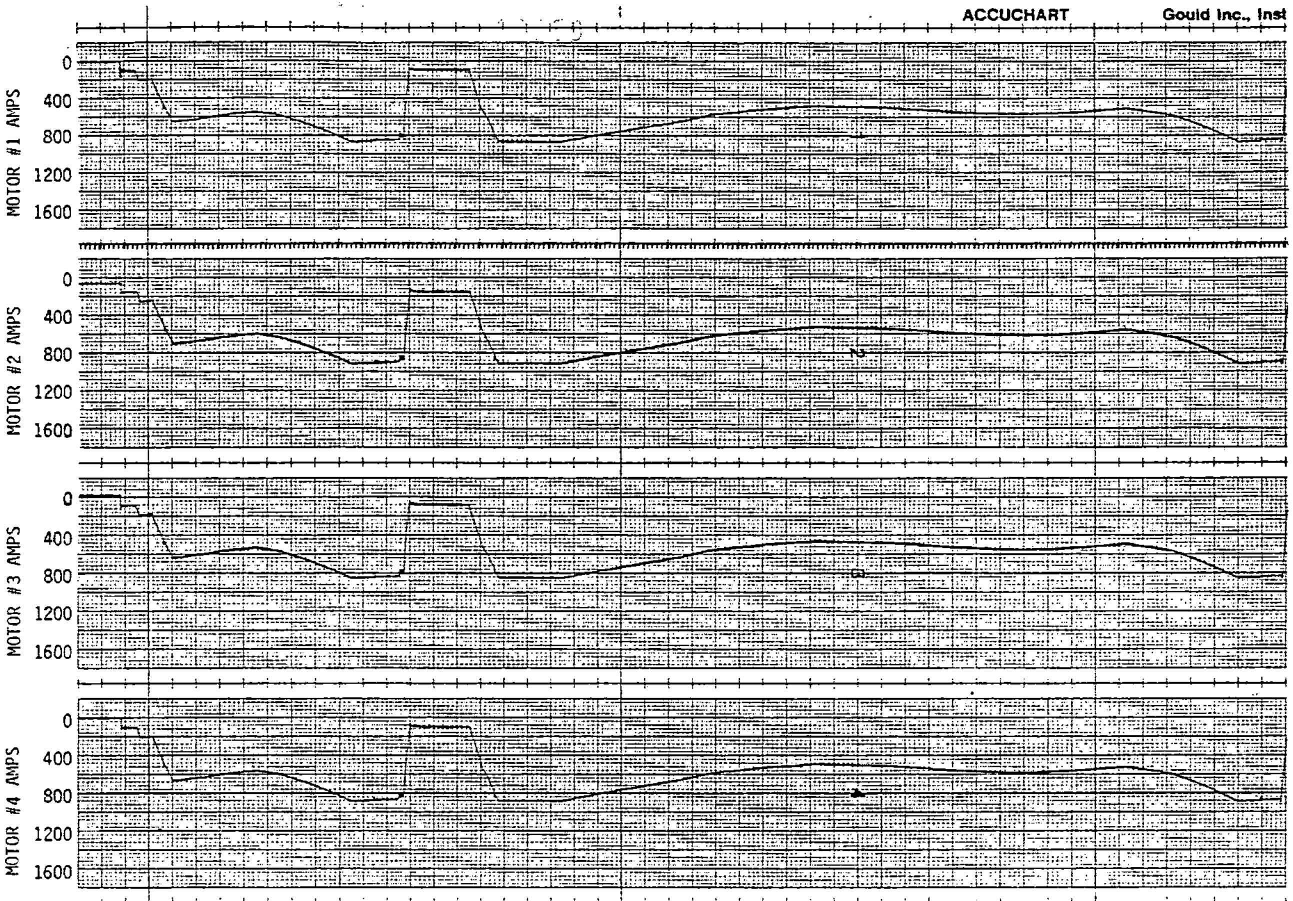
FIGURE 4.1 - BRAKING EFFORT VS SPEED CURVE

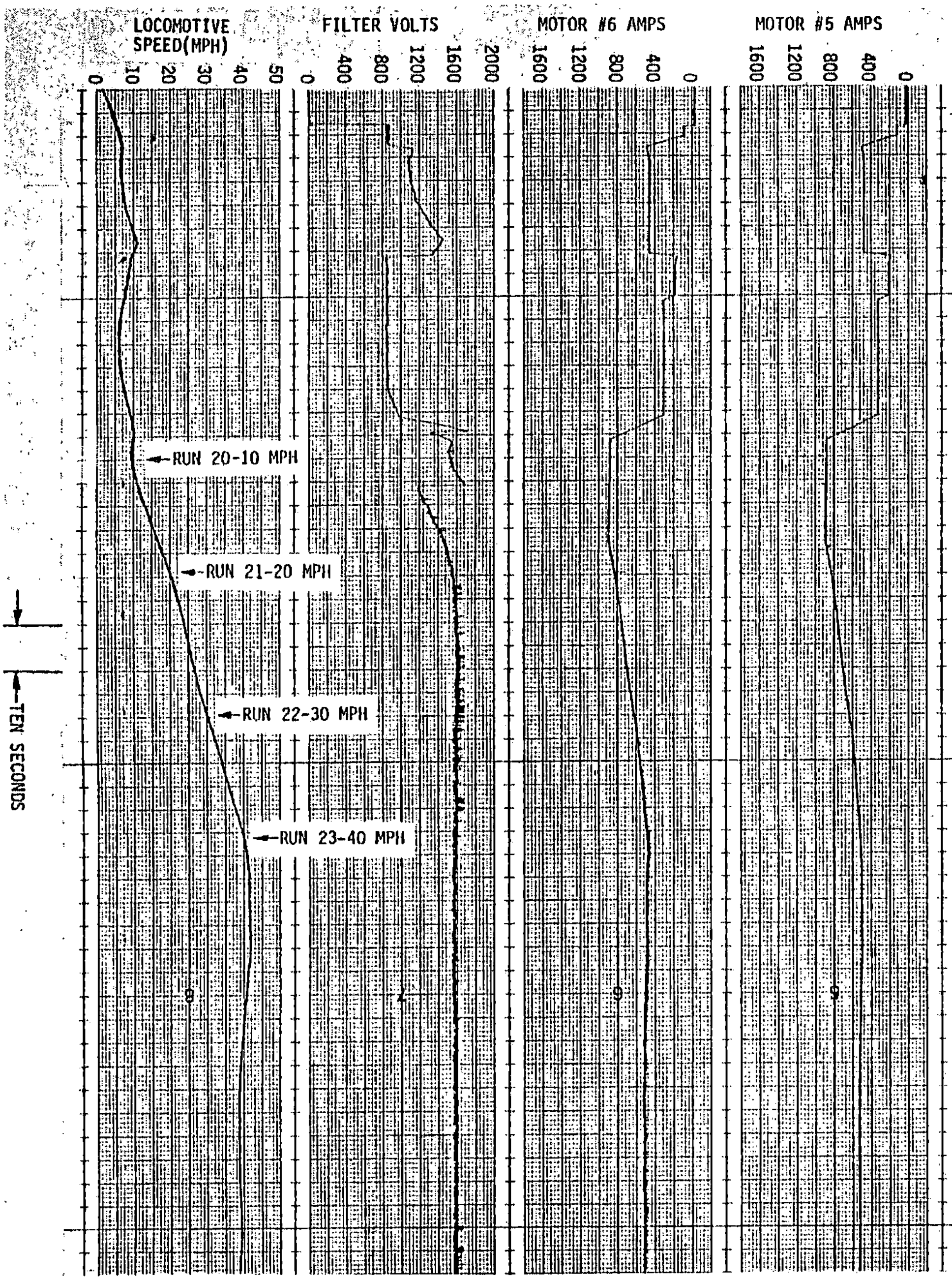




LOCOMOTIVE SPEED(MPH)
0 10 20 30 40 50
FILTER VOLTS
0 400 800 1200 1600 2000
MOTOR #6 AMPS
1600 1200 800 400 0
MOTOR #5 AMPS
1600 1200 800 400 0
RUN 16-10 MPH
RUN 17-20 MPH
RUN 18-30 MPH
RUN 19-40 MPH
TEN SECONDS

