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Comparative Evaluation of Energy Management Models for Transit Systems

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February 1984
Final Report

UMTA Technical Assistance Program

U.S. Department
of Transportation

Research and
Special Programs
Administration

Transportation
Systems Center

Kendall Square
Cambridge, Massachusetts 02142

April 13, 1984

Mr. Gunars Spons
UMTA, Director of TTC Programs
Transportation Test Center
Pueblo, Colorado 81001

Dear Gunars:

I am sending you this copy of the final report on the evaluation of rail computer models as they relate to the BART system. As you can see, it resulted in a rather lengthy report covering the many aspects of the study program. I appreciated your help in coordinating the data evaluation work as well as the initial BART test program.

Hope all is going well with you at TTC.

Sincerely,

John

John Stickler

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16. Abstract

The energy consumption of BART transit cars was measured with and without regeneration during the period 25 August - 2 September 1981. The test data was then compared with the predictions of different energy management models currently in use for transit system studies. This report presents the results of this comparative evaluation of these models.

The test plan, the instrumentation plan, the data reduction requirement, and the test data are first presented. Different energy management models are then discussed and the respective predictions are compared with the test data. Finally, the input data used by the models including the BART system and vehicle parameters, the operating conditions during test runs, etc., are detailed in separate Appendices A through D.

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PREFACE

The author wishes to express his sincere gratitude for the assistance provided by the following organizations: The General Electric Company, the Westinghouse Electric Corporation, the Garrett AiResearch Manufacturing Company, De Leuw Cather, Gibbs & Hill, the Bay Area Rapid Transit District, the Boeing Services International, the Transportation Test Center, Pueblo, Colorado, and the Rail Systems Center of the Mellon Institute, Pittsburgh, Pennsylvania.

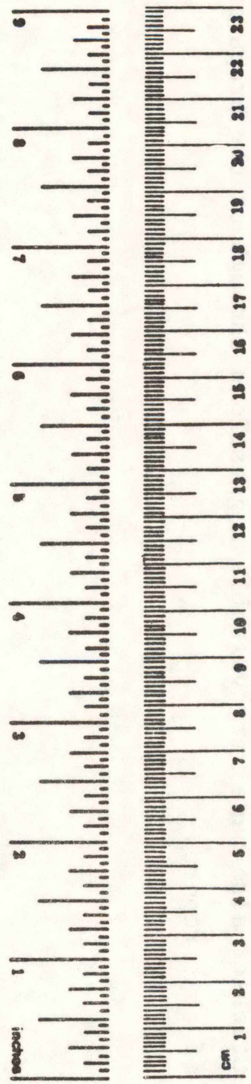
In addition, the author is deeply indebted to Dr. John Stickler of US DOT/ Transportation Systems Center, Cambridge, Massachusetts; Mr. M.F. Clapp of BART; and Mr. Robert Swearingen of the Boeing Services International for the endless hours spent during this evaluation effort. Dr. John Stickler also made very valuable suggestions throughout the preparation of this report.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

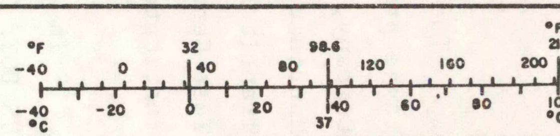
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

Recent advances in solid state control technology have led to chopper-controlled propulsion systems in urban rail transit applications. Such systems offer the potential for superior train performance through increased train propulsion efficiency and reduced train operating costs. The present program sponsored by the Urban Mass Transportation Administration (UMTA) studies the energy consumption characteristics of an urban rail system equipped with transit cars having solid state chopper-controlled propulsion system. The program objectives include the measurement of the transit system energy consumption during revenue and nonrevenue service operation and the study of the relative accuracy of current energy management models for predicting energy consumption in urban rail systems.

In early 1980, UMTA initiated a cooperative program between government, transit authorities, and transportation organizations in private industry to study the problem of energy consumption in an urban rail system equipped with the latest sophisticated control technology. The program as conceived consisted of two parts; an extensive test program designed to measure train and system energy consumption under revenue and nonrevenue service operations and a study program designed to examine the validity of present energy management models for predicting rail energy consumption. The program received enthusiastic response from several sectors of the transportation community. Transit authorities at Atlanta (MARTA) and San Francisco (BART) agreed to participate in the test program. Nine private industry organizations expressed a desire to participate in the validation studies of energy management models. BART was eventually selected as the site for the test program measurements which were conducted between August 23, 1981 and September 2, 1981. Of the nine organizations which expressed interest in the model validation studies, namely, Westinghouse, Garrett AiResearch, L.T. Klauder & Associates, Electrack Inc., Kaiser Engineers, Rail Systems Center of the Carnegie Mellon Institute, De Leuw Cather, Gibbs & Hill, and General Electric, the latter three organizations eventually submitted results from computer simulations using their respective energy management models. The Carnegie Mellon Institute model was run by the DOT/Transportation Systems Center, Cambridge, Massachusetts.

The report summarizes the program accomplishments in the BART energy consumption tests and the validation of energy management models developed by private industry. The section dealing with the test program contains the test plan and the BART test data. The latter includes power measurements at seven substations and at selected circuit locations within the train propulsion system. Substation and vehicle energy consumptions were found by numerical integration of the power data. The main problems experienced during the course of the measurements included certain instrumentation noise in both the substation and train propulsion data and unscheduled train service interruptions during some of the test runs. By using careful data reduction, the impact of instrumentation noise on the final test result was substantially reduced. The occasional interruption of train service during the initial non-revenue service runs proved somewhat troublesome and necessitated discarding certain portions of the early test data runs.

The BART tests comprised Baseline Tests to measure the energy consumption of a single train in the absence of energy regeneration and Revenue Tests with many trains to study the effect of regeneration on the total energy consumed during peak revenue service. The baseline runs provided important data for 'calibrating' the energy consumption characteristics of a single train and was used as the basis for validating the energy consumption models developed by private industry. The revenue runs measured the energy consumption with many trains in operation and offered a convenient means for examining the capability of present energy management models to predict rail energy consumption with regeneration present.

A summary of the prediction results for the four energy management models is given in the table below. For the Baseline Test, the predictions of Model #3 are in excellent agreement with the test data, and the other predictions, except one, are also within 10 percent of the test data. For the Revenue Test, the predictions are generally lower than the test data. Excessive cycling of the vehicle propulsion system through powering and braking could be one important reason for these lower estimates. Among the additional factors which contribute to discrepancies between model predictions and test results are errors arising from the numerical integration of the vehicle power to determine vehicle energy consumption, the effect of large weight differences between the train cars during the baseline runs, the effect of train length as a factor

MODEL PREDICTION VS. TEST DATA

RUN	Model #1	Model #2	Model #3	Model #4
BASELINE TEST				
M90 - M16	+2.75%	+2.00%	-2.50%	-6.00%
M16 - M90	-13.40%	+9.00%	-0.50%	+7.00%
REVENUE TEST				
M90 - M16	-	-	-	-
M16 - M90	-	-10.00%	-	-
MP6 - M90 - MP6	-29.00%	-	-4.00%	-

affecting the train speed profile as it relates to changes in speed restriction as well as the programmed decelerations at stations, and observed variations in train accelerations, decelerations, and cruise speeds compared with the nominal prescribed values.

Program goals were effectively met at the conclusion of the program effort. The BART tests provided data on the energy consumption characteristics of an urban rail system equipped with chopper-controlled rail vehicles. Comparison of the data with model predictions furnished each program participant with a means for assessing the validity of the respective model. It also provided important insights into possible ways to improve the model's validity and thereby enhance its effectiveness as a tool for future rail system analyses.

1. INTRODUCTION

Accurate prediction of energy consumption of a transit car for any given set of operating conditions, and the resulting rms and peak substation loading is vital to transit systems in evaluating different alternatives in equipment designs and operating procedures. Several equipment manufacturers and consulting groups have, therefore, developed different computer models to simulate vehicle operations in revenue and nonrevenue service. The Rail Systems Center of the Mellon Institute, Pittsburgh, Pennsylvania, has also developed such a model for the Urban Mass Transportation Administration (UMTA) of the U.S. Department of Transportation. Early 1980, UMTA initiated a program to validate these computer models by comparing actual energy consumption data of operating transit systems with the energy consumption predicted by these models.

This program received enthusiastic industry-wide cooperation in the form of participation in the preparation and review of the overall test program, and providing results of computer simulation. Transit systems at Atlanta (MARTA) and San Francisco (BART) agreed to participate in the measurement of energy consumption during revenue and nonrevenue service operations. Limited energy measurements were conducted at BART between August 23,1981 and September 2,1981. The test plan was prepared in cooperation with BART and the transit industry, and this plan is presented in Section 2. These tests were jointly conducted by BART and the Boeing Services International (BSI). The BSI also processed the data obtained during these tests. This data is presented in Section 3.

All the engineering data for the test section of the BART system and the operating conditions for the above energy measurement tests were provided to the transit industry to enable these organizations to run their respective computer models. The BART engineering data included the track charts, ATC/ATO system specifications, vehicle data, system history log, passenger density on the trains, electrical network layout, etc. This data is presented here in Appendix A.

A total of nine organizations had initially agreed to participate in this program, run their respective computer models, and provide the results to UMTA for comparison with the test data. These are: General Electric, Westinghouse, Garrett AiResearch, L.T.Klauder & Associates, De Leuw Cather, Gibbs & Hill, Electrack Inc., Kaiser Engineers, and the Rail Systems Center of the Mellon Institute. This UMTA program, however, was delayed considerably due to the lack of needed resources, and only three organizations actually submitted the results of their computer simulations. These are: General Electric, De Leuw Cather, and Gibbs & Hill. The Mellon Institute model was run by the DOT/Transportation Systems Center, Cambridge, Massachussetts. The results of these four computer models are presented in Sections 4-7.

2. BART TEST PLAN

The BART system shown in Figure 2.1, consists of three routes covering a total of 71 miles and 34 passenger stations. Simulation of rush-hour revenue service, with several hundred cars running with variable train consists, and monitoring energy consumption at various locations, is neither practical nor necessary to validate computer models. A small section of the system - M1 and M2 tracks between the mile posts of 6.00 and 15.30 - was, therefore, selected for conducting the energy measurements. This test track is a part of the Daly City - Concord, and the Daly City - Fremont routes. It covers nine passenger stations between the Daly City and the Embarcadero stations, and extends beyond the Embarcadero station for about 1.3 miles. The test track layout is presented in Figure 2.2.

This track was selected for two reasons: the electrical network for this part of the BART system can be isolated from the rest of the system, and there are no yards along this track length. This isolated electrical network, shown in Figure 2.3, has seven rectifier substations supplied from only one ac substation. The network simulation is, therefore, simplified, and hence less expensive. Since there are no yards, monitoring vehicle energy consumption is also simplified.

Simulation of the following two types of train operations was considered vital for model validation:

1. only one train running on the track, to obtain baseline energy consumption data for a car without regeneration, and
2. several trains running on the track with rush-hour headways to obtain data on the energy saving by regeneration.

The baseline test is quite straightforward, although it can be performed only during nonrevenue hours. It is also preferable if the regeneration test is

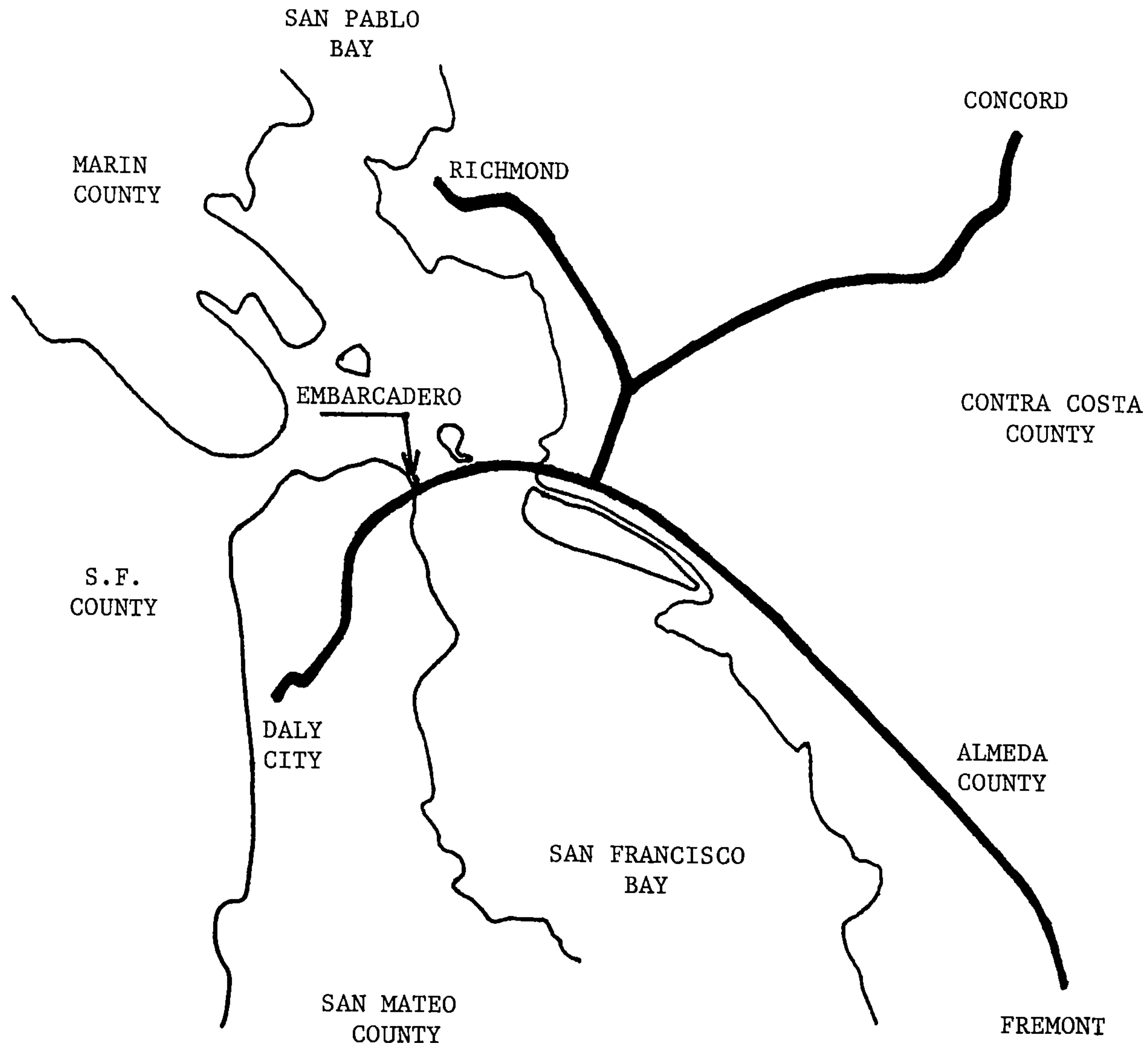


FIGURE 2.1 BART SYSTEM MAP

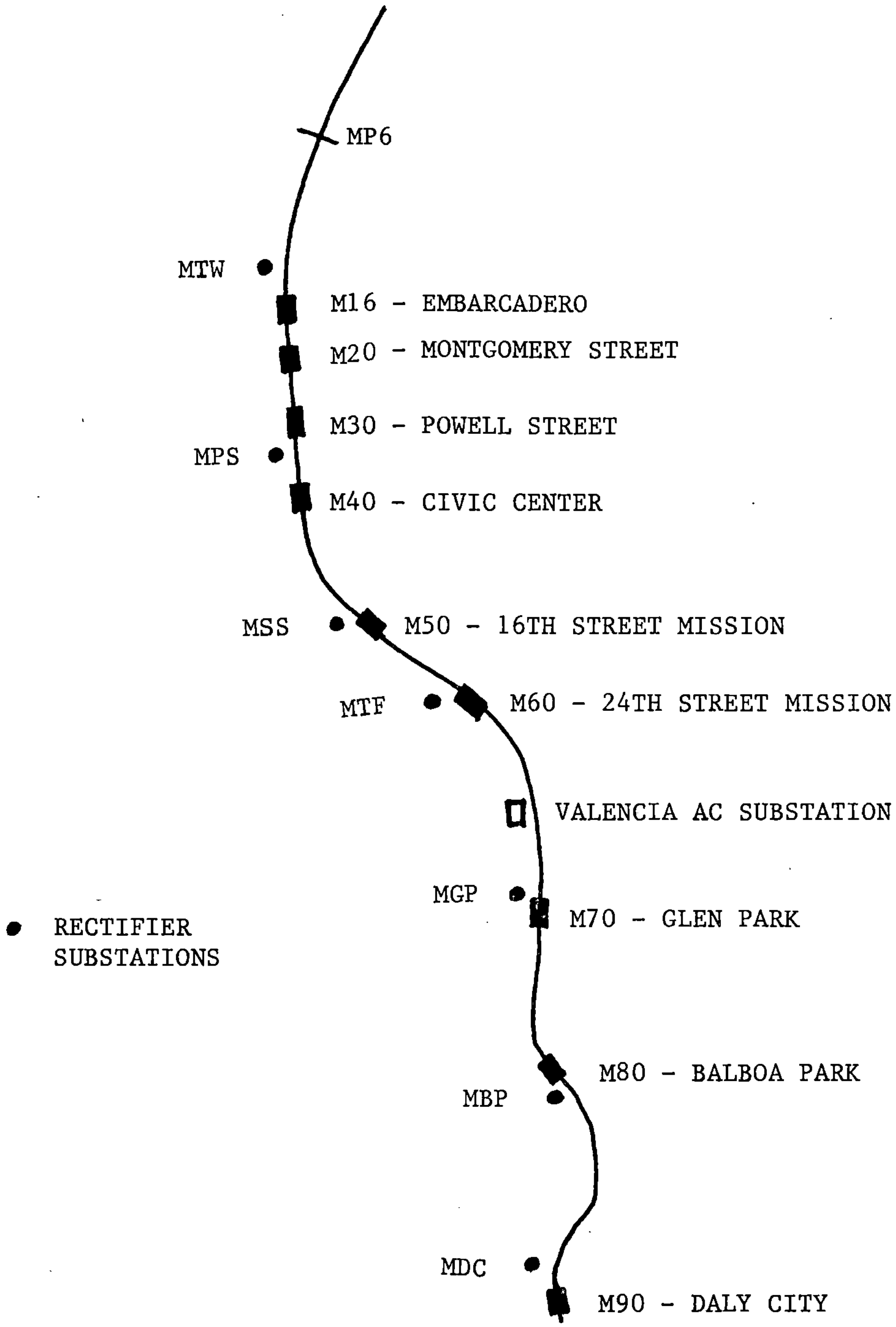


FIGURE 2.2 TRACK LAYOUT FOR THE TEST SECTION

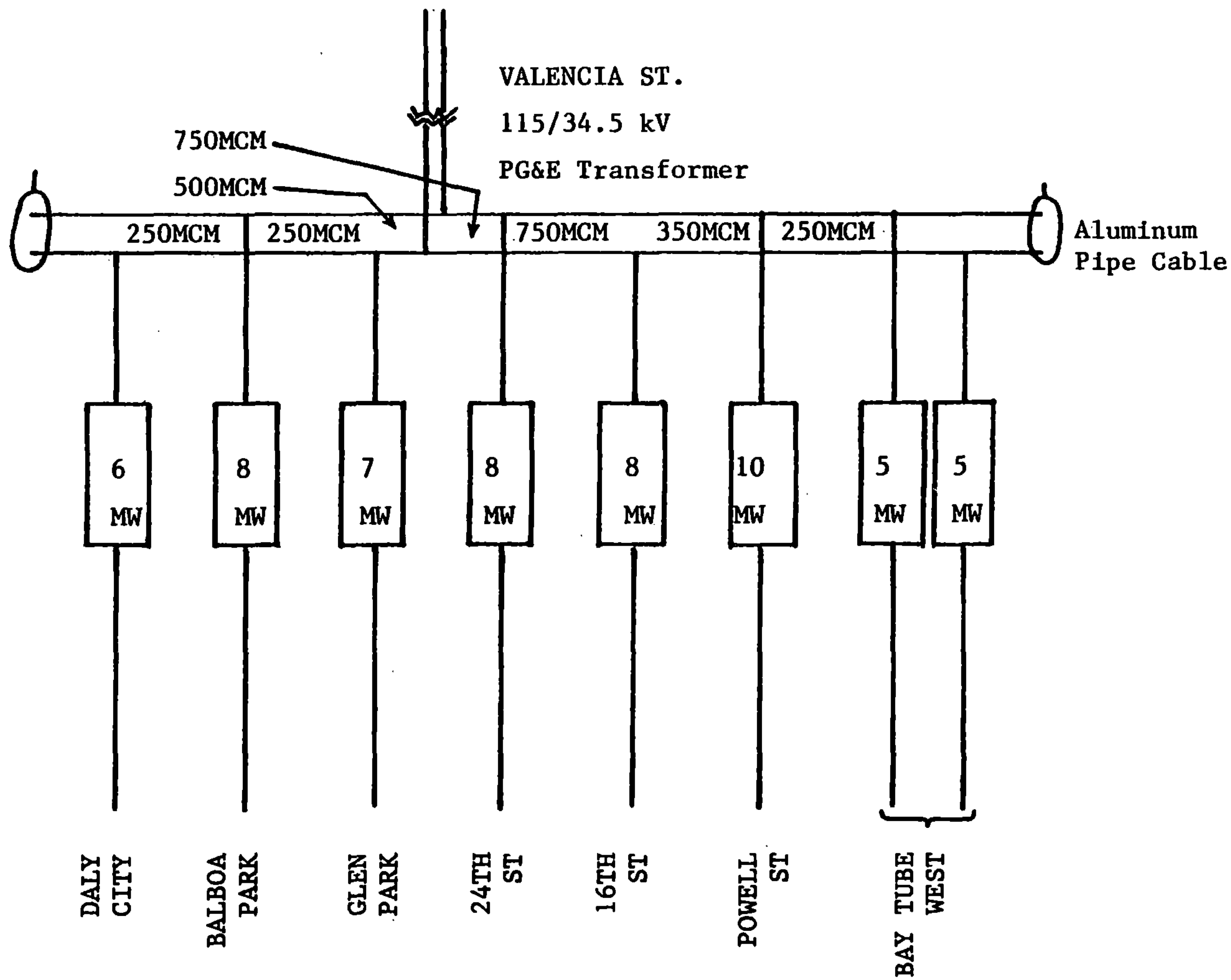


FIGURE 2.3 ELECTRICAL NETWORK SCHEMATIC

conducted during nonrevenue hours, because trains of equal length and weight can be dispatched at equal headways from both ends of a track. This would, of course, require several trains manned by train operators. For example, one would require six trains (see Figure 2.4) to be dispatched from both the Daly City and the Embarcadero passenger stations. This would require assembling special train consists before tests, parking them appropriately at both ends and in between, dispatching them on schedule, and reforming the trains after the tests for revenue service as necessary. Further, such tests could only be conducted early Sunday mornings, because enough time would not be available any other morning. These tests would, therefore, extend over a period of several weeks, would require many train operators working overtime, and would be very expensive.

It was, therefore, decided to monitor the energy consumption during the regular evening rush-hour period. This meant that the trains would be of variable length, and that the passenger loading of the trains would be variable, and would be known less accurately. BART computes the train loading data by correlating the number of passengers entering and leaving a particular passenger station to the trains arriving and departing that station.

The following two types of tests were planned:

Test 1 - Regeneration Test (Revenue Service)

Three instrumented cars would be added to a train consist, and this train would make one round trip between Richmond and Daly City, leaving Richmond at about 16:00 hours. The train would then enter the test area at about 16:45 hours, arrive at Daly City at about 17:00 hours, leave Daly City a few minutes later, and exit the test area at about 17:30 hours. The test data would be recorded onboard during this trip. The rectifier substation data would be recorded for a time period of about 14:00 - 19:00 hours.

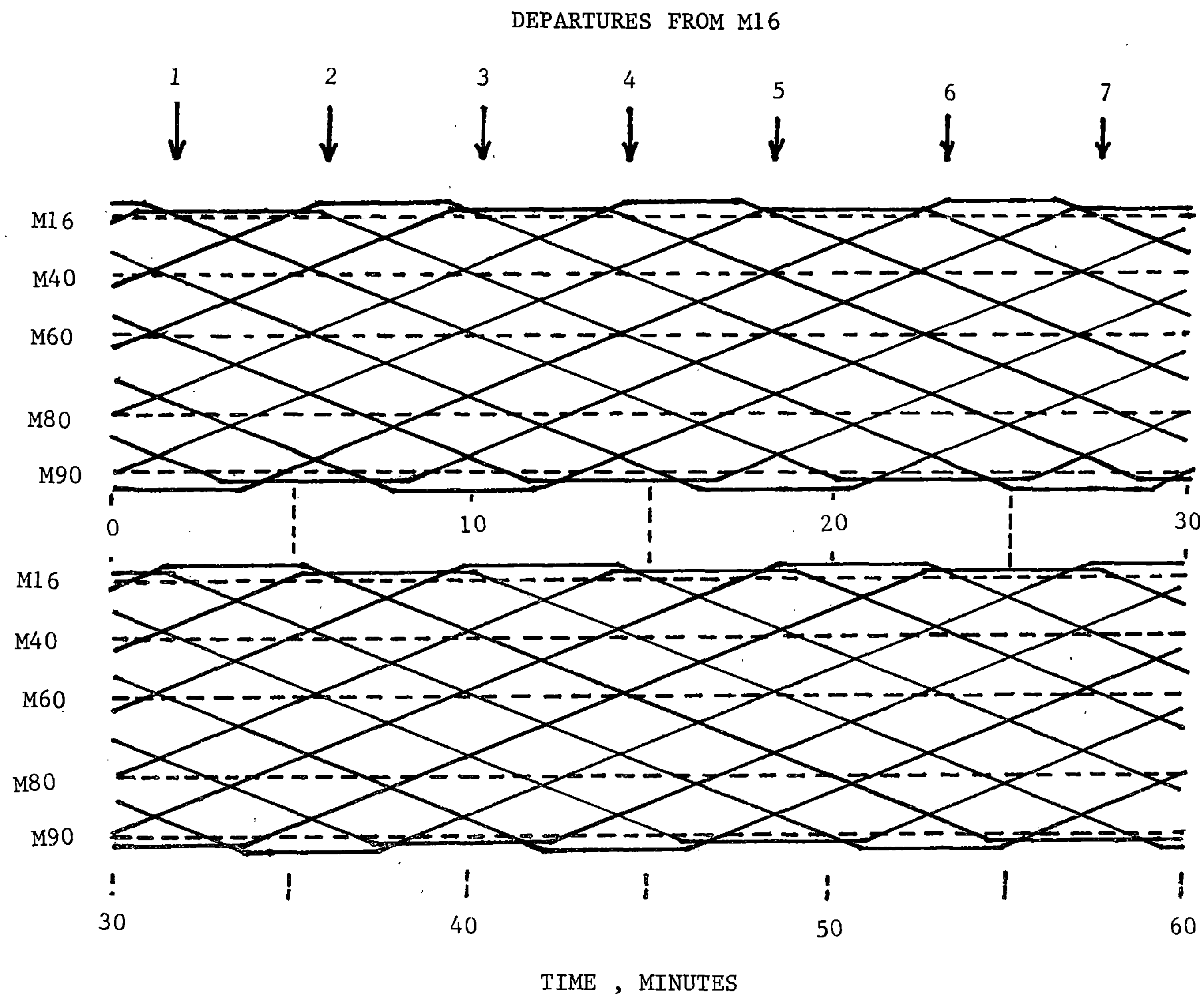


FIGURE 2.4 TRAFFIC CHART FOR THE ROUTE M16 - M90

Test 2 - Baseline Test (Nonrevenue Service)

A four-car train with the above three instrumented cars would make runs between Daly City and Embarcadero. The energy consumption would be monitored onboard and at the substations.

The detailed test plans are presented in Appendix B and Appendix C.

2.1 Instrumentation Plan

The schematic for the BART chopper is shown in Figure 2.5. It was necessary to monitor the energy consumed in the traction system, the onboard auxiliaries, and the total vehicle energy consumption. Some variables are normally monitored by the propulsion control system for internal use. These include the voltage across the line filter capacitor, motor currents for both the trucks, axle speed, etc. Some logic signals are also available that indicate whether a car is in propulsion or in braking. This plan attempted to use the available sensors, as far as possible. A certain level of redundancy was also introduced in measurements so that the required data would be obtained under possible sensor malfunctions.

The BART Engineering Car with many of the sensors in place is an A - car, and is designated as Car # 1. Two B - cars were also instrumented, and were designated as Car # 2, and Car # 3. These two cars carried passengers during the revenue service tests, but Car # 1 did not carry any passengers except for the test crew. Two 14 - channel FM magtape recorders were used to record a total of 24 variables. A few channels were left vacant to be available during tests, if required.

The channel assignments for the two recorders were as follows (refer to the BART chopper schematic for various sensor and variable designations):

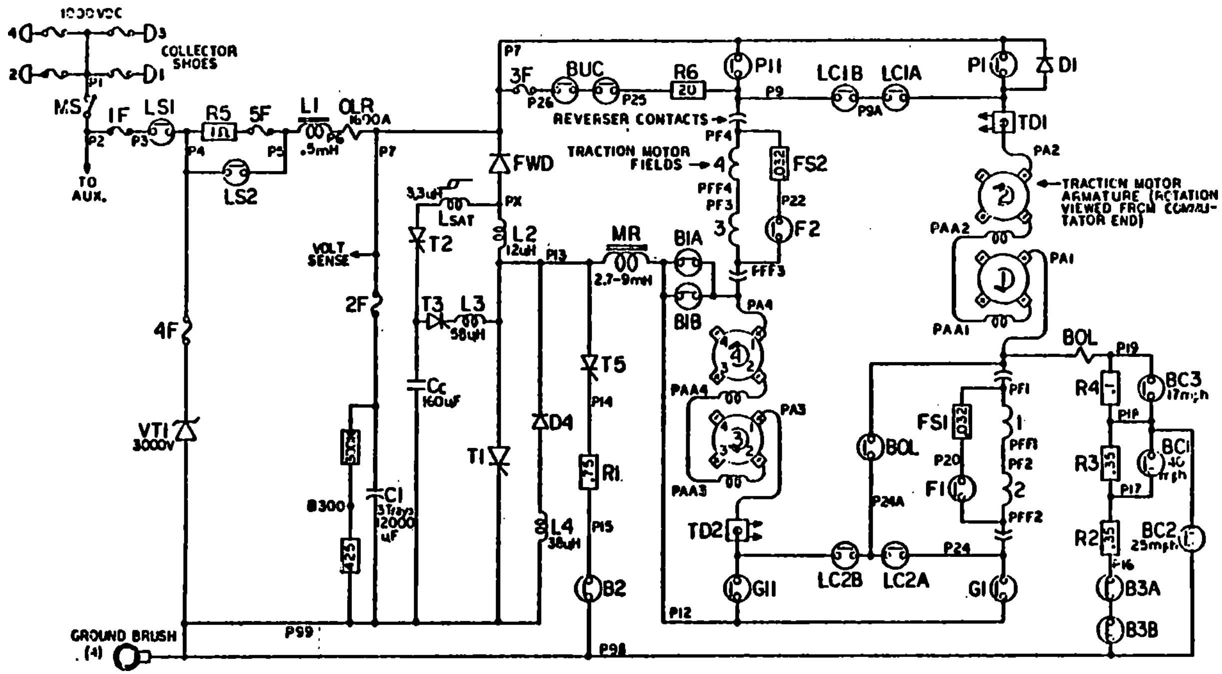


FIGURE 2.5 CHOPPER CIRCUIT SCHEMATIC

RECORDER A

Channel	Symbol	Description
1	V_1	Capacitor voltage for car # 1, sensor in place
2	I_{L1}	Line current for car # 1. The sensor TTD3 (±2000A) on this car had to be shifted as shown in Figure A-2 in Appendix A
3	I_{X1}	Auxiliary current for car # 1.
4	V_{M1}	Motor armature voltage for car # 1. The sensor (1500V) was connected between terminals PA3 and PA4.
5	I_{MX1}	Motor current in X-truck for car # 1, sensor TD1 in place.
6	I_{MY1}	Motor current in Y-truck for car # 1, sensor TD2 in place.
7	I_{DB1}	Dynamic braking current, car # 1. Sensor TTD2 in place.
8	I_{BR1}	Current in R2-R3-R4, car # 1. Sensor TTD1 in place.
9	L_1	LPBP logic signal, car # 1. 1 = Power, 0 = Brake.
10	-	Vacant
11	-	Vacant
12	ON/OFF	Manually operated switch to identify vehicle trips.
13	s	Speed, car # 1. Sensor in place.
14	t	Time

RECORDER B

1	V_2	Capacitor voltage for car # 2. Sensor in place.
2	I_{L2}	Line current, car # 2. Sensor was located as shown in Figure A-2.
3	I_{X2}	Auxiliary current, car # 2.
4	V_{M2}	Motor armature voltage, car # 2.

RECORDER B (CONTD.)

Channel	Symbol	Description
5	I_{MX2}	Motor current, X-truck, car # 2. Sensor in place.
6	I_{MY2}	Motor current, Y-truck, car # 2. Sensor in place.
7	I_{DB2}	Dynamic braking current for car # 2. Sensor (2000A) was connected in series with terminal P14 of resistor R1.
8	I_{BR2}	Current in R2-R3-R4, car # 2. Sensor was connected in series with terminal P19 of resistor R4.
9	L_2	LPBP logic, car # 2.
10	I_{L3}	Line current, car # 3.
11	I_{X3}	Auxiliary current, car # 3.
12	-	Vacant.
13	-	Vacant.
14	t	Time.

2.2 Data Reduction

The objective of this test program was to obtain sufficient and relevant data regarding energy consumption of transit cars to be able to validate computer models predicting the same. Several variables were, therefore, defined that are critical to such validation. These included:

- Station kW for seven stations and the total kW
- Vehicle input kW, auxiliary kW, and the traction kW
- Series resistance kW/motor kW in braking
- Dynamic braking kW/motor kW in braking
- Traction kW/motor kW in braking
- Input kW/motor kW in braking

- o Vehicle speed
- o Vehicle input voltage
- o Vehicle input current

All these variables are defined in terms of the observed variables in Appendix D.

The resistive losses in the series resistances R2, R3, and R4 and the dynamic braking resistance are included here to examine how much energy is not available for feedback to the third rail because it is lost in the chopper controller itself.

The information recorded during the tests was reduced in different ways to produce four basic types of output data for comparison with model predictions. These types were:

- o Instantaneous plots of all the variables for a very limited time period
- o One-minute averages for vehicle and substation kW loadings
- o Energy consumption (kWh) on a trip basis at the substations and in different onboard components such as motor, braking resistances, etc.
- o Substation loadings as 15-minute averages.

These data reduction requirements are detailed in Appendix D.

3. TEST DATA

The necessary sensors and the recording instruments were installed on the three cars and at the seven substations during the first three weeks of August 1981. After the initial checkouts and debugging, the tests were conducted during the period 23 August - 2 September 1981.

The Baseline Tests had to be conducted during the early nonrevenue hours of 2:00 to 7:00 of any Sunday. The first such test runs were conducted on 23 August. After completing one-and-a-half round trips between the Daly City (M90) and the Embarcadero (M16) stations, the tests had to be terminated because of an unexpected malfunction of the MA set on the Engineering Car. Additional tests were then conducted on 30 August, running the train for seven round trips between the Daly City and the Embarcadero stations. A total of eight-and-a-half round trips were thus run during these Baseline Tests. Out of all these trips, useful data was obtained only for six one-way runs - four (4) from Daly City to Embarcadero, and two (2) from Embarcadero to Daly City. During other runs, either the 'System History Log' was lost in the BART Central Computer, or some car equipment and/or some recording equipment malfunctioned. This is mentioned here only to give the reader an idea of what can be expected of a non-laboratory-type test environment, especially when several systems have to be coordinated.

The Regeneration Tests were conducted on the following six days: 25-28 August, and 1-2 September 1981. Out of these six days, however, useful data was obtained only on three days. For other days, either the 'System History Log' was lost, and/or the train dispatch data could not be correlated with the arrivals and the departures at the passenger stations, and/or the passenger density data could not be generated.

The data which could be used for this validation program, therefore, covered only the following runs:

<u>Baseline Tests</u> : 4 runs from M90 to M16, and 2 runs from M16 to M90.

The timing of these runs are presented in Table 3.1. This timing information should be used to identify the test data presented later.

Regeneration Tests : Afternoon rush-hour revenue service between 15:00 - 18:00 hours on 25-26 August, and 1 September 1981.

3.1 Baseline Test Data

The Baseline Test Data are presented in Figures 3.1 - 3.3. It includes different types of data such as the station loadings, vehicle input power, inherent circuit losses during vehicle braking, etc. These are separately discussed below.

3.1.1 Substation Loading

The one minute average of substation power is shown in Figure 3.1 and the instantaneous substation power in Figure 3.2. Large background noise was observed in the substation instantaneous power as can be seen in Figure 3.2. Without suitable corrections this would lead to extremely large errors in the integrated substation energies. Fortunately this noise error could be estimated for a baseline test run by correlating the test data of Figure 3.2 with the train schedule. During the train station dwell times, substation loading should be minimal and limited to the power demand of the train auxiliary systems. Moreover, any substation located relatively distant from the passenger station in question should experience near-zero loading during these periods of train station dwell. The substation power during these time periods was used to establish a baseline noise level which was subsequently subtracted from the substation power data to obtain the substation loading due to the moving train.

The energy consumption data for Run #4 and the corrected energy consumption are presented in Table 3.2. The total substation energy

TABLE 3.1

SCHEDULE OF BASELINE RUNS

RUN	TIME	ROUTE	DATE	RUN TIME
1	2:29:06 - 2:47:06	M90 - M16	Aug 23	0:18:00
2	3:15:17 - 3:40:50	M90 - M16	Aug 23	0:25:33
3	1:37:21 - 1:58:11	M90 - M16	Aug 30	0:20:50
4	3:15:22 - 3:34:49	M90 - M16	Aug 30	0:19:27
5	1:58:20 - 2:22:42	M16 - M90	Aug 30	0:24:22
6	2:52:42 - 3:12:30	M20 - M90	Aug 23	0:19:48

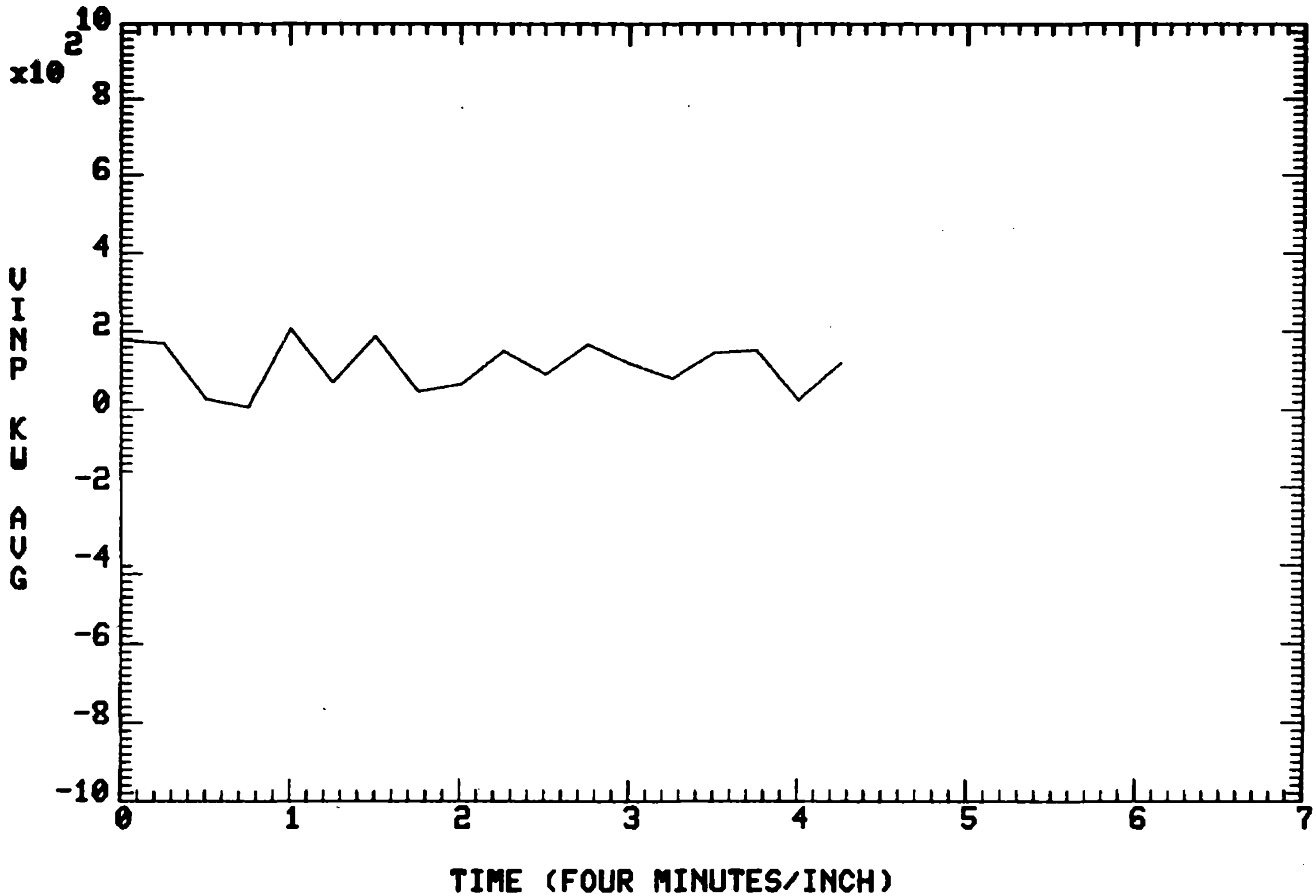
TABLE 3.2

ENERGY CONSUMPTION CORRECTED FOR ESTIMATED NOISE

SUB-STN.	RAW* KWH	CORRECTED KWH
MDC	58.7	16.8
MBP	50.0	17.6
MGP	44.3	18.0
MTF	34.6	13.2
MSS	27.0	13.9
MPS	51.9	32.7
MTW	76.8	16.8
TOTAL	343.3	129.0

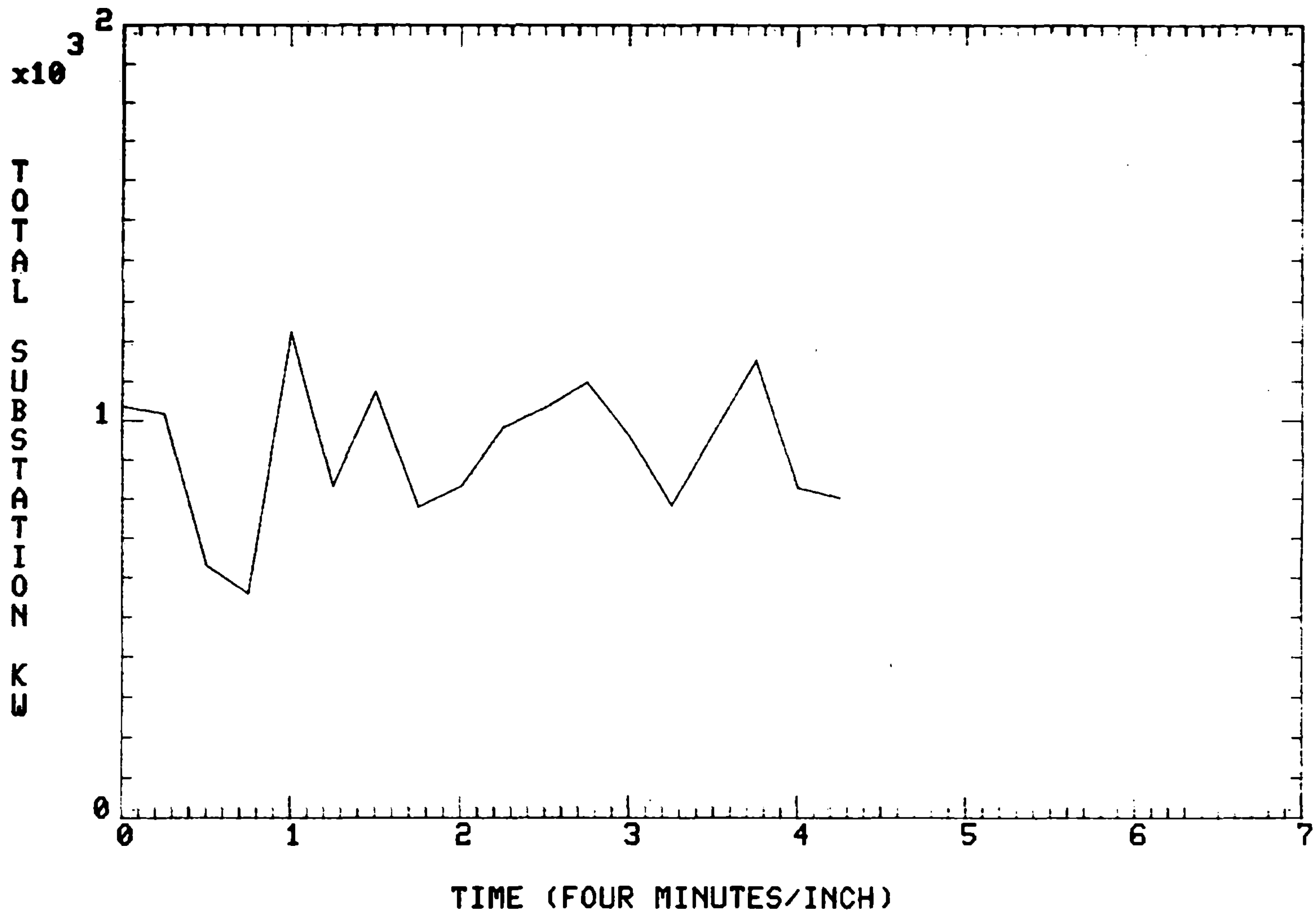
* includes background noise

FIGURE 3.1 VEHICLE AND SUBSTATION TEST DATA FOR BASELINE RUNS



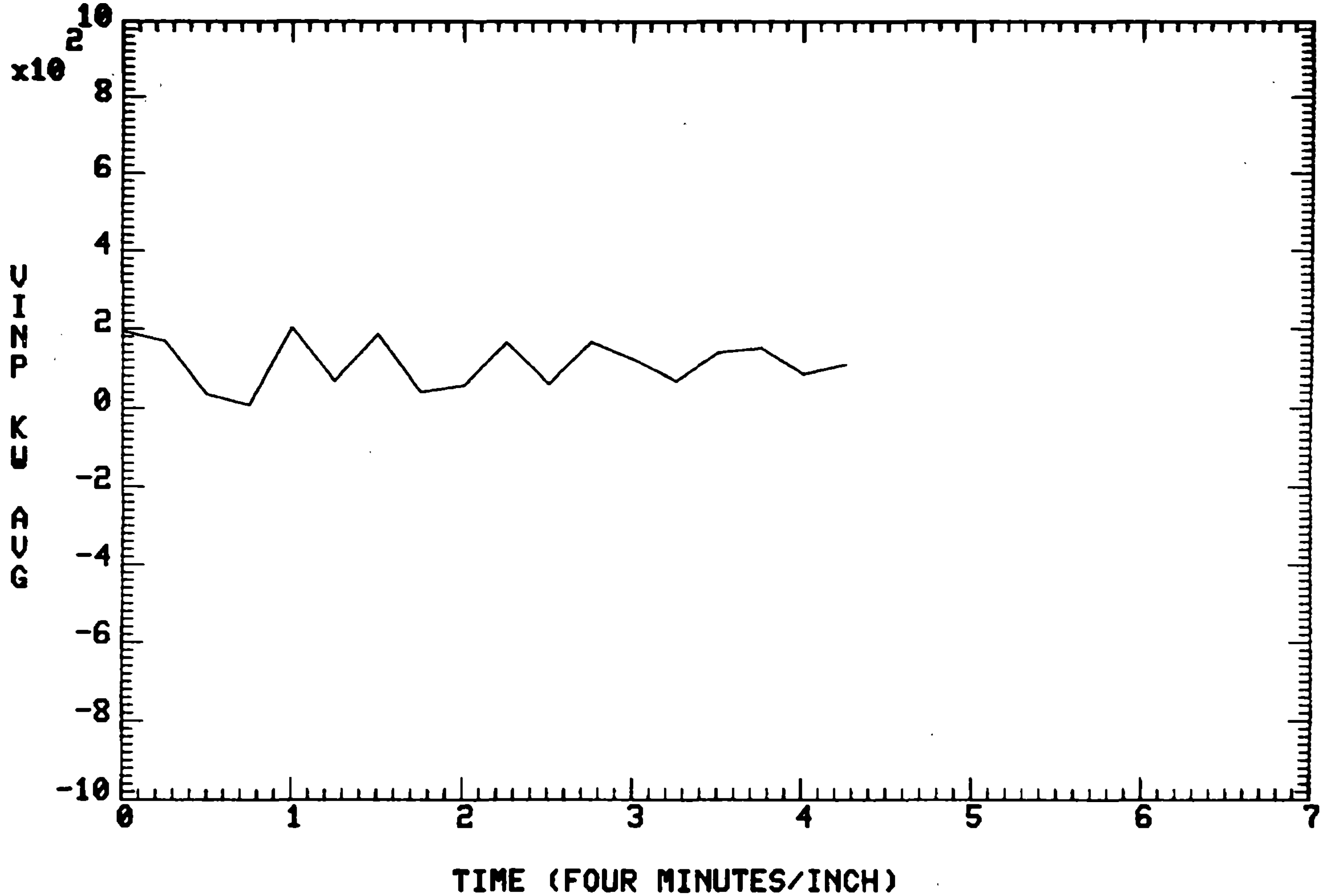
TEST 2 23AUG81 02:29:06 CAR #1 TYPE B1 PAGE 1 OF 3

(a)



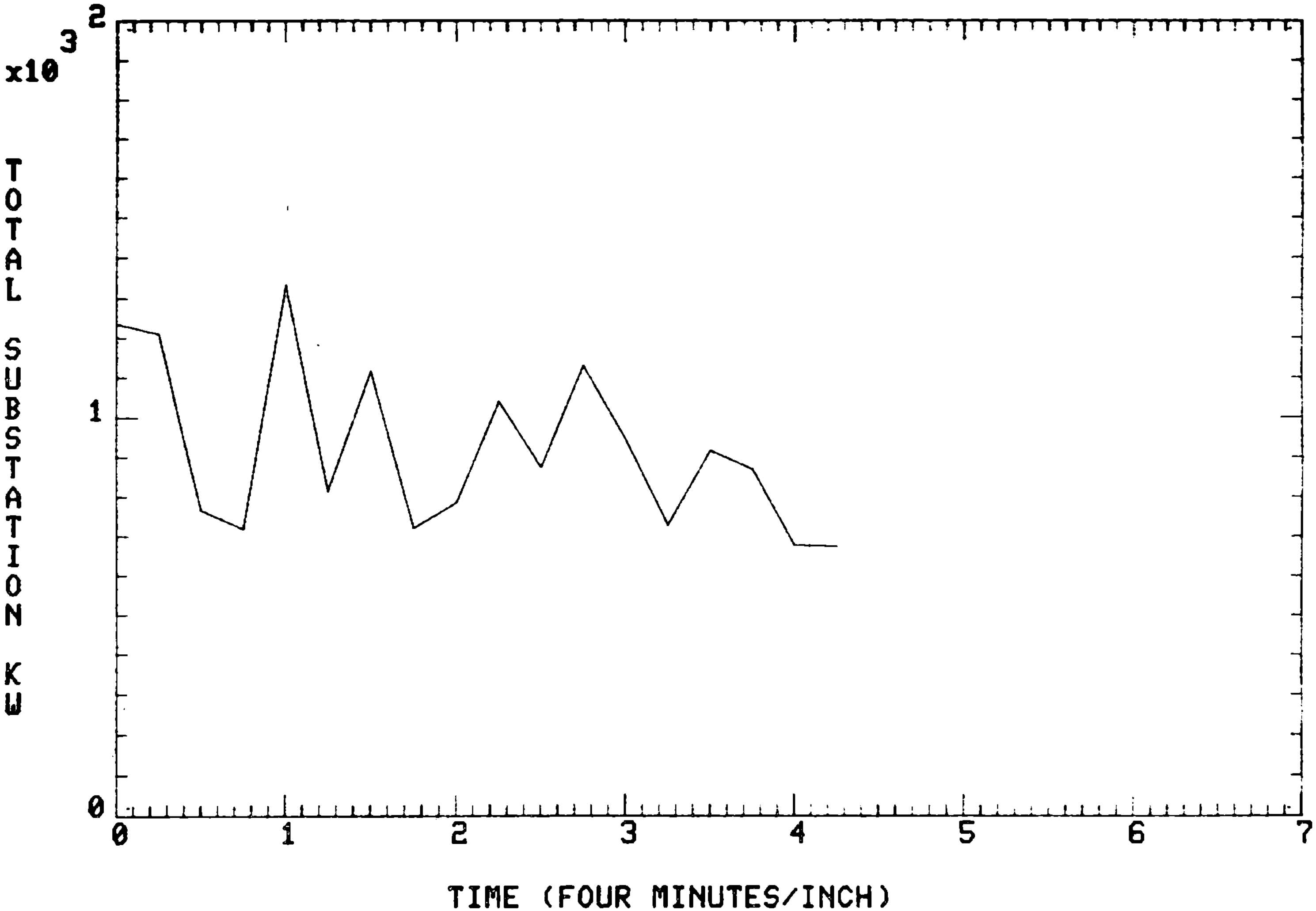
TEST #2 23AUG81 02:29:06 SUBSTATION TYPE B PAGE 1 OF 3

(b)



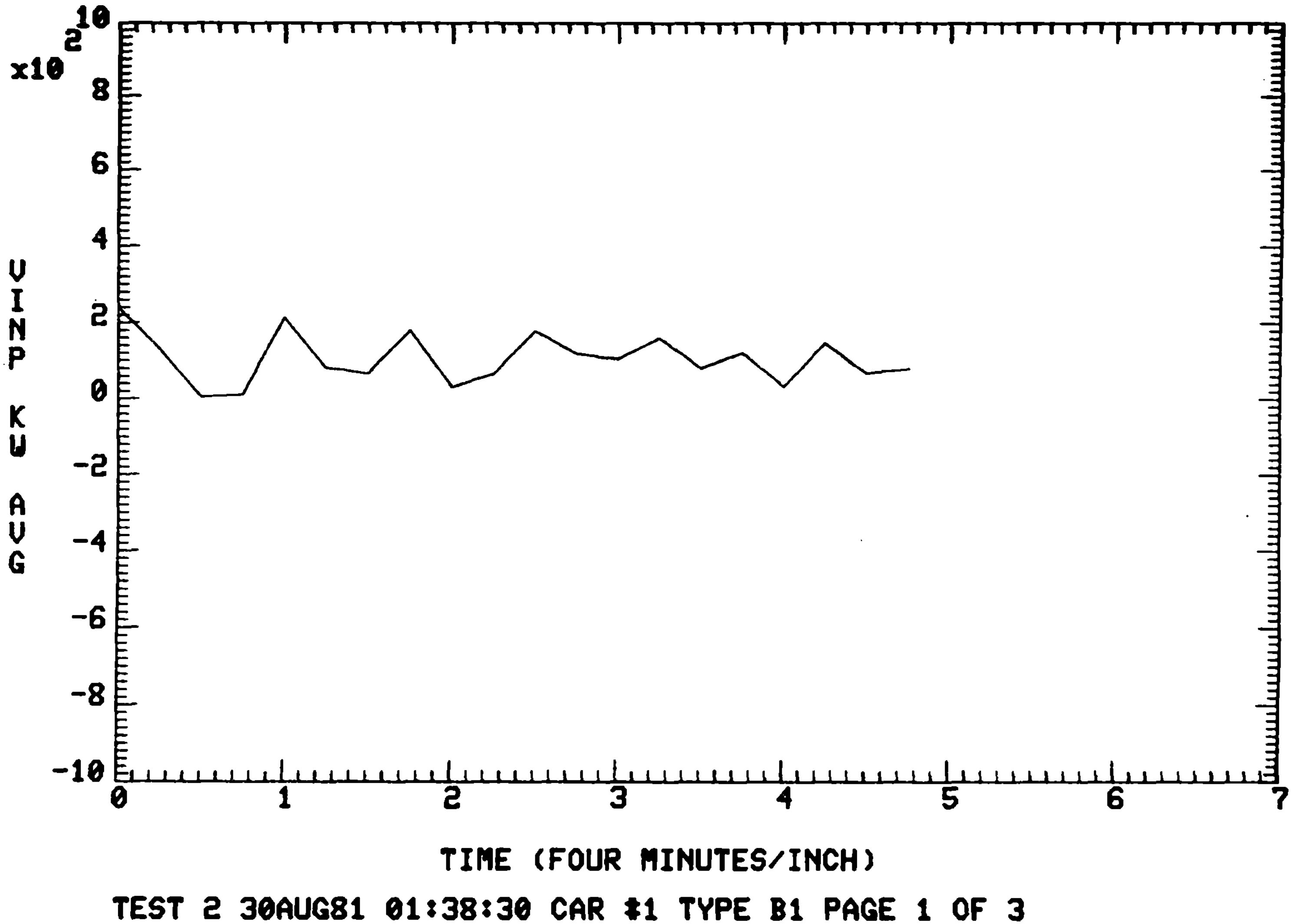
TEST 2 23AUG81 03:22:50 CAR #1 TYPE B1 PAGE 3 OF 3

(c)

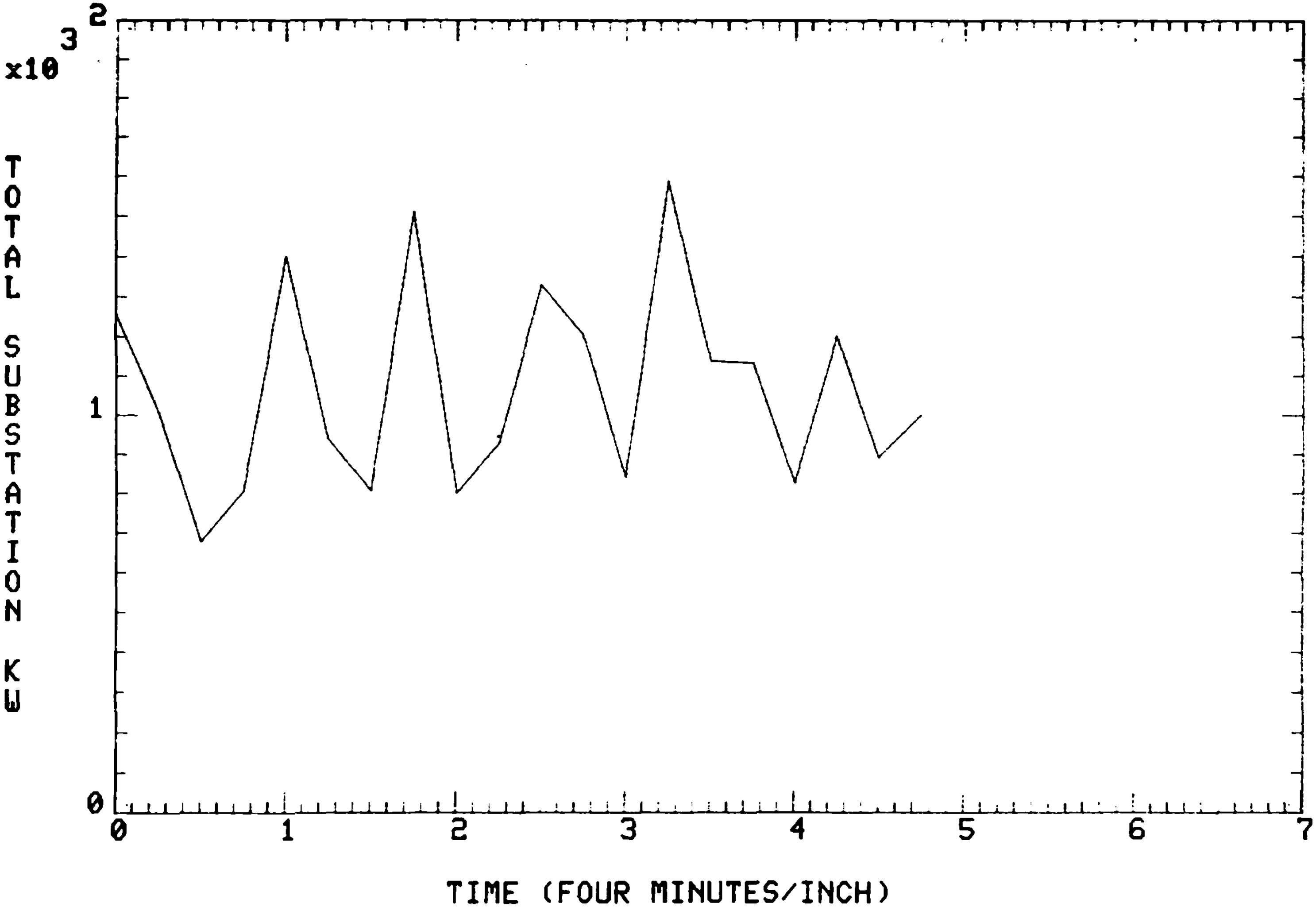


TEST #2 23AUG81 03:22:50 SUBSTATION TYPE B PAGE 3 OF 3

(d)

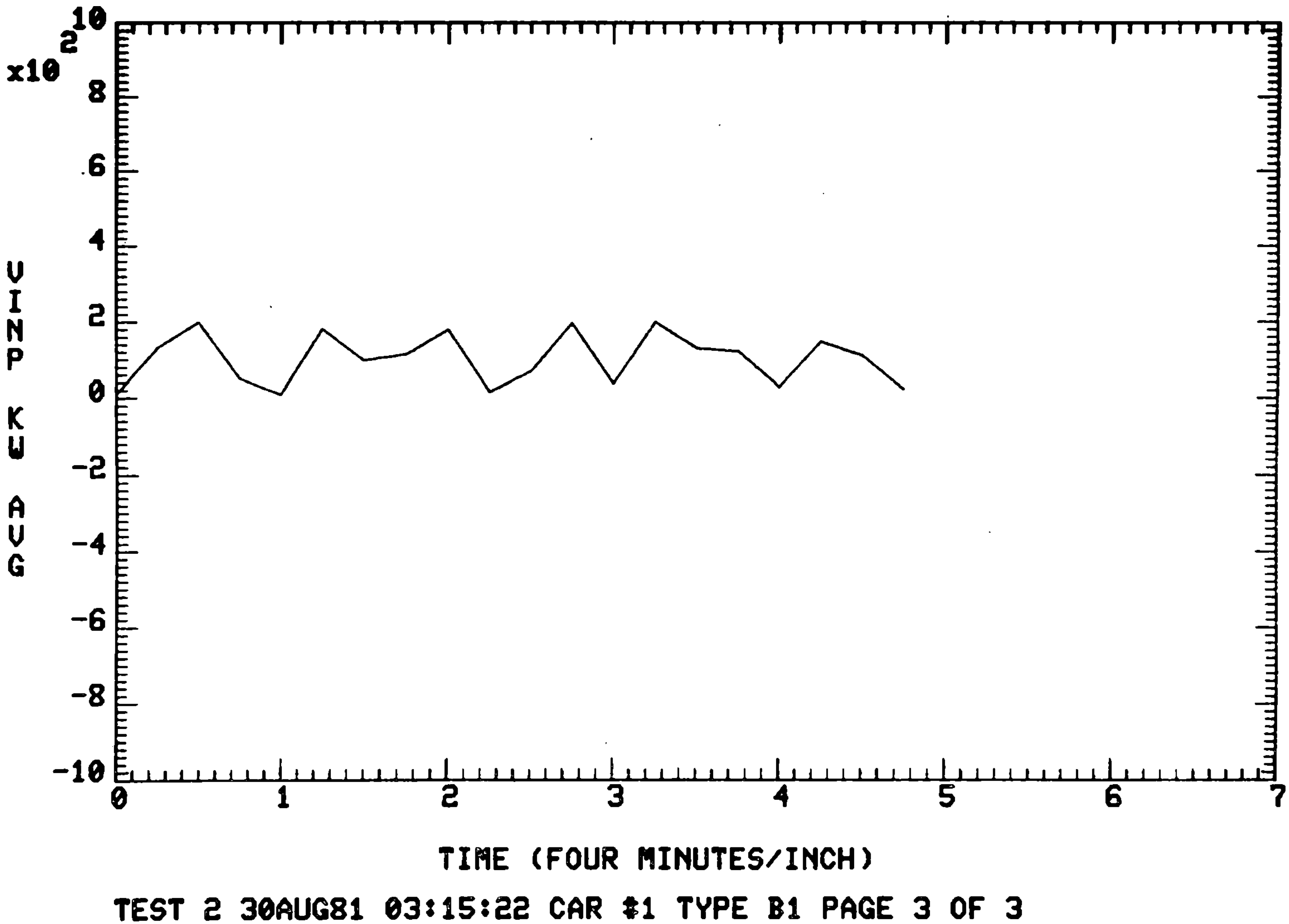

x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VINP KW AVG
0
1
2
3
4
5
6
7
TIME (FOUR MINUTES/INCH)
TEST 2 30AUG81 01:38:30 CAR #1 TYPE B1 PAGE 1 OF 3

(e)

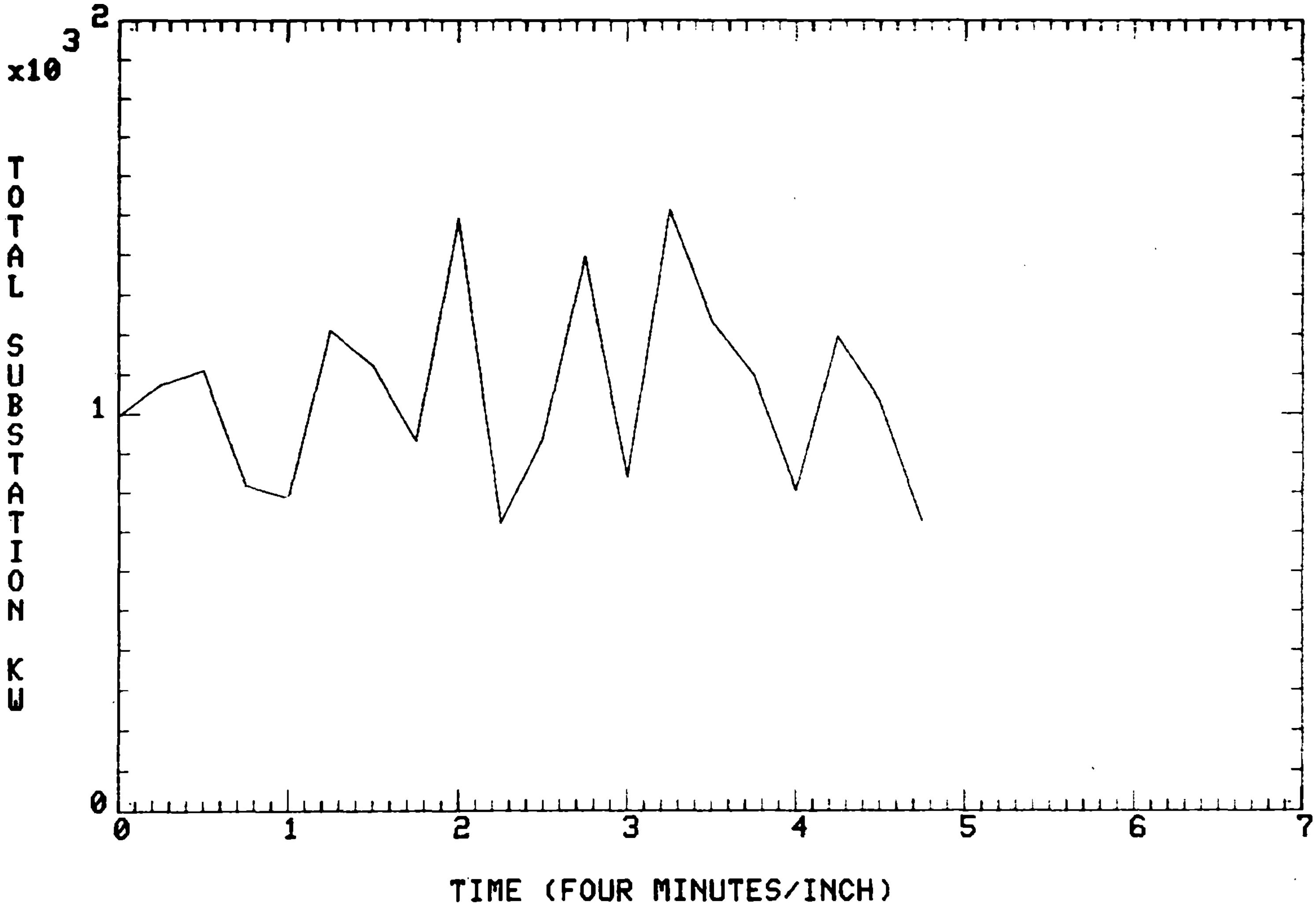


TEST #2 30AUG81 01:38:30 SUBSTATION TYPE B PAGE 1 OF 3

(f)

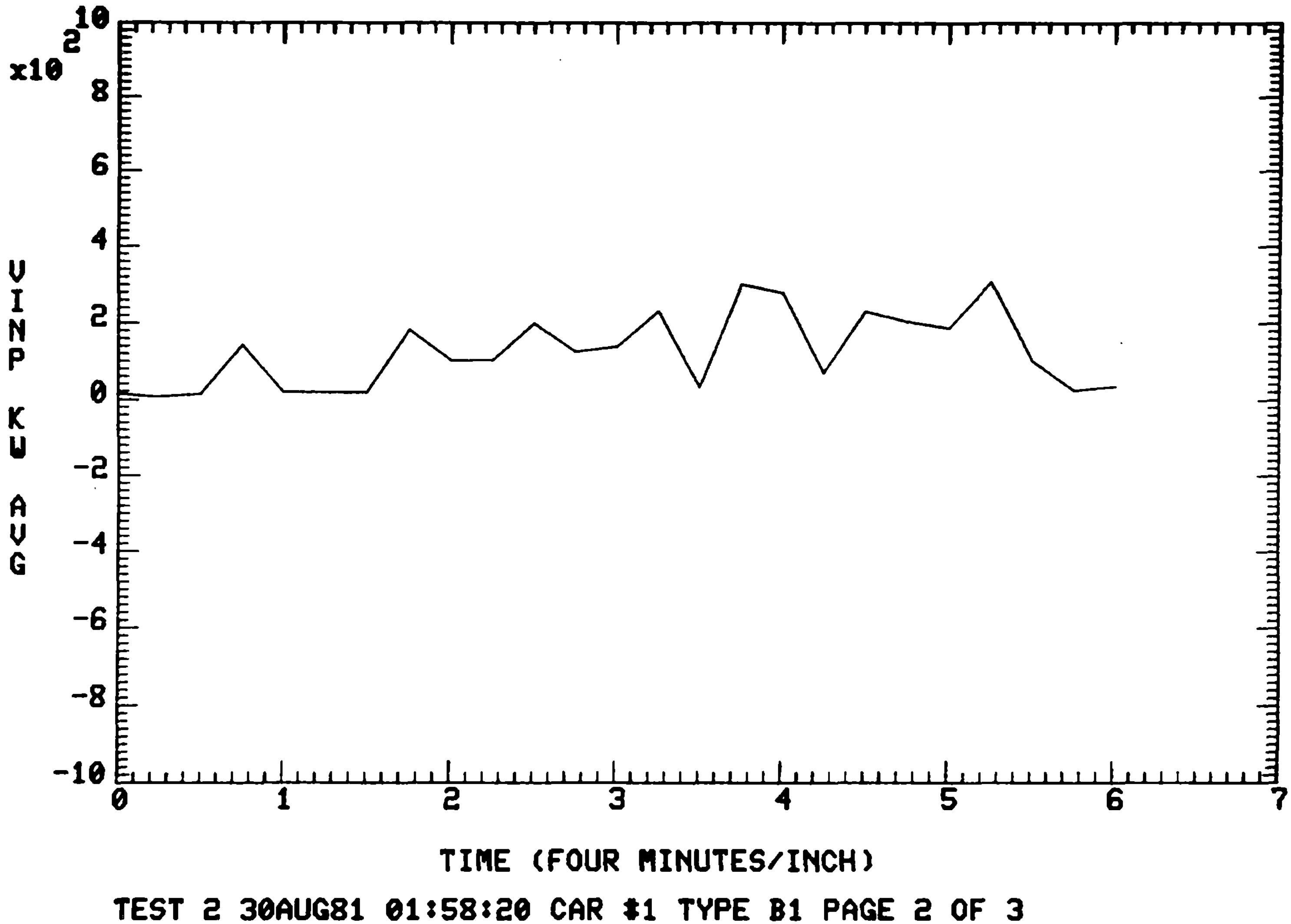

x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VINP KW AVG
0
1
2
3
4
5
6
7
TIME (FOUR MINUTES/INCH)
TEST 2 30AUG81 03:15:22 CAR #1 TYPE B1 PAGE 3 OF 3

(g)

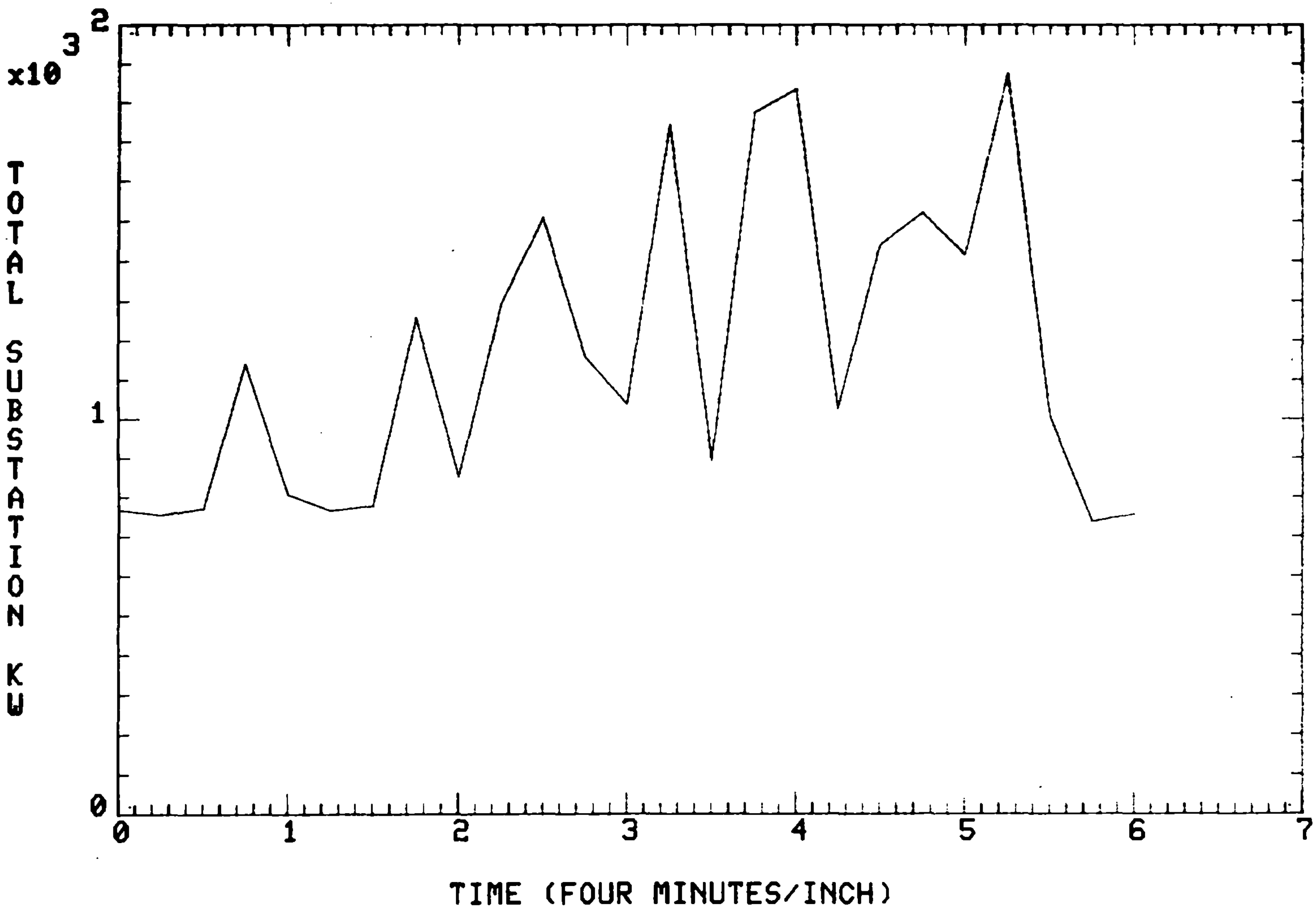


TEST #2 30AUG81 03:15:22 SUBSTATION TYPE B PAGE 3 OF 3

(h)

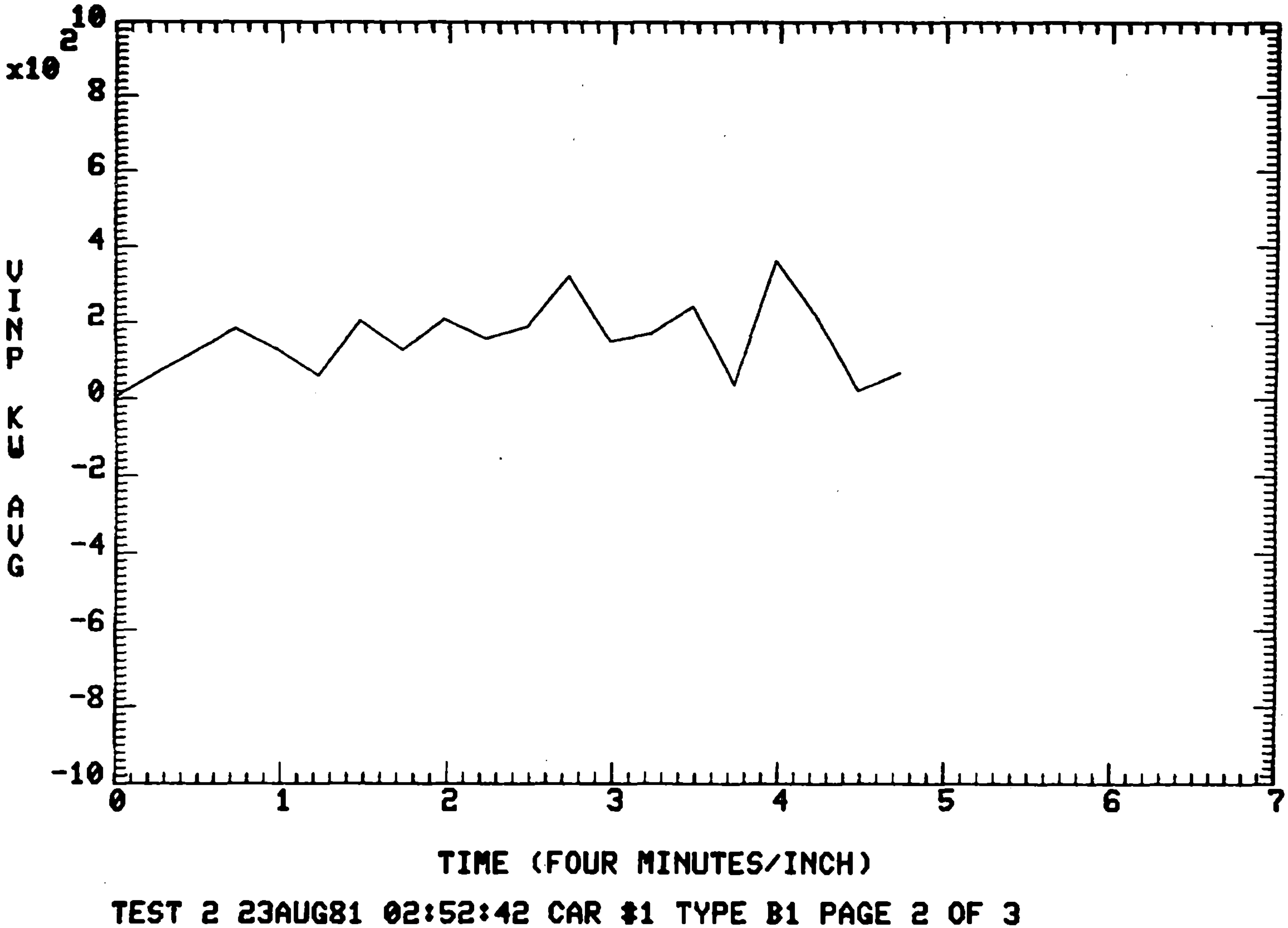

x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VINP KW AVG
0
1
2
3
4
5
6
7
TIME (FOUR MINUTES/INCH)
TEST 2 30AUG81 01:58:20 CAR #1 TYPE B1 PAGE 2 OF 3

(i)

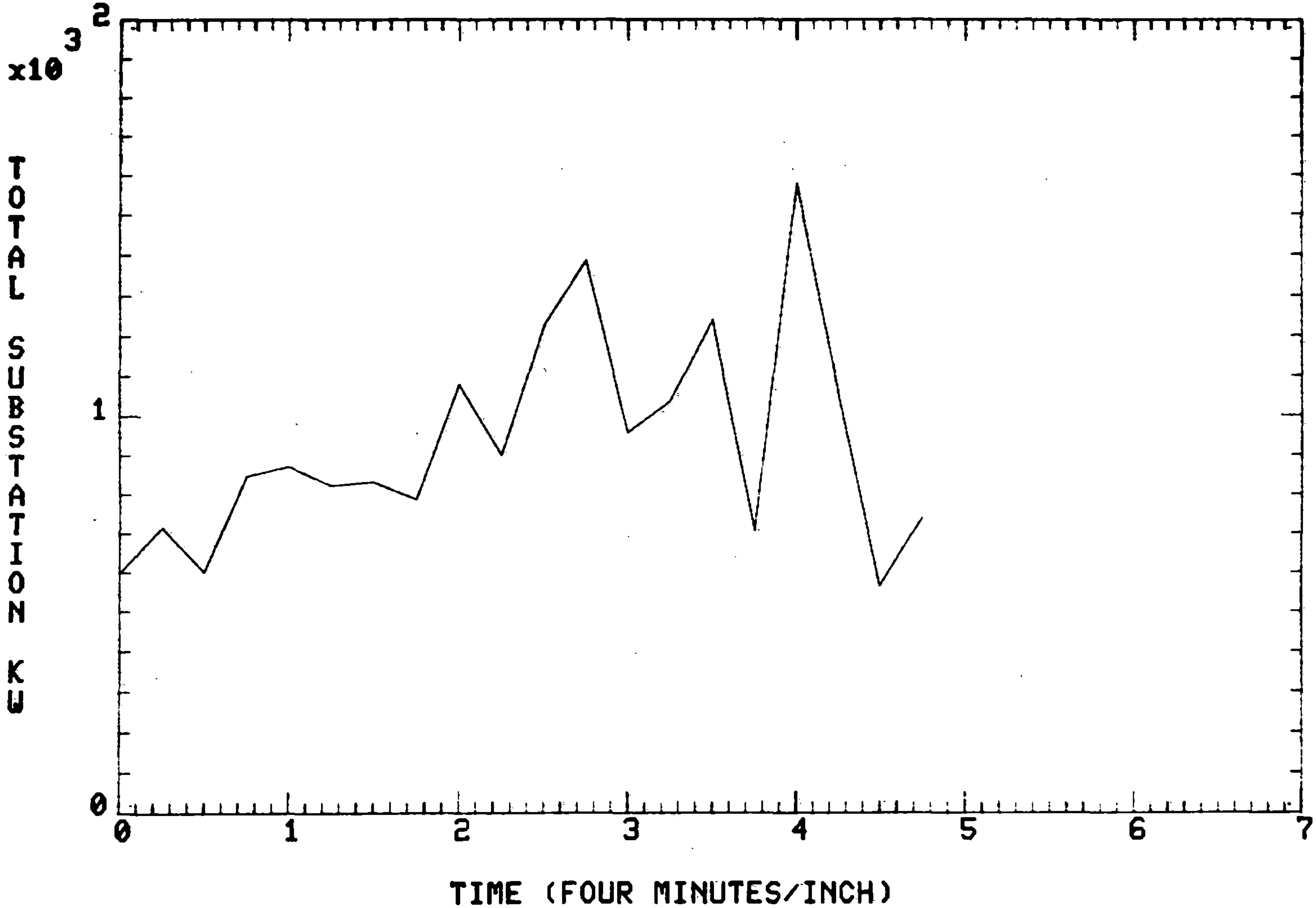


TEST #2 30AUG81 01:58:20 SUBSTATION TYPE B PAGE 2 OF 3

(j)


x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VINP KW AVG
0
1
2
3
4
5
6
7
TIME (FOUR MINUTES/INCH)
TEST 2 23AUG81 02:52:42 CAR #1 TYPE B1 PAGE 2 OF 3

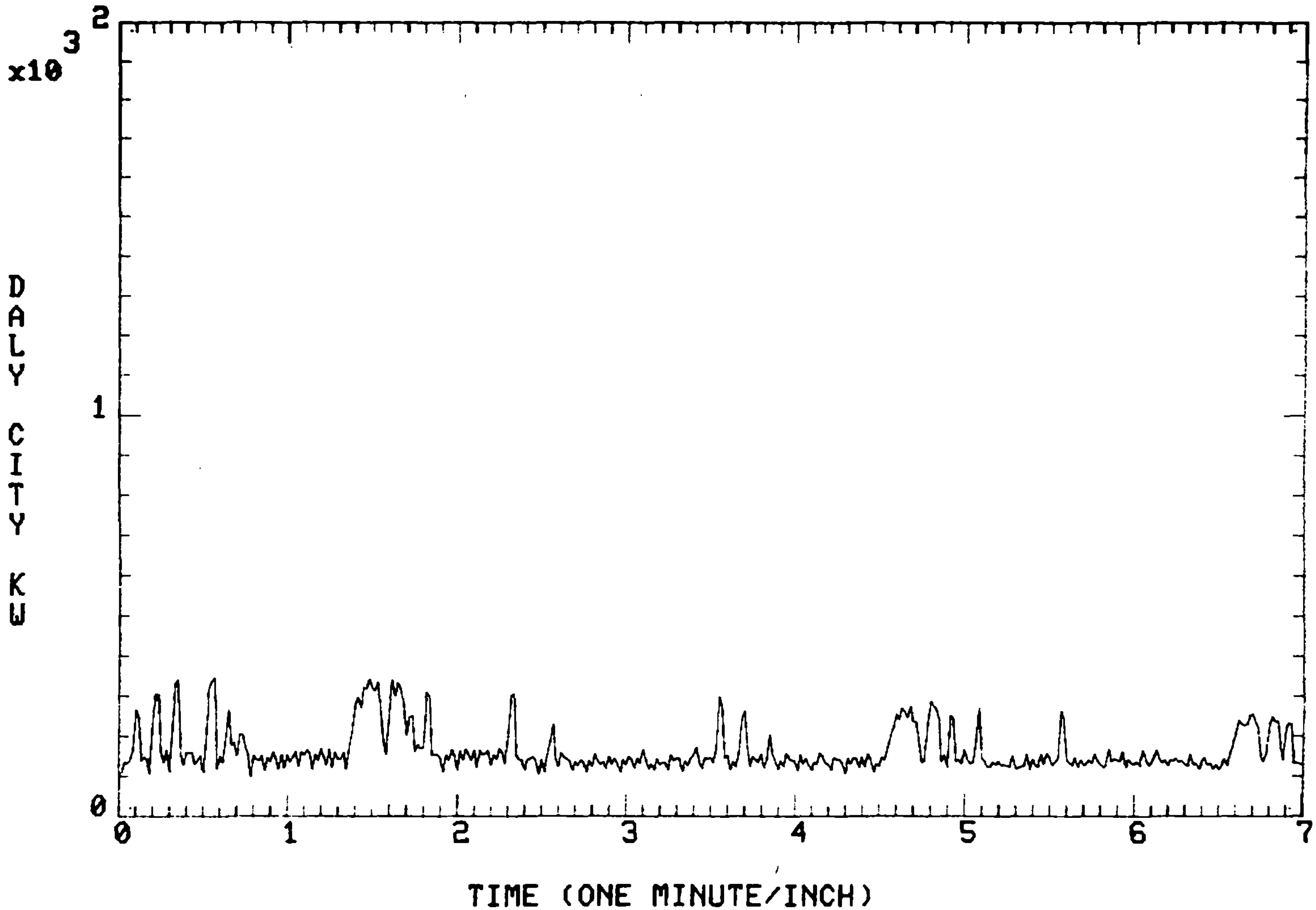
(k)



TEST #2 23AUG81 02:52:42 SUBSTATION TYPE B PAGE 2 OF 3

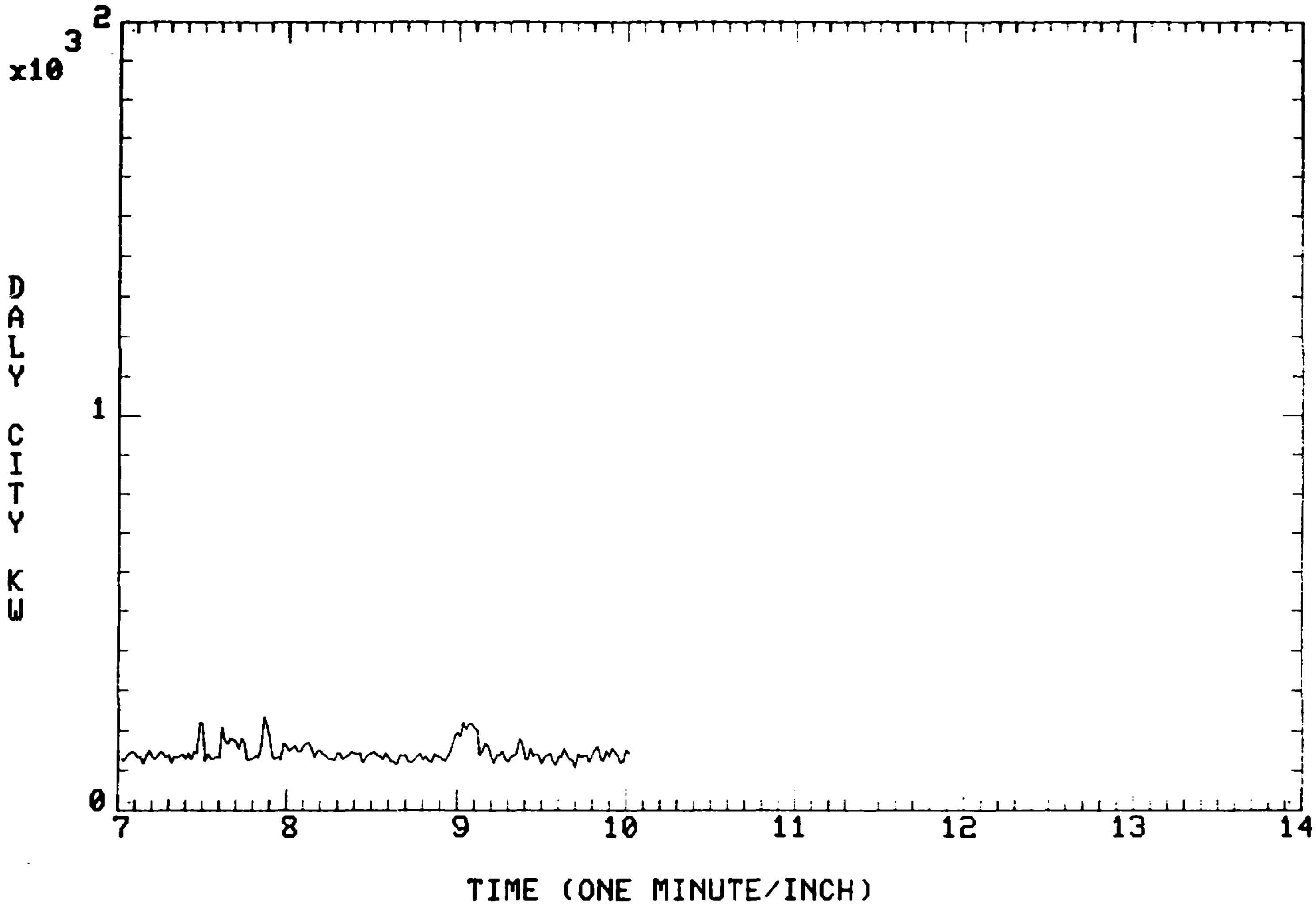
(l)

FIGURE 3.2 SUBSTATION LOADING DATA
FOR BASELINE RUN # 4



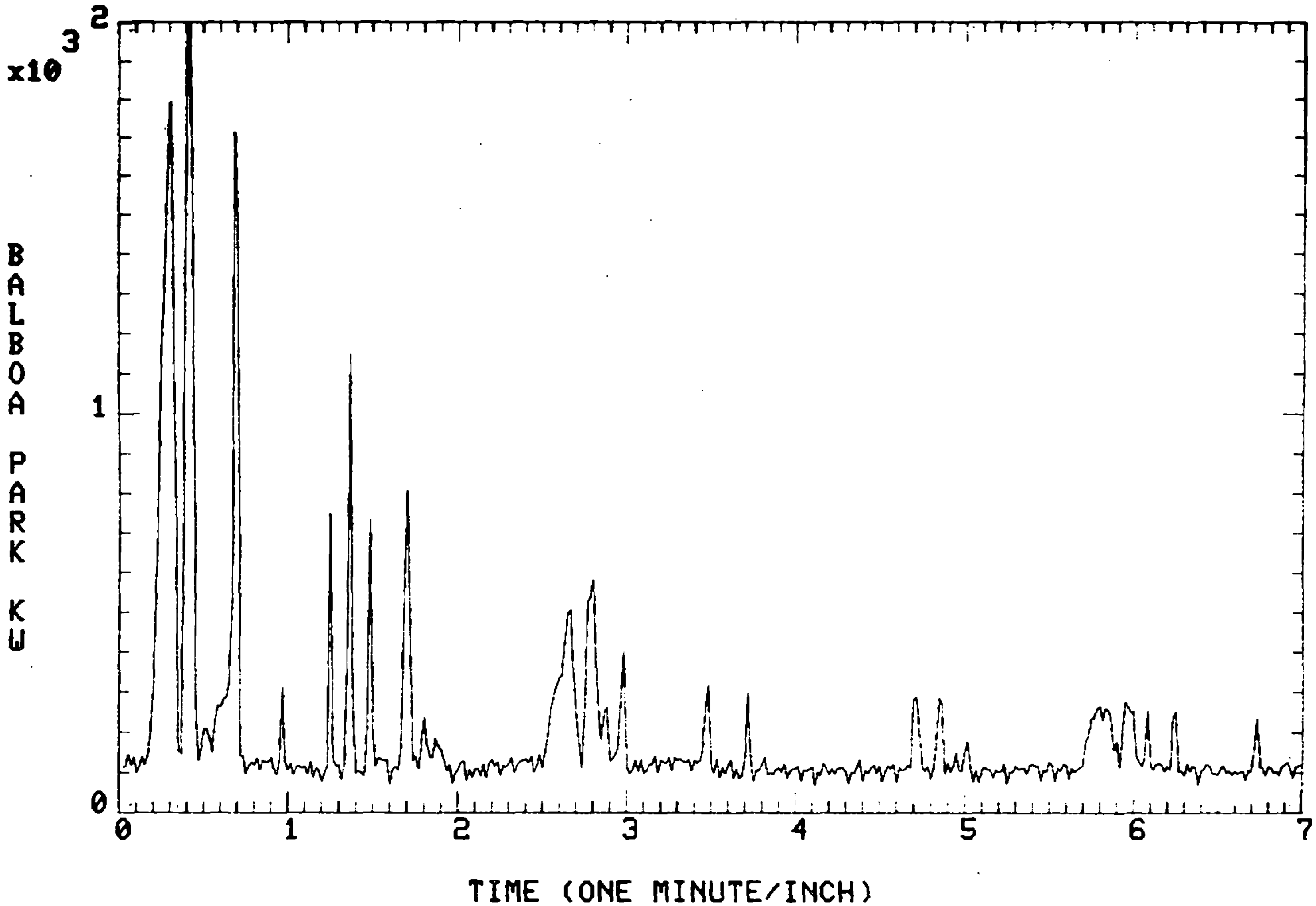
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 1 OF 2

(a)



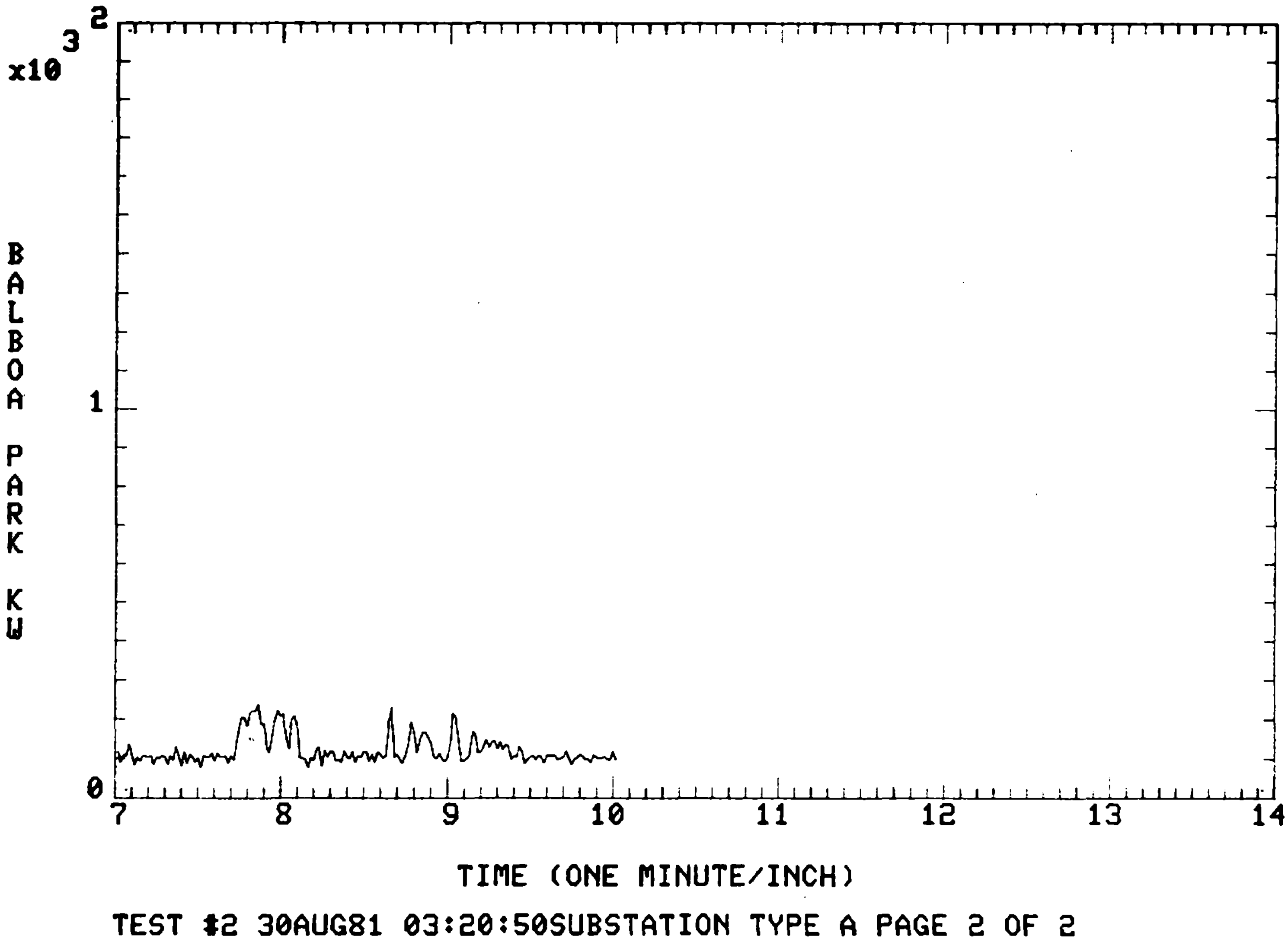
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 2 OF 2

(a)

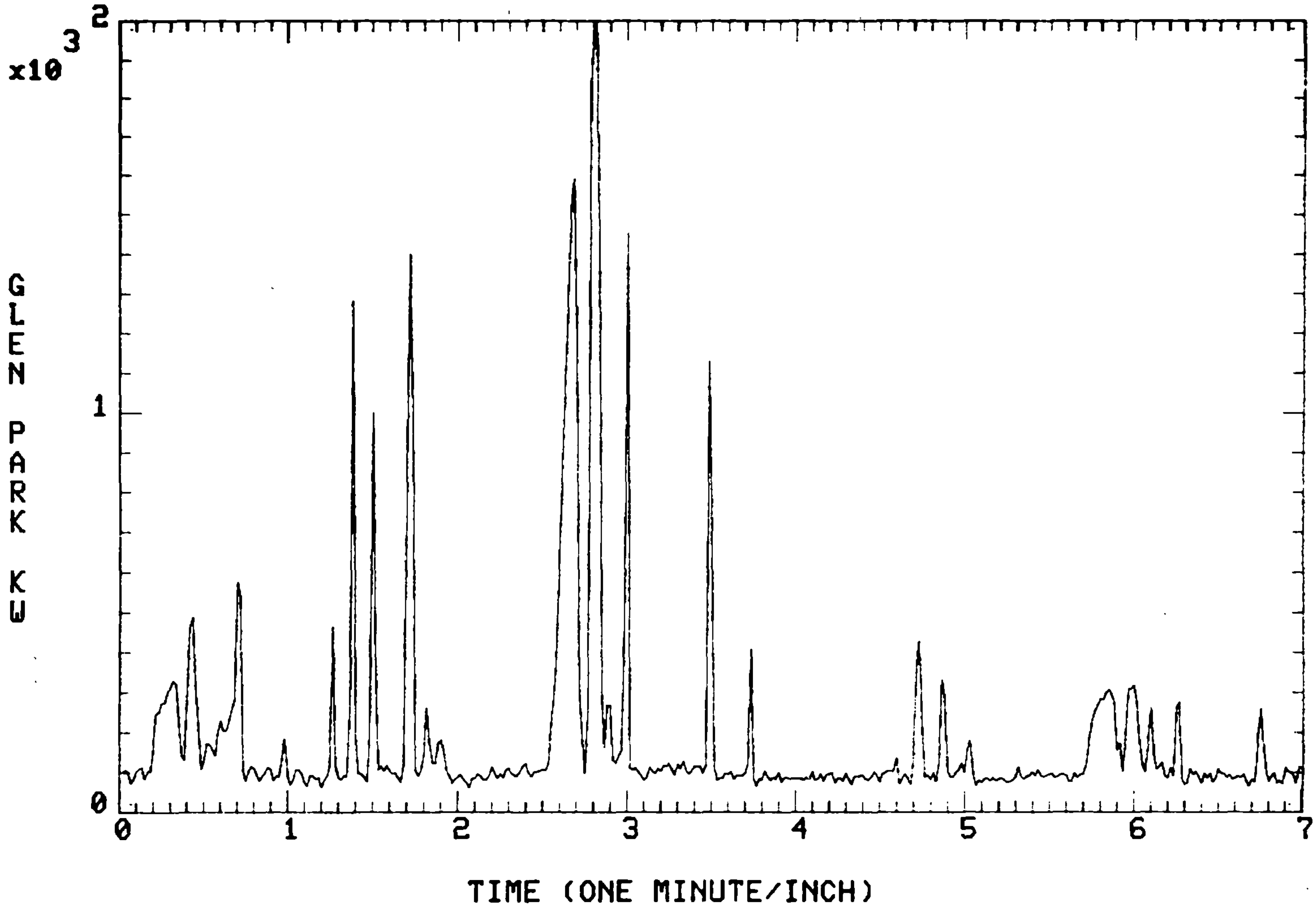


TEST #2 30AUG81 03:20:50SUBSTATION TYPE A PAGE 1 OF 2

(b)

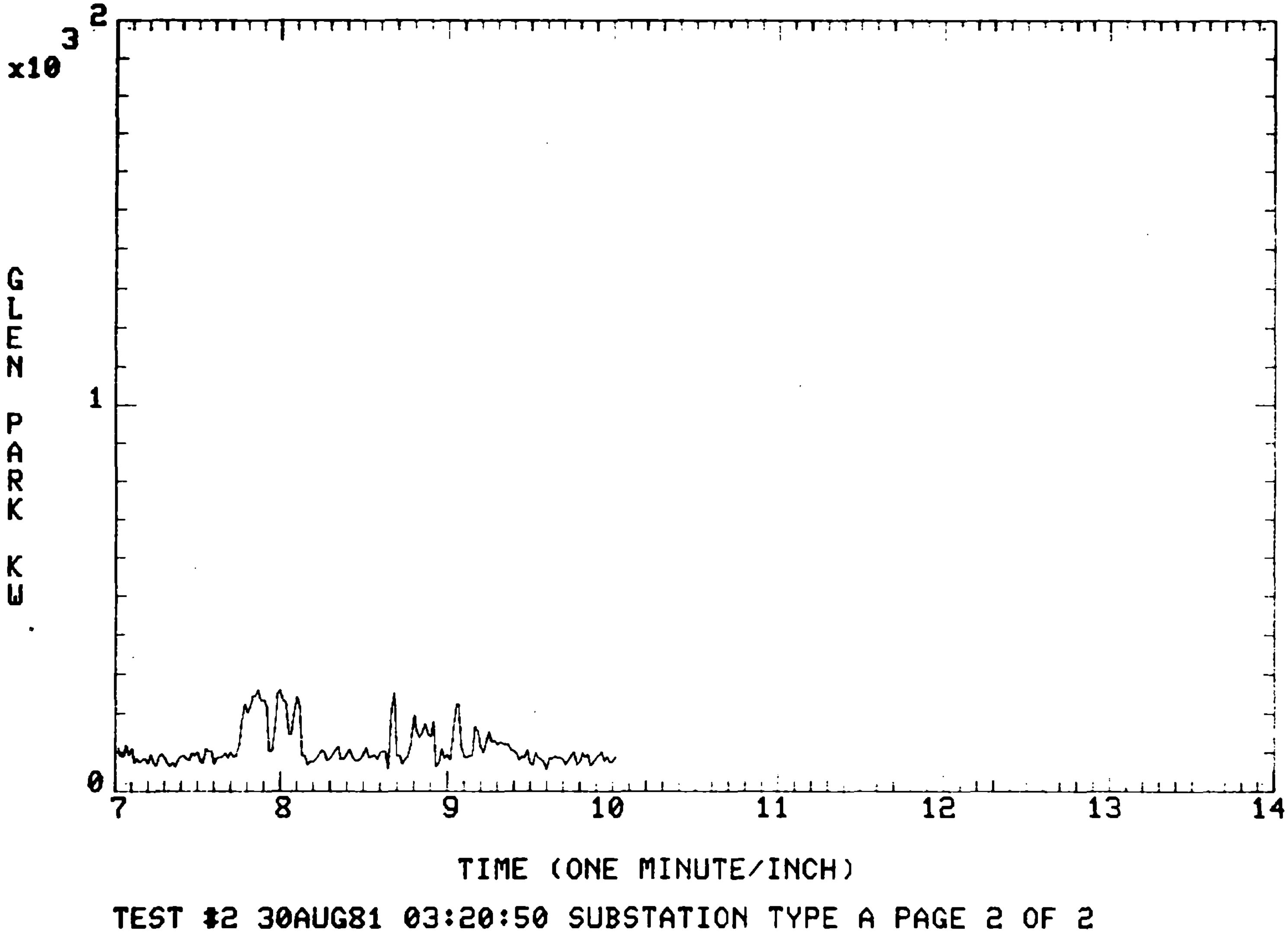

x10 3
2
1
0
BALBOA PARK KW
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST #2 30AUG81 03:20:50SUBSTATION TYPE A PAGE 2 OF 2

(b)

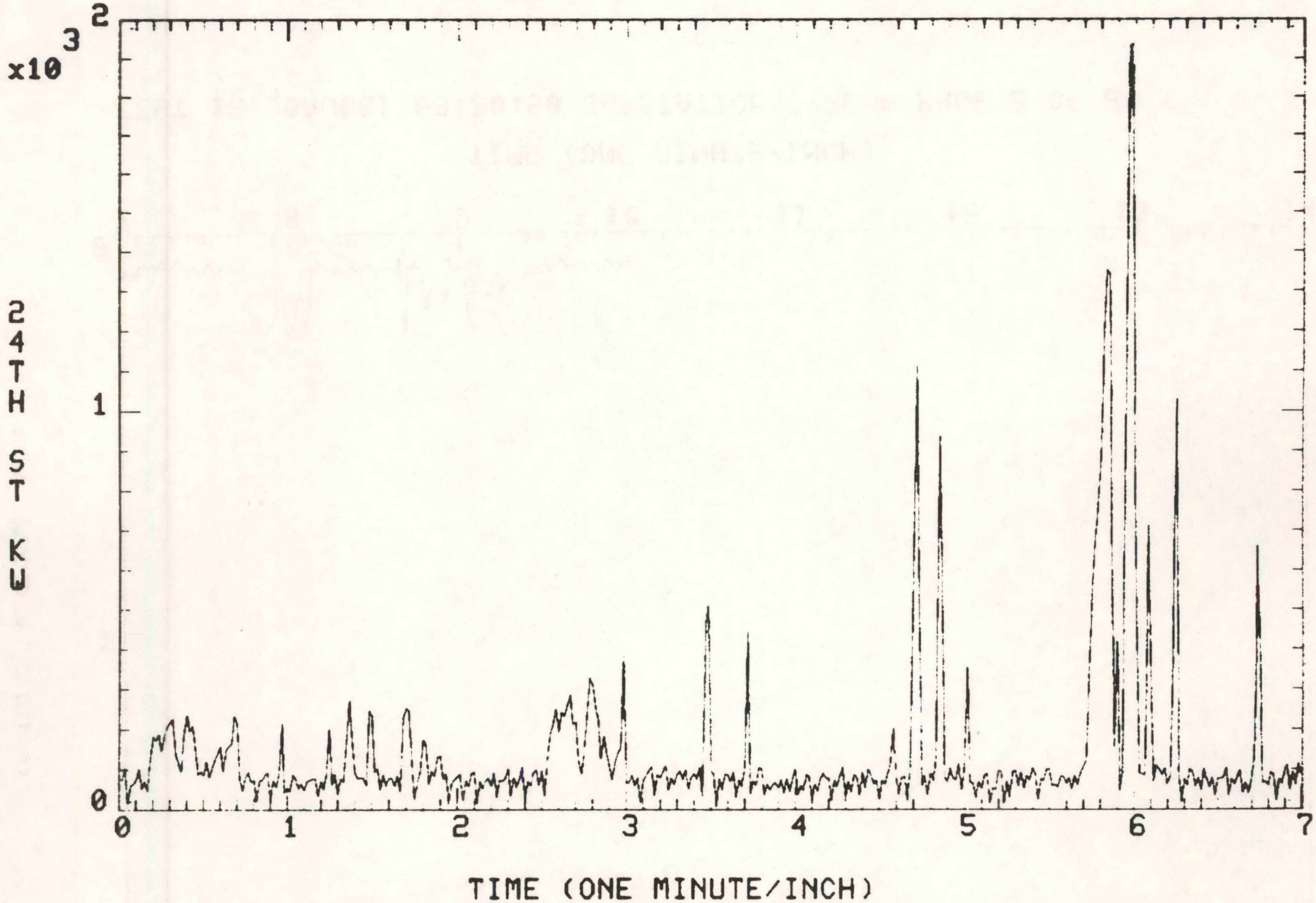


TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 1 OF 2

(c)

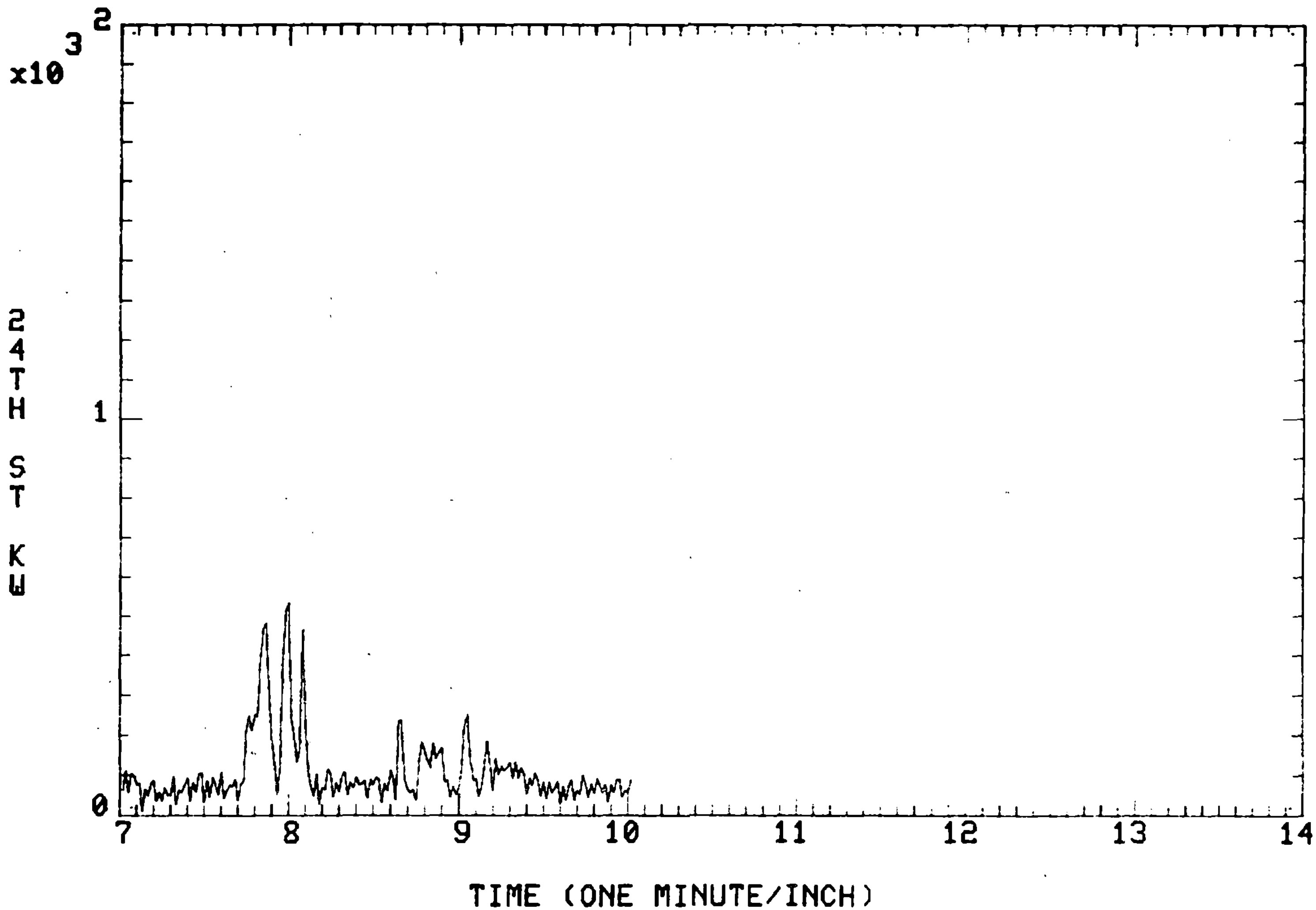

x10 3
2
1
0
GLEN PARK KW
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 2 OF 2

(c)



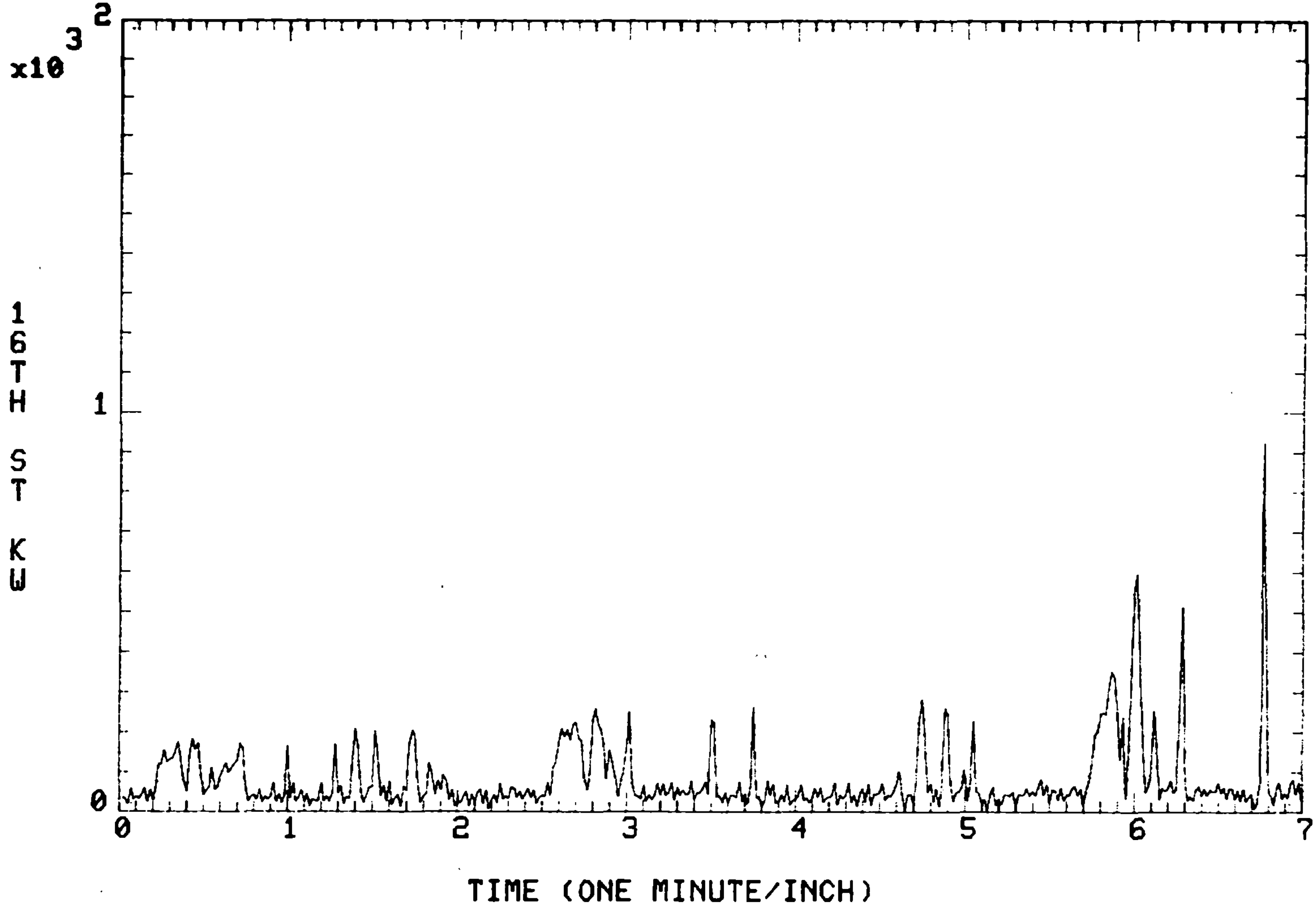
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 1 OF 2

(d)



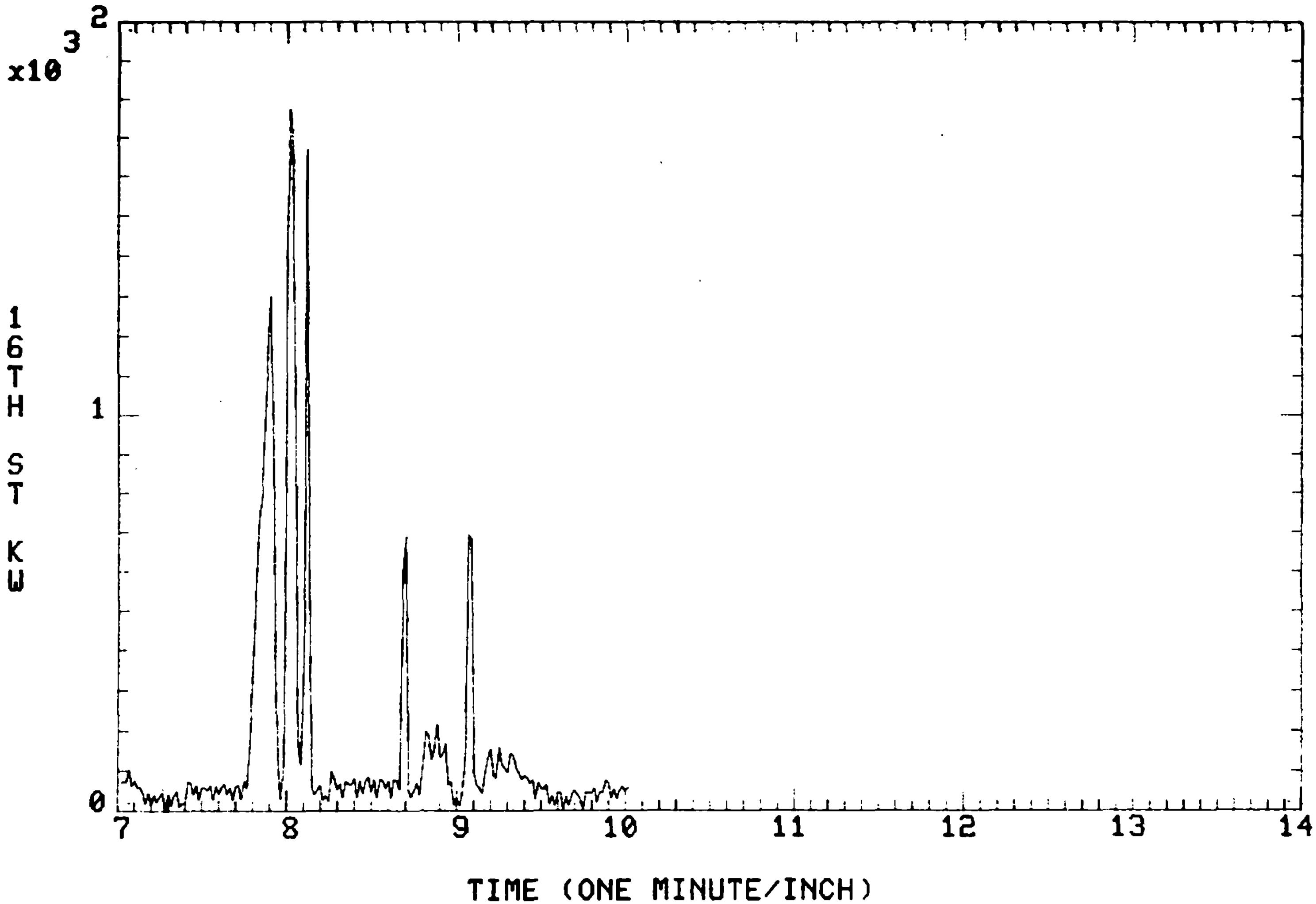
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 2 OF 2

(d)



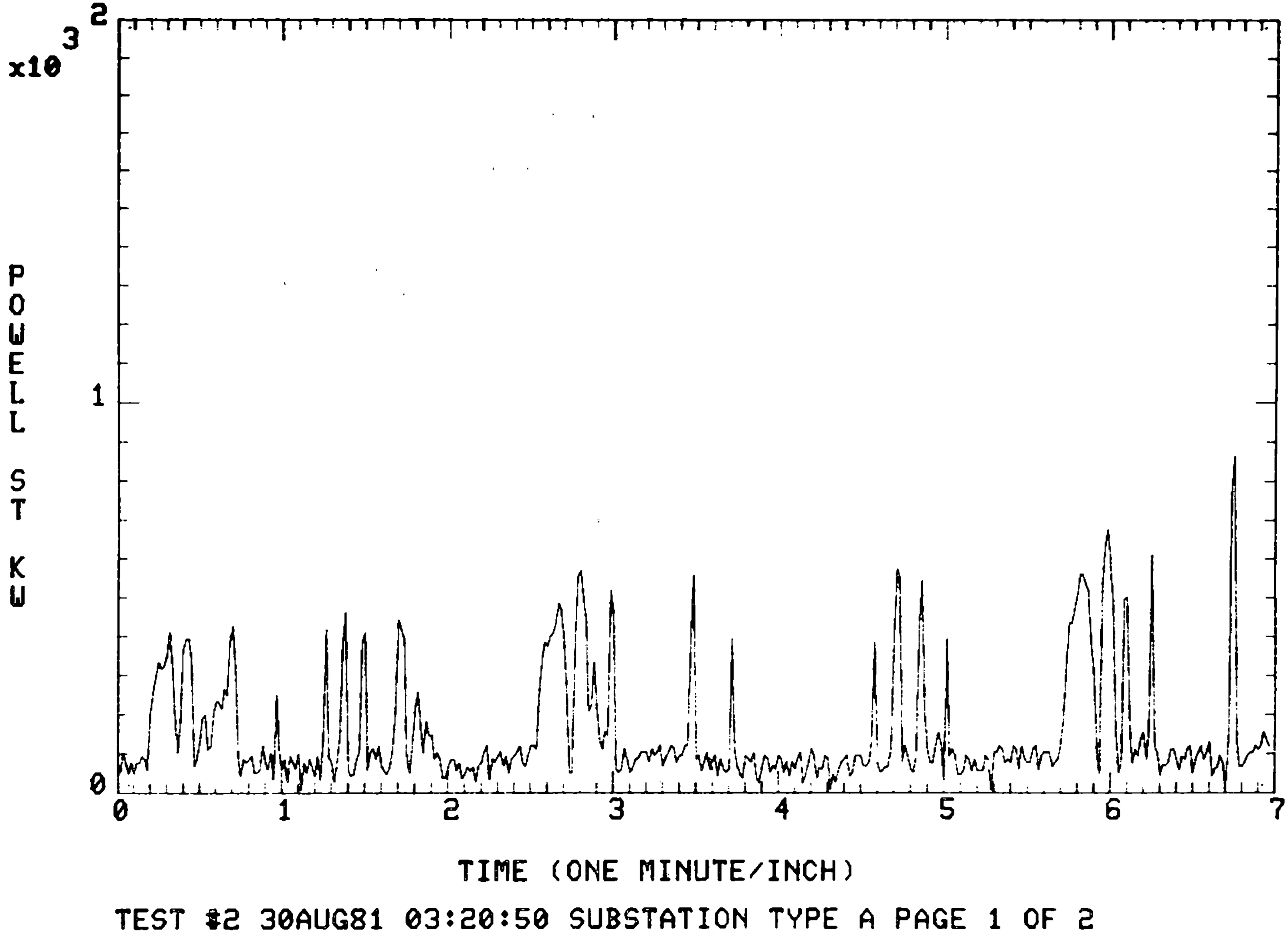
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 1 OF 2

(e)



