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REPORT NO. UMTA-MA-06-0041-77-8

A COMPREHENSIVE FIELD TEST AND EVALUATION OF AN ELECTRONIC SIGNPOST AVM SYSTEM
Volume I: Test Results

G. W. Gruver

Hoffmann Information Identification Inc.
Fort Worth TX 76107



AUGUST 1977
FINAL REPORT

43589

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Prepared for

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URBAN MASS TRANSPORTATION ADMINISTRATION
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Washington DC 20590

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16. Abstract

A comprehensive test of a direct proximity electronic signpost AVM system was conducted under operational conditions in downtown Philadelphia. Tests involved operation of a test vehicle while operating as a random route vehicle; e.g., police, taxi; and a fixed route vehicle; e.g., a transit bus. During random route tests, the vehicle operated on an unrestricted basis in a designated area in which the Hoffman overlapping signpost AVM system was installed. The vehicle's location was computed every 0.5 second by the AVM system and compared with its actual location at designated "checkpoints" in the random route area. In the random route tests, the system showed the capability of locating the vehicle to within 282 feet, at 95 percent of the sample points under a wide range of urban and environmental conditions.

Fixed route tests involved operation as a transit bus. An odometer and 15 signposts provided the vehicle's location to within 105 feet at 95% of the sample points along a 13 mile route. The time of passage of designated bus schedule "timepoint" was automatically determined to within 11 seconds 95 percent of the time.

This report contains two volumes. Volume II is an appendix.

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Automatic Vehicle Location System (AVL), Automatic Vehicle Monitoring System (AVM), Electronic Signpost, Direct Proximity, Random Route AVM, Fixed Route AVM, Multi-User AVM	DOCUMENT IS AVAILABLE TO THE U.S. PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

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PREFACE

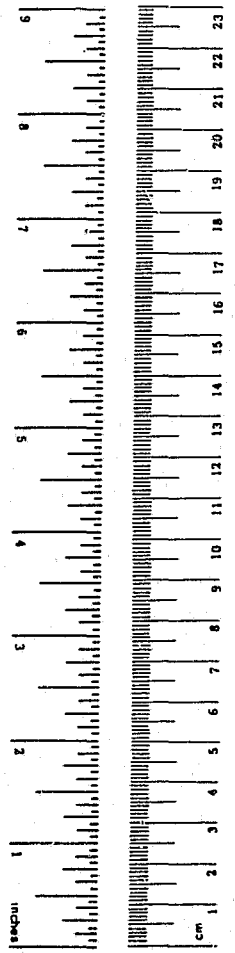
During the winter of 1976-77, four different techniques for automatically locating land vehicles were tested in both the low- and high-rise regions in Philadelphia, Pa. The tests were carried out by four different companies under separate contracts to the United States Department of Transportation, Transportation Systems Center. The tests were designed to evaluate the techniques for their applicability as location subsystems for automatic vehicle monitoring systems. This document represents one of the contractors' final report. A summary report on all systems tested is available as Report No. UMTA-MA-06-0041-77-2. This report describes the Phase I program which involved the installation and test of the Hoffman AVM System. Dr. George W. Gruver, the program director for Hoffman, prepared the report and personally conducted most of the testing. Ron Waits developed all of the program software and processed the test data. Jerry McKinney was in charge of the location and test equipment deployment and also performed most of the driving during formal tests.

We want to thank all of the technical, program, and contract personnel at the DOT. In particular the personnel in the offices of Messrs Blood, Symes, and Nelson were very helpful and enthusiastic. A special thanks is given to Bernie Kliem, our technical monitor and Joe Herlihy, who helped monitor our test. Also, Mr. Jack Ludwick of the Mitre Corporation helped make our software task much easier. We would also like to thank the many people in the City of Philadelphia who assisted us in deploying and housing our equipment.

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



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

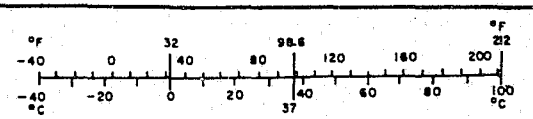


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1. INTRODUCTION

The application of Automatic Vehicle Monitoring (AVM) to enhance the management of mobile resources has, in recent years, become a subject of continued interest to all types of fleet vehicle operations. Transit, police, cargo, and mining operations have been involved in the development of AVM systems and are currently gathering data pertinent to quantifying the cost/benefits of AVM in a variety of commercial and service operations.

The United States Department of Transportation (DOT) has been interested in AVM for nearly a decade; this interest being directed, in particular, to improving transit and para-transit management activities. Under the sponsorship of the Urban Mass Transportation Authority (UMTA), the DOT is currently attempting to quantify the improvements which AVM can provide to transit, para-transit, and other types of fleet operations. This report contains the interim results obtained by Hoffman Information Identification, Inc. (HI^3) of Fort Worth, Texas, as a contractor to the Transportation Systems Center of the DOT on the UMTA Multi-User AVM Contract DOT-TSC-1237. This report covers the activities of Phase I which involved the installation and test of a HI^3 AVM System in the City of Philadelphia during the winter of 1976-1977. These tests represent the most extensive tests ever performed on an AVM system which can locate vehicles which operate either as fixed-route vehicles (transit) or as random-route vehicles (police, para-transit, taxi, etc.).

This volume contains a description of all test configurations, test procedures, location algorithms, data processing, and test results. An Appendix, Volume II, contains the test data and detailed data processing results.

2. EXECUTIVE SUMMARY

In September 1976, the Transportation Systems Center of the U.S. Department of Transportation entered into contracts with four companies for the design, development and deployment of a multi-user Automatic Vehicle Monitoring (AVM) System which can be deployed in any city. Hoffman Information Identification Incorporated (HI^3) of Fort Worth, Texas, a wholly owned subsidiary of Hoffman Electronics Corporation and its subcontractor, IBM, received one of these contracts. The program, sponsored by the Urban Mass Transportation Administration (UMTA) is referred to as Multi-User AVM since it is intended to provide AVM benefits to a multiplicity of users, including those fleets of vehicles which generally travel on fixed routes (transit) and those which may travel random routes (taxis, para-transit, dial-a-ride, police, pick-up and delivery, etc.).

The objectives of the Multi-User AVM program were to design, implement, and operate a multi-user AVM system in Los Angeles for the purpose of making a quantitative evaluation of AVM effectiveness, first for transit and para-transit, and second for other AVM users. From the outset, the program was divided into two phases. Phase I, which Hoffman completed on 28 February 1977, involved the demonstration and test of each contractor's vehicle location subsystem in Philadelphia, Pa. Phase II, which will be performed by one of the four contractors, will include the design, development, implementation, test, and operational support of a modern transit management system using a reliable, economical AVM system. The Phase II program will be conducted in conjunction with the Southern California Rapid Transit District (SCRTD) and other users, to be specified, in the Los Angeles area. The primary objective set for Phase I was that of quantifying through formal controlled tests, the ability of each contractor's AVM system to meet specified vehicle location and bus time-of-passage requirements.

The results presented in this report show that the HI^3 AVM system proposed for Phase II can provide a transit dispatcher with the location of all buses to within an accuracy of 105 feet 95 percent of the time. The average error in bus location was less than 50 feet for all Phase I tests. As an aid to providing improved service through adherence to schedule, the HI^3 AVM system can provide the time-of-passage of buses to within 11 seconds for 95 percent of the occurrences in which the bus fleet passes predesignated "timepoints". The average time-of-passage error for Phase I was 3.9 seconds. The same HI^3 AVM system can provide a dispatcher with the location of each unit of a fleet of random route vehicles, e.g., police, taxi, etc., to within 282 feet 95 percent of the time.

The overall goal of HI^3 during Phase I was to demonstrate the reliable and accurate performance of the HI^3 nationwide AVM system under conditions to be expected in the operation of a multi-user AVM system in any city in the United States. During previous UMTA AVM development programs, beginning

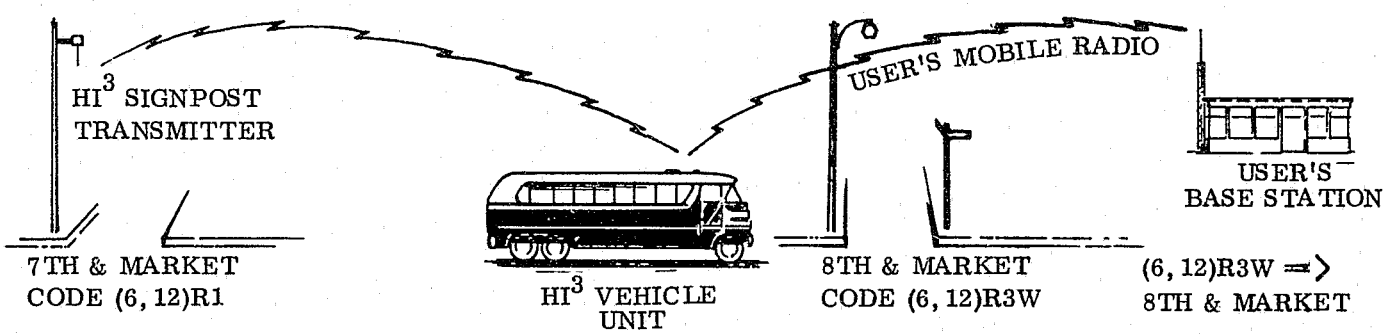
in 1970 with the "Monitor CTA" and including tests of several different location techniques in Philadelphia in 1972, UMTA and TSC developed a high degree of understanding of the requirements for a multi-user AVM system. In establishing the Statement of Work for Phase I, these requirements were translated into an explicit set of vehicle location test requirements. In response to these requirements, HI^3 prepared a Location Subsystem Test Requirements Plan which formed the basis for all Phase I tests, data processing and analyses.

Phase I tests were divided into two primary categories: (1) random route tests, and (2) fixed route tests. This report is organized in the same order, which was the order in which the HI^3 tests were conducted. A third category involved special case tests. These tests were conducted at various times throughout Phase I in Fort Worth, Texas, and in Philadelphia, Pa. The random route test equipment, data acquisition techniques and test data are described in Section 3. Random route data processing is described in Section 4. The results of the data processing and analysis are contained in Section 5. Similar information appropriate to fixed route tests, data processing and results are presented in Sections 6, 7, and 8 respectively. The special case tests are described and results are presented in Section 9. Section 10 has been dedicated to the presentation of a number of items which pertain directly to Phase II. These items include (1) the relationship between Phase I and Phase II equipment, (2) a proposed method for eliminating the use of an odometer on fixed route vehicles, (3) FCC requirements and the status of HI^3 equipment, (4) Federal, State, and local requirements for Phase II, (5) a discussion of a hybrid signpost-Loran system for "over-the-road" vehicles, and (6) special considerations pertinent to Phase II.

2.1 HI^3 AVM TECHNIQUE

HI^3 proposed to use a direct proximity signpost AVM system during Phase II and all Phase I tests were conducted through the use of a Phase II signpost system. As illustrated in Figure 2-1, the HI^3 AVM system receives basic location information, in the vehicle, as a result of the vehicle equipment receiving digitally coded RF transmissions from electronic "signposts." Each signpost transmits a unique 16-BIT code which represents an address (or an X, Y coordinate) in the city analogous to visual street sign identification. The vehicle's proximity to one or more of the signposts results in a simple location region code being stored in the vehicle. This location region code is transmitted to the base station over a mobile radio under base station computer control. At the base station, a simple table look-up by the computer determines a unique street address or X, Y coordinate pair as the vehicle's current location.

HI^3 signposts are powered by Lithium batteries and transmit at a frequency of 49.860 MHz. As a result of the extremely low power output requirements, they may be operated without a license as low power devices under Part 15 of the FCC rules. The use of lithium batteries provides a 7-10 year operating lifetime without battery replacement, and this is achieved over the temperature environment from -55 to 175 degrees F.



SIGNPOST SYSTEM PROVIDES EACH VEHICLE WITH LOCATION REGION CODE

LOCATION REGION CODE IS TRANSMITTED TO USER'S BASE STATION OVER USER'S ASSIGNED MOBILE RADIO FREQUENCY

USER'S BASE STATION TRANSLATES LOCATION REGION CODE INTO A UNIQUE STREET ADDRESS

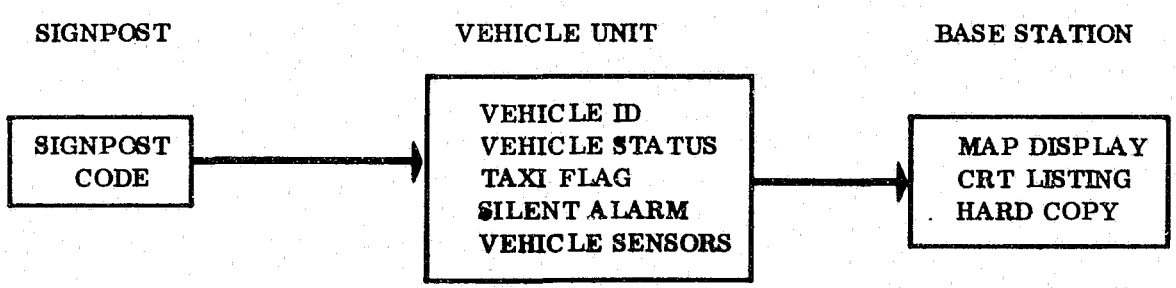


FIG. 2-1 HI3 MULTI-USER AVM BASIC PRINCIPLE OF OPERATION

When installed in a city, all users (transit, para-transit, taxi, police, pick-up and delivery, etc.) simultaneously share the use of the HI^3 signpost system. This is illustrated in Figure 2-2. Although a number of companies have proposed the use of signposts, a unique feature of the HI^3 approach is the use of overlapping signposts to create additional location regions, thereby reducing the number of signposts required to achieve a specified location accuracy within a given area.

The overlap technique has been previously tested by HI^3 in Los Angeles as part of the Cargo Security System and an overlapping signpost AVM system developed by HI^3 is currently operational in the Huntington Beach, California Police Department. Although proven during those two programs, the UMTA Phase I test program required the most comprehensive demonstration of the HI^3 overlap technique to date. The results obtained prove conclusively that the HI^3 AVM system proposed for Phase II can meet all of the vehicle location subsystem and system level specificiations set forth in the UMTA Multi-User AVM Specification. In addition, the HI^3 AVM system is a nation-wide system and can be operated in any city (where 99.99% of users operate) and can be interfaced with wide area type systems, e.g., Loran for special "over the road" applications. The nationwide feature is a result of the use of 49.86 MHz which may be used throughout the United States.

2.2 PHASE I TEST PROGRAM

The Phase I test program involved the installation of a HI^3 AVM location subsystem in Philadelphia to provide random-route coverage of an area and fixed-route coverage of a simulated bus route. The area and the route were selected by TSC. The location subsystem was to provide a basic location accuracy of at least 300 feet at 95 percent and 450 feet at 99.5 percent of all locations in the random route coverage area and along the specified fixed route. In order to establish the performance of the HI^3 location subsystem, a test vehicle, with an AVM vehicle unit and a recording system installed was repeatedly driven over routes selected by TSC while recording on cassettes every half-second, the output of the vehicle unit location register. During each test run, manual event markers were used to mark (record on cassette) the passage of physical landmarks called "checkpoints". Checkpoints were designated by TSC after installation of the location subsystem was complete. The X, Y coordinates of these checkpoints become the reference against which the performance of the AVM system was measured. During off-line data processing, the radial error between the X, Y coordinates of the checkpoint and the X, Y coordinates as computed through use of the AVM technology was computed. For example, during each of 10 random route test runs, each of which was over 11 miles in length, the passage of 62-63 checkpoints was recorded. All information necessary to compute the X, Y coordinates of the vehicle, as determined by the AVM system, were also recorded on cassette. At the end of 10 such runs, the cassettes were processed to determine the location error at each point. The location algorithm utilized was identical to that proposed for use in Phase II.

DIRECT RF PROXIMITY SIGNPOSTS PROVIDE ALL USER VEHICLES WITH LOCATION ADDRESSES AND ARE BASIC SOURCE OF BUS SCHEDULE INFORMATION.

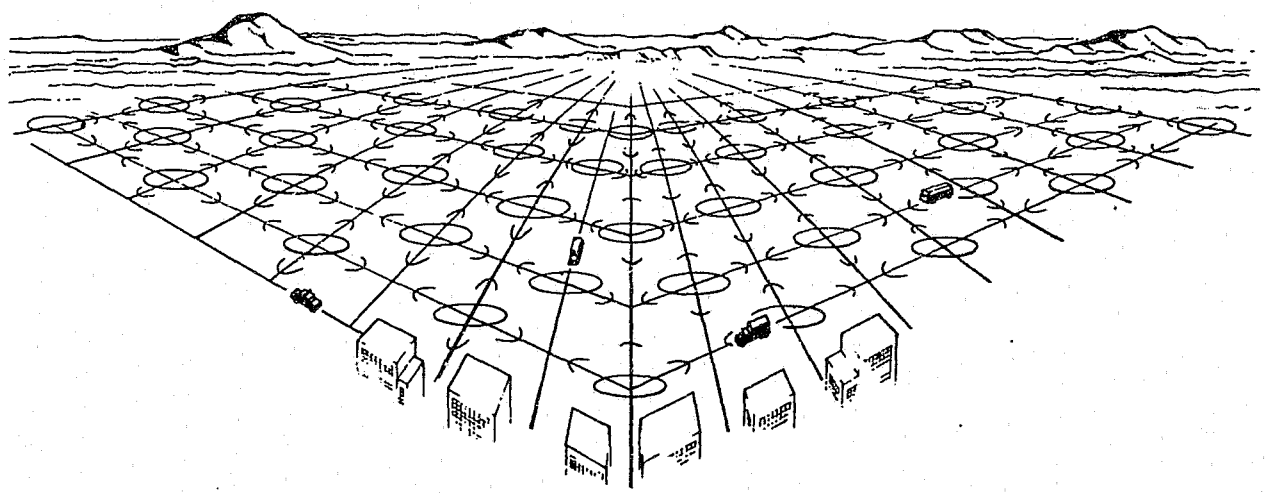


FIG. 2-2 HI^3 MULTI-USER AVM BASIC APPROACH

Fixed route tests involved the same activities as random route tests, however, an odometer was used to determine the vehicle's location along the fixed route after being automatically reset at signposts spaced approximately one mile apart along the route. In addition to the marking of TSC checkpoints, manual entries were made to document passage of the vehicle by "timepoints" which were designated by TSC to represent typical transit route timepoints. Also, the opening and closing of the door was simulated at approximately one-half of the 15 timepoints on each of the fixed route test runs. During off-line processing, the location errors and the errors between the actual time of passage by each timepoint and the time of passage estimated by use of the AVM system were computed. The AVM system was to determine the time of passage of the vehicle at timepoints to $\pm$ 15 seconds for 95 percent and $\pm$ 60 seconds for 99.5 percent of all such occurrences.

A total of 10 random route test runs were performed. This resulted in 622 checkpoint samples at which location errors were computed. When these same data were also processed through an AVM system simulation a total of 2235 samples were obtained corresponding to 1 sample every 20 seconds during the 10 runs. This simulation included the injection of communication errors into 5 percent of the samples. The HI^3 Phase II technique for detection and correction of these errors was simulated. Two different random routes were traveled involving passage through tunnels, along narrow streets through high-rise "canyons" and along wide boulevards. All tests were conducted under normal traffic conditions in downtown Philadelphia. A TSC Monitor was in the test vehicle during all tests.

A total of 33 fixed route test runs were performed over a 13 mile route. Each test provided data at 76 checkpoints and 15 timepoints. When processed through the AVM system simulation, a total of 7459 pseudo checkpoint samples were obtained.

Formal demonstrations of the HI^3 AVM system were conducted in Philadelphia on 15 and 28 December 1976 for UMTA personnel and their guests. These demonstrations involved operation of the HI^3 test vehicle in the random route area with 6-8 observers on board. All such demonstrations involved operation as a random-route vehicle with the vehicle location being provided in real-time on the on-board CRT. All demonstrations were 100 percent successful.

2.3 TEST RESULTS

All random route and fixed route data taken during the Phase I tests were processed by HI^3 to determine the AVM system performance. Data processing was performed off-line using an exact simulation of the proposed Phase II location subsystem and AVM communication system. These data show conclusively that the HI^3 AVM system can meet or exceed all performance criteria set for Phase II. Phase I results are summarized in Table 2-1. Detailed discussions of these results are contained in Sections 5 and 8.

TABLE 2-1 SUMMARY RESULTS OF PHASE I TESTING

	Specification (feet)	HI^3 Results (feet)
LOCATION SUBSYSTEM LOCATION ACCURACY:		
Random Route: 622 samples		
95% of samples less than	300	242
99.5% of samples less than	450	461
Average error, all samples	---	91
Maximum Average Error Over One-Tenth Mile Segment	450	315
Fixed Route: 2313 samples		
95% of all samples less than	300	107
99.5% of all samples less than	450	156
Average error, all samples	---	50
Maximum Average Error Over One-Tenth Mile Segment:	450	256
AVM SYSTEM LOCATION ACCURACY:		
Random Route: 2235 samples		
95% of samples less than	300	282
99.5% of samples less than	450	464
Average error, all samples	---	114
Fixed Route: 7459 samples		
95% of samples less than	300	105
99.5% of samples less than	450	188
Average error, all samples	---	48
	Specification (seconds)	HI^3 Results (seconds)
AVM TIMEPOINT PERFORMANCE: 451 samples		
95% of samples less than	15	11
99.5% of samples less than	60	24
Average error	---	3.9

Figure 2-3 contains cumulative error distributions of random route and fixed route test data results. When translated into an operational system for random route vehicles, these data indicate that under similar urban conditions, a police dispatcher would know, with a 95 percent confidence level, the location of each and every AVM-equipped vehicle to within 282 feet. Similarly, the fixed route data indicates that a bus dispatcher would have at his fingertips the location and schedule performance of every bus on all routes to within 105 feet and to within 11 seconds at a 95 percent confidence level. The application of this information to providing increased service, improved response time, better schedule adherence, etc., forms the basis for the entire Phase II program.

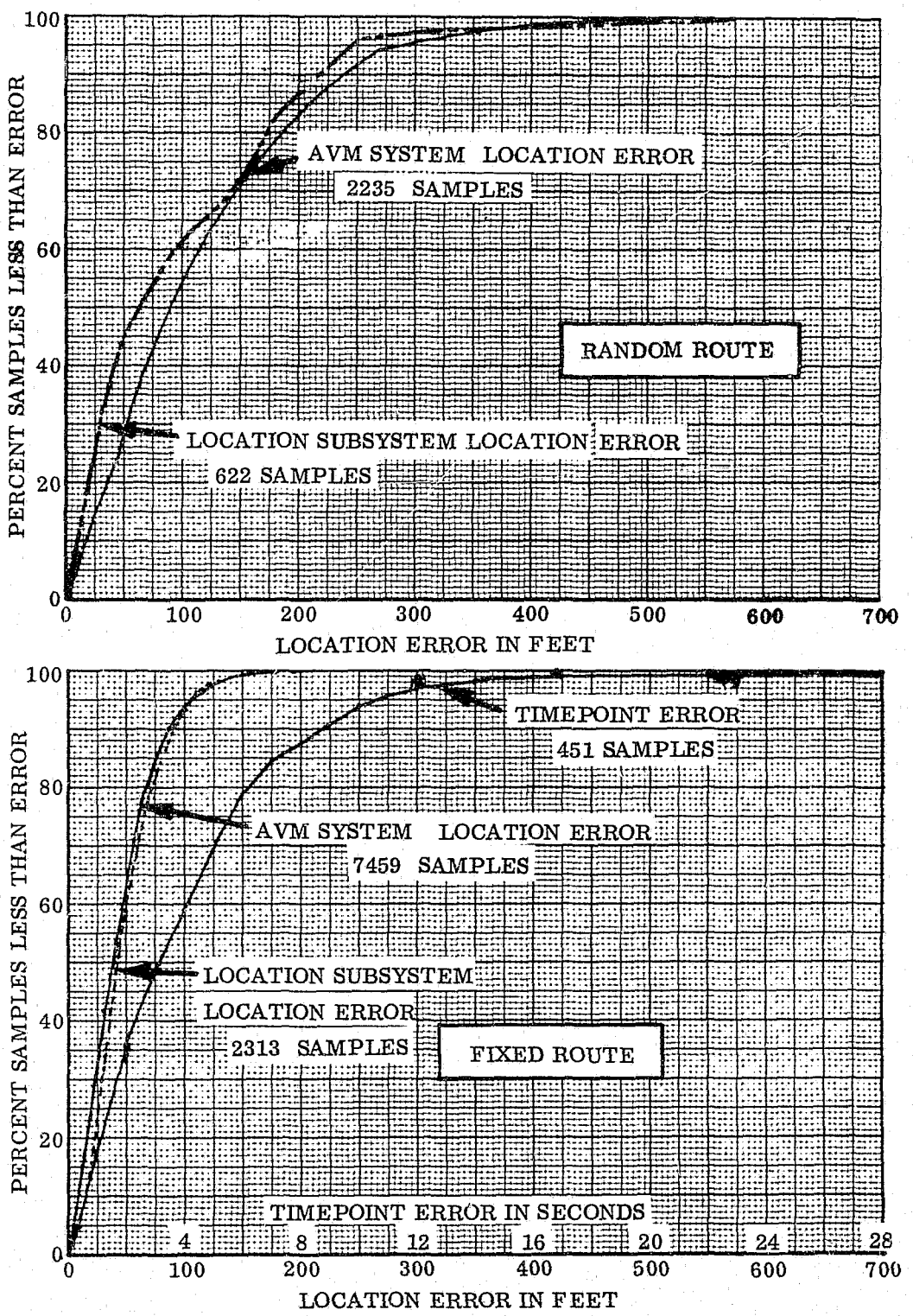


FIG. 2-3 DEMONSTRATED AVM SYSTEM PERFORMANCE

3. RANDOM ROUTE TESTS

3.1 RANDOM ROUTE TEST CONFIGURATION

The test system configuration used in the Phase I random route tests consisted of (1) the HI^3 test Location Subsystem (LS) and (2) a Data Acquisition System (DAS). The HI^3 test LS tested during Phase I random route tests is functionally identical to that proposed for Phase II.

3.1.1 Test Vehicle

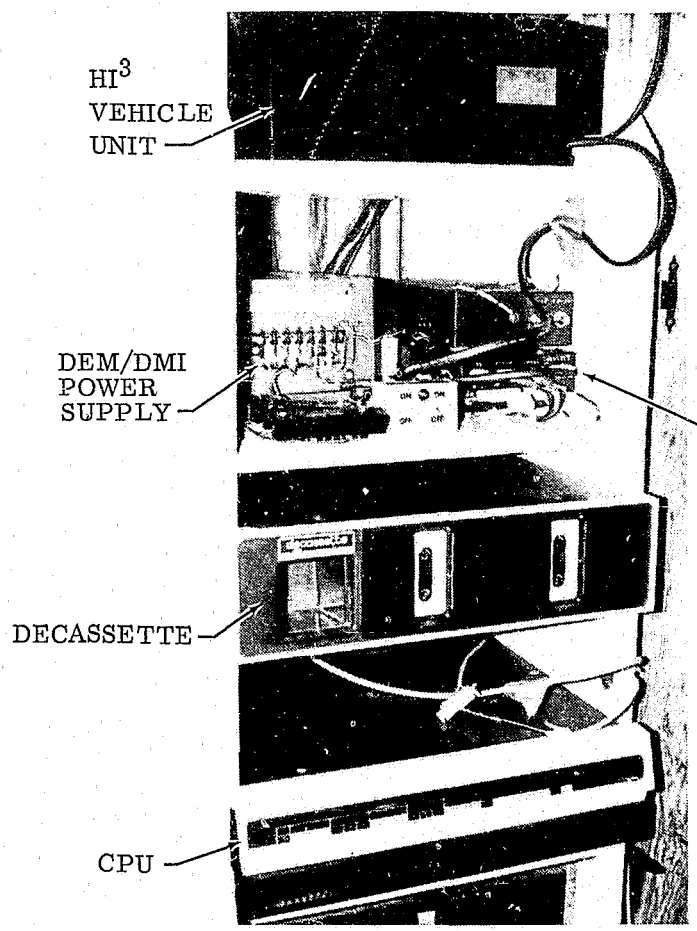
The Phase I test vehicle was a 1976 Winnebago equipped with a 4-KVA, 110-volt, auxiliary power unit. A special rack was provided for the DAS equipment. Figure 3-1 is the layout of the test vehicle which was so designed that the DAS operator was seated facing forward at the table on the right-hand side. The CRT/keyboard was located on the table. The DAS operator and the TSC Monitor could sit side-by-side during test runs.

3.1.2 Location Subsystem Equipment

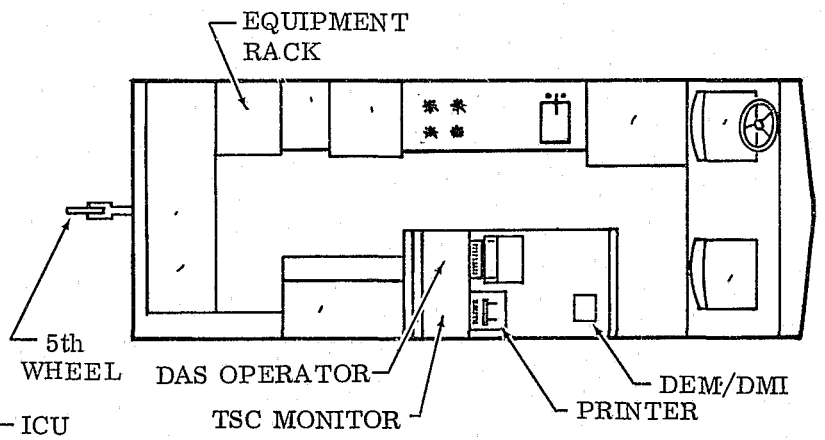
In the random route configuration, the LS consists of (1) signposts and (2) a vehicle unit.

3.1.2.1 Signposts. HI^3 signposts are small, lithium-battery-powered transmitters which transmit a digitally coded message at 49 MHz at an interval of approximately 2/3 of a second. Signpost electrical specifications are presented in Figures 3-2 and 3-3. Only 20 KHz of spectrum are utilized in order to comply with the most recent FCC rule (Docket No. 20119). Signpost mechanical specifications are shown in Figure 3-4. Test LS signposts are production HI^3 signposts (Model SP-03) and are identical to those proposed for installation in Phase II.

During the test program, the signposts utilized in Philadelphia were operated at 49.860 MHz. However, a number of special tests were conducted in Fort Worth by using signposts which were operated at 27.095 MHz with a corresponding vehicle unit receiver. HI^3 currently has a signpost system operating at Huntington Beach, California, and is in the second phase of a Cargo Security System, under LEAA sponsorship, in Los Angeles; this system also contains 27.095-MHz signposts. These units are operated as low power devices under Part 15 of the FCC rules in effect in November 1975. HI^3 has applied for type certification of the HI^3 signpost by the FCC in accordance with FCC Docket 20119 which was released 12 February 1976. In correspondence with Mr. Raymond Spence, FCC Chief Engineer, we have received assurance that there is no proposal pending before the FCC which would affect the operation of non-voice devices such as the HI^3 signpost in the 27-MHz band chosen for operation.



EQUIPMENT RACK



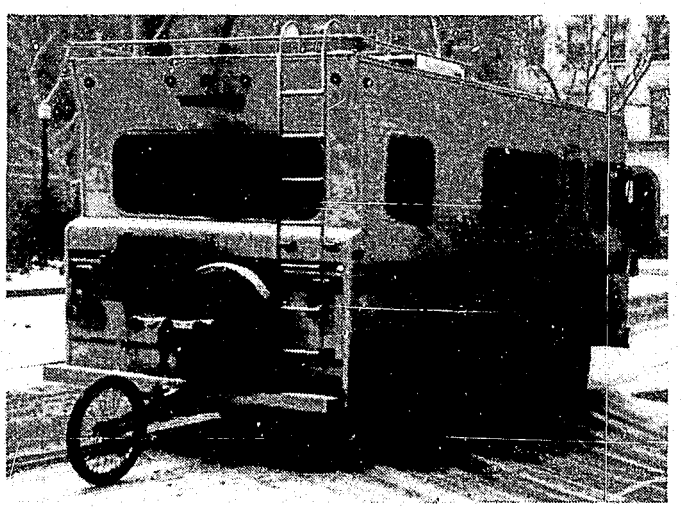


FIG. 3-1 HI^3 TEST VEHICLE EQUIPMENT LAYOUT

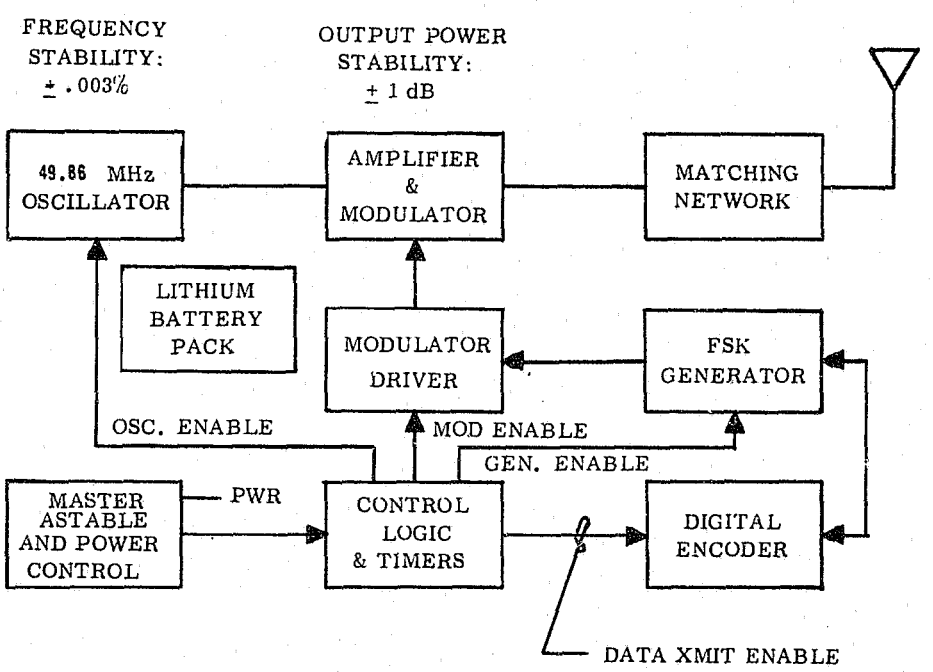


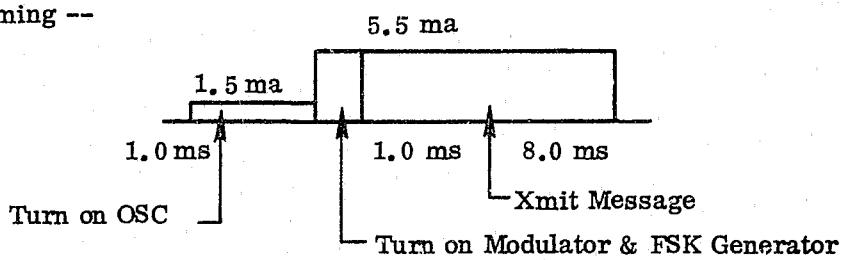
FIG. 3-2 HI^3 SIGNPOST BLOCK DIAGRAM

Communication Method -- Coherent FSK with BIT - $\overline{\text{BIT}}$ Technique

Message Length -- (16 Information Bits + 16 Bit Complements + 2 Error Bits)
= 34 Bits

Data Rate -- 4.5K BITS/Sec.

Transmitter Timing --



Bandwidth -- 20 KHz

Duty Cycle -- .015

Battery Capacity -- 10 AH

Average Current Drain = .015 x 5.0ma + 50ua = 125ua

Antenna Gain -- -14 dBI

Signpost PRF -- 1.5 Hz

Transmitter Frequency -- f_c = 49.860 MHz

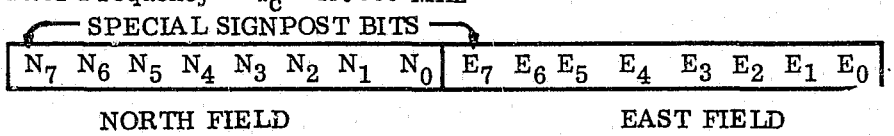


FIG. 3-3 HI^3 SIGNPOST ELECTRICAL SPECIFICATIONS

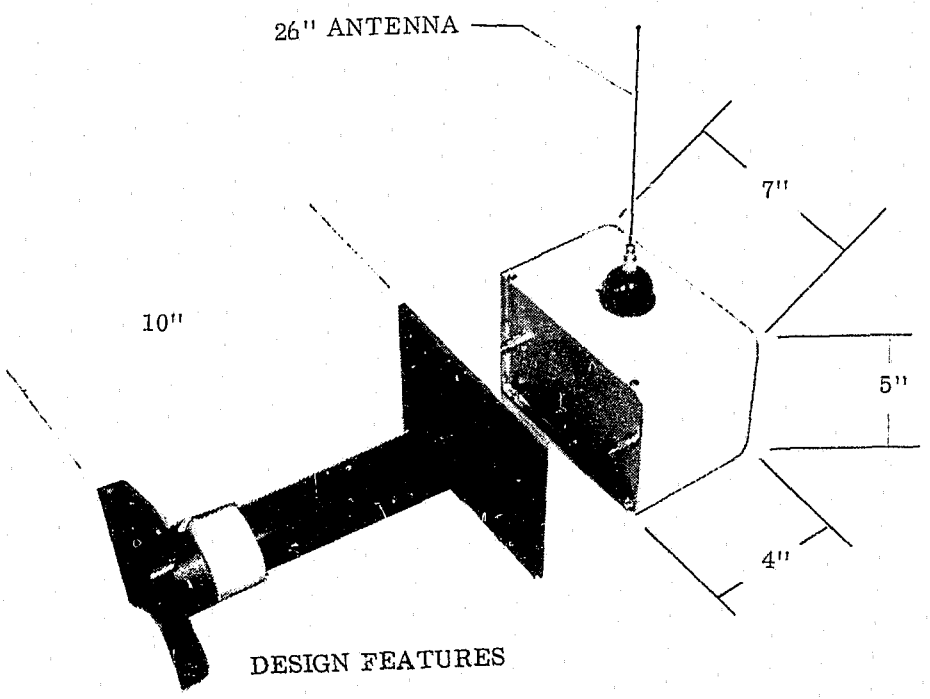


FIG. 3-4 HI^3 SIGNPOST MECHANICAL SPECIFICATIONS

However, low power operation at 27 MHz is contingent upon not producing harmful interference to licensees in the 27 MHz band. At 49.86 MHz, there are no licensees, and each user must operate within the environment created by all other users; consequently, any constraints on operation in any city are eliminated. The 49.86-MHz system tested during Phase I demonstrated superior AVM performance over 27 MHz. As a result of the test results obtained, it is proposed to utilize 49.86 MHz signposts in HI^3 during Phase II. Signposts operated at 49.86 MHz are subject to the same type of certification as that required for low-power devices operated at 27 MHz. HI^3 has applied for such certification. This action is discussed in Section 10.3.

HI^3 signposts are mounted on any available utility poles or street and traffic light standards in such a manner that the HI^3 vehicle equipment is able to receive the coded transmissions from one or more signposts and, through simple code and signal level comparisons in the vehicle unit, to determine a unique 18-bit code which corresponds to the center of a unique location region. This capability is explained fully in Paragraph 3.2.1. Forty-one signposts were available for use during Phase I testing. An odometer was utilized during fixed route tests to supplement the signpost system so that signposts were only needed at or near TSC designated timepoints. The use of the odometer in Phase I is fully explained in Section 6. A method of eliminating the need for an odometer in Phase II is discussed in Section 10.2.

3.1.2.2 Vehicle Equipment. In the random route configuration, HI^3 LS vehicle equipment consists of two items: (1) a 49.860-MHz antenna and a coax cable, and (2) a HI^3 vehicle unit. During Phase I, a standard, monopole (Antenna Specialist Model 303) was mounted on the roof of the test vehicle. The same vehicle unit was used during fixed route tests without modification.

The HI^3 vehicle unit shown in Figure 3-5 is a single electronic package which consists of the following equipment:

49.860-MHz Signpost Receiver	Digital Controller
Signpost Data Processor	Formatter
Location Region Storage	FSK Generator

The test LS vehicle unit draws its power directly from the test vehicle 12-volt system just as it will in the Phase II system. The vehicle unit is fused to prevent equipment damages and contains a built-in voltage regulator to compensate for voltage fluctuations.

Figure 3-6 is a block diagram of the major functions performed in the HI^3 vehicle unit. This unit is a standard HI^3 AVL vehicle unit which normally interfaces with a mobile radio. In the Phase I system, the normal radio interface is replaced with a hardwired interface to the HI^3 Interface Controller Unit (ICU).

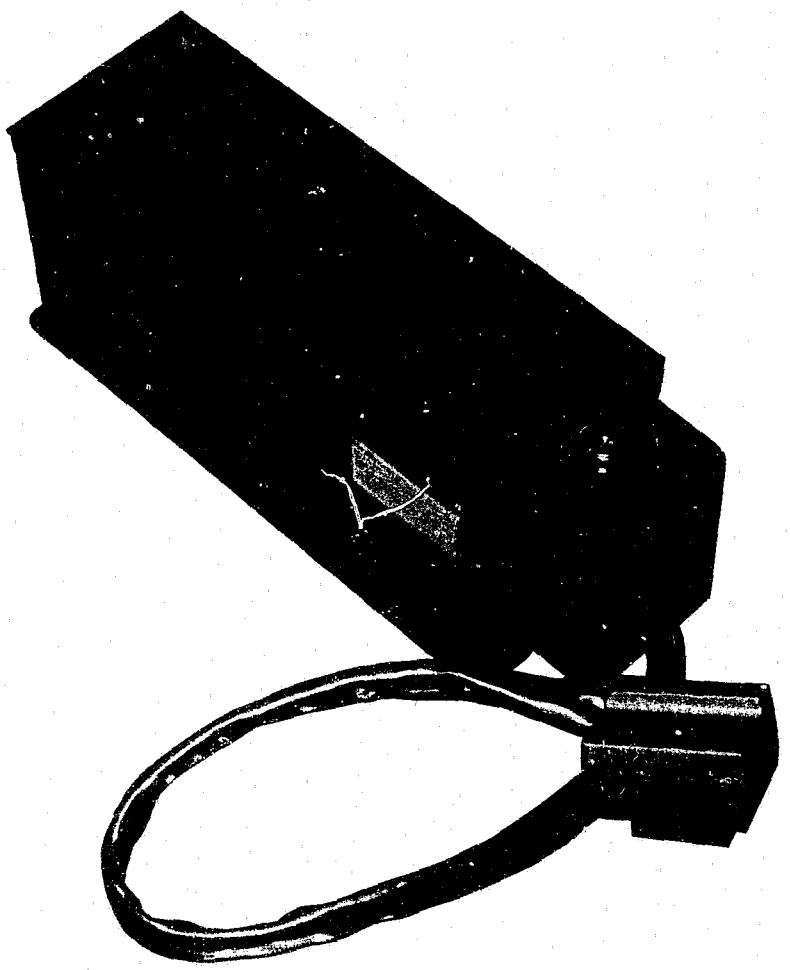
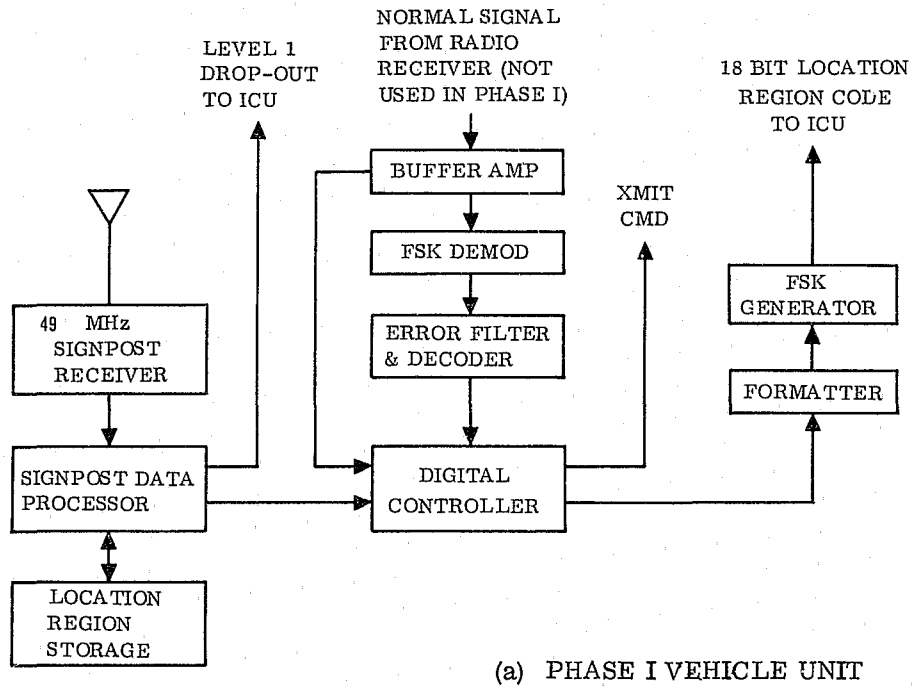
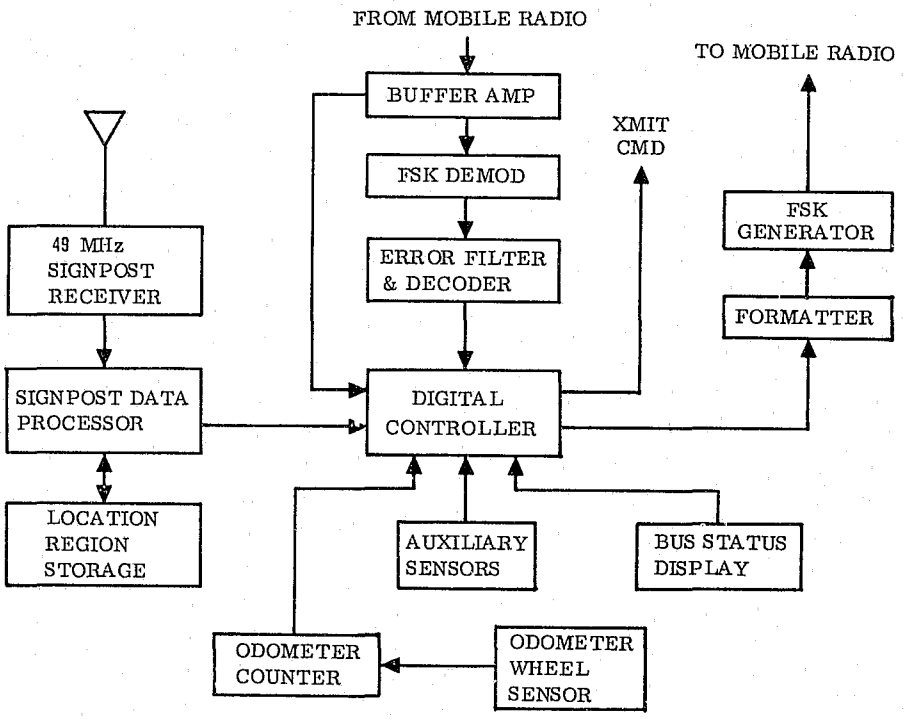


FIG. 3-5 HI^3 TEST L.S. VEHICLE UNIT



(a) PHASE I VEHICLE UNIT



(b) PHASE II VEHICLE UNIT

FIG. 3-6 HI[3] VEHICLE UNIT BLOCK DIAGRAM

The 49.860-MHz signpost receiver performs the following functions:

a. Receives the coherent FSK transmissions from signposts.

b. Synchronizes the information stream.

c. Performs demodulation of the FSK signal.

d. Determines the signal amplitude via the threshold detection circuitry.

e. Checks the signpost message for errors.

f. Decodes the 16-BIT signpost code.

g. Supplies the threshold level (Level 1, 2, or 3), a "data good" signal (if the signal passes the error filter) and the signpost code to the signpost data processor.

h. Supplies a "Level 1" or "NOT Level 1" logical signal to the ICU.

The hardwired signpost data processor performs the following functions, as illustrated in Figure 3-7 Information Flow Diagram:

1. In conjunction with the "last" signpost code, processes the "new" signpost code to derive an 18-BIT location region code which is comprised of the following information:

   7-BIT East Code from nearest (highest level) signpost
   7-BIT North Code from nearest (highest level) signpost
   4-BIT Region Code which identifies the overlap region between signposts.

   NOTE: Section 3.2.1 contains a detailed description of the process through which the 18-BIT location region code is generated.

2. Identifies timepoint signpost through bits E_7 and N_7 (this function was simulated during fixed route testing).

3. Stores the 18-BIT location region code as the vehicle's "current" location in the Location Region Storage.

4. Compares each newly computed 18-BIT location region code with the stored value and, if a difference is indicated, replacement of the previous code with the new code.

5. Supplies the "current" location region code to the digital controller for transmittal to the ICU.

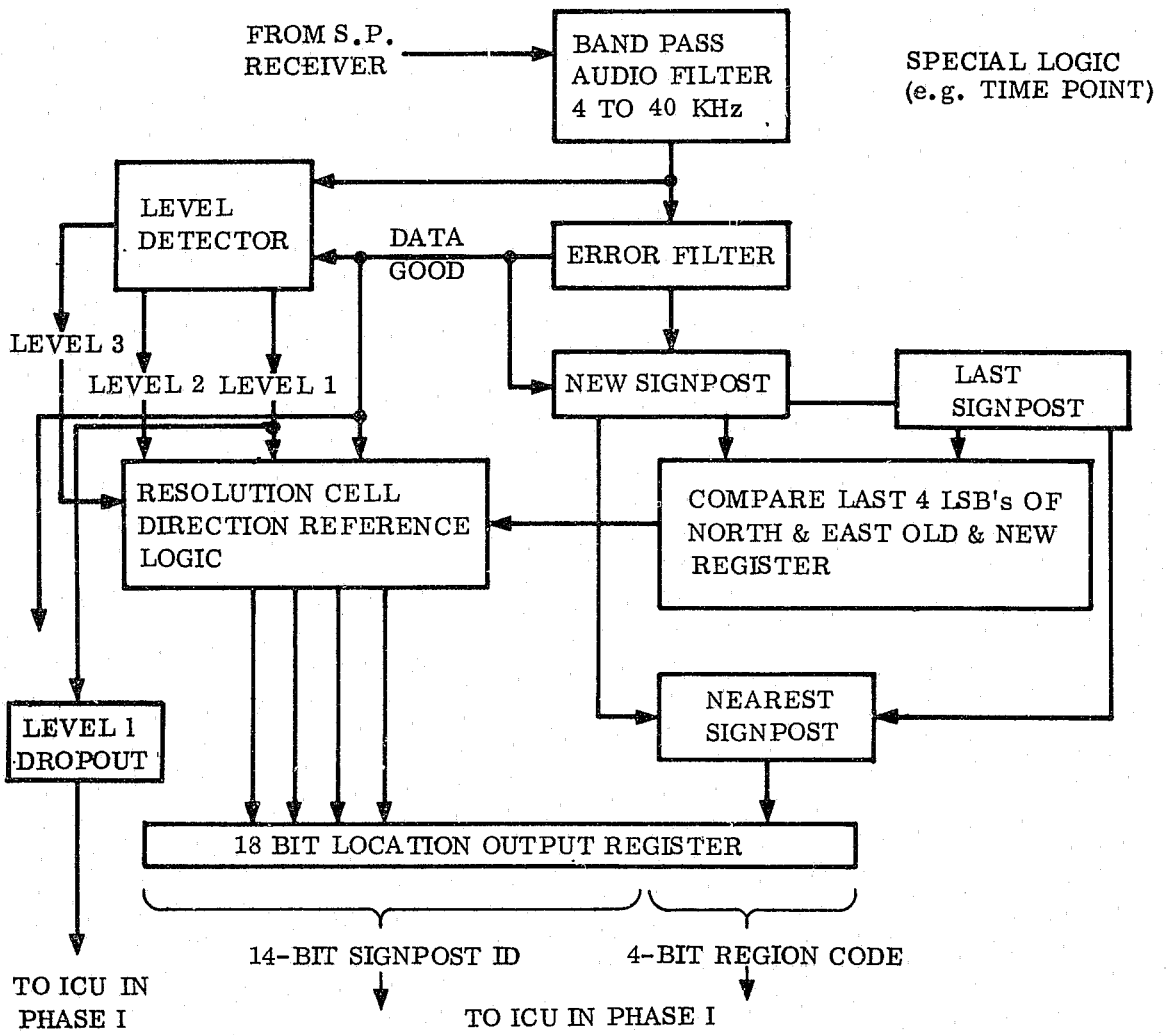


FIG. 3-7 HI^3 VEHICLE UNIT INFORMATION FLOW DIAGRAM

The Digital Controller controls the sampling of the location region storage and controls the transmission of location region data to the ICU.

The formatter encodes the message to the ICU in the B-$\overline{B}$ format. B corresponds to the bit (logical 1 or logical 0) and $\overline{B}$ corresponds to the bit complement. The B-$\overline{B}$ format requires that each bit be followed by the bit complement. For example, if a logical 1 were to be encoded, a 1-bit followed by a 0-bit would actually be encoded. This encoding technique provides effective error control through the use of an error filter at the base station. Note that a similar encoding scheme and error filters are incorporated in the signpost-to-vehicle unit link. The FSK generator generates the two audio frequencies, f_{high} and f_{low}, which correspond to the B and $\overline{B}$ respectively.

During Phase I, the vehicle unit operated in the "Automatic" mode in that all changes in the current location region code were automatically transmitted to the ICU. The ICU in turn stored this information until it was requested by the computer (every 0.5 second). During Phase II, the vehicle unit will operate in a functionally identical manner, i.e., data will only be supplied to the base station over the communication subsystem when it is requested by the computer.

The addition of the odometer, auxiliary sensors, bus status display, and radio receiver interfaces which will be implemented in Phase II is shown in the lower figure (Figure 3-6b). Actually, the Buffer Amplifier and Channel Open Detector, the PSK Demodulator, and the Error Filter and Decoder were included in the Phase I vehicle unit. However, they were not utilized since a radio link was not implemented. Thus, the only difference between the Phase I and Phase II vehicle units is in the Digital Controller Unit.

In Phase II, the digital controller unit will perform all of the functions performed in Phase I, plus the following additional functions:

a. Receive commands from the base station and control the message response via the radio transmitter.

b. Receive and accumulate pulses from the odometer and control the encoding of the odometer accumulator into the vehicle-to-base message. (Fixed Route only). Refer to Section 10 for a proposed means of eliminating the odometer from Phase II.

c. Receive inputs from auxiliary sensors (doors, passenger counters, etc.) and control the encoding of these data into the vehicle-to-base message.

d. Control the message traffic to and from the bus status display.

e. Identify timepoint signposts and the Level 1 drop-out signal and thereby control the generation of timepoint performance data.

f. Compare incoming message addresses to stored vehicle ID and control message response.

In the Phase I system, the contents of the location register were sent to an Interface Controller Unit (ICU) where they were sampled by the DAS as the "computed" vehicle location at the sample time. Under operational conditions (Phase II), the contents of the location register would be encoded by the Digital Controller and formatter as part of the vehicle-to-base message and transmitted via the communication subsystem to the base station under base station computer control. However, in the HI^3 design, this process was quite simple to simulate since vehicle location computations performed at the base station do not depend on any past history since only the last transmitted location data are used. Thus, the achievement of an exact system simulation is only a matter of the sampling rate (i.e., 20 seconds for Phase II versus every 1/2 second in the Phase I tests). Consequently, HI^3 LS accuracy is not influenced.

3.1.3 Data Acquisition System (DAS)

In the random route configuration, the DAS included the following equipment:

HI^3 Interface Control Unit (ICU)
PDP 11/05
DECassette
Cassettes
CB Monitor Unit (used during special 27 MHz tests only)
5th Wheel System
ADM-2 CRT/Keyboard
TI 743 Terminal.

Figure 3-8 is an interface block diagram of the DAS and its interface with the LS.

During random route testing, the DAS controlled the sampling of the LS location register as well as the 5th wheel. Tests were conducted by recording (1) a complete data record every 1/2 second and (2) each event marker entered manually by the DAS operator.

3.1.3.1 Recording Equipment. Recording equipment included the PDP 11/05 minicomputer, the DECassette, and the ADM-2 CRT/Keyboard. Under software control the PDP 11/05 caused data from the ICU and the keyboard to be recorded on cassette tapes.

Data were recorded on Mylar Cassettes (Dual Drive). A pair of cassettes were used to record all data on each test run.

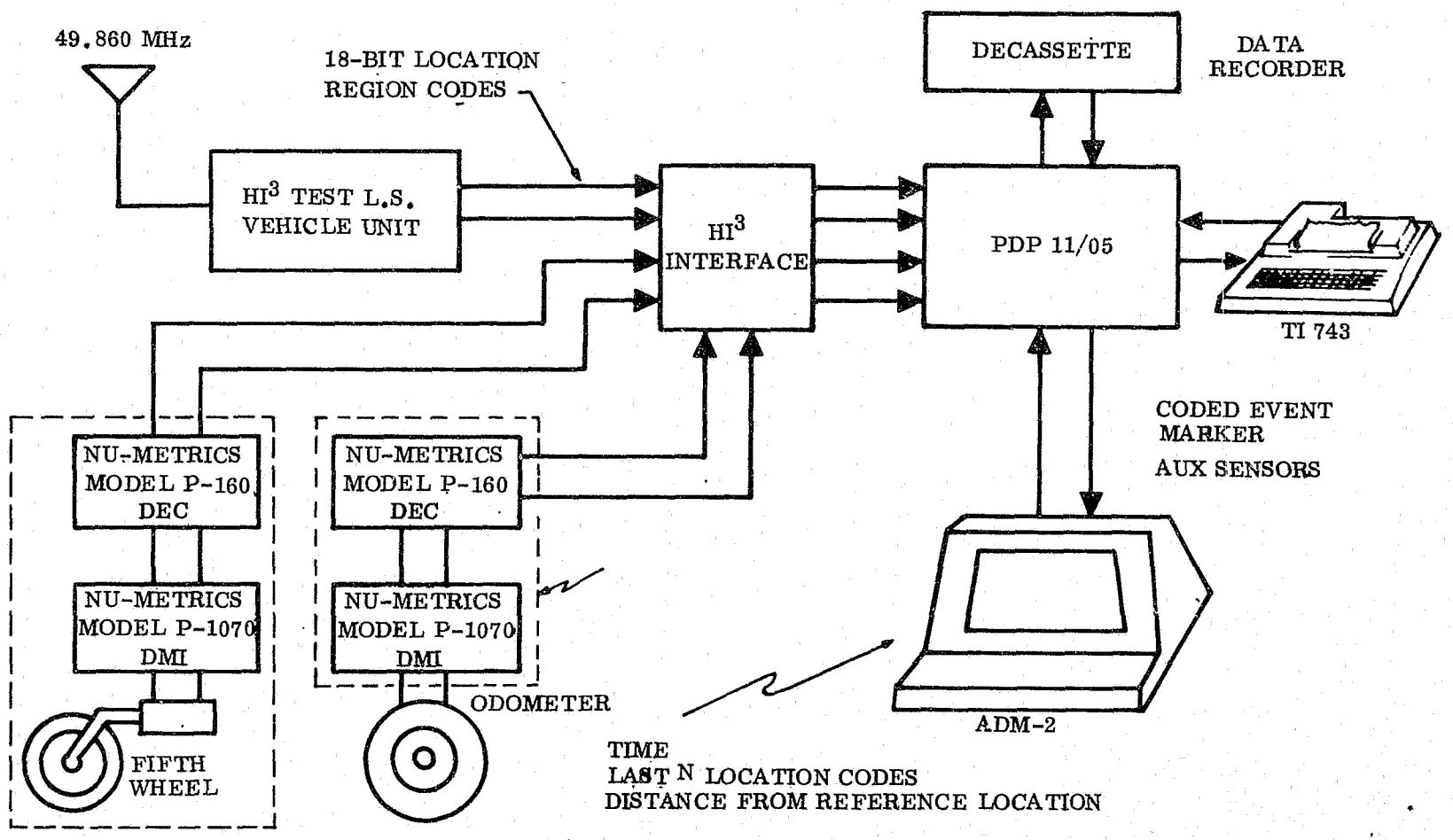


FIG. 3-8 HI^3 VEHICLE EQUIPMENT INTERFACE DIAGRAM

Data were recorded single-bit-serial sequentially. Each data sample consisted of a 80-BIT record as follows:

Item	Bits
Location Code	18
Odometer	12
5th Wheel	14
Clock	10 (ticks only)
Event Codes	8
Spare	18
TOTAL	80

Figure 3-9 reflects the basic DAS record format as it was divided into five 16-BIT words. Cassettes were duplicated onto IBM compatible magnetic tapes at the Blue Bell, Pennsylvania facility of Digital Equipment Corporation, for processing by MITRE Corporation.

3.1.3.2 Fifth Wheel Equipment. The fifth wheel was used (1) for verifying checkpoint relative X, Y coordinate distance from known locations and (2) for generating "pseudo" checkpoints during data analysis to simulate Phase II polling rates. The fifth wheel equipment included a Nucleus Corporation Model NC-7 fifth wheel, a Nu-Metrics Model P-1070 distance measuring instrument (DMI), and a Nu-Metrics Model P-160 Distance Event Controller (DEC). The configuration is shown in Figure 3-10.

3.1.3.3 Event Marking Equipment. Event marking was accomplished through use of the ADM-2 keyboard. Manual input of an event code via the keyboard caused a new record to be recorded. Event codes were entered by pressing, in sequence, the appropriate event function key, the event ID number, e.g., checkpoint number, and the RETURN key. A complete 80-BIT data record was recorded on cassette whenever the RETURN key was pressed. The following event codes were available.

	Function Key	Event ID	Return
Mark Passage of Checkpoint XX	CP	XX	"
Mark Passage of Signpost NN, EE (Only used during calibration runs)	SP	NN, EE	"
Mark Turn Intersection for use with "Pseudo" signposts	TA	XX	"
Signify Door Open at Timepoint YY	DO	YY	"
Signify Door Close at Timepoint YY	DC	YY	"
Signify Error in preceding event ZZ	EE	ZZ	"
Mark Time of Departure from Timepoint YY	TD	YY	"

HEADER RECORD	
Run Number	1st Word
Year	2nd Word
Month.	3rd Word
Day	4th Word
Hour	5th Word
Minutes	6th Word
Seconds	7th Word
Tick (1/60 of second)	8th Word
DATA RECORD	
S S S S S S T_9 T_8 T_7 T_6 T_5 T_4 T_3 T_2 T_1 T_0	1st Word
S S S S O_{11} O_{10} O_9 O_8 O_7 O_6 O_5 O_4 O_3 O_2 O_1 O_0	2nd Word
S S N_6 N_5 N_4 N_3 N_2 N_1 N_0 E_6 E_5 E_4 E_3 E_2 E_1 E_0	3rd Word
V_7 V_6 V_5 V_4 V_3 V_2 V_1 V_0 S S S S B_3 B_2 B_1 B_0	4th Word
S S F_{13} F_{12} F_{11} F_{10} F_9 F_8 F_7 F_6 F_5 F_4 F_3 F_2 F_1 F_0	5th Word

where

T - Time
V - Event
B - Region Field
N - North Field
E - East Field
F - 5th Wheel
S - Spare
O - Odometer

FIG. 3-9 BASIC DAS RECORD FORMAT

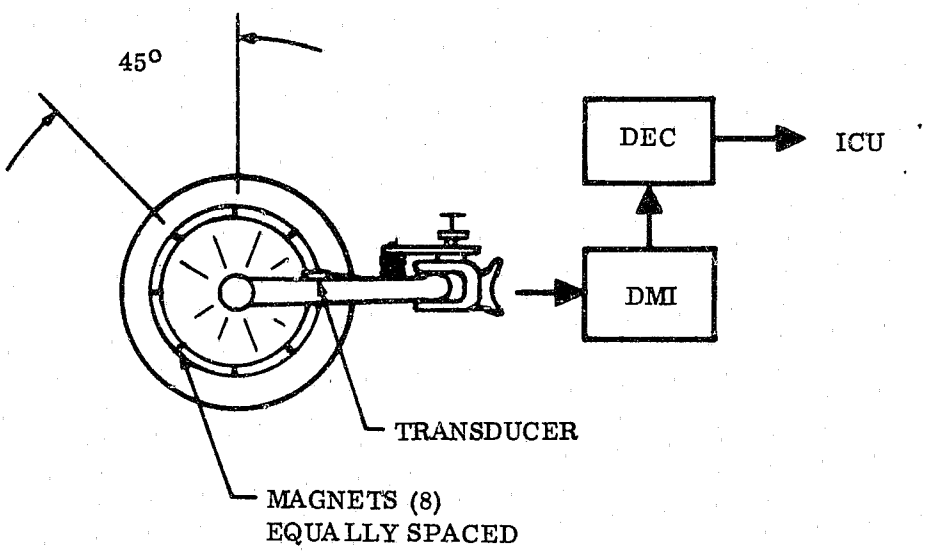
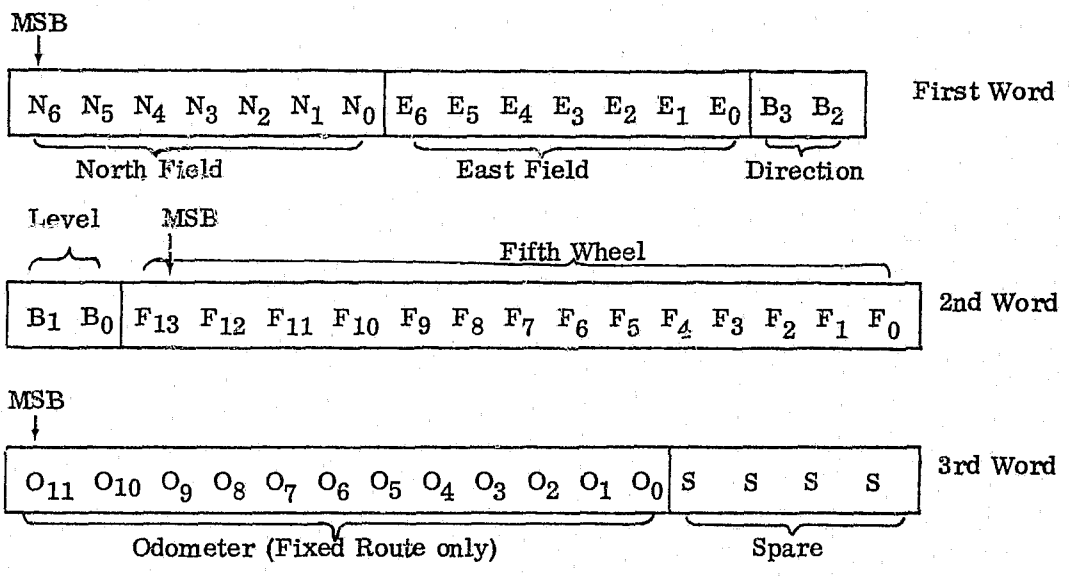


FIG. 3-10 FIFTH WHEEL CONFIGURATION

When the RETURN was depressed, an 80-BIT data record corresponding to the event key stroke time was added to the data stream in the appropriate time sequence, and the contents of the ICU output buffer were simultaneously written to the cassette and displayed on the CRT.

The Error Event was used to signify that an error had occurred in the previous event code, presumably an operator error, e.g., wrong checkpoint ID entered, etc. When the Error Event was used, an entry was made into the Run Log in terms of the nature of the error. During off-line data processing, such errors were flagged to the computer by the occurrence of the Error Event and ignored by the Data Processing Routine. A log of such errors is contained in the Appendix in association with the raw data.

3.1.3.4 Interface Controller Unit. The ICU controlled the acquisition of data for recording via the PDP 11/05 and DECassette and performed the function of a high-speed communication link between a vehicle and the base station. The input and output functions of the ICU are identified in Figure 3-11. During operation under control of the PDP 11/05, the ICU received a request-data pulse from the 11/05, set a flag which froze all data registers, caused an interrupt to the 11/05, and responded with a serial bit stream of 48 bits in the following sequence:



NOTE: These three words were output from the ICU to the DAS where they were reformatted and merged with time and event data to form the 5-word record shown in Figure 3-9. This word was recorded on cassette. This sequence relates only to the output of the ICU to the computer. The data was reformatted, as shown in Figure 3-9, for recording on cassette.

In Figure 3-11, the Signpost Location Region Register contains the most recent 18-BIT Location Region code generated by the Digital Controller Unit in

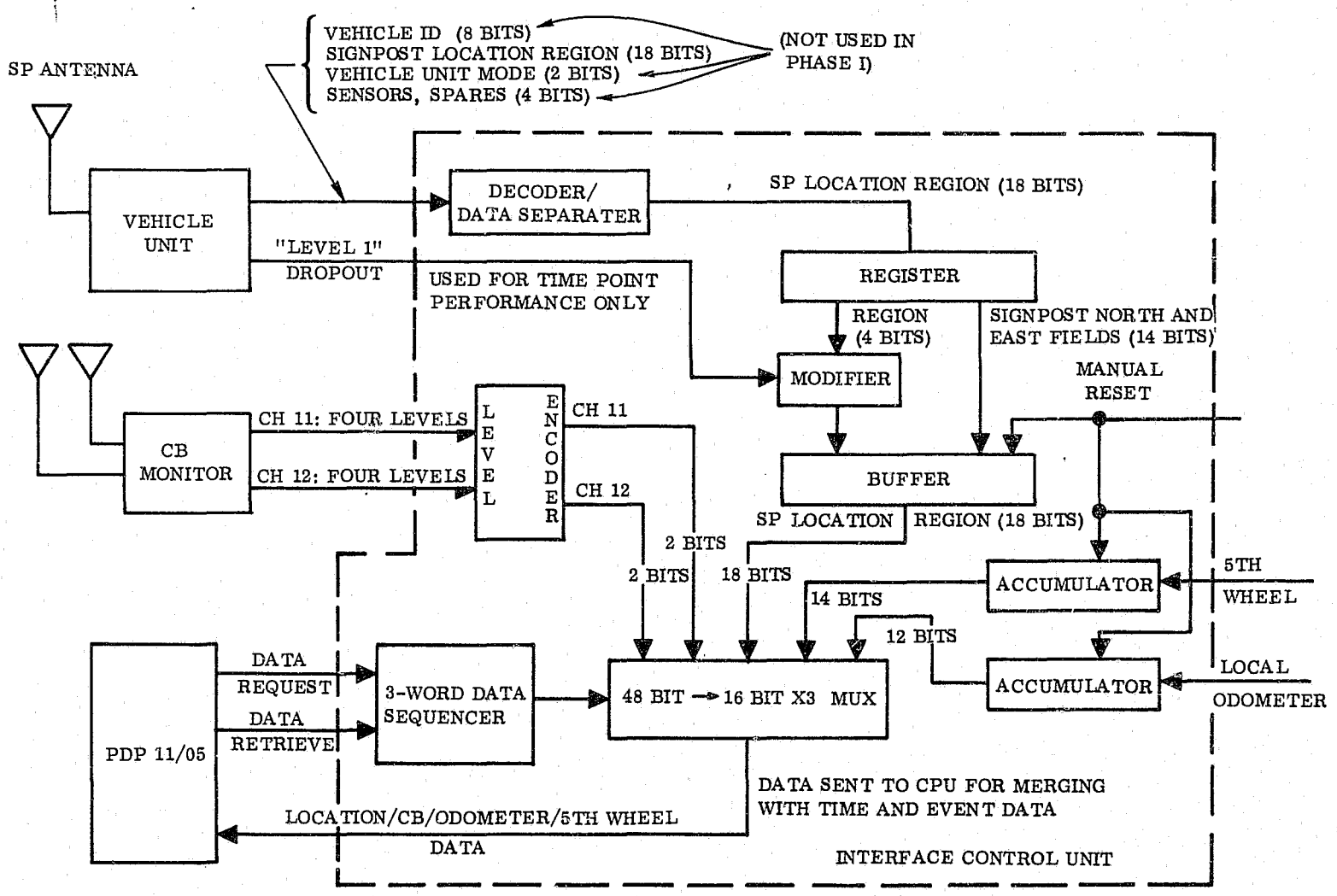


FIG. 3-11 HI^3 INTERFACE CONTROLLER UNIT (ICU)

the vehicle unit. This code includes a 7-BIT North code, a 7-BIT East Code, and a 4-BIT region or "B" code as follows:

North Code								East Code								Region Code			
N_7	N_6	N_5	N_4	N_3	N_2	N_1	N_0	E_7	E_6	E_5	E_4	E_3	E_2	E_1	E_0	B_3	B_2	B_1	B_0

Valid Region Codes which could be generated by the Phase I vehicle unit included the following:

Region Code				Region
B_3	B_2	B_1	B_0	
0	0	0	0	Region 1
0	0	0	1	Region 2 South
0	1	0	1	Region 2 East
1	1	0	1	Region 2 North
1	0	0	1	Region 2 West
0	0	1	0	Region 3 South
0	1	1	0	Region 3 East
1	1	1	0	Region 3 North
1	0	1	0	Region 3 West

(The physical meaning of these codes and their method of generation relative to signpost placement is discussed in detail in Paragraph 3.2.1).

The modifier block in Figure 3-11 caused an additional Region code, "0011", to be generated; this code corresponds to a Level 1 drop-out. This code was only used in computing timepoint performance. It is discussed in detail in paragraph 6.1.2.2. Thus, the buffer block in Figure 3-11 contains the 18-BIT signpost location region (with the region field possibly having been modified to a 0011) which became part of the recorded data.

3.1.3.5 Recording Software. Operation of the DAS was under software control through use of the CAPS operating system. Random Route data were recorded by using the program RANDOM which performed data recording and provided two displays as follows:

a. Display 1: Quick Look Verification Display

b. Display 2: Location Accuracy Summary Display.

3.1.3.6 In-Vehicle Displays. The DAS provided the capability of displaying selected data on the CRT for use in the testing, calibration, and verification of operation of the LS system. These displays were independent of and had no effect whatsoever on the cassette data recording function.

a. Quick Look Verification Display. To aid in the initial LS installation and calibration and in formal tests, a real-time display was used to examine the following parameters:

Event Code	North Field	East Field	Region Code		Odometer Distance	5th Wheel Distance	Time Min	Time Sec
-			---	---				
-	6	8	R2	West	1900	1900	08	42
1	6	8	R2	West	1920	1920	09	12
-								
-	6	8	R2	East	2104	2108	10	01
2	6	8	R3	East	2216	2218	10	32
-				---				
-	8	8	R1	---	2542	2542	11	17

The occurrence of each new location region or event marker caused a new line to be printed; the most current line was printed at the bottom of the screen.

b. Location Accuracy Summary Display. Another aid in the initial installation and testing was an in-the-vehicle display which provided a real-time estimate of performance. This display indicated (1) the X and Y values corresponding to each checkpoint (vehicle actual location), (2) the X and Y values of each recorded location region (vehicle's estimated location), and (3) the computed delta distance or error between these two X, Y values. The format was the following:

Checkpoint Number	Checkpoint Location X	Checkpoint Location Y	Signpost Region X	Signpost Region Y	Error (feet)
1	720300	403631	720100	403630	200
2	721731	402245	721700	402250	31
3	722190	401806	722185	401770	36
4	722729	401257	722730	401285	28
5	723195	400606	723150	400580	52

NOTE: The checkpoints provided by TSC were not loaded into the data recording software at any time during the Phase I test and calibration activities.