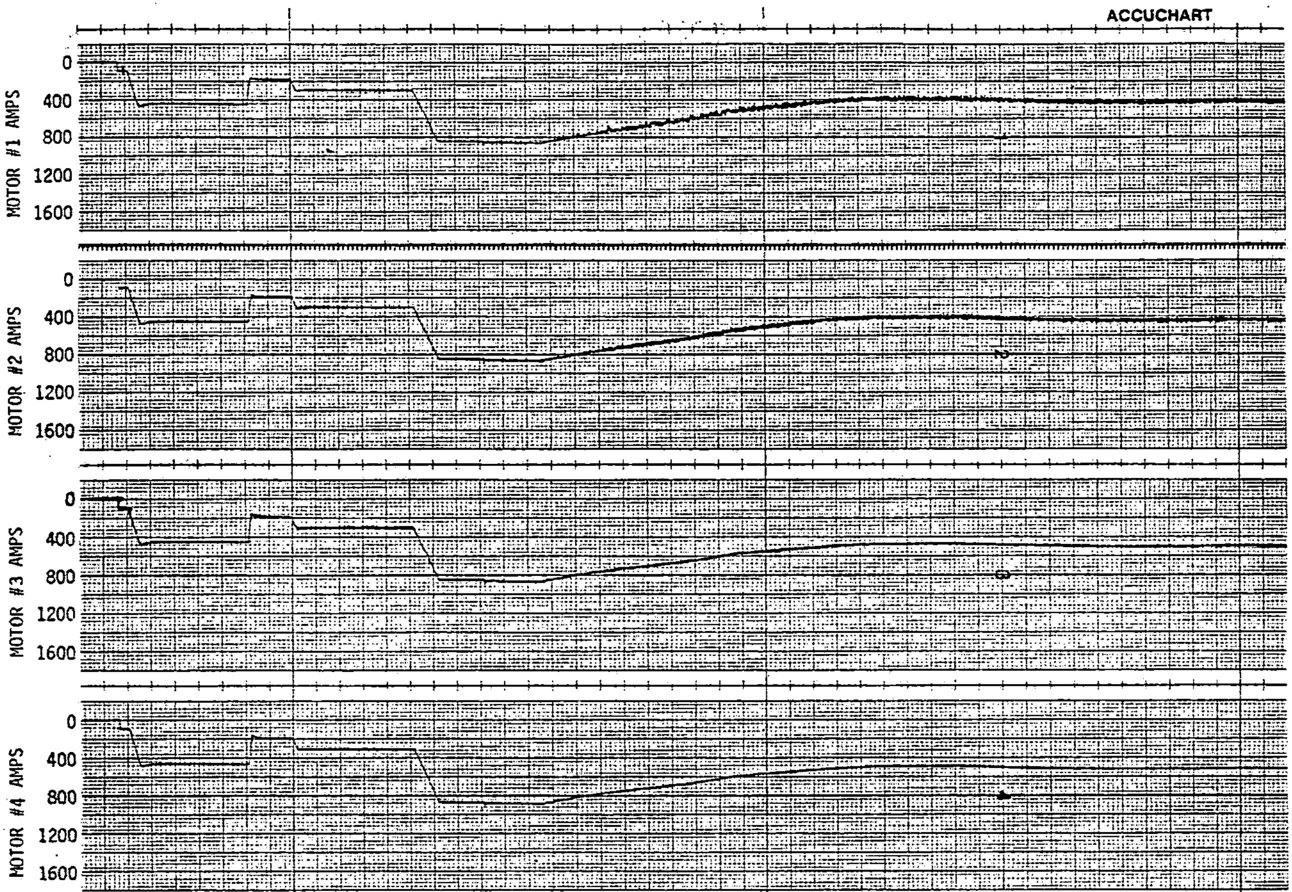
FIGURE 4.2 - RUNS 16, 17, 18 AND 19 - DYNAMIC BRAKING FOR 10, 20, 30 AND 40 MPH





LOCOMOTIVE SPEED(MPH)
0 10 20 30 40 50
FILTER VOLTS
0 400 800 1200 1600 2000
MOTOR #6 AMPS
1600 1200 800 400 0
MOTOR #5 AMPS
1600 1200 800 400 0
RUN 20-10 MPH
RUN 21-20 MPH
RUN 22-30 MPH
RUN 23-40 MPH
TEN SECONDS

FIGURE 4.3 - RUNS 20, 21, 22 AND 23 - DYNAMIC BRAKING FOR 10, 20, 30 AND 40 MPH



SECTION 5

WHEELSLIP EVALUATION

A. TEST SET-UP

Since much of the Chopper Locomotive testing was done during inclement weather, the wheelslip system got a thorough workout without having to manually wet the rails. As mentioned earlier, each of the six choppers is individually controlled such that when any axle slips or slides, only that particular motor current is reduced until the slip or slide is corrected.

B. FIGURES 5.1 AND 5.2 - WHEELSLIP - INDIVIDUAL AXLE CONTROL OF THE SIX TRACTION MOTOR CURRENTS

These two figures show the six traction motor currents randomly being reduced due to a wheelslip on that axle. The small ripple in the current signal is due to the 10 Hz ripple on the filter voltage.

C. FIGURES 5.3 AND 5.4 - WHEELSLIP - INDIVIDUAL AXLE CONTROL OF AXLES 1 AND 4

These two figures show axle speed, chopper reference voltage, and motor current for axles 1 and 4. As can be seen, a small increase in axle speed causes a reference reduction for that chopper which in turn reduces the traction motor current until the slip is corrected.

D. FIGURE 5.5 - WHEELSLIP - SIX AXLE VELOCITIES

Figure 5.5 shows the six axle velocities, filter volts, and the auto sand signal. The small bumps in the velocity traces show where the wheel started to slip and how it was corrected. The bottom trace is the auto sand signal which provides 5 seconds of sanding any time any axle reaches the first level of detection.