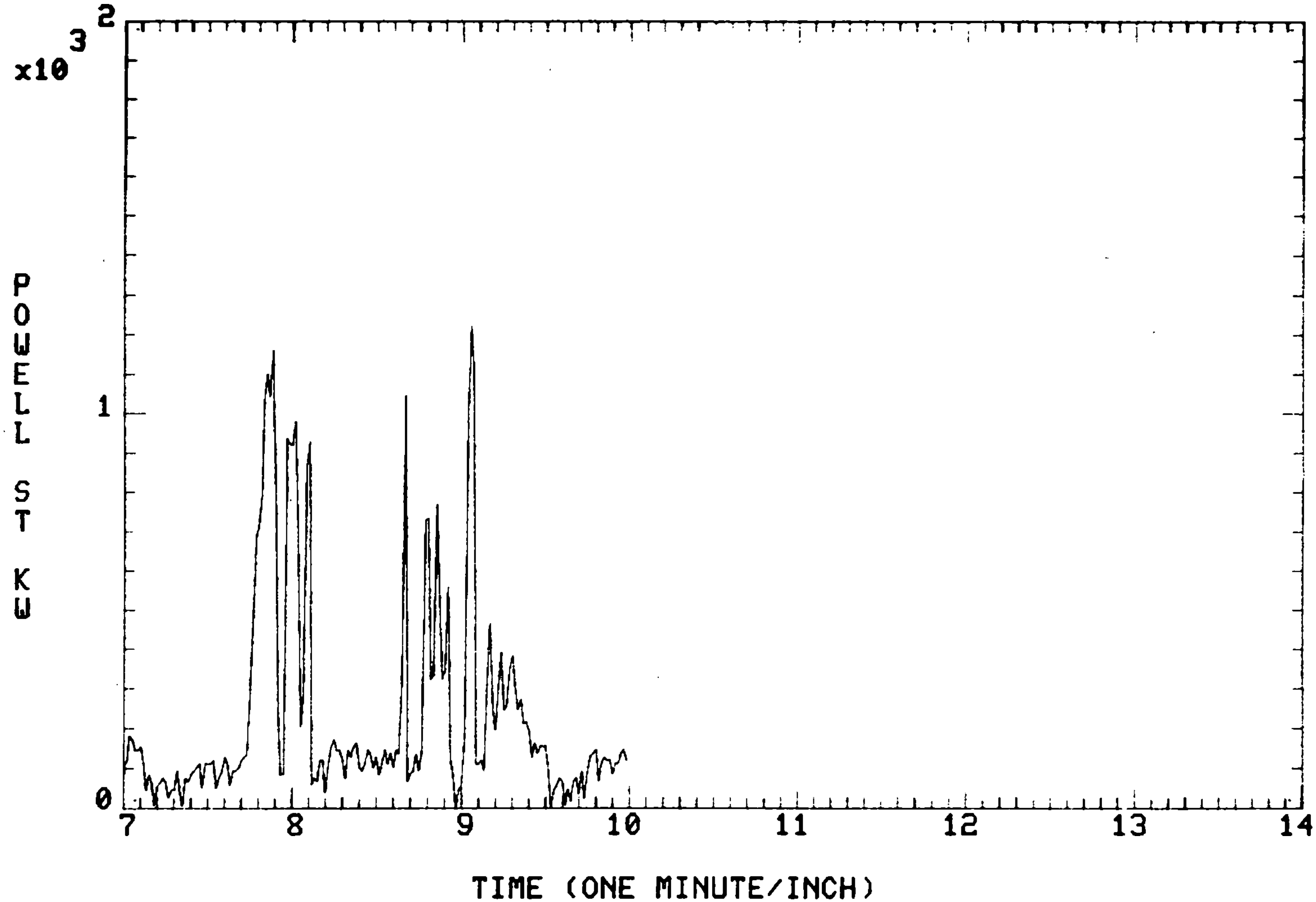
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 2 OF 2

(e)



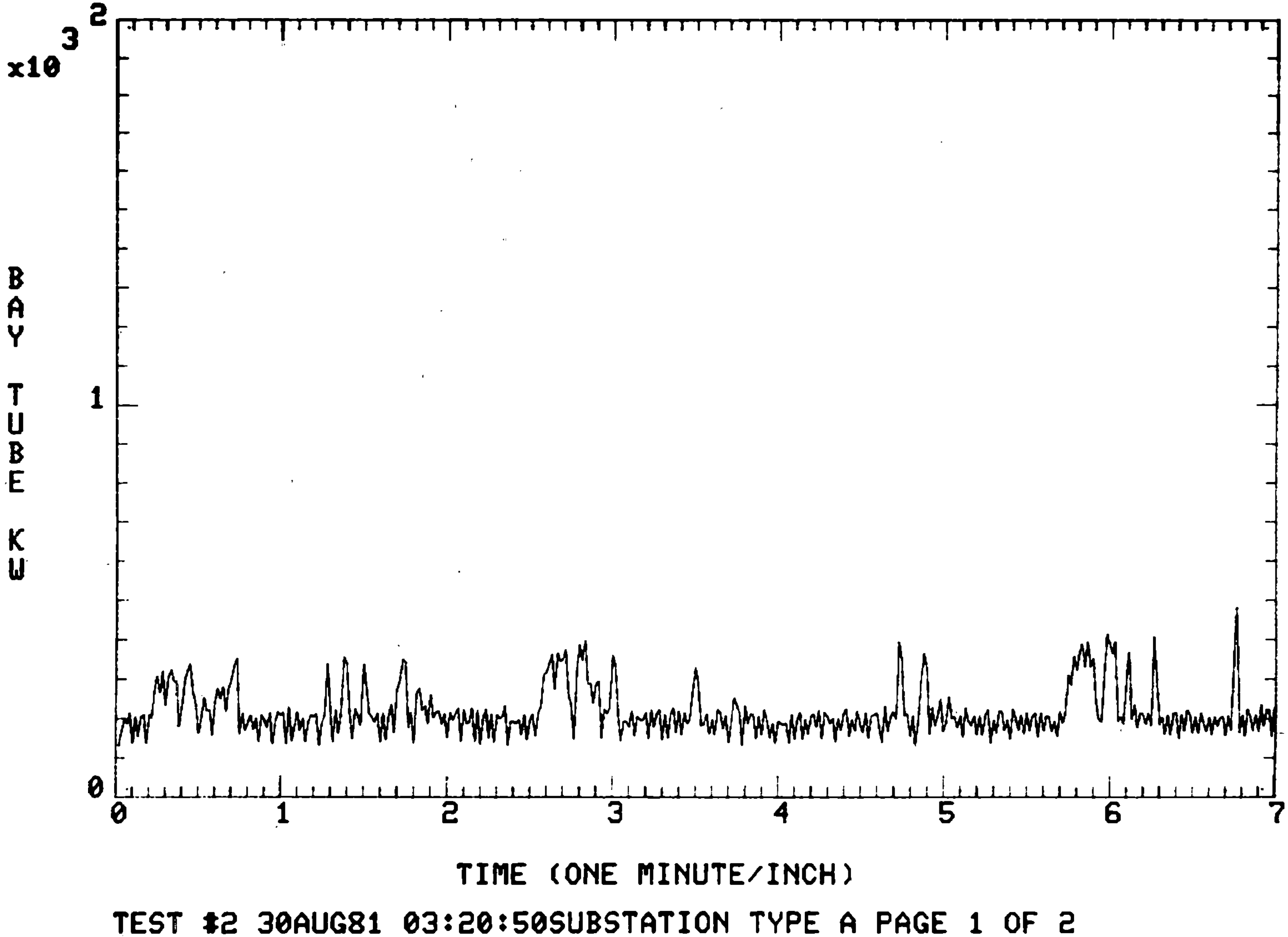
x10^3
2
1
0
POWELL ST KW
0 1 2 3 4 5 6 7
TIME (ONE MINUTE/INCH)
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 1 OF 2

(f)

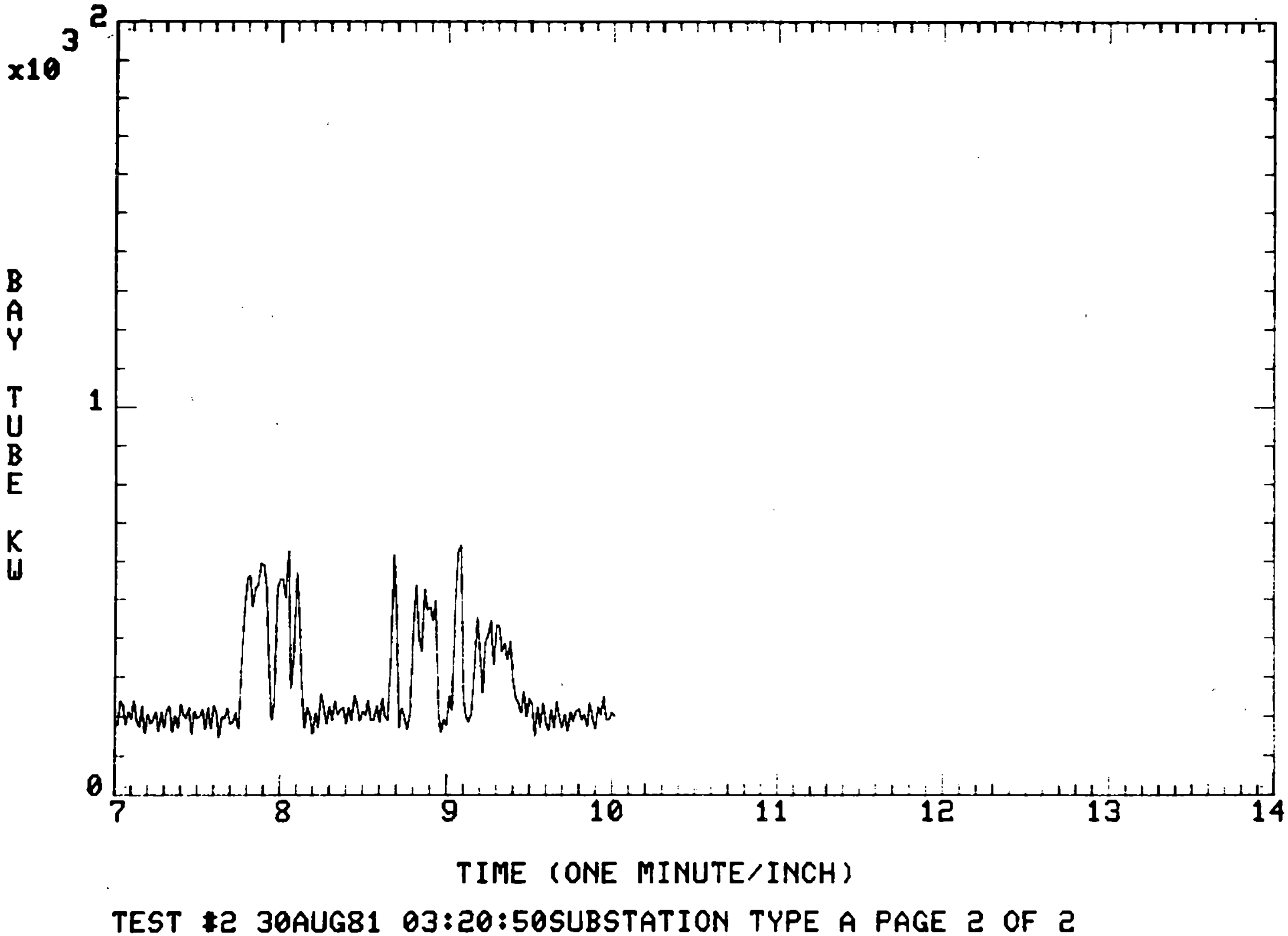


TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 2 OF 2

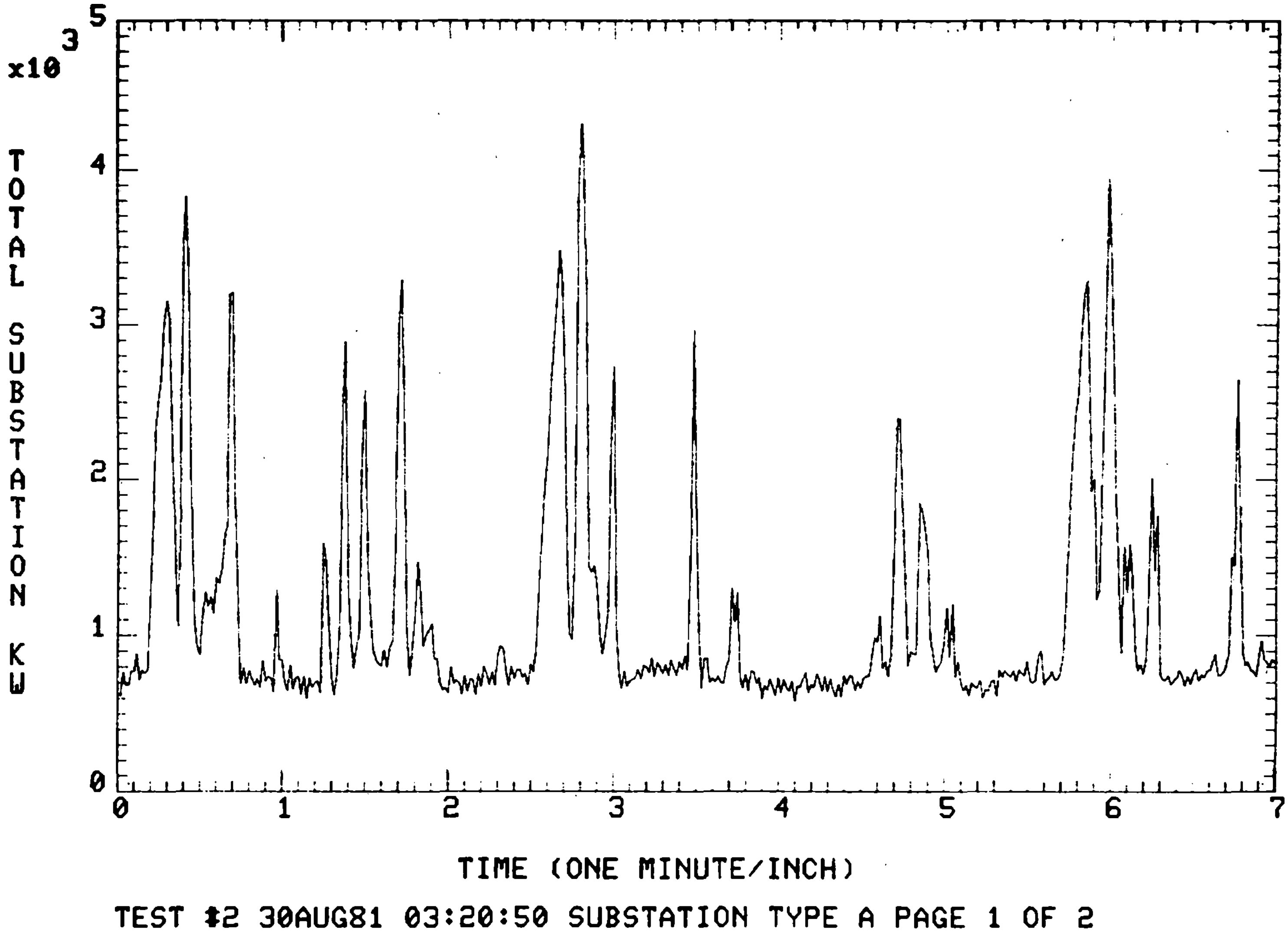
(f)


x10^3
2
1
0
BAY TUBE KW
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST #2 30AUG81 03:20:50SUBSTATION TYPE A PAGE 1 OF 2

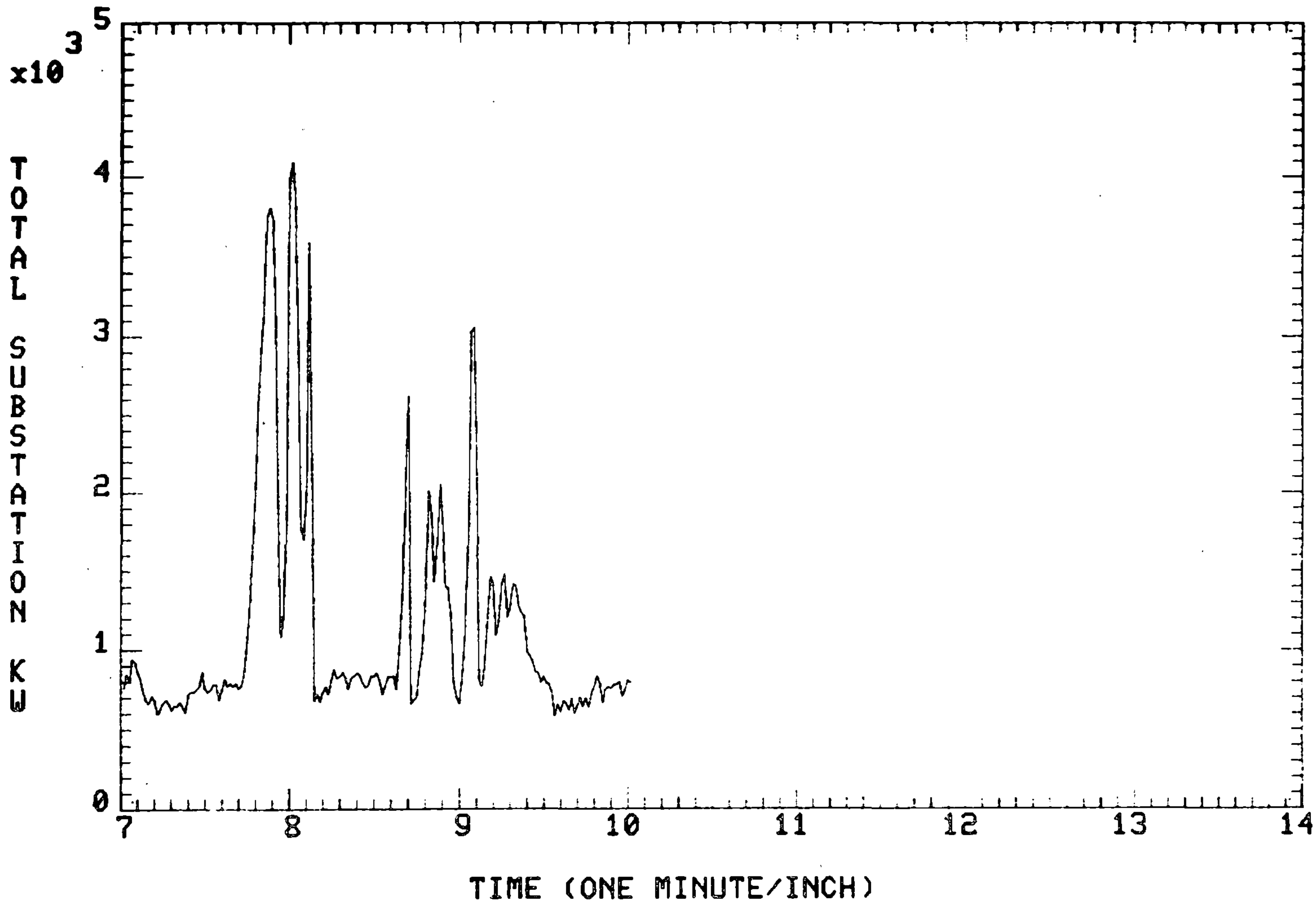
(g)


x10 3
2
1
0
BAY TUBE KW
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST #2 30AUG81 03:20:50SUBSTATION TYPE A PAGE 2 OF 2

(g)


x10^3
5
4
3
2
1
0
TOTAL SUBSTATION KW
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 1 OF 2

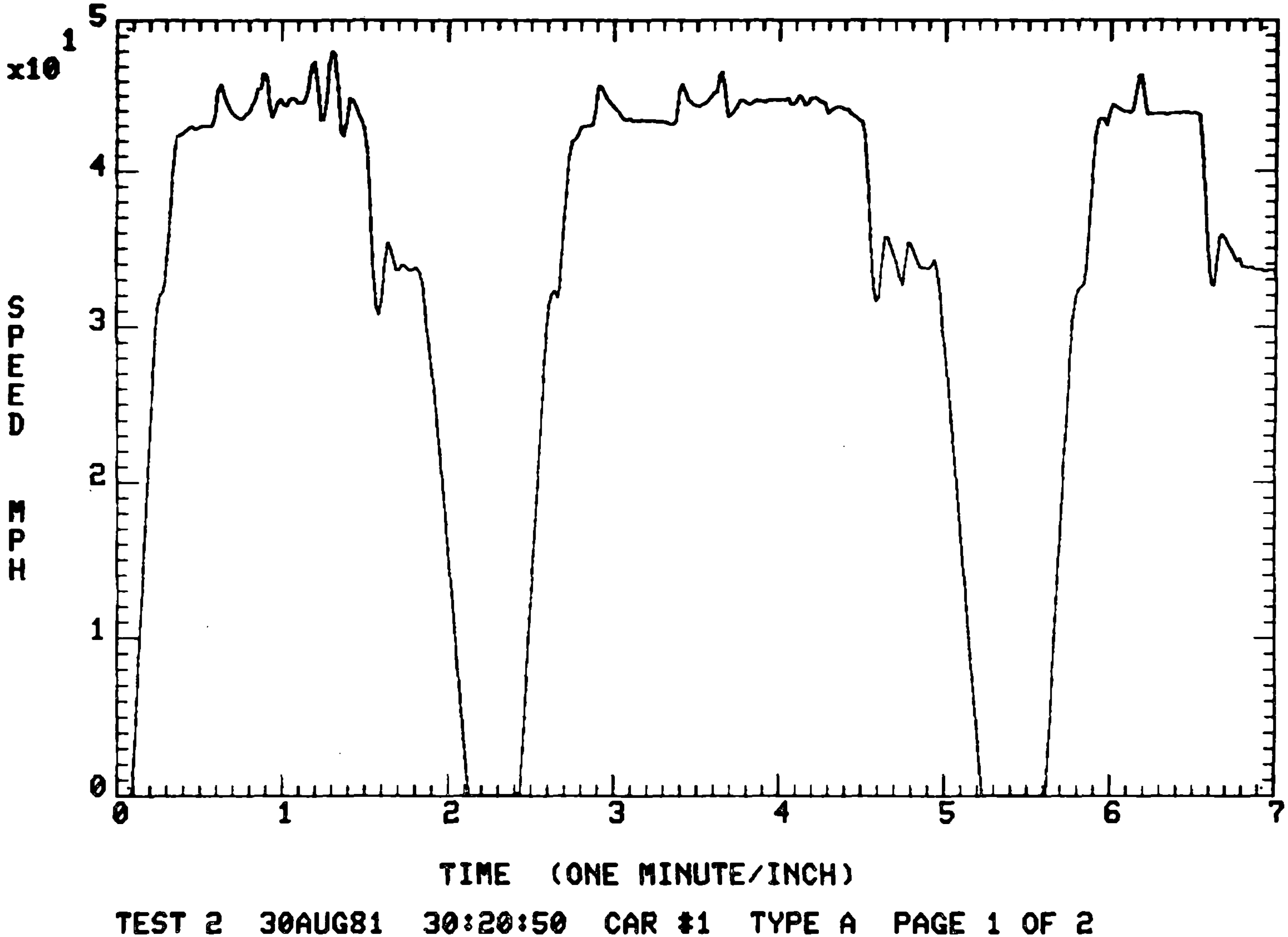
(h)



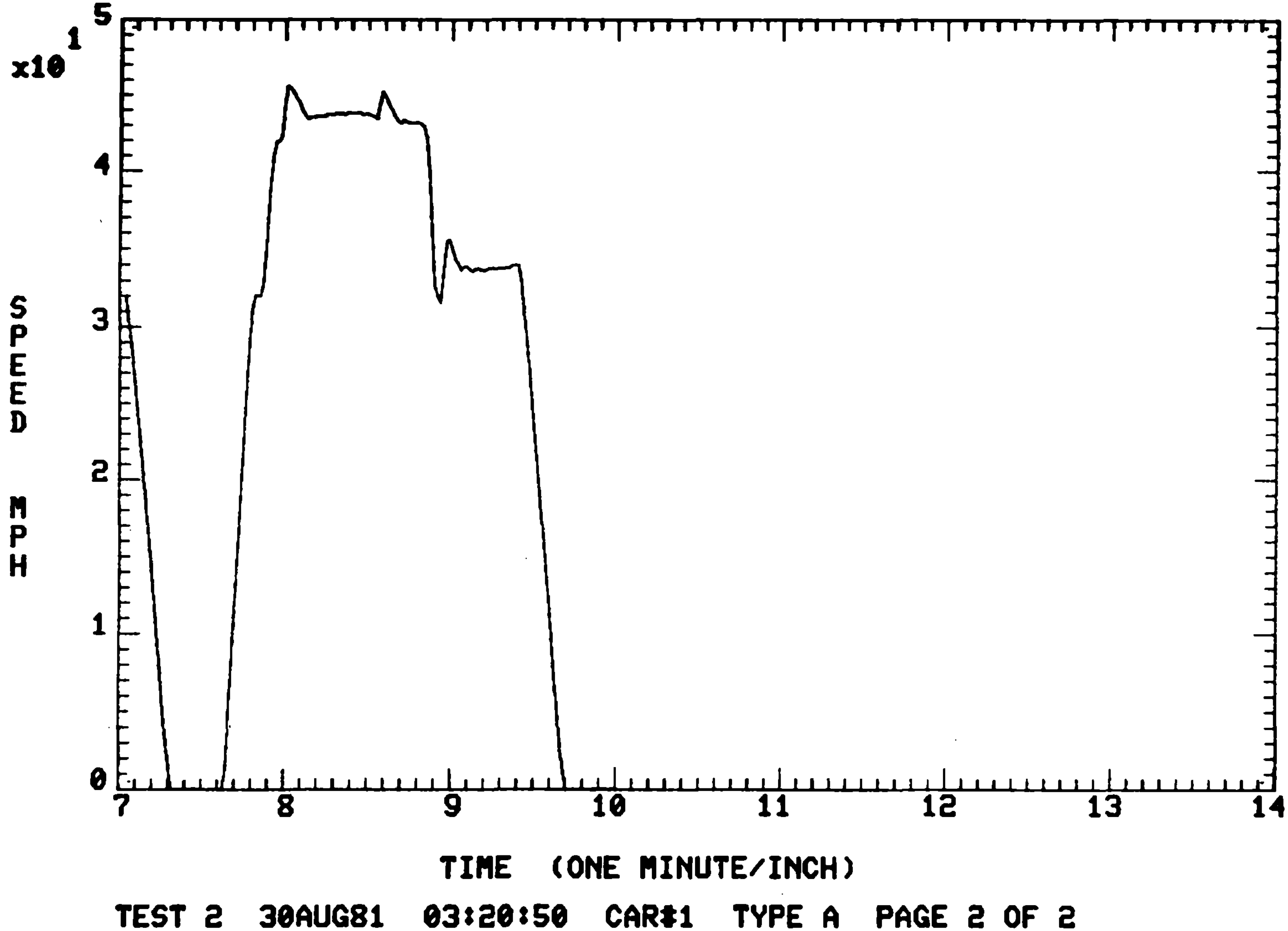
TEST #2 30AUG81 03:20:50 SUBSTATION TYPE A PAGE 2 OF 2

(h)

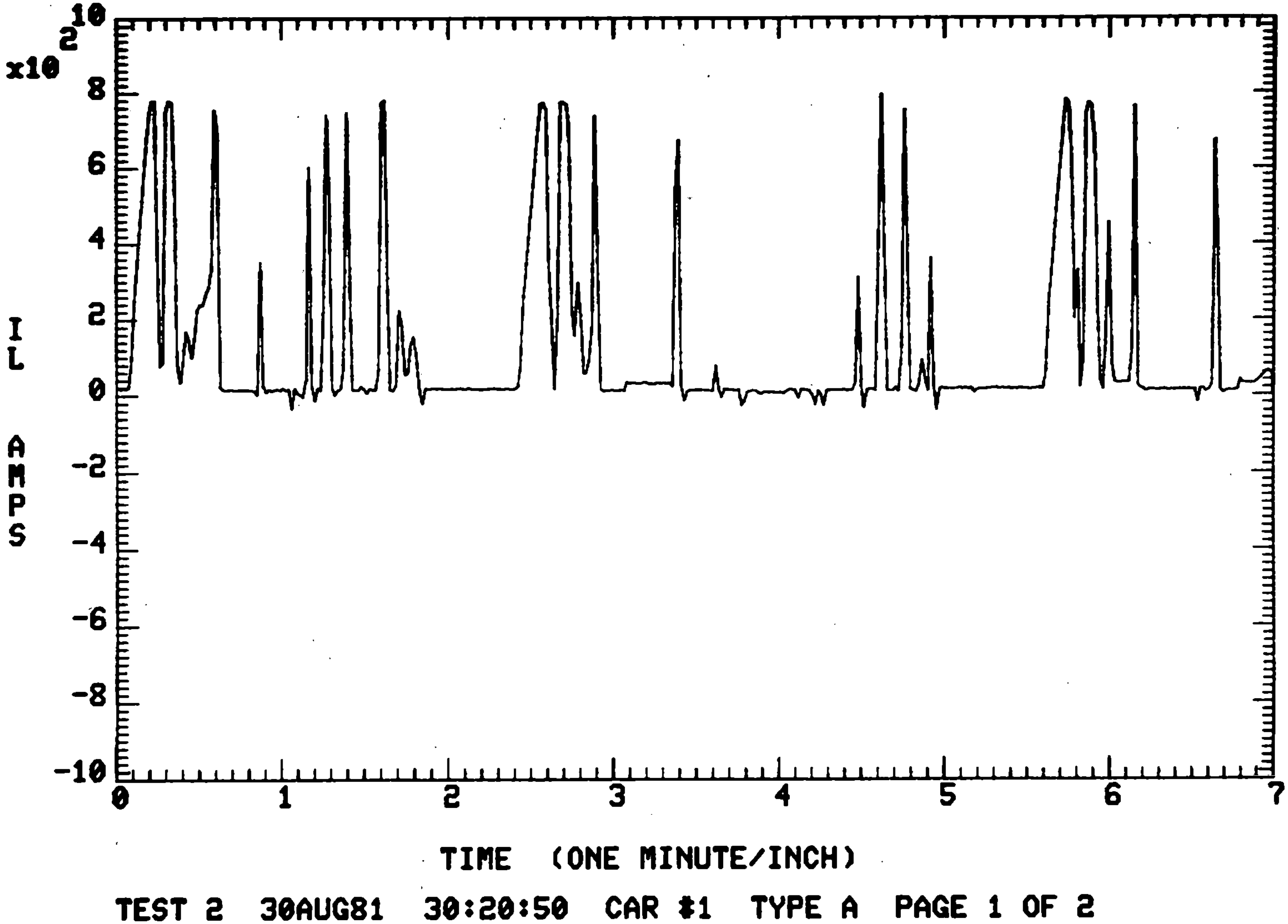
FIGURE 3.3 VEHICLE DATA FOR BASELINE RUN # 4


x10^1
SPEED MPH
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

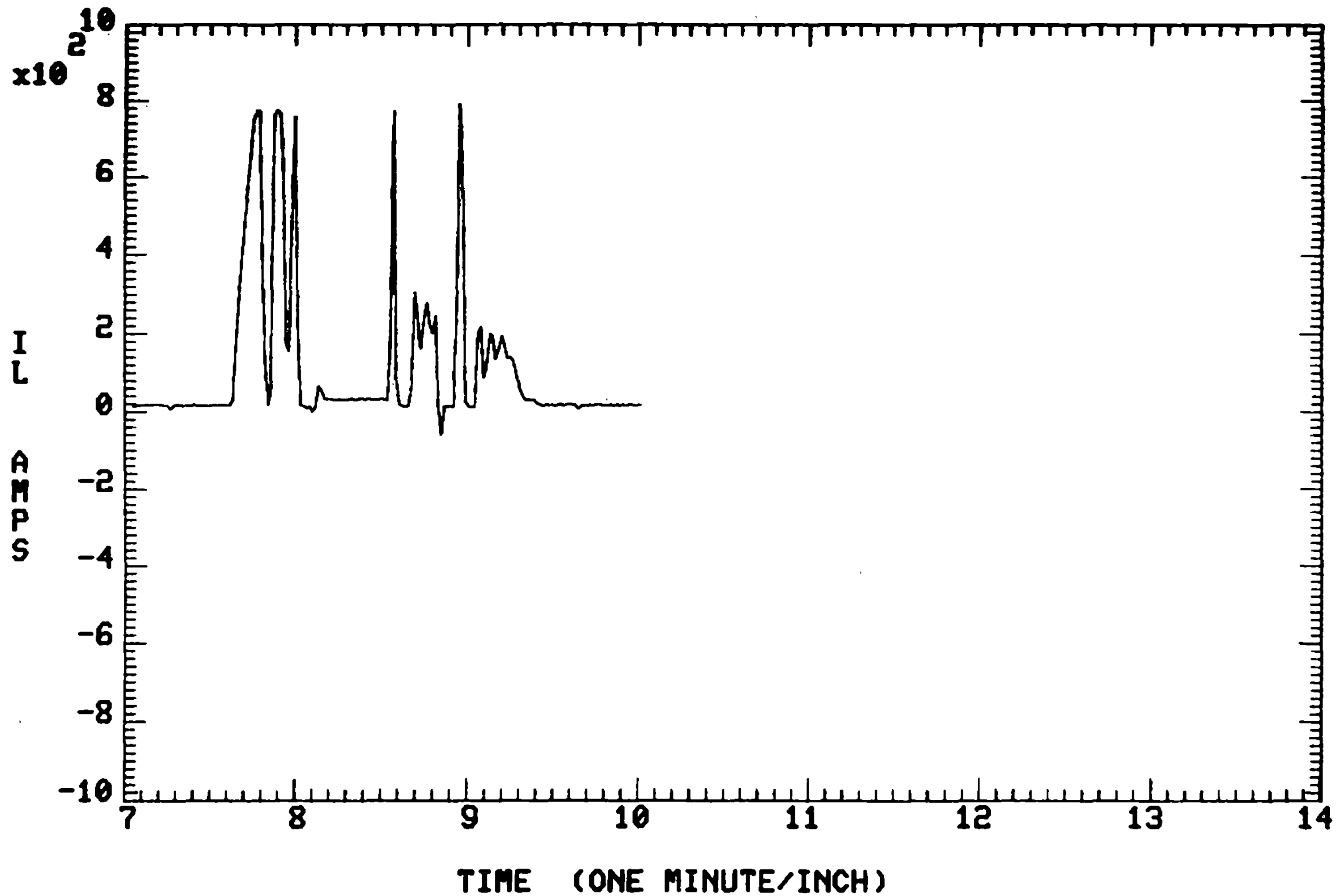
(a)


x10 1
5
4
3
2
1
0
SPEED MPH
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(a)

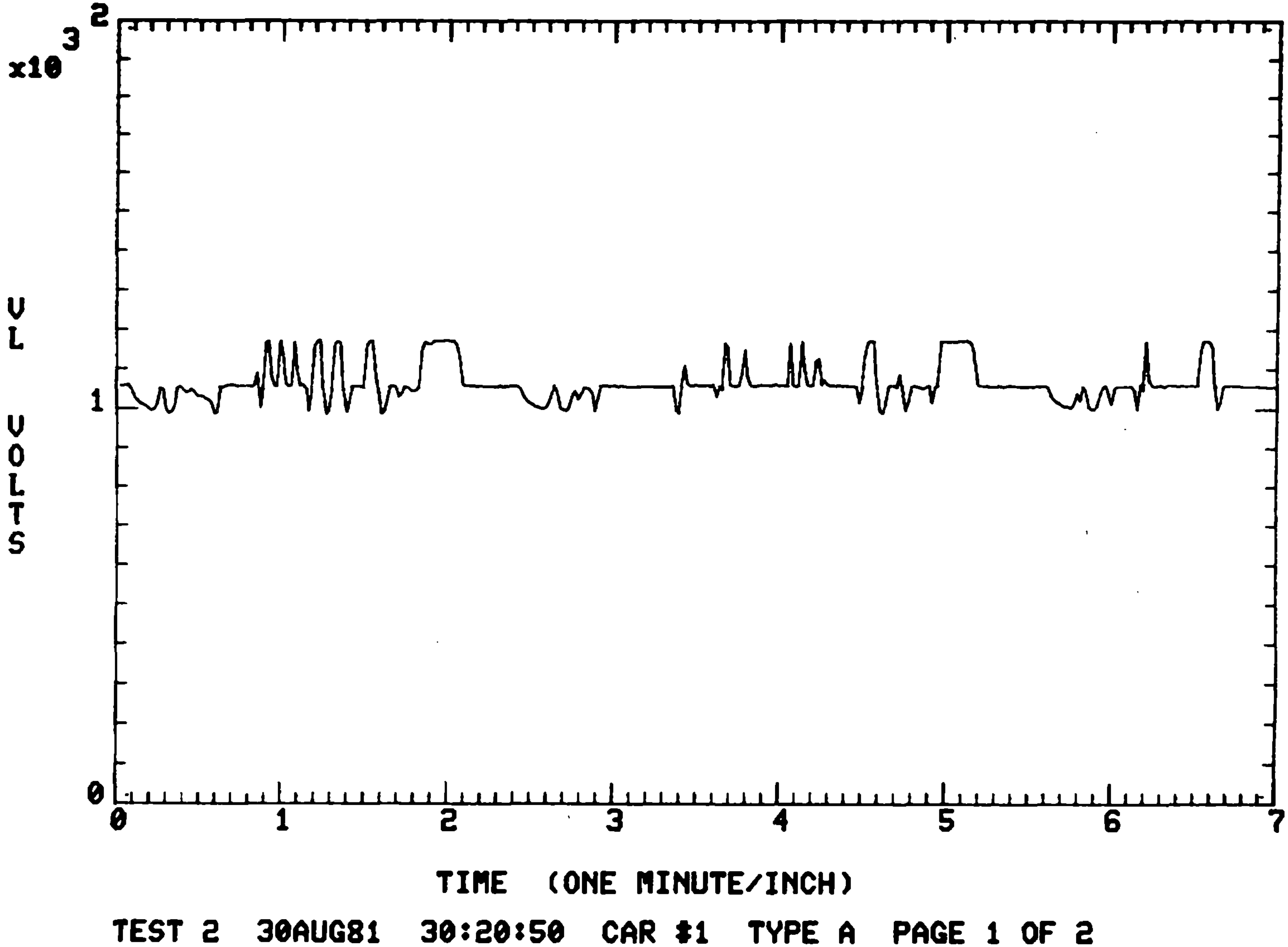

x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
I L
AMPS
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

(b)



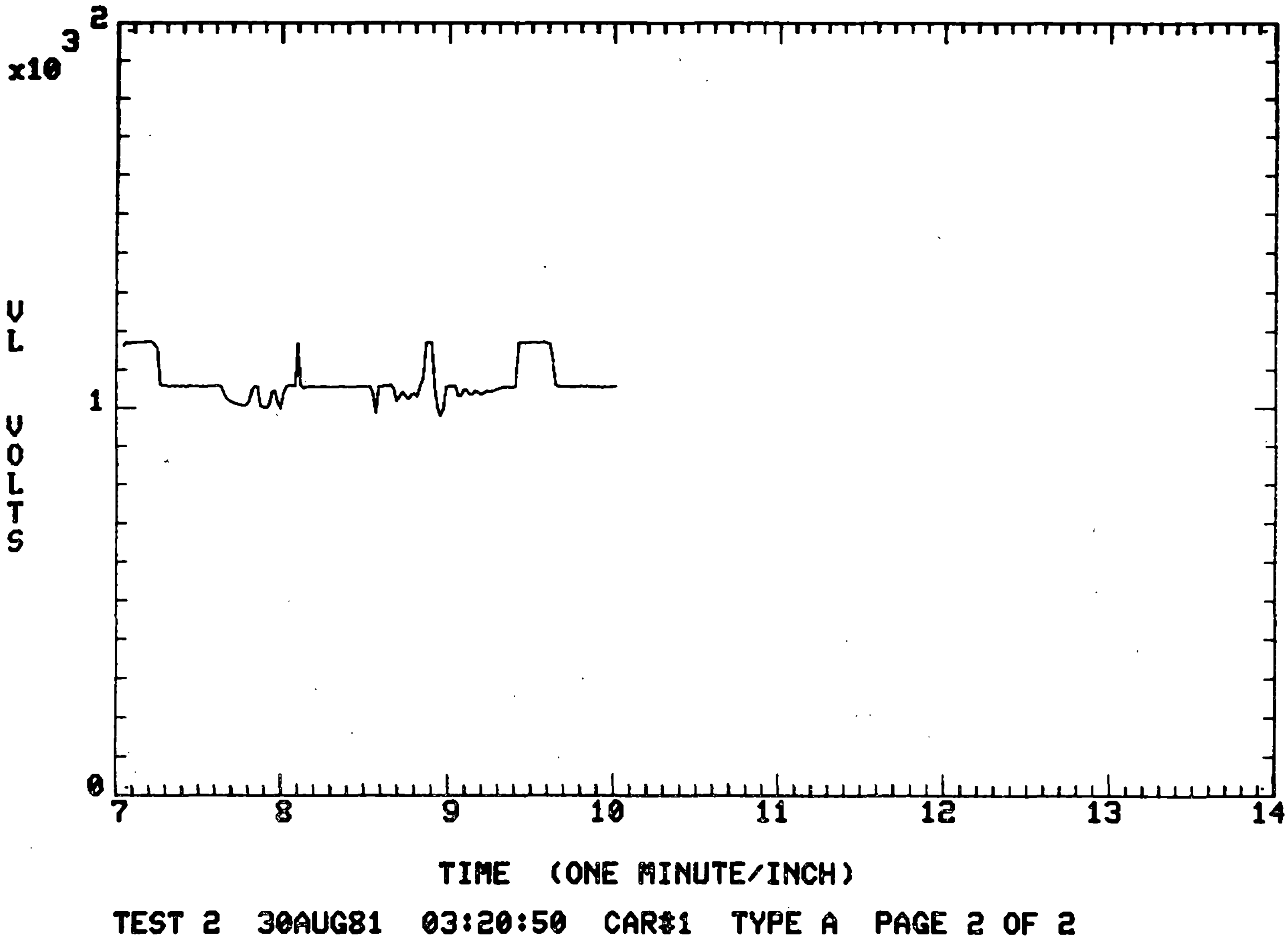
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(b)

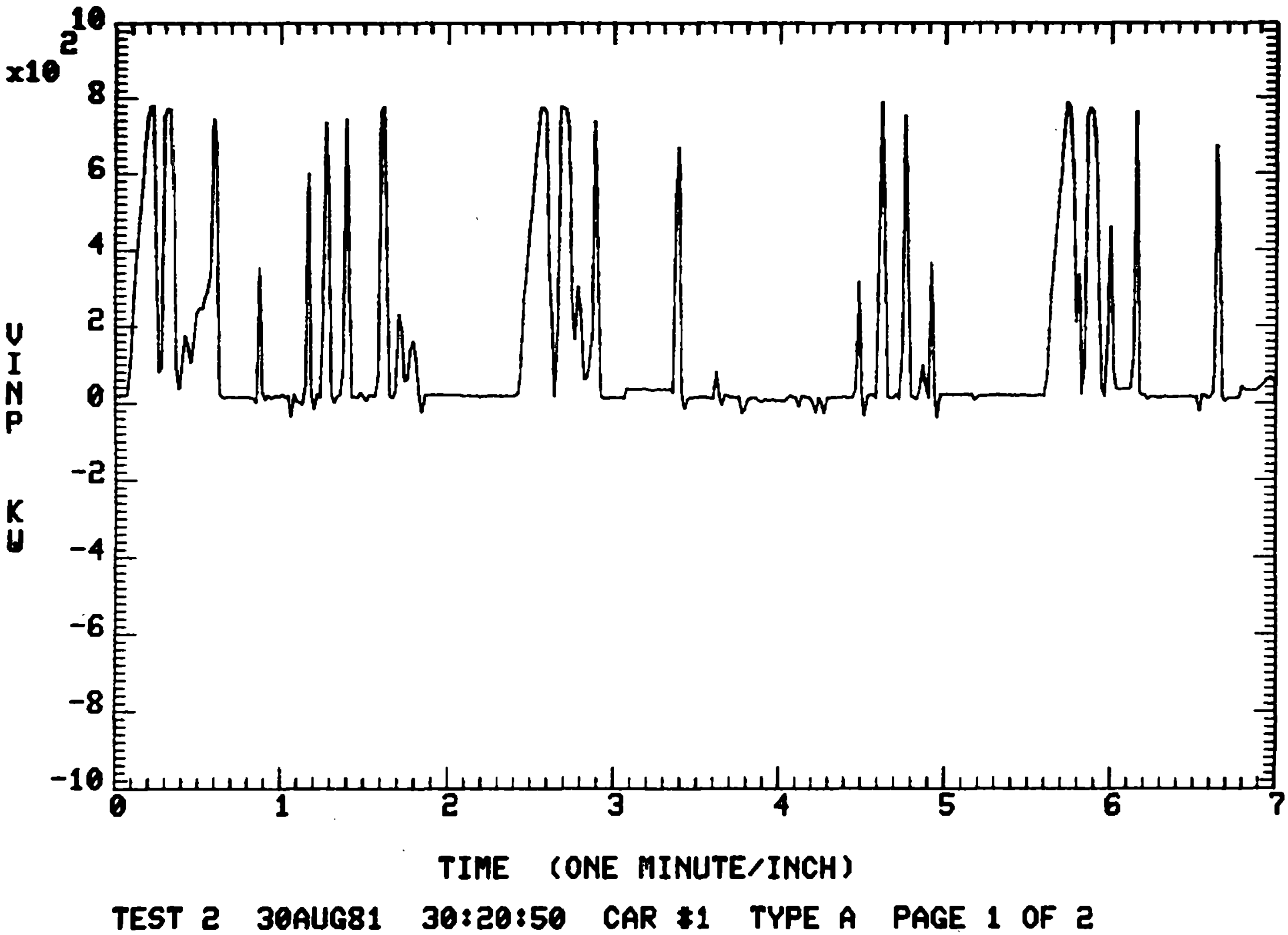


x10^3
2
1
0
VL VOLTS
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

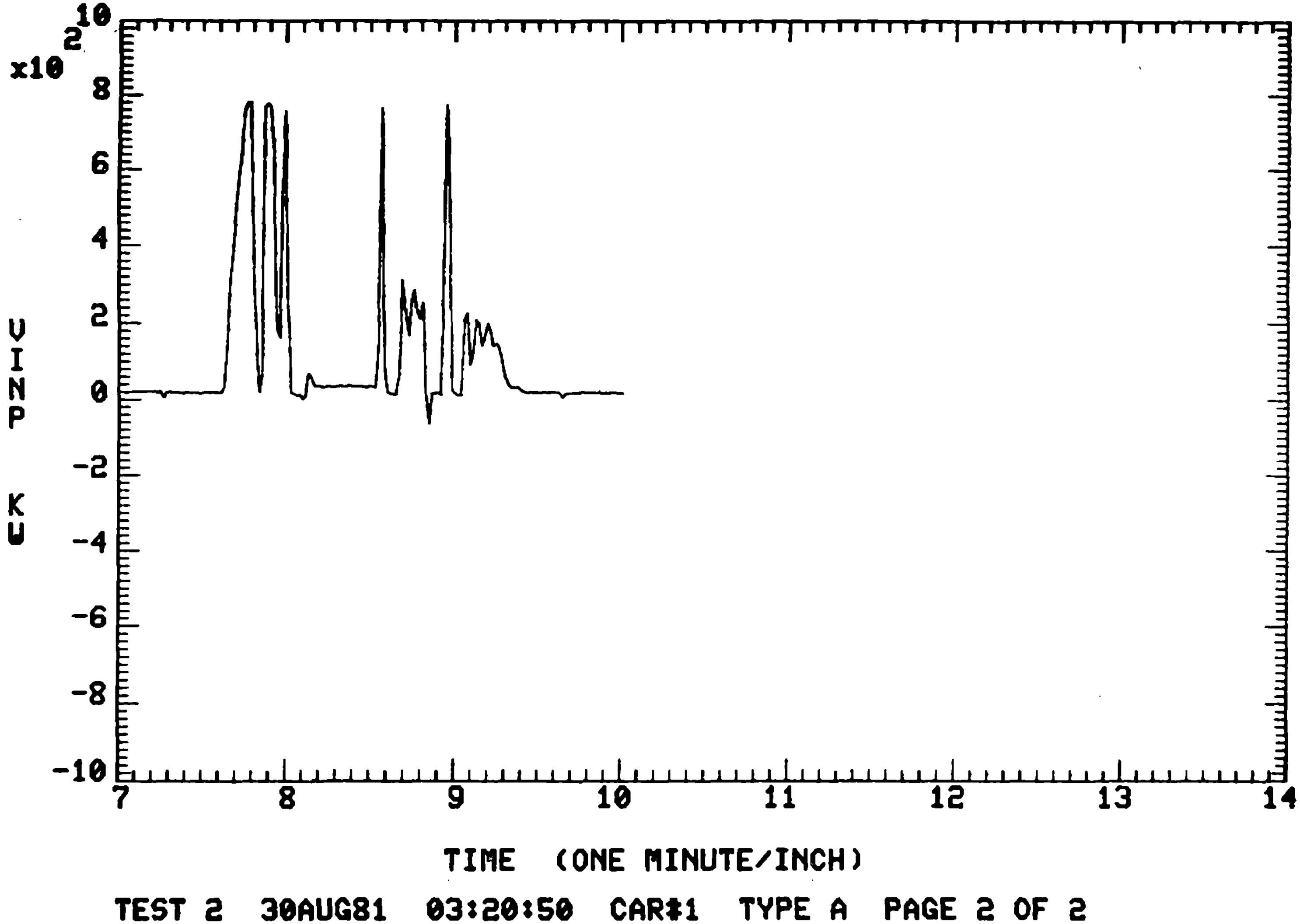
(c)


x10^3
2
1
0
VL VOLTS
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

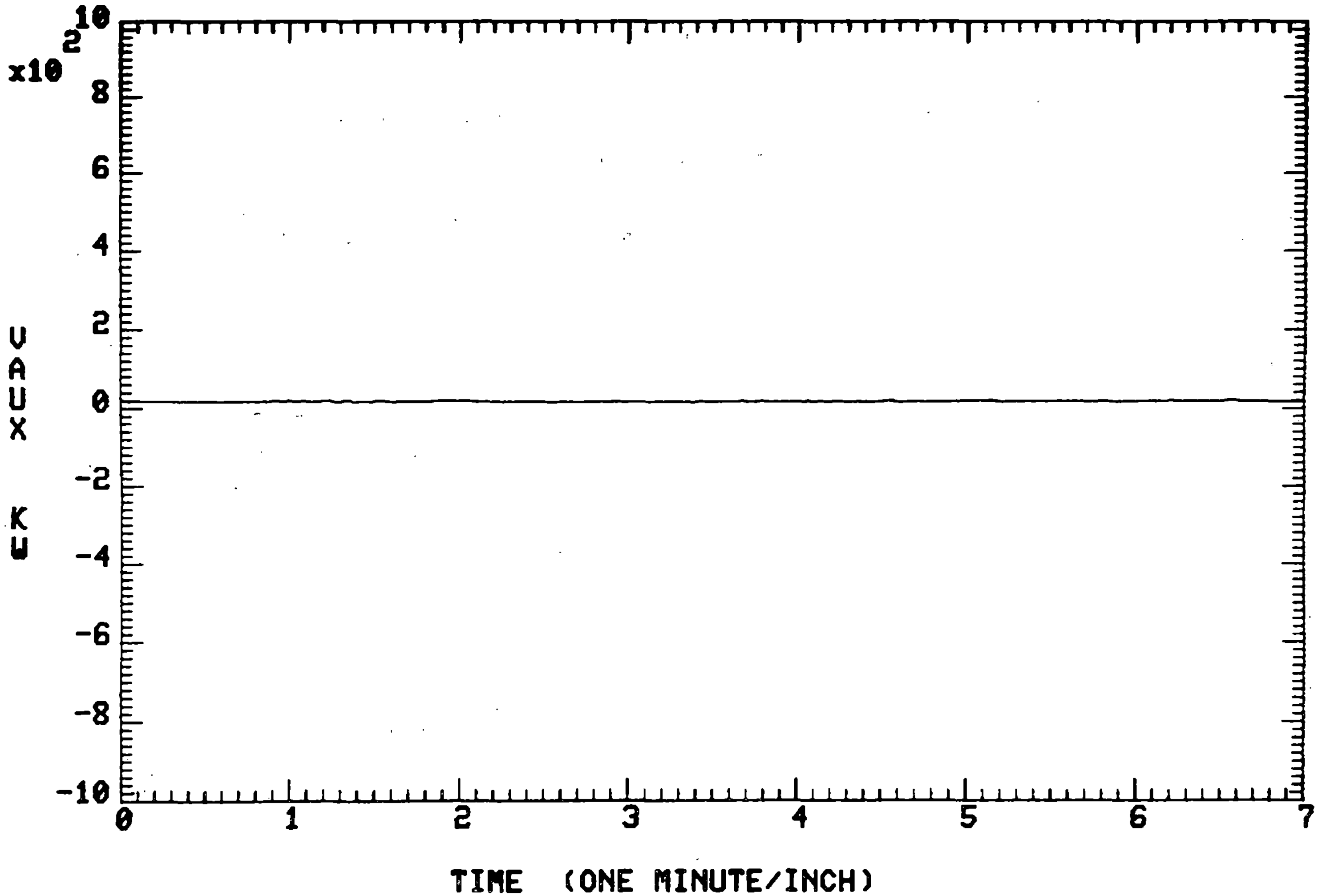
(c)


x10^2
VINP KW
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

(d)

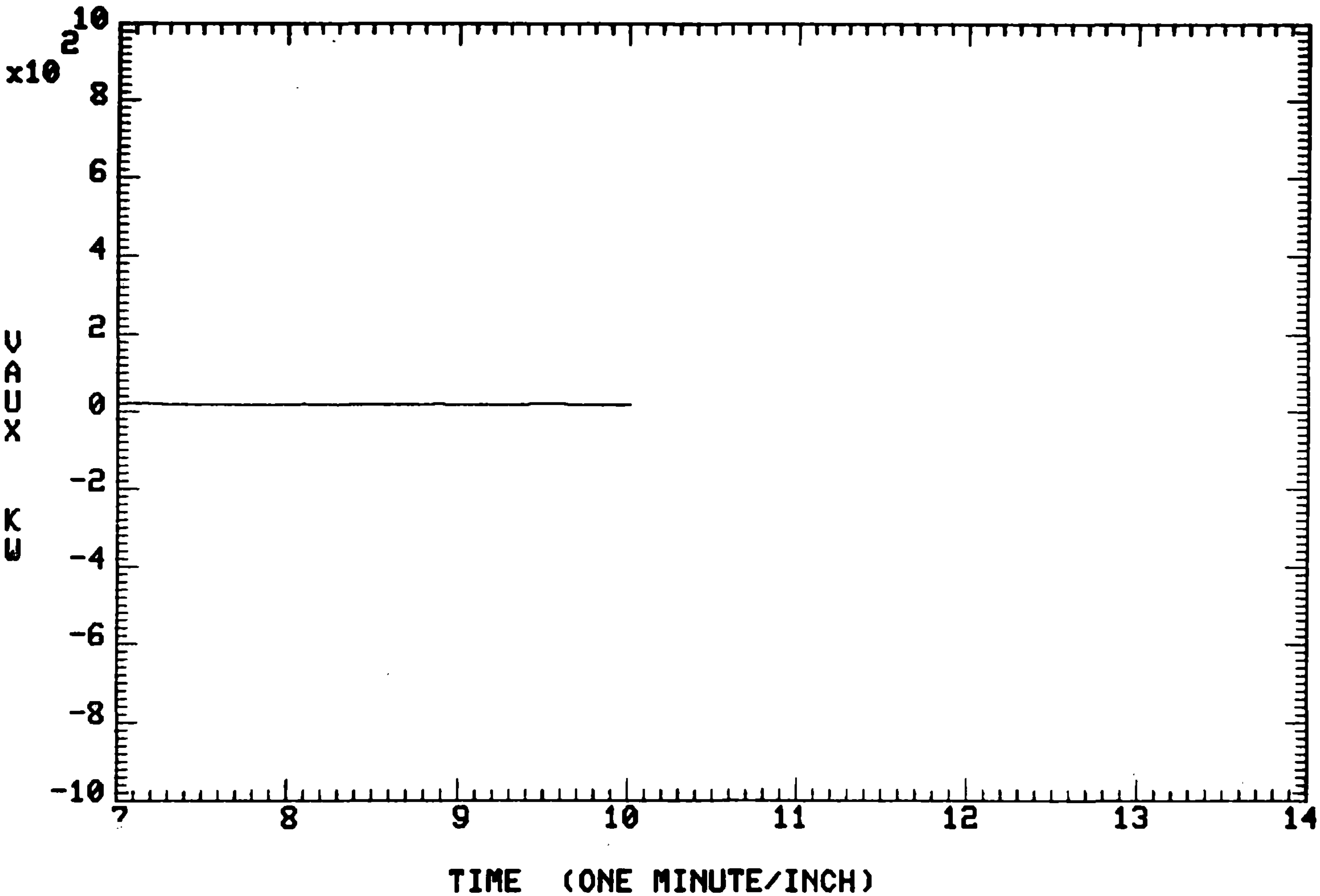

x10^2
VINP KW
10
8
6
4
2
0
-2
-4
-6
-8
-10
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(d)



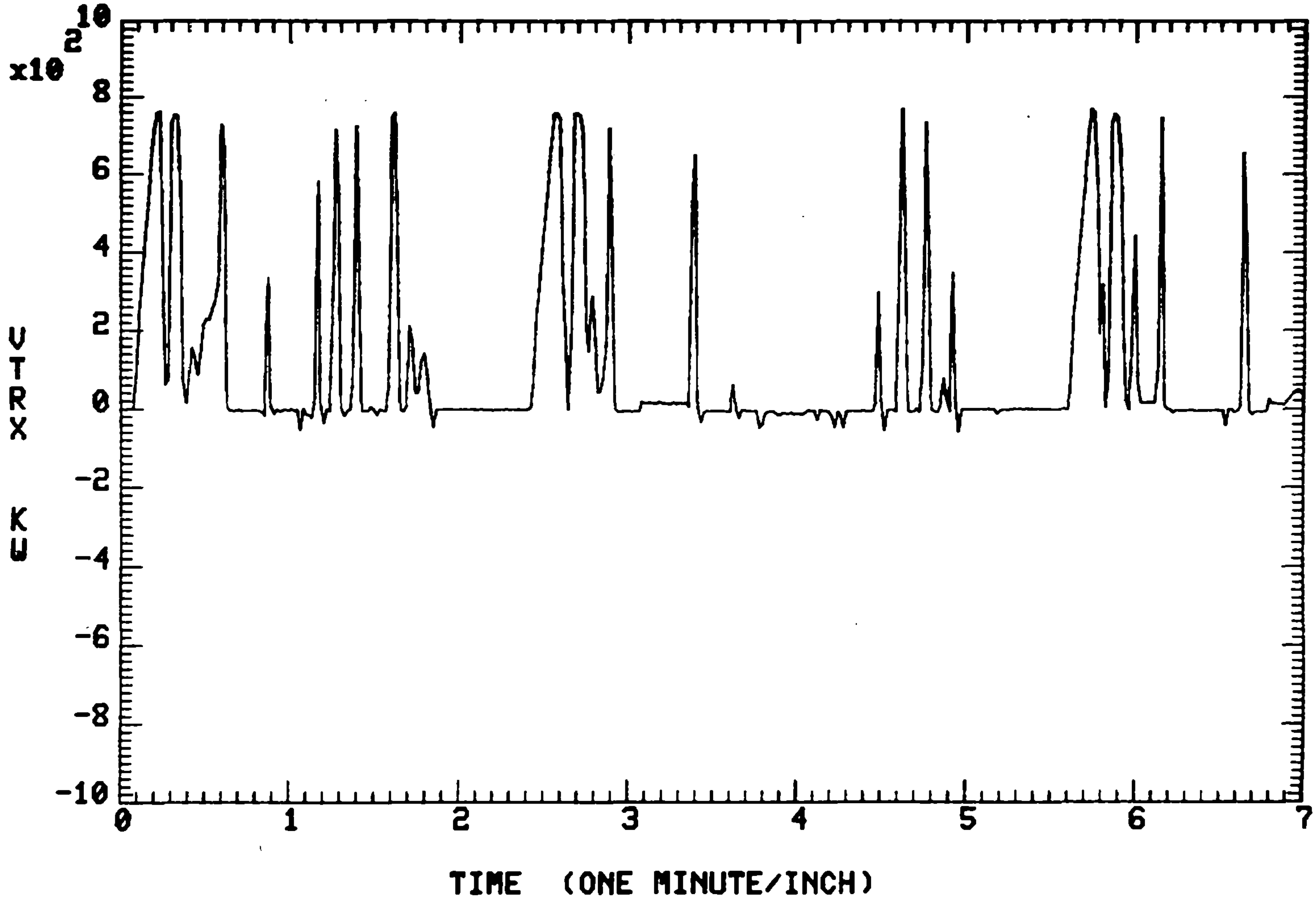
TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

(e)



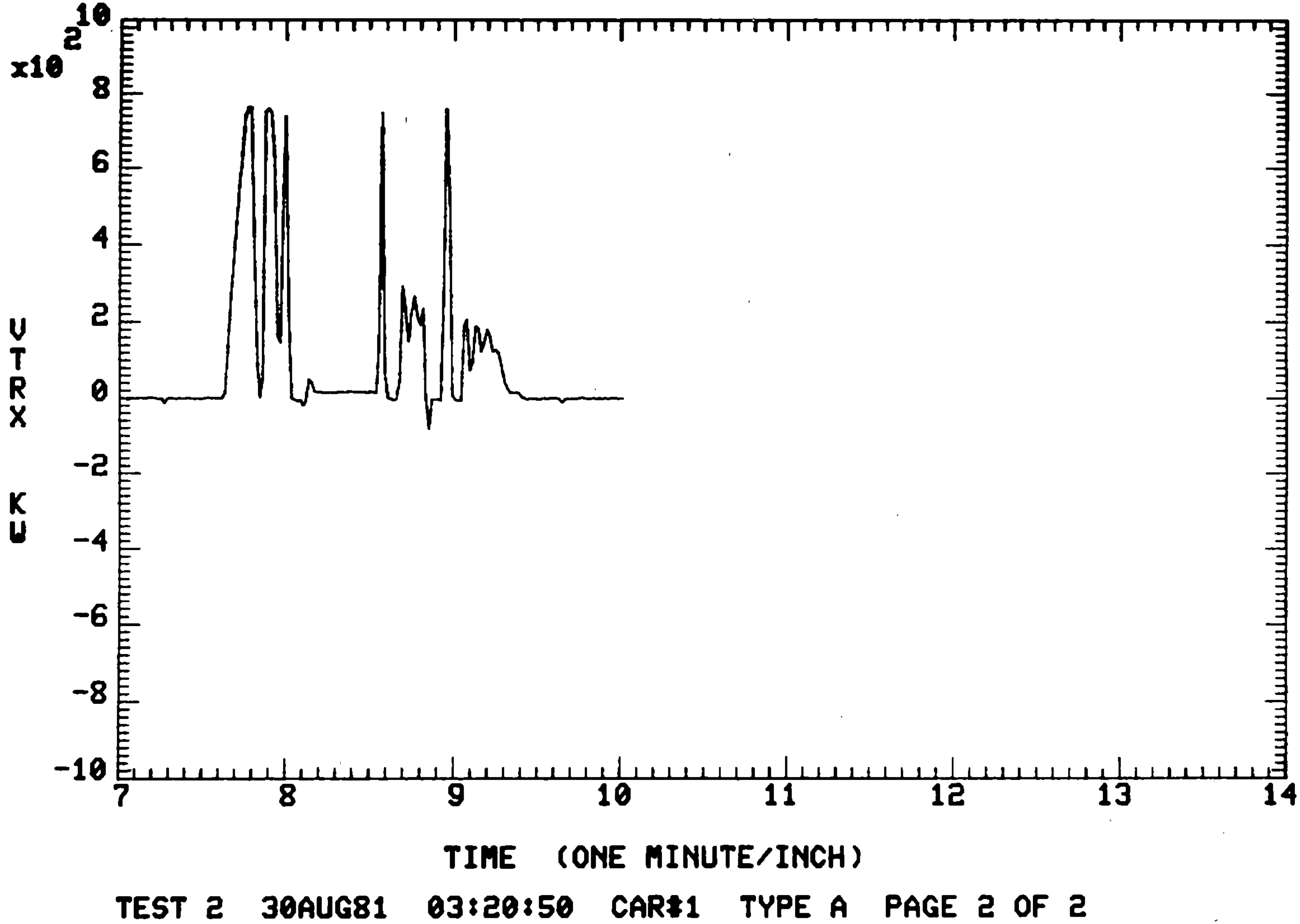
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(e)

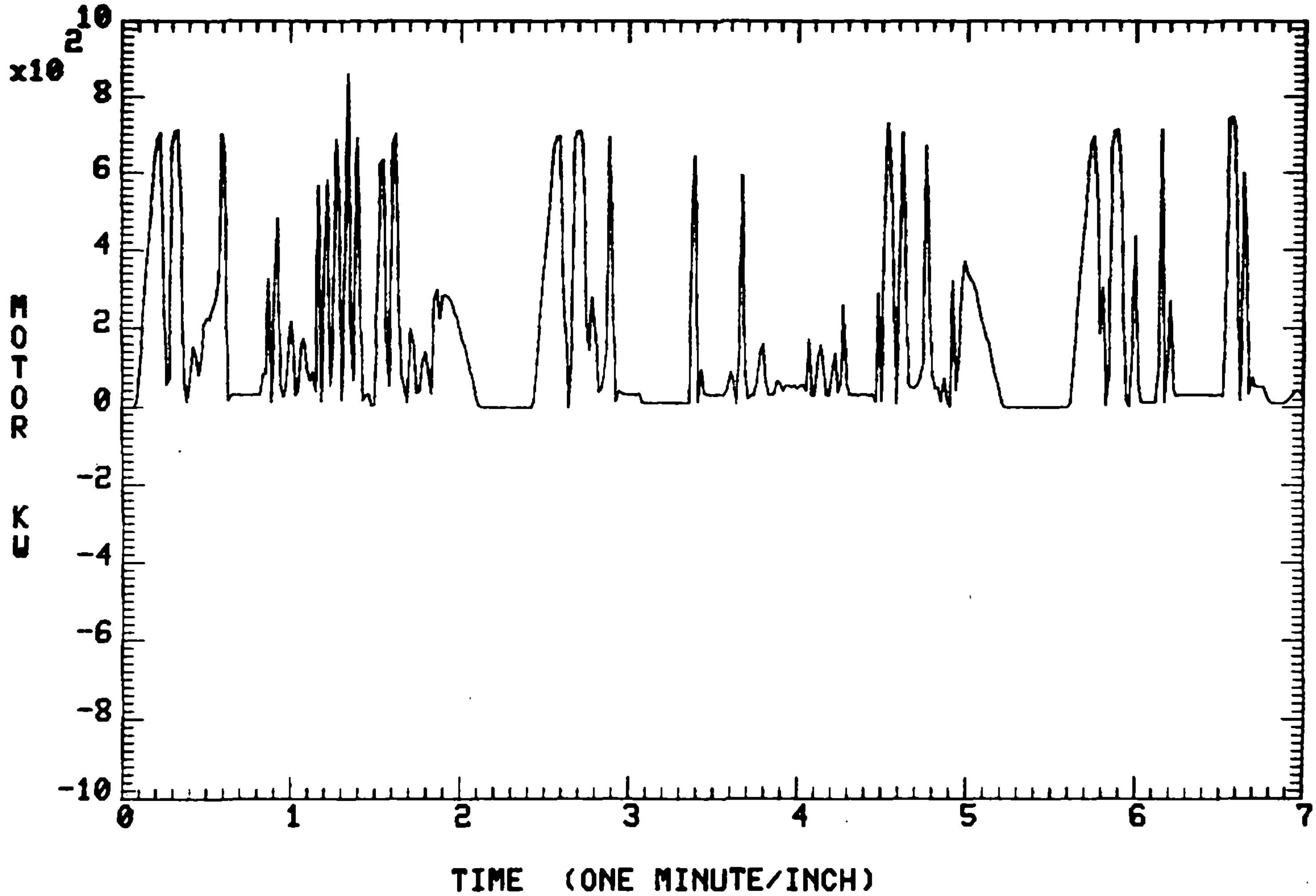


TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

(f)

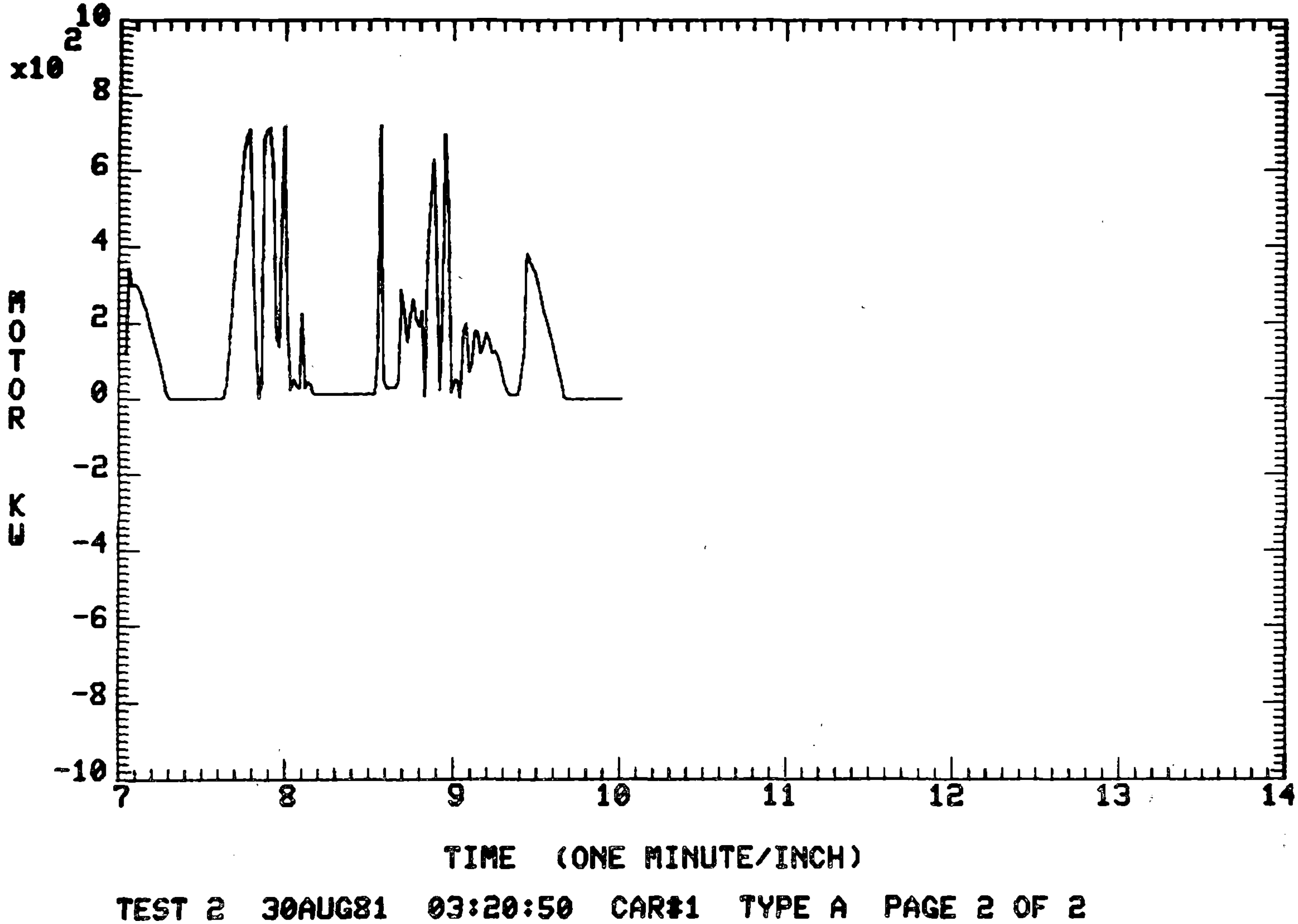

x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VTRX KW
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(f)

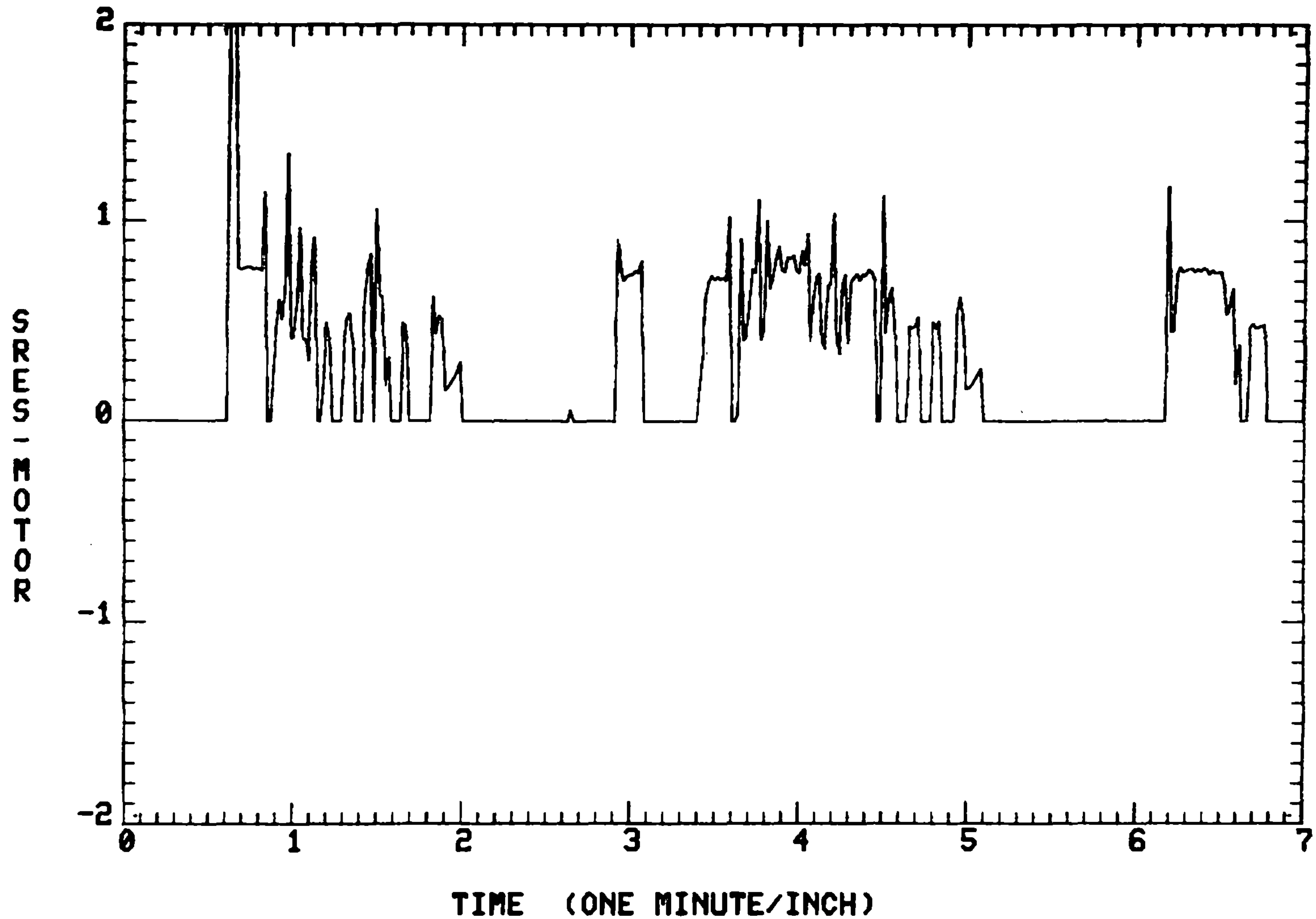


TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

(g)

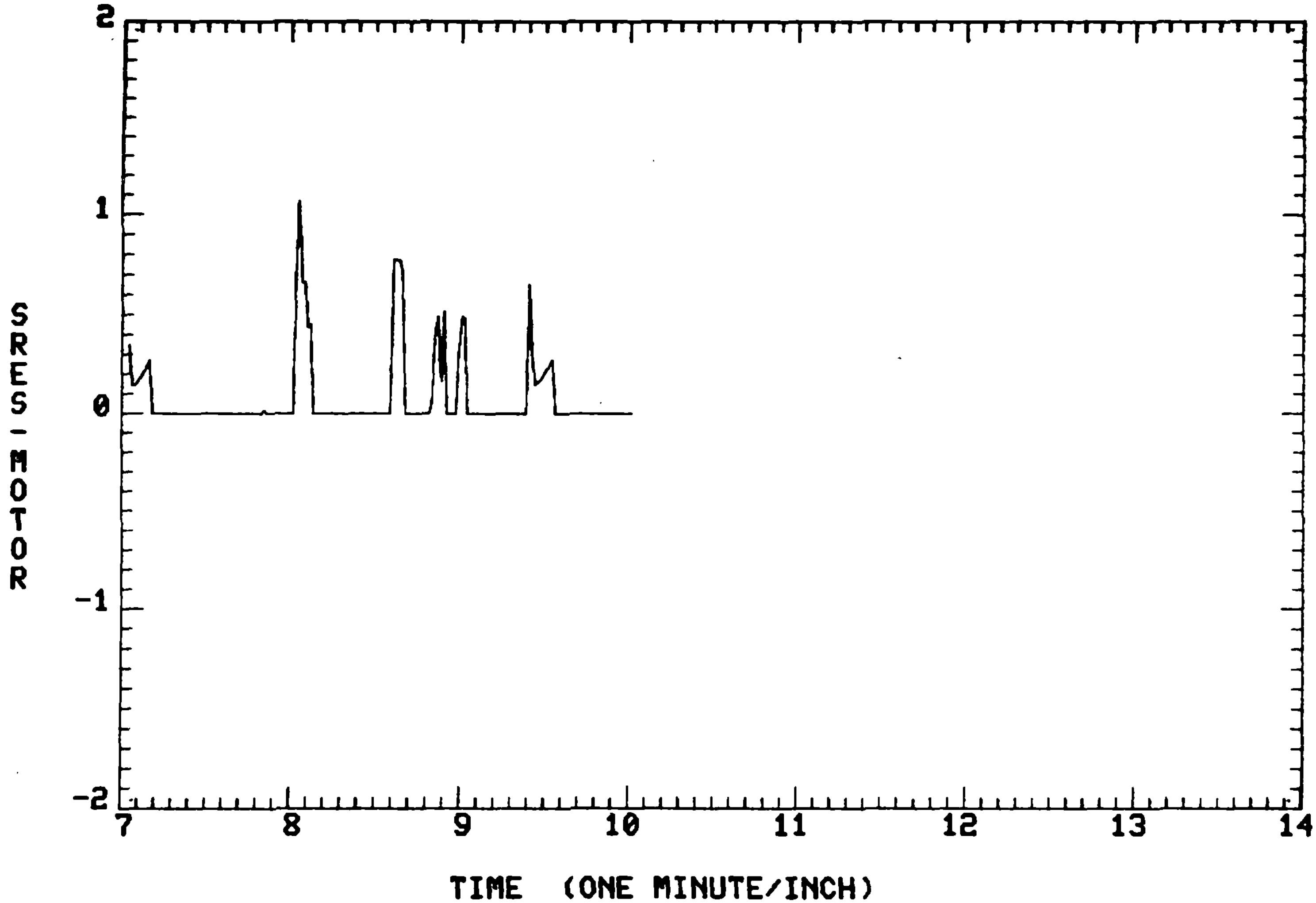

x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
MOTOR KW
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(g)



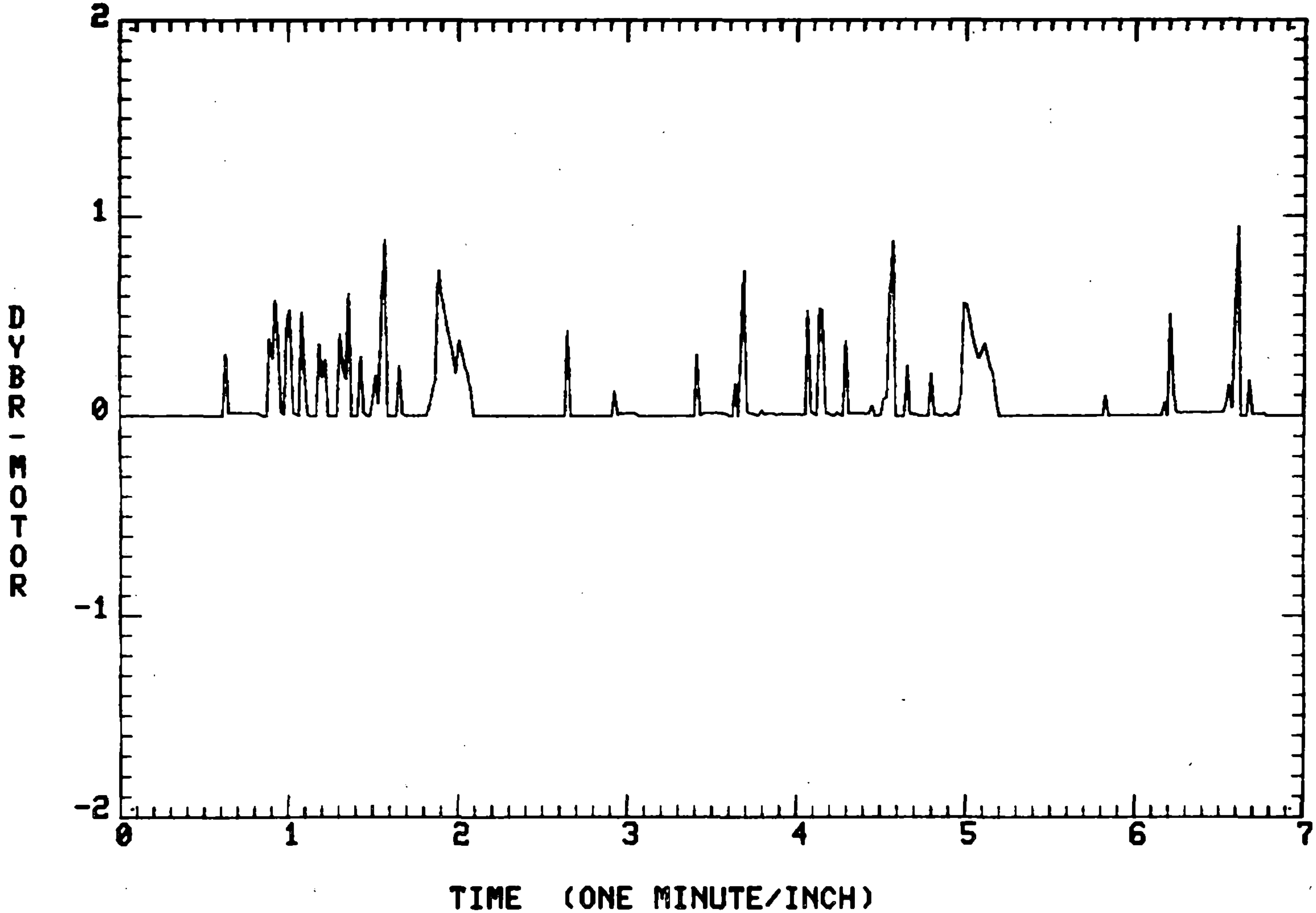
TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

(h)



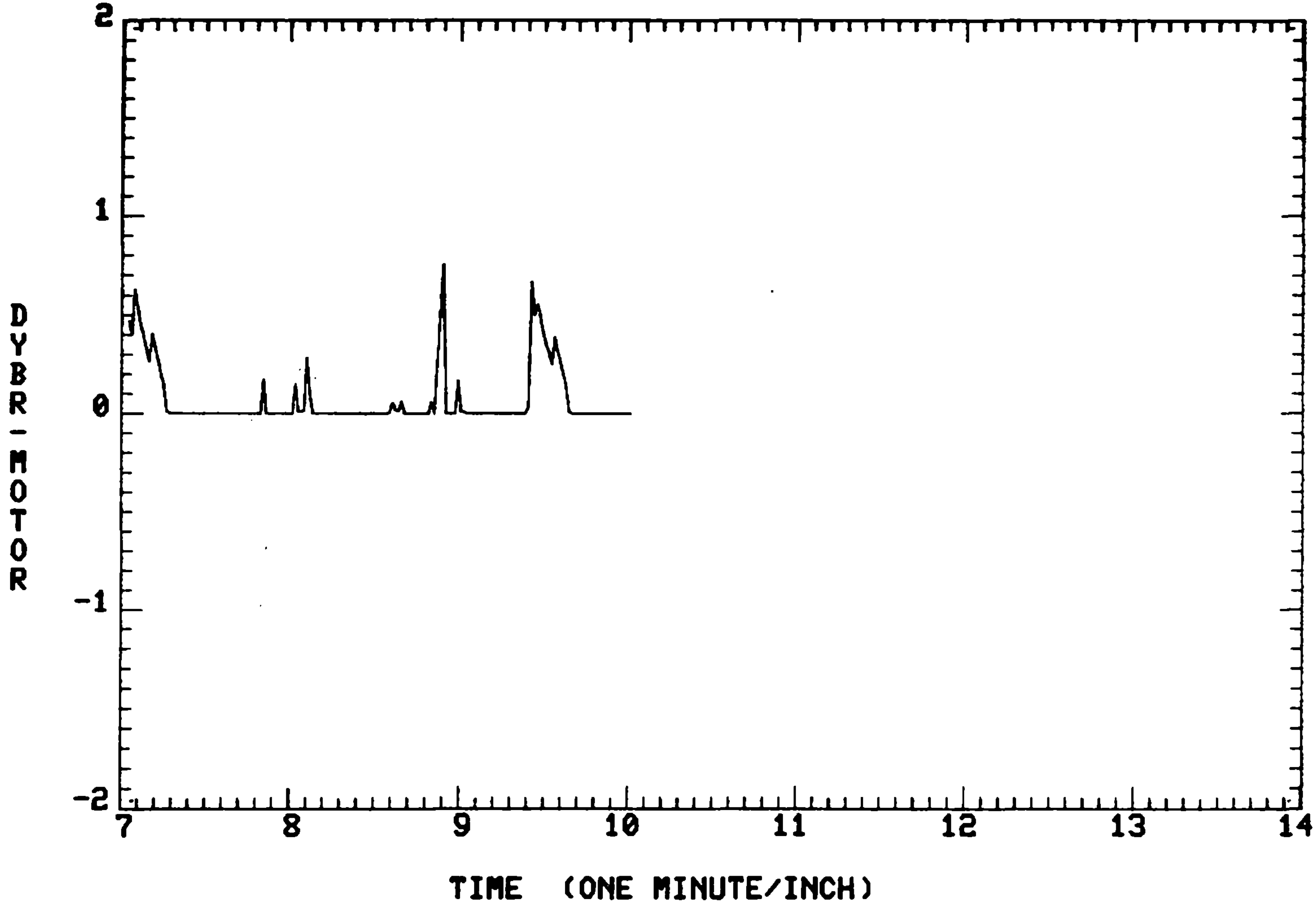
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(h)



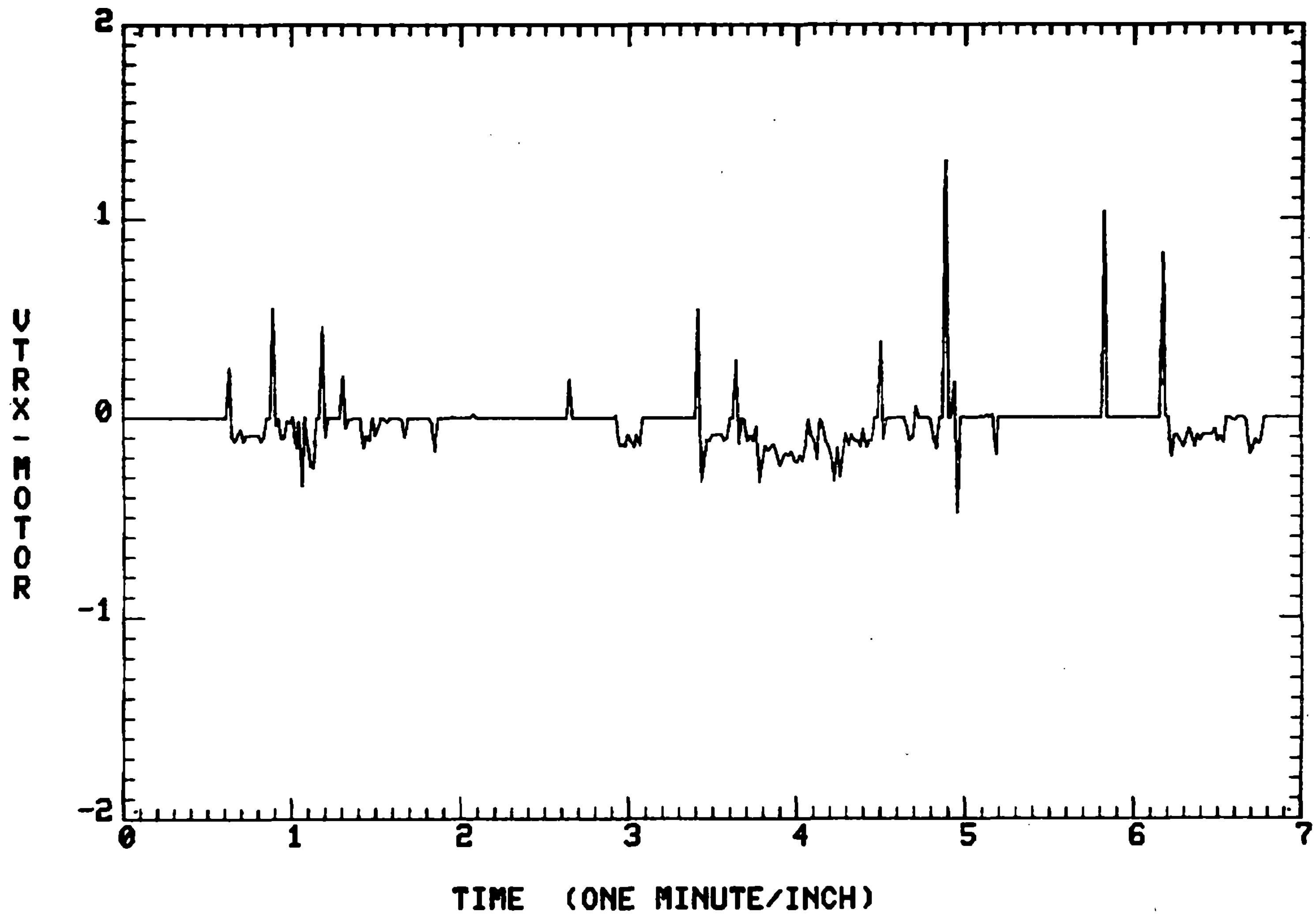
TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

(i)



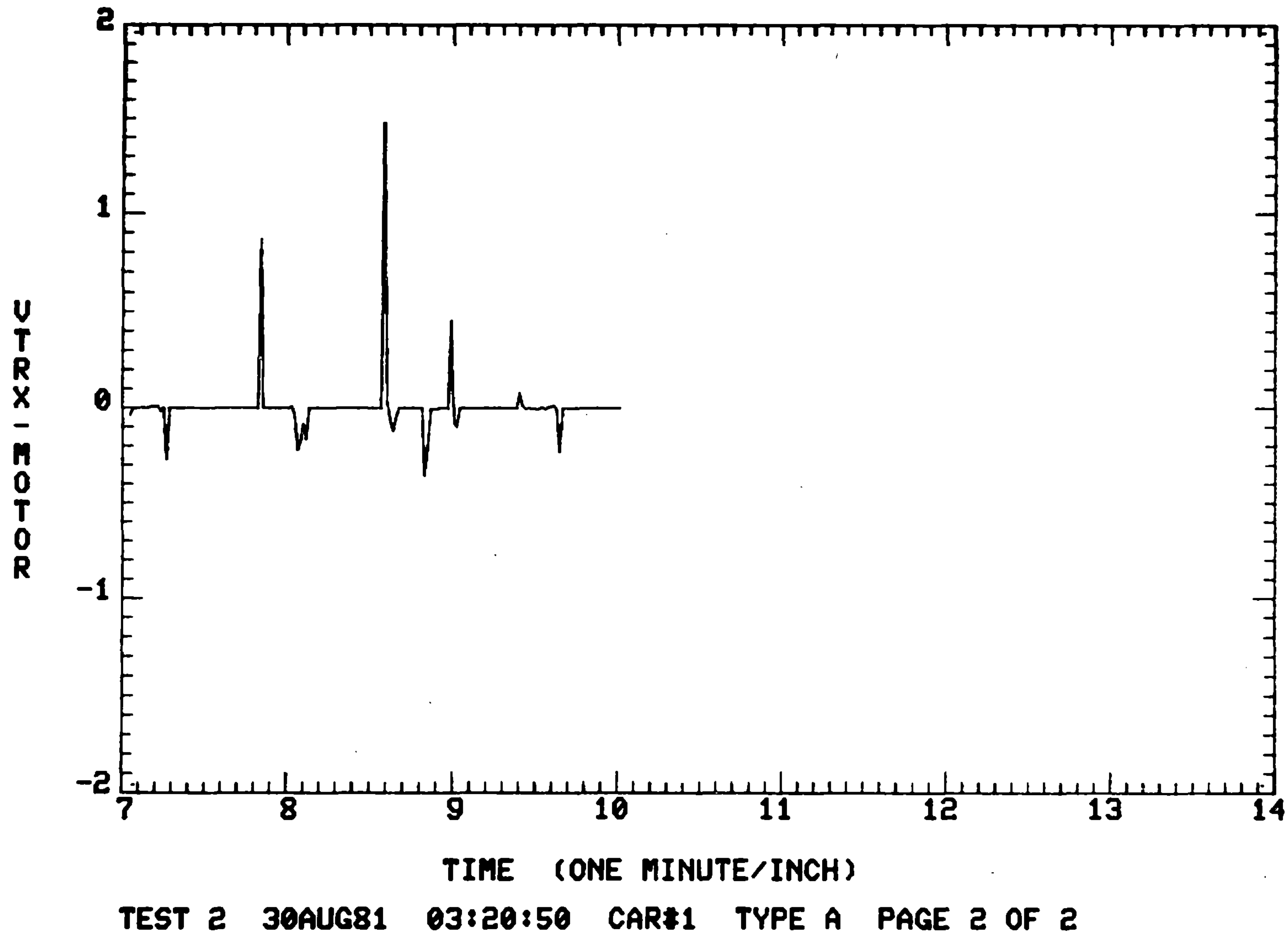
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(i)



TEST 2 30AUG81 30:20:50 CAR #1 TYPE A PAGE 1 OF 2

(j)


2
1
0
-1
-2
VTRX-MOTOR
7
8
9
10
11
12
13
14
TIME (ONE MINUTE/INCH)
TEST 2 30AUG81 03:20:50 CAR#1 TYPE A PAGE 2 OF 2

(j)

consumption for the run is 129.00 kWh which includes the train energy and the losses in the third rail. The estimated error for the individual substation loadings is ±0.3 kWh, except for the Powell Street (MPS) and the Bay Tube West (MTW) substations where the estimated error is ±1.0 kWh. It is interesting to note that the loading at the Powell Street substation is significantly greater than the other substations.

Unfortunately, however, similar plots are not available for other runs, and the energy consumption data for these runs cannot be corrected with any confidence.

3.1.2 Vehicle Data

The data recorded on the two cars can now be examined. The speed-time variation of Figure 3.3(a) is quite straightforward, where the ATO speed limits can be clearly identified. The deadband of the vehicle speed control system and the station dwell can also be seen. The line current drawn by the car as presented in Figure 3.3(b) can also be closely correlated to the speed-time variation, where each acceleration of the car corresponds to a current drawn by the car, and each deceleration corresponds to a zero current level. The current drawn by the car cannot be negative because there is no regeneration.

The input and the auxiliary currents were both monitored by magnetic flux type current sensors, and these sensors were located close to each other and to other current carrying cables. A significant level of noise was, therefore, seen in the auxiliary current recording. Hence the auxiliary power was assumed to be constant at 20 kW per car. Also, the line voltage variation was within a range of about 1060 - 5.7% and 1060 + 13.2%. The variation of the input kW and the traction kW with time, therefore, closely resembles the line current variation.

The problem of sensor noise arose several times during the test program. Line current sensors for Cars #2 and #3 exhibited large noise over a section of the track from Mile Post 13.84 to Mile Post 14.65, between the Daly City and the Balboa Park passenger stations. All attempts to eliminate this unexplained noise proved unsuccessful and the vehicle data for Cars #2 and #3 between these stations had to be discarded. A less serious but equally annoying problem was the zero offset error present in the line current sensors for these two cars. This offset error was discovered during data processing, and was eliminated using proper adjustments. These zero offset corrections were obtained by extrapolating the input line current to zero motor power, and the data was then corrected for this offset and for the constant auxiliary power. This procedure was used to correct the vehicle data for Car #2 for the baseline tests.

The power input monitored on the car is presented in Figure 3.1. Energy consumption of a single car is obtained by integrating the kW-time plots and is presented in Table 3.3 for all the six baseline runs.

The energy consumption associated with individual station runs was determined for Baseline Test Run #4. This data for the Engineering Car, i.e., Car #1, and for Car #2 is presented in Table 3.4. The relative magnitudes of the vehicle energy consumption for these cars reflect the large difference in weights of these cars. Car #1 weighs 98,000 lbs., and carried a test crew of 4 or 5, and the Car #2 was a B-car weighing 58,400 lbs. The station-to-station run times, the station dwells, and the auxiliary power consumption are also shown in this table.

Table 3.5 summarizes the station-to-station energy consumption of the test train obtained by adding energy consumption of Car #1 to the consumption of three cars of the type of Car #2. The total energy consumption for the entire trip is 117.00 kWh including the energy consumption

TABLE 3.3

ENERGY CONSUMPTION OF THE BART ENGINEERING CAR

RUN	KWH
1	33.59
2	34.21
3	37.31
4	34.49
5	51.75
6	53.19

Average of 1 - 4 for M90 - M16 trip = 34.90 kWh

Average of 5 - 6 for M16 - M90 trip = 52.47 kWh

TABLE 3.4

VEHICLE ENERGY CONSUMPTION FOR BASELINE RUN #4

STATION RUN	TIME SEC	CAR #1 KWH	CAR #2 KWH
M90 - M80	213	6.55	5.22*
M80 DWELL	18	0.09	0.09
M80 - M70	121	5.63	4.34
M70 DWELL	17	0.09	0.09
M70 - M60	169	5.40	4.42
M60 DWELL	24	0.13	0.13
M60 - M50	106	3.87	3.29
M50 DWELL	18	0.09	0.09
M50 - M40	124	5.53	4.15
M40 DWELL	21	0.11	0.11
M40 - M30	71	2.33	1.85
M30 DWELL	22	0.12	0.12
M30 - M20	65	2.53	1.97
M20 DWELL	17	0.09	0.09
M20 - M16	57	1.92	1.56
TOTAL	1063	34.48	27.52

* estimated by assuming an identical motor kW-to-total kW ratio for both the cars.

TABLE 3.5

TRAIN ENERGY CONSUMPTION FOR BASELINE RUN #4

STATION RUN	KWH*
M90 - M80	22.20**
M80 - M70	18.65
M70 - M60	18.66
M60 - M50	13.74
M50 - M40	17.98
M40 - M30	7.88
M30 - M20	8.44
M20 - M16	6.60
AUXILIARIES DURING STN. DWELL	2.88
TOTAL	117.03

* station-to-station energy excluding station dwell

** car #2 consumption estimated by assuming an identical motor kW-to-total kW ratio for both cars.

of the onboard auxiliaries during the station dwell times.

3.1.3 Motor Traction Power

The traction system accounts for most of the energy consumption of the car. During constant acceleration, the motor power increases approximately linearly with speed until the motor becomes power limited. The motor power then remains essentially constant during car acceleration.

The total motor input power for Car #1 and Car #2 are shown in Figure 3.3(k) for two acceleration runs from 0 - 42 mph. One of the runs is a baseline run, and the other is a revenue service run during the regeneration tests. The motor power undergoes a sharp drop in the speed range of 29 to 33 mph, in response to a circuit changeover for field shunting. Toward high speeds, the motors become power limited at 700 kW per car for Car #1 and at 740 kW per car for Car #2 respectively. The effect of car loading is clearly evident from these plots. During the baseline run with constant acceleration, the motors in Car #1 are loaded more than those in Car #2 by almost 30 percent. This is because Car #1 is substantially heavier than Car #2. During the revenue run, however, when Car #2 carries passengers, the relative motor power in the two cars is approximately equal. Also, the load weighing circuit of Car #1 is adjusted to increase motor tractive effort in proportion to the car weight only up to an AW2 weight of 82,000 lbs. Since the weight of Car #1 is 98,000 lbs., this car will experience a push from the remaining B-cars in the consist such that the resulting acceleration of Car #1 is consistent with the acceleration of the entire train.

3.1.4 Circuit Losses in Braking

When the propulsion system is in a braking mode, the traction motors operate as dc generators, and the kinetic energy of the car is converted into electrical energy. This energy usually flows to several different sinks. These include:

i) Series resistances R2, R3, and R4,
ii) Dynamic braking resistor,
iii) Line filter capacitor,
iv) Auxiliary systems,
v) Third rail distribution network (not receptive during the Baseline runs), and
vi) Other lossy circuit components.

This flow of energy is controlled as follows: the braking energy is first fed into the auxiliaries, the filter capacitor, and the third rail if it is receptive; when the capacitor voltage exceeds a predetermined level, the braking energy is diverted to the dynamic braking resistor, and is wasted as heat. During vehicle braking at speeds above 17 mph, an additional resistance of 0.1 - 0.8 ohm (R2, R3, R4) is inserted in the circuit. The fraction of the motor generated power lost in these resistances and the dynamic braking resistor are presented in Figures 3.3(h) - 3.3(i). It can be seen that considerable energy is lost in these series resistances, and this energy is not available to be fed back to the third rail, even if it were receptive. These loss calculations are made only when tha vehicle is in a braking mode as identified by the LPBP logic signal. These variables are, therefore, set to zero when the vehicle is in a propulsion mode.

It should be noted here that the switching in of the dynamic braking resistor can be accurately correlated with the charging of the filter capacitor as indicated by the step-increases in the line voltage.

3.1.5 VTRX/MOTOR in Braking

This ratio represents the fraction of the motor power returned to the third rail and the auxiliaries. In the Baseline Tests, the third rail is not receptive, and this ratio represents the braking power used to supply the auxiliaries. This ratio, by definition (see Appendix D), is always negative. The Figure 3.3(j), however, shows several short positive pulses. Most probably, this is because the ratio is being computed even when the vehicle is in propulsion. This was done due possibly to misinterpretation of the LPBP power/brake logic signal during transitions.

3.2 Regeneration Tests

These tests were conducted during evening rush hours for six days - 25-28 August and 1-2 September 1981. The total substation power and the energy consumption was monitored as usual by the Utility (PG & E) at the ac substation. Vehicle performance was monitored during these tests and energy consumption for specific runs was examined in detail.

3.2.1 Substation Loading

Table 3.6 presents the kW loading at the ac substation as recorded by the Utility. The maximum and the minimum substation loading during this period is shown in Figure 3.4. The kW-loading is computed as a 30-minute average, and the maximum should not be interpreted as a peak kW-load.

3.2.2 Vehicle Energy Consumption

The energy consumption of the BART Engineering Car during these tests was obtained by integrating the kW input data of Figure 3.5, and is presented in Table 3.7. It should be noted here that the train made just one round trip in the test section during the evening rush hour each day - MP6 to M90 and back. The effectiveness of regenerative braking at BART can be evaluated by comparing this data with that of Table 3.3.

TABLE 3.6

KW LOADING AT THE AC SUBSTATION

HOURS	AUG 25	AUG 26	AUG 27	AUG 28	SEPT 1	SEPT 2
15:00 - 15:30	4.06	4.38	3.83	3.88	4.13	4.38
15:30 - 16:00	4.96	5.00	5.01	4.94	4.54	5.13
16:00 - 16:30	5.62	6.00	5.82	7.11	6.12	6.88
16:30 - 17:00	6.45	7.13	5.54	7.46	7.08	7.25
17:00 - 17:30	6.10	6.13	6.35	5.29	6.12	8.25
17:30 - 18:00	4.71	4.25	6.15	4.23	4.66	5.63

TABLE 3.7

ENERGY CONSUMPTION OF THE BART ENGINEERING CAR

DATE	KWH M90 - MP6	EST.KWH M90 - M16	KWH MP6 - M90	EST.KWH M16 - M90
AUG 25	33.86		47.67	
AUG 26	34.00		44.80	
SEPT 1	33.36		48.53	
AVERAGE	33.74	28.00	47.00	43.50

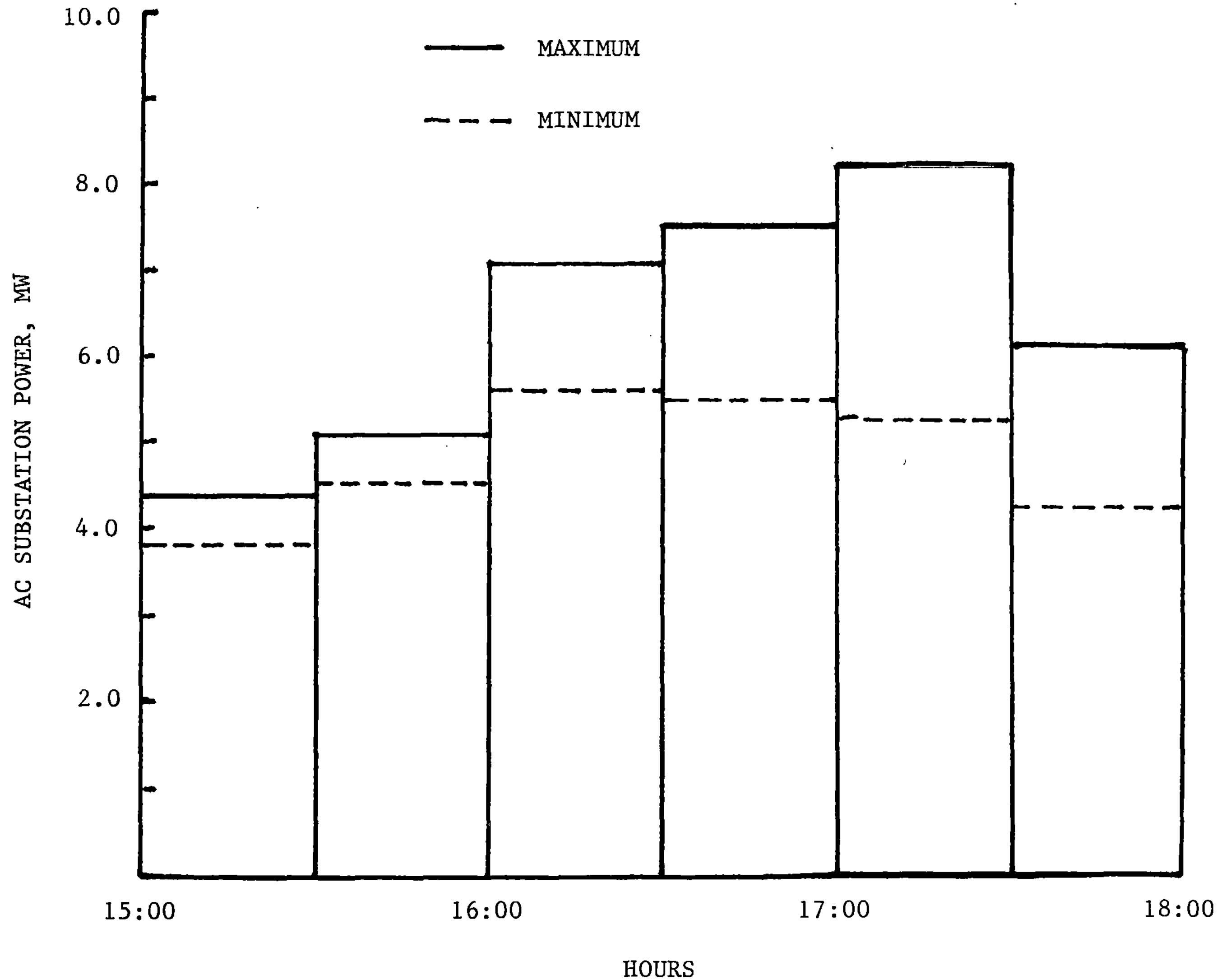
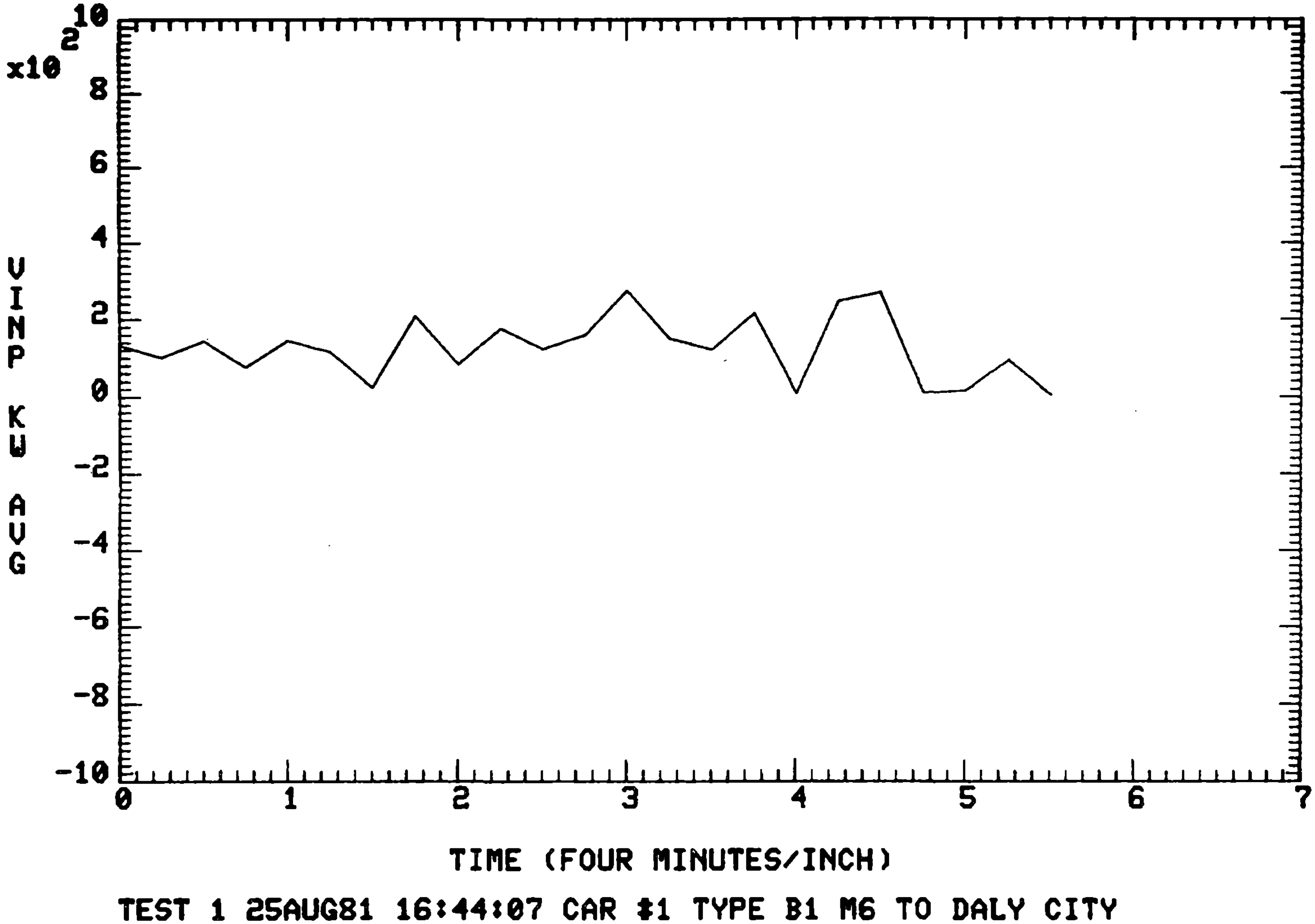
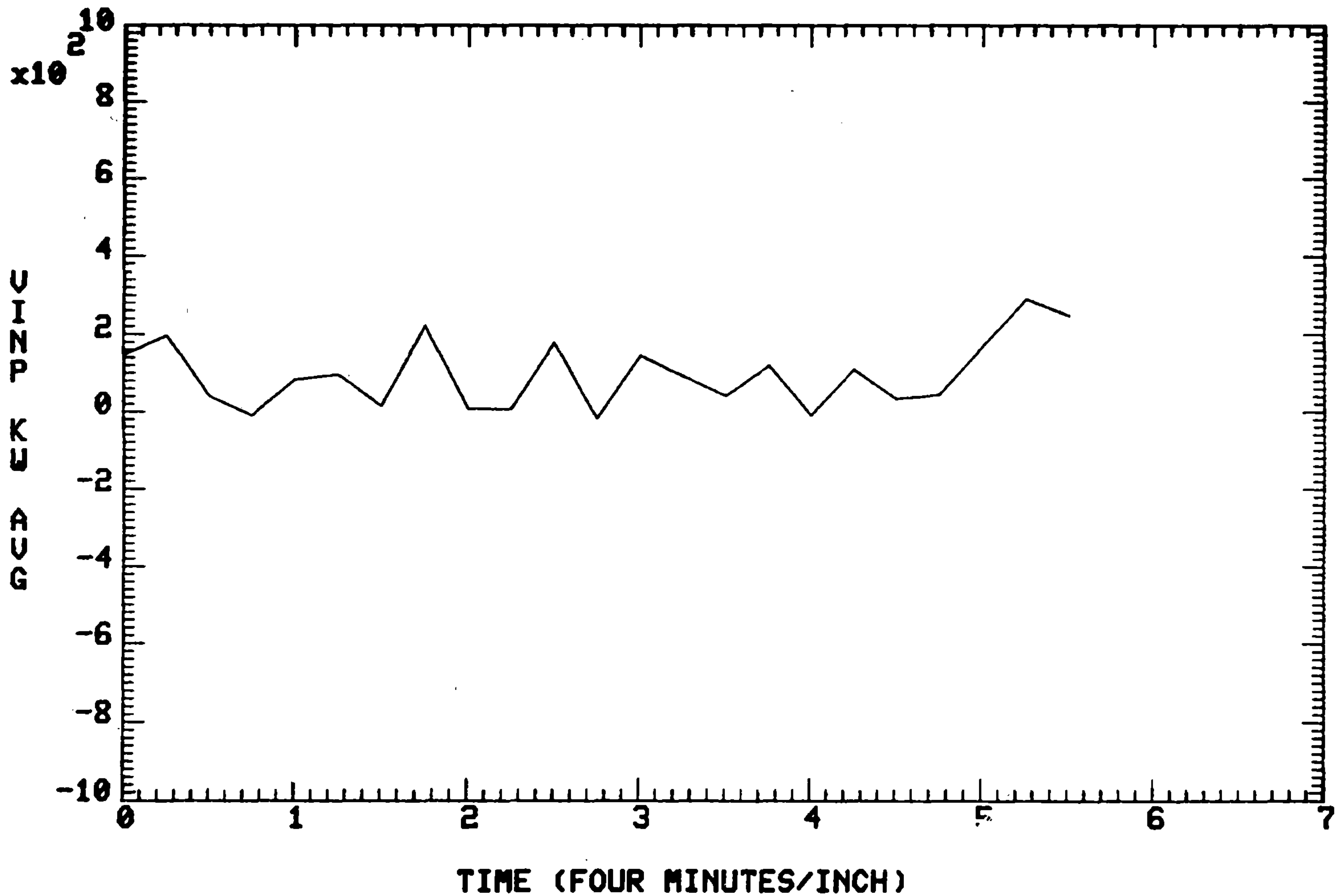


FIGURE 3.4 UTILITY DATA FOR TOTAL SUBSTATION LOAD

FIGURE 3.5 ENERGY CONSUMPTION ON A TRIP BASIS FOR REGENERATION TESTS

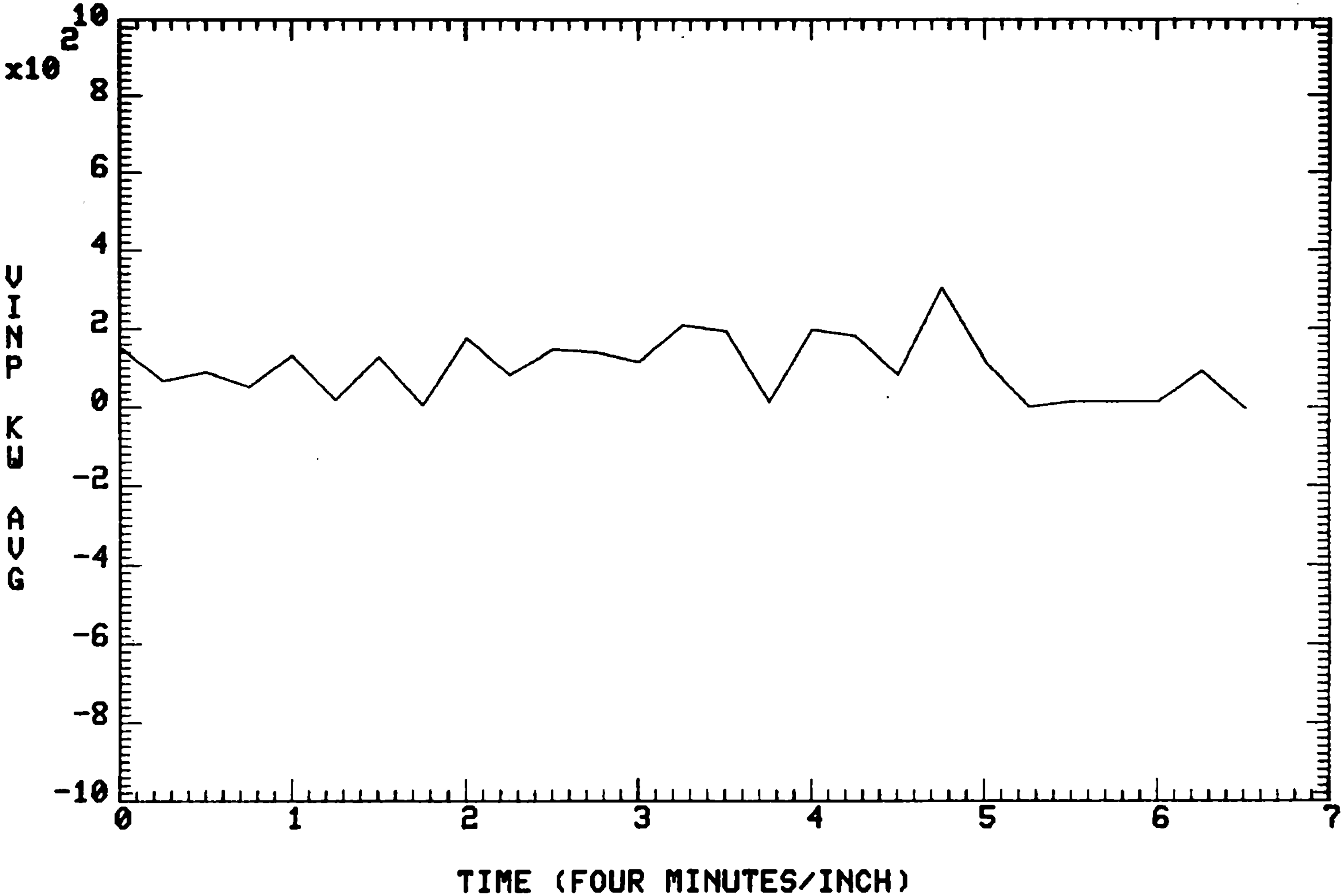

x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VINP KW AVG
0
1
2
3
4
5
6
7
TIME (FOUR MINUTES/INCH)
TEST 1 25AUG81 16:44:07 CAR #1 TYPE B1 M6 TO DALY CITY

(a)



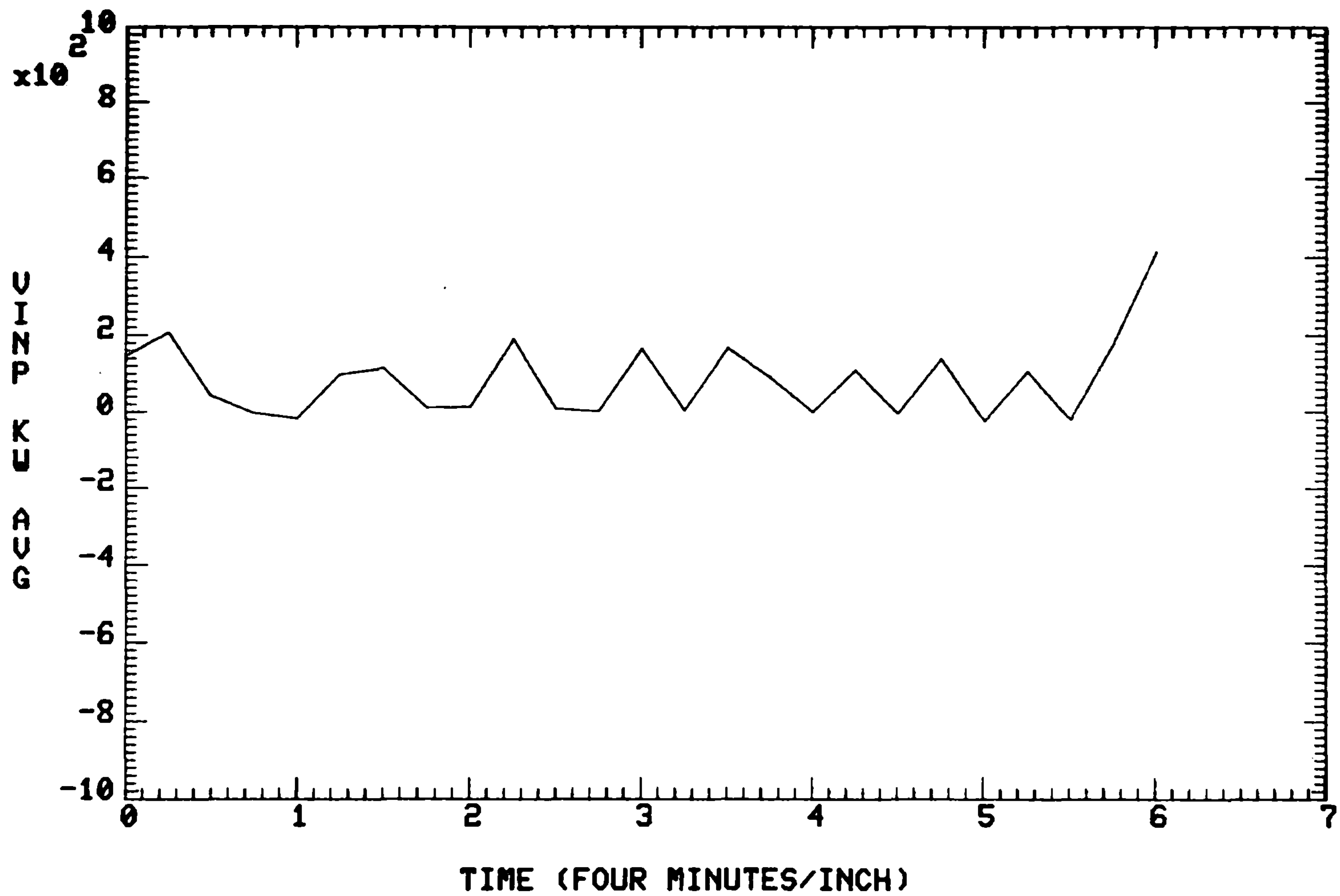
TEST 1 25AUG81 17:12:30 CAR #1 TYPE B1 DALY CITY TO M6

(b)



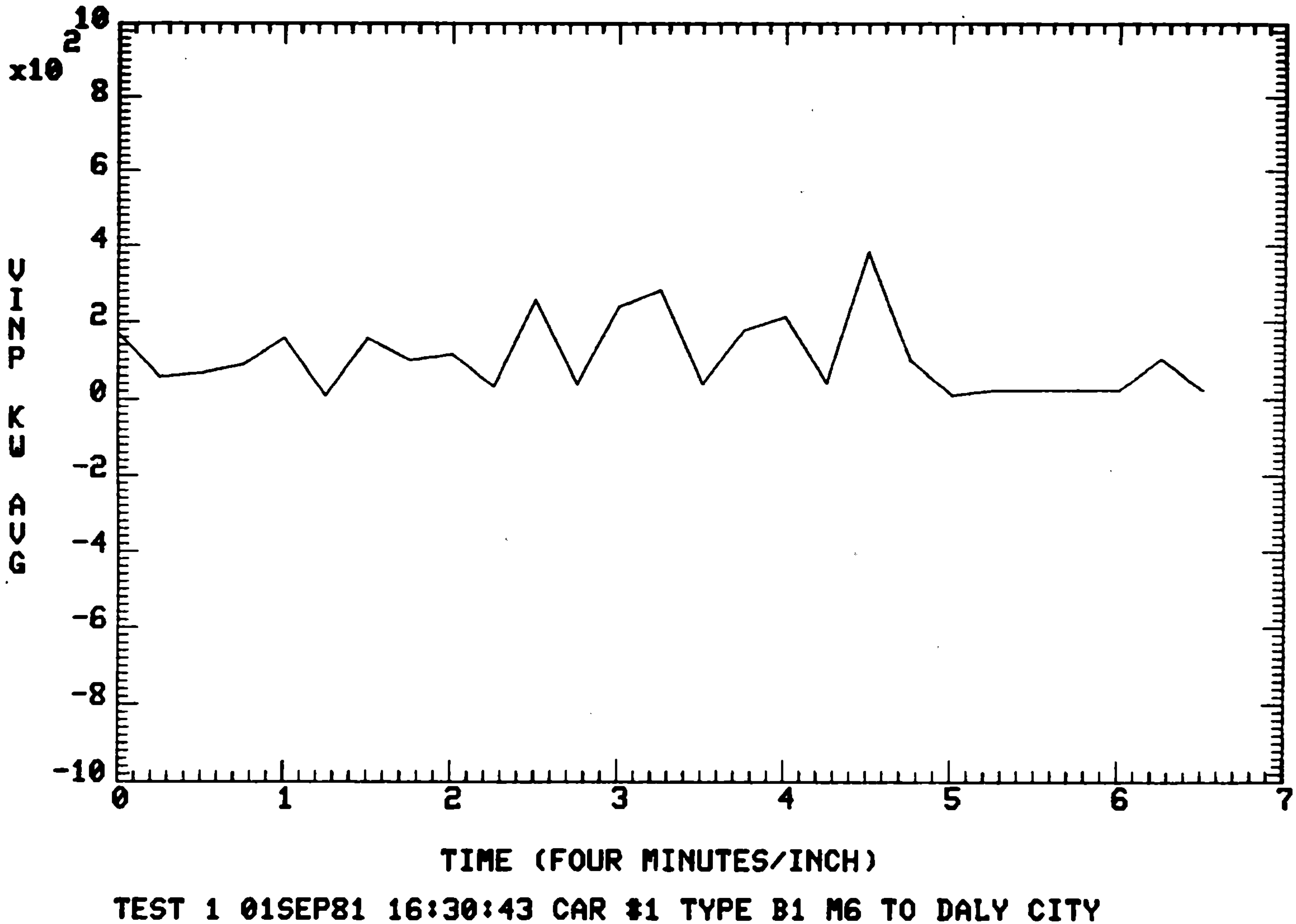
TEST 1 26AUG81 16:29:18 CAR #1 TYPE B1 M6 TO DALY CITY

(c)

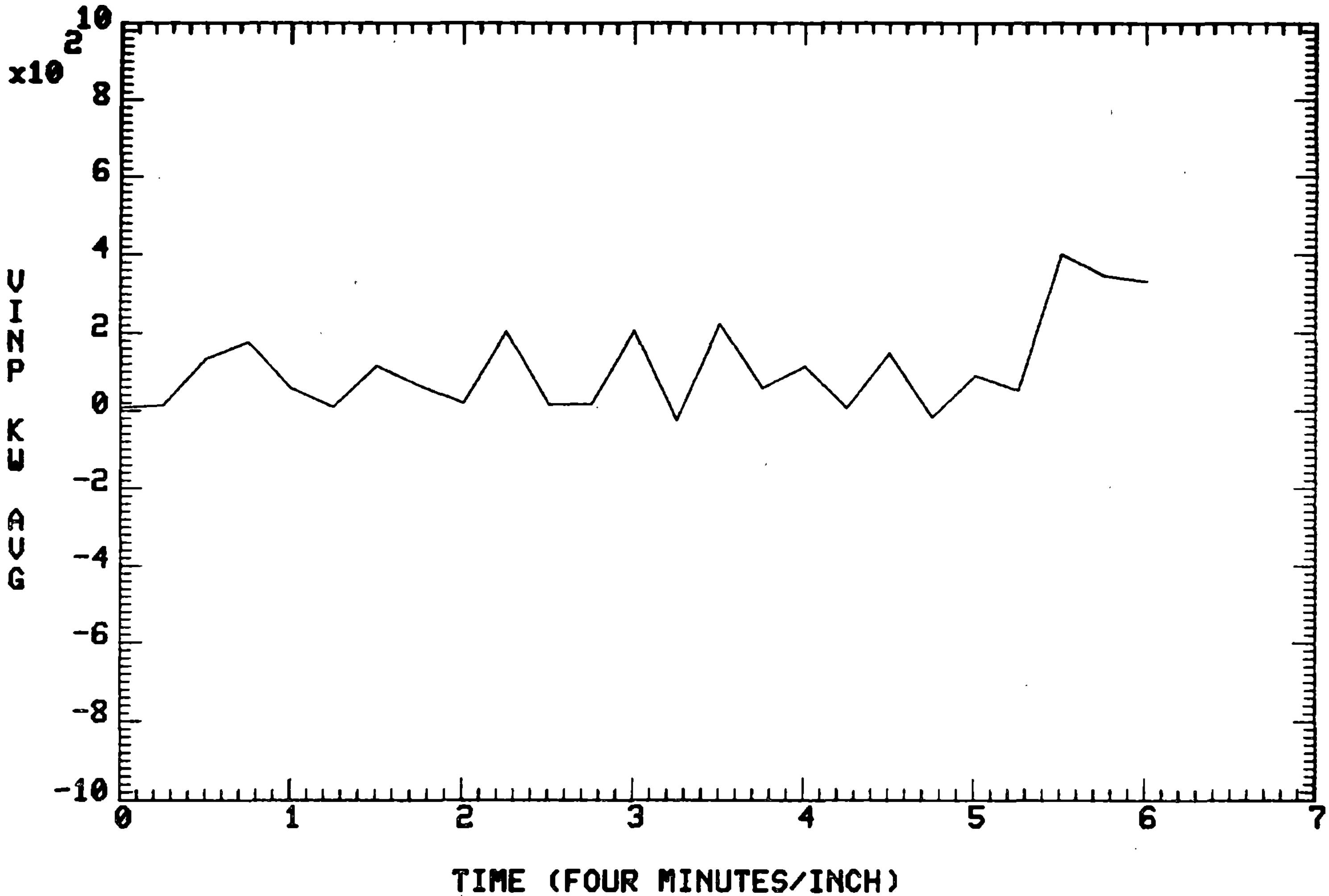


TEST 1 26AUG81 16:58:54 CAR #1 TYPE B1 DALY CITY TO M6

(d)


x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VINP KW AVG
0
1
2
3
4
5
6
7
TIME (FOUR MINUTES/INCH)
TEST 1 01SEP81 16:30:43 CAR #1 TYPE B1 M6 TO DALY CITY

(e)



TEST 1 01SEP81 16:58:54 CAR #1 TYPE B1 DALY CITY TO M6

(f)

Use of regenerative braking resulted in energy saving of close to 20 percent for the Daly City - Embarcadero run, and about 17 percent for the Embarcadero - Daly City run. Performance of the BART chopper during vehicle braking can be evaluated from the data presented in Table 3.8. It can be seen that during vehicle braking, only about one-third of the braking energy was fed into the third rail, and about two-thirds was lost in the propulsion system itself, a significant amount being lost in the series resistances R2 - R3 - R4.