In generating this display, input data consisted of (1) the ICU output data, (2) the stored signpost data base, and (3) a stored checkpoint data base. The signpost data base consisted of approximately 369 locations (refer to Section 4) stored on cassette and read into memory as part of the program "RANDOM".

Similarly, a set of 79 checkpoints generated by HI^3 (not the TSC primary or secondary checkpoints) were read into memory prior to running the program.

3.2 RANDOM ROUTE LOCATION SUBSYSTEM DEPLOYMENT

3.2.1 Signpost Deployment

Signposts were installed in the HI^3 random route test area in accordance with a pattern which provided the specified coverage of the test area and is that proposed for the Phase II program. Thus, no location support equipment simulation, such as the expected Phase II S/N conditions vs. Philadelphia deployment S/N conditions, was required for the HI^3 system. The test area was selected by TSC and was composed of 40 square blocks which included virtually all conditions of a typical metropolitan environment. The area included high-rise, low-rise, narrow and wide streets, underpasses, tunnels, trolleys, commercial, industrial, and residential areas. The area was surveyed by HI^3 and poles tentatively selected on 10 September 1976; pole agreements for these selected poles were contracted with the City of Philadelphia and the Philadelphia Electric Company. On 21 September, a data package was submitted to these agencies requesting permission to use selected poles. This permission was granted on 7 October 1976. A preliminary signpost layout was completed by utilizing 36 signposts (15 of which were used to simulate the infinite space of a wide area coverage). The signposts were coded and installed in a comparable area (street patterns and environment) of Fort Worth for preliminary checkout. These signposts allowed a determination of location to be made at any point within the random route test area (infinite space simulation). Originally, these signposts were operated at 27 MHz. However, after special tests in Fort Worth showed the superiority of 49 MHz, all were converted to 49.860 MHz. This conversion process required only three (3) working days. Five additional signposts were later added in Philadelphia in order to provide complete random route coverage within and in the vicinity of the 9 railroad overpasses and covered streets within the selected test area.

The test vehicle was used to perform preliminary and special tests of the LS in Fort Worth. Upon completion of these tests, the signposts were transported to Philadelphia and installed by HI^3 personnel in accordance with the original layout. Installation of the signposts required an average of 3.2 minutes per signpost including parking of the installation vehicle. This short time can be realized because HI^3 signposts need not be located at any specific height and installation methods have been perfected on such programs as the Huntington Beach AVM System. Refinements of the layout included the movement of 5 signposts in order to take advantage of or to reduce the effects of peculiar structures which were encountered, particularly in and near tunnels. Such refinements were routine and were fully documented prior to the initiation of formal tests. No signposts were moved or adjusted in any manner after the initiation of formal tests.

The HI^3 Random Route test area is shown in Figure 3-12 along with the signpost locations and the signpost codes. Figure 3-13 contains photographs of all installed random-route signposts.

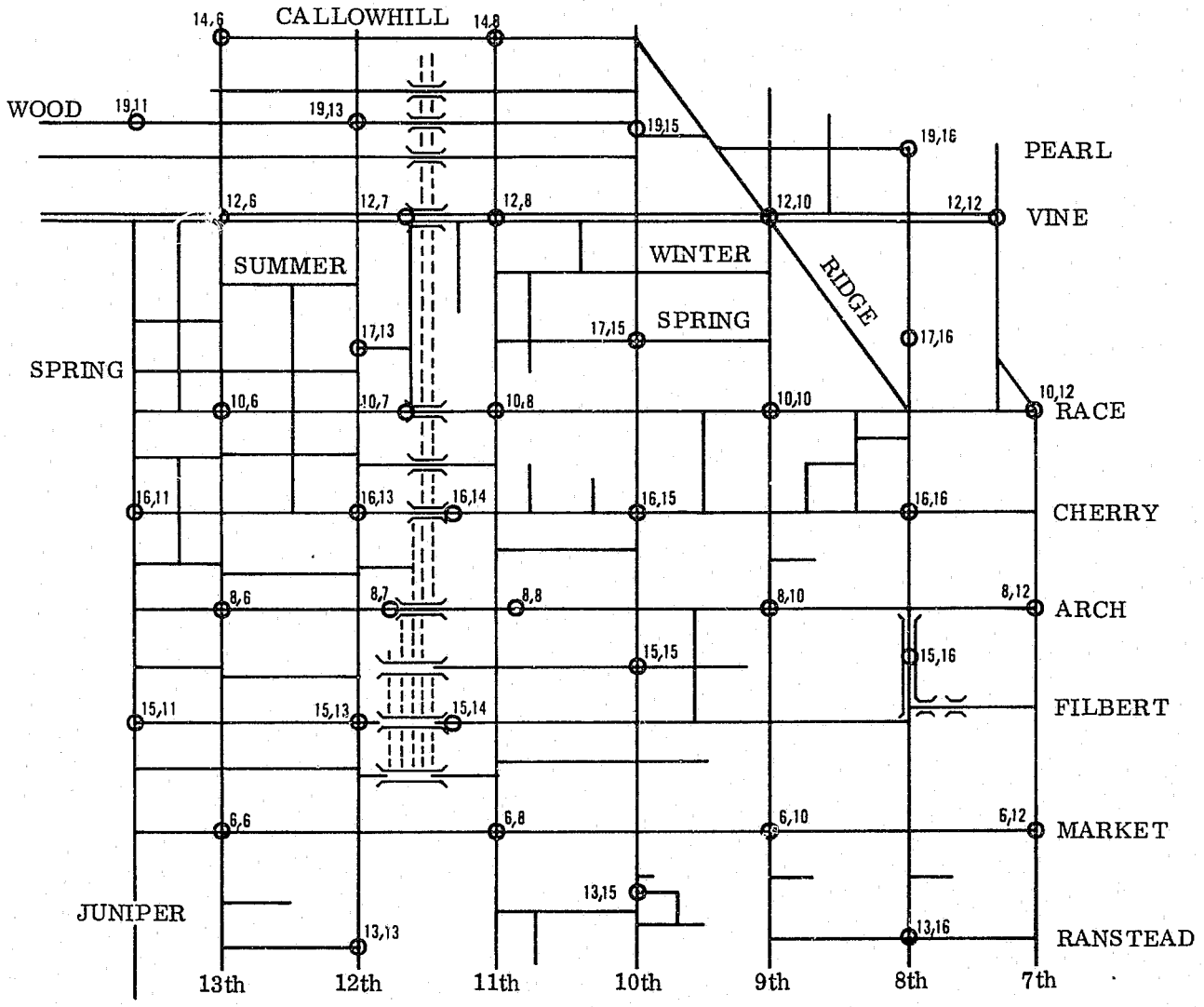


FIG. 3-12 HI[3] RANDOM ROUTE TEST AREA AND SIGNPOST LAYOUT

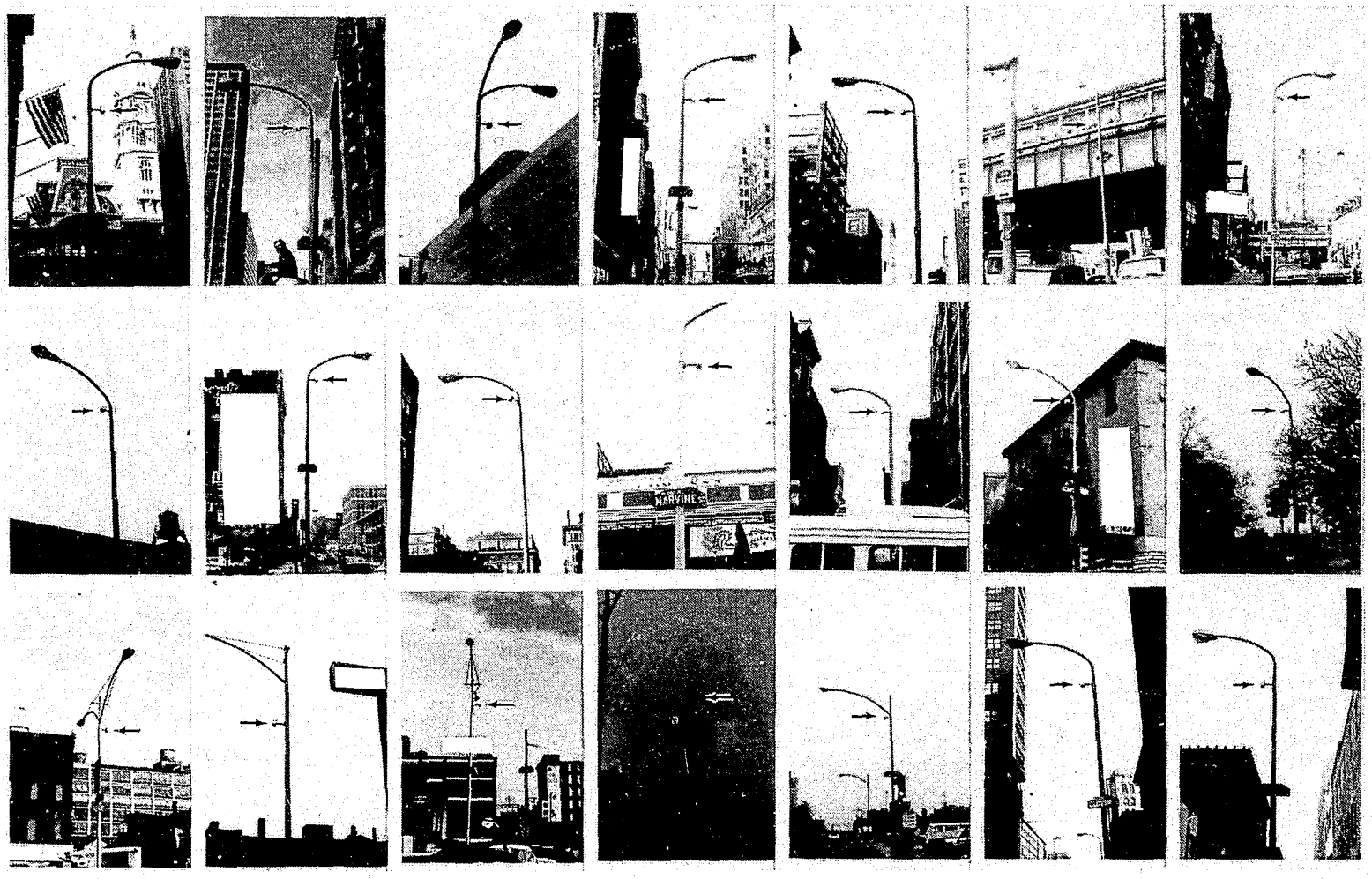


FIG. 3-13 RANDOM ROUTE SIGNPOSTS

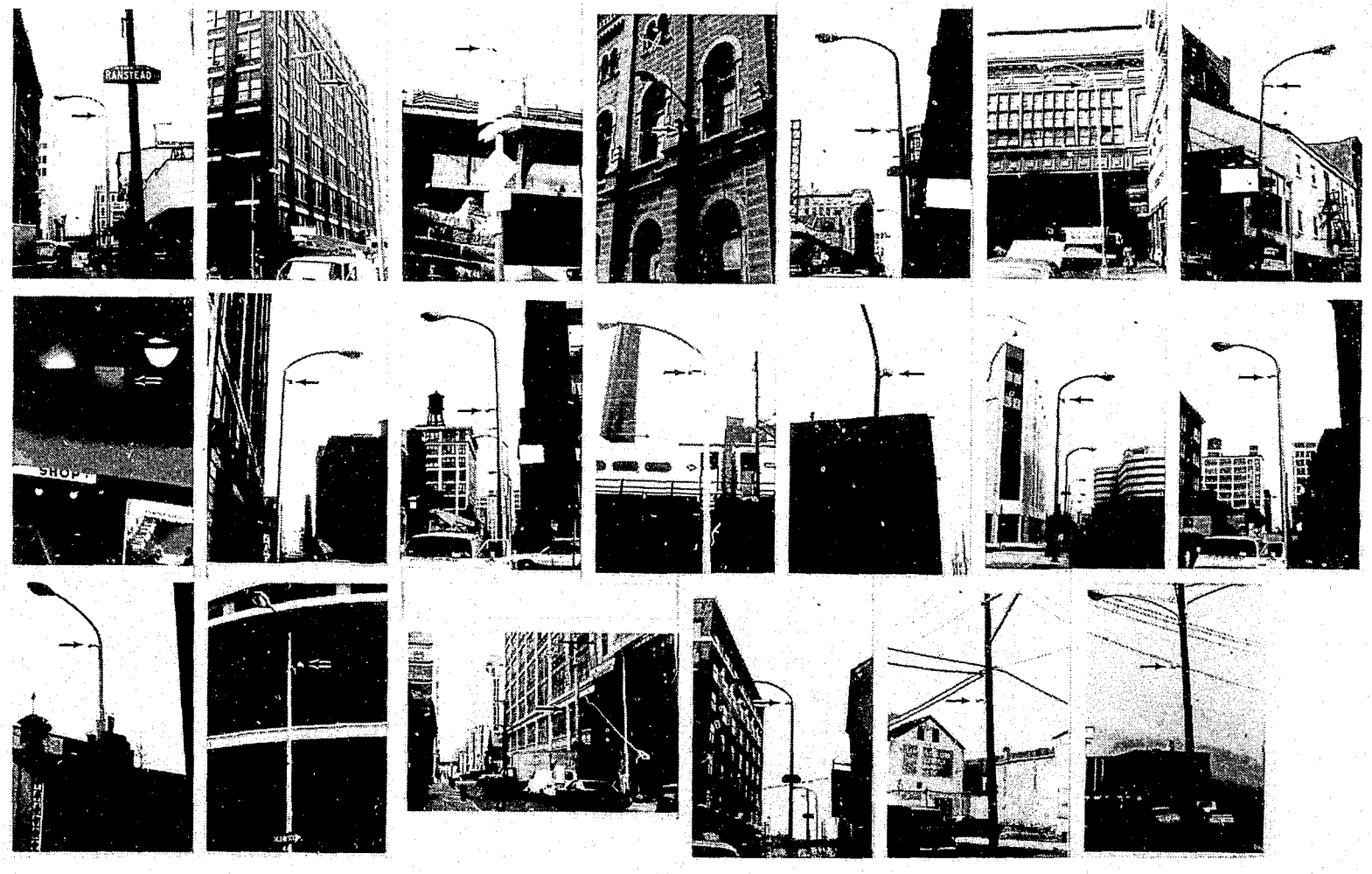
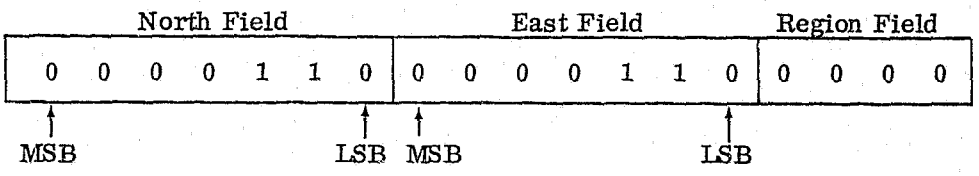


FIG. 3-13 RANDOM ROUTE SIGNPOSTS (CONT'D)

Signposts were deployed in a grid and are coded so as to create North-South and East-West chains. Along a North-South chain, only the 7-BIT North-South fields of the signpost codes change, increasing from South to North. Along an East-West chain, only the 7-BIT East-West fields of the signpost codes change, increasing from West-to-East. Examples of these respective cases are clearly evident on 13th Street which is a (North-South chain) and Market Street which is an (East-West chain).

Along any chain, receipt in the vehicle of the transmission from each of the two adjacent signposts provides sufficient information to allow the vehicle to identify up to 5 different location regions. This arrangement is depicted in Figure 3-14. The region nearest a signpost is called Region 1 and is declared as a result of receiving a valid signpost signal which exceeds a predetermined signal level, Level 1. Thus, a vehicle near signpost (6, 6) at 13th and Market would store a "6" in its North register, a "6" in its East register and a "Region 1" code in its Region register. The resulting 18-BIT code would be as follows:



In the region between two signposts, (6, 6) and (6, 8), for example, the vehicle may receive signals from both signposts at equal or at different signal levels. Two types of information are used to determine the three overlap regions between chaining signposts. First, the direction from a signpost is determined in the vehicle by comparing the 4 LSB's of the North and East fields received from two different signposts. The following truth table is used to determine direction in the vehicle:

Result of Comparing 4 LSB's of North/South and East/West Fields

North/South	East/West	Declaration
Increasing	No Change	North of
Decreasing	No Change	South of
No Change	Increasing	East of
No Change	Decreasing	West of
Not Same	Not Same	No Decision

Thus, a vehicle leaving 13th and Market, signpost (6, 6), traveling East would receive a signal from signpost (6, 8) at 11th and Market which, when the 4 LSB's of the North-South and East-West fields were compared, indicate that only the East-West field was changing, and that it was increasing. Therefore, the vehicle would declare that it was "East of" signpost (6, 6), e.g., East of the intersection of 13th and Market, and on Market Street.

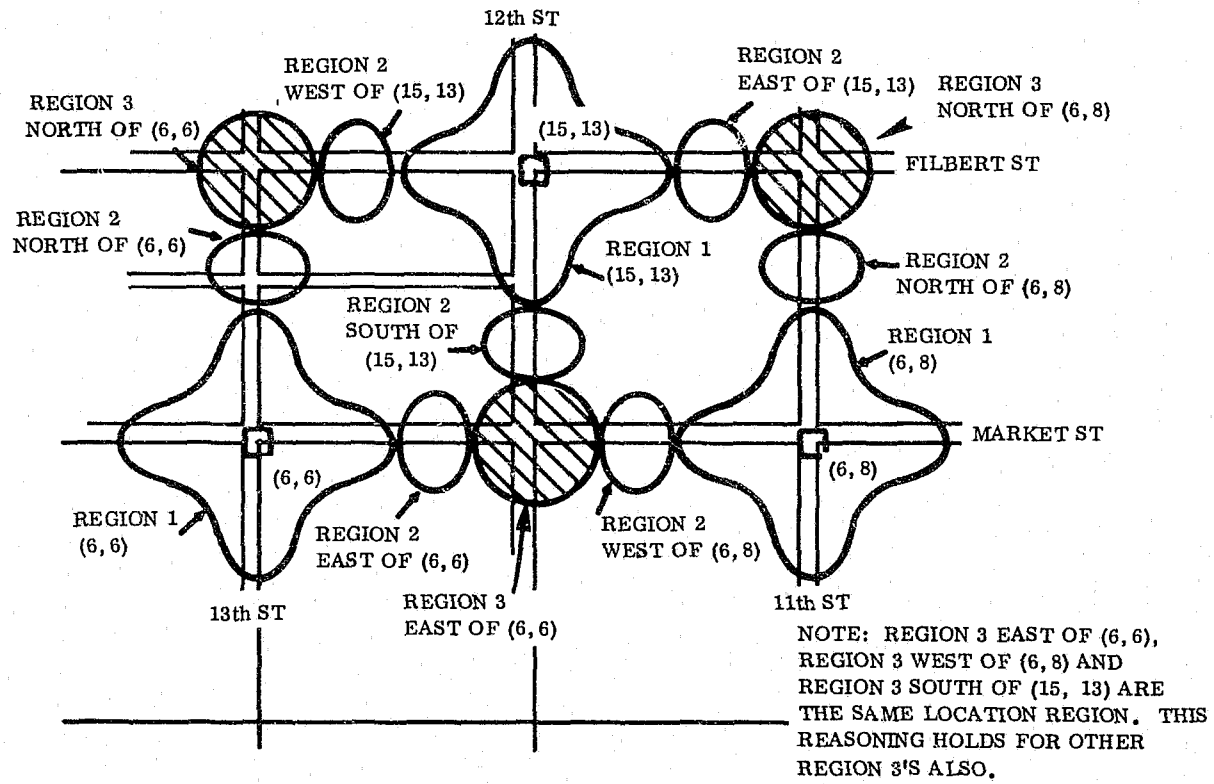


FIG. 3-14 OVERLAP REGION CREATED BY ADJACENT "CHAINING" SIGNPOSTS

The distance along Market would be determined (simultaneously with the determination of direction) by comparing the strength of the received signals from signposts (6,6) and (6,8). The following table identifies the results of this level comparison and Figure 3-15 illustrates the location of Region(s) 1, Region(s) 2, and Region(s) 3 relative to a pair of signposts:

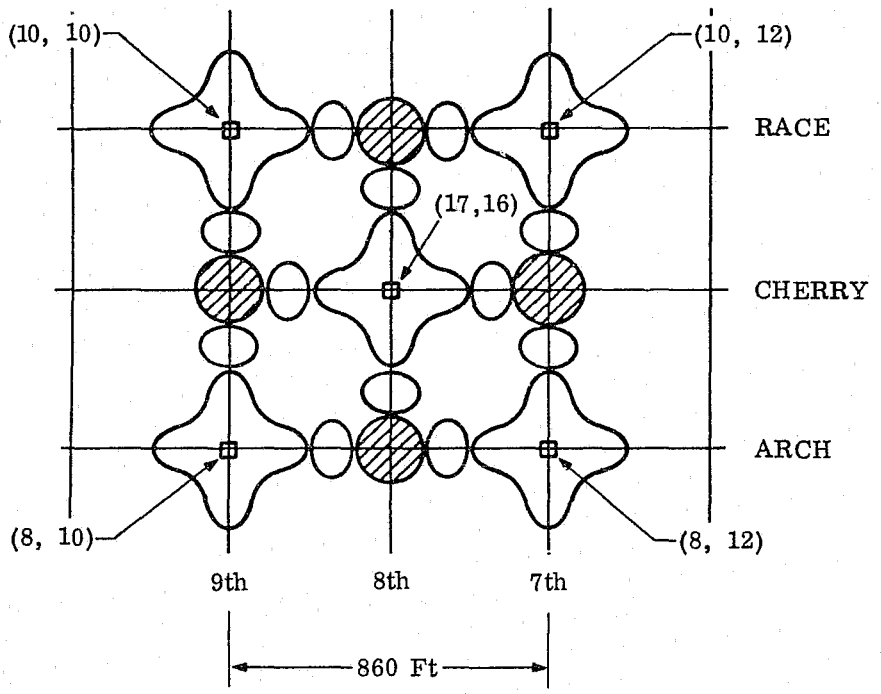
		Signpost A		
		Greater than -58 dBm*	Between -72 and -58 dBm	Between -82 and -72 dBm
Signpost B	Greater than -58 dBm	$R1_{A \text{ or } B}$	$R1_B$	$R1_B$
	Between -72 and -58	$R1_A$	$R3_{A \text{ or } B}$	$R2_B$
	Between -82 and -72	$R1_A$	$R2_A$	$R3_{A \text{ or } B}$

*dBm refers to the power level in decibels above a milliwatt and is $P(dBm) = 10 \log_{10} p(\text{milliwatts})$. Thus power level of 1 mw corresponds to 0 dBm. -60 dBm corresponds to a power level of 10^{-6} milliwatts or 10^{-9} watts.

Thus, if a Level 1 (signal greater than -58 dBm) is received from a signpost, the vehicle declares itself within the "Region 1" of that signpost or "at" the signpost. If a Level 2 or Level 3 is received, then either a Region 2 or Region 3 is declared, depending on the relative field strength received from the chaining signpost. If signals are received from two non-chaining signposts, e.g., signposts (6,6) and (15,13) the information is ignored and the previous location region is retained in the vehicle unit.

Combining the signpost code, region, and direction information allows each signpost to contribute to the formation of nine (9) location regions. For signpost (8,8) in Figure 3-12, these regions are as follows:

Signpost	Signpost Location Region	Approximate Center of Location Region
8,8	Region 1	11th and Arch
	Region 2 North of (8,8)	11th and Appletree
	Region 2 South of (8,8)	11th and Cuthbert
	Region 2 East of (8,8)	290 feet East of 11th and Arch
	Region 2 West of (8,8)	290 feet West of 11th and Arch
	Region 3 North of (8,8)	11th and Cherry
	Region 3 South of (8,8)	11th and Filbert
	Region 3 East of (8,8)	10th and Arch
	Region 3 West of (8,8)	12th and Arch



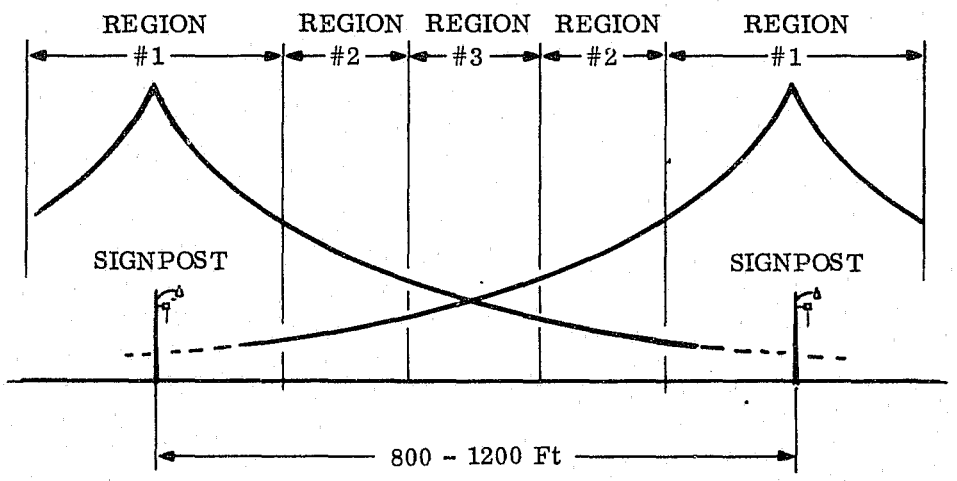


FIG. 3-15 HI^3 LS LOCATION REGIONS

Note that the location region identified as "Region 3 East of signpost (6, 6) would also be located at 12th and Market, the only difference between this region and Region 3 West of (6, 8) being the referenced signpost. Thus, in general, only five of the nine location regions associated with a signpost are unique, all Region 3's being duplicated. During Phase I, a set of X, Y stateplane coordinates were assigned to each location region in the coverage area. Whenever a new 18-BIT location code was received, the vehicle was assumed to be located at the corresponding X, Y stateplane coordinates.

Repeating, for clarity, the makeup of the 18-BIT location region code for random route location with signpost (8, 10) was:

Signpost Code		Region Field				
		Direction Field		Level Field		
North Field	East Field					Region Name
0 0 0 1 0 0 0	0 0 0 1 0 1 0	X	X	X	X	
		0	0	0	0	R1
		0	0	0	1	R2 South
		0	1	0	1	R2 East
		1	1	0	1	R2 North
		1	0	0	1	R2 West
		0	0	1	0	R3 South
		0	1	1	0	R3 East
		1	1	1	0	R3 North
		1	0	1	0	R3 West

Also, the HI^3 LS requires only one measurement to determine a new vehicle position, exactly as proposed for Phase II.

3.2.2 Random Route Area Mapping

After deployment of the signposts in Philadelphia, the system was calibrated to determine the location at which the boundaries between adjacent location regions occurred. After determining these boundary locations, through use of the in-vehicle display and manual analysis of listings of test cassettes, each location region was assigned a specific location region center, corresponding to a physical X, Y location in the test area. These locations were then utilized to create the signpost location region data base. During subsequent data processing, when an 18-BIT code recorded on cassette was processed, the vehicle's estimated location was given by the data base location corresponding to that 18-BIT code. Thus, a simple table look-up algorithm allowed the vehicle to be located at one of the 194 unique locations in the test area.

The generation of these 194 locations was accomplished by recording signpost location region codes, fifth wheel distance data, and event codes while driving the test vehicle over all streets within the test area. The boundary transitions were referenced (via the fifth wheel) to known X, Y locations supplied by the MITRE Corporation (locations identified by use of event codes). Analysis at Fort Worth allowed these boundaries to be located on a test area map. This map, presented in Figure 3-16, reflects the "Center" of all location regions on the basis of compiling multiple test runs through each region, including runs through different lanes. The map "center" of a location region was selected so as to minimize the location error on the basis of test and calibration data through the use of the HI^3 checkpoints. The centroid of a location region was selected as the point to be used in locating the vehicle when it declares a particular region code. In general, if a location region contained a street intersection, the center of the intersection was selected as the center of the location region.

Checkpoint Location and Marking. On 2 December 1976, TSC provided HI^3 with a list of sixty-three (63) primary checkpoints forty-eight (48) hours prior to initiating test runs 1 through 5. These checkpoints were identified in general (e.g., on Race East of 12th Street, West of Reading Railroad). HI^3 then identified specific landmarks: e.g., nearby street light, utility pole, sign, traffic standards, etc., which were approved by TSC as checkpoints. Each such point was identified by number, description, and location in terms of offset distances (X and Y) from the center of the nearest intersection. Subsequent to the completion of Test Runs 1 through 5, these offsets were translated into stateplane X, Y coordinates and became a part of the HI^3 Data Processing Software Data Base. Random Route Runs 1 through 5 were completed on 7 December 1976. On 12 December, TSC provided a list of 62 secondary checkpoints which were used during Random Route Runs 6 through 10. Random Route Runs 6 through 10 were conducted on 14 December 1976.

3.2.3 Location Subsystem Calibration

Calibration of the LS for random route testing involves (1) the establishment of the threshold levels for Levels 1, 2, and 3 in the vehicle unit, (2) the calibration of the fifth wheel over a measured distance calibration range, and (3) the use of the calibrated vehicle unit and fifth wheel to map the location area and generate the location region data base. Subsequently, only the threshold levels in the vehicle unit and the fifth wheel needed to be verified prior to the tests each day.

X and Y coordinate offset distances of checkpoints were determined through the use of the fifth wheel and DMI and a Measure Master manual device; when this measuring device was rolled along the pavement, it provided a direct counter readout of elapsed distance in feet.

3.2.3.1 Vehicle Unit Calibration. The calibration of the vehicle unit was verified on each test day with a calibrated signpost signal simulator and variable attenuator. Calibration involved attaching the output of the battery-powered

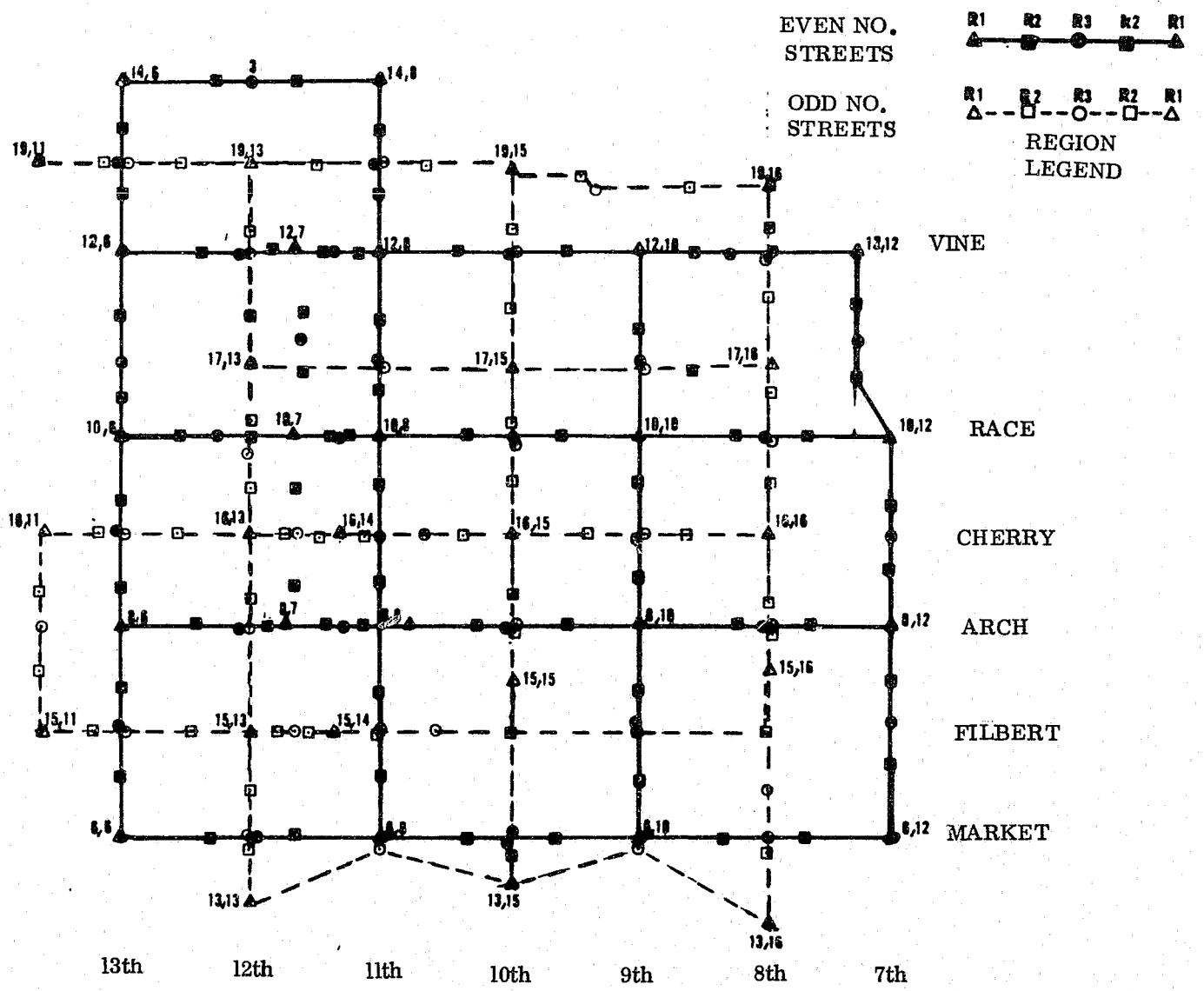


FIG. 3-16 MAP OF HI[3] LOCATION REGIONS

simulator to the vehicle unit antenna input connector with a short length of coax and a variable attenuator. The output of the simulator is -23 dBm. During calibration, the top of the vehicle unit box was removed in order to allow observation of three Light Emitting Diodes (LED's) which lighted whenever Level 3, 2 and 1 were respectively tripped. The trip level, in dBm, was obtained by subtracting the attenuation setting required to cause a level light (LED) to be extinguished from the -23 dBm value. Vehicle unit threshold level settings were not changed during random route testing. Threshold levels were -82, -72, and -58 dBm, respectively, for Levels 3, 2, and 1.

The threshold levels selected for use in the LS were determined so that they would provide adequate operation throughout a city (in this case the test area). Two factors influence the value of these thresholds: (1) the nominal spacing between signposts and (2) the RF background noise. The nominal spacing between signposts is primarily dictated by the street and block layout in a city. In most instances, HI^3 signposts are placed at intersections so as to take advantage of propagation down both streets in orthogonal directions. However, in some instances (e.g., signpost (15, 16) in the tunnel near Filbert and 8th) use of this method was not practical. Still, the threshold levels are set so as to divide the space between the signposts into location regions which allow the LS and system location accuracy specifications to be met.

The influence of RF background noise within the bandwidth of a signpost receiver is such that the signal-to-noise ratio at the receiver is reduced and the probability of an error in a received signpost transmission is increased. Although such an error will be detected and rejected by the vehicle unit's error filter, a missed transmission can cause an error if it occurs at or near a location region boundary. A survey of the in-band RF noise was made by HI^3 as part of Special Case Tests and is subsequently discussed in subsection 9.2. Analysis of this data demonstrates that the normal urban RF noise environment has been properly accounted for in the HI^3 system S/N design.

3.2.3.2 Fifth Wheel Calibration. The fifth wheel and odometer were calibrated each test day by driving a measured 1000-foot distance along Delaware Street. Neither odometer or fifth wheel calibrations were changed after initially being set at 979 and 872, respectively. With the exception of driving on ice and slush (when the fifth wheel introduced errors), both systems were always accurate within 0.2 percent of 1000 feet when the calibration was verified.

3.2.3.3 Location Region Data Base Calibration. The initial calibration of the location region data base was established through the use of the calibrated vehicle unit and the calibrated fifth wheel in the manner described in Paragraph 3.2.1. During the 48-hour period prior to commencing each series of tests, the operation of the signpost system was checked to verify its operation by driving the test area and simultaneously observing the CRT display. During calibration runs, a set of HI^3 checkpoints were used for which X, Y locations were available.

3.3 RANDOM ROUTE DATA ACQUISITION

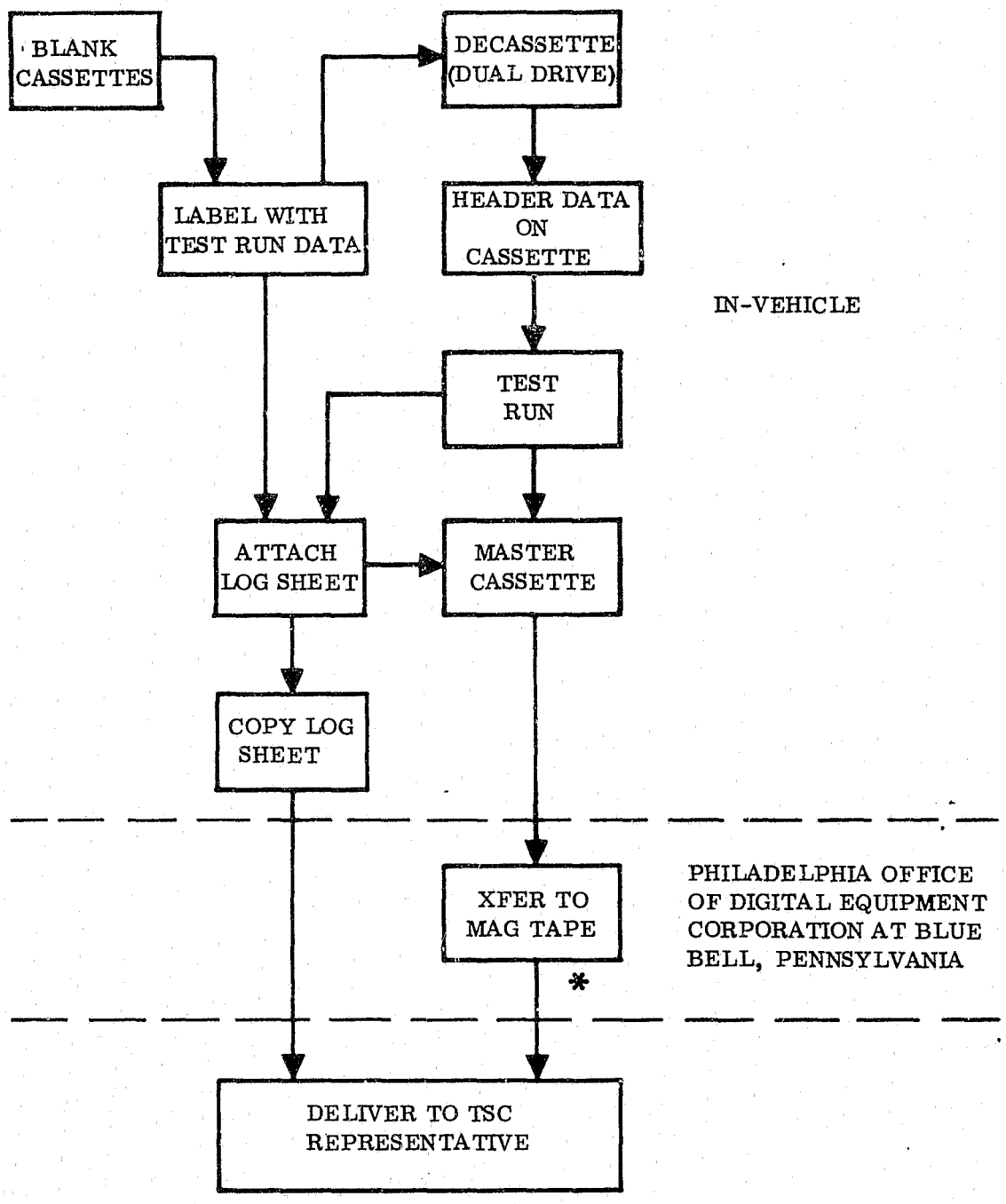
Test data were recorded on cassettes during all test runs. The sequence of events concerning data handling logistics is shown in Figure 3-17. Prior to a test run, header data identifying the test run parameters (refer to paragraph 3.1.3.1) were recorded on each pair of cassettes under the control of the RANDOM computer program.

A corresponding data log sheet was manually filled out by the Program Test Director and signed by the TSC Monitor after each Test Run. Figure 3-18 reflects a typical log sheet. At the conclusion of the Random Route test runs, all data cassettes were duplicated onto IBM compatible magnetic tapes. The master cassettes were retained by TSC until HI^3 software was validated at MITRE.

After keystroking the header data in response to prompters on the CRT display, the test vehicle driver proceeded to traverse the specified route. Passage of each designated checkpoint and each turn was recorded by keystroking the coded event marker. This action caused a time-coincident data record to be recorded on cassette. As a checkpoint or turn was approached, the test vehicle driver informed the test director/DAS operator to prepare for checkpoint NN. The DAS operator pressed first the CHECKPOINT function key and then keystroked the number NN. He then prepared to depress the RETURN key. As the test vehicle approached the checkpoint, the driver called out "standby", and then, as the front bumper of the test vehicle passed the designated checkpoint, he called out "MARK." Upon hearing this MARK, the DAS operator depressed the RETURN key. This action produced a data record and the appropriate checkpoint or turn number to be recorded on cassette. The Random Route Test Procedures are illustrated in Figure 3-19. All recorded data were retained and processed. No data were eliminated as poor or potentially poor.

All Random Route Tests commenced at 7th and Market heading North on 7th and ended at 7th and Market heading East on Market. The beginning and end of each run was indicated by entry of TA 64 (Turn 64) which was the number assigned by HI^3 to the intersection of 7th and Market.

The route traveled during Random Route Runs 1 through 5 is shown in Figure 3-20. TSC primary checkpoints are indicated by CP1, CP2, etc. Turn intersections are indicated by TA7, TA44, etc. The specific locations and landmarks selected by TSC as primary checkpoints are identified in Table 3-1. When the test vehicle left the random route test area and headed West at 13th and Market, TA58 was entered. TA58 was subsequently entered again when the vehicle re-entered the test area at 13th and Market and headed East after completing a turn-around at the City Hall. HI^3 Data Processing Software was designed to ignore data between successive entries of the same turn intersection number. This algorithm was authorized by TSC and was designed to keep from processing data outside of the random route test area during "pseudo" checkpoint processing for system simulation.



* LOG TAPE WITH TSC MONITOR

FIG. 3-17 HI^3 DATA HANDLING LOGISTICS

TEST DATA LOG

TEST RUN NO. 4 SHEET NO. 1 OF 1

TYPE OF TEST: Huffman London Route DATE: 12-7-76

BRIEF NARRATIVE DESCRIPTION OF TEST Time Start 2025 End 2150
Temp 46°F, Dry Windy.

ROUTE IDENTIFICATION: TSC Primary Route

EVENT MARKER NUMBER: 1-63 as assigned
Time: 31 Min. 41 Sec. at C.P. 25 thru C.P. 28 Trolley Car Following Directly Behind Test Vehicle.

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 2

VEHICLE UNIT THRESHOLD LEVELS: 1 -59 dBm 2 -72 dBm 3 -82 dBm

ODOMETER CAL: 997 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 45° PRECIPITATION: none ROAD CONDITIONS: Wet

TEST TAPE NO(S). 4-1 & 4-2 FILE NO. 1

SAMPLE RATE: 0.5 /

RUN TIME: 1Hr-25 Min.

TEST DIRECTOR George W. Huffman

TSC MONITOR K. W. K. Klein

FIG. 3-18 HI[3] TEST DATA LOG

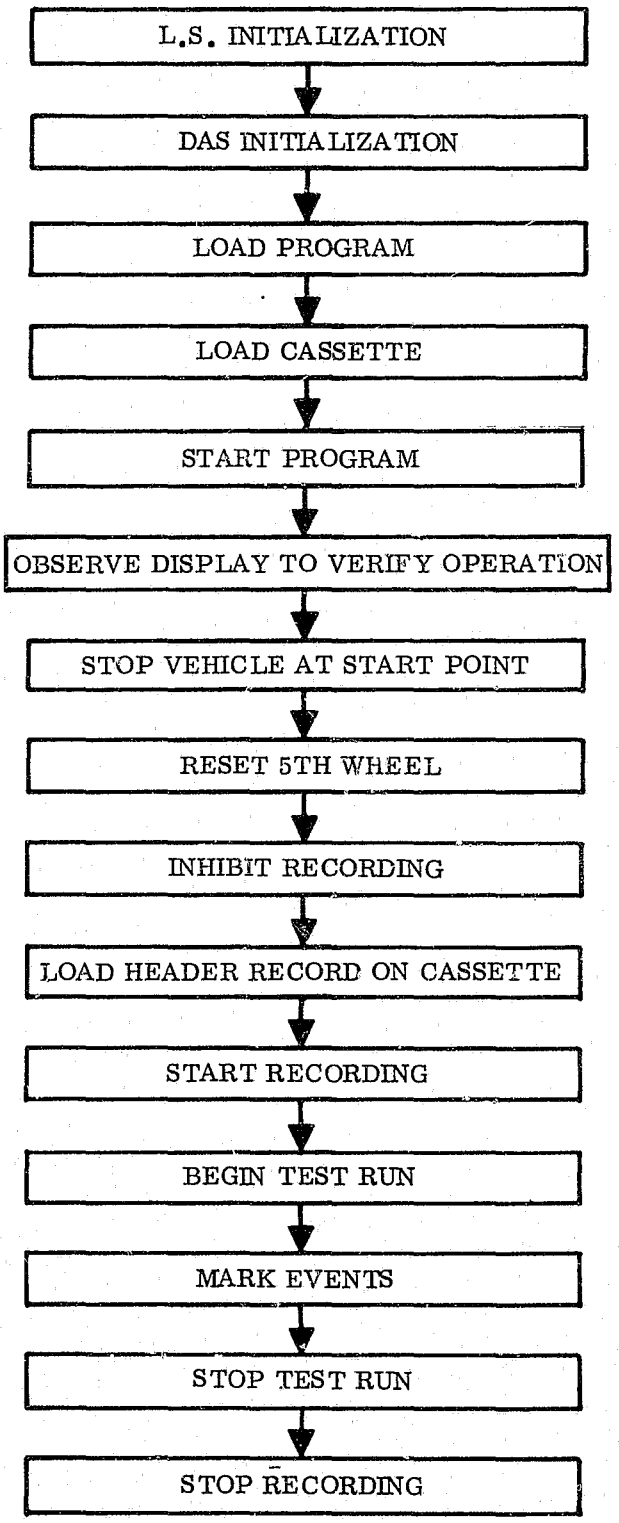


FIG. 3-19 HI^3 RANDOM ROUTE TEST PROCEDURES

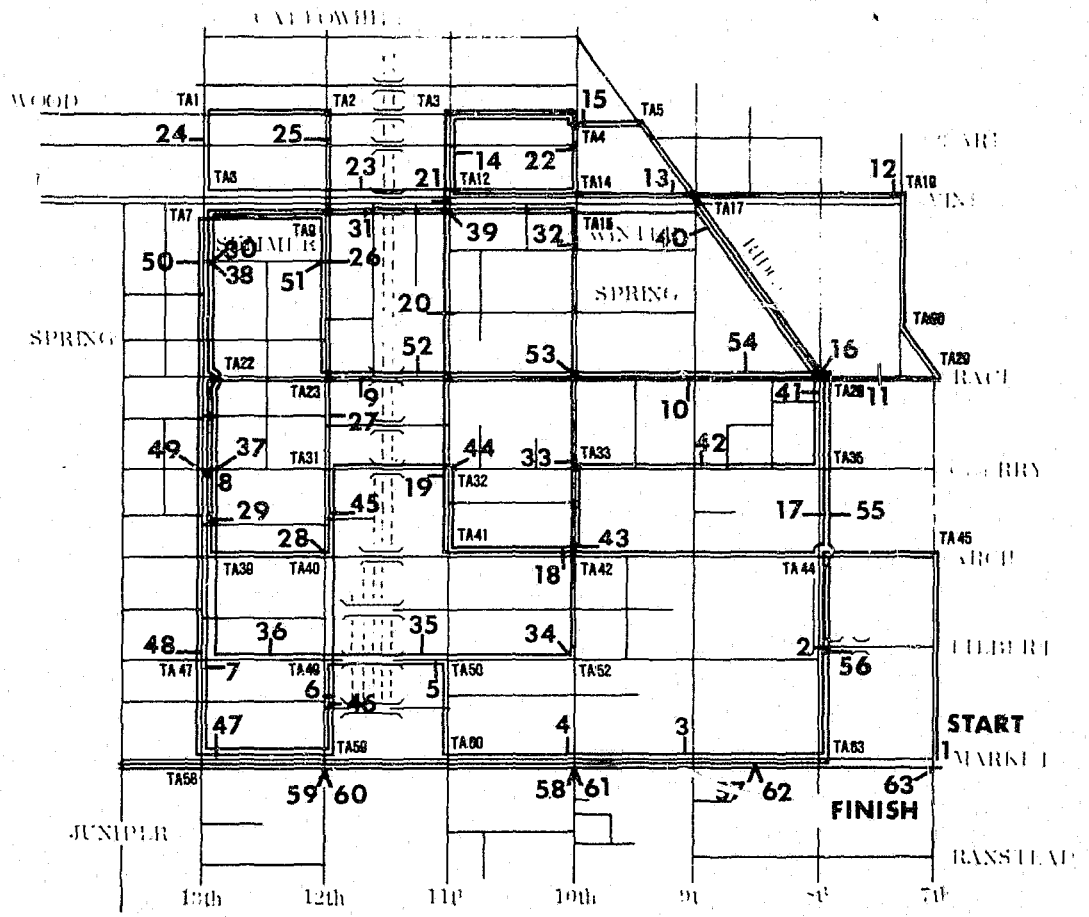


FIG. 3-20 PRIMARY RANDOM ROUTE AND CHECKPOINTS

TABLE 3-1 PRIMARY CHECKPOINTS

C. P. #	LOCATION/ LANDMARK
1	on 7th, curb northside of Market
2	on 8th, Center of Filbert
3	on Market, Center of 9th
4	on Market, Westside curb of 10th
5	on Filbert, Fireplug after West Turn from 11th
6	on 12th, Center of Commerce
7	on 13th, Center of Filbert
8	on 13th, Center of Cherry
9	on Race, St. Light West of Reading Tunnel, Between 11th & 12th
10	on Race, Center of 9th
11	on Race, Freeway sign between 7th & 8th
12	on Vine, Traffic Standard, Corner of 7th
13	on Vine, Traffic Standard, Northwest Corner of Ridge
14	on 11th, Center of Pearl
15	on Wood, Center of 10th, Manhole Cover
16	on Ridge, Center of Race
17	on 8th, Center of Appletree
18	on Arch, Center of 10th
19	on 11th, Center of Cherry
20	on 11th, Center of Spring
21	on 11th, Center of Vine
22	on 10th , Center of Pearl
23	on Vine, St. Light Northwest of Train Overpass Between 11th&12th
24	on 13th, Center of Pearl
25	on 12th, Center of Pearl
26	on 12th, Stop Sign, Southside of Summer
27	on 12th, North East Curb of Quarry
28	on 12th, Curb, Northside of Arch
29	on 13th, Center of Appletree
30	on 13th, Center of Summer, Fireplug
31	on Vine, St. Light Northeast of Elevated Train Overpass Between 11th & 12th
32	on 10th, Pole, Center of Winter
33	on 10th, Center of Cherry
34	on 10th, Northwest Curb of Filbert
35	on Filbert, After 11th at East Edge of Overpass
36	on Filbert, Black Pole Northside between 12th & 13th
37	on 13th, Center of Cherry
38	on 13th, Center of Summer Fireplug (westside)
39	on Vine, Center of 11th
40	on Vine, Center of 9th
41	On Ridge, Center of Race
42	on 9th, Center of Cherry
43	on 10th, North Curb of Arch
44	on 11th, Center of Cherry
45	on 12th, Center of Appletree
46	on 12th, Center of Commerce
47	on Market Curb Eastside of 13th
48	on 13th, Center of Filbert
49	on 13th, Center of Cherry
50	on 13th, Center of Summer Fireplug (westside)
51	on 12th, Stop Sign, South side of Summer
52	on Race, between 11th & 12th, St. Light South Eastside of Train Overpass
53	on Race, Center of 10th
54	on Race, Sign Southside , Between 8th & 9th
55	on 8th, Center of Appletree
56	on 8th, Center of Filbert
57	on Market, St. Light southside between 8th & 9th
58	on Market, Curb, westside of 10th
59	on Market, Center of 12th
60	on Market, Center of 12th
61	on Market, Center of 10th
62	on Market, Pole, Southside between 8th & 9th
63	on Market, Center of 7th

The test route, secondary checkpoints, and turn intersections used during random route test runs 6 through 10 are shown in Figure 3-21. The specific secondary checkpoint locations are identified in Table 3-2.

3.4 RANDOM ROUTE TEST DATA

As previously discussed in Section 3.1.3, test data were recorded on cassette every 0.5 second. This operation resulted in over 90,000 records, which, if printed out, would produce over 90,000 lines of print. In order to reduce the volume of data for this report, HI^3 wrote a computer program which prints out only those records which (1) contain an event marker or (2) contain a change in location region code. Only data of the type (1) and (2) are of interest during location subsystem data processing since only data at checkpoints are processed. During system level processing, all records or tape are of interest. However, in the interest of keeping this report manageable, complete listings of random route tapes have been provided to TSC separately. Listings of Random Route Test Runs 1 through 10 which show records of types (1) and (2) above are included in the Appendix. However, a listing of Run 7 is presented in Table 3-3 in order to show typical random route data. A list of column headings has been inserted; otherwise data is a direct dump of Run 7. However, only records which contain a location region change and/or a manual event entry are listed. Note that the odometer/fifth wheel columns are presented in terms of the number of pulses. To convert these columns to feet, they must be multiplied by the FPP calibration number which indicates the number of feet per pulse. In all cases during Phase I, this multiplier is two (2), so that the column values, when multiplied by 2 are converted to feet.

By recalling that the HI^3 vehicle unit stores the last received 18-BIT location code until a new valid code is received, it will be observed that either or both time and distance may change without a change in location code. In addition, the location code may change "toggle" while the vehicle is not moving, particularly if it is stopped in the vicinity of a boundary between two regions or in a location in which more than one 18-BIT code (e.g., Region 3) is used to describe a region. For example, between Time 34 minutes 14 seconds, and Time 34 minutes 25 seconds, Run 7 data in Table 3-3 is observed to toggle between the three codes (12,06) R2N, (14,06) R2S, and (14,06) R3S. By referring to Figure 3-12 and Table 3-2, it can be seen that Secondary Checkpoint 27 is located at 13th and Pearl, which is approximately 1/3 of the distance North of signpost (12,06), between signpost (12,06) and signpost (14,06). Reference to Table 5-7 will indicate that the location error incurred at CP 27 during Run 9 was 51 feet. If, for example, the CP had been marked at a time in which the location code was (12,06) R2N, i.e., 2 seconds and 38 feet later, the location error would have been 26 feet. However, in either case, the error would be considerably less than 300 feet.

Another typical case occurs at Times 11 minutes 7 seconds and 11 minutes 9 seconds in Table 3-3. In this case, the odometer readings are the same but the location codes are different. Note, however, that (13,15) R2N and (15,15) R3S are regions which share a common boundary as illustrated in Figure 3-16.

(Text Continues on 3-47)

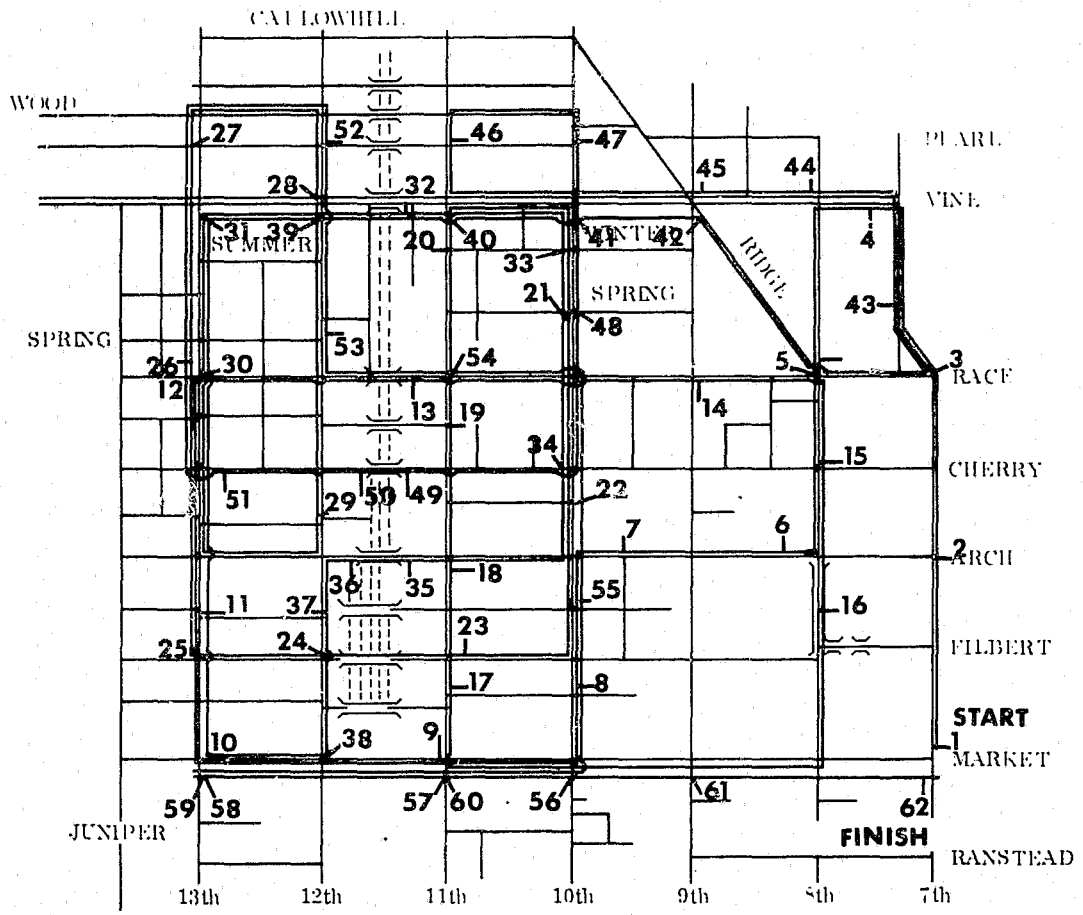


FIG. 3-21 SECONDARY RANDOM ROUTE AND CHECKPOINTS

TABLE 3-2 SECONDARY CHECKPOINTS

C. P. #	LOCATION/ LANDMARK
1	on 7th, Fire Plug, Northwest side of Market
2	on 7th, Center of Arch
3	on 7th, Center of Race
4	on Vine, Light Pole, North Side, between 7th &8th
5	on 8th, Center of Race
6	on Arch, After west turn on Arch, Fire Plug Southside
7	on Arch, Center of Hutchison
8	on 10th, Center of Filbert
9	on Market, Center of 11th
10	on Market, Overhead Signal Between 12th & 13th
11	on 13th, Center of Cuthbert
12	on Race, Wastebasket, North Side, After turn on Race
13	on Race, Light Pole, East Side of Elevated Train Overpass
14	on Race, Center of 9th
15	on 8th, Center of Cherry
16	on 8th, "NO STOPPING" sign east side between Arch & Filbert
17	on 11th, Center of Commerce
18	on 11th, Center of Arch
19	on 11th, Center of Quarry
20	on 11th, "ONE WAY " sign, west side of Winter
21	on 10th, Center of Spring
22	on 10th, Center of Appletree
23	on Filbert, South side "NO STOPPING" sign, between 10th and 11th
24	on Filbert, at west edge of Tunnel
25	on Filbert, Black Pole, North East Side of 13th
26	on 13th, Center of Spring
27	on 13th, Center of Pearl
28	on 12th, Center of Vine
29	on 12th, Center of Appletree
30	on 13th, Center of Race
31	on 13th, Pole, South Eastside of Vine
32	on Vine, "NO PARKING" sign, south Eastside of elevated Train Overpass
33	on 10th, Center of Winter
34	on 10th, Center of Cherry
35	on Arch, "NO PARKING" sign, west of 11th & East of Elevated Train Overpass
36	on Arch, Overhead Traffic Signal, West of Elevated Train Overpass, & East of 12th
37	on 12th, Center of Cuthbert
38	on 12th, Edge of Building, Northside of Market
39	on Vine, Center of 12th
40	on Vine, Center of 11th
41	on Vine, Center of 10th
42	on Vine, Center of 9th
43	on 7th, Telephone Booth, Westside, Between Race & Vine
44	on Vine, Center of 8th
45	on Vine, Center of 9th
46	on 11th, Center of Pearl
47	on 10th, Center of Pearl
48	on 10th, Center of Spring
49	on Cherry, Light Pole, Eastside of Elevated Train Overpass, & West of 11th
50	on Cherry, Light Pole, Westside of Elevated Train Overpass, East of 12th
51	on Cherry, Center of Iseminger
52	on 12th, Center of Pearl
53	on 12th, Center of Spring
54	on Race, Center of 11th
55	on 10th, Center of Cuthbert
56	on Market, Traffic Light, Nothwest Corner of 10th
57	on Market, Center of 11th
58	on Market, Overhead Signal, Between 12th & 13th
59	on Market, Overhead Signal, Between 13th & 12th
60	on Market, Center of 11th
61	on Market, Center of 9th
62	on Market, Center of 7th

TABLE 3-3 LISTING OF RECORDED RANDOM ROUTE TEST DATA

RUN 007 SAMPLE RATE 00.5 YEAR 76 MONTH 12 DAY 14 HOUR

FIFTH WHEEL FEET/PULSE 0002						ODOMETER FEET/PULSE 0002																	
	000	06	12		R1	D	00116	F	00000	T	00	50		000	06	08		R1	D	02997	F	00000	T	11	33
TA	064	06	12		R1	D	00206	F	00000	T	01	37	CP	009	06	08		R1	D	03076	F	00000	T	11	41
CP	001	06	12		R1	D	00262	F	00000	T	01	44		000	06	08		R2	W	D	03102	F	00000	T	11	59
	000	06	12		R2	N	D	00338	F	00000	T	01	51		000	06	06		R3	E	D	03193	F	00000	T	12	02
	000	08	12		R2	S	D	00379	F	00000	T	01	54		000	06	08		R2	W	D	03238	F	00000	T	12	08
	000	06	12		R2	N	D	00403	F	00000	T	01	56		000	06	06		R3	E	D	03295	F	00000	T	12	25
	000	06	12		R3	N	D	00416	F	00000	T	01	57		000	06	06		R1		D	03449	F	00000	T	12	43
	000	06	12		R2	N	D	00452	F	00000	T	02	00	CP	010	06	06		R1		D	03476	F	00000	T	13	14
	000	08	12		R2	S	D	00469	F	00000	T	02	02	TA	058	06	06		R1		D	03529	F	00000	T	13	36
	000	08	12		R1		D	00509	F	00000	T	02	26		000	06	06		R2	N	D	03615	F	00000	T	14	01
CP	002	08	12		R1		D	00582	F	00000	T	02	40		000	08	06		R2	S	D	03692	F	00000	T	14	08
	000	06	12		R2	N	D	00683	F	00000	T	03	14	CP	011	08	06		R2	S	D	03786	F	00000	T	14	20
	000	08	12		R1		D	00687	F	00000	T	03	14		000	08	06		R1		D	03803	F	00000	T	14	33
	000	08	12		R2	N	D	00707	F	00000	T	03	18		000	16	11		R1		D	04042	F	00000	T	15	13
	000	08	12		R1		D	00714	F	00000	T	03	19		000	10	06		R2	S	D	00045	F	00000	T	15	27
	000	08	12		R2	N	D	00717	F	00000	T	03	20		000	10	06		R1		D	00091	F	00000	T	15	54
	000	08	12		R1		D	00770	F	00000	T	03	31	TA	022	10	06		R1		D	00139	F	00000	T	16	00
	000	08	12		R3	N	D	00780	F	00000	T	03	24	CP	012	10	06		R1		D	00155	F	00000	T	16	04
	000	08	12		R2	N	D	00791	F	00000	T	03	26		000	10	06		R2	E	D	00251	F	00000	T	16	28
	000	10	12		R3	S	D	00744	F	00000	T	03	27		000	10	06		R3	W	D	00251	F	00000	T	16	29
	000	08	12		R2	N	D	00761	F	00000	T	04	00		000	10	07		R1		D	00390	F	00000	T	16	54
	000	10	12		R3	S	D	00786	F	00000	T	04	06		000	10	07		R2	W	D	00507	F	00000	T	17	04
	000	10	12		R2	S	D	00848	F	00000	T	04	15		000	10	07		R3	E	D	00523	F	00000	T	17	06
	000	10	12		R1		D	00852	F	00000	T	04	16	CP	013	10	07		R3	E	D	00529	F	00000	T	17	06
	000	10	12		R2	S	D	00856	F	00000	T	04	16		000	10	08		R1		D	00544	F	00000	T	17	08
	000	10	12		R1		D	00860	F	00000	T	04	17		000	10	08		R2	E	D	00795	F	00000	T	17	44
	000	10	12		R2	S	D	00872	F	00000	T	04	18		000	17	15		R2	S	D	00815	F	00000	T	18	05
	000	10	12		R1		D	00883	F	00000	T	04	20		000	16	15		R3	N	D	00818	F	00000	T	18	06
	000	10	12		R2	S	D	00885	F	00000	T	04	21		000	10	08		R2	E	D	00845	F	00000	T	18	09
	000	10	12		R1		D	00888	F	00000	T	04	22		000	10	08		R3	E	D	00868	F	00000	T	18	12
CP	003	10	12		R1		D	00979	F	00000	T	05	16		000	10	10		R2	W	D	00877	F	00000	T	18	13
TA	029	10	12		R1		D	00948	F	00000	T	05	19		000	10	10		R1		D	00994	F	00000	T	18	25
	000	10	12		R2	N	D	01053	F	00000	T	05	30	CP	014	10	10		R1		D	01033	F	00000	T	18	29
	000	10	12		R3	N	D	01116	F	00000	T	05	35		000	10	10		R2	E	D	01188	F	00000	T	18	43
TA	080	10	12		R3	N	D	01123	F	00000	T	05	36	TA	028	10	10		R3	E	D	01243	F	00000	T	19	33
	000	12	12		R2	S	D	01155	F	00000	T	05	38		000	17	16		R2	S	D	01312	F	00000	T	19	39
	000	12	12		R		D	01222	F	00000	T	05	45		000	16	16		R3	N	D	01327	F	00000	T	19	41
TA	019	12	12		R1		D	01266	F	00000	T	06	01		000	16	16		R2	N	D	01386	F	00000	T	19	46
CP	004	12	12		R1		D	01351	F	00000	T	06	12		000	16	16		R1		D	01392	F	00000	T	19	47
	000	12	12		R2	W	D	01387	F	00000	T	06	16	CP	015	16	16		R1		D	01426	F	00000	T	19	50
TA	018	12	12		R2	W	D	01416	F	00000	T	06	21		000	15	16		R3	N	D	01572	F	00000	T	20	04
	000	19	16		R2	S	D	01426	F	00000	T	06	23		000	15	16		R1		D	01601	F	00000	T	20	06
	000	19	16		R3	S	D	01459	F	00000	T	06	26	CP	016	15	16		R1		D	01693	F	00000	T	20	15
	000	19	16		R2	S	D	01471	F	00000	T	06	27		000	15	16		R2	S	D	01803	F	00000	T	20	25
	000	17	16		R2	N	D	01477	F	00000	T	06	28		000	13	16		R3	N	D	01898	F	00000	T	20	34
	000	17	16		R1		D	01523	F	00000	T	06	31	TA	063	13	16		R3	N	D	01973	F	00000	T	20	43
	000	10	10		R3	E	D	01636	F	00000	T	07	13		000	06	12		R3	W	D	01978	F	00000	T	20	45
	000	17	16		R1		D	01636	F	00000	T	07	14		000	06	10		R3	E	D	01985	F	00000	T	20	46
CP	005	17	16		R1		D	01721	F	00000	T	07	27		000	06	10		R2	E	D	02036	F	00000	T	20	54
	000	16	16		R3	N	D	01801	F	00000	T	07	34		000	06	10		R1		D	02067	F	00000	T	20	58
	000	16	16		R2	N	D	01836	F	00000	T	07	37		000	06	10		R2	E	D	02136	F	00000	T	21	02
	000	16	16		R1		D	01846	F	00000	T	07	38		000	06	10		R1		D	02149	F	00000	T	21	03
	000	15	16		R2	N	D	02011	F	00000	T	07	57		000	06	10		R2	W	D	02320	F	00000	T	22	00
	000	16	16		R3	S	D	02046	F	00000	T	08	03		000	06	08		R2	E	D	02434	F	00000	T	22	45
TA	044	16	16		R3	S	D	02059	F	00000	T	08	06		000	06	10		R3	W	D	02450	F	00000	T	22	47
	000	15	16		R1		D	02070	F	00000	T	08	08		000	13	21		R1		D	02455	F	00000	T	22	47
	000	08	12		R2	W	D	02077	F	00000	T	08	10		000	06	08		R2	E	D	02466	F	00000	T	22	48
CP	006	08	12		R2	W	D	02080	F	00000	T	08	10		000	06	10		R3	W	D	02484	F	00000	T	22	50
	000	08	10		R3	E	D	02087	F	00000	T	08	12		000	06	08		R2	E	D	02502	F	00000	T	22	51
	000	08	10		R2	E	D	02167	F	00000	T	08	21		000	06	08		R1		D	02526	F	00000	T	22	53
	000	08	10		R2	N	D	02173	F	00000	T	08	22		000	06	08		R2	E	D	02574	F	00000	T	22	57
	000	08	10		R2	E	D	02179	F	00000	T	08	22		000	06	08		R1		D	02589	F	00000	T	22	59
	000	08	10		R1		D	02214	F	00000	T	08	26	TA	060	06	08		R1		D	02650	F	00000	T	23	41
CP	007	08	10		R1		D	02408	F	00000	T	08	45	CP	017	06	08		R1		D	02764	F	00000	T	23	57
	000	08	10		R2	W	D	02441	F	00000	T	08	48		000	15	14		R1		D	02824	F	00000	T	24	04
	000	08	10		R3	W	D	02461	F	00000	T	08	52		000	08	08		R2	S	D	02977	F	00000	T	24	20
TA	042	08	10		R3	W	D	02497	F	00000	T	09	04		000	08	08		R1		D	01021	F	00000	T	24	25
	000	15	15		R1		D	02509	F	00000	T	09	06	CP	018	08	08		R1		D	03026	F	00000	T	24	35
	000	16	15		R3	S	D	02522	F	00000	T	09	08		000	16	14		R1		D	03158	F	00000	T	24	41
	000	15	15		R2	N	D	02529	F	00000	T	09	09	CP	019	16	14		R1		D	03287	F	00000	T	24	50
	000	15	15		R1		D	02533	F	00000	T	09	10		000	10	08		R2	W	D	03290	F	00000	T	25	01
CP	008	15	15		R1		D	02674	F	00000	T	09	25		000	10	08		R1		D	03305	F	00000	T	25	05
	000	13	15		R3	N	D	02711	F	00000	T	09	31		000	10	08		R3	W	D	03340	F	00000	T	25	07
	000	13	15		R2	N	D	02830	F	00000	T	11	05		000	10	08		R1		D	03345	F	00000	T	25	07
	000	15	15		R3	S	D	02833	F	00000	T	11	06		000	10	08		R2	N	D	03484	F	00000	T	25	20
	000	13	15		R2	N	D	02838	F	00000	T	11	07		000	10	08		R1		D	03487	F	00000	T	25	20
	000	15	15		R3	S	D	02838	F	00000	T	11	09		000	10	08		R2	N	D	03498	F	00000	T	25	21
TA	061	13	15		R1		D	02856	F	00000	T	11	16		000	12	08		R3	S	D	03515	F	00000	T	25	23
	000	06	10		R2	W	D	02883	F	00000	T	11	21		000	10	08		R2	N	D	03526	F	00000	T	25	24
	000	06	08		R2	E	D	02909	F	00000	T	11	25		000	12	08		R3	S	D	03534	F	00000	T	25	25
	000	06	10		R2	W	D	02915	F	00000	T	11	25		000	12	08		R2	S	D	03549	F	00000	T	25	27
	000	06	08		R2	E	D	02941	F	00000	T	11	28		000	10	08		R3	N	D	03556	F	00000	T	25	28
	000	06	08		R1		D	02952	F	00000	T	11	29		000	12	08		R2	S	D	03558	F	00000	T	25	29
	000	06	08		R2	E	D	02964	F	00000	T	11	30		000	10	08		R3	N	D	03561	F	00000	T	25	30
	000	06	08		R3	E	D	02975	F	00000	T	11	31		000	12	08		R2	S	D	03562	F	00000	T	25	30

TABLE 3-3 LISTING OF RECORDED RANDOM ROUTE TEST DATA (CONT'D)