FIGURE 5.1 - WHEELSLIP - INDIVIDUAL AXLE CONTROL OF THE SIX TRACTION MOTOR CURRENTS

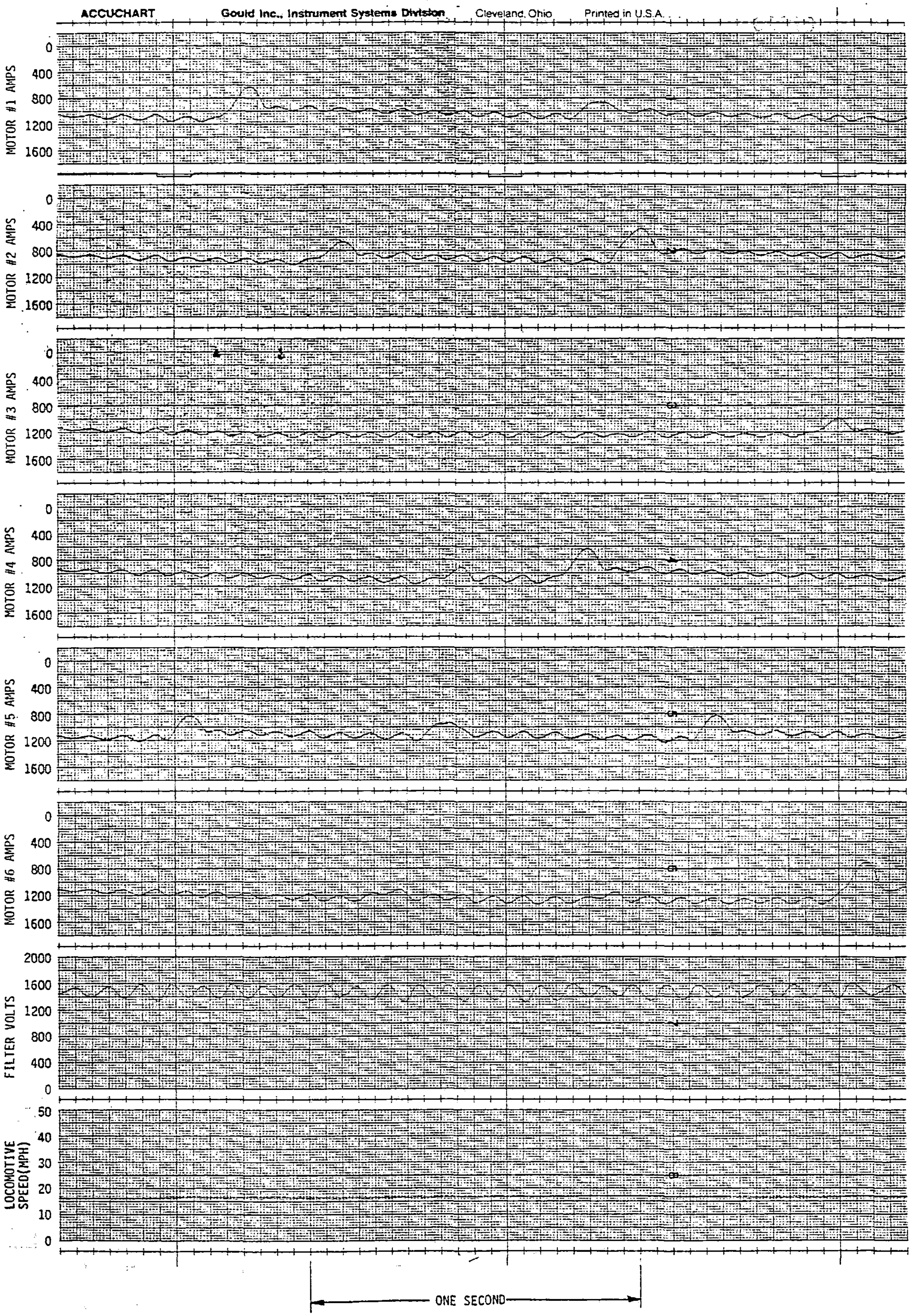
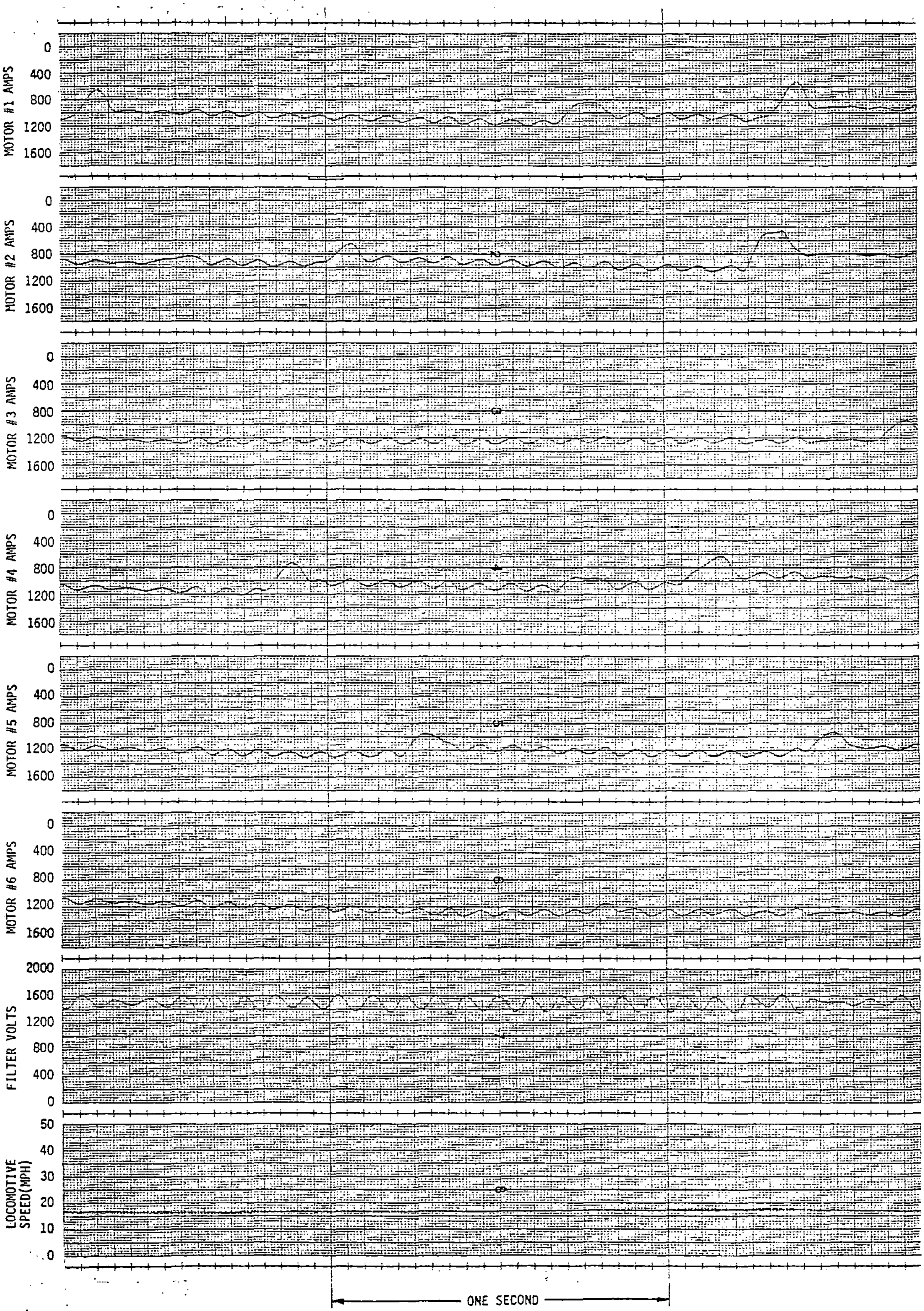
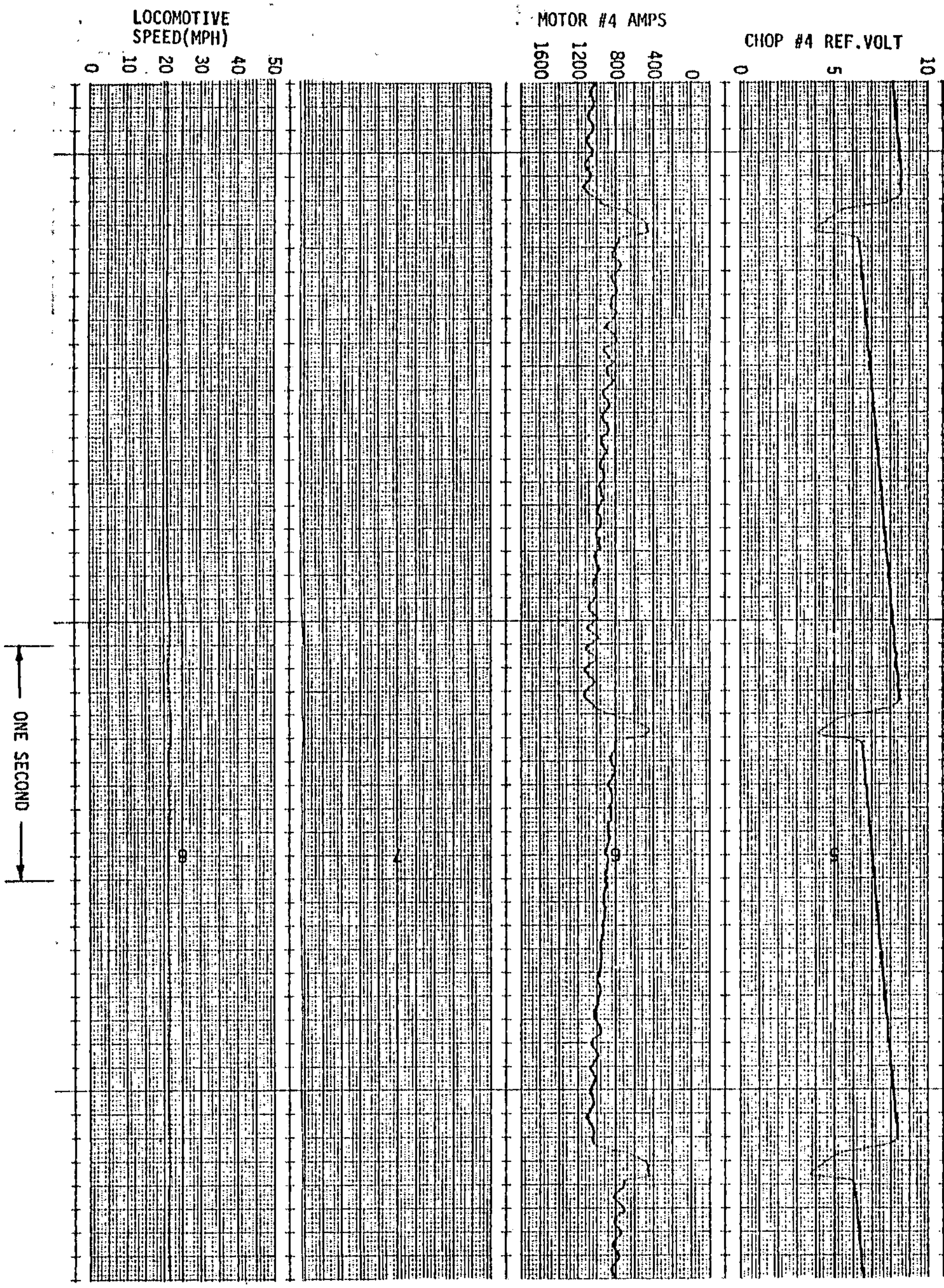