Some data recorded onboard the vehicles is now presented and discussed. The instantaneous variation of different variables is presented for a typical seven minute period. The data recorded on Car #1 is shown in Figure 3.6. The speed time variation typically shows different ATO speed limits, although the vehicle speed control system is cycling the propulsion system through several propulsion-braking cycles, most of them quite unnecessary. This can surely be eliminated by a better control system design. The feedback of energy into the third rail during vehicle braking can be clearly seen in the vehicle input power (VINP KW) chart. The 'MOTOR KW' clearly corresponds to the 'VINP KW', except that it is positive even during vehicle braking. This is because the current sensor in the motor circuit is unidirectional. The line current follows the vehicle input power closely because the third rail voltage is essentially constant.

The internal circuit losses during vehicle braking can be examined from Figures 3.6(h) and 3.6(i). These should be compared to similar losses shown in Figures 3.3(h) and 3.3(i) for the Baseline runs. With regenerative braking, some enrgy is returned to the third rail as shown in Figure 3.6(j), the dynamic braking is minimal, and a significant amount of energy is lost in the series resistances R2 - R3 - R4. As explained earlier, VTRX should never be positive during vehicle braking, and the positive swings of Figure 3.6(j) are most probably due to

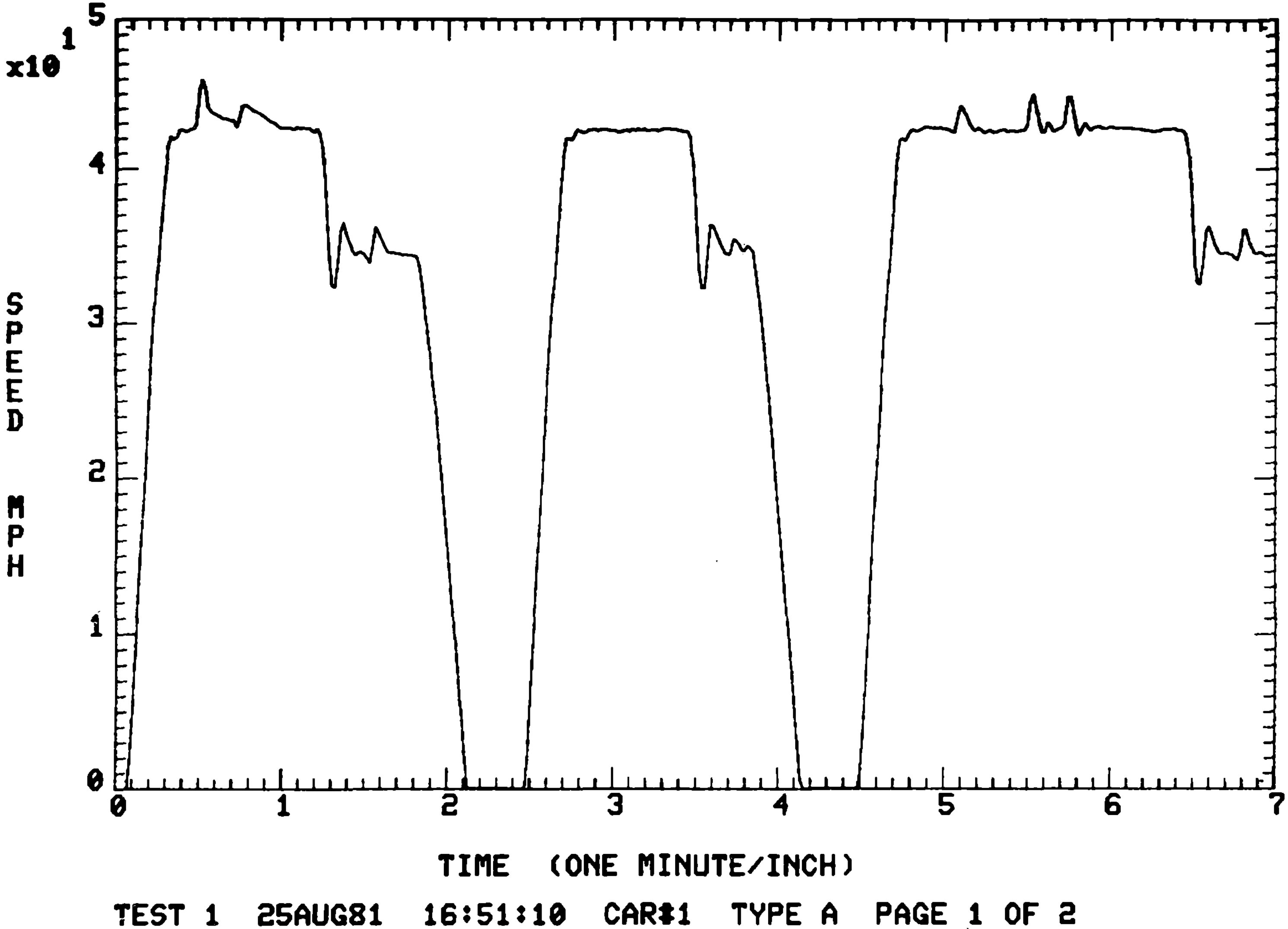
TABLE 3.8

ENERGY BREAKDOWN DURING VEHICLE BRAKING

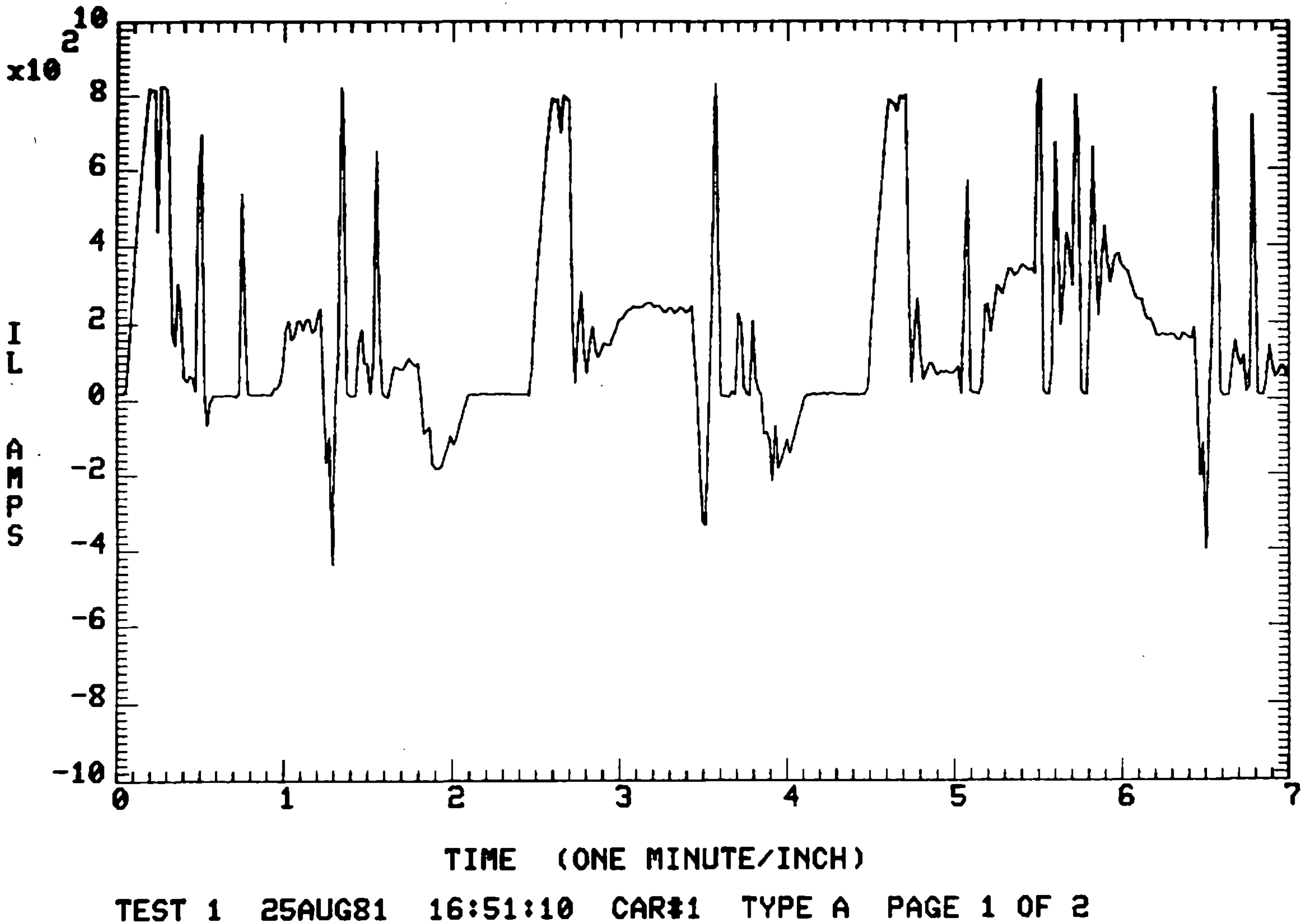
PERCENT BREAKDOWN FOR

	MP6 TO M90			M90 TO MP6		
DATE	LOST IN SERIES RESISTANCES	FEEDBACK	LOST IN DYNAMIC BR. RES.	LOST IN SERIES RESISTANCES	FEEDBACK	LOST IN DYNAMIC BR. RES.
25 AUG	37.5	30.5	0.6	33.5	36.5	1.3
26 AUG	37.1	34.0	0.6	33.6	40.0	0.6
1 SEPT	36.6	36.0	3.3	33.3	35.5	3.1

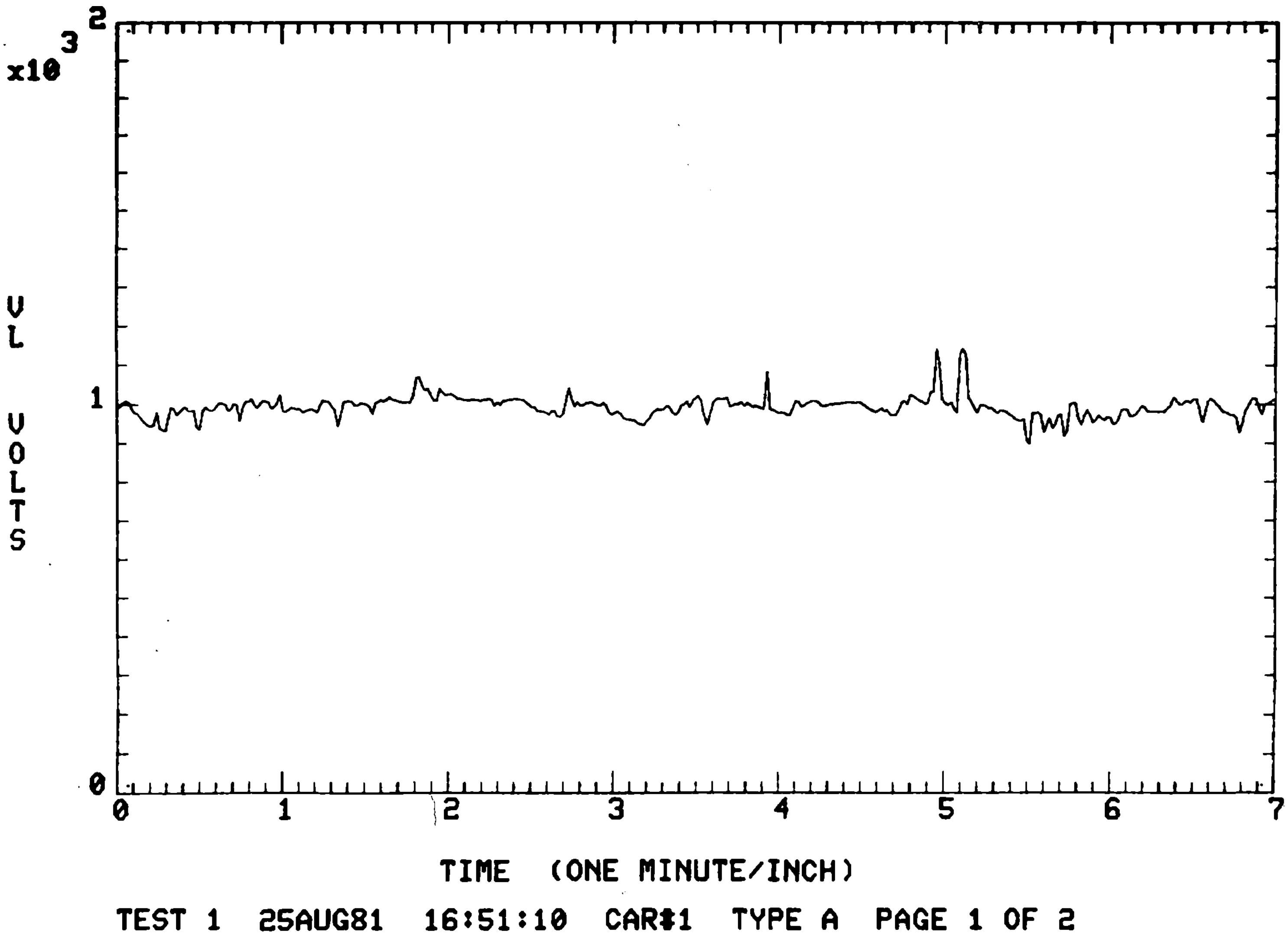
FIGURE 3.6 REGENERATION TEST DATA FOR CAR # 1


x10^1
SPEED MPH
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

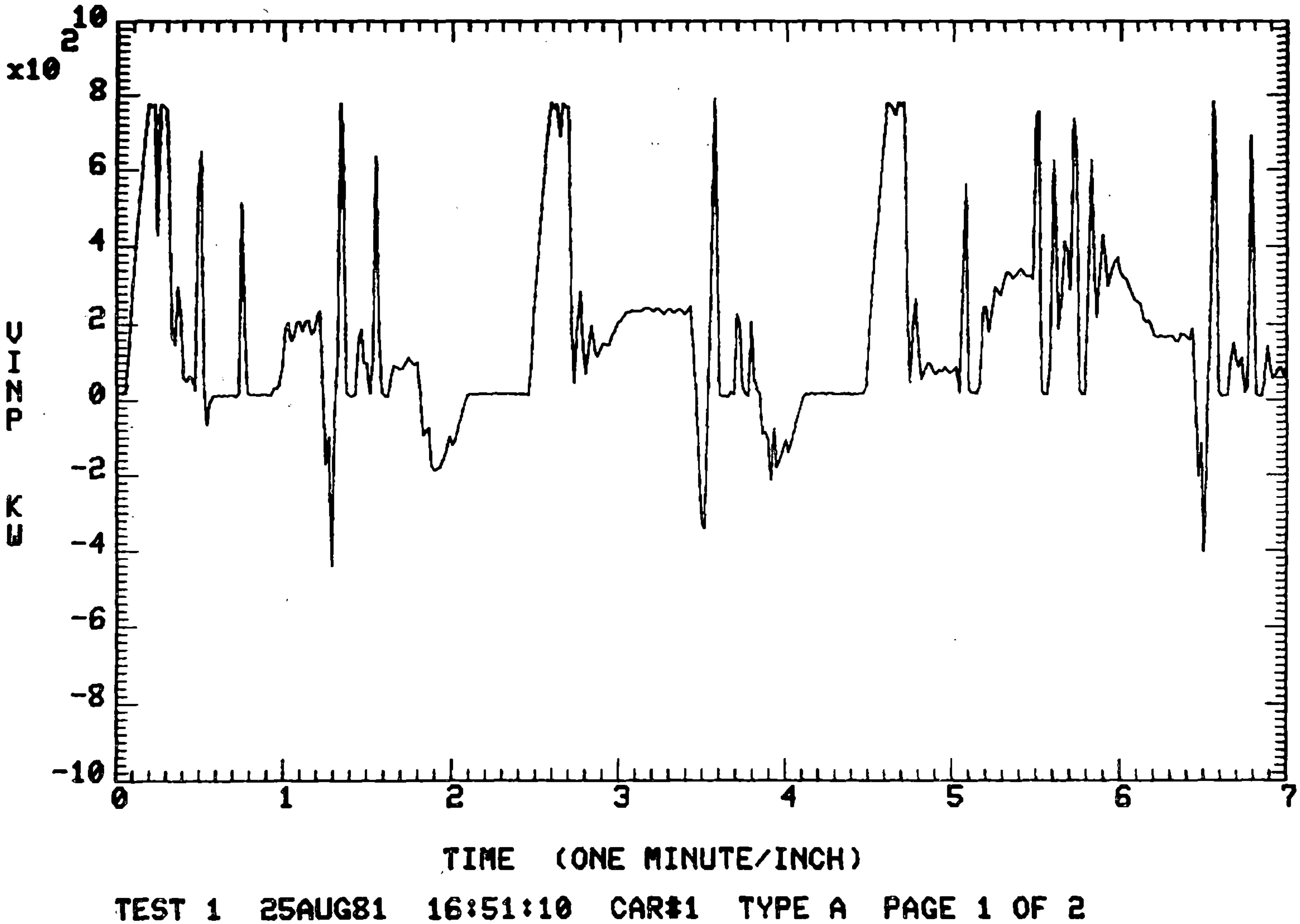
(a)


x10^2
IL AMPS
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

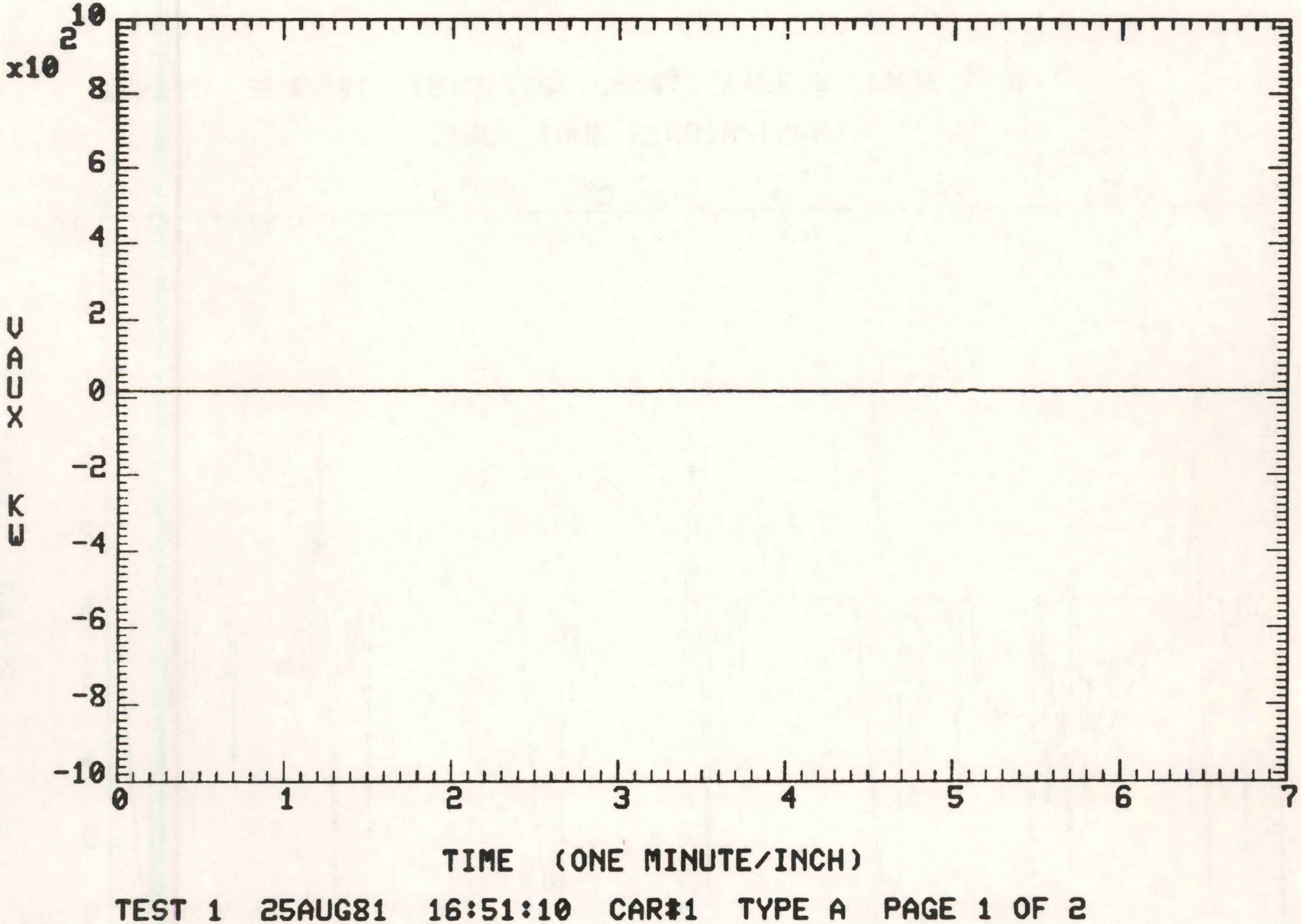
(b)


2
x10^3
1
0
VL VOLTS
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

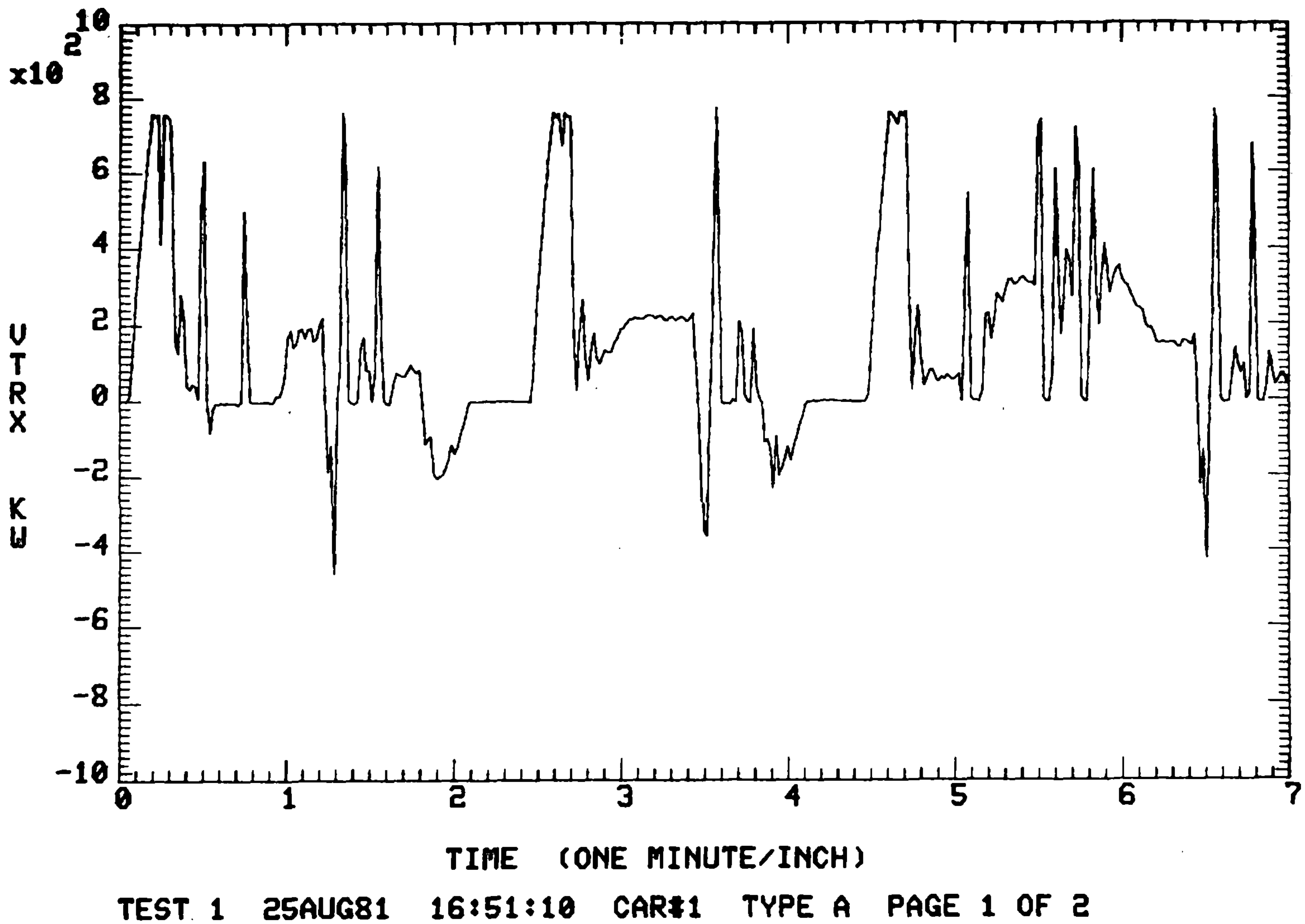
(c)


x10^2
VINP KW
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

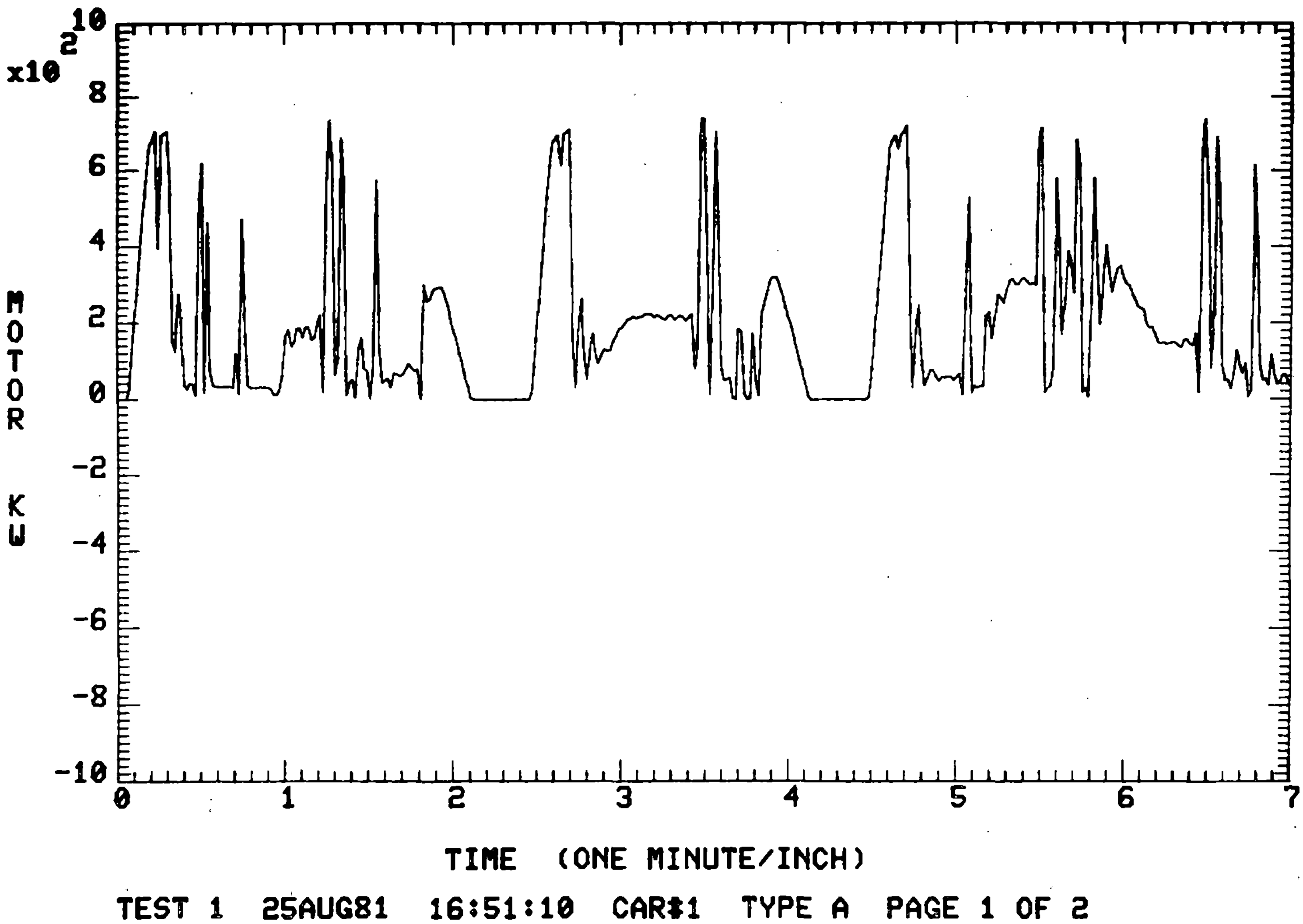
(d)


x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VAUX KW
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

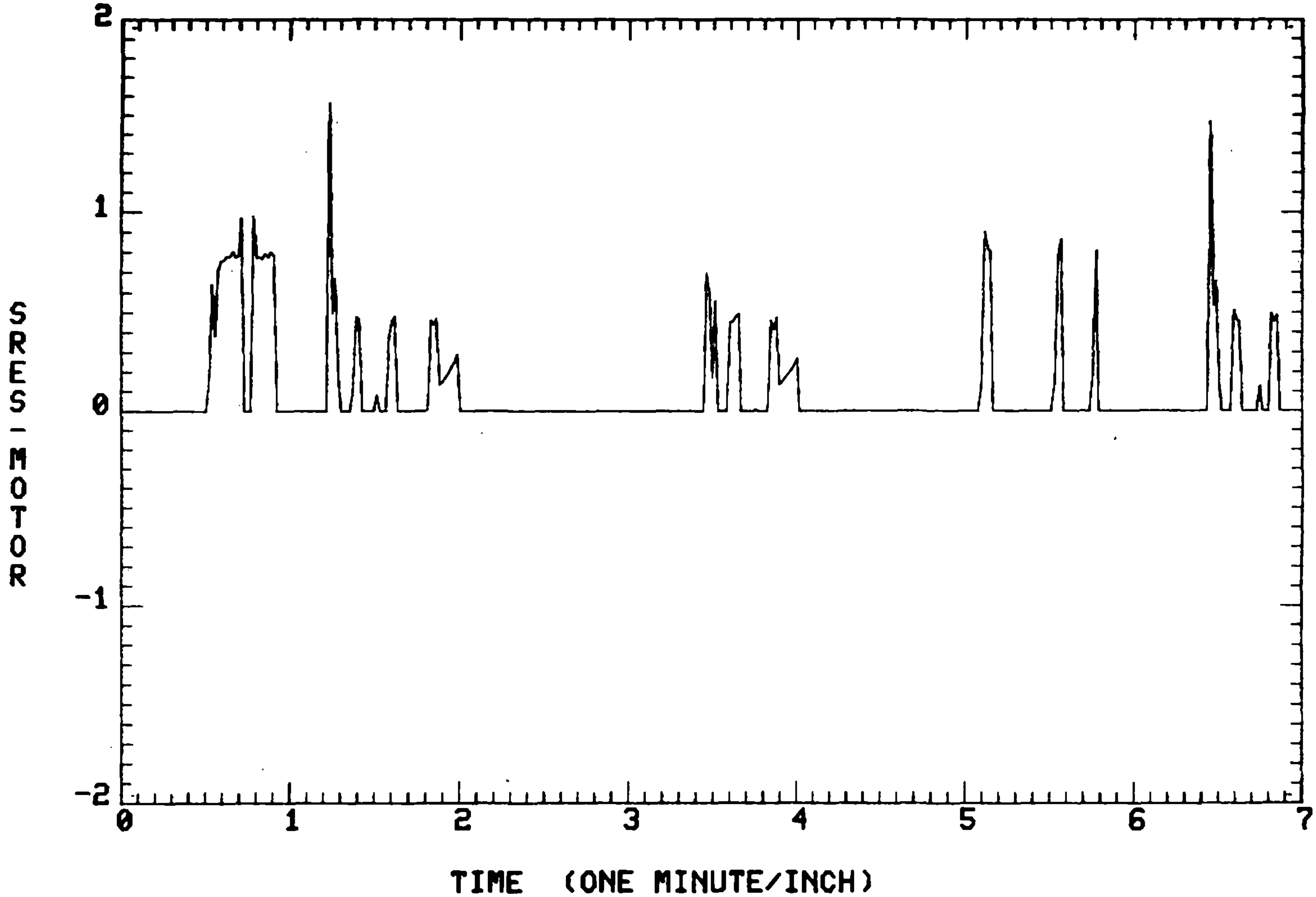
(e)


x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
V T R X K W
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

(f)

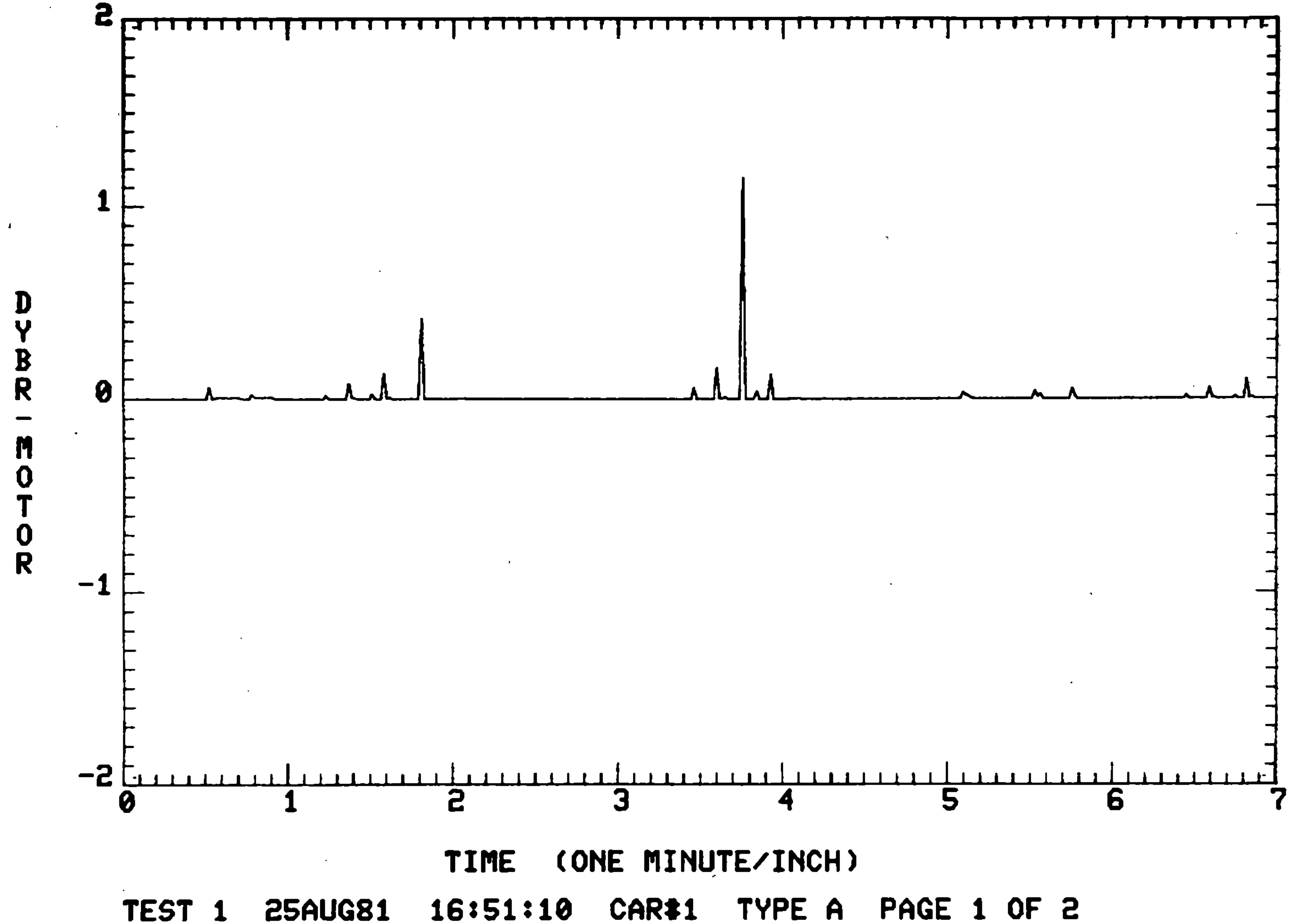

x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
MOTOR KW
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

(g)

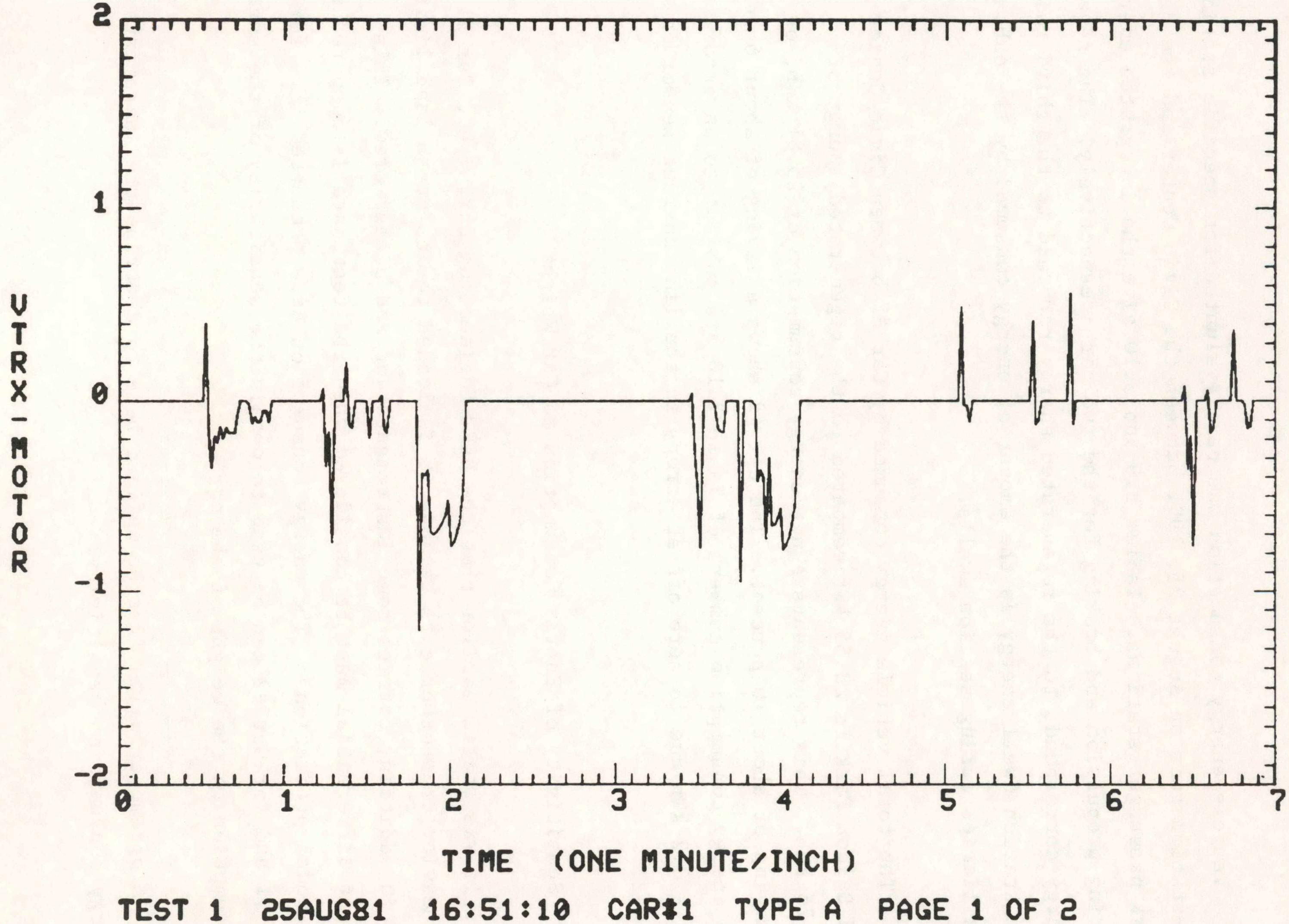


TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

(h)


2
1
0
-1
-2
0 1 2 3 4 5 6 7
DYBR-MOTOR
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

(i)


2
1
0
-1
-2
VTRX-MOTOR
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#1 TYPE A PAGE 1 OF 2

(j)

misinterpretation of the LPBP logic signal during power/brake transitions. The data recorded on Car #2 is presented in Figure 3.7 and is similar to that recorded on Car #1.

Vehicle energy consumption was next evaluated for specific station-to-station runs on August 25, 1981 between the Civic Center and the Balboa Park passenger stations. Tables 3.9 and 3.10 give the integrated energies during propulsion and braking for the two cars respectively. The negative energy corresponds to the regenerated energy returned to the third rail. The station dwell energy is the amount of energy consumed by the onboard auxiliaries during station dwells.

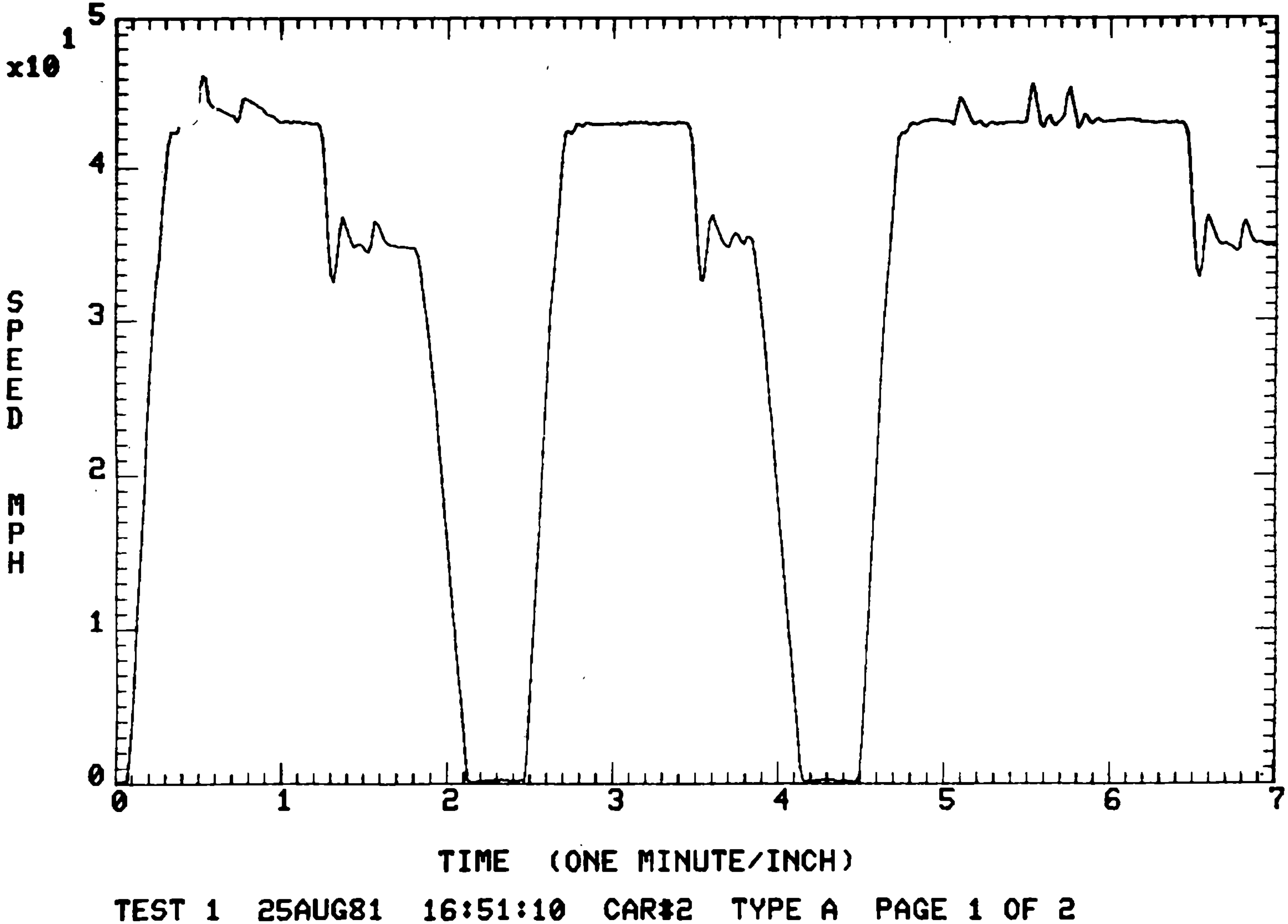
The total vehicle energy consumed by Car #1 between Civic Center and Balboa Park is 28.55 kWh compared to the regenerated energy of -2.75 kWh. This represents a net energy consumption of 25.81 kWh, or a saving of about 10 percent. The Car #2 shows a saving of about 6 percent. The energy consumption numbers of Table 3.10 are subject to an error of 0.1 - 0.2 kWh due to zero offset errors in the line current sensor in Car #2.

3.3 Sensitivity of Energy Consumption to Car Weight

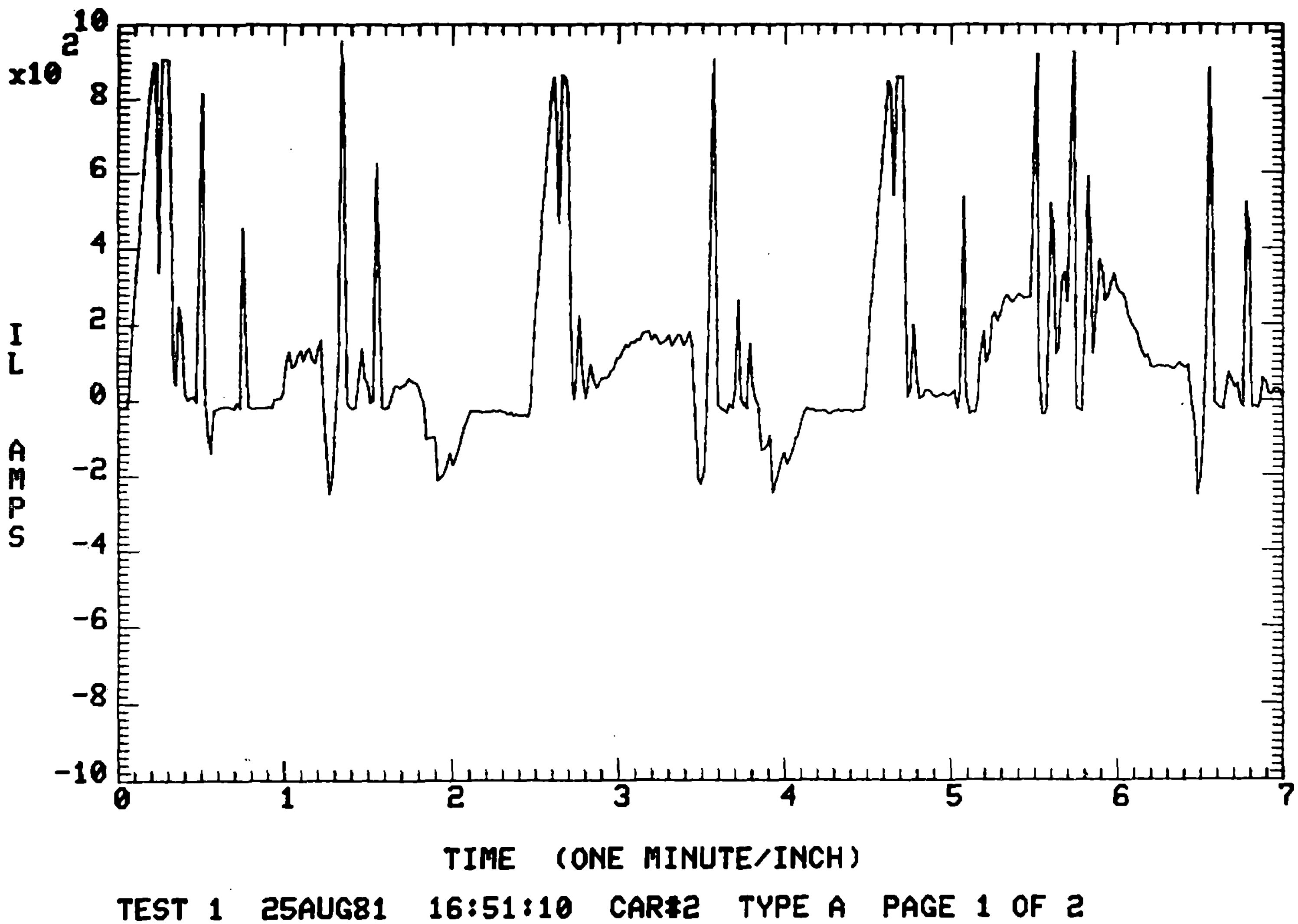
It was stated earlier that the BART Engineering Car, i.e., Car #1 is heavier than other cars because it is loaded to its crush load limit, and in addition, carries some instrumentation and a test crew. This weight differential must be considered when the test data is compared to the model predictions. The energy consumption data presented here for Car #1 and for Car #2 can be used to obtain the sensitivity of the energy consumption to the weight of the car.

A parameter will first be defined here to describe the incremental energy consumption sensitivity.

FIGURE 3.7 REGENERATION TEST DATA FOR CAR # 2


x10^1
SPEED MPH
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#2 TYPE A PAGE 1 OF 2

(a)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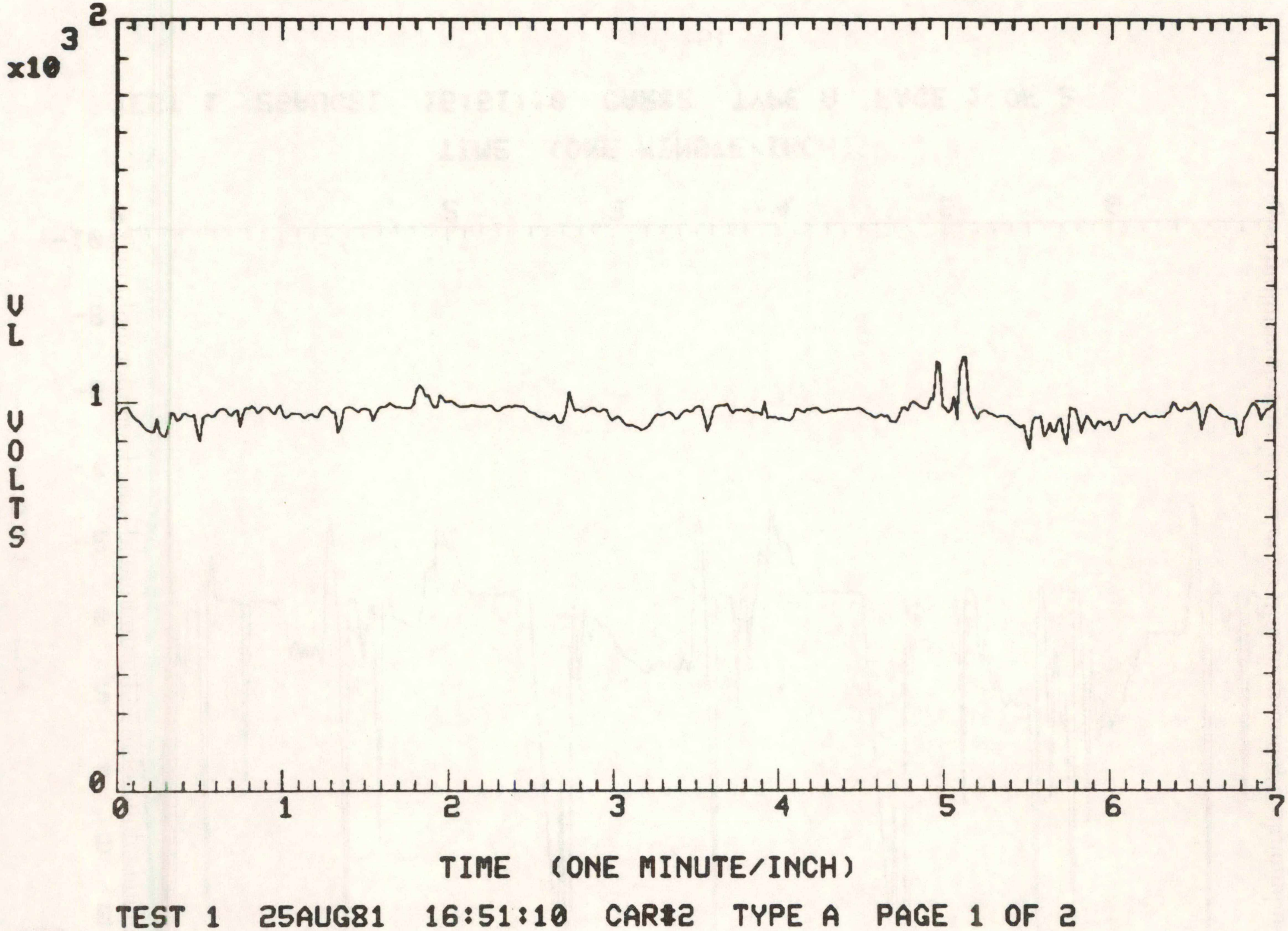
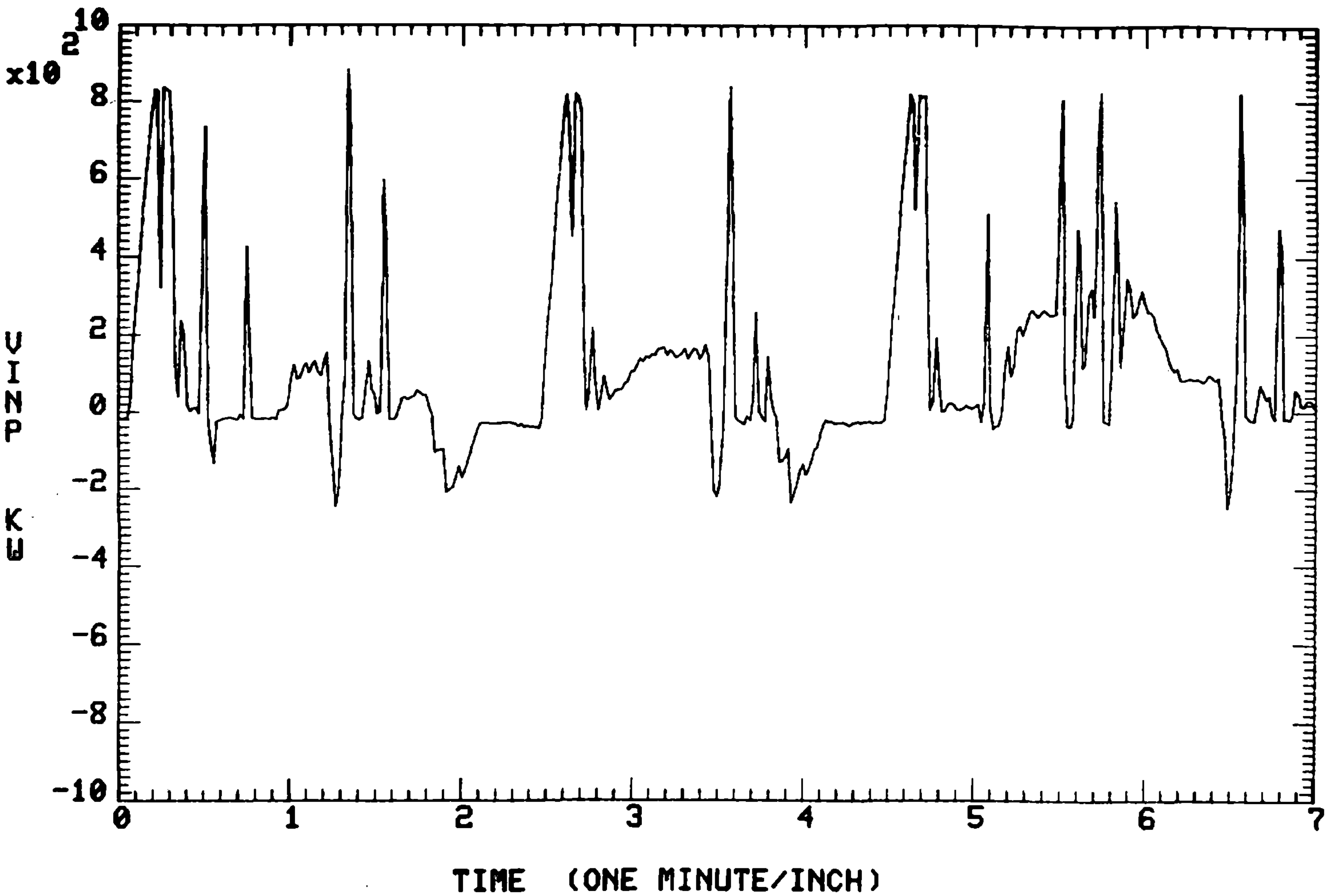
10
8
6
4
2
0
-2
-4
-6
-8
-10
IL AMPS
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#2 TYPE A PAGE 1 OF 2

(b)

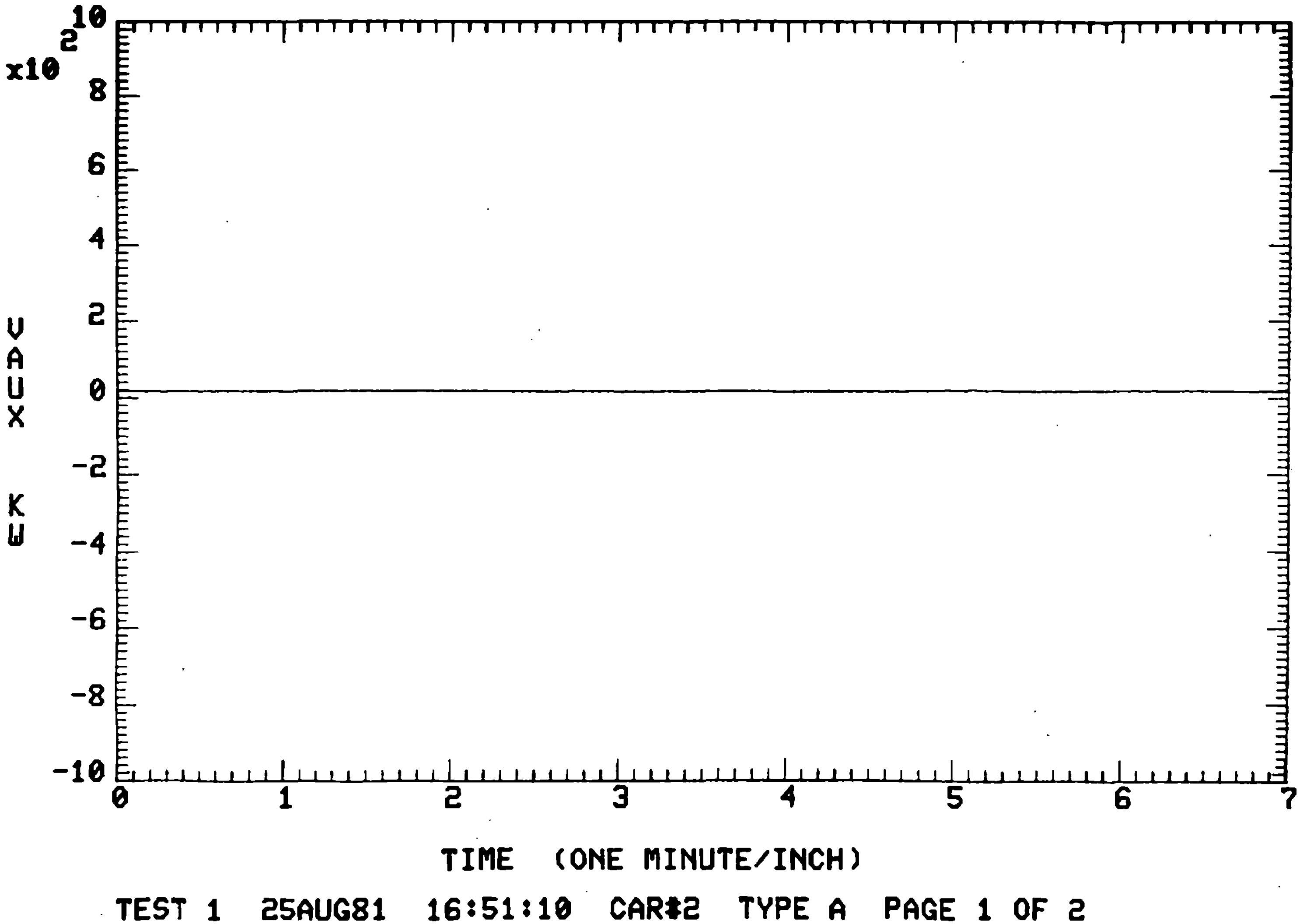

x10^3
VL VOLTS
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#2 TYPE A PAGE 1 OF 2

(c)

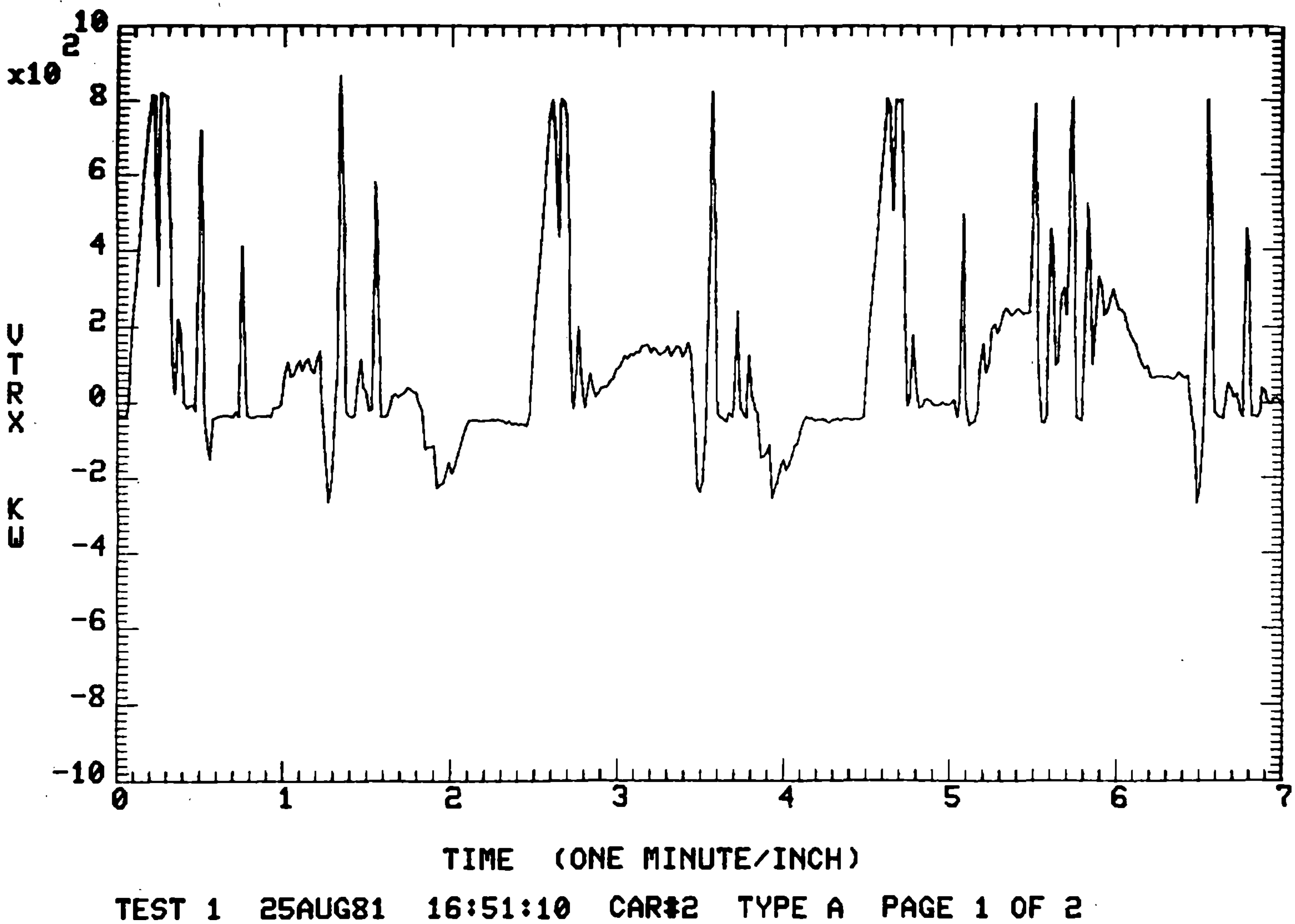


TEST 1 25AUG81 16:51:10 CAR#2 TYPE A PAGE 1 OF 2

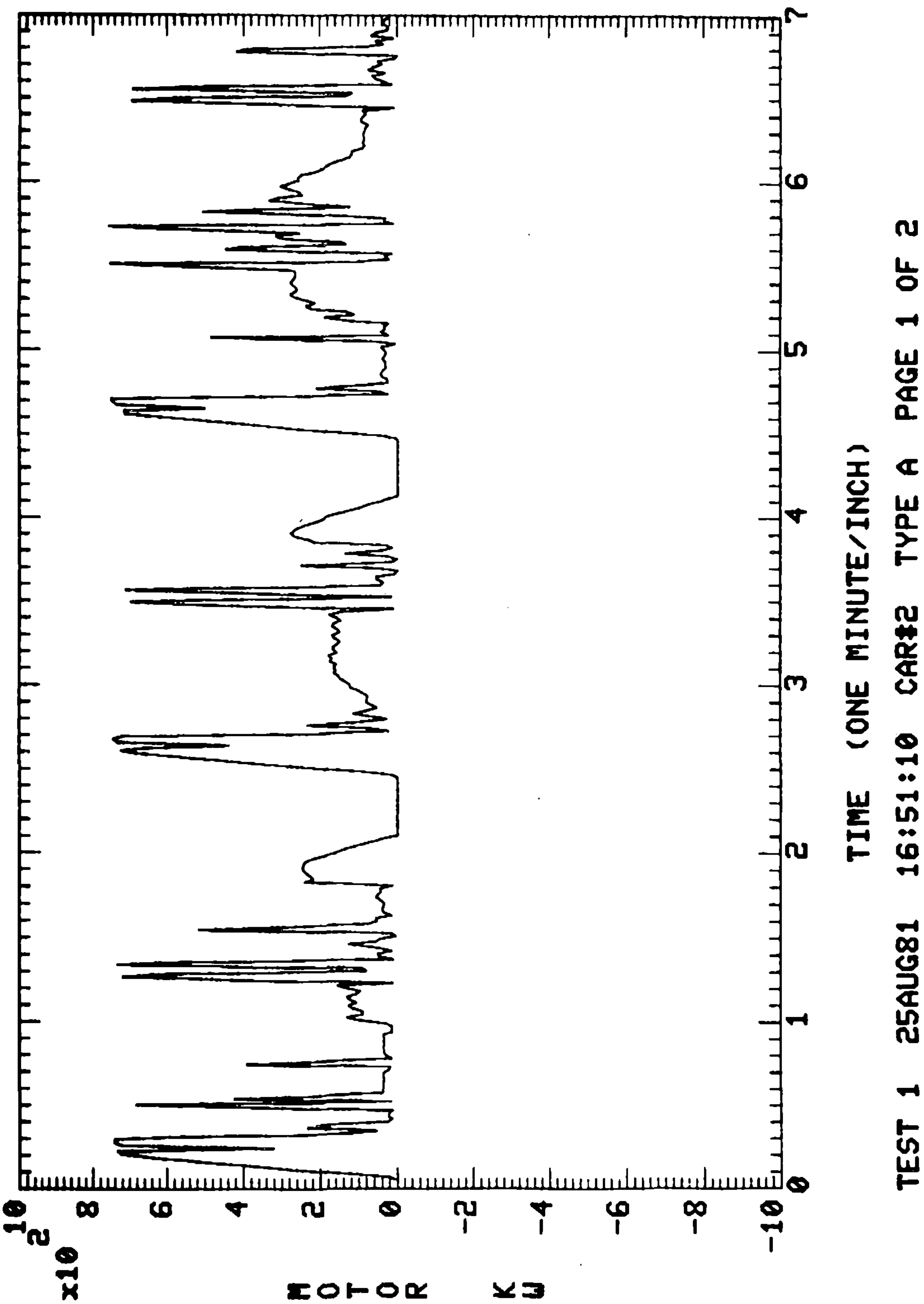
(d)


x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VAUX KW
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#2 TYPE A PAGE 1 OF 2

(e)


x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
VTRX KW
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#2 TYPE A PAGE 1 OF 2

(f)


MOTOR KW
x10^2
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST 1 25AUG81 16:51:10 CAR#2 TYPE A PAGE 1 OF 2

(g)

TABLE 3.9

ENERGY CONSUMPTION OF CAR #1

REGENERATION TEST ON 25 AUGUST 1981 FOR M40 TO M80 RUN

STATION RUN	TIME SEC	PROP KWH	BRK KWH	NET KWH
M40 - M50	123	5.48	-0.73	4.75
M50 DWELL	20	0.11		0.11
M50 - M60	101	5.63	-0.70	4.93
M60 DWELL	24	0.13		0.13
M60 - M70	173	10.38	-0.71	9.67
M70 DWELL	19	0.11		0.11
M70 - M80	141	6.71	-0.61	6.10
TOTAL	601	28.55	-2.75	25.81

TABLE 3.10

ENERGY CONSUMPTION OF CAR #2

REGENERATION TEST ON 25 AUGUST 1981 FOR M40 TO M80 RUN

STATION RUN	TIME SEC	PROP KWH	BRK KWH	NET KWH
M40 - M50	123	5.10	-0.45	4.65
M50 DWELL	20	0.11		0.11
M50 - M60	101	5.10	-0.51	4.59
M60 DWELL	24	0.13		0.13
M60 - M70	173	9.10	-0.39	8.71
M70 DWELL	19	0.11		0.11
M70 - M80	141	6.10	-0.33	5.77
TOTAL	601	25.75	-1.63	24.07

3.3.1 Incremental Energy Consumption Sensitivity

Let the energy consumption of a transit car with a weight W_1 be E_1, and let the energy consumption be E_2 for a car weight of W_2. Then

$$\Delta W = W_1 - W_2$$

and

$$\Delta E = E_1 - E_2$$

The incremental energy sensitivity parameter p is defined here as

$$p = \frac{\Delta E/E_1}{\Delta W/W_1}$$

This parameter p is assumed to be constant over the range of car weights encountered in this test program. For any other car weight W_3 of a car, for example, the energy consumption E_3 can then be obtained as

$$E_3 = E_1 \left\{ 1 - p\left(\frac{W_1 - W_3}{W_1}\right) \right\}$$

3.3.2 Sensitivity Parameter for Baseline Runs

The parameter p for the baseline runs is computed using the data for Run #4 alone. The parameter is, therefore, strictly valid only for the M90 - M16 runs, although it is also used here for runs in the opposite direction. For Run #4,

$$W_1 = 98{,}853 \text{ lbs.}$$
$$W_2 = 58{,}400 \text{ lbs.}$$

and $E_1 = 34.48$ kWh

$E_2 = 27.52$ kWh

Hence $p = 0.4933$

The average weight per car of the experimental train is 69,013.25 lbs. The energy consumption of the train per car can, therefore, be computed to be about 15 percent less than that for Car #1, or, the energy consumption of Car #1 should be about 17.5 percent higher than the average train energy consumption per car.

Similar computations can be made by ignoring the energy consumed by the car auxiliaries during station dwell. If the station dwell time is assumed to be zero, the energy consumption of Car #1 can be computed to be about 17.9 percent higher than the train energy consumption per car.

The above two factors are used here to compare the test data with model predictions, as presented in Table 8.1 and Table 8.2 in Section 8.

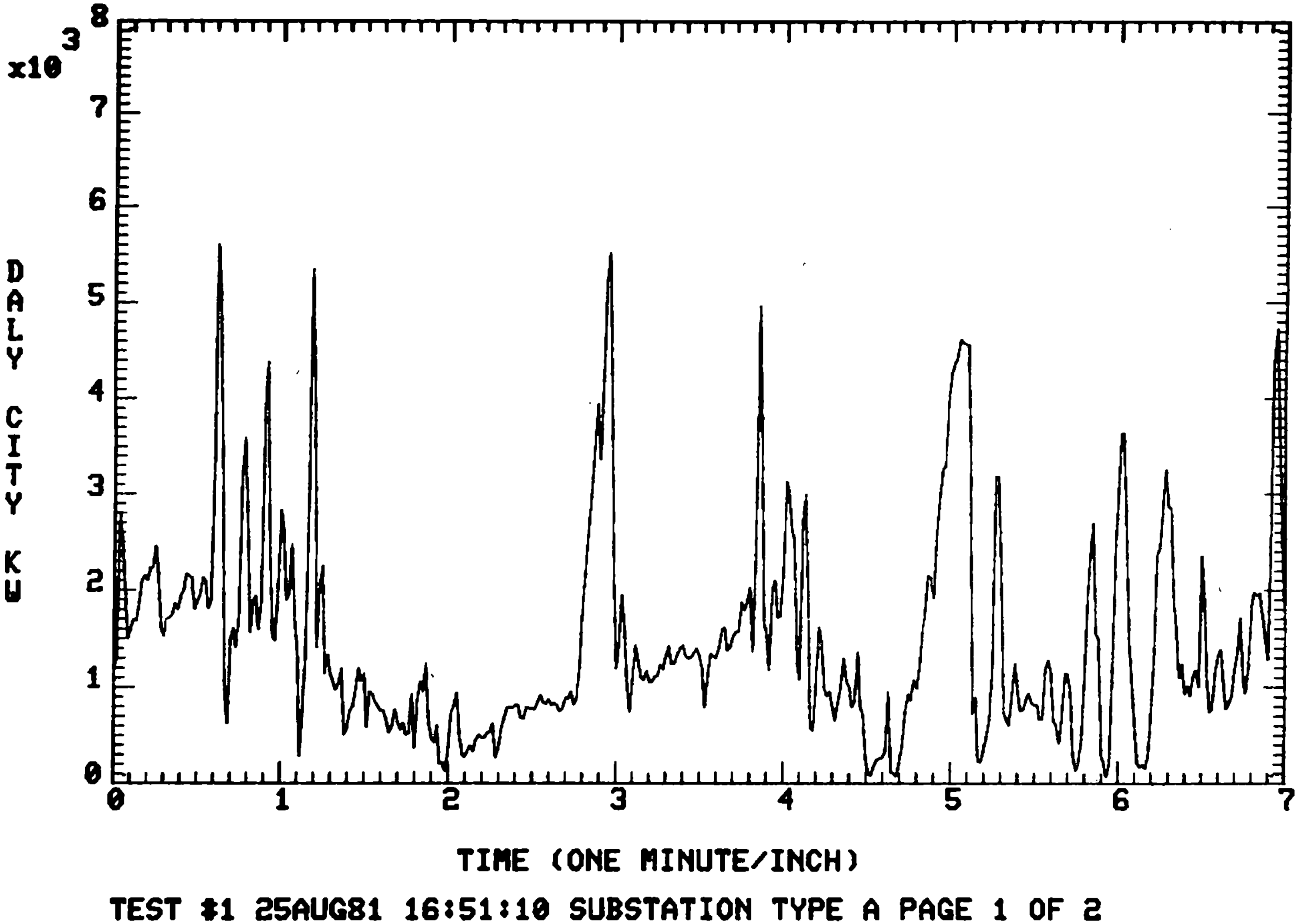
3.3.3 Sensitivity Parameter for Revenue Runs

The sensitivity parameter p cannot be accurately computed for the revenue runs because the weight of Car #2 is not precisely known. However, the energy consumption data presented in Table 3.9 and Table 3.10 can be used to estimate the sensitivity parameter p by assuming two passenger loading conditions - an empty car, and a loading of 75 passengers. These computations indicate that although the parameter p is sensitive to the passenegr loading, the ratio of the energy consumption of Car #1 to the energy consumption of the train per car is not very sensitive to the passenger loading. This is because the energy differential is quite small due to regeneration during revenue runs, and the train is a six-car consist. Under both conditions of passenger loading, the energy consumption of Car #1 was computed to be only about 5.8 percent higher than the average train consumption per car. This factor is used here to compare the test data with model predictions as presented in Table 8.1 in Section 8.

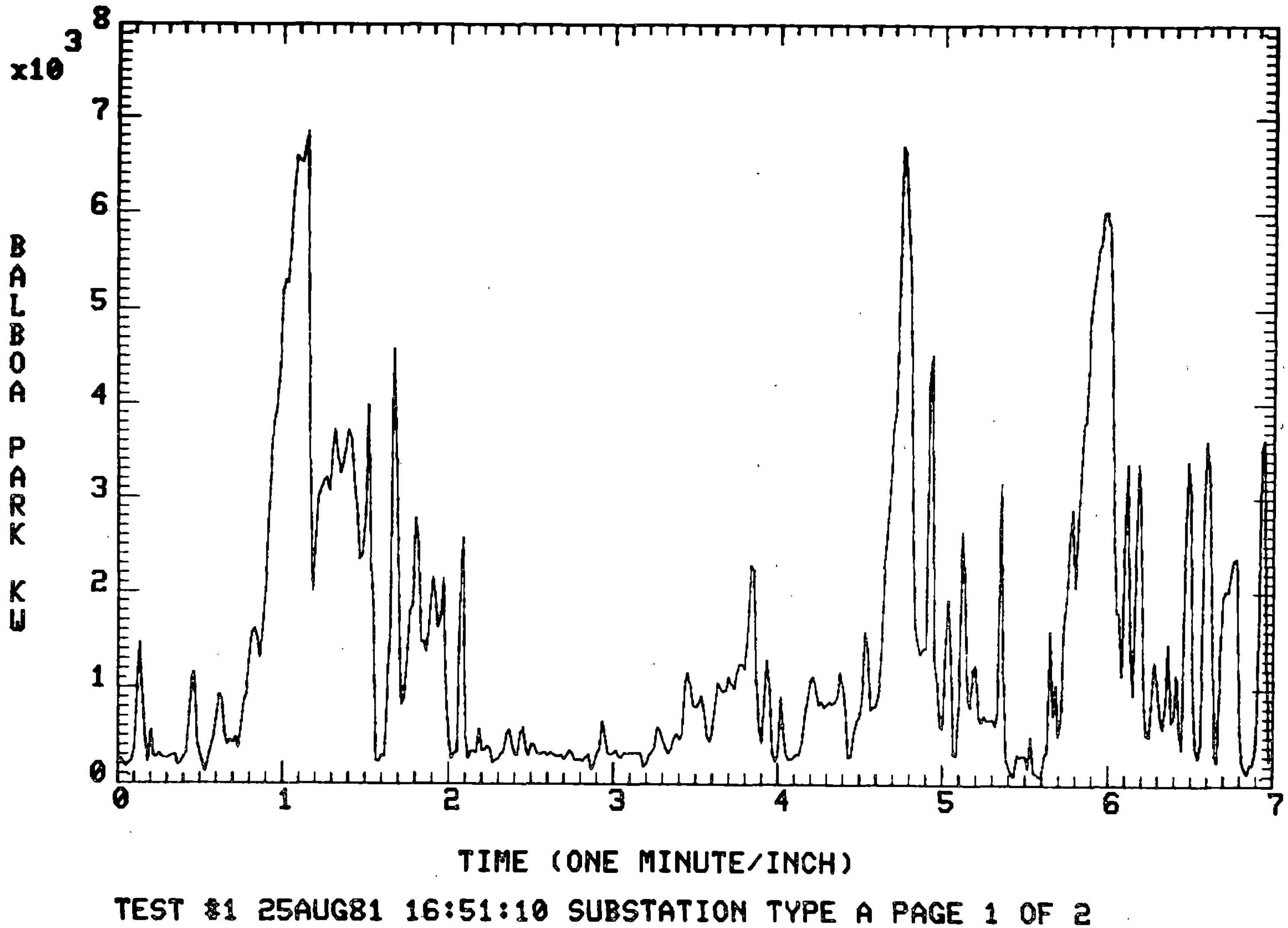
3.4 Noise in Data Recorded at the DC Substations

It was mentioned earlier that the data recorded at the seven dc substations was quite noisy. For Baseline runs with only one train on the test track, it was possible to estimate the noise levels sufficiently accurately and to obtain the kilo-watt-hours supplied by the stations. During Regeneration Test with regular revenue service, it is impossible to isolate the noise and consequently the kWh computations based on integrating the kW-time plots were highly inaccurate. Figure 3.8 presents some of the test data recorded at the substations and also shows the average loading of the individual substations as computed from the data recorded. The total energy consumption of the system recorded at the substations is compared with the ac substation measurements in Figure 3.9. The difference is clearly the result of the noise in the substation measurements. These measurements were, therefore, largely ignored.

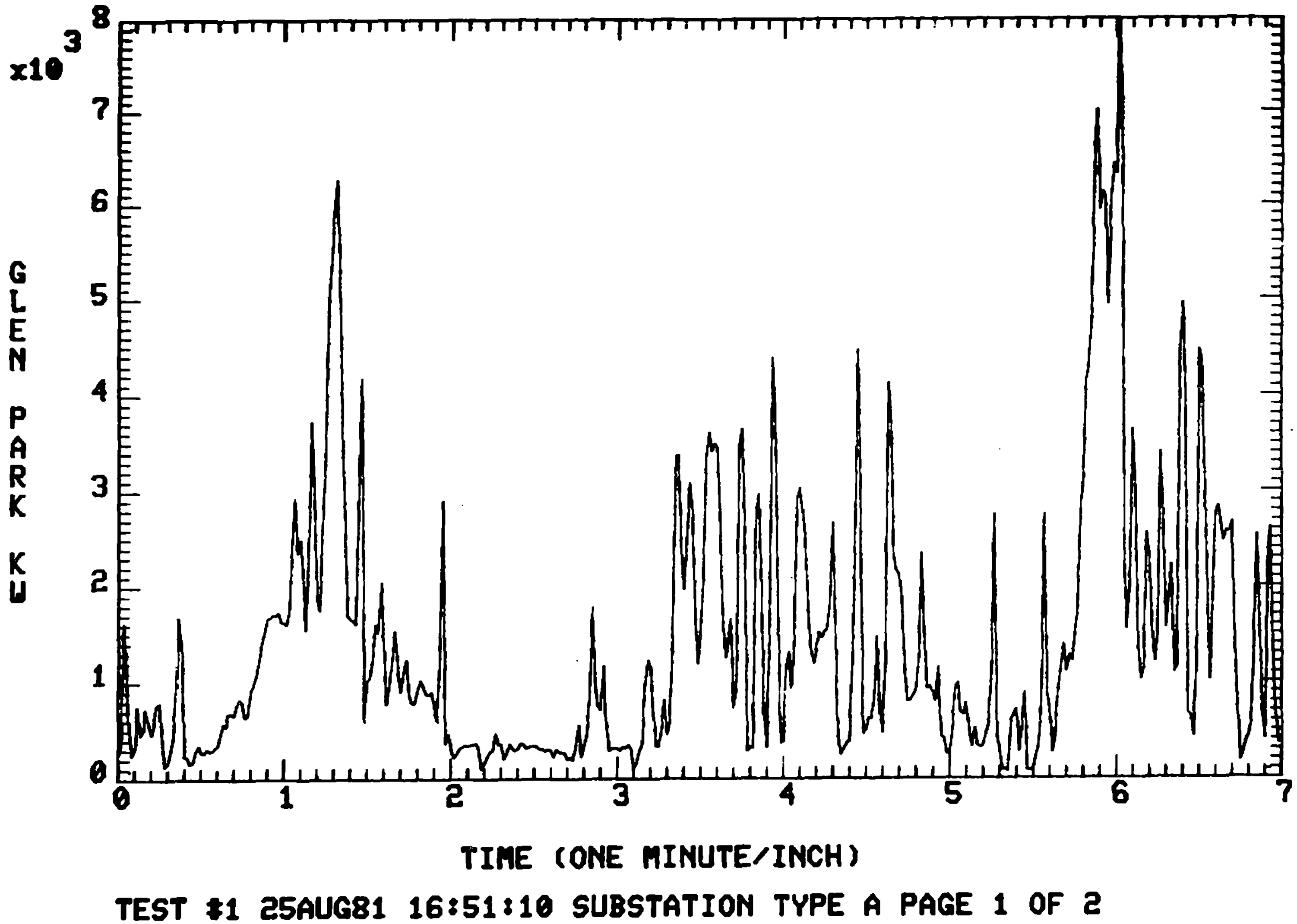
FIGURE 3.8 REGENERATION TEST DATA FOR SUBSTATIONS


x10 3
DALY CITY KW
0
1
2
3
4
5
6
7
8
TIME (ONE MINUTE/INCH)
TEST #1 25AUG81 16:51:10 SUBSTATION TYPE A PAGE 1 OF 2

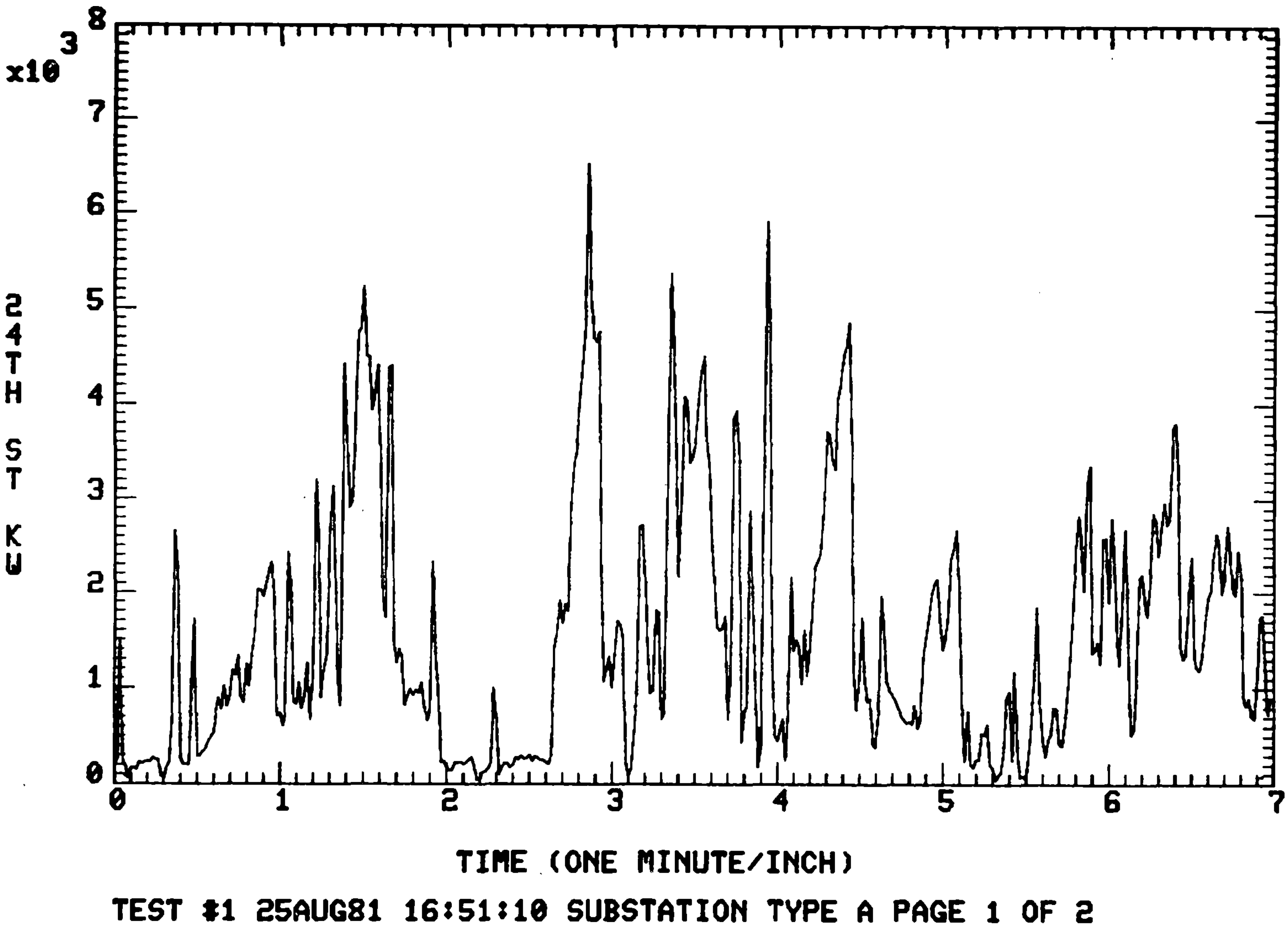
(a)


x10^3
BALBOA PARK KW
0
1
2
3
4
5
6
7
8
TIME (ONE MINUTE/INCH)
TEST #1 25AUG81 16:51:10 SUBSTATION TYPE A PAGE 1 OF 2

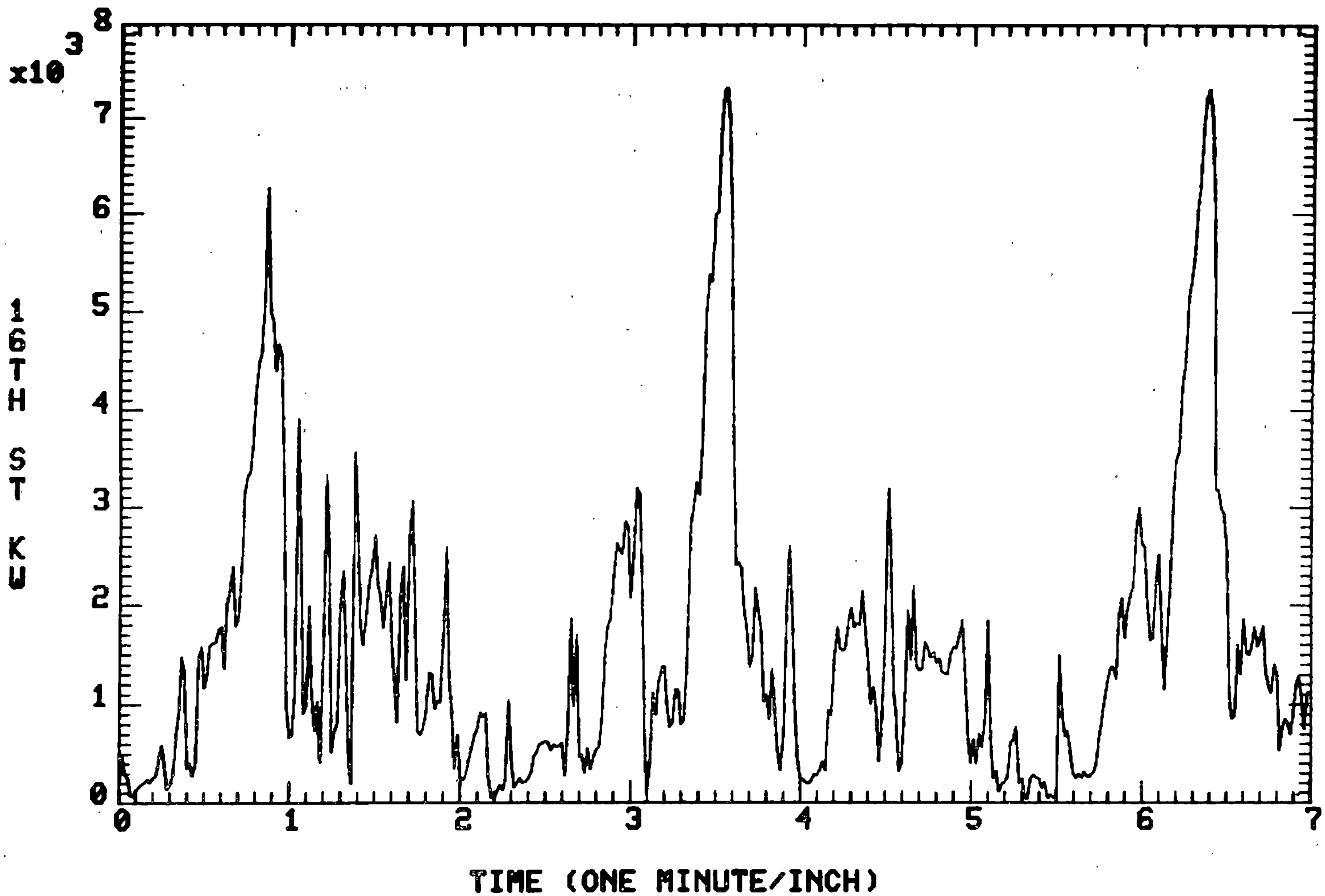
(b)


x10 3
GLEN PARK KW
0
1
2
3
4
5
6
7
8
TIME (ONE MINUTE/INCH)
TEST #1 25AUG81 16:51:10 SUBSTATION TYPE A PAGE 1 OF 2

(c)

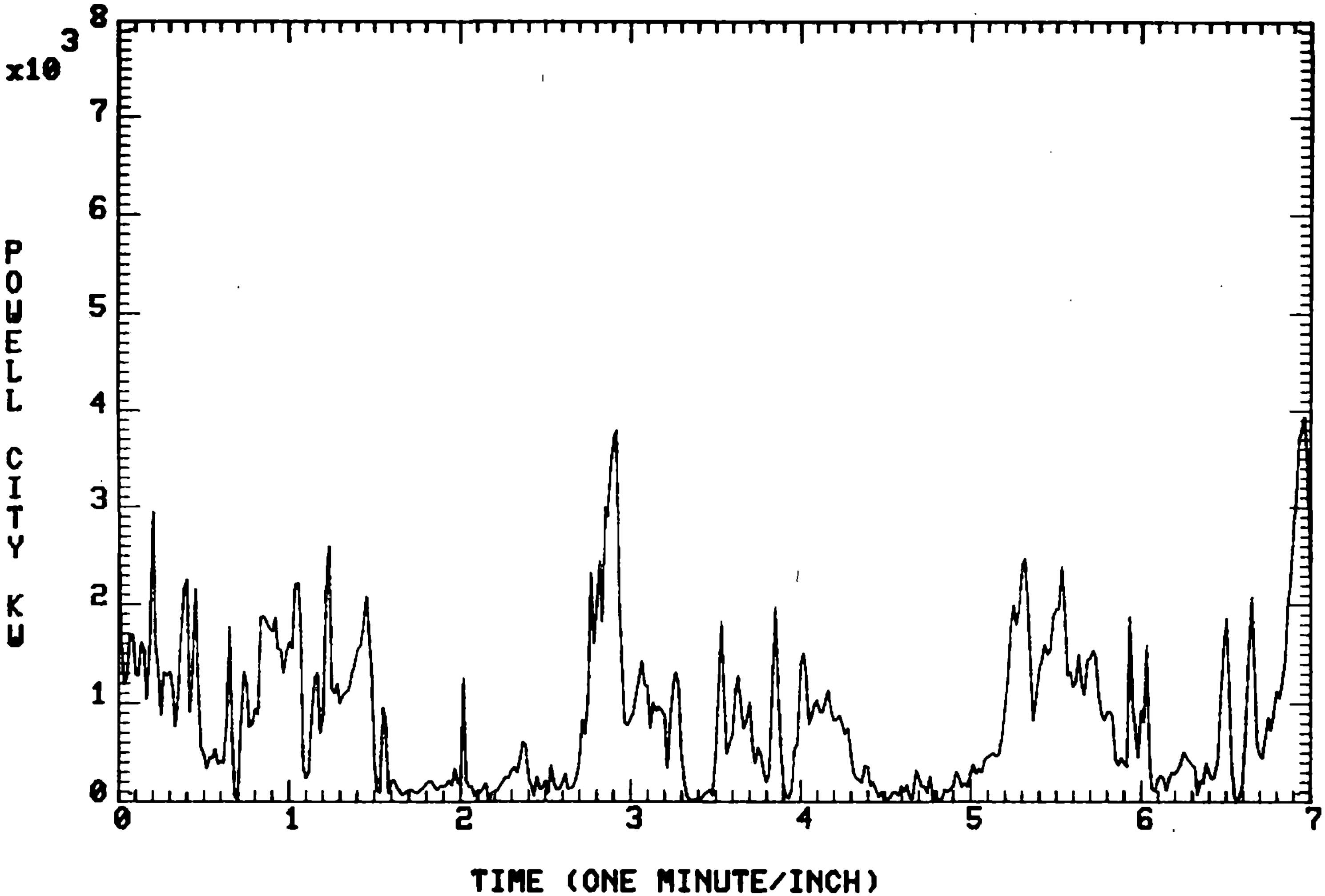

x10 3
24TH ST KW
0
1
2
3
4
5
6
7
8
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)
TEST #1 25AUG81 16:51:10 SUBSTATION TYPE A PAGE 1 OF 2

(d)



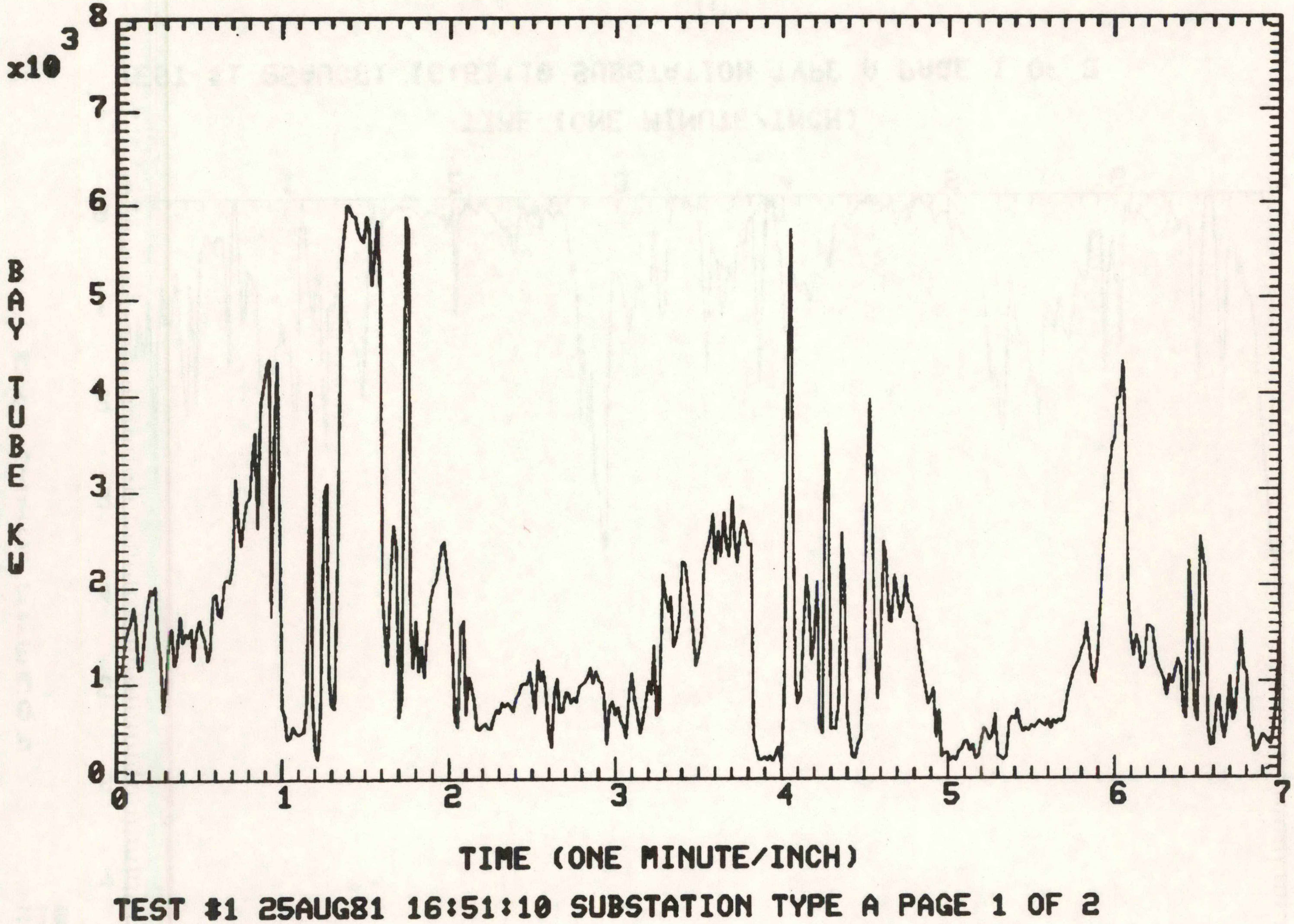
TEST #1 25AUG81 16:51:10 SUBSTATION TYPE A PAGE 1 OF 2

(e)

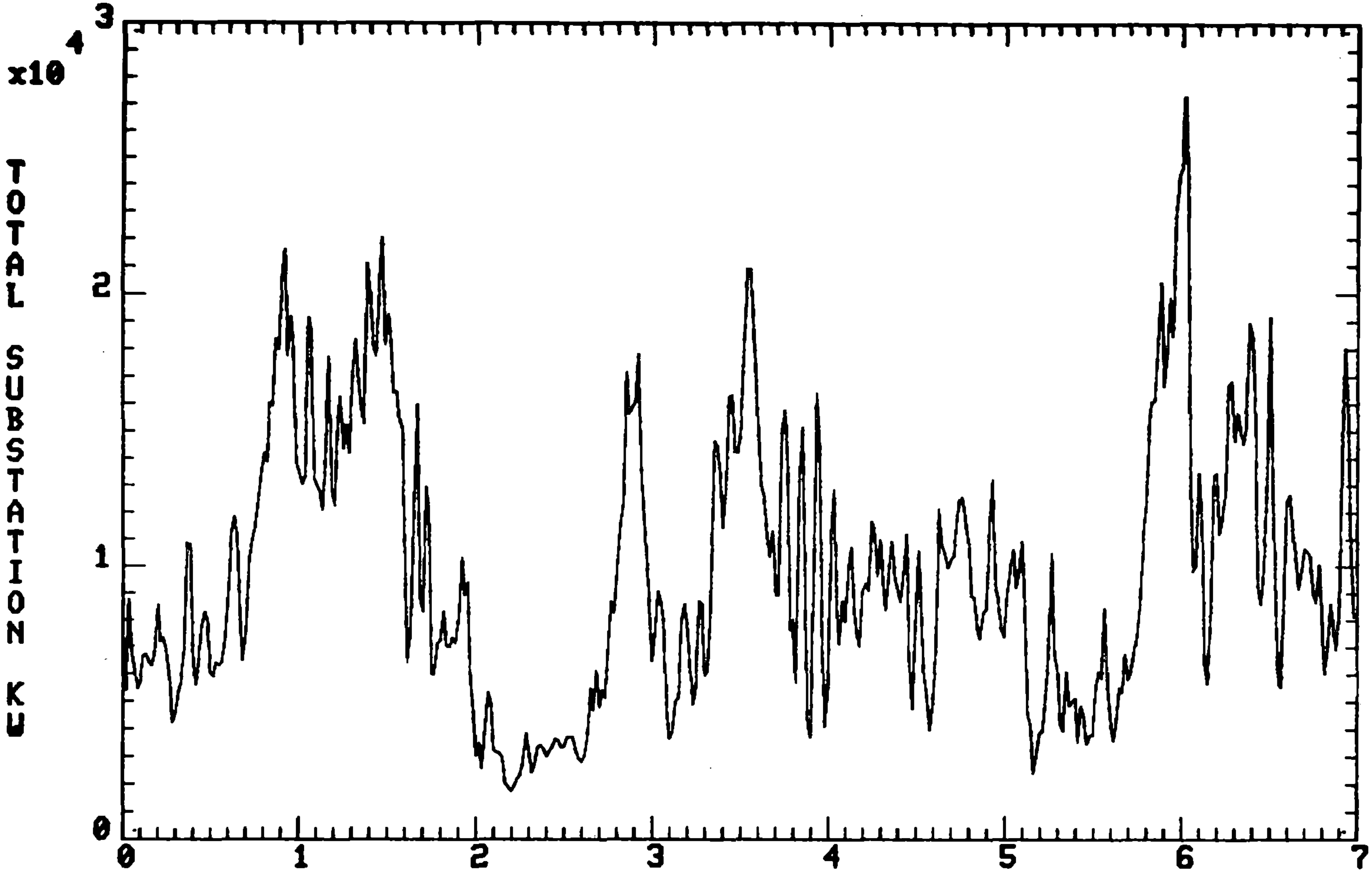


TEST #1 25AUG81 16:51:10 SUBSTATION TYPE A PAGE 1 OF 2

(f)

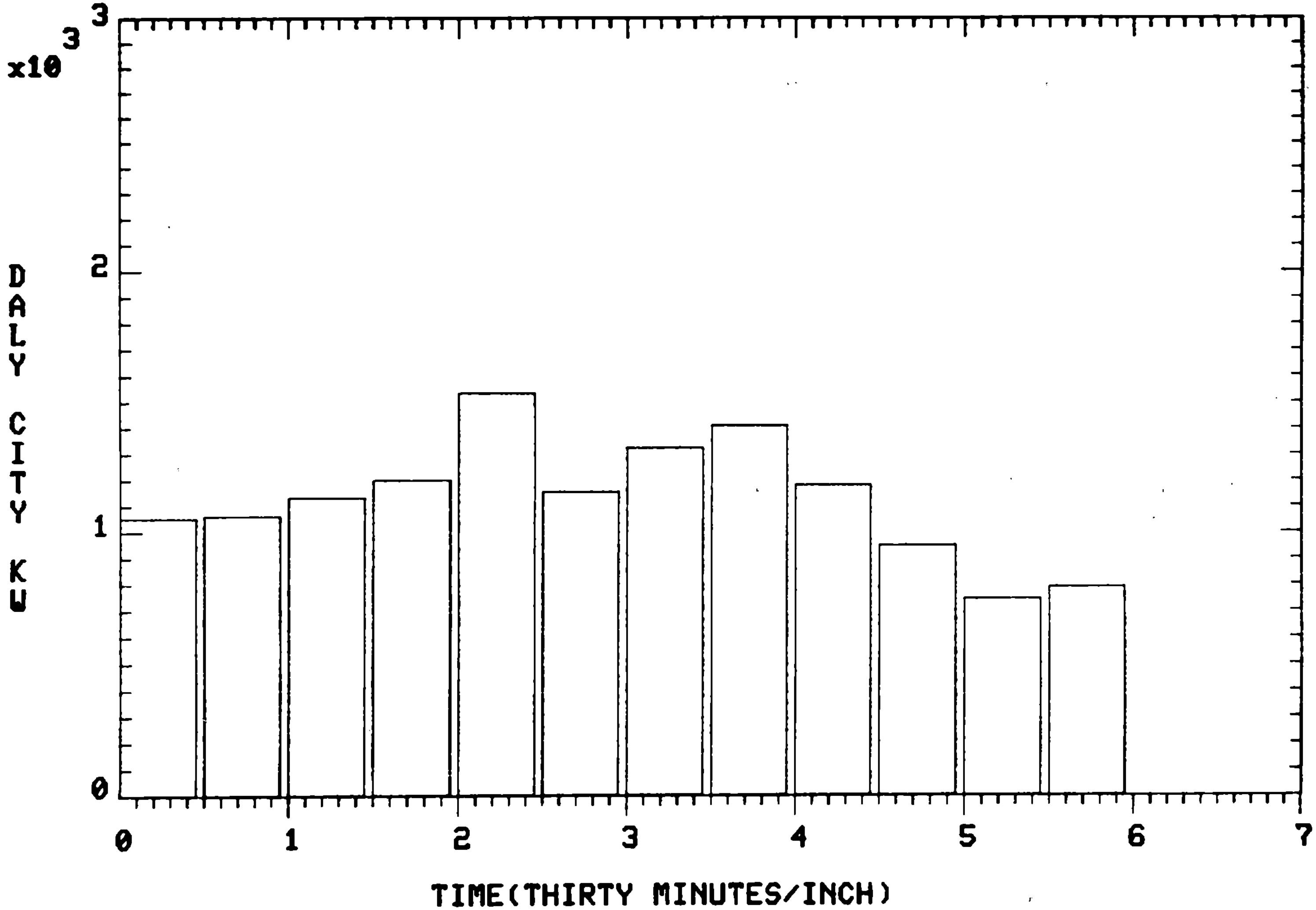

x10^3
BAY TUBE KW
0
1
2
3
4
5
6
7
8
TIME (ONE MINUTE/INCH)
TEST #1 25AUG81 16:51:10 SUBSTATION TYPE A PAGE 1 OF 2

(g)



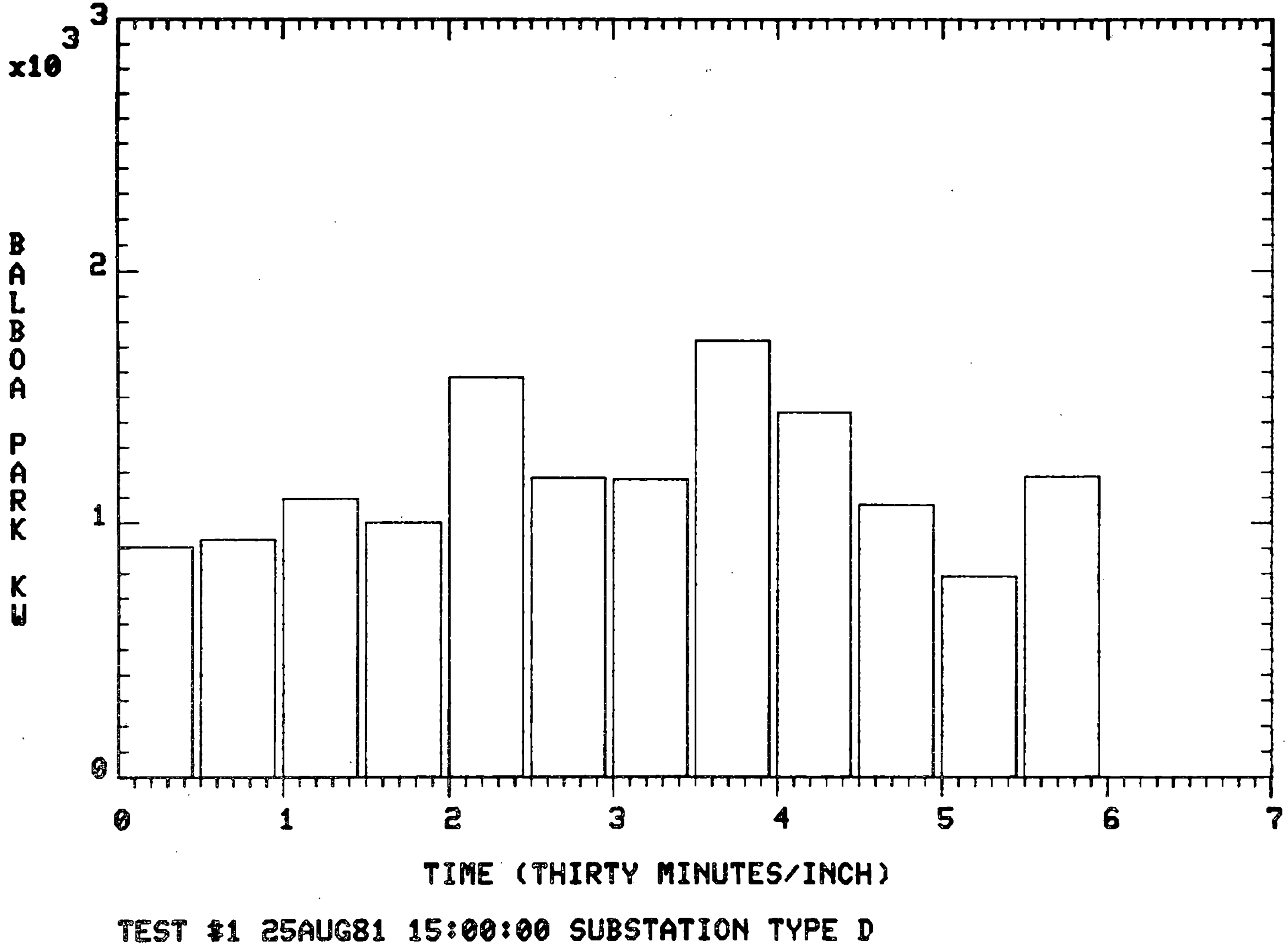
TEST #1 25AUG81 16:51:10 SUBSTATION TYPE A PAGE 1 OF 2

(h)

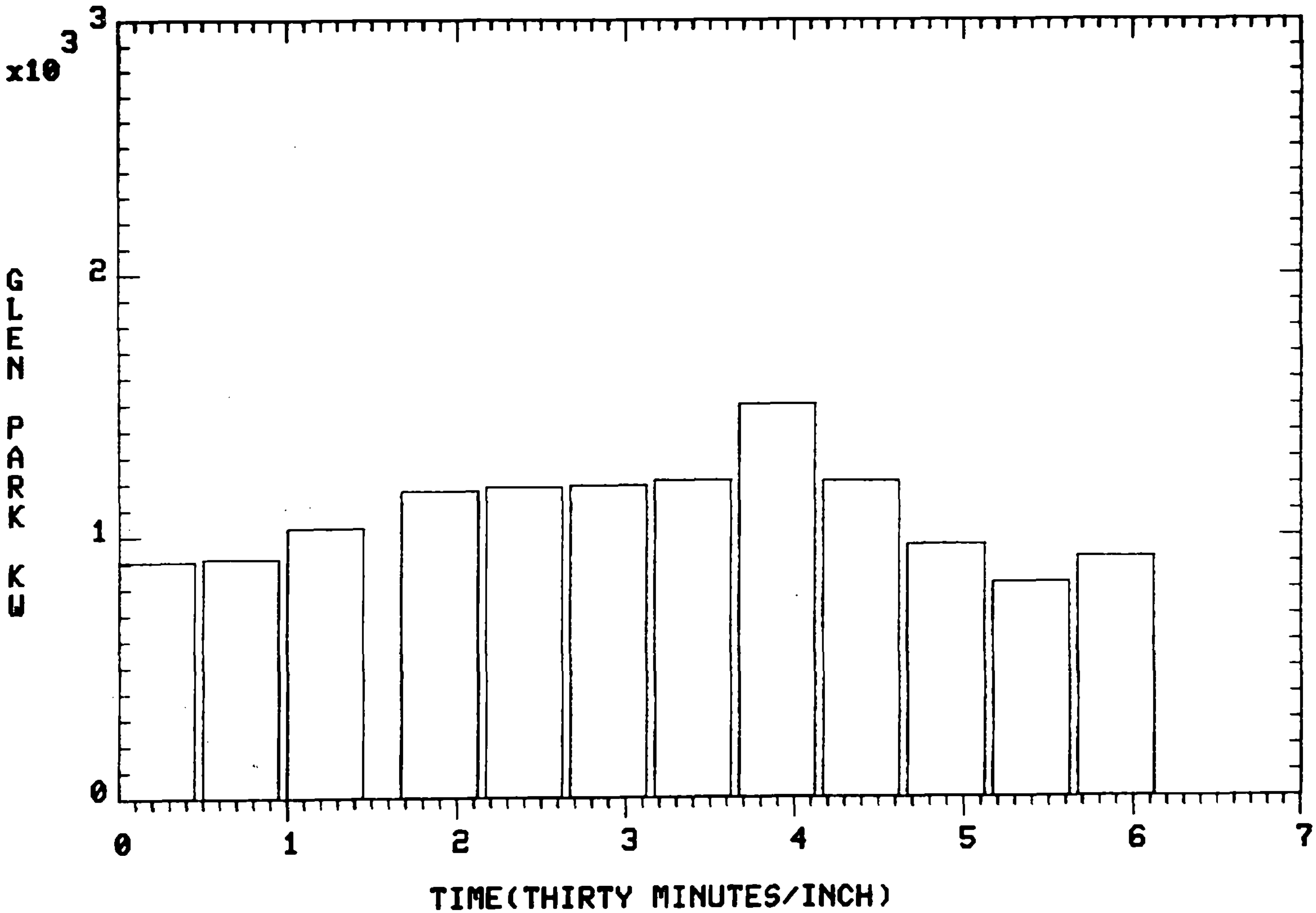


TEST #1 25AUG81 15:00:00 SUBSTATION TYPE D

(i)

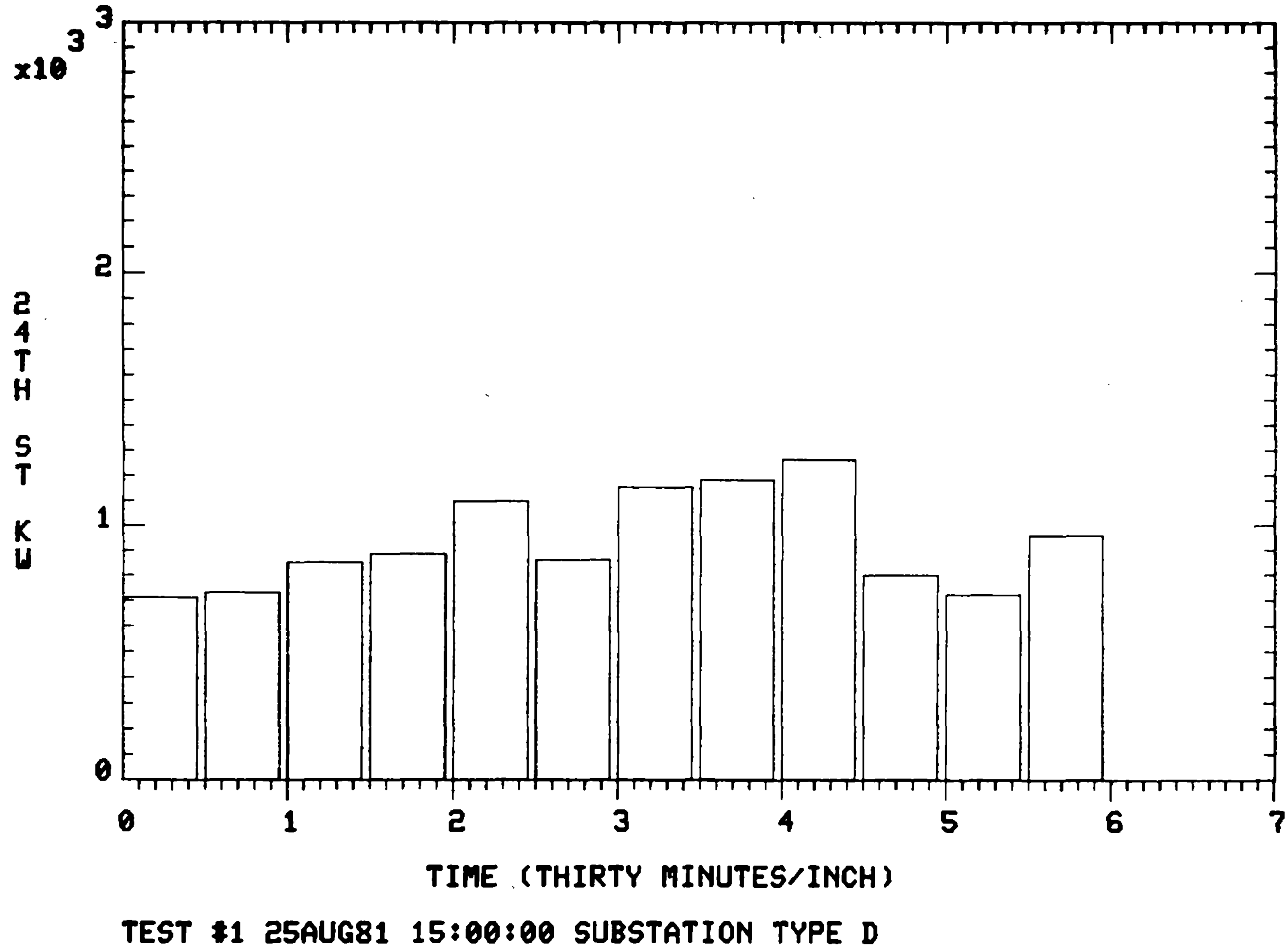

x10^3
3
2
1
0
BALBOA PARK KW
0
1
2
3
4
5
6
7
TIME (THIRTY MINUTES/INCH)
TEST #1 25AUG81 15:00:00 SUBSTATION TYPE D

(j)



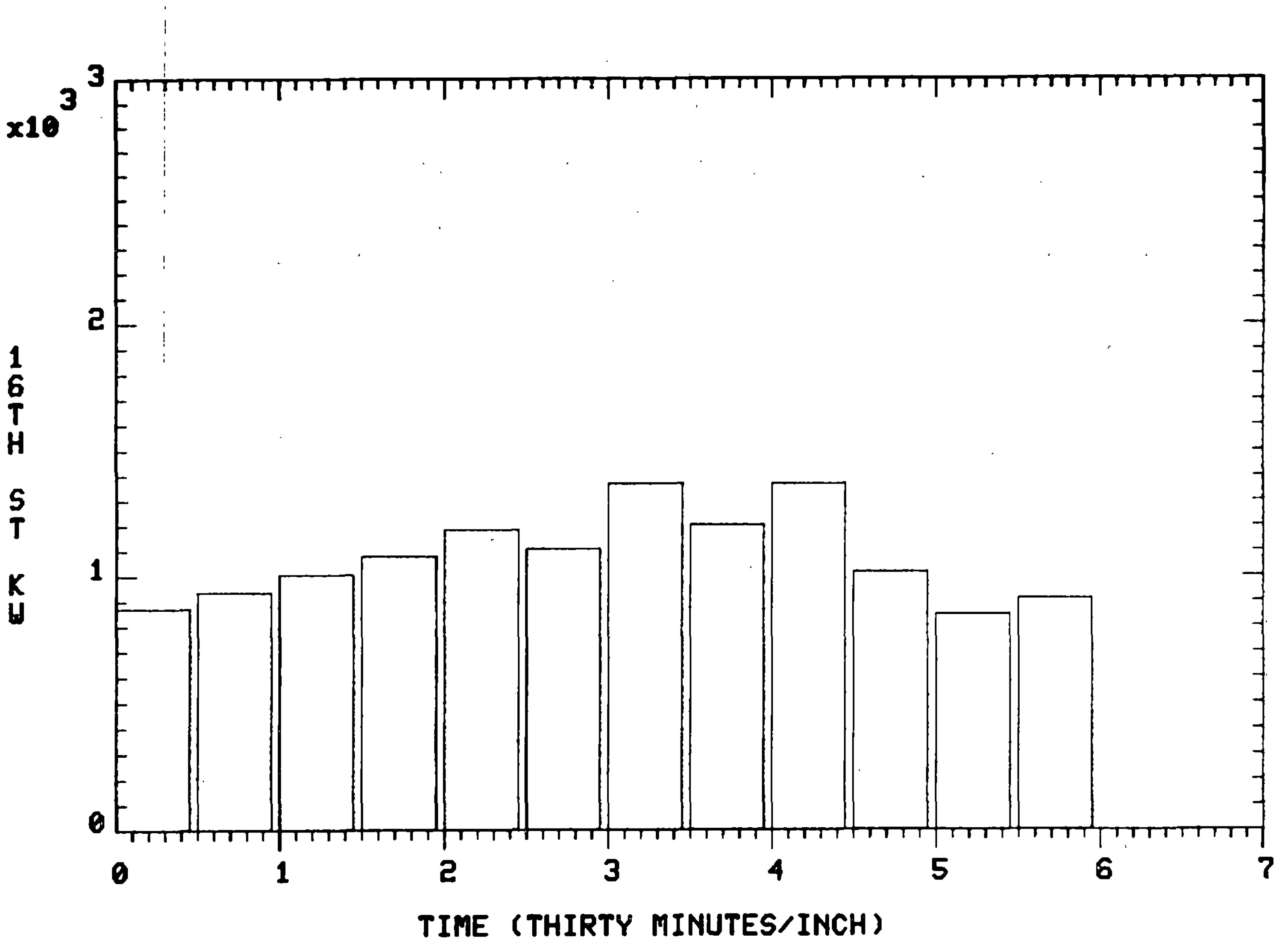
TEST #1 25AUG81 15:00:00 SUBSTATION TYPE D