	000	10	08	R3	N	0	03564	F	00000	T	25	32	TA	002	19	13	R1	0	02535	F	00000	T	35	00
	000	10	08	R2	N	0	03569	F	00000	T	25	34		000	12	07	R2	E	0	02636	F	00000	T	35	26
	000	12	08	R3	S	0	03570	F	00000	T	25	34		000	19	13	R2	S	0	02637	F	00000	T	35	30
	000	12	08	R2	S	0	03578	F	00000	T	25	38		000	12	07	R2	W	0	02637	F	00000	T	35	36
CP	020	12	08	R2	S	0	03603	F	00000	T	26	15		000	12	07	R2	E	0	02637	F	00000	T	35	36
	000	12	08	R1		0	03610	F	00000	T	26	16		000	19	13	R2	S	0	02637	F	00000	T	35	40
TA	013	12	08	R1		0	03705	F	00000	T	26	28		000	12	07	R2	E	0	02637	F	00000	T	35	43
	000	12	08	R2	W	0	03762	F	00000	T	26	33		000	19	13	R2	S	0	02637	F	00000	T	35	45
	000	12	08	R1		0	03769	F	00000	T	26	34		000	12	07	R2	E	0	02637	F	00000	T	35	46
	000	19	15	R3	S	0	03820	F	00000	T	26	38		000	19	13	R2	S	0	02637	F	00000	T	35	58
	000	12	08	R2	E	0	03876	F	00000	T	27	15		000	12	07	R2	E	0	02637	F	00000	T	36	00
TA	015	12	08	R2	E	0	03891	F	00000	T	27	17		000	19	13	R2	S	0	02637	F	00000	T	36	04
	000	17	15	R2	N	0	03904	F	00000	T	27	19		000	12	07	R2	E	0	02637	F	00000	T	36	04
	000	19	15	R3	S	0	03941	F	00000	T	27	24		000	19	13	R2	S	0	02637	F	00000	T	36	06
	000	17	15	R1		0	03945	F	00000	T	27	24		000	12	07	R2	E	0	02637	F	00000	T	36	06
	000	17	15	R3	N	0	03960	F	00000	T	27	26		000	19	13	R2	S	0	02642	F	00000	T	36	11
	000	17	15	R1		0	03971	F	00000	T	27	27		000	12	07	R1		0	02645	F	00000	T	36	12
	000	19	15	R3	S	0	03981	F	00000	T	27	28		000	12	07	R2	E	0	02656	F	00000	T	36	13
	000	17	15	R1		0	03987	F	00000	T	27	28		000	12	07	R2	W	0	02667	F	00000	T	36	15
CP	021	17	15	R1		0	04052	F	00000	T	27	34		000	12	06	R3	E	0	02671	F	00000	T	36	16
	000	17	15	R3	S	0	00070	F	00000	T	28	20		000	12	07	R2	W	0	02679	F	00000	T	36	17
	000	17	15	R2	S	0	00102	F	00000	T	28	24		000	17	13	R3	N	0	02687	F	00000	T	36	18
	000	16	15	R3	N	0	00121	F	00000	T	28	26	CP	028	17	13	R3	N	0	02696	F	00000	T	36	19
	000	16	15	R2	N	0	00155	F	00000	T	28	29		000	12	07	R2	W	0	02742	F	00000	T	36	24
	000	17	15	R3	S	0	00166	F	00000	T	28	30		000	17	13	R2	N	0	02769	F	00000	T	36	26
	000	16	15	R3		0	00196	F	00000	T	28	32		000	17	13	R1		0	02774	F	00000	T	36	27
CP	022	16	15	R1		0	00308	F	00000	T	29	00		000	10	07	R3	N	0	02885	F	00000	T	37	13
	000	15	15	R3	N	0	00351	F	00000	T	29	11		000	17	13	R1		0	02885	F	00000	T	37	14
	000	15	15	R2	N	0	00434	F	00000	T	29	21		000	10	07	R3	N	0	02885	F	00000	T	37	15
	000	16	15	R3	S	0	00438	F	00000	T	29	22		000	17	13	R1		0	02885	F	00000	T	37	15
	000	15	15	R2	N	0	00448	F	00000	T	29	23		000	10	07	R3	N	0	02885	F	00000	T	37	21
	000	15	15	R3	N	0	00455	F	00000	T	29	24		000	17	13	R1		0	02885	F	00000	T	37	26
	000	15	15	R1		0	00460	F	00000	T	29	25		000	12	07	R3	S	0	02885	F	00000	T	37	33
	000	15	15	R2	S	0	00585	F	00000	T	29	36		000	17	13	R1		0	02885	F	00000	T	37	34
	000	15	15	R1		0	00595	F	00000	T	29	38		000	12	07	R3	S	0	02949	F	00000	T	37	50
TA	052	15	15	R1		0	00603	F	00000	T	29	39		000	17	13	R1		0	02954	F	00000	T	37	50
	000	15	15	R2	S	0	00606	F	00000	T	29	40		000	17	13	R3	S	0	03036	F	00000	T	37	58
	000	15	15	R2	W	0	00626	F	00000	T	29	44		000	17	13	R2	S	0	03077	F	00000	T	38	08
	000	15	14	R3	E	0	00639	F	00000	T	29	46		000	16	13	R3	N	0	03079	F	00000	T	38	08
	000	15	14	R2	E	0	00682	F	00000	T	29	51		000	17	13	R2	S	0	03083	F	00000	T	38	09
CP	023	15	14	R2	E	0	00784	F	00000	T	30	02		000	16	13	R3	N	0	03086	F	00000	T	38	10
	000	15	14	R1		0	00787	F	00000	T	30	03		000	16	13	R1		0	03147	F	00000	T	38	24
	000	15	13	R2	E	0	00981	F	00000	T	30	35		000	16	13	R3	N	0	03147	F	00000	T	38	24
	000	15	13	R1		0	01015	F	00000	T	30	39		000	16	13	R1		0	03147	F	00000	T	38	26
CP	024	15	13	R1		0	01053	F	00000	T	31	26		000	17	13	R3	S	0	03147	F	00000	T	38	27
	000	15	13	R2	W	0	01178	F	00000	T	31	41		000	16	13	R1		0	03148	F	00000	T	38	28
	000	15	13	R3	W	0	01212	F	00000	T	31	44		000	16	13	R3	N	0	03148	F	00000	T	38	28
CP	025	15	13	R3	W	0	01250	F	00000	T	31	48		000	16	13	R1		0	03152	F	00000	T	38	30
TA	047	15	13	R3	W	0	01283	F	00000	T	31	53		000	32	27	R1		0	03213	F	00000	T	38	51
	000	08	06	R2	S	0	01335	F	00000	T	32	02		000	16	13	R1		0	03213	F	00000	T	38	52
	000	08	06	R1		0	01364	F	00000	T	32	07		000	32	27	R1		0	03213	F	00000	T	38	52
	000	16	11	R1		0	01630	F	00000	T	32	46		000	16	13	R1		0	03213	F	00000	T	38	58
	000	10	06	R1		0	01770	F	00000	T	33	04	CP	029	16	13	R1		0	03265	F	00000	T	39	15
	000	10	06	R2	N	0	01866	F	00000	T	33	14		000	08	07	R1		0	03310	F	00000	T	39	22
CP	026	10	06	R2	N	0	01882	F	00000	T	33	16		00	16	13	R2	S	0	03319	F	00000	T	39	23
	000	10	06	R1		0	01887	F	00000	T	33	16		000	15	13	R3	N	0	03321	F	00000	T	39	24
	000	10	06	R2	N	0	01903	F	00000	T	33	18		000	16	13	R2	S	0	03322	F	00000	T	39	24
	000	10	06	R1		0	01913	F	00000	T	33	19		000	08	07	R2	W	0	03323	F	00000	T	39	25
	000	10	06	R2	N	0	01923	F	00000	T	33	20		000	16	13	R3	S	0	03331	F	00000	T	39	30
	000	12	06	R3	S	0	01953	F	00000	T	33	23		000	08	07	R1		0	03331	F	00000	T	39	30
	000	10	06	R2	N	0	01962	F	00000	T	33	24		000	16	13	R3	S	0	03331	F	00000	T	39	31
	000	10	06	R3	N	0	01979	F	00000	T	33	26		000	08	07	R1		0	03331	F	00000	T	39	32
	000	12	06	R2	S	0	01987	F	00000	T	33	27		000	16	13	R1		0	03331	F	00000	T	39	34
	000	12	06	R1		0	02016	F	00000	T	33	31		000	08	07	R1		0	03331	F	00000	T	39	35
	000	12	06	R2	N	0	02213	F	00000	T	34	14		000	16	13	R3	S	0	03331	F	00000	T	39	36
	000	14	06	R2	S	0	02223	F	00000	T	34	15		000	08	07	R1		0	03331	F	00000	T	39	37
	000	14	06	R3	S	0	02228	F	00000	T	34	16		000	16	13	R3	S	0	03331	F	00000	T	39	37
CP	027	14	06	R3	S	0	02259	F	00000	T	34	19		000	08	07	R1		0	03331	F	00000	T	39	38
	000	12	06	R2	N	0	02278	F	00000	T	34	21		000	16	13	R3	S	0	03331	F	00000	T	39	39
	000	14	06	R2	S	0	02297	F	00000	T	34	23		000	08	07	R1		0	03331	F	00000	T	39	40
TA	001	14	06	R2	S	0	02308	F	00000	T	34	25		000	15	13	R3	N	0	03331	F	00000	T	39	44
	000	19	11	R1		0	02312	F	00000	T	34	26		000	15	13	R2	N	0	03331	F	00000	T	39	45
	000	19	11	R2	S	0	02320	F	00000	T	34	28		000	08	07	R1		0	03331	F	00000	T	39	46
	000	19	11	R1		0	02322	F	00000	T	34	28		000	15	13	R3	N	0	03331	F	00000	T	39	47
	000	12	06	R3	N	0	02345	F	00000	T	34	32		000	08	07	R1		0	03331	F	00000	T	39	50
	000	19	11	R1		0	02358	F	00000	T	34	34		000	15	13	R3	N	0	03331	F	00000	T	39	51
	000	19	13	R2	W	0	02390	F	00000	T	34	37		000	08	07	R1		0	03331	F	00000	T	39	53
	000	19	11	R3	E	0	02395	F	00000	T	34	37		000	16	13	R3	S	0	03331	F	00000	T	39	54
	000	19	13	R1		0	02434	F	00000	T	34	43		000	08	07	R1		0	03331	F	00000	T	39	55
	000	19	13	R2	W	0	02449	F	00000	T	34	45		000	16	13	R3	S	0	03345	F	00000	T	40	00
	000	19	13	R1		0	02454	F	00000	T	34	45		000	08	07	R1		0	03347	F	00000	T	40	01
	000	19	13	R2	W	0	02464	F	00000	T	34	47	TA	040	16	13	R3	S	0	03350	F	00000	T	40	02
	000	19	13	R1		0	02483	F	00000	T	34	48		000	08	07	R1		0	03351	F	00000	T	40	02

TABLE 3-3 LISTING OF RECORDED RANDOM ROUTE TEST DATA (CONT'D)

	000	16	15	R1		O	03353	F	00000	T	40	03		000	08	07	R1	O	01865	F	00000	T	48	25
	000	08	07	R1		O	03358	F	00000	T	40	05	TA	040	08	07	R1	O	01869	F	00000	T	48	26
	000	08	07	R2	W	O	03417	F	00000	T	40	13		000	08	07	R2	N	O	01979	F	00000	T	48	28
	000	08	06	R2	E	O	03426	F	00000	T	40	15		000	16	13	R3	S	O	01887	F	00000	T	48	30
	000	08	06	R3	E	O	03434	F	00000	T	40	16		000	15	13	R2	N	O	01925	F	00000	T	48	35
	000	08	07	R2	W	O	03437	F	00000	T	40	17		000	15	13	R1		O	01931	F	00000	T	48	36
	000	08	07	R3	W	O	03444	F	00000	T	40	18		000	15	13	R2	N	O	01936	F	00000	T	48	37
	000	08	07	R2	W	O	03446	F	00000	T	40	19		000	15	13	R1		O	01953	F	00000	T	48	46
	000	08	06	R3	E	O	03451	F	00000	T	40	20	CP	037	15	13	R1		O	01970	F	00000	T	48	09
	000	08	06	R1		O	03493	F	00000	T	40	25		000	15	13	R2	N	O	01995	F	00000	T	49	39
	000	08	06	R3	E	O	03514	F	00000	T	40	27		000	15	13	R1		O	01995	F	00000	T	49	42
	000	08	06	R1		O	03525	F	00000	T	40	28		000	15	13	R2	N	O	02010	F	00000	T	50	12
TA	039	08	06	R1		O	03572	F	00000	T	41	11		000	15	13	R1		O	02027	F	00000	T	50	19
	000	16	11	R1		O	03729	F	00000	T	41	28		000	15	13	R2	S	O	02136	F	00000	T	51	22
	000	10	06	R1		O	03884	F	00000	T	41	52		000	15	13	R1		O	02137	F	00000	T	51	24
CP	036	10	06	R1		O	03908	F	00000	T	41	55		000	15	13	R2	S	O	02143	F	00000	T	51	27
	000	10	06	R2	N	O	03993	F	00000	T	42	06		000	15	13	R1		O	02144	F	00000	T	51	27
	000	10	06	R1		O	04001	F	00000	T	42	07		000	60	55	R1		O	02148	F	00000	T	51	36
	000	10	06	R2	N	O	04018	F	00000	T	42	09		000	15	13	R1		O	02148	F	00000	T	51	37
	000	12	06	R3	S	O	04073	F	00000	T	42	15		000	15	13	R3	S	O	02179	F	00000	T	51	51
	000	12	06	R2	S	O	04078	F	00000	T	42	16		000	15	13	R2	S	O	02191	F	00000	T	51	52
	000	10	06	R3	N	O	00007	F	00000	T	42	35		000	15	13	R3	S	O	02195	F	00000	T	51	53
	000	12	06	R1		O	00018	F	00000	T	42	29		000	15	13	R2	S	O	02206	F	00000	T	51	54
CP	031	12	06	R1		O	00051	F	00000	T	42	48	CP	038	13	13	R3	N	O	02214	F	00000	T	51	56
TA	007	12	06	R1		O	00114	F	00000	T	43	48	TA	059	13	13	R3	N	O	02233	F	00000	T	52	00
	000	12	06	R2	E	O	00193	F	00000	T	43	58		000	06	06	R2	E	O	02311	F	00000	T	52	11
	000	12	06	R1		O	00197	F	00000	T	43	58		000	06	06	R1		O	02352	F	00000	T	52	14
	000	12	06	R2	E	O	00214	F	00000	T	44	00	TA	058	06	06	R1		O	02456	F	00000	T	53	04
	000	12	07	R3	W	O	00232	F	00000	T	44	03		000	06	06	R2	N	O	02584	F	00000	T	53	20
	000	12	06	R2	E	O	00238	F	00000	T	44	04		000	08	06	R3	S	O	02623	F	00000	T	53	27
	000	12	07	R3	W	O	00244	F	00000	T	44	05		000	08	06	R2	S	O	02623	F	00000	T	53	28
	000	12	07	R2	W	O	00250	F	00000	T	44	18		000	08	06	R3	S	O	02623	F	00000	T	53	31
	000	12	07	R3	W	O	00265	F	00000	T	44	21		000	08	06	R2	S	O	02623	F	00000	T	53	35
	000	12	07	R2	W	O	00311	F	00000	T	44	26		000	08	06	R3	S	O	02647	F	00000	T	53	41
	000	12	08	R3	W	O	00321	F	00000	T	44	27		000	08	06	R2	S	O	02667	F	00000	T	53	43
	000	12	07	R1		O	00326	F	00000	T	44	27		000	08	06	R1		O	02740	F	00000	T	53	51
	000	12	06	R2	E	O	00364	F	00000	T	44	30		000	16	11	R1		O	02978	F	00000	T	54	11
	000	12	07	R2	W	O	00371	F	00000	T	44	31		000	10	06	R2	S	O	03089	F	00000	T	54	24
	000	12	07	R1		O	00384	F	00000	T	44	32		000	10	06	R1		O	03142	F	00000	T	54	36
	000	12	08	R2	W	O	00398	F	00000	T	44	33		000	10	06	R2	N	O	03262	F	00000	T	54	47
	000	12	08	R3	W	O	00413	F	00000	T	44	34		000	12	06	R3	S	O	03310	F	00000	T	54	50
	000	12	07	R1		O	00421	F	00000	T	44	34		000	12	06	R2	S	O	03351	F	00000	T	54	53
	000	12	07	R2	E	O	00451	F	00000	T	44	36		000	12	06	R1		O	03404	F	00000	T	54	58
	000	12	08	R3	W	O	00459	F	00000	T	44	37	TA	007	12	06	R1		O	03476	F	00000	T	55	09
	000	12	08	R2	W	O	00474	F	00000	T	44	38		000	12	06	R2	E	O	03567	F	00000	T	55	20
	000	12	08	R1		O	00490	F	00000	T	44	39		000	12	07	R3	W	O	03606	F	00000	T	55	24
	000	12	08	R2	W	O	00497	F	00000	T	44	39		000	12	06	R1		O	03612	F	00000	T	55	24
	000	12	08	R1		O	00504	F	00000	T	44	40		000	12	06	R3	E	O	03617	F	00000	T	55	25
CP	032	12	08	R1		O	00526	F	00000	T	44	41	CP	039	12	06	R3	E	O	03709	F	00000	T	55	38
	000	12	08	R2	E	O	00724	F	00000	T	45	05		000	12	07	R1		O	03714	F	00000	T	55	38
	000	17	15	R3	N	O	00732	F	00000	T	45	06		000	24	15	R1		O	03750	F	00000	T	55	42
	000	19	15	R2	S	O	00755	F	00000	T	45	08		000	12	07	R1		O	03756	F	00000	T	55	42
TA	015	19	15	R2	S	O	00792	F	00000	T	45	13		000	12	08	R3	W	O	03831	F	00000	T	55	48
	000	17	15	R3	N	O	00799	F	00000	T	45	14		000	12	07	R1		O	03838	F	00000	T	55	48
	000	17	15	R2	N	O	00814	F	00000	T	45	17		000	12	07	R3	E	O	03846	F	00000	T	55	49
	000	17	15	R3	N	O	00831	F	00000	T	45	19		000	12	08	R1		O	03861	F	00000	T	55	50
	000	17	15	R2	N	O	00839	F	00000	T	45	20		000	12	07	R3	E	O	03883	F	00000	T	55	51
CP	033	17	15	R3	N	O	00846	F	00000	T	45	21		000	48	35	R1		O	03891	F	00000	T	55	52
	000	17	15	R1		O	00875	F	00000	T	45	25		000	12	08	R1		O	03906	F	00000	T	55	53
	000	17	15	R2	S	O	01031	F	00000	T	45	50	CP	040	12	08	R1		O	03940	F	00000	T	55	55
	000	17	15	R1		O	01038	F	00000	T	45	51		000	12	08	R2	E	O	04088	F	00000	T	56	10
	000	16	15	R3	N	O	01107	F	00000	T	45	59	CP	041	12	08	R3	E	O	00062	F	00000	T	56	20
	000	16	15	R2	N	O	01182	F	00000	T	46	07		000	19	15	R2	S	O	00125	F	00000	T	56	25
	000	16	15	R1		O	01186	F	00000	T	46	08		000	12	10	R2	W	O	00169	F	00000	T	56	29
	000	16	15	R2	N	O	01191	F	00000	T	46	09		000	19	16	R3	W	O	00200	F	00000	T	56	31
	000	16	15	R1		O	01193	F	00000	T	46	09		000	12	10	R1		O	00219	F	00000	T	56	33
CP	034	16	15	R1		O	01251	F	00000	T	46	17	CP	042	12	10	R1		O	00296	F	00000	T	56	39
	000	32	31	R1		O	01340	F	00000	T	46	28	TA	017	12	10	R1		O	00336	F	00000	T	56	42
	000	15	15	R3	N	O	01356	F	00000	T	46	29		000	17	16	R3	N	O	00371	F	00000	T	56	45
TA	042	15	15	R3	N	O	01419	F	00000	T	46	37		000	17	16	R2	N	O	00590	F	00000	T	57	01
	000	15	15	R2	N	O	01431	F	00000	T	46	39	TA	028	17	16	R2	N	O	00650	F	00000	T	57	57
	000	08	08	R2	E	O	01445	F	00000	T	46	42		000	16	16	R3	N	O	00698	F	00000	T	57	57
	000	08	08	R1		O	01449	F	00000	T	46	42		000	10	12	R2	W	O	00751	F	00000	T	58	01
	000	17	17	R*	C	O	01469	F	00000	T	46	45		000	10	12	R1		O	00812	F	00000	T	58	05
	000	08	08	R1		O	01504	F	00000	T	46	48	TA	029	10	12	R1		O	00864	F	00000	T	58	25
CP	035	08	08	R1		O	01689	F	00000	T	47	23		000	10	12	R2	N	O	00985	F	00000	T	58	40
	000	08	08	R2	W	O	01734	F	00000	T	47	28	TA	080	10	12	R2	N	O	01004	F	00000	T	58	42
	000	08	07	R1		O	01785	F	00000	T	47	34		000	10	12	R3	N	O	01029	F	00000	T	58	45
CP	036	08	07	R1		O	01830	F	00000	T	48	12	CP	043	10	12	R3	N	O	01041	F	00000	T	58	47
	000	08	06	R3	E	O	01849	F	00000	T	48	18		000	12	12	R1		O	01156	F	00000	T	59	05
	000	08	07	R1		O	01850	F	00000	T	48	19	TA	019	12	12	R1		O	01183	F	00000	T	59	08
	000	04	03	R3	S	O	01863	F	00000	T	48	24		000	12	12	R2	W	O	01321	F	00000	T	59	26

TABLE 3-3 LISTING OF RECORDED RANDOM ROUTE TEST DATA (CONT'D)

CP	044	12	12	R2	W	0	01342	F	00000	T	59	50		000	19	13	R3	S	0	00680	F	00000	T	71	28
	000	12	10	R3	E	0	01420	F	00000	T	59	58		000	12	07	R2	W	0	00695	F	00000	T	71	30
	000	12	10	R2	E	0	01466	F	00000	T	60	01		000	19	13	R3	S	0	00700	F	00000	T	71	30
	000	17	16	R3	N	0	01505	F	00000	T	60	04		000	12	07	R2	W	0	00706	F	00000	T	71	31
	000	12	10	R1		0	01538	F	00000	T	60	07		000	19	13	R3	S	0	00716	F	00000	T	71	32
CP	045	12	10	R1		0	01562	F	00000	T	60	09		000	17	13	R2	N	0	00737	F	00000	T	71	34
	000	12	10	R2	W	0	01755	F	00000	T	60	23		000	17	13	R1		0	00741	F	00000	T	71	34
	000	12	10	R3	W	0	01777	F	00000	T	60	24	CP	053	17	13	R1		0	00896	F	00000	T	71	51
	000	12	08	R2	E	0	01791	F	00000	T	60	25		000	17	13	R2	N	0	00946	F	00000	T	71	58
	000	19	15	R3	S	0	01904	F	00000	T	60	35		000	17	13	R1		0	00950	F	00000	T	71	58
	000	12	08	R2	W	0	01946	F	00000	T	60	39	TA	023	17	13	R1		0	00981	F	00000	T	72	03
	000	12	08	R1		0	01951	F	00000	T	60	40		000	10	07	R1		0	00999	F	00000	T	72	07
	000	12	08	R2	W	0	01966	F	00000	T	60	41		000	10	07	R3	E	0	01126	F	00000	T	72	19
	000	12	08	R1		0	01971	F	00000	T	60	42		000	10	08	R1		0	01136	F	00000	T	72	20
	000	12	08	R2	W	0	02030	F	00000	T	60	49		000	10	08	R2	W	0	01145	F	00000	T	72	21
TA	012	12	08	R1		0	02032	F	00000	T	60	50		000	10	08	R1		0	01148	F	00000	T	72	22
	000	12	08	R3	N	0	02060	F	00000	T	60	55		000	10	07	R3	E	0	01156	F	00000	T	72	24
	000	12	08	R2	W	0	02071	F	00000	T	60	57		000	10	08	R1		0	01156	F	00000	T	72	24
	000	12	08	R1		0	02074	F	00000	T	60	57	CP	054	10	08	R1		0	01197	F	00000	T	72	54
	000	12	08	R3	N	0	02086	F	00000	T	60	59		000	10	08	R2	E	0	01423	F	00000	T	74	12
CP	046	12	08	R3	N	0	02105	F	00000	T	61	01	TA	026	10	08	R2	E	0	01426	F	00000	T	74	13
	000	12	08	R2	W	0	02115	F	00000	T	61	03		000	16	15	R3	N	0	01441	F	00000	T	74	15
	000	12	08	R3	N	0	02119	F	00000	T	61	03		000	17	15	R2	S	0	01447	F	00000	T	74	16
	000	14	08	R1		0	02157	F	00000	T	61	09		000	16	15	R3	N	0	01468	F	00000	T	74	19
	000	14	08	R3	S	0	02159	F	00000	T	61	10		000	16	15	R2	N	0	01507	F	00000	T	74	26
TA	003	14	08	R2	S	0	02162	F	00000	T	61	10		000	16	15	R1		0	01514	F	00000	T	74	27
	000	14	08	R3	S	0	02167	F	00000	T	61	11		000	16	15	R2	N	0	01518	F	00000	T	74	28
	000	12	08	R2	N	0	02185	F	00000	T	61	15		000	16	15	R1		0	01522	F	00000	T	74	28
	000	19	15	R1		0	02276	F	00000	T	61	25		000	16	15	R2	S	0	01688	F	00000	T	75	30
TA	004	19	15	R1		0	02394	F	00000	T	62	10		000	16	15	R1		0	01698	F	00000	T	75	32
CP	047	19	15	R1		0	02438	F	00000	T	62	16		000	16	15	R2	S	0	01702	F	00000	T	75	32
	000	19	15	R2	S	0	02591	F	00000	T	63	26		000	15	15	R3	N	0	01712	F	00000	T	75	33
	000	17	15	R3	N	0	02595	F	00000	T	63	26		000	15	15	R2	N	0	01740	F	00000	T	75	36
	000	17	15	R2	N	0	02635	F	00000	T	63	30		000	15	15	R3	N	0	01753	F	00000	T	75	38
	000	17	15	R1		0	02656	F	00000	T	63	32		000	15	15	R1		0	01775	F	00000	T	75	41
CP	048	17	15	R1		0	02745	F	00000	T	63	41		000	15	15	R2	N	0	01795	F	00000	T	75	44
	000	16	15	R3	N	0	02855	F	00000	T	64	13		000	15	15	R1		0	01821	F	00000	T	75	47
	000	17	15	R2	S	0	02862	F	00000	T	64	14	P	055	15	15	R1		0	01865	F	00000	T	75	52
	000	16	15	R3	N	0	02866	F	00000	T	64	14		000	15	15	R2	S	0	02034	F	00000	T	76	21
	000	17	15	R2	S	0	02898	F	00000	T	64	19		000	13	15	R3	N	0	02082	F	00000	T	76	28
	000	16	15	R3	N	0	02906	F	00000	T	64	20		000	15	15	R2	S	0	02088	F	00000	T	76	29
	000	16	15	R1		0	02965	F	00000	T	64	30		000	15	15	R3	S	0	02093	F	00000	T	76	30
TA	033	16	15	R1		0	03033	F	00000	T	64	38		000	13	15	R2	N	0	02096	F	00000	T	76	31
	000	16	15	R2	W	0	03139	F	00000	T	64	54		000	15	15	R3	S	0	02097	F	00000	T	76	59
	000	16	14	R3	E	0	03150	F	00000	T	64	55		000	13	15	R2	N	0	02109	F	00000	T	77	02
	000	16	14	R1		0	03253	F	00000	T	65	11		000	15	15	R3	S	0	02117	F	00000	T	77	03
	000	16	14	R3	E	0	03265	F	00000	T	65	13		000	13	15	R2	N	0	02127	F	00000	T	77	05
	000	16	14	R1		0	03276	F	00000	T	65	15		000	13	15	R1		0	02137	F	00000	T	77	08
CP	049	16	14	R1		0	03317	F	00000	T	65	20		000	13	15	R2	N	0	02138	F	00000	T	77	08
	000	16	14	R2	W	0	03376	F	00000	T	65	27	A	061	13	15	R2	N	0	02141	F	00000	T	77	10
	000	16	13	R2	E	0	03381	F	00000	T	65	28		000	13	15	R1		0	02144	F	00000	T	77	11
CP	050	08	07	R3	N	0	03399	F	00000	T	65	30		000	06	08	R3	E	0	02147	F	00000	T	77	17
	000	16	13	R2	E	0	03416	F	00000	T	65	32		000	13	15	R1		0	02150	F	00000	T	77	18
	000	16	13	R1		0	03435	F	00000	T	65	34	P	056	13	15	R1		0	02151	F	00000	T	77	18
	000	10	06	R3	S	0	03653	F	00000	T	66	58		000	06	10	R3	W	0	02162	F	00000	T	77	21
CP	051	10	06	R3	S	0	03657	F	00000	T	66	59		000	06	10	R2	W	0	02167	F	00000	T	77	22
	000	16	11	R1		0	03687	F	00000	T	67	02		000	06	08	R2	E	0	02175	F	00000	T	77	24
TA	030	16	11	R1		0	03710	F	00000	T	67	15		000	06	08	R3	E	0	02191	F	00000	T	77	26
	000	10	06	R1		0	03839	F	00000	T	67	34		000	06	08	R2	E	0	02216	F	00000	T	77	29
	000	10	06	R2	N	0	03974	F	00000	T	67	51		000	06	08	R1		0	02258	F	00000	T	77	33
	000	12	06	R3	S	0	04029	F	00000	T	67	57		000	06	08	R2	E	0	02264	F	00000	T	77	34
	000	10	06	R2	N	0	04042	F	00000	T	67	59		000	06	08	R1		0	02281	F	00000	T	77	35
	000	10	06	R3	N	0	04046	F	00000	T	67	59	CP	057	06	08	R1		0	02366	F	00000	T	78	20
	000	12	06	R2	S	0	04050	F	00000	T	68	00		000	06	08	R2	W	0	02436	F	00000	T	78	30
	000	12	06	R1		0	00003	F	00000	T	68	06		000	06	08	R1		0	02444	F	00000	T	78	31
	000	12	06	R2	N	0	00196	F	00000	T	69	21		000	06	08	R2	W	0	02575	F	00000	T	78	49
	000	14	06	R3	S	0	00201	F	00000	T	69	22		000	06	06	R3	E	0	02575	F	00000	T	78	52
	000	14	06	R2	S	0	00250	F	00000	T	69	28		000	06	08	R2	W	0	02575	F	00000	T	78	56
	000	12	06	R2	N	0	00258	F	00000	T	69	29		000	06	06	R3	E	0	02575	F	00000	T	78	57
	000	12	06	R3	N	0	00261	F	00000	T	69	30		000	06	06	R1		0	02708	F	00000	T	79	20
TA	001	12	06	R3	N	0	00270	F	00000	T	69	31		000	06	06	R2	E	0	02714	F	00000	T	79	21
	000	14	06	R2	S	0	00272	F	00000	T	69	32		000	06	06	R1		0	02726	F	00000	T	79	22
	000	19	11	R1		0	00275	F	00000	T	69	32	CP	058	06	06	R1		0	02768	F	00000	T	79	26
	000	19	13	R3	W	0	00339	F	00000	T	69	41	TA	058	06	06	R1		0	02821	F	00000	T	80	08
	000	19	13	R1		0	00400	F	00000	T	69	47		000	15	11	R1		0	03058	F	00000	T	80	59
TA	002	19	13	R1		0	00493	F	00000	T	70	07		000	06	06	R1		0	00190	F	00000	T	85	15
CP	052	19	13	R1		0	00539	F	00000	T	70	21	TA	058	06	06	R1		0	00272	F	00000	T	85	38
	000	12	07	R1		0	00607	F	00000	T	70	29	CP	059	06	06	R1		0	00322	F	00000	T	86	06
	000	19	13	R2	S	0	00616	F	00000	T	70	31		000	06	06	R2	E	0	00367	F	00000	T	86	11
	000	12	07	R2	E	0	00639	F	00000	T	71	24		000	06	06	R3	E	0	00397	F	00000	T	86	48
	000	19	13	R3	S	0	00647	F	00000	T	71	25		000	06	06	R2	E	0	00421	F	00000	T	86	51
	000	12	07	R2	W	0	00652	F	00000	T	71	25		000	06	06	R3	E	0	00468	F	00000	T	86	55
	000	17	13	R3	N	0	00666	F	00000	T	71	27		000	06	08	R1		0	00625	F	00000	T	87	09
	000	12	07	R2	W	0	00670	F	00000	T	71	27	CP	060	06	08	R1		0	00723	F	00000	T	87	21

TABLE 3-3 LISTING OF RECORDED RANDOM ROUTE TEST DATA (CONT'D)

	000	06	08	R2	E	0	00886	F	00000	T 88 39
	000	06	08	R3	E	0	00904	F	00000	T 88 42
	000	06	08	R2	E	0	00909	F	00000	T 88 43
	000	13	15	R1		0	00941	F	00000	T 89 23
	000	06	08	R3	E	0	00944	F	00000	T 89 24
	000	06	08	R2	E	0	00970	F	00000	T 89 27
	000	06	10	R3	W	0	00977	F	00000	T 89 28
	000	06	10	R2	W	0	01000	F	00000	T 89 31
	000	06	08	R3	E	0	01009	F	00000	T 89 33
	000	06	10	R2	W	0	01012	F	00000	T 89 33
	000	06	10	R3	W	0	01023	F	00000	T 89 41
	000	06	10	R2	W	0	01036	F	00000	T 89 56
	000	06	10	R1		0	01047	F	00000	T 90 03
	000	06	10	R2	W	0	01047	F	00000	T 90 08
	000	06	10	R1		0	01047	F	00000	T 90 41
	000	06	10	R2	W	0	01047	F	00000	T 90 43
	000	06	10	R1		0	01047	F	00000	T 90 44
	000	06	10	R2	W	0	01047	F	00000	T 90 49
	000	06	10	R1		0	01047	F	00000	T 90 57
	000	06	10	R2	W	0	01047	F	00000	T 90 59
	000	06	10	R1		0	01047	F	00000	T 91 02
	000	06	10	R2	W	0	01047	F	00000	T 91 04
	000	06	10	R1		0	01053	F	00000	T 91 08
	000	06	10	R2	W	0	01091	F	00000	T 92 01
	000	06	10	R1		0	01098	F	00000	T 92 02
CP	061	06	10	R1		0	01171	F	00000	T 92 55
	000	06	10	R2	E	0	01251	F	00000	T 93 34
	000	06	10	R1		0	01260	F	00000	T 93 35
	000	06	10	R2	E	0	01278	F	00000	T 93 38
	000	06	10	R1		0	01280	F	00000	T 93 39
	000	06	10	R2	E	0	01287	F	00000	T 93 40
	000	06	10	R3	E	0	01312	F	00000	T 94 01
	000	06	10	R2	E	0	01312	F	00000	T 94 04
	000	06	10	R3	E	0	01370	F	00000	T 94 21
	000	06	10	R2	E	0	01392	F	00000	T 94 24
	000	06	10	R3	E	0	01408	F	00000	T 94 26
	000	06	12	R2	W	0	01428	F	00000	T 94 28
	000	06	12	R1		0	01505	F	00000	T 94 35
CP	062	06	12	R1		0	01631	F	00000	T 94 46
TA	064	06	12	R1		0	01650	F	00000	T 94 49

At Time 22 minutes 47 seconds, the reason for signpost code (13, 21), which is an invalid code, cannot be explicitly determined. It is thought to be a power transient in the auxiliary generator. This and other occurrences of invalid code had no influence on the test results since only one invalid code was recorded at a TSC checkpoint, and this occurrence (CP 18 during Run 8) was automatically screened out by the data processing screening algorithm in exactly the same manner as that proposed for use in Phase II. It should be noted that only 9 out of 11,476 records on Run 7 contained an invalid data record signpost code, 0.078 percent. It should be noted that, during use of CPMAIN, only 1 of 1,563 samples required use of the screening algorithm, 0.064 percent compared to the allowable 2 percent.

CONTINUED

1 OF 8

4. RANDOM ROUTE DATA PROCESSING

The processing of random route data was accomplished in three parts by the three computer programs depicted in Figure 4-1. Program CPMAIN was used to compute LS location errors at TSC checkpoints. Program RRSL was used to compute AVM System Level errors at pseudo checkpoints which were representative of a simulated polling interval of 20 seconds with a simulated communication system error rate of 5 percent. Program RRTEN was used to compute the average location error over each one-tenth mile segment of the random route.

4.1 SAMPLE SIZE

The end result of Phase I was directed toward evaluating the performance of the HI^3 LS and AVM system. The performance specifications were stated in terms of 95 and 99.5 percentile values of the data samples. The sample space for the random route tests was selected by TSC to be representative of a typical urban environment which covered approximately 40 square blocks of downtown Philadelphia (previously shown in Figure 3-12).

In the HI^3 proposal and in the HI^3 memorandum to TSC of April 15, 1976, HI^3 addressed sample size requirements in terms of 2σ and 3σ values, based on the normal distribution. In actuality, the 2σ value of the normal distribution is the 97.7 percent point and the 3σ value is the 99.87 percentile value. Thus, if a sufficient number of samples were obtained to reflect the 2σ and 3σ values accurately, then the 95 and 99.5 percentile requirements should have automatically been satisfied, provided that the sample size is sufficiently large to invoke the law of large numbers; e.g., the ultimate normality of the distribution in question. Use of the 2σ and 3σ values allowed explicit mathematical expressions to be used in deriving the required sample size under the assumption that, in the limit, the distribution of location errors approaches the normal distribution.

In order to arrive at an explicit formulation, normality of the HI^3 location error density function was assumed. As noted subsequently, Phase I tests showed that this assumption was not strictly valid.

HI^3 rationale for use in the 2α and 3α values in determining sample size was based on Mood, Introduction to the Theory of Applied Statistics, (McGraw-Hill, 1950) p. 214.

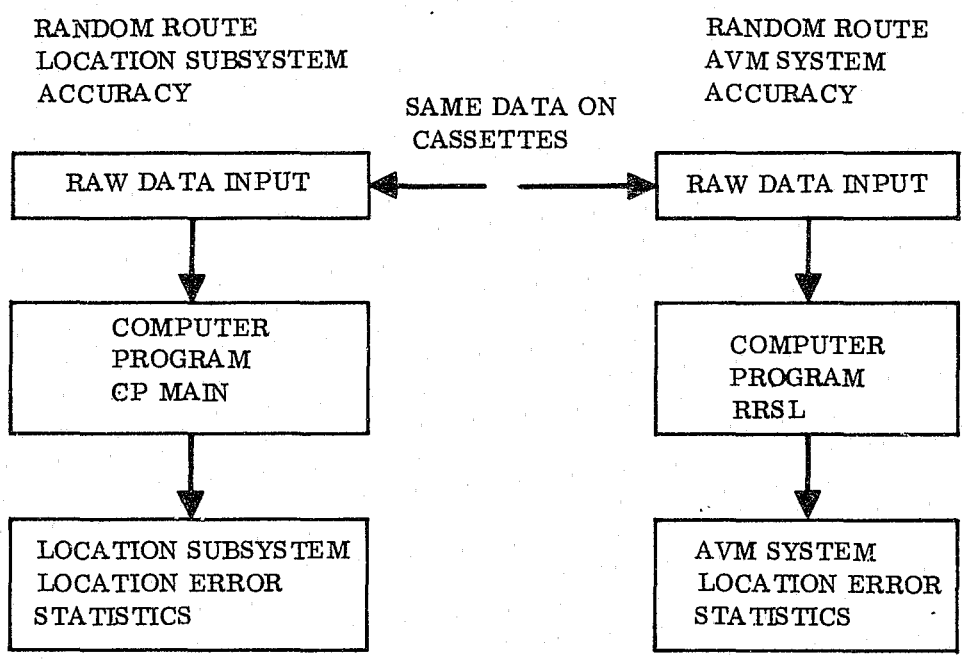


FIG. 4-1 RANDOM ROUTE DATA PROCESSING

Following Mood, and assuming that the radial error is normally distributed with mean α_1, and variance α_2, the distribution can be written as

$$f(X;\ \alpha_1,\ \alpha_2) = \frac{1}{\sqrt{2\pi\ \alpha_2}}\ e - \left(\frac{1}{2\ \alpha_2}\right)(X - \alpha_1)^2$$

Then the estimators of α_1 and α_2 are given by

$$\hat{\alpha}_1 = \frac{1}{N}\sum X_i \quad \text{(mean estimate)}$$

$$\hat{\alpha}_2 = \frac{1}{N}\sum (X_i - \hat{\alpha}_1)^2 \quad \text{(variance estimate)}$$

In accordance with the theorem, these two estimates will themselves be normally distributed for large samples. It can be shown that the exact distribution of $\hat{\alpha}_2$, the variance estimator, approaches the normal form,

$$f(\hat{\alpha}_2;\ \mu_s\ \sigma_s) = \frac{1}{\sqrt{2\pi}}\ \frac{1}{\sqrt{\frac{2}{n}}\ 2\ \alpha_2}\ e\ \frac{-(\hat{\alpha}_2 - \alpha_2)^2}{2\ \alpha_2^{\ 2}\sqrt{\frac{2}{n}}}$$

Thus, as n becomes large, the sample standard deviation σ_s of the distribution of $\hat{\alpha}_2$ becomes

$$\sigma_s = \sqrt{\frac{2}{n}}\ \alpha_2 \qquad (4\text{-}1)$$

and the sample mean, μ_s of the distribution of $\hat{\alpha}_2$, becomes α_2 where α_2 is the variance of the parent distribution ($\sqrt{\alpha_2}$ would then be the parent distribution's standard deviation). Use of equation 4-1 allows us to bound the sample σ_s. For example, assume that there will be no more than 0.26 percent chance that the standard deviation, σ_s, of the sample distribution differs from the standard deviation, $\sqrt{\alpha_2}$, of the parent distribution by more than X percent. Then we want

$$P\left\{\left[(1\text{-}X)\sqrt{\alpha_2}\right]^2 \le \sigma_s^{\ 2} \le \left[(1+X)\sqrt{\alpha_2}\right]^2\right\} \ge (1\text{-}0.0026) = 0.9974$$

or

$$P\left\{(1\text{-}X)^2\ \alpha_2 \le \sigma_s^{\ 2} \le (1+X)^2\ \alpha_2\right\} \ge 0.9974$$

Thus, we want σ_s^2, the sample variance, to be within a specified percentage of α_2 the parent distribution's variance, 99.74 percent of the time.

If X = 15 percent, then

$$P\left\{ .7225\ \alpha_2 \leq \sigma_s^2 \leq 1.3225\ \alpha_2 \right\} \geq 0.9974$$

This is true if the 3 sigma value of the sample distribution, $3\ \sigma_s$, is less than $0.2775\ \alpha_2$.

$$3\ \sigma_s < 0.2775\ \alpha_2$$

By substituting from Equation 4-1, then

$$3\sqrt{\frac{2}{n}}\ \alpha_2 < 0.2775\ \alpha_2, \quad \text{or} \quad n > \frac{18}{\left(1-(1-X)^2\right)^2}$$

and, subsequently solving for n gives the required sample size, n, for the standard deviation of the sample population to differ from the standard deviation of the parent population by no more than 15 percent.

In this case

$$3\sqrt{\frac{2}{n}} < 0.2775 \quad n > \frac{18}{\left(1-(1-.15)^2\right)^2}$$

and

$$n > 233.$$

This statement also holds for the $2\ \sigma_s$ value of the sample population. The data in the following table indicate the number of independent samples, n, necessary to assure that the sample $2\ \sigma_s$ differs from the actual 2σ by no more than X percent with a confidence of 99.74 percent.

X(Percent Error in $2\ \sigma_s$) of the sample	N(Number of Samples)
0.20	139
0.15	233
0.11	416
0.10	499
0.05	1894

Therefore, 499 independent samples will verify with 99.74 percent confidence that the sample $2\ \sigma_s$ will deviate from the actual 2σ by no more than 10 percent.

In order to relate the sample size more directly to the AVM specification and to minimize the dependence of the analysis on an assumed density function, MITRE and TSC investigated the use of a non-parametric approach. The basis for this approach was simply that a sample would pass an accuracy requirement with a probability p (and fail with a probability of 1-p). Then in a set of repeated Bernouilli trials, the probability that a specific number of data points (r) out of a sample of size (n) do not meet the accuracy requirement can be represented by the binomial probability distribution e(n, r, p):

$$e(n,\ r,\ p) = \frac{n!}{r!(n-r)!}\ (1-p)^{n-r}\ p^{r}$$

where

n = sample size
r = number of unsuccessful samples
p = the system error probability

The probability that <u>at least</u> r unsuccessful data points will occur is represented by the cumulative binomial probability distribution E(n, r, p):

$$E(n,\ r,\ p) = \sum_{x=r}^{n} e(n,\ x,\ p)$$

Using "Tables of the Cumulative Binomial Probability Distribution" published by the Computation Laboratory of Harvard University in 1955, TSC generated Table 4-1. Sample sizes from 50 to 1000 were considered. For each sample size, a value of r was selected such that the Type I error* was as near to 0.05 as could be obtained from the cumulative binomial distribution tables. This was to insure that the probability of rejecting a good system was only 5 percent. The column of Type I errors in Table 4-1 corresponds to a 95% system, one which has a system error probability p_0, equal to 0.05. For example, for n = 300, the system will fail the test if the test sample contains 22 or more unsuccessful data points (22 or more samples with errors equal to or exceeding 300 feet). Thus, there is a 0.049 probability (Type I error) that an actual 95 percent system will fail the test.

However, of equal concern is the Type II error. For example, Table 4-1 shows that for n = 300 there is a 0.05 probability (Type II error) that a 90 percent system (one with an error rate of $p_1 = 0.1$) will pass the test and a 0.56 probability that a 93 percent system ($p_1 = 0.07$) will pass the test.

* A Type I error is the probability of rejecting the null hypothesis (e.g., the system error probability is less than 5 percent) when it is indeed true. A Type II error is the probability of accepting the null hypothesis when it is actually false.

TABLE 4-1 TYPE I (δ) AND TYPE II (β) ERRORS FOR VARIOUS SAMPLE SIZES

No. of Samples n	No. of Failures r	Type I Error α $p^* = .05$	Type II Errors for Values of p_1**				
			β_1 $p_1^* = .06$	β_1 $p_1 = .07$	β_1 $p_1 = .08$	β_1 $p_1 = .09$	β_1 $p_1 = .10$
50	6	.038	.92	.86	.79	.69	.62
100	9	.063	.85	.64	.59	.45	.32
200	16	.044	.85	.67	.46	.28	.14
220	17	.051	.83	.63	.41	.22	.11
260	20	.039	.85	.64	.40	.20	.09
300	22	.049	.81	.56	.30	.13	.05
340	25	.037	.83	.57	.30	.12	.04
380	27	.044	.79	.50	.23	.08	.02
400	28	.047	.77	.47	.21	.06	.01
420	29	.052	.76	.44	.18	.05	.01
460	32	.04	.78	.46	.18	.05	.01
500	34	.045	.75	.40	.14	.03	.005
550	37	.044	.74	.38	.12	.02	.003
600	40	.042	.73	.35	.10	.02	.002
650	43	.04	.72	.33	.08	.01	.001
700	45	.054	.66	.26	.05	.005	.000
750	48	.051	.66	.24	.04	.004	.000
800	51	.048	.65	.23	.04	.003	.000
850	54	.046	.65	.21	.03	.002	.000
900	57	.043	.64	.19	.03	.001	.000
1000	62	.051	.59	.15	.01	.000	.000

*p_o is the assumed failure rate of the system

**p_1 is the actual failure rate of the system

In contrast, if the sample size n were 600, there would be only a 0.002 probability that a 90 percent system would pass the tests; however, a 0.73 probability would exist for a 94 percent system passing.

TSC developed a measure of Type II error severity which it used in quantifying the effects of Type II errors in order to more clearly define the sample size requirements. This measure was

$$M_\beta = \sum \beta_1 \frac{(p_1 - p_0)}{0.1}$$

where

M_β = the measure of potential Type II error severity for a given sample size

β_1 = the Type II error associated with a system error probability (e.g., $\beta_1 = 0.21$ for $p_1 = 0.08$ and n = 400 from Table 4-2.)

p_1 = system error probability

p_0 = maximum allowable system error probability.

The number of terms in the summation for M_β is equal to the number of p's that have a Type II error of approximately 0.05 or more. For example, for 700 samples (reference Table 4-1).

$$M_\beta = \frac{0.66 \times (.06 - .05) + 0.26(.07 - .05) + 0.5(.08 - 0.5)}{0.01}$$

or

$$M_\beta = 1.3$$

A plot of M_β versus (n) is shown in Figure 4-2. The sample size to be used is not clearly obvious since the knee of the curve is not well defined. However, the major bend in the curve is completed somewhere between 500 and 700 samples.

The results obtained by HI[3] and the non-parametric results obtained by TSC were both indicative of a required sample size greater than 450. This material, when weighed with the costs of requiring a much larger sample size (as a means of minimizing the Type I and Type II errors) resulted in TSC approving the following minimum sample size requirements.

Random Route Checkpoints	600
Fixed Route Checkpoints	600
Fixed Route Timepoints	450.

Test routes, checkpoints, and timepoints were selected by TSC as a means of assuring that these minimum sample sizes were realized.

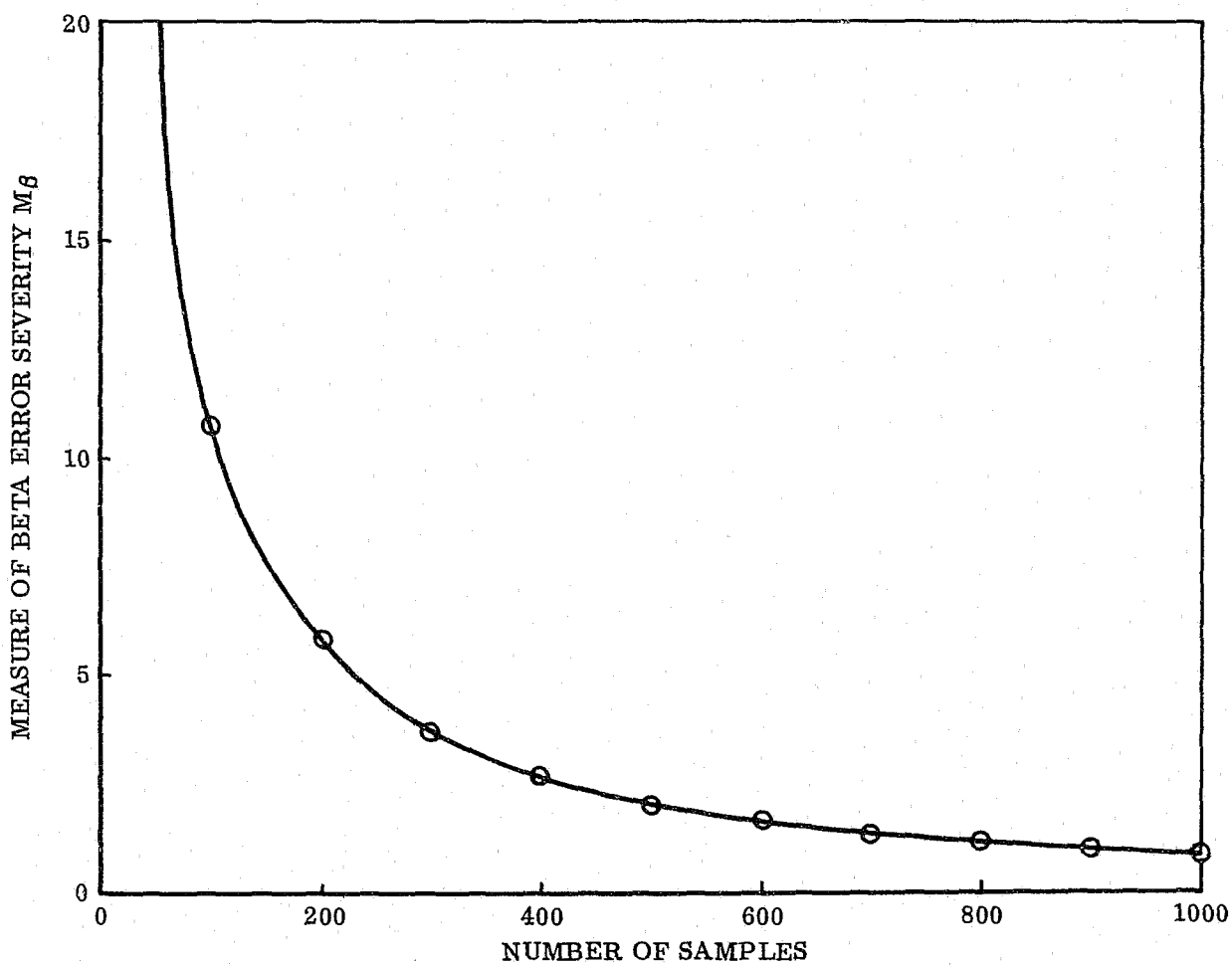


FIG. 4-2 M_β VS. SAMPLE SIZE

Subsequent to the tests, HI^3 analyzed test data to determine the actual distribution of the location subsystem errors. These data are presented in Section 10.

To insure that the samples are random, TSC chose the sample points (checkpoints) in the test area prior to the installation of the location subsystem. However, the location subsystem was installed by HI^3 without knowledge of the checkpoint locations. To further insure that the samples were independent, the checkpoints were located more than 500 feet apart; consequently, the samples were independent at both time and space for a designed 300-foot location system. Also, the samples were obtained during a number of random route tests taken on different days and at different times during the day. Performance of the tests at different times during the day resulted in the elimination of potential time of day biases (e.g., morning and evening rush hours) which might have been otherwise incurred.

In order to assure that the sample size was more than adquate, a total of 622 samples were taken during 10 test runs by using two different sets of TSC designated checkpoints. 622 samples corresponds to a 9 percent error in the $2\sigma_s$ of the sample.

4.2 RANDOM ROUTE DATA PROCESSING

Data processing of random route data involved (1) the determination of the vehicles actual location at each checkpoint specified by TSC and (2) the calculation of the radial location error at each checkpoint by using the location subsystem calculated location. In addition, steps (1) and (2) were repeated at points separated by 20 seconds to simulate the Phase II polling scheme as well as communication errors.

4.2.1 Vehicle Actual Location at Checkpoints

The actual vehicle position was always assumed to be the X, Y coordinates of the checkpoint at the time the checkpoint event was recorded on the raw data tape. The actual vehicle location was determined from the CPTABL file contained in Table 4-2.

4.2.2 Vehicle Computed (Location Subsystem) Location

In the case of random route data processing at TSC checkpoints, the computed location of the vehicle was also determined directly from a table look-up in the Signpost File (SPTABL). As a result of HI^3 pretest mapping and calibration, each possible 18-BIT location region code had been assigned a specific pair of stateplane coordinates. Figure 4-3 is an illustration of the algorithm used to determine the vehicle's computed (Location Subsystem) location.

TABLE 4-2 RANDOM ROUTE CHECKPOINT FILE (BASES FOR CPTABL)

Primary CP#	State Plane Coordinates		Secondary CP#	State Plane Coordinates	
	X(feet)	Y(feet)		X(feet)	Y(feet)
1	2728180	235705	1	2728183	235731
2	2727835	236136	2	2728277	236397
3	2727321	235782	3	2728354	237054
4	2726852	235848	4	2728150	237778
5	2726455	236268	5	2727969	237159
6	2726009	236222	6	2727830	236470
7	2725585	236389	7	2727140	236596
8	2725705	237100	8	2726918	236223
9	2726369	237383	9	2726427	235897
10	2727500	237204	10	2725645	236003
11	2728211	237127	11	2725618	236511
12	2728298	237738	12	2725771	237426
13	2727515	237919	13	2726509	237341
14	2726741	238159	14	2727500	237204
15	2727147	238153	15	2727910	236813
16	2727969	237159	16	2727860	236290
17	2727891	236661	17	2726451	236137
18	2726956	236572	18	2726530	236631
19	2726580	236988	19	2726600	237104
20	2726655	237544	20	2726693	237755
21	2726714	237933	21	2727090	237458
22	2727157	238093	22	2726981	236811
23	2726464	238014	23	2726545	236276
24	2725867	238275	24	2726046	236355
25	2726296	238232	25	2725646	236397
26	2726239	237764	26	2725745	237541
27	2726156	237203	27	2725867	238275
28	2726075	236713	28	2726247	237988
29	2725684	236934	29	2726102	236886
30	2725809	237838	30	2725730	237421
31	2726459	237919	31	2725813	237865
32	2727090	237702	32	2726638	237895
33	2726996	236930	33	2727090	237702
34	2726920	236239	34	2726996	236930
35	2726316	236285	35	2726453	236641
36	2725756	236411	36	2726147	236705
37	2725705	237100	37	2726044	236446
38	2725809	237838	38	2725994	235984
39	2726710	237886	39	2726267	237988
40	2727589	237840	40	2726714	237933
41	2727969	237159	41	2727121	237879
42	2727444	236878	42	2727591	237859
43	2726958	236590	43	2728288	237464
44	2726580	236988	44	2728059	237803
45	2726102	236885	45	2727591	237859
46	2725996	236139	46	2726741	238159
47	2725553	236009	47	2727157	238093
48	2725585	236389	48	2727090	237458
49	2725705	237100	49	2726427	237006
50	2725809	237838	50	2726284	237063
51	2726239	237764	51	2725830	237115
52	2726507	237341	52	2726396	238232
53	2727055	237376	53	2726192	237484
54	2727715	237176	54	2726627	237326
55	2727891	236661	55	2726909	236376
56	2727837	236109	56	2726838	235874
57	2727561	235756	57	2726427	235897
58	2726865	235846	58	2725645	236003
59	2725988	235938	59	2725645	236003
60	2725988	235938	60	2726427	235897
61	2726865	235846	61	2727321	235782
62	2727561	235756	62	2728176	235673
63	2728176	235673			

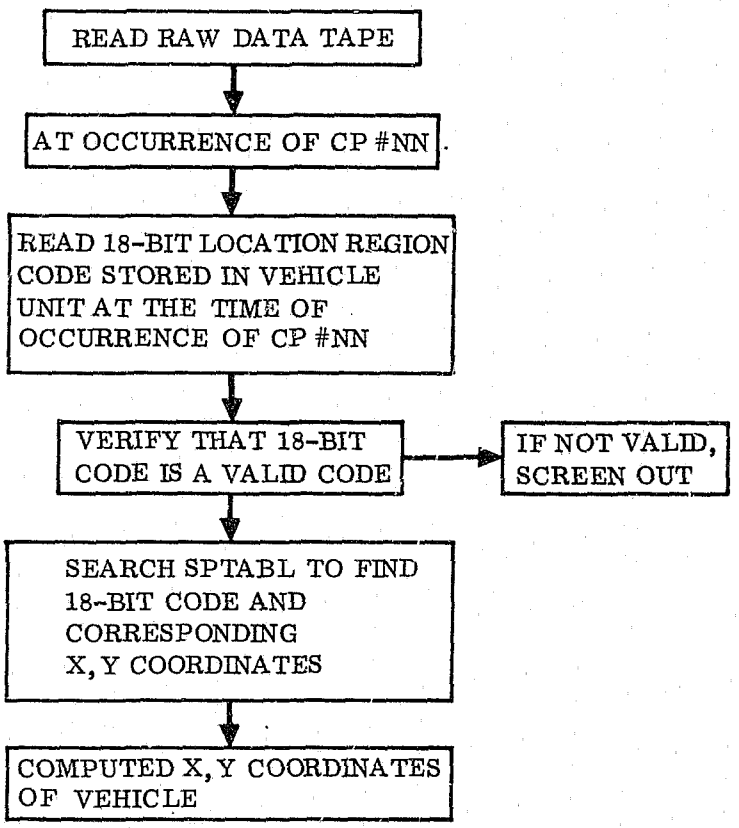


FIG. 4-3 METHOD OF COMPUTING (LS) VEHICLE LOCATION IN RANDOM ROUTE TESTS

During the data reduction process, a "reasonableness" or screening algorithm was used to check the 18-BIT location region code recorded at each checkpoint for validity against the stored data base. If the code were not valid, that data record was rejected and subsequently printed out as a "bad data" record The table, SPTABL, of valid 18-BIT codes and X, Y coordinates was supplied to the TSC Monitor prior to recording and data processing, and the data became part of the computer data base. SPTABL is contained in Table 4-3. The X, Y locations of each checkpoint, relative to the closest intersection center, were also determined and supplied to the TSC Monitor prior to commencing the tests. Thus, all of the data listed in Tables 4-2 and 4-3 were supplied to the TSC Monitor prior to the actual test runs.

4.2.3 Vehicle Actual Location at Pseudo Checkpoints

During AVM System level data processing, Program RRSL, raw data on tape was used to take samples every 20 seconds. Each such sample, in order, was assigned a pseudo checkpoint number (PCP). The actual location of the vehicle at each PCP was determined through use of the fifth wheel in terms of the distance from a known location, Turn (TA) or Checkpoint (CP), and the passage of the vehicle was recorded on cassette by a manual entry. The algorithm used to determine the actual vehicle location at PCP's is shown in Figure 4-4. The geometry associated with this algorithm is illustrated in Figure 4-5.

Note that four possible situations can be used for locating a PCP

Between two successive CP's

Between two successive TA's

After a TA and prior to a CP

After a CP and prior to a TA.

The case illustrated in Figure 4-5 corresponds to (3) in which the PCP (the sample) occurred after a turn and prior to a checkpoint. As shown in Figure 4-4, the marking of turns (TA's) in no way affects the operation of the location subsystem or the AVM system. The sole function of the location subsystem is to determine, at the sample point (either checkpoint or pseudo checkpoint), the signpost location region code which, through the use of the SPTABL, uniquely determines the X, Y location assigned to the vehicle at the sample point. The turn event serves only as a means of establishing the vehicle's actual or reference location at those locations (pseudo checkpoints) which were not determined by physical measurement prior to the tests.

In summary, the TA and CP events, in conjunction with the 5th wheel, determine the actual location of pseudo checkpoints. The signpost location region code associated with the pseudo checkpoint sample determines the AVM system and LS location.

TABLE 4-3 RANDOM ROUTE SIGNPOST FILE (SPTABL)

```
    .BYTE   06.,06.
 R1 5553.,06009.
R2S 5553.,06009.
R2E 5844.,05972.
R2N 5565.,06245.
R2W 5553.,06009.
R3S 5553.,06009.
R3E 5988.,05938.
R3N 5585.,06389.
R3W 5553.,06009.
    .BYTE   06.,08.
 R1 6427.,05897.
R2S 6427.,05897.
R2E 6725.,05859.
R2N 6461.,06142.
R2W 6135.,05934.
R3S 6427.,05897.
R3E 6865.,05846.
R3N 6468.,06266.
R3W 5988.,05938.
    .BYTE   06.,10.
 R1 7321.,05782.
R2S 7321.,05782.
R2E 7606.,05746.
R2N 7348.,06024.
R2W 7023.,05820.
R3S 7321.,05782.
R3E 7779.,05728.
R3N 7374.,06159.
R3W 6865.,05846.
    .BYTE   06.,12.
 R1 8176.,05673.
R2S 8176.,05673.
R2E 8176.,05673.
R2N 8210.,05914.
R2W 7891.,05709.
R3S 8176.,05673.
R3E 8176.,05673.
R3N 8241.,06069.
R3W 7779.,05728.
    .BYTE   08.,06.
 R1 5644.,06735.
R2S 5618.,06511.
R2E 5862.,06571.
R2N 5673.,06964.
R2W 5644.,06735.
R3S 5585.,06389.
R3E 5971.,06713.
R3N 5705.,07100.
R3W 5644.,06735.

    .BYTE   08.,07.
 R1 6298.,06690.
R2S 6298.,06690.
R2E 6298.,06690.
R2N 6325.,06908.
R2W 6080.,06705.
R3S 6298.,06690.
R3E 6414.,06661.
R3N 6339.,07017.
R3W 5971.,06713.
    .BYTE   08.,08.
 R1 6530.,06631.
R2S 6496.,06386.
R2E 6821.,06590.
R2N 6562.,06862.
R2W 6453.,06651.
R3S 6468.,06266.
R3E 6956.,06572.
R3N 6580.,06988.
R3W 6414.,06661.
    .BYTE   08.,10.
 R1 7403.,06509.
R2S 7375.,06267.
R2E 7694.,06584.
R2N 7435.,06741.
R2W 7112.,06550.
R3S 7374.,06159.
R3E 7882.,06463.
R3N 7444.,06878.
R3W 6956.,06572.
    .BYTE   08.,12.
 R1 8277.,06397.
R2S 8243.,06156.
R2E 8277.,06397.
R2N 8303.,06616.
R2W 7986.,06434.
R3S 8241.,06069.
R3E 8277.,06397.
R3N 8336.,06743.
R3W 7882.,06463.
    .BYTE   10.,06.
 R1 5730.,07421.
R2S 5701.,07192.
R2E 5946.,07395.
R2N 5766.,07629.
R2W 5730.,07421.
R3S 5705.,07100.
R3E 6055.,07383.
R3N 5784.,07733.
R3W 5730.,07421.

    .BYTE   10.,07.
 R1 6379.,07344.
R2S 6352.,07126.
R2E 6503.,07335.
R2N 6463.,07556.
R2W 6176.,07358.
R3S 6339.,07017.
R3E 6503.,07335.
R3N 6451.,07659.
R3W 6055.,07383.
    .BYTE   10.,08.
 R1 6627.,07326.
R2S 6595.,07094.
R2E 6918.,07285.
R2N 6656.,07528.
R2W 6503.,07335.
R3S 6580.,06988.
R3E 7055.,07276.
R3N 6671.,07630.
R3W 6503.,07335.
    .BYTE   10.,10.
 R1 7500.,07204.
R2S 7468.,06972.
R2E 7785.,07154.
R2N 7720.,07422.
R2W 7209.,07245.
R3S 7444.,06878.
R3E 7969.,07159.
R3N 7691.,07532.
R3W 7055.,07276.
    .BYTE   10.,12.
 R1 8354.,07054.
R2S 8328.,06835.
R2E 8354.,07054.
R2N 8246.,07276.
R2W 8069.,07104.
R3S 8336.,06743.
R3E 8354.,07054.
R3N 8263.,07388.
R3W 7969.,07159.
    .BYTE   12.,06.
 R1 5837.,08045.
R2S 5801.,07837.
R2E 6065.,08021.
R2N 5859.,08250.
R2W 5837.,08045.
R3S 5784.,07733.
R3E 6193.,08011.
R3N 5871.,08326.
R3W 5837.,08045.

    .BYTE   12.,07.
 R1 6523.,07974.
R2S 6475.,07764.
R2E 6623.,07965.
R2N 6523.,07974.
R2W 6294.,07997.
R3S 6451.,07659.
R3E 6623.,07965.
R3N 6523.,07974.
R3W 6193.,08011.
    .BYTE   12.,08.
 R1 6714.,07933.
R2S 6685.,07731.
R2E 7006.,07908.
R2N 6742.,08141.
R2W 6623.,07965.
R3S 6671.,07630.
R3E 7133.,07896.
R3N 6739.,08205.
R3W 6623.,07965.
    .BYTE   12.,10.
 R1 7591.,07859.
R2S 7618.,07641.
R2E 7834.,07813.
R2N 7591.,07859.
R2W 7296.,07884.
R3S 7691.,07532.
R3E 7956.,07803.
R3N 7591.,07859.
R3W 7133.,07896.
    .BYTE   12.,12.
 R1 8321.,07721.
R2S 8283.,07499.
R2E 8321.,07721.
R2N 8321.,07721.
R2W 8059.,07803.
R3S 8263.,07388.
R3E 8321.,07721.
R3N 8321.,07721.
R3W 7956.,07803.
    .BYTE   14.,06.
 R1 5916.,08533.
R2S 5881.,08456.
R2E 6201.,08626.
R2N 5916.,08533.
R2W 5916.,08533.
R3S 5871.,08326.
R3E 6339.,08600.
R3N 5916.,08533.
R3W 5916.,08533.
```

TABLE 4-3 RANDOM ROUTE SIGNPOST FILE (SPTABL) (CONT'D)

```
    .BYTE   14.,08.
R1  6761.,08397.
R2S 6770.,08348.
R2E 6798.,08556.
R2N 6761.,08397.
R2W 6761.,08397.
R3S 6739.,08205.
R3E 6798.,08556.
R3N 6761.,08397.
R3W 6761.,08397.
    .BYTE   13.,13.
R1  5953.,05737.
R2S 5953.,05737.
R2E 6427.,05897.
R2N 5988.,05938.
R2W 5953.,05737.
R3S 5953.,05737.
R3E 6427.,05897.
R3N 5990.,06048.
R3W 5953.,05737.
    .BYTE   13.,15.
R1  6842.,05691.
R2S 6842.,05691.
R2E 7321.,05782.
R2N 6865.,05846.
R2W 6427.,05897.
R3S 6842.,05691.
R3E 7321.,05782.
R3N 6876.,06034.
R3W 6427.,05897.
    .BYTE   13.,16.
R1  7729.,05507.
R2S 7729.,05507.
R2E 7729.,05507.
R2N 7779.,05728.
R2W 7321.,05782.
R3S 7729.,05507.
R3E 7729.,05507.
R3N 7793.,05844.
R3W 7321.,05782.
    .BYTE   15.,11.
R1  5286.,06454.
R2S 5286.,06454.
R2E 5508.,06417.
R2N 5323.,06659.
R2W 5286.,06454.
R3S 5286.,06454.
R3E 5585.,06389.
R3N 5349.,06815.
R3W 5286.,06454.

    .BYTE   15.,13.
R1  6020.,06358.
R2S 5996.,06139.
R2E 6109.,06336.
R2N 6044.,06446.
R2W 5779.,06379.
R3S 5990.,06049.
R3E 6174.,06328.
R3N 6073.,06695.
R3W 5585.,06389.
    .BYTE   15.,14.
R1  6321.,06307.
R2S 6321.,06307.
R2E 6468.,06266.
R2N 6350.,06682.
R2W 6252.,06318.
R3S 6321.,06307.
R3E 6693.,06245.
R3N 6350.,06682.
R3W 6174.,06328.
    .BYTE   15.,15.
R1  6909.,06376.
R2S 6918.,06223.
R2E 6918.,06223.
R2N 6956.,06572.
R2W 6614.,06370.
R3S 6876.,06034.
R3E 7374.,06159.
R3N 6956.,06572.
R3W 6693.,06245.
    .BYTE   15.,16.
R1  7856.,06280.
R2S 7814.,05989.
R2E 7856.,06280.
R2N 7882.,06463.
R2W 7830.,06096.
R3S 7793.,05844.
R3E 7856.,06280.
R3N 7882.,06463.
R3W 7374.,06159.
    .BYTE   16.,11.
R1  5553.,07099.
R2S 5359.,06907.
R2E 5743.,07080.
R2N 5553.,07099.
R2W 5553.,07099.
R3S 5349.,06815.
R3E 5837.,07071.
R3N 5553.,07099.
R3W 5553.,07099.

    .BYTE   16.,13.
R1  6122.,07042.
R2S 6090.,06814.
R2E 6275.,07024.
R2N 6144.,07215.
R2W 5932.,07061.
R3S 6073.,06695.
R3E 6275.,07024.
R3N 6170.,07301.
R3W 5832.,07071.
    .BYTE   16.,14.
R1  6427.,07006.
R2S 6555.,06819.
R2E 6580.,06983.
R2N 6427.,07006.
R2W 6275.,07024.
R3S 6530.,06631.
R3E 6712.,06968.
R3N 6427.,07006.
R3W 6275.,07024.
    .BYTE   16.,15.
R1  6996.,06930.
R2S 6967.,06745.
R2E 7301.,06891.
R2N 7027.,07106.
R2W 6806.,06955.
R3S 6956.,06572.
R3E 7444.,06878.
R3N 7045.,07131.
R3W 6712.,06968.
    .BYTE   16.,16.
R1  7910.,06813.
R2S 7883.,06574.
R2E 7910.,06813.
R2N 7942.,07016.
R2W 7605.,06852.
R3S 7882.,06463.
R3E 8336.,06743.
R3N 7969.,07159.
R3W 7444.,06878.
    .BYTE   17.,13.
R1  6219.,07561.
R2S 6176.,07358.
R2E 6489.,07527.
R2N 6202.,07764.
R2W 6008.,07556.
R3S 6170.,07301.
R3E 6640.,07590.
R3N 6276.,07989.
R3W 5789.,07510.

    .BYTE   17.,15.
R1  7090.,07468.
R2S 7058.,07282.
R2E 7395.,07446.
R2N 7083.,07662.
R2W 6790.,07492.
R3S 7045.,07181.
R3E 7548.,07440.
R3N 7133.,07896.
R3W 6640.,07590.
    .BYTE   17.,16.
R1  8006.,07422.
R2S 7937.,07283.
R2E 8006.,07422.
R2N 8024.,07610.
R2W 7701.,07434.
R3S 7969.,07159.
R3E 8006.,07422.
R3N 8059.,07750.
R3W 7548.,07440.
    .BYTE   19.,11.
R1  5689.,08331.
R2S 5689.,08331.
R2E 5893.,08315.
R2N 5689.,08331.
R2W 5689.,08331.
R3S 5689.,08331.
R3E 5995.,08307.
R3N 5689.,08331.
R3W 5689.,08331.
    .BYTE   19.,13.
R1  6300.,08282.
R2S 6273.,08041.
R2E 6582.,08239.
R2N 6300.,08282.
R2W 6096.,08301.
R3S 6276.,07989.
R3E 6739.,08205.
R3N 6300.,08282.
R3W 5995.,08307.
    .BYTE   19.,15.
R1  7147.,08153.
R2S 7135.,07922.
R2E 7457.,08054.
R2N 7147.,08153.
R2W 6865.,08196.
R3S 7133.,07896.
R3E 7457.,08054.
R3N 7147.,08153.
R3W 6739.,08205.
    .BYTE   19.,16.
R1  8059.,07803.
R2S 8059.,07803.
R2E 8059.,07803.
R2N 8059.,07903.
R2W 7755.,08042.
R3S 8059.,07750.
R3E 8059.,07803.
R3N 8059.,07803.
R3W 7457.,08054.
```

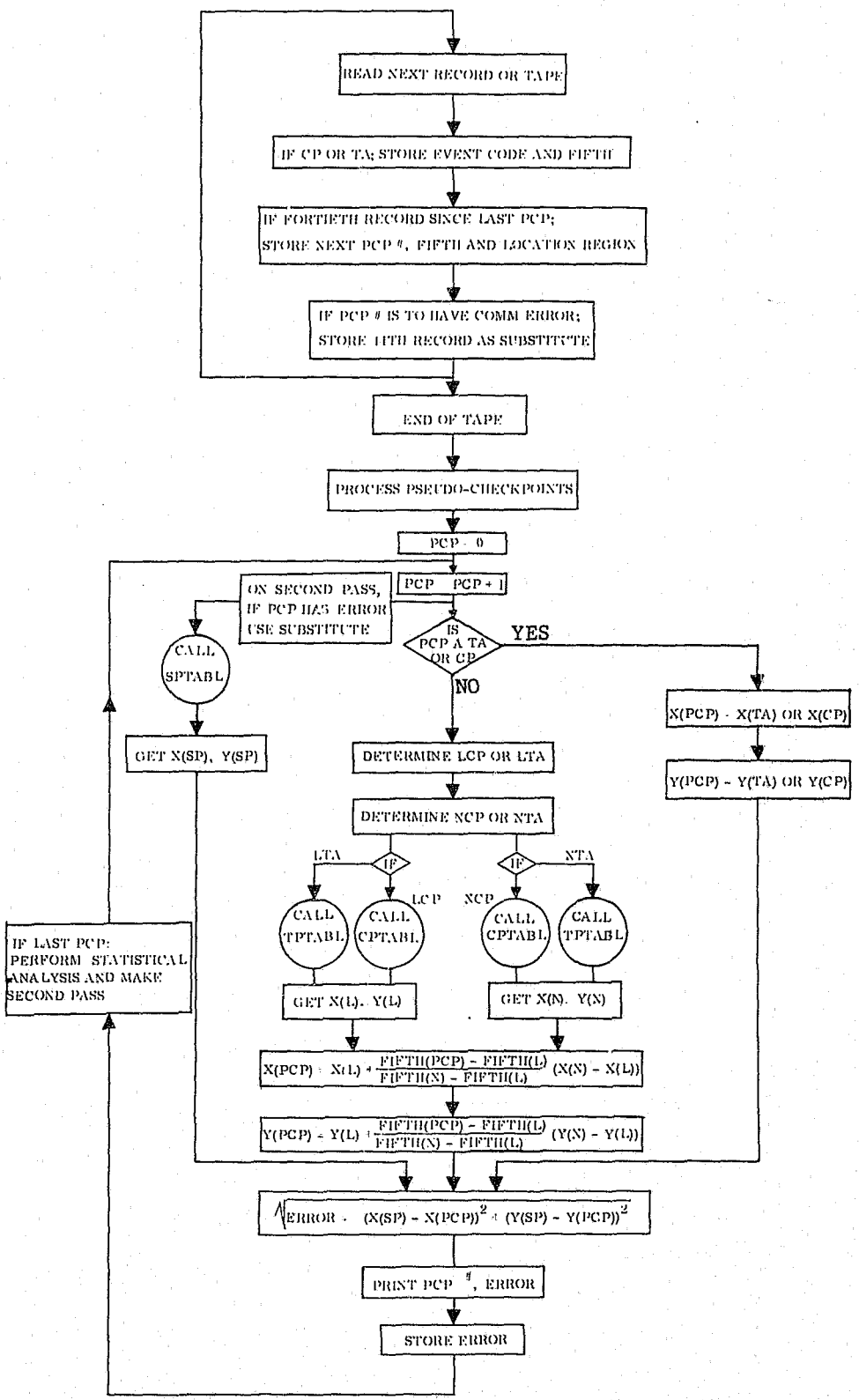


FIG. 4-4 FIXED ROUTE LOCATION ERROR ALGORITHM

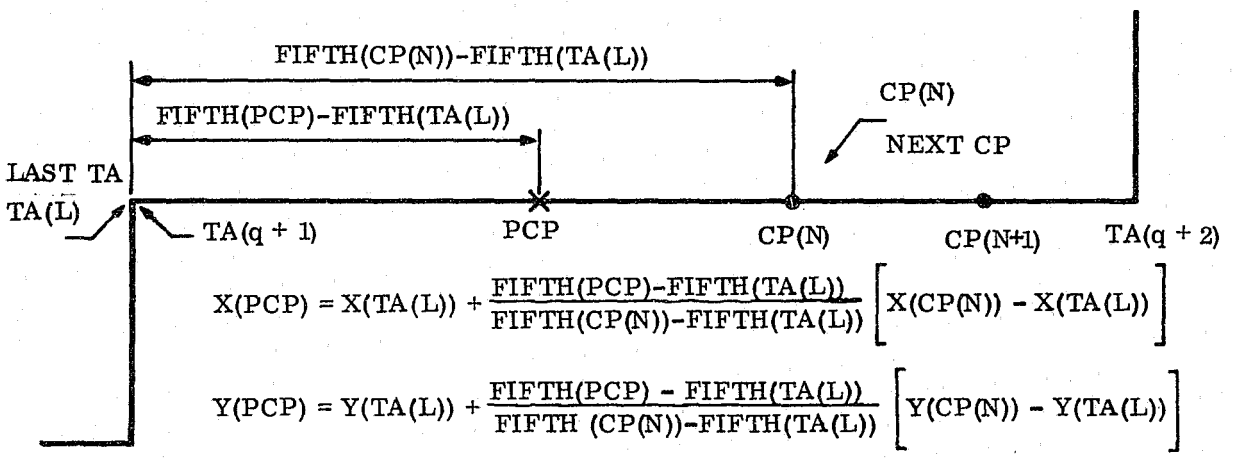


FIG. 4-5 USE OF TA AND CP EVENTS WITH 5TH WHEEL TO DETERMINE PSEUDO CHECKPOINT LOCATION

4.2.4 Vehicle Computed (AVM System) Location at Pseudo Checkpoints

As summarized in the previous paragraph, the random route vehicle's location, as computed by the AVM system, is always determined solely by the signpost location region code stored in the vehicle at the sample time. This identification is true whether the sample time is determined by a manual checkpoint entry or by offline sampling of the data recorded at half-second intervals.