FIGURE 5.2 - WHEELSLIP - INDIVIDUAL AXLE CONTROL OF THE SIX TRACTION MOTOR CURRENTS





LOCOMOTIVE SPEED(MPH)
0 10 20 30 40 50
MOTOR #4 AMPS
1600 1200 800 400 0
CHOP #4 REF.VOLT
0 5 10
ONE SECOND

FIGURE 5.3 - WHEELSLIP - INDIVIDUAL AXLE CONTROL OF AXLES 1 AND 4

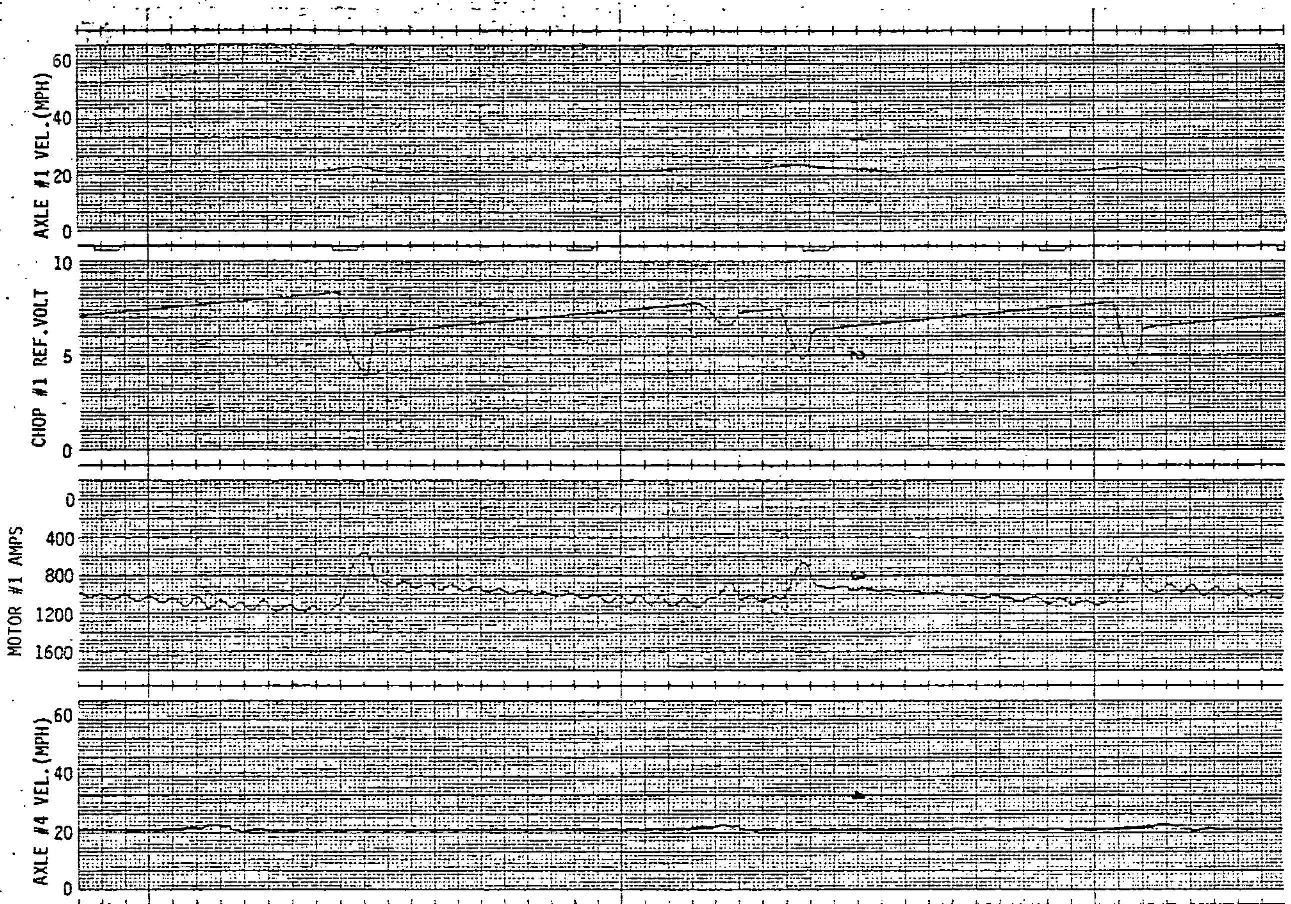
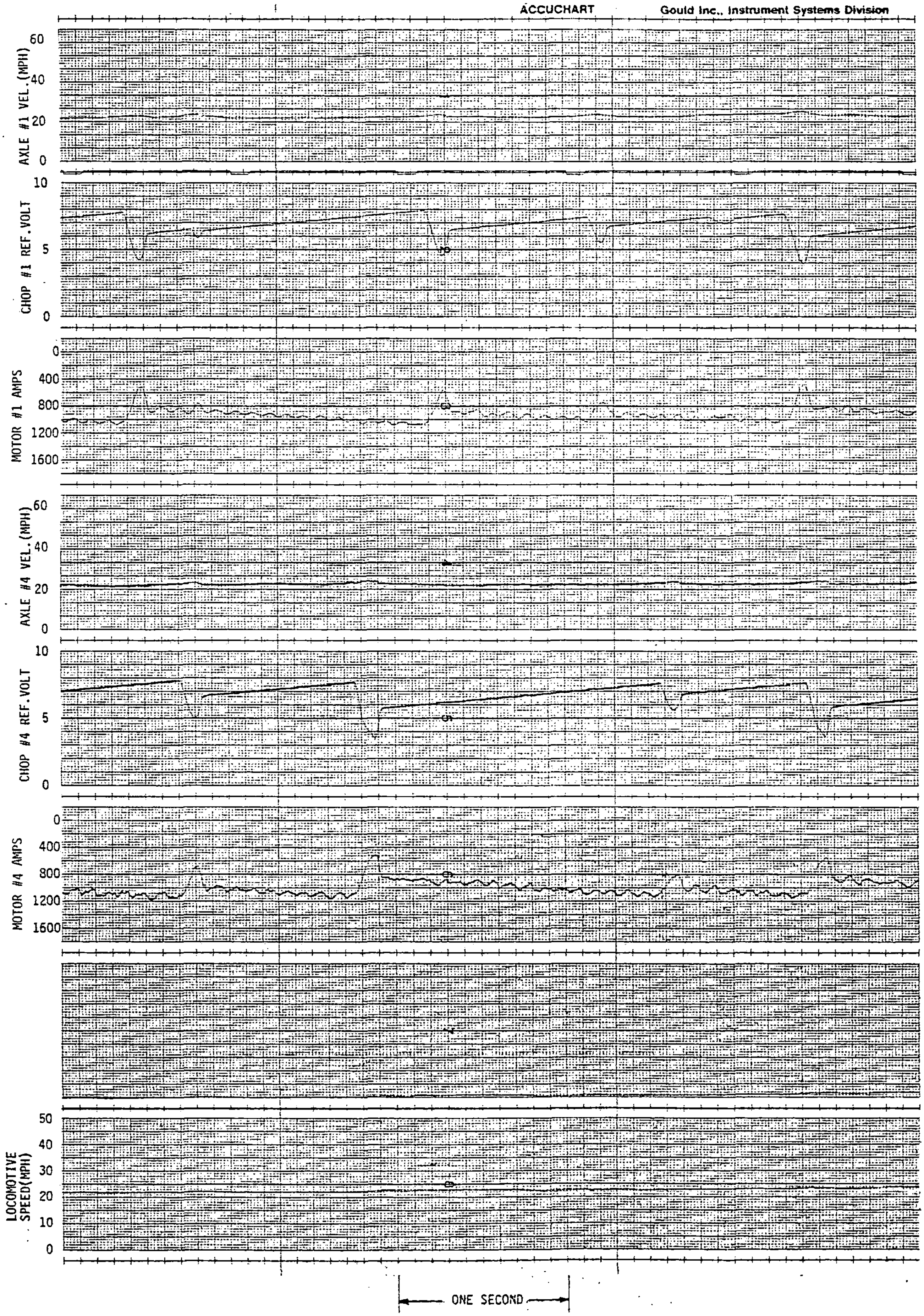


FIGURE 5.4 - WHEELSLIP - INDIVIDUAL AXLE CONTROL OF AXLES 1 AND 4



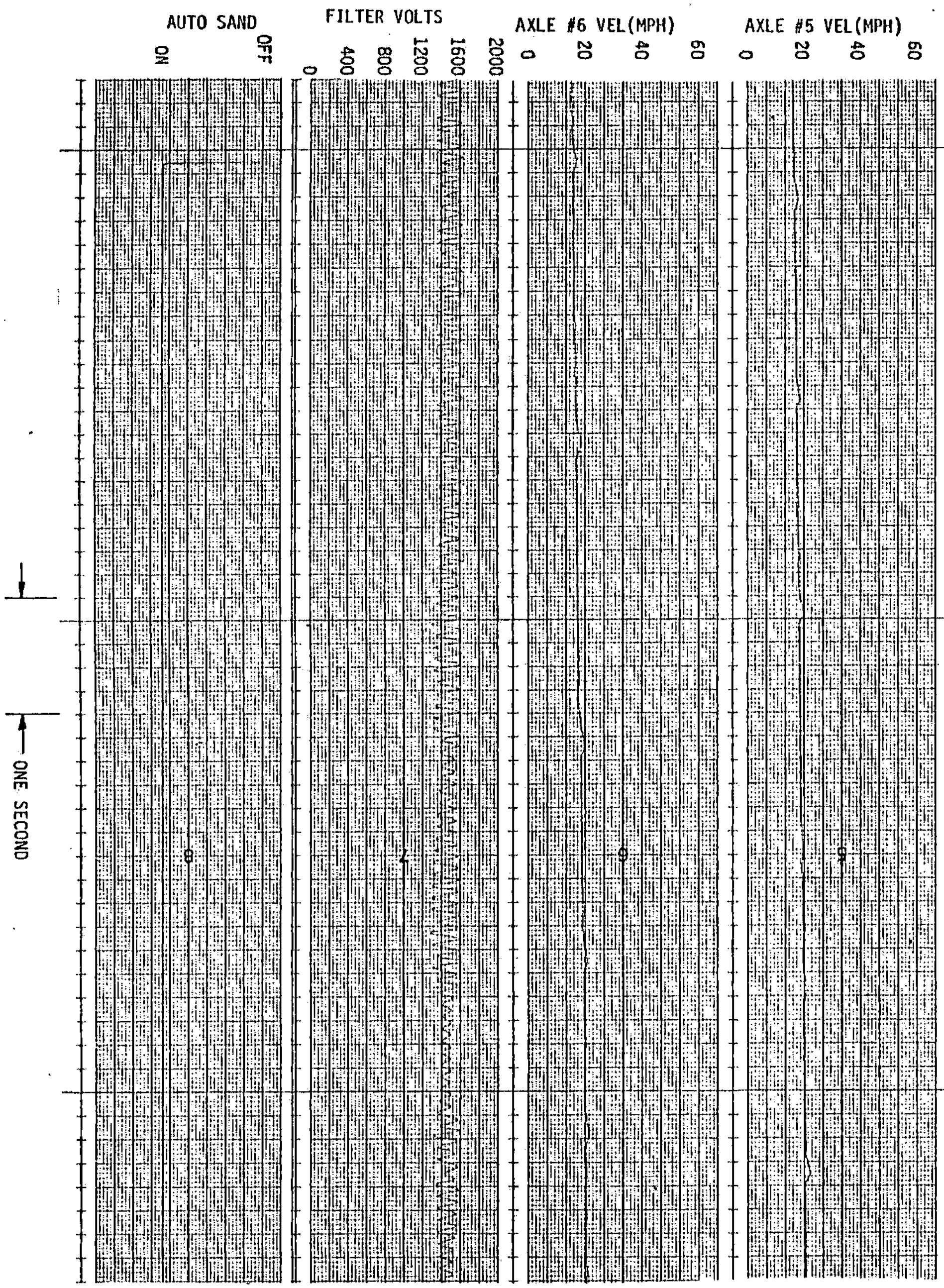
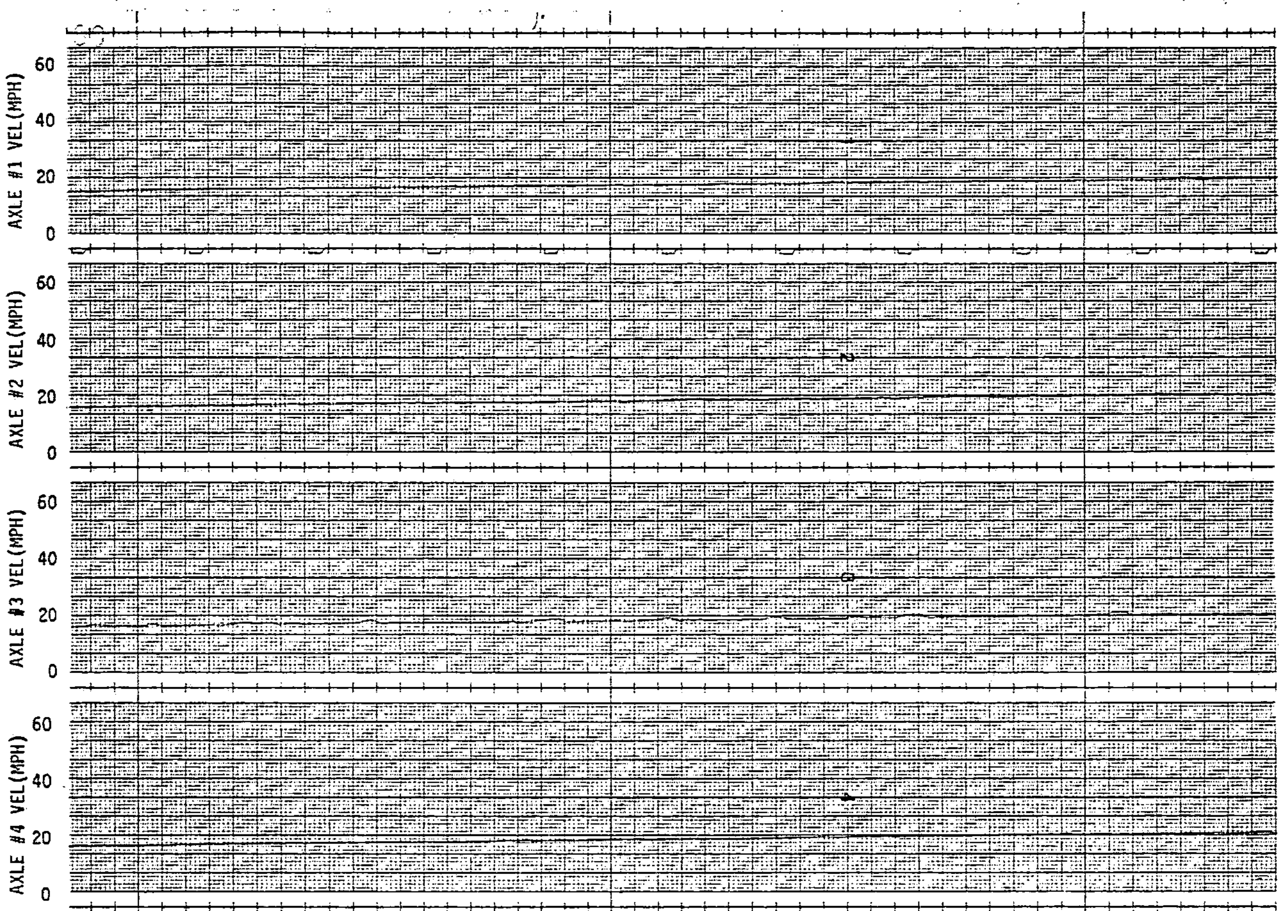