(k)



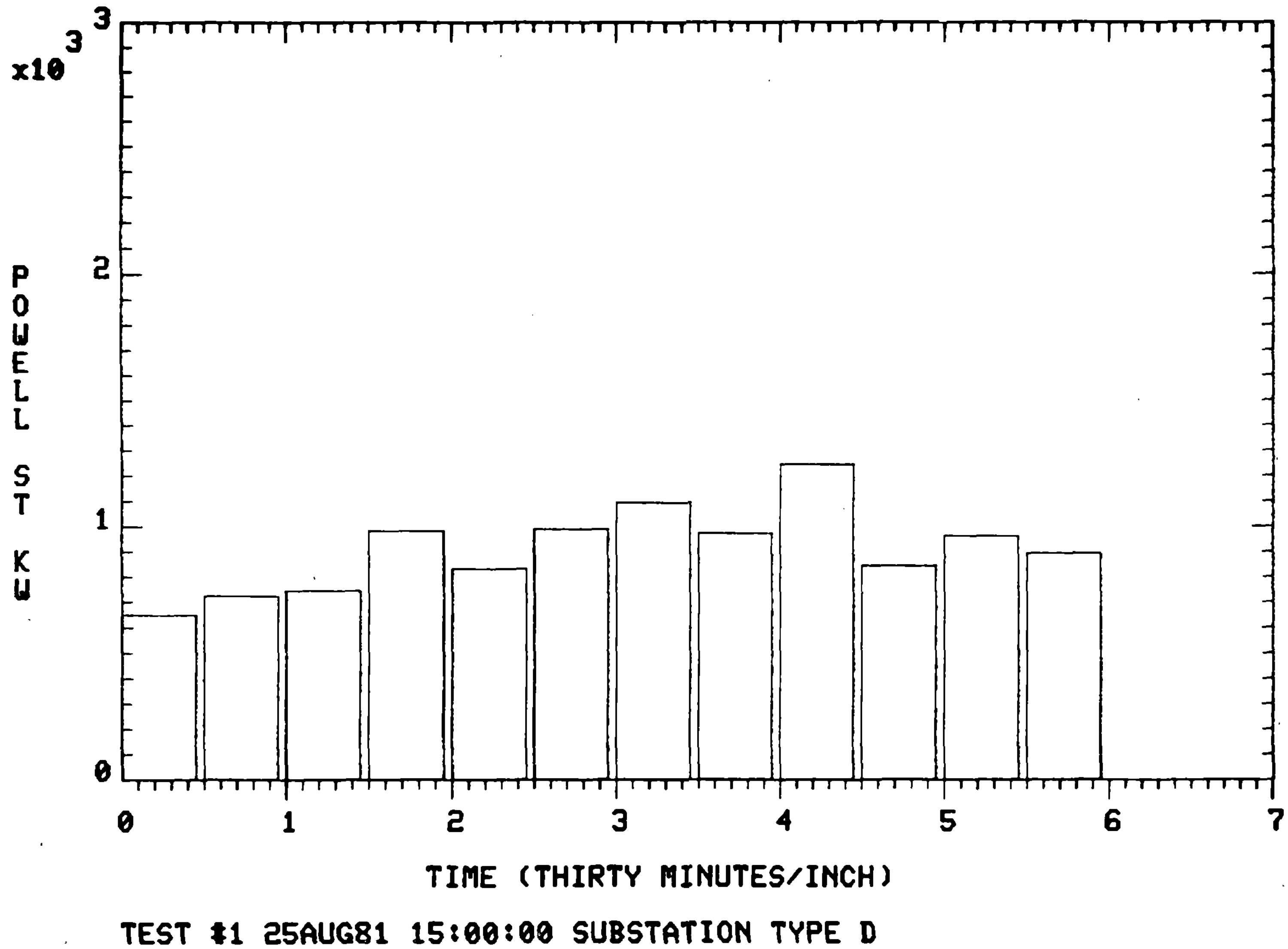
x10^3
3
2
1
0
24TH ST KW
0 1 2 3 4 5 6 7
TIME (THIRTY MINUTES/INCH)
TEST #1 25AUG81 15:00:00 SUBSTATION TYPE D

(1)

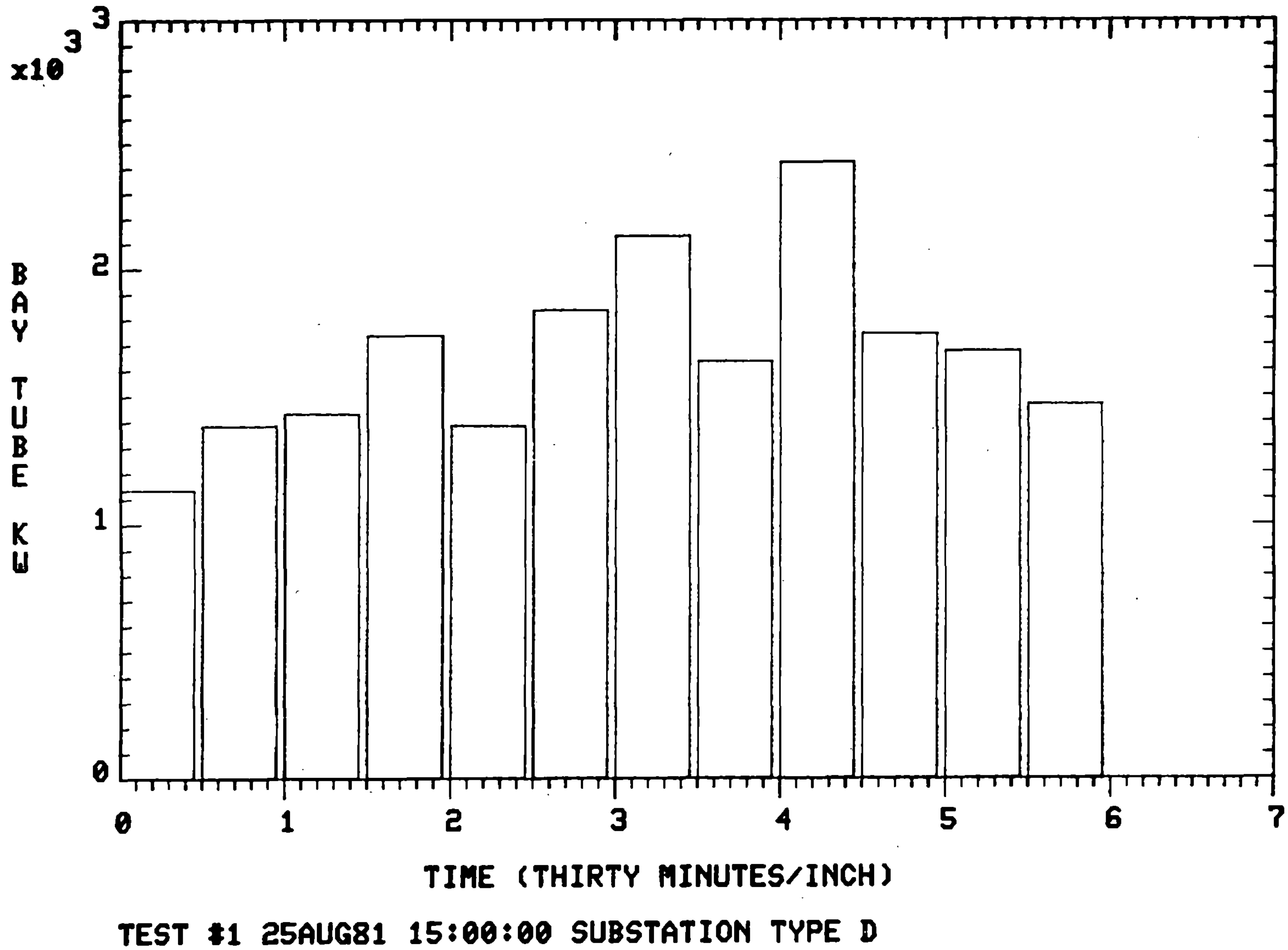


TEST #1 25AUG81 15:00:00 SUBSTATION TYPE D

(m)

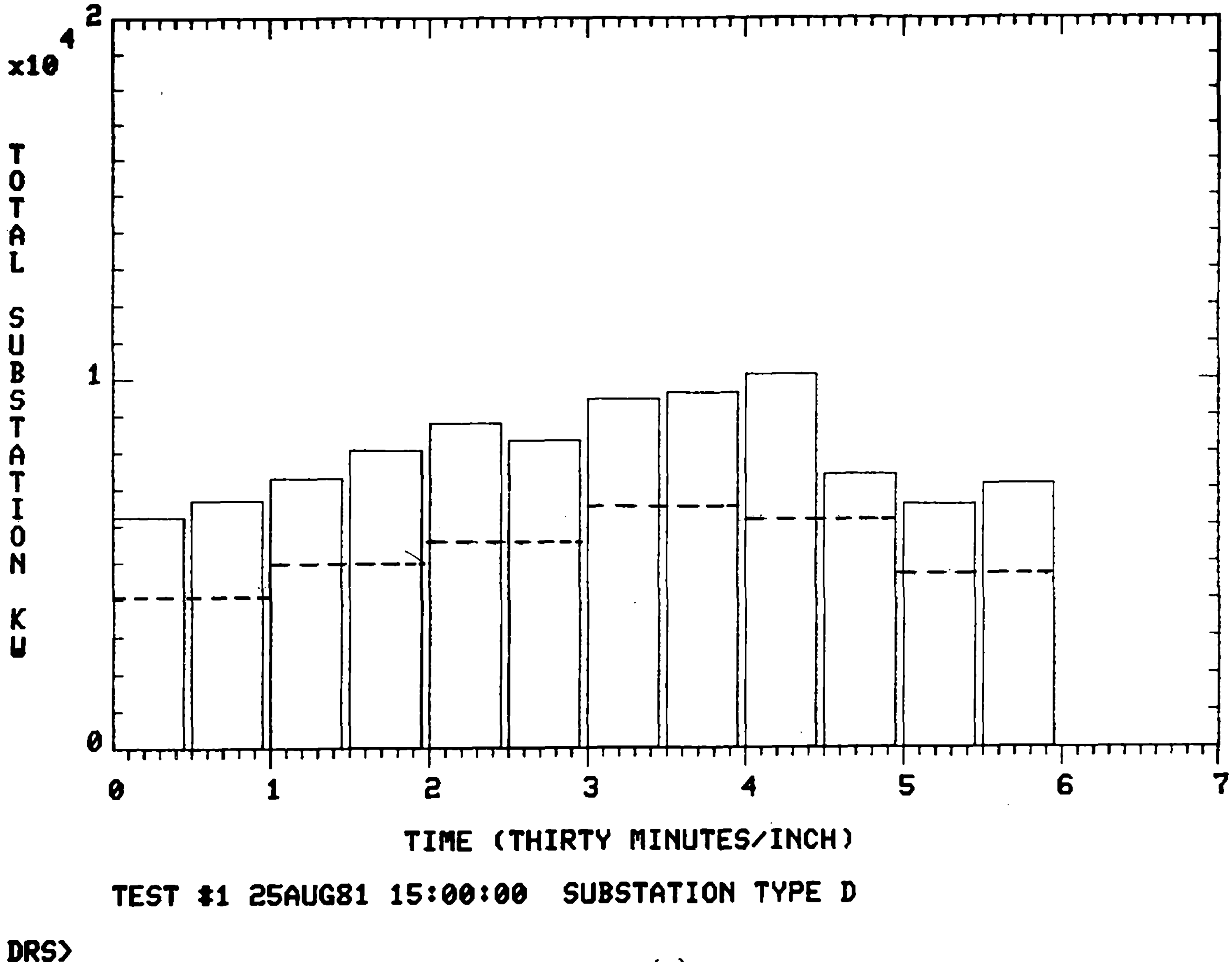

x10^3
3
2
1
0
POWELL ST KW
0
1
2
3
4
5
6
7
TIME (THIRTY MINUTES/INCH)
TEST #1 25AUG81 15:00:00 SUBSTATION TYPE D

(n)


x10^3
3
2
1
0
BAY TUBE KW
0
1
2
3
4
5
6
7
TIME (THIRTY MINUTES/INCH)
TEST #1 25AUG81 15:00:00 SUBSTATION TYPE D

(o)

FIGURE 3.9 TOTAL SUBSTATION LOAD


2
x10^4
TOTAL SUBSTATION KW
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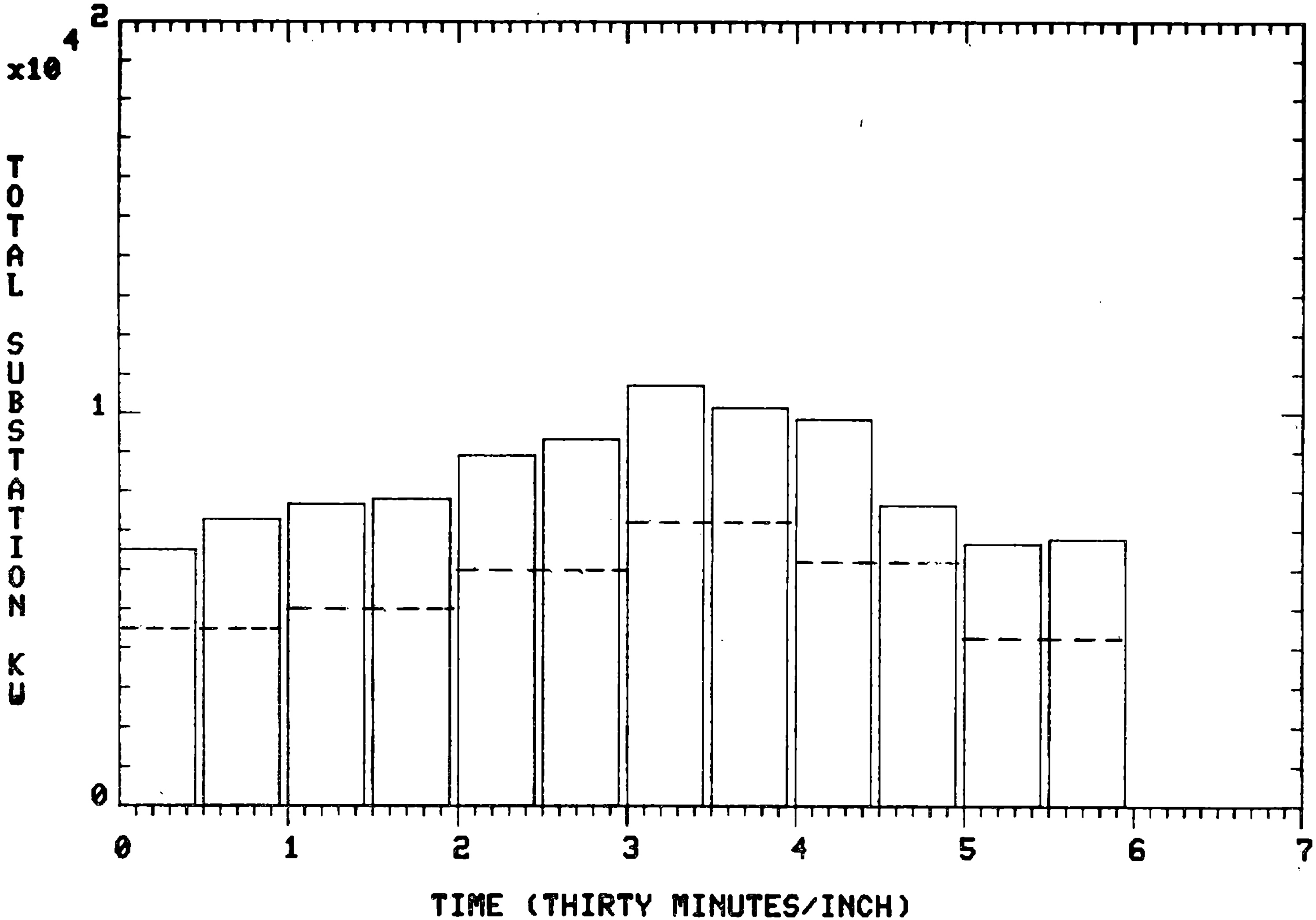
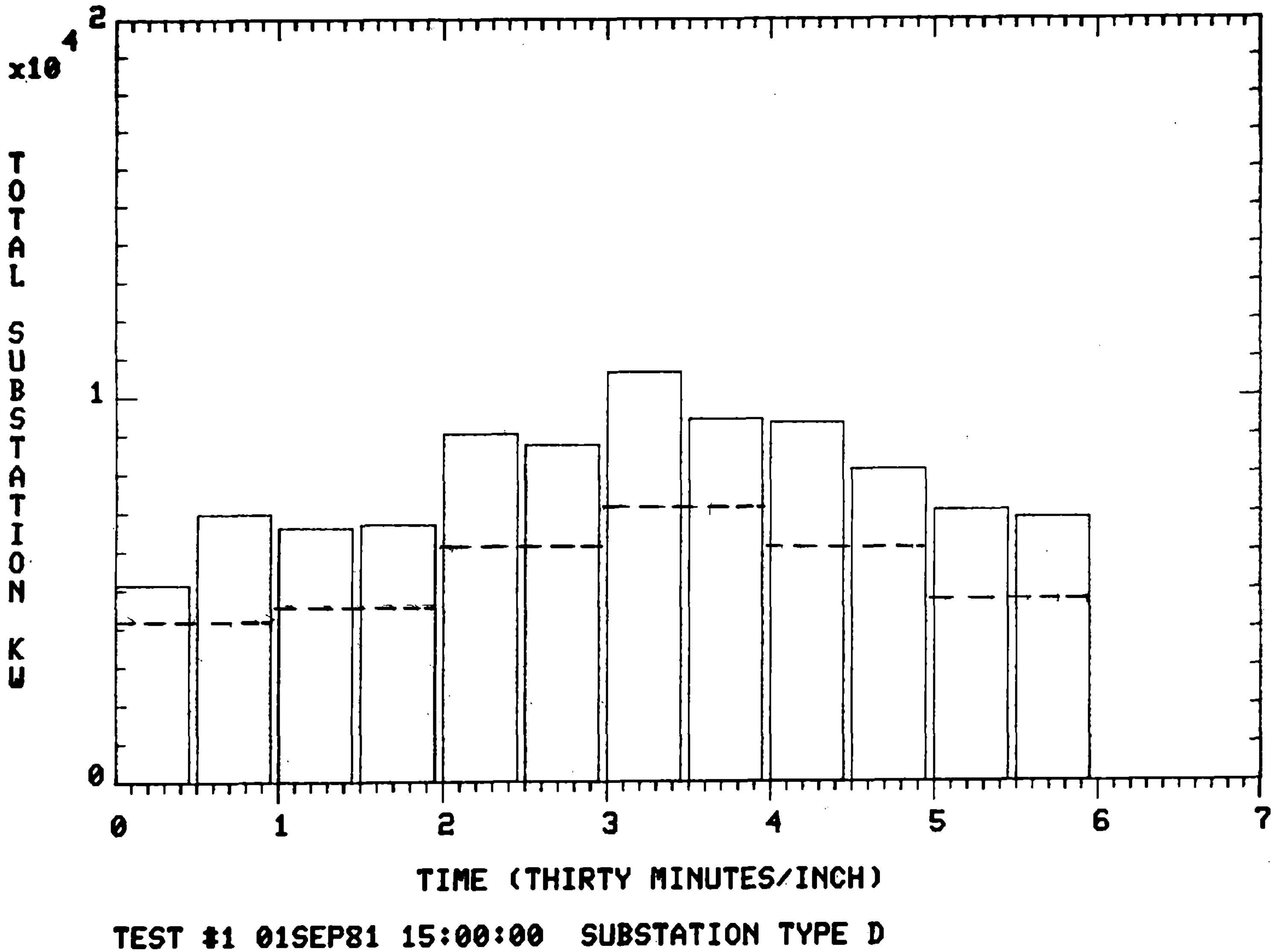
0
0
1
2
3
4
5
6
7
TIME (THIRTY MINUTES/INCH)
TEST #1 25AUG81 15:00:00 SUBSTATION TYPE D
DRS>

(a)



TEST #1 26AUG81 15:00:00 SUBSTATION TYPE D

(b)


x10^4
2
1
0
TOTAL SUBSTATION KW
0
1
2
3
4
5
6
7
TIME (THIRTY MINUTES/INCH)
TEST #1 01SEP81 15:00:00 SUBSTATION TYPE D

(c)

4. COMPUTER MODEL # 1

This computer model basically computes a series of steady state solutions for a transit network, having up to 80 trains and/or substations on one or two tracks, with trains running in opposite directions on a two track system. The program automatically sets up a network of trains and substations at regular intervals of time, based on train movements for a given headway and starting times. This network is then solved to obtain voltage and current at each node, i.e., at a train, or at a substation.

The model assumes that all the trains use either dynamic braking or regenerative braking. A mixed fleet is not permissible. For regenerative braking, line receptivity is computed at each train, and for dynamic braking, the line current is assumed to be equal to the auxiliary current.

4.1 Input Requirements

The basic parameters that define any system include the car weight, acceleration/deceleration rates, speed limits, train consist, line voltage, circuit parameters, etc. In addition to these, the following data files must be set up prior to execution of this model. These are:

1. Information about the two trains travelling in opposite direction, in the form of different time series such as speed, position, tractive effort, operating mode, line current, etc. These time series (S-T-D files) are generated automatically by executing a separate computer program.

2. Information about all the electrical substations within the network such as location, MW rating, efficiency, length and impedance of individual feeders, etc.

4.2 Program Output

The output for each node at any instant of time includes:

- o Node
- o Distance from one end of the system, ft.
- o Speed, mph.
- o Tractive effort, lbs/car
- o Current flowing out of the node, amps.
- o Voltage at the node, volts
- o Line receptivity for regenerative braking (regenerated current as a percentage of the potential current at maximum line voltage)
- o Mode of operation for a train or a substation as
  - \- 5 train in regenerative braking, for coming to a stop or to maintain a given speed
  - \- 1 substation delivering power
  - 0 train parked and drawing auxiliary power
  - \+ 1 train at full acceleration
  - \+ 2 train motoring at a constant speed
  - \+ 3 substation not delivering power
  - \- 3 receptive substation
  - \+ 5 train in dynamic braking

An output summary at any instant of time includes:

- o Power delivered by all the substations, MW
- o Power from all trains in regenerative braking, MW
- o Power drawn by all trains, MW
- o Location of substation sinking the highest current, ft.
- o Current dissipated by the above substation, amps.
- o Power lost in substation impedances, MW

- Power lost in all rail heating, MW
- Regenerative power available if the line is fully receptive, MW
- Power absorbed by all dissipative substations, MW
- Average line receptivity, percent
- Power dissipated in friction or dynamic brake, MW
- Power lost in series R1 resistance, MW
- Power into train auxiliaries of trains in regeneration, MW
- Total electric brake power, MW
- Headways, seconds
- Total number of trains
- Number of trains in mode 5
- Number of stopped trains
- Number of motoring trains

Input data summary at the end of each run includes:

- S-T-D filenames
- Substation location filename
- Output filename
- Receptive substation voltage
- No-load substation voltage
- Maximum receptive substation current
- Times of trains # 1 and # 2, seconds
- Rail resistance, ohm/mile
- Net energy consumption at trains, kWh/car-mile
- Average total substation loading, MW
- Flag if regenerative braking is not used.

4.3 BART Test Simulation

The revenue service operation for which all the operational data was provided covered a total of nine hours of actual operation. The parameters such as train length, performance level, passenger load, dwell, headway, etc., varied over a very wide range during this period. The model was, therefore, used to simulate only a 10-minute period - 16:51:25 hours to 17:01:25 hours on 25 August 1981.

As explained earlier, the simulation assumes that all the trains have equal length, and run with a fixed headway. The performance level and the dwell can, however, be different for each direction of travel. This ten minute period was, therefore, closely examined and the following constants were selected for use in the simulation:

- A train length of 8 cars
- A performance level of PL2 for trains departing from the Daly City station, and a level of PL1 for trains in the opposite direction
- An average dwell of 14.3 seconds for trains leaving the Daly City, and a dwell of 17 seconds for trains in the opposite direction. A correction of 10 seconds was added to the above dwells, because the dwells given in the 'BART System Log' represent only the time interval between the door openings and door closings at the stations.
- Actual values for the passenger loads on the trains were averaged for each station in each direction. These varied from a low of two per car leaving the Daly City to a high of 220 per car leaving the Embarcadero station towards Oakland.
- Over this ten minute period, the headway averaged 254 seconds, with a low of 137 seconds, a high of 601 seconds, and a median of 200 seconds. A value of 254 seconds was used in this simulation.
- Train departures in both directions were based on the actual schedule of the test train 453-06 of 25 August 1981. The doors closed at the Embarcadero station at 16:46:43 hours. For simulation, it was assumed that the train left the Mile Post 6 (MP6) at 16:44:17 hours. The closest actual departure from the Daly City was at 16:44:10 hours. By adding one half of the ten seconds

correction, the correct departure was assumed to be at 16:44:15 hours, i.e., with an offset of 2 seconds between the traffic in the opposite directions.

- The test section is open-ended at the MP6 end beyond the Embarcadero station, i.e., the trains are in motion when they enter or leave the test track. This model assumes that the trains are at zero speed at both ends of the test section. This causes the Daly City-bound trains to accelerate at MP6, and increases the load at the Bay Tube West substation. This is, of course, partially offset by the trains assumed to be at zero speed in the opposite direction, although they are in fact accelerating.
- This model also assumes a fixed level track braking rate, in contrast to BART method of applying brakes at the approaching end of a platform. For this simulation, this fixed stopping distance was combined with the approach speeds and grades to compute an average braking rate for each direction.
- The average wheel diameter of 29.194 inches for the three test cars was used for the entire fleet.
- Vehicle speeds are assumed to be held at (ATO limit - 2) mph.

As noted earlier, the station dwell was adjusted by 10 seconds to account for the time interval between the start (and end) of the train motion and the closing (and opening) of the car doors. When the recorded running time was adjusted downward by this amount, excellent correlation was obtained with computer predictions for the Baseline runs, as summarized in Tables 4.1 and 4.2.

4.4 Results of Simulation

The results of simulation of the Baseline runs are presented in Table 4.3, and these are compared with the test data in Table 4.4.

TABLE 4.1

RESULTS OF MODEL # 1

RUN TIME CORRELATION FOR BASELINE RUN M90 - M16

RUN	SECONDS DATA**	SECONDS MODEL
M90 - M80	228*	210
M80 - M70	127	123
M70 - M60	172	172
M60 - M50	107	108
M50 - M40	126	125
M40 - M30	73	70
M30 - M20	68	67
M20 - M16	56	59

** Average of Runs 1 - 4 , adjusted

* Run 1 only

TABLE 4.2

RESULTS OF MODEL # 1

RUN TIME CORRELATION FOR BASELINE RUN M16 - M90

	SECONDS	
RUN	DATA*	MODEL
M16 - M20	-	61
M20 - M30	-	68
M30 - M40	66	70
M40 - M50	128	128
M50 - M60	104	106
M60 - M70	179	185
M70 - M80	131	116
M80 - M90	223	217

* Average of Runs 5 - 6, adjusted

TABLE 4.3

RESULTS OF MODEL # 1

VEHICLE AND SUBSTATION ENERGY CONSUMPTION FOR BASELINE RUNS

RUN	CAR KWH	KWH FOR SUBSTATIONS FOR A FOUR CAR TRAIN							
		MDC	MBP	MGP	MTF	MSS	MPS	MTW	TOTAL
1	34.42	19.09	21.77	20.43	18.42	19.09	22.11	15.74	137.33
2	34.88	19.07	21.42	16.40	18.41	19.74	24.43	19.41	140.54
3	30.76	18.92	18.19	21.47	11.64	12.37	23.29	17.10	123.70
4	33.54	18.40	20.78	19.42	18.06	17.72	22.14	18.74	132.86
5	45.09	11.80	35.41	25.30	22.60	17.20	27.66	40.47	182.12
6	44.46	11.88	34.28	23.08	22.40	19.01	27.83	39.71	179.88

Notes: 1. All results based on MP6 - M90 and M90 - MP6 runs.

2. Energy per car for M16 - MP6 is 2.88 kWh.

3. Energy per car for MP6 - M16 is 6.10 kWh.

TABLE 4.4

RESULTS OF MODEL # 1

ENERGY CONSUMPTION (KWH/CAR) OF BASELINE RUNS

RUN	MODEL[1]	AVG. MODEL	DATA[2]	AVG. DATA
1	31.54		33.59	
2	32.00		34.21	
		30.52		34.90
3	27.88		37.31	
4	30.66		34.49	
5	38.99		51.75	
		38.68		52.47
6	38.36		53.19	

1 Model assumes total station dwell times equal to 10 seconds plus the dwell given in Tables A-5 through A-10.

2 Test data is for Engineering Car which weighs over 43 percent more than the average train weight per car.

It should be remembered here that the weight of the BART Engineering Car is over 43 percent more than the average weight per car of the experimental train. Its energy consumption is, therefore, higher than that of the train on a per car basis. The specific energy consumption of a car has a weak incremental relationship to its weight, and this relationship is quite route specific. The sensitivity of the transit car energy consumption to its weight was discussed earlier in Section 3.3. Accounting for this weight differential, the model prediction for the baseline runs seems to be about 2.75 percent higher than the test data for the M90 - M16 trip, although for some reason, the model predictions seem to be about 13.4 percent lower than the test data for the M16 - M90 trip.

The revenue service was simulated with a headway of 254 seconds, i.e., 4 minutes and 14 seconds. Since identical trains are continually dispatched with this headway, the substation loading is also periodic over this time period. The 30-minute average substation loading is, therefore, meaningless under these conditions. The peak and the average loading over a typical headway cycle are, however, presented in Table 4.5. The total substation load is predicted to be 6.13 MW, and is in very good agreement with the 6.45 MW load measured at the ac substation by the utility system.

Some typical charts resulting from this simulation are presented in Figures 4.1 - 4.3. Simulation of the Baseline Run #5 shows very clearly that each of the substations is loaded in sequence starting from the Bay Tube West substation, as the train moves from Embarcadero to Daly City. In the revenue service simulation, each substation has a heavy load whenever a train is accelerating in its vicinity. For example, the Daly City passenger station, i.e., only once in a headway cycle. The Bay Tube West substation will, however, supply accelerating trains at the Montgomery Street, the Embarcadero, and the MP6 (a pseudo station assumed for this simulation) passenger stations.

TABLE 4.5

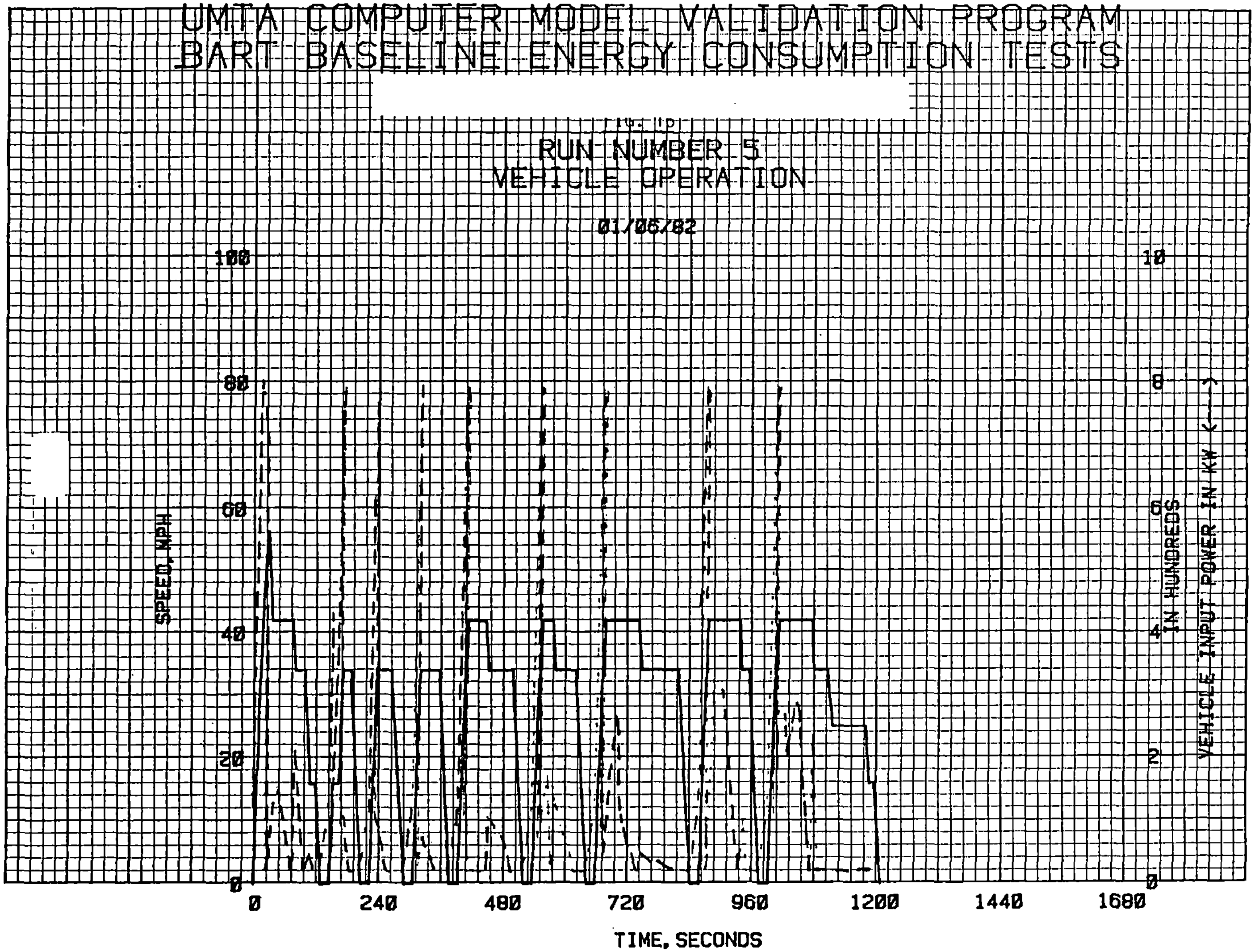
RESULTS OF MODEL # 1

AVERAGE AND PEAK SUBSTATION LOADS FOR REGENERATION TEST

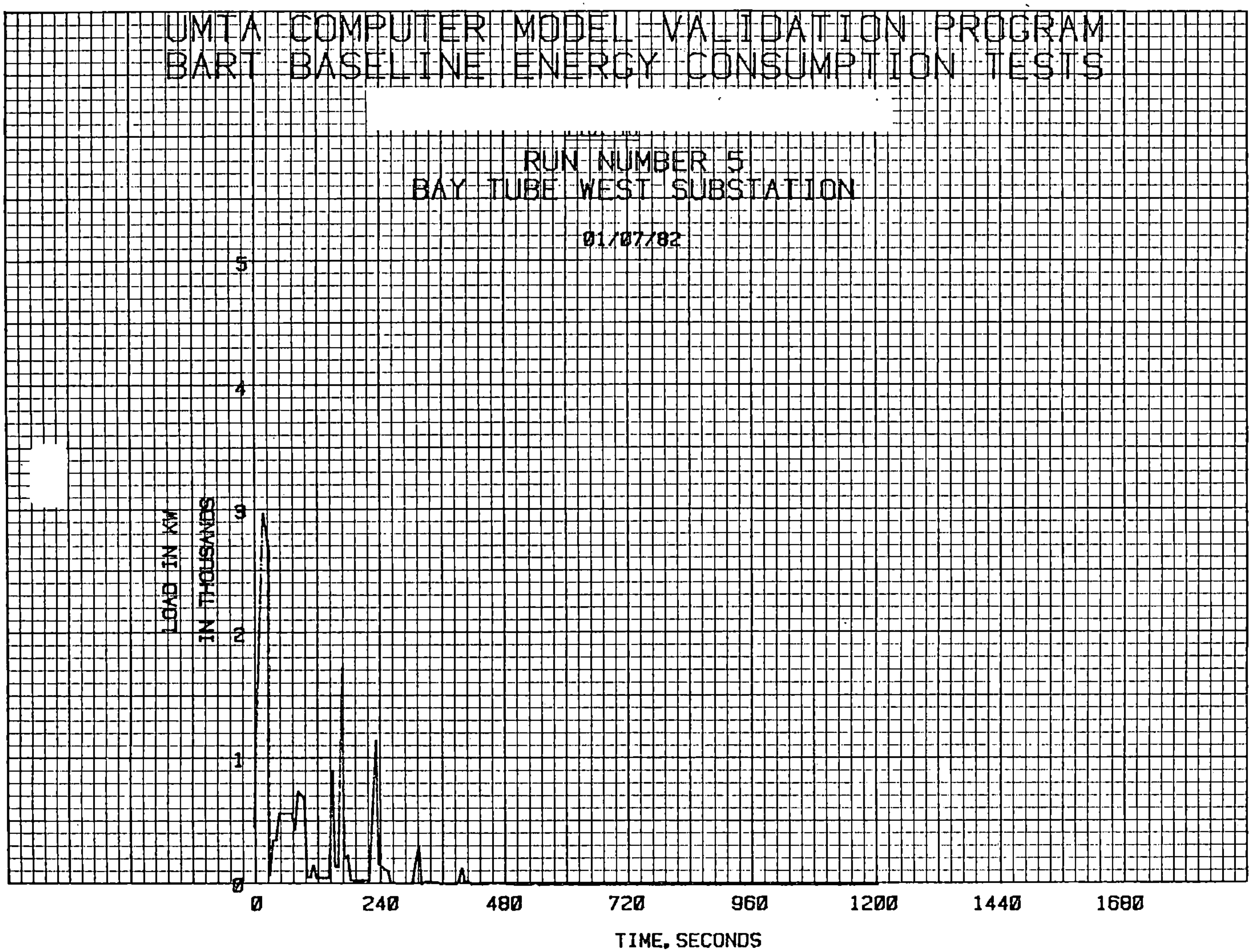
SUB STN	AVG. MW	PEAK MW	TIME*
MTW	1.119	6.291	16:53:02
MPS	0.850	6.640	16:54:15
MSS	0.962	5.718	16:52:07
MTF	0.909	6.094	16:52:07
MGP	0.733	4.581	16:55:05
MBP	0.768	5.693	16:53:41
MDC	0.645	5.452	16:52:55
TOTAL	6.130	18.508	16:54:08

* During a 254 seconds headway cycle beginning at 16:51:26

FN-521-A (8-50) (E) 70X100 1/10 Inch Divisions

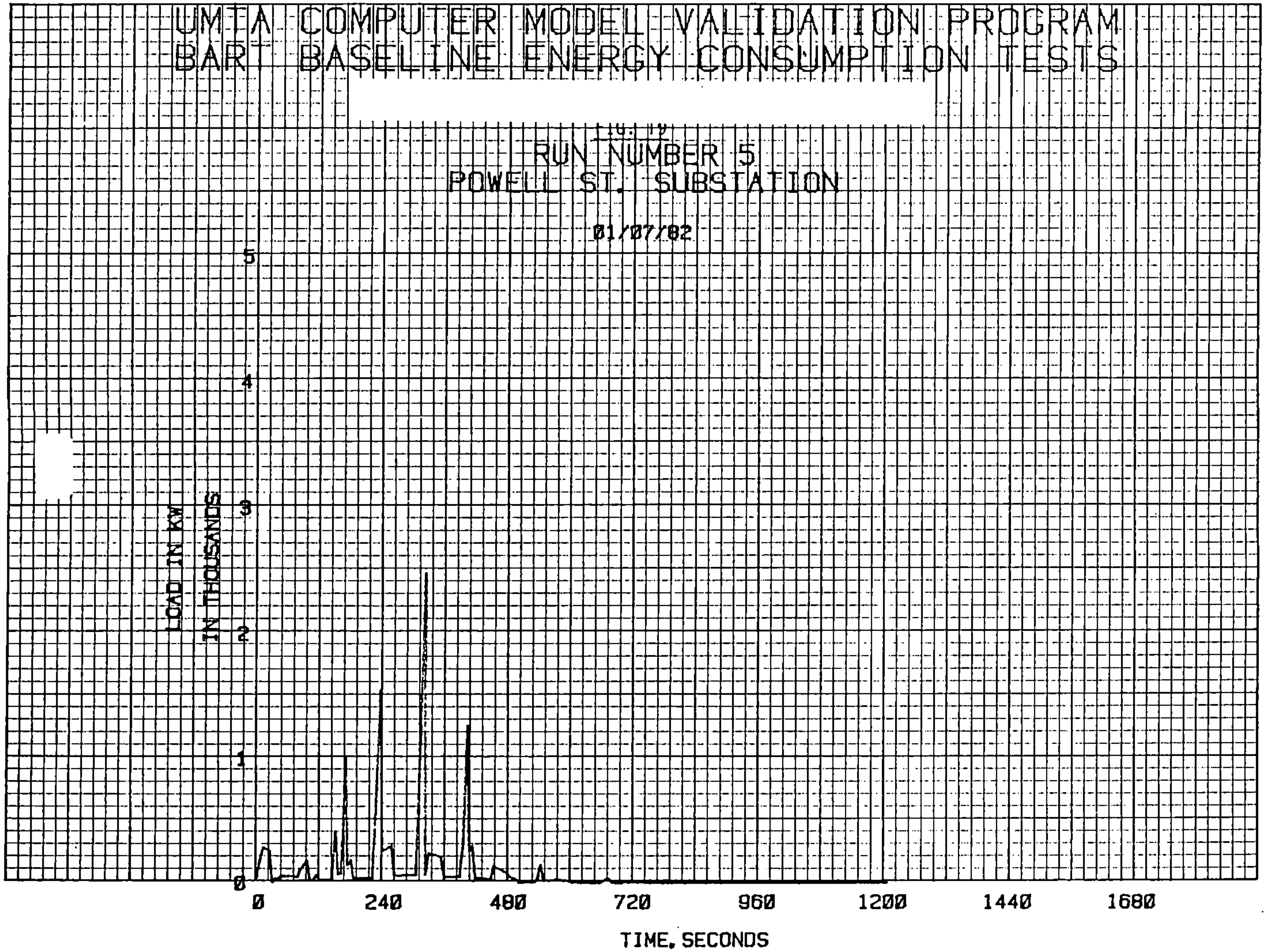


(a)

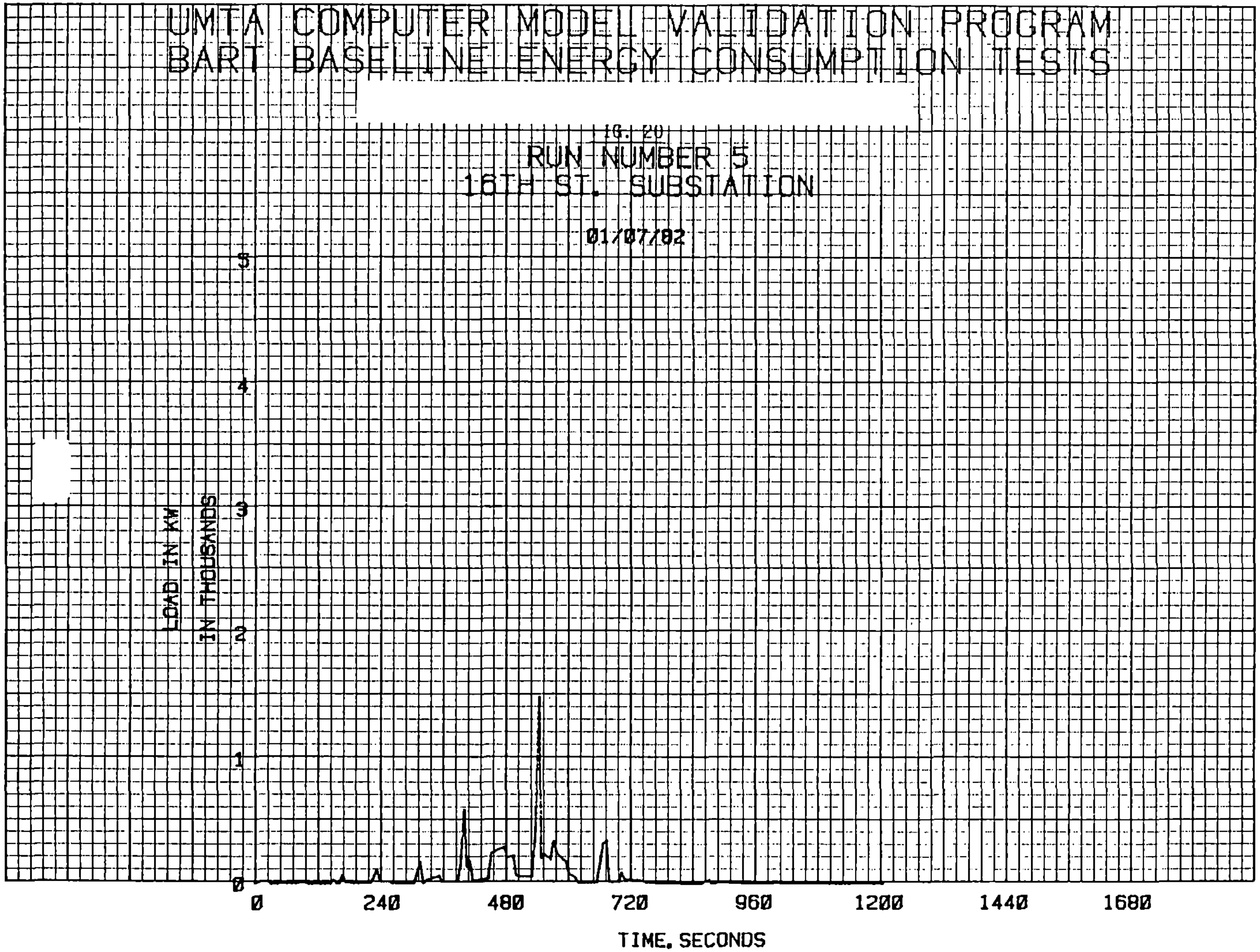

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART BASELINE ENERGY CONSUMPTION TESTS
RUN NUMBER 5
BAY TUBE WEST SUBSTATION
01/07/82
LOAD IN KW
IN THOUSANDS
0
1
2
3
4
5
0
240
480
720
960
1200
1440
1680
TIME, SECONDS

(b)

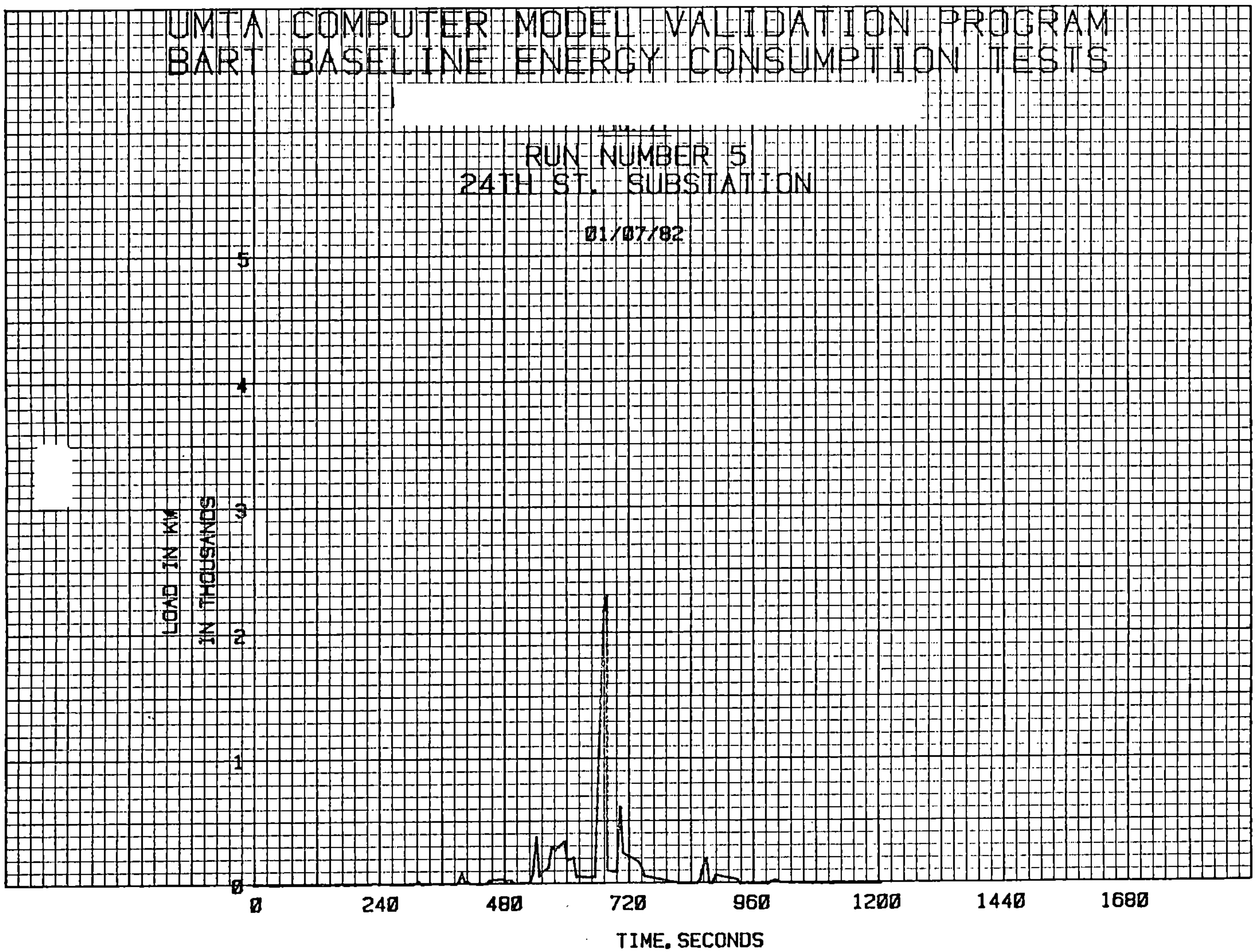
FN-521-A (8-70) (E) 10X100 1/10 Inch Divisions



(c)

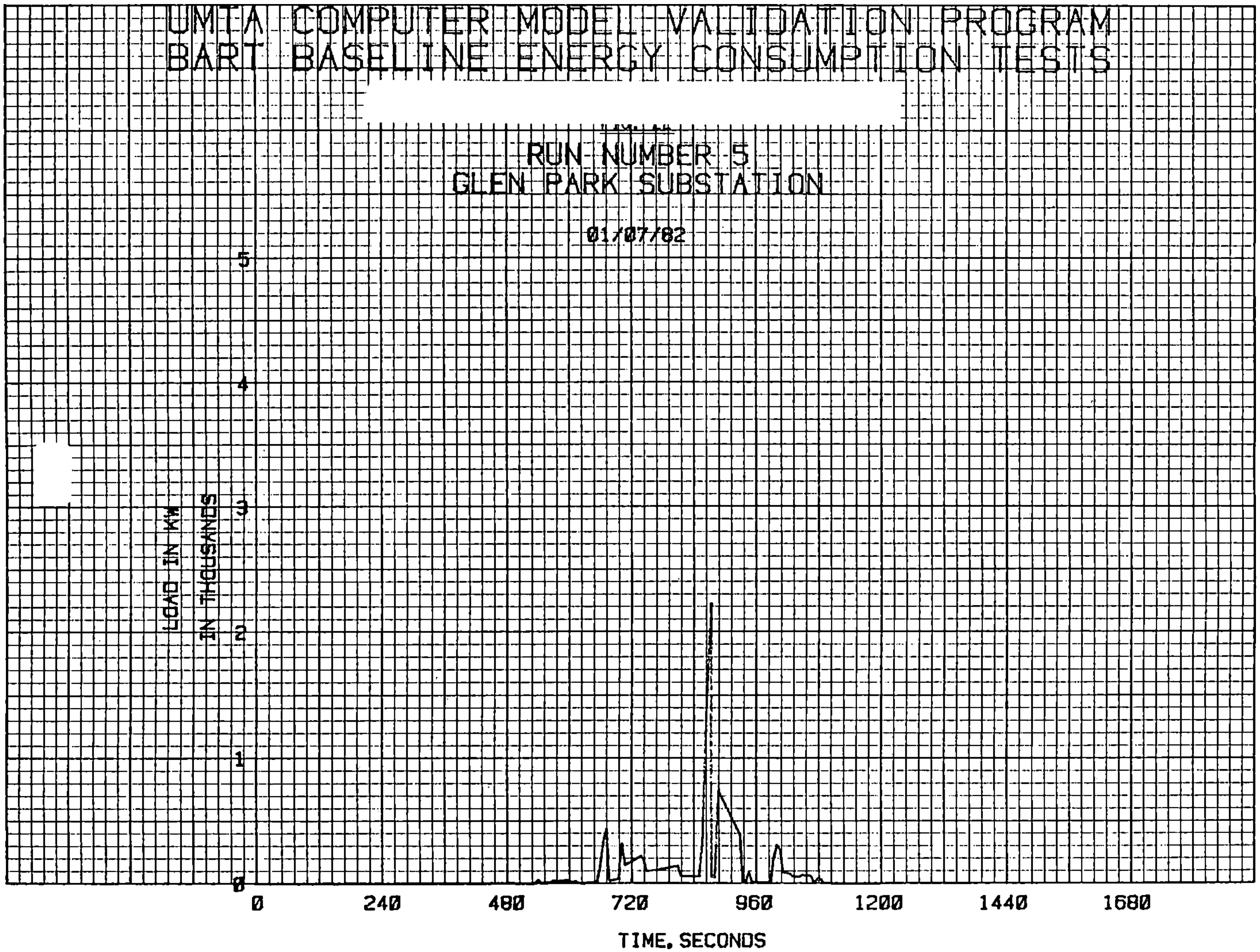

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART BASELINE ENERGY CONSUMPTION TESTS
RUN NUMBER 5
16TH ST. SUBSTATION
01/07/82
LOAD IN KW
IN THOUSANDS
0
1
2
3
4
5
0
240
480
720
960
1200
1440
1680
TIME, SECONDS

(d)

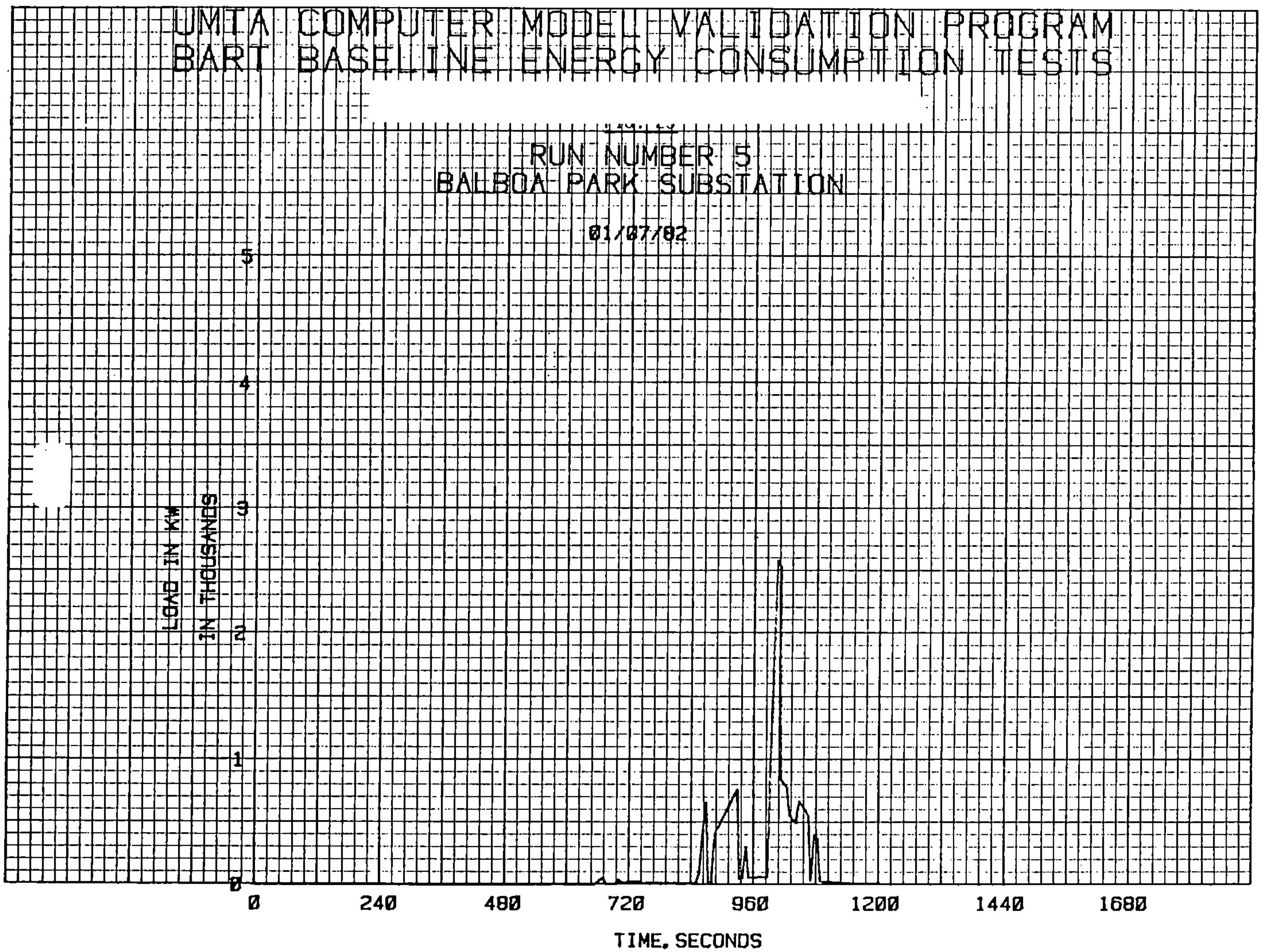

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART BASELINE ENERGY CONSUMPTION TESTS
RUN NUMBER 5
24TH ST. SUBSTATION
01/07/82
LOAD IN KW
IN THOUSANDS
0
1
2
3
4
5
0
240
480
720
960
1200
1440
1680
TIME, SECONDS

(e)

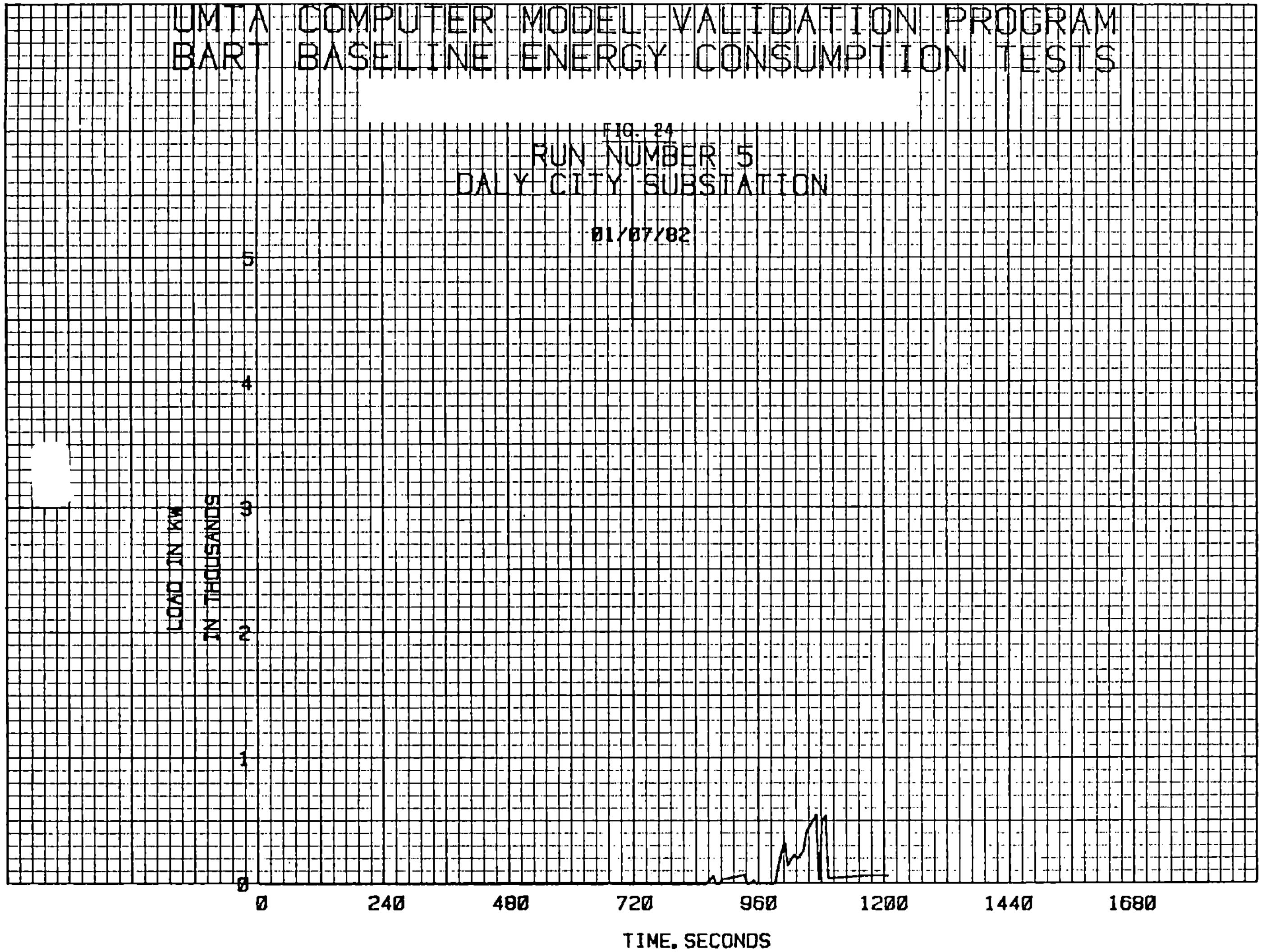
FN-521-A (P "0) (E) 70X100 1/10 Inch Divisions



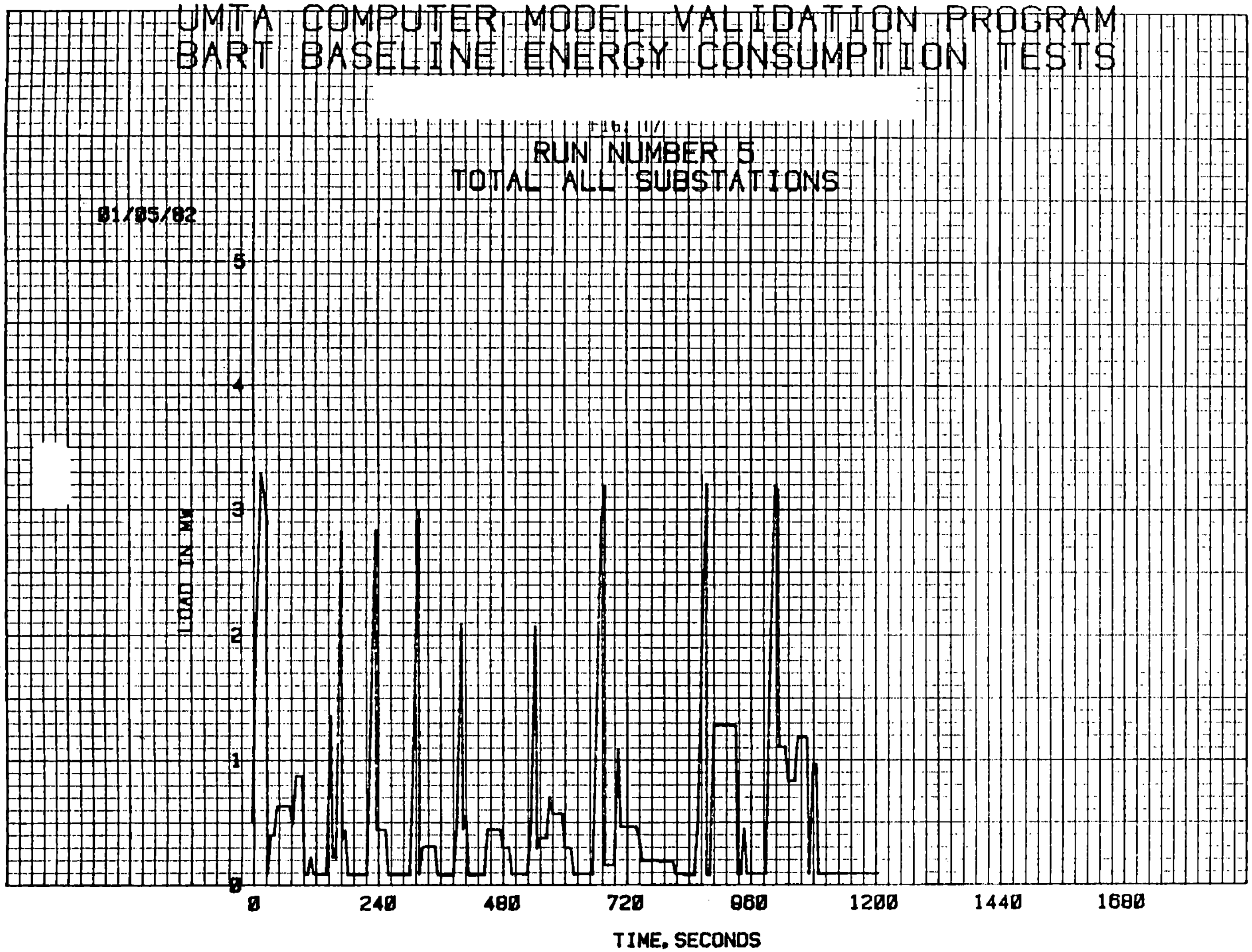
(f)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART BASELINE ENERGY CONSUMPTION TESTS
RUN NUMBER 5
BALBOA PARK SUBSTATION
01/07/82
LOAD IN KW
IN THOUSANDS
0
1
2
3
4
5
0
240
480
720
960
1200
1440
1680
TIME, SECONDS

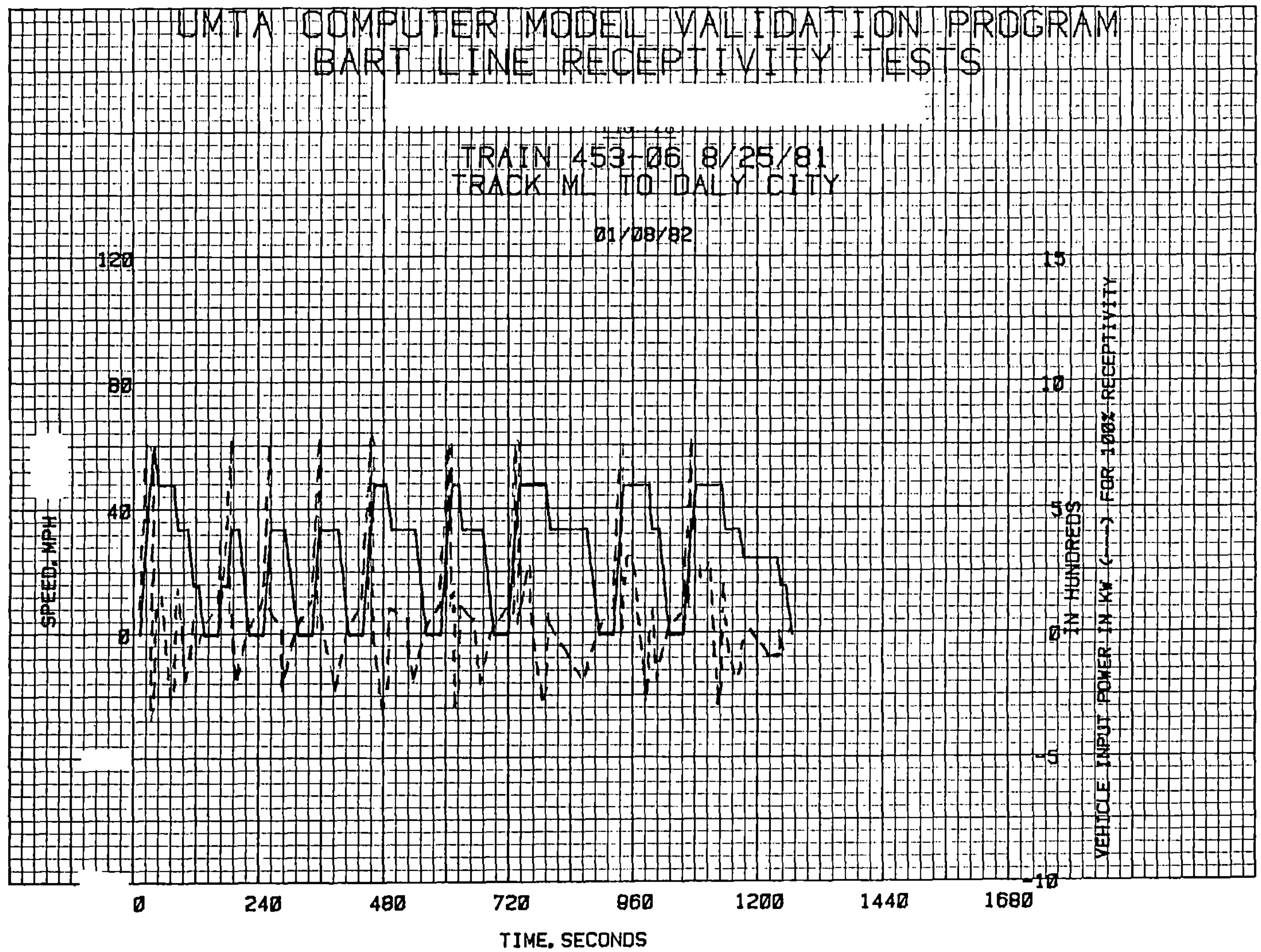
(g)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART BASELINE ENERGY CONSUMPTION TESTS
FIG. 24
RUN NUMBER 5
DALY CITY SUBSTATION
01/07/82
LOAD IN KW
IN THOUSANDS
0
1
2
3
4
5
0
240
480
720
960
1200
1440
1680
TIME, SECONDS

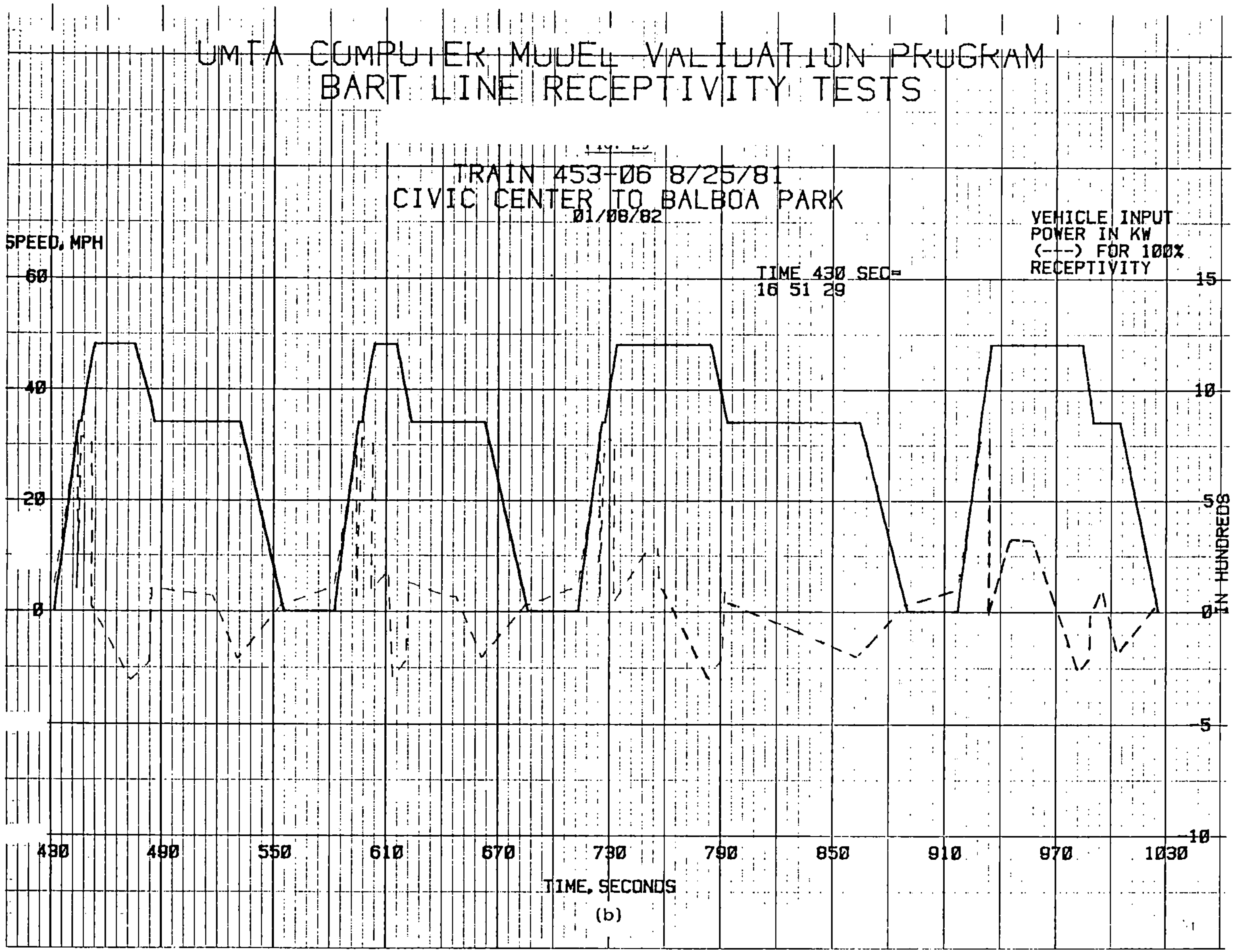
(h)

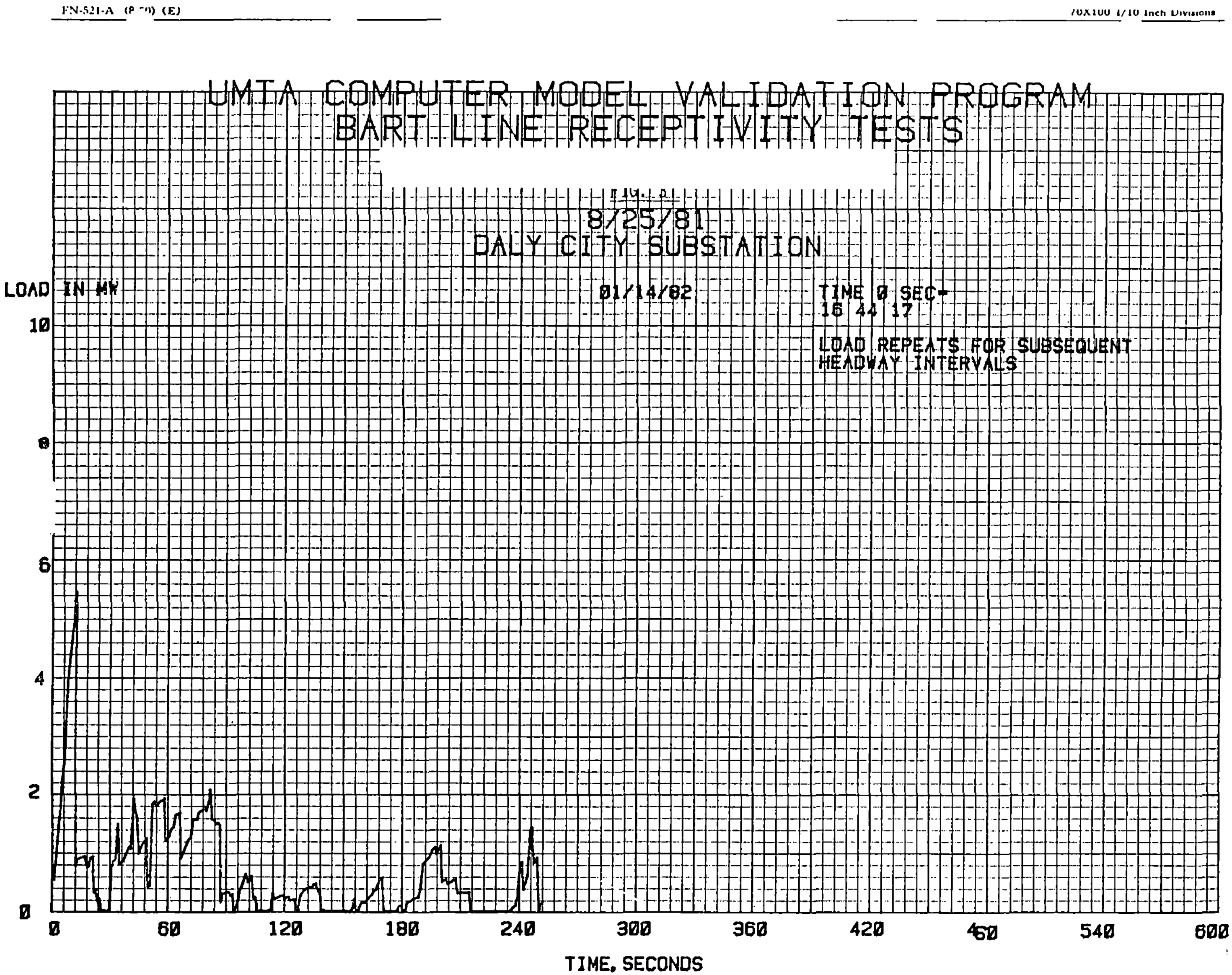

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART BASELINE ENERGY CONSUMPTION TESTS
RUN NUMBER 5
TOTAL ALL SUBSTATIONS
01/05/82
LOAD IN MW
0
1
2
3
4
5
0
240
480
720
960
1200
1440
1680
TIME, SECONDS

(i)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
TRAIN 453-06 8/25/81
TRACK ML TO DALY CITY
01/08/82
120
80
40
0
SPEED, MPH
15
10
5
0
-5
-10
IN HUNDREDS
VEHICLE INPUT POWER IN KW (----) FOR 100% RECEPTIVITY
0
240
480
720
960
1200
1440
1680
TIME, SECONDS

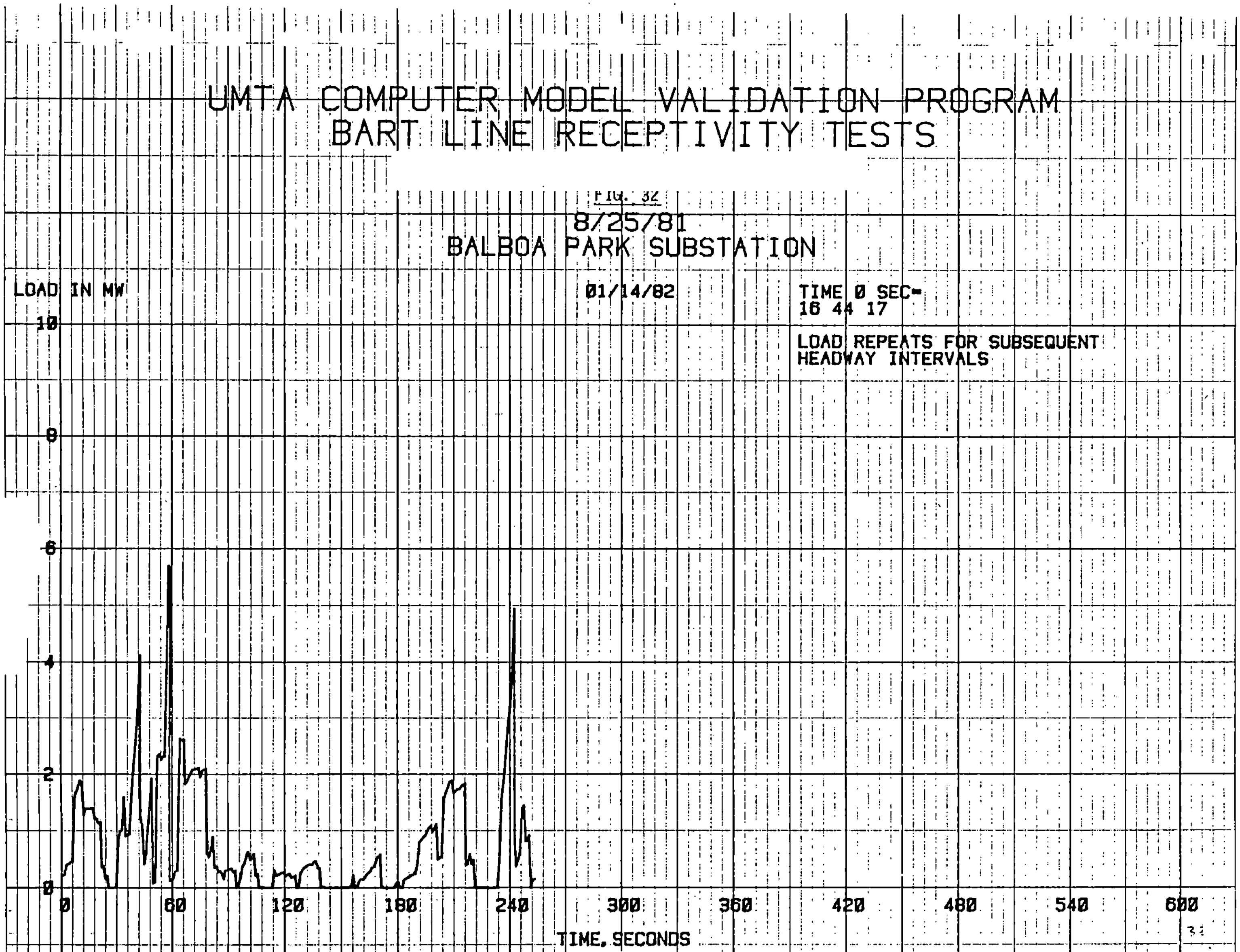
(a)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
TRAIN 453-06 8/25/81
CIVIC CENTER TO BALBOA PARK
01/08/82
SPEED, MPH
TIME 430 SEC=
16 51 29
VEHICLE INPUT
POWER IN KW
(---) FOR 100%
RECEPTIVITY
IN HUNDREDS
60
40
20
0
15
10
5
0
-5
-10
430
490
550
610
670
730
790
850
910
970
1030
TIME, SECONDS
(b)

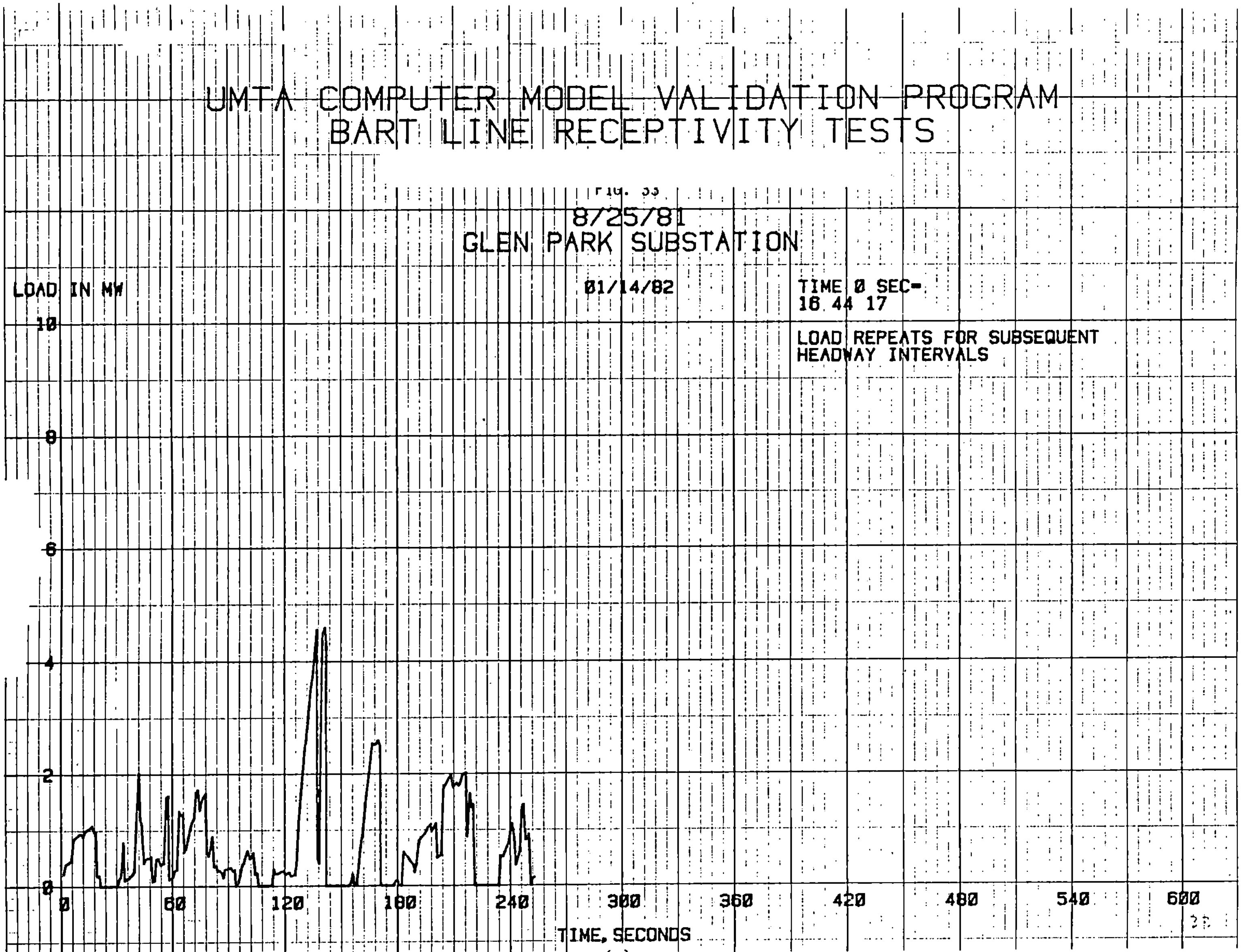


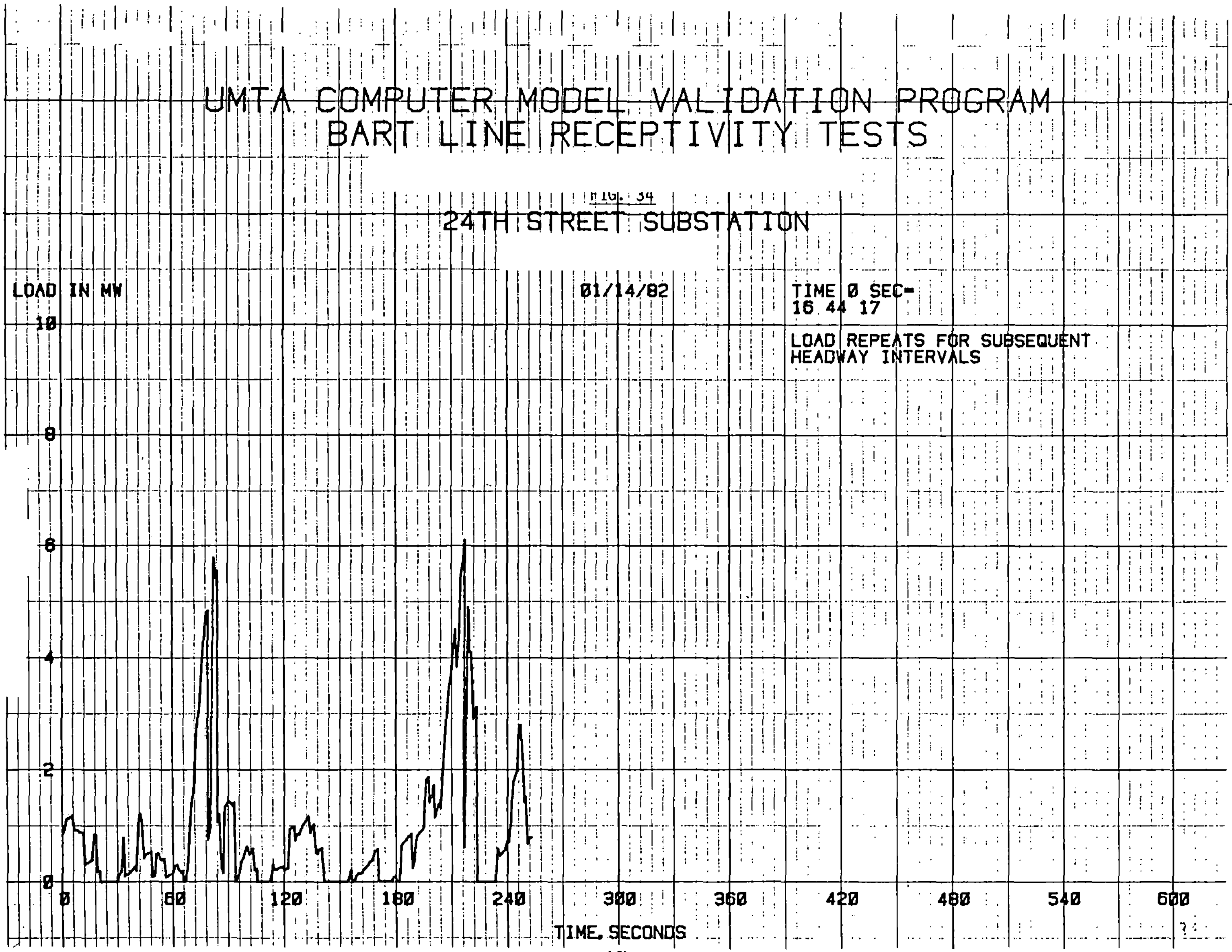
FN-521-A (P 70) (E)
70X100 1/10 Inch Divisions
UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
8/25/81
DALY CITY SUBSTATION
LOAD IN MW
01/14/82
TIME 0 SEC-
16 44 17
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
0
60
120
180
240
300
360
420
480
540
600
TIME, SECONDS

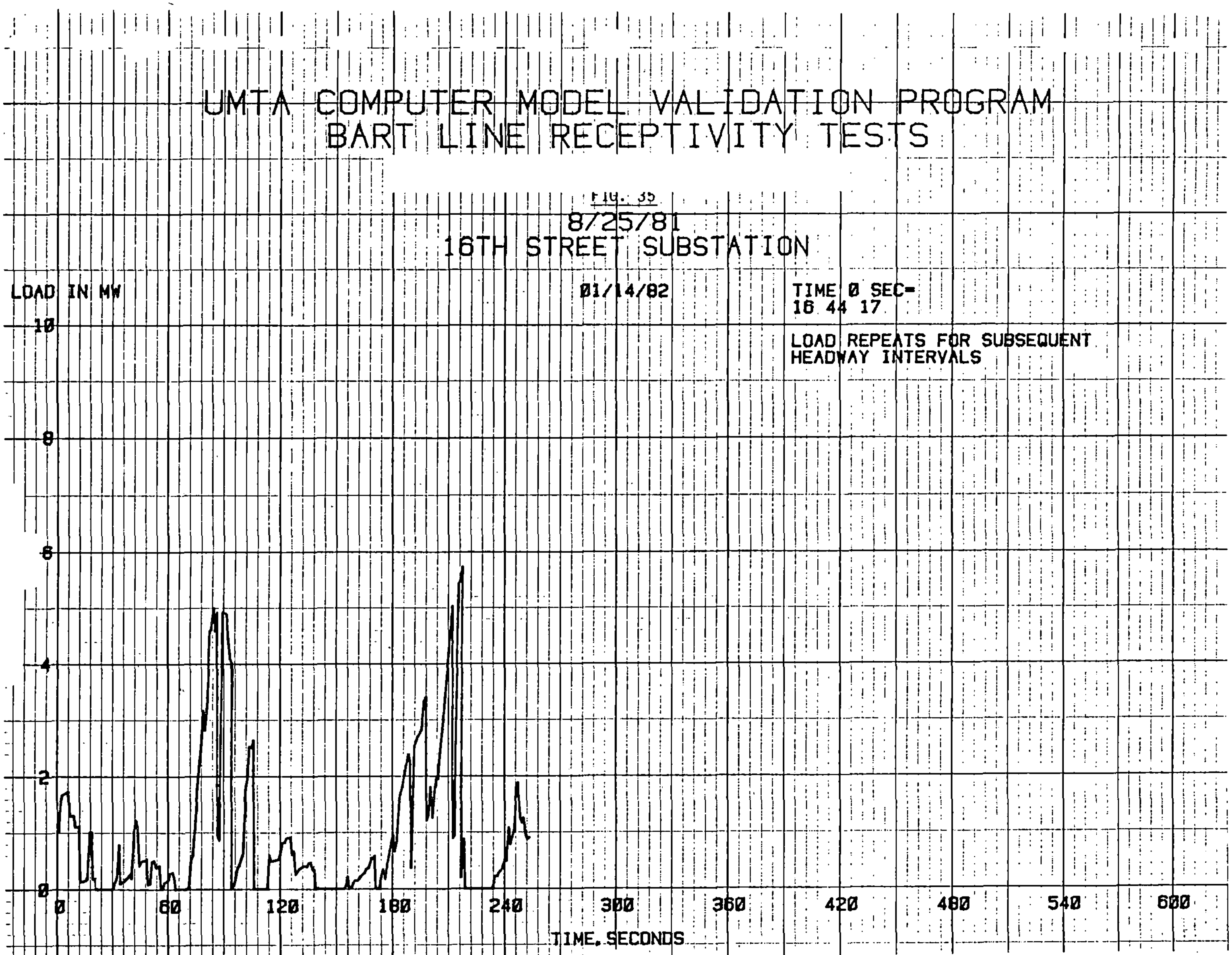
(c)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 32
8/25/81
BALBOA PARK SUBSTATION
LOAD IN MW
01/14/82
TIME 0 SEC=
16 44 17
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
0
60
120
180
240
300
360
420
480
540
600
TIME, SECONDS

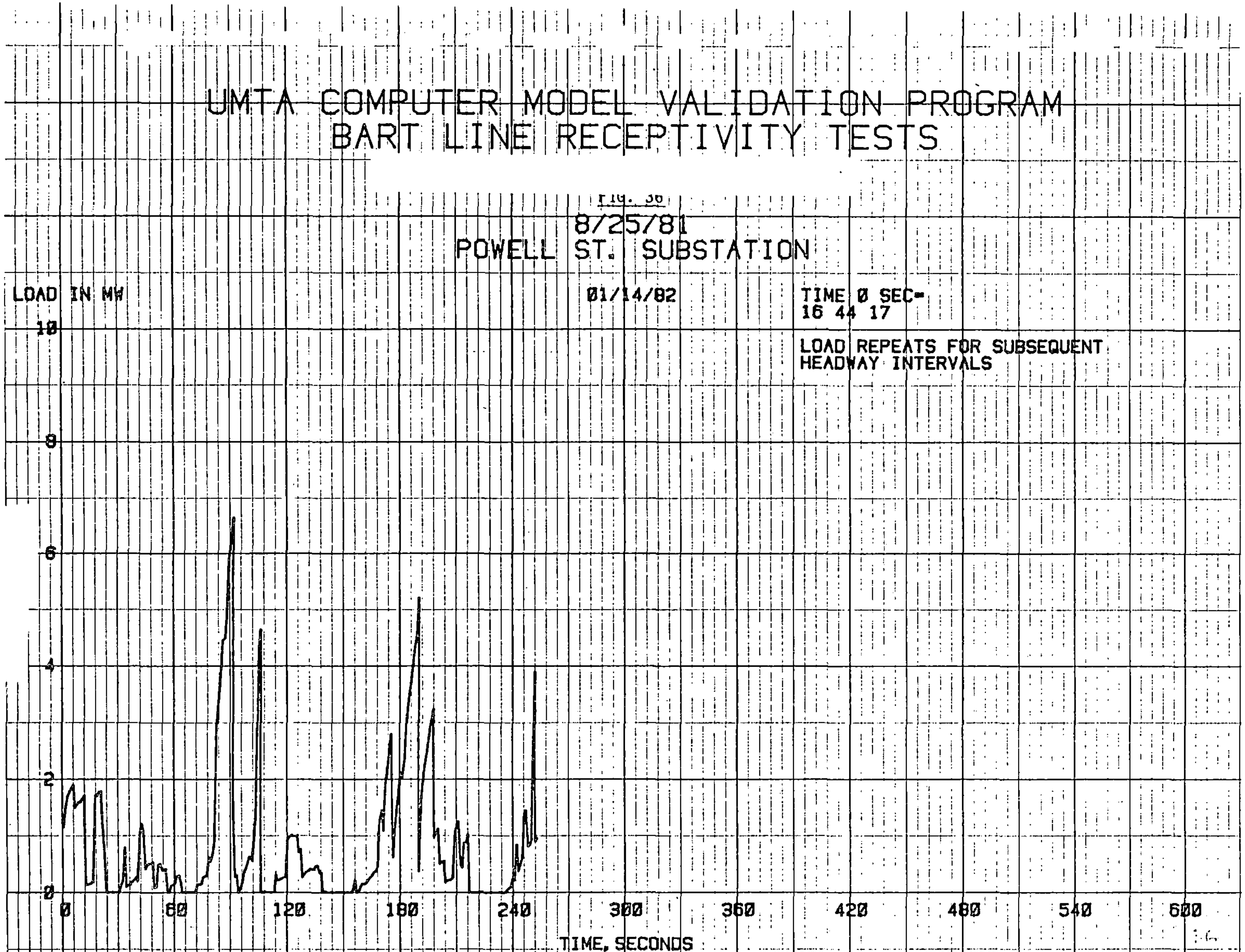
(d)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
8/25/81
GLEN PARK SUBSTATION
LOAD IN MW
01/14/82
TIME 0 SEC=
16 44 17
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
0
60
120
180
240
300
360
420
480
540
600
TIME, SECONDS
(e)

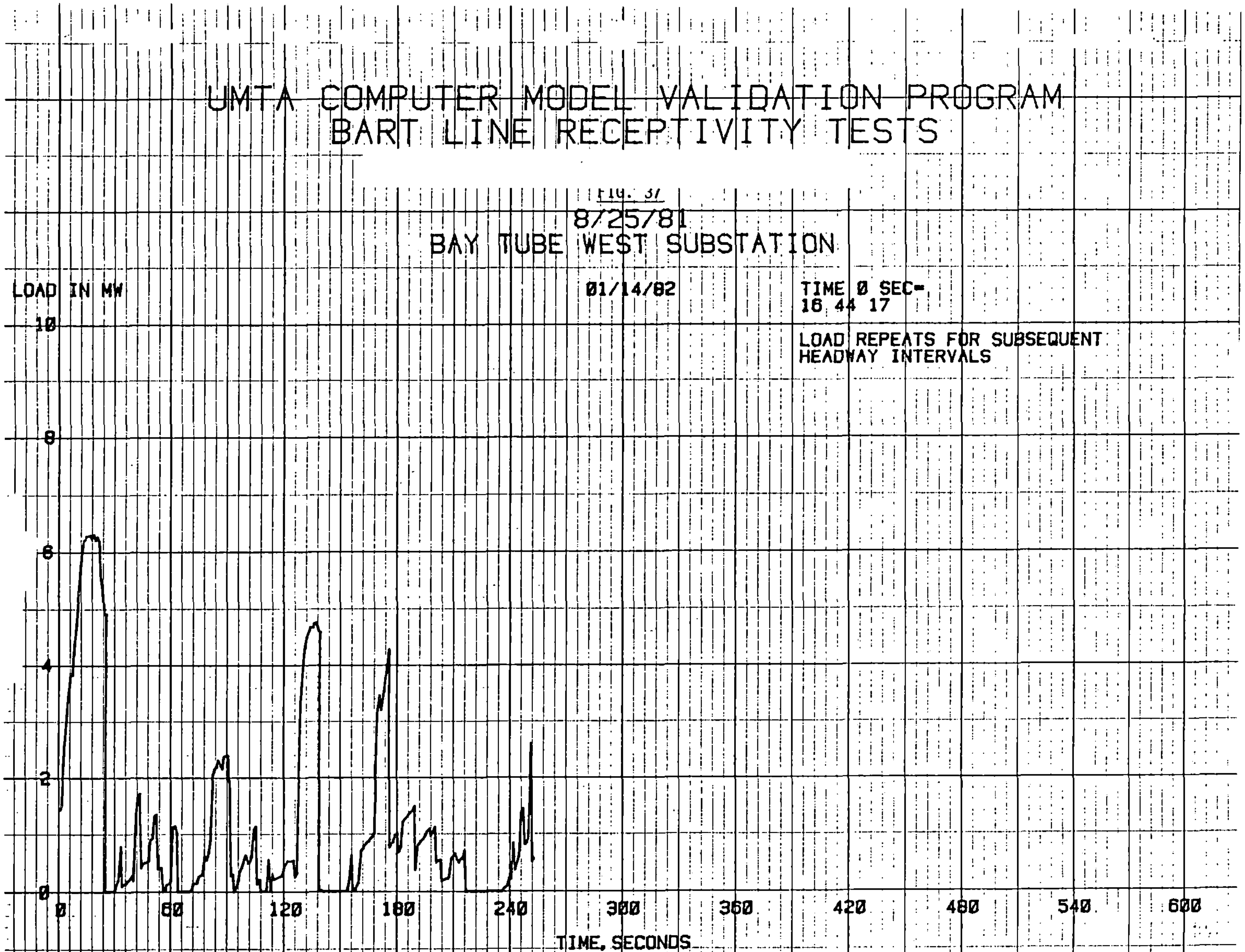

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 34
24TH STREET SUBSTATION
LOAD IN MW
01/14/82
TIME 0 SEC=
16 44 17
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
0
60
120
180
240
300
360
420
480
540
600
TIME, SECONDS
(f)

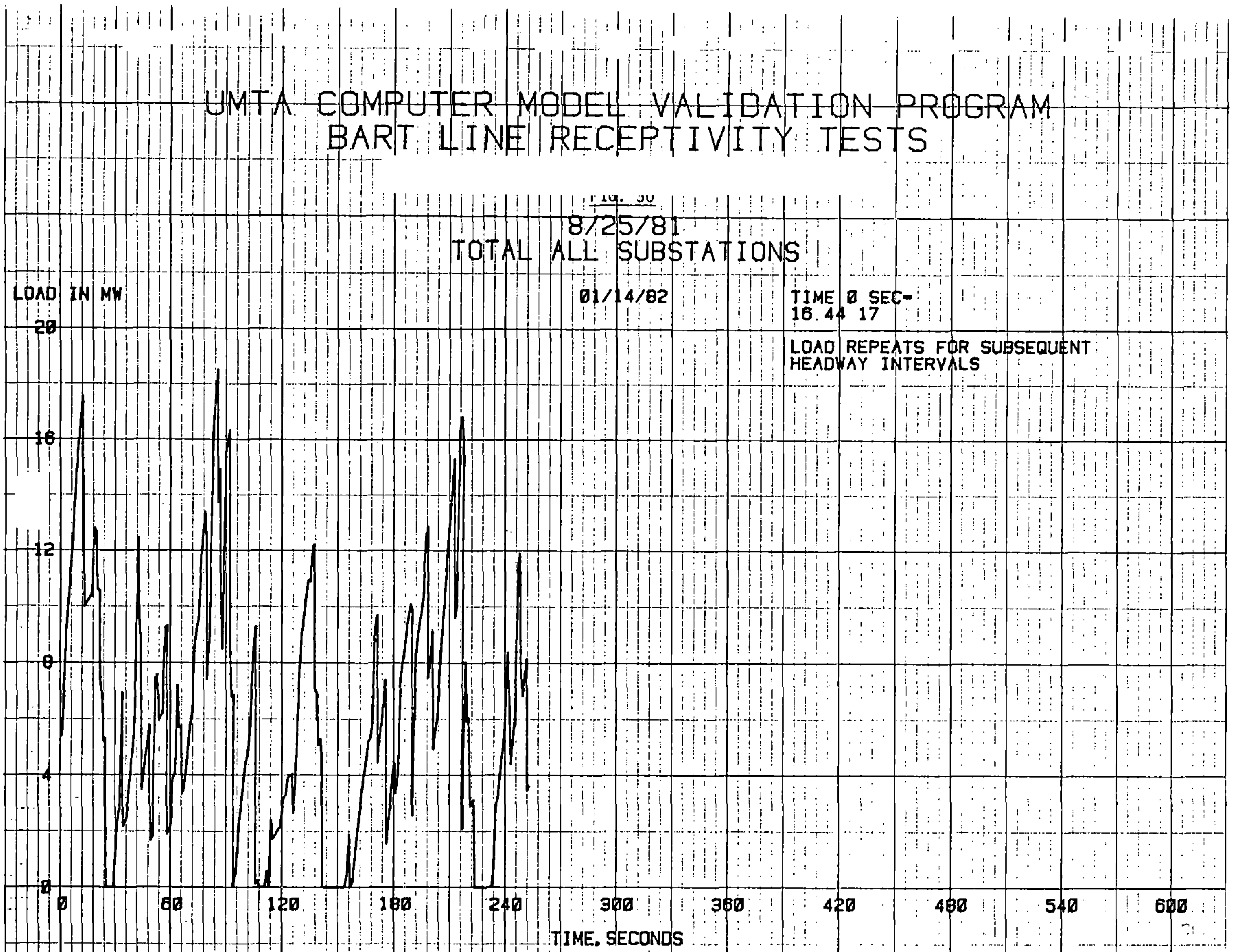

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 35
8/25/81
16TH STREET SUBSTATION
LOAD IN MW
01/14/82
TIME 0 SEC=
16 44 17
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
0
60
120
180
240
300
360
420
480
540
600
TIME, SECONDS

(g)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 36
8/25/81
POWELL ST. SUBSTATION
LOAD IN MW
01/14/82
TIME 0 SEC=
16 44 17
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
0
60
120
180
240
300
360
420
480
540
600
TIME, SECONDS

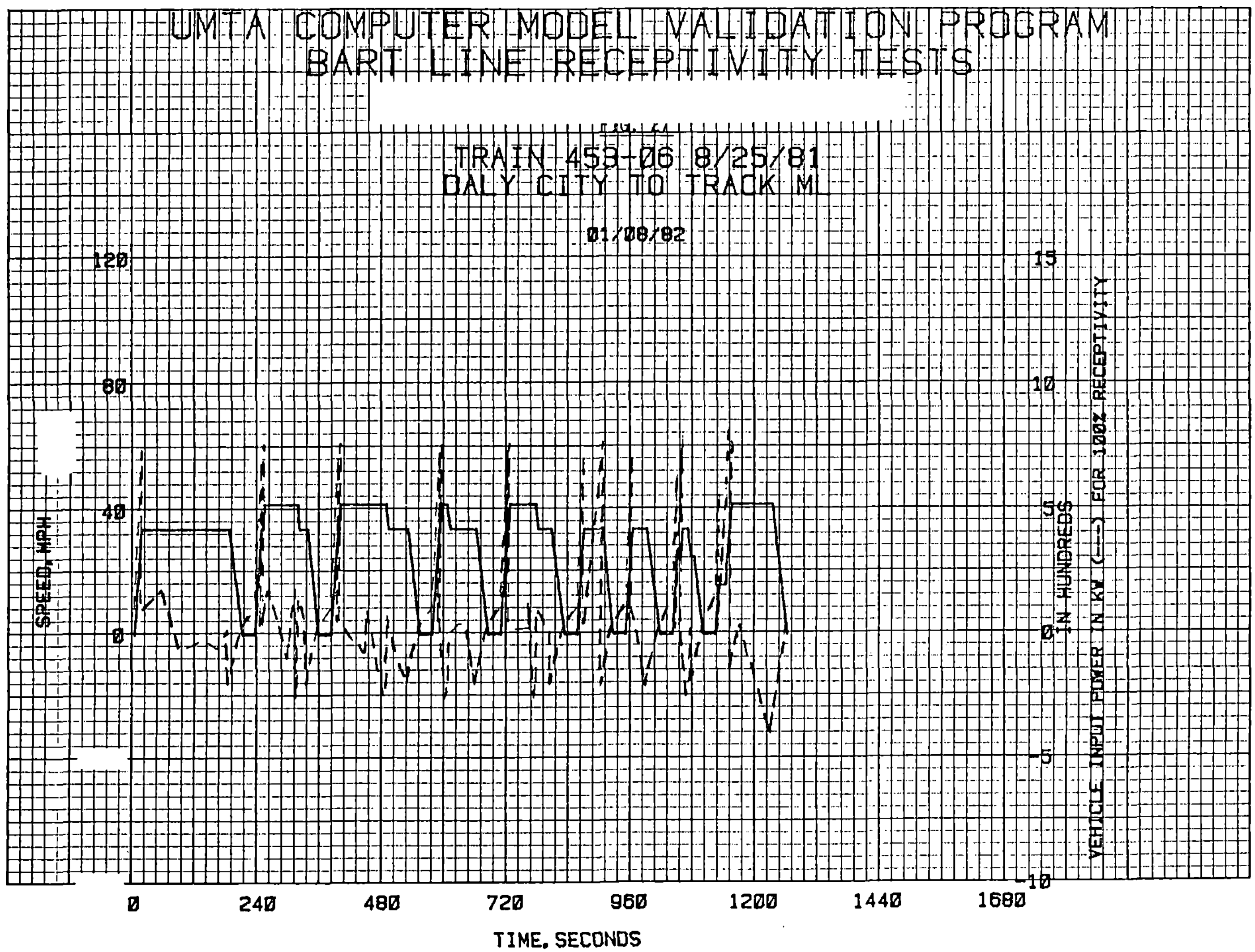
(h)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 37
8/25/81
BAY TUBE WEST SUBSTATION
LOAD IN MW
01/14/82
TIME 0 SEC=
16 44 17
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
0
60
120
180
240
300
360
420
480
540
600
TIME, SECONDS
(i)

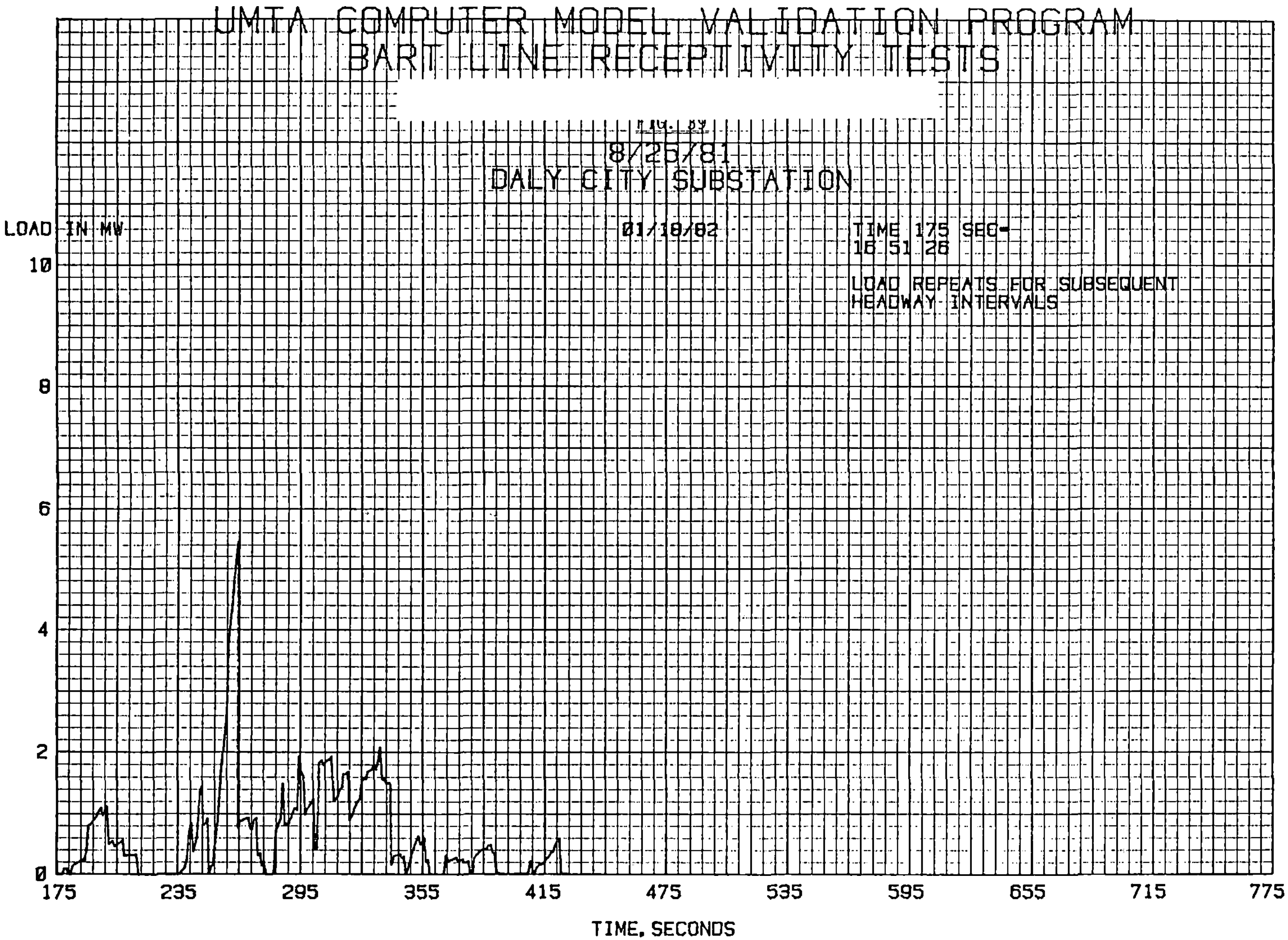

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
8/25/81
TOTAL ALL SUBSTATIONS
LOAD IN MW
01/14/82
TIME Ø SEC-
16.44 17
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
20
16
12
8
4
Ø
Ø
60
120
180
240
300
360
420
480
540
600
TIME, SECONDS

(j)

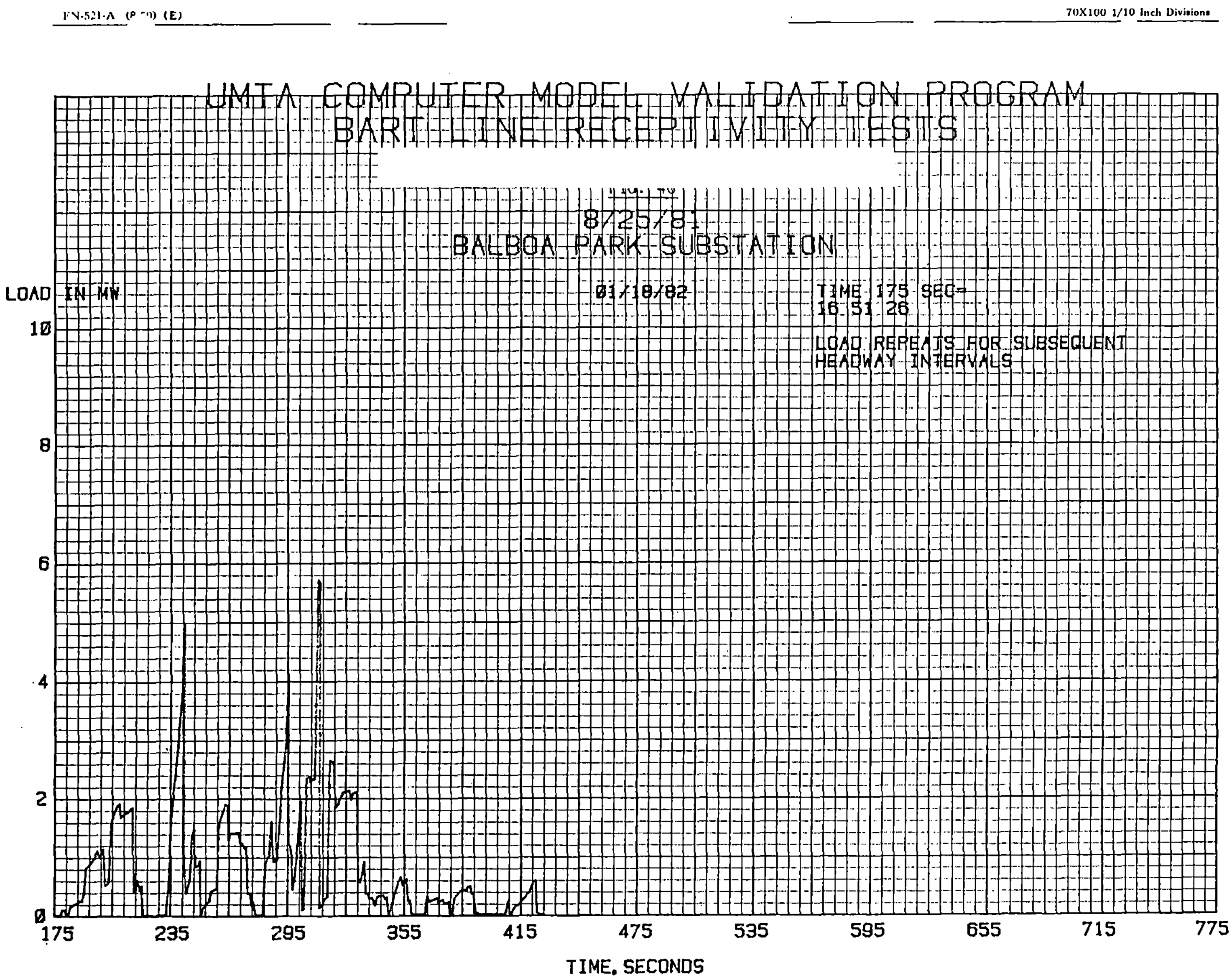
FN-521-A (P 70) (E) 70X100 1/10 Inch Divisions



(a)

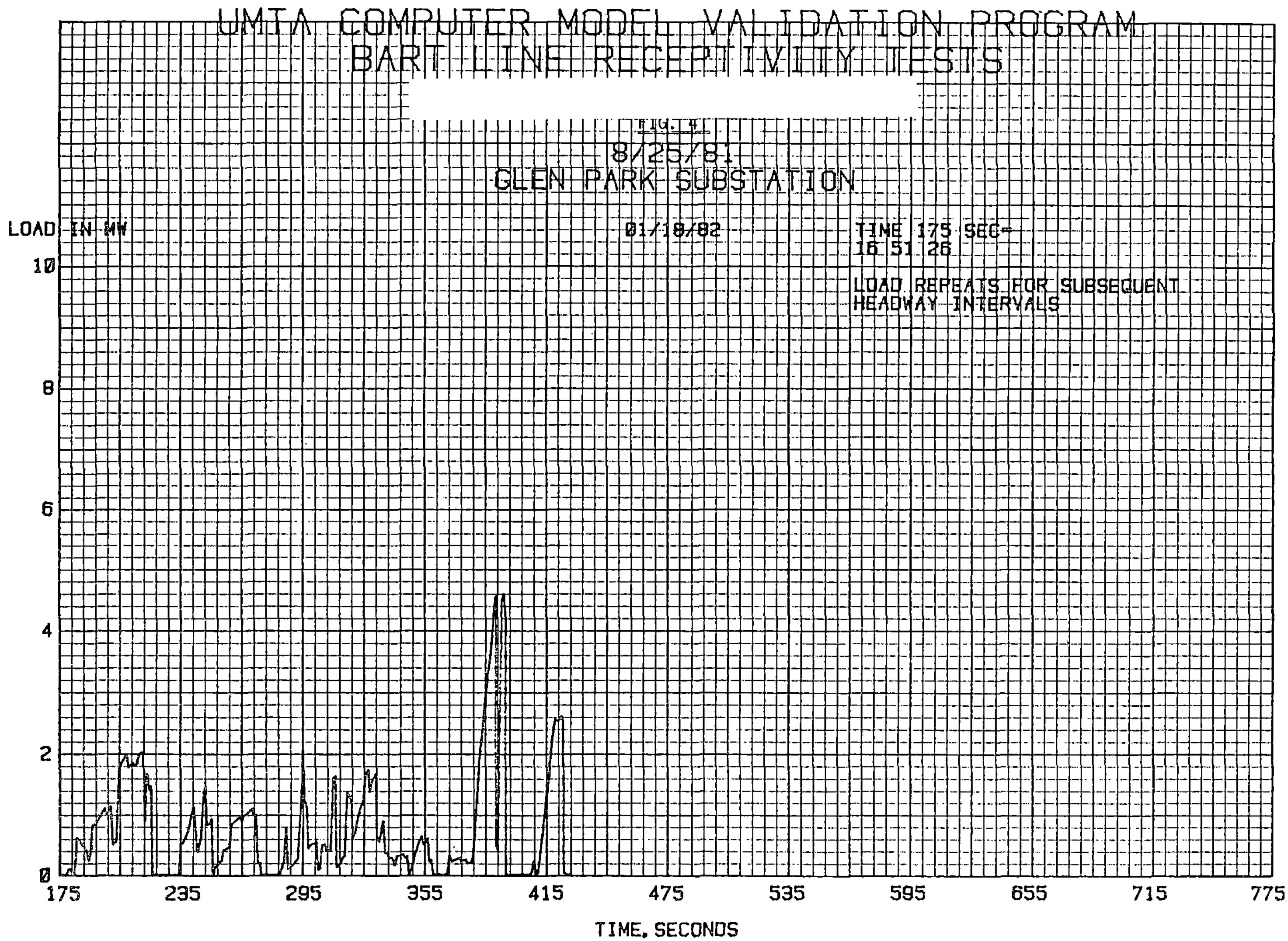

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
8/25/81
DALY CITY SUBSTATION
LOAD IN MW
01/18/82
TIME 175 SEC-
16 51 26
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
175
235
295
355
415
475
535
595
655
715
775
TIME, SECONDS

(b)

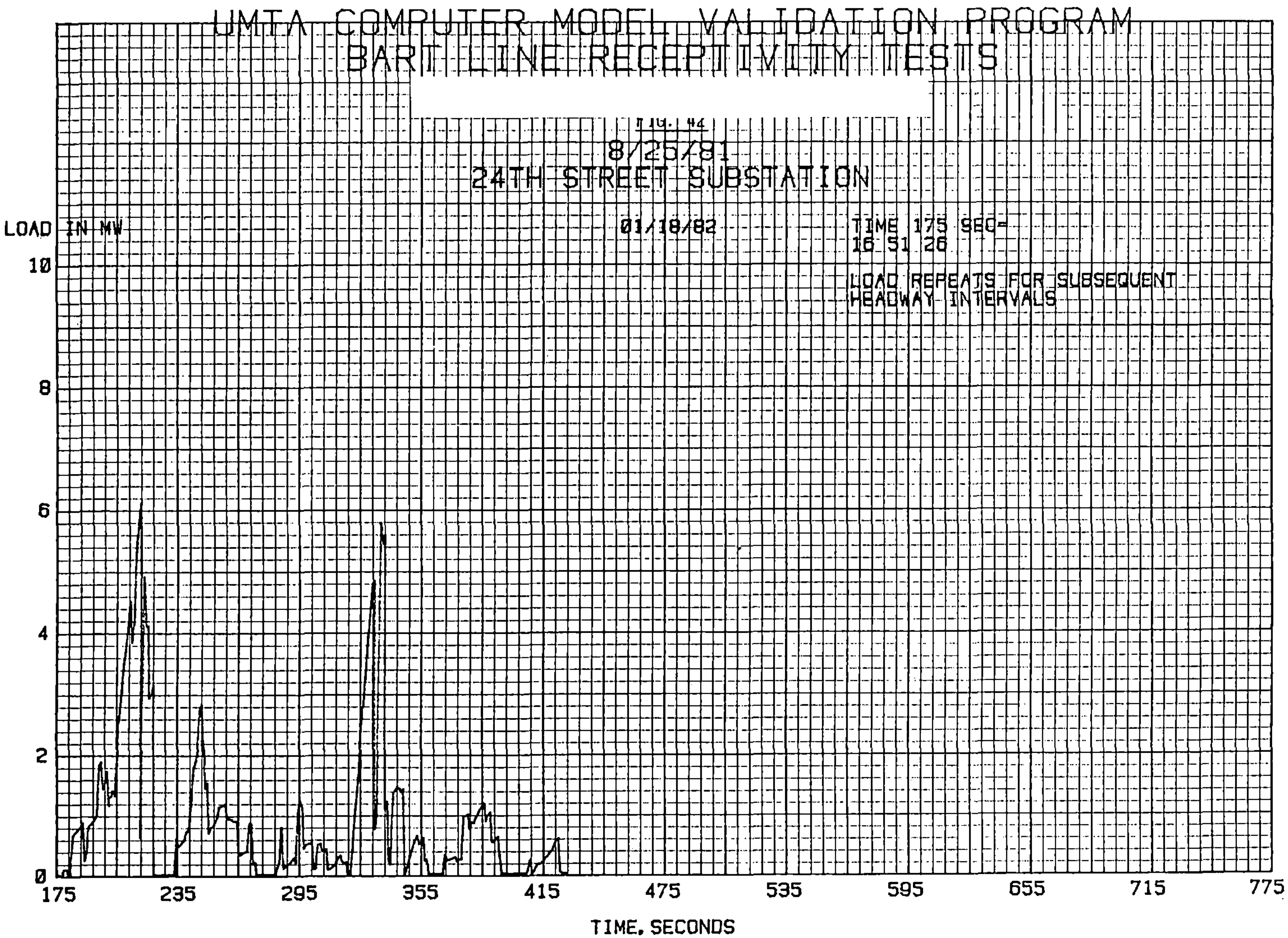


FN-521-A
70X100 1/10 Inch Divisions
UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
8/25/81
BALBOA PARK SUBSTATION
LOAD IN MW
01/18/82
TIME 175 SEC=
16.51 26
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
175
235
295
355
415
475
535
595
655
715
775
TIME, SECONDS

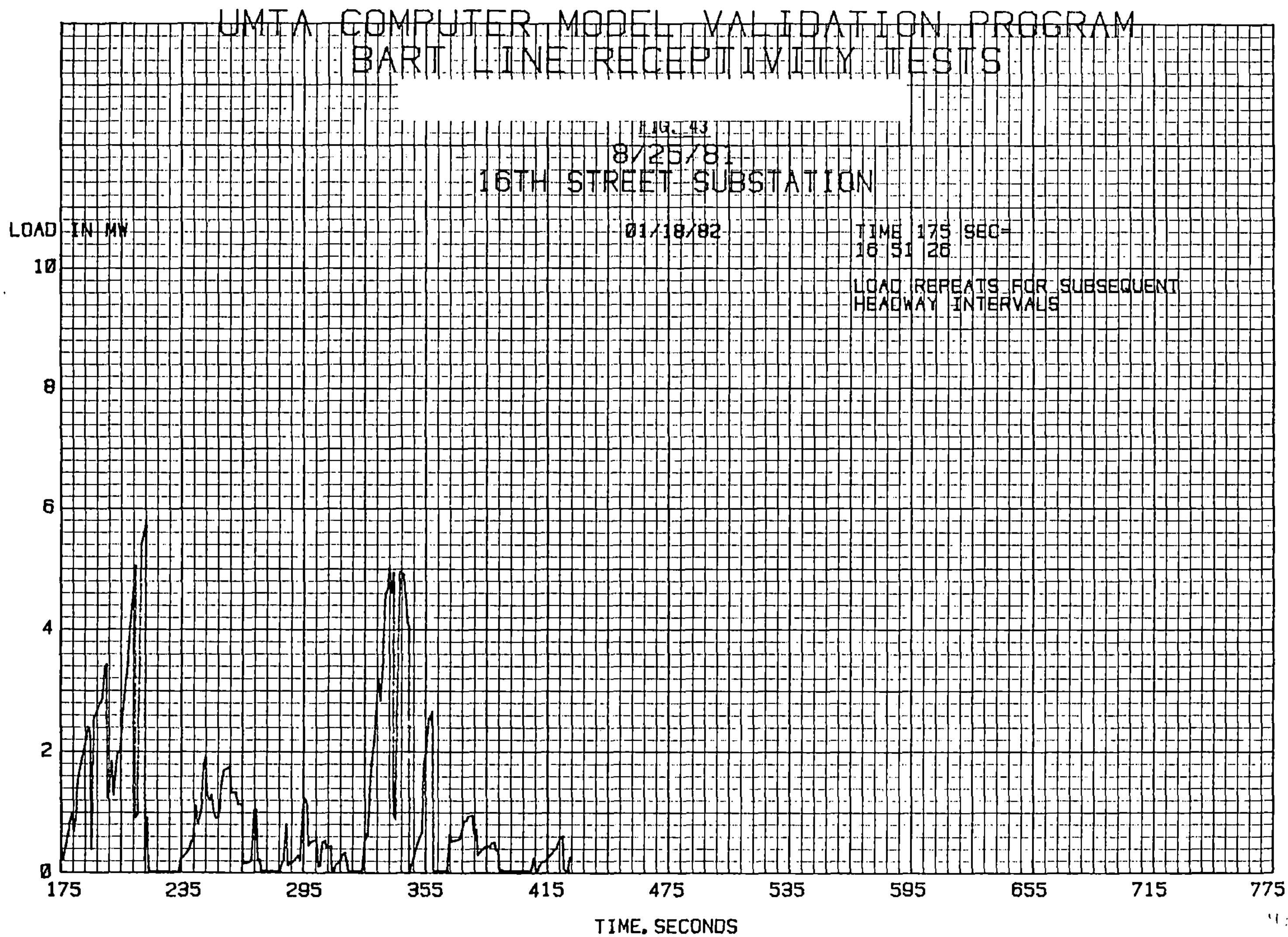
(c)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 4
8/25/81
GLEN PARK SUBSTATION
LOAD IN MW
01/18/82
TIME 175 SEC=
16 51 26
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
175
235
295
355
415
475
535
595
655
715
775
TIME, SECONDS

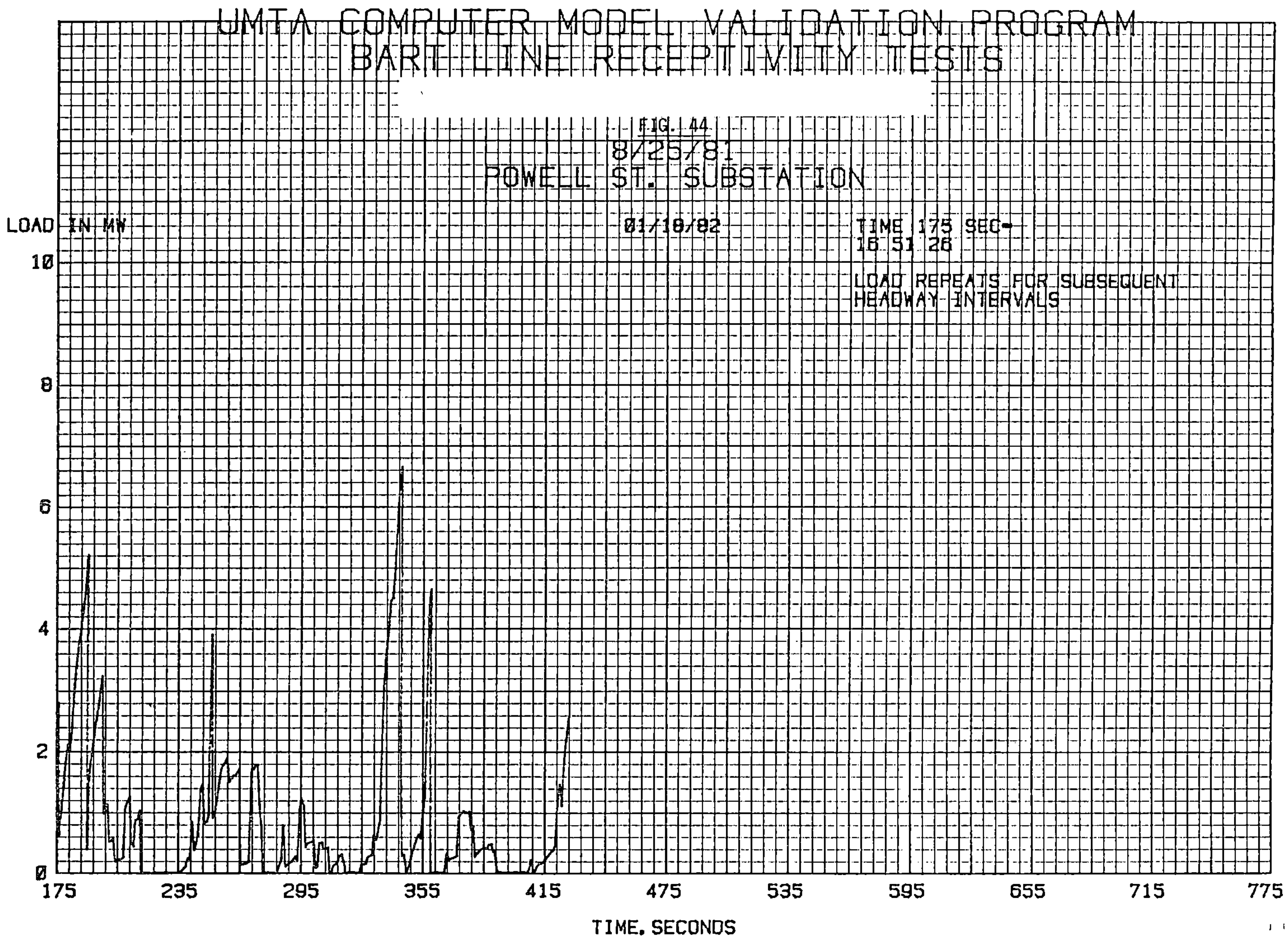
(d)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 42
8/25/81
24TH STREET SUBSTATION
LOAD IN MW
01/18/82
TIME 175 SEC=
16 51 26
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
175
235
295
355
415
475
535
595
655
715
775
TIME, SECONDS

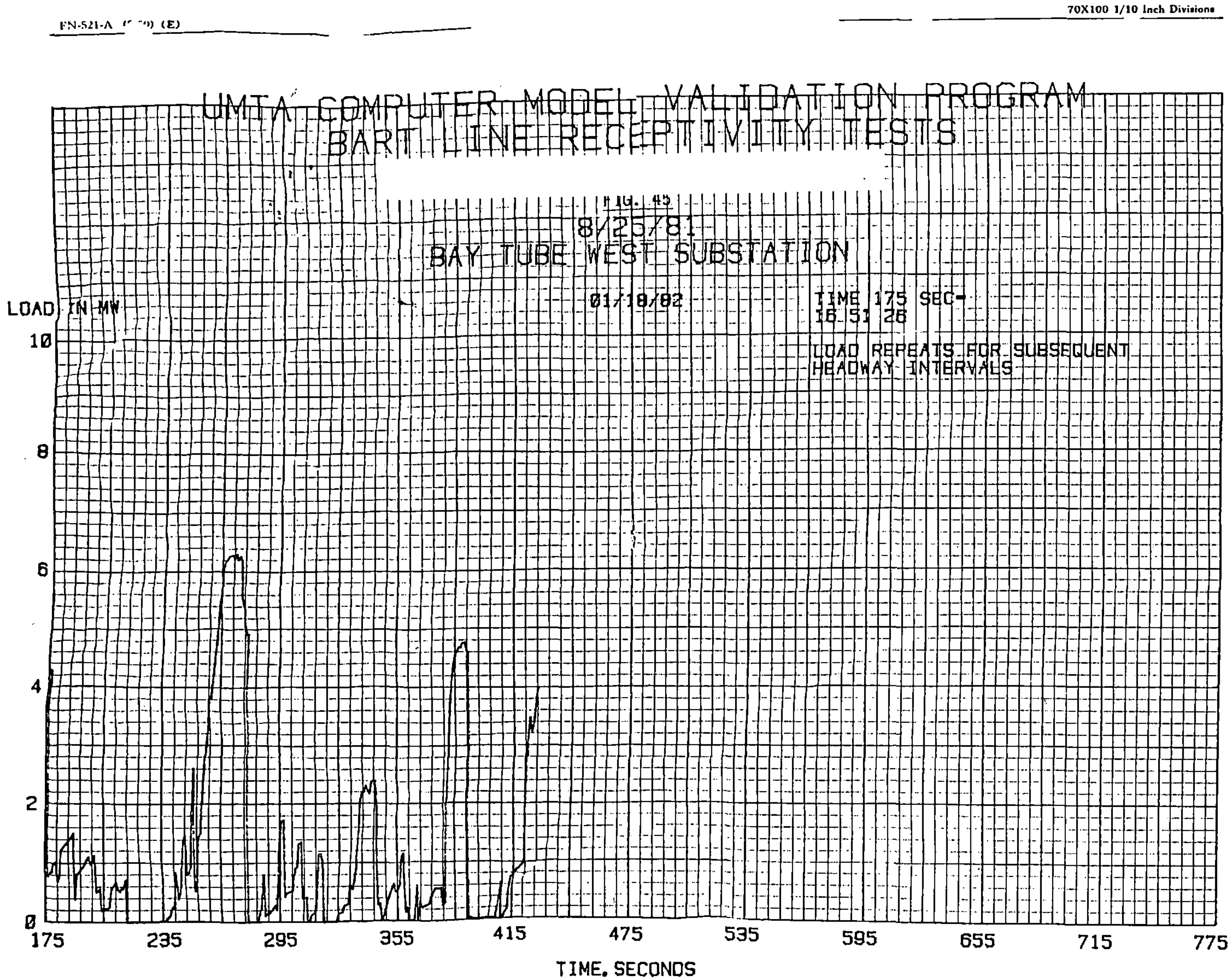
(e)


UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 43
8/25/81
16TH STREET SUBSTATION
LOAD IN MW
01/18/82
TIME 175 SEC=
16 51 26
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
0
2
4
6
8
10
175
235
295
355
415
475
535
595
655
715
775
TIME, SECONDS

(f)

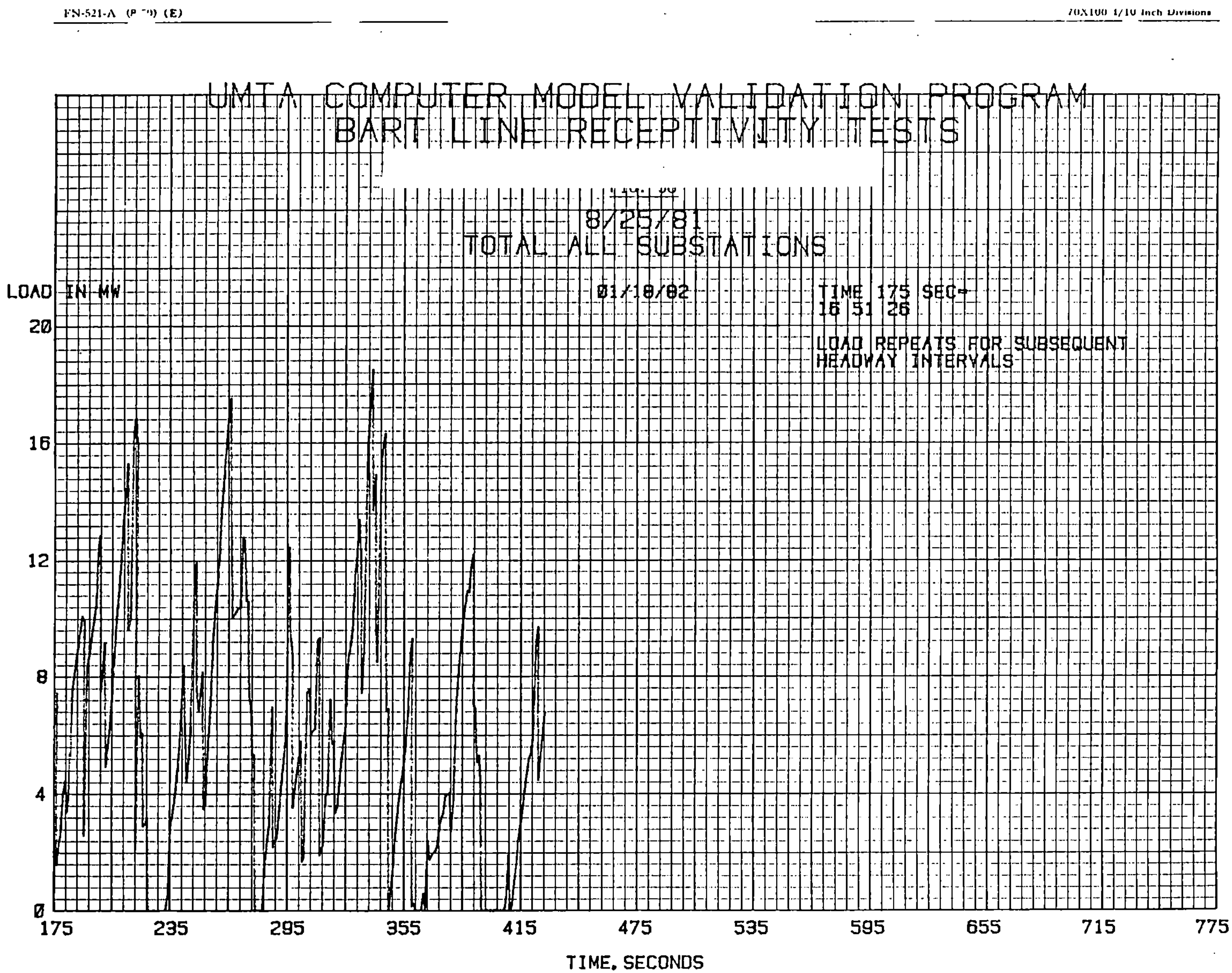

UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 44
8/25/81
POWELL ST. SUBSTATION
LOAD IN MW
01/18/82
TIME 175 SEC-
16 51 26
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
10
8
6
4
2
0
175
235
295
355
415
475
535
595
655
715
775
TIME, SECONDS

(g)



FN-521-A
70X100 1/10 Inch Divisions
UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
FIG. 45
8/25/81
BAY TUBE WEST SUBSTATION
01/10/82
TIME 175 SEC-
16 51 26
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
LOAD IN MW
10
8
6
4
2
0
175
235
295
355
415
475
535
595
655
715
775
TIME, SECONDS

(h)


FN-521-A (8-79) (E)
70X100 1/10 Inch Divisions
UMTA COMPUTER MODEL VALIDATION PROGRAM
BART LINE RECEPTIVITY TESTS
8/25/81
TOTAL ALL SUBSTATIONS
LOAD IN MW
01/18/82
TIME 175 SEC=
16 51 26
LOAD REPEATS FOR SUBSEQUENT
HEADWAY INTERVALS
20
16
12
8
4
0
175
235
295
355
415
475
535
595
655
715
775
TIME, SECONDS

(i)

The energy consumption of a car in revenue service was computed to be 52.55 kWh for a round trip between MP6 and M90. For the same trip, the energy consumption of the BART Engineering Car was measured to be 78.74 kWh. Accounting for the weight differential, the prediction seems to be about 29 percent lower than the test data.