4.2.5 AVM System Simulation

During the first pass through the recorded data, as shown in Figure 4-3, a pseudo checkpoint was selected every 20 seconds (40 records). This operation simulated the 20-second polling interval proposed for Phase II. In addition, the effects of a base-to-vehicle-to-base communication link were simulated in terms of simulating a 5-percent communication error rate. This simulation was affected by selecting in a random manner, 5 percent of the pseudo checkpoints and by assuming that the base station detected an error in the polling response or did not receive a response. When such an error is detected, the proposed Phase II system would poll the vehicle in question during the next 1-second guard-band time interval set aside for the transit route under consideration. For each route, this guard-band would occur within a maximum of two (2) seconds after the route poll began. Thus, within two seconds of detecting the error, the base station would poll the affected vehicle again. This was simulated by substituting the 18-BIT location code from the record occurring two (2) seconds (four records) further into the tape for the location code associated with the PCP. The proposed Phase II Polling scheme is illustrated in Figure 4-6 and was exactly simulated by the routine summarized in Figure 4-7.

In this simulation, the actual vehicle location is that computed for the original PCP. The AVM system location is the location region associated with the record (PCP) occurring two (2) seconds later.

A third routine, RRTEN, processed random route data to compute the average location error over 528 foot segments. This routine treats each sample record as a PCP, thereby processing approximately 9600 samples during each run.

4.3 RANDOM ROUTE DATA PROCESSING SOFTWARE

Random Route Data Processing Software was developed as three separate programs: (1) Random Route Location Subsystem Data Processor (CPMAIN), (2) Random Route System Level Data Processor (RRSL), and (3) Random Route One-Tenth Mile Average (RRTEN) routine. These programs were used to perform the data processing associated with the items discussed in subsection 4.2. Software was coded in FORTRAN IV for use on the HI^3 PDP-11/05 computer and, after checkout, converted for running on the IBM 370/145 at MITRE.

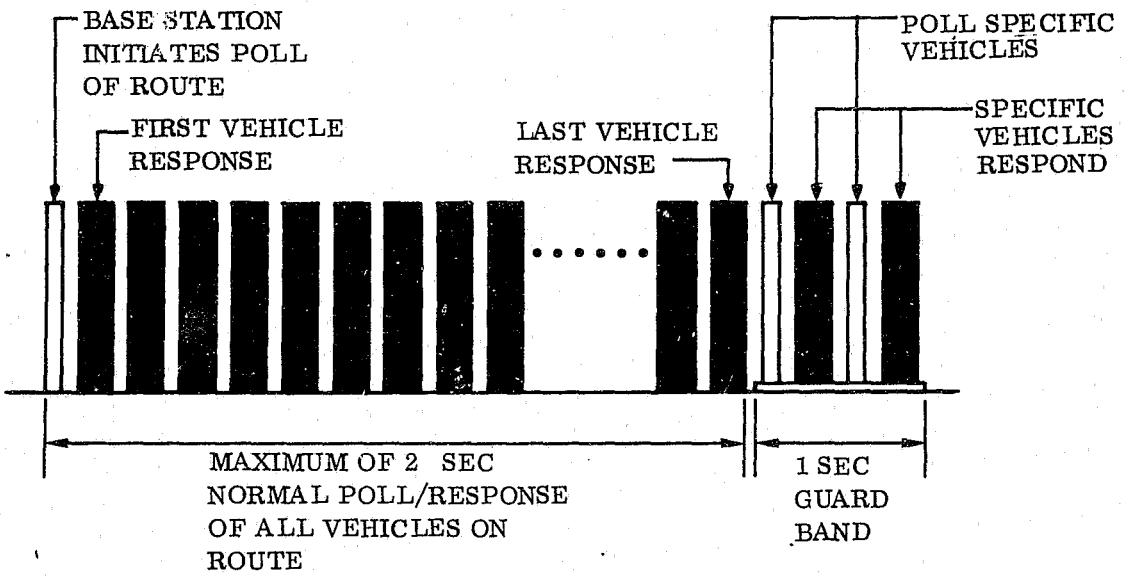
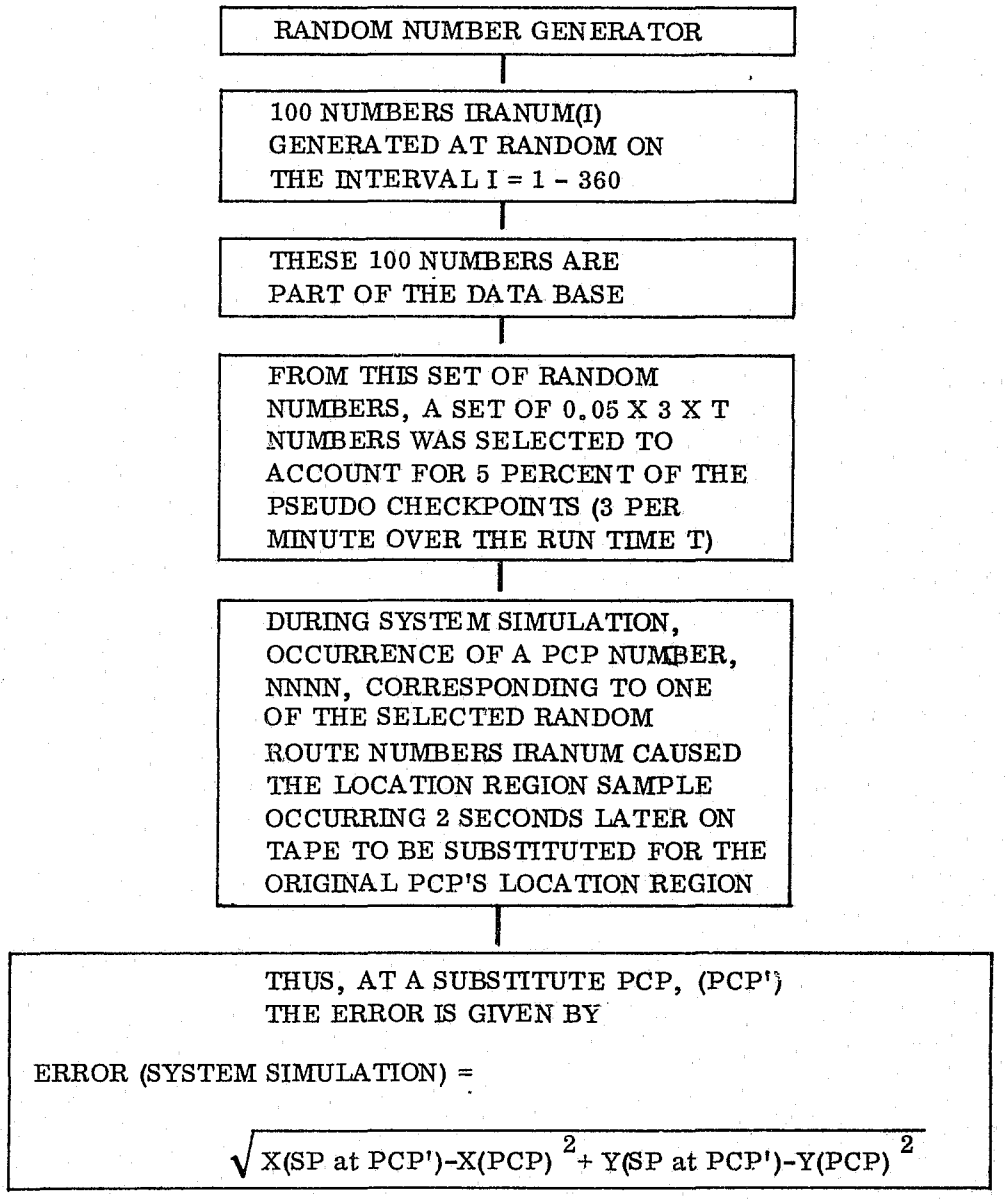


FIG. 4-6 USE OF GUARD BAND TO POLL SPECIFIC VEHICLES IN WHICH COMMUNICATION ERROR DETECTED



PCP = ORIGINAL PSEUDO CHECKPOINT SAMPLE

PCP' = SUBSTITUTE SAMPLE OCCURING 2 SECONDS LATER

FIG. 4-7 GENERAL METHOD FOR SIMULATING COMMUNICATION ERRORS

Figure 4-8 contains a flow chart of the CPMAIN routine used to process random route checkpoint data. A complete FORTRAN listing and documentation of CPMAIN was submitted to TSC and MITRE. Section 5 contains output data from this program which were used to process HI^3 Random Route Data Runs 1 through 10 The data base requirements for this routine are as follows:

1. SPTABL - X, Y state plane coordinates of each signpost location region 18-bit code

2. CPTABL - X, Y state plane coordinates of each TSC designated checkpoint (primary or secondary) (Table 4-1).

Figure 4-9 contains a flow chart of the RRSL routine used to process Random Route AVM System level data. A complete listing and documentation of RRSL was also provided to TSC and MITRE. Section 5 contains output data from this routine. In addition to SPTABL and CPTABL, this routine involves the use of TPTABL, and the X, Y state plane coordinates of each run on TSC designated primary and secondary random routes.

The overall methodology of the HI^3 software, including data recording, data handling, and data processing is shown in Figure 4-10.

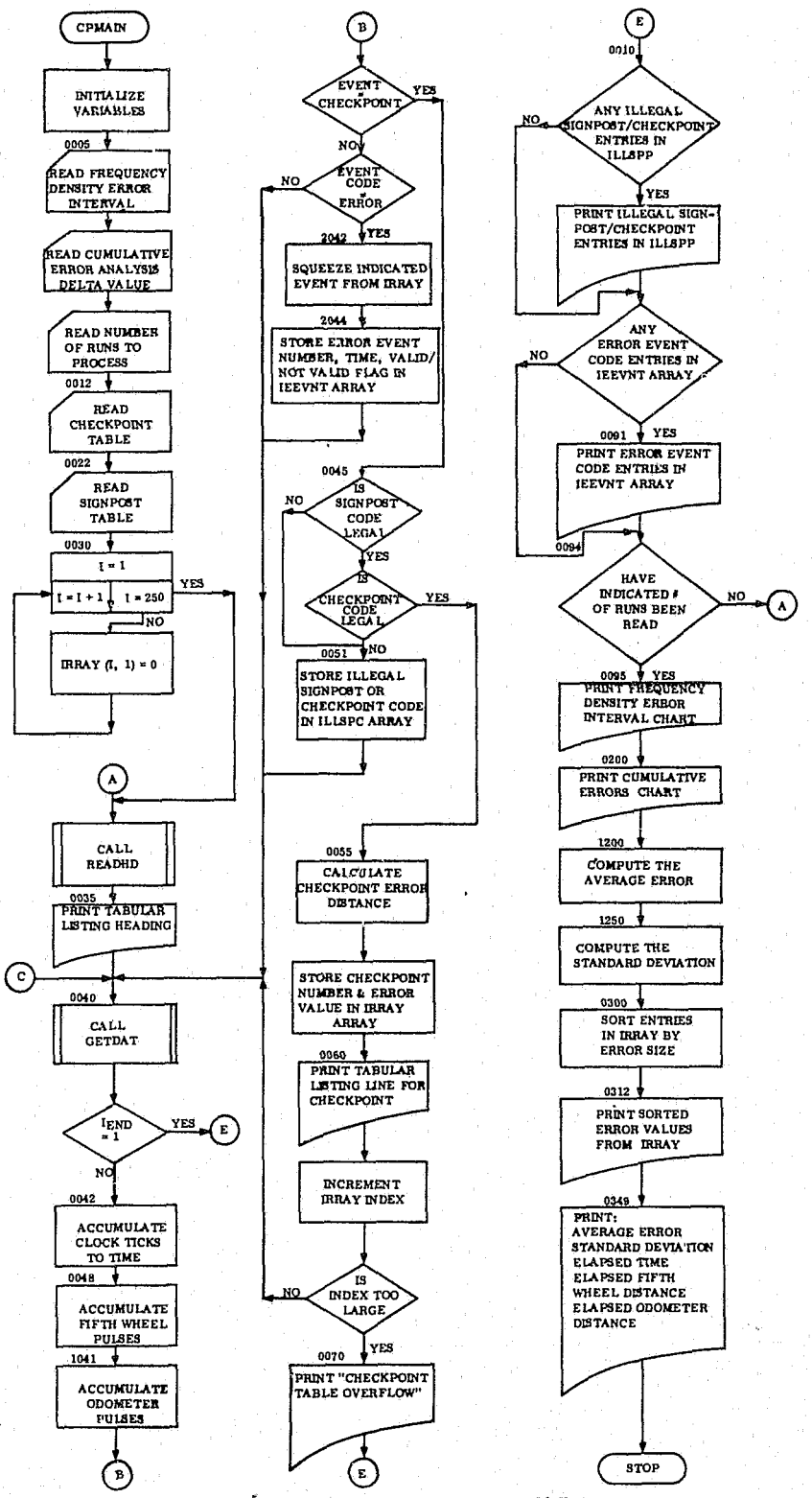


FIG. 4-8 FLOW CHART OF CPMAIN

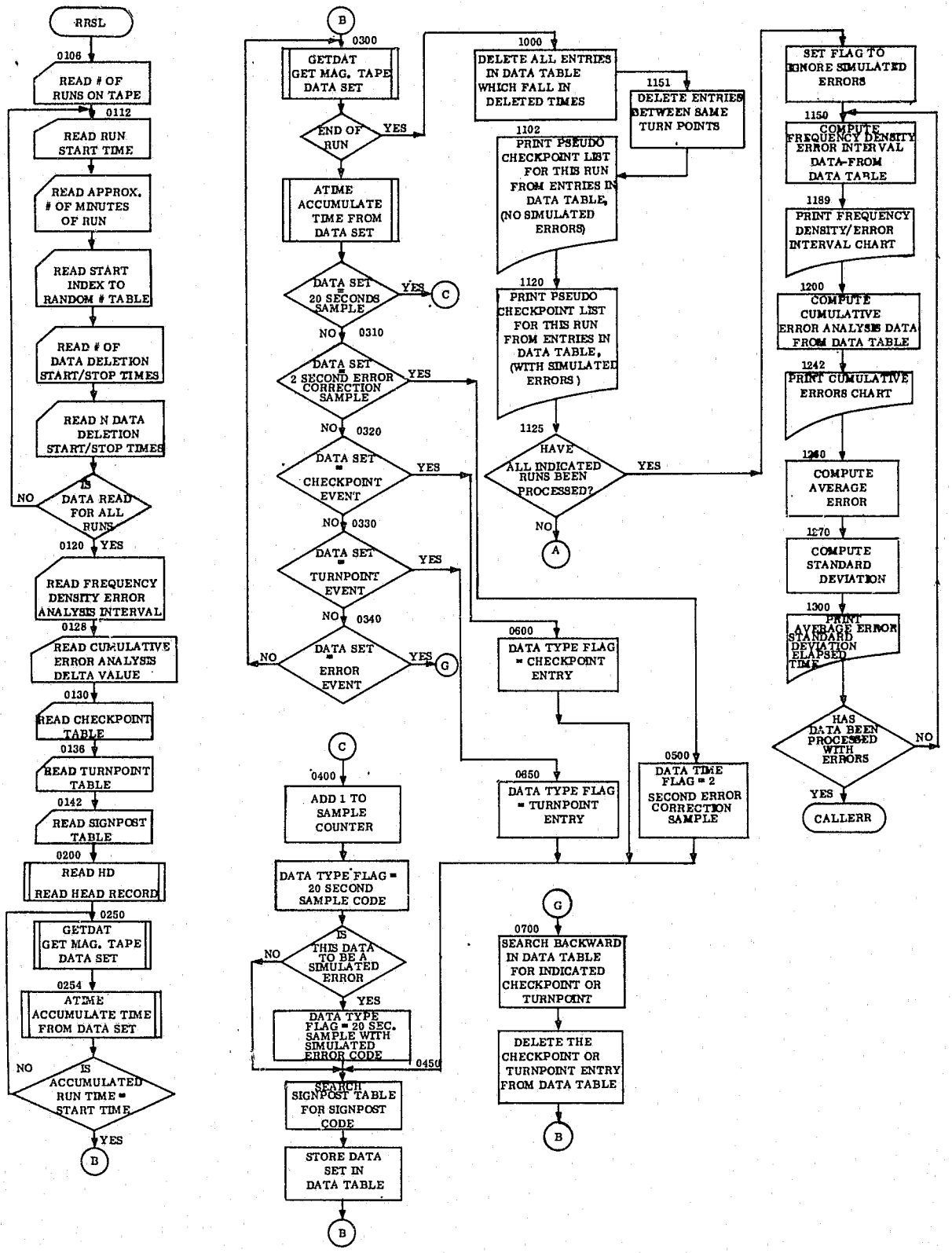


FIG. 4-9 FLOW CHART OF RRSL

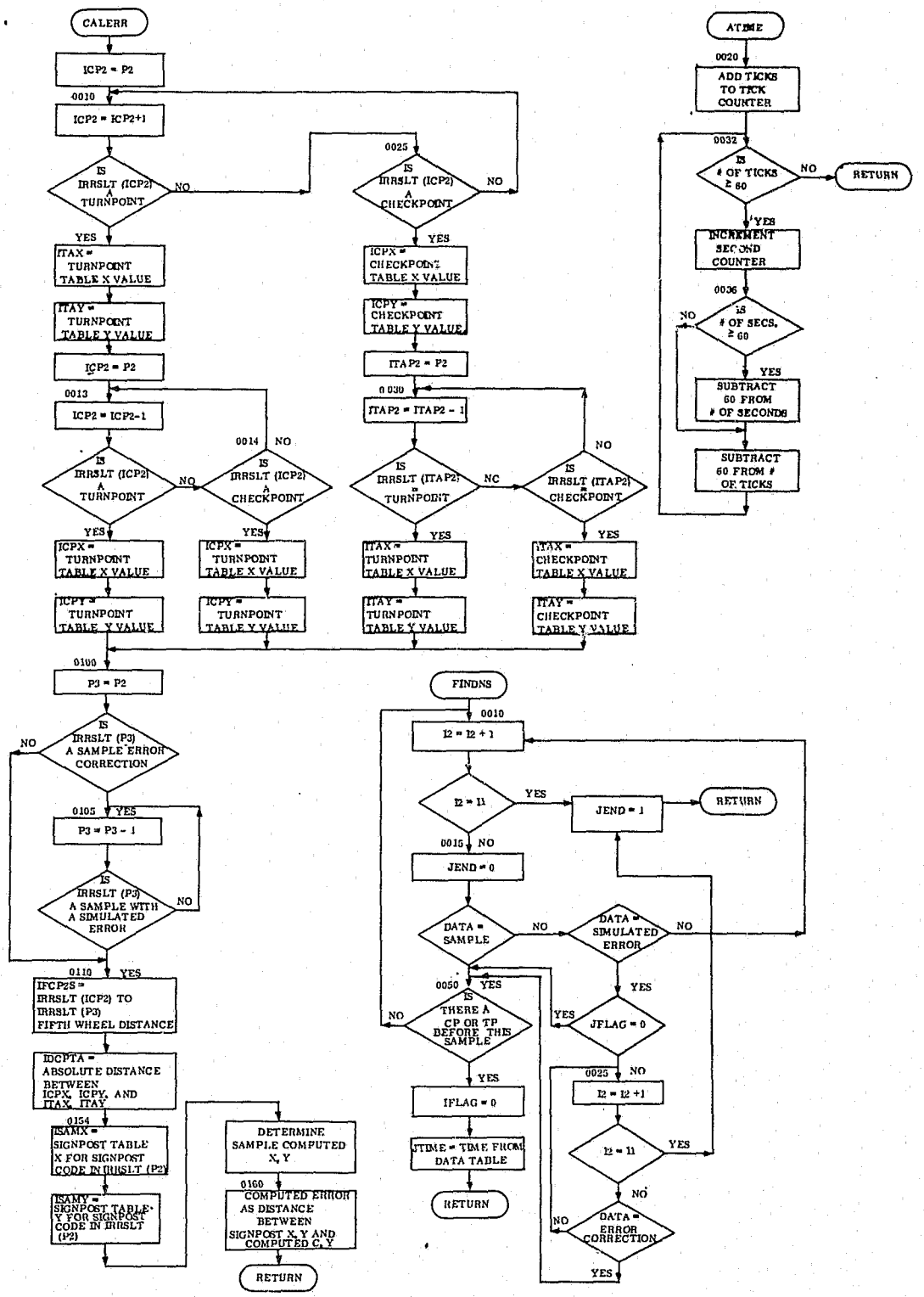
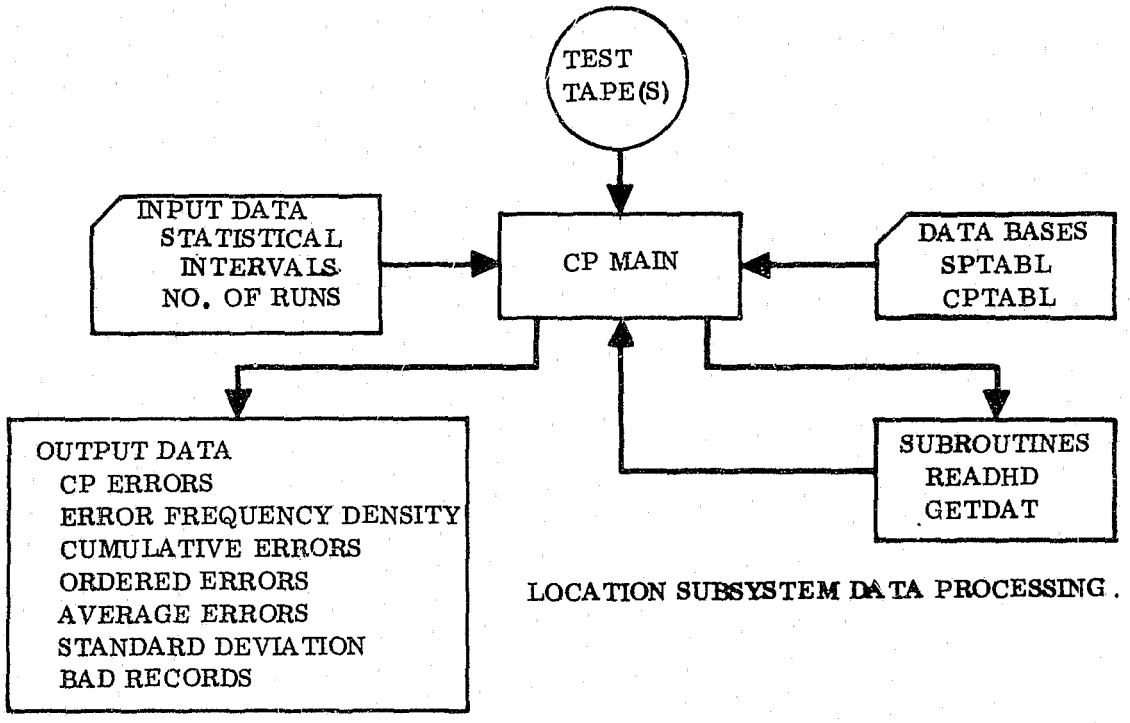
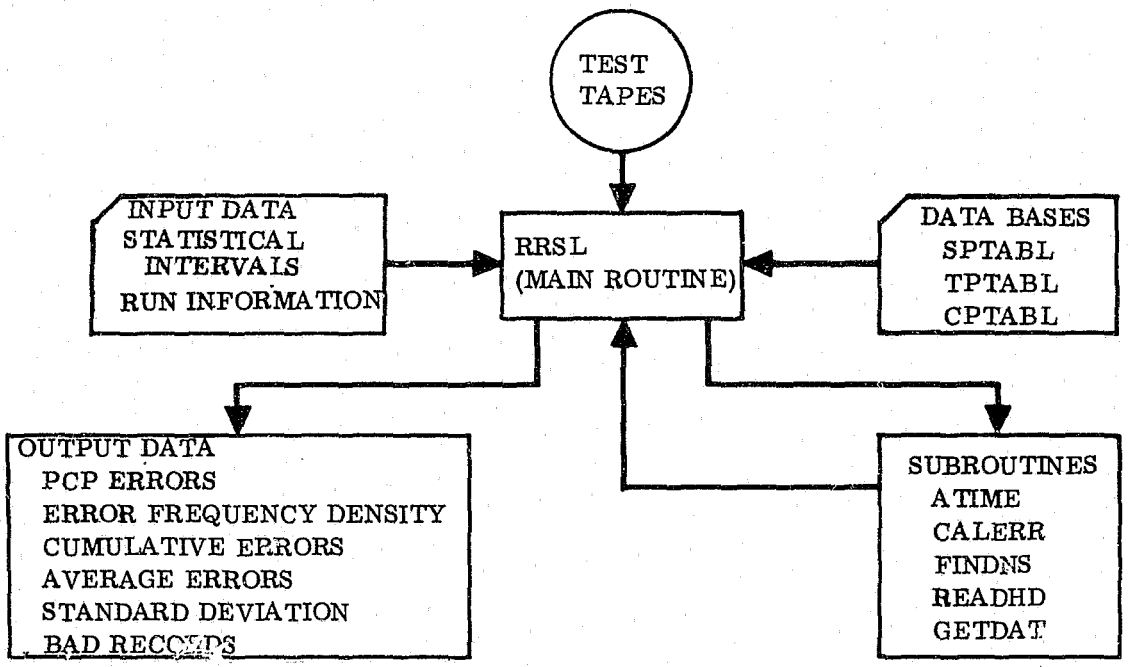


FIG. 4-9 FLOW CHART OF RRSL (CONT'D)



LOCATION SUBSYSTEM DATA PROCESSING.



AVM SYSTEM LEVEL DATA PROCESSING

FIG. 4-10 RANDOM ROUTE DATA PROCESSING SOFTWARE

5. RANDOM ROUTE TEST RESULTS

The results obtained by processing Random Route Runs 1 through 10 by use of data processing routines CPMAIN, RRSL, and RRTEN are presented in this section. Location error data, associated with the location subsystem in which TSC checkpoints are the reference, are shown separately from the data associated with pseudo checkpoints that represent AVM System Level errors. In each instance, however, the error incurred at each individual checkpoint and the statistics of the errors are presented. The results obtained for both the location subsystem and the AVM system simulation presented in this section are summarized in the following table.

SUMMARY OF RANDOM ROUTE TEST RESULTS

	Location Subsystem	AVM System
No. of Samples	622	2235
Average Error	91 Feet	114 Feet
95% Error	242 Feet	289 Feet
99.5% Error	461 Feet	460 Feet
% Samples Less than 300 Feet	97.26	95.66
% Samples Less than 450 Feet	98.87	99.38

The impact of simulating 5 percent communication errors was negligible.

Maximum average error over any 1/10th mile segment was 315 feet.

5.1 LOCATION SUBSYSTEM ERRORS

The location errors incurred at each Primary Checkpoint on each of Runs 1 through 5 are presented in Table 5-1. Of the 313 samples (CP 30 on Run 1 was not processed because it was incorrectly entered and CP 18 on Run 3 was screened out because of an invalid signpost code; refer to Subsection 3.7). Of the 313 samples, the error for 11 samples exceeded 300 feet and the error for 6 samples exceeded 450 feet. Thus, for TSC Primary Checkpoints, Runs 1 through 5, the following error statistics were obtained:

95 percent of samples were less than 245 feet

99.5 percent of samples were less than 466 feet

TABLE 5-1 LOCATION SUBSYSTEM ERRORS AT PRIMARY CHECKPOINTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	32	145	0	157	139	455	0	152	40	0	153	28	96	46	0	0	153	0	154	219	0
2	32	145	0	13	139	137	0	152	40	0	143	28	96	46	0	0	153	0	154	16	0
3	32	145	0	13	139	137	0	152	40	0	153	28	96	46	0	0	153	-	154	258	0
4	32	145	460	13	139	137	0	152	40	0	143	28	96	46	0	0	153	0	154	16	0
5	32	145	0	13	139	455	0	152	40	0	244	351	96	46	0	114	153	0	154	219	0

	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
1	60	71	231	50	203	98	9	202	-	86	40	0	137	22	172	152	8	47	19	184	0
2	60	71	231	50	203	363	224	202	8	86	244	0	137	22	39	152	8	47	19	465	97
3	60	71	231	50	203	98	224	202	208	86	40	0	137	22	275	152	208	47	19	0	0
4	60	71	231	50	203	98	224	202	208	86	244	0	137	22	172	152	8	47	19	0	0
5	432	71	231	50	203	363	224	202	8	179	198	0	137	22	275	152	208	47	19	0	137

	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
1	18	0	157	221	92	126	152	8	203	7	6	216	153	122	46	0	147	147	156	241	0
2	18	154	157	221	92	0	152	208	203	7	137	216	153	122	241	0	0	0	156	241	0
3	18	154	157	221	92	0	152	208	203	7	6	320	153	172	46	156	147	111	460	241	0
4	18	154	157	221	92	0	152	208	203	7	95	73	153	122	241	156	147	0	156	241	0
5	18	133	157	361	92	145	152	8	203	120	137	73	153	172	241	0	0	0	0	241	0

Average error was 109 feet

Maximum average error over one-tenth mile segment: 315 feet.

Individual output error statistics obtained by use of CPMAIN for Runs 1 through 5 are contained in Tables 5-2 through 5-6. Figure 5-1 is a plot of the error histograms for each of these runs and Figure 5-2 is a plot of the error histogram for all five primary runs, as well as a cumulative error distribution based on all five runs. The 95 percent and 99.5 percent points are indicated on the cumulative distribution. Note that a number of errors are zero. This zero error condition is obtained because of the discrete nature of the HI^3 location subsystem. Generally, the X, Y location coordinates assigned to a location region are coordinates of the center of the nearest intersection. Thus, in those cases in which the TSC checkpoints were associated with the center of an intersection, the resulting error may be zero. (Note: The X, Y stateplane coordinates of intersections in central Philadelphia was provided to HI^3 by TSC.) These coordinates were generated by MITRE through the process of digitizing the intersections of a 2000:1 scale map of Philadelphia. The stated error of this process was 40 feet RMS.

Table 5-7 contains a list of the location errors incurred at each Secondary Checkpoint on each of Runs 6 through 10. Of these 309 samples (CP 18 was missed on Run 8), only 6 exceeded 300 feet and only one exceeded 450 feet. For Runs 6 through 10, the following error statistics were obtained:

95 percent of samples less than 242 feet

99.5 percent of samples less than 411 feet

Average error was 73 feet.

Maximum average error over one-tenth mile segment: 234 feet.

Individual output error statistics obtained using CPMAIN for Runs 6 through 10 are contained in Tables 5-8 through 5-12. As a result of a bad cassette on Run 10, CPMAIN was unable to process the last 21 checkpoints of Run 10. However, a dump of this cassette was obtained by using the CAPS operating system. The first 41 were processed successfully. The last 21 were processed manually as follows:

1. Read location region code at each checkpoint from the dump of Run 10

2. Manually look up X, Y coordinates from signpost data base SPTABL

3. Manually look up X, Y coordinates of secondary checkpoint from CPTABL

(Text continued on 5-17)

TABLE 5-2 RANDOM ROUTE ERROR STATISTICS, RUN 1

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	21	33.87%
25- 50	7	11.29%
50 75	3	4.84%
75- 100	3	4.84%
100- 125	1	1.61%
125- 150	6	9.68%
150- 175	11	17.74%
175- 200	1	1.61%
200- 225	6	9.68%
225- 250	2	3.23%
450- 475	1	1.61%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	13	20.97%
25	21	33.87%
50	29	46.77%
75	31	50.00%
100	34	54.84%
125	35	56.45%
150	41	66.13%
175	52	83.87%
200	53	85.48%
225	59	95.16%
250	61	98.39%
475	62	100.00%

TABLE 5-3 RANDOM ROUTE ERROR STATISTICS, RUN 2

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	22	34.92%
25- 50	6	9.52%
50- 75	3	4.76%
75- 100	3	4.76%
100- 125	1	1.59%
125- 150	6	9.52%
150- 175	9	14.29%
200- 225	7	11.11%
225- 250	4	6.35%
350- 375	1	1.59%
450- 475	1	1.59%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	14	22.22%
25	22	34.92%
50	29	46.03%
75	31	49.21%
100	34	53.97%
125	35	55.56%
150	41	65.08%
175	50	79.37%
225	57	90.48%
250	61	96.83%
375	62	98.41%
475	63	100.00%

TABLE 5-4 RANDOM ROUTE ERROR STATISTICS, RUN 3

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	18	29.03%
25-	50	7	11.29%
50-	75	3	4.84%
75-	100	3	4.84%
100-	125	1	1.61%
125-	150	5	8.06%
150-	175	11	17.74%
200-	225	8	12.90%
225-	250	2	3.23%
250-	275	1	1.61%
275-	300	1	1.61%
300-	325	1	1.61%
450-	475	1	1.61%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	12	19.35%
25	18	29.03%
50	26	41.94%
75	28	45.16%
100	31	50.00%
125	32	51.61%
150	37	59.68%
175	48	77.42%
225	56	90.32%
250	58	93.55%
275	60	96.77%
325	61	98.39%
475	62	100.00%

TABLE 5-5 RANDOM ROUTE ERROR STATISTICS, RUN 4

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	20	31.75%
25- 50	5	7.94%
50- 75	4	6.35%
75- 100	4	6.35%
100- 125	1	1.59%
125- 150	6	9.52%
150- 175	11	17.46%
200- 225	7	11.11%
225- 250	4	6.35%
450- 475	1	1.59%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	13	20.63%
25	20	31.75%
50	26	41.27%
75	29	46.03%
100	33	52.38%
125	34	53.97%
150	40	63.49%
175	51	80.95%
225	58	92.06%
250	62	98.41%
475	63	100.00%

TABLE 5-6 RANDOM ROUTE ERROR STATISTICS, RUN 5

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	21	32.81%
25- 50	4	6.25%
50- 75	3	4.69%
75- 100	1	1.56%
100- 125	2	3.12%
125- 150	7	10.94%
150- 175	8	12.50%
175- 200	2	3.12%
200- 225	6	9.37%
225- 250	4	6.25%
275- 300	1	1.56%
350- 375	2	3.12%
425- 450	1	1.56%
450- 475	1	1.56%
550- 575	1	1.56%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	15	23.44%
25	21	32.81%
50	26	40.62%
75	28	43.75%
100	29	45.31%
125	31	48.44%
150	38	59.37%
175	46	71.87%
200	48	75.00%
225	54	84.37%
250	58	90.62%
275	59	92.19%
375	61	95.31%
450	62	96.87%
475	63	98.44%
575	64	100.00%

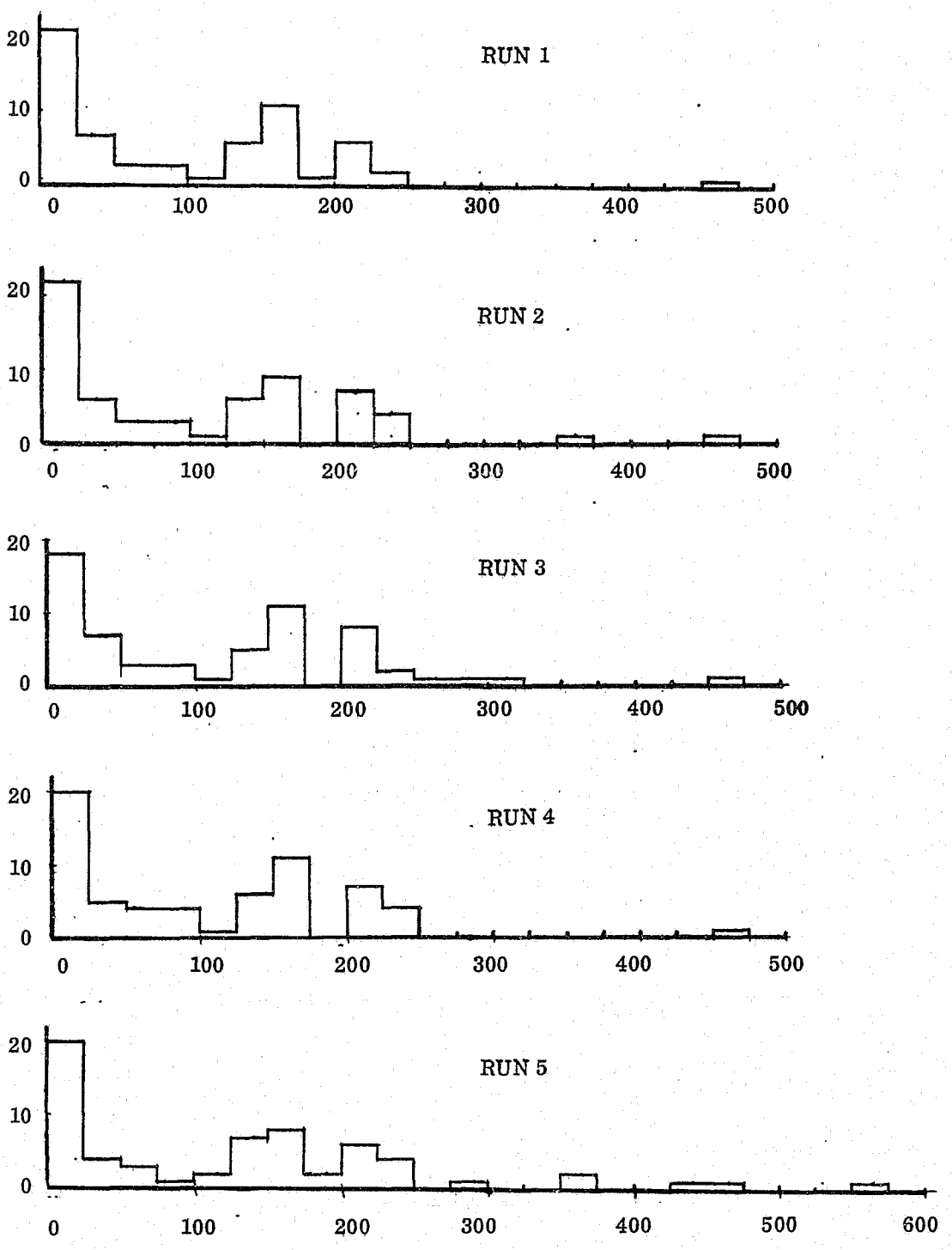


FIG. 5-1 RANDOM ROUTE LOCATION SUBSYSTEM ERRORS, RUNS 1-5

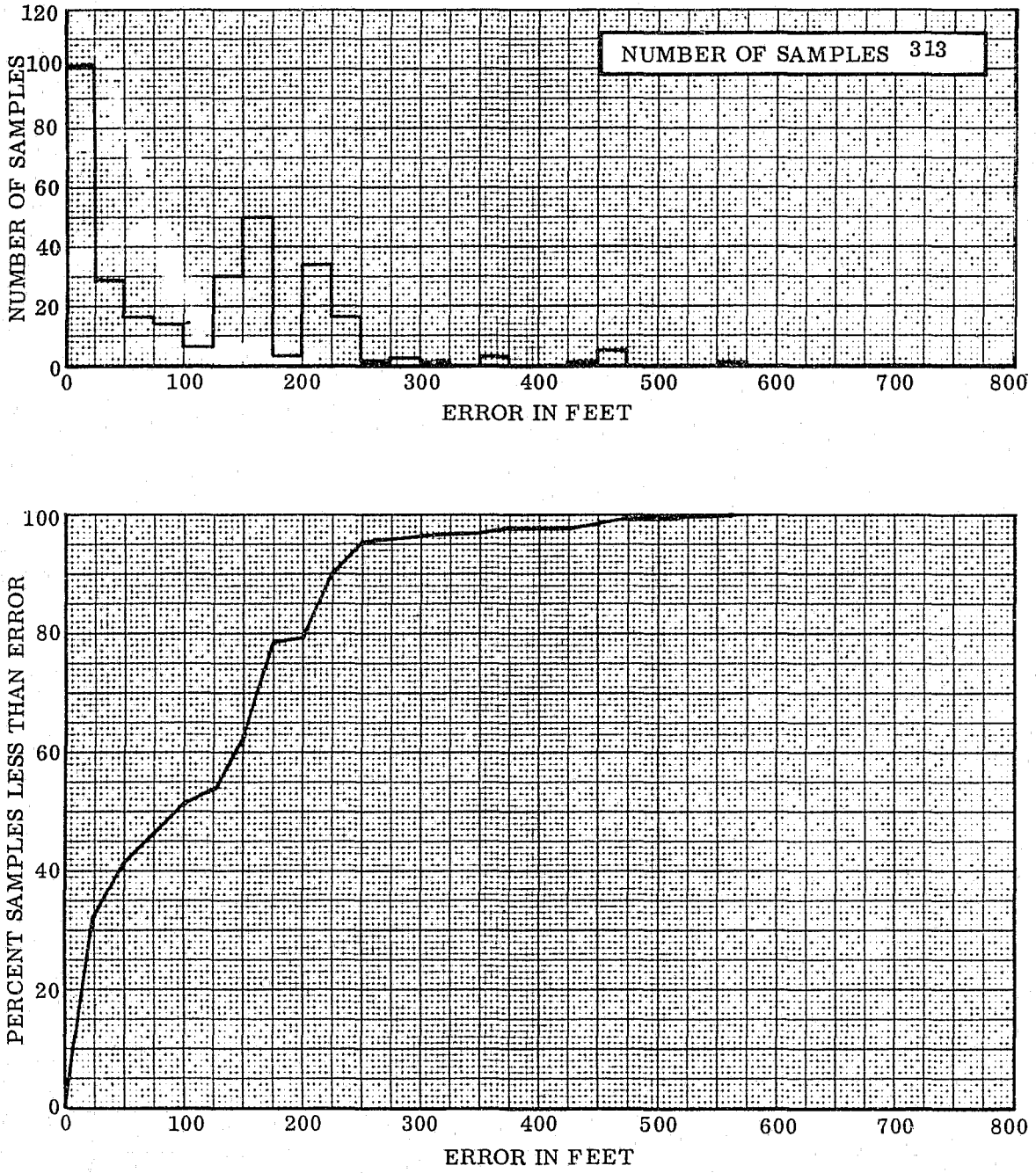


FIG. 5-2 RANDOM ROUTE LOCATION SUBSYSTEM ERRORS, RUNS 1-5

TABLE 5-7 LOCATION SUBSYSTEM ERRORS AT SECONDARY CHECKPOINTS

CHECKPOINTS

RUNS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
6	58	0	0	180	128	191	277	153	0	92	0	41	8	0	0	10	241	0	198	25	0
7	58	0	0	180	265	160	277	153	0	92	0	41	8	0	0	10	241	0	198	25	0
8	58	0	0	180	0	191	53	153	0	92	225	41	8	0	0	10	241	-	250	25	0
9	58	0	0	94	128	52	53	153	0	92	0	41	8	0	0	10	241	79	198	179	0
10	58	0	0	180	128	52	277	153	0	92	225	41	8	0	0	10	241	370	250	25	0

RUNS	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
6	119	77	20	61	120	26	47	157	0	181	84	40	0	77	151	89	64	9	0	410	0
7	119	77	20	61	90	51	29	157	0	181	84	198	0	77	151	89	64	77	0	20	0
8	119	226	20	61	90	51	29	157	0	181	84	40	0	10	151	89	64	77	0	410	0
9	119	77	20	139	120	51	47	157	0	181	84	198	0	10	151	89	64	9	0	20	0
10	119	77	20	139	90	51	376	157	0	181	84	40	0	43	151	89	155	77	0	45	0

RUNS	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
6	192	0	0	46	60	0	0	40	115	50	81	0	0	38	0	92	92	0	0	0
7	80	0	0	46	60	0	0	71	115	50	81	0	0	183	0	92	92	0	0	0
8	80	0	0	46	60	0	0	40	47	50	312	0	0	183	0	92	92	0	0	0
9	192	274	0	46	60	0	0	40	47	50	81	0	0	192	0	92	92	0	0	0
10	80	274	0	227	60	0	0	160	47	50	81	0	0	192	0	92	92	0	460	0

TABLE 5-8 RANDOM ROUTE ERROR STATISTICS, RUN 6

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	26	41.94%
25- 50	8	12.90%
50- 75	5	8.06%
75- 100	8	12.90%
100- 125	3	4.84%
125- 150	1	1.61%
150- 175	3	4.84%
175- 200	5	8.06%
225- 250	1	1.61%
275- 300	1	1.61%
400- 425	1	1.61%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	22	35.48%
25	27	43.55%
50	35	56.45%
75	39	62.90%
100	47	75.81%
125	50	80.65%
150	51	82.26%
175	54	87.10%
200	59	95.16%
250	60	96.77%
300	61	98.39%
425	62	100.00%

TABLE 5-9 RANDOM ROUTE ERROR STATISTICS, RUN 7

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	26	41.94%
25-	50	4	6.45%
50-	75	7	11.29%
75-	100	11	17.74%
100-	125	2	3.23%
150-	175	4	6.45%
175-	200	5	8.06%
225-	250	1	1.61%
250-	275	1	1.61%
275-	300	1	1.61%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	22	35.48%
25	27	43.55%
50	31	50.00%
75	37	59.68%
100	48	77.42%
125	50	80.65%
175	54	87.10%
200	59	95.16%
250	60	96.77%
275	61	98.39%
300	62	100.00%

TABLE 5-10 RANDOM ROUTE ERROR STATISTICS, RUN 8

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	25	40.98%
25- 50	7	11.48%
50- 75	7	11.48%
75- 100	8	13.11%
100- 125	1	1.64%
150- 175	3	4.92%
175- 200	4	6.56%
225- 250	3	4.92%
250- 275	1	1.64%
300- 325	1	1.64%
400- 425	1	1.64%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	21	34.43%
25	26	42.62%
50	33	54.10%
75	39	63.93%
100	47	77.05%
125	48	78.69%
175	51	83.61%
200	55	90.16%
225	56	91.80%
250	59	96.72%
325	60	98.36%
425	61	100.00%

TABLE 5-11 RANDOM ROUTE ERROR STATISTICS, RUN 9

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	26	41.27%
25- 50	5	7.94%
50- 75	7	11.11%
75- 100	9	14.29%
100- 125	2	3.17%
125- 150	2	3.17%
150- 175	3	4.76%
175- 200	6	9.52%
225- 250	1	1.59%
250- 275	1	1.59%
9950- 9975	1	1.59%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	20	31.75%
25	26	41.27%
50	32	50.79%
75	38	60.32%
100	47	74.60%
125	49	77.78%
150	51	80.95%
175	54	85.71%
200	60	95.24%
250	61	96.83%
275	62	98.41%
9975	63	100.00%

TABLE 5-12 RANDOM ROUTE ERROR STATISTICS, RUN 10

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	12	28.57%
25-	50	5	11.90%
50-	75	3	7.14%
75-	100	6	14.29%
100-	125	1	2.38%
125-	150	2	4.76%
150-	175	4	9.52%
175-	200	2	4.76%
225-	250	2	4.76%
250-	275	1	2.38%
275-	300	1	2.38%
350-	375	1	2.38%
375-	400	1	2.38%
1350-	1375	1	2.38%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	9	21.43%
25	13	30.95%
50	17	40.48%
75	20	47.62%
100	26	61.90%
125	27	64.29%
150	29	69.05%
175	33	78.57%
200	35	83.33%
225	36	85.71%
250	38	90.48%
300	39	92.86%
375	40	95.24%
400	41	97.62%
1375	42	100.00%

4. Compute error:

$$\text{ERROR (CP)} = \sqrt{\left[X(SP) - X(CP)\right]^2 + \left(Y(SP) - Y(CP)\right)^2} \quad .$$

Table 5-13 contains the results obtained by using CPMAIN to compute the location error at CP 1 through CP 41 and manual computation necessary to compute the location error at CP 42 through CP 62. The tabular results obtained for all random route runs are contained in the Appendix.

Figure 5-3 contains error histograms of the results obtained during each of Runs 6 through 10. Figure 5-4 is an error histogram for Runs 6 through 10 combined and a cumulative error distribution.

Figure 5-5 contains the overall results obtained during Runs 1 through 10 inclusive, in terms of the frequency of errors over 25-foot error intervals and the cumulative error distribution for all 622 samples.

It is significant to note that, of the 6 errors which exceeded 450 feet, three occurred at the same location, CP 6 on Run 1 and Run 5 and CP 46 on Run 5 (primary checkpoints 6 and 46 were at the same location). In each of the cases, analysis of the cassette dumps shows that a Region 1 from signpost (15, 13) was not received, even though the test vehicle passed within 40 feet of the signpost just prior to approaching the checkpoint. Subsequent to the completion of Runs 1 through 5, it was determined (refer to Section 3 for details) that the vehicle unit clock frequency had been slightly maladjusted and caused a slight degradation in the ability of the unit to lock up on all signposts as their FSK changed (within design tolerance) as a function of temperature. This phenomenon was noticed as the temperature was rapidly dropping towards freezing during Run 5. Prior to Run 6, the vehicle unit clock frequency was correctly set. Subsequent test runs were made in temperatures as low as $8^{\circ}F$, following overnight low temperatures of $0^{\circ}F$.

This adjustment reduced the location subsystem error significantly, i.e., whereas Runs 1 through 5 incurred 5 errors, exceeding 450 feet, Runs 6 through 10 incurred only 1 such error, and whereas Runs 1 through 5 incurred 11 errors exceeding 300 feet, Runs 6 through 10 incurred only 6 such errors.

5.2 RANDOM ROUTE AVM SYSTEM ERRORS

The results obtained by processing Random Route Runs 1 through 10 by use of data processing routine RRSL are presented in this subsection. Location errors associated with the HI^3 AVM System in which pseudo checkpoints serve as the reference are also presented. Pseudo checkpoints were determined by simulating a 20-second polling interval. This simulation was affected by selecting every 40th data record from the test data. The methodology for computing the reference location at each pseudo checkpoint is described in paragraph 4.2.3.

(Text continued on 5-22)

TABLE 5-13 TABULAR LISTING OF LOCATION SUBSYSTEM ERRORS, RUN # 10

LF	X(CF)	Y(CF)	LOCATION	REGION	X(SF)	Y(SF)	ERROR
1	8183	5731	6,12	R1	8176	5673	58
2	8277	6397	8,12	R1	8277	6397	0
3	8354	7054	10,12	R1	8354	7054	0
4	8150	7778	12,12	R1	8321	7721	180
5	7969	7159	17,16	R2S	7937	7283	128
44	8059	7803	15,16	R3N	7882	6463	1351
6	7830	6470	15,16	R2N	7882	6463	52
7	7140	6596	8,10	R1	7403	6509	277
8	6918	6223	15,15	R1	6909	6376	153
9	6427	5897	6, 8	R1	6427	5897	0
10	5461	6021	6, 6	R1	5553	6009	92
11	5618	6511	8, 6	R1	5644	6735	225
12	5771	7426	10, 6	R1	5730	7421	41
13	6509	7341	10, 8	R2W	6503	7335	8
14	7500	7204	10,10	R1	7500	7204	0
15	7910	6813	16,16	R1	7910	6813	0
16	7860	6290	15,16	R1	7856	6280	10
17	6451	6137	6, 8	R1	6427	5897	241
18	6530	6631	8, 8	R3S	6468	6266	370
19	6600	7104	10, 8	R2W	6503	7335	250
20	6693	7755	12, 8	R2S	6685	7731	25
21	7090	7458	17,15	R1	7090	7458	0
22	6981	6811	16,15	R1	6996	6930	119
23	6545	6276	15,14	R2E	6468	6266	77
24	6046	6355	15,13	R1	6026	6358	20
25	5646	6397	15,11	R2E	5508	6417	139
26	5745	7541	10, 6	R2N	5766	7629	90
27	5867	8275	14, 6	R3S	5871	8326	51
28	6247	7988	12, 8	R3W	6623	7965	376
29	6102	6886	16,13	R1	6122	7042	157
30	5730	7421	10, 6	R1	5730	7421	0
31	5813	7865	12, 6	R1	5837	8045	181
32	6638	7895	12, 8	R1	6714	7933	84
33	7090	7702	17,15	R2N	7083	7662	40
*34	6996	6930	16,15	R1	6996	6930	0

CT1:RUN010.001

35	6453	6641	8, 8	R3W	6414	6661	43
36	6147	6705	8, 7	R1	6298	6690	151
37	6044	6446	15,13	R1	6026	6358	89
38	5994	5984	15,13	R2S	5996	6139	155
39	6267	7988	12, 6	R3E	6193	8011	77
40	6714	7933	12, 8	R1	6714	7933	0
41	7121	7879	19,15	R2S	7135	7922	45
42	7591	7859	12,10	R1	7591	7859	0
43	8288	7464	10,12	R3N	8263	7388	80
44	8059	7803	12,12	R1	8321	7721	274
45	7591	7859	12,10	R1	7591	7859	0
46	6741	8159	12, 8	R2W	6623	7965	227
47	7157	8093	19,15	R1	7147	8153	60
48	7090	7458	17,15	R1	7090	7458	0
49	6427	7006	16,14	R1	6427	7006	0
50	6284	7063	8, 7	R2N	6325	6908	160
51	5820	7115	16,13	R3W	5837	7071	47
52	6296	8232	19,13	R1	6300	8282	50
53	6192	7484	17,13	R1	6219	7561	81
54	6627	7326	10, 8	R1	6627	7326	0
55	6909	6376	15,15	R1	6909	6376	0
56	6838	5874	6,10	R2W	7023	5820	192
57	6427	5897	6,18	R1	6427	5897	0
58	5461	6021	6,16	R1	5553	6009	92
59	5461	6021	6, 6	R1	5553	6009	92
60	6427	5897	6, 8	R1	6427	5897	0
61	7321	5782	6, 8	R3E	6965	5846	460
62	8178	5673	6,12	R1	8176	5673	0

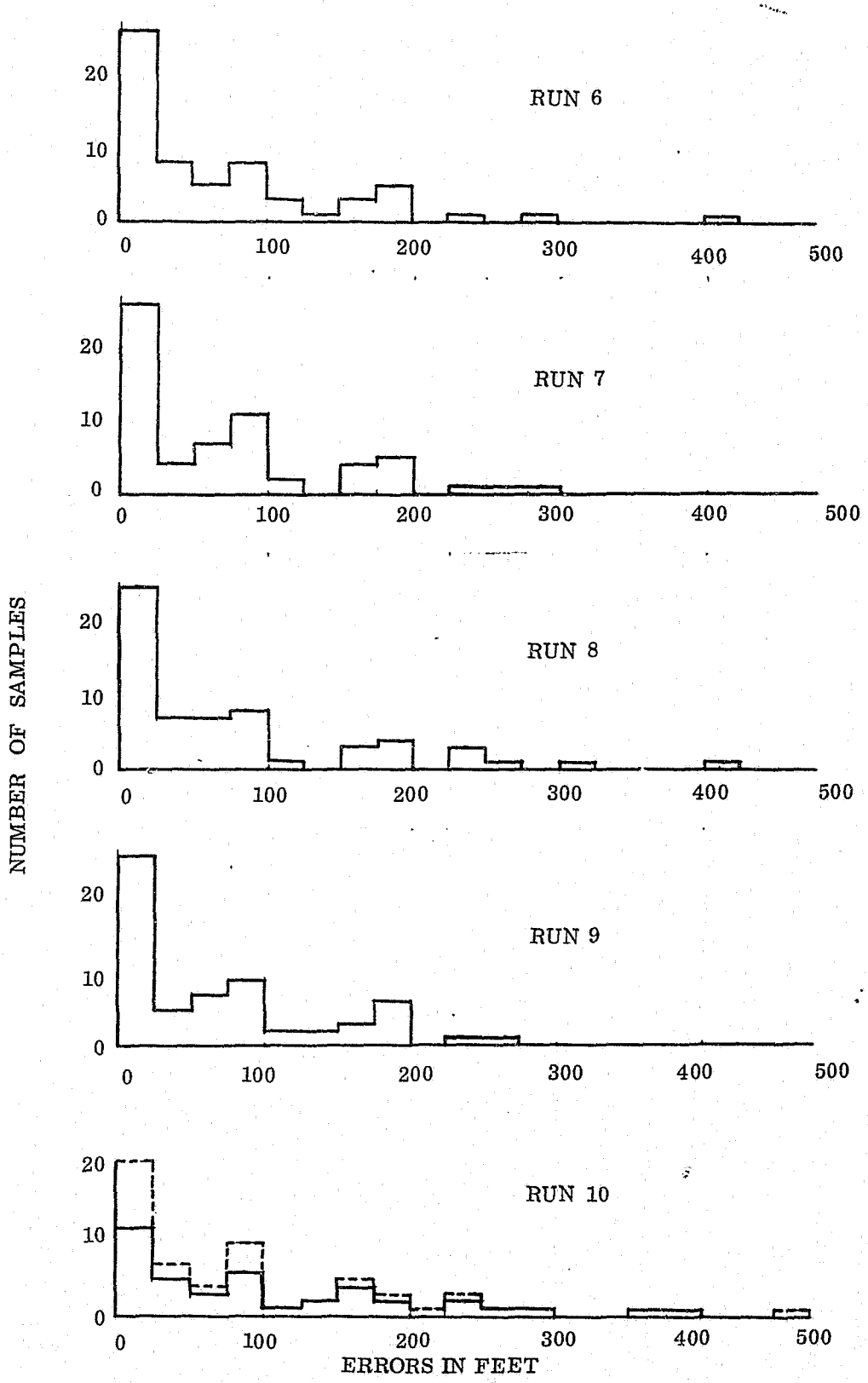


FIG. 5-3 RANDOM ROUTE LOCATION SUBSYSTEM ERRORS, RUNS 6-10

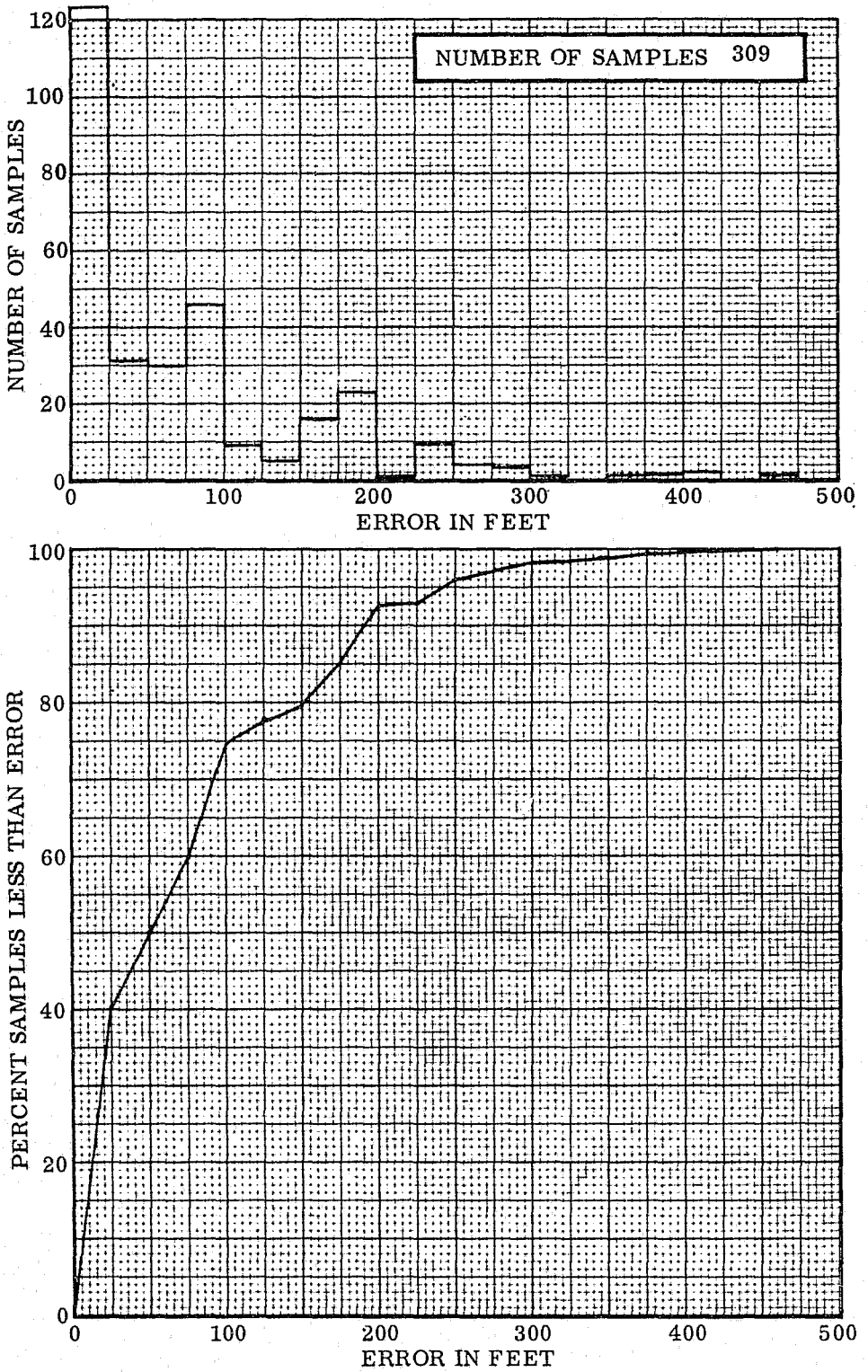
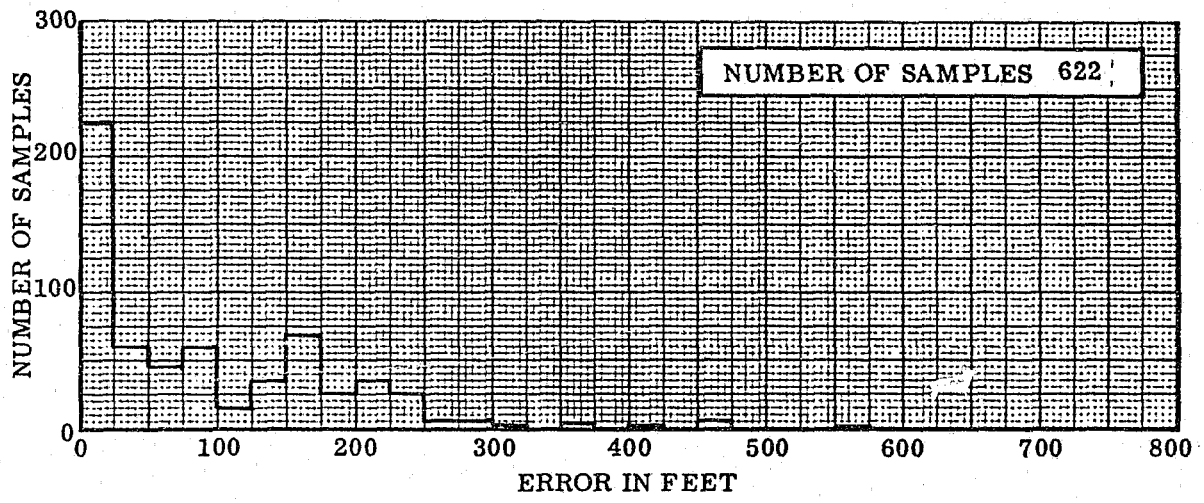


FIG. 5-4 RANDOM ROUTE LOCATION SUBSYSTEM ERRORS, RUNS 6-10



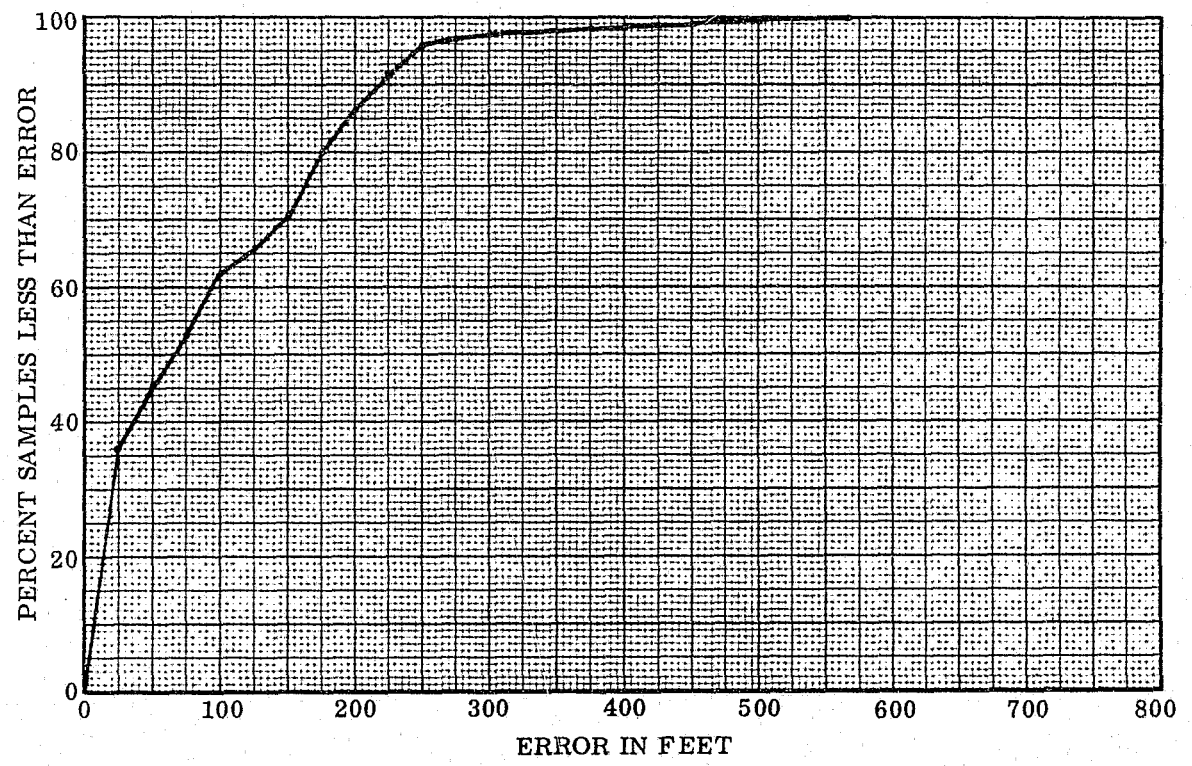


FIG. 5-5 RANDOM ROUTE LOCATION SUBSYSTEM ERRORS, RUNS 1-10

Individual listing of pseudo checkpoint errors for Runs 1 through 10 are presented in the Appendix. However, for illustration, Table 5-14 contains a copy of the RRSL output listing for Run 10. This listing represents the first pass through the program which simulates the 20-second polling interval but does not simulate communication errors. Table 5-15 contains the error statistics for these data as well as those for the results obtained when a 5-percent communication error was to shift one error from the 50-75 foot interval to the 325-350 foot interval.

Figures 5-6 through 5-15 contain error histograms and cumulative error distributions of Random Route AVM System Errors for Runs 1 through 10. As in the case of Location Subsystem data processing of Run 10, the last portion (CP 41 to end of tape) of the run was processed manually. In Figures 5-6 through 5-15, the solid lines represent the results obtained with no communication errors simulated. Where a difference occurred, a dashed line has been used to represent the results obtained when a 5-percent communication error rate was simulated. Note that, in general, this difference is hardly perceptible.

Table 5-16 contains a summary of the Random Route AVM System error statistics for Runs 1 through 10. Note that Run 5, during which the maladjusted vehicle unit clock frequency produced the most location subsystem errors (as a result of the temperature being the lowest), contributed 17 system level errors which exceeded 300 feet whereas the other 9 runs contributed only 81 such errors. Thus, Run 5, representing only 7.6 percent of the total samples processed, produced 17.3 percent of the errors exceeding 300 feet. Similarly only 7.6 percent of the data produced 3 samples, or 21 percent of the errors exceeding 450 feet. Subsection 9.2.4 contains a detailed discussion of this frequency maladjustment. Section 10 contains a discussion of pertinent problems in recording, processing, and analyzing test data.

Figure 5-16 contains a histogram and cumulative distribution of Random Route AVM system errors, both with and without communication errors, for Random Route Runs 1 through 10. As a result of the HI^3 communication error detection and correction technique, the impact of 5 percent communication errors is negligible. In Table 5-17, the impact of 5 percent communication errors on AVM system accuracy are quantified.