AUTO SAND
ON
OFF
FILTER VOLTS
0
400
800
1200
1600
2000
AXLE #6 VEL(MPH)
0
20
40
60
AXLE #5 VEL(MPH)
0
20
40
60
ONE SECOND

FIGURE 5.5 - WHEELSLIP - SIX AXLE VELOCITIES



SECTION 6

POWER FACTOR

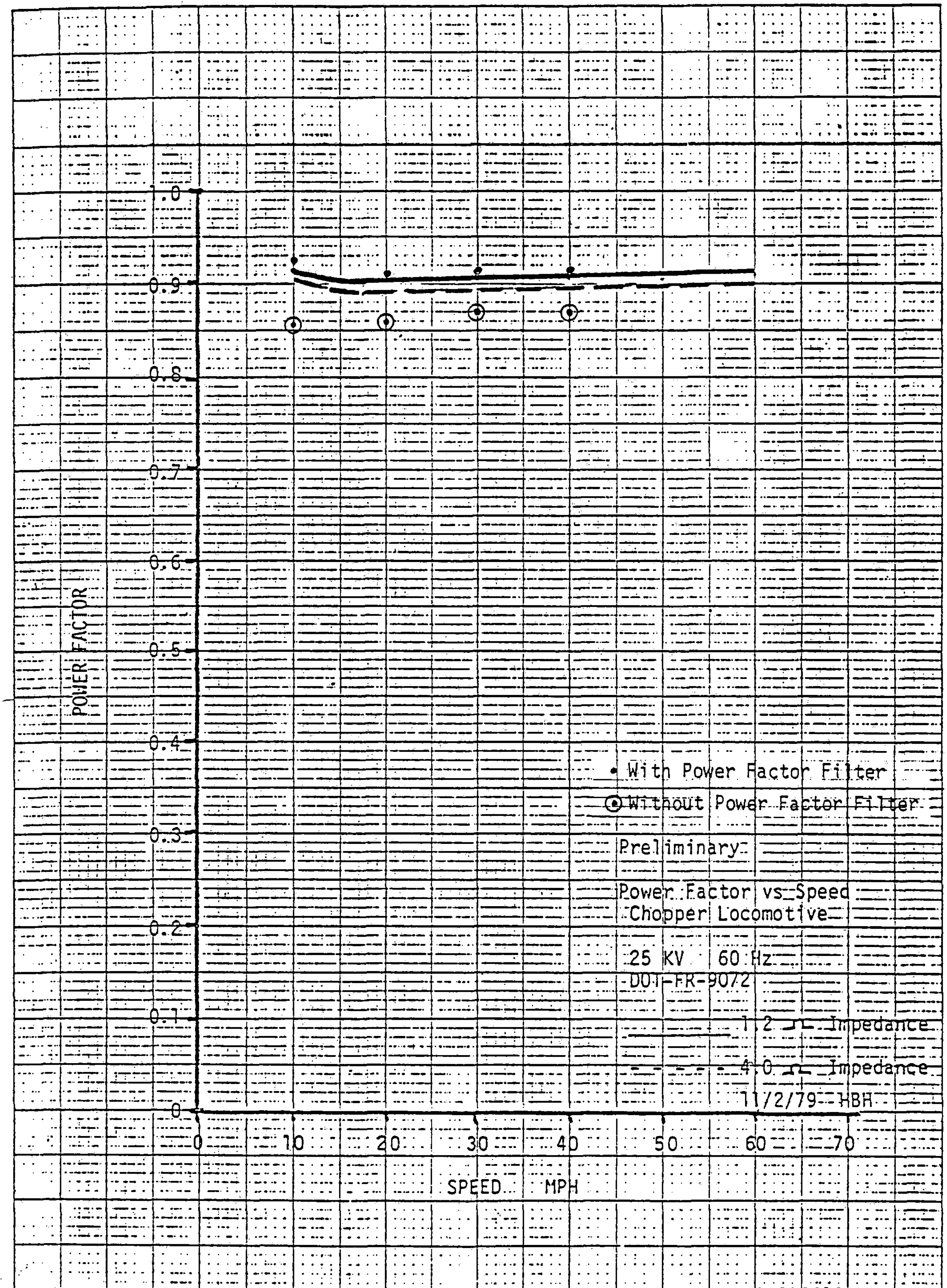
A. GENERAL

Locomotive power factor was read directly from the Magtrol Power Analyzer during the motoring runs covered in Section 3. This instrument gives total power factor, i.e., the displacement power factor (which measures how much the fundamental current waveshape is displaced from the fundamental voltage waveshape) multiplied by the distortion power factor (which measures how much harmonic current there is to "distort" the fundamental current).

B. FIGURE 6.1 - POWER FACTOR VS SPEED CURVE

Figure 6.1 shows the power factor data plotted on the published power factor curve, 41H119318, both with and without the power factor correcting filter connected. Power factor was slightly better than was predicted by the computer runs.

FIGURE 6.1 - POWER FACTOR VS SPEED CURVE



41H119318

41H119318

SECTION 7

LOCOMOTIVE EFFICIENCY

A. GENERAL

Locomotive efficiency is defined as the output power at the rail divided by the input power at the catenary. The output power was found by measuring the traction motor currents (to get tractive effort) and locomotive speed. The input power was found by reading the watts from the Power Factor/Wattmeter and using the correct multiplication factors to account for the location of the meter.

$$\text{Locomotive Efficiency} = \frac{\text{Output Power}}{\text{Input Power}}$$

$$\text{where Output Power (KW)} = \frac{\text{Tractive Effort (Lbs)*Speed(mph)}}{375} *0.746$$