5. COMPUTER MODEL # 2

This model was developed by the Rail Systems Center of the Mellon Institute, Pittsburgh, Pennsylvania, under the sponsorship of the Urban Mass Transportation Administration. This is a general purpose model to study the power flows and costs in transportation systems. The model contains two principal subprograms which are linked together to simulate actual transit or main line operations.

The two subprograms are:

1. <u>Train Performance Simulator</u>

   This program simulates the operation of a single car or a train for any given track and vehicle characteristics. It computes the speed-time-distance and power consumption profiles. The total power is divided into all of its important components. Dynamic or regenerative braking, and/or onboard energy storage can also be simulated.

2. <u>Electric Network Simulator</u>

   This program simulates the power flows in the electrical distribution network for any given traffic pattern. This is done by first establishing the network topology at any given time by knowing the positions of the trains and then by solving the appropriate node equations for this network. The train time tables and passenger loading data is used by the train performance simulator to generate the necessary information to define the network topology. This is done at regular time intervals.

   The program output provides a total picture of the electrical system such as node voltages, currents, power flows into nodes, etc.

5.1 Input Requirements

The following inputs are required for this simulation:

- o Train characteristics such as weight, passenger load, length, auxiliary power, etc.
- o Characteristics of the propulsion system such as number and types of motors, operating curves for motors and gears, motor control, control logic, wheel diameter, etc.
- o System characteristics such as track charts, acceleration and braking rates, ATO characteristics, etc.
- o Train time tables.

This simulation uses actual values of different variables such as train length and weight, station dwell, headways, etc., and hence requires a considerable amount of book-keeping of all these variables.

Usual substation data such as the type, the location, line reactances, efficiency, etc. is also required for all the substations in the system.

5.2 Program Output

A large volume of program output is provided, some of it at the user's request. It includes:

- o Summary of the input data
- o Vehicle trajectories such as speed-position, position-time curves
- o Power and energy computations such as
  - power demand (negative during regenerative braking) with position
  - energy consumption with position
  - component power flows for motors, resistors, controllers, etc.

- Summary consumption data such as kWh/car-mile, average and peak kW loads, gross and net kWh, kWh recovered by regeneration
- Electrical network load flows at regular intervals, average and peak power demand at each substation, etc.

5.3 BART Test Simulation

Two Baseline Test runs, Run #4 and Run #5, were simulated with this model. The energy consumption computed with this model is compared with the test data in Table 5.1 and Table 5.2. Station dwell times used in these model predictions were adjusted to make the train departure times compatible with the train schedules given in Tables A-8 and A-9. Under these conditions, the predicted energy consumption for Run #4 is about 2 percent higher than the test data, and about 9 percent higher for Run #5 than the test data. The test results can also be compared by assuming a zero station dwell. The prediction is then about 1 percent lower than the test data for Run #4, and about 3.6 percent higher than the test data for Run #5. This comparison is presented later in Table 8.2 in Section 8.

The Regeneration Test was simulated only for the revenue run between Emabarcadero and Daly City passenger stations. Table 5.3 shows the predicted energy consumption of Train 453-04 with the passenger loading as given in Table A-12. The predicted total trip energy is 150.52 kWh for the train, i.e., 37.63 kWh per car. The measured energy consumption of Car #1 was 47.67 kWh between MP6 and the Daly City station. An energy consumption of 3.4 kWh was measured between MP6 and the Embarcadero station, thus leaving 44.27 kWh for the Embarcadero - Daly City run. Considering the weight differential of the test car, the predicted energy consumption is about 10 percent lower than the test data.

The amount of energy saved during regeneration is quite sensitive to the voltage level across the filter capacitor at which regeneration is

TABLE 5.1

RESULTS OF MODEL # 2

ENERGY CONSUMPTION FOR BASELINE RUN # 4

RUN	MODEL KWH/TRAIN	MODEL KWH/CAR	DATA KWH/CAR
M90 - M80	24.37		
M80 - M70	18.68		
M70 - M60	18.00		
M60 - M50	13.90		
M50 - M40	17.30		
M40 - M30	11.90		
M30 - M20	9.30		
M20 - M16	6.48		
TOTAL	119.95	29.98	34.49

Note: The test data is for the BART Engineering Car which weighs over 43 percent more than the average train weight per car.

Station dwells modified to be consistent with train departures specified in Table A-8

TABLE 5.2

RESULTS OF MODEL # 2

ENERGY CONSUMPTION FOR BASELINE RUN # 5

RUN	MODEL KWH/TRAIN	MODEL KWH/CAR	DATA KWH/CAR
M16 - M20	15.70		
M20 - M30	15.37		
M30 - M40	12.55		
M40 - M50	20.67		
M50 - M60	23.35		
M60 - M70	40.78		
M70 - M80	28.01		
M80 - M90	35.94		
TOTAL	192.37	48.09	51.75

Note: The test data is for the BART Engineering Car which weighs over 43 percent more than the average train weight per car.

Station dwells modified to be consistent with train departures specified in Table A-9

TABLE 5.3

RESULTS OF MODEL # 2

ENERGY CONSUMPTION FOR REVENUE RUN; TRAIN 453-04

RUN	MODEL[1] KWH/TRAIN	RUN TIME[2] SECONDS
M16 - M20	7.88	55
M20 - M30	7.48	63
M30 - M40	10.72	62
M40 - M50	21.28	110
M50 - M60	18.20	93
M60 - M70	35.08	152
M70 - M80	21.40	115
M80 - M90	28.48	203
TOTAL	150.52	853
GROSS INPUT ENERGY	192.00	
REGENERATED ENERGY	41.60	

1 Total traction energy including energy consumption during station dwells for four car train. Multiply by 1.5 to get energy consumption of a six-car train.

2 Start-to-stop time.

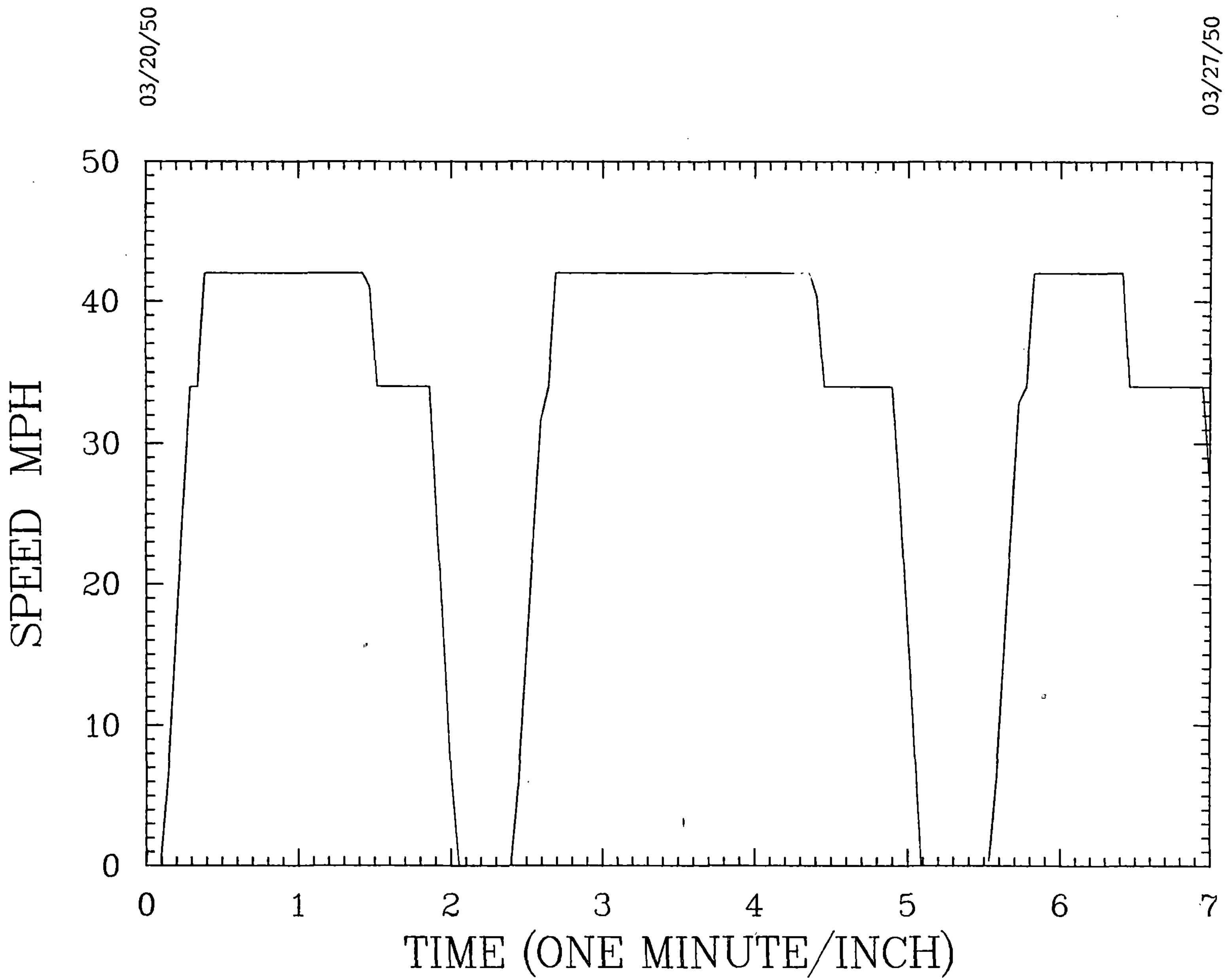
terminated. This may be one of the reasons why the line receptivity is predicted to be higher than that found in actual revenue service. As a result, the energy saving by regeneration is predicted to be over 21½ percent, whereas it has been actually under 20 percent.

Some of the results of this simulation are presented graphically in Figures 5.1 - 5.3. The input kW presented in Figure 5.2(b) clearly shows the energy being returned to the third rail during vehicle braking. The substation loading charts of Figure 5.3 should be compared with those of Figure 3.8. This comparison is, however, not easily done because the instantaneous variations of Figure 5.3 are sensitive to the time interval between two successive network computations, and those of Figure 3.8 are noisy.

The 15-minute average total substation loading predicted by this model is compared with the 30-minute average loading monitored by the utility system at the ac substation in Figure 5.4. The peak hour loading predicted is less than 8 percent higher than the actual loading, and the overall agreement over the three hour period is very good.

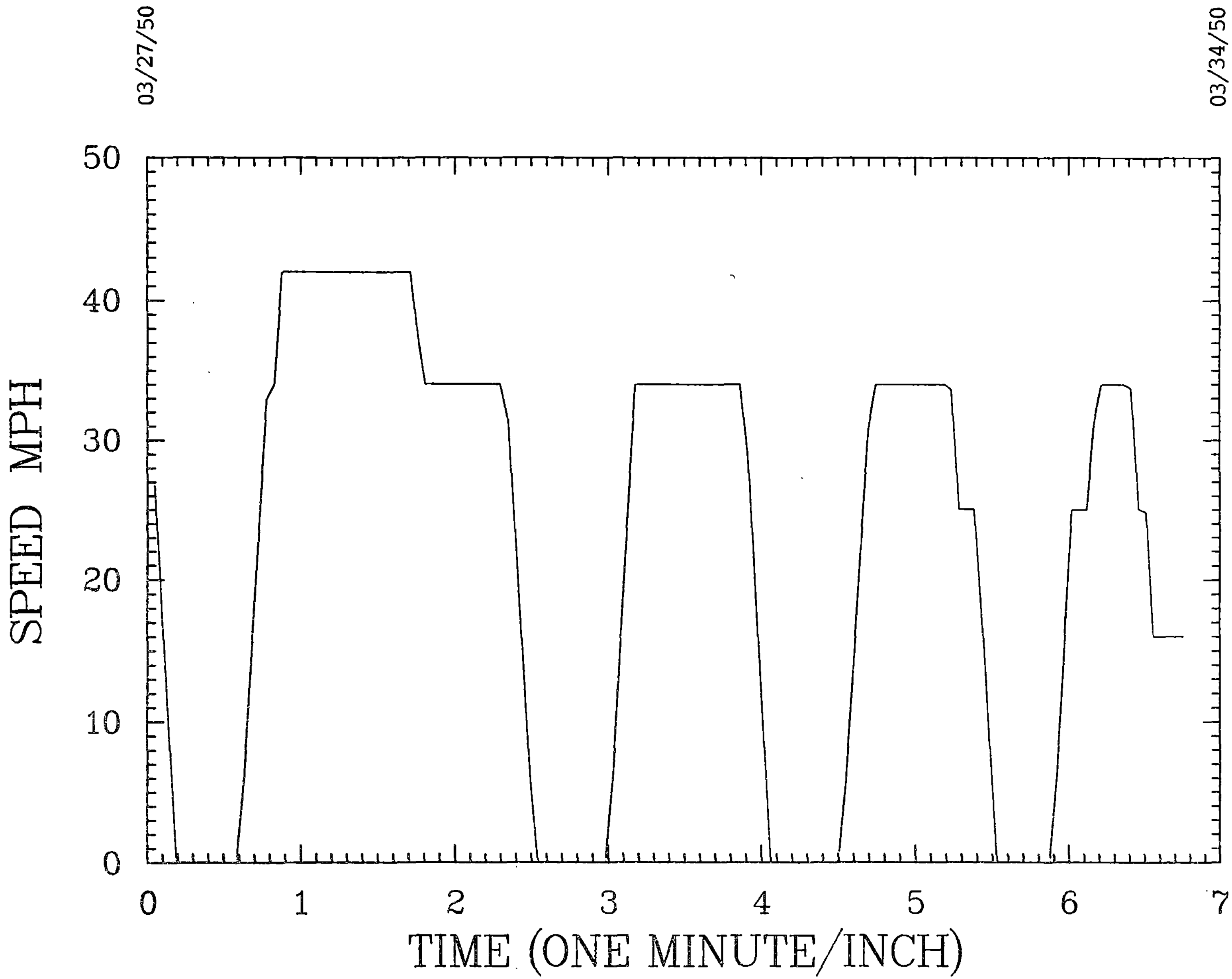
FIGURE 5.1 BASELINE TEST SIMULATION - MODEL # 2

TEST #2 BASELINE RUN NO. 4: 03/20/50 to 03/27/50 PAGE 1 OF 2

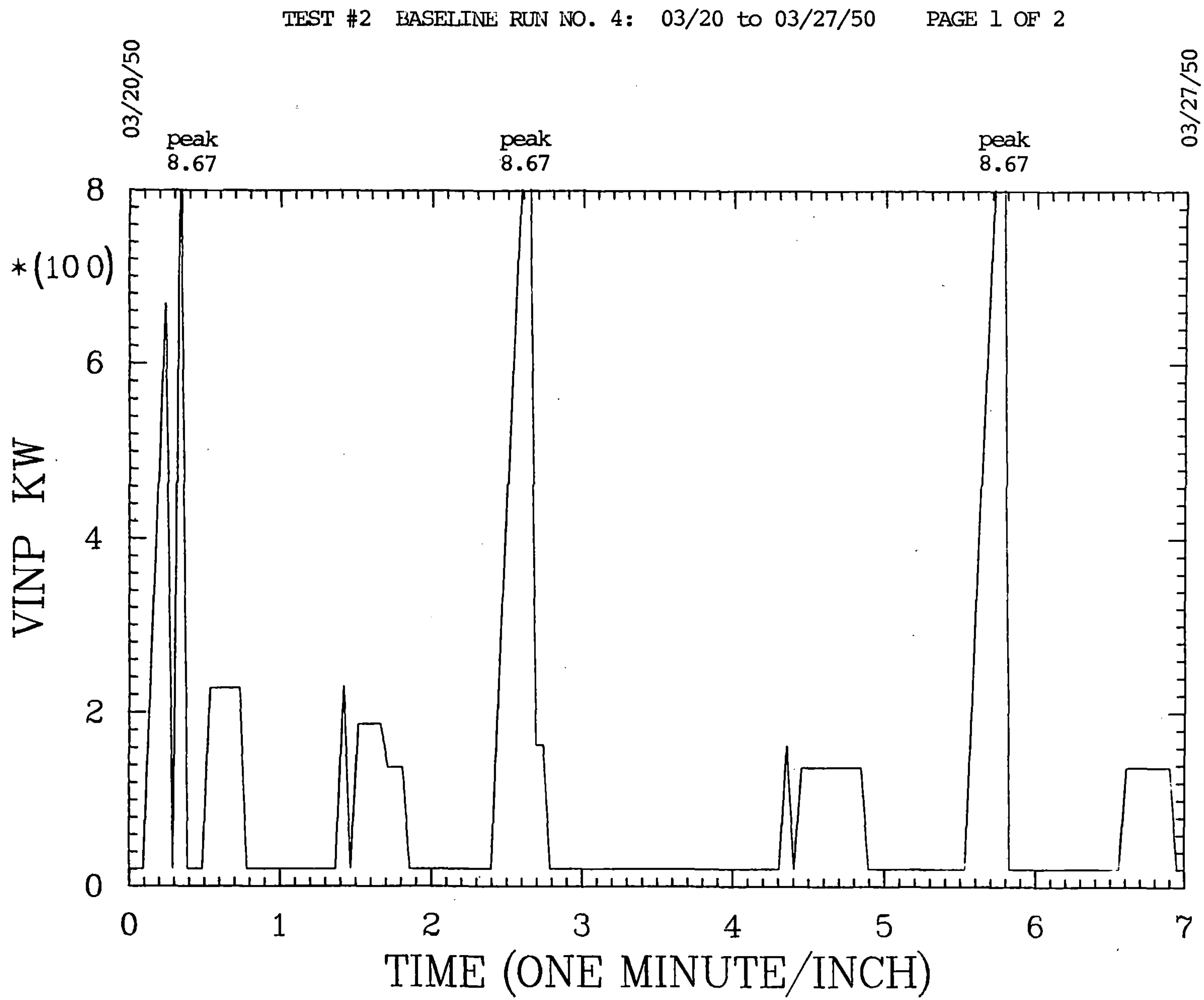


(a)

TEST #2 BASELINE RUN NO. 4: 03/27/50 to 03/34/50 PAGE 2 OF 2

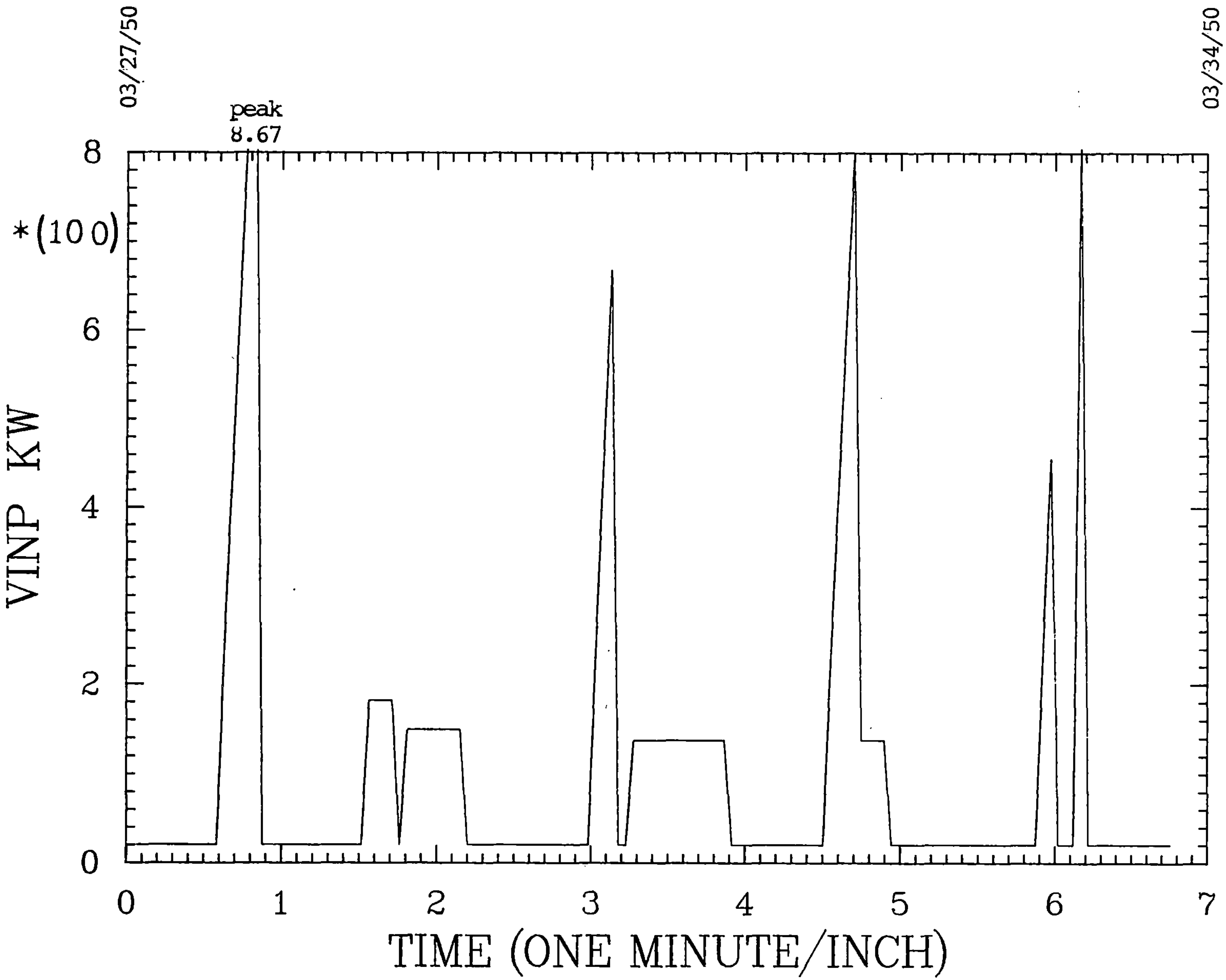


(a)


TEST #2 BASELINE RUN NO. 4: 03/20 to 03/27/50 PAGE 1 OF 2
03/20/50
03/27/50
peak
8.67
peak
8.67
peak
8.67
VINP KW *(100)
8
6
4
2
0
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)

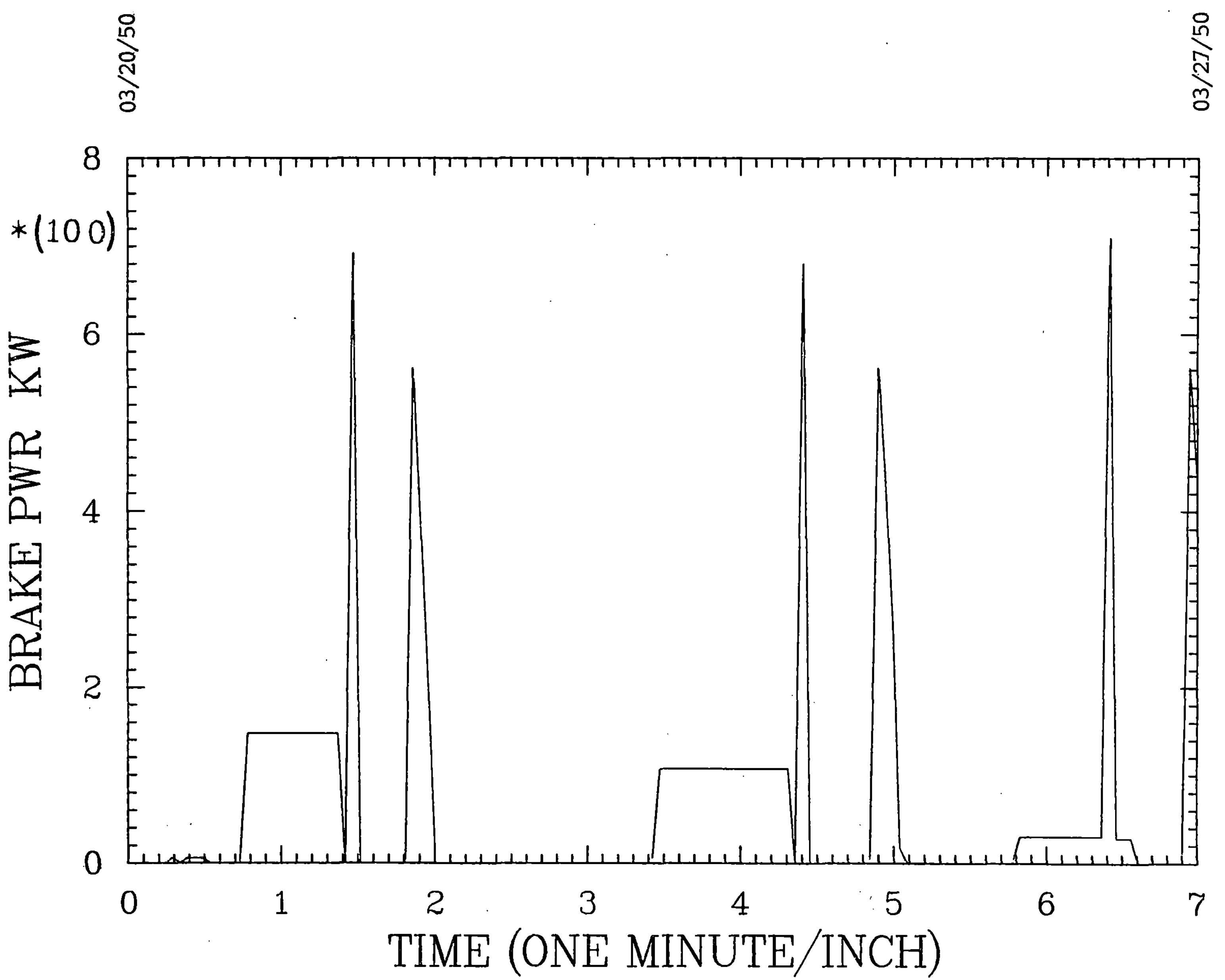
(b)

TEST #2 BASELINE RUN NO. 4: 03/27/50 to 03/34/50 PAGE 2 OF 2



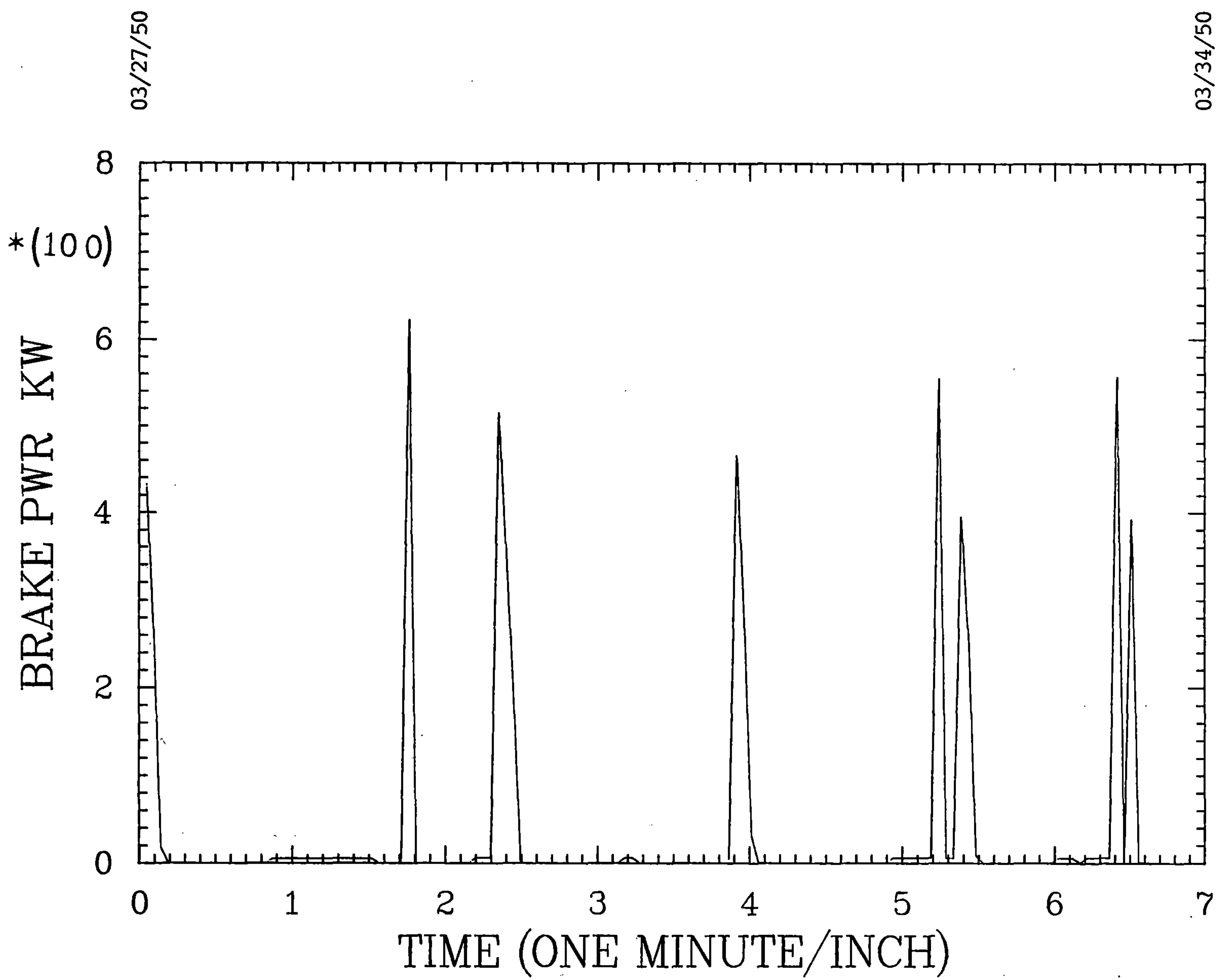
(b)

TEST #2 BASELINE RUN NO. 4: 03/20/50 to 03/27/50 PAGE 1 OF 2



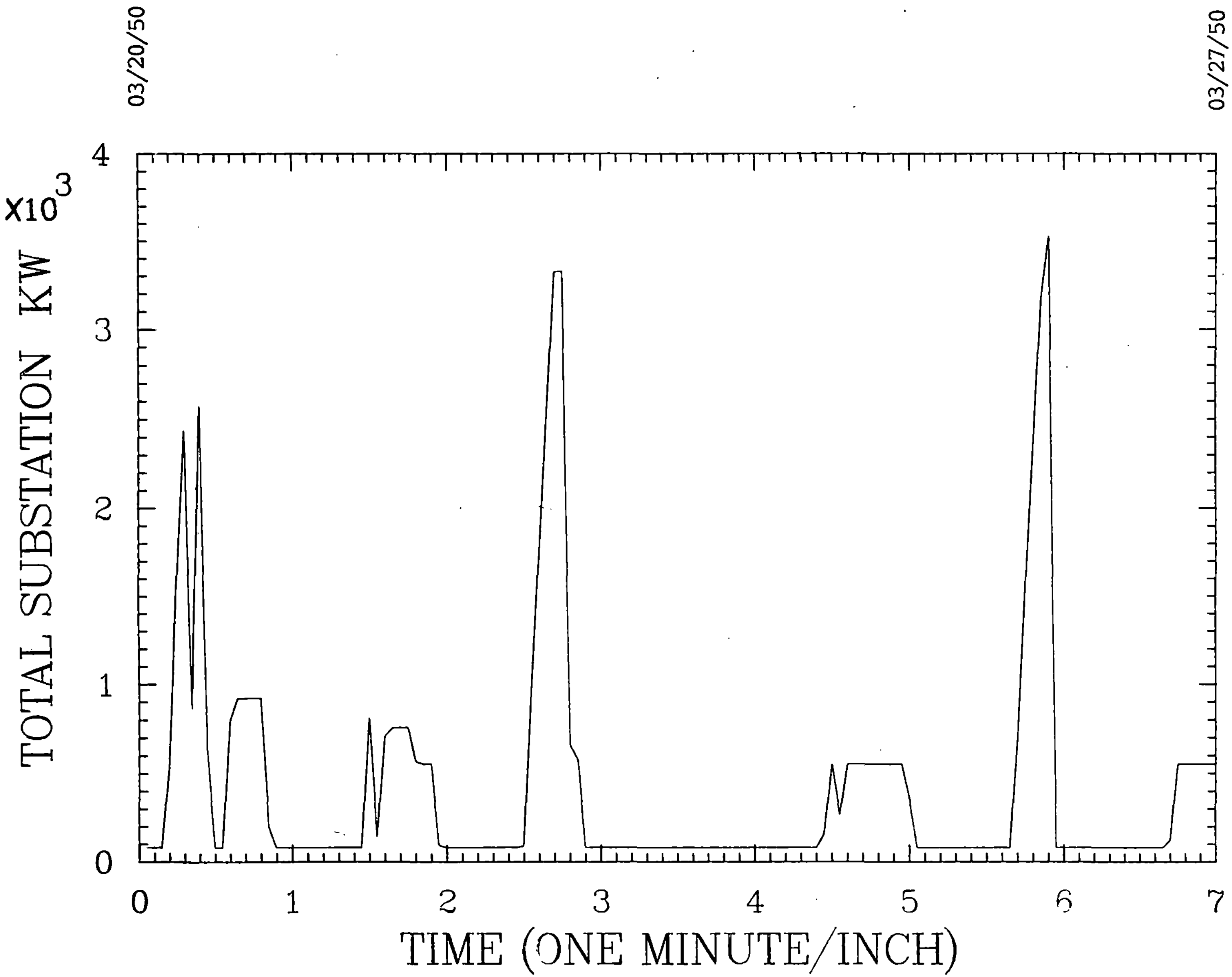
(c)

TEST #2 BASELINE RUN NO. 4: 03/27/50 to 03/34/50 PAGE 2 OF 2



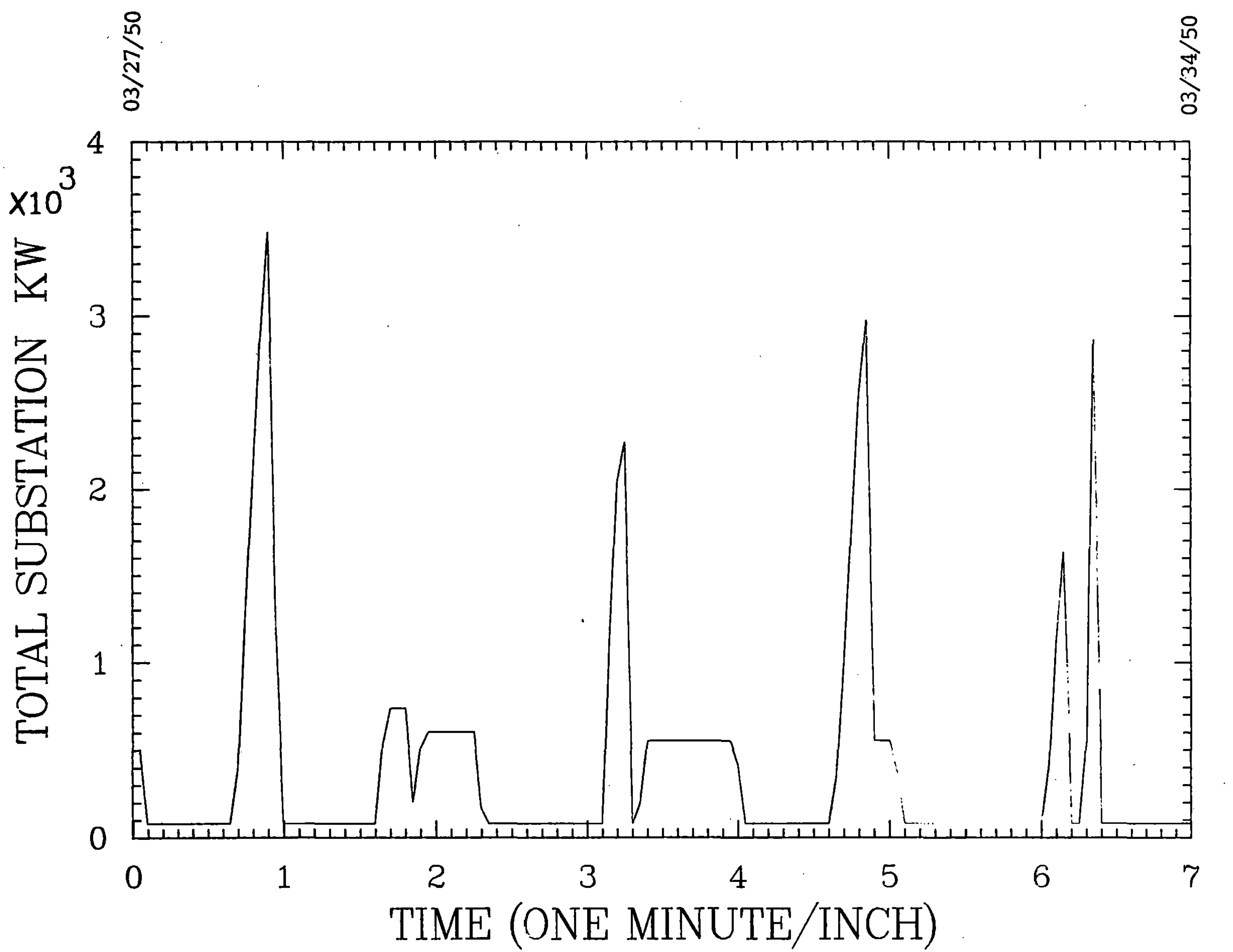
(c)

TEST #2 BASELINE RUN NO. 4: 03/20/50 to 03/27/50 PAGE 1 OF 2



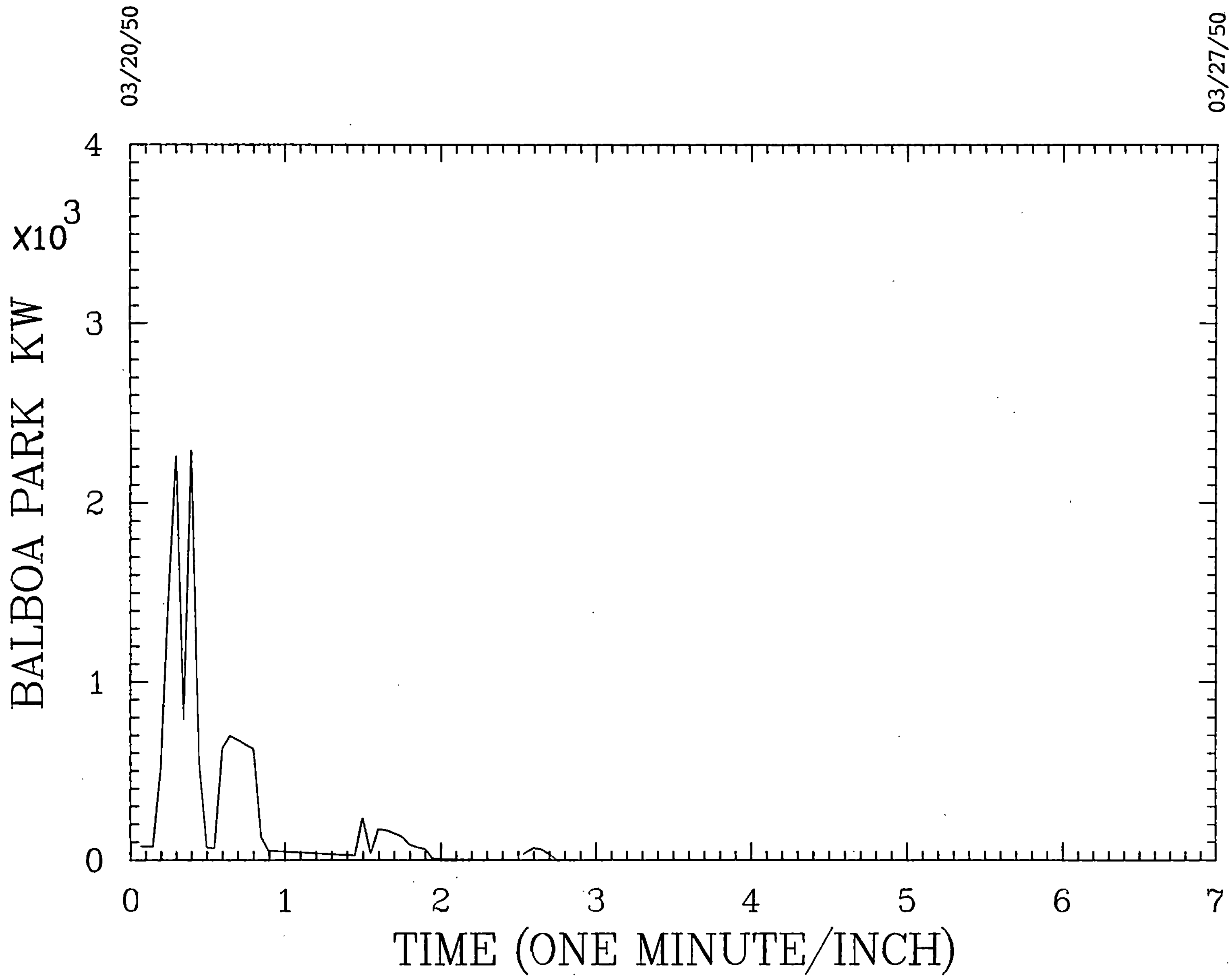
(d)

TEST #2 BASELINE RUN NO. 4: 03/27/50 to 03/34/50 PAGE 2 OF 2



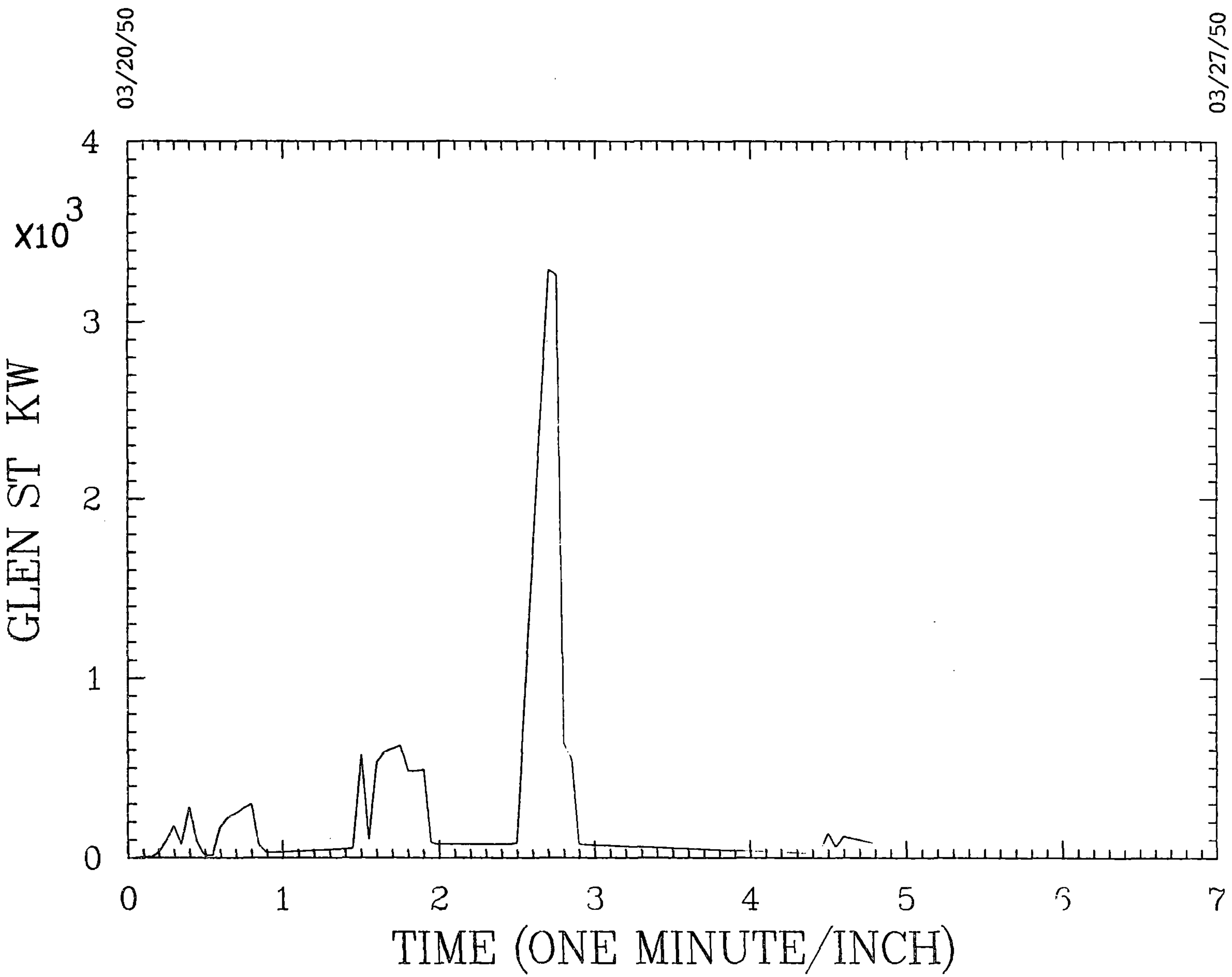
(d)

TEST #12 BASELINE RUN NO. 4; 03/20/50 to 03/27/50 PAGE 1 OF 2



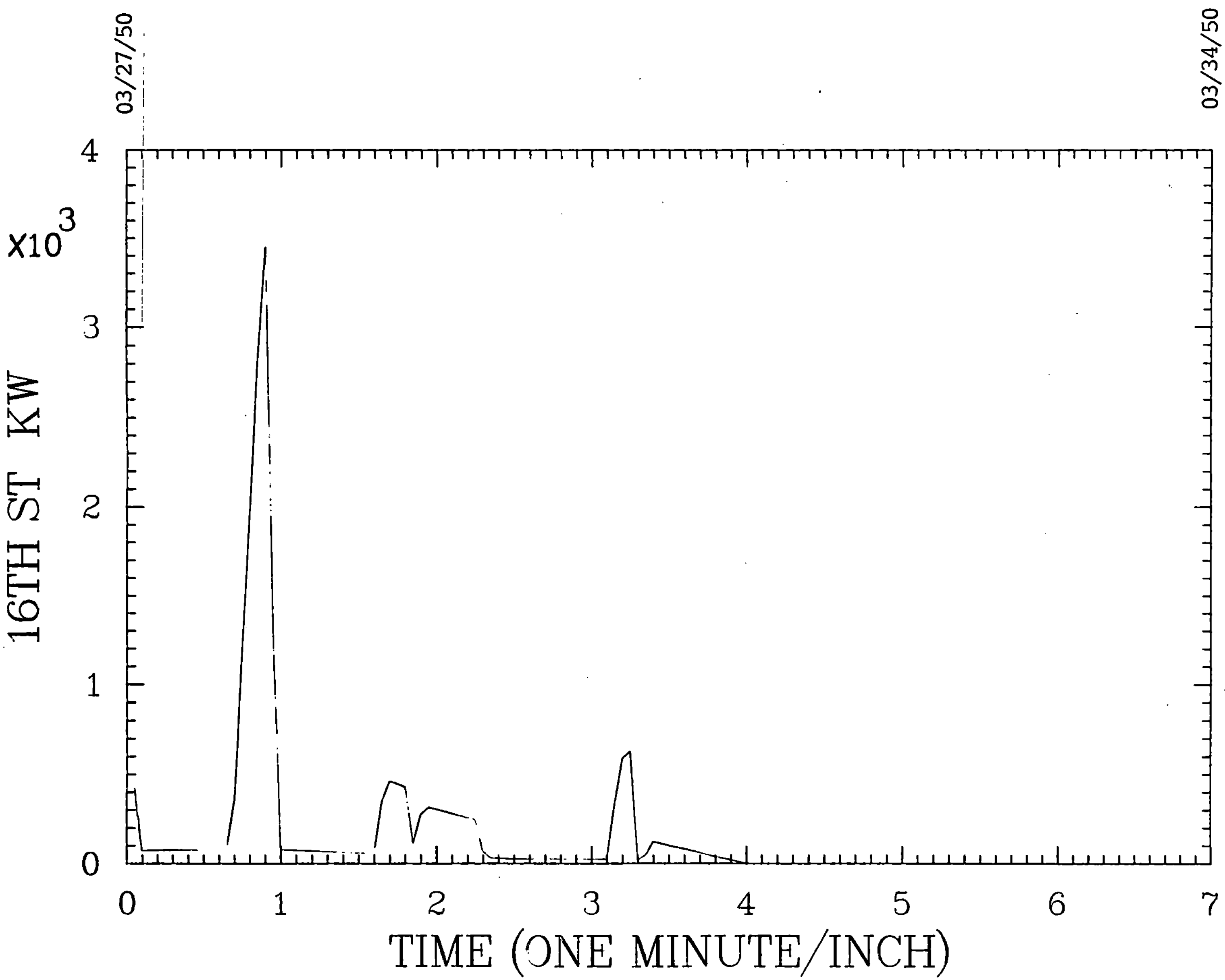
(e)

TEST #2 BASELINE RUN NO. 4: 03/20/50 to 03/27/50



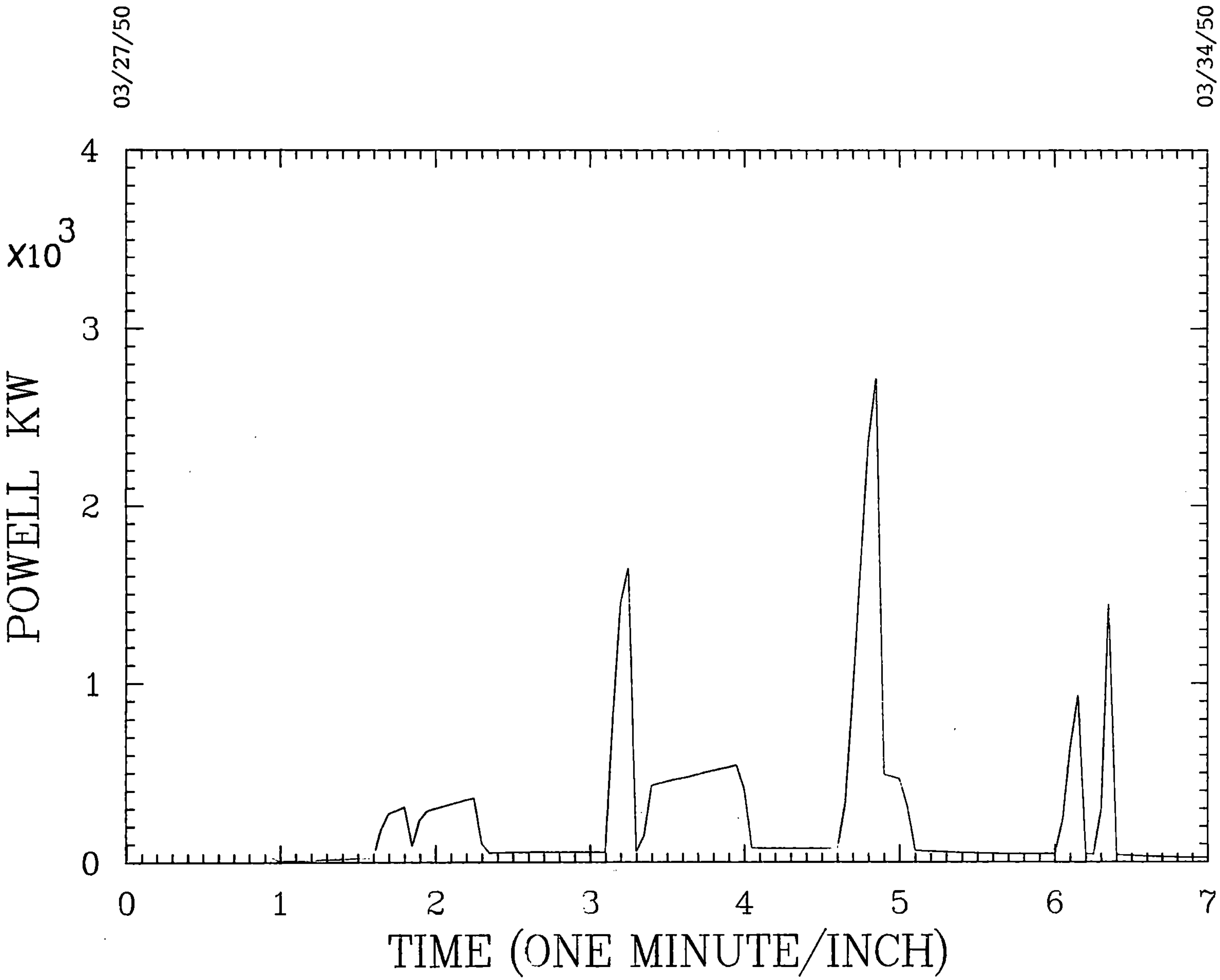
(f)

TEST #2 BASELINE RUN NO. 4: 03/27/50 to 03/34/50



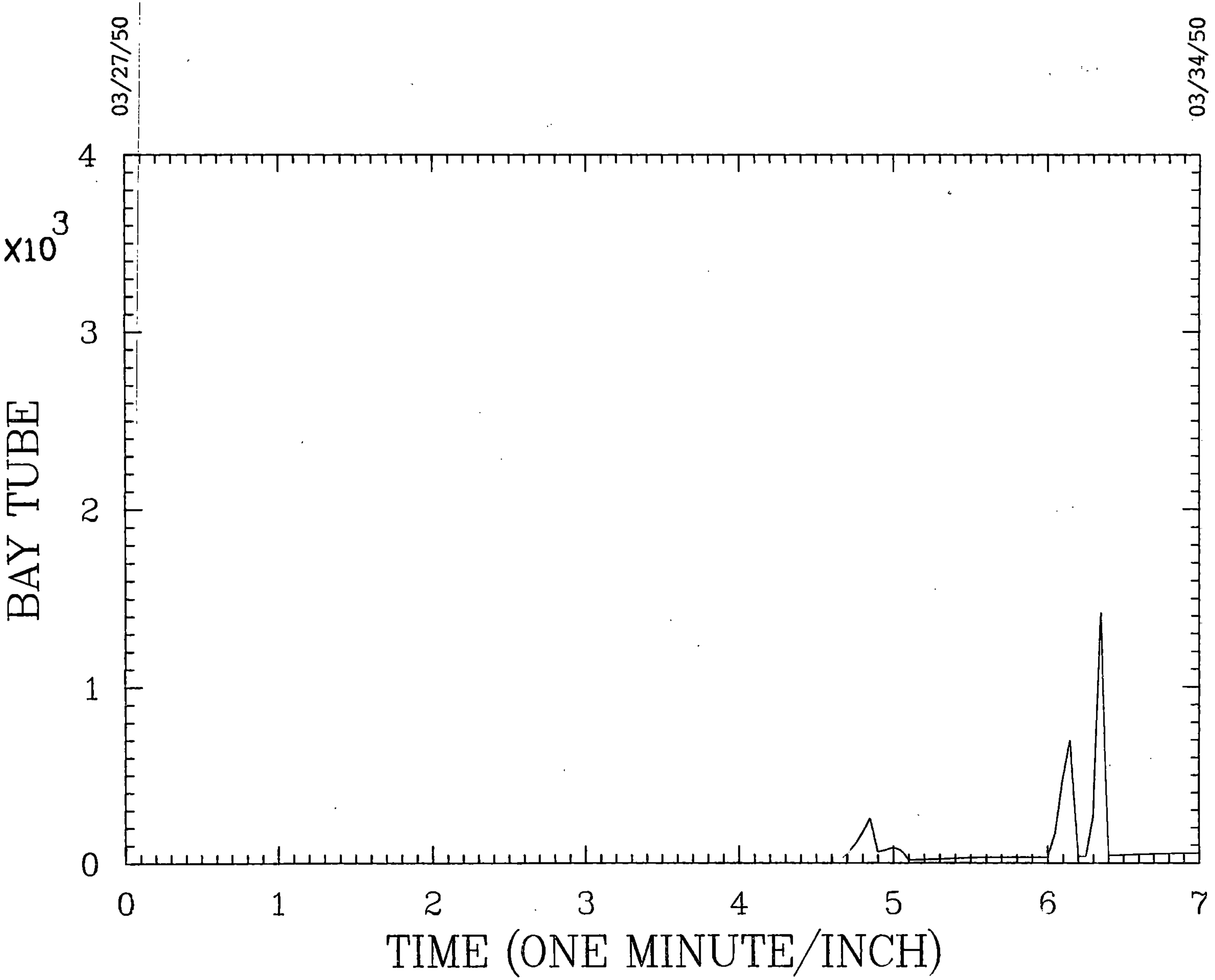
(g)

TEST #2 BASELINE RUN NO. 4: 03/27/50 to 03/34/50



(h)

TEST #2 BASELINE RUN NO. 4: 03/27/50 to 03/34/50

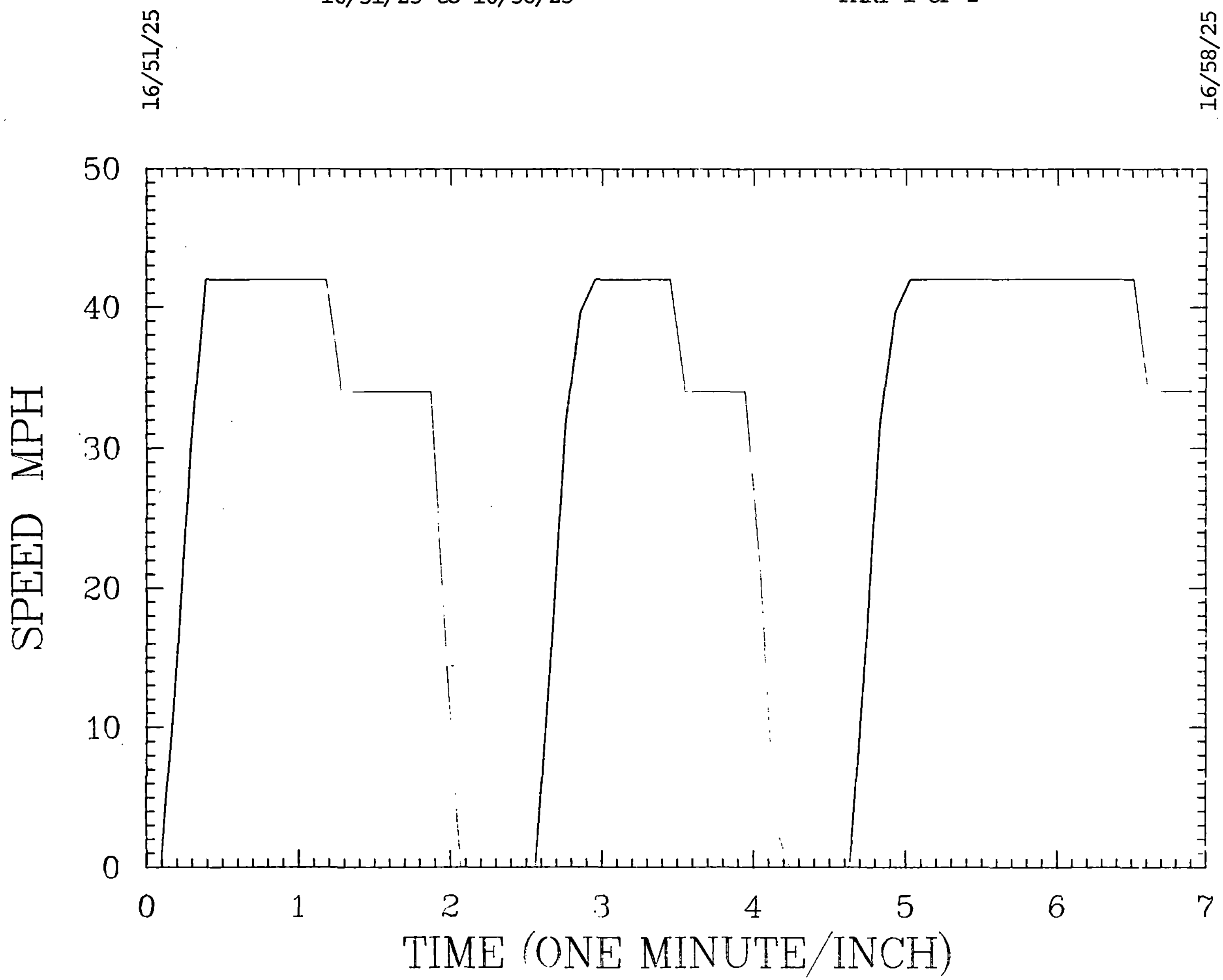


(i)

FIGURE 5.2 REGENERATION TEST SIMULATION
VEHICLE DATA - MODEL # 2

TEST #1 REVENUE RUN: 25 AUGUST 1981, TRAIN 453-04

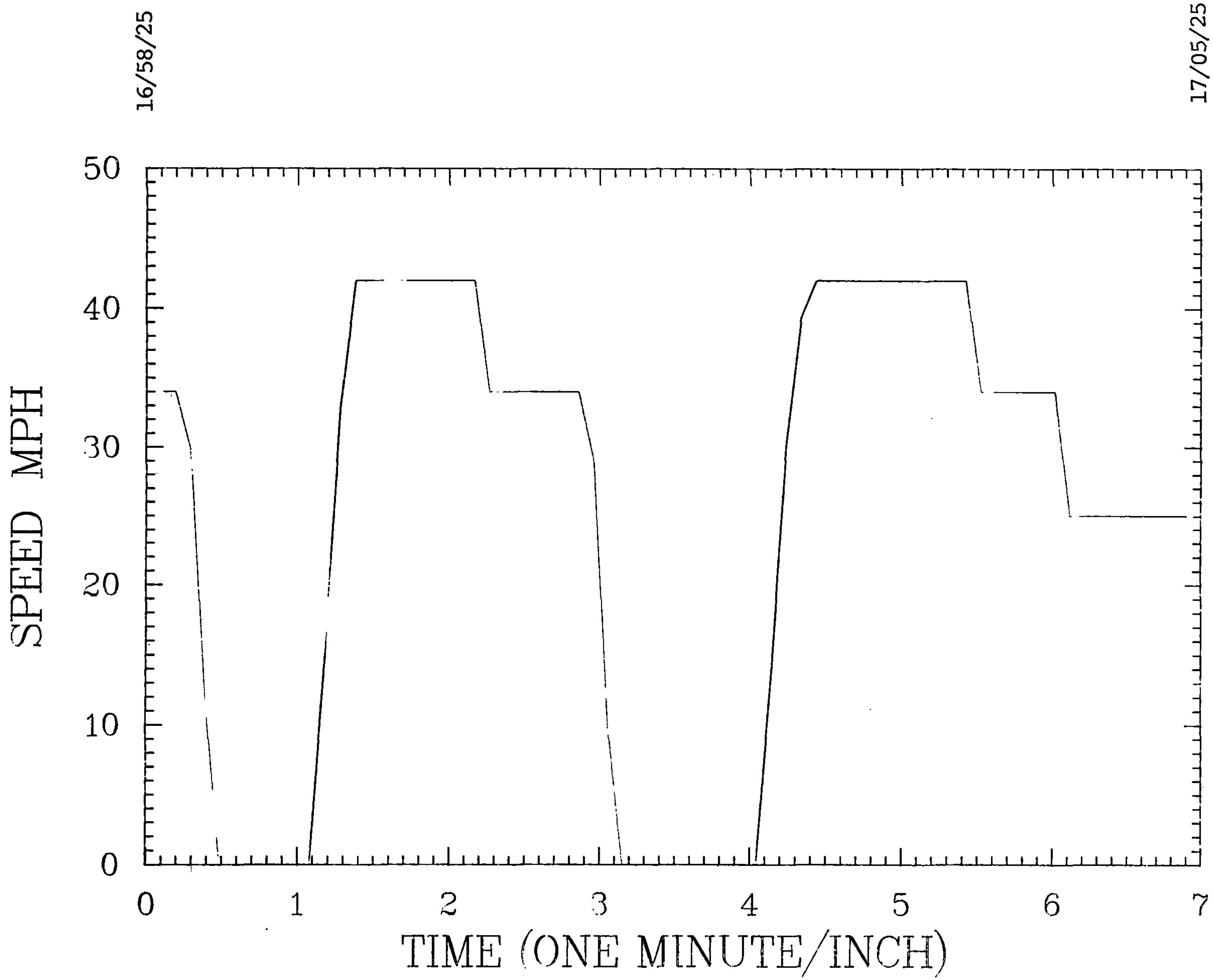
16/51/25 to 16/58/25 PART 1 OF 2



(a)

TEST #1 REVENUE RUN: 25 AUGUST 1981, TRAIN 453-04

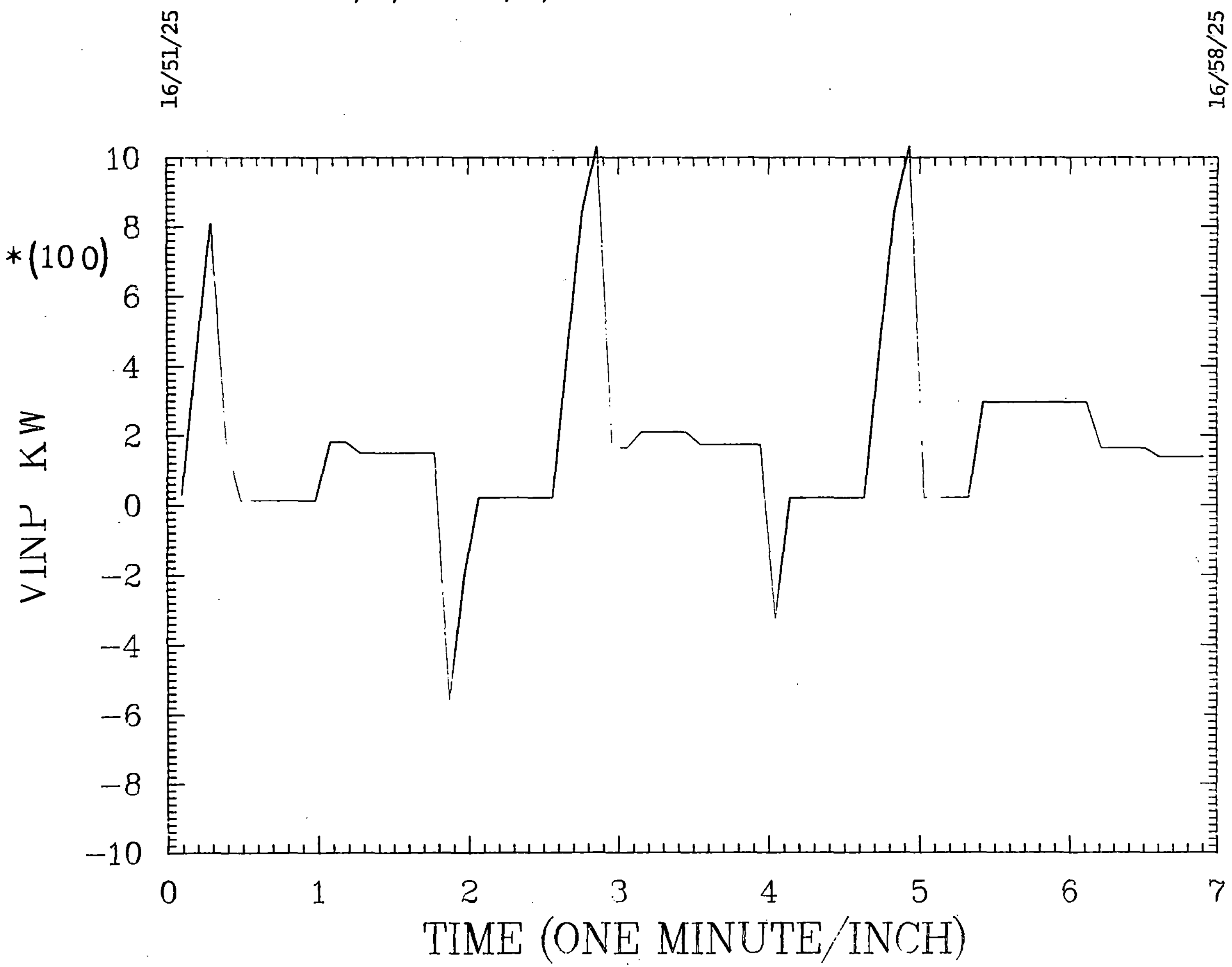
16/58/25 to 17/05/25 PART 2 OF 2



(a)

TEST #1 REVENUE RUN: 25 AUGUST 1981, TRAIN 453-04

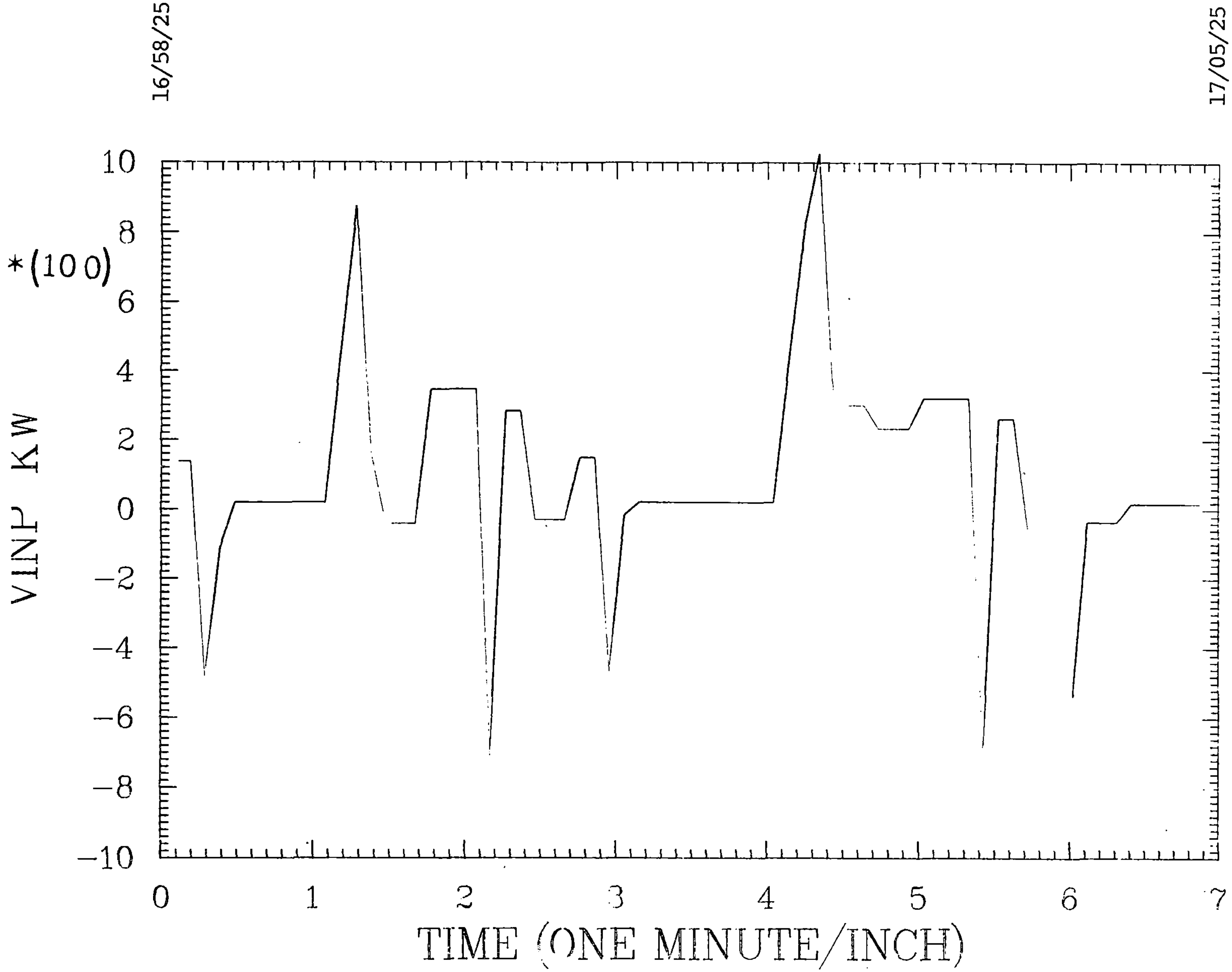
16/51/25 to 16/58/25



(b)

TEST #1 REVENUE RUN: 25 AUGUST 1981, TRAIN 453-04

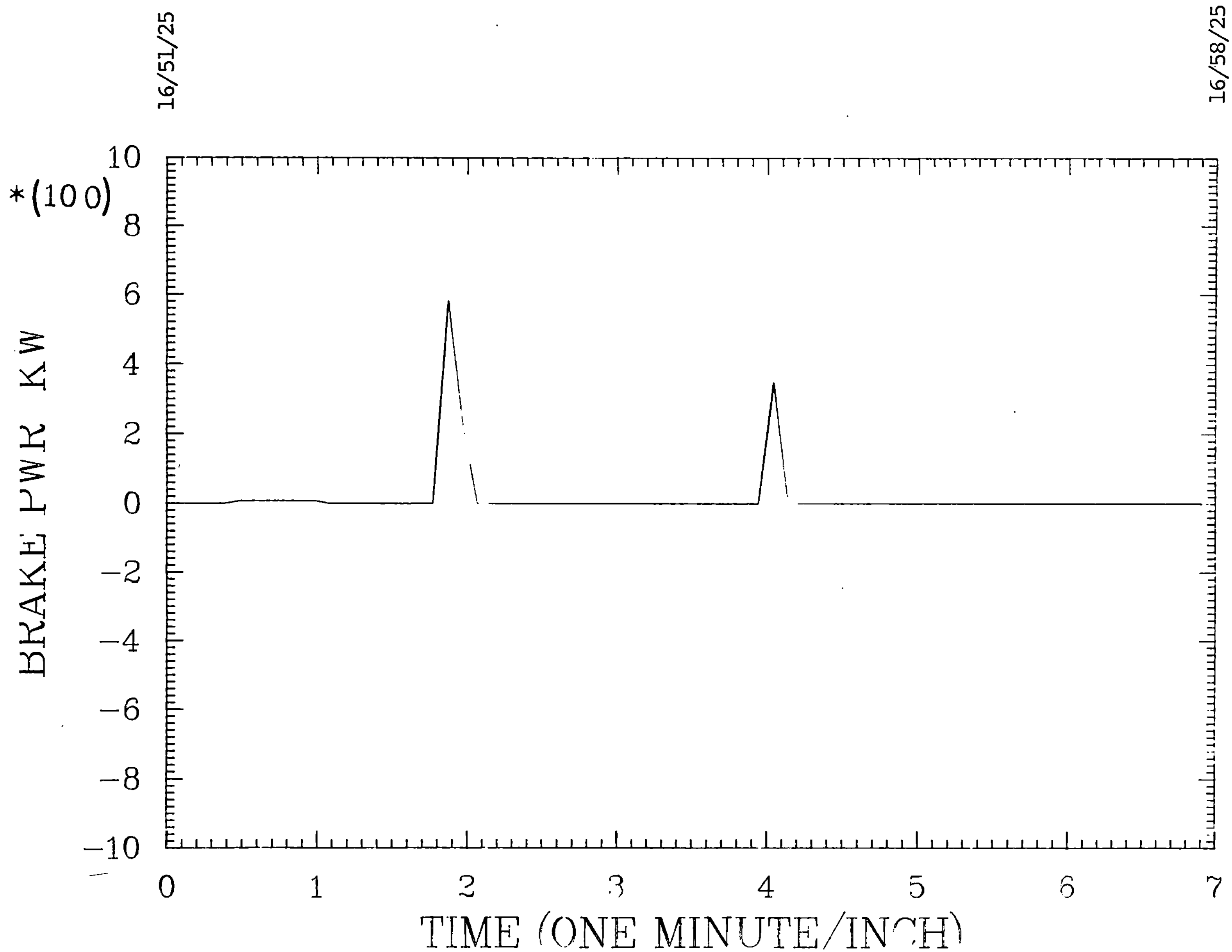
16/58/25 to 17/05/25 PART 2 OF 2



(b)

TEST #1 REVENUE RUN: 25 AUGUST 1981, TRAIN 453-04

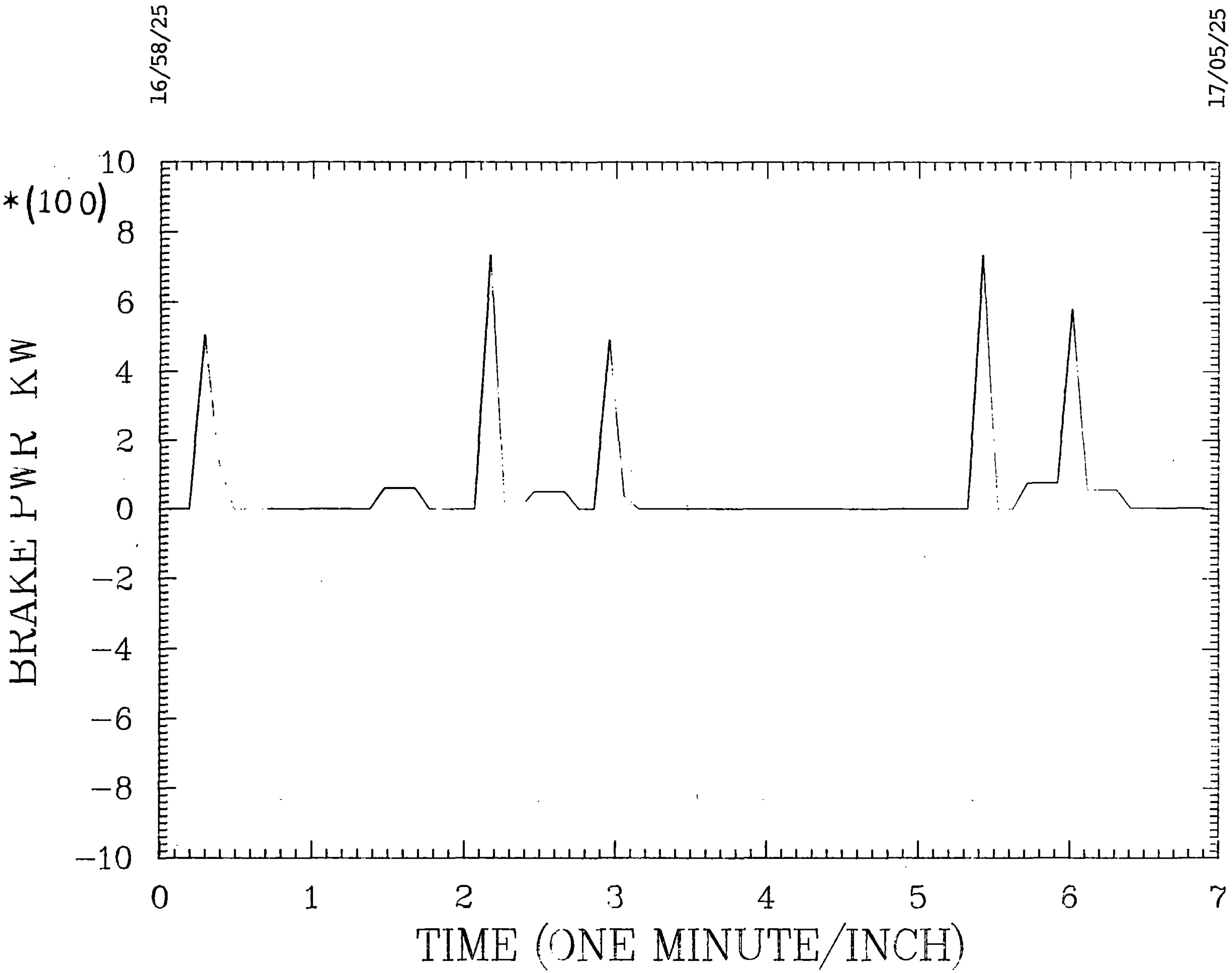
16/51/25 to 16/58/25 PART 1 OF 2



(c)

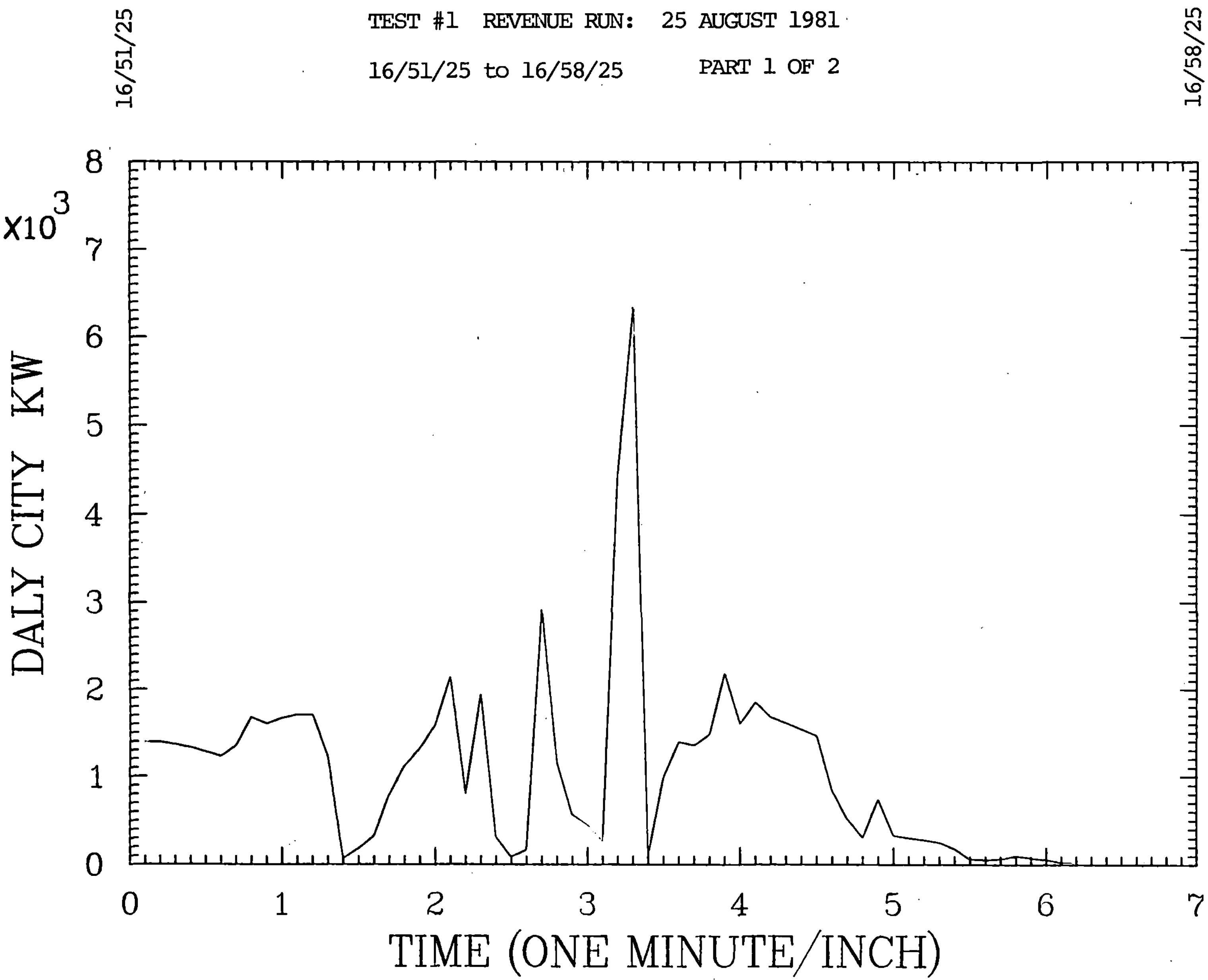
TEST #1 REVENUE RUN: 25 AUGUST 1981, TRAIN 453-04

16/58/25 to 17/05/25 PART 2 OF 2



(c)

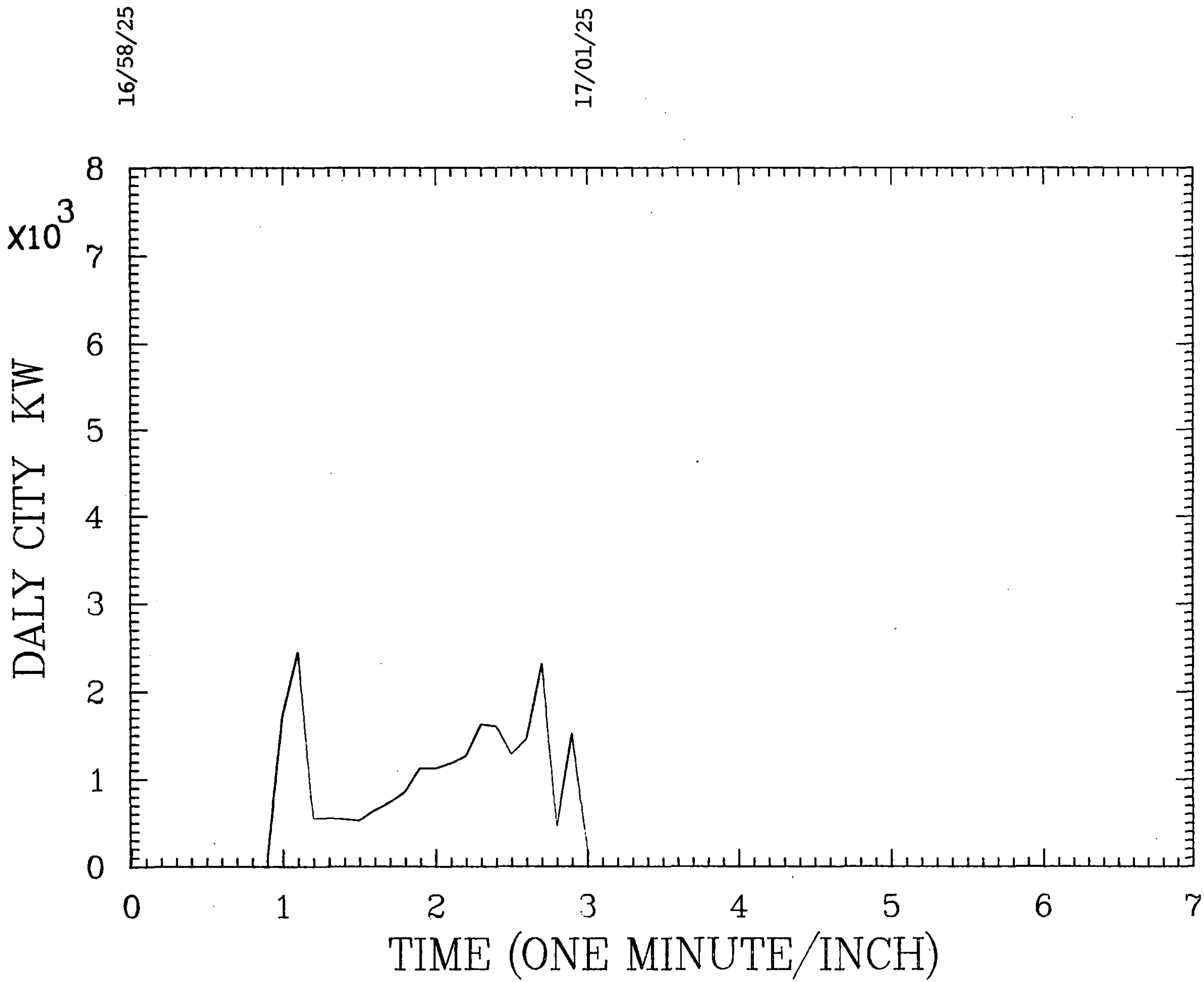
FIGURE 5.3 REGENERATION TEST SIMULATION
SUBSTATION LOADS - MODEL # 2


TEST #1 REVENUE RUN: 25 AUGUST 1981
16/51/25 to 16/58/25
PART 1 OF 2
16/51/25
16/58/25
DALY CITY KW
X10^3
0
1
2
3
4
5
6
7
8
TIME (ONE MINUTE/INCH)

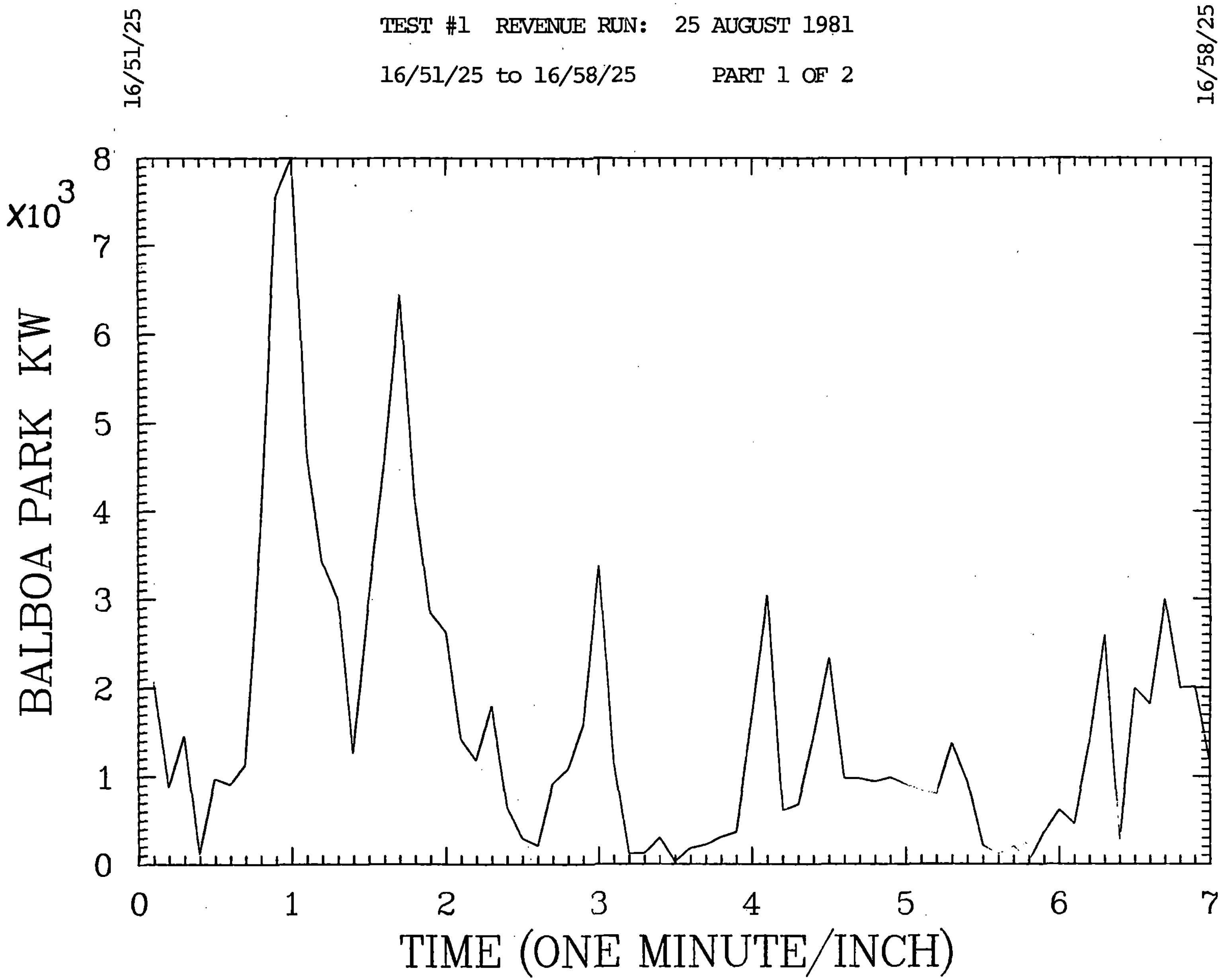
(a)

TEST #1 REVENUE RUN: 25 AUGUST 1981

16/58/25 to 17/01/25 PART 2 OF 2



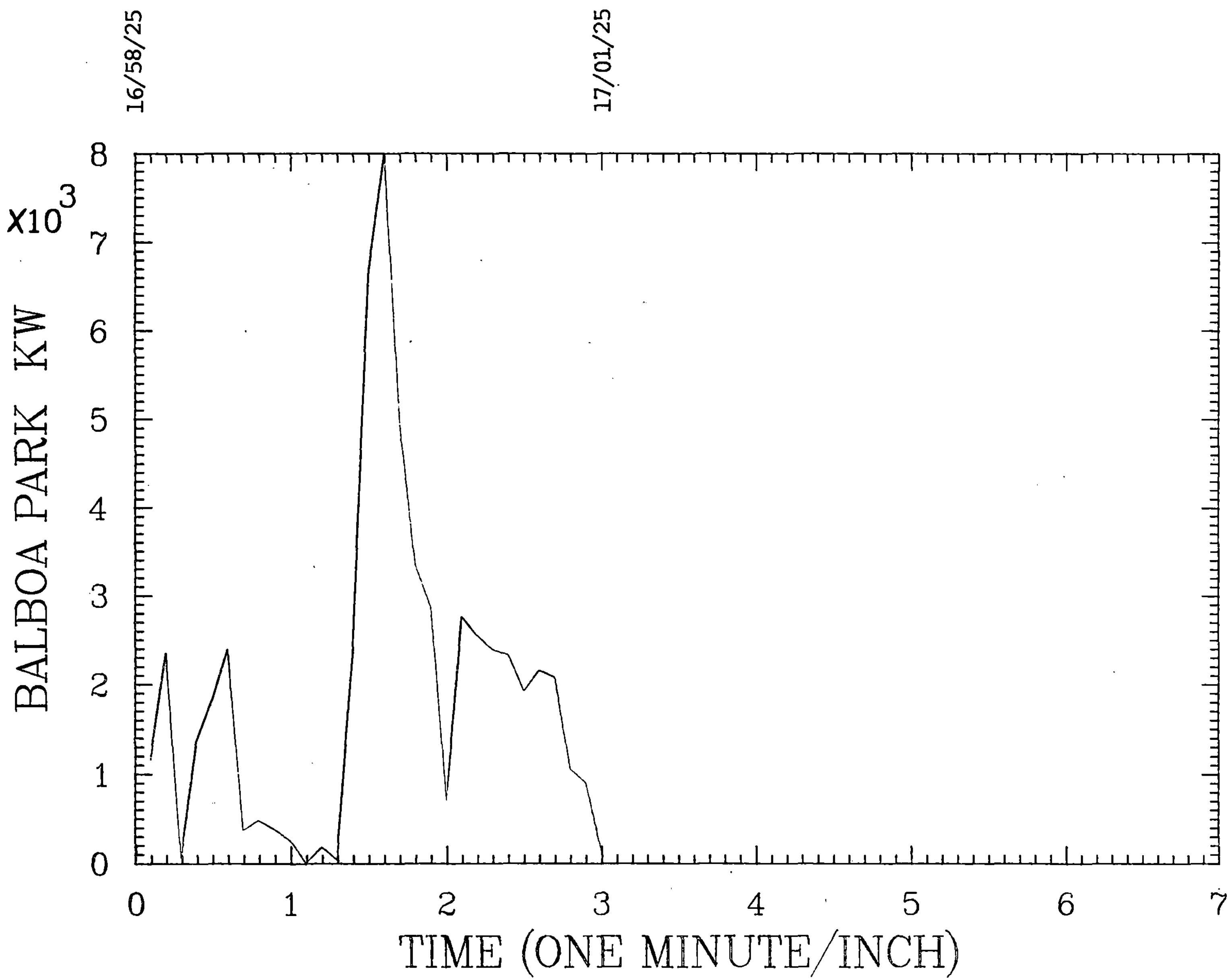
(a)


16/51/25
TEST #1 REVENUE RUN: 25 AUGUST 1981
16/51/25 to 16/58/25 PART 1 OF 2
16/58/25
X10^3
BALBOA PARK KW
0
1
2
3
4
5
6
7
8
0
1
2
3
4
5
6
7
TIME (ONE MINUTE/INCH)

(b)

TEST #1 REVENUE RUN: 25 AUGUST 1981

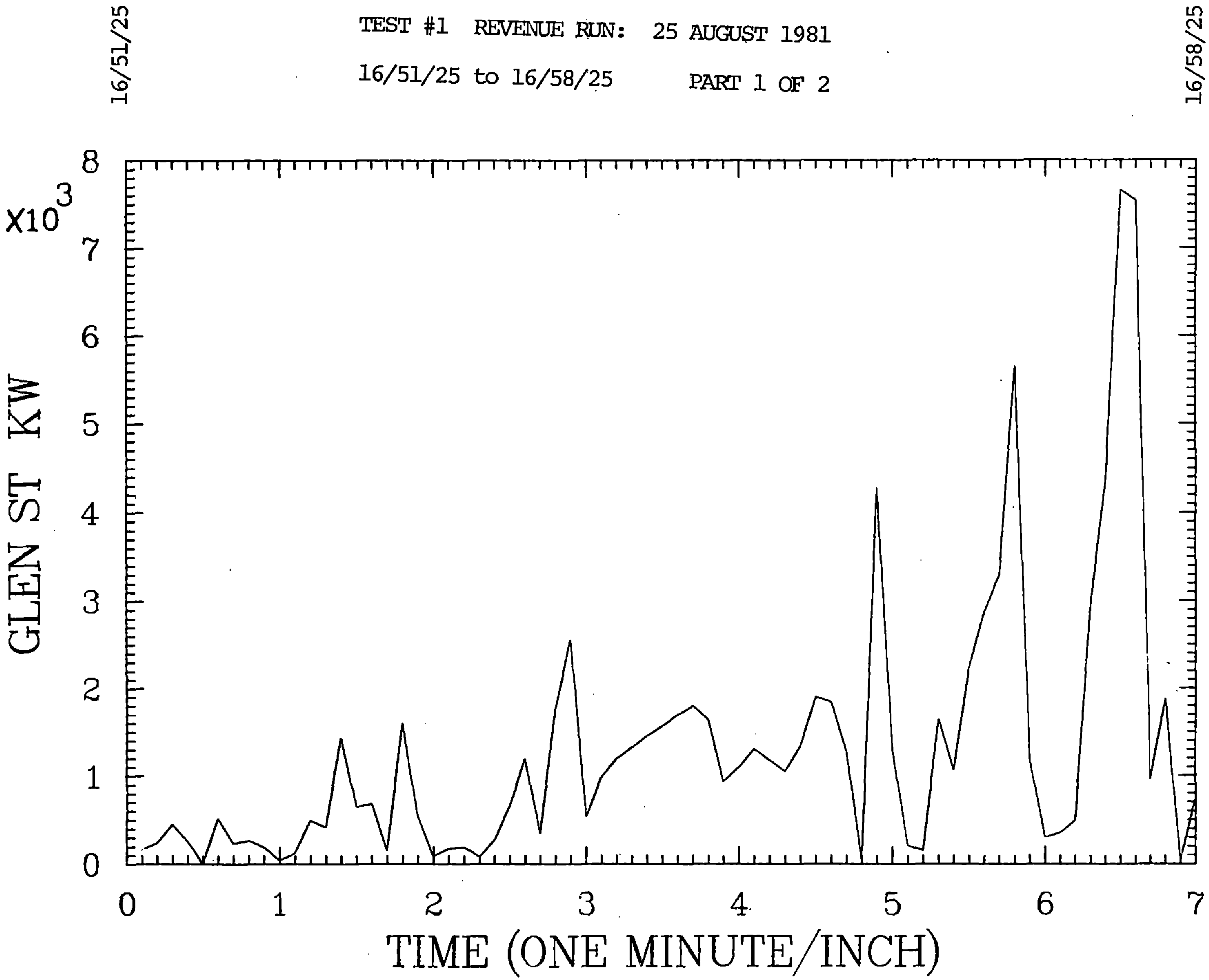
16/58/25 to 17/01/25 PART 2 OF 2



(b)

TEST #1 REVENUE RUN: 25 AUGUST 1981

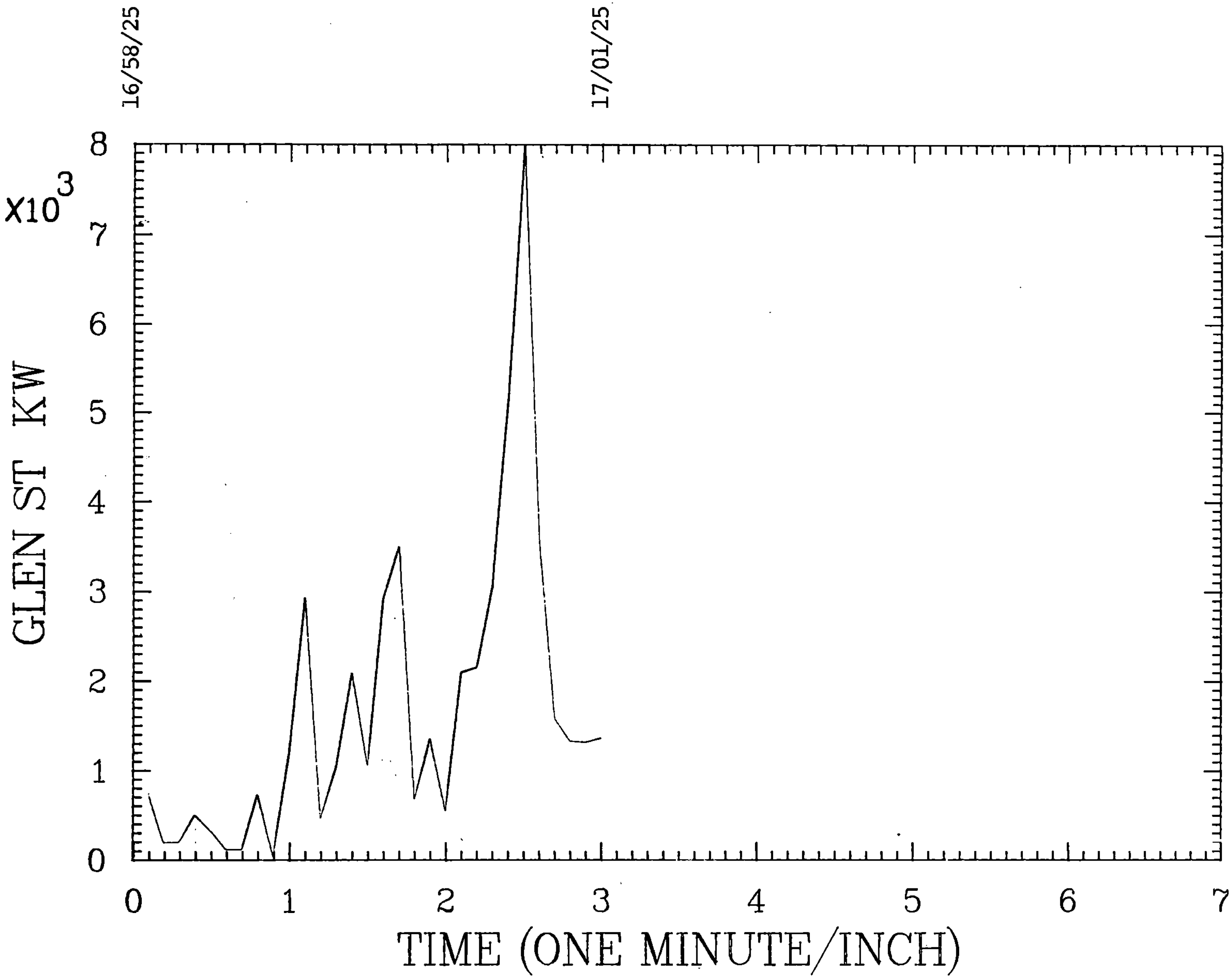
16/51/25 to 16/58/25 PART 1 OF 2



(c)

TEST #1 REVENUE RUN: 25 AUGUST 1981

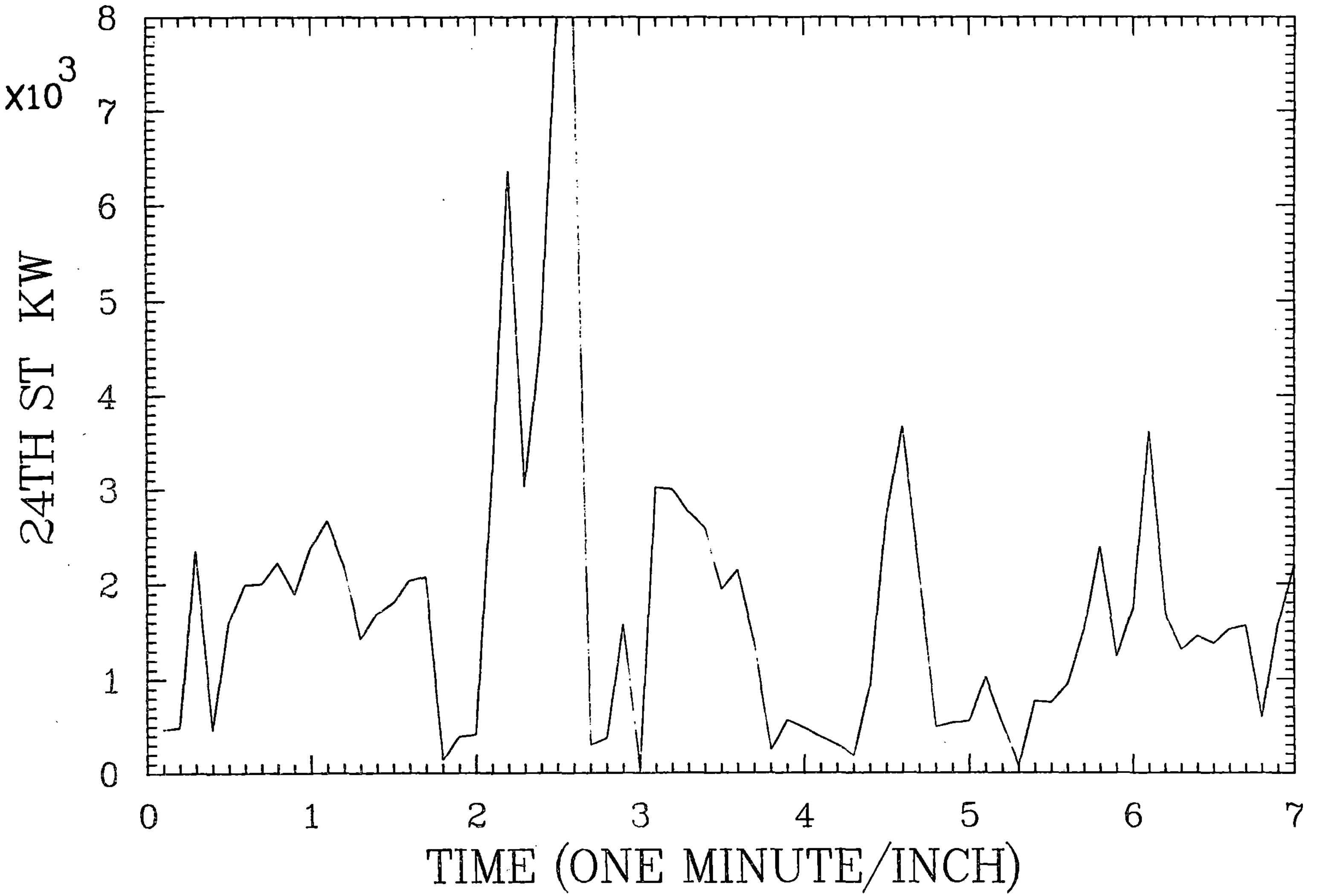
16/58/25 to 17/01/25 PART 2 OF 2



(c)

16/51/25 TEST #1 REVENUE RUN: 25 AUGUST 1981 16/58/25

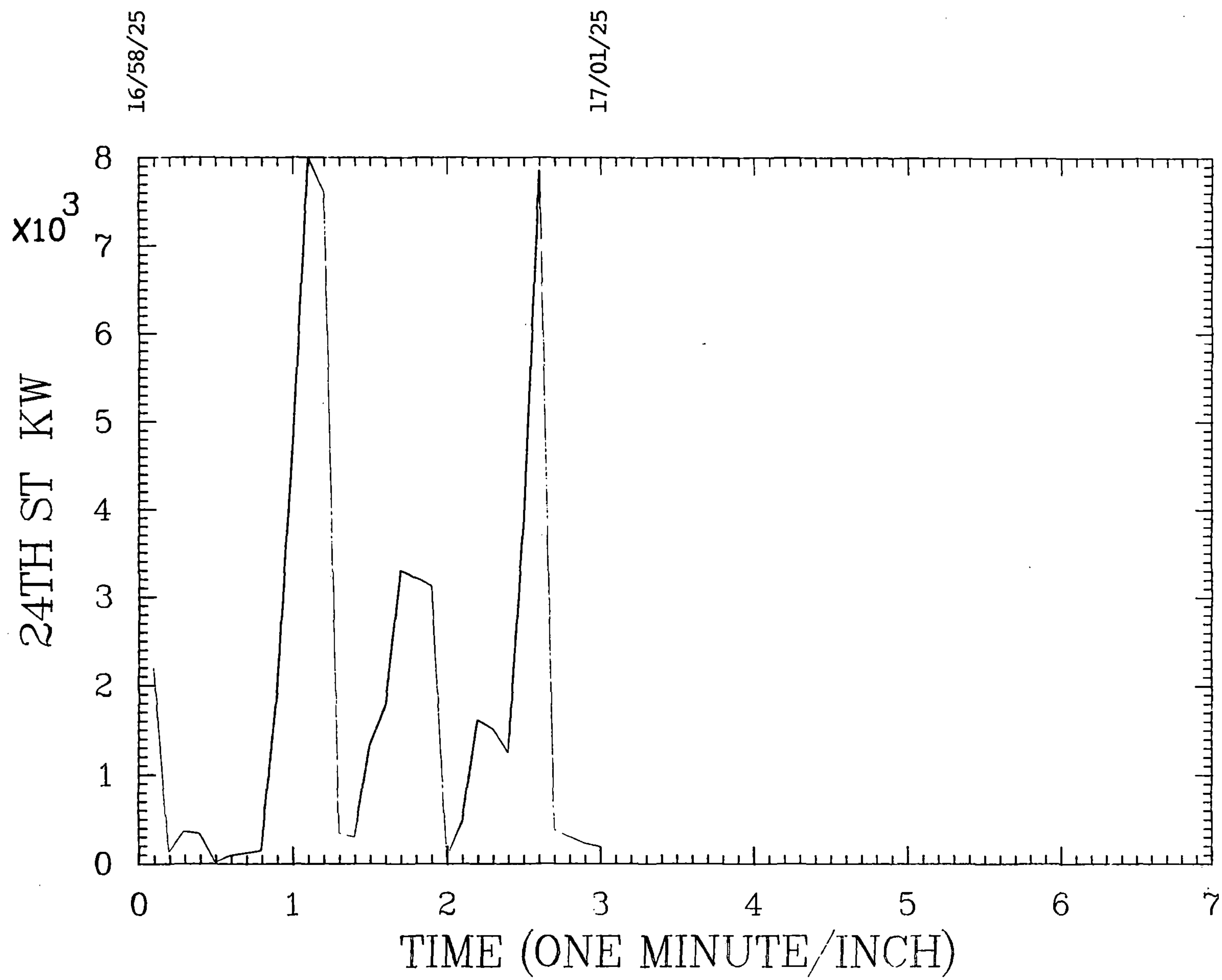
16/51/25 to 16/58/25 PART 1 OF 2



(d)