5.3 AVERAGE ERROR OVER ONE-TENTH MILE SEGMENTS

The results obtained by processing Runs 1 through 10 by use of the RRTEN routine are tabulated in Tables 5-18 and 5-19. Table 5-18 contains results associated with Runs 1 through 5 and the Primary Route. Table 5-19 contains results associated with Runs 6 through 10 and the Secondary Route. The largest single one-tenth mile average on any single run was 455 feet. This occurred during the 64th segment on Run 8. The average error obtained over this segment during Runs 6, 7, 8, and 9 (Run 10 could not be processed past the 60th segment) was 234 feet. Tables 5-18 and 5-19 also contain data averaged over these corresponding five runs. The

(Text continued on 5-45)

TABLE 5-14 RRSL OUTPUT LISTING FOR RANDOM ROUTE RUN # 3

SIMULATED ERRORS PSEUDO CP #	ERROR	TIME	ODOM
1	0	2:34	553
2	14	2:52	560
3	70	3:14	737
4	3	3:32	771
5	2	3:52	866
6	65	4:32	1177
7	37	4:52	1356
8	279	5:12	1519
9	85	5:32	1572
10	211	5:52	1724
11	27	6:12	1816
12	199	6:32	1928
13	47	6:52	2063
14	153	7:12	2163
15	97	7:34	2297
16	46	7:52	2422
17	162	8:12	2584
18	48	8:32	2625
19	19	8:52	2635
20	236	9:12	2744
21	22	9:32	2805
22	22	9:52	2805
23	56	10:12	2964
24	8	10:34	2988
25	21	10:52	3003
26	152	11:12	3181
27	226	11:32	3336
28	229	11:52	3361
29	18	12:12	3524
30	69	12:32	3556
31	36	12:52	3702
32	122	13:12	3885
33	56	13:32	4068
34	32	13:52	154
35	28	14:12	156
36	48	14:32	210
37	15	14:54	447
38	24	15:12	611
39	24	15:32	611
40	139	15:52	693
41	372	16:12	869
42	113	16:32	886
43	180	16:52	1041
44	82	17:12	1237
45	221	17:32	1433
46	99	17:52	1662
47	142	18:12	1823
48	31	18:32	1942
49	92	18:52	2117
50	91	19:12	2209
51	217	19:32	2272
52	139	19:52	2382

TABLE 5-14 RRSL OUTPUT LISTING FOR RANDOM ROUTE RUN # 3 (Cont'd)

53	137	20:12	2383
54	137	20:32	2383
55	196	20:54	2575
56	133	21:12	2782
57	0	21:32	2867
58	10	21:52	3049
59	68	22:12	3186
60	216	22:34	3284
61	58	22:52	3476
62	161	23:12	3649
63	335	23:32	3777
64	107	23:52	3891
65	155	24:12	4050
66	44	24:32	122
67	42	24:52	123
68	12	25:12	138
69	6	25:32	312
70	112	25:52	406
71	67	26:12	496
72	7	26:32	641
73	57	26:52	814
74	53	27:12	916
75	197	27:32	989
76	197	27:52	989
77	78	28:12	1048
78	67	28:32	1206
79	62	28:52	1209
80	122	29:12	1287
81	127	29:32	1498
82	48	29:52	1676
83	48	30:12	1676
84	42	30:32	1788
85	217	30:52	1943
86	13	31:12	2072
87	214	31:32	2180
88	74	31:52	2180
89	362	32:12	2180
90	182	32:32	2311
91	56	32:52	2476
92	381	33:12	2536
93	77	33:32	2619
94	163	33:52	2801
95	269	34:12	2936
96	58	34:32	3100
97	34	34:52	3112
98	166	35:12	3261
99	205	35:32	3452
100	168	35:52	3655
101	49	36:12	3761
102	119	36:32	3884
103	95	36:52	4066
104	201	37:12	202
105	111	37:32	359
106	48	37:52	518

TABLE 5-14 RRSL OUTPUT LISTING FOR RANDOM ROUTE RUN # 3 (Cont'd)

107	118	38:12	594
108	109	38:32	750
109	233	38:52	941
110	26	39:12	1108
111	92	39:32	1241
112	170	39:52	1391
113	66	40:12	1511
114	21	40:32	1619
115	21	40:54	1619
116	38	41:12	1648
117	321	41:32	1791
118	220	41:52	1924
119	103	42:12	2086
120	158	42:32	2263
121	40	42:52	2427
122	177	43:12	2637
123	103	43:32	2674
124	258	43:52	2833
125	154	44:12	2981
126	88	44:32	3211
127	238	44:52	3438
128	36	45:12	3598
129	36	45:32	3598
130	2	45:52	3624
131	570	46:33	3858
132	0	46:53	4025
133	53	47:13	79
134	175	47:33	200
135	136	47:53	278
136	190	48:13	418
137	72	48:33	542
138	6	48:53	683
139	12	49:46	692
140	12	50: 3	692
141	141	50:23	704
142	65	50:43	886
143	17	51: 3	910
144	158	51:23	1053
145	29	51:43	1179
146	106	52: 3	1294
147	246	52:23	1402
148	249	52:45	1514
149	40	53: 3	1604
150	257	53:23	1753
151	102	53:43	1831
152	143	54: 3	1853
153	250	54:23	1986
154	140	54:43	2041
155	110	55: 3	2056
156	72	55:23	2075
157	9	55:43	2181
158	164	56: 3	2342
159	117	56:23	2494
160	159	56:43	2653

TABLE 5-14 RRSL OUTPUT LISTING FOR RANDOM ROUTE RUN # 3 (Cont'd)

161	48	57: 3	2774
162	72	57:23	2831
163	198	57:43	3033
164	224	58: 0	3097
165	147	58:20	3272
166	169	58:40	3398
167	187	59: 0	3576
168	42	59:20	3714
169	114	59:42	3911
170	127	60: 0	4046
171	179	60:20	104
172	46	60:40	171
173	46	61: 0	171
174	47	61:20	316
175	103	61:40	389
176	103	62: 0	389
177	5	62:20	413
178	24	62:40	574
179	61	63: 0	750
180	120	63:20	927
181	30	63:40	1072
182	111	64: 0	1166
183	69	64:20	1336
184	242	64:40	1492
185	48	65: 0	1545
186	230	65:20	1720
187	107	65:40	1782
188	213	66: 0	1942
189	24	66:20	1993
190	56	66:42	2098
191	82	67: 0	2235
192	10	67:20	2281
193	20	68: 0	4035
194	249	68:20	117
195	62	68:40	211
196	62	69: 0	211
197	75	69:20	354
198	18	69:40	542
199	113	70: 0	740
200	122	70:20	931
201	18	70:40	1148

TABLE 5-15 ERROR STATISTICS FOR RUN #3

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	31	15.50%
25- 50	32	16.00%
50- 75	26	13.00%
75- 100	15	7.50%
100- 125	21	10.50%
125- 150	13	6.50%
150- 175	18	9.00%
175- 200	10	5.00%
200- 225	11	5.50%
225- 250	8	4.00%
250- 275	4	2.00%
275- 300	3	1.50%
300- 325	1	0.50%
325- 350	2	1.00%
350- 375	2	1.00%
375- 400	1	0.50%
400- 425	1	0.50%
550- 575	1	0.50%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	3	1.50%
25	31	15.50%
50	63	31.50%
75	89	44.50%
100	104	52.00%
125	125	62.50%
150	139	69.50%
175	157	78.50%
200	166	83.00%
225	177	88.50%
250	186	93.00%
275	189	94.50%
300	192	96.00%
325	193	96.50%
350	195	97.50%
375	197	98.50%
400	198	99.00%
425	199	99.50%
575	200	100.00%

AVERAGE ERROR = 113.59
STANDARD DEVIATION = 92.84
ELAPSED TIME = 4111

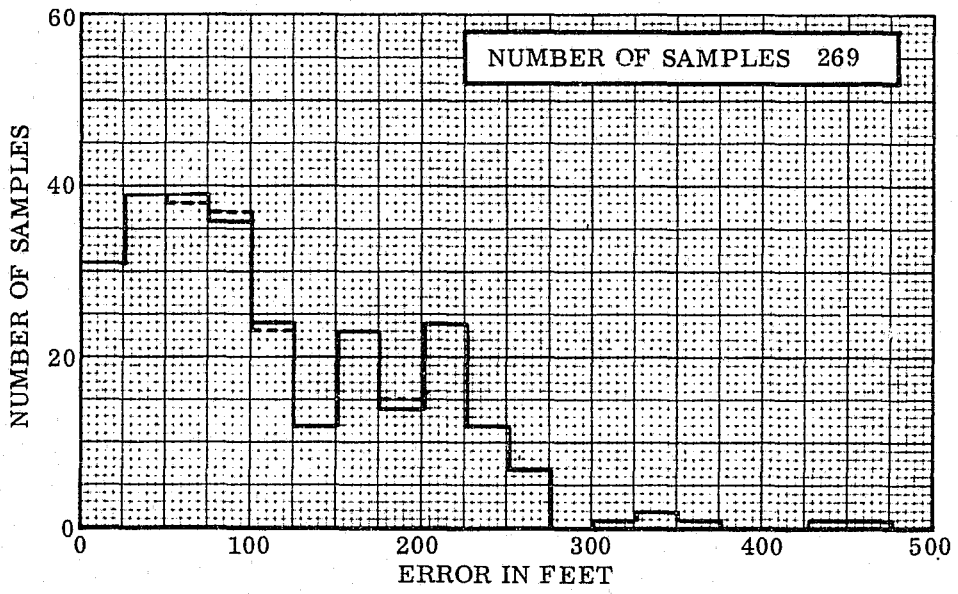
ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	31	15.50%
25- 50	32	16.00%
50- 75	27	13.50%
75- 100	15	7.50%
100- 125	21	10.50%
125- 150	13	6.50%
150- 175	18	9.00%
175- 200	10	5.00%
200- 225	11	5.50%
225- 250	8	4.00%
250- 275	4	2.00%
275- 300	3	1.50%
300- 325	1	0.50%
325- 350	1	0.50%
350- 375	2	1.00%
375- 400	1	0.50%
400- 425	1	0.50%
550- 575	1	0.50%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	3	1.50%
25	31	15.50%
50	63	31.50%
75	90	45.00%
100	105	52.50%
125	126	63.00%
150	140	70.00%
175	158	79.00%
200	167	83.50%
225	178	89.00%
250	187	93.50%
275	190	95.00%
300	193	96.50%
325	194	97.00%
350	195	97.50%
375	197	98.50%
400	198	99.00%
425	199	99.50%
575	200	100.00%

AVERAGE ERROR = 112.29
STANDARD DEVIATION = 91.61
ELAPSED TIME = 4111



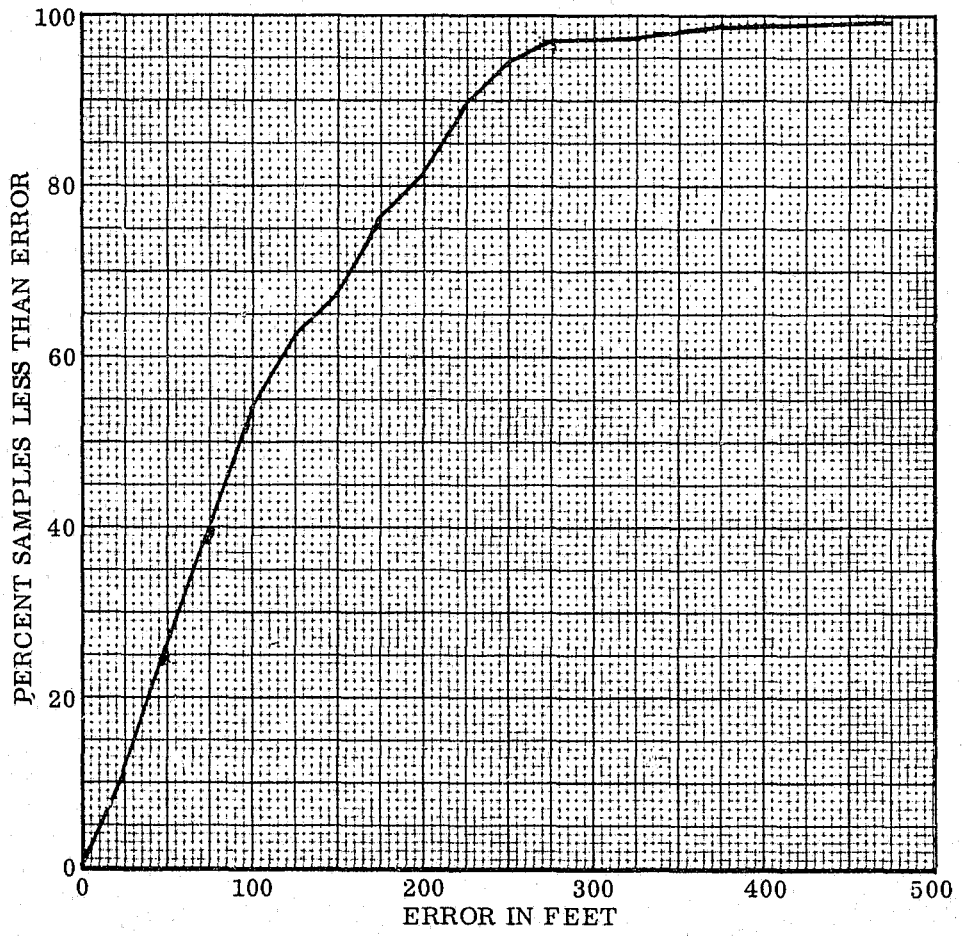


FIG. 5-6 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #1

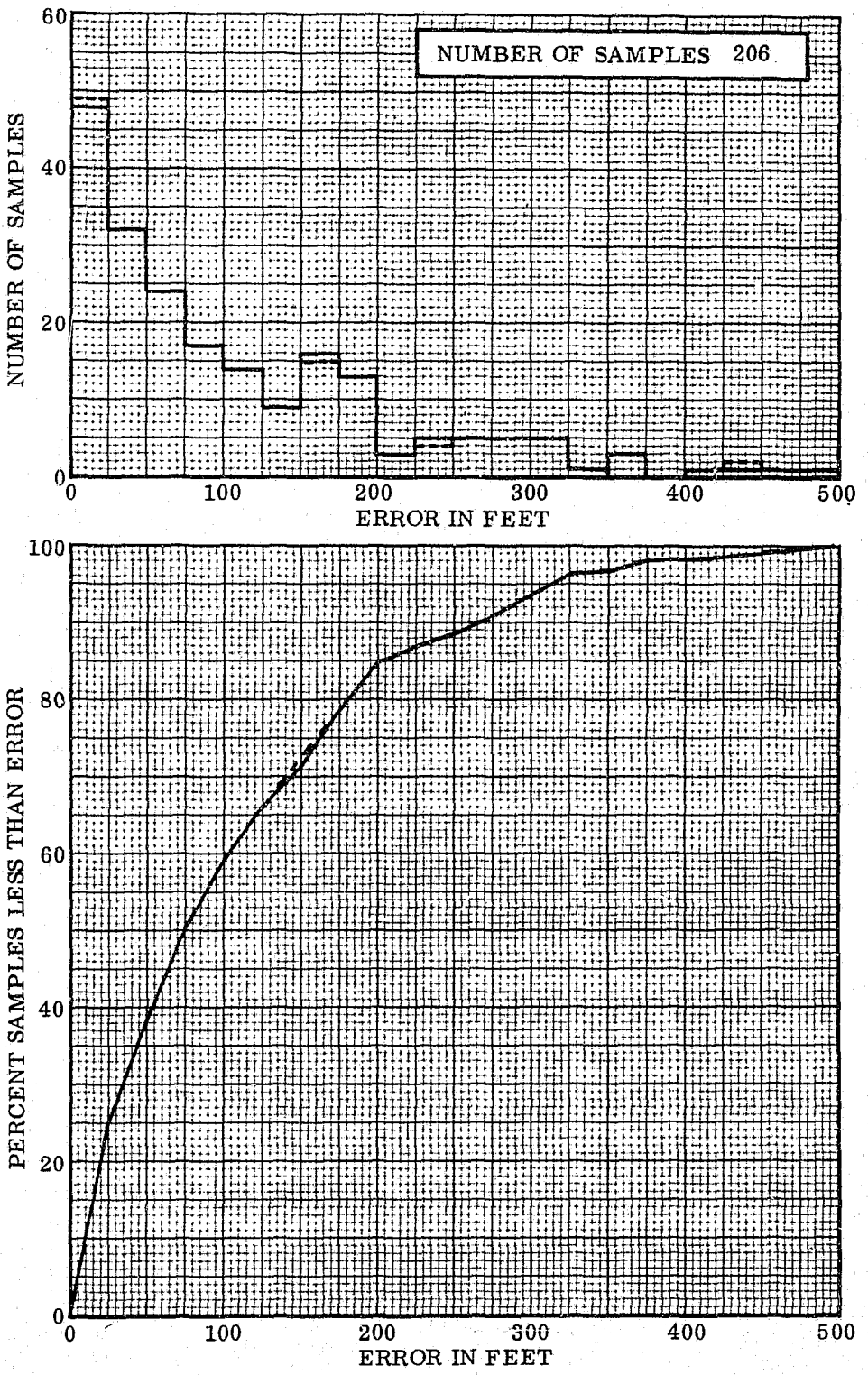


FIG. 5-7 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #2

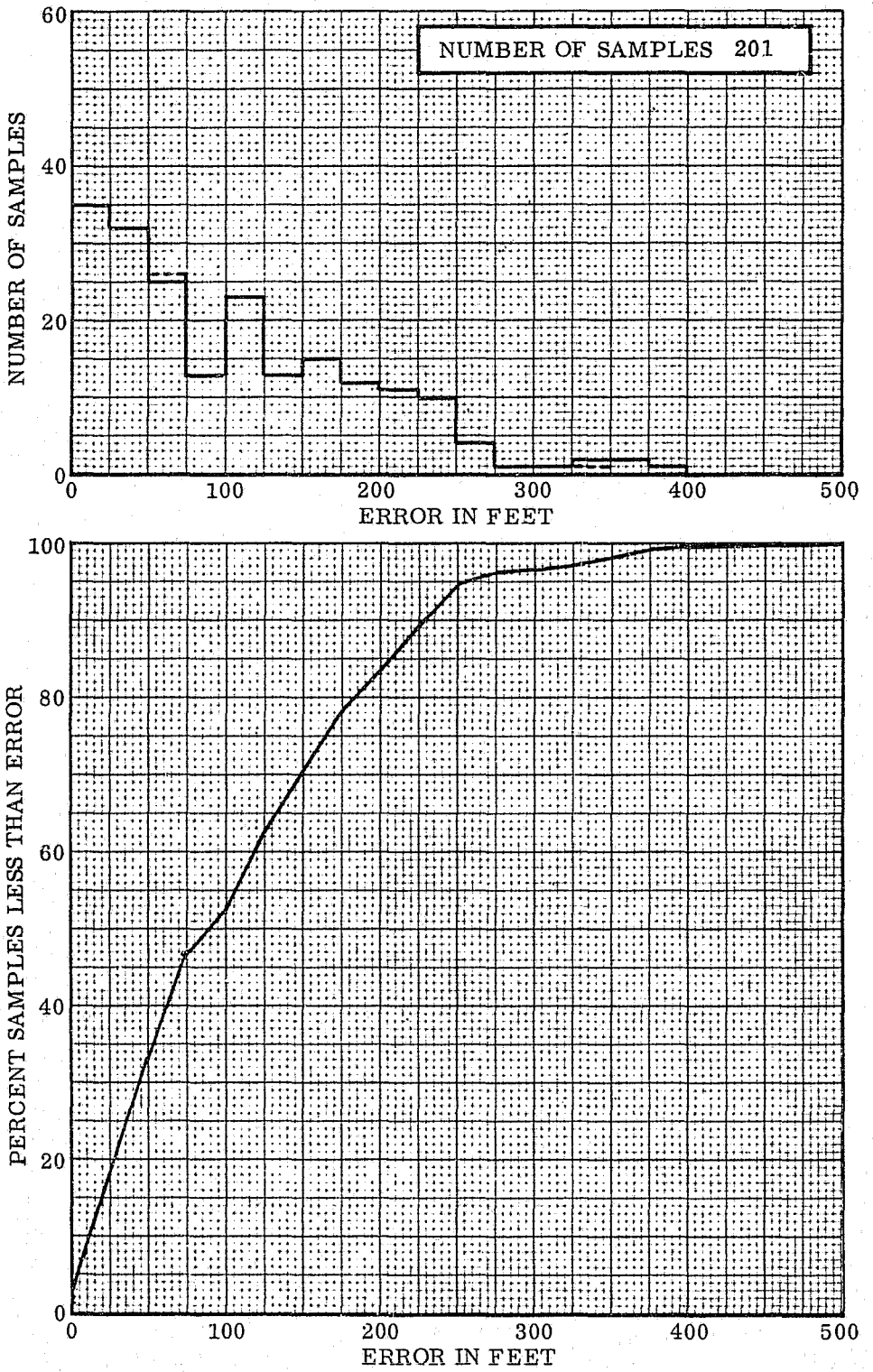
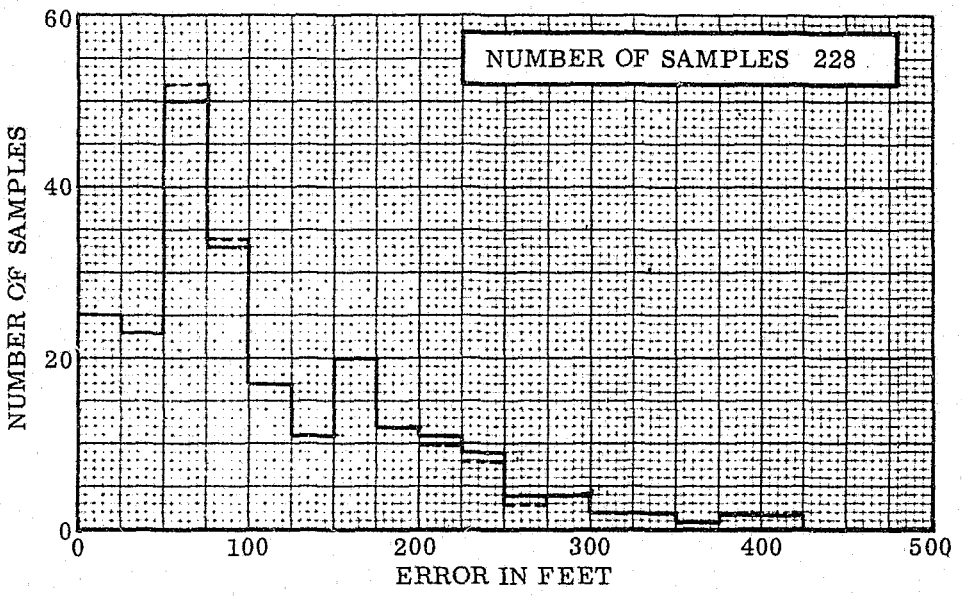


FIG. 5-8 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #3



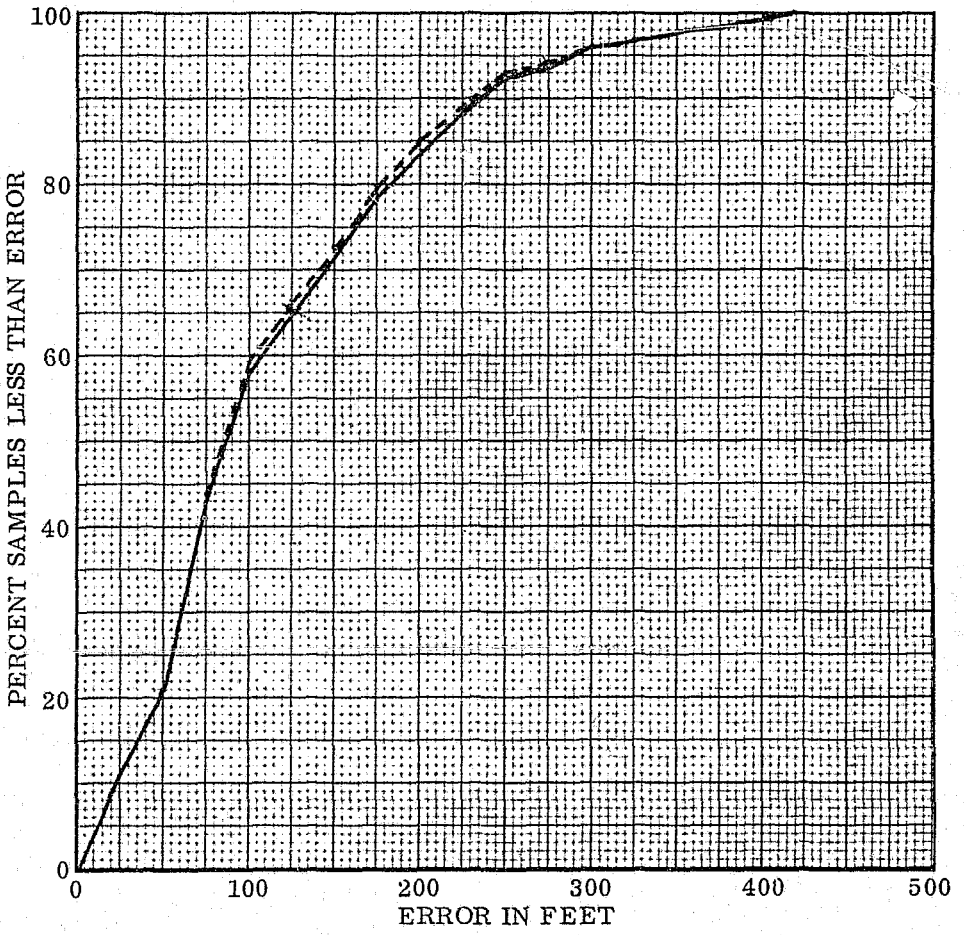
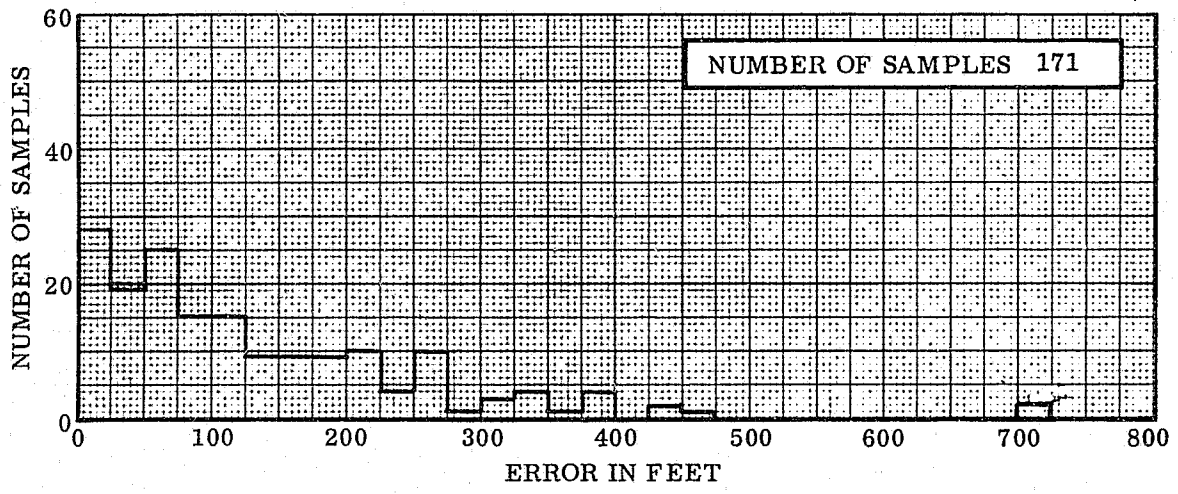


FIG. 5-9 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #4



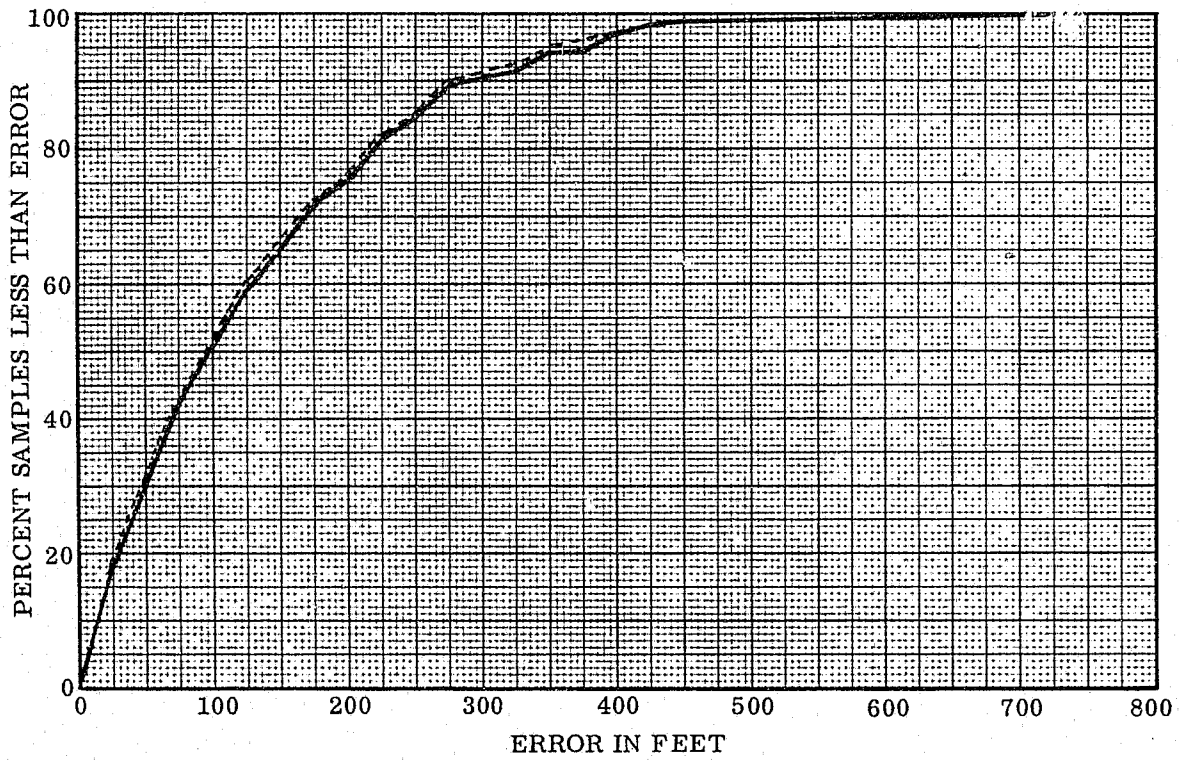


FIG. 5-10 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #5

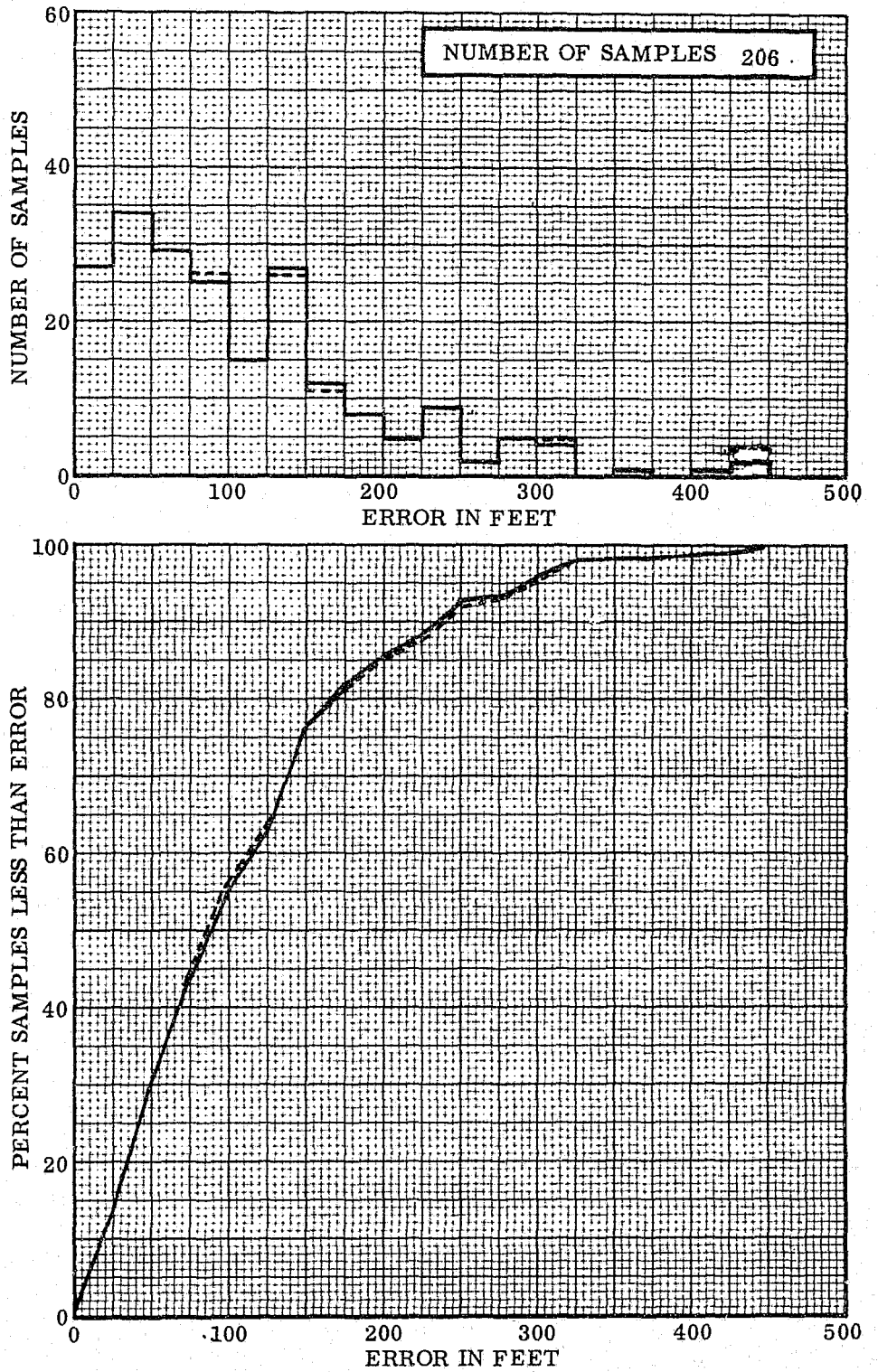
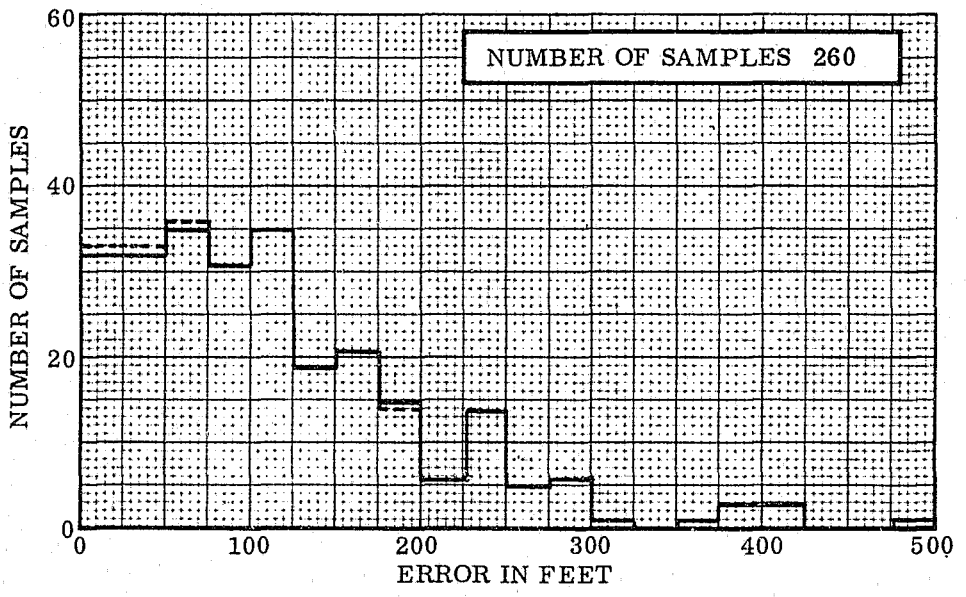


FIG. 5-11 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #6



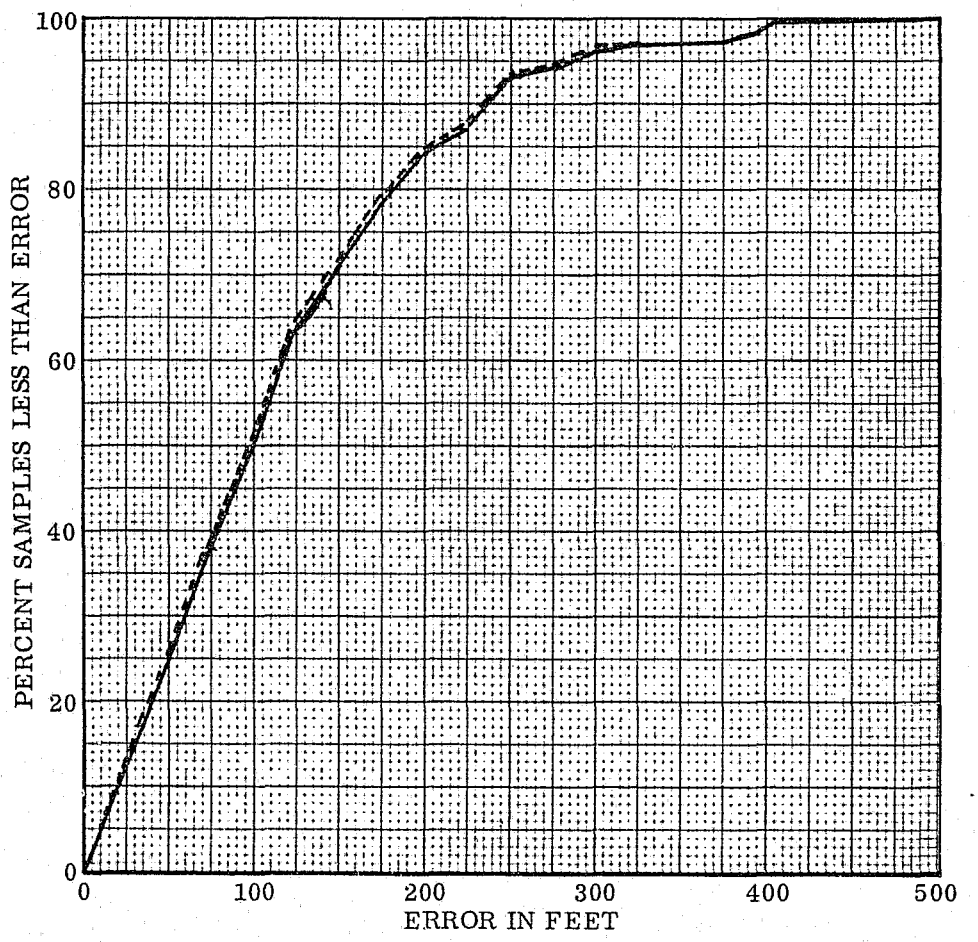


FIG. 5-12 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #7

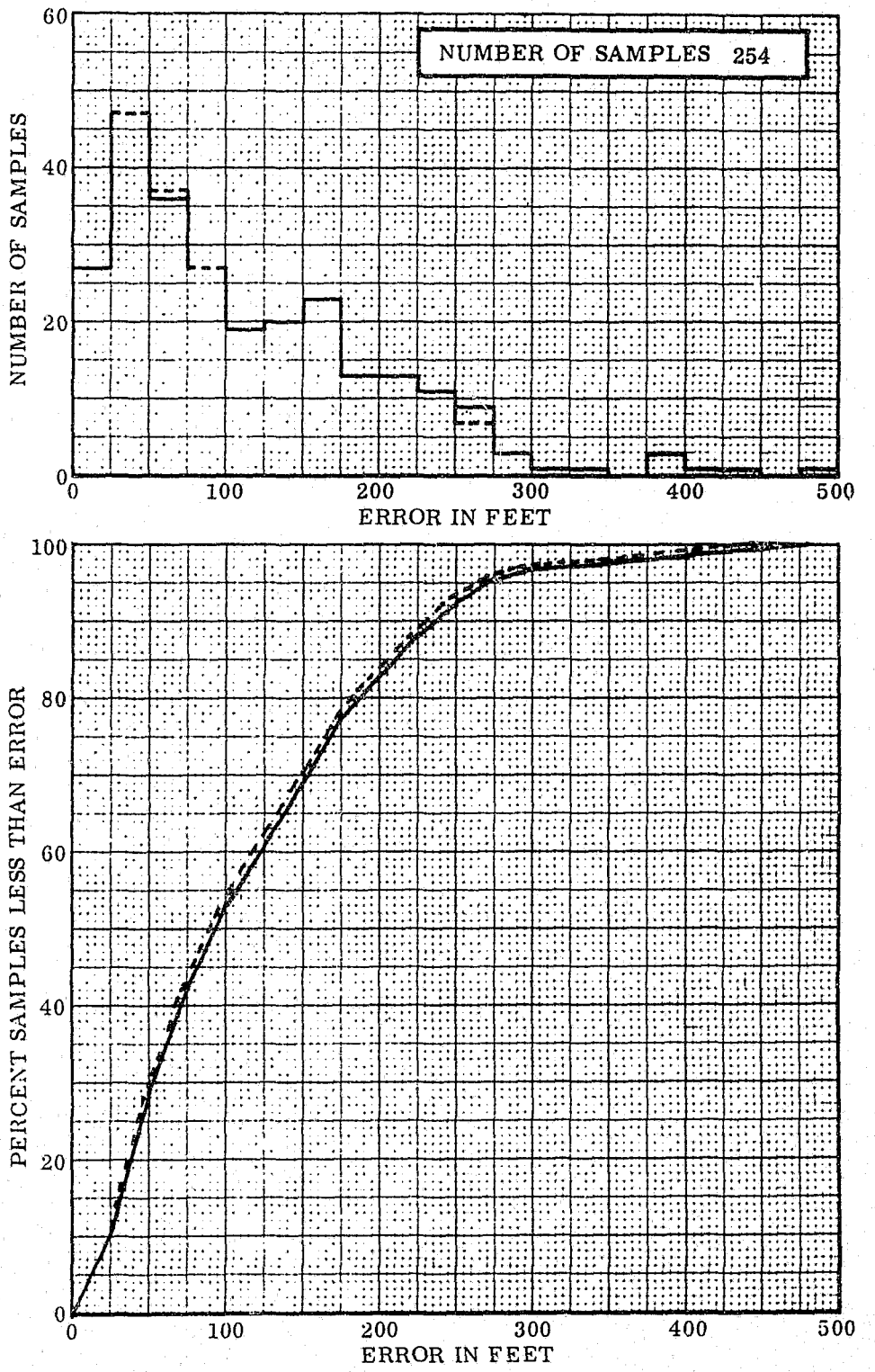


FIG. 5-13 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #8

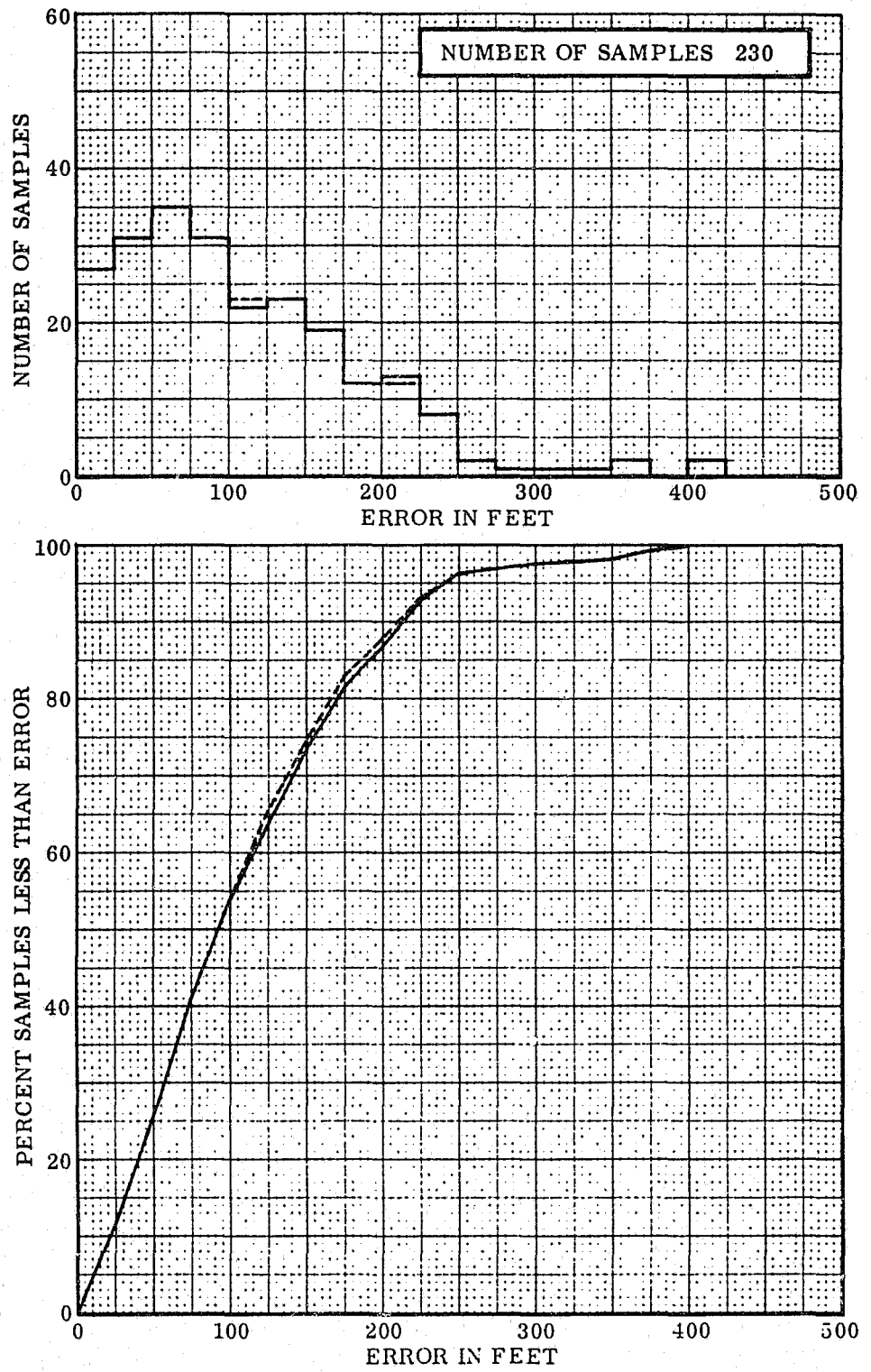
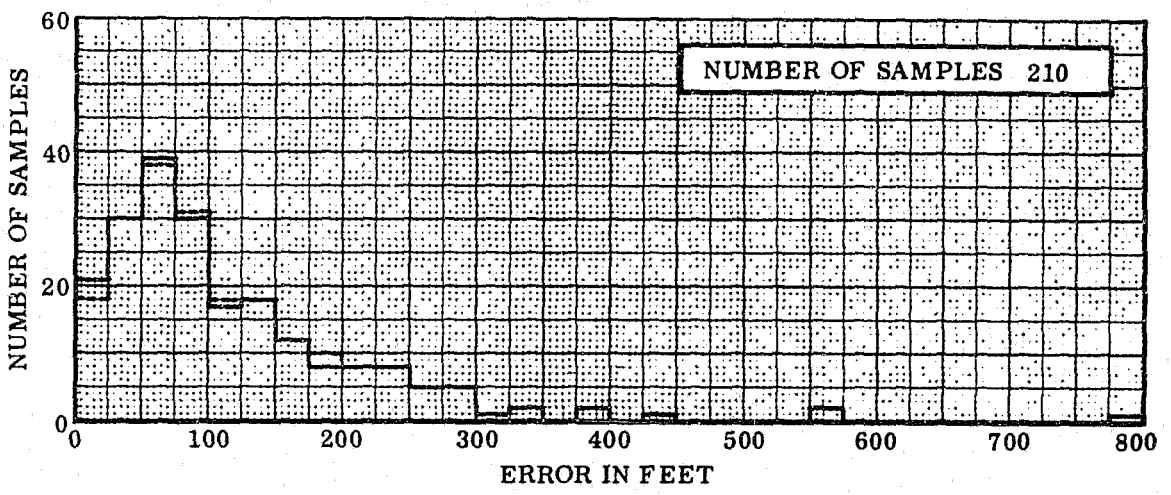


FIG. 5-14 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #9



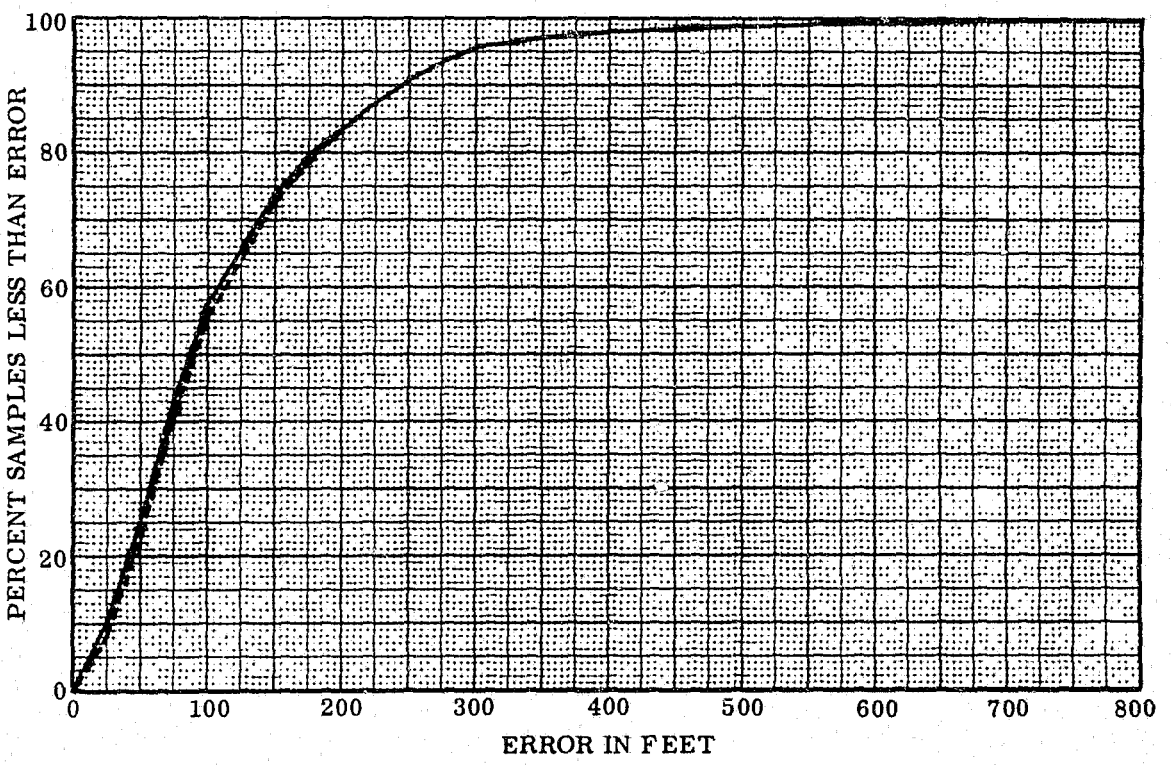
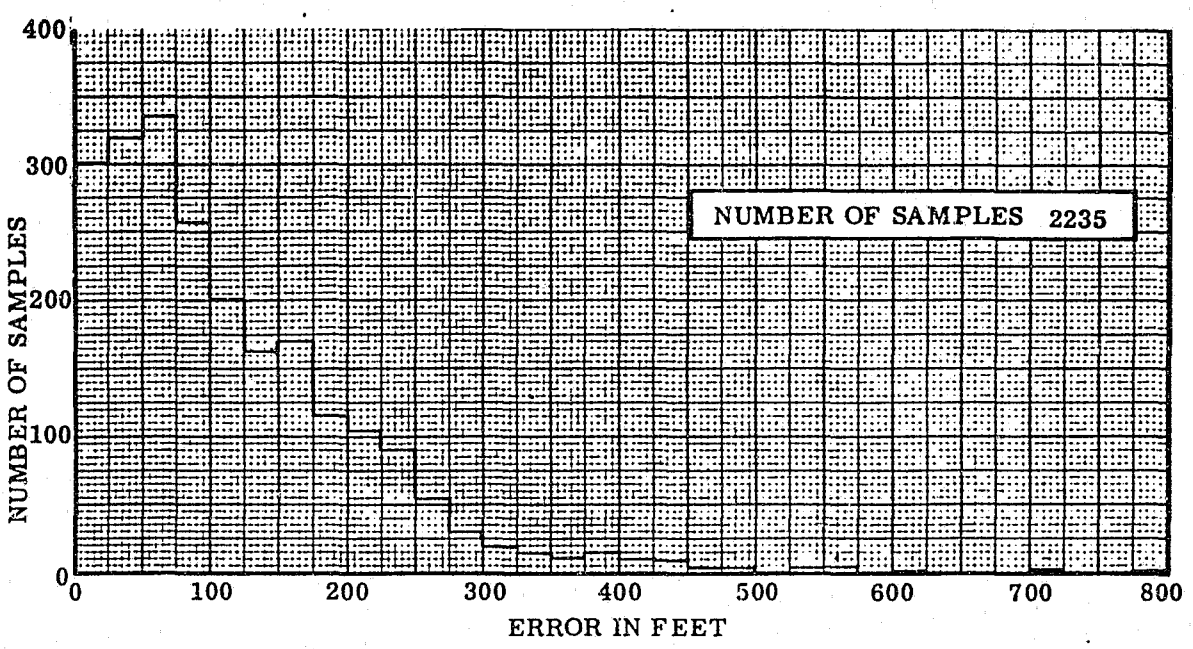


FIG. 5-15 RANDOM ROUTE AVM SYSTEM LEVEL ERROR RUN #10



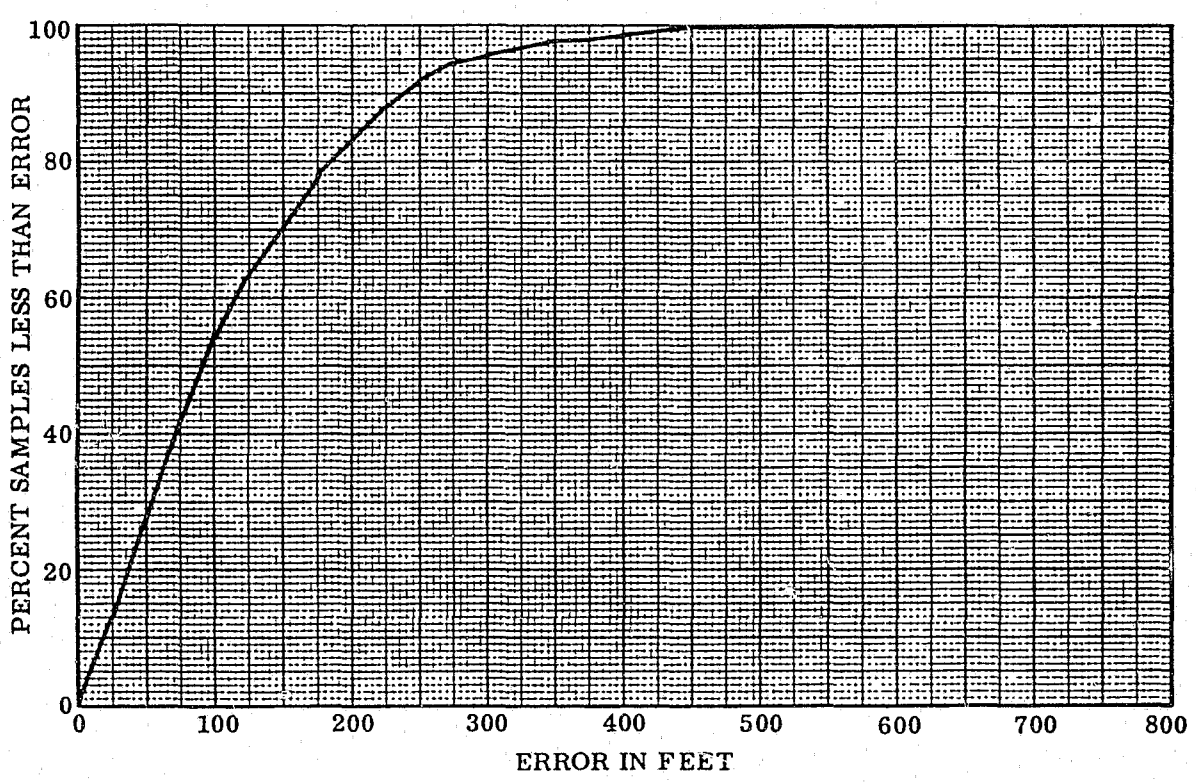


FIG. 5-16 RANDOM ROUTE AVM SYSTEM LEVEL ERROR, RUNS #1-10

TABLE 5-16 SUMMARY RANDOM ROUTE AVM SYSTEM ERROR STATISTICS, NO COMMUNICATION ERRORS

Run #	Average Error (feet)	% Samples < 300'	% Samples < 450'	Max Error (feet)
1	115	97.03	98.88	617
2	109	93.89	99.13	496
3	110	96.0	99.50	570
4	114	96.05	100.00	420
5	133	90.06	98.25	721
6	109	95.15	100.00	446
7	116	96.54	99.62	480
8	114	96.85	99.61	482
9	109	97.39	100.00	794
10	112	95.69	98.56	794
All Runs Combined	114	95.66	99.38	794
All Runs Excluding Run #5	112	96.16	99.47	794

TABLE 5-17 IMPACT OF 5 PERCENT COMMUNICATION ERRORS ON AVM SYSTEM ACCURACY

Run #	No. PCP's	No Errors which Increased	No Errors which Decreased	% Less than 300' - No Com Error	% Less than 300' - 5% Com Errors
1	269	3	1	97.03	97.03
2	206	1	1	93.69	93.20
3	201	0	1	97.01	97.01
4	228	0	4	96.05	96.05
5	171	0	1	90.64	91.23
6	206	1	1	96.12	95.63
7	260	0	4	96.54	96.92
8	254	1	3	96.85	97 24
9	230	0	1	97.39	97.39
10	210	4	0	95.71	95.71
Combined 1-10	2235	10	17	95.79	95.88

TABLE 5-18 AVERAGE ERROR OVER ONE-TENTH MILE SEGMENTS OF RANDOM ROUTE RUNS 1-5

RUN 1 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

59	179	113	102	122	214	106	227	184	56
73	114	96	84	188	51	115	226	78	105
258	100	151	205	367	84	142	152	171	75
* 79	47	154	136	110	158	90	114	161	103

CT1:RUN001.001

122	93	188	173	93	116	117	105	75	75
197	119	57	57	102	128	121	94	113	125
193	118	131	73	137	137	147	105	119	68
51	111	111	155	129	74	204	67	124	114
131	75	122	115	85	121	148	135	174	78

RUN 2 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

168	99	127	76	179	90	75	83	98	68
91	89	51	55	227	43	76	158	106	175
146	114	89	209	358	105	99	142	139	104
86	71	127	144	94	140	76	85	143	146
*198	134	179	60	75	117	225	123	71	83

CT1:RUN002.001

149	89	122	144	194	70	153	161	142	255
208	389	145	119	81	110	73	231	172	71
102	93	132	90	195	142	76	239	67	102
120	79	99	149	115	69	61	96	223	114
74									

RUN 3 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

126	81	57	68	84	102	133	51	72	28
173	152	78	140	45	85	83	236	80	102
88	117	165	142	154	113	324	129	207	125
116	93	70	161	94	71	148	146	146	173
*176	95	129	117	121	181	121	103	151	131

CT1:RUN003.001

110	125	107	129	112	200	96	139	52	335
113	118	110	143	106	104	177	139	116	73
188	62	115	151	110	152	66	99	98	119
81	83	107	81	88	71	77	97	89	

TABLE 5-18 AVERAGE ERROR OVER ONE-TENTH MILE SEGMENTS OF RANDOM ROUTE RUNS 1-5 (CONT'D)

RUN 4 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

144	134	95	78	103	80	125	65	75	57
77	263	120	76	169	85	116	202	64	81
148	70	87	166	259	105	112	111	119	151
74	85	114	135	94	160	83	236	190	132
*162	148	129	122	94	100	145	94	87	87

CT1:RUN004.001

123	88	80	125	100	93	113	88	158	160
147	149	110	64	107	139	186	191	116	66
54	118	113	156	118	62	141	91	72	148
63	88	95	80	108	44	76	172	149	101

RUN 5 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

253	149	127	108	75	93	102	295	160	85
46	89	84	78	208	119	212	142	248	139
177	153	93	174	437	359	174	185	97	104
139	106	164	228	103	180	115	125	188	191
231	177	285	102	97	115	270	91	60	119
*110	117	167	147	83	149	194	214	134	75

CT1:RUN005.001

85	151	101	41	153	155	330	406	103	65
139	69	101	149	145	135	85	148	110	119
163	88	60	50	39	82	126	117	88	

COMPOSITE PRIMARY RUNS 1-5
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

150	128	104	87	113	116	108	144	118	59
92	141	85	112	167	107	120	193	115	120
163	110	117	179	315	153	170	144	147	112
99	80	126	161	99	142	102	141	166	149
178	129	182	115	96	126	176	103	89	99
138	107	86	120	118	128	135	139	139	190
149	185	119	88	117	129	182	214	125	69
107	114	114	140	139	113	114	129	94	120
112	82	97	95	87	77	98	123	145	97
74									

TABLE 5-18 AVERAGE ERROR OVER ONE-TENTH MILE SEGMENTS OF RANDOM ROUTE RUNS 6-10

RUN 6 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

138	68	71	189	140	145	96	182	83	168
106	128	110	92	139	96	62	247	115	103
62	59	77	95	97	194	162	94	117	107
75	98	152	51	63	90	122	89	101	93
*125	115	181	80	103	119	121	158	85	109

CT1:RUN006.001

117	63	99	128	77	49	89	59	77	78
228	141	266	72	81	117	131	167	100	80
94	69	75	94	89	86	104	127	141	109
132	90	97	105	83	158	91	96	125	78
67									

RUN 7 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

92	71	76	134	82	132	103	136	102	110
110	115	80	105	84	214	73	199	75	106
113	74	69	51	103	160	171	45	108	85
*118	85	154	60	73	109	134	130	133	171

CT1:RUN007.001

134	81	185	65	144	114	132	160	98	106
77	135	135	90	163	59	86	132	68	83
77	107	165	312	65	98	93	157	101	119
175	88	72	93	84	171	122	112	57	48
123	129	236	121	125	56	154	52	95	129
105	83								

RUN 8 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

117	83	98	72	97	117	159	119	92	136
63	139	59	93	164	88	58	226	49	82
76	50	104	93	85	162	176	78	91	81
* 71	68	174	57	49	89	161	117	123	61

CT1:RUN008.001

106	126	123	91	113	85	101	161	146	59
85	147	142	171	121	54	125	150	78	116
73	205	63	466	75	72	77	94	84	106
51	133	77	77	94	158	77	94	237	129
157	102	89	82	218	81	109	42	67	145
77	124								

TABLE 5-18 AVERAGE ERROR OVER ONE-TENTH MILE SEGMENTS OF RANDOM ROUTE RUNS 6-10 (CONT'D)

RUN 9 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

67	83	85	116	116	158	124	101	94	122
65	83	90	99	149	84	73	154	138	104
77	76	70	80	107	184	165	60	119	86
55	108	146	108	50	117	110	110	100	92
*138	104	175	112	129	91	133	90	122	69

CT1:RUN009.001

112	108	98	135	77	67	180	85	108	107
156	119	276	86	91	135	119	156	80	152
119	131	103	79	109	132	99	97	162	101
110	142	67	163	96	82	72	94	131	73
71									

RUN 10 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

55	76	49	118	117	122	96	128	100	120
100	96	89	122	106	45	98	124	122	74
69	94	151	75	85	184	177	87	91	106
166	68	89	143	77	66	99	109	82	87
*119	166	90	133	160	103	141	117	182	176

CT1:RUN010.001

95	100	148	84	120	180	57	83	149	98

?ERR 61 ILLEGAL MEMORY REFERENCE
IN ROUTINE ".MAIN." LINE 40

COMPOSITE SECONDARY RUNS 6-10
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

94	76	76	126	110	134	115	133	94	131
89	112	86	102	128	105	73	190	100	94
79	71	94	79	95	177	170	73	105	93
97	85	143	84	62	94	125	111	108	101
124	118	151	96	130	102	126	137	127	104
97	110	124	122	112	82	107	102	96	96
134	143	193	234	78	106	105	144	91	114
110	105	82	86	94	137	101	108	149	97
131	116	122	118	131	94	107	71	105	106
80	104								

largest segment average was 315 feet and 234 feet respectively for the Primary and Secondary Routes respectively.

Processing with RRTEN began at Checkpoint 1 and ended at TA 64 on each run. The turnaround route around City Hall between TA 58 and TA 58 was not processed since this area was not within the designated random route area.

As noted in subsection 5.1 and 5.2, Run 10 could not be processed past Checkpoint 41. Whereas both checkpoints and pseudo checkpoints corresponding to the remainder of Run 10 were processed manually, no attempt was made to process the 2310 individual records manually as a supplement to RRTEN. HI^3 believes that the approximately 87,000 samples processed by RRTEN and the subsequent results were sufficient to warrant this decision.

5.4 RANDOM ROUTE DATA PROCESSING ANOMALIES

During the recording of random route data, a few manual entry errors were made. These errors were flagged through entry of the EE event and, in four cases, subsequently corrected via card input to the CPMAIN, RRSL and RRTEN programs. These errors are identified in Table 5-20.

As noted in Table 5-20, Run 10 could not be processed past CP 41. A listing of the data recorded during Run 10 is shown in Figure 5-13. The data recorded during the five records following Time 53:04 are erroneous. Note that the signpost codes are non-existent, the odometer has jumped over 2100 counts, the fifth wheel column contains data, and time is erratic. Since time is recorded via the CPU and is independent of the location subsystem and ICU, this indicates that this is a data recording problem and not a system problem. A more detailed discussion of this problem is contained in Subsection 8.3 in association with fixed route data.

TABLE 5-20 RANDOM ROUTE DATA PROCESSING ANOMALIES

RUN NO.	PROBLEM	SOLUTION
1	TA 63 entered two times following CP56	Deleted second entry of TA63 after CP56 via card input to RRSL and RRTEN
1	CP30 entered in error early	EE30 followed by correct entry of CP30
3	TA34 entered in error following CP17, should have been TA44	EE34 followed by TA44
3	Missed entry of CP18	Missed checkpoint
4	TA58 entered in error at beginning of tape	EE58 followed by TA64
5	TA64 entered too early at beginning of tape	EE64 followed by correct entry of TA64
7	TA64 entered twice	No effect
8	TA64 entered twice	No effect
9	CP64 entered in error for TA64	Replace CP64 with TA64 via card input
10	CP44 entered in error for TA44 following CP5	Replace CP44 with TA44 via card input
10	CP61 entered in error for TA61 following CP55	Replace CP61 with TA61 via card input
10	Couldn't process past checkpoint 41	Computed 21 checkpoint and 57 pseudo checkpoint manually

6. FIXED ROUTE TESTS

6.1 FIXED ROUTE TEST CONFIGURATION

The fixed route system configuration tested in Philadelphia consisted of (1) the test LS as proposed in the HI^3 Proposal, and (2) a Data Acquisition System (DAS). The LS tested in the fixed route tests was functionally identical to that proposed for Phase II, and such factors as deployment technique, signal-to-noise ratios, and signpost design are exactly those proposed for Phase II.

6.1.1 Test Vehicle

The test vehicle used during fixed route tests is the same vehicle described in paragraph 3.1.1.

6.1.2 Location Subsystem Equipment

In the fixed route configuration, the LS consisted of (1) signposts and (2) vehicle equipment functionally identical to that proposed for Phase II.

6.1.2.1 Signposts. The signposts used during the fixed route tests were identical to those described in paragraph 3.1.2.1 and used during the random route tests.

During fixed route tests, signposts were mounted on available utility poles or street and traffic light standards in such a manner that the HI^3 vehicle equipment was able to receive the coded transmissions from each signpost. Fifteen signposts were used, one near each timepoint. Thus, signposts were separated, on the average, by 4,900 feet.

6.1.2.2 Vehicle Equipment. In the fixed route configuration, HI^3 test LS vehicle equipment consisted of three items: (1) a 49.860-MHz antenna and coax cable, (2) a HI^3 vehicle unit, and (3) an odometer. For the Philadelphia tests, a standard, monopole (Antenna Specialist Model M303) tuned to 49.860 MHz was mounted on the roof of the test vehicle. The vehicle unit and antenna were the same as those used during random route tests and described in detail in paragraph 3.1.2.2.

During operation as a fixed route vehicle, the operation of the Phase II vehicle unit is identical to that of a Phase II random route vehicle unit in that all received signpost codes are received and processed to determine an 18-bit location region code. The only difference is that when a valid signpost Region 1 code is received onboard a Phase II vehicle operating in the fixed route mode, the vehicle unit would check to determine if this were the first occurrence of a Region 1 code from that signpost, and, if so, it would (1) automatically generate a signal that resets, to zero, an odometer counter, (2) store the 18-BIT location region code, and (3) check the two special signpost bits, E_7 and N_7, to determine the type of signpost used in the proposed Phase II system.

	North Field								East Field							
	N_7	N_6	N_5	N_4	N_3	N_2	N_1	N_0	E_7	E_6	E_5	E_4	E_3	E_2	E_1	E_0
Random Route	0	X	X	X	X	X	X	X	0	X	X	X	X	X	X	X
Timepoint	1	X	X	X	X	X	X	X	1	X	X	X	X	X	X	X

In this way, the vehicle unit always knows if timepoint performance is to be reported. The action then in each case is shown in the following table:

BIT PATTERN (N_7, E_7)	TYPE SIGNPOST	PHASE II VEHICLE LOGIC
0, 0	Random Route or Fixed Route	When Region 1 is first received: Store 18-BIT location region code Reset odometer When next polled, transmit 18-BIT location region code and odometer reading
1, 1	Timepoint	When Region 1 is first received: Store 18-BIT location region code When next polled transmit 18-BIT location region code and odometer reading Compute timepoint information and store When next polled, transmit 18-BIT location region code, odometer reading and timepoint information

The Phase II fixed route vehicle unit logic is shown in Figure 6-1. All signposts in the Phase I tests were coded with a (0, 0) in the (N_7, E_7) bits; therefore, the DAS was used to simulate the (1, 1) in the (N_7, E_7) bits for all fixed route runs. This simulation was effected by having the Data Processing Routine check all received signpost codes against a table of valid fixed-route signposts.

When fixed route test data were being recorded, the modifier block shown in Figure 3-11 was enabled so that R1 dropout (R1D) was recorded upon receipt of a not Level 1 signal after receipt of a Level 1 signal. In the ideal case, a vehicle passing in close proximity to a signpost would encounter a Level 1

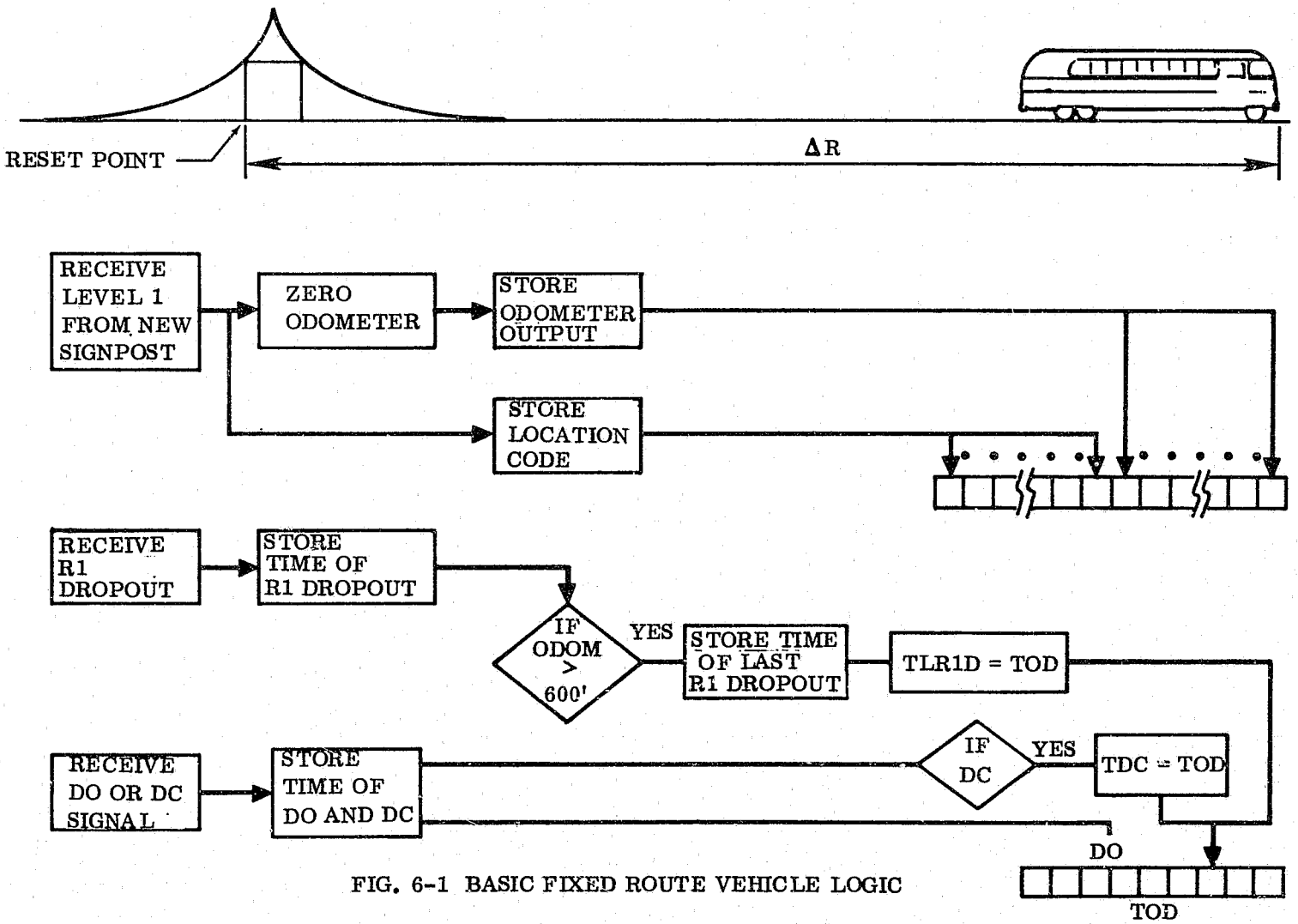


FIG. 6-1 BASIC FIXED ROUTE VEHICLE LOGIC

signal at the R1 radius as it approached the signpost and a not Level 1 signal just past the R1 radius on the far side of the signpost. In actual practice, the effects of local structures create nulls and dips in the signpost field pattern. In a few instances, these cause more than one R1D. However, the location of the R1 and the last R1D are extremely stable as can easily be shown from observation of the test data. Refer to Table 6-1 for R1 stability. The stability of the R1D location is evidenced in the results obtained for the timepoint performance subsequently presented in Section 8.

The LS vehicle unit drew its power directly from the test vehicle 12-volt system just as it would in the Phase II system. The vehicle unit was fuzed to prevent damage, and it included a built-in voltage fluctuation in the vehicle power system.

The contents of the ICU were sampled by the DAS. Those data constituted the "computed" vehicle location at the sample time (checkpoint or pseudo checkpoint). Under operational conditions, (Phase II), the contents of the vehicle unit location register and odometer would be encoded as part of the vehicle-to-base message and transmitted via the communications subsystem to the base station under base station computer control.

6.1.2.3 Odometer. In fixed route tests, an odometer was used to determine vehicle location between signposts. This instrument consisted of eight permanent magnets attached to the left front wheel and a magnetic pickup coil. The odometer senses revolutions of the front wheel through a magnetic pickup as the magnets pass across the pickup coil. The odometer was powered from the vehicle 12-volt DC power system. Pulses from the calibrated odometer were accumulated in the ICU and recorded on cassette through the interface shown in Figure 3-11.

6.1.3 DAS Equipment

The DAS hardware used during fixed route tests was identical to that used in random route tests. Only the functions of event marking, software, and in-vehicle displays were different. Only during the fixed route tests, a switch on the ICU enabled the modifier block (Figure 3-11) so that it could generate the 0011 code in the "B" field whenever an R1 dropout occurred.

6.1.3.1 Fixed Route Event Marking. The event codes described in paragraph 3.1.3.4 and the method of marking events were the same used for fixed route testing. During fixed route testing, the following events were "marked" to cause a time-coincident record of vehicle and DAS data to be recorded on cassette.