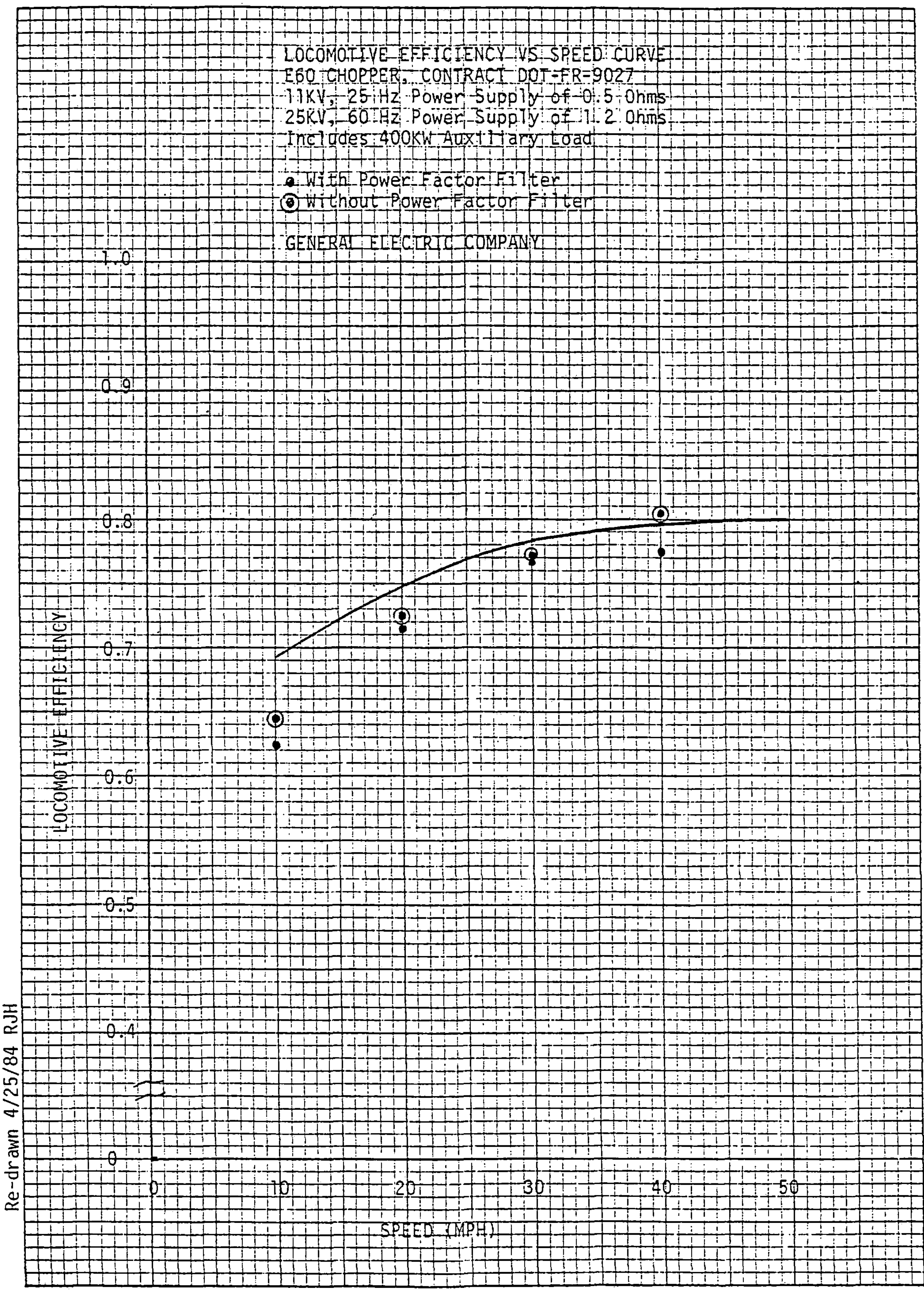
$$\text{Input Power (KW)} = \text{Wattmeter Reading} *$$

$$\frac{160}{1} \text{ CT Current Ratio} * \frac{25{,}000}{104.2} \text{ PT Voltage Ratio} * \frac{1}{1000}$$

B. FIGURE 7.1 - EFFICIENCY VS SPEED CURVE

Figure 7.1 shows the efficiency data plotted on the published efficiency vs speed curve, 41H115682, both with and without the power factor correction filter connected. Locomotive losses were more than calculated so the efficiency was not as good as expected.

FIGURE 7.1 - EFFICIENCY VS SPEED CURVE



SECTION 8

PSOPHOMETRIC CURRENT

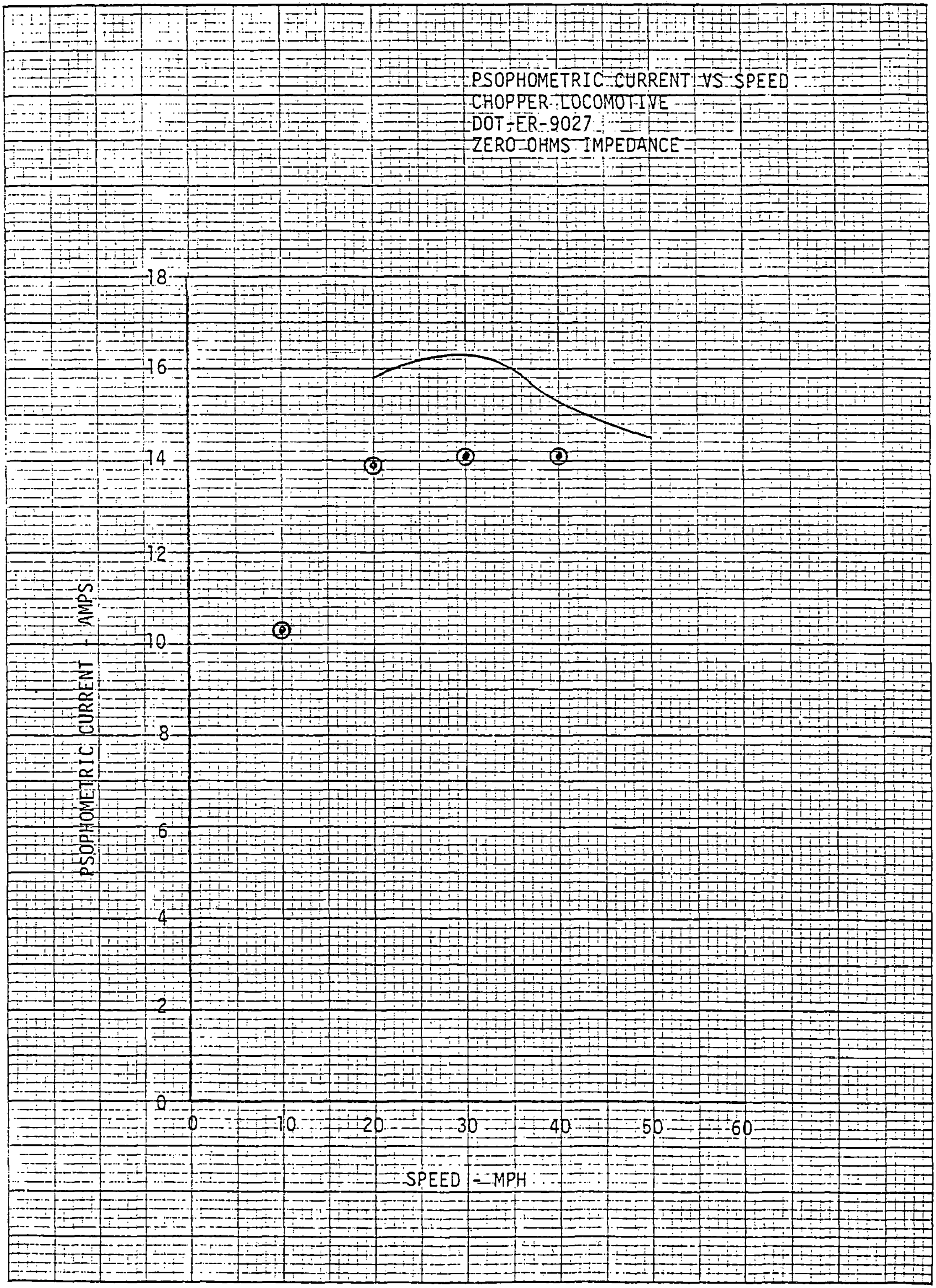
A. GENERAL

The psophometric current is an RMS number that is the result of taking the square root of the sum of the squares of each harmonic current multiplied by the weighing factor at that frequency. It was found using the Psophometer and the non-inductive resistor shunt shown in Fig. 2.1. The shunt was a 0.0002485 Ohm resistor connected in the primary winding of the main power transformer. The voltage across the shunt was fed to the Psophometer which internally applied the required frequency weighting curve to it and displayed the resulting voltage on the scale on the front of the meter. When this voltage is divided by the resistance of the shunt the result is the psophometric current number.

B. FIGURE 8.1 - PSOPHOMETRIC CURRENT VS SPEED CURVE

Figure 8.1 shows the psophometric current data plotted on curve 41H106104. Existing computer data for 10 MPH could not be found, but for 20-40 MPH the resulting psophometric current was 1-2 amps better than expected.

FIGURE 8.1 - PSOPHOMETRIC CURRENT VS SPEED CURVE



41H106104

4/25/84 RJH

SECTION 9

IN-SERVICE RUNS ON CONRAIL

A. GENERAL

The original schedule called for six round trips from the South Kearny Yard in Newark, N. J. to the Potomac Yard in Washington D.C., but for not more than a total elapsed time of two weeks. Because of problems with the track in the South Kearny Yard, downed catenary due to an ice storm, and scheduling of FRA observers, only two round trips were completed.

The Chopper Locomotive was to be tested as part of one of the trailer van (TV) trains that Conrail operates on a daily basis over Amtrak's Northeast Corridor tracks. This run is about 240 miles one way with about 200 miles under energized catenary at 11 KV, 25 Hz.

B. TEST CONSIST

The Chopper Locomotive was placed at the head end of the consist and MU'd with the two GP38-2 diesel electric locomotives which normally pull this train. The diesels were used to pull the train in and out of the yards and over the High Line in Philadelphia which is not energized. Once under the catenary on the main line, the Chopper was energized and the two diesels isolated. This procedure worked well and could be done without stopping the train.

A two channel brush recorder was used to monitor the D.C. filter voltage and traction motor #5 current. Instrumentation was not available to record any other data.

C. RUN 1 - NEWARK TO WASHINGTON

This first run was made with TV23 on 3/7/84 leaving South Kearny at about 9:00 PM. TV23 included units 8071 and 8072 and 27 cars with a total weight of 2450 tons. As the consist was leaving the yard, two wheels of the Chopper Locomotive and one wheel of the first diesel unit derailed on a sharp curve. After the locomotives were re-railed, TV23 departed at 11:35 PM. Riders included:

John Marchetti - FRA (only to PHiladelphia)
Henry Liban - Conrail
Tad Mahoney - Conrail
William Faulhaver - Conrail
Ronald Griebel - GE
Robert Hopkins - GE

Figure 9-1 shows a typical sweep of the throttle from IDLE to N8 at about 45 MPH and Figure 9.2 shows two motoring/dynamic braking cycles taken during the first run.