TEST #1 REVENUE RUN: 25 AUGUST 1981

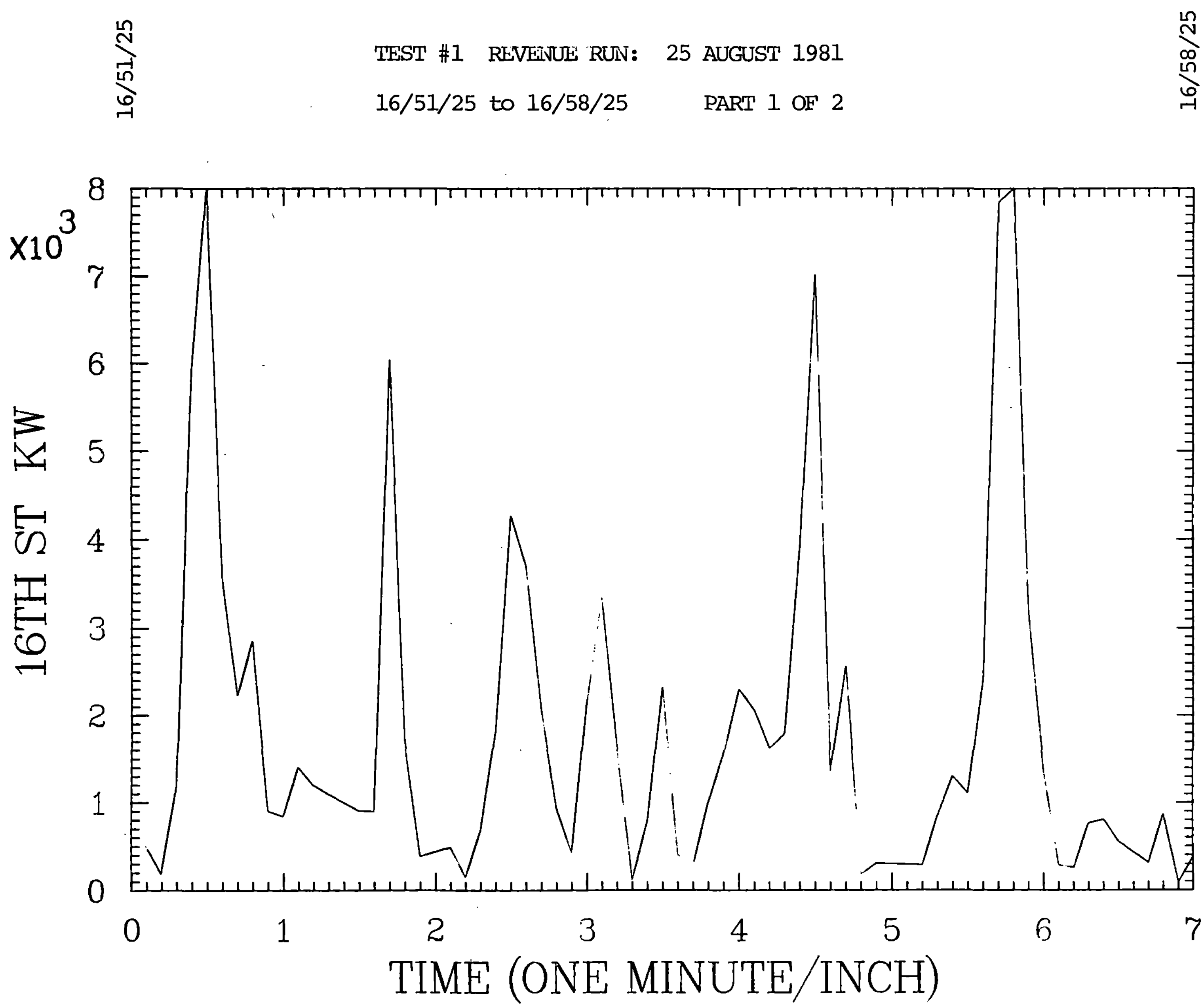
16/58/25 to 17/01/25 PART 2 OF 2



(d)

TEST #1 REVENUE RUN: 25 AUGUST 1981

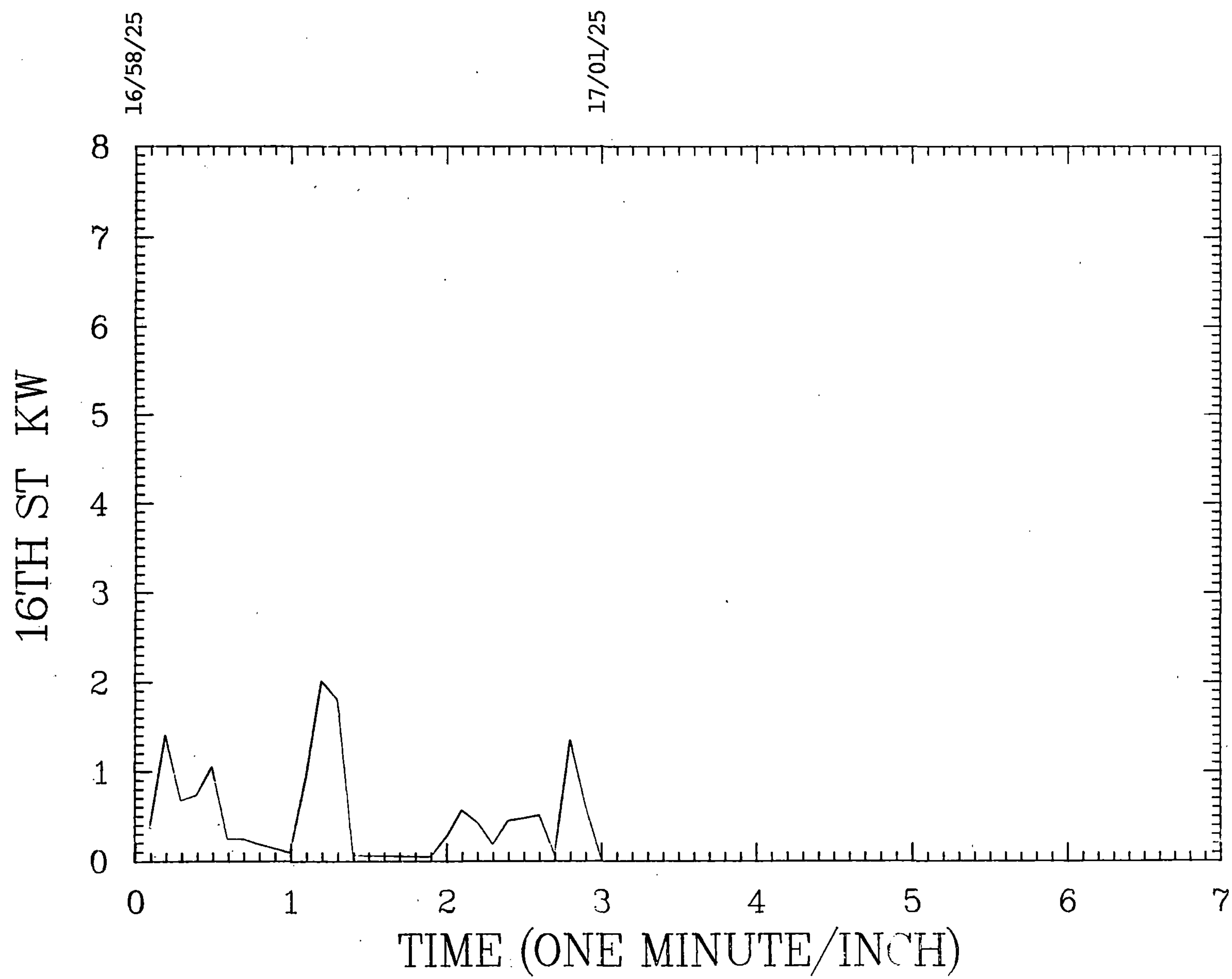
16/51/25 to 16/58/25 PART 1 OF 2



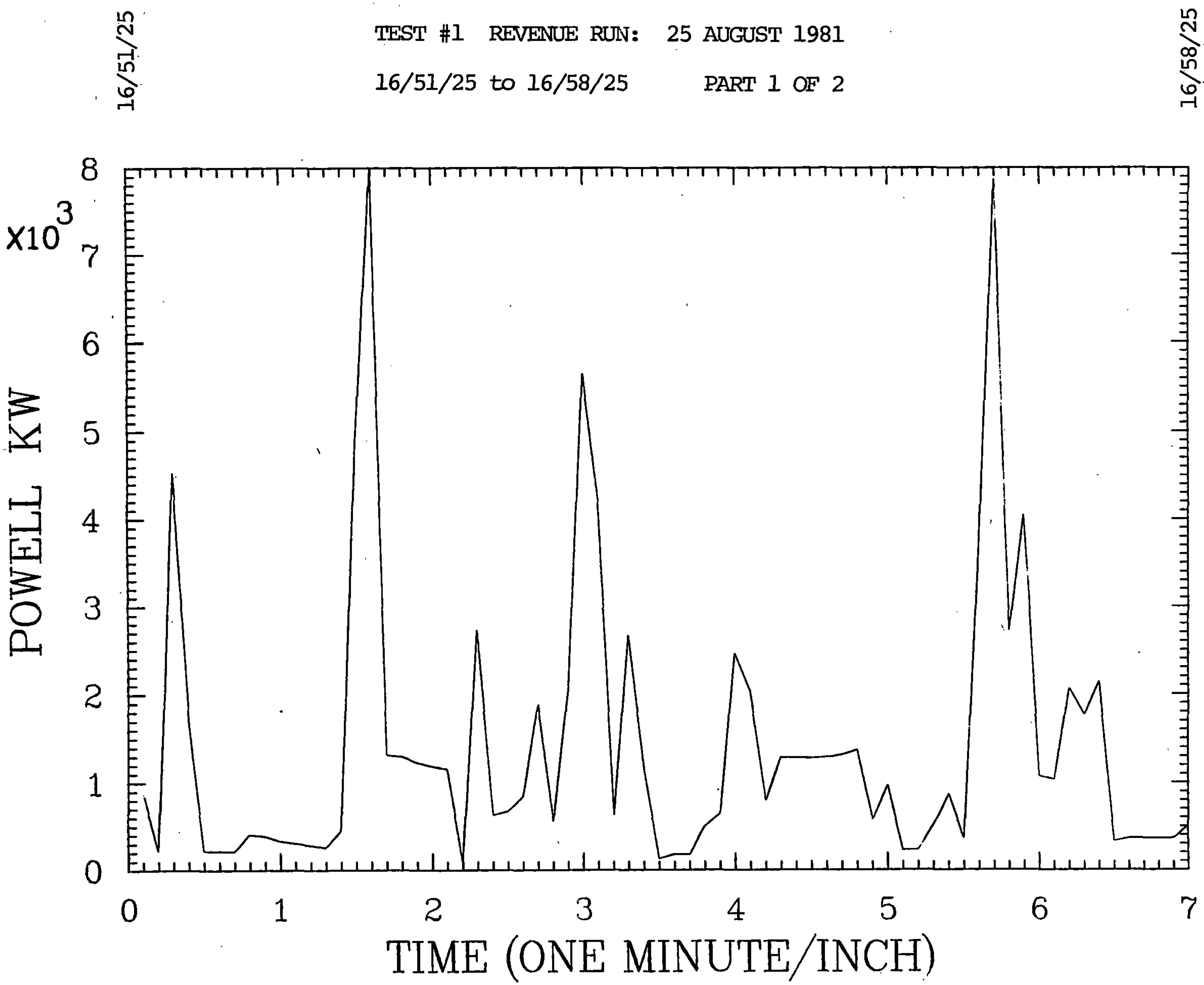
(e)

TEST #1 REVENUE RUN: 25 AUGUST 1981

16/58/25 to 17/01/25 PART 2 OF 2



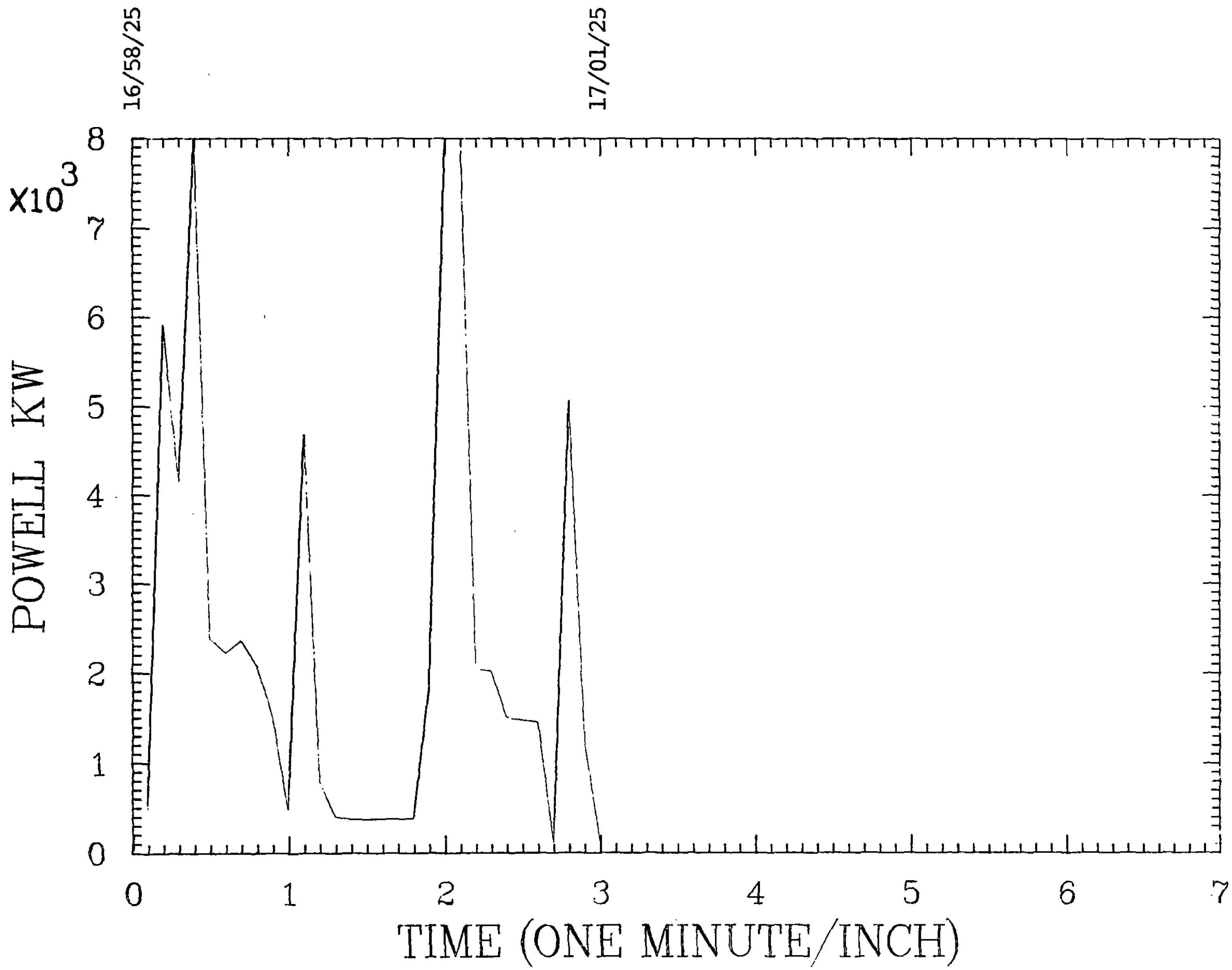
(e)


TEST #1 REVENUE RUN: 25 AUGUST 1981
16/51/25 to 16/58/25 PART 1 OF 2
16/51/25
16/58/25
POWELL KW
X10^3
TIME (ONE MINUTE/INCH)
0
1
2
3
4
5
6
7
8

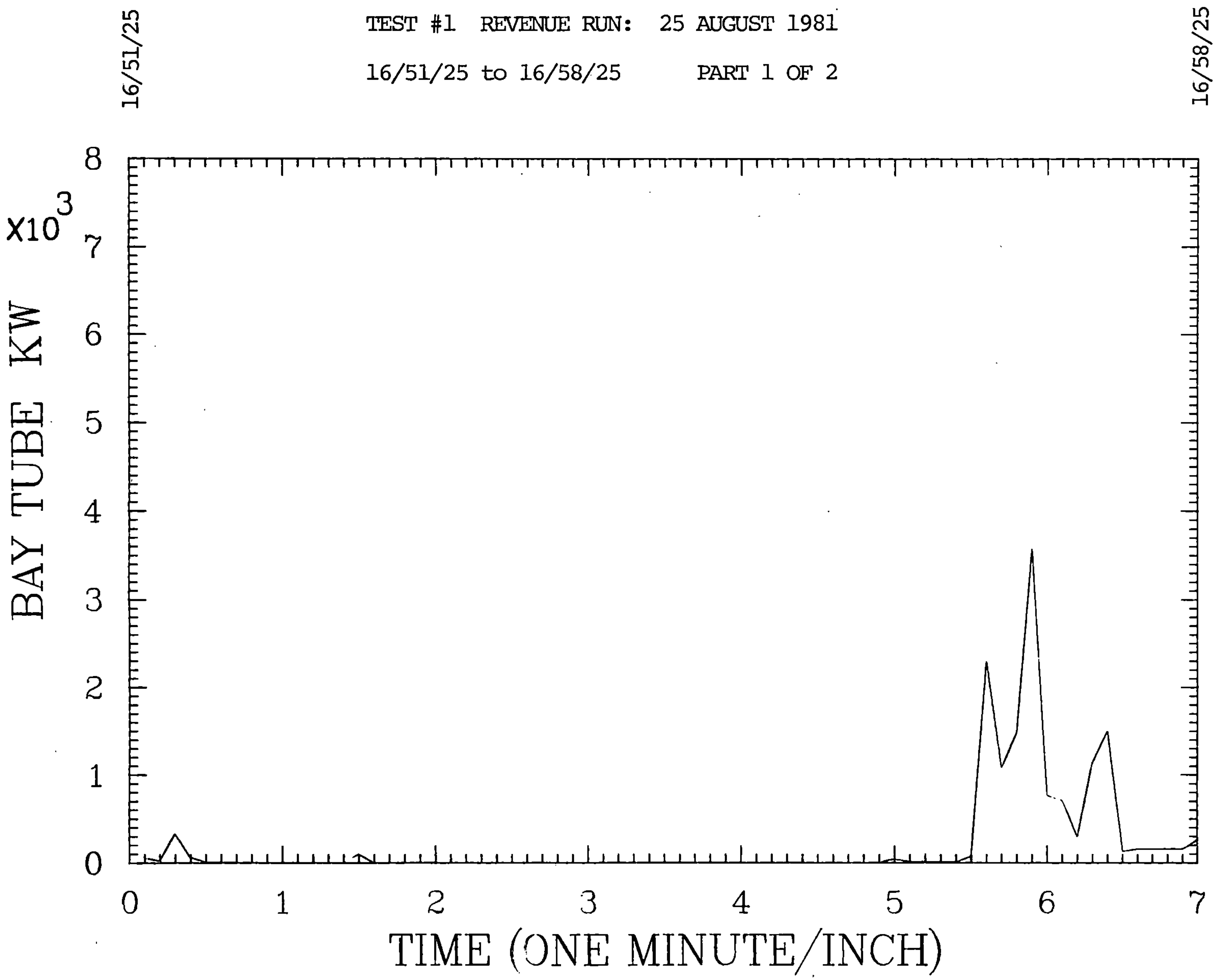
(f)

TEST #1 REVENUE RUN: 25 AUGUST 1981

16/58/25 to 17/01/25 PART 2 OF 2



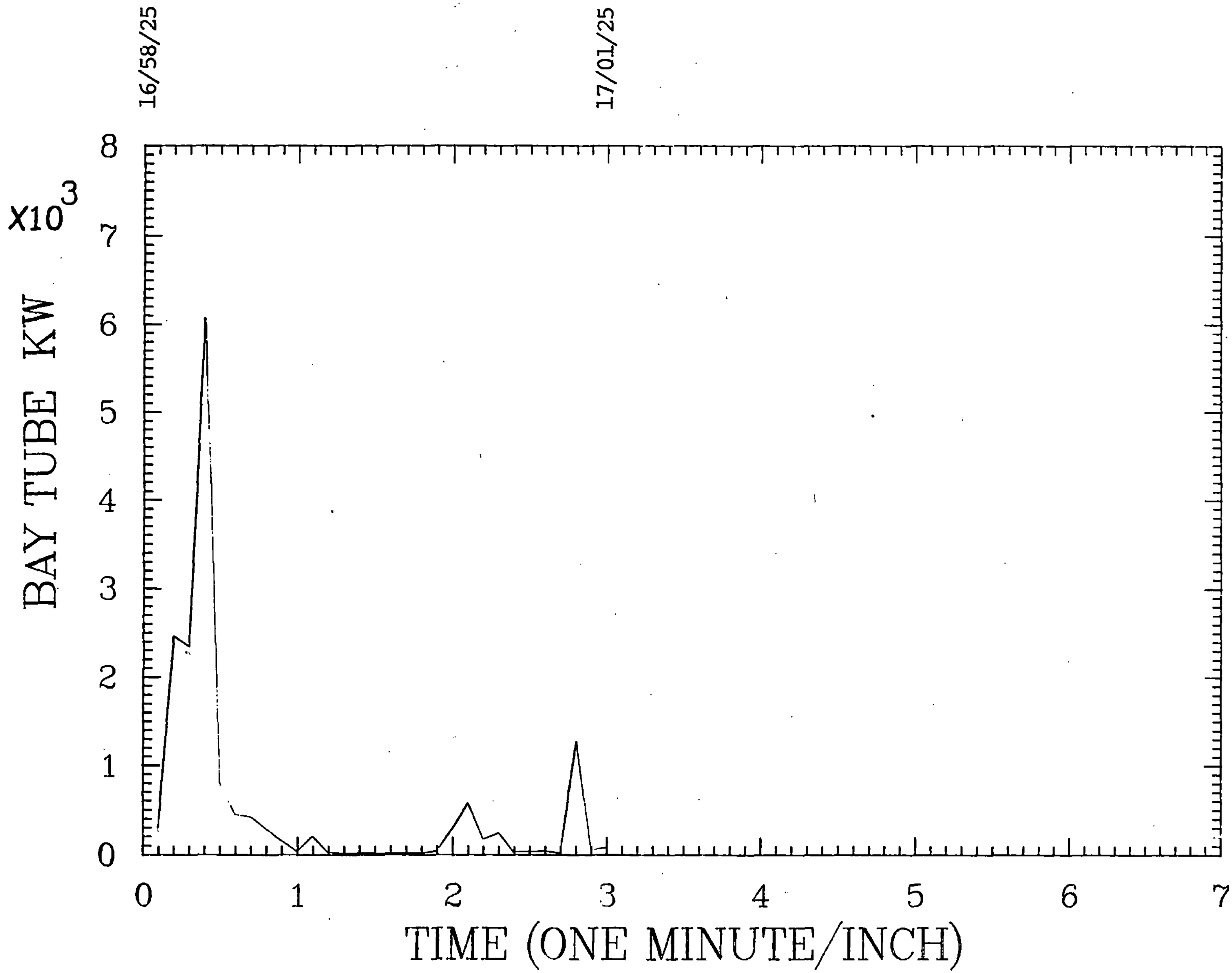
(f)


TEST #1 REVENUE RUN: 25 AUGUST 1981
16/51/25 to 16/58/25 PART 1 OF 2
16/51/25
16/58/25
BAY TUBE KW
X10^3
TIME (ONE MINUTE/INCH)
0
1
2
3
4
5
6
7
8

(g)

TEST #1 REVENUE RUN: 25 AUGUST 1981

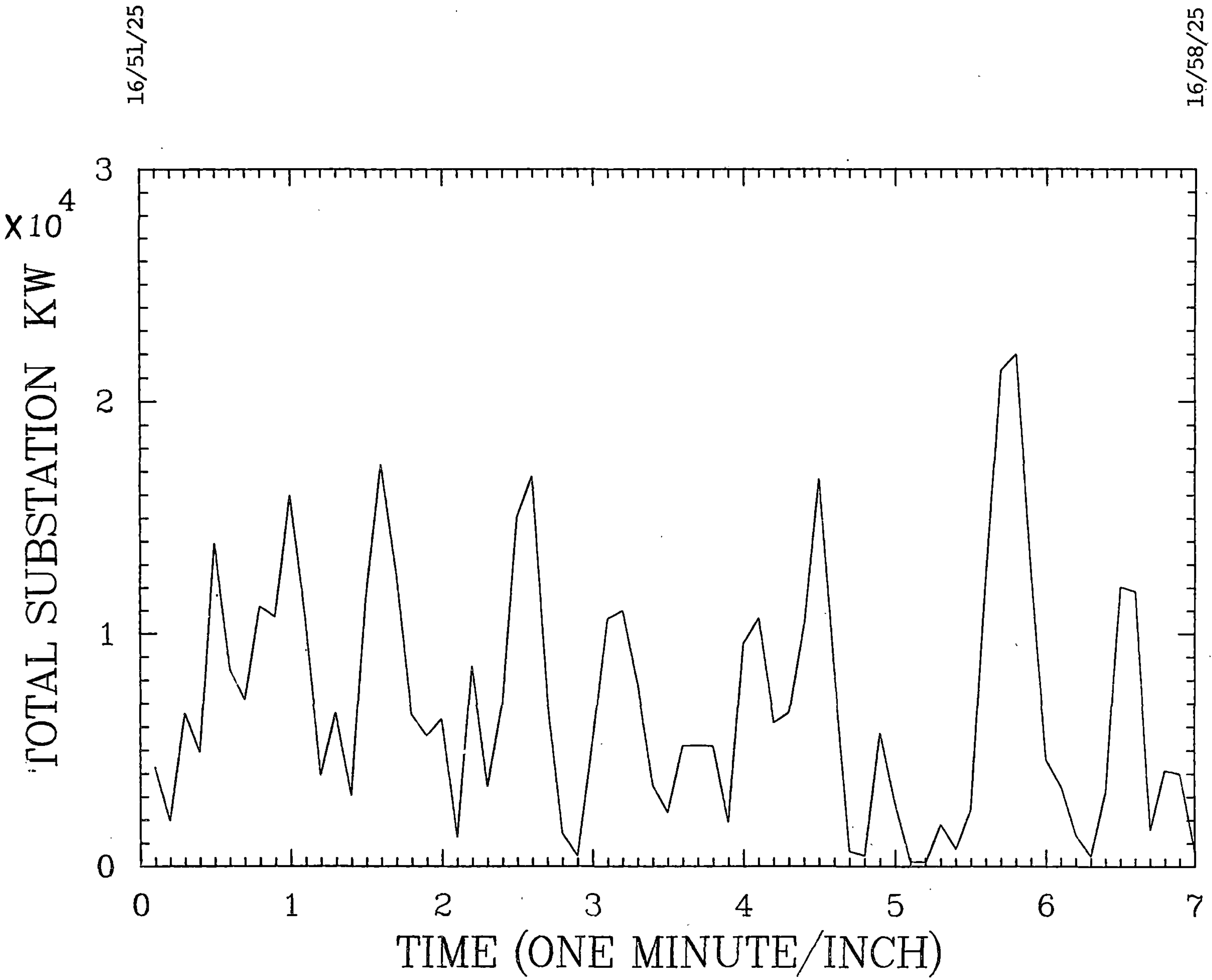
16/58/25 to 17/01/25 PART 2 OF 2



(g)

TEST #1 REVENUE RUN: 25 AUGUST 1981

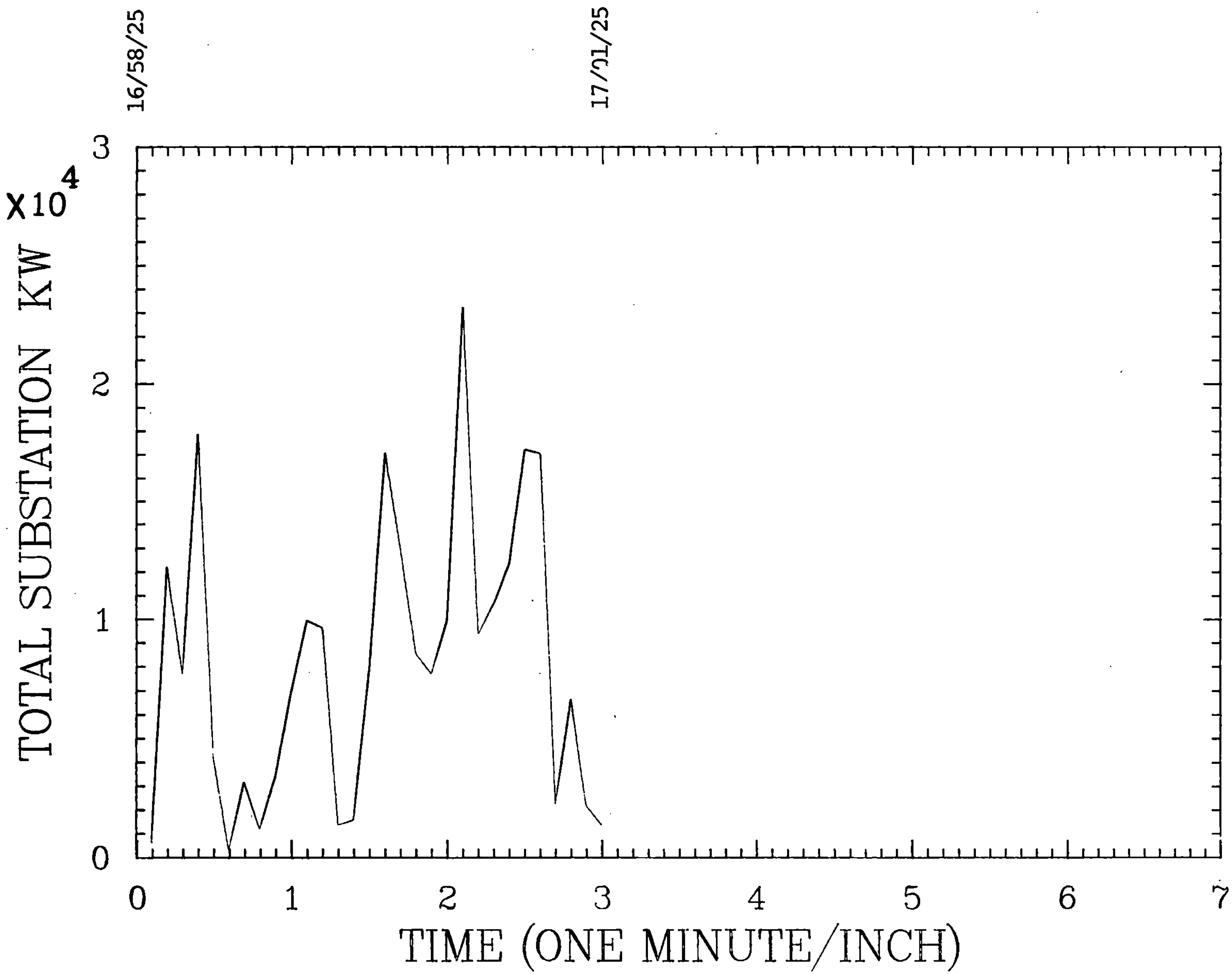
16/51/25 to 16/58/25 PART 1 OF 2



(h)

TEST #1 REVENUE RUN: 25 AUGUST 1981

16/58/25 to 17/01/25 PART 2 OF 2



(h)

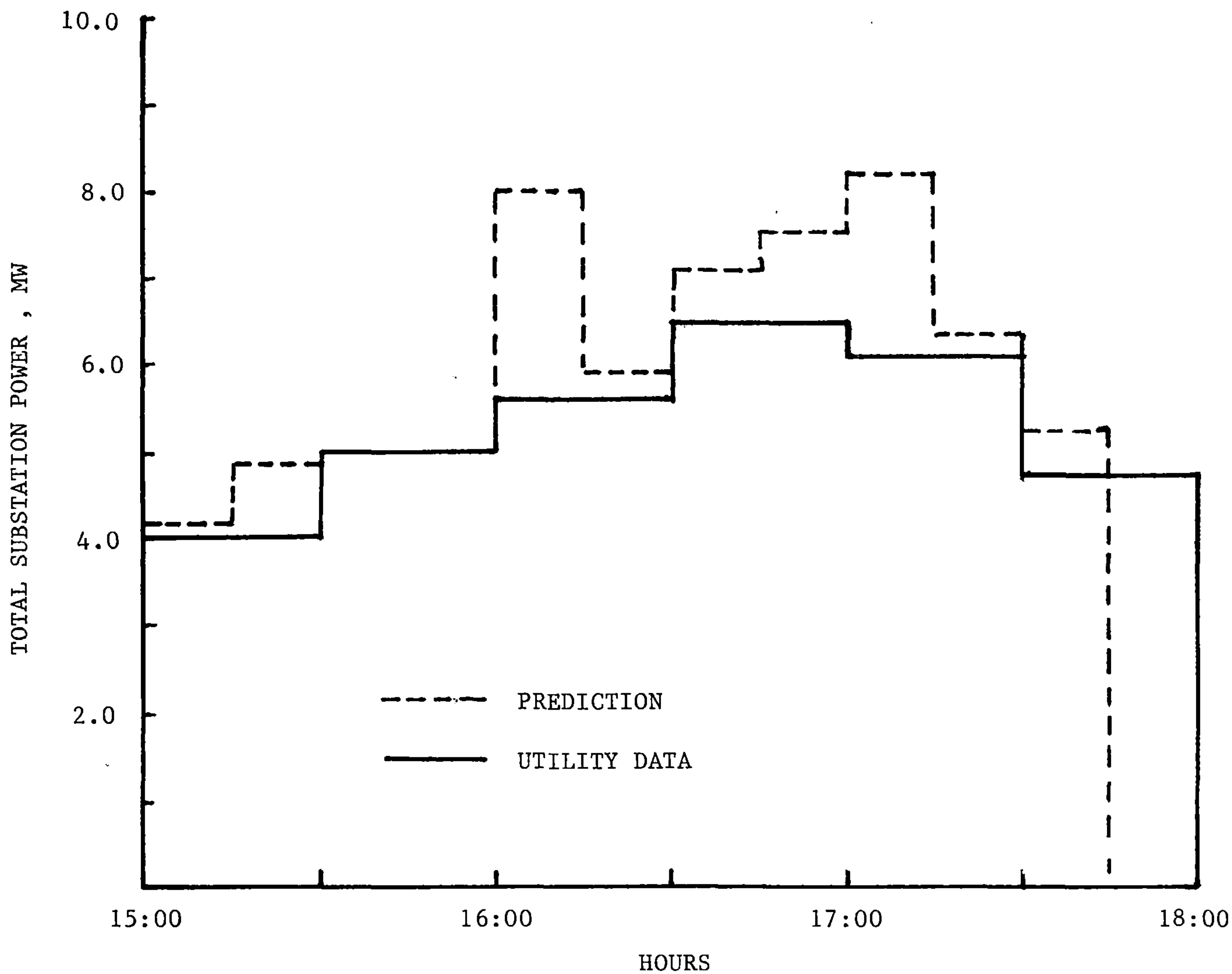


FIGURE 5.4 COMPARISON OF TOTAL SUBSTATION POWER - MODEL # 2

6. COMPUTER MODEL # 3

This computer model was initially developed to simulate vehicle operation and obtain the resulting rms substation loading for a given traffic pattern. The vehicle performance program computes the power and energy requirements for any given vehicle and track characteristics. This information is then used to obtain the rms substation loading by assuming a set of identical trains moving at constant headways in both directions. The starting times for the two directions can have an offset over a headway cycle. Typically these programs are used to study substation capacity requirements under worst-case conditions.

The model requires a set of input data defining the vehicle, the track, and the electrical network - essentially similar to that discussed for earlier models. The program output produced is also similar as presented below.

The simulation of the Baseline Runs was quite straightforward with this model. The basic substation loading model was, however, modified to simulate the Regeneration Tests. The train consists, passenger loading, performance levels, dwells, and other parameters varied over a wide range during the nine hours of revenue operations on 25-26 August, and 1 September 1981. This period was, therefore, first divided into sequential 7½ minute time slots. The data for each time slot was then examined to define a set of constants such as train length and weight, passenger load, dwell, headway, performance level, etc. to represent the traffic during that time slot. The simulation model was then run for all these time slots to obtain the substation loading.

6.1 BART Test Simulation

The results of the Baseline Test simulation are presented in Tables 6.1 and 6.2. Accounting for the higher weight of the BART Engineering Car, the energy consumption predictions are in very good agreement (within 3%) with

TABLE 6.1

RESULTS OF MODEL # 3

ENERGY CONSUMPTION PER CAR FOR BASELINE RUNS

TRIP	MODEL[1] KWH	DATA[2] KWH
M90 - M16	28.95	34.90
M16 - M90	44.44	52.47

1 Model assumes an average station dwell of 23 seconds

2 For Car #1 which weighs over 43 percent more than the average weight per car of the test train

TABLE 6.2

RESULTS OF MODEL # 3

ENERGY CONSUMPTION AT THE SUBSTATIONS FOR BASELINE RUNS

(KWH FOR A FOUR CAR TRAIN)

SUBSTATION	M16 - M90	M90 - M16
MTW	15.29	9.33
MPS	25.45	18.23
MSS	26.57	18.26
MTF	31.55	17.78
MGP	33.00	19.29
MBP	32.55	18.03
MDC	14.90	15.54
TOTAL	179.32	116.46

the measured consumption. The kW loading for the vehicle and all the substations are presented in Figure 6.1.

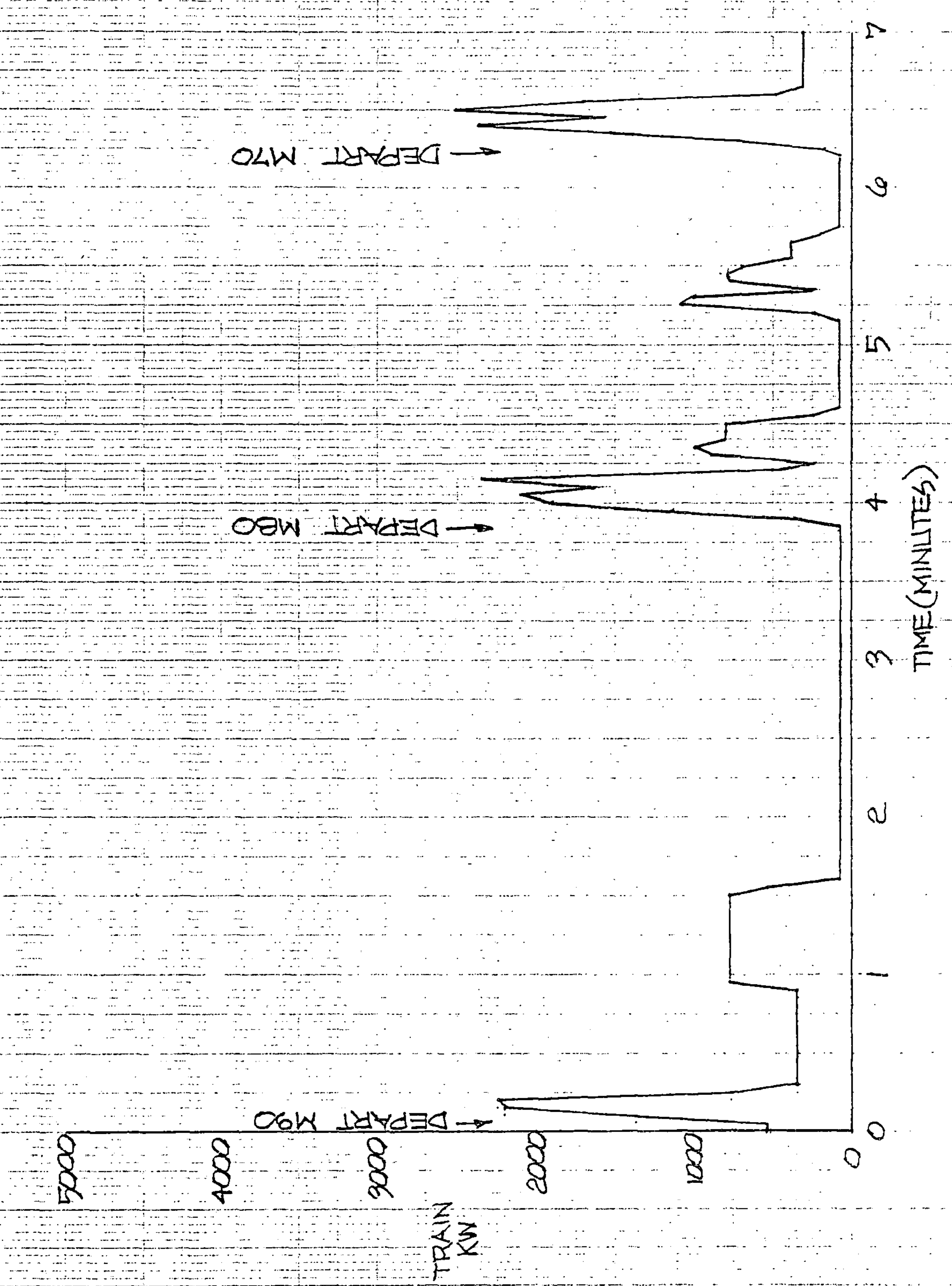
The Regeneration Test simulation is based on an assumption that 50 percent of the available braking energy is fed back to the third rail system. The loading on the different substations for the three hour time period is presented in Figure 6.2. The total substation loading predicted by this model for the three days is compared with the Utility data in Figure 6.3. The total energy consumption during the three rush-hour periods is compared with the test data in Table 6.3. The predictions are 22-25 percent higher than the respective test data,

The specific energy consumption of a car in revenue service is predicted to be 3.9 kWh/car-mile. This means that the round trip energy consumption between MP6 and M90 is 73.00 kWh per car. The energy consumption for the BART Engineering Car was measured to be 80.74 kWh for the same round trip. Again, accounting for the higher weight of the Engineering Car, the model prediction seems to be lower by about 4 percent.

FIGURE 6.1 BASELINE TEST SIMULATION - MODEL # 3

TRAIN LOADING - 4 CAR BASELINE
DIRECTION - M90 TO M16

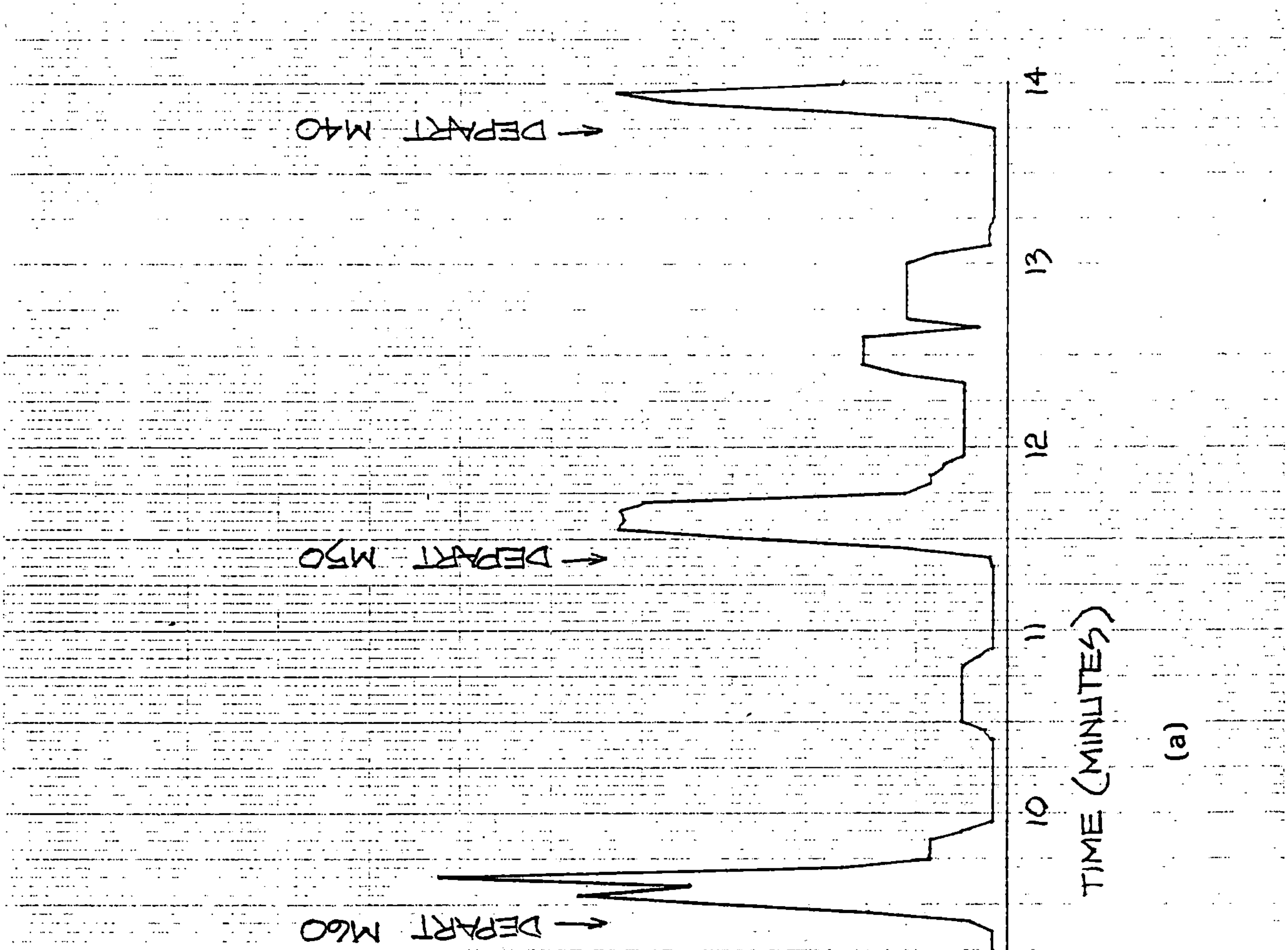
SHEET 1
OF 3

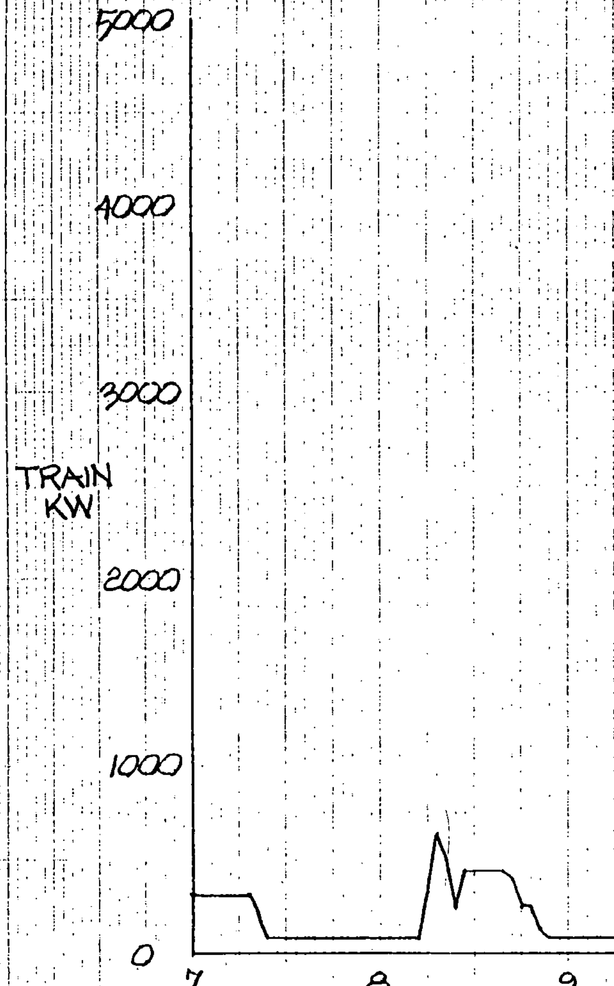


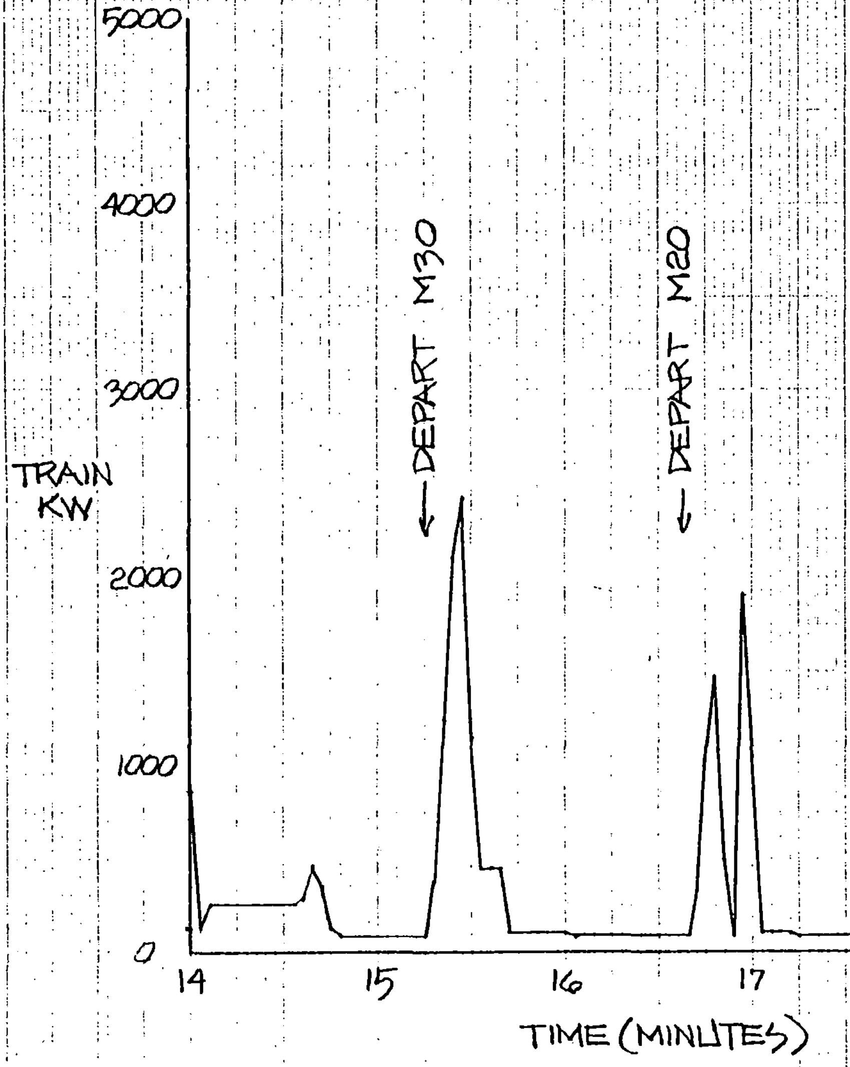
(a)

TRAIN LOADING - 4 CAR BASELINE
DIRECTION - M90 TO M16

SHEET 2
OF 3



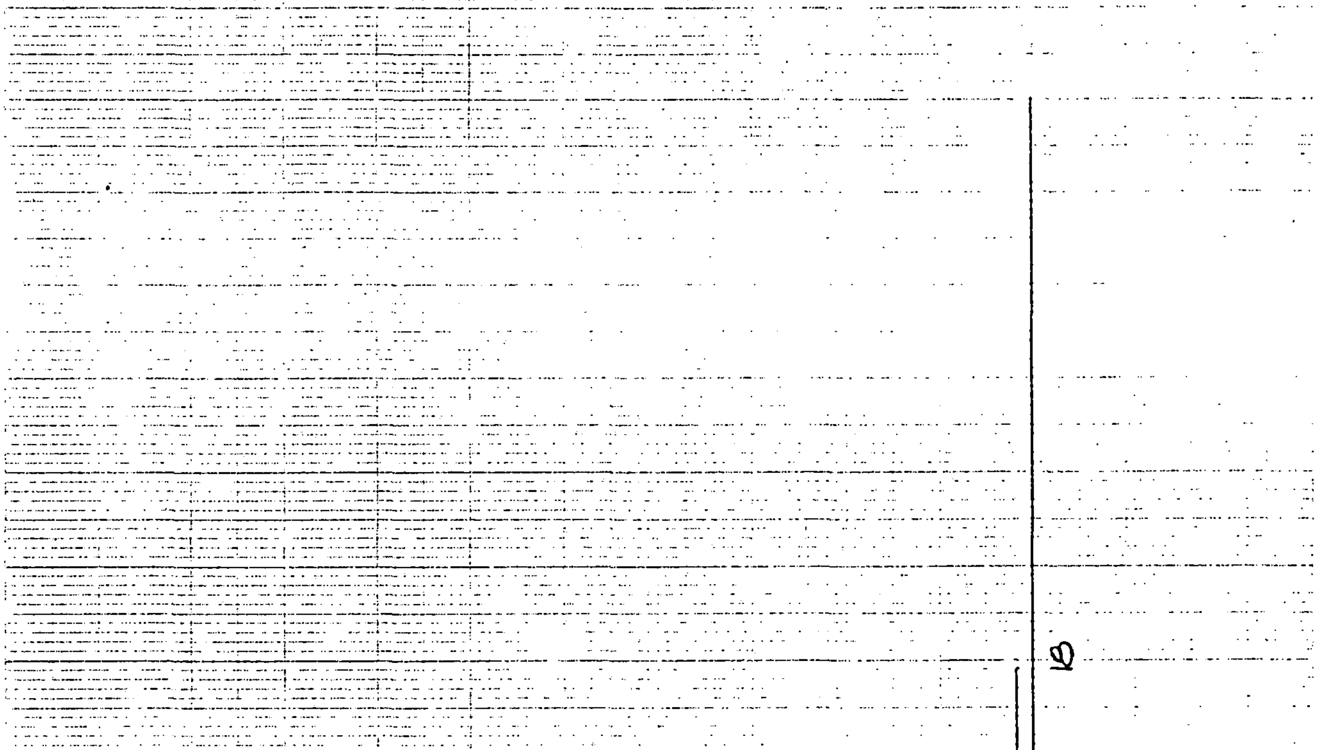

TRAIN
KW
0
1000
2000
3000
4000
5000
7
8
9

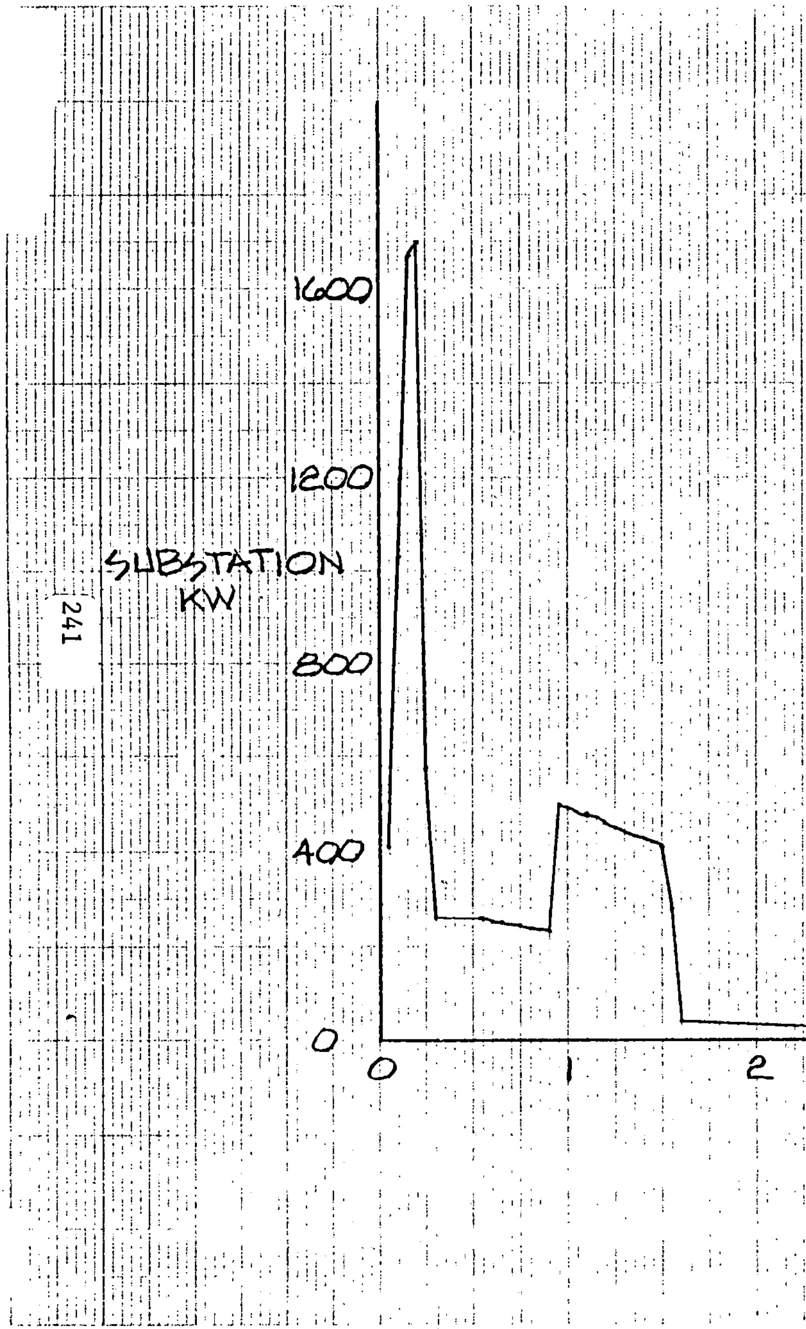

5000
4000
3000
2000
1000
0
TRAIN KW
← DEPART M30
← DEPART M20
14
15
16
17
TIME (MINUTES)

(a)

TRAIN LOADING - 4 CAR BASELINE
DIRECTION - M90 TO M16

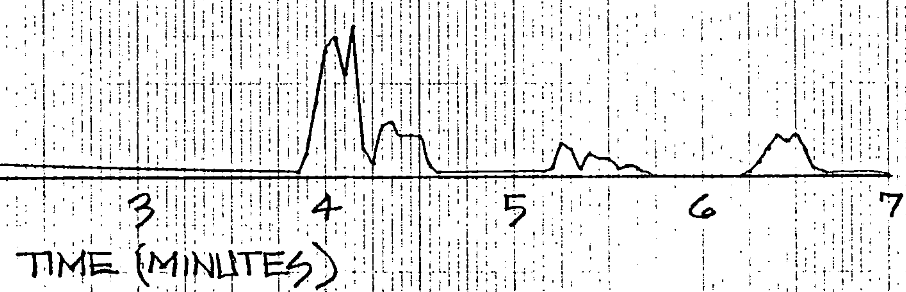
SHEET 3
OF 3




SUBSTATION KW
1600
1200
800
400
0
0
1
2

MDC SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16

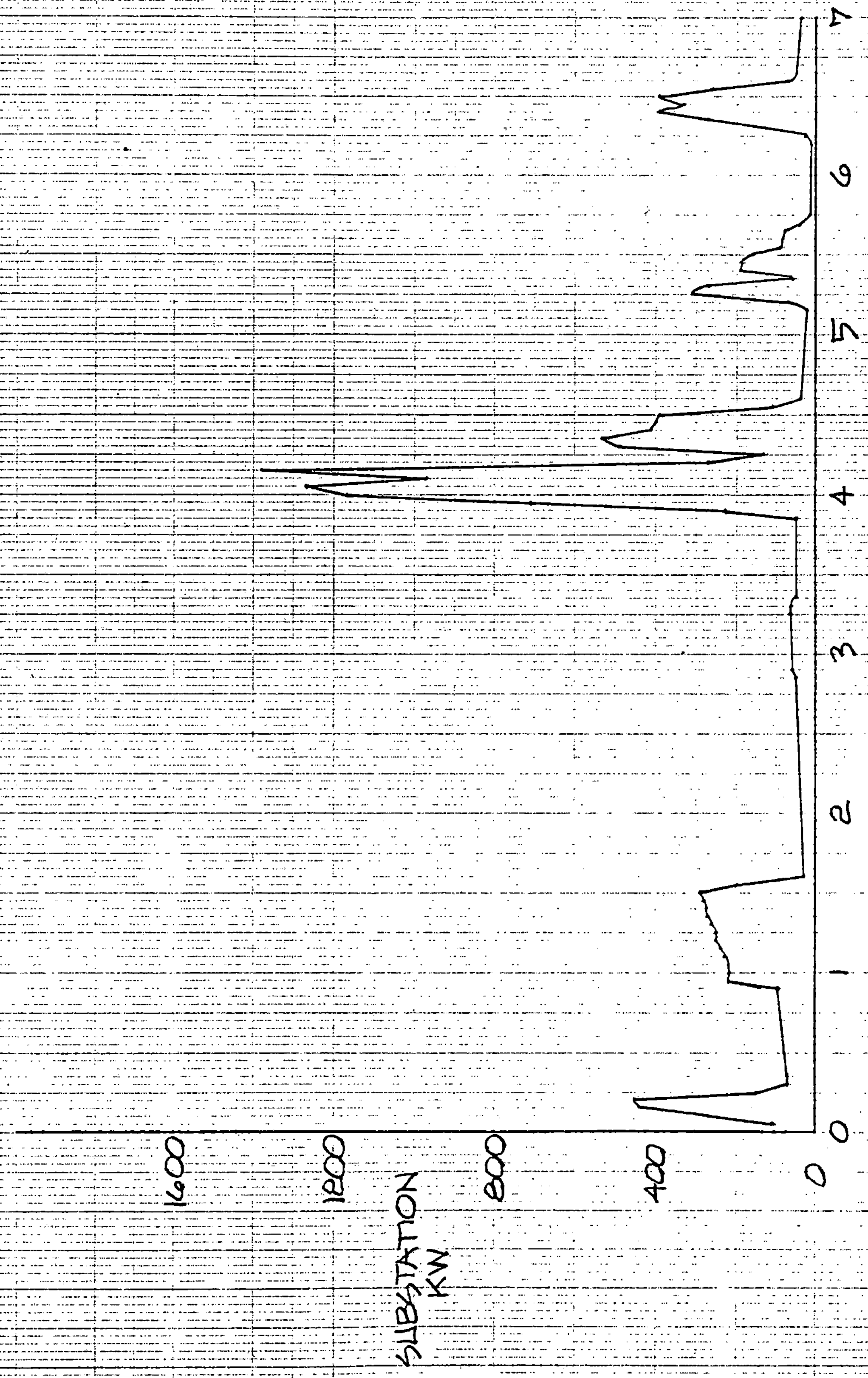
SHEET 1
OF 1



(b)

MBP SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16

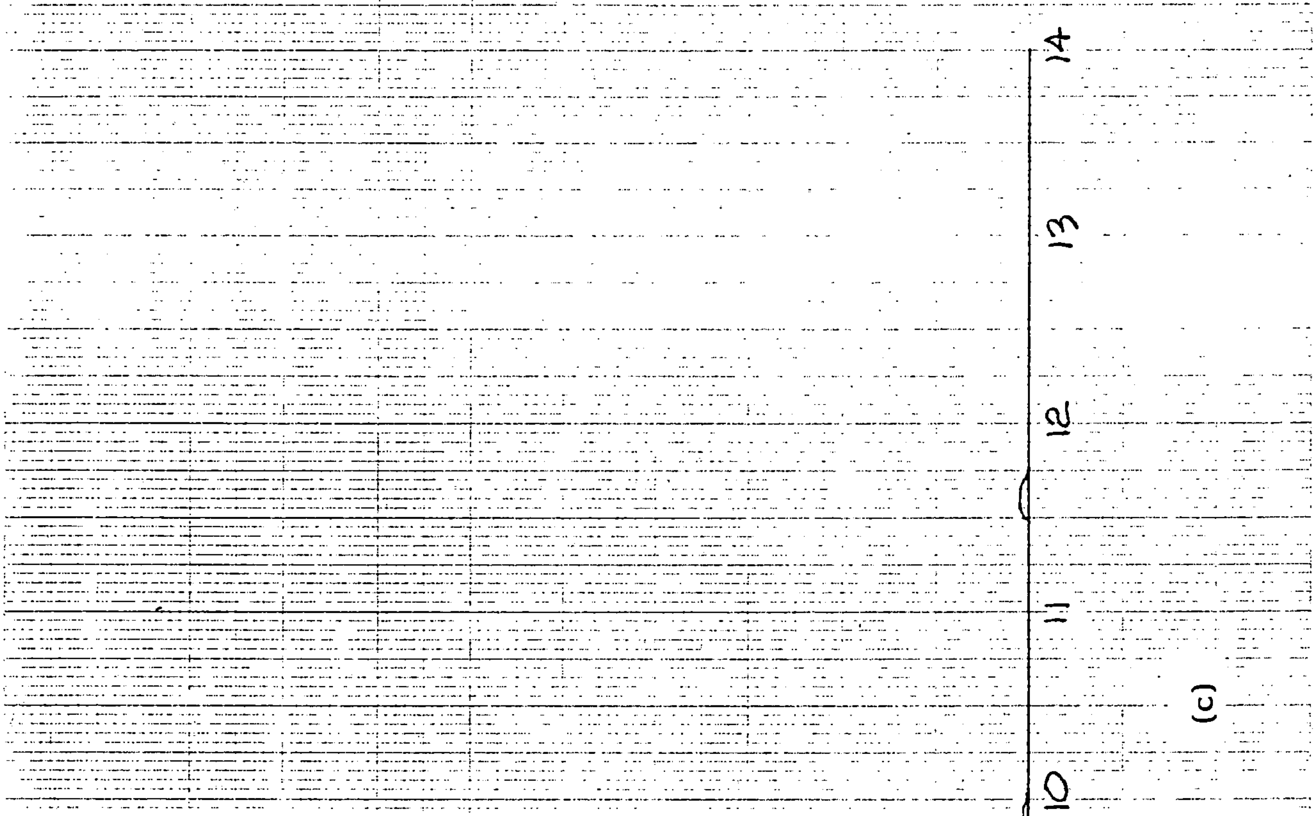
SHEET 1 OF 2

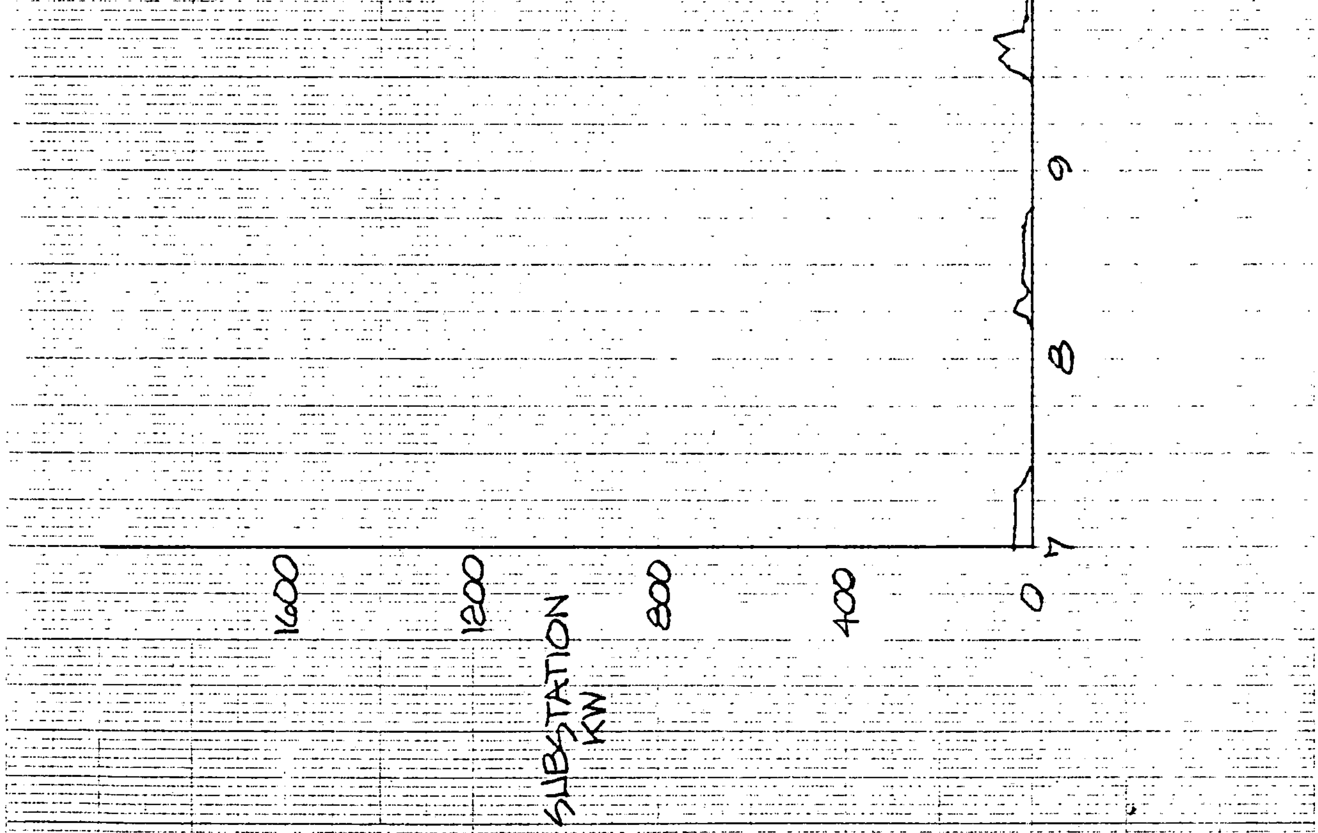


(c)

MBP SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16

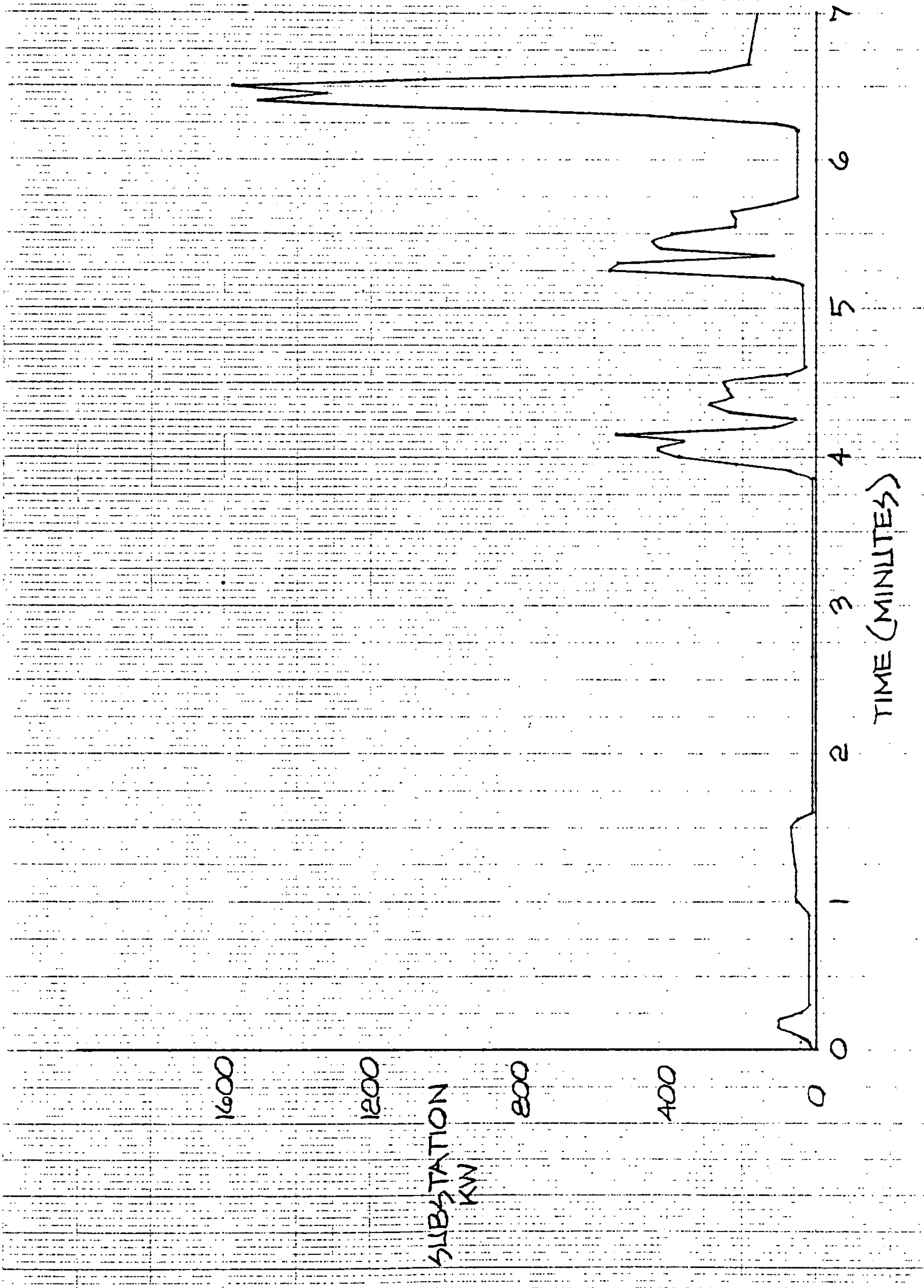
SHEET 2
OF 2



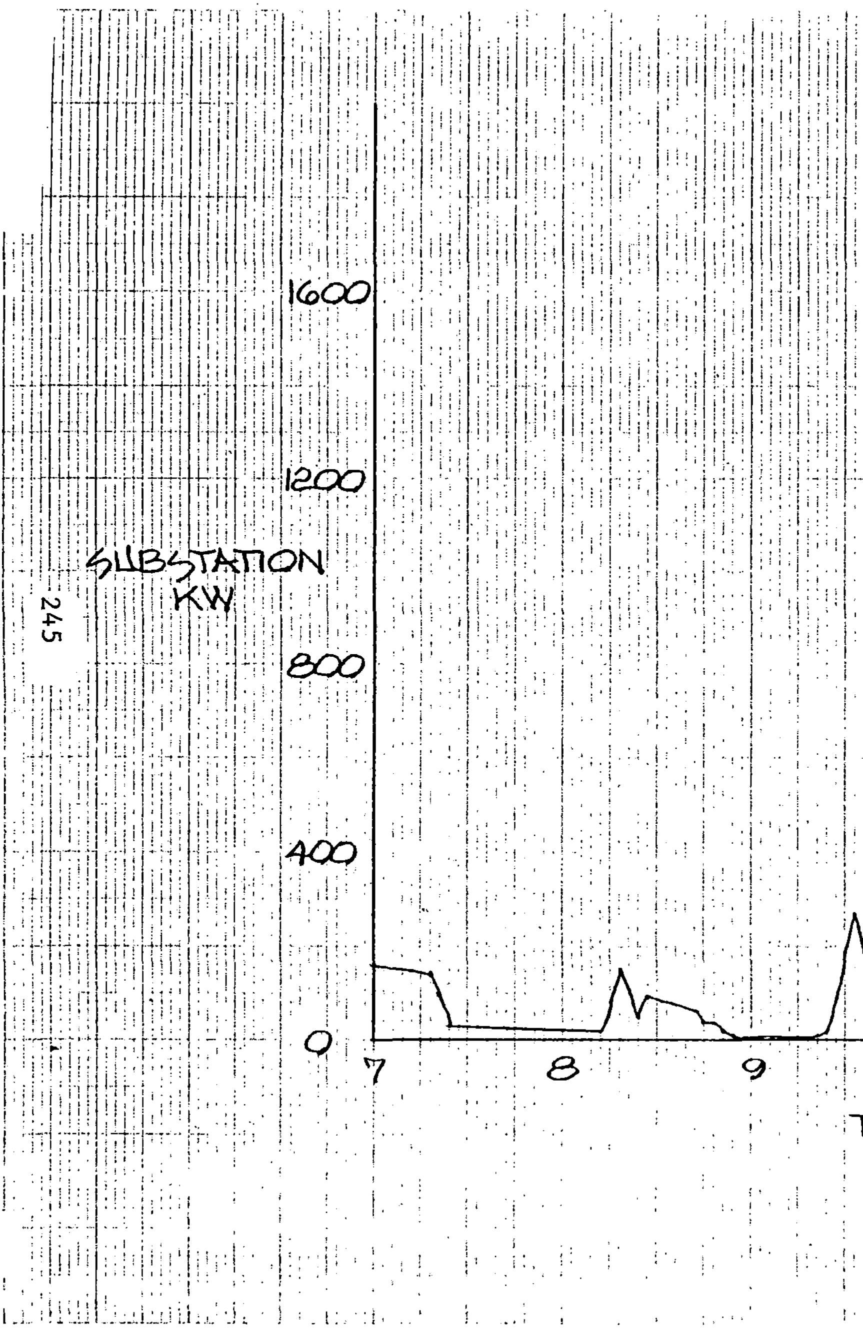


0
400
800
1200
1600
SUBSTATION
KW
4
6
8

MGP SUBSTATION LOADING
4 CAR BASELINE
DIRECTION – M90 TO M16



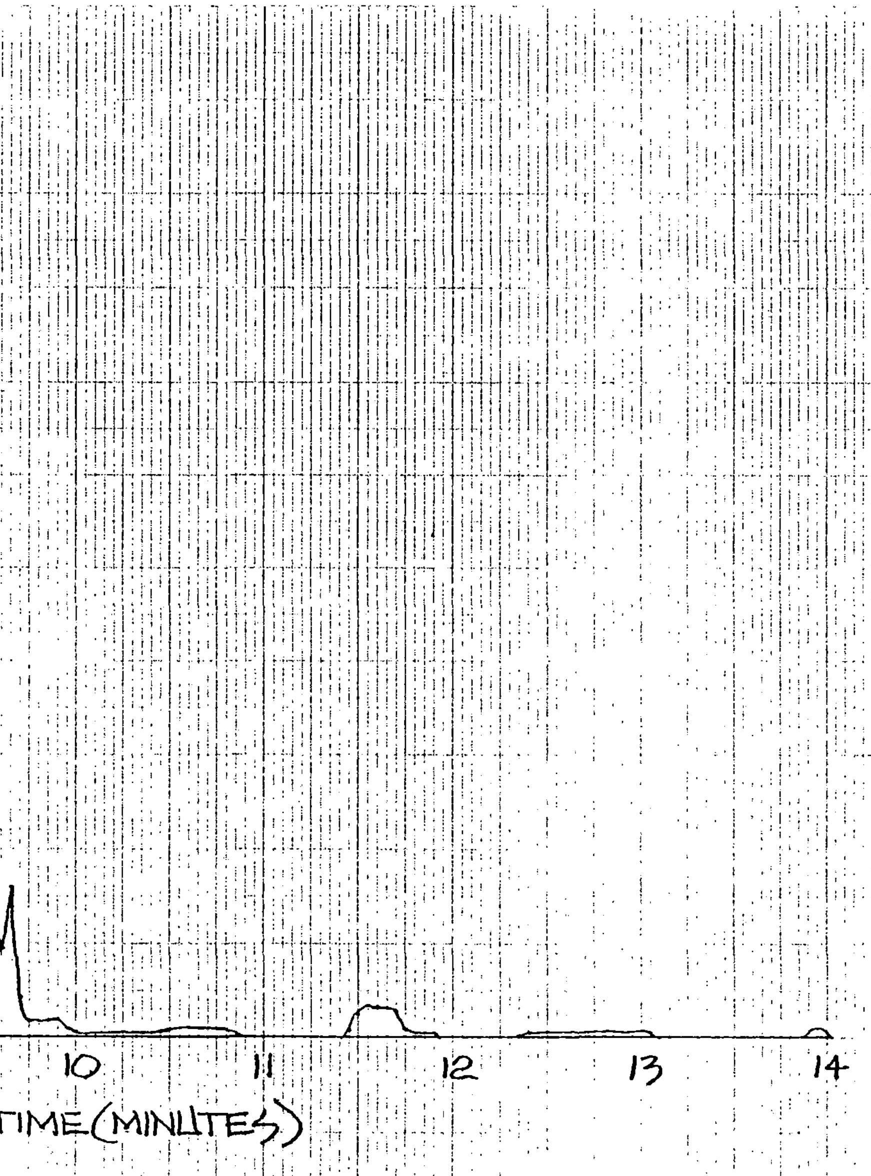
(d)



245

MGP SUBSTATION LOADING
4 CAR BASELINE
DIRECTION- M90 TO M16

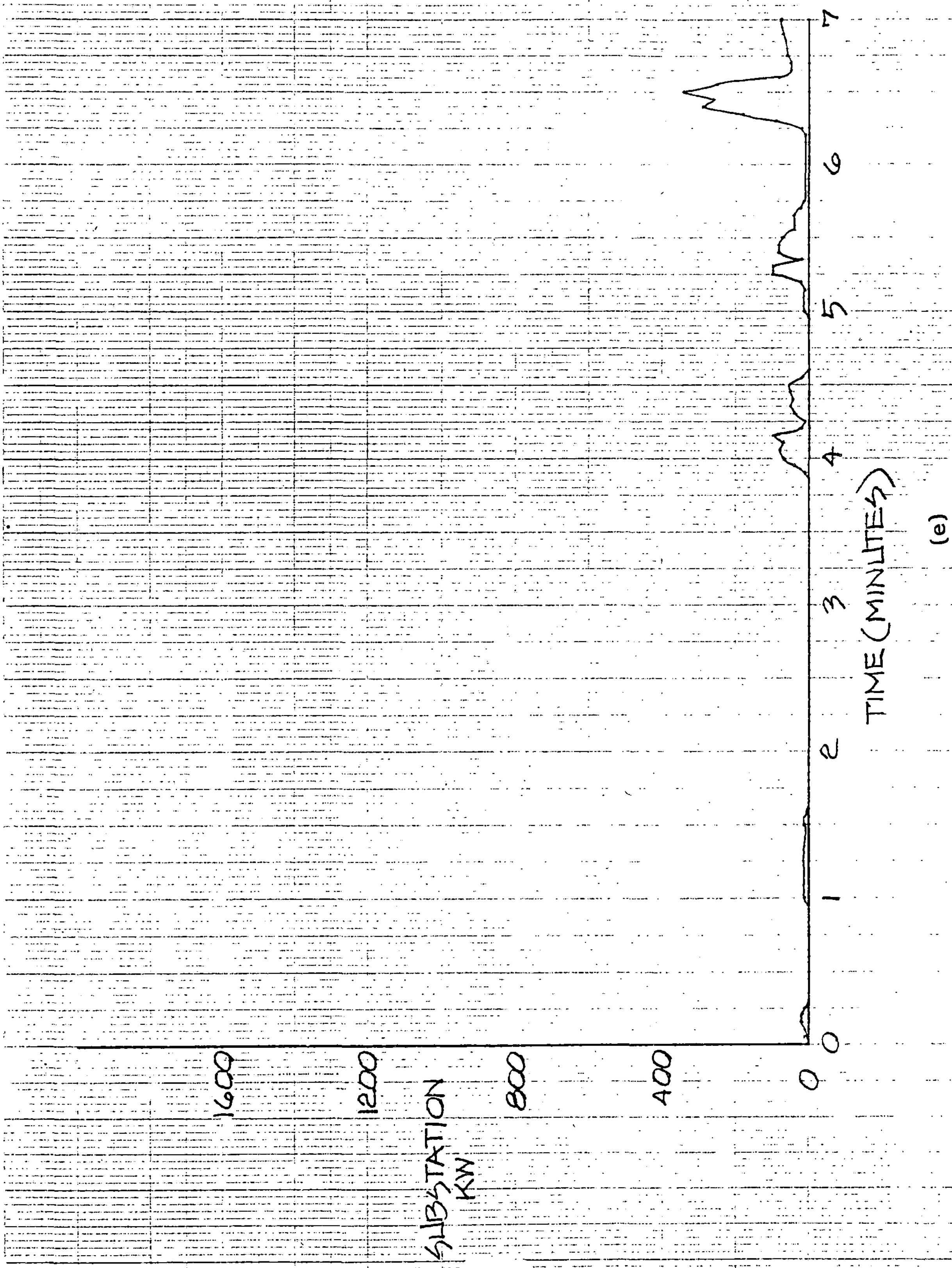
SHEET 2
OF 2

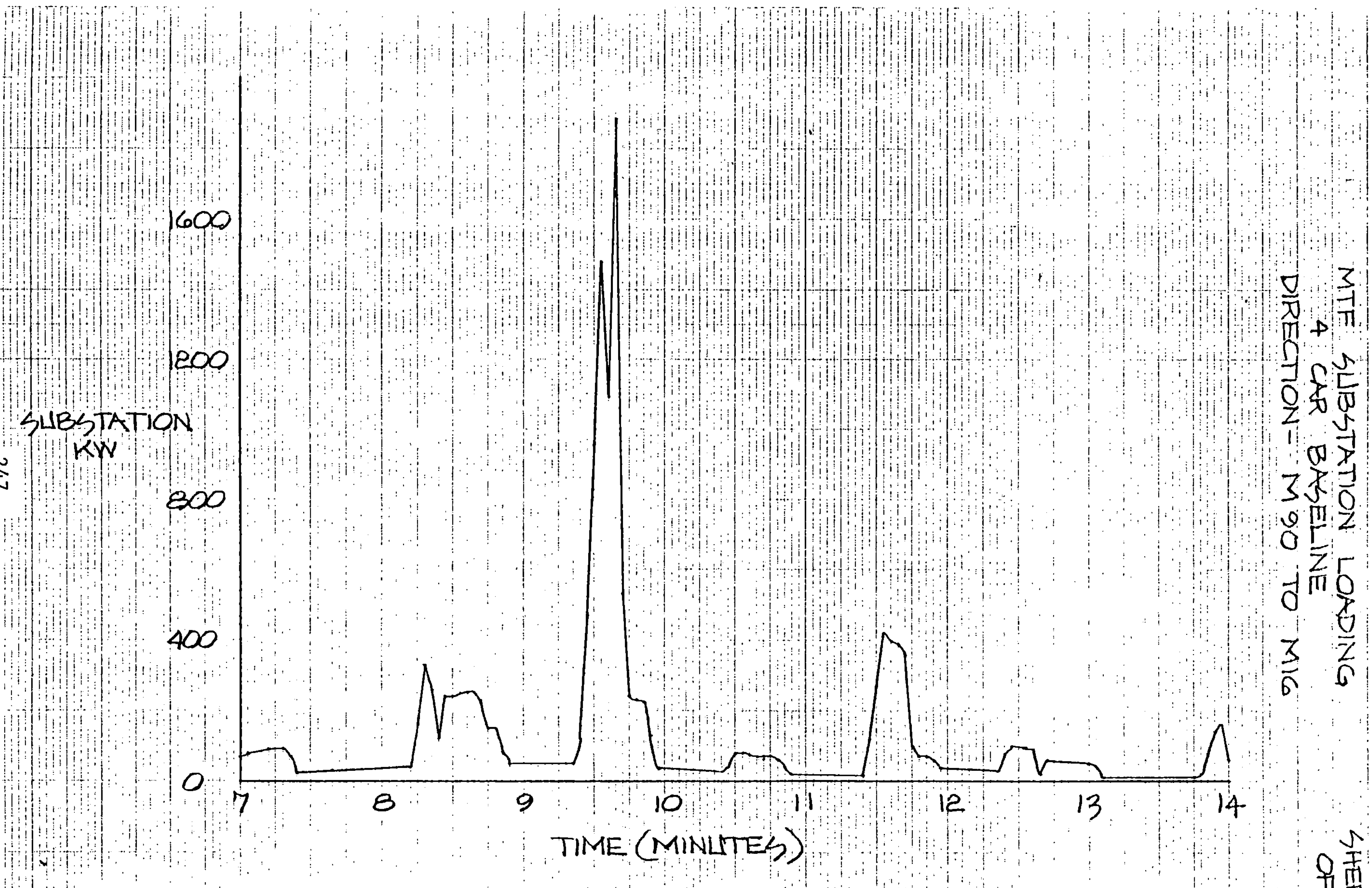


(d)

MTF SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16

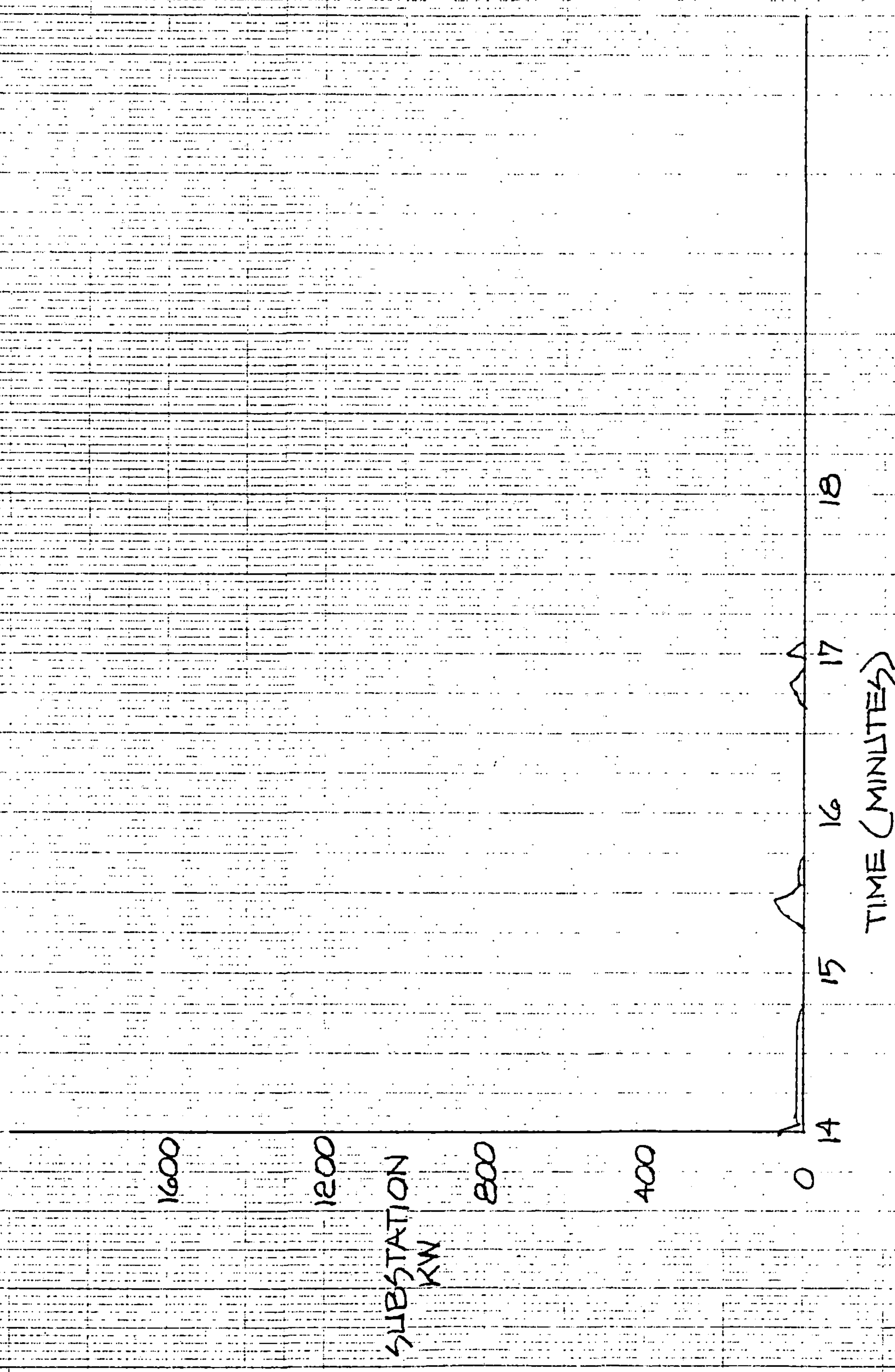
SHEET 1 OF 3




MTF SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16
SUBSTATION KW
1600
1200
800
400
0
7
8
9
10
11
12
13
14
TIME (MINUTES)
SHEET 2 OF 3

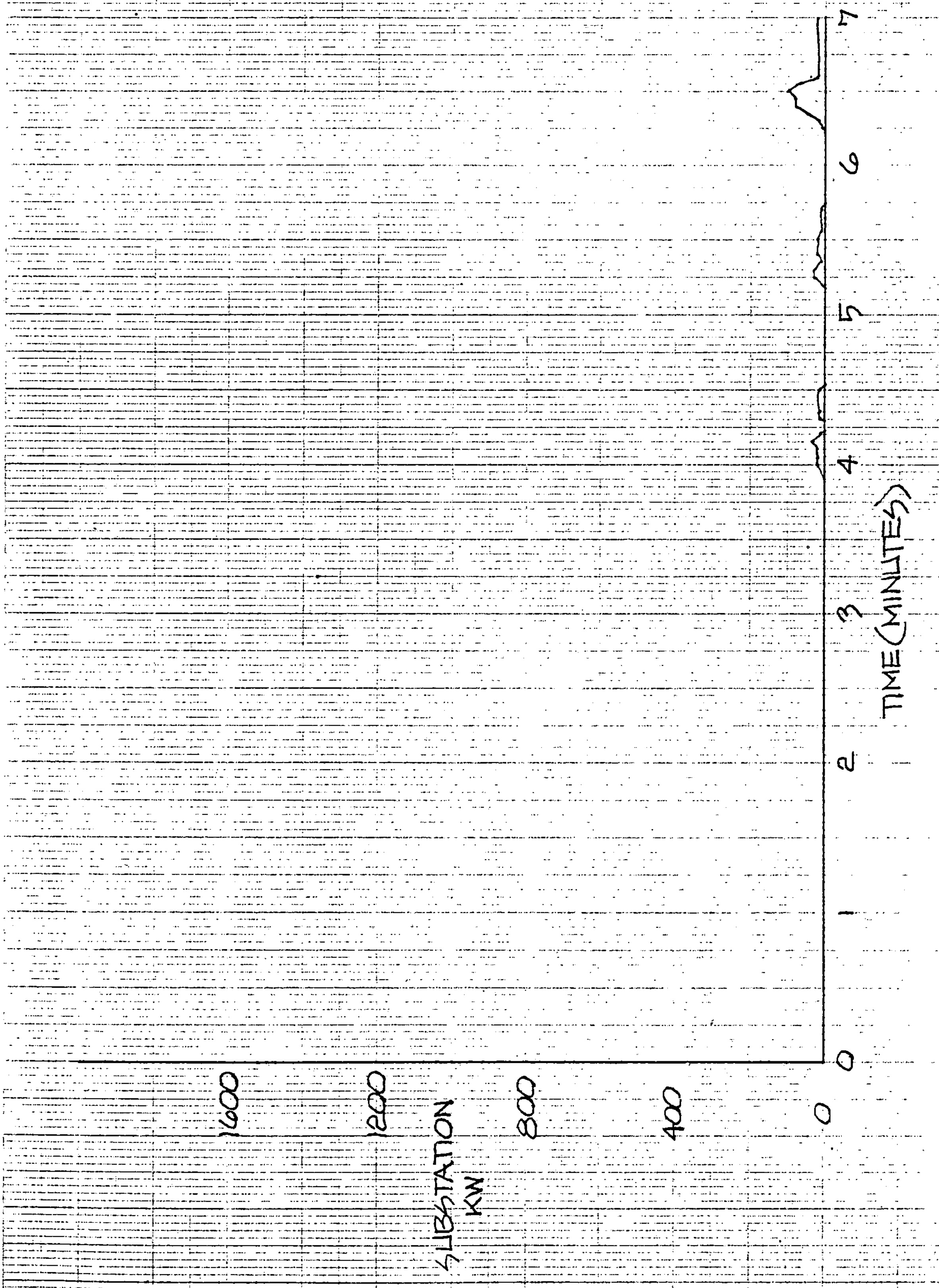
(e)

MTF SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16



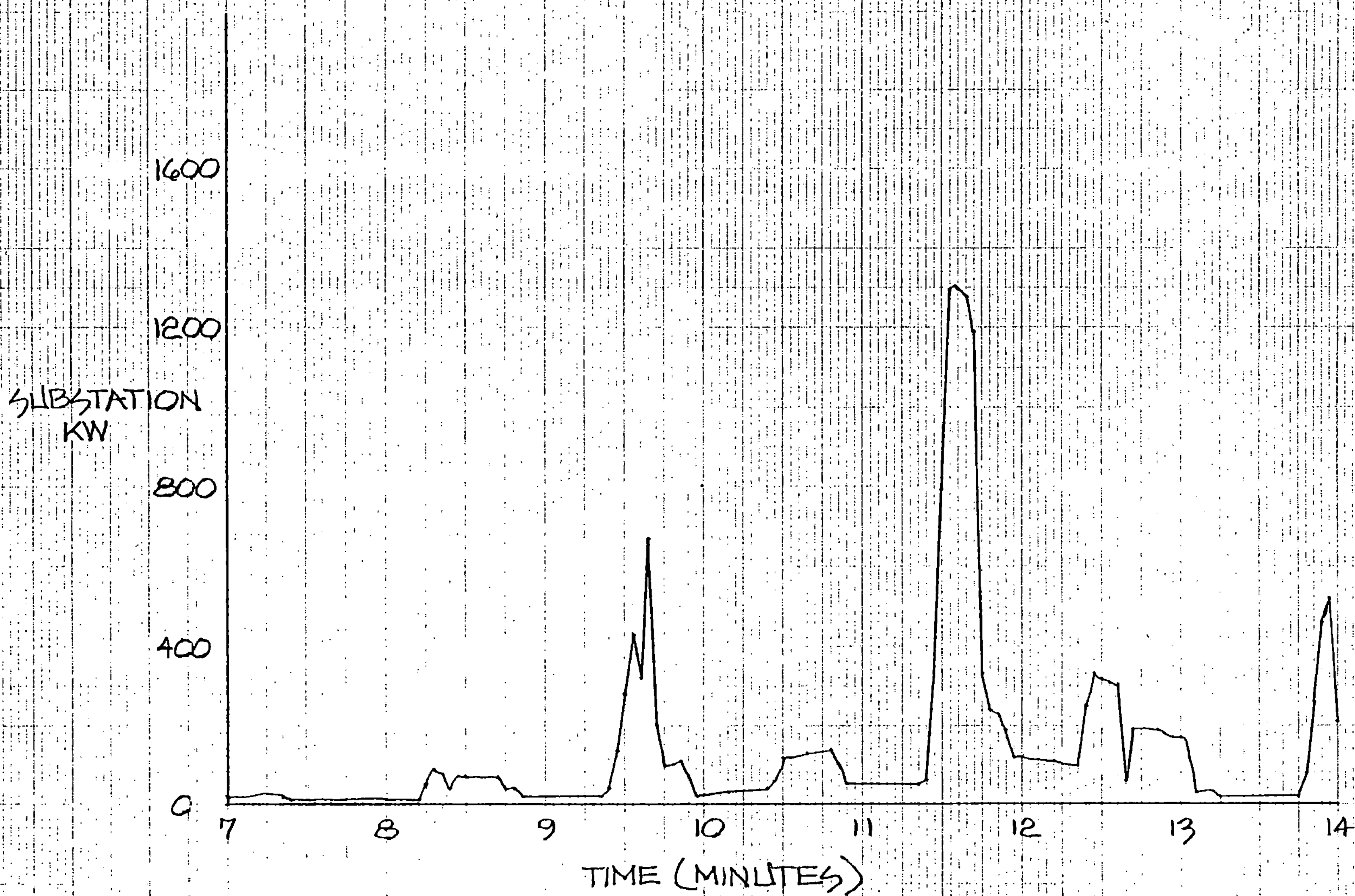
(e)

MSS SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16



(f)

M55 SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16

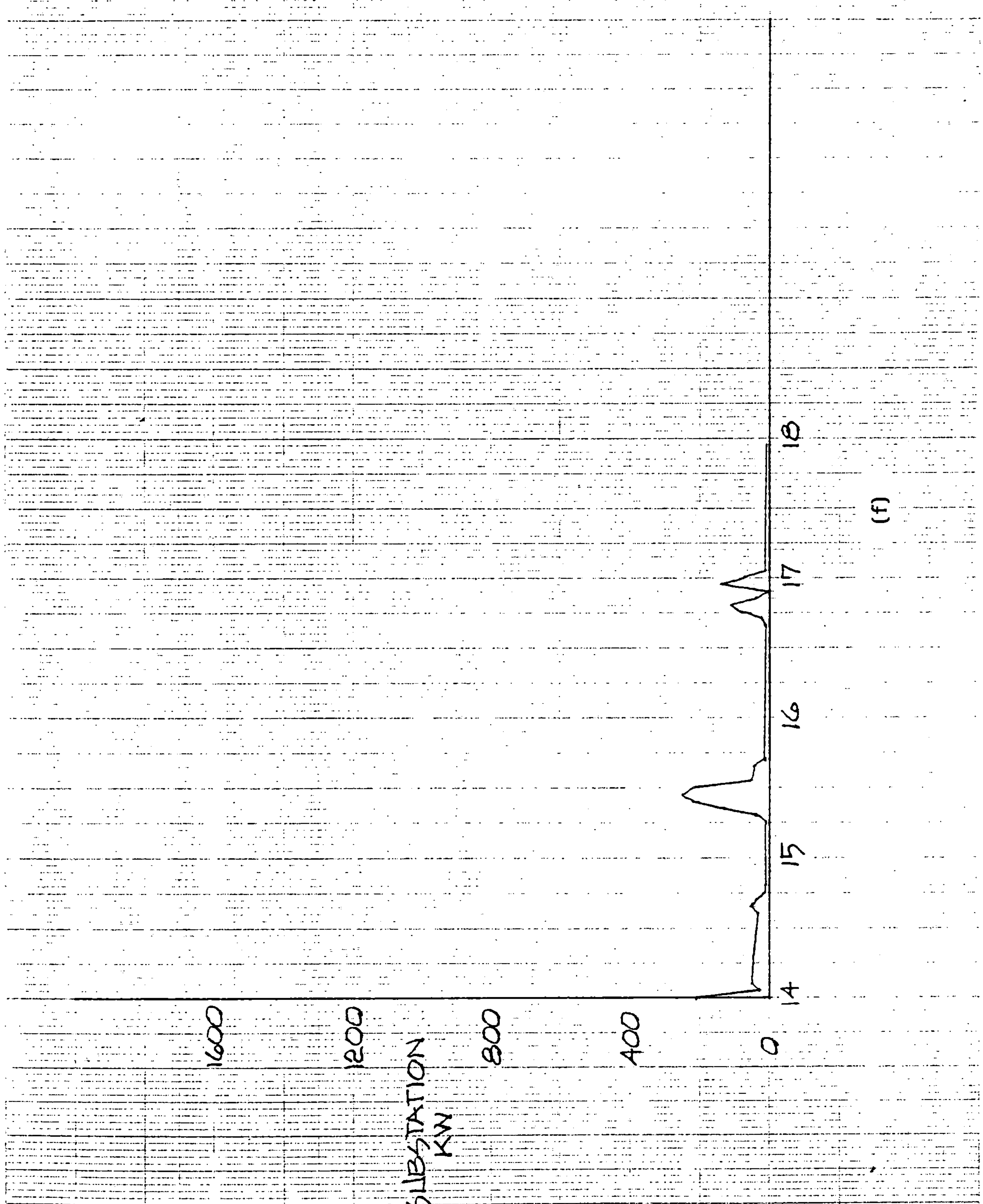


(f)

SHEET 2 OF 3

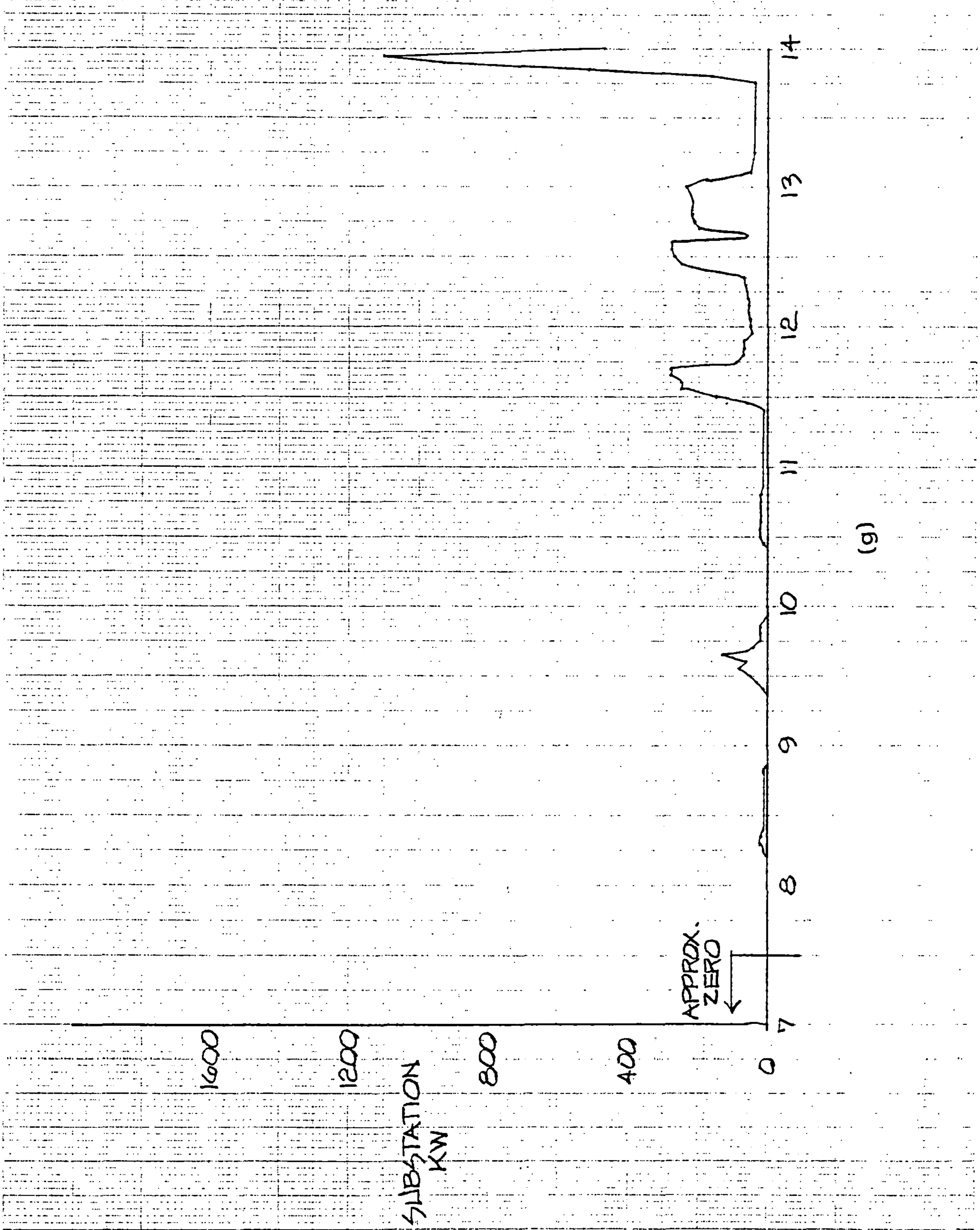
MSS SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16

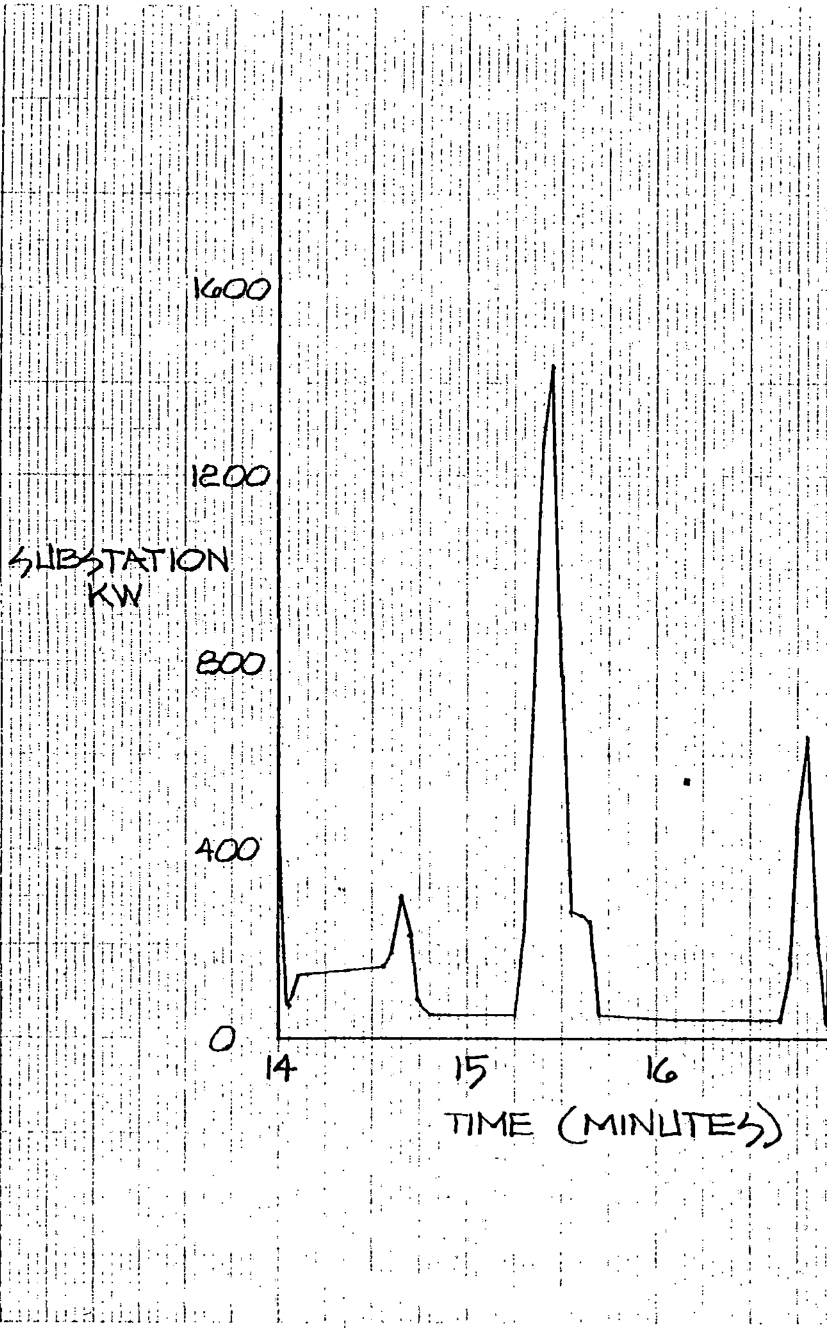
SHEET 3
OF 3



MPS SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16

SHEET 1
OF 2



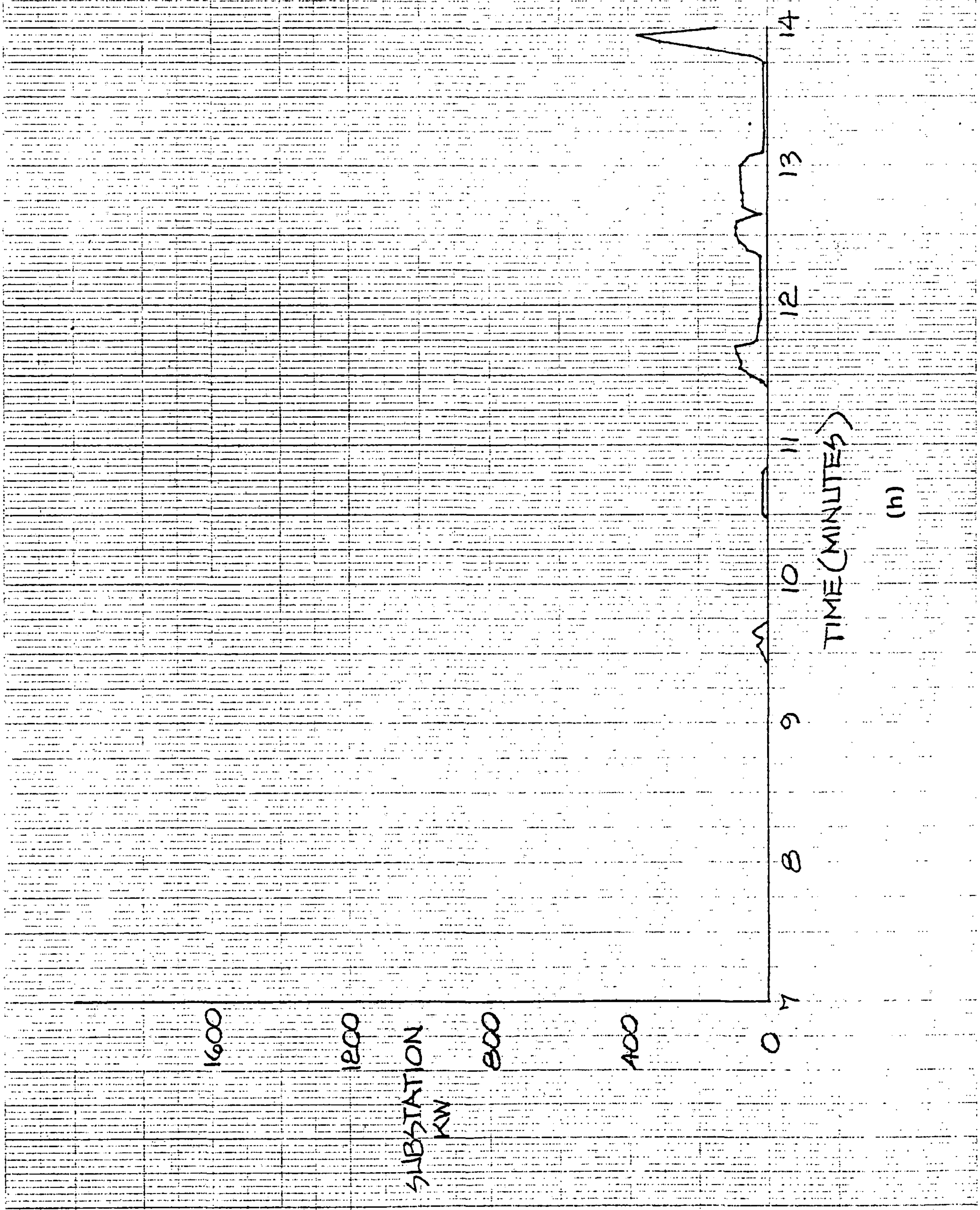

1600
1200
SUBSTATION KW
800
400
0
14
15
16
TIME (MINUTES)

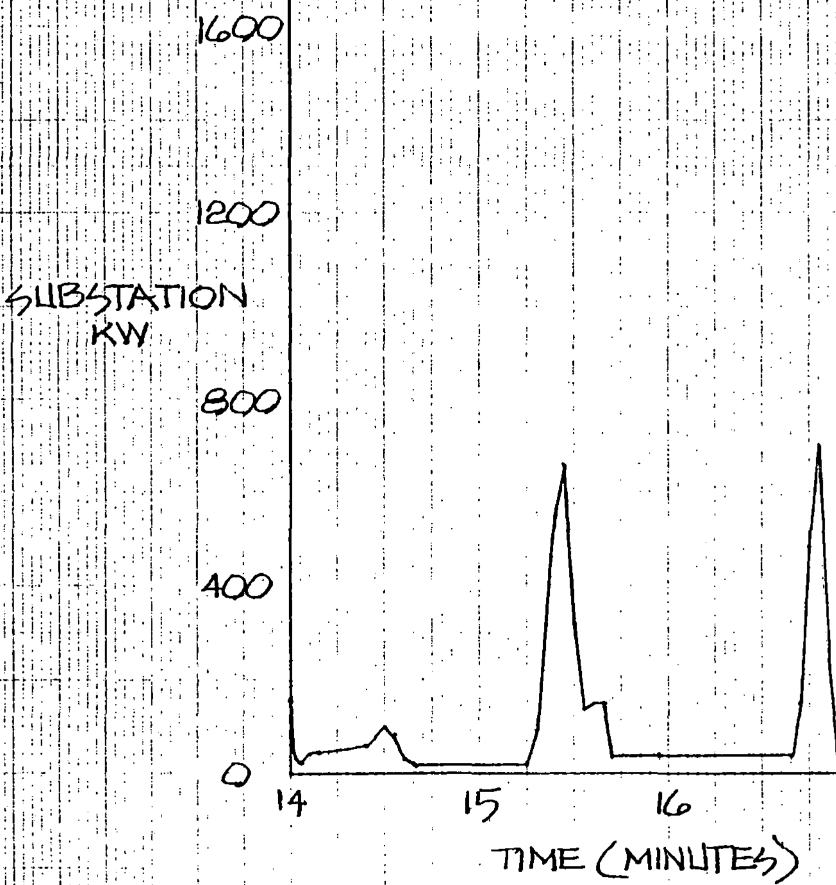
MPS SUBSTATION LOADING
4 CAR BASELINE
DIRECTION- M90 TO M16

SHEET 2
OF 2

MTW SUBSTATION LOADING
4 CAR BASELINE
DIRECTION - M90 TO M16

SHEET 1
OF 2

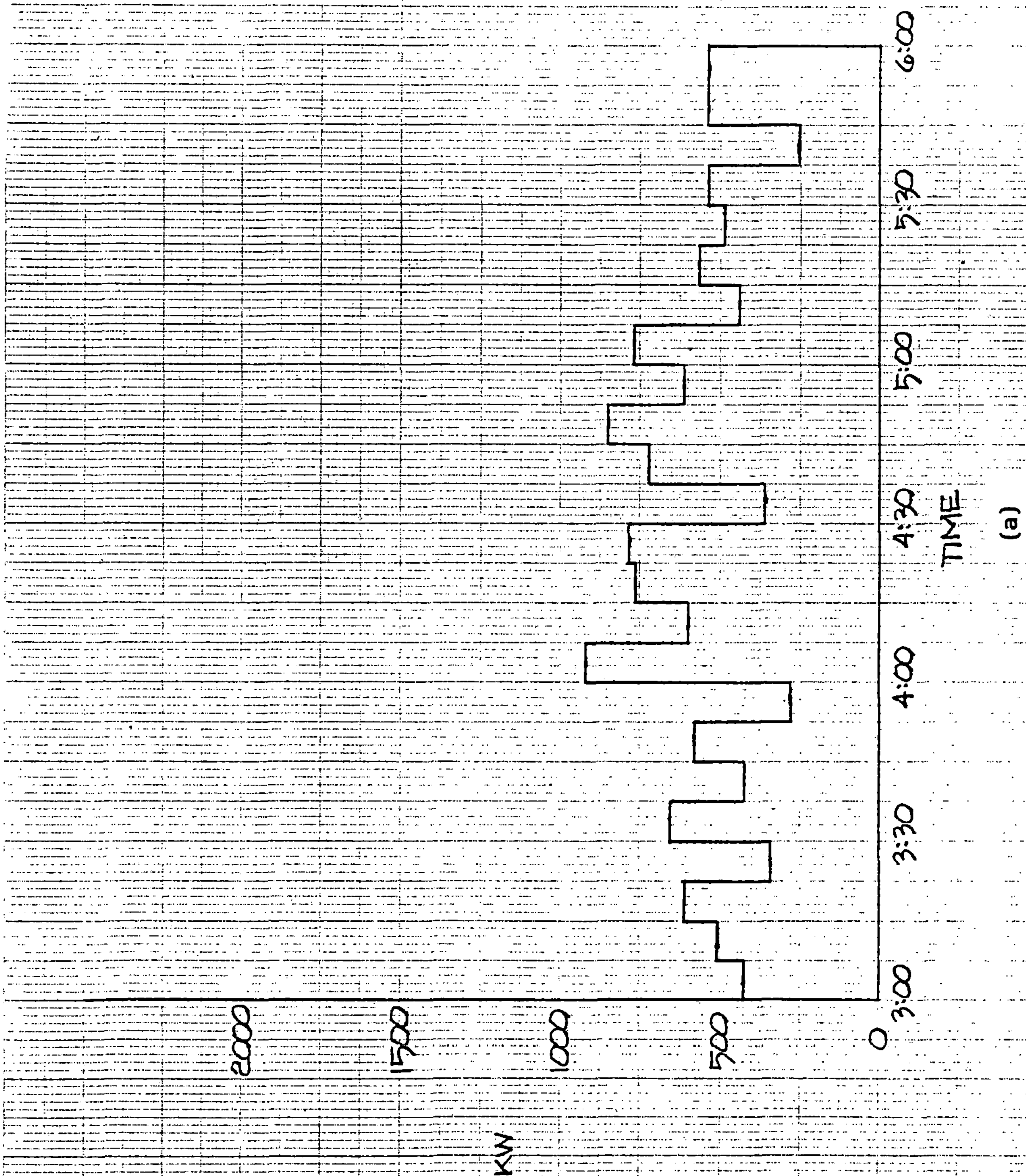


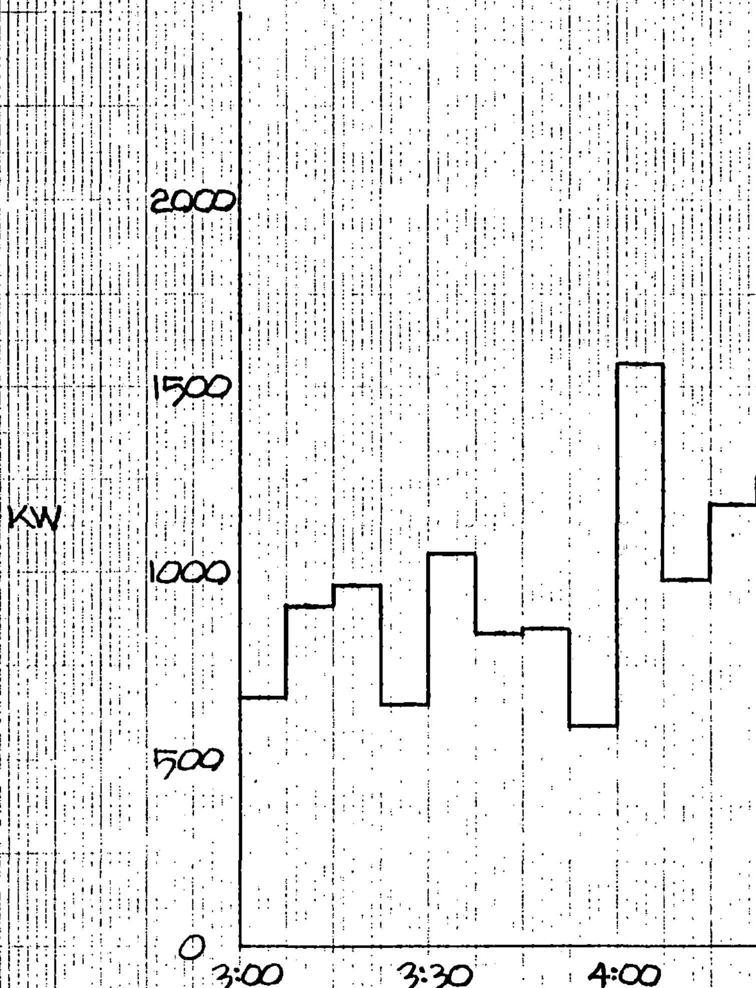

1600
1200
SUBSTATION KW
800
400
0
14
15
16
TIME (MINUTES)