TABLE 6-1 EXPERIMENTAL DETERMINATION OF R(i)

		Distance From R1 to Next Timepoint :							
SP	TP	12-28-76 # 6	12-28-76 # 7	12-17-76 # 5	12-12-76 # 4	12-29-76 # 10	12-29-76 # 11	Average $\hat{R}(i)$	STD Deviation σ
7, 13	1	198	250	234	264	244	246	239	20.5
14, 6	2	326	324	316	342	364	354	338	17.2
15, 13	3	258	286	288	308	270	276	281	15.7
		1-11-77 # 1	1-11-77 #1	1-11-77 #2	1-11-77 #3				
12, 6	4	272	266	258	260			264	14.0
6, 8	5	268	288	282	282	310	290	287	10.6
6, 6	6	212	214	228	258	220	202	222	17.8
16, 13	7	220	256	-	-	228	230	234	13.5
12, 10	8	214	220	-	224	166	200	205	20.9
14, 8	9	262	256	276	314	244	320	279	28.6
15, 11	10	394	404	390	-	378	398	393	8.7
19, 13	11	326	324	304	326	318	322	320	10.6
16, 11	12	274	288	322	302	324	292	300	18.0
13, 13	13	276	292	274	348	264	300	292	27.6
8, 7	14	256	214	208	252	260	246	239	20.6
10, 6	15	208	268	210	206	-	260	230	27.6

Average STD Deviation : 18.1 feet

Function	Function Key	Event ID	Return
Mark Passage of Checkpoint XX	CP	XX	"
Mark Passage of Signpost NN, EE	SP	NN, EE	"
Mark Turn Intersection YY	TA	YY	"
Mark Departure from Timepoint XX	TD	XX	"
Signify Door Open at Timepoint XX	DO	XX	"
Signify Door Close at Timepoint XX	DC	XX	"
Signify Error in Preceding Event ZZ	EE	ZZ	"

The door open/close events and the departure times were recorded under the direction of the TSC Monitor.

6.1.3.2 Fixed Route Recording Software. The only basic difference between fixed and random route DAS recording software was that associated with generation of the in-vehicle displays and the number of records recorded on cassette No. 1. Computer program FROUTE was used to record Fixed Route Data.

6.1.3.3 In-Vehicle Displays. Three display formats were implemented for use in the test vehicle. These displays included (1) a "Quick-Look Verification Display", (2) a "Fixed Route Location Accuracy Summary Display," and (3) a "Timepoint Performance Display." Only the "Quick-Look Verification Display" was used during formal test runs.

a. Fixed Route Quick-Look Verification Display. Typical display format corresponding to Fixed Route Run #40 is shown in Figure 6-2. All event codes were manually entered via the CRT keyboard. Note the occurrence of R1 dropouts (R1D). The method in which the R1D is used in computing timepoint performance has been discussed in paragraph 6.1.2.2. The quick-look display allowed the DAS operator to verify operation of the LS and the DAS. The odometer reading was not actually reset in the vehicle during the Phase I tests, but during off-line processing. If used during Phase II, the odometer would be reset automatically.

b. Fixed Route Location Accuracy Summary Display. The Location Accuracy Summary Display was intended to provide a real-time estimate of location during test calibration. The display actually showed both computed and actual locations and the location error at each checkpoint. However, as a result of the fact that the PDP cassette operating system did not allow the use of floating point arithmetic, implementation of this process was too coarse in terms of computed error values to be of value. Therefore, it was not used.

c. Timepoint Performance Display. This display provided, in real time, the timepoint performance error including full implementation of the timepoint performance algorithm described in paragraph 7.2.3. This display was extensively used during HI^3 test and calibration runs to verify timepoint performance.

EVENT	NORTH	EAST	REGION		ODOMETER	5TH WHEEL	TIME
TA 001	00	00	R1		O 00004	F 00004	T 00 06
TA 002	00	00	R1		O 00073	F 00073	T 00 16
000	17	13	R1		O 00130	F 00128	T 00 23
000	17	13	R1	D	O 00135	F 00133	T 00 23
CP 001	17	13	R1		O 00139	F 00137	T 00 24
TD 001	17	13	R1		O 00215	F 00213	T 00 31
000	17	13	R1	D	O 00252	F 00249	T 00 35
000	17	13	R1		O 00256	F 00254	T 00 35
000	17	13	R1	D	O 00266	F 00263	T 00 36
000	17	13	R1		O 00271	F 00268	T 00 37
000	17	13	R1	D	O 00275	F 00272	T 00 37
000	17	13	R1		O 00280	F 00277	T 00 38
000	17	13	R1	D	O 00322	F 00319	T 00 42
000	17	13	R1		O 00327	F 00324	T 00 42
TA 003	17	13	R1		O 00472	F 00470	T 01 17
CP 002	17	13	R1		O 00763	F 00760	T 02 07
CP 003	17	13	R1		O 01140	F 01136	T 02 39
000	14	06	R1		O 01753	F 01746	T 04 22
000	14	06	R1	D	O 01765	F 01757	T 04 23
CP 004	14	06	R1		O 01771	F 01763	T 04 24
DD 002	14	06	R1		O 01870	F 01862	T 04 35
DC 002	14	06	R1		O 01870	F 01862	T 04 46
TD 002	14	06	R1		O 01901	F 01893	T 04 52
000	14	06	R1	D	O 01913	F 01905	T 04 54
^^ 004	14	06	R1		O 01915	F 01908	T 04 5[illegible]

FIG. 6-2 TYPICAL QUICK LOOK VERIFICATION DISPLAY

However, this display was called only one time during formal fixed route testing, and that time was as a demonstration for the TSC Monitor during Run 11, the first fixed route test run. Figure 6-3 contains a sketch of this display.

6.2 FIXED ROUTE LOCATION SUBSYSTEM DEPLOYMENT

6.2.1 Signpost Deployment

Fifteen signposts were installed along the test route near the timepoints designated by TSC. The test route and the fifteen timepoint locations were selected by TSC. The area was surveyed by HI^3 personnel, poles selected, and a pole agreement for the selected poles obtained from the City of Philadelphia. These 15 signposts, in conjunction with the odometer, allowed a determination of location to be made at any point along the selected test route. Upon completion of the random route tests, the 15 signposts were installed along the fixed route. All 15 were installed within less than two hours including driving time by HI^3 personnel.

Figure 6-4 reflects the test route, the signpost locations, and the signpost codes. Figure 6-5 contains photographs of all 15 fixed route signposts.

6.2.2 Fixed Route Mapping

Even though fixed route location can be determined as a computed location in terms of the elapsed odometer distance along a fixed route, HI^3 provided computed X, Y locations of the vehicle during data processing. This action necessitated the determination of X, Y coordinates for Region 1 reset points and measurement of offset coordinates for those checkpoints which were not at the centered intersections.

Determination of Region 1 Reset Points. For each fixed route signpost, a reset point (Ri) was determined experimentally. The reset point of a fixed route signpost is the average location, including effects of different traffic lanes, time of day, etc., at which the Region 1 boundary occurs when the signpost is approached along the fixed route. This value would be used in the base station computer in Phase II (in the data processing algorithm in Phase I) as a reference for the odometer, which would be reset to zero at each Region 1 reset point. The reset point and its relationship to the signpost and the odometer have been shown in Figure 6-1.

The reset location for each signpost was determined by repeatedly driving the test vehicle past the signpost, each time recording the distance between (1) the occurrence of the Region 1 and (2) the point of passage of the timepoint (the latter a known X, Y location). The Fixed Route Quick Look Verification Display was used to accumulate a number of such recordings with the test vehicle traveling in all possible lanes and at different speeds. From each set of values, a value of Ri was selected for the i^{th} fixed route signpost for use during off-line processing as part of the permanent data base.

Timepoint	Estimated TOD	Actual TOD	Error	Door
1	0:58.5	0:57.0	1.5	
2	5:33.0	5:31.0	2.0	
3	13:23.5	13:27.5	-4.0	Yes
4	20:00.5	20:12.5	-12.0	Yes
5	31:15.0	31:42.5	-27.5	Yes
6	35:37.5	35:45.5	-8.0	Yes
7	41:29.0	41:28.5	0.5	
8	48:51.0	48:56.5	-5.5	Yes
9	56:43.5	56:45.5	-2.0	
10	66:32.0	66:34.5	-2.5	Yes
11	71:23.5	71:26.0	-2.5	Yes
12	75:37.0	75:37.5	-0.5	
13	85:20.5	85:29.0	-4.0	Yes
14	90:38.0	90:40.0	-2.0	
15	99:38.5	99:38.5	0.0	

FIG. 6-3 TIMEPOINT PERFORMANCE DISPLAY

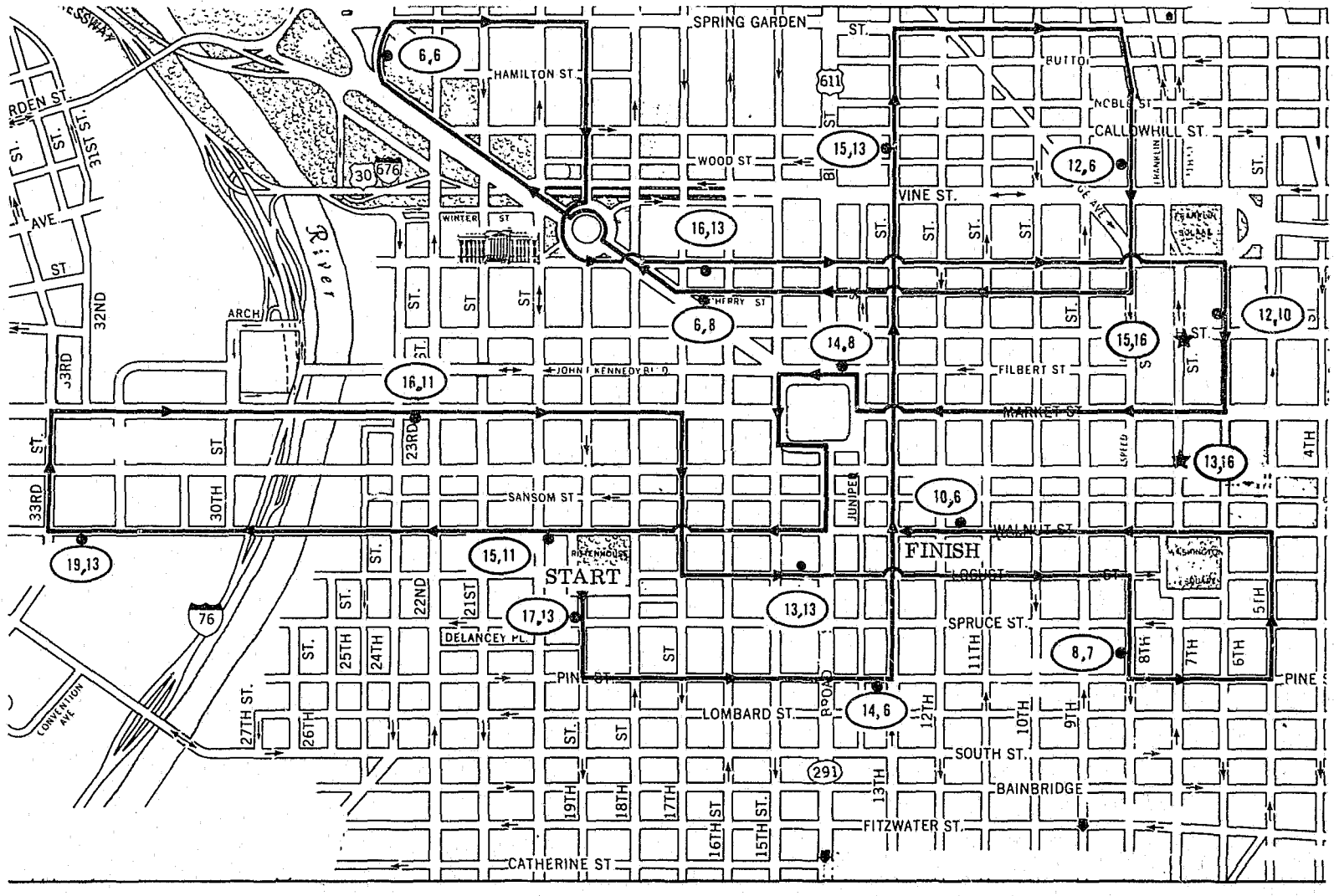


FIG. 6-4 HI[3] FIXED ROUTE & FIXED ROUTE SIGNPOSTS

Table 6-1 contains the results of these calibration runs. In each case, at least four passes by each signpost were made, and the FROUTE Program was used to record the odometer values at which the Region 1 was received and upon the occurrence of the event marking the passage of the timepoint. The X, Y location of the Ri point was computed as an offset from the timepoint location, which was known in terms of stateplane coordinates. The radius at signpost "i" was the average, Ri, presented in Table 6-1 and computed on the basis of the four or more passes. The small variance in Ri at each signpost, as well as the small average variance (18.1 feet for all 15 signposts), is significant in that it represents the stability of the Region 1 radius of HI[3] signposts. Once the offset distance was established, the stateplane coordinates of the Ri points were computed by using the following pair of equations:

$$X'(Ri) = X'(TPi) + X \cos 7.3^{o} + Y \sin 7.3^{o}$$

$$Y'(Ri) = Y'(TPi) + Y \cos 7.3^{o} + X \sin 7.3^{o}$$

where X and Y are the street offset coordinates of the Ri point relative to the timepoint; X' (TPi), Y' (TPi) are the stateplane coordinates of the i^{th} timepoint and 7.3^{o} is the angle between the stateplane coordinate system and the nominally North-South and East-West oriented streets in downtown Philadelphia. The location of each fixed route timepoint and the associated Ri are identified in Table 6-2.

Determination of ΔT_L. This parameter is used during off-line processing (and in the Phase II base station) to compute the time of departure whenever the vehicle door is not opened and closed at a transit timepoint. ΔT_L is defined in association with Figure 6-6. During off-line data processing, the time of departure, TOD, is computed as follows:

Door Opens/Closes	TOD Set Equal to --
Yes	Time Door Closes (TDC)
No	TLR1D - ΔT_L

where TLR1D is the time of occurrence of the last R1 dropout from the signposts (the last time the "B" field is set to 0011 at the signpost code).

Values of ΔT_L were determined experimentally by repeatedly measuring the times of TD and TLR1D under typical traffic conditions. Table 6-3 contains experimental data taken to determine the values of ΔT_L for use in computing the time of departure. These data were obtained by driving the test vehicle past each timepoint while using FROUTE to record all data, including marking the passage of the timepoint NN with a TD(NN) event. For each timepoint, the average difference between occurrence of the last R1 dropout (TLR1D) and the TD marker

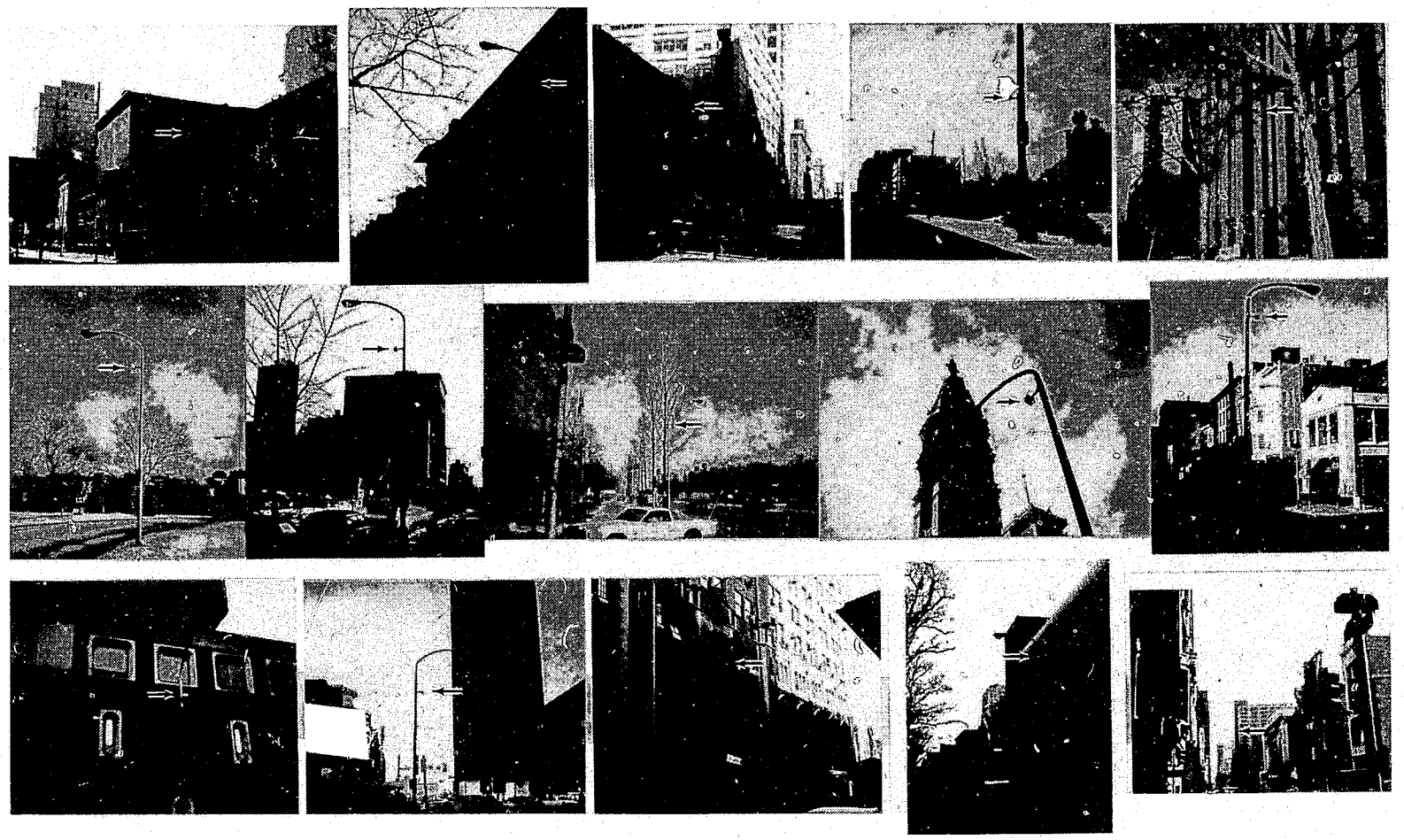
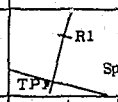
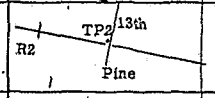
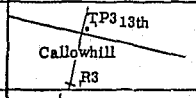
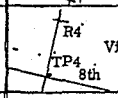
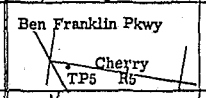
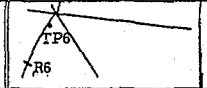
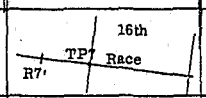
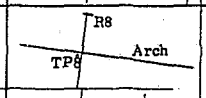
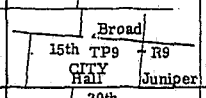
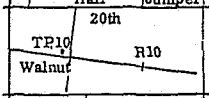
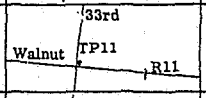
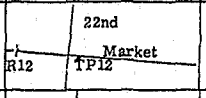
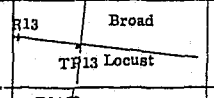
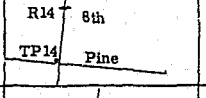
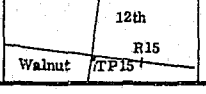


FIG. 6-5 FIXED ROUTE SIGNPOSTS

CONTINUED

2 OF 8

TABLE 6-2 FIXED ROUTE TIME POINTS AND Ri RESET POINTS

TIMEPOINT	GEOMETRY OF Ri RELATION TO TIMEPOINT	Ri DISTANCE TO TIMEPOINT	STATE PLANE COORDINATES OF TIMEPOINT	OFFSET IN FT. TO TP	CORRECTED STATE PLANE COORDINATES OF R
#1		Y = 239	X = 2722388 Y = 234383	$\Delta X' = 30$ $\Delta Y' = 237$	$X' = 2722418$ $Y' = 234620$
#2		X = -338	X = 2725180 Y = 233508	$\Delta X' = -335$ $\Delta Y' = 43$	$X' = 2724845$ $Y' = 233551$
#3		Y = -281	X = 2725921 Y = 238663	$\Delta X' = -36$ $\Delta Y' = -279$	$X' = 2725885$ $Y' = 238384$
#4		Y = 264	X = 2728078 Y = 237808.3	$\Delta X' = 33$ $\Delta Y' = 262$	$X' = 2728111$ $Y' = 238070$
#5		X = 287	X = 2723857 Y = 237304.9	$\Delta X' = 285$ $\Delta Y' = -36$	$X' = 2724142$ $Y' = 237269$
#6		R = 222'	X = 2721134 Y = 240231	$\Delta X = -71'$ $\Delta Y = -131'$	$X' = 2721063$ $Y' = 240100$
#7		X = -234	X = 2724216 Y = 237591.6	$\Delta X' = -232$ $\Delta Y' = 30$	$X' = 2723984$ $Y' = 237622$
#8		Y = 205	X = 2728698 Y = 23631.2	$\Delta X' = 26$ $\Delta Y' = 203$	$X' = 2728724$ $Y' = 236517$
#9		R = 279'	X = 2725101 Y = 236454.3	$\Delta X' = 168$ $\Delta Y' = -183$	$X' = 2725269$ $Y' = 236271$
#10		X = +393'	X = 2721955 Y = 235324.0	$\Delta X' = 390'$ $\Delta Y' = -50$	$X' = 2722345$ $Y' = 235274$
#11		X = +320'	X = 2717519 Y = 235944	$\Delta X' = 317$ $\Delta Y' = -41$	$X' = 2717836$ $Y' = 235903$
#12		X = -300	X = 2721257 Y = 236561.2	$\Delta X' = -297$ $\Delta Y' = 38$	$X' = 2720960$ $Y' = 236599$
#13		X = -292	X = 2724675 Y = 234527	$\Delta X' = -290$ $\Delta Y' = 37$	$X' = 2724385$ $Y' = 234564$
#14		X = +239'	X = 2727418 Y = 233227	$\Delta X' = 30$ $\Delta Y' = 237$	$X' = 2727448$ $Y' = 233464$
#15		X = +230	X = 2725844 Y = 234799	$\Delta X' = 228$ $\Delta Y' = -29$	$X' = 2726072$ $Y' = 234770$

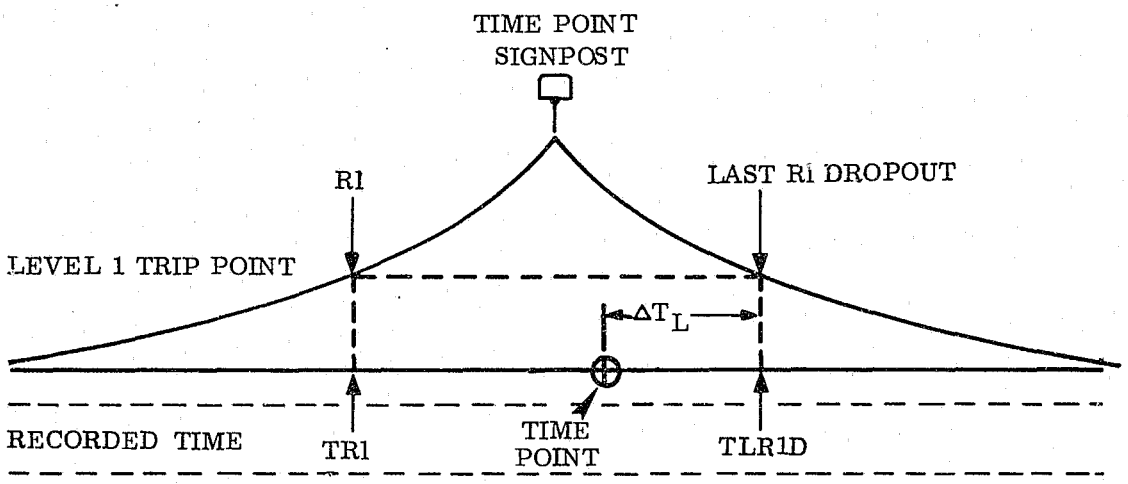


FIG. 6-6 HI^3 TIMEPOINT PARAMETERS

TABLE 6-3 EXPERIMENTAL DETERMINATION OF ΔT_L

TIME POINT NUMBER	Run No. and Date					AVERAGE TIME	SELECTED VALUE OF ΔT_L
	RUN # 5 12-12-76	RUN # 6 12-28-76	RUN # 7 12=28-76	RUN # 10 12-29-76	RUN # 11 12-29-76		
	Time in Seconds						
1	9	-	4	9	6	7	7
2	5	8	7	8	7	7	7
3	6	8	6	8	9	7.4	7
4	Run # 1 1-11-77	8	Run # 5 1-11-77	3	Run # 6 1-11-77 5	5.3	5
5	5	5	6	6	8	6	6
6	1	0	6	-1	2	1.6	2
7	-	-1	-	-3	-3	-2.3	-2
8	-	1	1	3	3	2	2
9	11	10	10	7	8	9.2	9
10	3	7	-	5	4	4.8	5
11	4	3	-	4	8	4.8	5
12	0	1	1	0	1	0.6	1
13	3	1	1	0	1	1.2	1
14	8	1	5	8	4	5.2	5
15	5	3	4	-	6	4.5	5

was taken as the value of ΔT_L to be used in the data processing program. These values became the timepoint data base, TPDELT.

6.2.3 Timepoint Location and Marking

Timepoint locations were selected by TSC. Specific landmarks, i.e., signs, street lights, etc. which served as timepoints were selected by HI^3 and approved by TSC. The landmarks selected as timepoints are identified in Table 6-4.

6.2.4 Location Subsystem Calibration

Calibration of the LS for the fixed route test involved (1) the establishing of the vehicle unit Level 1 threshold, (2) the calibrating of the fifth wheel against a measured distance, (3) the calibration of the odometer against a measured distance, and (4) the use of the vehicle unit and DAS to determine the values of the Region 1 boundaries and ΔT_L for each timepoint for use in the data base. On the day of each formal test run, only the calibration of the vehicle unit Level 1 threshold and the fifth wheel and odometer had to be verified. Calibration of the items was accomplished in the same manner as that primarily described in paragraph 3.2.2 for random route tests. The fifth wheel was calibrated in exactly the same manner as the odometer. Except in those instances in which snow and ice caused an accumulation of the fifth wheel, the odometer and fifth wheel were calibrated to within 1 foot in 1000 feet on the calibration run.

6.3 FIXED ROUTE DATA ACQUISITION

Fixed route test data were recorded on cassettes during Runs 11 through 43. The sequence of events depicted in Figure 3-17 was utilized during data acquisition and handling. Header data were recorded on each cassette pair under the control of program FROUTE just prior to commencing a test run. A data log sheet was filled out for each run and signed by the HI^3 Test Director and the TSC Monitor. Figure 6-7 contains a typical fixed route data log. Copies of all log sheets are contained in the Appendix. At the conclusion of the 33 fixed route test runs, all cassettes were duplicated onto magnetic tapes for use at MITRE. Since HI^3 data processing software was not checked out and running at MITRE, all cassettes were retained by the TSC Monitor until February, 1977, when software checkout was completed at MITRE.

Checkpoint, Door Open, Door Close, Timepoint, and Turn Event were manually entered at designated locations during each run. Locations of fixed route checkpoints, turns, and timepoints are shown in Figure 6-8. The following entries were required for a typical run.

1. Timepoint (TD's) ---------- 15

2. Door Open ---------- 7-8

TABLE 6-4 HI[3] TIMEPOINTS

TP Number	Identification/Landmarks
1	Traffic light on S.W. corner 19th & Spruce
2	Traffic Light on N.W. corner of 13th & Pine
3	Traffic Light on N.E. corner of 13th & Callowhill
4	Street Light on N.E. corner of 8th & Vine
5	Last ornamental Street Light Pole on Cherry at S.E. Corner of Cherry and Ben Franklin Parkway
6	Street light on Crescent at S.E. corner of Crescent and Spring Garden
7	Center of 16th & Race
8	Street light on S.W. corner of 6th & Arch
9	No Parking Sign on north side of JFK Blvd. at N.E. corner of Broad & JFK
10	SEPTA STOP (sign) at N.W, corner of 20th & Walnut
11	Street Light at N.E. corner of 33rd and Walnut
12	SEPTA STOP (sign) at S.E. Corner of 22nd and Market
13	Street Light at S.W. corner of Broad and Locust
14	SEPTA STOP (sign) at N.W. corner of 8th & Pine
15	Street Light at S.E. corner of 12th & Walnut

START 1015
END 1145

TEST DATA LOG

TEST RUN NO. 39 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-17-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

DOOR CLOSED AT
TP 2
TP 3
TP 4
TP 5
TP 6
TP 8
TP 11
TP 13

1. Overnight temperatures (eight spots) were 0°F with wind chill factor -42°F.

2. Entered CP#27 at 20th St. in error (should have been prior to 19th). Entered EE27 and then entered CP#27 at correct location

4. Received overlays from 13,16 and 15,16 at 7th and Market as off-route declaration.
13,16 at 7th and Nanatenel
15,16 at 7th and Filbert.

5. Entered CP 58 ≈ 50 feet late

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE 0° PRECIPITATION: NONE ROAD CONDITIONS: ICE AND SLUSH

TEST TAPE NO(S). 39-1 and 39-2 FILE NO.

SAMPLE RATE: 0.5 TEST DIRECTOR George W. Young

RUN TIME: 1HR - 30 MIN TSC MONITOR Bernard A. Keller

DISTANCE: Odometer 13mi 220
5th wheel 12mi 5125

FIG. 6-7 HI³ FIXED ROUTE TEST DATA LOG

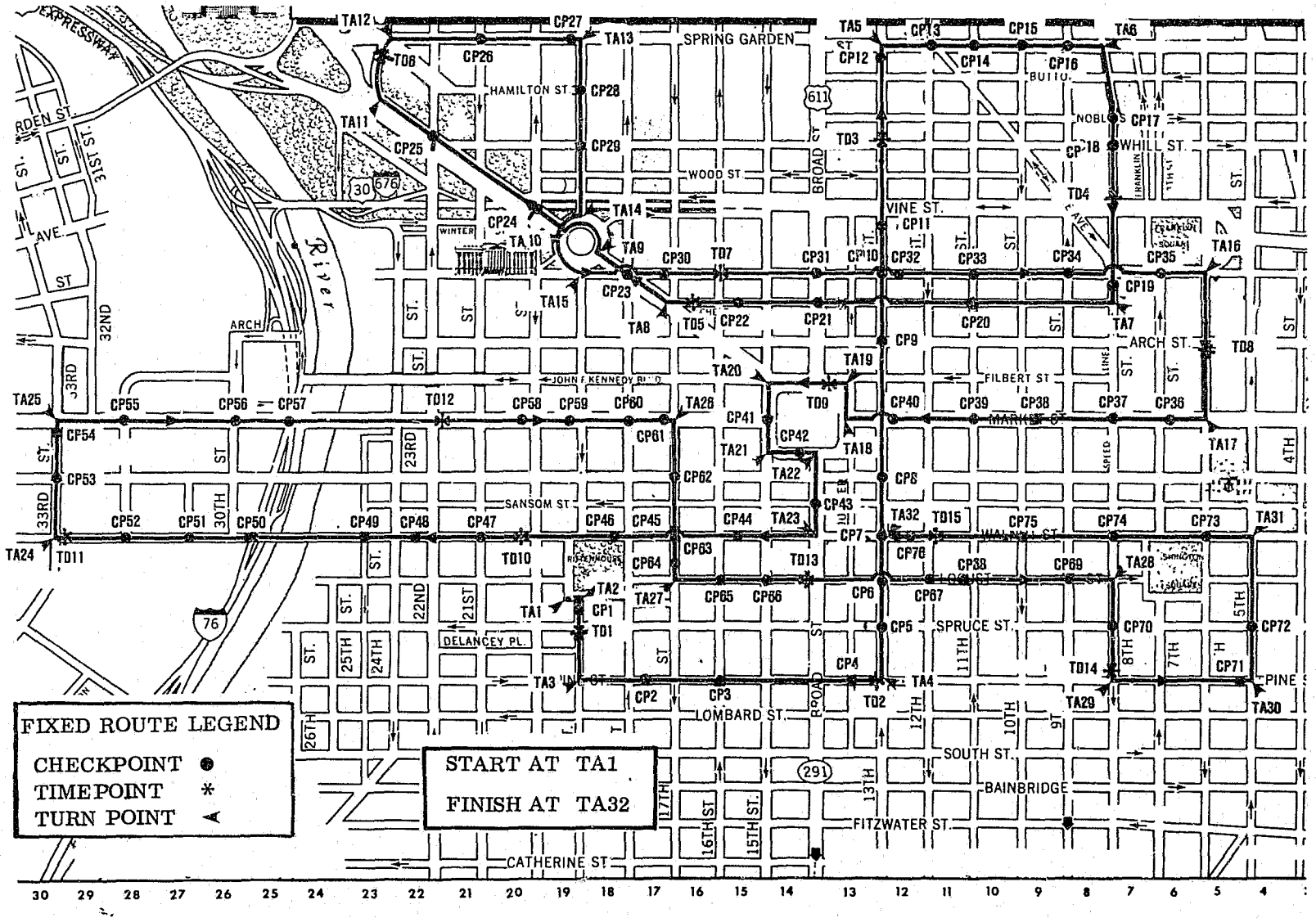


FIG. 6-8 FIXED ROUTE EVENT MARKERS

3. Door Close (DC's) ---------- 7-8

4. Checkpoints (CP's) --------- 76

5. Turnpoints (TA's) ---------- 32

Total ---------- 139 Events per run.

Entry of these 139 events involved the use of approximately 521 separate keystroking entries during each run for a total of over 17,000 separate keyboard entries during the fixed route test program. As a result of manual entry errors (wrong event or event at wrong time), the Error Event (EE) was used 22 times during the 33 runs. In conjunction with these errors, Table 6-5 contains a list of the anomalies which occurred during manual data entry. The card input corrections required for data processing are also included. Note that in cases in which a TD or a CP were missed, these entries were simply not processed, no attempt being made to insert these entries into the data. However, since the TA's are necessary for pseudo checkpoint computation of the reference location of the vehicle, these were inserted at the approximate location of the associated turn.

After each test, the fixed route cassette run was dumped in the test vehicle, by using program FRUMP. During this process it was found that Runs 19 and 33 could not be dumped. It was subsequently found by reference to the printer output during the FROUTE loading cycle that the Test Director failed to zero the Run 33 cassettes prior to beginning the run. Run 20 could not be dumped past checkpoint 46, as a result of an auxiliary generator failure at that point. Because of these problems and loss of a magnet from the fifth wheel during Run 32, three additional fixed route runs were made in order to assure an adequate number of timepoint samples.

Formal fixed route test procedures involved the following procedures. After loading the fixed route data recording program FROUTE, the test vehicle driver proceeded to traverse the specified route. Coincident with passage of each designated checkpoint, turn, and timepoint, a coded event marker, CP(NN), TA(XX), or TD(YY), respectively, and a time coincident data record were recorded on cassette. As a checkpoint, turn, or timepoint was approached, the driver informed the DAS operator to prepare for event NN. The DAS operator pressed first the appropriate event function key and then keystroked the number NN. He then prepared to depress the "RETURN" key. As the test vehicle approached the event, the driver called out "standby" and then, as the front bumper of the test vehicle passed the designated event he called out "MARK." Upon hearing this MARK, the DAS operator depressed the RETURN key and thus caused a data record and the event number to be recorded on cassette. Door Open (DO) and Door Close (DC) events were similarly recorded. The fixed route test procedures are shown in Figure 6-9. Automatic switch-over from cassette No. 1 to cassette No. 2 occurred at the end of 60 minutes of recording when program FROUTE was used.

TABLE 6-5 FIXED ROUTE MANUAL DATA ENTRY ANOMALIES

RUN NO.	ANOMALIE	ACTION REQUIRED TO PROCESS DATA
14	Missed TA16	Card Input of TA16 at proper location
16	Missed TA24	Card Input of TA24 at proper location
17	Missed TD11	None Required
18	Missed CP43	None Required
20	Missed CP37	None Required
21	Missed CP6	None Required
22	Missed CP11	None Required
26	Missed TD15	None Required
27	Missed CP48	None Required
27	Missed TA10	Card Input of TA10 at proper location
27	Entered TD10 in error	Card Input of Delete TD10
30	Entered DC13 for DC11	None Required
31	Missed TA10	Card Input of TA10 at proper location
32	Entered TD13 for DO13	Card Input of DO13 for first TD13
33	Couldn't enter DO10 and noted that cassette was not turning during 10-30 second period	None Required
34	Missed CP40 and 54	
34	DO2, DC2, and TD2 entered 1 block early	Deleted with EE events
40	Entered CP40 twice	Card Input to Delete first occurrence
37	Entered DC7 in Error	Card Input to Delete first DC7

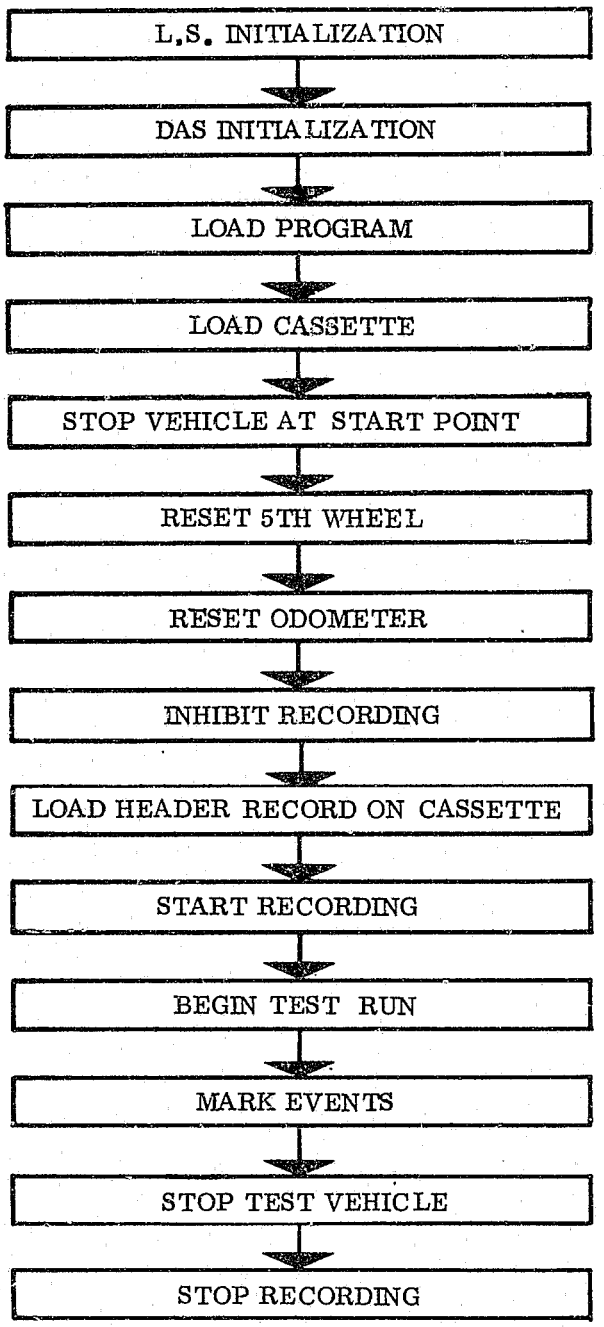


FIG. 6-9 FIXED ROUTE TEST PROCEDURE

No adjustments were made in the LS during a test run. However, minor adjustments of the fifth wheel were required twice during the fixed route test program. A log of all such adjustments was made a part of the test results and is summarized in Table 6-6. All data recorded were retained and processed. No data were eliminated as poor or potentially poor.

Twenty four hours prior to the scheduled commencement of the first fixed route test run and 24 hours after receipt of the fixed route checkpoint locations, HI[3] informed the TSC Monitor that the test was "go." Run 11 began at 1310 on 13 January 1977. The final test run, Run 43 ended at 2140 on 17 January 1977. The average run time was 1 hour and 23 minutes. Thus, nearly 46 hours of formal test runs were completed during a 104 hour period. Snow began falling during Run No. 18. All subsequent test runs encountered slick slushy streets, snow, sleet, or freezing rain and temperatures as low as 8°F and as high as 38°F.

The TSC Monitor was in the test vehicle during all fixed route test runs.

6.4 FIXED ROUTE TEST DATA

Fixed route test data were recorded every 0.5 seconds during the test runs. Except as noted in subsection 6.3, all data were listed by using program FRUMP to certify that the data were recorded on the cassettes. As in the case of random route data, only "change" data and event data records were dumped or listed. Copies of these listings are provided in the Appendix. As an example, Table 6-7 contains a listing of typical fixed route test data dump corresponding to Run 27. Note the occurrence of TA's, CP's, TD's, DO's, DC's, and signpost codes. With regard to the signpost codes, only the R1 and R1D codes were significant. For example, the fact that the R3N code occurs after CP 7 is a result of overlap between signposts (14,06) and (10,06). Although all signpost data were recorded, the occurrence of overlap regions had no effect on the fixed route tests since only the R1 and R1D were used during data processing.

Note that the R1D record is followed by an R1 record. This combination results from the fact that the last valid location code is always stored in the vehicle. The R1D code is a special code used only for fixed route vehicles and is not a location region code per se. As soon as the R1D code is sampled by the computer, the ICU clears the 0011 code from the "B" field, and since the resulting 0000 code corresponds to the Region 1, this location code is automatically recorded as the subsequent sample.

As previously discussed in paragraph 6.1.3.1, more than one R1D may occur, particularly if the test vehicle should stop near a Region 1 boundary. However, the timepoint performance algorithm used during Phase I (and proposed for use during Phase II) has been designed to use only the last R1D occurring for each timepoint signpost.

TABLE 6-6 ADJUSTMENTS REQUIRED TO DAS DURING FIXED ROUTE TESTS

Run #	Problem	Required Action
20	Auxiliary Generator Stalled after CP#46	Repaired automatic choke. Required approximately 5 minutes to wire choke open
32	Lost magnet from 5th Wheel 36 minutes into Run due to heavy ice on streets	Replaced magnet with spare magnet. Required 20 minutes to replace.
26	Connector to 5th Wheel sensor filled with water due to melting ice and water thrown up from fifth wheel	Dried out connector and sealed with tape.

TABLE 6-7 TYPICAL FIXED ROUTE DATA LISTING

```
-> PRMP.LBR
.ST 14156                                          1/18/77  B. Klein

RUN 027  SAMPLE RATE 00.5  YEAR 77  MONTH 01  DAY 15  HOUR 12  MIN 10

FIFTH WHEEL FEET/PULSE  0002    ODOMETER FEET/PULSE  0002
```

TR	001	00	00	R1		D	00004	F	00004	T	00	13		000	14	00	R1		D	02974	F	02996	T	17	22
TR	002	00	00	R1		D	00074	F	00075	T	00	23		000	14	00	R1	D	D	02990	F	02912	T	17	35
	000	17	13	R1		D	00114	F	00112	T	00	29		000	14	00	R1		D	02992	F	02914	T	17	35
	000	17	13	R1	D	D	00119	F	00117	T	00	29		000	14	00	R1	D	D	02999	F	02922	T	17	37
	000	17	13	R1		D	00124	F	00122	T	00	29		000	14	00	R1		D	03003	F	02926	T	17	33
SP	001	17	13	R1		D	00134	F	00132	T	00	30	TR	019	14	00	R1		D	03005	F	02957	T	17	42
TR	001	17	13	R1		D	00213	F	00215	T	00	37		000	14	00	R1	D	D	03018	F	02971	T	17	44
	000	17	13	R1	D	D	00255	F	00253	T	00	40		000	14	00	R1		D	03051	F	02974	T	17	44
	000	17	13	R1		D	00261	F	00259	T	00	40	DD	009	14	00	R1		D	03103	F	03027	T	17	52
	000	17	13	R1	D	D	00274	F	00271	T	00	41	DD	009	14	00	R1		D	03105	F	03029	T	17	52
	000	17	13	R1		D	00280	F	00277	T	00	42	TR	009	14	00	R1		D	03122	F	03046	T	18	00
	000	17	13	R1	D	D	00325	F	00323	T	00	45		000	14	00	R1	D	D	03137	F	03062	T	18	05
	000	17	13	R1		D	00332	F	00331	T	00	46		000	14	00	R1		D	03142	F	03067	T	18	05
TR	003	17	13	R1		D	00471	F	00470	T	01	23		000	14	00	R1	D	D	03193	F	03109	T	18	09
SP	002	17	13	R1		D	00755	F	00756	T	02	03		000	14	00	R1		D	03199	F	03115	T	18	09
SP	003	17	13	R1		D	01139	F	01139	T	02	33	TR	020	14	00	R1		D	03373	F	03303	T	18	28
	000	14	05	R1		D	01751	F	01753	T	04	35	SP	041	14	00	R1		D	03531	F	03452	T	19	12
SP	004	14	05	R1	D	D	01757	F	01756	T	04	35	TR	021	14	00	R1		D	03552	F	03539	T	19	27
	000	14	05	R1		D	01773	F	01772	T	04	37	SP	042	14	00	R1		D	03737	F	03717	T	19	39
DD	002	14	05	R1		D	01959	F	01953	T	04	43	TR	022	14	00	R1		D	03953	F	03795	T	19	47
DD	002	14	05	R1		D	01970	F	01970	T	04	51	SP	043	14	00	R1		D	04031	F	03951	T	19	57
TR	002	14	05	R1		D	01894	F	01894	T	04	55	TR	023	14	00	R1		D	04173	F	04195	T	20	05
	000	14	05	R1	D	D	01910	F	01913	T	04	59	SP	044	14	00	R1		D	09505	F	04528	T	21	13
TR	004	14	05	R1		D	01913	F	01913	T	04	59	SP	045	14	00	R1		D	09842	F	04954	T	21	12
	000	14	05	R1	D	D	01930	F	01931	T	05	02	SP	046	14	00	R1		D	01127	F	05149	T	21	15
	000	14	05	R1		D	01933	F	01931	T	05	03		000	15	11	R1		D	01335	F	05195	T	21	05
SP	005	14	05	R1		D	02159	F	02150	T	05	25		000	15	11	R1	D	D	01497	F	05123	T	21	07
SP	006	14	05	R1		D	02337	F	02333	T	05	39		000	15	11	R1		D	01115	F	05135	T	21	07
SP	007	14	05	R1		D	02595	F	02596	T	07	05		000	15	11	R1	D	D	01516	F	05557	T	21	13
	000	10	05	R3	N	D	02502	F	02502	T	07	35		000	15	11	R1		D	01559	F	05572	T	21	13
SP	008	10	05	R3	N	D	02332	F	02331	T	09	05	DD	010	15	11	R1		D	01572	F	05593	T	21	23
SP	009	10	05	R3	N	D	03535	F	03533	T	09	37	DD	010	15	11	R1		D	01572	F	05593	T	21	35
SP	010	10	05	R3	N	D	03380	F	03377	T	10	03		000	15	11	R1	D	D	01574	F	05595	T	21	37
SP	011	10	05	R3	N	D	00035	F	04999	T	10	23		000	15	11	R1		D	01576	F	05597	T	21	33
	000	15	13	R1		D	03279	F	04370	T	10	50	TR	010	15	11	R1		D	01593	F	05598	T	21	39
TR	003	15	13	R1		D	03115	F	04597	T	11	14		000	15	11	R1	D	D	01615	F	05637	T	21	43
	000	15	13	R1	D	D	03117	F	04599	T	11	05		000	15	11	R1		D	01622	F	05643	T	21	44
	000	15	13	R1		D	03153	F	04644	T	11	37	SP	047	15	11	R1		D	01799	F	05912	T	21	14
	000	15	13	R1	D	D	03505	F	04595	T	11	10	SP	048	15	11	R1		D	02199	F	06131	T	21	43
	000	15	13	R1		D	03513	F	04604	T	11	11	SP	049	15	11	R1		D	02158	F	06190	T	21	49
	000	14	13	R3	N	D	03592	F	04734	T	11	23	SP	049	15	11	R1		D	02229	F	06352	T	21	00
SP	012	14	13	R3	N	D	03821	F	04912	T	11	33	SP	050	15	11	R1		D	02315	F	06333	T	21	10
TR	005	14	13	R3	N	D	03993	F	04993	T	11	51	SP	051	15	11	R1		D	03193	F	07213	T	21	05
SP	013	14	13	R3	N	D	01113	F	05201	T	12	20	SP	052	15	11	R1		D	03513	F	07535	T	21	27
SP	014	14	13	R3	N	D	01332	F	05119	T	12	13		000	19	13	R1		D	03515	F	07571	T	21	30
SP	015	14	13	R3	N	D	01554	F	05551	T	13	07	DD	011	19	13	R1		D	03795	F	07320	T	21	03
SP	016	14	13	R3	N	D	01795	F	05573	T	13	25	DD	011	19	13	R1		D	03990	F	07335	T	21	13
TR	006	14	13	R3	N	D	01951	F	05039	T	13	39		000	19	13	R1	D	D	03302	F	07323	T	21	13
SP	017	14	13	R3	N	D	02150	F	05543	T	14	13		000	19	13	R1		D	03903	F	07329	T	21	14
SP	018	14	13	R3	N	D	02311	F	05593	T	14	32	TD	011	19	13	R1		D	03313	F	07339	T	21	15
	000	12	05	R1		D	02542	F	05725	T	14	33	TR	024	19	13	R1		D	03331	F	07355	T	21	19
DD	004	12	05	R1		D	02758	F	05942	T	14	49		000	19	13	R1	D	D	03310	F	07353	T	21	29
DD	004	12	05	R1		D	02758	F	05942	T	15	05		000	19	13	R1		D	03314	F	07353	T	21	20
TD	004	12	05	R1		D	02779	F	05961	T	15	15	SP	053	19	13	R1		D	00003	F	03123	T	21	13
	000	12	05	R1	D	D	02313	F	05997	T	15	19	SP	054	19	13	R1		D	00252	F	03371	T	21	02
	000	12	05	R1		D	02320	F	05993	T	15	19	TR	025	19	13	R1		D	00273	F	03331	T	21	05
SP	019	12	05	R1		D	03227	F	07311	T	16	03	SP	055	19	13	R1		D	00502	F	03719	T	21	01
TR	007	12	05	R1		D	03307	F	07339	T	16	12	SP	056	19	13	R1		D	01125	F	09243	T	21	25
SP	020	12	05	R1		D	03976	F	03041	T	17	41	SP	057	19	13	R1		D	01403	F	09522	T	21	19
SP	021	12	05	R1		D	09532	F	09793	T	20	03		000	15	11	R1		D	01959	F	10079	T	20	31
SP	022	12	05	R1		D	01922	F	09159	T	21	55		000	15	11	R1	D	D	01953	F	10093	T	20	35
	000	05	03	R1		D	01103	F	09249	T	22	19		000	15	11	R1		D	01957	F	10097	T	20	35
TD	005	14	03	R1		D	01249	F	09377	T	23	00	DD	012	15	11	R1		D	02109	F	10229	T	20	19
	000	05	03	R1	D	D	01297	F	09424	T	23	01		000	15	11	R1	D	D	02113	F	10235	T	20	51
	000	05	03	R1		D	01303	F	09430	T	23	05		000	15	11	R1		D	02115	F	10233	T	20	51
TR	008	05	03	R1		D	01323	F	09450	T	23	07		000	15	11	R1	D	D	02116	F	10235	T	20	59
SP	023	05	03	R1		D	01595	F	09722	T	23	24		000	15	11	R1		D	02115	F	10235	T	21	09
TR	009	05	03	R1		D	01729	F	09854	T	23	33	DD	012	15	11	R1		D	02115	F	10235	T	21	01
TD	010	05	03	R1		D	02053	F	10180	T	24	05		000	15	11	R1	D	D	02117	F	10237	T	21	02
SP	024	05	03	R1		D	02206	F	10332	T	25	03		000	15	11	R1		D	02118	F	10239	T	21	03
SP	025	05	03	R1		D	02822	F	10943	T	25	15	TD	012	15	11	R1		D	02120	F	10240	T	21	03
	000	05	05	R3	E	D	03213	F	11343	T	25	39	SP	058	15	11	R1		D	03551	F	10573	T	21	33
TR	011	05	05	R3	E	D	03245	F	11370	T	25	11	SP	059	15	11	R1		D	03755	F	10577	T	22	31
	000	05	05	R1		D	03329	F	11453	T	25	13	SP	050	15	11	R1		D	03041	F	11152	T	23	01
TD	035	05	05	R1		D	03134	F	11547	T	25	27	SP	051	15	11	R1		D	03211	F	11331	T	23	17
	000	05	05	R1	D	D	03134	F	11557	T	25	29	TR	026	15	11	R1		D	03269	F	11339	T	23	25
	000	05	05	R1		D	03435	F	11559	T	25	29	SP	052	15	11	R1		D	03535	F	11555	T	24	17
DD	035	05	05	R1		D	03150	F	11573	T	25	39	SP	053	15	11	R1		D	03315	F	11935	T	24	13
DC	035	05	05	R1		D	03150	F	11573	T	25	41	SP	054	15	11	R1		D	03951	F	12030	T	24	57
TR	012	05	05	R1		D	03135	F	11509	T	25	51	TR	027	15	11	R1		D	04027	F	12147	T	25	17
SP	026	05	05	R1		D	03310	F	12052	T	27	35	SP	055	15	11	R1		D	09141	F	12353	T	25	09
SP	027	05	05	R1		D	03320	F	12539	T	28	49	SP	055	15	11	R1		D	09355	F	12582	T	26	33
TR	013	05	05	R1		D	03345	F	12551	T	28	44		000	13	13	R1		D	01453	F	12559	T	25	41
SP	028	05	05	R1		D	03531	F	12793	T	29	09		000	13	13	R1	D	D	01550	F	12755	T	25	19
SP	029	05	05	R1		D	03548	F	13054	T	29	50		000	13	13	R1		D	01555	F	12773	T	25	19
TR	014	05	05	R1		D	01232	F	13147	T	30	22	TD	013	13	13	R1		D	09535	F	12902	T	25	52
TR	015	05	05	R1		D	01531	F	13752	T	30	45		000	13	13	R1	D	D	09504	F	12921	T	25	54
SP	030	05	05	R1		D	01774	F	14194	T	32	05		000	13	13	R1		D	00509	F	13325	T	25	55
	000	15	13	R1		D	02092	F	14313	T	32	15	SP	057	13	13	R1		D	01135	F	13354	T	29	35
	000	15	13	R1	D	D	02205	F	14426	T	32	27	SP	059	13	13	R1		D	01337	F	13554	T	29	51
	000	15	13	R1		D	02209	F	14430	T	32	29	SP	059	13	13	R1		D	01309	F	14026	T	29	15
TD	007	15	13	R1		D	02213	F	14434	T	32	29	TR	029	13	13	R1		D	02050	F	14255	T	30	07
SP	031	15	13	R1		D	02678	F	14399	T	33	52	SP	070	13	13	R1		D	02259	F	14473	T	29	43
SP	032	15	13	R1		D	03098	F	15318	T	34	26		000	03	07	R1	D	D	02375	F	14539	T	29	52
SP	033	15	13	R1		D	03434	F	15553	T	34	53		000	03	07	R1		D	02338	F	14502	T	29	53
SP	034	15	13	R1		D	03987	F	15104	T	35	37		000	03	07	R1		D	02395	F	14503	T	29	51
SP	035	15	13	R1		D	00240	F	00170	T	35	50	TD	014	03	07	R1		D	02559	F	14723	T	31	19
TR	016	15	13	R1		D	00474	F	00403	T	37	09		000	03	07	R1	D	D	02525	F	14749	T	31	22
	000	12	10	R3	W	D	00501	F	00429	T	37	12	TR	029	03	07	R1		D	02529	F	14743	T	31	22
	000	12	10	R1		D	00729	F	00559	T	37	39	SP	071	03	07	R1		D	03150	F	15377	T	28	59
DD	009	12	10	R1		D	00750	F	00579	T	37	37	TR	030	03	07	R1		D	03191	F	15410	T	29	29
DC	009	12	10	R1		D	00771	F	00599	T	37	47	SP	072	03	07	R1		D	03440	F	15559	T	24	11
TD	008	12	10	R1		D	00814	F	00743	T	37	52	TR	031	03	07	R1		D	03331	F	15099	T	25	31
	000	12	10	R1	D	D	00843	F	00772	T	37	55	SP	073	03	07	R1		D	04095	F	15315	T	25	19
	000	12	10	R1		D	00849	F	00777	T	37	55	SP	074	03	07	R1		D	09447	F	00330	T	27	59
TR	017	12	10	R1		D	01173	F	01100	T	41	35	SP	075	03	07	R1		D	09599	F	09322	T	29	13
SP	036	12	10	R1		D	01334	F	01259	T	41	52		000	02	05	R3	N	D	01095	F	01033	T	29	31
SP	037	12	10	R1		D	01519	F	01543	T	42	39		000	10	05	R1		D	01249	F	01181	T	30	03
SP	038	12	10	R1		D	02045	F	01971	T	44	13	TD	015	10	05	R1		D	01332	F	01254	T	30	11
SP	039	12	10	R1		D	02235	F	02222	T	45	05		000	10	05	R1	D	D	01379	F	01311	T	30	15
SP	040	12	10	R1		D	02599	F	02515	T	46	14		000	10	05	R1		D	01394	F	01317	T	30	16
TR	018	12	10	R1		D	02999	F	02823	T	47	19	SP	076	10	05	R1		D	01159	F	01391	T	30	22
	000	14	09	R1		D	02955	F	02996	T	47	20	TR	032	10	06	R1		D	01552	F	01493	T	30	33
	000	14	09	R1	D	D	02971	F	02993	T	47	21	DD	035	12	05	R2	S	D	01355	F	21945	T	35	29

Both odometer and fifth wheel values recorded on cassette and shown in Table 6-7 are recorded in pulses and must be multiplied by 2 in order to be converted to feet. Both units were calibrated to provide one pulse every two feet. Note also that whereas the odometer rolls over after CP's 11, 20, 26, and 34, the fifth wheel does not roll over until after CP 34. This action occurs since only 12 bits ($2^{12} = 4096$) were used to record odometer data and 14 bits ($2^{14} = 16,384$) were used to record fifth wheel data. During data processing, all such modulo 2^N features are recognized by the data processing routine. The time printed out in Table 6-7 is correct to the second although the data recorded on cassette and used during data processing are correct to the half-second.

The DO 085 codes observed in the last two records are the end-of-file marks. All data processing is terminated upon the occurrence of the last TA entry, TA 32, which signifies the end of run. The DO 085 code is written on tape automatically as a result of action of the Close Tape function key.

The odometer was driven from magnets attached to the left front wheel, whereas the fifth wheel was mounted on the centerline of the test vehicle. As a result, they traveled different distances when the vehicle turned. This is evident in the data shown in Table 6-7. For example, at time 00:28, the odometer is 4 feet ahead of the fifth wheel. At TA3, a left turn was made, subsequently, the fifth wheel caught up with the odometer. The left turn at TA4 caused the fifth wheel to exceed the odometer (see time 06:05). Note that, at the end of the run, the odometer indicates a total elapsed distance of 68,660 feet in comparison to the 68,522 feet indicated by the fifth wheel, a difference of 138 feet, or 0.2 percent. Analysis of the test route indicates that 5 more 90-degree right turns are made than left turns. This action would result in the odometer's traveling a greater distance than the fifth wheel. Theoretically, an offset of X feet from the center line of the vehicle would result in $\pi/2$ X feet difference for each 90-degree turn. By using an offset value of X = 4 feet and five turns, $5 \times \pi/2 \times 4 = 31$ feet of this difference are accounted for. The remaining difference (107 feet or 0.156 percent) is attributed to calibration of the two units over only a 1000-foot range.

Within human judgment, each test run was started at the same location and ended at the same location. Table 6-8 is a summary of the elapsed distances indicated by the odometer and fifth wheel during the fixed route runs. The temperature during the run and the street conditions are also appended.

Table 6-9 contains a typical odometer/fifth wheel calibration run over the 1000-foot Delaware Street range. CP 1 signified the start of the run. CP2 signified the end of the run. The TA events were used to record data at interim times. This run was made after replacing the magnet which was lost from the fifth wheel during Run 32. The indicated odometer distance was $2 \times 502 = 1004$ feet. The indicated fifth wheel distance was $2 \times 500 = 1000$ feet. No attempt was made to "improve" the calibration by changing the DEM calibration numbers as a result of these tests since street conditions were uncertain.

TABLE 6-8 ODOMETER AND 5TH WHEEL TEST DATA

Run No.	Total Run Elapsed Distance		ODOM-Fifth	Temperature	Street Conditions
	Odometer (ft)	5th Wheel (ft)			
11	68562	68610	-48	24	Dry
12	68336	68608	-272	23	Dry
13	68736	68770	-34	24	Dry
14*	49800	49816	-16	24	Dry
15	68478	68596	-118	23	Dry
17	68408	68598	-190	30	Dry
18	68490	68596	-106	32	Began Snowing
21	68950	68092	858	33	Slush
23	69048	67714	1334	32	Freezing Rain
24*					
25*	23234	22912	322	32	Rain
26	68776	68510	266	33	Slush
27	68650	68512	138	34	Slush
28	68596	68512	84	38	Slush
30	68680	68610	70	34	Slush
31	68576	68900	-324	34	Slush
34*	36684	36364	320	26	Snow
35	68876	68320	556	26	Snow
36	68802	68456	446	28	Snow
38	68894	68356	540	15	Slush
39	68872	68474	398	8	Ice
40*	38552	38368	184	8	Ice
41	68760	68536	224	12	Ice
42	68838	68516	322	12	Ice
43*	56718	56492	226	12	Ice

*Data incomplete due to record errors during run.

TABLE 6-9 TYPICAL ODOMETER/5th WHEEL CALIBRATION DATA

TEST DATA LOG

TEST RUN #32 CONTINUED SHEET 4 OF 4

```
.L FRUMP.LDA

.ST 14156

RUN 001  SAMPLE RATE 00.5  YEAR 77  MONTH 01  DAY 16  HOUR 10  MIN 25

FIFTH WHEEL FEET/PULSE  0002    ODOMETER FEET/PULSE  0002
CP 001     00     00     R1      O 00000    F 00000   T 00 03
TA 002     00     00     R1      O 00057    F 00057   T 00 17
TA 003     00     00     R1      O 00100    F 00101   T 00 21
TA 004     00     00     R1      O 00140    F 00140   T 00 24
TA 005     00     00     R1      O 00181    F 00180   T 00 28
TA 006     00     00     R1      O 00220    F 00220   T 00 31
TA 006     00     00     R1      O 00258    F 00257   T 00 35
TA 006     00     00     R1      O 00295    F 00295   T 00 38
TA 007     00     00     R1      O 00322    F 00321   T 00 41
TA 001     00     00     R1      O 00353    F 00353   T 00 44
TA 001     00     00     R1      O 00384    F 00384   T 00 47
TA 001     00     00     R1      O 00419    F 00419   T 00 50
TA 001     00     00     R1      O 00447    F 00446   T 00 53
TA 001     00     00     R1      O 00472    F 00471   T 00 56
TA 001     00     00     R1      O 00495    F 00494   T 01 00
CP 002     00     00     R1      O 00502    F 00500   T 01 03
DO 085     42     85     R2 E    O 01365    F 21845   T 08 03
DO 085
```

DATA DUMP AS DESCRIBED ON SHEET 3 OF 4

1/16/77 B. Klein

7. FIXED ROUTE DATA PROCESSING

The processing of fixed route data was accomplished in three parts by use of three computer programs FRLS, FRSYS, and FRTEN. The same data were input to the three programs. The programs were coded separately in order to accommodate the PDP 11/05 processor at HI^3. As shown in Figure 7-1, FRLS processed timepoint and checkpoint data, whereas FRSYS processed AVM System Level Errors (pseudo checkpoints) and FRTEN processed each record to generate average errors over 528 foot street segments.

7.1 SAMPLE SIZE

The sample size for fixed route data was determined through the use of the processes described in Subsection 4.1. Since TSC designated 76 checkpoints, 30 runs would result in processing of 2280 checkpoints, considerably more than the number of samples required. However, since only 15 timepoints could be accommodated per run during a 13-mile run and be representative of the spacing between timepoints on actual transit routes, the number of timepoint samples dictated the number of runs. As discussed in subsection 4.1, the sample size analyses coupled with the cost of requiring additional runs, resulted in TSC requiring 30 runs, for a total of 450 timepoint samples. HI^3 actually processed exactly 451 timepoint samples.

7.2 FIXED ROUTE DATA PROCESSING

7.2.1 Fixed Route Location Errors

Location error data processing of fixed route data involved computing (1) the vehicle's actual location (at checkpoints and pseudo checkpoints), (2) the vehicle's estimated location (using the location subsystem or AVM system), and (3) the radial error between the locations determined in (1) and (2).

7.2.1.1 Vehicle Actual Location at Checkpoints. The actual location of the vehicle was assumed to be the X, Y location of the TSC checkpoint at the time the appropriate CP event was recorded on tape. The CPTABL file contained the X, Y location of each checkpoint as determined by (1) the digitized intersections provided by MITRE and (2) the offset distances measured by HI^3. The actual values used in CPTABL were the X' and Y' values of the stateplane coordinates shown in the Appendix except that 2,710,000 was subtracted from X' values and 230,000 was subtracted from Y' values. Table 7-1 contains actual CPTABL stateplane entries.

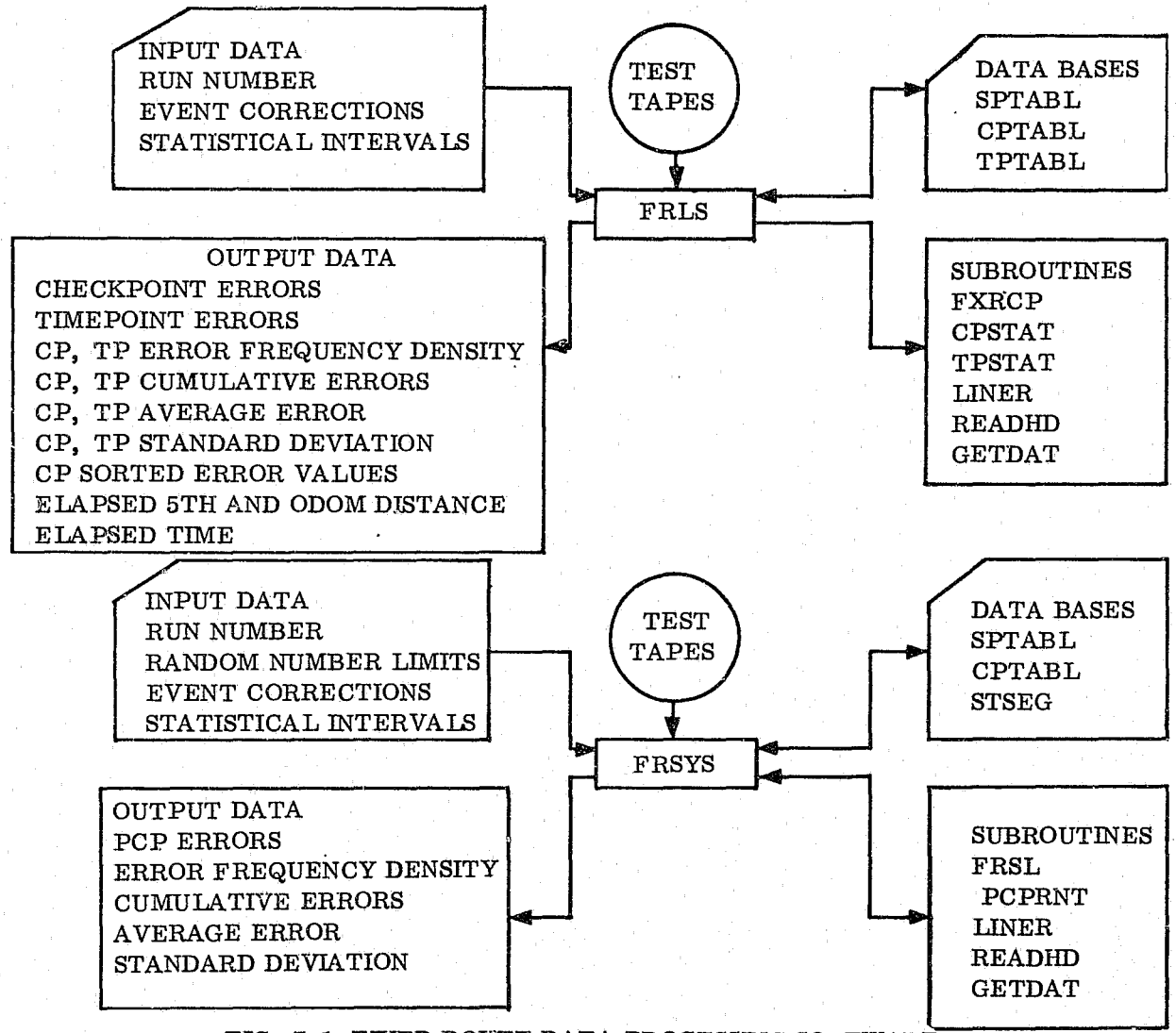


FIG. 7-1 FIXED ROUTE DATA PROCESSING SOFTWARE

TABLE 7-1 FIXED ROUTE CHECKPOINT STATEPLANE COORDINATES

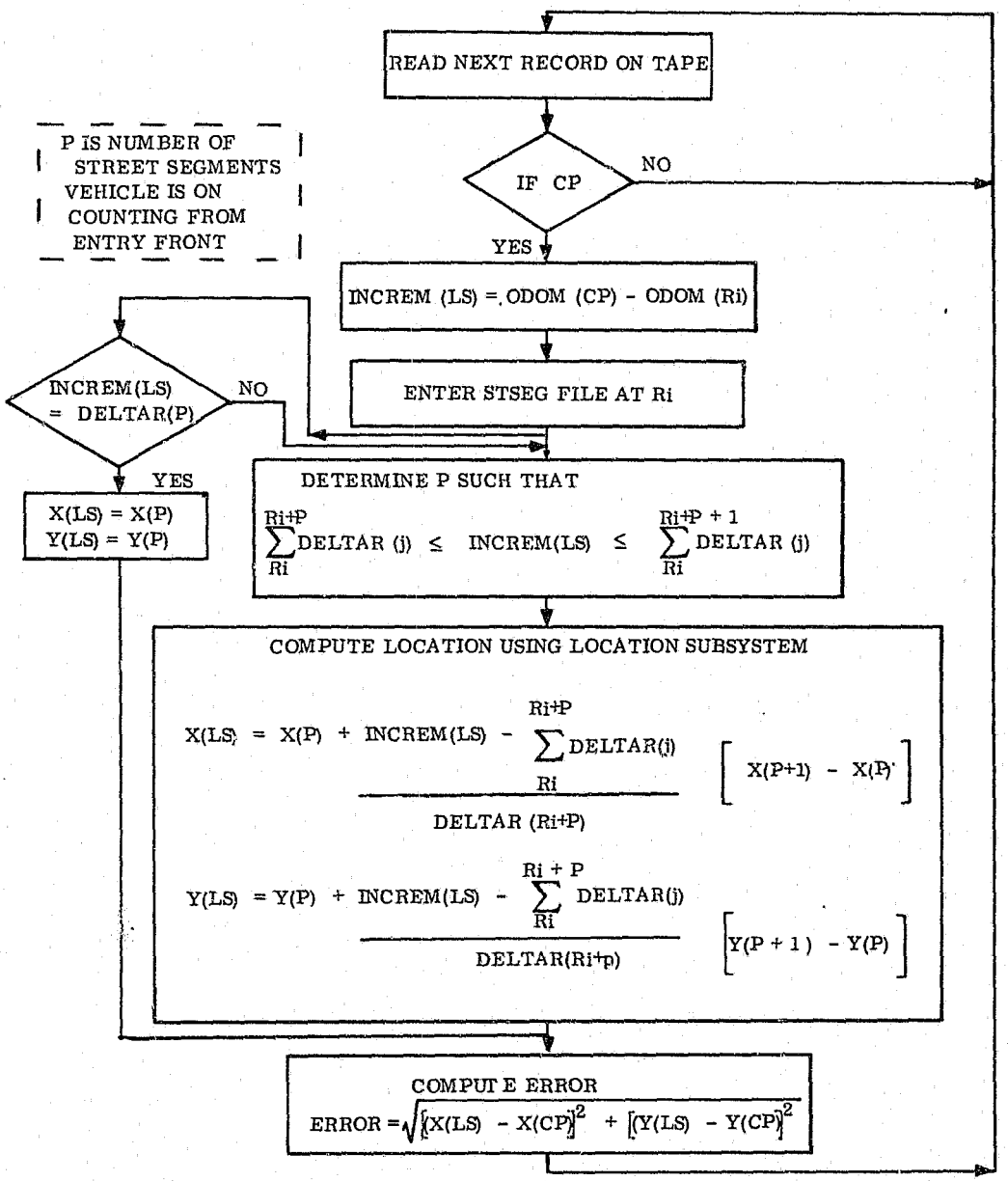
Checkpoint No.	State Plane Coordinates		Checkpoint No.	State Plane Coordinates	
	X (feet)	Y (feet)		X (feet)	Y(feet)
1	2722431	234529	44	2724055	235037
2	2722895	233792	45	2723388	235138
3	2723632	233698	46	2722862	235200
4	2724904	233541	47	2721518	235369
5	2725277	234035	48	2720787	235472
6	2725334	234441	49	2720462	235513
7	2725383	234869	50	2719558	235647
8	2725475	235453	51	2718740	235757
9	2725644	236735	52	2718145	235840
10	2725730	237421	53	2717537	236481
11	2725809	237838	54	2717652	236971
12	2776042	239499	55	2718320	236948
13	2726512	239618	56	2719345	236825
14	2726941	239578	57	2719894	236731
15	2727368	239554	58	2722136	236444
16	2727811	239507	59	2722561	236405
17	2728095	238454	60	2723099	236331
18	2728109	238343	61	2723452	236271
19	2727929	236962	62	2723455	235695
20	2726580	236988	63	2723388	235138
21	2725087	237167	64	2723372	234812
22	2724282	237260	65	2723787	234668
23	2723313	237718	66	2724242	234594
24	2722500	238500	67	2725770	234381
25	2721590	239350	68	2726152	234347
26	2722190	240181	69	2727121	234202
27	2723151	240036	70	2727491	233736
28	2723130	239554	71	2728691	233072
29	2723052	239039	72	2729268	233498
30	2723699	237663	73	2728484	234477
31	2725123	237495	74	2727621	234597
32	2725948	237393	75	2726706	234705
33	2726627	237326	76	2725624	234856
34	2727500	237204			
35	2728354	237054			
36	2728300	235657			
37	2727779	235728			
38	2726908	235840			
39	2726427	235897			
40	2725645	236003			
41	2724638	236127			
42	2724717	235780			
43	2724816	235222			

7.2.1.2 Vehicle Actual Location at Pseudo Checkpoints. In Fixed Route Data Processing, pseudo checkpoints were selected in exactly the same manner as in Random Route Data Processing, i.e., by sampling the recorded data every 20 seconds. The technique used to determine the vehicle location at a pseudo checkpoint was also exactly the same as that used in the Random Route System Level routine RRSL, as previously discussed in paragraph 4.2.3. As in the case of RRSL, the vehicle's actual location (i.e., that of the pseudo checkpoint) was determined explicitly through use of (1) the last TA or CP, (2) the next TA or CP, and (3) the 5th wheel distance from the last TA or CP to the pseudo checkpoint.