The Chopper Locomotive ran very well with only the following minor problems:

1. The crowbar overvoltage protection circuit activated twice - probably on noise spikes.

2. The axle 5 wheelslip indication light flickered a few times for no apparent reason.

3. The "no battery charge" light flickered for about a minute while the train was stopped to check out a hot axle box indication.

4. The electric cab heat was inadequate so the feed from the auxiliary transformer was changed to provide an additional 30 VAC to the heaters. This additional load may have been a contributing cause for the blowing of the auxiliary transformer fuse on the return trip.

Arrived at Potomac Yard at 6:30 AM.

D. RUN 2 - WASHINGTON TO NEWARK

Prior to departing on the return trip 3/8/84, the crowbar setting was changed from 2060 to 2200 volts to de-sensitize it. Also, because of a complaint from the engineer on the first run, the independent brake pressure switch was disconnected to permit the application of traction power with the independent brake on.

TV24 with the Chopper, units 8071 and 8072, and 27 cars with a total weight of 2016 tons left the Potomac Yard at 10:50 PM. Riders included:

* Henry Liban	-	Conrail
Tad Mahoney	-	Conrail
* Ronald Griebel	-	GE
* Robert Hopkins	-	GE

* Left train in Philadelphia

A snowstorm caused so many delays that at 7:00 AM, TV24 was still in Philadelphia. The train crew had to leave and another crew did not arrive until about 1:00 PM to take TV24 to Newark.

The Chopper Locomotive ran well and only had two minor problems.

1. One crowbar activation.

2. The auxiliary transformer fuse (70A) blew near Baltimore. A spare fuse was not available so the feed to the transformer was tied temporarily to the blower fuse for the remainder of the trip.

Figure 9.3 shows a typical motoring sequence and Figure 9.4 shows a motoring/dynamic braking cycle during Run 2.

E. RUN 3 - NEWARK TO WASHINGTON

This trip was to commence on 3/21/84 but was cancelled when the Chopper Locomotive again derailed on the same curve leaving the South Kearny Yard.

On 3/13/84, a 100A fuse was installed for the auxiliary transformer (replaced the 70A fuse which blew during Run 2), and some additional filtering was added to the crowbar detection circuit. At 7:30 PM, this trip was cancelled due to an ice storm which damaged some catenary.

Run 3 finally commenced on 3/14/84 at 9:10 PM with units 8071 and 8072 and a train weight of 2325 tons. Riders included:

John Stephenson - L.T. Klauder (FRA)
Chip Savoye - Conrail
Robert Hopkins - GE

When the Chopper Locomotive was energized on the main line, the air operated power contactors would not close. About one hour later when the train was stopped for a signal, it was discovered that someone closed the control air cut out cock in the compressor cab, thus no control air pressure was available for the air operated contactors. The cut out cock was opened and the Chopper Locomotive completed the trip to Washington. The Chopper worked well with the only problem occurring in the wheelslip panel with false wheelslip indications a couple of times.

Figure 9.5 shows a motoring trace with some wheelslips occurring between N6 and N7. Figure 9.6 shows another motoring/dynamic braking cycle.

TV23 arrived at Potomac Yard at 6:30 AM.

F. <u>RUN 4 - WASHINGTON TO NEWARK</u>

TV24 which included a GP38 (7854) and a U23B (2553) locomotive with a train weight of 1858 tons left Washington at 8:45 PM on 3/15/84. Riders included:

Cliff Gannett	-	FRA (only to Baltimore)
Gordon Stevens	-	FRA
Claude Dickson	-	Conrail (only to Baltimore)
Chip Savoye	-	Conrail
Henry Liban	-	Conrail
Robert Hopkins	-	GE

When the Chopper was energized on the main line, the power contactors would not pick up. The problem was traced to an open interlock in the vacuum breaker which was by-passed with a jumper to correct the problem.

The Chopper ran well to Philadelphia where a "power circuit ground" indication occurred which could not be cleared up with any of the traction motor cut-out switches. The Chopper was isolated for the remainder of the trip.

One other problem occurred in the wheelslip panel which prevented the Chopper from starting the train. It is theorized that with the brakes on, the locomotive was moving so slowly that individual pulses from the traction motor speed sensors looked like wheelslips to the detection circuits. One of the diesels was cut in to get the train moving which corrected the problem.

TV24 arrived in Newark at 6:00 AM.