MTW SUBSTATION LOADING
4 CAR BASELINE
DIRECTION- M90 TO M16

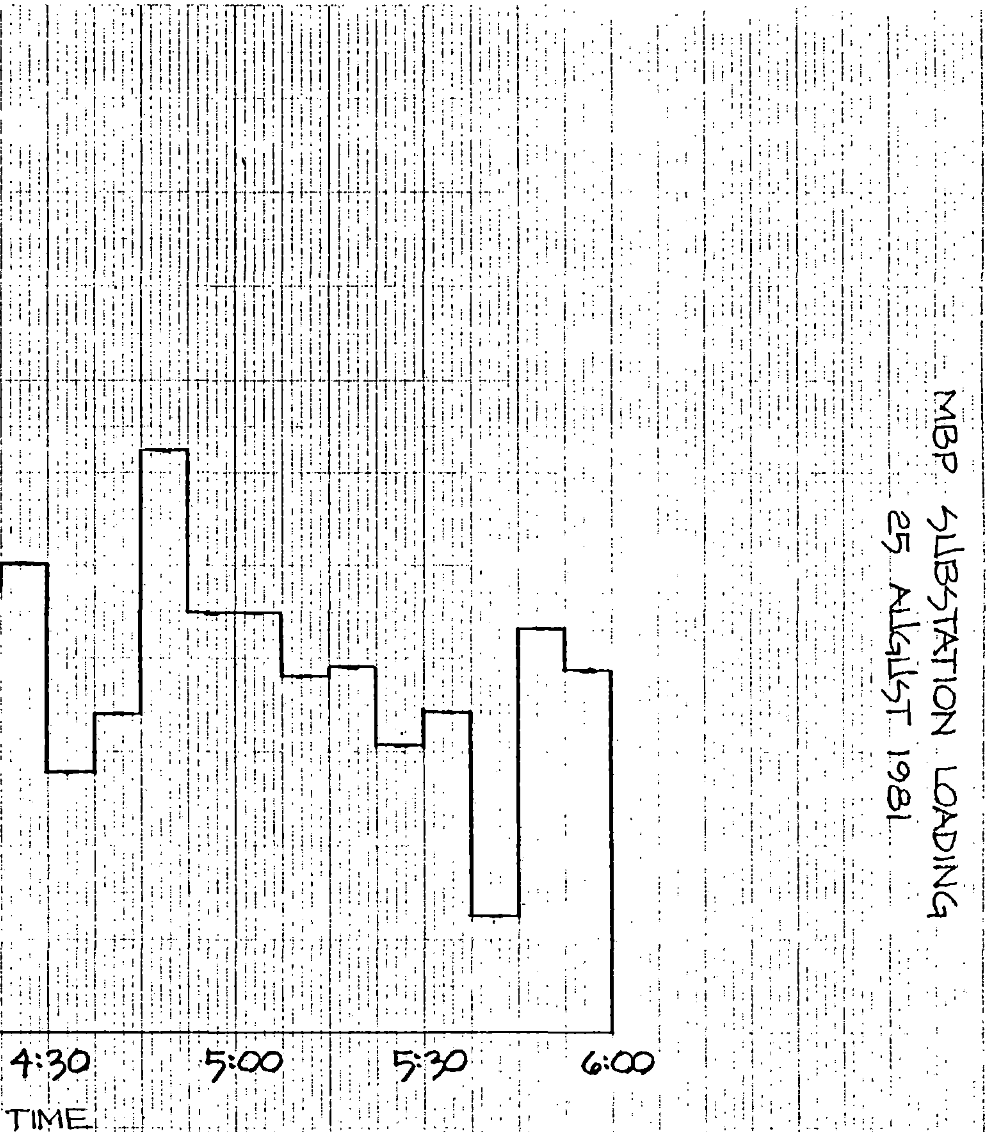
SHEET 2
OF 2

MDC SUBSTATION LOADING
25 AUGUST 1981



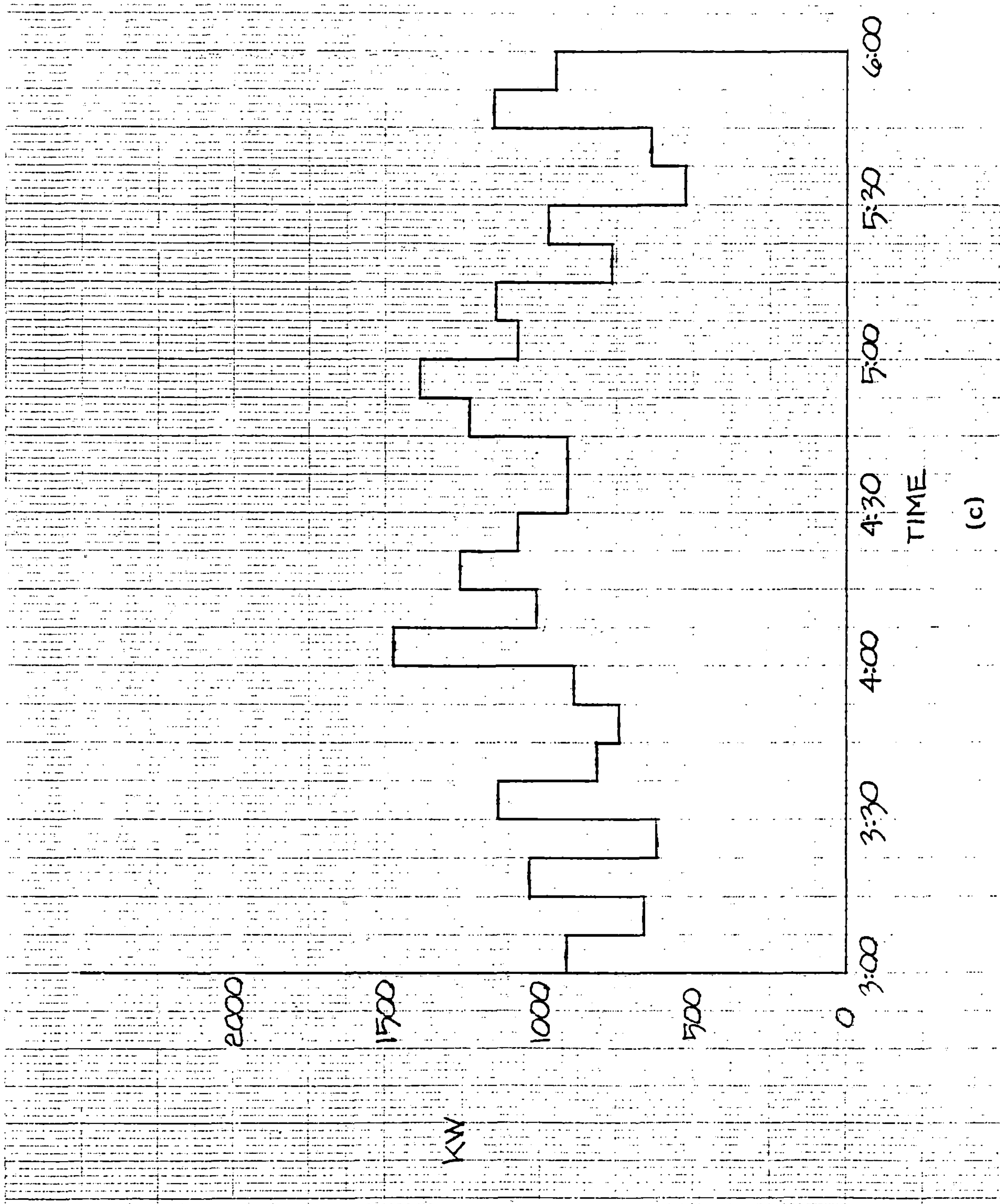


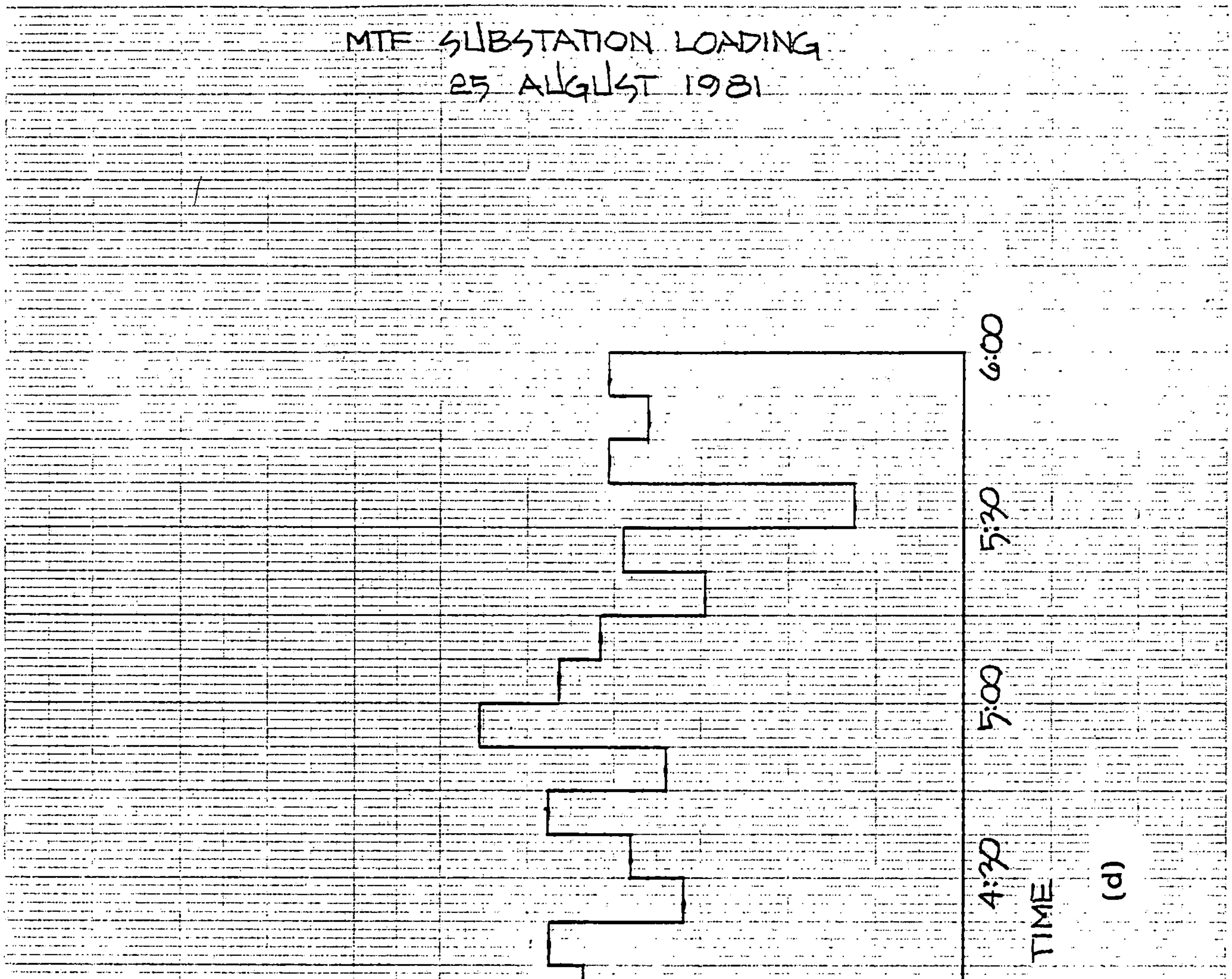
KW
2000
1500
1000
500
0
3:00
3:30
4:00



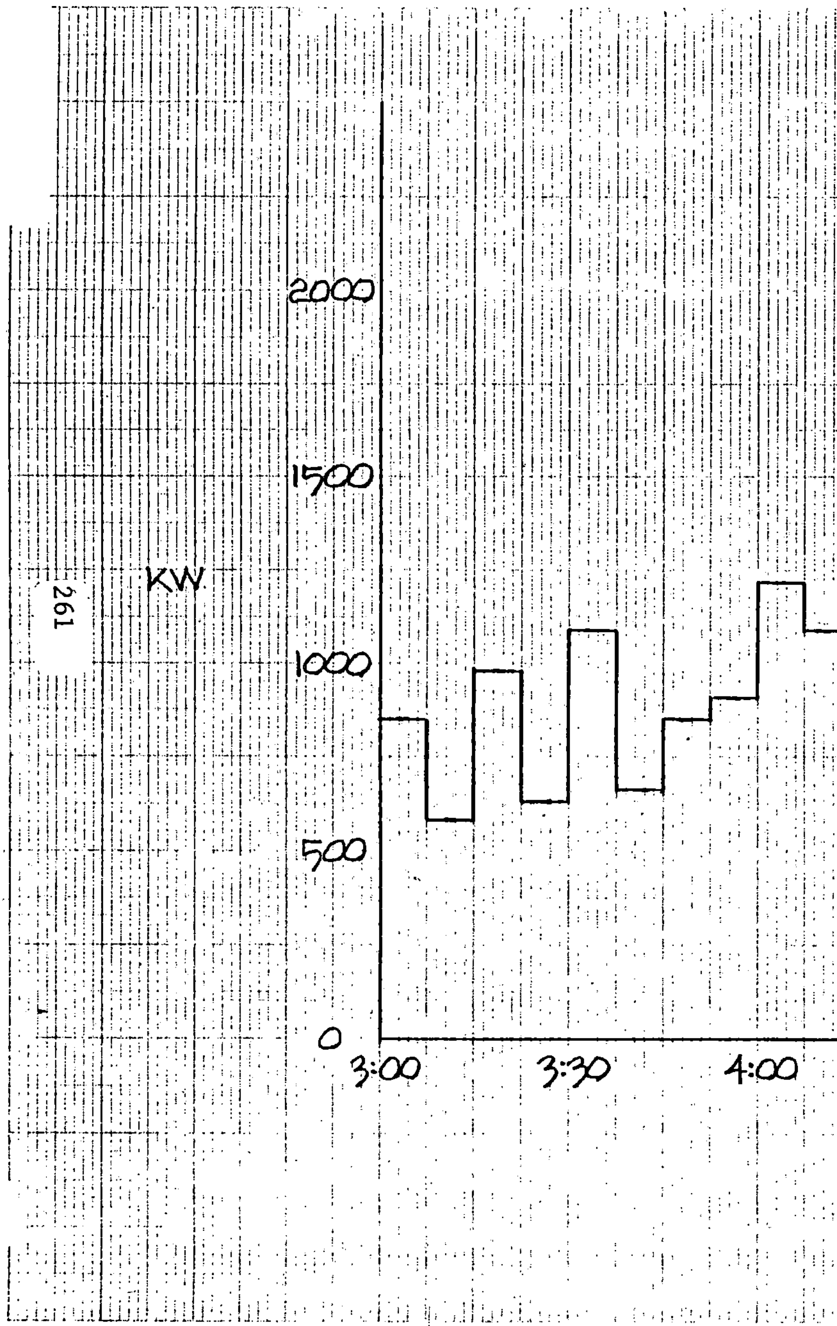
(b)

MGP SUBSTATION LOADING
25 AUGUST 1981



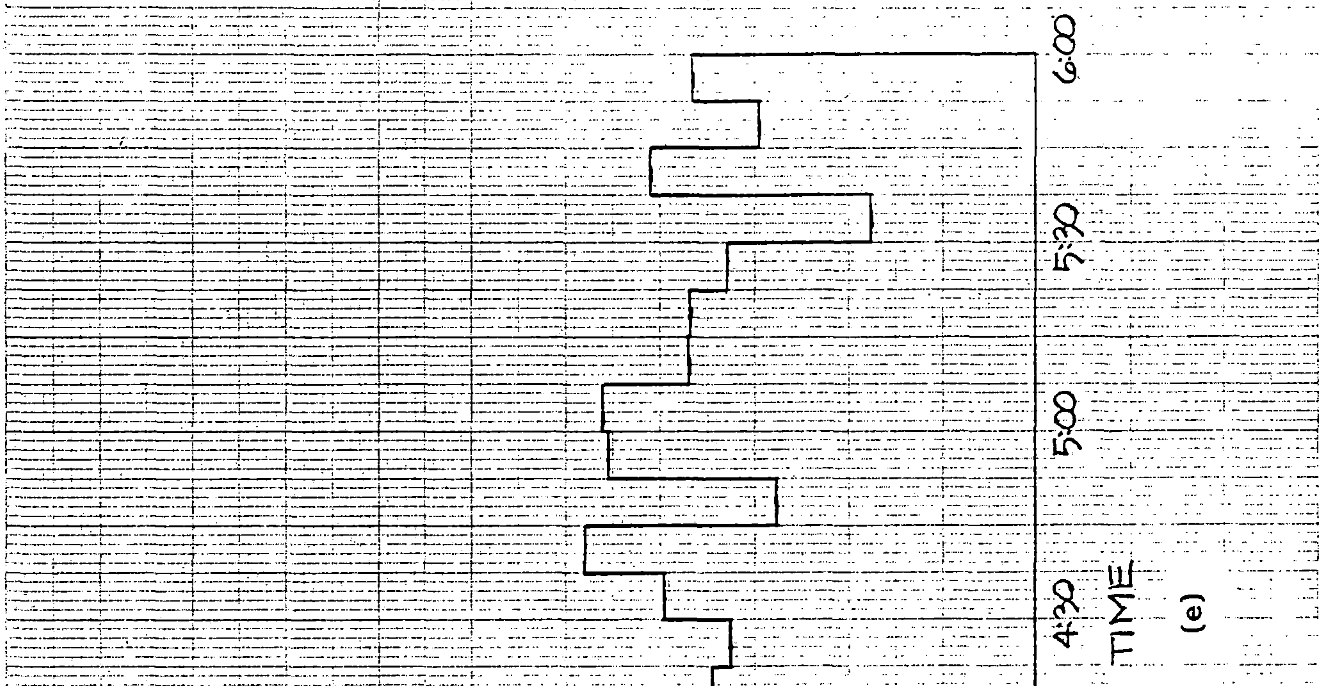


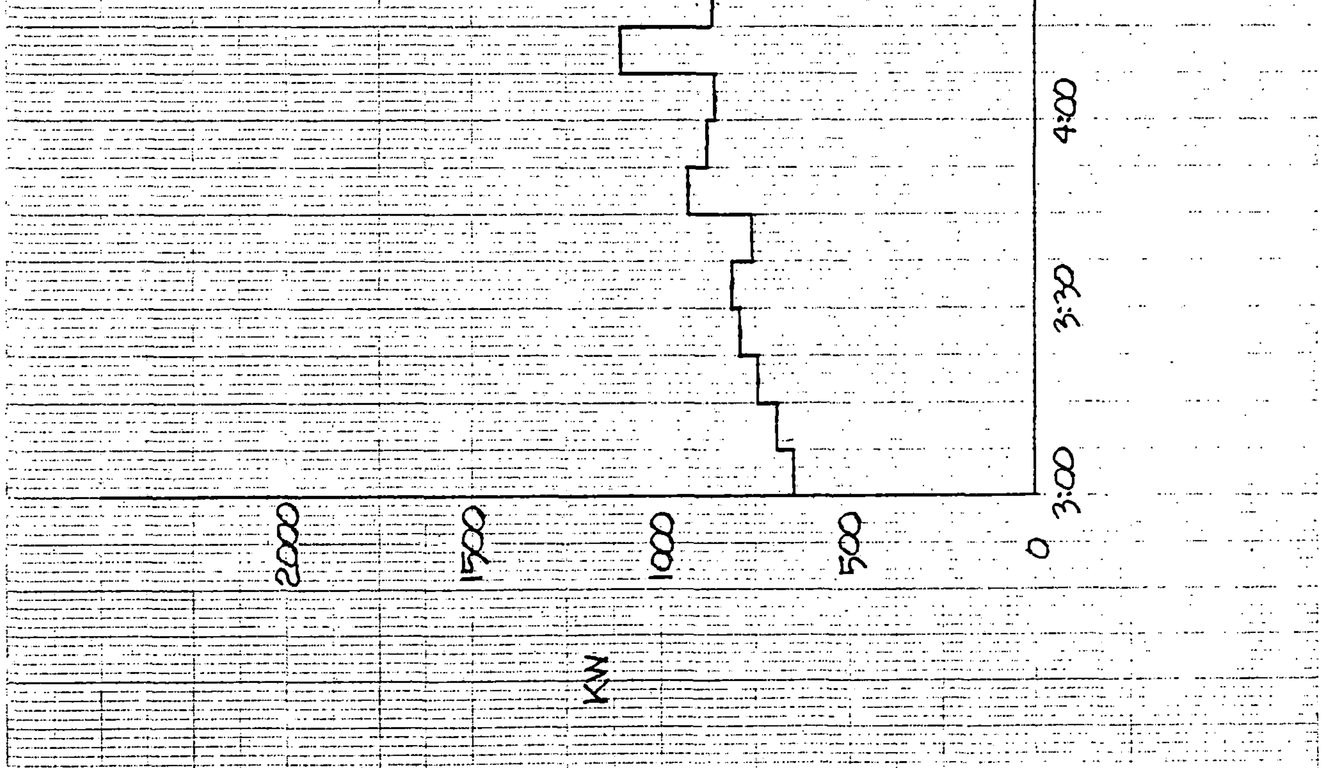
MTF SUBSTATION LOADING
25 AUGUST 1981
6:00
5:30
5:00
4:30
TIME
(d)



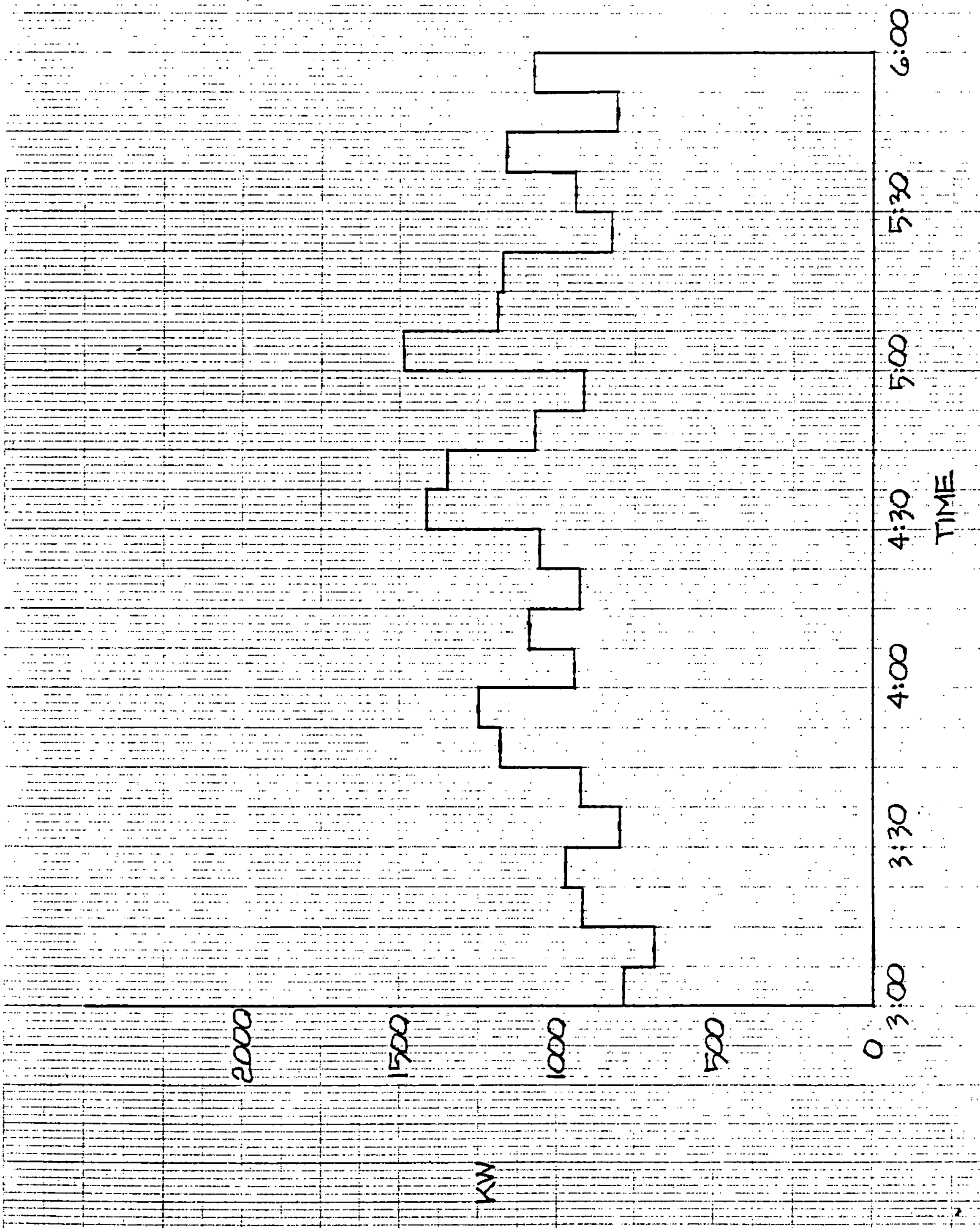
KW
2000
1500
1000
500
0
3:00
3:30
4:00

MSS SUBSTATION LOADING
25 AUGUST 1981



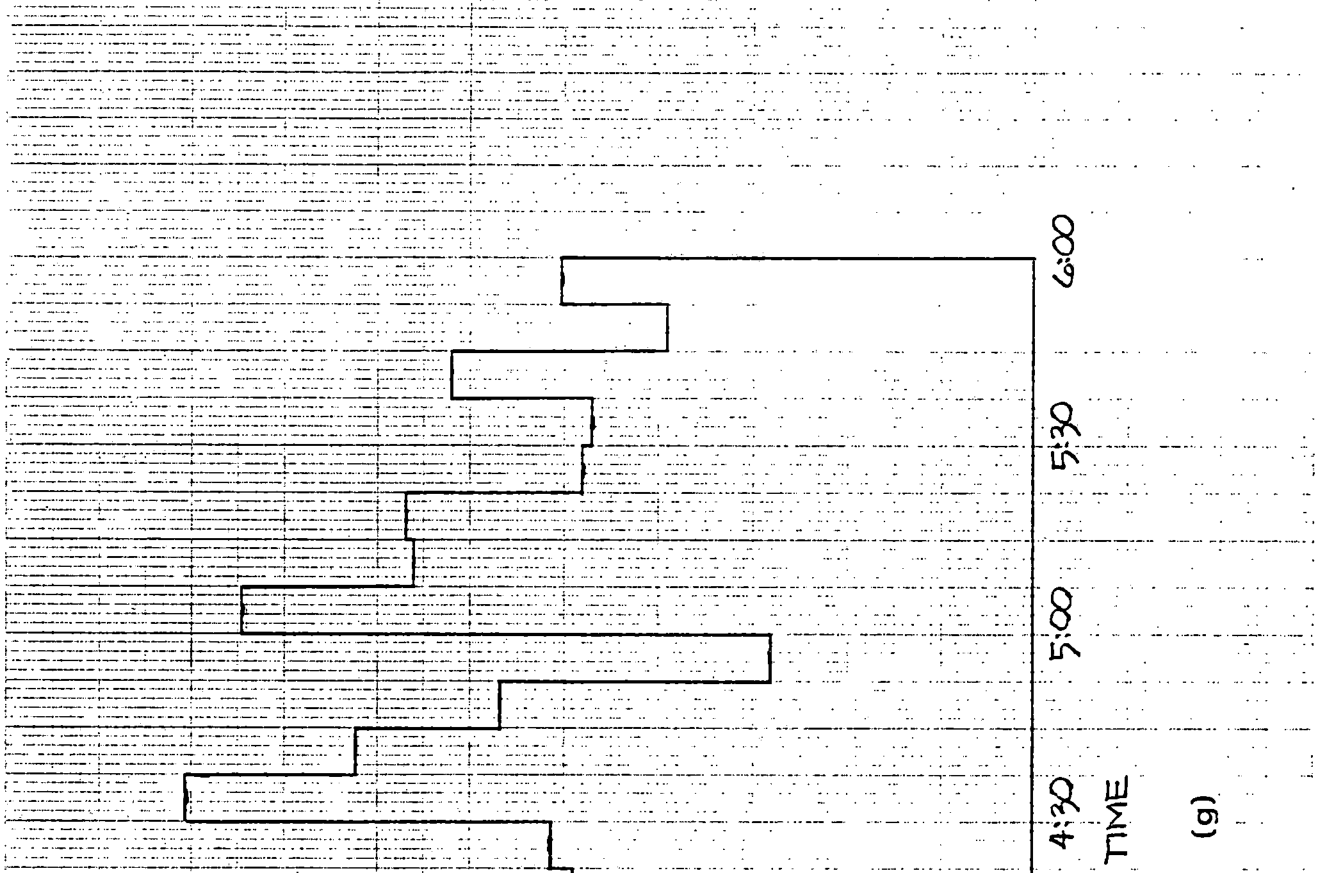

4:00
3:30
3:00
0
500
1000
1500
2000
KW

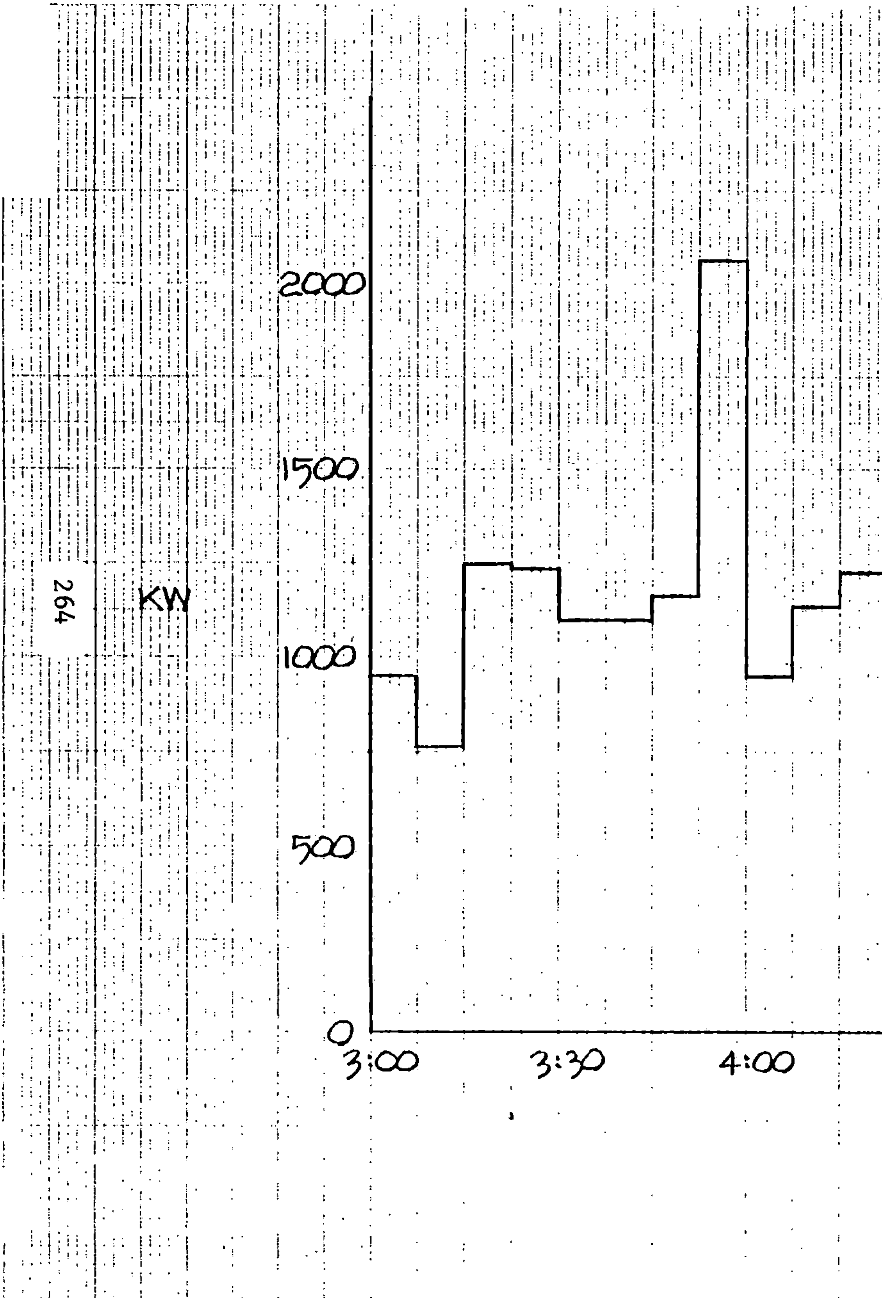
MPS SUBSTATION LOADING
25 AUGUST 1981



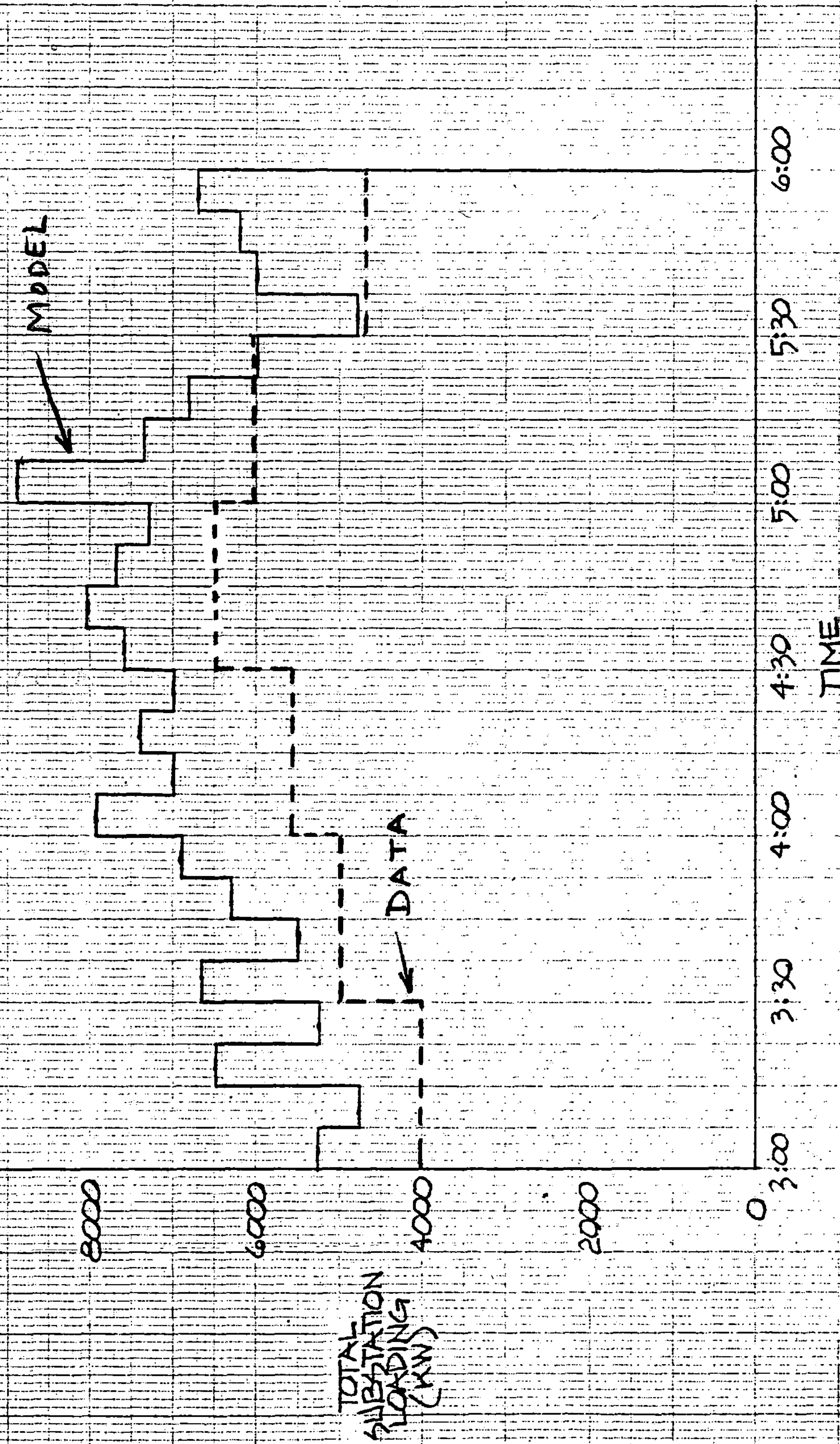
(f)

MTW SUBSTATION LOADING
25 AUGUST 1981



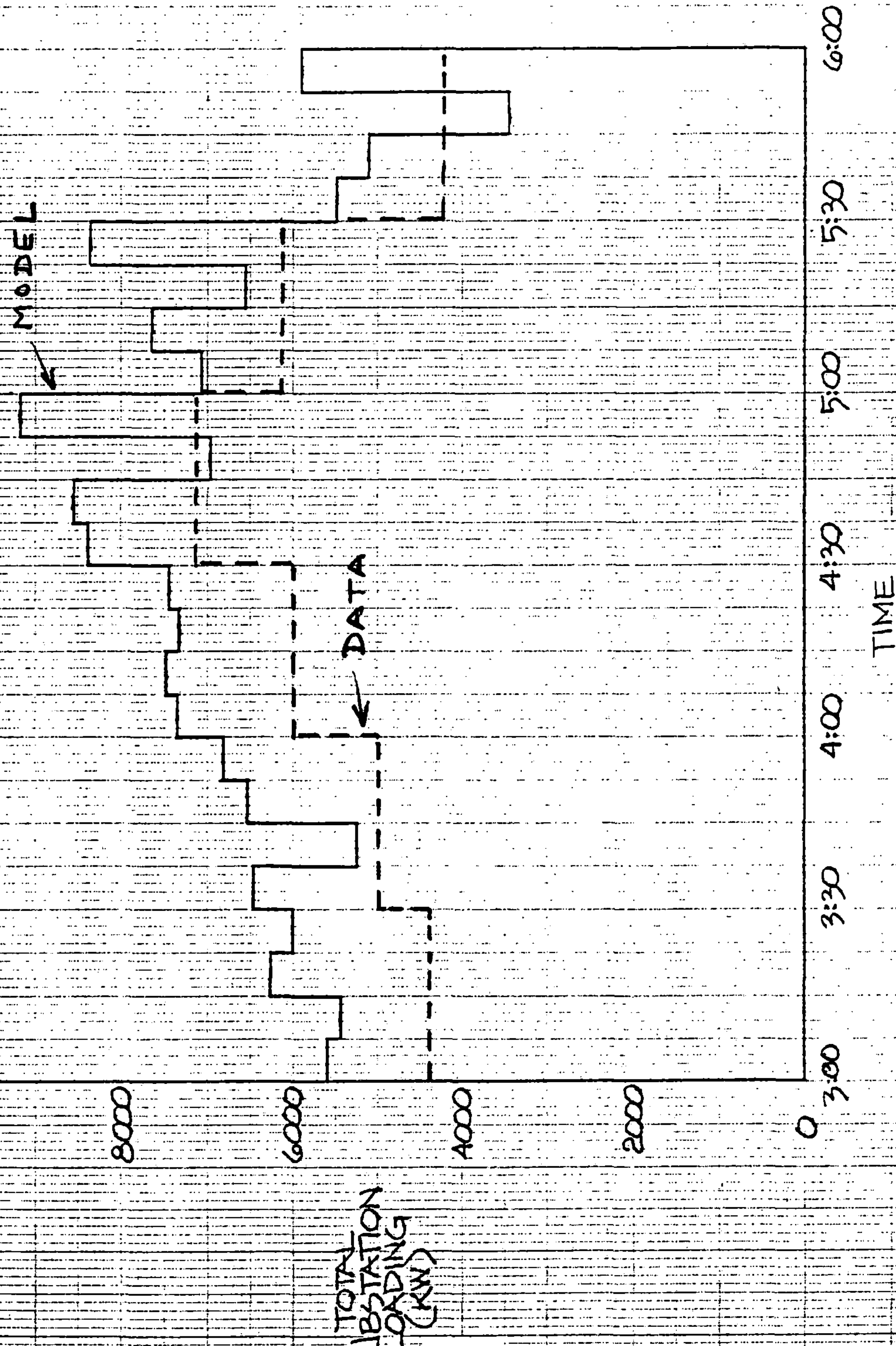

264
KW
2000
1500
1000
500
0
3:00
3:30
4:00

TOTAL SUBSTATION LOADING
25 AUGUST 1981

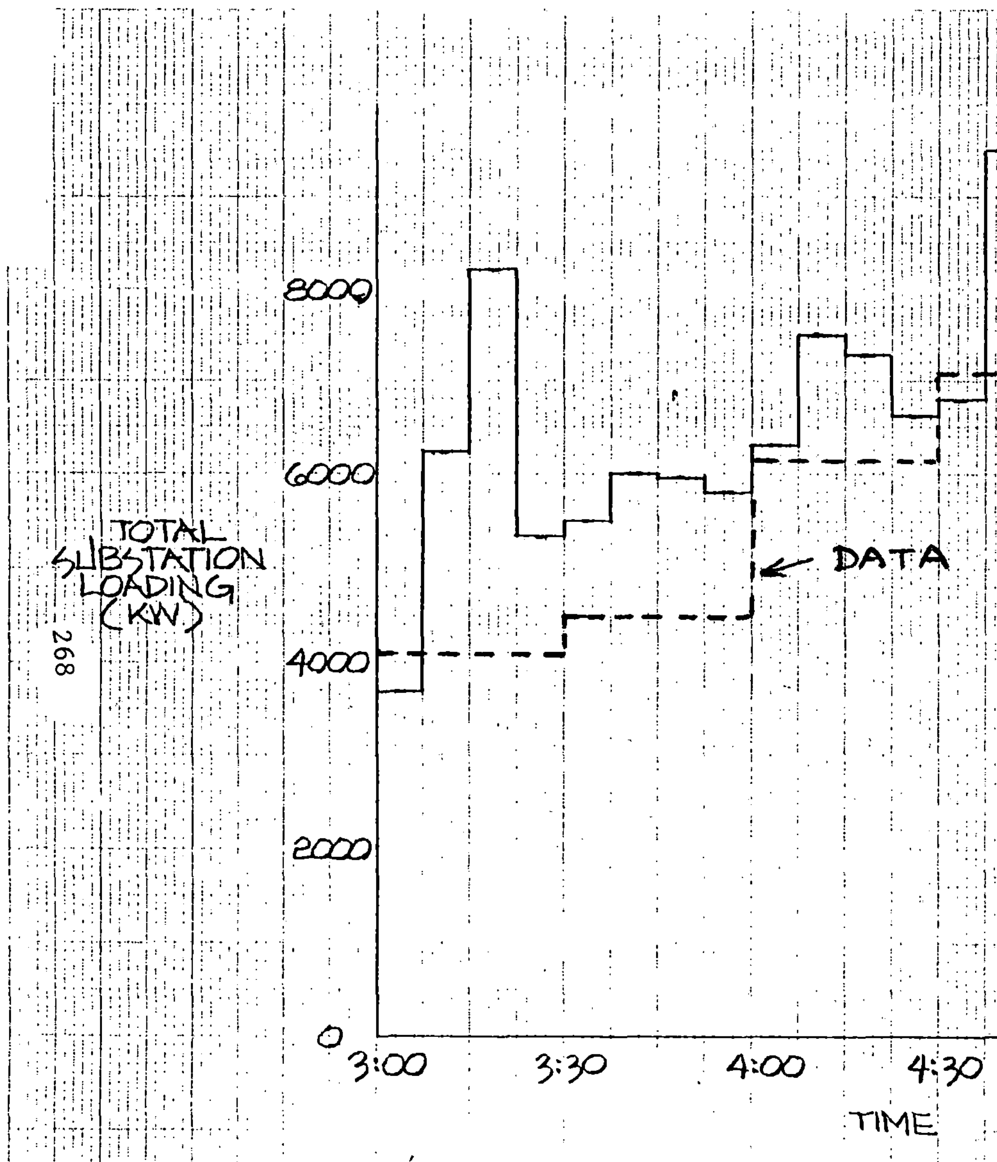


(a)

TOTAL SUBSTATION LOADING
26 AUGUST 1981



(b)


8000
6000
4000
2000
0
TOTAL SUBSTATION LOADING (KW)
DATA
3:00
3:30
4:00
4:30
TIME

(c)

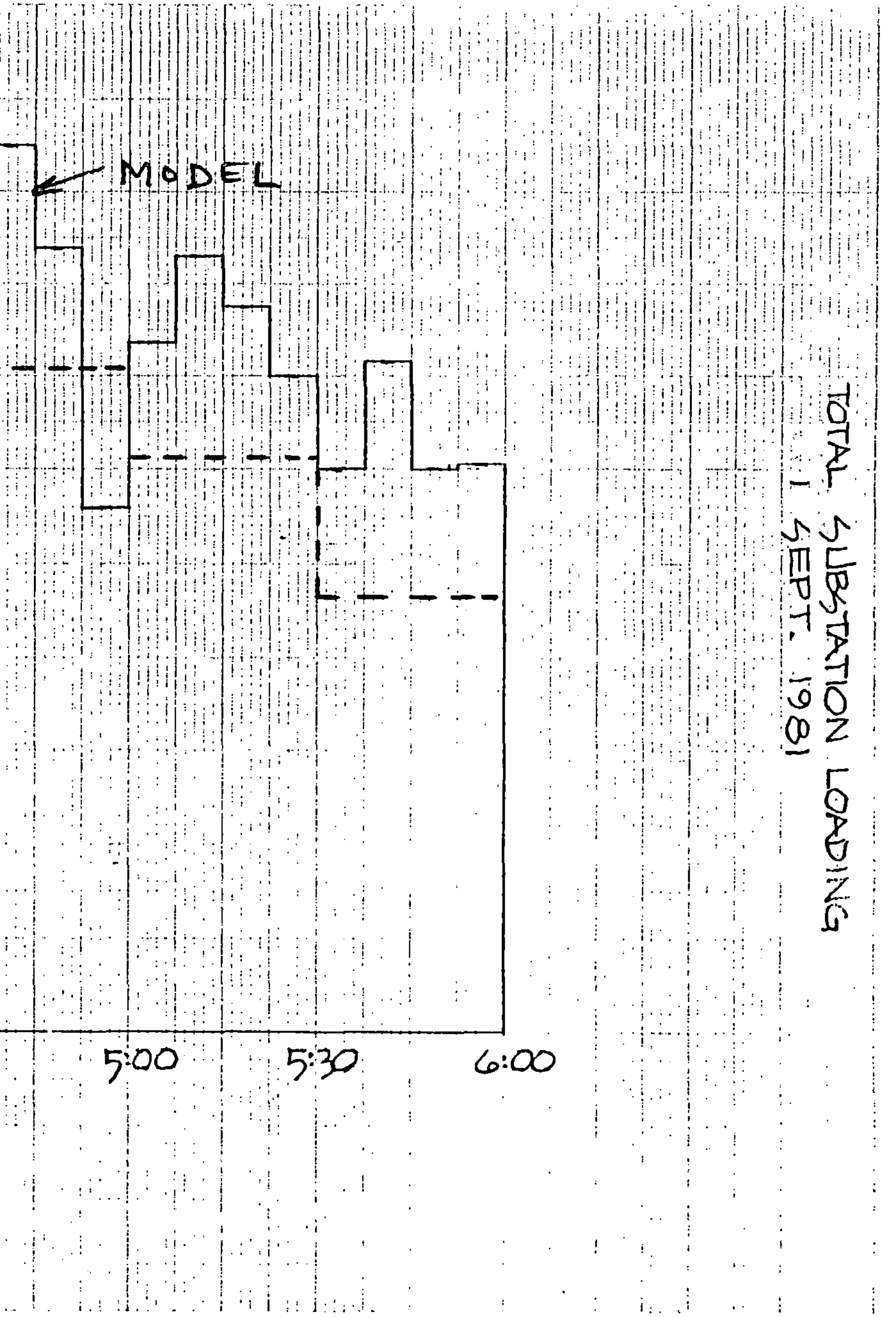

MODEL
5:00
5:30
6:00
TOTAL SUBSTATION LOADING
1 SEPT. 1981

TABLE 6.3

RESULTS OF MODEL # 3

REGENERATION TESTS

TOTAL ENERGY CONSUMPTION DURING 15:00 - 18:00 HOURS

DATE	MODEL KWH	DATA KWH
25 AUG	19976	15950
26 AUG	20101	16445
1 SEPT	20065	16325

7. COMPUTER MODEL # 4

This model is also a general purpose simulation, consisting basically of two programs. One simulates the vehicle performance for any given vehicle and track characteristics, and the other simulates the electrical distribution network for any given network topology and traffic patterns.

The vehicle simulation program can model different types of vehicles such as transit cars, intercity passenger and/or MU cars, freight cars, etc. For each station-to-station run, the power requirements and the energy consumption are computed on an instantaneous and on a trip basis. The network simulator then computes the peak, the average, and the rms feeder and substation currents for the given traffic pattern and traffic density.

This model was used to simulate only the vehicle performance for one run between the Daly City (M90) and the Embarcadero (M16) passenger stations in each direction. The electrical network simulator was not used for these runs. The Regeneration Test was not simulated at all.

A typical program output of this model is presented in Table 7.1 for a limited vehicle run from the Daly City station to the Balboa Park station. The motion of train is monitored every second, computing the distance travelled, the current drawn, etc., at every step. Cumulative energy consumption computations are then provided at the end of each such run. The results of this simulation are presented in Table 7.2. Accounting for the higher weight of the BART Engineering Car, the predicted energy consumption for the M16 - M90 trip seems to be about 6 percent lower than the test data, whereas it is about 7 percent higher for the M90 - M16 trip.

TABLE 7.1

RESULTS OF MODEL # 4
A TYPICAL PROGRAM PRINTOUT

NON-REVENUE SERVICE TEST RUN ON "MR" TRACK (DALY CITY - EMBACADERO)

(1) DALY CITY TO BALBOA PARK (OPEN-TO-TUNNEL AT 8260)

TRACK DATA

CURVE CHANGE POINTS
700.00 10170.00

CURVATURE
0.0 0.0

GRADE CHANGE POINTS
700.00 2660.00 4488.00 6860.00 8010.00 8260.00 9060.00 9470.00
10170.00

GRADES
0.80 2.75 -3.50 -2.11 -3.19 -3.19 -1.00 -1.00
-1.00

SPEED LIMIT CHANGE POINTS
700.00 9470.00 10170.00

SPEED LIMITS
36.00 36.00 0.0

FACTOR "D" CHANGE POINTS :
700.00 8260.00 10170.00

FACTOR "D" VALUES IN LBS/(FT*MPH)SQ. :
0.002400 0.019200 0.019200

NON-REVENUE SERVICE TEST RUN ON "MR" T

(1) DALY CITY TO BALBOA PARK (OPEN-TO-

TIME SEC	VELOCITY MPH	TRAIN LOCATION FT	STOP DIST FT
0.0	30.00	700.	0.
1.00	32.73	746.	298.
2.00	35.25	796.	348.
3.00	36.00	848.	364.
4.00	36.00	901.	364.
5.00	36.00	954.	364.
6.00	36.00	1007.	364.
7.00	36.00	1059.	364.
8.00	36.00	1112.	364.
9.00	36.00	1165.	364.
10.00	36.00	1218.	364.
11.00	36.00	1271.	364.
12.00	36.00	1323.	364.
13.00	36.00	1376.	364.
14.00	36.00	1429.	364.
15.00	36.00	1482.	364.
16.00	36.00	1535.	364.
17.00	36.00	1587.	364.
18.00	36.00	1640.	364.
19.00	36.00	1693.	364.
20.00	36.00	1746.	364.
21.00	36.00	1798.	364.
22.00	36.00	1851.	364.
23.00	36.00	1904.	364.
24.00	36.00	1957.	364.
25.00	36.00	2010.	364.
26.00	36.00	2062.	364.
27.00	36.00	2115.	364.
28.00	36.00	2168.	364.
29.00	36.00	2221.	364.
30.00	36.00	2274.	364.
31.00	36.00	2326.	364.
32.00	36.00	2379.	364.
33.00	36.00	2432.	364.
34.00	36.00	2485.	364.
35.00	36.00	2538.	364.
36.00	36.00	2590.	364.
37.00	36.00	2643.	364.
38.00	36.00	2696.	364.
39.00	36.00	2749.	364.
40.00	36.00	2802.	364.
41.00	36.00	2854.	364.
42.00	36.00	2907.	364.
43.00	36.00	2960.	364.
44.00	36.00	3013.	364.
45.00	36.00	3066.	364.
46.00	36.00	3118.	364.

TRACK (DALY CITY - EMBACADERO)

-TUNNEL AT 8260)

STOPPING STATION FT	CURRENT AMP	TOTAL RESIST LBS
700.	94.	0.
1044.	2770.	-3347.
1144.	2651.	-3422.
1212.	337.	-3496.
1265.	341.	-3519.
1318.	341.	-3519.
1371.	341.	-3519.
1424.	341.	-3519.
1476.	341.	-3519.
1529.	341.	-3519.
1582.	341.	-3519.
1635.	341.	-3519.
1688.	341.	-3519.
1740.	341.	-3519.
1793.	341.	-3519.
1846.	341.	-3519.
1899.	341.	-3519.
1952.	341.	-3519.
2004.	341.	-3519.
2057.	341.	-3519.
2110.	341.	-3519.
2163.	341.	-3519.
2216.	341.	-3519.
2268.	341.	-3519.
2321.	341.	-3519.
2374.	341.	-3519.
2427.	341.	-3519.
2480.	341.	-3519.
2532.	341.	-3519.
2585.	341.	-3519.
2638.	341.	-3519.
2691.	341.	-3519.
2744.	341.	-3519.
2796.	341.	-3519.
2849.	341.	-3519.
2902.	341.	-3519.
2955.	341.	-3519.
3008.	341.	-3519.
3060.	341.	-3519.
3113.	718.	-8903.
3166.	718.	-8903.
3219.	718.	-8903.
3272.	718.	-8903.
3324.	718.	-8903.
3377.	718.	-8903.
3430.	718.	-8903.
3483.	718.	-8903.

(1) DALY CITY TO BALBOA PARK (OPEN-TO-TUNNEL AT 8260)
(CONTINUED)

TIME SEC	VELOCITY MPH	TRAIN LOCATION FT	STOP DIST FT	STOPPING STATION FT	CURREN AMP
47.00	36.00	3171.	364.	3536.	718.
48.00	36.00	3224.	364.	3588.	718.
49.00	36.00	3277.	364.	3641.	718.
50.00	36.00	3330.	364.	3694.	718.
51.00	36.00	3382.	364.	3747.	718.
52.00	36.00	3435.	364.	3800.	718.
53.00	36.00	3488.	364.	3852.	718.
54.00	36.00	3541.	364.	3905.	718.
55.00	36.00	3594.	364.	3958.	718.
56.00	36.00	3646.	364.	4011.	718.
57.00	36.00	3699.	364.	4064.	718.
58.00	36.00	3752.	364.	4116.	718.
59.00	36.00	3805.	364.	4169.	718.
60.00	36.00	3858.	364.	4222.	718.
61.00	36.00	3910.	364.	4275.	718.
62.00	36.00	3963.	364.	4328.	718.
63.00	36.00	4016.	364.	4380.	718.
64.00	36.00	4069.	364.	4433.	718.
65.00	36.00	4122.	364.	4486.	718.
66.00	36.00	4174.	364.	4539.	718.
67.00	36.00	4227.	364.	4592.	718.
68.00	36.00	4280.	364.	4644.	718.
69.00	36.00	4333.	364.	4697.	718.
70.00	36.00	4386.	364.	4750.	718.
71.00	36.00	4438.	364.	4803.	718.
72.00	36.00	4491.	364.	4856.	718.
73.00	36.00	4544.	364.	4908.	94.
74.00	36.00	4597.	364.	4961.	94.
75.00	36.00	4650.	364.	5014.	94.
76.00	36.00	4702.	364.	5067.	94.
77.00	36.00	4755.	364.	5120.	94.
78.00	36.00	4808.	364.	5172.	94.
79.00	36.00	4861.	364.	5225.	94.
80.00	36.00	4914.	364.	5278.	94.
81.00	36.00	4966.	364.	5331.	94.
82.00	36.00	5019.	364.	5384.	94.
83.00	36.00	5072.	364.	5436.	94.
84.00	36.00	5125.	364.	5489.	94.
85.00	36.00	5178.	364.	5542.	94.
86.00	36.00	5230.	364.	5595.	94.
87.00	36.00	5283.	364.	5648.	94.
88.00	36.00	5336.	364.	5700.	94.
89.00	36.00	5389.	364.	5753.	94.
90.00	36.00	5442.	364.	5806.	94.
91.00	36.00	5494.	364.	5859.	94.
92.00	36.00	5547.	364.	5912.	94.
93.00	36.00	5600.	364.	5964.	94.
94.00	36.00	5653.	364.	6017.	94.
95.00	36.00	5706.	364.	6070.	94.
96.00	36.00	5758.	364.	6123.	94.

T	TOTAL RESIST LBS
	-8903.
	-8903.
	-8903.
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(1) DALY CITY TO BALBOA PARK (OPEN-TO-TUNNEL AT 8260)
(CONTINUED)

TIME SEC	VELOCITY MPH	TRAIN LOCATION FT	STOP DIST FT	STOPPING STATION FT	CURRENT AMP	TOTAL RESIST LBS
97.00	36.00	5811.	364.	6176.	94.	8353.
98.00	36.00	5864.	364.	6228.	94.	8353.
99.00	36.00	5917.	364.	6281.	94.	8353.
100.00	36.00	5970.	364.	6334.	94.	8353.
101.00	36.00	6022.	364.	6387.	94.	8353.
102.00	36.00	6075.	364.	6439.	94.	8353.
103.00	36.00	6128.	364.	6492.	94.	8353.
104.00	36.00	6181.	364.	6545.	94.	8353.
105.00	36.00	6234.	364.	6598.	94.	8353.
106.00	36.00	6286.	364.	6651.	94.	8353.
107.00	36.00	6339.	364.	6703.	94.	8353.
108.00	36.00	6392.	364.	6756.	94.	8353.
109.00	36.00	6445.	364.	6809.	94.	8353.
110.00	36.00	6498.	364.	6862.	94.	8353.
111.00	36.00	6550.	364.	6915.	94.	8353.
112.00	36.00	6603.	364.	6967.	94.	8353.
113.00	36.00	6656.	364.	7020.	94.	8353.
114.00	36.00	6709.	364.	7073.	94.	8353.
115.00	36.00	6762.	364.	7126.	94.	8353.
116.00	36.00	6814.	364.	7179.	94.	8353.
117.00	36.00	6867.	364.	7231.	94.	8353.
118.00	36.00	6920.	364.	7284.	94.	4516.
119.00	36.00	6973.	364.	7337.	94.	4516.
120.00	36.00	7026.	364.	7390.	94.	4516.
121.00	36.00	7078.	364.	7443.	94.	4516.
122.00	36.00	7131.	364.	7495.	94.	4516.
123.00	36.00	7184.	364.	7548.	94.	4516.
124.00	36.00	7237.	364.	7601.	94.	4516.
125.00	36.00	7289.	364.	7654.	94.	4516.
126.00	36.00	7342.	364.	7707.	94.	4516.
127.00	36.00	7395.	364.	7759.	94.	4516.
128.00	36.00	7448.	364.	7812.	94.	4516.
129.00	36.00	7501.	364.	7865.	94.	4516.
130.00	36.00	7553.	364.	7918.	94.	4516.
131.00	36.00	7606.	364.	7971.	94.	4516.
132.00	36.00	7659.	364.	8023.	94.	4516.
133.00	36.00	7712.	364.	8076.	94.	4516.
134.00	36.00	7765.	364.	8129.	94.	4516.
135.00	36.00	7817.	364.	8182.	94.	4516.
136.00	36.00	7870.	364.	8235.	94.	4516.
137.00	36.00	7923.	364.	8287.	94.	4516.
138.00	36.00	7976.	364.	8340.	94.	4516.
139.00	36.00	8029.	364.	8393.	94.	4516.
140.00	36.00	8081.	364.	8446.	94.	7497.
141.00	36.00	8134.	364.	8499.	94.	7497.
142.00	36.00	8187.	364.	8551.	94.	7497.
143.00	36.00	8240.	364.	8604.	94.	7497.
144.00	36.00	8293.	364.	8657.	94.	7497.
145.00	36.00	8345.	364.	8710.	94.	5320.
146.00	36.00	8398.	364.	8763.	94.	5320.

(1) DALY CITY TO BALBOA PARK (OPEN-TO-TUNNEL AT 8260)
(CONTINUED)

TIME SEC	VELOCITY MPH	TRAIN LOCATION FT	STOP DIST FT	STOPPING STATION FT	CURREN AMP
147.00	36.00	8451.	364.	8815.	94.
148.00	36.00	8504.	364.	8868.	94.
149.00	36.00	8557.	364.	8921.	94.
150.00	36.00	8609.	364.	8974.	94.
151.00	36.00	8662.	364.	9027.	94.
152.00	36.00	8715.	364.	9079.	94.
153.00	36.00	8768.	364.	9132.	94.
154.00	36.00	8821.	364.	9185.	94.
155.00	36.00	8873.	364.	9238.	94.
156.00	36.00	8926.	364.	9291.	94.
157.00	36.00	8979.	364.	9343.	94.
158.00	36.00	9032.	364.	9396.	94.
159.00	36.00	9085.	364.	9449.	94.
160.00	36.00	9137.	364.	9502.	145.
161.00	36.00	9190.	364.	9555.	145.
162.00	36.00	9243.	364.	9607.	145.
163.00	36.00	9296.	364.	9660.	145.
164.00	36.00	9349.	364.	9713.	145.
165.00	36.00	9401.	364.	9766.	145.
166.00	36.00	9454.	364.	9818.	145.
167.00	36.00	9507.	364.	9871.	145.
168.00	36.00	9560.	364.	9924.	145.
169.00	36.00	9613.	364.	9977.	145.
170.00	36.00	9665.	364.	10030.	145.
171.00	36.00	9718.	364.	10082.	145.
172.00	36.00	9771.	364.	10135.	145.
172.66	36.00	9806.	364.	10170.	145.
173.66	33.53	9857.	313.	10170.	94.
174.66	31.07	9904.	266.	10170.	94.
175.66	28.60	9948.	222.	10170.	94.
176.66	26.13	9988.	182.	10170.	94.
177.66	23.67	10024.	146.	10170.	94.
178.66	21.20	10057.	113.	10170.	94.
179.66	18.46	10086.	84.	10170.	94.
180.66	15.46	10111.	59.	10170.	94.
181.66	12.46	10132.	38.	10170.	94.
182.66	9.46	10148.	22.	10170.	94.
183.66	6.46	10160.	10.	10170.	94.
184.66	3.46	10167.	3.	10170.	94.
185.90	0.0	10170.	0.	10170.	94.

T	TOTAL RESIST LBS
	5320.
	5320.
	5320.
	5320.
	5320.
	5320.
	5320.
	5320.
	5320.
	5320.
	5320.
	5320.
	5320.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-727.
	-364.
	-27.
	286.
	574.
	838.
	1077.
	1314.
	1538.
	1726.
	1878.
	1993.
	0.

TABLE 7.2

RESULTS OF MODEL # 4

ENERGY CONSUMPTION FOR BASELINE RUNS

RUN	MODEL[1] KWH/CAR	DATA[2] KWH/CAR
M90 - M16	27.83	34.90
M16 - M90	47.83	52.47

1 Model assumes an average station dwell of 20 seconds

2 For Car #1 which weighs over 43 percent more than the average weight per car of the test train

8. CONCLUSIONS

All the computer models essentially consisted of two major programs - one to simulate performance of a vehicle for given operating conditions, and the other to simulate the electrical distribution network. The electrical network has a variable topology, because the locations of the sinks, i.e., the locations of the trains drawing propulsion and/or auxiliary power, and the location of the sources, i.e., the location of regenerating trains are constantly changing with the motion of trains.

Simulation of the Baseline Tests was quite straightforward, because most of the important variables, if not all, were uniquely defined. Simulation of Regeneration Tests was, however, made more difficult because many variables such as length and weight of trains, station dwell, performance levels, etc., varied over a very wide range. Some models used average values of these variables to define the traffic patterns for simulation.

The input data supplied to the industry group included the track charts, ATO specifications, vehicle details, train schedules, System History Log from the BART Central Computer, passenger loading of the trains, etc. The total data package was very accurate, complete, and totally consistent within itself and with the test conditions. A large volume of useful data was recorded during the test program. The data recorded at the seven substations was, however, found to be very noisy, and was largely ignored.

The predictions of the four models are compared with the test data in Table 8.1. For the Baseline Test, the predictions of Model #3 are in excellent agreement with the test data, and other predictions, except one, are also within 10 percent of the test data. For the Regeneration Test, the predictions are generally lower than the test data. Excessive cycling of the vehicle propulsion system through powering and braking could be one important reason for these lower estimates. It should also be noted here

TABLE 8.1

COMPARISON OF MODEL PREDICTIONS WITH THE TEST DATA

RUN	PREDICTION IS HIGHER OR LOWER THAN TEST DATA FOR MODEL #1	MODEL #2	MODEL #3	MODEL #4
BASELINE TEST				
M90 - M16	2.75% high	2.00% high	2.50% low	6.00% low
M16 - M90	13.40% low	9.00% high	0.50% low	7.00% high
REGENERATION TEST				
M90 - M16	-	-	-	-
M16 - M90	-	10.00% low	-	-
MP6 - M90 - MP6	29.00 low	-	4.00% low	-

that these models have not been 'fine tuned' in any way to simulate the BART system in particular.

The comparison of Table 8.1 is based on an assumed sensitivity of the energy consumption of a transit car to its weight. This sensitivity is very route specific, and is known more accurately only for the Baseline Run #4, i.e., for the M90 - M16 route. The model predictions are, therefore, very close to the test data for Baseline runs on this route. Prediction of Model #1 for the Regeneration Test shows a large error. Most probably, this is due to averaging of several variables defining the revenue service, and due to assuming a passenger station at MP6, the open end of the test track.

The model predictions were also compared with the test data by assuming zero station dwell. This was done primarily because the station-to-station run times and the station dwells could not be simultaneously matched with the System History Log data for any simulation. Such a comparison was made for Run #4 and for Run #5 of the Baseline Test by assuming a constant auxiliary load of 20 kW per car. The results are presented in Table 8.2. The predictions are generally closer to the test data under these conditions as seen by comparing the results in Table 8.2 to those presented in Table 8.1.

TABLE 8.2

COMPARISON OF MODEL PREDICTIONS WITH THE TEST DATA
FOR ZERO STATION DWELL TIME

BASELINE	PREDICTION IS HIGHER OR LOWER THAN TEST DATA FOR			
RUN	MODEL #1	MODEL #2	MODEL #3	MODEL #4
#4 (M90 - M16)	4.40% high	1.00% low	2.00% low	5.50% low
#5 (M16 - M90)	11.50% low	3.60% high	0.50% high	8.60% high

Note: The test data and model predictions modified for zero station dwell with the auxiliary load assumed to be 20 kW per car.

APPENDIX A

INPUT DATA SUPPLIED FOR COMPUTER SIMULATION

A.1 GENERAL INFORMATION

The basic system information such as the data for vehicle and propulsion equipment as well as the physical characteristics of the tunnel are given below.

<u>Vehicle Data</u>

Weight of A-car (empty)	60,400 lbs.
Weight of B-car (empty)	58,400 lbs.
Equivalent Rotational Weight	7,032 lbs.
Number of Cars in Train	3-10 variable, A-cars at both ends and B-cars in between
Axles/Car	4
Motors/Car	4
Frontal Car Area	100 Sq. ft.
Length of Car	70 ft.
Acceleration	3.0 mphps nominal, modified with the performance level PL as given in Table A-1.
Deceleration	3.0 mphps
Jerk	2.0 mphpsps
Wheel Diameter*	30 in. (new), 28 in. (worn)
Line Voltage	850 V (minimum), 1150 V (max.)
Gear Ratio	5.58
Average Power to Auxiliaries	≈ 20 kW

The train resistance is given by

$$R \text{ (lbs.)} = 1.3NW + 116N + 0.045NWV + [\ 0.0024 + 0.00034(N - 1)\ ]\ AV^2$$

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* Average wheel diameter for three instrumented cars - 29.194 in.

where

N - Number of cars in the train consist

W - Car weight, tons

V - Speed, mph

A - Frontal area, sq. ft.

<u>Motor Data</u>

Main field resistance	0.018 ohm
Armature and commutation field resistance	0.0238 ohm
Field weakening ratio	50 % (100 % for braking)
Motor performance curves	presented in Fig. A-1.
Motor connection	2S2P

<u>Chopper Data</u> (See Figure A-2)

Resistance of line reactor	0.00185 ohm
Iron losses of line reactor	160 watts
Resistance of motor reactor	0.0154 ohm
Iron losses of motor reactor	1460 watts
Resistance of filter capacitor	0.007 ohm
Resistance of line side cable	0.0004 ohm
Resistance of motor side cable	0.003 ohm
Chopper commutation losses	3700 watts

<u>Propulsion System</u>

Maximum tractive effort	limited to AW2 loading, i.e., 82,000 lbs

<u>Tunnel Data</u>

Internal diameter	16 ft. 10 in.
Vent structures	
- At all underground stations	9 ft. X 9 ft. shaft at both ends
- Others	as given in track data in Tables A-2 and A-3

TABLE A-1

DOWNGRADING OF ATC SPEED COMMANDS
AND ACCELERATION RATES WITH PERFORMANCE LEVELS

Perf. Level PL	Acc. Rate MPHPS	Revised Speed Commands for Nominal Commands MPH						
		80	70	50	36	27	18	6
1	3.0	80	70	50	36	27	18	6
2	3.0	70	60	44	36	27	18	6
3	1.5	70	60	44	36	27	18	6
4	3.0	60	60	50	36	27	18	6
5	1.5	60	60	50	36	27	18	6
6	1.5	44	44	44	36	27	18	6

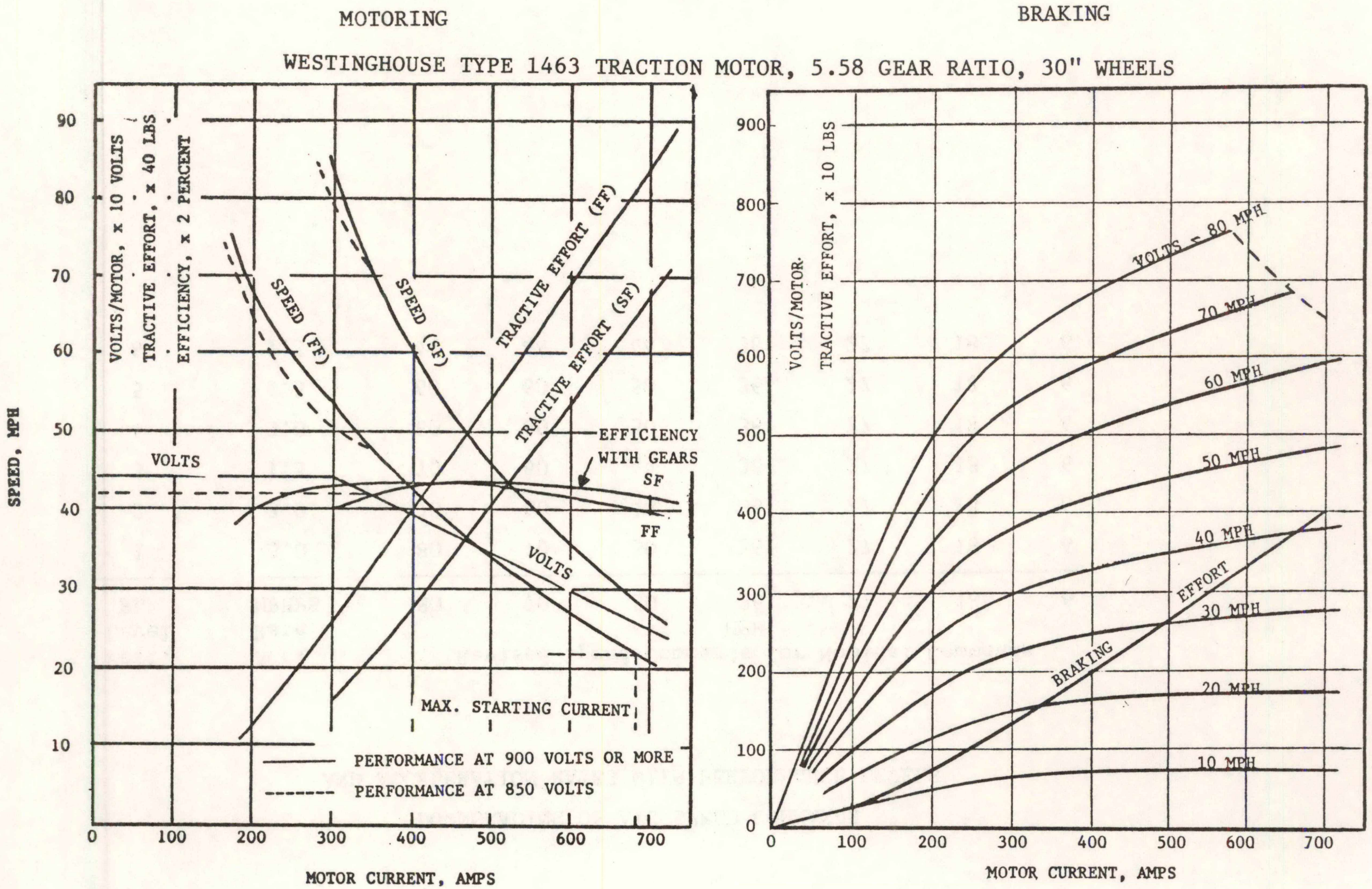

FIGURE A-1. MOTOR PERFORMANCE CURVES

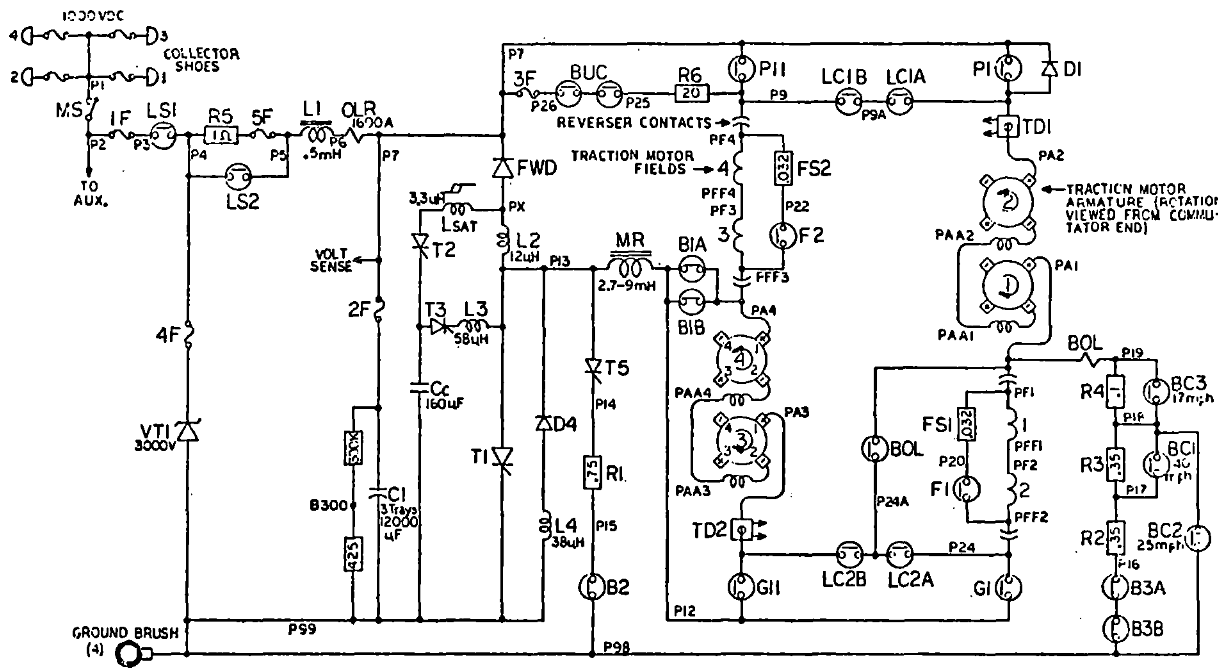

FIGURE A-2. CHOPPER CIRCUIT SCHEMATIC

TABLE A-2

TRACK DATA

FOR

TRACK MR FROM DALY CITY TO ABOUT MP 6.00

From	To	Grade %	Speed mph	Track type	Notes
0	700	0.8	36	GR	Platform-DALY CITY (M90)
700	2660	0.8	36	GR	
2660	4488	2.75	36	GR	
4488	6860	-3.50	36	GR	
6860	8010	-2.11	36	GR	
8010	8260	-3.19	36	GR	
8260	9060	-3.19	36	SB	Tunnel Entry 8260
9060	9470	-1.0	36	SB	
9470	10170	-1.0	36	SB	Platform - BALBOA PARK (M80)
10170	10200	-1.0	36	SB	
10200	10810	-1.0	50	SB	
10810	11085	2.11	50	SB	Tunnel Entry 11085
11085	11710	2.11	50	GR	
11710	13305	-3.89	50	GR	
13305	14160	-3.89	50	SB	Tunnel Exit 13305
14160	14535	2.138	50	SB	
14535	15105	2.138	36	SB	
15105	15545	0.30	36	SB	
15545	16245	0.30	36	SB	Platform - GLEN PARK (M70)
16245	16275	0.30	36	SB	
16275	16660	0.30	50	SB	
16660	19360	-0.675	50	SB	

19360	22585	-3.12	50	SB	Vents at 19712[1],22175[2]
22585	22975	0.546	50	SB	
22975	24010	0.546	36	SB	
24010	24295	-0.30	36	SB	
24295	24995	-0.30	36	SB	Platform - 24TH ST. MISSION (M60)
24995	24998	-0.30	36	SB	
24998	25964	-0.30	50	SB	
24964	27540	-1.60	50	SB	Vents at 26139[3] and 27209[4]
27540	27914	-1.60	36	SB	
27914	28965	-0.30	36	SB	
28965	29665	-0.30	36	SB	Platform - 16TH ST. MISSION (M50)
29665	29694	-0.30	36	SB	
29694	30596	-0.30	50	SB	
30596	32346	-0.99	50	SB	Vent at 32215[5]
32346	33186	1.06	50	SB	
33186	34446	1.06	36	SB	
34446	34831	-1.00	36	SB	
34831	35531	-1.00	36	SB	Platform - CIVIC CENTER (M40)
35531	35705	-1.00	36	SB	
35705	37296	-0.316	36	SB	
37296	37494	0.70	36	SB	
37494	38194	0.70	36	SB	Platform - POWELL ST. (M30)
38194	38686	0.70	36	SB	
38686	39815	-1.00	36	SB	
39815	39845	-1.00	27	SB	
39845	40545	-1.00	27	SB	Platform - MONTGOMERY ST. (M20)
40545	40575	-1.00	27	SB	

40575	41511	-1.0	36	SB	
41511	41721	-0.60	27	SB	
41721	42421	-0.60	18	SB	Platform - EMBARCADERO (M16)
42421	42432	-0.60	18	SB	
42432	42802	-0.60	50	SB	
42802	43695	-3.05	50	SB	
43695	43854	-1.27	50	SB	
43854	45748	-1.27	80	SB	Vent at 43860[6]
45748	48682	-0.30	80	SB	End of test track at 48682

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1. Fan opening 4'1" radius circle
   Fan damper opening 8'8" square
   Surge damper 17'2" x 7'2"

2. Fan opening 4'1½" radius circle
   Fan damper opening 8'2" x 8'8"
   Surge damper 17'2" x 7'2"

3. Fan partition opening 11' x 10'6"
   Fan damper opening 8'8" square
   Surge damper 14'1" x 8'7"

4. Fan part. opening 11' x 9'3"
   Fan damper opening 8'7" square
   Surge damper 14'1" x 8'7"

5. Fan opening 4'1½" radius circle
   Fan damper opening 8'8" square
   Surge damper 14'2" x 8'8"

6. Vent shaft 14'11" x 26'7"
   Fans and other equipment in
   side chamber.

TABLE A-3

TRACK DATA
FOR
TRACK ML FROM ABOUT MP 6.00 TO DALY CITY

From	To	Grade %	Speed mph	Track type	Notes
0	2204	0.30	80	SB	
2204	2936	0.30	50	SB	
2936	4837	1.27	50	SB	Vent at 4822
4837	5003	1.27	36	SB	
5003	5889	3.05	36	SB	
5889	6259	0.60	36	SB	
6259	6270	0.60	18	SB	
6270	6970	0.60	18	SB	Platform EMBARCADERO (M16)
6970	6972	0.60	18	SB	
6972	7473	0.60	36	SB	
7473	8146	1.00	36	SB	
8146	8846	1.00	36	SB	Platform - MONTGOMERY ST. (M20)
8846	10005	1.00	36	SB	
10005	10497	-0.70	36	SB	
10497	11197	-0.70	36	SB	Platform - POWELL ST. (M30)
11197	11395	-0.70	36	SB	
11395	12986	0.316	36	SB	
12986	13160	1.00	36	SB	
13160	13860	1.00	36	SB	Platform - CIVIC CENTER (M40)
13860	13890	1.00	36	SB	
13890	14245	1.00	50	SB	

TABLE A-3 (CONTD.)

14245	16378	-1.044	50	SB	
16378	17358	0.99	50	SB	Vent at 16467
17358	18128	0.99	36	SB	
18128	19060	0.30	36	SB	
19060	19760	0.30	36	SB	Platform 16TH ST. MISSION (M50)
19760	19790	0.30	36	SB	
19790	20811	0.30	50	SB	
20811	22582	1.6	50	SB	Vents at 21473 and 22543
22582	22761	1.6	36	SB	
22761	23730	0.3	36	SB	
23730	24430	0.3	36	SB	Platform - 24TH ST.MISSION (M60)
24430	24461	0.3	36	SB	
24461	24716	0.3	50	SB	
24716	26124	-0.546	50	SB	
26124	29351	3.12	50	SB	Vents at 26507 and 28970
29351	30715	0.675	50	SB	
30715	32026	0.675	36	SB	
32026	32441	-0.30	36	SB	
32441	33141	-0.30	36	SB	Platform - GLENPARK (M70)
33141	33171	-0.30	36	SB	
33171	33581	-0.30	50	SB	
33581	34526	-2.138	50	SB	
34526	35381	3.89	50	SB	Tunnel Exit at 35381
35381	36459	3.89	50	GR	
36459	36976	3.89	36	GR	
36976	37601	-2.104	36	GR	
37601	37881	-2.104	36	SB	Tunnel Entry at 37601
37881	38516	1.00	36	SB	

TABLE A-3 (CONTD.)

38516	39216	1.00	36	SB	Platform - BALBOA PARK (M80)
39216	39294	1.00	36	SB	
39294	39636	1.00	50	SB	
39636	40426	3.198	50	SB	Tunnel Exit at 40426
40426	40686	3.198	50	GR	
40686	41826	2.116	50	GR	
41826	43625	3.50	50	GR	
43625	44187	3.50	36	GR	
44187	45412	-2.769	36	GR	
45412	46003	-2.75	27	GR	
46003	47972	-0.80	27	GR	
47972	48002	-0.80	18	GR	
48002	48702	-0.80	18	GR	Platform - DALY CITY (M90)

Refer Table A-2 for data on vent structures.

Electrical Network

There are seven rectifier substations supplied by one ac substation as shown in Figure A-3. The locations of these substations and their ratings are given in Table A-4. The full load efficiency of the rectifier substations may be assumed to be 98 percent.

A.2 TRACK DATA

The track section on the M-line between the mile posts of about 6.00 and 15.00 is used as the test track. The track MR (or M2) is for traffic from Daly City to Embarcadero and the track ML (or M1) is for traffic in the opposite direction - from Embarcadero to Daly City.

The type of track, the grade and the ATC speed limit for these tracks are presented in Tables A-3 and A-4. The length of the platforms, vent locations, tunnel portals are clearly identified. The onboard control initiates the Program Stop when the train approaches the leading edge of the platform. This Program Stop automatically brings the train to a complete stop at the platform as required irrespective of the length of the train consist. The vehicle speed is maintained within a range of (-0.75±0.5) mph and (-4.75±0.5) mph from the specified limit. The ATC speed limits given here are modified for different performance levels as shown in Table A-1.

A.3 BASELINE ENERGY CONSUMPTION TEST

A four-car instrumented train was run under non-revenue service conditions on the test track to establish some baseline data on the energy consumption of a car without regeneration. Since this train was the only train on the track, energy regenerated during vehicle braking may be assumed to be zero.

The train schedules and other data for these runs are given in Tables A-5 through A-10. This data and the data given earlier should be sufficient to predict the energy consumption of the train using computer models.

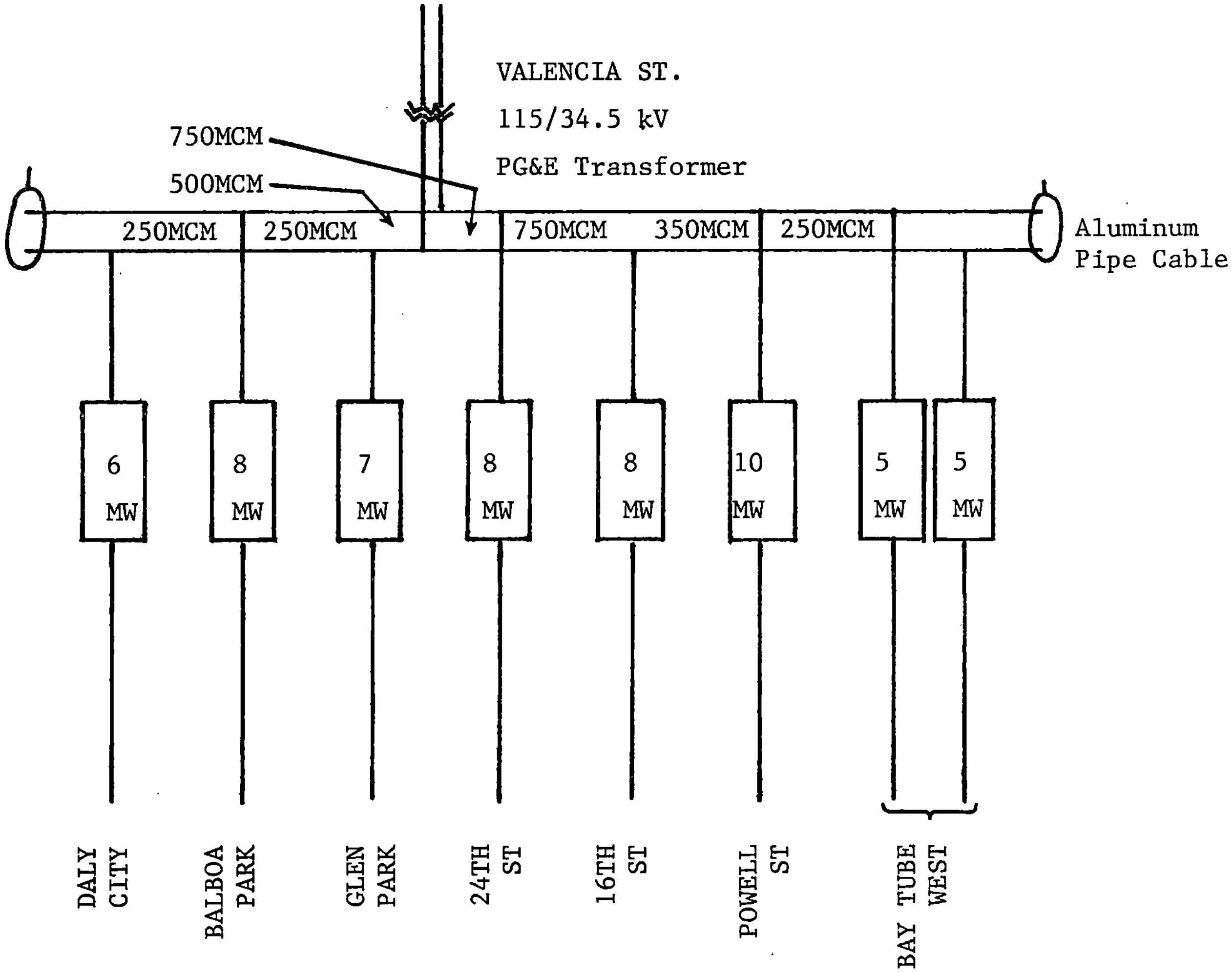

FIGURE A-3. ELECTRICAL NETWORK SCHEMATIC

TABLE A-4

ELECTRICAL SUBSTATION DATA

Substation	Type	MW/MVA	Location[1]
Daly City	DC	6	1469
Balboa Park	DC	8	9470
Glen Park	DC	7	16195
Valencia[2]	AC	50	22175
24th Street	DC	8	24963
16th Street	DC	8	29635
Powell Street	DC	10	37524
Bay Tube West	DC	10	43860

1. With reference to the Daly City end of the platform on the MR (or M2) track at the Daly City passenger station.
2. Supplies ac power input to all dc substations.

TABLE A-5

BASELINE ENERGY CONSUMPTION TEST

RUN # 1

NUMBER OF CARS 4

TRAIN WEIGHT 276,110 LBS.

STATION	ARR TIME	DEP TIME	PL
M90	-	02 29 06	2
M80	02 33 04	02 33 10	2
M70	02 35 28	02 35 35	2
M60	02 38 38	02 38 44	2
M50	02 40 38	02 40 45	2
M40	02 43 00	02 43 07	2
M30	02 44 29	02 44 36	2
M20	02 45 51	02 45 59	2
M16	02 47 06	-	2

TABLE A-6

BASELINE ENERGY CONSUMPTION TEST

RUN # 2
NUMBER OF CARS 4
TRAIN WEIGHT 276,110 LBS.

STATION	ARR TIME	DEP TIME	PL
M90	-	03 15 17	2
M80	03 26 47	03 26 53	2
M70	03 29 09	03 29 16	2
M60	03 32 19	03 32 26	2
M50	03 34 21	03 34 28	2
M40	03 36 43	03 36 50	2
M30	03 38 13	03 38 19	2
M20	03 39 35	03 39 42	2
M16	03 40 50	-	2

TABLE A-7

BASELINE ENERGY CONSUMPTION TEST

RUN # 3
NUMBER OF CARS 4
TRAIN WEIGHT 276,053 LBS.

STATION	ARR TIME	DEP TIME	PL.
M90	-	01 37 21	2
M80	01 42 07	01 42 19	2
M70	01 44 39	01 45 06	2
M60	01 48 11	01 48 38	2
M50	01 50 44	01 51 03	2
M40	01 53 23	01 53 47	2
M30	01 55 12	01 55 32	2
M20	01 56 57	01 57 07	2
M16	01 58 11	-	2

TABLE A-8

BASELINE ENERGY CONSUMPTION TEST

RUN # 4

NUMBER OF CARS 4

TRAIN WEIGHT 276,053 LBS.

STATION	ARR TIME	DEP TIME	PL.
M90	-	03 15 22	2
M80	03 20 42	03 20 50	2
M70	03 23 03	03 23 10	2
M60	03 26 09	03 26 22	2
M50	03 28 15	03 28 23	2
M40	03 30 37	03 30 47	2
M30	03 32 09	03 32 20	2
M20	03 33 35	03 33 44	2
M16	03 34 49	-	2

TABLE A-9

BASELINE ENERGY CONSUMPTION TEST

RUN # 5

NUMBER OF CARS 4

TRAIN WEIGHT 276,053 LBS.

STATION	ARR TIME	DEP TIME	PL.
M16	-	01 58 20	2
M20	02 02 38	02 02 44	2
M30	02 06 53	02 06 59	2
M40	02 08 22	02 08 29	2
M50	02 10 48	02 10 55	2
M60	02 12 49	02 12 57	2
M70	02 16 13	02 16 20	2
M80	02 18 42	02 18 48	2
M90	02 22 42	-	2

TABLE A-10

BASELINE ENERGY CONSUMPTION TEST

RUN # 6

NUMBER OF CARS 4

TRAIN WEIGHT 276,110 LBS.

STATION	ARR TIME	DEP TIME	PL.
M16	-	-	
M20	-	02 52 42	2
M30	02 56 58	02 57 07	2
M40	02 58 29	02 58 36	2
M50	03 00 53	03 01 00	2
M60	03 02 53	03 03 01	2
M70	03 06 03	03 06 11	2
M80	03 08 31	03 08 38	2
M90	03 12 30	-	

to predict the energy consumption of the train using computer models.

A.4 REGENERATION TESTS

The energy consumption of the instrumented train and at the seven substations was monitored during the evening rush hours between 3.00 P.M. and 6.00 P.M. on three days - 25 August 1981, 26 August 1981, and 1 September 1981. The instrumented train was operating in regular revenue service.

The data for the test on 25 August 1981 is organized here as follows:

Table A-11	Arrivals and departures from Daly City
Table A-12	Passenger loading data for arriving trains
Table A-13	Passenger loading data for departing trains
Table A-14	System history log for each train from BART computer

Similar data for 26 August and 1 September 1981 was provided to the industry groups, although it is not presented here.

A.4.1 ADDITIONAL COMMENTS ON THE DATA

The data presented in Tables A-11 through A-14 and the different formats are clarified below.

Arrivals and Departures from Daly City

As mentioned earlier, the test track section is approximately between the mile posts of 6.00 and 15.30 on the M-line. A train travelling from Embarcadero to Oakland West leaves the test section about 1 minute and 23 seconds after it leaves the Embarcadero station. Similarly, a train travelling from Oakland West to Embarcadero enters the test section about 1 minute 47 seconds before it arrives at the Embarcadero station. A few number of trains, such as those leaving Daly City before 3.00 P.M. and those arriving at Daly City after 6.00 P.M., are in the test track section for only part of their runs.

A very small number of trains departing from Daly City in the evening were parked there earlier in the morning. There is, therefore, no corresponding train arrival in the evening for these departing trains. This data is complete and accurate as presented in spite of such apparent anamolies.

The arrival and departure times are given in HR MN SEC format. The last two digits in the train ID number identify the length of the train. For example, a train with an ID of 115-06 has 6 cars in the consist. The test train ID was different for different days; for 25 August it was 453-06.

Passenger Loading Data

Passenger loading data for the individual trains is given separately for the arriving and the departing trains. For the arriving trains, the number of passengers given for station heading, * denotes the number of passengers on the train when the train entered the test section. These passengers were on the train when the train left the Oakland West station. The average weight of a passenger may be assumed to be 160 lbs.

System History Log Data

The central computer at BART keeps track of each train as it arrives at and departs from each passenger station on the entire system. This system history log is given here for every train that was in the test section between 3.00 P.M. and 6.00 P.M. during these tests. Only the following information on the computer printouts is required for use in computer simulations:

(a) Train ID - For most of the trains identified in this history log, the train IDs can be matched with those given in the arrival and departure data. But this may not be possible for some trains, such as those taken out of service before reaching their destinations or some transition trains. The train ID on the history log should then be ignored, and the trains matched by their arrival and departure times.

(b) Station Platform for Arrival and Departure - The passenger station and the platform number for arriving and departing trains is identified by LOC on the log sheet. The last digit 1,2, or 3 identifies the platform number and the stations on the M-line are identified as M90, M80, .. , M16. The other stations are outside the test track section, and the data for these should be ignored. The end of the test section is at about mile post 6.00, between the stations M16 (Embarcadero) and M10 (Oakland West).

(c) Arrival and Departure Times - The arrival and departure times for each of the passenger stations are given in the second and the third columns in the HR MN SEC format. For any train departing from Daly City, the time at which it leaves the test section may be obtained by adding 1 minute and 23 seconds to the time of departure from station M16. Similarly, for any train arriving at Daly City, the time at which it enters the test section may be obtained by subtracting 1 minute and 47 seconds from the time of arrival at station M16.

The arrival times at M90 (Daly City) for departing trains and the time of departure at M90 for the arriving trains should be ignored.

(d) Station Dwell - The dwell times for the trains at each station are given under the column ACT DWL. This dwell is given in seconds, and the dwell times given at the beginning and at the end of a run should be ignored.

Further, this dwell is the time interval between the opening and the closing of the car doors. Actual station dwell exceeds this ACT DWL by about 8 - 12 seconds.

(e) Performance Level - The performance level (PL) under which a train ran is given in the last column and it is between 1 and 6. The ATC speed commands are modified for different performance levels as in Table A-1.

Such a system history log was not available for a very limited number of trains. The arrival and departure times and the passenger loading data for these trains was, however, available from other computer records at BART. Blank sheets have, therefore, been added to the log data in place of complete log sheets for these trains.

TABLE A-11

ARRIVALS AND DEPARTURES FROM DALY CITY
25 AUGUST 1981

ARRIVALS		DEPARTURES	
TIME	TRAIN	TRAIN	TIME
		452-04	14 45 52
		372-05	14 50 37
		112-03	14 55 57
		454-04	15 04 22
15 03 37	115-06	375-10	15 09 28
15 08 10	456-04	115-06	15 10 31
15 13 41	377-09	456-04	15 15 40
15 18 16	117-06	377-09	15 20 37
15 22 44	459-05	117-06	15 25 29
15 28 15	379-09	459-05	15 30 38
15 33 00	119-07	379-09	15 35 24
15 38 04	441-03	119-07	15 38 05
15 41 03	361-10	441-03	15 45 42
15 48 06	101-09	361-10	15 50 30
15 53 03	443-05	101-09	15 55 32
15 58 30	363-10	443-05	16 00 37
16 04 14	103-10	363-10	16 05 38
16 08 14	445-05	103-10	16 10 29
16 13 13	365-10	445-05	16 13 50
16 16 53	105-10	365-10	16 17 30
16 21 23	387-10	105-10	16 21 25
16 23 41	447-03	387-10	16 24 36
16 27 55	367-10	447-03	16 28 39

16 33 00	107-10	367-10	16 32 36
16 37 45	449-04	107-10	16 41 26
16 47 54	369-10	389-10	16 43 20
16 50 53	109-10	449-04	16 44 10
16 56 50	451-04	369-10	16 51 15
17 00 46	371-10	109-10	16 54 34
17 03 18	111-10	451-04	16 59 16
17 06 44	§453-06	391-10	17 01 44
17 09 59	373-10	371-10	17 04 04
17 16 10	113-09	111-10	17 07 17
17 20 28	455-04	§453-06	17 13 02
17 25 57	375-10	373-10	17 18 12
17 31 49	115-06	113-09	17 22 59
17 35 44	457-05	455-04	17 28 02
17 40 49	377-09	375-10	17 33 10
17 52 40	117-06	115-06	17 38 03
17 54 48	459-03	457-05	17 42 54
17 57 42	379-09	377-09	17 48 07
18 01 00	119-07	117-06	17 53 56
18 05 49	441-05	459-03	17 58 01
18 09 54	361-10		
18 16 00	101-09		
18 20 32	443-05		

§ Instrumented Train. Add 38,588 lbs. to the weight of empty train plus the weight of the passengers.

TABLE A-12

PASSENGER LOADING DATA

25 AUGUST 1981

TRAINS ARRIVING AT M90

STATION	115-06	456-04	377-09	117-06	459-05	379-09	119-07	441-03	361-10
*	80	125	93	99	51	127	44	1	215
M16	78	125	80	83	87	107	49	2	227
M20	73	137	83	90	145	98	69	3	275
M30	64	138	84	82	196	88	75	3	287
M40	70	126	80	83	207	79	77	3	290
M50	58	117	75	71	205	69	66	3	279
M60	43	100	71	50	189	59	60	3	241
M70	30	72	62	25	173	53	47	3	198
M80	21	59	49	18	152	36	44	3	145
M90	-	-	-	-	-	-	-	-	-

TABLE A-12 (CONTD.)

	TRAINS ARRIVING AT M90								
STATION	101-09	443-05	363-10	103-10	445-05	365-10	105-10	387-10	447-03
*	106	18	220	51	7	260	133	42	5
M16	117	54	228	71	47	243	173	70	10
M20	165	91	305	86	100	271	231	125	23
M30	184	105	324	74	124	218	231	145	32
M40	199	122	329	73	133	202	251	155	41
M50	186	120	312	74	141	182	252	144	41
M60	168	106	252	74	142	126	238	125	40
M70	149	103	176	75	140	82	188	116	20
M80	123	101	90	71	140	42	151	63	20
M90	–	–	–	–	–	–	–	–	–

TABLE A-12 (CONTD.)

	TRAINS ARRIVING AT M90							
STATION	367-10	107-10	449-04	369-10	109-10	451-04	371-10	111-10
*	157	93	107	126	112	5	205	0
M16	325	138	165	161	82	31	508	23
M20	615	202	233	246	83	64	935	40
M30	707	189	264	243	71	71	1025	51
M40	783	193	289	261	53	81	1114	63
M50	749	181	277	254	48	83	1066	66
M60	639	161	261	195	44	83	934	67
M70	505	142	243	127	43	63	711	65
M80	361	106	234	70	32	63	460	54
M90	-	-	-	-	-	-	-	-

TABLE A-12 (CONTD.)

TRAINS ARRIVING AT M90

STATION	453-06	373-10	113-09	455-04	375-10	115-06	457-05	377-09
*	0	338	130	22	211	199	0	503
M16	7	555	352	100	513	246	3	773
M20	18	738	660	228	894	298	9	1269
M30	22	765	729	272	1032	263	11	1371
M40	26	803	786	295	1086	219	11	1425
M50	26	751	757	300	1023	213	11	1331
M60	26	621	684	283	834	196	9	1119
M70	26	448	570	230	624	144	9	837
M80	29	287	399	199	354	130	9	554
M90	-	-	-	-	-	-	-	-

TABLE A-12 (CONTD.)

STATION	TRAINS ARRIVING AT M90 117-06	459-03	379-09	119-07	441-05	361-10	101-09	443-05
*	10	31	86	85	12	306	69	85
M16	19	82	98	76	121	286	117	150
M20	36	203	124	73	308	293	217	232
M30	44	266	141	58	441	272	297	294
M40	45	294	124	51	467	238	315	295
M50	45	271	126	42	453	216	299	287
M60	44	219	123	37	358	192	254	242
M70	43	161	109	33	252	117	178	186
M80	43	89	104	29	224	88	111	117
M90	-	-	-	-	-	-	-	-

TABLE A-13

PASSENGER LOADING DATA

25 AUGUST 1981

TRAINS DEPARTING FROM M90

STATION	452-04	372-05	112-03	454-04	375-10	115-06	456-04	377-09
M90	27	15	12	19	22	42	0	42
M80	47	31	25	30	35	59	29	68
M70	56	40	32	41	44	68	38	74
M60	66	47	40	43	54	69	52	74
M50	71	56	43	49	75	78	60	70
M40	123	94	90	84	140	114	99	132
M30	200	158	124	124	227	163	153	161
M20	267	286	191	159	388	258	229	330
M16	340	386	260	192	498	330	307	519
*	–	–	–	–	–	–	–	–

TABLE A-13 (CONTD.)

STATION	TRAINS DEPARTING FROM M90							
	117-06	459-05	379-09	119-07	441-03	361-10	101-09	443-05
M90	0	32	16	37	16	22	18	34
M80	18	55	42	44	27	43	38	50
M70	26	65	56	52	34	52	54	57
M60	35	75	66	71	36	60	72	61
M50	50	84	77	77	44	80	84	63
M40	146	142	189	162	82	257	180	73
M30	186	179	301	228	128	445	269	70
M20	283	253	546	380	210	940	515	65
M16	383	322	727	539	247	1237	656	83
*	-	-	-	-	-	-	-	-

TABLE A-13 (CONTD.)

TRAINS DEPARTING FROM M90

STATION	363-10	103-10	445-05	365-10	105-10	387-10	447-03	367-10	107-10
M90	2	6	13	19	23	20	18	86	31
M80	3	8	19	52	56	42	41	134	47
M70	2	12	29	69	65	52	51	142	50
M60	4	18	36	87	87	67	56	169	54
M50	4	32	50	114	128	83	67	215	60
M40	24	180	66	380	369	194	176	523	128
M30	38	275	82	569	552	260	213	688	152
M20	61	631	119	1261	1004	582	327	1405	276
M16	74	993	166	1782	1546	882	405	2198	424
*	-	-	-	-	-	-	-	-	-

TABLE A-13 (CONTD.)

TRAINS DEPARTING FROM M90

STATION	389-10	449-04	369-10	109-10	451-04	391-10	371-10	111-10	453-06
M90	0	10	1	19	13	-	29	38	0
M80	8	23	1	32	15	9	37	56	12
M70	13	27	2	39	15	15	38	68	15
M60	21	35	2	46	22	20	49	74	22
M50	38	37	4	60	27	44	56	96	34
M40	148	60	2	159	49	211	141	182	125
M30	262	86	2	269	63	377	217	268	200
M20	670	154	2	615	105	836	464	518	352
M16	1087	197	1	924	125	1204	674	671	461
*	-	-	-	-	-	-	-	-	-

TABLE A-13 (CONTD.)

TRAINS DEPARTING FROM M90

STATION	373-10	113-09	455-04	375-10	115-06	457-05	377-09	117-06	459-03
M90	23	17	12	31	32	19	21	28	0
M80	38	20	26	45	44	26	35	31	5
M70	40	32	28	46	55	32	45	29	11
M60	56	47	37	53	73	33	57	34	13
M50	98	62	51	54	92	41	70	32	17
M40	214	163	100	119	183	97	163	28	36
M30	356	286	181	258	354	161	326	36	70
M20	693	493	274	581	607	228	609	52	93
M16	975	639	340	800	808	284	825	63	111
*	-	-	-	-	-	-	-	-	-

TABLE A-14

SYSTEM HISTORY LOG DATA FOR 25 AUGUST 1981

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

		TRAIN	ORIGIN	DESTINATION	DISP TIME
07 08/25/81 15:03:19	18	115-06	A90	M90	13:56:46

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	13:56:52	13:57:03	523	0	14:01:33	-13656	7	11	2
A80-2	14:02:36	14:02:46	420	0	14:07:28	82	5	11	1
A70-2	14:08:24	14:08:29	431	0	14:12:04	56	5	5	1
A65-2	14:11:44	14:11:44	3600	0	14:16:12	-20	5	0	1
A50-2	14:16:33	14:16:40	419	6	14:20:11	-21	5	7	1
A40-2	14:20:13	14:20:23	423	0	14:24:09	2	5	10	1
A30-2	14:24:07	14:24:13	432	6	14:27:08	-2	5	6	1
A20-2	14:27:03	14:27:09	423	0	14:31:18	-5	5	6	1
A10-2	14:31:21	14:31:30	428	0	14:35:56	3	5	9	1
M10-1	14:36:26	14:36:35	351	0	14:42:58	30	7	9	1
M16-1	14:42:40	14:43:05	294	0	14:44:18	-18	14	25	1
M20-1	14:44:11	14:44:24	298	0	14:45:39	-7	16	13	1
M30-1	14:45:41	14:46:03	302	0	14:47:24	2	25	22	1
M40-1	14:47:25	14:47:34	306	0	14:49:38	1	5	9	1
M50-1	14:49:43	14:49:49	280	0	14:51:40	5	5	6	1
M60-1	14:51:39	14:51:47	271	0	14:54:40	-1	5	8	1
M70-1	14:54:36	14:54:42	250	0	14:56:57	-4	5	6	1
M80-1	14:57:05	14:57:14	244	0	15:01:31	8	5	9	1
M90-2	15:03:07	0: 0: 0	0	0	0: 0: 0	96	7	11	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:08:32 18 TRAIN 456-03 ORIGIN R65 DESTINATION M90 DISP TIME 14:09:45

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	14:11:28	14:11:30	261	0	14:15:35	-12780	5	2	2
R50-2	14:15:32	14:15:39	258	0	14:18:45	-3	5	7	2
R40-2	14:18:39	14:19:05	266	0	14:22:28	-6	5	26	2
R30-2	14:22:15	14:22:22	292	0	14:24:54	-13	5	7	6
R20-2	14:24:48	14:25:04	292	0	14:27:53	-6	5	16	6
R10-2	14:27:41	14:27:48	294	0	14:31:33	-12	5	7	6
K30-4	14:31:28	14:31:48	303	0	14:35:00	-5	15	20	2
R20-2	14:34:49	14:35:21	303	0	14:36:40	-11	24	32	2
R10-2	14:36:26	14:36:55	306	0	14:40:45	-14	26	29	4
M10-1	14:40:34	14:40:46	248	0	14:47:50	-11	10	12	2
M16-1	14:47:26	14:47:57	286	0	14:49:14	-24	30	31	6
M20-1	14:49:06	14:49:52	295	0	14:51:08	-8	30	46	3
M30-1	14:51:11	14:52:04	330	0	14:53:25	3	22	53	2
M40-1	14:53:23	14:53:39	358	0	14:55:56	-2	5	16	2
M50-1	14:55:50	14:56:17	367	0	14:58:12	-6	5	27	2
M60-1	14:58:30	14:58:51	411	0	15:01:55	18	5	21	2
M70-1	15:01:48	15:01:59	432	0	15:04:22	-7	5	11	2
M80-1	15:04:14	15:04:22	429	0	15:08:48	-8	5	8	2
M90-1	15:08:10	0: 0: 0	0	0	0: 0: 0	-38	12	22	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:13:53 18 TRAIN ORIGIN DESTINATION DISP TIME
377-09 C60 M90 14:01:00

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	14:01:07	14:07:04	729	0	14:12:55	-20899	359	357	2
C50-2	14:12:39	14:12:57	849	0	14:15:57	-16	15	18	4
C40-2	14:15:44	14:15:59	854	0	14:20:48	-13	15	15	3
C30-2	14:20:34	14:20:46	850	0	14:26:12	-14	15	12	3
C20-2	14:25:54	14:26:07	847	0	14:32:30	-18	15	13	4
C10-2	14:32:31	14:32:45	875	0	14:36:02	1	10	14	2
K30-2	14:35:54	14:36:12	869	0	14:39:24	-8	15	18	2
R20-2	14:39:14	14:39:33	265	0	14:40:56	-10	23	19	6
R10-2	14:40:43	14:41:11	257	0	14:45:05	-13	30	28	6
M10-1	14:44:58	14:45:06	264	0	14:52:10	-7	10	8	2
M16-1	14:51:45	14:52:12	259	0	14:53:29	-25	30	27	6
M20-1	14:53:40	14:54:23	274	0	14:55:38	11	30	43	2
M30-1	14:55:37	14:55:55	266	0	14:57:18	-1	19	18	4
M40-1	14:57:19	14:57:25	236	0	14:59:55	1	5	6	5
M50-1	14:59:51	14:59:57	242	0	15:02:05	-4	5	6	6
M60-1	15:02:05	15:02:15	215	0	15:05:19	0	5	10	2
M70-1	15:05:11	15:05:18	204	0	15:07:57	-8	5	7	6
M80-1	15:07:53	15:07:59	219	0	15:12:30	-4	5	6	5
M90-2	15:13:41	0: 0: 0	0	0	0: 0: 0	71	7	12	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE: MO DY YR HR MN SC TASK

07 08/25/81 15:18:31 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
117-06	A90	M90	14:09:59

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-1	14:10:05	14:10:11	676	0	14:14:41	-12883	7	6	2
A80-2	14:15:18	14:15:34	488	0	14:20:43	37	5	16	2
A70-2	14:20:46	14:21:08	502	6	14:24:43	3	5	22	1
A60-2	14:24:24	14:24:24	3600	6	14:28:52	-19	5	0	1
A50-2	14:29:18	14:29:28	425	0	14:32:59	26	5	10	1
A40-2	14:32:50	14:32:58	404	0	14:36:44	-9	5	8	1
A30-2	14:36:41	14:36:52	345	0	14:39:47	-3	5	11	1
A20-2	14:39:56	14:40:08	342	0	14:44:17	9	5	12	1
A10-2	14:44:14	14:44:34	325	0	14:49:00	-3	5	20	2
M10-1	14:49:04	14:49:15	247	0	14:56:19	4	10	11	2
M16-1	14:56:25	14:56:55	280	0	14:58:08	6	30	30	2
M20-1	14:58:01	14:58:34	261	0	14:59:49	-7	30	33	2
M30-1	14:59:49	15:00:39	282	0	15:02:00	0	30	50	2
M40-1	15:02:01	15:02:12	282	0	15:04:29	1	5	11	2
M50-1	15:04:32	15:04:48	280	0	15:06:43	3	5	16	2
M60-1	15:06:44	15:06:55	279	0	15:09:59	1	5	11	2
M70-1	15:10:05	15:10:17	294	0	15:12:40	6	5	12	2
M80-1	15:12:41	15:12:51	288	0	15:17:17	1	5	10	2
M90-1	15:18:16	0: 0: 0	0	0	0: 0: 0	59	7	15	0

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:23:07 1B TRAIN ORIGIN
459-04 [illegible]65

LOC	ARR TIME	DEP TIME	HDWAY
R60-2	14:25:20	14:25:25	232
R50-2	14:29:30	14:29:43	230
R40-2	14:32:45	14:32:50	234
R30-2	14:36:14	14:36:21	240
R20-2	14:38:46	14:39:04	236
R10-2	14:41:45	14:41:51	245
K30-4	14:45:13	14:45:24	240
R20-2	14:48:31	14:48:55	228
R10-2	14:50:06	14:50:33	224
M10-1	14:54:26	14:54:38	321
M16-1	15:01:29	15:01:56	304
M20-1	15:03:07	15:03:37	306
M30-1	15:04:58	15:05:26	309
M40-1	15:06:52	15:07:04	291
M50-1	15:09:39	15:09:45	307
M60-1	15:11:57	15:12:04	313
M70-1	15:15:34	15:15:43	328
M80-1	15:18:02	15:18:09	321
M90-2	15:22:44	0: 0: 0	0

DESTINATION	DISP TIME
M90	14:23:30

STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
0	14:29:30	-11948	5	5	2
0	14:32:49	0	5	13	2
0	14:36:13	-4	5	5	2
0	14:38:47	1	5	7	2
0	14:41:45	-1	5	18	2
0	14:45:09	0	5	6	2
0	14:48:36	4	7	11	2
0	14:50:15	-5	25	24	5
0	14:54:27	-9	30	27	6
0	15:01:42	-1	10	12	2
0	15:03:13	-13	30	27	6
0	15:04:58	-6	30	30	6
0	15:06:52	0	30	28	6
0	15:09:39	0	5	12	6
0	15:11:53	0	5	6	6
0	15:15:20	4	5	7	4
0	15:18:06	14	5	9	2
0	15:22:40	-4	5	7	5
0	0: 0: 0	4	28	23	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:28:26 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
379-09	C60	M90	14:16:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-1	14:16:07	14:21:04	901	0	14:26:55	-12501	288	297	2
C50-2	14:26:57	14:27:07	858	0	14:29:52	2	7	10	2
C40-2	14:29:50	14:30:03	846	0	14:34:41	-2	12	13	2
C30-2	14:34:49	14:34:59	856	0	14:40:09	8	7	10	2
C20-2	14:40:04	14:40:25	850	0	14:46:26	-5	15	21	2
C10-2	14:48:15	14:48:27	944	0	14:51:44	109	7	12	2
K30-2	14:51:36	14:51:50	942	0	14:55:02	-8	7	14	1
K20-2	14:54:55	14:55:03	384	0	14:56:22	-7	7	8	1
K10-2	14:56:14	14:56:22	368	0	15:00:12	-8	7	8	1
M10-1	15:00:14	15:00:27	348	0	15:06:49	2	7	13	1
M16-1	15:06:35	15:06:48	306	0	15:08:01	-14	14	13	1
M20-1	15:07:55	15:08:29	288	0	15:09:44	-6	30	34	1
M30-1	15:09:45	15:10:26	287	0	15:11:47	1	30	41	1
M40-1	15:11:49	15:12:00	297	0	15:14:04	2	5	11	1
M50-1	15:14:10	15:14:14	271	0	15:16:05	6	5	4	1
M60-1	15:16:09	15:16:22	252	0	15:19:15	4	5	13	1
M70-1	15:19:12	15:19:26	218	0	15:21:41	-3	5	14	1
M80-1	15:21:40	15:21:54	218	0	15:26:11	-1	5	14	1
M90-1	15:28:15	0: 0: 0	0	0	0: 0: 0	124	7	11	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:33:09 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
119-07	A90	M90	14:24:31

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	14:24:38	14:24:56	564	0	14:29:26	-11990	7	18	2
A80-2	14:29:08	14:29:14	388	0	14:34:22	-18	5	6	2
A70-2	14:34:19	14:34:24	391	0	14:38:09	-3	5	5	2
A60-2	14:38:06	14:38:06	3600	0	14:42:34	-3	5	0	2
A50-2	14:42:51	14:42:57	404	0	14:46:59	17	5	6	4
A40-2	14:47:03	14:47:09	425	0	14:51:18	4	5	6	3
A30-2	14:51:24	14:51:32	428	0	14:54:40	6	5	8	2
A20-2	14:54:41	14:54:49	426	0	14:59:10	1	5	8	2
A10-2	14:59:16	14:59:25	428	0	15:03:53	6	5	9	6
M10-1	15:03:57	15:04:04	223	0	15:11:08	4	10	7	2
M16-1	15:11:06	15:11:34	271	0	15:12:51	-2	30	28	6
M20-1	15:12:46	15:13:14	291	0	15:14:35	-5	30	28	6
M30-1	15:14:36	15:15:05	291	0	15:16:31	1	30	29	6
M40-1	15:16:31	15:16:40	282	0	15:19:15	0	5	9	6
M50-1	15:19:17	15:19:23	307	0	15:21:31	2	5	6	6
M6 -1	15:21:38	15:21:45	329	0	15:25:07	7	5	7	5
M70-1	15:25:24	15:25:32	372	0	15:27:58	17	5	8	3
M80-1	15:28:04	15:28:11	384	0	15:32:37	6	5	7	4
M90-2	15:33:00	0: 0: 0	0	0	0: 0: 0	23	7	9	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:38:23 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
441-04	365	M90	14:38:30

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	14:40:09	14:40:20	239	0	14:44:25	-11059	5	11	2
R50-2	14:44:22	14:44:32	254	0	14:47:38	-3	5	10	2
R40-2	14:47:38	14:47:45	257	0	14:51:08	0	5	7	2
R30-2	14:51:05	14:51:12	248	0	14:53:40	-3	5	7	4
R20-2	14:53:39	14:54:02	239	0	14:56:43	-1	5	23	2
R10-2	14:56:39	14:56:50	243	0	15:00:08	-4	5	11	2
K30-4	15:00:06	15:00:22	234	0	15:03:34	-2	14	16	2
K20-2	15:03:32	15:03:59	232	0	15:05:18	-2	25	27	2
K10-2	15:05:11	15:05:34	229	0	15:09:28	-7	26	23	6
M10-1	15:09:24	15:09:32	327	0	15:16:36	-4	10	8	2
M16-1	15:16:29	15:17:16	323	0	15:18:29	-7	30	47	2
M20-1	15:18:19	15:18:56	333	0	15:20:11	-10	30	37	2
M30-1	15:20:15	15:20:55	339	0	15:22:16	4	23	40	2
M40-1	15:22:16	15:22:31	345	0	15:24:48	0	5	15	2
M50-1	15:24:45	15:24:56	328	0	15:26:56	-3	5	11	3
M60-1	15:26:51	15:27:05	313	0	15:30:15	-5	5	14	3
M70-1	15:30:14	15:30:28	290	0	15:33:07	-1	5	14	6
M80-1	15:33:10	15:33:32	306	0	15:37:58	3	5	22	2
M90-1	15:38:01	0: 0: 0	0	0	0: 0: 0	3	11	22	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:41:29 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
361-10	C60	M90	14:33:56

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C50-2	14:34:03	14:35:58	1075	0	14:41:49	-11425	113	115	2
C55-2	14:41:50	14:42:17	893	0	14:45:02	1	11	27	2
C40-2	14:45:18	14:45:29	928	0	14:50:07	16	7	11	2
C30-2	14:50:20	14:50:31	930	0	14:55:41	13	7	11	2
C20-2	14:55:41	14:55:50	937	0	15:01:51	0	7	9	2
C10-2	15:03:12	15:03:18	897	0	15:06:35	81	7	6	2
K30-2	15:06:37	15:06:52	901	0	15:10:04	2	7	15	1
R20-2	15:09:55	15:10:03	383	0	15:11:22	-9	7	8	1
R10-2	15:11:13	15:11:24	362	0	15:15:14	-9	7	11	1
M10-1	15:15:10	15:15:18	346	0	15:21:40	-4	7	8	1
M16-1	15:21:24	15:21:50	295	0	15:23:03	-16	25	26	1
M20-1	15:22:55	15:23:28	276	0	15:24:43	-8	30	33	1
M30-1	15:24:46	15:25:15	270	0	15:26:36	2	30	30	1
M40-1	15:26:37	15:26:45	261	0	15:28:49	1	5	8	1
M50-1	15:28:57	15:29:06	252	0	15:30:57	8	5	9	1
M60-1	15:30:54	15:31:07	243	0	15:34:00	-3	5	13	1
M70-1	15:33:56	15:34:03	222	0	15:36:18	-4	5	7	1
M80-1	15:36:20	15:36:31	190	0	15:40:48	2	5	11	1
M90-2	15:41:03	0: 0: 0	0	0	0: 0: 0	16	30	26	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:48:59 18 TRAIN ORIGIN DESTINATION DISP TIME

TRAIN	ORIGIN	DESTINATION	DISP TIME
101-09	A90	M90	14:38:23

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	14:38:29	14:39:26	448	0	14:43:56	-11159	52	57	2
A80-2	14:44:00	14:44:06	447	0	14:49:14	4	5	6	2
A70-2	14:49:13	14:49:20	412	0	14:53:19	-1	5	7	3
A60-2	14:53:09	14:53:09	3600	0	14:57:36	-10	5	0	3
A50-2	14:58:01	14:58:06	432	0	15:01:59	25	5	5	3
A40-2	15:02:01	15:02:10	419	6	15:06:48	2	5	9	5
A30-2	15:07:22	15:07:38	483	6	15:10:46	34	5	16	2
A20-2	15:10:50	15:10:57	494	0	15:15:18	4	5	7	2
A10-2	15:15:24	15:15:41	492	0	15:20:07	6	5	17	2
M10-1	15:20:29	15:20:34	319	0	15:27:38	22	7	5	2
M16-1	15:27:39	15:27:53	375	0	15:29:06	1	7	14	2
M20-1	15:29:20	15:29:29	385	0	15:30:44	14	7	9	2
M30-1	15:30:43	15:30:52	358	0	15:32:13	-1	7	9	2
M40-1	15:32:12	15:32:18	335	0	15:34:35	-1	5	6	2
M50-1	15:34:40	15:34:45	343	0	15:36:46	5	5	5	3
M60-1	15:36:47	15:37:01	353	0	15:40:05	1	5	14	2
M70-1	15:40:10	15:40:15	374	0	15:42:54	5	5	5	6
M80-1	15:43:03	15:43:08	403	0	15:47:34	9	5	5	4
M90-1	15:48:46	0: 0: 0	0	0	0: 0: 0	72	7	13	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE		TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81 15:53:28	1B	443-03	R65	M90	14:53:52

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	14:55:44	14:56:09	333	0	14:59:54	-10124	5	25	1
R50-2	14:59:57	15:00:05	331	0	15:02:56	3	5	8	1
R40-2	15:02:58	15:03:13	315	0	15:06:19	2	5	15	1
R30-2	15:06:17	15:06:25	304	0	15:08:51	-2	5	8	1
R20-2	15:08:54	15:09:06	304	0	15:11:47	3	5	12	1
R10-2	15:11:47	15:11:54	300	0	15:14:59	0	5	7	1
K30-4	15:15:10	15:15:26	290	0	15:18:38	11	9	16	1
K20-2	15:18:34	15:19:00	266	0	15:20:19	-4	23	26	1
K10-2	15:20:09	15:20:50	252	0	15:24:40	-10	28	41	1
M10-1	15:24:42	15:24:50	253	0	15:31:12	2	7	8	1
M16-1	15:31:07	15:31:39	208	0	15:32:52	-5	30	32	1
M20-1	15:32:45	15:33:14	205	0	15:34:29	-7	30	29	1
M30-1	15:34:30	15:35:09	227	0	15:36:30	1	30	39	1
M40-1	15:36:31	15:36:42	259	0	15:38:46	1	5	11	1
M50-1	15:38:53	15:39:01	253	0	15:40:52	7	5	8	1
M60-1	15:40:51	15:41:02	244	0	15:43:55	-1	5	11	1
M70-1	15:43:55	15:44:12	225	0	15:46:27	0	5	17	1
M80-1	15:46:27	15:46:38	204	0	15:50:56	0	5	11	1
M90-2	15:53:03	0: 0: 0	0	0	0: 0: 0	127	9	25	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE MO DY YR HR MN SC	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07 08/25/81 15:58:45	18	363-10	C60	M90	14:46:37

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	14:46:44	14:50:30	761	0	14:56:21	-10664	252	226	2
C50-2	14:56:29	14:56:43	879	0	14:59:28	8	15	14	2
C40-2	14:59:24	14:59:45	846	0	15:04:23	-4	15	21	2
C30-2	15:04:29	15:04:43	849	0	15:09:53	6	15	14	2
C20-2	15:09:50	15:10:06	849	0	15:16:07	-3	15	16	2
C10-2	15:16:00	15:16:18	768	0	15:19:35	-7	16	18	2
K30-2	15:19:38	15:19:57	781	0	15:23:09	3	15	19	2
R20-2	15:23:05	15:23:31	271	0	15:24:50	-4	26	26	2
R10-2	15:24:37	15:25:08	269	0	15:28:58	-13	30	31	2
M10-1	15:28:56	15:29:06	254	0	15:36:10	-2	10	10	2
M16-1	15:35:57	15:36:24	290	0	15:37:37	-13	30	27	2
M20-1	15:37:34	15:38:02	289	0	15:39:17	-3	30	28	2
M30-1	15:39:22	15:39:49	292	0	15:41:10	5	30	27	2
M40-1	15:41:12	15:41:25	281	0	15:43:42	2	5	13	2
M50-1	15:43:42	15:43:51	289	0	15:45:46	0	5	9	2
M60-1	15:45:45	15:45:54	294	0	15:48:58	-1	5	9	2
M70-1	15:48:58	15:49:06	303	0	15:51:29	0	5	8	2
M80-1	15:51:27	15:51:34	300	0	15:56:01	-2	5	7	2
M90-1	15:58:30	0: 0: 0	0	0	0: 0: 0	149	7	15	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE MO DY YR HR MN SC	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07 08/25/81 16:04:38	1B	103-10	A90	M90	14:54:53

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	14:55:04	14:56:16	558	0	15:00:46	-10164	7	72	2
A80-2	15:01:06	15:01:17	570	0	15:06:25	20	5	11	2
A70-2	15:06:19	15:06:28	529	6	15:10:13	-6	5	9	2
A60-2	15:10:10	15:10:10	3600	6	15:14:36	-3	5	0	2
A50-2	15:15:01	15:15:14	496	6	15:18:45	25	5	13	1
A40-2	15:18:36	15:18:42	479	6	15:22:28	-9	5	6	1
A30-2	15:22:32	15:22:43	466	6	15:25:38	4	5	11	1
A20-2	15:25:38	15:25:46	456	0	15:29:55	0	5	8	1
A10-2	15:29:57	15:30:13	438	0	15:34:39	2	5	16	1
M10-1	15:34:45	15:34:53	349	0	15:41:15	6	7	8	1
M16-1	15:45:10	15:45:27	553	0	15:46:40	235	7	17	1
M20-1	15:46:33	15:46:49	539	0	15:48:04	-7	7	16	1
M30-1	15:48:06	15:48:19	524	0	15:49:40	2	7	13	1
M40-1	15:49:42	15:49:56	510	0	15:52:00	2	5	14	1
M50-1	15:52:07	15:52:24	505	0	15:54:15	7	5	17	1
M60-1	15:54:13	15:54:24	508	0	15:57:17	-2	5	11	1
M70-1	15:57:24	15:57:34	506	0	15:59:49	7	5	10	1
M80-1	15:59:51	16:00:02	504	0	16:04:19	2	5	11	1
M90-2	16:04:14	0: 0: 0	0	0	0: 0: 0	-5	7	24	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:08:27 18 TRAIN ORIGIN DESTINATION DISP TIME

	TRAIN	ORIGIN	DESTINATION	DISP TIME
07 08/25/81 16:08:27 18	445-04	R65	M90	15:08:29

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	15:11:20	15:11:28	394	0	15:15:33	-9188	7	8	2
R50-2	15:15:23	15:15:29	366	0	15:18:35	-10	5	6	2
R40-2	15:18:33	15:18:40	363	0	15:22:03	-2	5	7	2
R30-2	15:22:01	15:22:07	364	0	15:24:33	-2	5	6	2
R20-2	15:24:31	15:24:39	359	0	15:27:20	-2	5	8	2
R10-2	15:27:18	15:27:23	351	0	15:30:41	-2	5	5	2
K30-4	15:30:43	15:30:55	342	0	15:34:07	2	7	12	2
K20-2	15:34:01	15:34:12	318	0	15:35:31	-6	7	11	2
K10-2	15:35:21	15:35:38	277	0	15:39:28	-10	20	17	4
M10-1	15:39:27	15:39:36	282	0	15:46:40	-1	10	9	2
M16-1	15:47:05	15:47:26	115	0	15:48:39	25	7	21	2
M20-1	15:48:35	15:48:52	122	0	15:50:08	-4	17	17	3
M30-1	15:50:21	15:50:35	135	0	15:51:59	13	17	14	5
M40-1	15:51:57	15:52:04	135	0	15:54:39	-2	5	7	6
M50-1	15:54:36	15:54:44	149	0	15:56:52	-3	5	8	6
M60-1	15:56:53	15:56:59	160	0	16:00:15	1	5	6	4
M70-1	16:00:28	16:00:38	184	0	16:03:07	13	5	10	4
M80-1	16:03:10	16:03:20	199	0	16:07:46	3	5	10	4
M90-1	16:08:14	0: 0: 0	0	0	0: 0: 0	28	7	13	0

ENERGY CONSUMPTION TEST NO, 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE MO DY YR HR MN SC	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07 08/25/81 16:13:27	1B	365-10	C60	M90	15:01:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	15:01:08	15:04:38	864	0	15:10:29	-9800	212	210	2
C50-2	15:10:20	15:10:35	831	0	15:13:20	-9	15	15	2
C40-2	15:13:28	15:13:44	844	0	15:18:22	8	15	16	2
C30-2	15:18:39	15:18:53	850	0	15:24:03	17	7	14	2
C20-2	15:24:02	15:24:08	852	0	15:30:09	-1	7	6	2
C10-2	15:30:06	15:30:16	846	0	15:33:33	-3	10	10	2
K30-2	15:33:38	15:33:56	840	0	15:37:08	5	7	18	2
R20-2	15:37:09	15:37:21	189	0	15:38:40	1	11	12	2
R10-2	15:38:53	15:39:06	212	0	15:42:56	13	12	13	2
M10-1	15:43:09	15:43:22	222	0	15:50:26	13	7	13	2
M16-1	15:50:23	15:50:38	198	0	15:51:51	-3	11	15	2
M20-1	15:51:45	15:52:22	190	0	15:53:37	-6	30	37	2
M30-1	15:53:39	15:53:59	198	0	15:55:20	2	23	20	2
M40-1	15:55:33	15:55:42	217	0	15:57:59	13	5	9	2
M50-1	15:57:59	15:58:05	203	0	16:00:00	0	5	6	2
M60-1	16:00:03	16:00:18	190	0	16:03:22	3	5	15	2
M70-1	16:03:21	16:03:29	173	0	16:05:52	-1	5	8	2
M80-1	16:05:53	16:06:00	163	0	16:10:26	1	5	7	2
M90-2	16:13:13	0: 0: 0	0	0	0: 0: 0	187	7	13	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE: MO DY YR HR MN SC TASK

07 08/25/81 16:17:11 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
105-10	A90	M90	15:07:13

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	14:08:20	15:07:16	454	0	15:12:30	-12968	7	3536	1
A80-2	15:12:46	15:12:58	205	0	15:17:40	16	5	12	1
A70-2	15:17:36	15:17:48	191	0	15:21:23	-4	5	12	1
A60-2	15:24:54	15:24:54	3600	0	15:29:20	211	5	0	1
A50-2	15:29:40	15:29:53	424	0	15:33:24	20	5	13	1
A40-2	15:33:07	15:33:15	412	0	15:37:01	-17	5	8	1
A30-2	15:36:52	15:37:01	395	0	15:39:56	-9	5	9	1
A20-2	15:39:52	15:40:05	372	0	15:44:14	-4	5	13	1
A10-2	15:44:03	15:44:16	358	0	15:48:42	-11	5	13	1
M10-1	15:48:35	15:48:48	327	0	15:55:10	-7	7	13	1
M16-1	15:54:45	15:54:59	262	0	15:56:12	-25	7	14	1
M20-1	15:56:05	15:56:24	260	0	15:57:39	-7	8	19	1
M30-1	15:57:39	15:57:56	240	0	15:59:17	0	19	17	1
M40-1	15:59:17	15:59:24	223	0	16:01:28	0	5	7	1
M50-1	16:01:34	16:01:40	215	0	16:03:31	6	5	6	1
M60-1	16:03:30	16:03:37	207	0	16:06:30	-1	5	7	1
M70-1	16:06:26	16:06:36	185	0	16:08:51	-4	5	10	1
M80-1	16:08:47	16:08:55	174	0	16:13:12	-4	5	8	1
M90-1	16:16:53	0: 0: 0	0	0	0: 0: 0	221	7	18	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE		TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81 16:21:42	1B	387-10	C60	M90	15:09:34