7.2.1.3 Vehicle Computed Location. The estimated location of the vehicle was computed through use of the last reset signpost code, and the elapsed odometer distance from that signpost's region 1 boundary (R(i)). The simplified flow chart in Figure 7-2 shows the process incorporated in FRLS to compute location errors. The odometer is first used to compute the vehicle's distance along the route from the last reset point to establish on which street segment the vehicle is located, and then it is used to compute the X, Y location on the basis of the distance the vehicle has traveled along the street segment. Table 7-2 contains the street segment file STSEG. Each point in the STSEG file is identified in Figure 6-8.

7.2.1.4 Vehicle Computed (AVM System) Location at Pseudo Checkpoints. At pseudo checkpoints, the exact same algorithm discussed in paragraph 7.2.1.3 was used to determine the vehicle's computed location. This approach was used regardless of whether or not a communication error has been simulated. Thus, as in the case of checkpoints, the vehicle's computed location was determined totally on the basis of the elapsed odometer distance from the last encountered fixed route signpost. Note that the marking of turns in no way influences the computation of vehicle location through the use of the location subsystem.

7.2.1.5 Off-Route Declaration. During off-line data processing, each recorded signpost code is checked against a valid signpost file. If an invalid code is observed, it is ignored as part of the screening algorithm. Each recorded signpost code is also checked against the fixed route signpost file. If a valid signpost code is not a fixed route signpost for the route in question, an "off-route" declaration is made. This function was simulated during runs 38 through 43 by installing a pair of signposts along the route so that their codes would be recorded in the test vehicle. In each instance, the data processing routine declared an off-route condition upon the first occurrence of a code from either of these signposts. The locations of these signposts are indicated in Figure 6-4. The actual algorithm by which the vehicle's estimated location was determined, off-line, is indicated in the flow chart in Figure 7-2.



WHERE: CP IS CHECKPOINT

INCREM(LS) IS THE ELAPSED ODOMETER READING (IN FEET) SINCE LAST RESET

STSEG FILE IS AS SHOWN IN TABLE 7-2

DELTAR(j) IS THE LENGTH IN FEET OF THE jth STREET SEGMENT

$\sum_{Ri}^{Ri+p}$ DELTAR(j) IS THE DISTANCE FROM THE LAST RESET TO THE Ri+pth STREET SEGMENT

DELTAR(Ri+p) IS THE STREET SEGMENT ON WHICH THE VEHICLE IS ON

X(LS) IS COMPUTED X BY LS, Y(LS) IS COMPUTED Y BY LS

X(CP), Y(CP) IS X, Y FROM CPTABL

FIG. 7-2 SIMPLIFIED FLOW CHART OF FRLS LOCATION ERROR ALGORITHM

TABLE 7-2 FIXED ROUTE STSEG FILE

Street Segment Index	State Plane Coordinates *		Deltar (feet)
	X(feet)	Y(feet)	
TA1	12305	4700	140
TA2	12444	4683	68
R1	12418	4620	745
TA3	12332	3880	2534
R2	14845	3551	361
TA4	15201	3489	4943
R3	15885	8384	1298
TA5	16064	9670	2057
TA6	18115	9510	1581
R4	18094	7929	1131
TA7	17910	6813	3795
R5	14142	7269	433
TA8	13711	7308	839
TA9	13145	7928	533
TA10	12745	8280	2258
TA11	11085	9810	291
R6	11063	10100	279
TA12	11235	10320	1977
TA13	13195	10061	1775
TA14	12922	8307	521
TA15	12888	7787	1108
R7	13984	7622	4883
TA16	1832	7038	532
R8	18724	6517	913
TA17	18642	5608	3436
TA18	15234	6043	231
R9	15269	6271	109
TA19	15277	6380	602
TA20	14681	6467	685
TA21	14595	5787	296
TA22	14890	5758	811
TA23	14788	4953	2464
R10	12345	5274	4553
R11	7836	5903	368
TA24	7469	5924	1127
TA25	7660	7035	3329
R12	10960	6599	2626
TA26	13564	6256	1563
TA27	13358	4707	1037
R13	14385	4564	3200
TA28	17560	4161	706
R14	17448	3464	276
TA29	17425	3189	1333
TA30	18752	3064	1383
TA31	18914	4437	2861
R15	16072	4770	696
TA32	15383	4869	00000

* Add 2710, 000 to X and 230, 000 to Y to get State Plane Coordinate.

7.2.2 AVM System Simulation

During the first pass, when fixed route test data were processed through the use of program FRSYS, the location error was computed for every 40th record (20-second sampling interval). On the second pass, 5 percent of the samples (selected in a random manner) were assumed to contain a communcation error. In these cases, the vehicle's actual location (fifth wheel) was not changed; however, detection of a communication error (simulated) caused the AVM system to poll the vehicle within 2 seconds to obtain a new AVM computed location. As in the random route case, this correction technique was implemented by computing the vehicle's location on the basis of the fourth record (2 seconds) subsequent to the originally selected PCP. The error was then computed as follows for the two cases:

No Communication Error Detected

$$\text{Location Error} = \sqrt{\Big(X(\text{LS at PCP}) - X(\text{PCP})\Big)^2 + \Big(Y(\text{LS at PCP}) - Y(\text{PCP})\Big)^2}$$

Communication Error Detected at PCP

$$\text{Location Error} = \sqrt{\Big(X(\text{LS at PCP} + 2\text{ sec}) - X(\text{PCP})\Big)^2 + \Big(Y(\text{LS at PCP} + 2\text{sec} - Y(\text{PCP})\Big)^2}$$

7.2.3 Timepoint Performance Computation

The computation of timepoint performance was performed by use of the FRLS routine at each event-marked timepoint recorded on cassette during each fixed route test run. Figure 7-2 contains the algorithm used to determine timepoint passage. The TDO, TDC, and TLRID information would be stored in the Phase II vehicle until requested by the base station. This information consists of values for TDO and TDC or a value for TLR1D. These values are stored in the vehicle until the next timepoint is encountered. If a communication error is detected during transmission of timepoint data to the base station, it will be retrieved on a subsequent poll; however, the values would not be changed.

7.2.4 Average Error Over One-Tenth Mile Segments

Computer program FRTEN was used to compute the average location error over 528 foot segments of the fixed route tests. This program treated each record as if it were a pseudo checkpoint thereby computing each location error in exactly the same manner as FRSYS. The average of all such errors over each 528 foot long segment of the 13-mile route was then determined.

7.3 FIXED ROUTE DATA PROCESSING SOFTWARE

Flow charts of fixed route data processing software routines FRSYS, and FRTEN are contained in the Appendix.

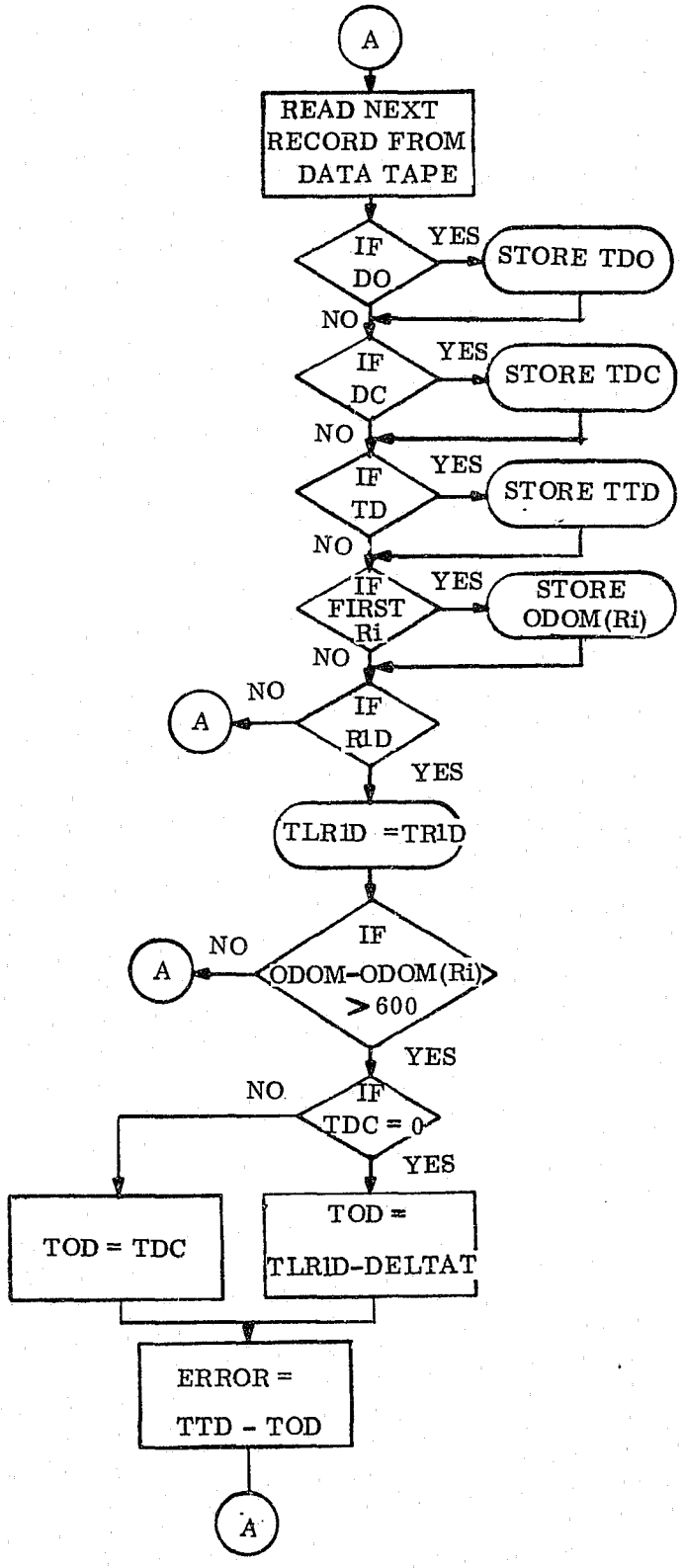


FIG. 7-3 SIMPLIFIED FLOW CHART OF TIMEPOINT PERFOMANCE ALGORITHM

8. FIXED ROUTE TEST RESULTS

The results obtained by processing Fixed Route Runs 11 through 43 through the use of the data processing routines FRLS, FRSYS, and FRTEN are presented in this section. Location error data are presented separately from timepoint performance error data. The results obtained for both the location subsystem and the AVM system simulation are summarized in the following table:

SUMMARY OF FIXED ROUTE TEST RESULTS

Location Subsystem:	
No. of Samples	2313
Average Error	50 feet
95% Error	107 feet
99.5% Error	156 feet
% Errors Less Than 300 Feet	99.91
% Errors Less Than 450 Feet	99.96
Maximum Average Error over 1/10th Mile Segment	256 feet
AVM System (Location Error): With 5% Comm Errors	
No. of Samples	7459
Average Error	48 feet
95% Error	105 feet
99.5% Error	188 feet
% Errors Less Than 300 Feet	99.84
% Errors Less Than 450 Feet	99.97
AVM System (Timepoint Performance)	
No. of Samples	451
Average Error	3.9 seconds
95% Error	11 seconds
99.5% Error	24 seconds
% Errors Less Than 15 Seconds	98.67
% Errors Less Than 60 Seconds	100.00

8.1 LOCATION SUBSYSTEM TEST RESULTS

The vehicle location results obtained by processing fixed route data tapes through the Fixed Route Location Subsystem (FRLS) routine are summarized in Table 8-1. As a result of certain anomalies, some of which were described in Section 6, all 33 data runs could not be processed in total. Table 8-2 contains a brief description of the problems encountered in processing each data run. In

TABLE 8-1 FIXED ROUTE LOCATION SUBSYSTEM TEST RESULTS

Run No.	No. of Checkpoints Processed	Average Error (feet)	95% of Errors Less than (feet)	99.5% of Errors Less than (feet)
11	76	51.48	104	128
12	76	56.79	115	143
13	76	52.44	107	142
14	76	49.16	102	119
15	76	50.28	108	140
16	76	48.86	100	117
17	76	50.88	102	119
18	75	54.13	119	130
19	Bad Tape	---	---	---
20	45	58.47	125	162
21	73	41.06	106	144
22	76	45.14	107	152
23	76	46.73	135	174
24	75	67.60	145	1509 *
25	76	62.84	244	309
26	76	38.16	91	101
27	76	48.10	102	126
28	75	45.54	92	113
29	74	43.58	99	104
30	76	44.23	89	120
31	76	56.60	105	405
32	75	42.73	95	125
33	Bad Tape	---	---	---
34	75	46.04	97	139
35	75	40.94	87	131
36	76	50.16	115	156
37	76	51.72	111	148
38	76	53.81	101	119
39	76	53.35	103	144
40	76	47.44	103	111
41	76	37.45	79	118
42	76	53.60	107	306
43	75	61.10	127	185
Total	2313	49.85	107	156

*Computation error: Manual computation yields 12 feet at CP3.

TABLE 8-2 FIXED ROUTE DATA PROCESSING ANOMALIES (FRLS)

RUN NO.	PROBLEM	RESULT
14	Couldn't Process Past CP54	22 Checkpoints Processed manually
18	Missed CP 43	75 Checkpoints
19	Bad Tape, couldn't dump in vehicle	No Results
20	Generator Stalled after CP46	45 Checkpoints
21	CP66 entered for CP6; CP111 entered for CP11; Missed CP36; Entry Error at CP47; Missed CP49	Replaced CP66 with CP6 Replaced CP11 with CP111 72 Total Checkpoints
24	Didn't Process CP54 from Tape: Recording Error in Odometer Between CP53 and CP55	13 Checkpoints Processed manually
28	Missed CP9	75 Checkpoints
29	Missed CP1; Missed CP28	74 Checkpoints
31	CP7 Entered Early	Produced 4051 Error at CP7
32	First TD13 should be DO13	Card Input Change
33	Bad Tape, couldn't dump in vehicle	No Results
34	Couldn't read past CP37	37 Checkpoints Processed manually
35	Missed CP1	75 Checkpoints
39	"Off Route" During CP37-CP40	4 Checkpoints Processed manually
40	Couldn't Process Past CP40 due to bad records on tape	38 Checkpoints Processed manually
41	"Off Route" During CP37-CP40	4 Checkpoints Processed manually
42	" " "	4 Checkpoints Processed manually
43	" " "	4 Checkpoints Processed manually

most cases, the information contained in Table 8-2 applies to use of the AVM system simulation routine also. Pertinent differences are described in Subsection 8.2. A detailed discussion of processing anomalies is contained in subsection 8.3.

As a result of the problems described in Table 8-2, only 31 of 33 runs were successfully processed through use of FRLS. Two runs, Runs 19 and 33, could not be processed at all. Runs 19 and 33 were known to have contained recording errors which were confirmed in the test vehicle immediately after each run. Also, Run 20 was cut short due to failure of the auxiliary generator just after checkpoint 46. Run 20 could not be processed through the FRSYS routine. Runs 24, 25, 34, 40, and 43 also could not be processed completely due to data recording errors. All of these problems were noted on the appropriate test data logs or made known to the TSC Monitor while at DEC transferring data from cassettes to magnetic tape. Details are discussed in subsection 8.3

Assuming that 30 runs were processed, the number of checkpoints would then be 30 x 76 = 2280 checkpoints minus the 20 (4 during each of 5 runs), which were not processed due to an "off-route" declaration on Runs 39 through 43, leaves 2260 possible checkpoints. A total of 2171 checkpoints representing 98 percent of these possible samples were actually processed through the use of FRLS. A total of 142 checkpoints were processed manually (as noted in Table 8-2) for a grand total of 2313 checkpoints.

Table 8-3 contains typical results obtained as output data from the FRLS routine when Run 27 was processed. Figure 8-1 contains a plot of the error statistics of all fixed route location subsystem data combined. These results document conclusively the performance obtained through use of the HI^3 location subsystem as a means of maintaining the location of fixed route transit vehicles. Note that the average error of 50 feet is approximately the length of a standard bus.

Figures 8-2 through 8-32 contain error histograms and cumulative error distributions corresponding to each set of test data which were processed. These results, coupled with the results obtained during random route tests, also demonstrate the ability of the HI^3 fixed route AVM system which is described in Subsection 10.2 (odometer eliminated) to meet the fixed route transit AVM requirements of the UMTA Multi-User AVM Program. The HI^3 fixed route system was installed, calibrated, and data recording software checked out in the test vehicle, during only five working days. Output data corresponding to each set of processed data are contained in the Appendix.

Table 8-4 contains typical results obtained by processing test data through use of the FRTEN routine. During each such run, every recorded data record on the test tape was processed as a pseudo checkpoint for a total of approximately 10,000 points per run using the FRTEN routine. Although similar results for all runs would be too voluminous to present in this volume, Table 8-5 contains a

(Text continued on 8-42)

TABLE 8-3 FIXED ROUTE RUN #27 CHECKPOINT ERRORS

FIXED ROUTE RUN # 27 CHECKPOINT ERRORS

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
1	12431	4529	1	3	40.	12413.	4580.	54.
2	12895	3792	1	4	559.	12886.	3807.	18.
3	13632	3698	1	4	1305.	13626.	3711.	14.
4	14904	3541	2	5	26.	14871.	3547.	34.
5	15277	4035	2	6	449.	15263.	3934.	102.
6	15334	4441	2	6	905.	15326.	4385.	56.
7	15383	4869	2	6	1321.	15384.	4797.	72.
8	15475	5453	2	6	1895.	15463.	5366.	88.
9	15644	6735	2	6	3203.	15644.	6661.	74.
10	15736	7421	2	6	3891.	15739.	7342.	79.
11	15809	7838	2	6	4335.	15801.	7782.	57.
12	16042	9499	3	7	1086.	16035.	9460.	40.
13	16512	9618	3	8	372.	16435.	9641.	80.
14	16941	9578	3	8	810.	16872.	9607.	75.
15	17368	9554	3	8	1274.	17334.	9571.	38.
16	17811	9507	3	8	1718.	17777.	9536.	45.
17	18095	8454	3	9	1009.	18112.	8501.	50.
18	18109	8343	3	9	1117.	18112.	8393.	50.
19	17929	6962	4	10	1170.	17926.	6915.	47.
20	16580	6988	4	11	1395.	16525.	6981.	56.
21	15087	7167	4	11	2899.	15032.	7161.	56.
22	14282	7260	4	11	3679.	14257.	7255.	25.
23	13313	7718	5	13	551.	13339.	7715.	26.
24	12500	8500	5	15	401.	12450.	8552.	72.
25	11590	9350	5	15	1633.	11544.	9387.	58.
26	12190	10181	6	18	943.	12170.	10196.	25.
27	13151	10036	6	18	1895.	13114.	10072.	52.
28	13130	9554	6	19	440.	13127.	9626.	72.
29	13052	9039	6	19	974.	13045.	9099.	60.
30	13699	7663	6	21	930.	13808.	7649.	110.
31	15123	7495	7	22	1172.	15148.	7482.	28.
32	15948	7393	7	22	2012.	15982.	7381.	36.
33	16627	7326	7	22	2684.	16649.	7301.	33.
34	17500	7204	7	22	3590.	17548.	7193.	50.
35	18345	7054	7	22	4488.	18440.	7085.	100.
36	18300	5657	8	25	297.	18347.	5646.	49.
37	17779	5728	8	25	865.	17784.	5718.	12.
38	16908	5840	8	25	1719.	16937.	5826.	32.
39	16427	5897	8	25	2221.	16439.	5889.	14.
40	15645	6003	8	25	3009.	15658.	5989.	19.
41	14638	6127	9	29	427.	14627.	6043.	85.
42	14717	5780	9	30	248.	14842.	5763.	126.
43	14816	5222	9	31	632.	14811.	5131.	91.
44	14055	5037	9	32	771.	14024.	5053.	35.
45	13388	5138	9	32	1443.	13357.	5141.	31.
46	12862	5200	9	32	2013.	12792.	5215.	71.

TABLE 8-3 FIXED ROUTE RUN #27 CHECKPOINT ERRORS (CONT'D)

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
47	11518	5369	10	33	810.	11543.	5386.	30.
48	10787	5472	10	33	1448.	10911.	5474.	124.
49	10462	5513	10	33	1888.	10475.	5535.	26.
50	9558	5647	10	33	2860.	9513.	5669.	50.
51	8740	5757	10	33	3616.	8764.	5774.	29.
52	8145	5840	10	33	4250.	8136.	5861.	23.
53	7537	6481	11	35	538.	7560.	6454.	35.
54	7652	6971	11	35	1036.	7645.	6945.	27.
55	8320	6948	11	36	609.	8264.	6955.	57.
56	9345	6825	11	36	1655.	9301.	6818.	45.
*57	9894	6731	11	36	2211.	9852.	6745.	45.
CT1:RUN027.001								
58	12136	6444	12	37	1184.	12134.	6444.	2.
59	12561	6405	12	37	1594.	12541.	6391.	25.
60	13099	6331	12	37	2164.	13106.	6316.	16.
61	13452	6271	12	37	2504.	13443.	6272.	9.
62	13455	5695	12	38	528.	13494.	5733.	55.
63	13388	5138	12	38	1088.	13421.	5178.	51.
64	13372	4812	12	38	1378.	13382.	4890.	79.
65	13787	4668	12	39	367.	13721.	4656.	67.
66	14242	4594	12	39	815.	14165.	4595.	77.
67	15770	4381	13	40	1366.	15740.	4392.	32.
68	16152	4347	13	40	1768.	16139.	4341.	14.
69	17121	4202	13	40	2712.	17076.	4222.	50.
70	17491	3736	13	41	410.	17495.	3756.	21.
71	18691	3072	14	43	1294.	18713.	3068.	23.
72	18782	3565	14	44	521.	18813.	3581.	35.
73	18484	4477	14	45	448.	18469.	4489.	19.
74	17621	4597	14	45	1344.	17579.	4593.	42.
75	16706	4705	14	45	2228.	16701.	4696.	10.
76	15624	4856	15	46	420.	15656.	4830.	42.

TABLE 8-3 FIXED ROUTE RUN #27 CHECKPOINT ERRORS (CONT'D)

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	2	2.63
10- 20	9	11.84
20- 30	11	14.47
30- 40	12	15.79
40- 50	9	11.84
50- 60	14	18.42
60- 70	1	1.32
70- 80	9	11.84
80- 90	3	3.95
90- 100	2	2.63
100- 110	2	2.63
120- 130	2	2.63

CUMULATIVE ERRORS

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	2	2.63
20	11	14.47
30	22	28.95
40	34	44.74
50	43	56.58
60	57	75.00
70	58	76.32
80	67	88.16
90	70	92.11
100	72	94.74
110	74	97.37
120	74	97.37
130	76	100.00

AVERAGE ERROR	=	48.10	
STANDARD DEVIATION	=	27.26	
ELAPSED TIME	=	80: 0	
ELAPSED DISTANCE	=	68512.	(5TH WHEEL)
ELAPSED DISTANCE	=	68650.	(ODOMETER)

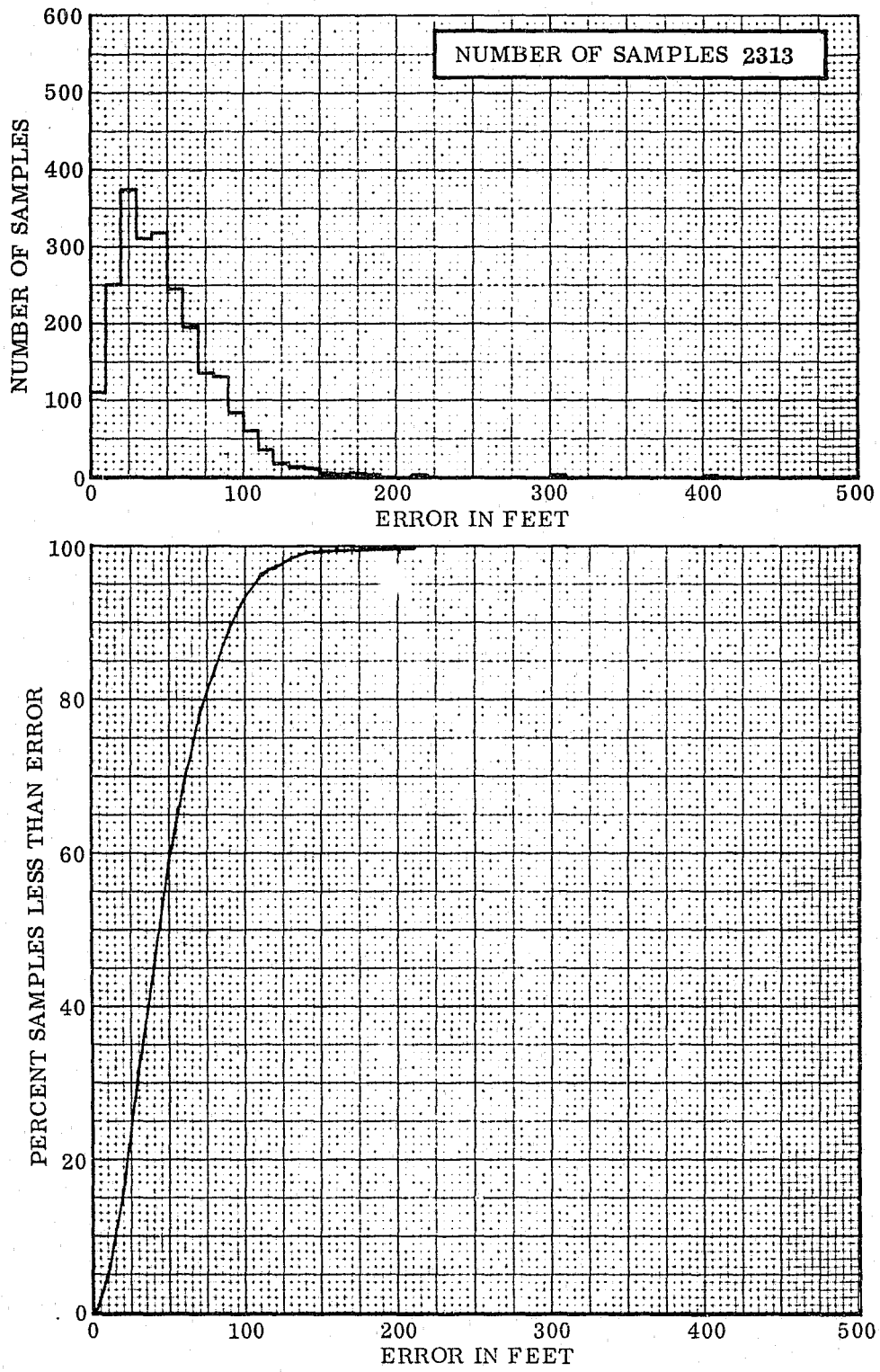


FIG. 8-1 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, ALL RUNS

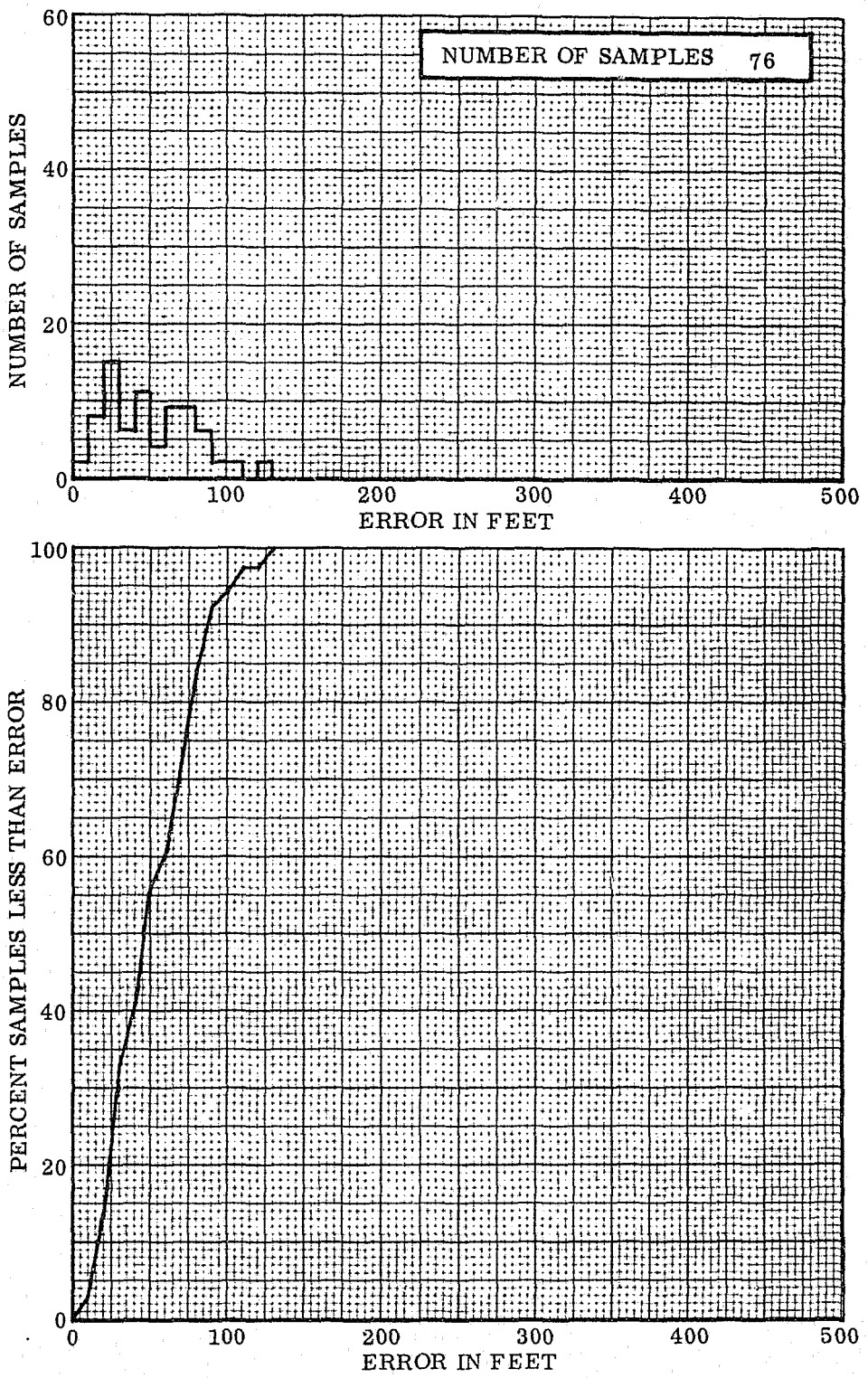


FIG. 8-2 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 11

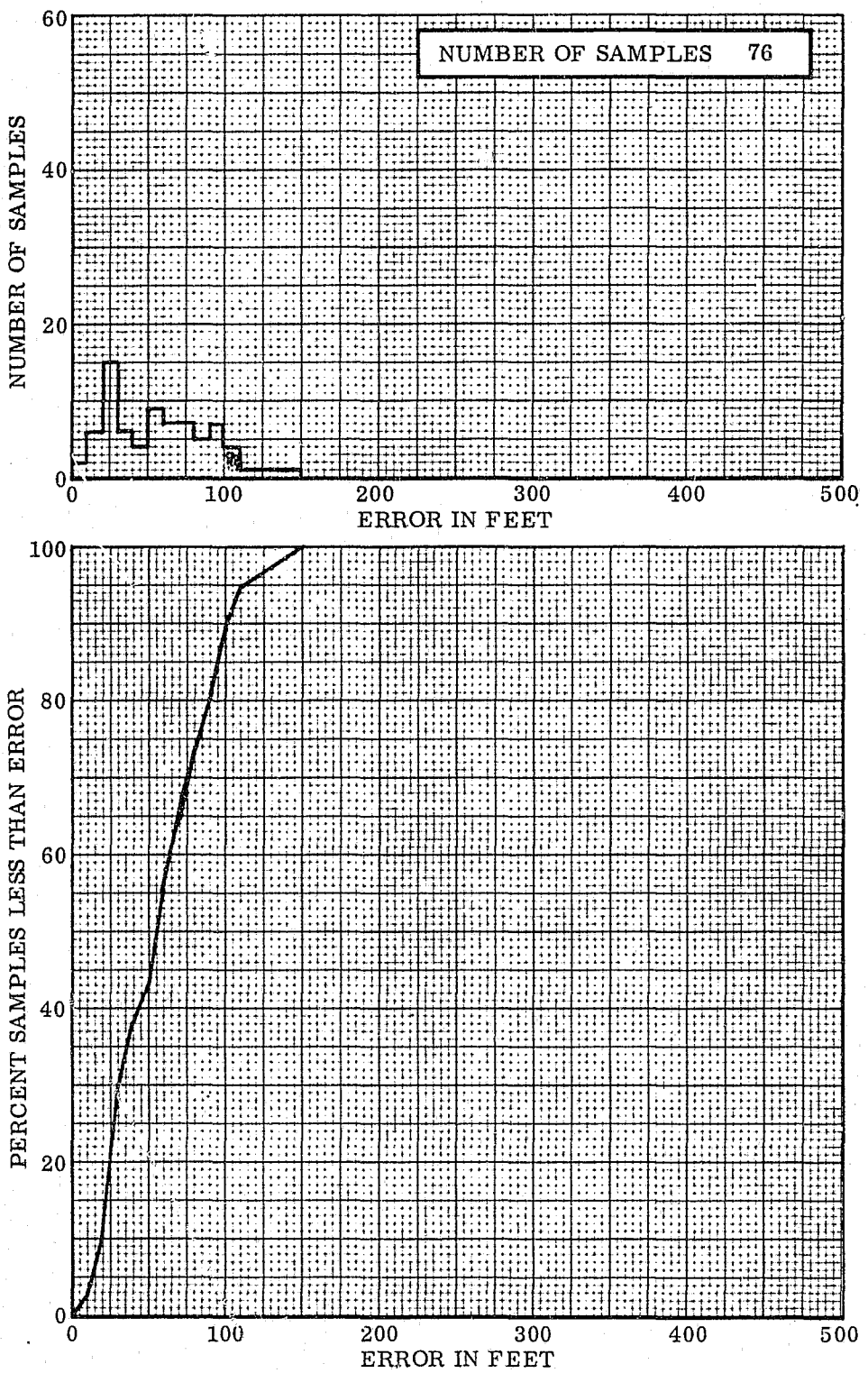


FIG. 8-3 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 12

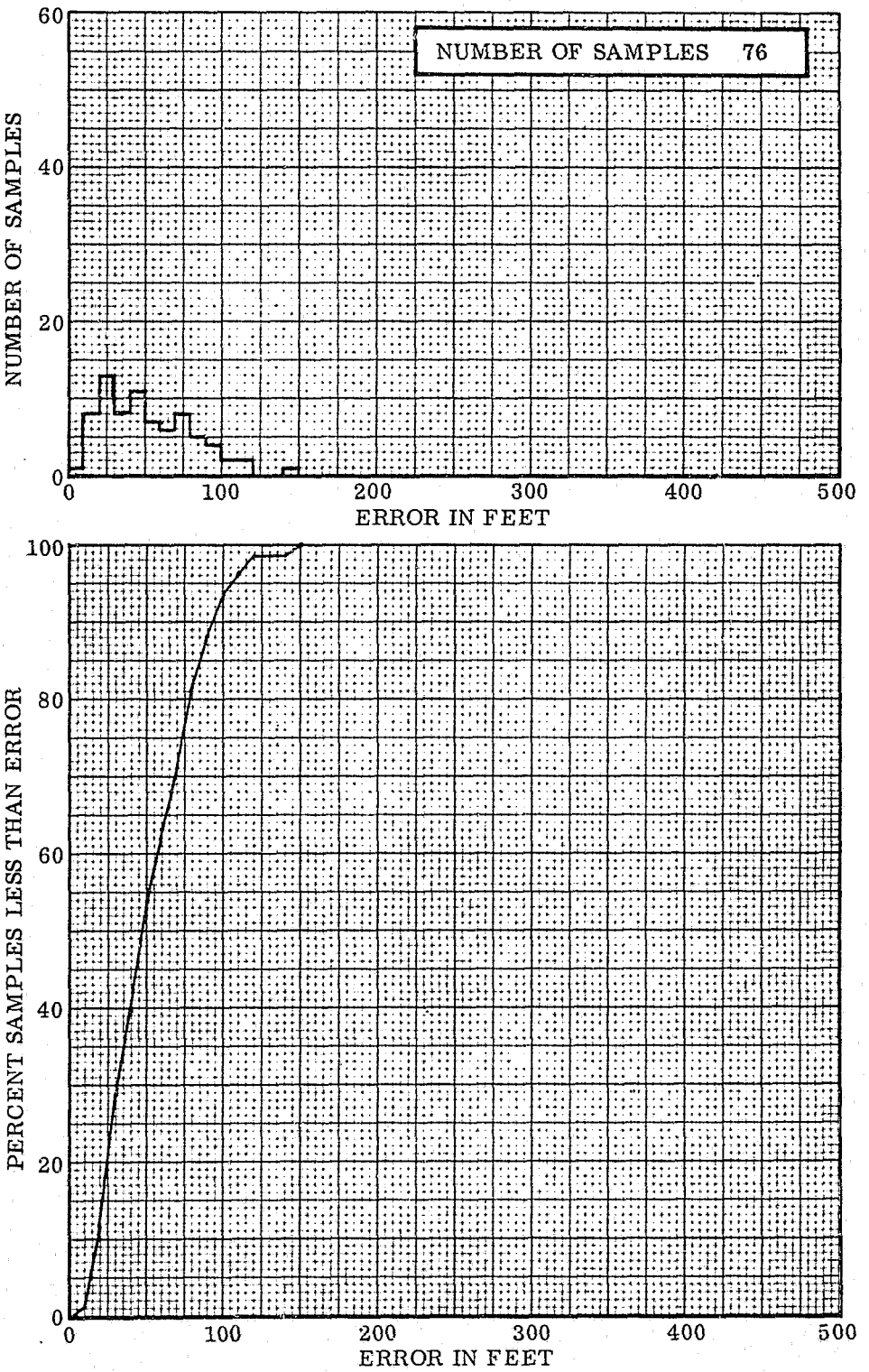


FIG. 8-4 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 13

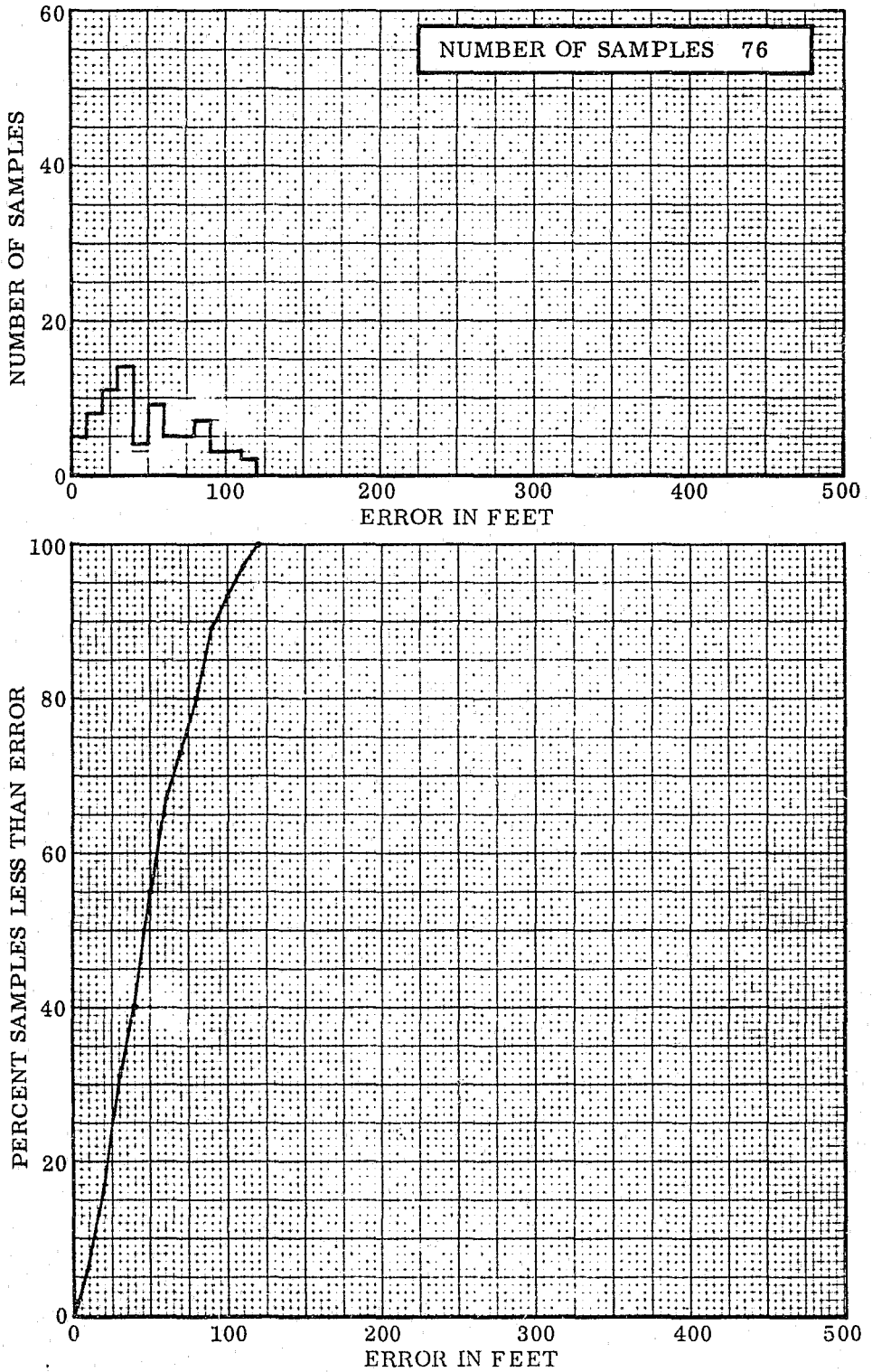


FIG. 8-5 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 14

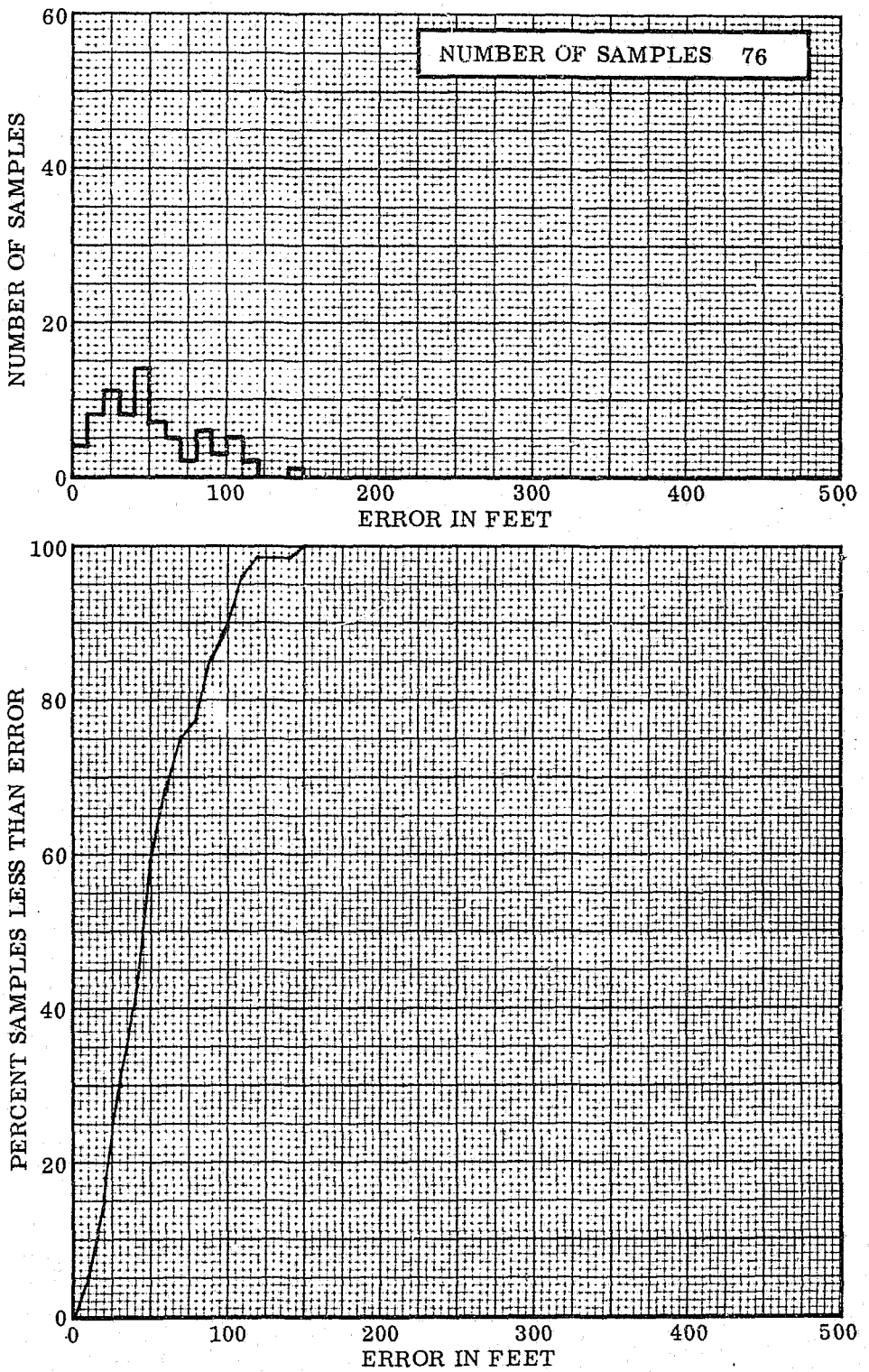


FIG. 8-6 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 15

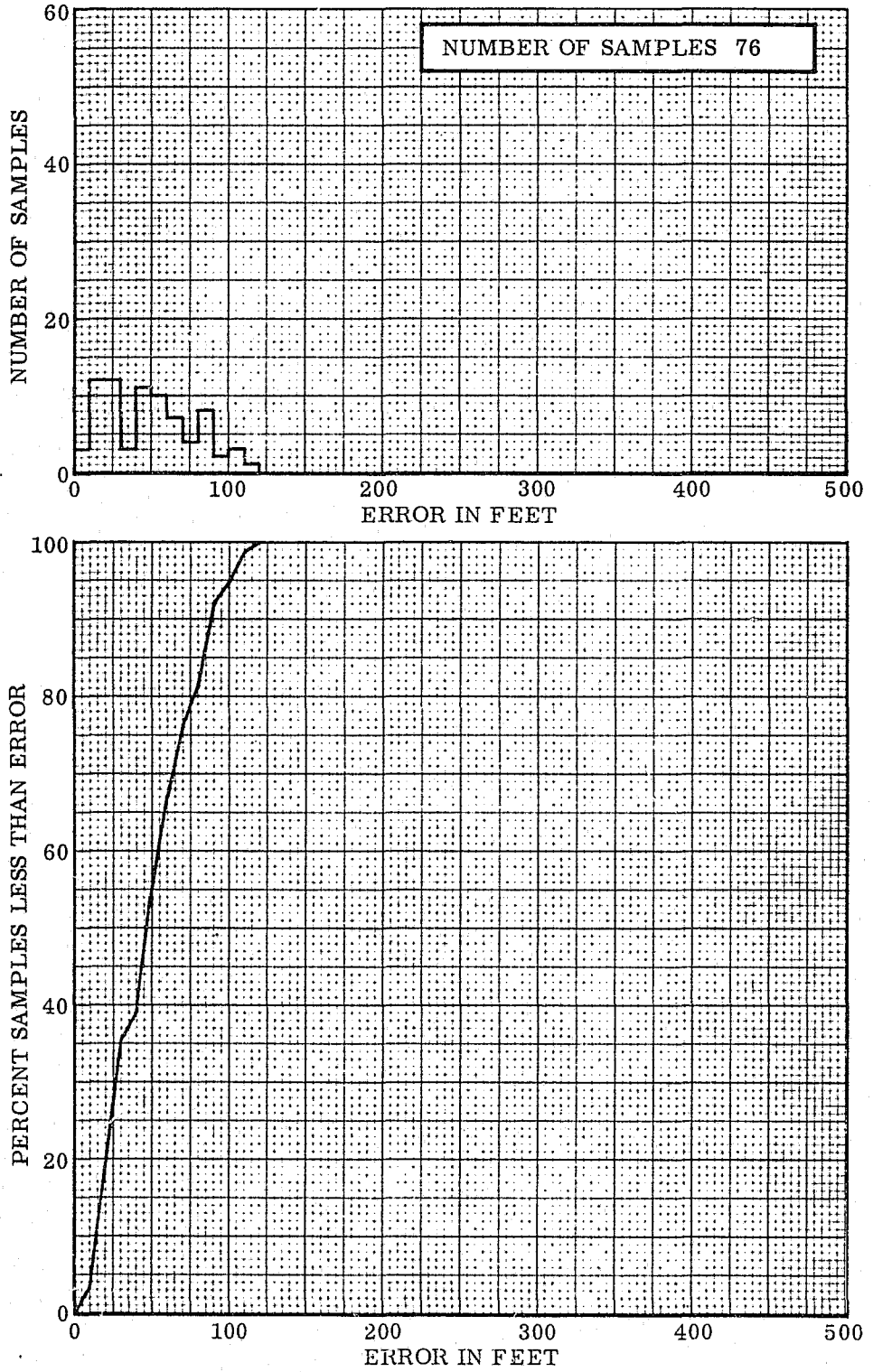
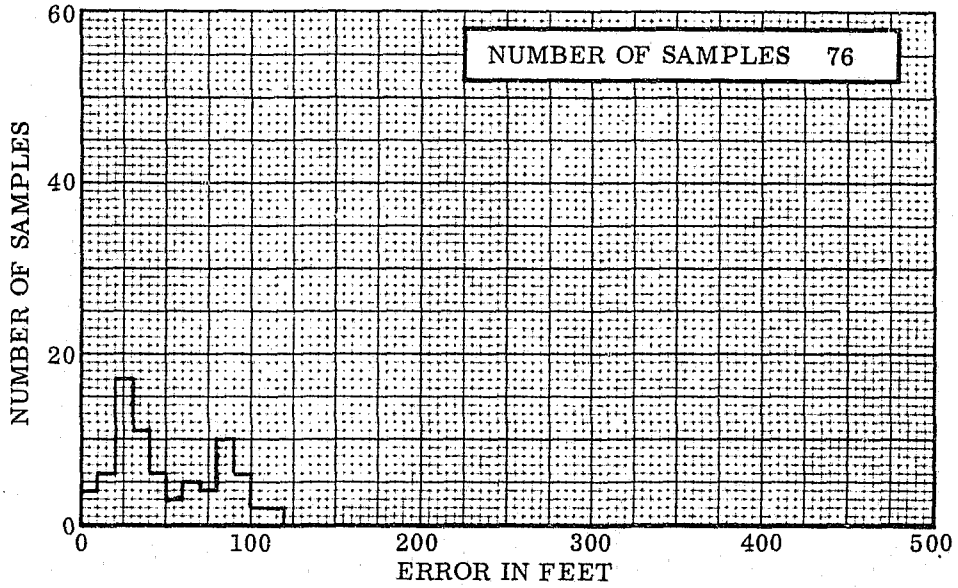


FIGURE 8-7 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 16



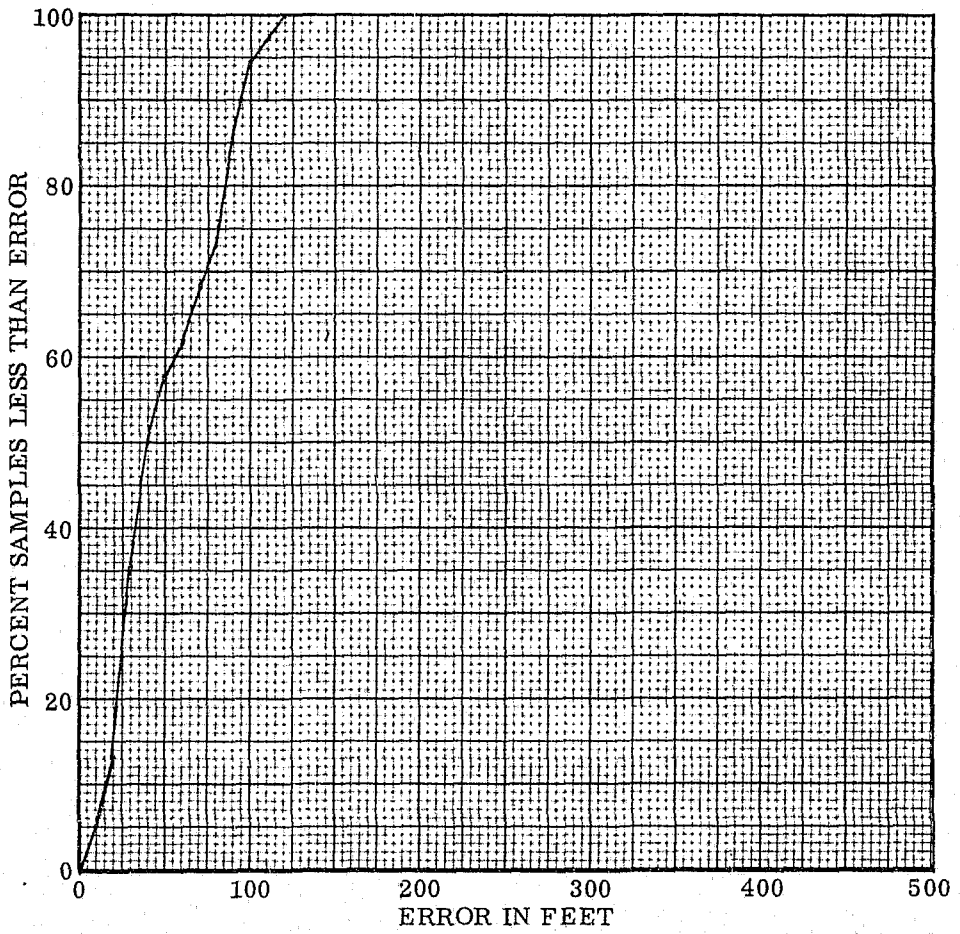
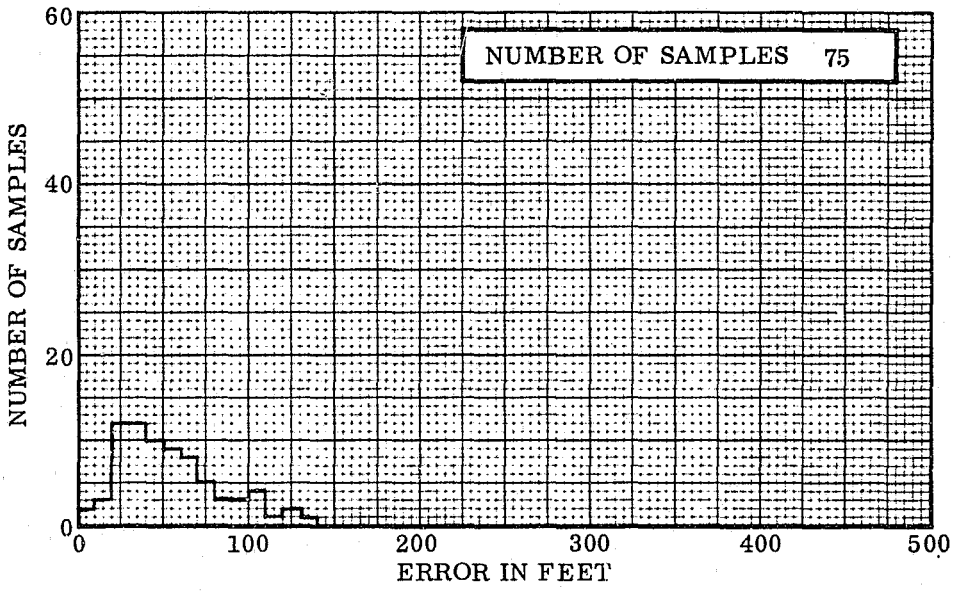


FIG. 8-8 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 17



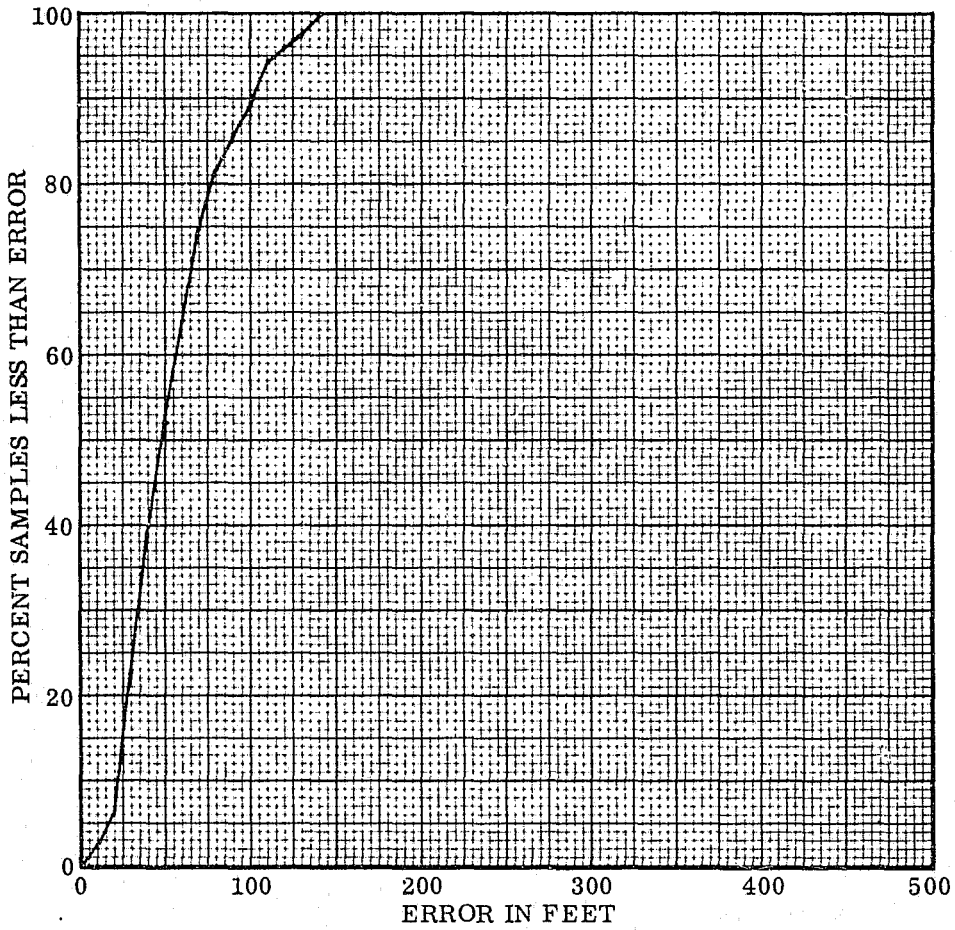


FIG. 8-9 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 18

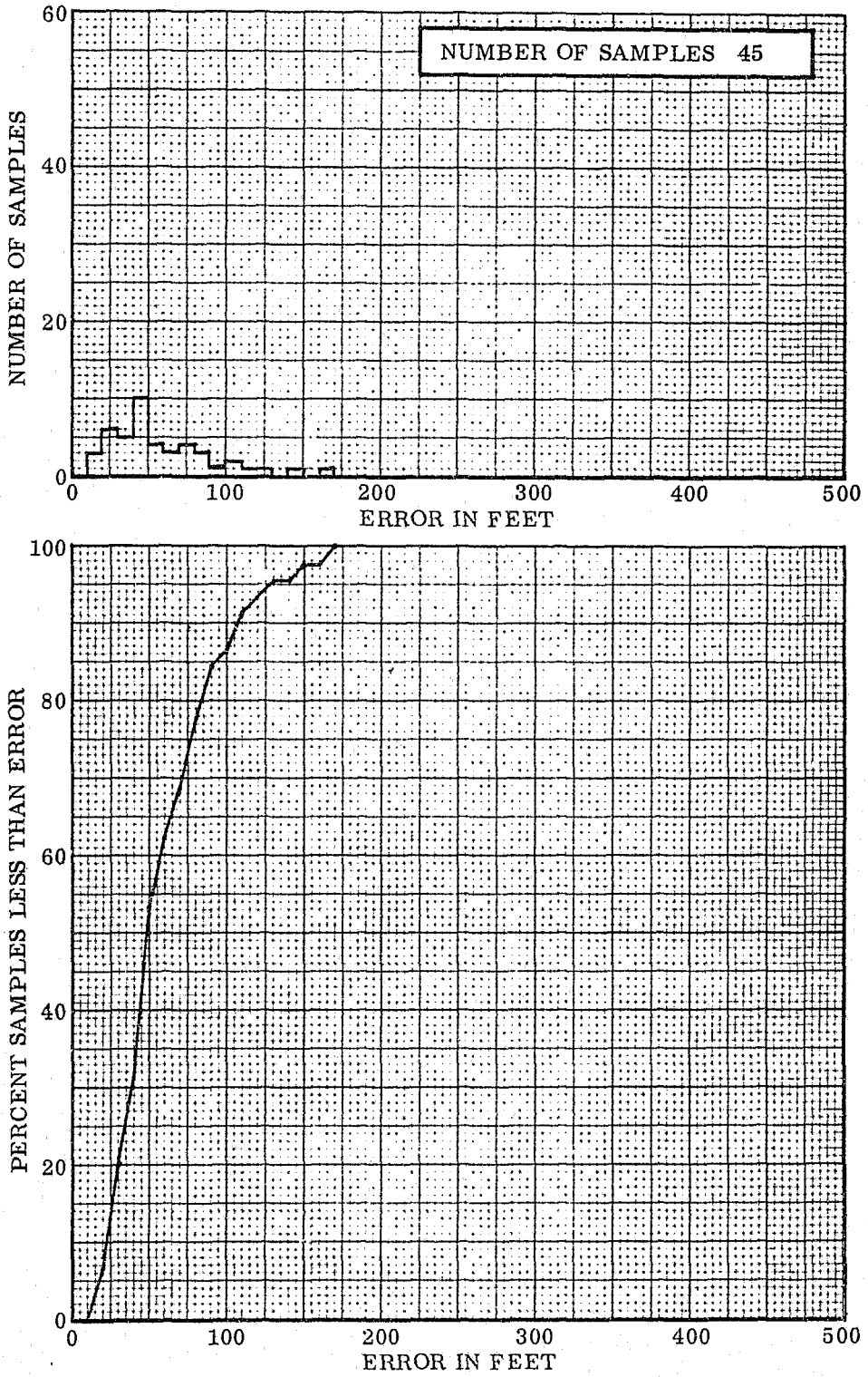


FIG. 8-10 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 20

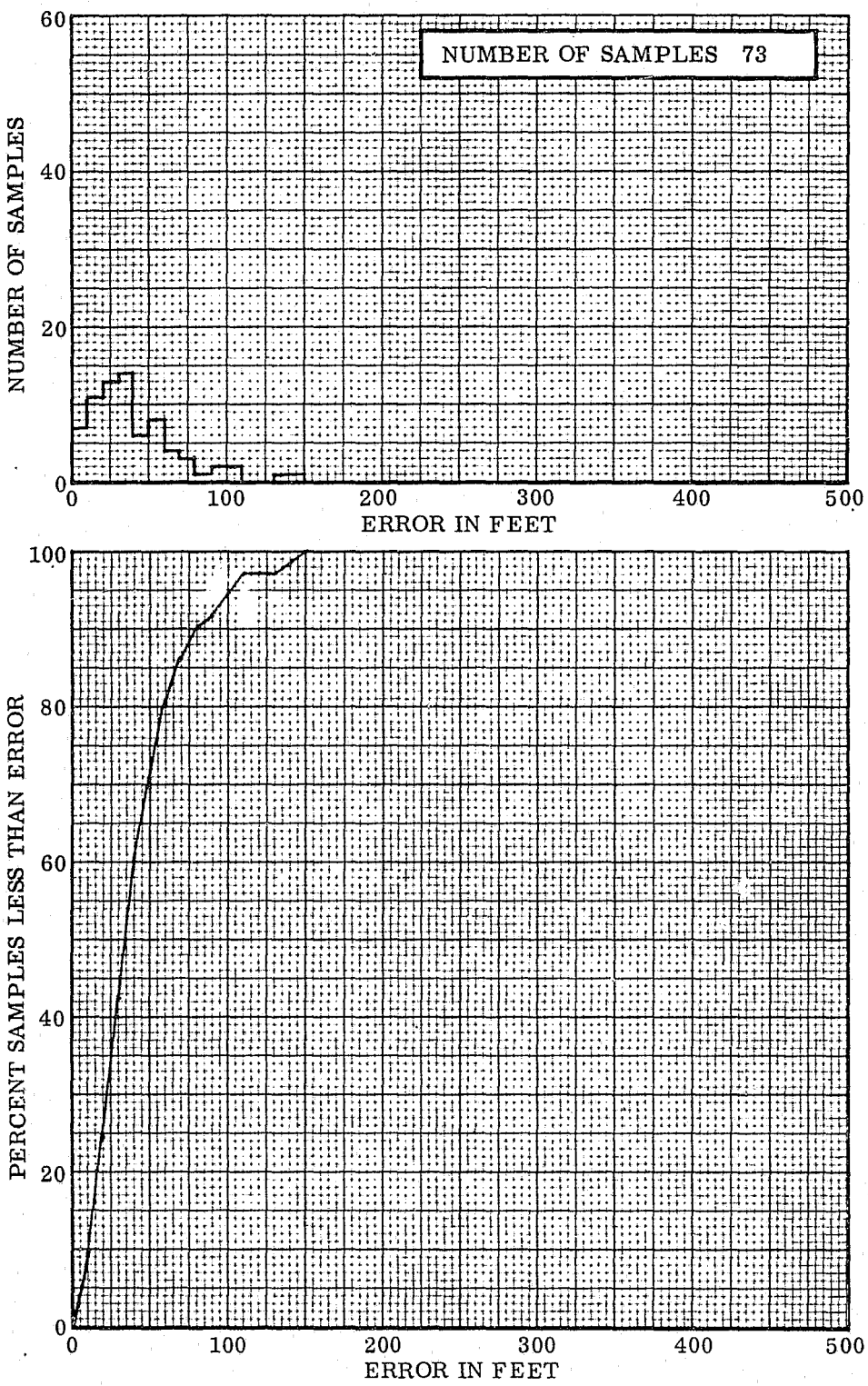


FIG. 8-11 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 21

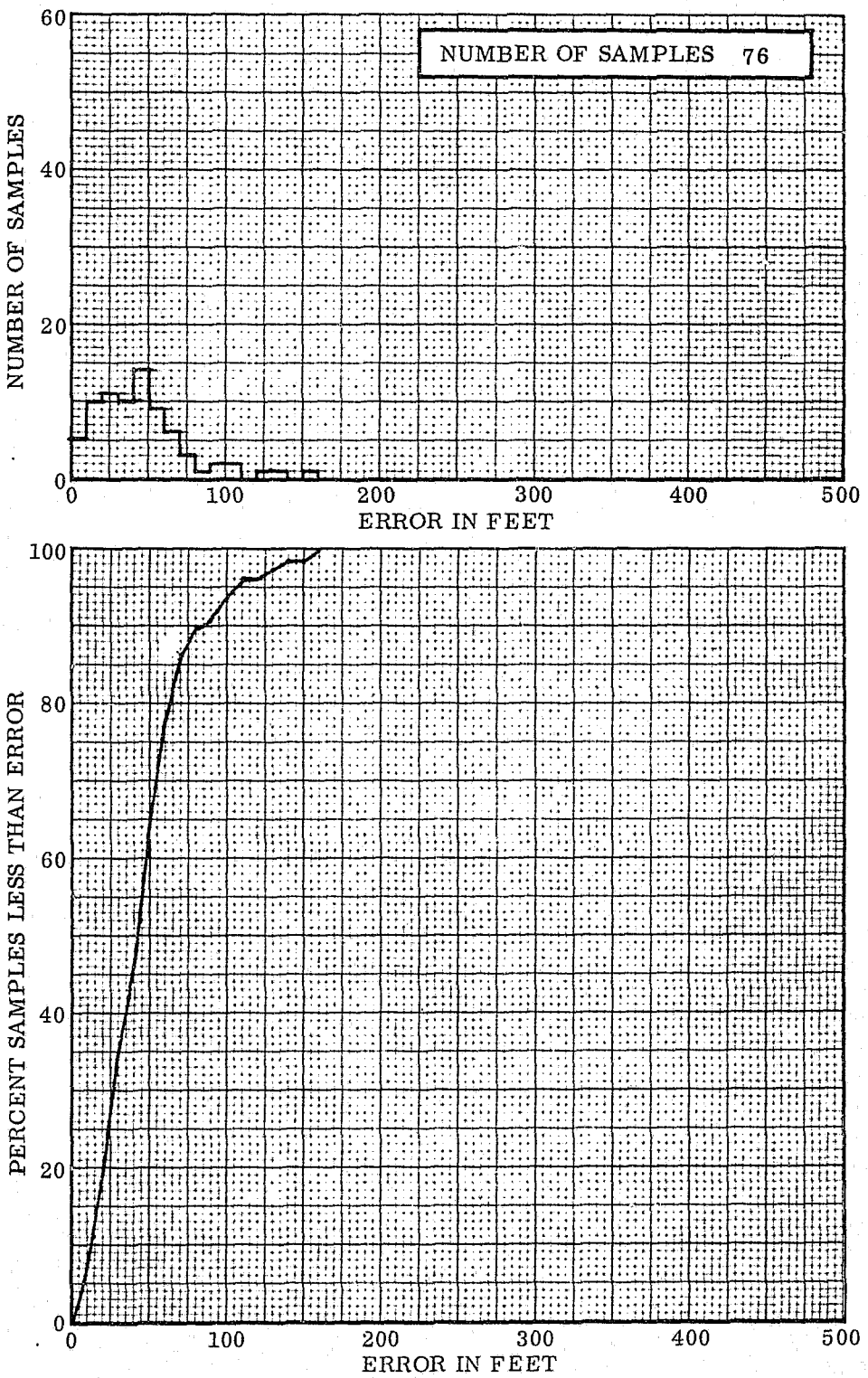
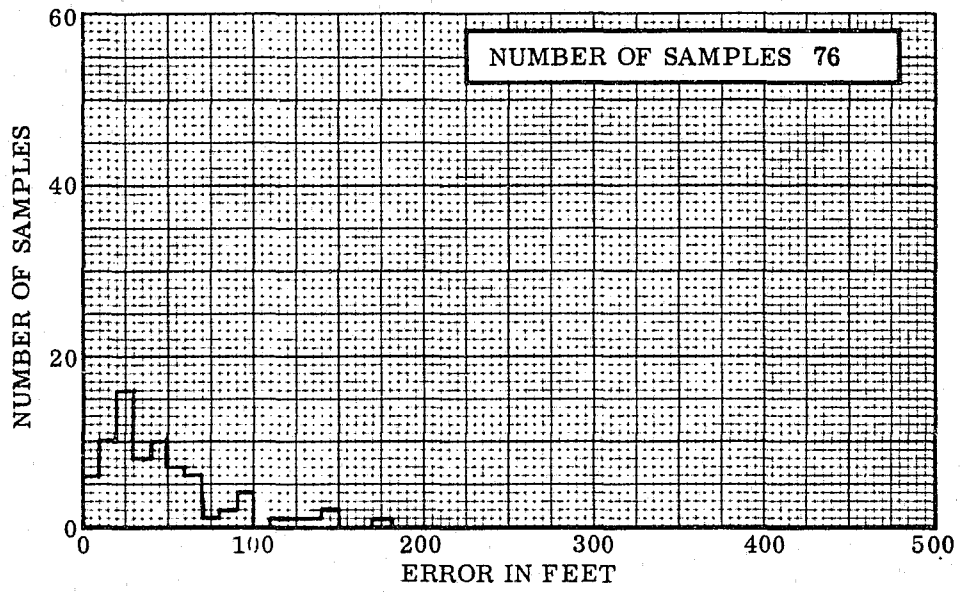