FIGURE 9.1 - RUN 1 - MOTORING

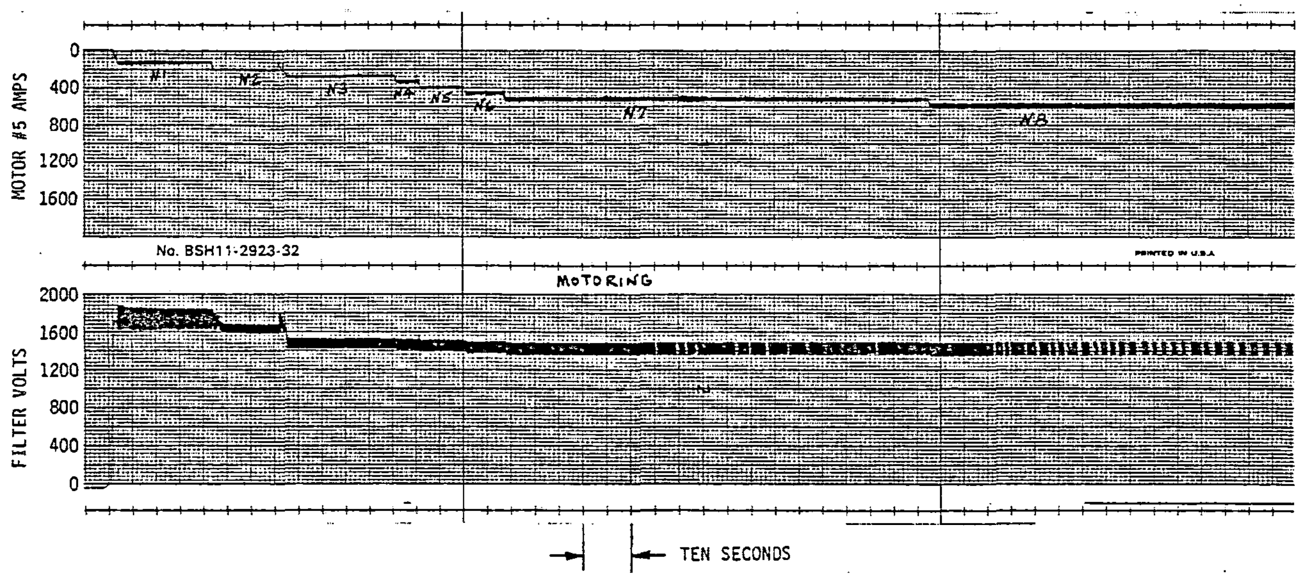


FIGURE 9.2 - RUN 1 - MOTORING/DYNAMIC BRAKING CYCLES

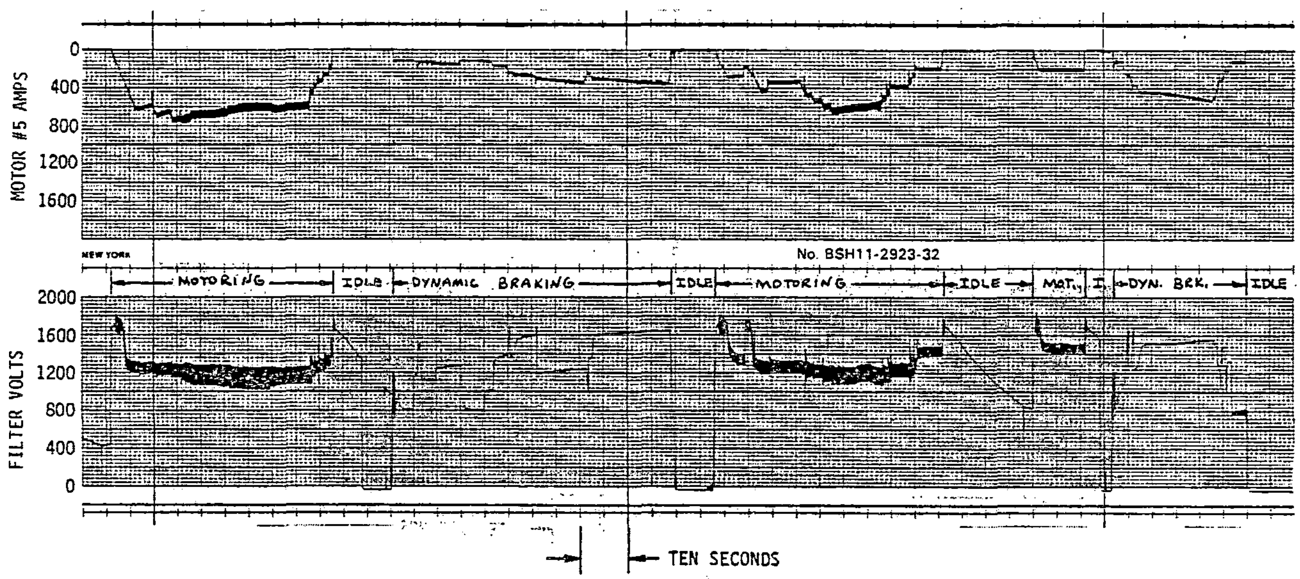


FIGURE 9.3 - RUN 2 - MOTORING

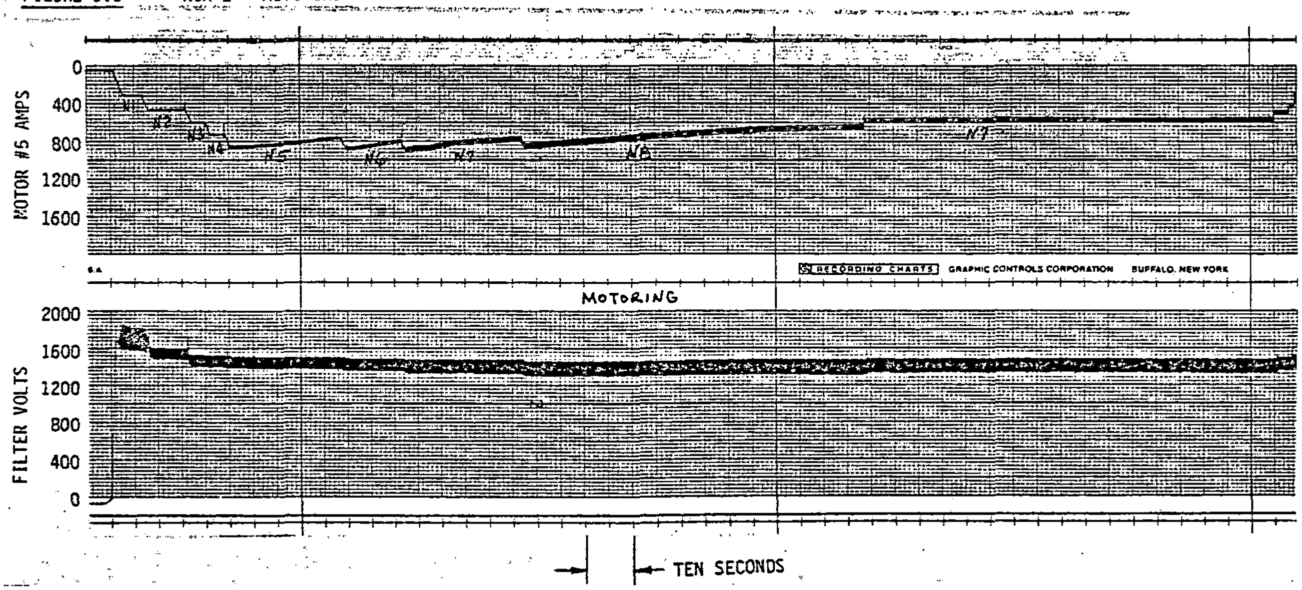


FIGURE 9.4 - RUN 2 - MOTORING/DYNAMIC BRAKING CYCLE

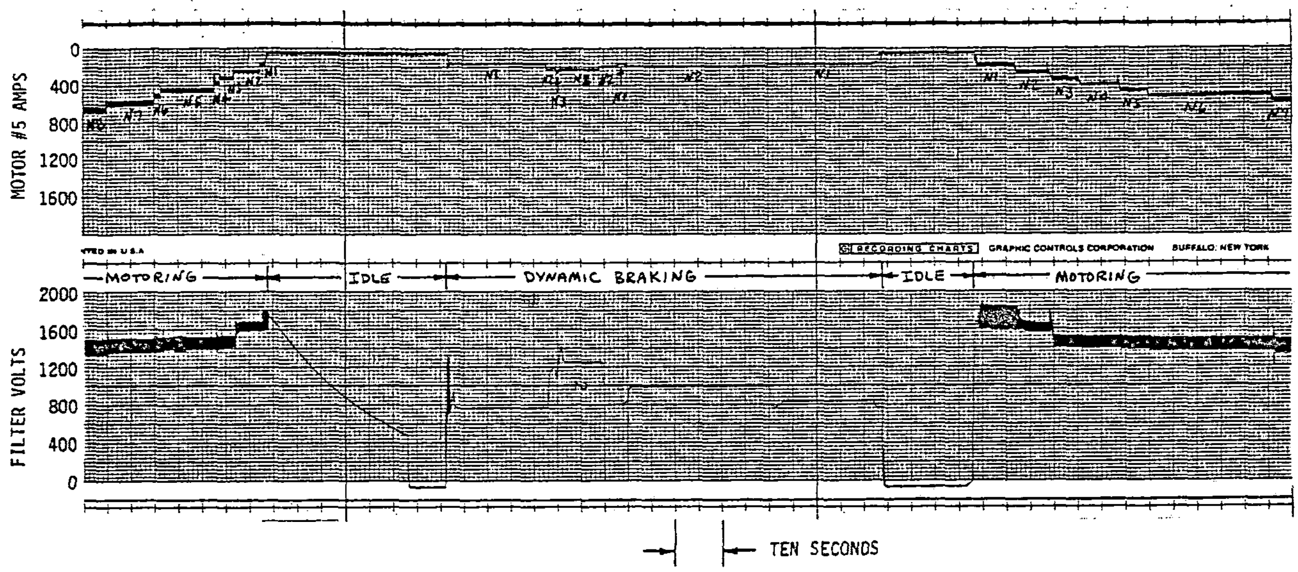


FIGURE 9.5 - RUN 3 - MOTORING WITH WHEELSLIPS

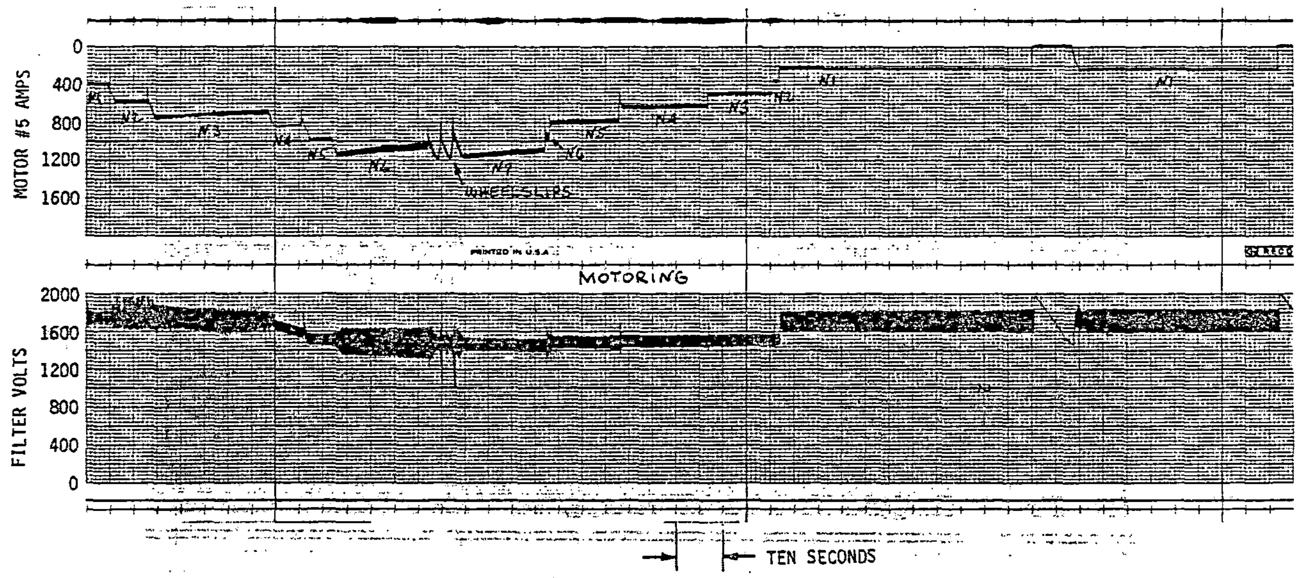
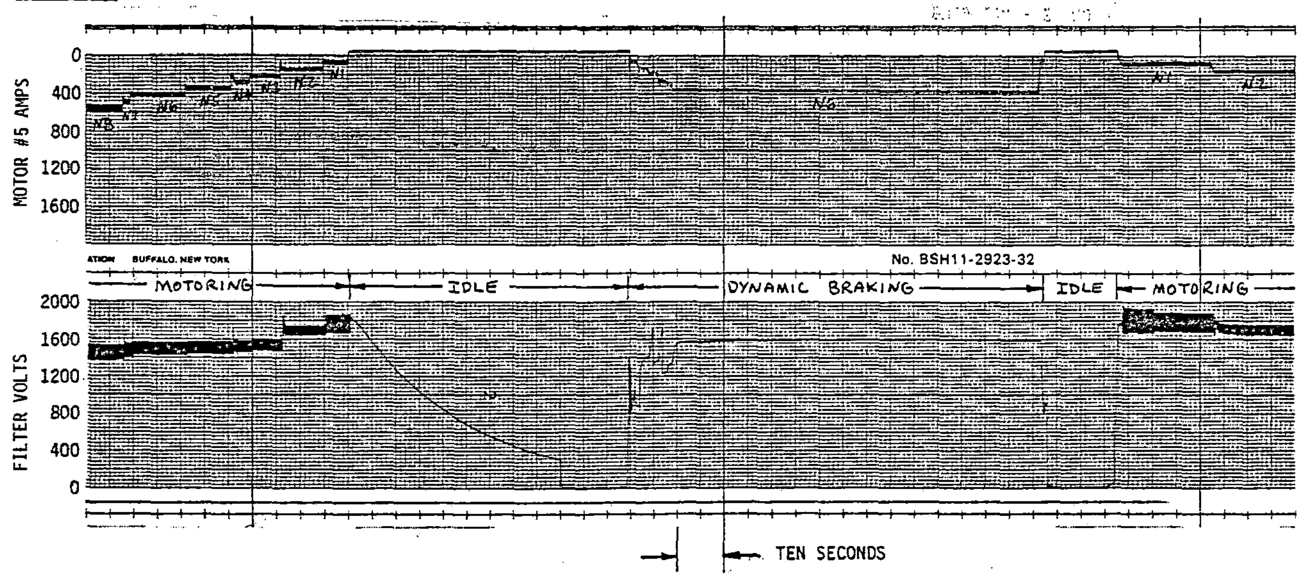


FIGURE 9.6 - RUN 3 - MOTORING/DYNAMIC BRAKING CYCLE



Chopper Locomotive Demonstration Program, Phase II, 1984
US DOT, FRA, Robert Hopkins