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	15:09:40	15:11:59	513	0	15:17:50	-9288	150	139	2
C50-2	15:18:15	15:18:27	475	0	15:21:12	25	7	12	2
C40-2	15:24:15	15:24:21	647	0	15:28:32	183	7	6	1
C30-2	15:28:42	15:28:50	604	0	15:33:35	10	7	8	1
C20-2	15:34:06	15:34:20	604	0	15:39:52	31	7	14	1
C10-2	15:40:52	15:40:59	646	0	15:44:12	60	7	7	1
K30-2	15:45:10	15:45:25	692	0	15:48:37	58	7	15	1
R20-2	15:48:29	15:48:41	415	0	15:50:00	-8	7	12	1
R10-2	15:49:47	15:50:08	396	0	15:53:58	-13	7	21	1
M10-1	15:54:39	15:54:47	363	0	16:01:09	41	7	8	1
M16-1	16:01:00	16:01:18	375	0	16:02:31	-9	7	18	1
M20-1	16:02:23	16:02:45	378	0	16:04:00	-8	7	22	1
M30-1	16:04:02	16:04:17	383	0	16:05:38	2	7	15	1
M40-1	16:05:39	16:05:49	382	0	16:07:53	1	5	10	1
M50-1	16:08:01	16:08:09	387	0	16:10:00	8	5	8	1
M60-1	16:10:01	16:10:08	391	0	16:13:01	1	5	7	1
M70-1	16:13:05	16:13:16	399	0	16:15:32	4	5	11	1
M80-1	16:15:32	16:15:40	406	0	16:19:57	0	5	8	1
M90-2	16:21:23	0:0:0	0	0	0:0:0	86	7	19	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:24:01 1B	TRAIN	ORIGIN	DESTINATION	DISP TIME
	447-03	R65	M90	15:24:40

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	15:27:21	15:27:46	560	0	15:31:31	-8227	7	25	1
R50-2	15:31:32	15:31:42	558	0	15:34:33	1	5	10	1
R40-2	15:34:33	15:34:41	545	0	15:37:47	0	5	8	1
R30-2	15:37:47	15:37:53	529	0	15:40:19	0	5	6	1
R20-2	15:40:23	15:40:39	523	0	15:43:20	4	5	16	1
R10-2	15:43:19	15:43:32	524	0	15:46:37	-1	5	13	1
K30-4	15:46:43	15:46:58	514	0	15:50:11	6	7	15	1
R20-2	15:51:00	15:51:09	151	0	15:52:28	49	7	9	1
R10-2	15:52:30	15:52:55	164	0	15:56:45	2	7	25	1
M10-1	15:56:45	15:56:54	126	0	16:03:16	0	7	9	1
M16-1	16:03:10	16:03:45	130	0	16:04:58	-6	7	35	1
M20-1	16:04:51	16:06:00	148	0	16:07:15	-7	7	69	1
M30-1	16:07:15	16:08:06	193	0	16:09:27	0	7	51	1
M40-1	16:09:27	16:09:46	228	0	16:11:50	0	5	19	1
M50-1	16:11:57	16:12:02	236	0	16:13:53	7	5	5	1
M60-1	16:13:55	16:14:06	234	0	16:16:59	2	5	11	1
M70-1	16:16:58	16:17:08	233	0	16:19:23	-1	5	10	1
M80-1	16:19:24	16:19:34	231	0	16:23:51	1	5	10	1
M90-1	16:23:41	0: 0: 0	0	0	0: 0: 0	-10	7	20	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:28:12 18 TRAIN ORIGIN DESTINATION DISP TIME

TRAIN	ORIGIN	DESTINATION	DISP TIME
367-10	C60	M90	15:16:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	15:16:08	15:19:47	327	0	15:25:38	-8900	212	219	2
C50-2	15:25:32	15:25:44	437	0	15:28:29	-6	15	12	2
C40-2	15:28:30	15:28:43	255	0	15:33:21	1	15	13	2
C30-2	15:33:22	15:33:34	279	0	15:38:44	1	15	12	2
C20-2	15:38:44	15:38:56	278	0	15:45:04	0	15	12	3
C10-2	15:46:07	15:46:14	315	0	15:49:31	63	7	7	2
K30-2	15:49:34	15:49:45	264	0	15:52:57	3	7	11	2
R20-2	15:53:36	15:53:43	156	0	15:55:02	39	7	7	2
R10-2	15:55:23	15:55:31	172	0	15:59:21	21	7	8	2
M10-1	15:59:26	15:59:34	161	0	16:06:38	5	7	8	2
M16-1	16:06:29	16:06:49	200	0	16:08:02	-9	7	20	2
M20-1	16:07:56	16:08:11	185	0	16:09:26	-6	7	15	2
M30-1	16:10:10	16:10:18	175	0	16:11:39	44	7	8	2
M40-1	16:11:42	16:11:55	135	0	16:14:25	3	5	13	5
M50-1	16:14:28	16:14:35	151	0	16:16:43	3	5	7	6
M60-1	16:16:51	16:17:00	176	0	16:20:04	8	5	9	2
M70-1	16:20:07	16:20:13	189	0	16:22:36	3	5	6	2
M80-1	16:22:39	16:22:47	195	0	16:27:13	3	5	8	2
M90-2	16:27:55	10:30:[illegible]	[illegible]	0	0: 0: 0	42	7	17	0

DATE	:	25 AUGUST 1981
TRAIN ID	:	107-10
ARRIVAL TIME	:	16 33 00

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:38:15 1B   TRAIN 449-03   ORIGIN R65

LOC	ARR TIME	DEP TIME	HDWAY
R60-2	15:42:07	15:42:52	427
R50-2	15:46:31	15:46:45	440
R40-2	15:49:49	15:49:54	440
R30-2	15:52:58	15:53:07	434
R20-2	15:55:29	15:55:52	432
R10-2	15:58:27	15:58:44	435
K30-4	16:01:48	16:02:11	438
R20-2	16:05:12	16:05:24	416
R10-2	16:06:31	16:06:57	380
M10-1	16:10:39	16:10:48	673
M16-1	16:16:50	16:17:38	620
M20-1	16:18:42	16:19:35	646
M30-1	16:20:49	16:21:47	639
M40-1	16:23:07	16:23:30	685
M50-1	16:25:44	16:25:58	676
M60-1	16:27:49	16:28:06	658
M70-1	16:31:07	16:31:26	661
M80-1	16:33:45	16:34:01	666
M90-2	16:37:45	0: 0: 0	0

DESTINATION	DISP TIME
M90	15:40:34

STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
0	15:46:37	-7341	7	45	1
0	15:49:36	-6	5	14	1
0	15:53:00	13	5	5	1
0	15:55:33	-2	5	9	1
0	15:58:33	-4	5	23	1
0	16:01:49	-6	5	17	1
0	16:05:23	-1	7	23	1
0	16:06:43	-11	7	12	1
0	16:10:47	-12	7	26	1
0	16:17:10	-8	7	9	1
0	16:18:51	-20	7	48	2
0	16:20:50	-9	7	53	2
0	16:23:08	-1	7	58	2
0	16:25:47	-1	5	23	2
0	16:27:53	-3	5	14	2
0	16:31:10	-4	5	17	2
0	16:33:49	-3	5	19	2
0	16:38:27	-4	5	16	2
0	0: 0: 0	-42	27	30	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:48:05 1B TRAIN ORIGIN DESTINATION DISP TIME
369-10 C60 M90 15:31:34

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	15:31:41	15:34:46	933	0	15:40:37	-7967	180	185	2
C50-2	15:40:19	15:40:31	887	0	15:43:31	-18	15	12	4
C40-2	15:43:21	15:43:34	891	0	15:48:23	-10	15	13	3
C30-2	15:48:19	15:48:32	897	0	15:53:42	-4	15	13	2
C20-2	15:53:32	15:53:44	888	0	15:59:52	-10	15	12	3
C10-2	15:59:36	16:00:00	809	0	16:03:31	-16	26	24	6
K30-2	16:03:24	16:03:42	830	0	16:06:56	-7	15	18	4
K20-2	16:07:39	16:07:47	147	0	16:09:06	43	7	8	2
K10-2	16:09:38	16:09:46	187	0	16:13:36	32	7	8	2
M10-1	16:14:45	16:14:53	121	0	16:21:57	69	10	8	2
M16-1	16:22:49	16:23:03	127	0	16:24:16	52	7	14	2
M20-1	16:24:21	16:24:35	119	0	16:25:50	5	7	14	2
M30-1	16:26:09	16:26:16	133	0	16:27:37	19	7	7	2
M40-1	16:27:44	16:27:51	132	0	16:30:21	7	5	7	5
M50-1	16:30:18	16:30:24	132	0	16:32:32	-3	5	6	6
M60-1	16:32:38	16:32:46	143	0	16:35:56	6	5	8	3
M70-1	16:35:52	16:35:59	143	0	16:38:28	-4	7	7	4
M80-1	16:38:56	16:39:04	174	0	16:43:30	28	7	8	2
M90-1	16:47:54	0: 0: 0	0	0	0: 0: 0	264	7	11	0

343

ENERGY CONSUMPTION TEST NO, 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:51:20 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
109-10	A90	M90	15:36:05

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	15:36:12	15:36:57	584	0	15:41:27	-7696	39	45	2
A80-2	15:41:08	15:41:19	450	0	15:46:33	-19	5	11	3
A70-2	15:48:39	15:51:02	490	0	15:54:47	126	0	143	2
A60-2	16:00:12	16:00:12	3600	0	16:04:38	325	5	0	2
A50-2	16:04:56	16:05:15	291	0	16:08:46	18	5	19	1
A40-2	16:08:36	16:08:50	303	0	16:12:36	-10	5	14	1
A30-2	16:12:30	16:12:42	311	0	16:15:37	-6	5	12	1
A20-2	16:15:33	16:15:48	313	0	16:19:57	-4	5	15	1
A10-2	16:19:48	16:20:01	315	0	16:24:27	-9	5	13	1
M10-1	16:24:25	16:24:57	580	0	16:31:19	-2	7	32	1
M16-1	16:31:00	16:31:24	491	0	16:32:37	-19	7	24	1
M20-1	16:32:30	16:32:55	489	0	16:34:10	-7	7	25	1
M30-1	16:34:11	16:34:28	482	0	16:35:49	1	7	17	1
M40-1	16:35:49	16:36:02	485	0	16:38:06	0	5	13	1
M50-1	16:38:10	16:38:22	472	0	16:40:13	4	5	12	1
M60-1	16:40:08	16:40:22	450	0	16:43:15	-5	5	14	1
M70-1	16:43:09	16:43:26	437	0	16:45:41	-6	7	17	1
M80-1	16:45:38	16:45:55	402	0	16:50:12	-3	7	17	1
M90-2	16:50:53	0: 0: 0	0	0	0: 0: 0	41	7	26	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE MO DY YR HR MN SC TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07 08/25/81 16:57:22 1B	451-05	R65	M90	15:58:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	15:59:53	15:59:58	521	0	16:04:03	-6275	5	5	2
R50-2	16:04:04	16:04:12	518	0	16:07:03	1	5	8	1
R40-2	16:07:05	16:07:15	503	0	16:10:21	2	5	10	1
R30-2	16:10:18	16:10:25	486	0	16:12:51	-3	5	7	1
R20-2	16:12:56	16:13:15	487	0	16:15:56	5	5	19	1
R10-2	16:15:51	16:15:59	481	0	16:19:05	-5	5	8	1
K30-4	16:19:07	16:19:21	463	0	16:22:33	2	10	14	1
K20-2	16:22:24	16:22:39	444	0	16:23:58	-9	10	15	1
K10-2	16:23:47	16:24:00	418	0	16:27:50	-11	10	13	1
M10-1	16:27:45	16:27:55	200	0	16:34:18	-5	10	10	1
M16-1	16:34:01	16:34:41	182	0	16:35:54	-17	10	40	1
M20-1	16:35:46	16:36:21	196	0	16:37:36	-8	10	35	1
M30-1	16:37:36	16:37:59	205	0	16:39:20	0	10	23	1
M40-1	16:39:20	16:39:36	211	0	16:41:40	0	5	16	1
M50-1	16:41:44	16:41:52	214	0	16:43:43	4	5	8	1
M60-1	16:43:43	16:43:52	215	0	16:46:45	0	5	9	1
M70-1	16:46:45	16:46:56	216	0	16:49:11	0	10	11	1
M80-1	16:49:09	16:49:19	211	0	16:53:37	-2	10	10	1
M90-2	16:56:50	0: 0: 0	0	0	0: 0: 0	193	10	31	0

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:01:07 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
371-10	C60	M90	15:46:00

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	15:46:07	15:49:47	867	0	15:55:38	-7101	213	220	2
C50-2	15:55:21	15:55:33	902	0	15:58:24	-17	15	12	3
C40-2	15:58:26	15:58:40	905	0	16:03:19	2	15	14	2
C30-2	16:03:15	16:03:27	896	0	16:08:37	-4	15	12	2
C20-2	16:08:28	16:08:42	897	0	16:15:05	-9	15	14	4
C10-2	16:15:11	16:15:19	935	0	16:18:36	6	7	8	2
K30-2	16:19:13	16:20:48	949	0	16:24:00	37	7	95	2
R20-2	16:25:01	16:25:11	157	0	16:26:30	61	7	10	2
R10-2	16:26:35	16:26:43	168	0	16:30:33	5	7	8	1
M10-1	16:30:35	16:30:41	170	0	16:37:03	2	7	6	1
M16-1	16:36:53	16:37:13	171	0	16:38:27	-10	7	20	1
M20-1	16:38:22	16:38:40	156	0	16:39:55	-5	7	18	1
M30-1	16:40:04	16:40:18	148	0	16:41:39	9	7	14	1
M40-1	16:41:41	16:41:48	141	0	16:43:52	2	5	7	1
M50-1	16:44:02	16:44:11	138	0	16:46:02	10	5	9	1
M60-1	16:46:04	16:46:12	141	0	16:49:05	2	5	8	1
M70-1	16:49:06	16:49:16	141	0	16:51:31	1	7	10	1
M80-1	16:51:33	16:51:43	144	0	16:56:00	2	12	10	1
M90-1	17:00:46	0: 0: 0	0	0	0: 0: 0	286	7	21	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:03:45 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
111-10	A90	M90	15:50:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-1	15:50:07	15:52:30	326	0	15:57:00	-6861	103	143	2
A80-2	15:57:09	15:57:18	333	0	16:02:26	9	5	9	2
A70-2	16:02:13	16:03:20	331	0	16:06:55	-13	7	67	1
A60-2	16:11:48	16:11:48	3600	0	16:16:14	293	5	0	1
A50-2	16:16:32	16:16:39	241	0	16:20:10	18	5	7	1
A40-2	16:19:52	16:20:03	233	0	16:23:49	-18	5	11	1
A30-2	16:23:34	16:23:50	202	0	16:26:45	-15	5	16	1
A20-2	16:26:42	16:26:52	173	0	16:31:01	-3	5	10	1
A10-2	16:32:36	16:32:45	267	0	16:37:11	95	7	9	1
M10-1	16:36:47	16:36:47	170	0	16:44:01	-24	7	0	1
M16-1	16:44:03	15:44:26	430	0	16:45:39	2	7	23	1
M20-1	16:45:36	16:46:04	434	0	16:47:19	-3	7	28	1
M30-1	16:47:22	16:47:42	438	0	16:49:03	3	7	20	1
M40-1	16:49:04	16:49:21	443	0	16:51:25	1	5	17	1
M50-1	16:51:28	16:51:38	446	0	16:53:29	3	5	10	1
M60-1	16:53:23	16:53:37	439	0	16:56:30	-6	5	14	1
M70-1	16:56:22	16:56:41	436	0	16:58:56	-8	7	19	1
M80-1	16:58:53	16:59:06	440	0	17:03:23	-3	7	13	1
M90-2	17:03:18	0: 0: 0	0	0	0: 0: 0	-5	7	27	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:07:00 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
453-04	R65	M90	16:06:23

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	F
R60-2	16:08:27	16:08:36	278	0	16:12:41	-5761	5	9	2
R50-2	16:12:38	16:12:46	286	0	16:15:52	-3	5	8	2
R40-2	16:16:01	16:16:10	245	0	16:19:33	9	5	9	2
R30-2	16:19:28	16:19:35	250	0	16:22:01	-5	5	7	2
R20-2	16:22:00	16:22:08	247	0	16:24:49	-1	5	8	2
R10-2	16:24:44	16:24:53	204	0	16:28:11	-5	5	9	2
K30-4	16:28:14	16:28:28	208	0	16:31:40	3	7	14	2
R20-2	16:31:35	16:31:44	204	0	16:33:03	-5	7	9	2
R10-2	16:32:51	16:33:13	176	0	16:37:03	-12	20	22	2
M10-1	16:38:54	16:39:14	499	0	16:46:18	111	10	20	2
M16-1	16:46:19	16:46:43	136	0	16:47:56	1	7	24	1
M20-1	16:47:51	16:48:10	135	0	16:49:25	-5	7	19	1
M30-1	16:49:40	16:49:52	138	0	16:51:13	15	7	12	1
M40-1	16:51:14	16:51:25	130	0	16:53:29	1	5	11	1
M50-1	16:53:39	16:53:46	131	0	16:55:37	10	5	7	1
M60-1	16:55:40	16:55:48	137	0	16:58:41	3	5	8	1
M70-1	16:58:53	16:59:00	151	0	17:01:15	12	7	7	1
M80-1	17:01:22	17:01:46	149	0	17:06:03	7	25	24	1
M90-1	17:06:44	0: 0: 0	0	0	0: 0: 0	41	7	16	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE		TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81 17:10:17	18	373-10	C60	M90	16:01:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-1	16:01:08	16:05:38	900	0	16:11:29	-6200	138	270	2
C50-2	16:12:41	16:12:49	1040	0	16:15:22	72	7	8	1
C40-2	16:15:23	16:15:32	1017	0	16:19:43	1	7	9	1
C30-2	16:19:37	16:19:44	982	0	16:24:29	-6	7	7	1
C20-2	16:24:22	16:24:33	953	0	16:30:05	-7	7	11	1
C10-2	16:29:43	16:29:51	873	0	16:33:08	-22	7	8	2
K30-2	16:33:01	16:33:14	828	0	16:36:26	-7	7	13	2
R20-2	16:36:15	16:36:25	280	0	16:37:44	-11	7	10	2
R10-2	16:37:41	16:37:52	290	0	16:41:42	-3	9	11	2
M10-1	16:41:30	16:41:39	156	0	16:48:43	-12	10	9	2
M16-1	16:48:33	16:48:59	134	0	16:50:16	-10	30	26	6
M20-1	16:50:24	16:50:55	153	0	16:52:16	8	30	31	6
M30-1	16:52:17	16:52:45	157	0	16:54:08	1	30	28	4
M40-1	16:54:11	16:54:19	177	0	16:56:49	3	5	8	5
M50-1	16:56:46	16:56:58	187	0	16:59:02	-3	5	12	5
M60-1	16:59:04	16:59:12	204	0	17:02:28	2	5	8	4
M70-1	17:02:35	17:02:51	222	0	17:05:17	7	19	16	3
M80-1	17:05:15	17:05:29	233	0	17:09:55	-2	15	14	4
M90-2	17:09:59	0: 0: 0	0	0	0: 0: 0	4	22	17	0

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:16:38 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
113-09	A90	M90	16:05:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-1	16:05:07	16:06:51	340	0	16:11:21	-5991	104	104	2
A80-2	16:11:40	16:11:45	331	0	16:16:53	19	5	5	2
A70-2	16:16:42	16:17:11	313	0	16:20:56	-11	0	29	2
A60-2	16:21:34	16:21:34	3600	0	16:26:01	38	5	0	2
A50-2	16:26:17	16:26:23	332	0	16:30:22	16	5	6	2
A40-2	16:30:00	16:30:07	327	0	16:34:09	-22	5	7	2
A30-2	16:34:05	16:38:40	318	0	16:41:35	-4	5	275	1
A20-2	16:41:31	16:41:40	553	0	16:45:49	-4	5	9	1
A10-2	16:45:41	16:45:55	530	0	16:50:21	-8	7	14	1
M10-1	16:50:19	16:50:29	529	0	16:56:51	-2	7	10	1
M16-1	16:56:31	16:57:01	478	0	16:58:14	-20	7	30	1
M20-1	16:58:06	16:58:39	462	0	16:59:54	-8	7	33	1
M30-1	16:59:59	17:00:21	462	0	17:01:42	5	7	22	1
M40-1	17:01:42	17:01:59	451	0	17:04:03	0	5	17	1
M50-1	17:04:07	17:04:14	441	0	17:06:05	4	5	7	1
M60-1	17:06:02	17:06:19	418	0	17:09:12	-3	5	17	1
M70-1	17:09:07	17:09:19	392	0	17:11:34	-5	7	12	1
M80-1	17:11:32	17:11:43	377	0	17:16:00	-2	7	11	1
M90-1	17:16:10	0: 0: 0	0	0	0: 0: 0	10	7	27	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:20:48 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
455-04	R65	M90	16:21:57

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	16:23:41	16:23:44	312	0	16:27:49	-4847	5	3	2
R50-2	16:27:44	16:27:52	302	0	16:30:58	-5	5	8	2
R40-2	16:30:49	16:30:58	293	0	16:34:21	-9	5	9	2
R30-2	16:34:08	16:34:14	284	0	16:36:40	-13	5	6	2
R20-2	16:36:36	16:36:52	280	0	16:39:33	-4	5	16	2
R10-2	16:39:23	16:39:37	271	0	16:42:55	-10	5	14	2
K30-4	16:42:50	16:43:02	268	0	16:46:14	-5	7	12	2
K20-2	16:46:04	16:46:25	256	0	16:47:45	-10	22	21	5
K10-2	16:47:34	16:48:02	245	0	16:51:56	-11	30	28	6
M10-1	16:52:41	16:52:50	142	0	16:59:54	45	7	9	2
M1K-1	16:59:30	17:00:12	179	0	17:01:25	-24	10	42	2
M20-1	17:01:15	17:01:41	189	0	17:02:56	-10	8	26	2
M30-1	17:02:57	17:03:20	178	0	17:04:41	1	10	23	2
M40-1	17:04:39	17:04:54	177	0	17:07:11	-2	5	15	2
M50-1	17:07:06	17:07:15	179	0	17:09:23	-5	5	9	6
M60-1	17:09:18	17:09:26	196	0	17:12:48	-5	5	8	5
M70-1	17:12:53	17:13:12	226	0	17:15:38	5	22	19	3
M80-1	17:15:33	17:15:48	241	0	17:20:14	-5	18	15	4
M90-2	17:20:28	0: 0: 0	0	0	0: 0: 0	14	14	19	0

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:26:16 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
375-10	C60	M90	16:16:19

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	16:15:25	16:19:51	917	0	16:25:42	-5283	121	206	2
C50-2	16:25:41	16:25:49	780	0	16:28:34	-1	7	8	2
C40-2	16:28:36	16:28:49	793	0	16:33:27	2	7	13	2
C30-2	16:33:31	16:33:43	834	0	16:38:28	4	7	12	1
C20-2	16:38:31	16:38:45	849	0	16:44:17	3	7	14	1
C10-2	16:44:12	16:44:23	868	0	16:47:36	-5	7	11	1
K30-2	16:47:34	16:47:49	874	0	16:51:02	-2	7	15	1
R20-2	16:50:57	16:51:08	292	0	16:52:27	-5	9	11	1
R10-2	16:52:14	16:52:43	280	0	16:56:33	-13	30	29	1
M10-1	16:56:35	16:56:46	234	0	17:03:08	2	10	11	1
M16-1	17:03:00	17:03:32	210	0	17:04:45	-8	30	32	1
M20-1	17:04:37	17:05:10	202	0	17:06:25	-8	30	33	1
M30-1	17:06:25	17:06:55	208	0	17:08:16	0	30	30	1
M40-1	17:08:18	17:08:38	219	0	17:10:42	2	5	20	1
M50-1	17:10:49	17:11:00	223	0	17:12:51	7	5	11	1
M60-1	17:12:49	17:13:05	211	0	17:15:58	-2	5	16	1
M70-1	17:15:58	17:16:30	186	0	17:18:45	0	30	32	1
M80-1	17:18:44	17:19:14	191	0	17:23:31	-1	30	30	1
M90-1	17:25:57	0: 0: 0	0	0	0: 0: 0	146	7	19	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:32:25 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
115-06	A90	M90	16:22:12

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	16:22:18	16:22:40	639	0	16:27:10	-4930	7	22	2
A80-2	16:26:48	16:26:56	427	0	16:32:04	-22	5	8	2
A70-2	16:31:56	16:32:07	425	0	16:35:52	-8	10	11	2
A60-2	16:36:01	16:36:01	3600	0	16:40:29	9	5	0	2
A50-2	16:40:52	16:41:00	449	0	16:44:59	23	5	8	2
A40-2	16:44:34	16:44:50	447	0	16:48:52	-25	5	16	2
A30-2	16:49:05	16:51:35	474	0	16:54:43	13	5	150	2
A20-2	16:54:49	16:55:25	589	0	16:59:35	6	5	36	1
A10-2	16:59:35	17:00:09	598	0	17:04:36	0	7	34	1
M10-1	17:04:51	17:05:07	496	0	17:11:29	15	7	16	1
M16-1	17:11:12	17:11:46	492	0	17:12:59	-17	7	34	1
M20-1	17:12:51	17:13:29	495	0	17:14:44	-8	7	38	1
M30-1	17:14:45	17:15:17	500	0	17:16:38	1	7	32	1
M40-1	17:16:39	17:17:08	501	0	17:19:12	1	5	29	1
M50-1	17:19:15	17:19:40	506	0	17:21:31	3	5	25	1
M60-1	17:21:26	17:21:49	517	0	17:24:42	-5	5	23	1
M70-1	17:24:39	17:25:21	520	0	17:27:36	-3	7	42	1
M80-1	17:27:34	17:27:59	530	0	17:32:16	-2	7	25	1
M90-2	17:31:49	0: 0: 0	0	0	0: 0: 0	-27	7	36	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:36:17 1B TRAIN 457-04 ORIGIN R65 DESTINATION M90 DISP TIME 16:35:59

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	16:37:43	16:37:56	356	0	16:42:01	-4005	5	13	2
R50-2	16:41:57	16:42:13	359	0	16:45:19	-4	5	16	2
R40-2	16:45:15	16:45:22	365	0	16:48:45	-4	5	7	2
R30-2	16:48:42	16:48:51	362	0	16:51:17	-3	5	9	2
R20-2	16:51:14	16:51:25	357	0	16:54:06	-3	5	11	2
R10-2	16:54:02	16:54:17	347	0	16:57:36	-4	5	15	2
K30-4	16:57:37	16:57:57	346	0	17:01:09	1	13	20	2
K20-2	17:01:05	17:01:24	349	0	17:02:44	-4	22	19	5
K10-2	17:02:37	17:03:04	336	0	17:06:58	-7	29	27	6
M1 -1	17:07:06	17:07:16	135	0	17:14:20	8	7	10	2
M16-1	17:14:08	17:14:35	176	0	17:15:52	-12	27	27	6
M20-1	17:15:46	17:16:29	174	0	17:17:44	-6	30	43	2
M30-1	17:17:44	17:18:11	179	0	17:19:32	0	24	27	2
M40-1	17:19:34	17:19:47	175	0	17:22:17	2	5	13	5
M50-1	17:22:16	17:22:26	181	0	17:24:34	-1	5	10	6
M60-1	17:24:34	17:24:47	188	0	17:27:51	0	5	13	2
M70-1	17:27:49	17:28:11	190	0	17:30:40	-2	25	22	4
M80-1	17:30:43	17:30:59	189	0	17:35:25	3	8	16	2
M90-1	17:35:44	0: 0: 0	0	0	0: 0: 0	19	7	33	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:41:10 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
377-09	C60	M90	16:31:11

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	16:31:18	16:33:37	893	0	16:39:28	-4390	128	139	2
C50-2	16:39:04	16:39:20	803	0	16:42:10	-24	15	16	3
C40-2	16:42:04	16:42:21	808	0	16:47:10	-6	15	17	3
C30-2	16:46:59	16:47:16	809	0	16:52:26	-11	15	17	2
C20-2	16:52:13	16:52:33	822	0	16:58:41	-13	15	20	3
C10-2	16:58:22	16:58:47	850	0	17:02:18	-19	25	25	6
K30-2	17:02:13	17:02:35	878	0	17:05:47	-5	15	22	2
K20-2	17:05:37	17:06:04	272	0	17:07:24	-10	25	27	5
K10-2	17:07:13	17:07:45	276	0	17:11:39	-11	30	32	6
M10-1	17:11:31	17:11:43	265	0	17:18:47	-8	10	12	2
M16-1	17:18:22	17:18:54	254	0	17:20:11	-25	30	32	6
M20-1	17:20:02	17:20:35	256	0	17:21:56	-9	30	33	6
M30-1	17:21:56	17:22:31	252	0	17:23:57	-1	30	36	6
M40-1	17:23:56	17:24:07	262	0	17:26:43	-1	5	11	6
M50-1	17:26:37	17:26:50	261	0	17:28:58	-6	5	13	6
M60-1	17:28:54	17:29:04	260	0	17:32:26	-4	5	10	5
M70-1	17:32:27	17:32:52	278	0	17:35:16	1	25	25	2
M80-1	17:35:09	17:35:29	266	0	17:39:55	-7	21	20	4
M90-2	17:40:49	0: 0: 0	0	0	0: 0: 0	54	7	21	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:53:19 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
117-06	A90	M90	16:35:55

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	16:36:01	16:36:48	582	0	16:41:18	-4107	50	47	2
A80-2	16:41:44	16:42:01	483	0	16:47:09	26	5	17	2
A70-2	16:48:17	16:48:22	562	0	16:52:07	68	7	5	2
A60-2	16:52:11	16:52:11	3600	0	16:56:39	4	5	0	2
A50-2	16:57:05	16:57:14	574	0	17:01:13	26	5	9	2
A40-2	17:00:58	17:01:04	536	0	17:05:06	-15	5	6	2
A30-2	17:05:21	17:05:41	534	0	17:08:36	15	5	20	1
A20-2	17:08:58	17:09:07	474	0	17:13:16	22	5	9	1
A10-2	17:13:36	17:13:58	467	0	17:18:24	20	7	22	1
M10-1	17:22:24	17:22:40	653	0	17:29:44	240	5	16	2
M16-1	17:30:20	17:30:50	718	0	17:32:03	36	7	30	2
M20-1	17:32:06	17:32:39	724	0	17:33:55	3	7	33	2
M30-1	17:34:00	17:34:22	724	0	17:35:43	5	7	22	2
M40-1	17:35:58	17:36:22	722	0	17:38:39	15	5	24	2
M50-1	17:38:56	17:39:19	739	0	17:41:14	17	5	23	2
M60-1	17:41:23	17:41:44	749	0	17:44:48	9	5	21	2
M70-1	17:45:07	17:45:35	761	0	17:47:58	19	7	28	2
M80-1	17:48:05	17:48:33	776	0	17:52:59	7	7	28	2
M90-2	17:52:40	0: 0: 0	0	0	0: 0: 0	-19	7	38	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:55:06 18 TRAIN ORIGIN DESTINATION DISP TIME

TRAIN	ORIGIN	DESTINATION	DISP TIME
459-05	R65	M90	16:51:40

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	16:53:42	16:53:49	179	0	16:57:54	-3046	5	7	2
R50-2	16:57:53	16:58:07	191	0	17:01:13	-1	5	14	2
R40-2	17:01:09	17:01:25	210	0	17:04:48	-4	5	16	2
R30-2	17:04:42	17:04:50	234	0	17:07:16	-6	5	8	2
R20-2	17:07:15	17:07:35	230	0	17:10:16	-1	5	20	2
R10-2	17:10:14	17:10:37	215	0	17:13:56	-2	5	23	2
K30-4	17:13:58	17:14:10	235	0	17:17:22	2	7	12	2
R20-2	17:17:21	17:18:40	229	0	17:19:59	-1	7	79	2
R10-2	17:20:59	17:21:18	303	0	17:25:08	60	7	19	2
M10-1	17:25:03	17:25:16	159	0	17:32:20	-5	7	13	2
M15-1	17:32:49	17:33:21	149	0	17:34:34	29	7	32	2
M20-1	17:34:30	17:34:58	144	0	17:36:13	-4	7	28	2
M30-1	17:36:30	17:37:00	150	0	17:38:21	17	7	30	2
M40-1	17:38:25	17:38:41	147	0	17:41:11	4	5	16	5
M50-1	17:41:18	17:41:32	142	0	17:43:40	7	5	14	6
M60-1	17:43:44	17:44:05	141	0	17:47:15	4	5	21	3
M70-1	17:47:33	17:47:55	145	0	17:50:24	18	25	22	4
M80-1	17:50:34	17:50:56	149	0	17:55:27	10	25	22	5
M90-1	17:54:58	0: 0: 0	0	0	0: 0: 0	-39	7	18	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:57:57 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
379-09	C60	M90	16:47:51

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	16:47:57	16:48:42	999	0	16:54:33	-3391	29	45	2
C50-2	16:54:17	16:54:33	913	0	16:57:18	-16	15	16	2
C45-2	16:57:11	16:57:35	907	0	17:02:13	-7	15	24	2
C30-2	17:02:06	17:02:19	906	0	17:07:29	-7	15	13	2
C20-2	17:07:22	17:07:38	909	0	17:13:46	-7	15	16	3
C10-2	17:13:33	17:13:45	911	0	17:17:16	-13	14	12	6
K30-2	17:17:11	17:17:31	898	0	17:20:43	-5	15	20	2
R20-2	17:21:48	17:21:59	267	0	17:23:18	65	7	11	2
R10-2	17:23:28	17:23:55	149	0	17:27:45	10	7	27	2
M10-1	17:27:43	17:27:55	160	0	17:34:59	-2	7	12	2
M16-1	17:35:10	17:35:29	141	0	17:36:42	11	7	19	2
M20-1	17:36:56	17:37:18	146	0	17:38:33	14	7	22	2
M30-1	17:39:08	17:39:27	158	0	17:40:48	35	7	19	2
M40-1	17:40:50	17:40:59	145	0	17:43:29	2	5	9	5
M50-1	17:43:41	17:44:02	143	0	17:46:10	12	5	21	6
M60-1	17:46:13	17:46:24	149	0	17:49:40	3	5	11	4
M70-1	17:50:01	17:50:31	148	0	17:53:00	21	25	30	4
M80-1	17:53:09	17:53:29	156	0	17:57:55	9	21	20	4
M90-2	17:57:42	0: 0: 0	0	0	0: 0: 0	-13	7	15	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:01:27 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
119-07	A90	M90	16:49:25

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-2	16:49:31	16:50:54	480	0	16:55:59	-3297	140	83	5
A80-2	16:55:54	16:56:14	491	0	17:01:28	-5	5	20	3
A70-2	17:01:22	17:01:37	496	0	17:05:50	-6	15	15	4
A60-2	17:05:40	17:05:40	3600	0	17:10:08	-10	5	0	4
A50-2	17:10:23	17:10:32	536	0	17:14:34	15	5	9	4
A40-2	17:14:36	17:14:43	561	0	17:18:52	2	5	7	3
A30-2	17:18:52	17:19:13	570	0	17:22:21	0	5	21	2
A20-2	17:23:06	17:23:17	621	0	17:27:38	45	5	11	2
A10-2	17:27:39	17:28:01	578	0	17:32:27	1	7	22	2
C10-1	17:32:24	17:32:38	281	0	17:39:43	-3	7	14	2
M10-1	17:39:33	17:39:51	263	0	17:41:04	-10	7	18	2
M20-1	17:40:56	17:41:15	240	0	17:42:30	-8	17	19	2
M30-1	17:42:53	17:43:06	225	0	17:44:27	23	7	13	2
M40-1	17:44:27	17:44:43	217	0	17:47:00	0	5	16	2
M50-1	17:46:58	17:47:05	197	0	17:49:13	-2	5	7	6
M60-1	17:49:17	17:49:30	184	0	17:52:40	4	5	13	3
M70-1	17:52:41	17:53:04	161	0	17:55:33	1	23	23	4
M80-1	17:55:36	17:56:01	146	0	18:00:22	3	25	25	3
M90-1	18:01:00	0: 0: 0	0	0	0: 0: 0	38	7	27	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:06:06 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
441-04	R65	M90	17:05:59

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	17:07:45	17:07:56	247	0	17:12:01	-2203	5	11	2
R50-2	17:11:54	17:12:00	220	0	17:15:06	-7	5	6	2
R40-2	17:15:05	17:15:14	216	0	17:18:37	-1	5	9	2
R30-2	17:18:31	17:18:39	215	0	17:21:08	-6	5	8	5
R20-2	17:21:12	17:21:28	219	0	17:24:09	4	5	16	2
R10-2	17:24:09	17:24:14	190	0	17:27:36	0	5	5	3
K30-4	17:27:42	17:27:55	199	0	17:31:07	6	8	13	2
R20-2	17:31:06	17:31:27	189	0	17:32:46	-1	21	21	2
R10-2	17:32:36	17:33:05	181	0	17:36:59	-10	30	29	6
M10-1	17:37:04	17:37:10	280	0	17:44:14	5	7	6	2
M16-1	17:44:05	17:44:44	272	0	17:45:57	-9	30	39	2
M20-1	17:45:50	17:46:30	294	0	17:47:45	-7	30	40	2
M30-1	17:47:47	17:48:31	294	0	17:49:52	2	21	44	2
M40-1	17:49:55	17:50:12	328	0	17:52:30	3	5	17	2
M50-1	17:52:27	17:52:34	329	0	17:54:29	-3	5	7	2
M60-1	17:54:28	17:54:40	311	0	17:57:50	-1	5	12	3
M70-1	17:57:44	17:58:06	302	0	18:00:37	-6	25	22	5
M80-1	18:00:41	18:00:56	305	0	18:05:18	4	10	15	3
M90-2	18:05:49	0: 0: 0	0	0	0: 0: 0	31	7	17	0

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:10:18 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
361-10	C60	M90	16:58:53

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
C60-2	16:58:59	17:03:48	662	0	17:09:39	-2729	267	289	2
C50-2	17:09:33	17:09:44	916	0	17:12:29	-6	7	11	2
C40-2	17:12:29	17:12:39	918	0	17:17:17	0	7	10	2
C30-2	17:17:18	17:17:40	913	0	17:22:50	1	7	22	2
C20-2	17:22:50	17:22:58	928	0	17:28:59	0	7	8	2
C10-2	17:28:57	17:29:08	924	0	17:32:25	-2	7	11	2
K30-2	17:32:28	17:32:48	917	0	17:36:00	3	7	20	2
R20-2	17:35:56	17:36:05	290	0	17:37:25	-4	10	9	5
R10-2	17:37:17	17:37:43	281	0	17:41:37	-8	28	26	6
M10-1	17:41:36	17:41:44	272	0	17:48:48	-1	10	8	2
M15-1	17:48:44	17:49:11	279	0	17:50:28	-4	30	27	6
M20-1	17:50:23	17:50:50	273	0	17:52:11	-5	30	27	6
M30-1	17:52:13	17:52:42	266	0	17:54:08	2	30	29	6
M40-1	17:54:11	17:54:18	256	0	17:56:48	3	5	7	5
M50-1	17:56:51	17:56:58	264	0	17:59:02	3	5	7	5
M60-1	17:59:11	17:59:22	283	0	18:02:26	9	5	11	2
M70-1	18:02:26	18:02:48	282	0	18:05:17	0	25	22	4
M80-1	18:05:21	18:05:29	280	0	18:09:55	4	9	8	4
M90-1	18:09:54	0: 0: 0	0	0	0: 0: 0	-1	27	24	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE MO DY YR HR MN SC	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07 08/25/81 18:16:19	18	101-09	A90	M90	17:05:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
A90-1	17:05:07	17:07:02	295	0	17:11:32	-2361	104	115	2
A80-2	17:13:39	17:13:48	547	0	17:18:56	127	5	9	2
A70-2	17:18:51	17:19:06	547	0	17:22:41	-5	7	15	1
A6 -2	17:22:17	17:22:17	3600	0	17:26:44	-24	5	0	1
A50-2	17:28:14	17:28:24	592	0	17:31:55	90	5	10	1
A40-2	17:31:43	17:31:46	549	0	17:35:32	-12	5	3	1
A30-2	17:36:01	17:36:09	545	0	17:39:04	29	5	8	1
A20-2	17:38:46	17:38:55	454	0	17:43:04	-18	5	9	1
A10-2	17:43:48	17:43:59	459	0	17:48:25	44	7	11	1
M10-1	17:48:22	17:48:31	406	0	17:54:53	-3	7	9	1
M15-1	17:54:33	17:54:49	349	0	17:56:02	-20	7	16	1
M20-1	17:55:54	17:56:14	331	0	17:57:29	-8	19	20	1
M30-1	17:57:28	17:57:58	315	0	17:59:20	-1	30	30	1
M40-1	17:59:19	17:59:32	308	0	18:01:36	-1	5	13	1
M50-1	18:01:40	18:01:49	289	0	18:03:40	4	5	9	1
M60-1	18:03:36	18:03:42	265	0	18:06:35	-4	5	6	1
M70-1	18:06:31	18:06:58	245	0	18:09:13	-4	30	27	1
M80-1	18:09:10	18:09:37	229	0	18:13:54	-3	30	27	1
M90-2	18:16:00	0: 0: 0	0	0	0: 0: 0	126	7	19	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:20:56 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
443-04	R65	M90	17:21:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R60-2	17:22:48	17:22:54	248	0	17:26:59	-1300	5	6	2
R50-2	17:26:52	17:26:58	238	0	17:30:04	-7	5	6	2
R40-2	17:30:03	17:30:12	229	0	17:33:35	-1	5	9	2
R30-2	17:33:34	17:33:39	231	0	17:36:08	-1	5	5	5
R20-2	17:36:08	17:36:28	223	0	17:39:09	0	5	20	2
R10-2	17:39:06	17:39:14	220	0	17:42:36	-3	5	8	3
K30-4	17:42:35	17:42:55	204	0	17:46:07	-1	15	20	2
R20-2	17:46:00	17:46:26	196	0	17:47:46	-7	25	26	5
R10-2	17:47:36	17:48:13	174	0	17:52:03	-10	30	37	2
M10-1	17:52:04	17:52:12	222	0	17:59:16	1	7	8	2
M16-1	17:58:57	17:59:33	264	0	18:00:50	-19	30	36	6
M20-1	18:00:43	18:01:25	289	0	18:02:40	-7	30	42	2
M30-1	18:02:40	18:03:11	312	0	18:04:32	0	27	31	2
M40-1	18:04:33	18:04:52	314	0	18:07:09	1	5	19	2
M50-1	18:07:03	18:07:16	323	0	18:09:24	-6	5	13	6
M60-1	18:09:20	18:09:38	344	0	18:12:48	-4	5	18	3
M70-1	18:13:02	18:13:16	392	0	18:15:39	14	12	14	2
M80-1	18:15:32	18:15:58	382	0	18:20:24	-7	19	26	2
M90-1	18:20:32	0: 0: 0	0	0	0: 0: 0	8	10	24	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:46:20	1B		TRAIN	ORIGIN	DESTINATION	DISP TIME		
			452-04	M90	R65	14:41:21		

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	14:41:27	14:45:52	609	0	14:49:47	-1098	240	265	2
M80-2	14:49:45	14:49:53	623	0	14:52:10	-2	5	8	2
M75-2	14:52:12	14:52:20	605	0	14:55:27	2	5	8	2
M60-2	14:55:25	14:55:40	611	0	14:57:35	-2	5	15	2
M50-2	14:57:30	14:57:41	612	0	14:59:57	-5	11	11	2
M40-2	14:59:56	15:00:15	609	0	15:01:39	-1	5	19	5
M30-2	15:01:33	15:01:51	604	0	15:03:12	-6	5	18	6
M20-2	15:03:07	15:03:40	575	0	15:04:52	-5	5	33	6
M16-2	15:04:43	15:05:24	535	0	15:12:30	-9	20	41	2
M10-2	15:12:16	15:12:31	531	0	15:16:37	-14	5	15	2
R10-1	15:16:24	15:16:53	339	0	15:18:07	-13	27	29	4
R20-1	15:17:55	15:18:23	331	0	15:21:55	-12	28	28	6
R30-1	15:21:34	15:21:49	346	0	15:25:21	-21	15	15	5
R10-1	15:25:30	15:25:40	348	0	15:28:06	9	10	10	2
R20-1	15:28:06	15:28:23	350	0	15:30:46	0	15	17	2
R30-1	15:30:33	15:30:49	343	0	15:34:35	-13	15	16	4
R40-1	15:34:50	15:35:00	366	0	15:38:08	15	7	10	2
R50-1	15:38:06	15:38:24	368	0	15:42:14	-2	9	18	2
R60-1	15:42:23	15:43:10	392	0	15:45:20	9	7	47	2
R65-1	15:46:20	0: 0: 0	0	0	0: 0: 0	60	0	0	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 15:56:15 18 TRAIN 372-05 ORIGIN M90 DESTINATION C60 DISP TIME 14:49:25

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	14:49:32	14:50:37	485	0	14:54:29	-10496	58	65	2
M80-2	14:54:14	14:54:25	269	0	14:56:53	-15	5	11	4
M70-2	14:56:54	14:57:03	282	0	15:00:13	1	5	9	4
M60-2	15:00:26	15:00:35	301	0	15:02:30	13	5	9	2
M50-2	15:02:26	15:02:41	296	0	15:04:57	-4	15	15	2
M40-2	15:04:54	15:05:04	298	0	15:06:29	-3	5	10	6
M30-2	15:06:29	15:06:55	296	0	15:08:16	0	5	26	6
M20-2	15:08:14	15:08:48	306	0	15:10:01	-2	5	34	2
M16-2	15:09:57	15:10:36	314	0	15:17:42	-4	16	39	2
M10-2	15:17:33	15:17:52	317	0	15:21:58	-9	5	19	2
K10-1	15:21:48	15:22:08	324	0	15:23:20	-10	7	20	2
R20-1	15:23:13	15:23:28	318	0	15:26:56	-7	14	15	2
R30-3	15:26:39	15:27:10	828	0	15:29:59	-17	19	31	3
C10-1	15:30:13	15:30:34	832	0	15:36:10	14	7	21	2
C20-1	15:36:01	15:36:13	837	0	15:41:22	69	9	12	2
C30-1	15:41:14	15:41:36	836	0	15:46:19	-8	15	22	2
C40-1	15:46:11	15:46:32	846	0	15:49:22	-8	15	21	2
C50-1	15:49:19	15:49:35	843	0	15:55:58	-3	15	16	2
C60-2	15:55:37	0: 0: 0	0	0	0: 0: 0	-21	30	38	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE: MO DY YR HR MN SC TASK

07 08/25/81 16:05:23 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
112-03	M90	A90	14:52:26

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	14:52:32	14:55:52	180	0	14:59:47	-10316	175	200	2
M80-2	15:00:01	15:00:09	347	0	15:02:26	14	5	8	2
M70-2	15:02:25	15:02:32	331	0	15:05:39	-1	5	7	2
M60-2	15:05:34	15:05:47	308	0	15:07:42	-5	5	13	2
M50-2	15:07:39	15:07:48	313	0	15:10:04	-3	7	9	2
M40-2	15:10:05	15:10:31	311	0	15:11:53	1	5	26	2
M30-2	15:11:54	15:12:38	325	0	15:13:54	1	5	44	2
M20-2	15:13:52	15:14:27	338	0	15:15:40	-2	5	35	2
M16-2	15:15:31	15:16:42	334	0	15:23:48	-9	7	71	2
M10-2	15:23:39	15:24:10	366	0	15:28:41	-9	5	31	2
A10-1	15:28:42	15:29:31	562	0	15:33:21	1	7	49	2
A20-1	15:33:19	15:34:01	590	0	15:37:15	-2	7	42	2
A30-1	15:37:09	15:37:30	611	0	15:41:26	-6	7	21	2
A40-1	15:41:18	15:41:40	608	0	15:45:32	-8	7	22	2
A50-1	15:45:15	15:45:46	607	0	15:49:17	-17	7	31	1
A60-1	15:48:54	15:48:54	3600	0	15:53:07	-23	0	0	1
A70-1	15:53:26	15:53:39	590	0	15:58:16	19	7	13	1
A80-1	16:00:25	16:00:44	681	0	16:05:06	129	7	19	1
A90-2	16:05:02	0: 0: 0	0	0	0: 0: 0	-4	7	21	C

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:00:53 1B TRAIN 454-04 ORIGIN M90 DESTINATION R65 DISP TIME 14:58:14

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	14:58:20	15:00:30	348	0	15:04:22	-9968	130	130	2
M80-2	15:04:11	15:04:17	250	0	15:06:53	-11	5	6	6
M70-2	15:06:53	15:07:00	268	0	15:10:15	0	5	7	5
M60-2	15:10:29	15:10:36	295	0	15:12:31	14	5	7	2
M50-2	15:12:31	15:12:38	292	0	15:14:54	0	10	7	2
M40-2	15:14:53	15:15:04	288	0	15:16:29	-1	5	11	6
M30-2	15:16:30	15:16:50	276	0	15:18:11	1	5	20	6
M20-2	15:18:11	15:18:50	259	0	15:20:03	0	5	39	2
M16-2	15:19:55	15:20:35	264	0	15:27:41	-8	18	40	2
M10-2	15:27:18	15:27:24	219	0	15:31:33	-23	5	6	4
K10-1	15:31:26	15:31:51	350	0	15:33:07	-7	25	25	6
K20-1	15:33:18	15:33:36	370	0	15:37:04	11	9	18	2
K30-1	15:36:50	15:37:09	365	0	15:40:30	-14	15	19	2
R10-1	15:40:22	15:40:44	339	0	15:43:10	-8	10	22	2
R20-1	15:43:06	15:43:31	349	0	15:45:54	-4	15	25	2
R30-1	15:45:52	15:46:07	355	0	15:49:46	-2	9	15	2
R40-1	15:49:34	15:49:46	351	0	15:52:53	-12	15	12	2
R50-1	15:52:44	15:53:02	346	0	15:57:04	-9	15	18	4
R60-1	15:57:10	15:57:28	347	0	15:59:38	6	11	18	2
R65-1	16:00:53	0: 0: 0	0	0	0: 0: 0	75	0	0	0

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:11:21 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
375-10	M90	C60	15:03:27

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	15:03:33	15:05:33	313	0	15:09:28	-9655	115	120	2
M80-2	15:09:34	15:09:40	323	0	15:11:57	6	5	6	2
M70-2	15:11:58	15:12:06	305	0	15:15:16	1	5	8	4
M60-2	15:15:32	15:15:44	303	0	15:17:39	16	5	12	2
M50-2	15:17:35	15:17:49	304	0	15:20:05	-4	7	14	2
M40-2	15:20:04	15:20:18	311	0	15:21:40	-1	5	14	3
M30-2	15:21:43	15:21:55	313	0	15:23:16	3	5	12	6
M20-2	15:23:18	15:23:36	307	0	15:24:48	2	5	18	6
M15-2	15:24:44	15:25:04	289	0	15:32:10	-4	20	20	2
M10-2	15:32:07	15:32:13	289	0	15:36:28	-3	5	6	6
R10-1	15:36:20	15:36:48	294	0	15:38:04	-8	30	28	6
R20-1	15:37:57	15:38:23	279	0	15:41:55	-7	27	26	6
R30-3	15:41:43	15:41:57	904	0	15:45:09	-12	16	14	6
C10-1	15:45:19	15:45:31	906	0	15:51:07	10	7	12	2
C20-1	15:51:00	15:51:14	899	0	15:56:23	-7	11	14	2
C30-1	15:56:16	15:56:28	902	0	16:01:11	-7	15	12	3
C40-1	16:01:14	16:01:38	903	0	16:04:28	3	15	24	2
C50-1	16:04:27	16:04:38	908	0	16:11:02	-1	8	11	2
C60-2	16:11:00	0: 0: 0	0	0	0: 0: 0	-2	18	21	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:19:13 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
115-06	M90	A90	15:05:05

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	15:05:32	15:10:31	119	0	15:14:23	-9536	298	299	2
M80-2	15:14:16	15:14:33	282	0	15:16:50	-7	5	17	3
M70-2	15:16:53	15:17:01	295	0	15:20:16	3	5	8	5
M60-2	15:20:33	15:20:41	301	0	15:22:36	17	5	8	2
M50-2	15:22:39	15:22:43	302	0	15:24:59	1	7	6	2
M40-2	15:25:01	15:25:36	297	0	15:26:58	2	5	35	2
M30-2	15:26:58	15:27:19	315	0	15:28:35	0	5	21	2
M20-2	15:28:33	15:29:11	315	0	15:30:24	-2	5	38	2
M16-2	15:30:15	15:30:45	331	0	15:37:51	-9	7	30	2
M10-2	15:38:00	15:38:11	353	0	15:42:42	9	5	11	2
A10-1	15:42:57	15:43:07	530	0	15:46:57	15	7	10	2
A20-1	15:46:57	15:47:11	526	0	15:50:25	0	7	14	2
A30-1	15:50:21	15:50:35	529	0	15:54:31	-4	7	14	2
A40-1	15:55:04	15:55:20	567	0	15:59:12	33	7	16	2
A50-1	15:58:58	15:59:11	553	0	16:03:01	-24	7	13	2
A60-1	16:02:41	16:02:41	3600	0	16:06:52	-20	0	0	2
A70-1	16:08:28	16:08:39	636	0	16:13:41	96	7	11	2
A80-1	16:13:32	16:13:46	612	0	16:18:29	-9	7	14	2
A90-2	16:18:29	0: 0: 0	0	0	0: 0: 0	0	7	43	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:13:15 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
456-04	M90	R65	15:11:35

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	15:11:42	15:15:40	370	0	15:19:35	-9166	225	238	2
M80-2	15:19:52	15:19:58	336	0	15:22:15	17	5	6	2
M70-2	15:22:17	15:22:23	324	0	15:25:30	2	5	6	2
M60-2	15:25:28	15:25:36	296	0	15:27:31	-1	5	7	2
M50-2	15:27:31	15:27:39	294	0	15:29:55	0	10	8	2
M40-2	15:29:56	15:30:12	295	0	15:31:37	1	5	16	6
M30-2	15:31:39	15:32:11	281	0	15:33:27	2	5	32	2
M20-2	15:33:27	15:33:48	294	0	15:35:01	0	5	21	2
M15-2	15:34:52	15:35:29	277	0	15:42:35	-9	20	37	2
M1 -2	15:42:32	15:42:45	272	0	15:46:51	-3	5	13	2
K10-1	15:46:53	15:47:07	350	0	15:48:19	2	7	14	2
K20-1	15:48:14	15:48:33	347	0	15:52:01	-5	13	19	2
K30-1	15:51:56	15:52:11	366	0	15:55:31	-5	14	15	2
R10-1	15:55:33	15:55:41	384	0	15:58:07	2	7	8	2
R20-1	15:58:08	15:58:25	389	0	16:00:48	1	14	17	2
R30-1	16:00:51	16:01:00	366	0	16:04:38	3	10	9	2
R40-1	16:04:36	16:04:48	386	0	16:07:55	-2	15	12	2
R50-1	16:07:55	16:08:08	399	0	16:11:58	0	15	13	2
R60-1	16:11:51	16:12:18	410	0	16:14:28	-7	30	27	6
R65-2	16:13:15	0: 0: 0	0	0	0: 0: 0	-73	0	0	0

ENERGY CONSUMPTION TEST NO, 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:26:29 18 TRAIN 377-09 ORIGIN M90 DESTINATION C60 DISP TIME 15:17:41

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	15:17:48	15:20:37	366	0	15:24:29	-8800	162	169	2
M80-2	15:24:30	15:24:36	278	0	15:26:53	1	5	6	3
M70-2	15:27:00	15:27:05	283	0	15:30:16	7	5	5	4
M60-2	15:30:37	15:31:38	308	0	15:33:33	22	5	61	2
M50-2	15:33:30	15:34:53	359	0	15:37:09	-3	7	83	2
M40-2	15:37:09	15:37:32	434	0	15:38:54	0	5	23	1
M30-2	15:38:56	15:39:13	437	0	15:40:29	2	5	17	1
M20-2	15:40:29	15:40:54	422	0	15:42:02	0	5	25	1
M16-2	15:41:58	15:42:23	426	0	15:48:42	-4	7	25	1
C1 -2	15:48:52	15:49:04	380	0	15:53:05	10	5	12	1
K1 -1	15:53:16	15:53:42	383	0	15:54:54	11	7	26	1
K2 -1	15:54:48	15:54:57	394	0	15:58:25	-6	7	9	1
P3 -3	15:58:20	15:58:42	997	0	16:01:17	-5	7	22	1
C10-1	16:01:35	16:01:51	976	0	16:06:54	18	7	16	1
C20-1	16:06:58	16:07:12	958	0	16:11:53	4	7	14	1
C3 -1	16:12:05	16:12:25	949	0	16:16:39	12	7	20	1
C40-1	16:16:48	16:17:04	934	0	16:19:40	9	7	16	1
C50-1	16:19:46	16:20:04	919	0	16:25:54	6	7	18	1
C6 -2	16:26:07	0: 0: 0	0	0	0: 0: 0	13	10	22	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:34:26 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
117-06	M90	A90	15:22:47

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	15:22:53	15:25:29	305	0	15:29:24	-8495	154	156	2
M80-2	15:29:25	15:29:37	299	0	15:31:54	5	5	8	3
M70-2	15:31:54	15:32:03	294	0	15:35:13	0	5	9	4
M60-2	15:35:22	15:35:31	285	0	15:37:26	9	5	9	2
M50-2	15:37:24	15:37:34	234	0	15:40:04	-2	12	10	5
M40-2	15:40:03	15:40:14	173	0	15:41:38	-1	5	11	5
M30-2	15:41:39	15:41:58	163	0	15:43:19	1	5	19	6
M20-2	15:43:16	15:43:33	167	0	15:44:45	-3	5	17	6
M16-2	15:44:44	15:45:19	166	0	15:52:25	-1	25	35	2
M10-2	15:52:12	15:52:20	200	0	15:56:59	-13	5	8	6
A10-1	15:57:03	15:57:28	644	0	16:01:50	4	25	25	5
A20-1	16:02:19	16:02:29	709	0	16:05:43	29	7	10	2
A30-1	16:05:42	16:05:59	704	0	16:09:55	-1	7	17	2
A40-1	16:09:55	16:10:07	713	0	16:14:00	0	7	12	2
A50-1	16:13:21	16:13:36	659	0	16:17:42	-39	20	15	4
A60-1	16:18:22	16:18:22	3600	0	16:22:33	40	0	0	4
A70-1	16:22:53	16:23:14	726	0	16:28:16	25	7	16	2
A80-1	16:29:06	16:29:19	761	0	16:34:02	50	7	13	2
A90-2	16:33:59	0: 0: 0	0	0	0: 0: 0	-3	7	27	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:29:26 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
459-05	M90	R65	15:28:09

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	15:28:16	15:30:38	323	0	15:34:30	-8172	134	142	2
M80-2	15:34:15	15:34:28	290	0	15:36:45	-11	5	9	3
M70-2	15:36:49	15:36:57	295	0	15:40:12	4	5	8	5
M60-2	15:40:31	15:40:46	309	0	15:42:41	19	5	15	2
M50-2	15:42:38	15:42:46	314	0	15:45:02	-3	7	8	2
M40-2	15:45:03	15:45:17	300	0	15:46:39	1	5	14	2
M30-2	15:46:38	15:47:01	299	0	15:48:22	-1	5	23	6
M20-2	15:48:20	15:48:51	304	0	15:50:03	-2	5	31	6
M16-2	15:49:58	15:50:42	314	0	15:57:48	-5	25	44	2
M10-2	15:57:38	15:57:49	326	0	16:02:05	-10	5	11	6
K10-1	16:01:55	16:02:23	356	0	16:03:39	-10	30	28	6
K20-1	16:03:32	16:04:05	338	0	16:07:33	-7	30	33	2
K30-1	16:07:21	16:07:55	352	0	16:11:15	-12	20	34	2
R10-1	16:11:12	16:11:27	384	0	16:13:53	-3	15	15	2
R20-1	16:13:49	16:14:33	393	0	16:16:57	-4	28	44	2
R30-1	16:16:55	16:17:07	424	0	16:20:45	-2	7	12	2
R40-1	16:20:39	16:20:59	442	0	16:24:06	-6	19	20	2
R50-1	16:24:02	16:24:22	461	0	16:28:12	-4	20	20	2
R60-1	16:28:01	16:28:30	475	0	16:30:40	-11	29	29	6
R65-2	16:29:26	0: 0: 0	0	0	0: 0: 0	-74	0	0	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:42:51 1B TRAIN ORIGIN DESTINATION DISP TIME

379-09 M90 C60 15:33:14

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	15:33:20	15:35:24	304	0	15:39:22	-7868	127	124	5
M80-2	15:39:33	15:39:42	314	0	15:41:59	11	5	9	2
M70-2	15:41:58	15:42:04	309	0	15:45:14	-1	5	6	4
M60-2	15:45:32	15:45:50	301	0	15:47:45	18	5	18	2
M50-2	15:47:45	15:47:52	307	0	15:50:08	0	7	7	2
M40-2	15:50:13	15:50:28	310	0	15:51:50	5	5	15	2
M30-2	15:51:50	15:52:08	312	0	15:53:24	0	5	18	2
M20-2	15:53:24	15:53:43	304	0	15:54:55	0	5	19	6
M16-2	15:54:50	15:55:12	292	0	16:02:18	-5	25	22	2
M10-2	16:02:19	16:02:33	281	0	16:06:48	1	5	14	6
R10-1	16:06:37	16:07:04	282	0	16:08:20	-11	30	27	6
R20-1	16:08:12	16:08:39	280	0	16:12:11	-8	30	27	6
R30-3	16:12:01	16:13:01	821	0	16:15:50	-10	30	60	3
C10-1	16:16:08	16:16:24	873	0	16:22:00	18	7	16	2
C20-1	16:21:56	16:22:08	898	0	16:27:17	-4	7	12	2
C30-1	16:27:15	16:27:35	910	0	16:32:18	-2	23	20	3
C40-1	16:32:19	16:32:41	931	0	16:35:36	1	25	22	4
C50-1	16:35:51	16:36:07	965	0	16:42:30	15	7	16	2
C60-2	16:42:26	0: 0: 0	0	0	0: 0: 0	-4	20	25	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:47:24	18	TRAIN	ORIGIN	DESTINATION	DISP TIME		
		119-07	M90	A90	15:37:06		

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	15:37:15	15:38:05	235	0	15:42:08	-7633	195	50	6
M80-2	15:42:01	15:42:15	148	0	15:44:32	-7	5	14	2
M70-2	15:44:31	15:44:41	153	0	15:47:48	-1	5	10	2
M60-2	15:48:02	15:48:33	150	0	15:50:28	14	5	31	2
M50-2	15:50:26	15:50:55	161	0	15:53:11	-2	30	29	2
M40-2	15:53:11	15:53:30	178	0	15:54:52	0	5	19	2
M30-2	15:54:51	15:55:16	181	0	15:56:32	-1	5	25	2
M20-2	15:56:30	15:57:31	186	0	15:58:44	-2	5	61	2
M16-2	15:58:34	15:59:25	224	0	16:06:31	-10	30	51	2
MI -2	16:06:29	16:06:40	250	0	16:11:11	-2	5	11	2
A10-1	16:11:10	16:11:33	456	0	16:15:23	-1	25	23	2
A20-1	16:15:23	16:16:12	438	0	16:19:26	0	30	49	2
A30-1	16:19:25	16:19:44	487	0	16:23:20	-1	21	19	1
A40-1	16:23:38	16:24:01	494	0	16:27:54	18	20	23	2
A50-1	16:27:41	16:28:32	502	0	16:32:22	-13	20	51	2
A60-1	16:32:01	16:32:01	3600	0	16:36:12	-21	0	0	2
A70-1	16:36:35	16:36:58	542	0	16:42:00	23	20	23	2
A80-1	16:41:52	16:42:16	546	0	16:46:59	-2	7	18	2
A90-2	16:47:06	0: 0: 0	0	0	0: 0: 0	7	7	18	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:49:00 18 TRAIN 441-03 ORIGIN 190 DESTINATION R65 DISP TIME 15:41:58

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
R9[illegible]-1	15:42:03	15:45:42	288	0	15:49:37	-7345	203	219	2
R8[illegible]-2	15:49:54	15:50:01	473	0	15:52:18	17	5	7	2
R7[illegible]-2	15:52:18	15:52:22	467	0	15:55:29	0	5	4	2
[illegible]-2	15:55:29	15:55:36	447	0	15:57:31	0	5	7	2
[illegible]5[illegible]-2	15:57:41	15:57:46	435	0	16:00:02	10	7	5	2
[illegible]4[illegible]-2	16:00:03	16:00:41	412	0	16:02:03	1	5	38	2
[illegible]3[illegible]-2	16:02:05	16:02:41	434	0	16:03:57	2	5	36	2
R2[illegible]-2	16:04:02	16:04:35	452	0	16:05:48	5	5	33	2
R16-2	16:05:41	16:06:09	427	0	16:13:15	-7	7	28	2
RI -2	16:13:16	16:13:38	407	0	16:17:44	1	5	22	2
RI[illegible]-1	16:20:00	16:20:18	141	0	16:21:30	136	7	18	2
R2[illegible]-1	16:21:53	16:22:04	148	0	16:25:32	23	7	11	2
R3[illegible]-3	16:25:29	16:25:45	808	0	16:29:05	-3	7	16	2
PI[illegible]-1	16:29:08	16:29:15	151	0	16:31:45	3	7	7	3
[illegible]2[illegible]-1	16:31:50	16:32:05	155	0	16:34:29	5	7	15	1
[illegible]3[illegible]-1	16:34:31	16:34:38	150	0	16:37:58	2	7	7	1
R4[illegible]-1	16:38:05	16:38:16	148	0	16:41:08	7	7	11	1
[illegible]5[illegible]-1	16:41:09	16:41:27	154	0	16:45:05	1	7	18	1
R6[illegible]-1	16:47:40	16:47:52	320	0	16:50:02	155	7	12	1
R65-2	16:49:00	0: 0: 0	0	0	0: 0: 0	-62	0	0	0

ENERGY CONSUMPTION TEST NO, 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:57:54 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
361-10	M90	C60	15:46:29

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	15:46:35	15:50:33	272	0	15:54:25	-7073	235	238	2
M80-2	15:54:25	15:55:02	271	0	15:57:19	0	5	37	2
M70-2	15:57:16	15:57:24	298	0	16:00:31	-3	5	8	2
M60-2	16:00:26	16:00:36	297	0	16:02:31	-5	5	10	2
M50-2	16:02:29	16:02:38	288	0	16:04:54	-2	7	9	2
M40-2	16:04:55	16:05:08	292	0	16:06:33	1	5	13	6
M30-2	16:06:33	16:06:49	268	0	16:08:10	0	5	16	6
M20-2	16:08:11	16:08:33	249	0	16:09:45	1	5	22	6
M16-2	16:09:39	16:10:07	238	0	16:17:37	-6	25	28	3
M1 -2	16:17:13	16:17:22	237	0	16:21:37	-24	5	9	6
R10-1	16:22:34	16:22:48	154	0	16:24:00	57	7	14	2
R20-1	16:24:28	16:24:39	155	0	16:28:07	28	7	11	2
R30-1	16:27:55	16:28:19	287	0	16:31:19	-12	7	24	2
C10-1	16:31:18	16:31:35	910	0	16:37:11	-1	7	17	2
C20-1	16:37:03	16:37:13	907	0	16:42:22	-8	7	10	2
C30-1	16:42:19	16:42:36	904	0	16:47:19	-3	19	17	3
C40-1	16:47:28	16:47:45	909	0	16:50:35	9	18	17	2
C50-1	16:50:37	16:50:57	886	0	16:57:20	2	20	20	2
C60-2	16:57:28	0: 0: 0	0	0	0: 0: 0	8	18	25	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:03:01 1B TRAIN ORIGIN DESTINATION DISP TIME
101-09 M90 A90 15:53:19

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	15:53:25	15:55:32	410	0	15:59:27	-6663	121	127	2
M80-2	15:59:32	15:59:38	307	0	16:01:55	5	5	6	2
M70-2	16:01:52	16:01:59	276	0	16:05:14	-3	5	7	5
M60-2	16:05:24	16:05:31	299	0	16:07:26	10	5	7	2
M50-2	16:07:24	16:07:32	295	0	16:09:48	-2	11	8	2
M40-2	16:09:44	16:10:00	289	0	16:11:25	-4	5	16	6
M30-2	16:11:32	16:11:59	299	0	16:13:20	7	5	27	6
M20-2	16:13:21	16:13:54	310	0	16:15:06	1	5	33	6
M16-2	16:15:00	16:15:30	321	0	16:22:36	-6	25	30	2
M10-2	16:22:22	16:22:50	309	0	16:27:29	-14	5	28	6
A10-1	16:27:26	16:27:52	439	0	16:31:50	-3	25	26	3
A20-1	16:31:45	16:32:02	450	0	16:35:27	-5	20	17	3
A30-1	16:35:17	16:35:35	449	0	16:39:31	-10	15	18	2
A40-1	16:39:29	16:39:48	426	0	16:43:32	-2	19	19	3
A50-1	16:43:31	16:43:50	423	0	16:47:48	-1	20	19	3
A60-1	16:47:22	16:47:22	3600	0	16:51:32	-26	0	0	3
A70-1	16:51:48	16:52:03	407	0	16:57:30	16	20	15	4
A80-1	16:57:51	16:58:08	466	0	17:02:51	21	7	17	2
A90-1	17:02:41	0: 0: 0	0	0	0: 0: 0	-10	7	20	0

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BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 16:59:49 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
443-05	M90	R65	15:58:46

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	15:58:51	16:00:37	326	0	16:04:29	-6337	98	106	2
M80-2	16:04:15	16:04:23	283	0	16:06:53	-14	5	8	5
M70-2	16:07:18	16:07:24	326	0	16:10:31	25	5	6	2
M60-2	16:10:30	16:10:41	305	0	16:12:36	-1	5	11	2
M50-2	16:12:33	16:13:05	309	0	16:15:21	-3	7	32	2
M40-2	16:15:20	16:15:32	336	0	16:16:54	-1	5	12	2
M30-2	16:16:56	16:17:21	324	0	16:18:37	2	5	25	2
M20-2	16:18:39	16:19:11	318	0	16:20:24	2	5	32	2
M16-2	16:20:16	16:20:42	317	0	16:27:48	-8	15	26	2
M10-2	16:27:39	16:27:55	317	0	16:32:02	-9	5	16	2
R10-1	16:33:48	16:34:09	146	0	16:35:21	106	7	21	2
R20-1	16:35:53	16:36:34	161	0	16:40:02	32	7	41	2
R30-3	16:39:47	16:40:03	858	0	16:43:23	-15	7	16	2
R10-1	16:43:21	16:43:32	171	0	16:45:50	-2	7	11	1
R20-1	16:45:47	16:46:01	164	0	16:48:24	-3	7	14	1
R30-1	16:48:20	16:48:32	149	0	16:51:52	-4	7	12	1
R40-1	16:51:46	16:51:56	147	0	16:54:48	-6	7	10	1
R50-1	16:54:44	16:55:15	144	0	16:58:53	-4	14	31	1
R60-1	16:58:35	16:58:54	155	0	17:01:04	-18	7	19	1
R65-2	16:59:49	0: 0: 0	0	0	0: 0: 0	-75	0	0	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE		TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81 17:12:50	18	363-10	M90	C60	16:02:51

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	16:02:58	16:05:38	247	0	16:09:33	-6090	150	160	2
M85-2	16:09:46	16:09:56	331	0	16:12:13	13	5	10	2
M70-2	16:12:11	16:12:18	293	0	16:15:25	-2	5	7	2
M60-2	16:15:19	16:15:27	289	0	16:17:22	-6	5	8	2
M50-2	16:17:21	16:17:32	288	0	16:19:48	-1	12	11	2
M40-2	16:19:49	16:20:03	269	0	16:21:28	1	5	14	6
M30-2	16:21:32	16:21:43	276	0	16:23:04	4	5	11	6
M20-2	16:23:06	16:23:26	267	0	16:24:38	2	5	20	6
M16-2	16:24:35	16:24:59	258	0	16:32:29	-3	25	24	3
M10-2	16:32:05	16:32:13	266	0	16:36:28	-24	5	8	6
R10-1	16:36:31	16:37:03	163	0	16:38:19	3	30	32	6
R20-1	16:38:53	16:39:07	180	0	16:42:35	34	14	14	2
R30-1	16:42:25	16:42:46	328	0	16:45:46	-10	20	21	2
C10-1	16:45:44	16:46:00	866	0	16:51:36	-2	15	16	2
C20-1	16:51:30	16:51:51	867	0	16:57:14	-6	20	21	3
C30-1	16:57:02	16:57:25	883	0	17:02:08	-12	25	23	3
C40-1	17:02:07	17:02:32	879	0	17:05:33	-1	25	25	5
C50-1	17:05:46	17:06:02	909	0	17:12:25	13	12	16	2
C60-1	17:12:18	0: 0: 0	0	0	0: 0: 0	-7	29	32	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:16:20 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
503-10	M90	A90	16:07:09

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	16:07:16	16:10:29	258	0	16:14:21	-5832	194	193	2
M80-2	16:14:12	16:14:17	266	0	16:16:53	-9	5	5	6
M70-2	16:16:52	16:16:57	281	0	16:20:12	-1	5	5	5
M60-2	16:20:25	16:20:35	306	0	16:22:30	13	5	10	2
M50-2	16:22:25	16:22:38	304	0	16:24:54	-5	10	13	2
M40-2	16:24:52	16:25:30	303	0	16:26:52	-2	5	38	2
M30-2	16:27:02	16:27:39	330	0	16:28:55	10	5	37	2
M20-2	16:29:07	16:29:41	362	0	16:30:54	12	5	34	2
M15-2	16:30:42	16:30:55	367	0	16:38:01	-12	7	13	2
M10-2	16:37:54	16:38:01	349	0	16:42:38	-7	5	7	5
A10-1	16:42:39	16:43:01	562	0	16:46:51	1	25	22	2
A20-1	16:46:59	16:47:12	585	0	16:50:26	8	15	13	2
A30-1	16:50:24	16:51:10	577	0	16:54:46	-2	15	46	1
A40-1	16:54:47	16:55:06	560	0	16:58:32	1	7	19	1
A50-1	16:58:24	16:58:45	547	0	17:02:16	-8	20	21	1
A60-1	17:02:00	17:02:00	3600	0	17:06:09	-16	0	0	1
A70-1	17:06:32	17:06:49	497	0	17:11:25	23	20	17	1
A80-1	17:11:13	17:11:26	479	0	17:15:48	-12	7	13	1
A90-1	17:15:51	0: 0: 0	0	0	0: 0: 0	3	30	29	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:14:28 19 TRAIN 445-05 ORIGIN M90 DESTINATION R65 DISP TIME 16:12:47

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	16:12:53	16:13:50	337	0	16:17:45	-5495	41	57	2
M80-2	16:17:52	16:18:02	220	0	16:20:19	7	5	10	2
M70-2	16:20:16	16:20:26	204	0	16:23:33	-3	5	10	2
M60-2	16:23:21	16:23:30	176	0	16:25:30	-12	5	9	4
M50-2	16:25:21	16:25:49	176	0	16:28:19	-9	12	28	5
M40-2	16:28:01	16:28:18	189	0	16:29:43	-18	5	17	6
M30-2	16:29:43	16:30:08	161	0	16:31:29	0	5	25	6
M20-2	16:31:30	16:32:02	142	0	16:33:14	1	5	32	6
M16-2	16:33:07	16:34:01	146	0	16:41:07	-7	25	54	2
M10-2	16:43:08	16:43:24	314	0	16:47:30	121	5	16	2
K10-1	16:47:23	16:47:52	434	0	16:49:04	-7	7	29	2
R20-1	16:48:57	16:49:20	417	0	16:52:48	-7	7	23	2
R30-1	16:52:36	16:53:15	415	0	16:56:35	-12	7	39	1
R10-1	16:56:29	16:56:40	426	0	16:58:58	-6	7	11	1
R20-1	16:59:03	16:59:19	421	0	17:01:42	5	7	16	1
R30-1	17:01:40	17:01:51	412	0	17:05:11	-2	7	11	1
R40-1	17:05:56	17:06:08	414	0	17:09:00	-5	7	12	1
R50-1	17:09:08	17:09:29	412	0	17:13:07	8	7	21	1
R60-1	17:13:05	17:13:34	416	0	17:15:44	-2	7	29	1
R65-2	17:14:28	0: 0: 0	0	0	0: 0: 0	-76	0	0	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:24:36 18 TRAIN ORIGIN DESTINATION DISP TIME

365-10 M90 C60 16:16:55

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	16:17:02	16:17:30	249	0	16:21:22	-5246	20	28	2
M80-2	16:21:16	16:21:23	204	0	16:23:40	-6	5	7	3
M70-2	16:23:44	16:23:51	208	0	16:27:06	4	5	7	5
M60-2	16:27:23	16:27:32	242	0	16:29:27	17	5	9	2
M50-2	16:29:26	16:29:34	245	0	16:31:50	-1	7	8	2
M40-2	16:31:50	16:32:04	229	0	16:33:29	0	5	14	6
M30-2	16:33:31	16:33:39	228	0	16:35:00	2	5	8	6
M20-2	16:35:11	16:35:37	221	0	16:36:49	11	5	26	6
M16-2	16:36:48	16:37:13	220	0	16:44:19	-1	25	25	2
M10-2	16:45:39	16:45:49	151	0	16:49:55	80	5	10	2
K10-1	16:49:52	16:50:08	149	0	16:51:20	-3	7	16	2
K20-1	16:51:41	16:51:57	164	0	16:55:25	21	7	16	2
K30-3	16:55:18	16:55:36	931	0	16:58:23	-7	7	18	2
C10-1	16:58:36	16:58:52	772	0	17:04:28	13	7	16	2
C20-1	17:04:28	17:04:40	778	0	17:09:49	0	7	12	2
C30-1	17:09:53	17:10:05	771	0	17:14:48	4	7	12	2
C40-1	17:14:49	17:15:06	762	0	17:17:56	1	7	17	2
C50-1	17:18:00	17:18:20	734	0	17:24:10	4	7	20	1
C60-2	17:24:29	0: 0: 0	0	0	0: 0: 0	19	9	6	0

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:29:11 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
105-10	M90	A90	16:20:41

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	16:20:47	16:21:25	225	0	16:25:20	-5021	17	38	2
M80-2	16:25:22	16:25:28	246	0	16:27:45	2	5	6	2
M70-2	16:27:49	16:27:56	245	0	16:31:03	4	5	7	2
M60-2	16:31:03	16:31:12	220	0	16:33:07	0	5	9	2
M50-2	16:33:07	16:33:20	223	0	16:35:36	0	7	13	2
M40-2	16:35:35	16:36:01	225	0	16:37:23	-1	5	26	2
M30-2	16:37:22	16:37:54	231	0	16:39:10	-1	5	32	2
M20-2	16:39:09	16:39:41	238	0	16:40:54	-1	5	32	2
M16-2	16:40:43	16:41:09	235	0	16:48:16	-11	25	26	2
M10-2	16:48:29	16:48:47	170	0	16:53:18	13	5	18	2
A10-1	16:53:13	16:54:07	395	0	16:57:58	-5	25	54	2
A20-1	16:57:58	16:58:11	437	0	17:01:25	0	7	13	2
A30-1	17:01:24	17:02:03	437	0	17:05:59	-1	7	39	2
A40-1	17:06:00	17:06:11	444	0	17:10:03	1	7	11	2
A50-1	17:09:51	17:10:11	439	0	17:14:01	-12	7	20	2
A60-1	17:13:42	17:13:42	3600	0	17:17:51	-19	0	0	2
A70-1	17:18:21	17:18:30	448	0	17:23:32	30	7	9	2
A80-1	17:23:34	17:23:49	456	0	17:28:32	2	7	15	2
A90-1	17:28:46	0: 0: 0	0	0	0: 0: 0	14	7	25	0

DATE	:	25 AUGUST 1981
TRAIN ID	:	387-10
DEPARTURE TIME	:	16 24 36

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:26:49 18 TRAIN ORIGIN DESTINATION DISP TIME
447-03 M90 R65 16:26:28

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	16:26:34	16:28:39	243	0	16:32:34	-4674	120	125	2
M80-2	16:32:37	16:32:48	237	0	16:35:05	3	5	11	2
M70-2	16:35:01	16:35:07	221	0	16:38:22	-4	5	6	5
M60-2	16:38:10	16:38:16	204	0	16:40:22	-12	5	6	6
M50-2	16:40:13	16:40:23	207	0	16:42:56	-9	12	10	6
M40-2	16:42:36	16:42:57	204	0	16:44:22	-20	5	21	6
M30-2	16:44:18	16:44:39	202	0	16:46:00	-4	5	21	6
M20-2	16:45:51	16:46:22	204	0	16:47:34	-9	5	31	6
M16-2	16:47:26	16:48:02	215	0	16:55:32	-8	25	36	3
MI0-2	16:55:00	16:55:19	222	0	16:59:34	-32	5	19	6
RI0-1	16:59:17	16:59:49	218	0	17:01:05	-17	30	32	6
R20-1	17:00:54	17:01:25	215	0	17:04:57	-11	30	31	6
R30-1	17:04:38	17:05:08	399	0	17:08:51	-19	30	30	6
RI0-1	17:08:23	17:08:50	386	0	17:11:36	-28	30	27	6
R20-1	17:11:11	17:11:46	389	0	17:14:14	-25	30	35	6
R30-1	17:14:05	17:14:28	397	0	17:18:43	-9	25	23	6
R40-1	17:17:56	17:18:24	409	0	17:22:05	-47	30	28	6
R50-1	17:21:23	17:21:50	418	0	17:26:20	-42	29	27	6
R60-1	17:25:25	17:25:55	391	0	17:28:05	-55	30	30	6
R65-2	17:26:49	0: 0: 0	0	0	0: 0: 0	-76	0	0	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE	MO DY YR	HR MN SC	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81	17:39:19	1B	367-10	M90	C60	16:30:50

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	16:30:57	16:32:36	263	0	16:36:28	-4411	85	99	2
M80-2	16:36:17	16:36:23	219	0	16:38:40	-11	5	6	3
M70-2	16:38:36	16:38:45	215	0	16:42:00	-4	5	9	5
M60-2	16:42:05	16:42:12	235	0	16:44:14	5	5	7	5
M50-2	16:44:14	16:44:23	241	0	16:46:39	0	12	9	2
M40-2	16:46:32	16:46:45	236	0	16:48:10	-7	5	13	6
M30-2	16:48:09	16:48:27	231	0	16:49:48	-1	5	18	6
M20-2	16:49:47	16:50:07	235	0	16:51:20	-1	5	20	6
M16-2	16:51:14	16:51:39	228	0	16:59:09	-6	25	25	3
M10-2	16:58:29	16:58:40	209	0	17:02:55	-40	5	11	6
R10-1	17:02:41	17:03:10	204	0	17:04:26	-14	30	29	6
R20-1	17:04:17	17:04:48	203	0	17:08:20	-9	30	31	6
R30-3	17:08:05	17:08:33	413	0	17:11:45	-15	30	28	6
C10-1	17:11:50	17:13:07	407	0	17:18:11	5	15	77	1
C20-1	17:18:01	17:18:19	440	0	17:23:00	-10	20	18	1
C30-1	17:23:00	17:23:26	412	0	17:27:40	0	25	26	1
C40-1	17:27:36	17:28:05	357	0	17:30:41	-4	30	29	1
C50-1	17:30:41	17:31:14	347	0	17:37:04	0	30	33	1
C60-2	17:38:50	0: 0: 0	0	0	0: 0: 0	106	30	29	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2.

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:49:24 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
107-10	M90	A90	16:40:13

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	16:41:05	16:41:26	608	0	16:45:21	-3803	7	21	1
M80-2	16:46:52	16:46:58	635	0	16:49:15	91	5	6	2
M70-2	16:49:10	16:49:17	634	0	16:52:25	-5	5	7	2
M60-2	16:52:13	16:52:20	608	0	16:54:09	-12	5	7	1
M50-2	16:54:09	16:54:19	595	0	16:56:29	0	7	10	1
M40-2	16:56:28	16:56:49	596	0	16:58:11	-1	5	21	1
M30-2	16:58:12	16:58:28	603	0	16:59:44	1	5	16	1
M20-2	16:59:44	17:00:17	597	0	17:01:25	0	5	33	1
M16-2	17:01:20	17:01:54	606	0	17:08:13	-5	7	34	1
M10-2	17:08:19	17:08:43	590	0	17:13:19	6	5	24	1
A10-1	17:13:18	17:14:06	784	0	17:17:39	-1	7	48	1
A20-1	17:17:40	17:18:11	789	0	17:21:16	1	7	31	1
A30-1	17:21:09	17:21:34	788	0	17:25:10	-7	7	25	1
A40-1	17:25:10	17:25:38	780	0	17:29:04	0	7	28	1
A50-1	17:29:06	17:29:28	778	0	17:32:59	2	7	22	1
A60-1	17:32:41	17:32:41	3600	0	17:36:50	-18	0	0	1
A70-1	17:37:14	17:37:33	772	0	17:42:09	24	7	19	1
A80-1	17:43:23	17:43:48	407	0	17:48:10	74	17	25	1
A90-1	17:48:41	0: 0: 0	0	0	0: 0: 0	31	7	43	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:52:30 1B	TRAIN	ORIGIN	DESTINATION	DISP TIME
	389-10	M90	C60	16:39:53

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-3	16:43:16	16:43:20	55	0	16:47:15	-3672	7	4	2
M80-2	16:49:10	16:49:16	138	0	16:51:46	115	5	6	5
M70-2	16:51:51	16:51:56	161	0	16:55:03	5	5	5	2
M60-2	16:55:01	16:55:06	168	0	16:56:55	-2	5	5	1
M50-2	16:56:59	16:57:10	170	0	16:59:20	4	12	11	1
M40-2	16:59:16	16:59:33	168	0	17:00:55	-4	5	17	1
M30-2	17:00:55	17:01:13	163	0	17:02:29	0	5	18	1
M20-2	17:02:28	17:02:59	164	0	17:04:07	-1	5	31	1
M16-2	17:04:05	17:04:34	165	0	17:10:53	-2	7	29	1
M10-2	17:11:21	17:11:38	182	0	17:15:39	28	5	17	1
R10-1	17:15:41	17:16:22	392	0	17:17:34	2	7	41	1
R20-1	17:17:28	17:18:03	381	0	17:21:31	-6	7	35	1
R30-3	17:21:23	17:22:12	798	0	17:24:47	-8	7	49	1
C10-1	17:25:03	17:25:33	793	0	17:30:36	16	7	30	1
C20-1	17:31:12	17:31:41	791	0	17:36:22	36	7	29	1
C30-1	17:36:29	17:36:50	809	0	17:41:04	7	7	21	1
C40-1	17:41:01	17:41:33	805	0	17:44:09	-3	7	32	1
C50-1	17:44:19	17:44:50	818	0	17:50:40	10	7	31	1
C60-2	17:51:44	0: 0: 0	0	0	0: 0: 0	64	7	46	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:45:39 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
449-04	M90	R65	16:42:14

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	16:42:21	16:44:10	76	0	16:48:05	-3727	76	109	1
M80-2	16:51:24	16:51:29	134	0	16:53:59	199	5	5	5
M70-2	16:54:05	16:54:11	134	0	16:57:01	6	5	6	1
M60-2	16:57:18	16:57:26	137	0	16:59:15	17	5	8	1
M50-2	16:59:17	16:59:29	138	0	17:01:39	2	12	12	1
M40-2	17:01:38	17:02:01	142	0	17:03:23	-1	5	23	1
M30-2	17:03:26	17:03:42	151	0	17:04:58	3	5	16	1
M20-2	17:05:01	17:05:29	153	0	17:06:37	3	5	28	1
M16-2	17:06:39	17:07:10	154	0	17:13:29	2	7	31	1
M10-2	17:13:44	17:13:57	143	0	17:17:58	15	5	13	1
K10-1	17:18:00	17:18:41	139	0	17:19:53	2	7	41	1
K20-1	17:20:22	17:20:49	174	0	17:24:17	29	7	27	1
K30-1	17:24:06	17:25:07	525	0	17:28:28	-11	7	61	1
R10-1	17:28:16	17:28:38	546	0	17:30:56	-12	7	22	1
R20-1	17:30:56	17:31:30	508	0	17:33:53	0	7	34	1
R30-1	17:33:57	17:34:15	509	0	17:37:35	4	7	18	1
R40-1	17:37:35	17:37:51	502	0	17:40:43	0	7	16	1
R50-1	17:40:42	17:41:06	486	0	17:44:44	-1	7	24	1
R60-1	17:44:23	17:44:43	474	0	17:46:53	-21	7	20	1
R55-2	17:45:39	0: 0: 0	0	0	0: 0: 0	-74	0	0	0

BARTD SYSTEM LEG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 17:59:28 1B TRAIN 369-10 ORIGIN 190 DESTINATION C60 DISP TIME 16:49:25

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	16:49:32	16:51:15	376	0	16:55:10	-3296	7	103	1
M80-2	16:55:19	16:55:26	235	0	16:57:43	9	5	7	2
M70-2	16:57:46	16:57:51	221	0	17:00:58	3	5	5	2
M60-2	17:01:00	17:01:48	222	0	17:03:43	2	5	48	2
M50-2	17:03:42	17:03:55	265	0	17:06:11	-1	7	13	2
M40-2	17:06:11	17:06:30	273	0	17:07:52	0	5	19	2
M30-2	17:07:52	17:08:03	266	0	17:09:19	0	5	11	2
M20-2	17:09:23	17:09:44	262	0	17:10:57	4	5	21	2
M16-2	17:10:50	17:11:10	251	0	17:18:16	-7	7	20	2
M10-2	17:18:26	17:18:39	282	0	17:22:40	10	5	13	1
R10-1	17:24:25	17:24:42	118	0	17:25:54	105	7	17	1
R20-1	17:26:20	17:26:39	152	0	17:30:08	26	7	19	1
R30-1	17:29:54	17:30:16	348	0	17:33:16	-14	7	22	1
C10-1	17:33:02	17:33:18	479	0	17:38:21	-14	7	16	1
C20-1	17:38:15	17:38:35	423	0	17:43:16	-6	7	20	1
C30-1	17:43:18	17:43:36	409	0	17:47:50	2	7	18	1
C40-1	17:47:50	17:48:12	409	0	17:50:48	0	7	22	1
C50-1	17:50:49	17:51:08	390	0	17:56:58	1	7	19	1
C60-1	17:58:35	0: 0: 0	0	0	0: 0: 0	97	7	53	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE	MO DY YR	HR MN SC	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81	17:59:22	1B	109-10	M90	A90	16:53:04

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	16:53:11	16:54:34	219	0	16:58:29	-3077	37	83	1
M80-2	16:58:14	16:58:27	175	0	17:00:44	-15	5	13	2
M70-2	17:00:38	17:00:43	172	0	17:03:50	-6	5	5	2
M60-2	17:03:51	17:03:58	171	0	17:06:04	1	5	7	6
M50-2	17:06:07	17:06:16	145	0	17:08:46	3	12	9	5
M40-2	17:08:46	17:09:15	154	0	17:10:37	-1	5	30	1
M30-2	17:10:35	17:10:48	163	0	17:12:04	-2	5	13	1
M20-2	17:12:02	17:12:25	159	0	17:13:33	-2	5	23	1
M16-2	17:13:27	17:13:43	157	0	17:20:02	-6	13	16	1
M10-2	17:20:47	17:20:56	141	0	17:25:32	45	5	9	1
A10-1	17:26:36	17:26:46	311	0	17:30:19	64	7	10	1
A20-1	17:30:12	17:30:35	296	0	17:33:40	-7	7	23	1
A30-1	17:33:29	17:33:42	284	0	17:37:18	-11	7	13	1
A40-1	17:37:15	17:37:56	263	0	17:41:22	-3	7	41	1
A50-1	17:41:14	17:41:33	222	0	17:45:04	-8	7	19	1
A60-1	17:44:39	17:44:39	3600	0	17:48:48	-25	0	0	1
A70-1	17:49:13	17:49:30	203	0	17:54:06	25	7	17	1
A80-1	17:53:52	17:54:10	203	0	17:58:32	-14	17	18	1
A90-1	17:59:02	0: 0: 0	0	0	0: 0: 0	30	7	19	0

392

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:06:42 18 TRAIN 451-04 ORIGIN M90 DESTINATION R65 DISP TIME 16:59:00

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	16:59:07	16:59:16	356	0	17:03:12	-2721	7	9	1
M80-2	17:03:42	17:03:50	123	0	17:06:20	30	5	8	5
M70-2	17:06:31	17:06:40	149	0	17:09:47	11	5	9	2
M60-2	17:09:47	17:10:00	156	0	17:11:49	0	5	13	1
M50-2	17:11:45	17:11:59	153	0	17:14:09	-4	12	14	1
M40-2	17:14:01	17:14:19	151	0	17:15:41	-8	5	18	1
M30-2	17:15:38	17:16:03	155	0	17:17:19	-3	5	25	1
M20-2	17:17:15	17:17:43	163	0	17:18:51	-4	5	28	1
M16-2	17:18:44	17:19:15	146	0	17:25:35	-7	24	31	1
M10-2	17:28:02	17:28:19	121	0	17:32:20	147	5	17	1
K10-1	17:36:24	17:36:47	372	0	17:37:59	244	7	23	1
R20-1	17:37:50	17:38:11	386	0	17:41:39	-9	7	21	1
R30-1	17:41:20	17:42:05	686	0	17:45:25	-19	7	45	1
R10-1	17:45:06	17:45:28	823	0	17:47:46	-19	7	22	1
R20-1	17:47:39	17:48:11	825	0	17:50:34	-27	7	32	1
R30-1	17:50:26	17:50:44	817	0	17:54:04	-8	7	18	1
R40-1	17:53:51	17:54:06	803	0	17:56:58	-13	7	15	1
R50-1	17:56:48	17:57:22	785	0	18:01:00	-10	7	34	1
R60-1	18:02:10	18:02:41	676	0	18:04:51	70	7	31	1
R65-1	18:06:42	0: 0: 0	0	0	0: 0: 0	111	0	0	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:06:50 18 TRAIN ORIGIN DESTINATION DISP TIME
391-10 M90 C60 16:57:09

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M80-2	17:01:39	17:01:44	205	0	17:04:01	-2569	5	5	2
M70-2	17:04:02	17:04:09	204	0	17:07:16	1	5	7	2
M60-2	17:07:11	17:07:18	200	0	17:09:07	-5	5	7	1
M50-2	17:09:12	17:09:22	185	0	17:11:32	5	12	10	1
M40-2	17:11:30	17:11:42	165	0	17:13:04	-2	5	12	1
M30-2	17:13:03	17:13:15	148	0	17:14:31	-1	5	12	1
M20-2	17:14:32	17:14:59	150	0	17:16:07	1	5	27	1
M16-2	17:16:18	17:16:33	171	0	17:22:52	11	7	15	1
M10-2	17:26:01	17:26:11	314	0	17:30:12	189	5	10	1
R10-1	17:30:12	17:30:20	347	0	17:31:32	0	7	8	1
R20-1	17:31:24	17:31:32	304	0	17:35:00	-8	7	8	1
R30-3	17:34:57	17:35:16	449	0	17:37:51	-3	7	19	1
C10-1	17:38:30	17:38:39	328	0	17:43:43	39	7	9	1
C20-1	17:43:34	17:43:44	319	0	17:48:25	-9	7	10	1
C30-1	17:48:24	17:48:32	306	0	17:52:46	-1	7	8	1
C40-1	17:52:44	17:52:55	294	0	17:55:50	-2	7	11	4
C50-1	17:56:05	17:56:18	317	0	18:02:08	15	7	13	1
C60-1	18:06:33	0: 0: 0	0	0	0: 0: 0	265	7	17	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:13:12 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
371-10	M90	C60	17:03:40

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	17:03:47	17:04:04	280	0	17:07:59	-2441	7	17	1
M80-2	17:08:06	17:08:14	264	0	17:10:21	7	5	8	1
M70-2	17:10:22	17:10:27	231	0	17:13:17	1	5	5	1
M60-2	17:13:18	17:13:24	212	0	17:15:13	1	5	6	1
M50-2	17:15:15	17:15:20	210	0	17:17:30	2	7	5	1
M40-2	17:17:32	17:17:42	211	0	17:19:04	2	5	10	1
M30-2	17:19:04	17:19:16	207	0	17:20:32	0	5	12	1
M20-2	17:20:31	17:20:57	196	0	17:22:05	-1	5	26	1
M16-2	17:22:10	17:22:26	206	0	17:28:45	5	14	16	1
M10-2	17:30:31	17:30:42	149	0	17:34:43	106	5	11	1
R10-1	17:38:27	17:38:33	123	0	17:39:45	224	7	6	1
R20-1	17:40:17	17:40:27	147	0	17:43:55	32	7	10	1
R30-3	17:43:42	17:43:56	525	0	17:46:31	-13	7	14	1
C10-1	17:46:43	17:46:51	493	0	17:51:54	12	7	8	1
C20-1	17:51:49	17:51:58	495	0	17:56:39	-5	7	9	1
C30-1	17:56:41	17:56:52	497	0	18:01:06	2	7	11	1
C40-1	18:02:04	18:02:14	560	0	18:04:50	58	7	10	1
C50-1	18:04:51	18:05:04	525	0	18:10:54	1	7	13	1
C60-2	18:12:42	0: 0: 0	0	0	0: 0: 0	108	7	29	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE	DATE TIME	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81 18:14:48	18	111-10	M90	A90	17:06:56

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	17:07:03	17:07:17	196	0	17:11:12	-2245	7	14	1
M80-2	17:10:56	17:11:06	170	0	17:13:23	-16	5	10	3
M70-2	17:13:18	17:13:27	176	0	17:16:42	-5	5	9	5
M60-2	17:16:25	17:16:32	186	0	17:18:27	-17	5	7	2
M50-2	17:18:25	17:18:47	190	0	17:21:03	-2	23	22	2
M4 -2	17:21:00	17:21:16	208	0	17:22:38	-3	5	16	2
M30-2	17:22:43	17:22:55	218	0	17:24:11	5	5	12	2
M20-2	17:24:11	17:24:31	220	0	17:25:44	0	5	20	2
M16-2	17:25:33	17:25:53	203	0	17:32:59	-11	25	20	2
M1 -2	17:33:24	17:33:40	173	0	17:38:11	25	5	16	2
A10-1	17:40:40	17:40:55	471	0	17:44:45	149	7	15	2
A20-1	17:44:42	17:44:52	471	0	17:48:06	-3	7	10	2
A30-1	17:48:03	17:48:12	473	0	17:52:08	-3	7	9	2
A40-1	17:52:05	17:52:17	469	0	17:56:09	-3	7	12	2
A50-1	17:55:54	17:56:13	468	0	18:00:03	-15	7	19	2
A6 -1	17:59:42	17:59:42	3600	0	18:03:51	-21	0	0	2
A70-1	18:04:13	18:04:26	466	0	18:09:28	22	7	13	2
A80-1	18:09:23	18:09:36	459	0	18:14:19	-5	7	13	2
A90-1	18:14:25	0: 0: 0	0	0	0: 0: 0	6	7	23	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

CODE		TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81 18:18:21	1B	453-06	M90	R65	17:09:54

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	17:10:01	17:13:02	178	0	17:16:57	-2067	176	181	1
M80-2	17:17:05	17:17:30	369	0	17:19:47	8	5	25	2
M70-2	17:19:44	17:19:53	386	0	17:23:00	-3	5	9	2
M60-2	17:22:51	17:23:05	386	0	17:25:00	-9	5	14	2
M50-2	17:24:56	17:25:12	391	0	17:27:28	-4	9	16	2
M40-2	17:27:42	17:28:01	402	0	17:29:23	14	5	19	2
M30-2	17:29:23	17:29:44	400	0	17:31:00	0	5	21	2
M20-2	17:30:59	17:31:38	408	0	17:32:51	-1	5	39	2
M16-2	17:32:41	17:33:16	428	0	17:40:22	-10	20	35	2
MI0-2	17:40:12	17:40:26	408	0	17:44:32	-10	5	14	2
RI0-1	17:44:28	17:45:02	211	0	17:46:14	-4	27	34	2
R20-1	17:46:07	17:46:31	197	0	17:50:03	-7	25	24	6
R30-1	17:49:52	17:50:18	208	0	17:53:40	-11	20	26	3
RI0-1	17:53:41	17:53:57	221	0	17:56:27	1	15	16	3
R20-1	17:56:27	17:57:17	226	0	17:59:40	0	24	50	2
R30-1	17:59:39	17:59:49	218	0	18:03:27	-1	7	10	2
R40-1	18:03:22	18:03:38	217	0	18:06:45	-5	7	16	2
R50-1	18:06:41	18:06:55	200	0	18:10:45	-4	14	14	2
R60-1	18:13:58	18:14:18	384	0	18:16:28	193	7	20	2
R65-2	18:18:21	0: 0: 0	0	0	0: 0: 0	113	0	0	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:27:42 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
373-10	M90	C60	17:15:01

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	17:15:08	17:18:12	307	0	17:22:07	-1760	172	184	1
M80-2	17:21:55	17:22:02	290	0	17:24:19	-12	5	7	3
M70-2	17:24:15	17:24:31	271	0	17:27:46	-4	5	16	5
M60-2	17:27:26	17:27:31	275	0	17:29:37	-20	5	5	6
M50-2	17:29:26	17:29:46	270	0	17:32:19	-11	22	20	6
M40-2	17:31:57	17:32:13	255	0	17:33:38	-22	5	16	6
M30-2	17:33:52	17:34:33	269	0	17:35:54	14	5	41	6
M20-2	17:35:51	17:36:30	292	0	17:37:43	-3	5	39	2
M16-2	17:38:18	17:38:45	337	0	17:45:51	35	7	27	2
M10-2	17:45:41	17:46:06	329	0	17:50:12	-10	5	25	2
R10-1	17:50:05	17:50:25	337	0	17:51:37	-7	7	20	2
R20-1	17:51:29	17:51:41	322	0	17:55:09	-8	7	12	2
R30-3	17:54:56	17:55:13	674	0	17:58:24	-13	20	17	4
C10-1	17:58:06	17:58:23	683	0	18:04:00	-18	15	17	2
C20-1	18:03:47	18:04:04	718	0	18:09:27	-13	20	17	3
C30-1	18:09:04	18:09:26	743	0	18:14:30	-23	25	22	5
C40-1	18:13:59	18:14:27	715	0	18:17:47	-31	30	28	6
C50-1	18:17:13	18:17:35	742	0	18:24:44	-34	25	22	5
C60-1	18:27:20	0: 0: 0	0	0	0: 0: 0	156	7	22	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:30:02 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
113-09	M90	A90	17:19:21

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWLL	ACT DWL	PL
M90-1	17:19:27	17:22:59	259	0	17:26:54	-1501	210	212	1
M80-2	17:27:02	17:27:08	307	0	17:29:25	8	5	6	2
M70-2	17:29:23	17:29:30	308	0	17:32:45	-2	5	7	5
M60-2	17:32:56	17:33:03	330	0	17:34:59	11	5	7	2
M50-2	17:34:58	17:35:04	332	0	17:37:20	-1	7	6	2
M40-2	17:37:20	17:37:39	323	0	17:39:04	0	5	19	6
M30-2	17:39:04	17:39:17	312	0	17:40:38	0	5	13	6
M20-2	17:40:37	17:40:57	286	0	17:42:09	-1	5	20	6
M10-2	17:42:03	17:42:26	225	0	17:49:56	-6	25	23	3
M1 -2	17:49:21	17:49:31	221	0	17:54:10	-35	5	10	6
A10-1	17:54:07	17:54:30	380	0	17:58:52	-3	25	23	5
A20-1	17:58:45	17:59:02	412	0	18:02:55	-7	20	17	5
A30-1	18:02:36	18:02:51	442	0	18:06:47	-19	15	15	2
A40-1	18:06:39	18:06:57	440	0	18:11:07	-8	20	18	5
A50-1	18:11:02	18:11:20	473	0	18:15:18	-5	20	18	3
A6 -1	18:14:52	18:14:52	3600	0	18:19:02	-26	0	0	3
A70-1	18:19:17	18:19:34	468	0	18:25:01	15	20	17	4
A80-1	18:24:58	18:25:06	391	0	18:29:49	-3	7	8	2
A90-1	18:29:45	0: 0: 0	0	0	0: 0: 0	-4	7	17	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:29:24 18

TRAIN	ORIGIN	DESTINATION	DISP TIME
455-04	M90	R66	17:23:19

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	17:23:25	17:28:02	238	0	17:31:57	-1293	275	277	1
M80-2	17:31:52	17:31:59	290	0	17:34:16	-5	5	7	3
M70-2	17:34:21	17:34:29	298	0	17:37:44	5	5	8	5
M60-2	17:37:57	17:38:05	301	0	17:40:00	13	5	8	2
M50-2	17:39:59	17:40:05	301	0	17:42:22	-1	7	6	2
M40-2	17:42:29	17:42:41	309	0	17:44:06	7	5	12	6
M30-2	17:44:08	17:44:35	304	0	17:45:54	2	5	27	4
M20-2	17:45:54	17:46:19	318	0	17:47:31	0	5	25	6
M16-2	17:47:28	17:47:52	325	0	17:54:58	-3	25	24	2
M10-2	17:55:02	17:55:15	340	0	17:59:30	4	5	13	6
R10-1	17:59:32	17:59:56	388	0	18:01:11	2	25	24	5
R20-1	18:01:06	18:01:30	377	0	18:05:02	-5	26	24	6
R30-1	18:04:55	18:05:13	388	0	18:08:40	-7	20	18	4
R10-1	18:08:56	18:09:06	386	0	18:11:32	16	7	10	2
R20-1	18:11:33	18:11:52	390	0	18:14:15	1	19	19	2
R30-1	18:14:23	18:14:32	392	0	18:18:10	8	7	9	2
R40-1	18:18:27	18:18:37	405	0	18:21:44	17	7	10	2
R50-1	18:21:47	18:22:02	403	0	18:25:52	3	8	15	2
R60-1	18:26:17	18:26:42	414	0	18:28:52	25	7	25	2
R65-2	18:29:24	0: 0: 0	0	0	0: 0: 0	32	0	0	0

~~BARTD SYSTEM LOG TAPE~~

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:40:28 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
375-10	M90	C60	17:30:19

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWLI	ACT DWL	PL
M90-1	17:30:25	17:33:10	420	0	17:37:05	-843	152	165	1
M80-2	17:37:14	17:37:19	322	0	17:39:36	9	5	5	2
M70-2	17:39:38	17:39:44	317	0	17:42:51	2	5	6	2
M60-2	17:42:48	17:42:55	291	0	17:44:53	-3	5	7	3
M50-2	17:44:57	17:45:03	298	0	17:47:19	4	8	6	2
M40-2	17:47:22	17:47:40	293	0	17:49:05	3	5	18	6
M30-2	17:49:06	17:49:19	298	0	17:50:40	1	5	13	6
M20-2	17:50:42	17:51:10	287	0	17:52:22	2	5	28	6
M16-2	17:52:16	17:52:40	288	0	17:59:46	-6	25	24	2
M10-2	17:59:42	17:59:51	280	0	18:04:06	-4	5	9	6
K10-1	18:03:55	18:04:23	263	0	18:05:39	-11	30	28	6
K20-1	18:05:30	18:05:57	264	0	18:09:29	-9	30	27	6
K30-3	18:09:16	18:10:25	860	0	18:13:14	-13	30	69	3
C10-1	18:13:35	18:13:48	929	0	18:19:24	21	7	13	2
C20-1	18:19:17	18:19:33	930	0	18:24:42	-7	17	16	2
C30-1	18:24:37	18:24:59	933	0	18:29:43	-5	25	22	3
C40-1	18:29:42	18:30:08	943	0	18:33:03	-1	25	26	4
C50-1	18:33:16	18:33:32	963	0	18:39:55	13	11	16	2
C60-2	18:40:00	0: 0: 0	0	0	0: 0: 0	5	16	28	0

BARTD SYSTEM LOG TAPE PAGE 212

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 18:45:01 1B	TRAIN	ORIGIN	DESTINATION	DISP TIME
	115-06	M90	A90	17:35:53

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	17:35:59	17:38:03	334	0	17:41:58	-509	121	124	1
M80-2	17:41:44	17:41:50	270	0	17:44:20	-14	5	6	5
M70-2	17:44:29	17:44:41	291	0	17:47:48	9	5	12	2
M60-2	17:47:41	17:47:48	293	0	17:49:50	-7	5	7	5
M50-2	17:49:58	17:50:04	301	0	17:52:20	8	7	6	2
M40-2	17:52:23	17:52:33	301	0	17:53:58	3	5	10	6
M30-2	17:54:00	17:54:29	294	0	17:55:50	2	5	29	6
M20-2	17:56:12	17:56:35	330	0	17:57:48	22	5	23	2
M16-2	17:57:39	17:57:59	323	0	18:05:05	-9	22	20	2
M10-2	18:04:59	18:05:20	317	0	18:09:59	-6	5	21	6
A10-1	18:10:13	18:10:33	366	0	18:14:23	14	21	20	2
A20-1	18:14:22	18:14:40	383	0	18:17:54	-1	20	18	2
A30-1	18:17:51	18:18:05	394	0	18:22:01	-3	15	14	2
A40-1	18:22:00	18:22:17	389	0	18:26:01	-1	18	17	3
A50-1	18:26:05	18:26:24	407	0	18:30:14	4	20	19	2
A60-1	18:29:54	18:29:54	3600	0	18:34:05	-20	0	0	2
A70-1	18:34:29	18:34:49	434	0	18:40:01	24	20	20	3
A80-1	18:39:58	18:40:10	250	0	18:44:53	-3	7	12	2
A90-1	18:44:48	0: 0: 0	0	0	0: 0: 0	-5	7	12	0

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE: MO DY YR HR MN SC TASK

07 08/25/81 18:44:07 1B

TRAIN	ORIGIN	DESTINATION	DISP TIME
457-05	M90	R65	17:40:30

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	17:40:36	17:42:54	277	0	17:46:49	-232	141	138	1
M80-2	17:47:06	17:47:12	322	0	17:49:29	17	5	6	2
M70-2	17:49:32	17:49:41	303	0	17:52:48	3	5	9	2
M60-2	17:52:39	17:52:46	298	0	17:54:52	-9	5	7	6
M50-2	17:54:58	17:55:05	300	0	17:57:21	6	7	7	2
M40-2	17:57:24	17:57:35	301	0	17:59:00	3	5	11	6
M30-2	17:59:01	17:59:21	301	0	18:00:42	1	5	20	6
M20-2	18:00:42	18:01:20	270	0	18:02:32	0	5	38	6
M16-2	18:02:27	18:02:50	288	0	18:09:56	-5	25	23	2
MI -2	18:09:46	18:09:55	287	0	18:14:10	-10	5	9	6
K10-1	18:14:02	18:14:43	364	0	18:15:59	-8	30	41	6
R20-1	18:15:52	18:16:19	371	0	18:19:51	-7	30	27	6
R30-1	18:19:40	18:20:27	340	0	18:23:47	-11	21	47	2
R10-1	18:23:45	18:23:57	350	0	18:26:23	-2	14	12	2
R20-1	18:26:20	18:27:02	356	0	18:29:25	-3	27	42	2
R30-1	18:29:22	18:29:33	386	0	18:33:11	-3	8	11	2
R40-1	18:33:08	18:33:25	394	0	18:36:32	-3	20	17	2
R50-1	18:36:28	18:36:45	392	0	18:40:35	-4	20	17	2
R60-1	18:40:35	18:42:00	378	0	18:44:10	0	25	85	2
R65-2	18:44:07	0: 0: 0	0	0	0: 0: 0	-3	0	0	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 2-8/25/81--CLAPP

CODE	MO DY YR	HR MN SC	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81	18:55:05	18	377-09	M90	C60	17:44:09

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	17:44:16	17:48:07	220	0	17:52:02	-12	224	231	1
M80-2	17:52:00	17:52:07	294	0	17:54:24	-2	5	7	3
M70-2	17:54:32	17:54:41	300	0	17:57:48	8	5	9	2
M60-2	17:57:43	17:57:51	304	0	17:59:53	-5	5	8	5
M50-2	18:00:01	18:00:08	303	0	18:02:24	8	7	7	2
M40-2	18:02:26	18:02:35	302	0	18:04:00	2	5	9	6
M30-2	18:04:04	18:04:16	303	0	18:05:37	4	5	12	6
M20-2	18:05:41	18:06:00	299	0	18:07:12	4	5	19	6
M16-2	18:07:15	18:07:38	288	0	18:15:08	3	25	23	3
M10-2	18:14:55	18:15:03	309	0	18:19:18	-13	5	8	6
R10-1	18:19:21	18:19:50	319	0	18:21:06	3	30	29	6
R20-1	18:20:58	18:21:28	306	0	18:25:00	-8	30	30	6
R30-3	18:24:57	18:25:17	941	0	18:28:06	-3	20	20	3
C10-1	18:28:29	18:28:41	894	0	18:34:17	23	9	12	2
C20-1	18:34:17	18:34:34	900	0	18:39:43	0	17	17	2
C30-1	18:39:45	18:40:03	908	0	18:44:46	2	23	18	3
C40-1	18:44:57	18:45:14	915	0	18:48:04	11	19	17	2
C50-1	18:48:07	18:48:27	891	0	18:54:50	3	21	20	2
C60-1	18:54:38	0: 0: 0	0	0	0: 0: 0	-12	30	26	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST No. 1 - 08/25/81 CLAPP

CODE	MO DY YR	HR MN SC	TASK	TRAIN	ORIGIN	DESTINATION	DISP TIME
07	08/25/81	19:02:30	12	117-06	M90	A90	17:53:31

LOC	ARR TIME	DEP TIME	HDWAY	STRAN	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-2	17:53:37	17:53:55	[illegible]	0	17:57:51	[illegible]	7	19	1
M80-2	17:57:35	17:57:48	335	0	18:00:05	-16	6	13	2
M70-2	18:00:09	18:00:22	331	0	18:03:29	-2	5	19	2
M60-2	18:03:19	18:03:31	336	0	18:05:26	-10	5	12	2
M50-2	18:05:22	18:05:33	321	0	18:07:49	-4	7	11	2
M40-2	18:07:46	18:08:15	320	0	18:09:37	-2	5	29	2
M30-2	18:09:42	18:10:43	339	0	18:11:59	5	6	61	2
M20-2	18:12:58	18:13:17	498	0	18:14:30	59	6	19	2
M16-2	18:15:40	18:15:59	505	0	18:22:05	70	7	19	2
M10-2	18:25:04	18:25:45	609	0	18:30:21	119	6	41	1
A10-1	18:30:18	18:30:31	767	0	18:35:04	-2	7	13	1
A20-1	18:34:33	18:34:44	783	0	18:37:49	29	7	11	1
A30-1	18:37:38	18:37:46	764	0	18:41:22	-11	7	8	1
A40-1	18:41:18	18:41:32	741	0	18:44:58	-4	7	14	1
A50-1	18:44:50	18:45:06	730	0	18:48:37	-8	7	16	1
A60-1	18:48:17	18:48:17	3600	0	18:52:28	-20	0	0	1
A70-1	18:52:54	18:53:11	737	0	18:57:47	26	7	17	1
A80-1	18:57:48	18:58:02	543	0	19:02:24	1	7	14	1
A90-1	19:02:10	01 01 0	0	0	01 01 0	-14	7	20	0

BARTD SYSTEM LOG TAPE

ENERGY CONSUMPTION TEST NO. 1 - 08/25/81 CLAPP

CODE MO DY YR HR MN SC TASK

07 08/25/81 19:01:31 18 TRAIN 459-03 ORIGIN M90 DESTINATION R65 DISP TIME 17:55:59

LOC	ARR TIME	DEP TIME	HDWAY	STRAT	PRED ARR	RUN DEV	ADJ DWL	ACT DWL	PL
M90-1	17:55:05	17:58:01	148	0	18:01:56	697	112	115	1
M80-2	18:02:14	18:02:21	279	0	18:04:38	18	5	7	2
M70-2	18:04:39	18:04:48	277	0	18:07:55	1	5	9	2
M60-2	18:07:49	18:07:57	270	0	18:09:52	-6	5	8	2
M50-2	18:09:53	18:10:01	271	0	18:12:17	1	12	8	2
M40-2	18:12:16	18:12:27	270	0	18:13:52	-1	5	11	6
M30-2	18:13:54	18:14:19	251	0	18:15:40	2	5	25	6
M20-2	18:16:22	18:17:20	203	0	18:18:33	42	5	58	2
M16-2	18:18:33	18:19:13	173	0	18:26:19	0	7	40	2
M10-2	18:27:59	18:28:17	175	0	18:32:24	100	5	18	2
K10-1	18:32:27	18:32:45	581	0	18:33:57	3	7	18	2
K20-1	18:33:52	18:34:03	563	0	18:37:31	-5	7	11	2
R30-1	18:37:24	18:37:44	549	0	18:41:04	-7	7	20	2
R10-1	18:41:05	18:41:14	529	0	18:43:40	1	7	9	2
R20-1	18:43:39	18:43:57	511	0	18:46:20	-1	7	18	2
R30-1	18:46:22	18:46:34	509	0	18:50:12	2	7	12	2
R40-1	18:50:25	18:50:37	527	0	18:53:44	13	7	12	2
R50-1	18:53:41	18:53:54	521	0	18:57:44	-3	7	13	2
R60-1	18:57:44	18:58:28	507	0	19:00:38	0	7	44	2
R65-2	19:01:31	0: 0: 0	0	0	0: 0: 0	59	0	0	0

APPENDIX B

TEST PROCEDURE
FOR
LINE RECEPTIVITY TEST

B.1 TEST OBJECTIVE

This test is to determine energy consumption of a regenerative chopper car in evening rush hour traffic.

B.2 TEST EQUIPMENT AND INSTRUMENTATION

Three cars of a revenue train and seven substations will be instrumented to measure energy consumption at different substations and the test vehicles.

B.2.1 TEST TRACK

This test shall be performed on the ML and MR tracks between Daly City and about one-third mile beyond the Embarcadero Station (approximately between the mile posts at 6.00 and 15.30).

The electrical network for this part of the BART system shall be isolated from the rest of the system by opening the switches MWG1 (between ML05 and ML04) and MWG2 (between MR05 and MR04). These two switches shall be left open during the entire test period.

B.2.2 VEHICLES

Three instrumented cars are required for this test. One of the three cars shall be the engineering test car and it shall carry all the recording equipment as defined in Appendix D. This engineering car shall not carry any passengers. Two revenue B-cars shall also be instrumented as defined in Appendix D, but shall also carry passengers. Additional cars shall be added to this consist to make up a revenue train; these cars shall not be instrumented and shall carry passengers. The rest of the fleet in regular revenue service is not instrumented for this test.

B.2.3 INSTRUMENTATION

The data on the test vehicle shall be recorded on two 14-channel FM magtape recorders. The variables to be recorded and the requirements and the location of the sensors are presented in Appendix D.

The data at the substations shall be recorded on a (minimum) 4-channel tape recorder. The following variables shall be recorded:

Channel	Variables
1	Third rail voltage
2	Current in Rectifier Bridge #1
3	Current in Rectifier Bridge #2
4	Time

The voltage and current sensors are already in place at each of the seven substations. These sensors shall be calibrated if necessary.

B.3 TEST PROCEDURE

1. Confirm that all the system computers are up.
2. Identify data tapes with test number, date and substation name at the seven substations. Start all the recorders prior to 1500 hours.
3. Board test train (train 451) at Richmond Yard prior to 1430 and verify all instrumentation running and calibrated.
4. Identify data tapes with test number, date and train number. Start recorders upon dispatch.

5. Have Train Operator verify with Central that gap breakers MWG 1 and MWG 2 are open.
6. Train will leave Richmond Yard at 1553 hours, and make one round trip to Daly City and return. Stop recorders upon arrival at Richmond Yard.
7. Stop the seven substation recorders after 1900 hours.
8. Repeat this entire procedure for a period of five working days.
9. Fill out request for system history log.
10. Fill out request for train loading report.
11. Fill out request for Valencia St. Switching Station energy consumption data.

B.4 TEST DATA

At the end of each day's running, all the recorded data tapes from wayside and vehicle shall be reviewed to determine that the data has in fact been recorded on the tapes. This shall be done by making random spot checks on the tapes.

B.5 DATA REDUCTION

The data collected during these tests shall be reduced according to the requirements specified in Appendix E.

APPENDIX C

TEST PROCEDURE
FOR
BASELINE ENERGY CONSUMPTION TEST

C.1 TEST OBJECTIVE

This test is to determine energy consumption of a chopper car without regeneration.

C.2 TEST EQUIPMENT AND INSTRUMENTATION

Three cars and seven substations will be instrumented to measure energy consumption at different substations and the test vehicles.

C.2.1 TEST TRACK

This test shall be performed on the ML and MR tracks between the Daly City and Embarcadero Stations (M16-M90) approximately between the mile posts at 7.25 and 15.30. Exclusive use of the M-line between mile posts 6.00 and 15.30 is required.

The electrical network for this part of the BART system shall be isolated from the rest of the system by opening the switches MWG1 (between ML05 and ML04) and MWG2 (between MR05 and MR04). These two switches shall be left open during the entire test period.

C.2.2 VEHICLES

One four-car train consisting of the three cars that are instrumented for the Line Receptivity Test and one revenue A-car are required for this test.

C.2.3 INSTRUMENTATION

The instrumentation requirements are identical to those of the Line Receptivity Test described earlier.

C.3 TEST PROCEDURE

1. Confirm that all the system computers are up.
2. Verify all onboard instrumentation is operational and calibrated.
3. Position the test train at Daly City prior to 0200 hours.
4. Identify recorders and data tapes with test number, date and substation name at the seven substations. Start all the recorders prior to 0200 hours.
5. Record car numbers, instrumentation weight, ballast weight, if any, test crew names and weight including the train operator.
6. Identify onboard data tapes with test number, date and train number.
7. Mark the start of run on channel 12 of the tape recorder A by using switch provided.
8. Dispatch the train to Embarcadero under ATO control, making all station stops with nominal 20 second dwell times and 150 second turn back.
9. Repeat 7.
10. Dispatch train back to Daly City, making all the station stops with nominal 20 second dwell times and 150 second turn back.
11. Repeat 7 through 10 for as many number of times as possible.
12. At the end of the test period, stop all the recorders.
13. Fill out request for system history log.
14. Fill out request for Valencia St. Switching Station energy consumption data for the test period.
15. The entire procedure shall be repeated for a total of minimum of eight round trips between the Daly City and Embarcadero stations.

C.4 TEST DATA

At the end of each night's running, all the recorded tapes shall be reviewed to determine that the data has in fact been recorded on the tapes. This shall be done by making random spot checks on the tapes.

C.5 DATA REDUCTION

The data collected during these tests shall be reduced according to the requirements specified in Appendix E.

APPENDIX D

DATA REDUCTION REQUIREMENTS

The objective of this test program is to obtain sufficient and relevant data regarding energy consumption of transit cars to be able to validate computer models predicting the same. Three types of data reduction are defined here. The data reduction requirements of different tests are then specified in terms of these types.

Type A (Correlation of Several Variables in Time)

Variable No.	Variable
1-8	Total kW and station kW for seven stations
9	Vehicle input kW
10	Vehicle auxiliary kW
11	Vehicle traction kW
12	Series resistance kW/Motor kW in braking
13	Dynamic braking kW/Motor kW in braking
14	Traction kW/Motor kW in braking
15	input kW/Motor kW in braking
16	Vehicle speed
17	Vehicle input current, I_L
18	Vehicle input voltage, V_L

All these variables have been defined later in terms of observed variables.

Type B (Average Energy Consumption)

The following variables will be printed and plotted as functions of time by taking average values oveı 1-minute intervals. The averages for individual runs between Daly City and the end of the test track section and similar return runs will also be computed and printed out.

Variable No.	Variable
1-8	Total kW and station kW for seven stations
9	Vehicle input kW
10	Vehicle auxiliary kW
11	Vehicle traction kW

Following variables will be computed for individual runs.

Variable No.	Variable
1-8	Total kWh and station kWh for seven stations
9	Vehicle input kWh
10	Vehicle auxiliary kWh
11	Vehicle traction kWh
12	Motor kWh in braking
13	Series resistance kWh/Motor kWh in braking
14	Dynamic braking kWh/Motor kWh in braking
15	Traction kWh/Motor kWh in braking
16	Input kWh/Motor kWh in braking

Type C (Average Energy Consumption)

Station kW for the seven substations and the total kW will be plotted as functions of time by taking 1 minute averages.

Type D (Average Energy Consumption)

Station kW for the seven substations and the total kW will be printed out as functions of time by taking 15-minute averages.

The data collected during all the tests will be reduced as follows:

Test	Data Reduction
Regeneration Test	Type A for one run
	Type B for all runs
	Type C for one rush hour period
	Type D for all the data
Baseline Test	Type A for one round trip
	Type B for all runs

The output variables are to be computed from the observed variables by using the following equations:

Vehicle input voltage $V_L = V + 0.00185\ (I_L - I_X)$

Traction current $I_T = I_L - I_X$

Vehicle input kW $= V_L \cdot I_L$

Vehicle Aux. kW $= V_L \cdot I_X$

Vehicle traction kW $= V_L \cdot I_T$

Dynamic braking kW $= 0.75\ I_{DB}^2$

Series resistance kW $= R_{eq} \cdot I_{DR}^2$

Motor kW $= 2.V_M\ (I_{MX} + I_{MY}) - 0.036\ (I_{MX}^2 + I_{MY}^2)$

where the equivalent resistance R_{eq} is computed in three steps as follows:

Step 1 : Compute T

$$T = (47/15)\ I \quad \text{for } I \leq 150$$
$$= (69/11).(I - 75) \quad \text{for } I > 150$$

Step 2 : Compute N_2 and N_3

$$N_2 = 22 + (15/3100)\,T$$

$$N_3 = 28 + (27/3100)\,T$$

Step 3 : Compute R_{eq}

$$\begin{aligned} R_{eq} &= 0.0 \text{ ohm} && \text{for } N \le 17 \\ &= 0.1 \text{ ohm} && \text{for } 17 < N \le N_2 \\ &= 0.405 \text{ ohm} && \text{for } N_2 < N \le N_3 \\ &= 0.71 \text{ ohm} && \text{for } N > N_3 \end{aligned}$$

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