FIG. 8-12 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 22



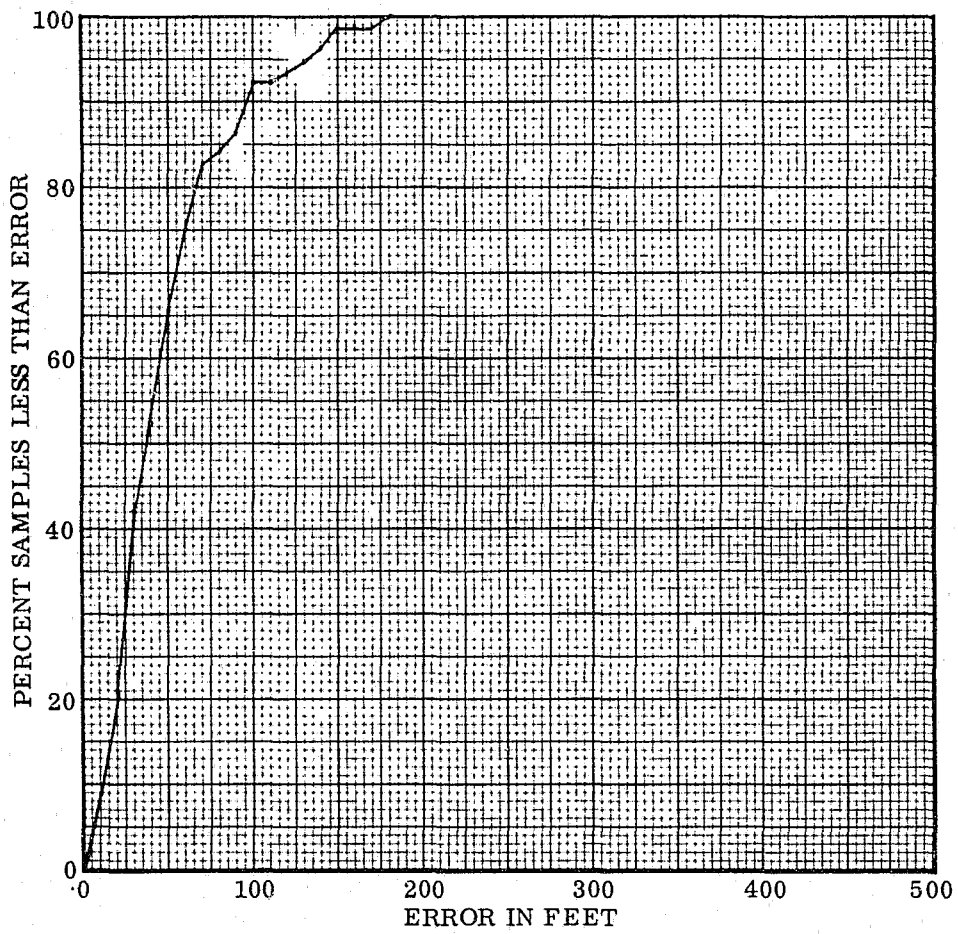


FIG. 8-13 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 23

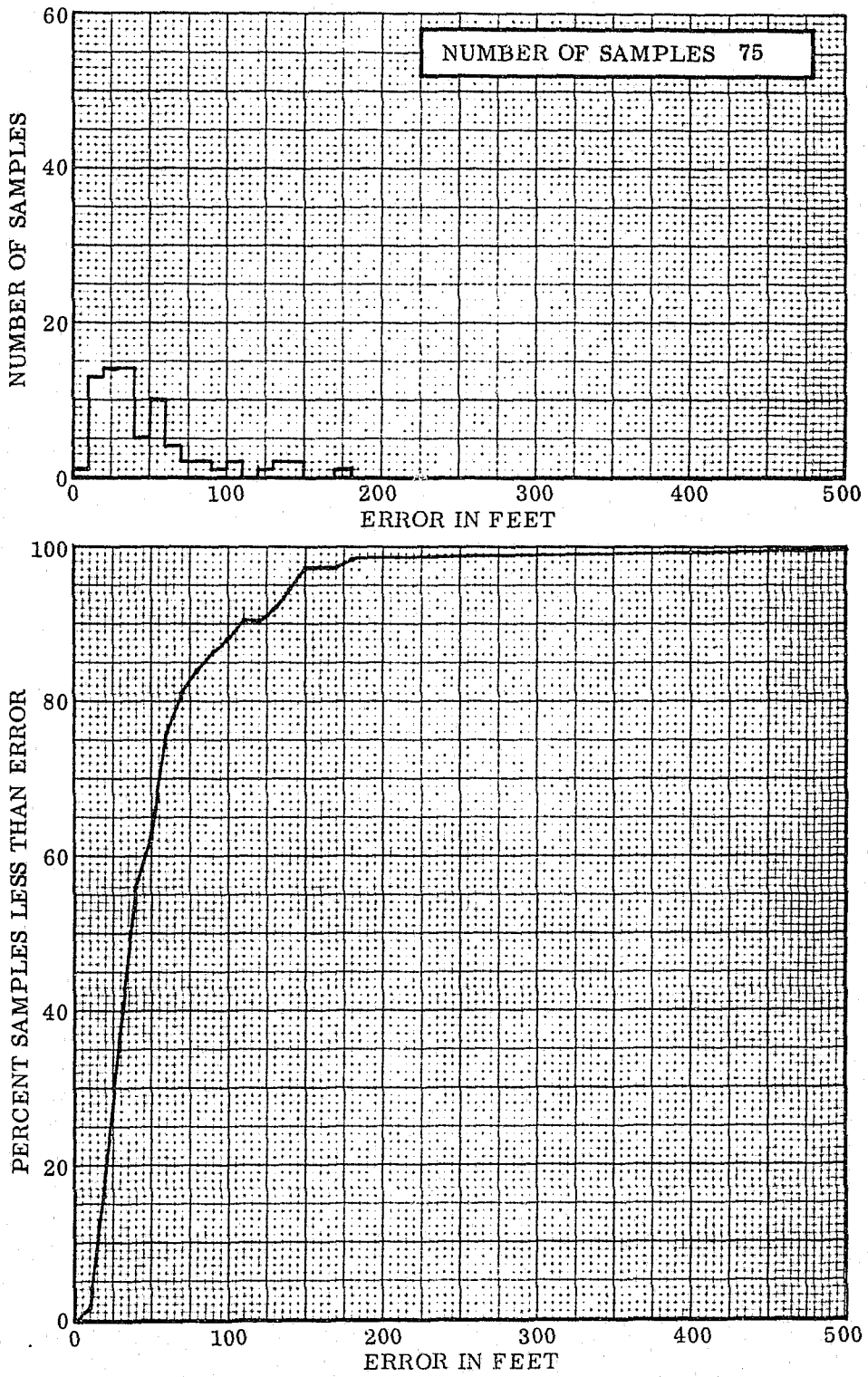


FIG. 8-14 FIXED ROUTE LOCATION SUBSYSTEM ERROR STATISTICS, RUN 24

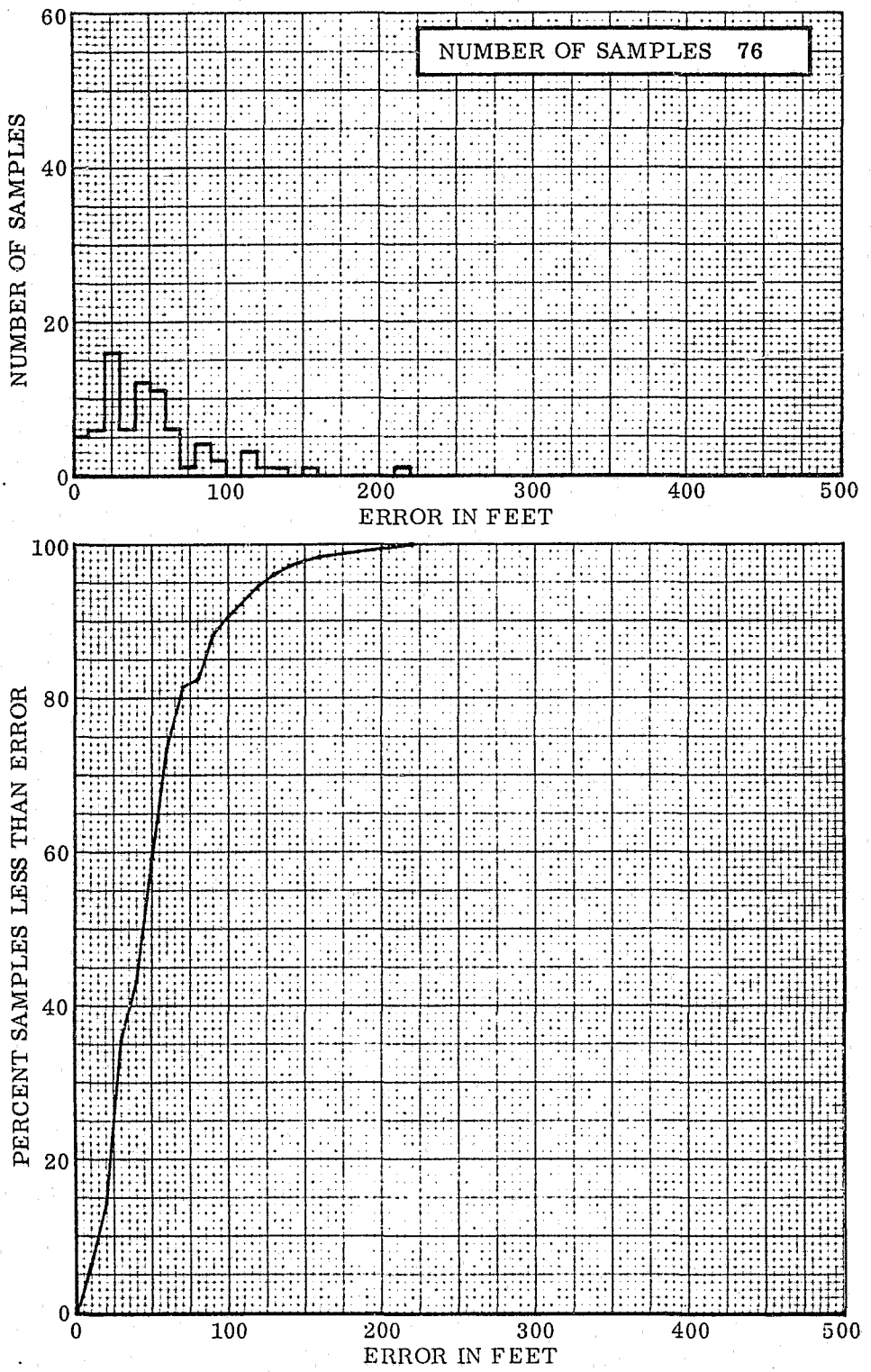


FIG. 8-15 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 25

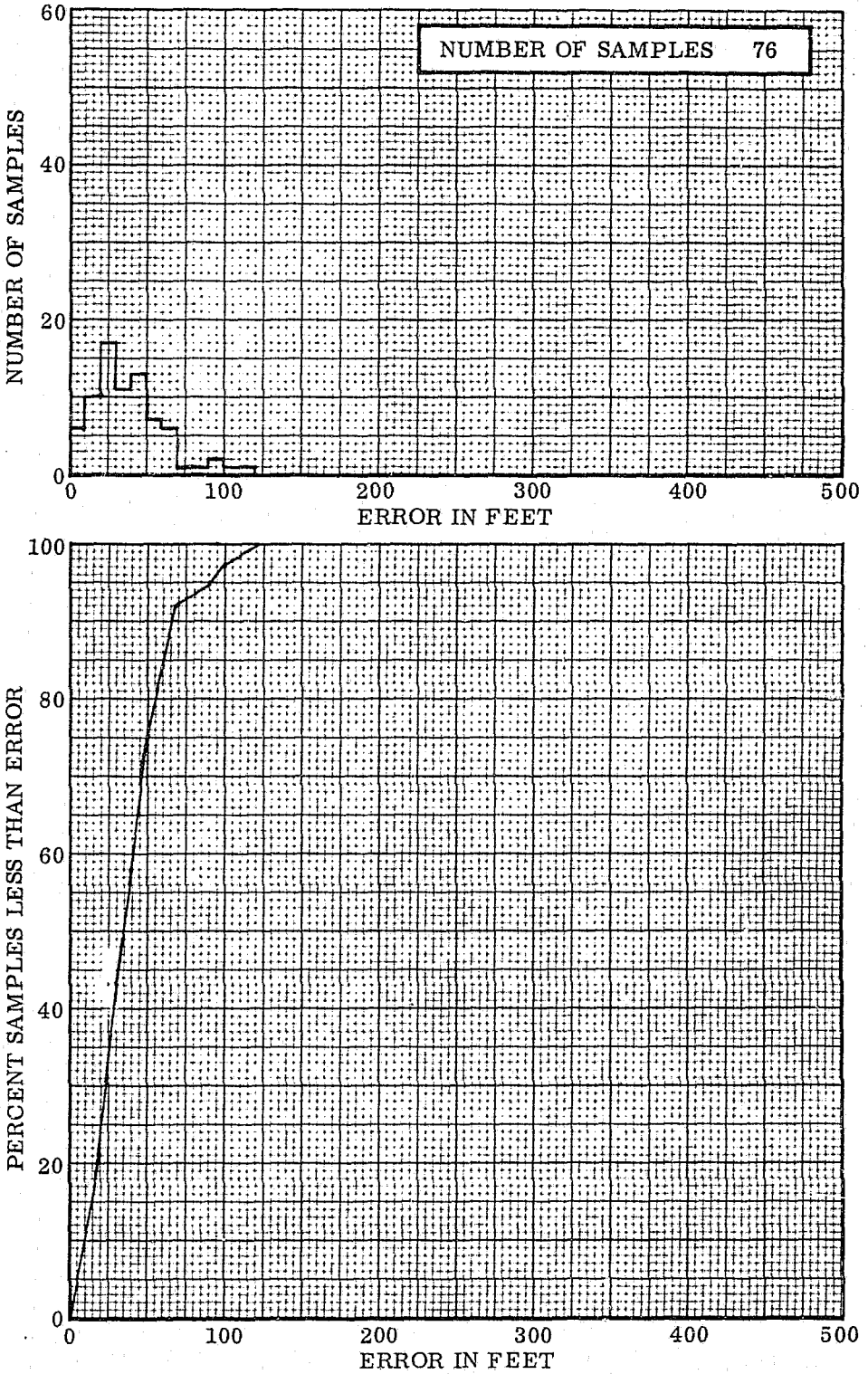
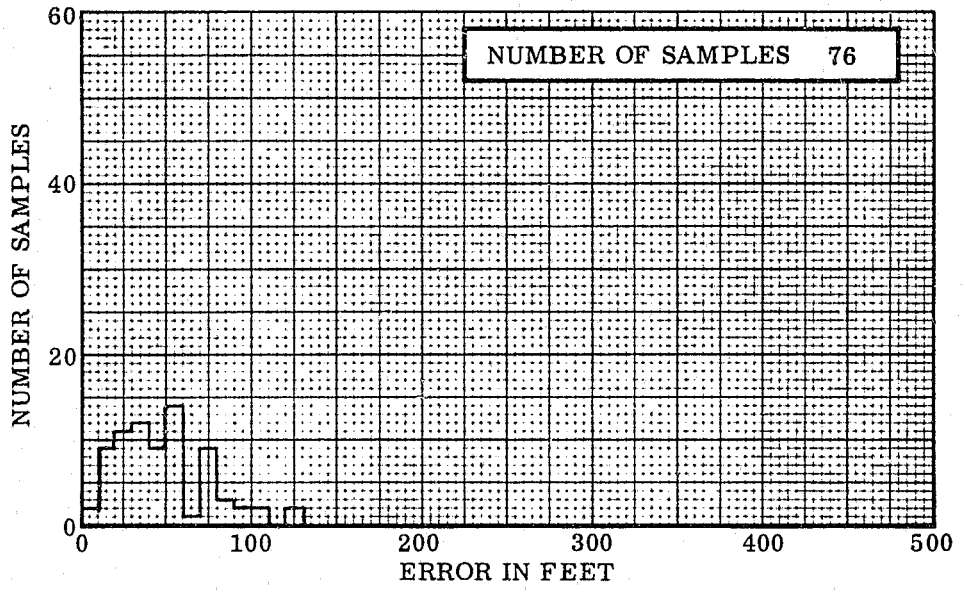


FIG. 8-16 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 26



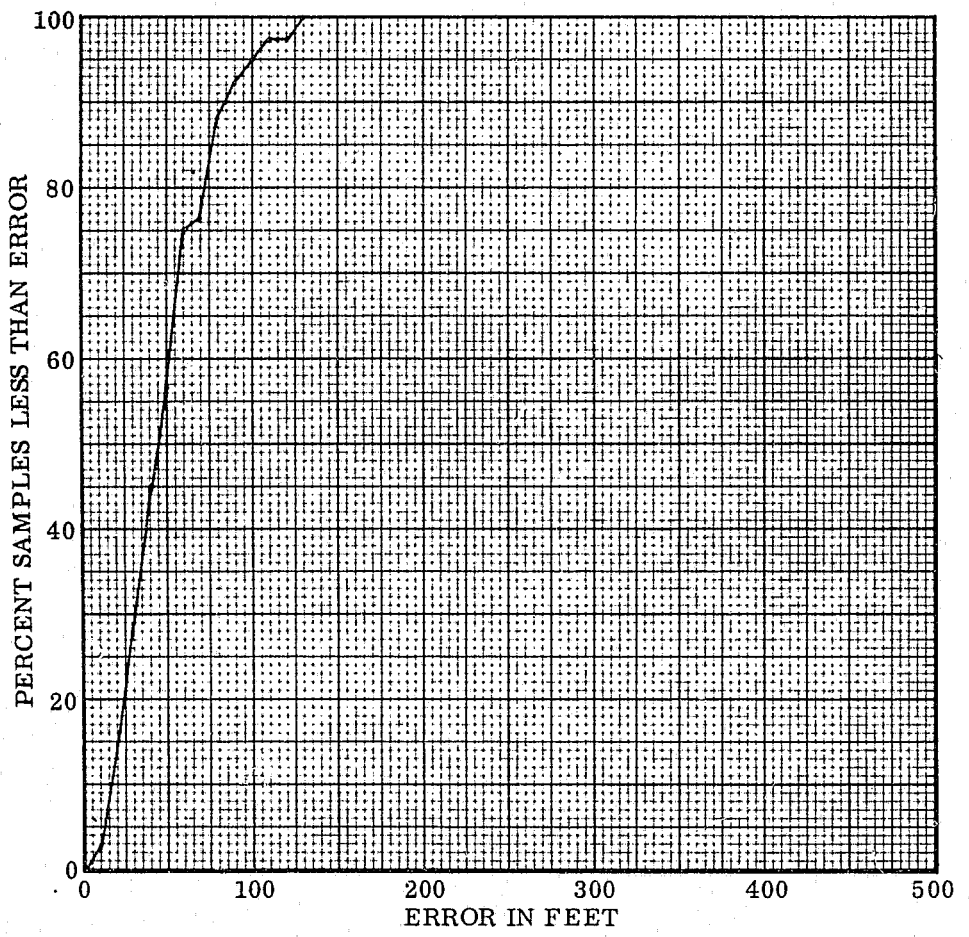


FIG. 8-17 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 27

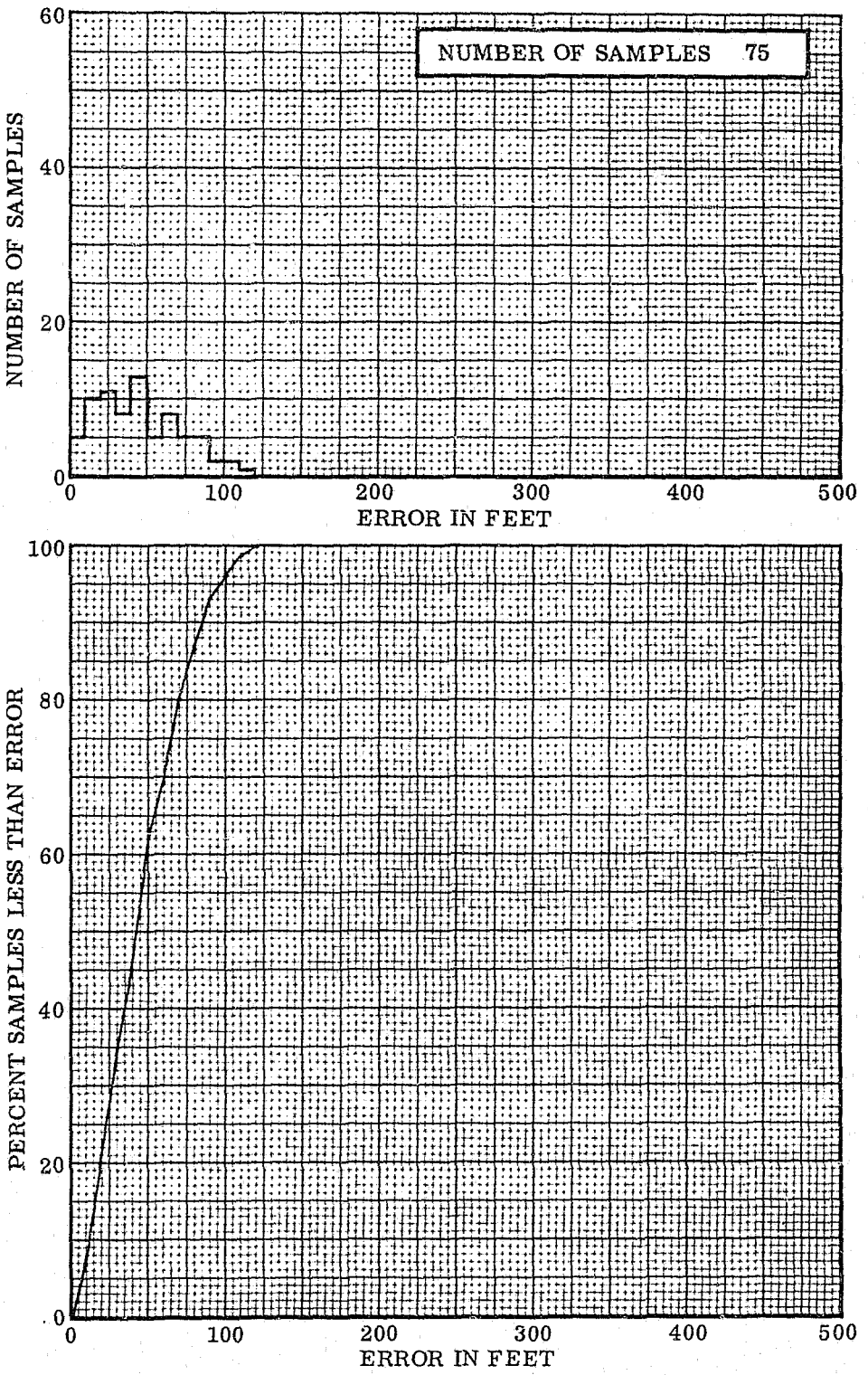
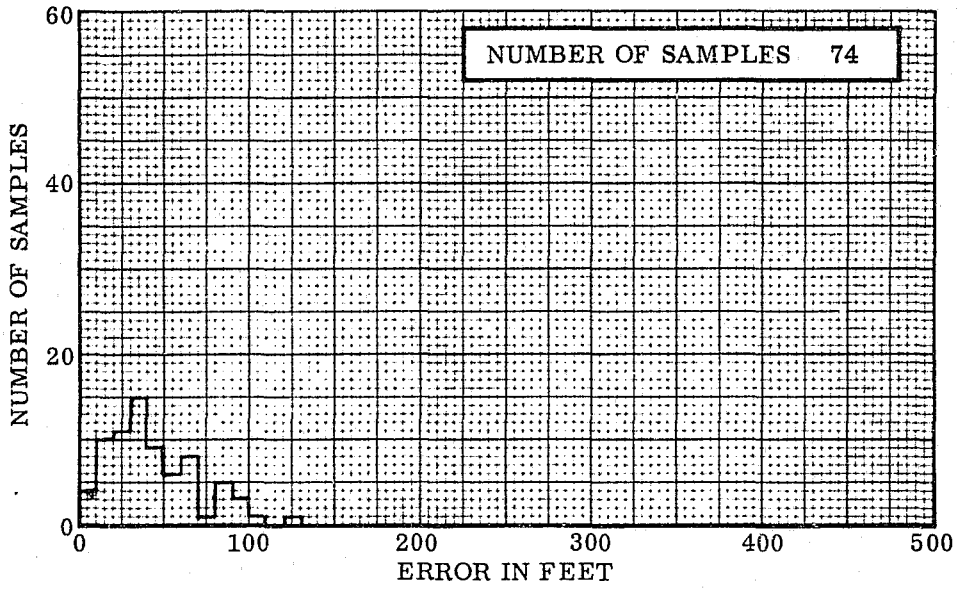


FIG. 8-18 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 28



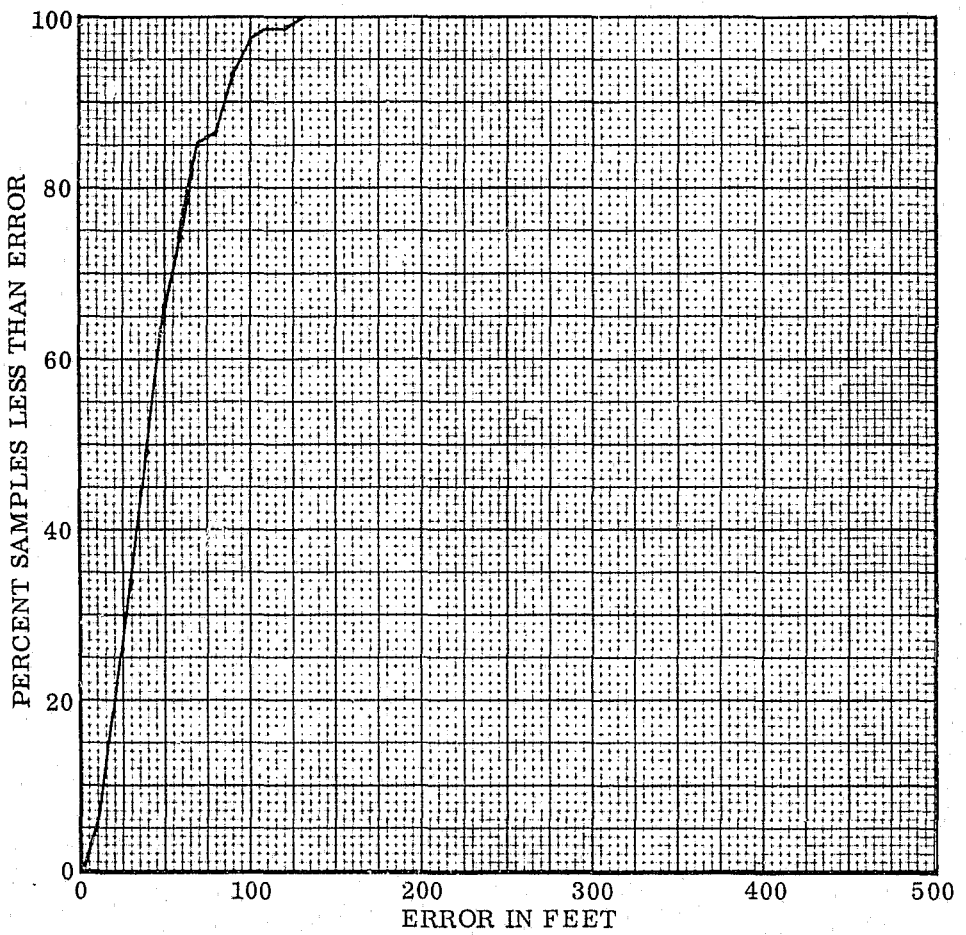


FIG. 8-19 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 29

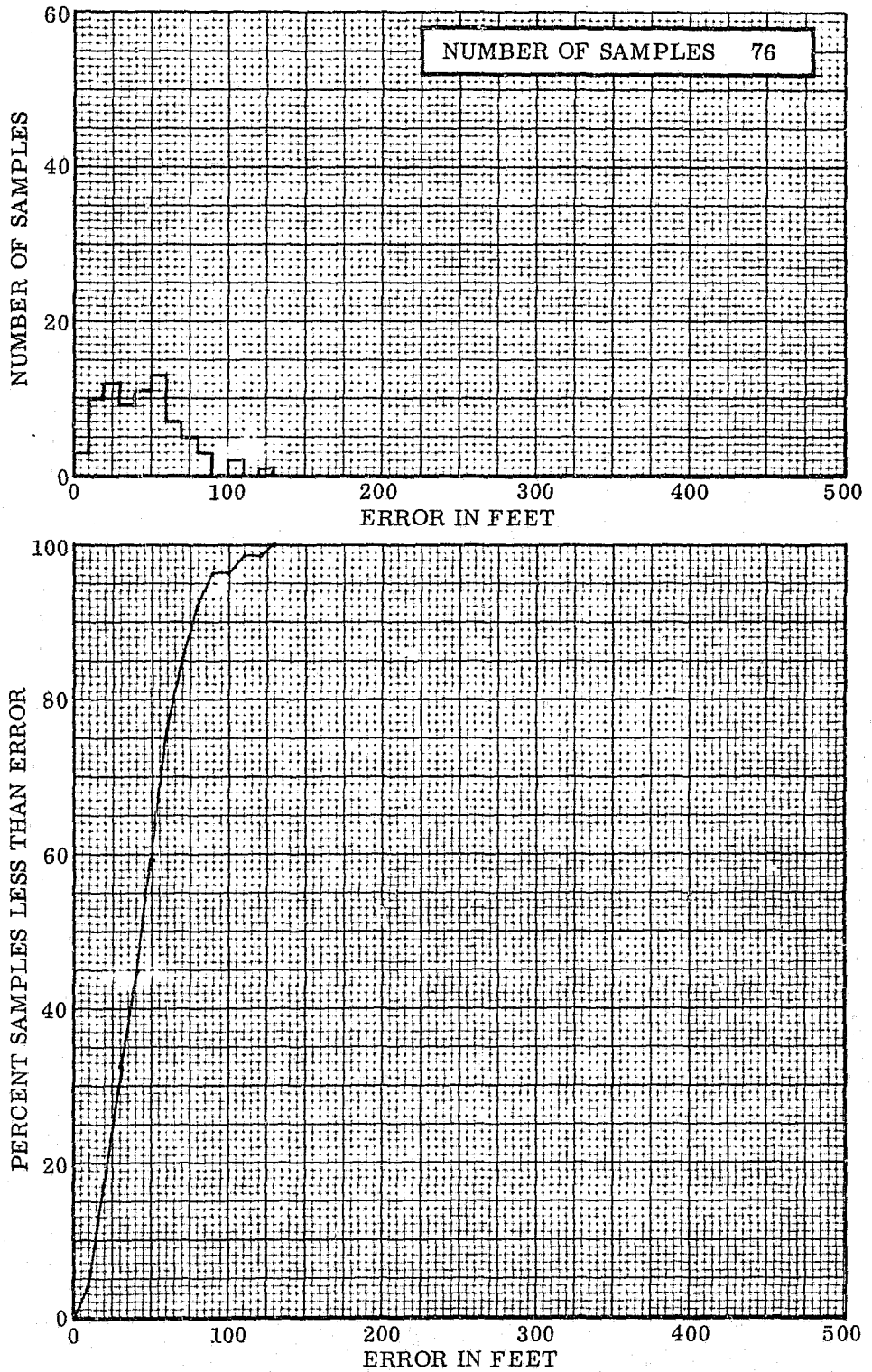


FIG. 8-20 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 30

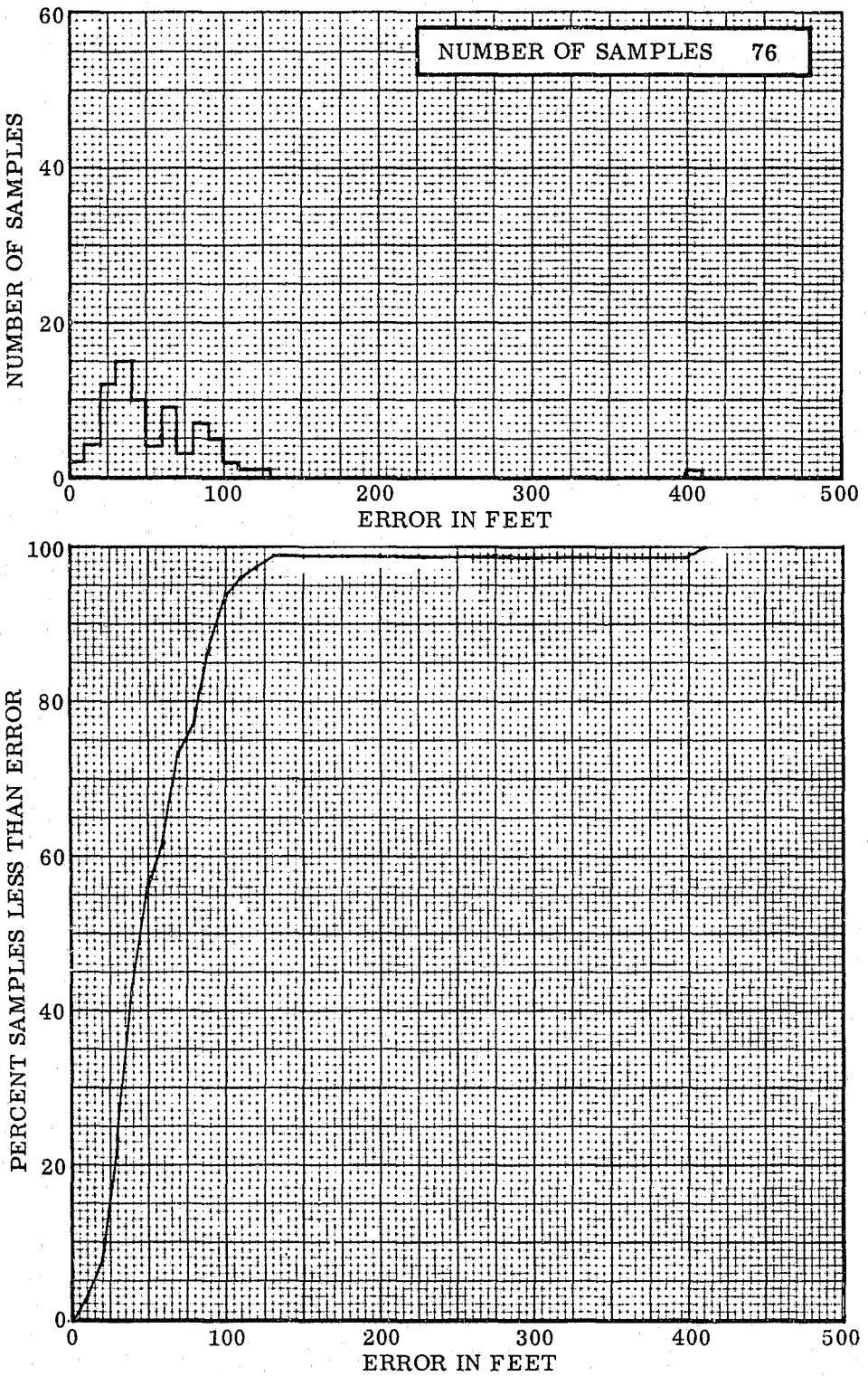


FIG. 8-21 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 31

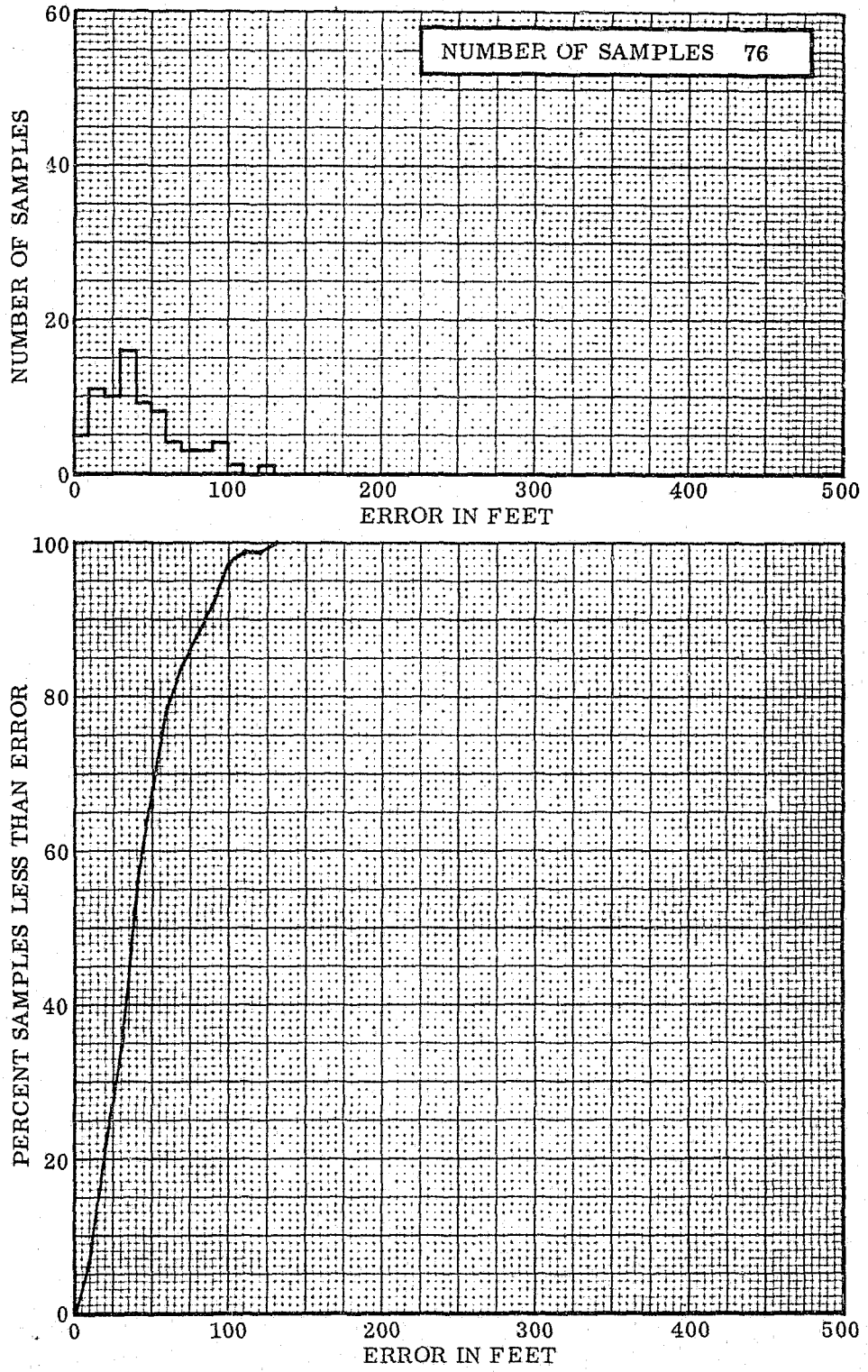


FIG. 8-22 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 32

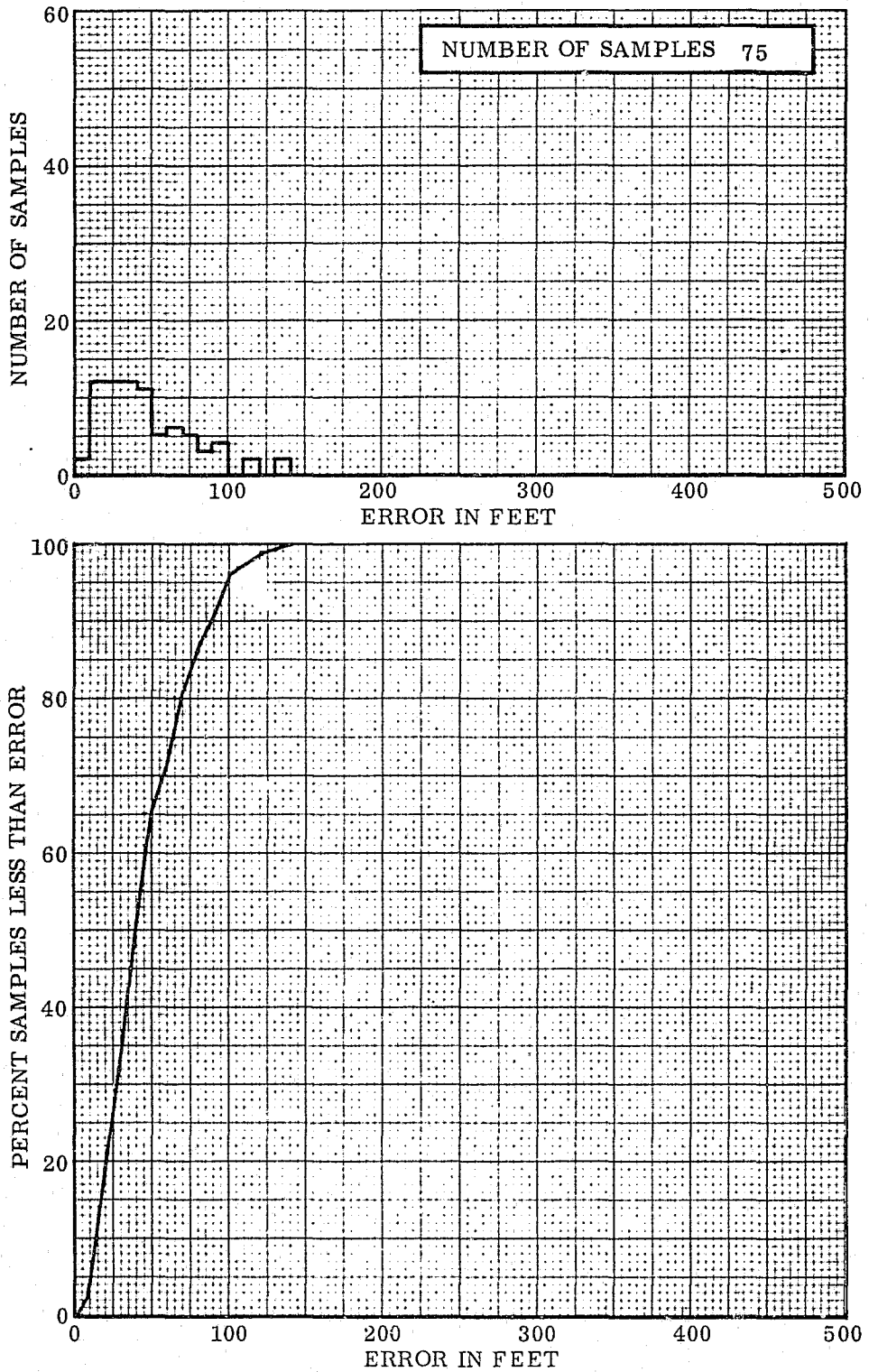


FIG. 8-23 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 34

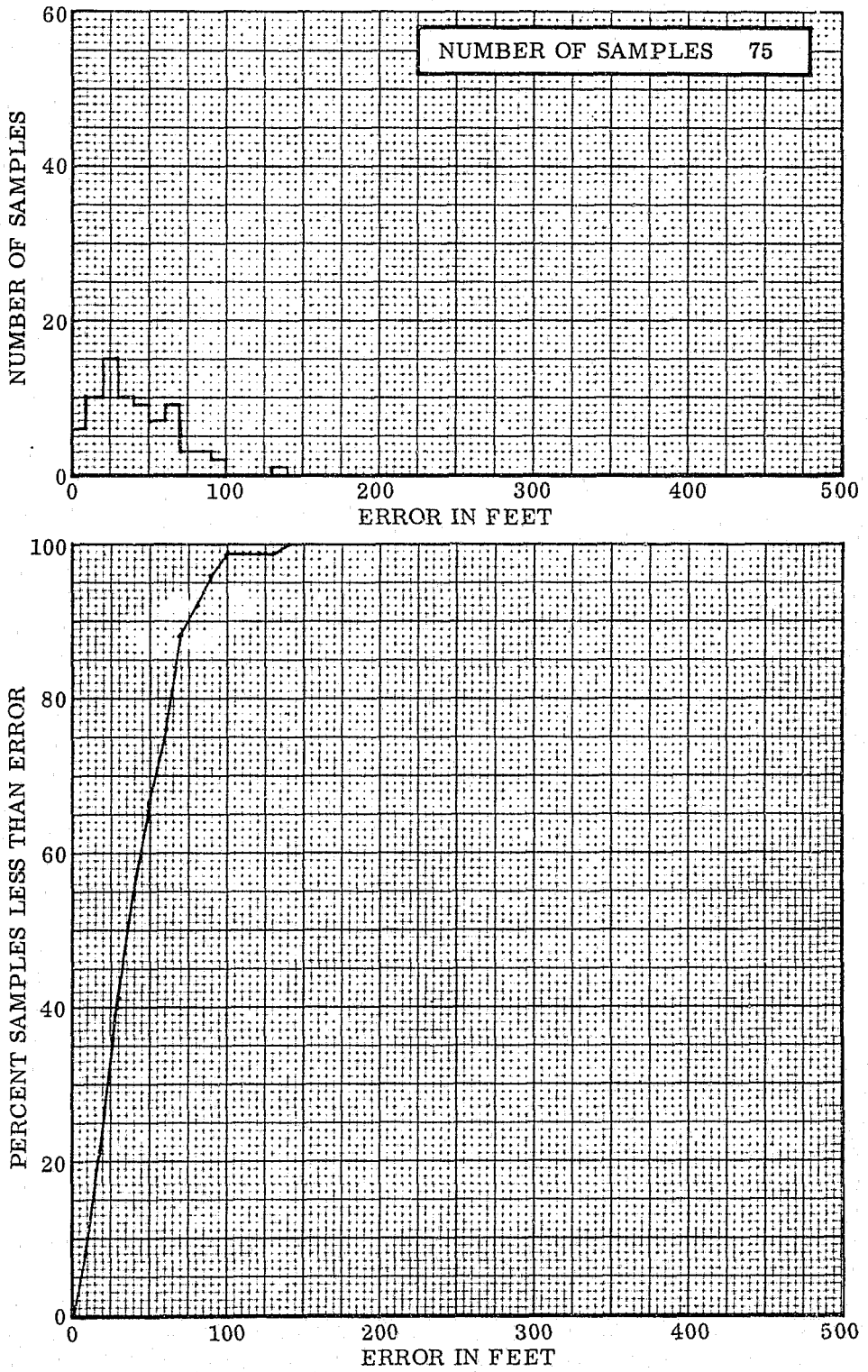


FIG. 8-24 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 35

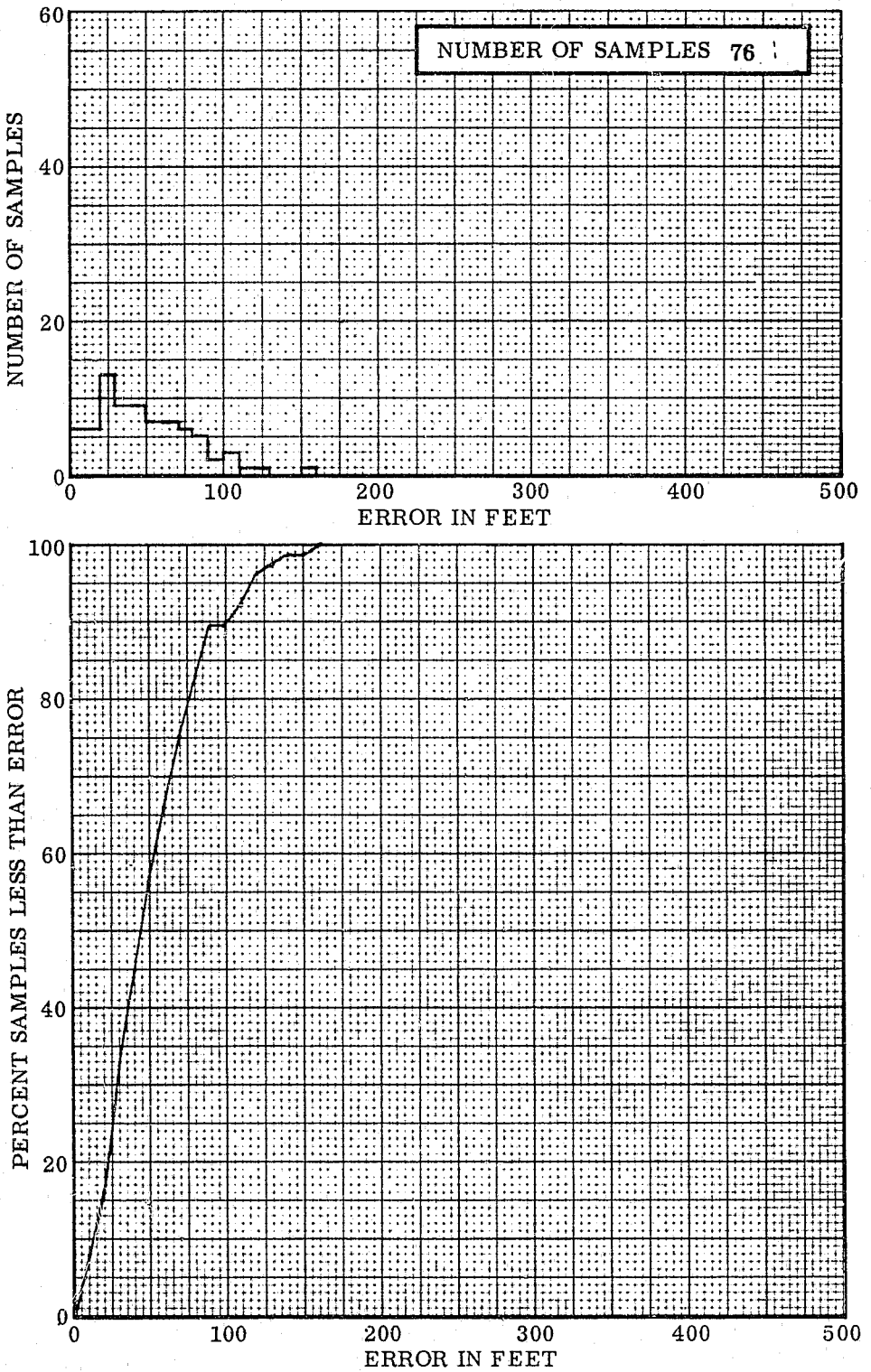


FIG. 8-25 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 36

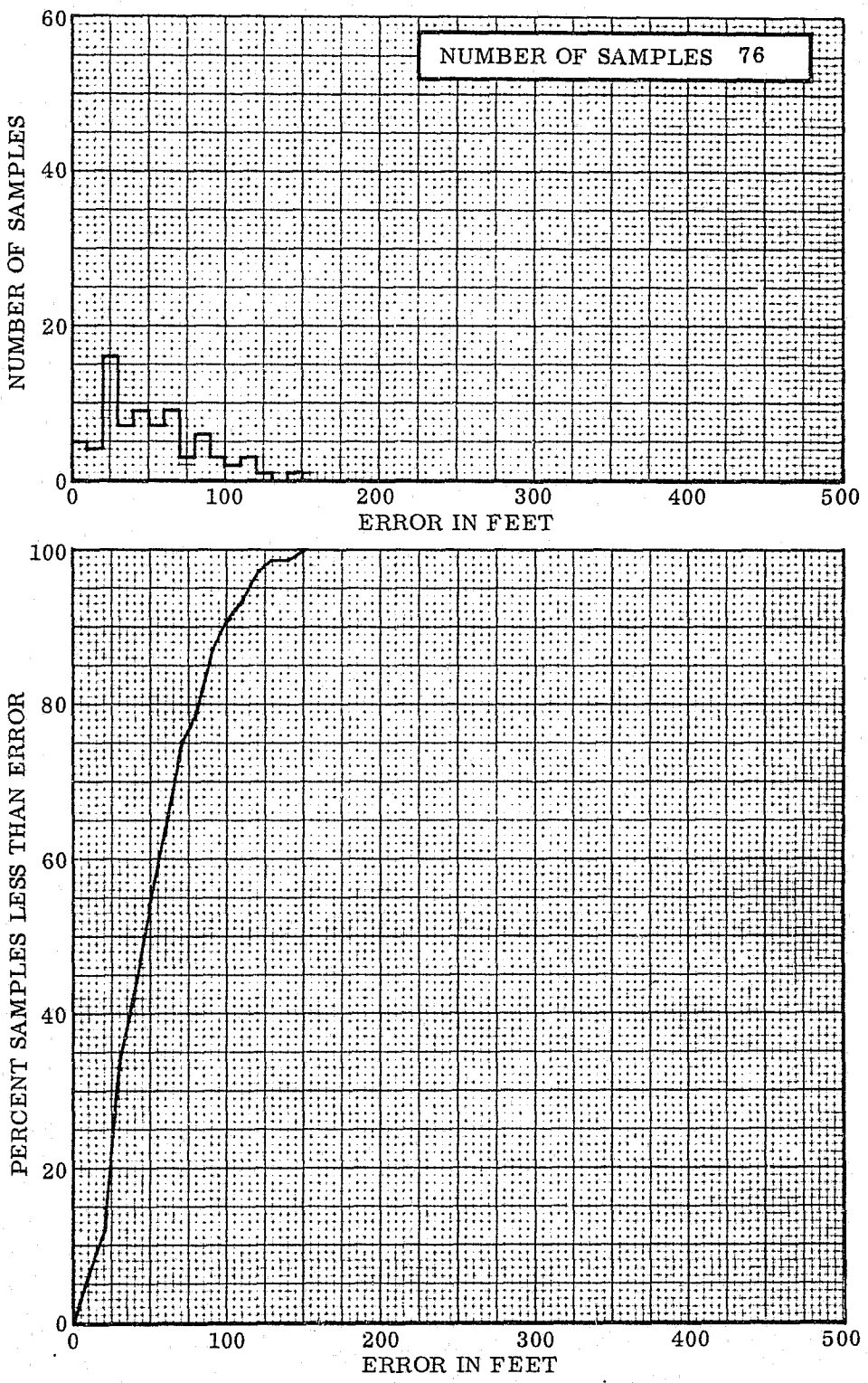


FIG. 8-26 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 37

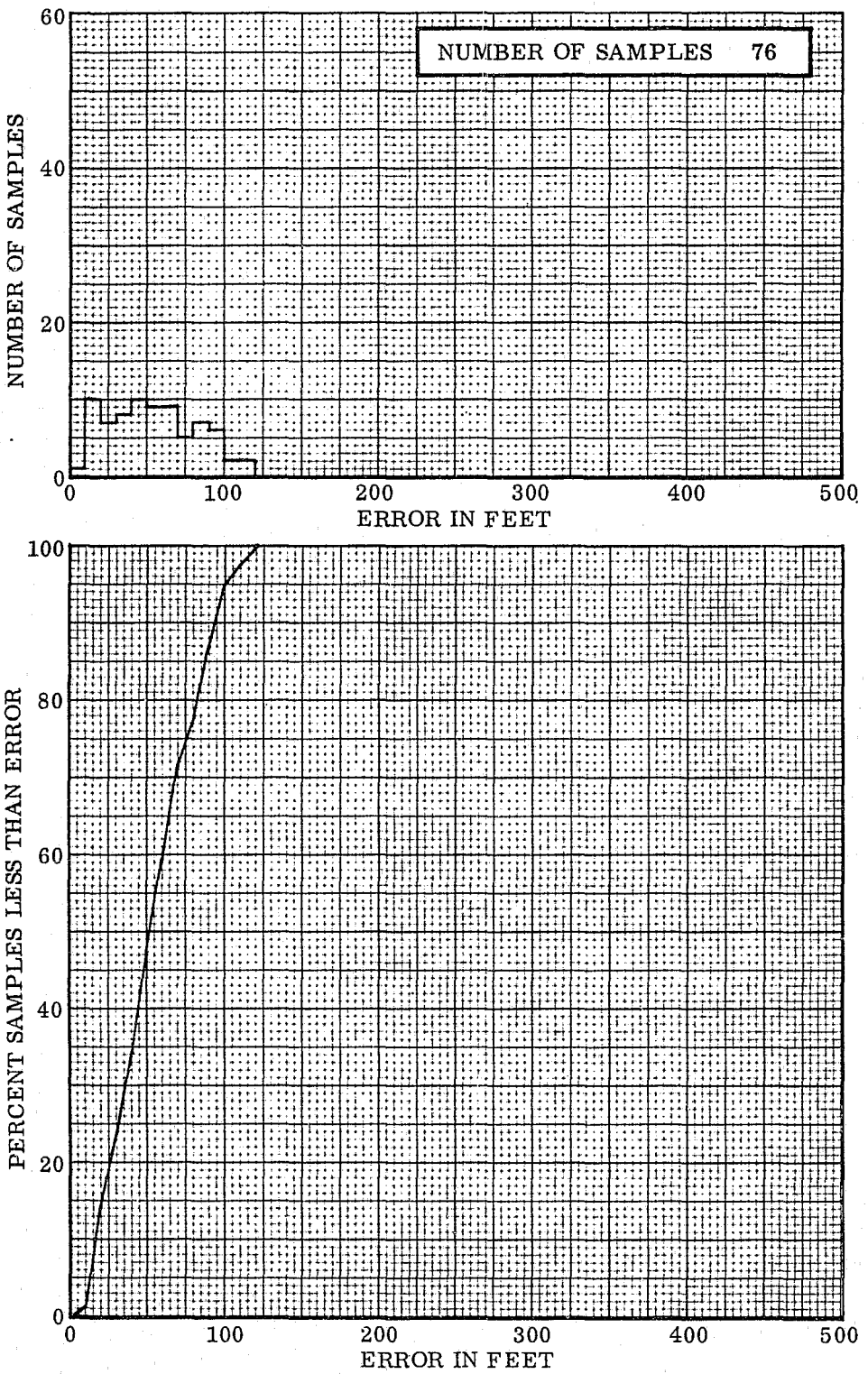


FIG. 8-27 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 38

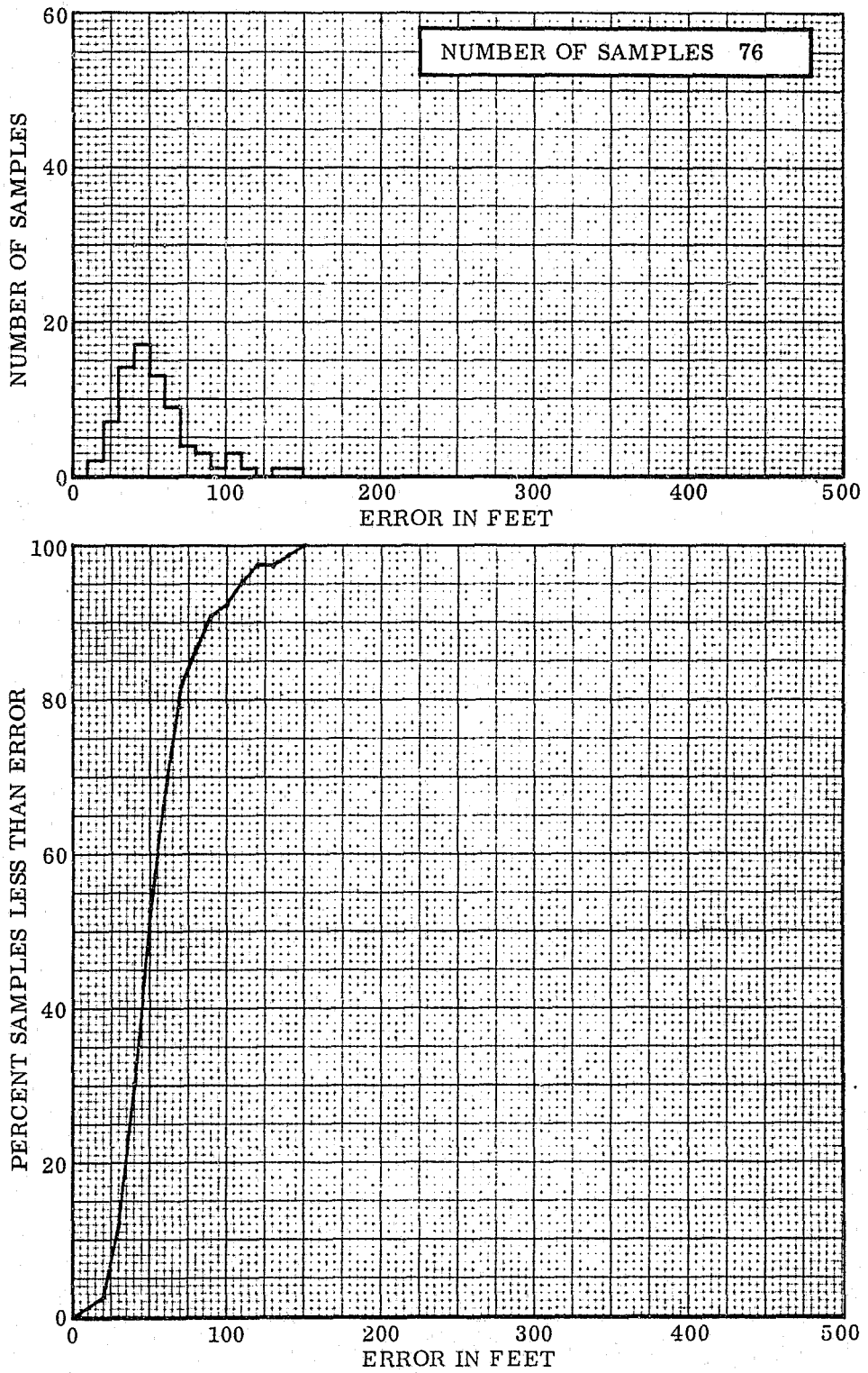


FIG. 8-28 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 39

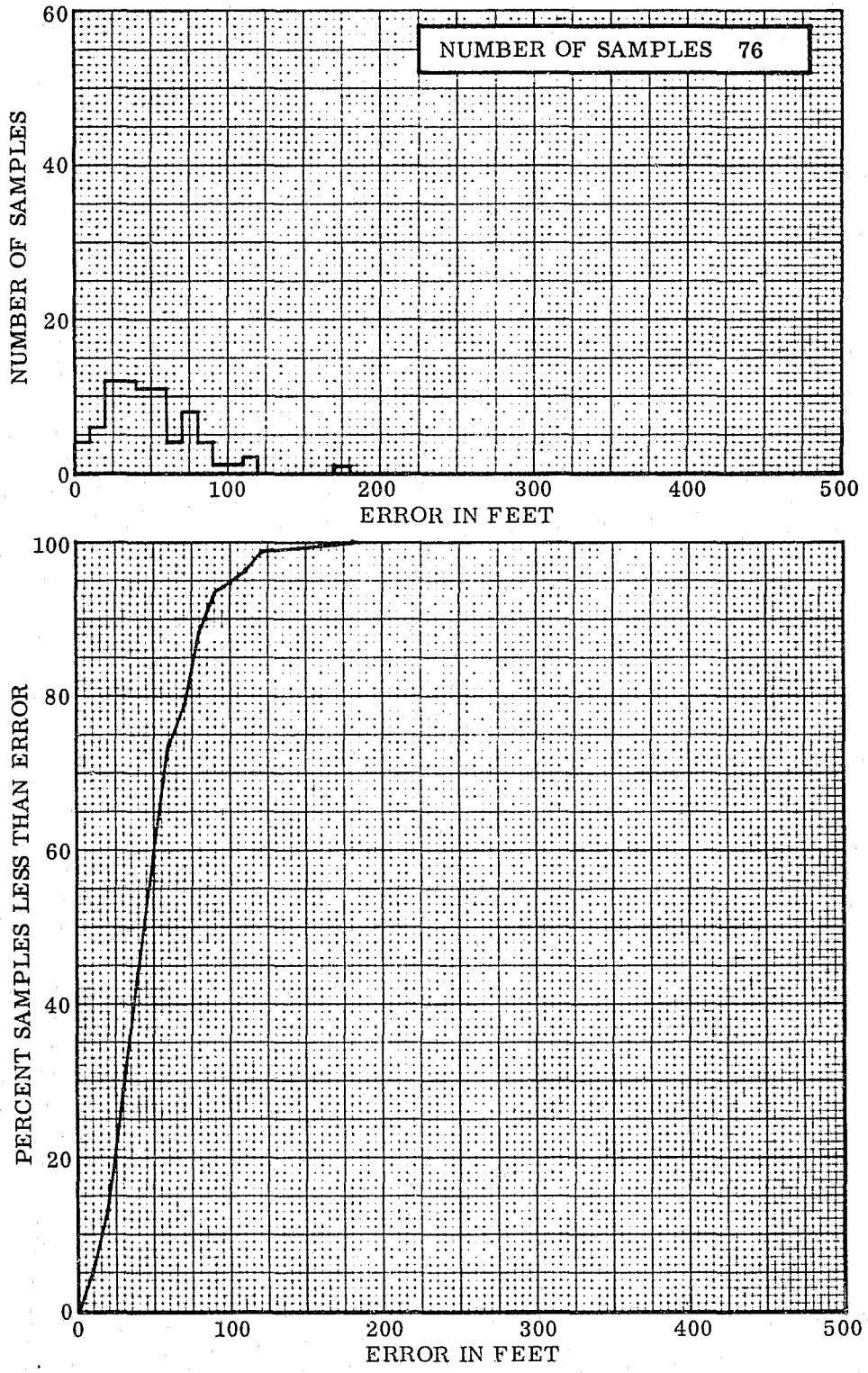


FIG. 8-29 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 40

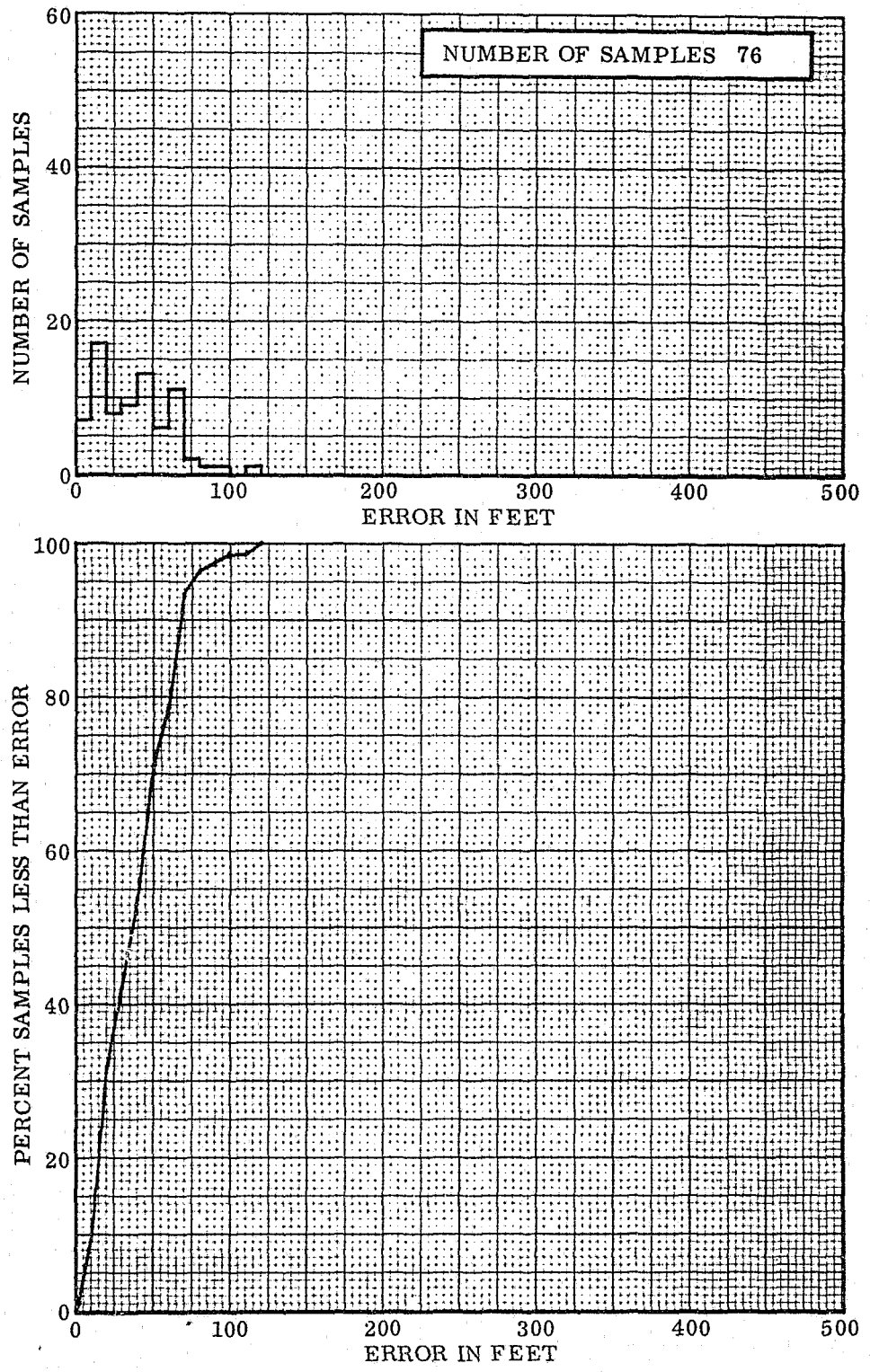


FIG. 8-30 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 41

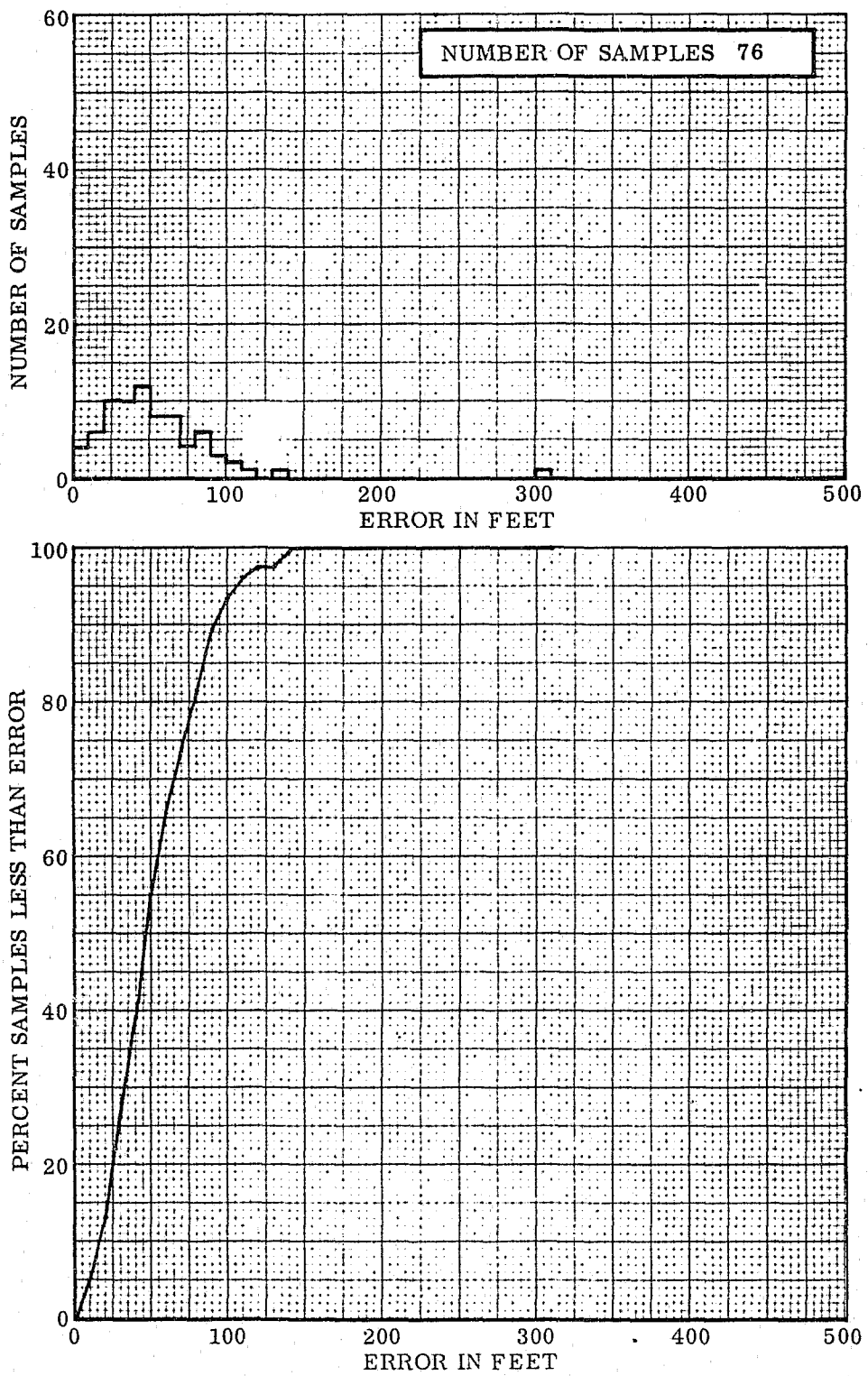


FIG. 8-31 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 42

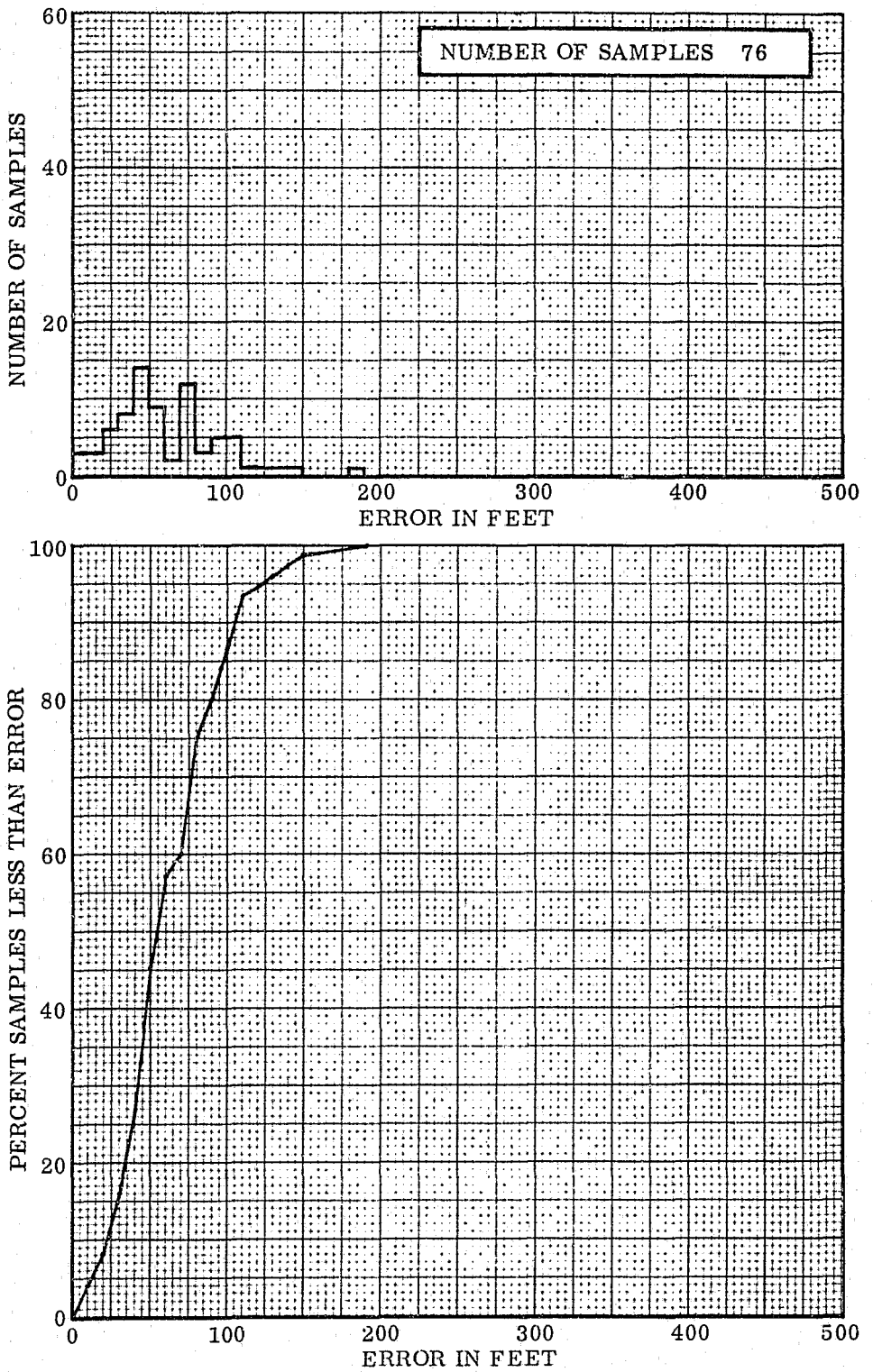


FIG. 8-32 FIXED ROUTE LOCATION SUBSYSTEM ERRORS, RUN 43

TABLE 8-4 AVERAGE ERRORS OVER ONE-TENTH MILE SEGMENTS
OF FIXED ROUTE RUNS 13 AND 18

RUN 13 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

28	25	18	16	14	13	4	34	25	31
59	61	60	43	44	19	2	36	65	87
76	57	23	39	60	30	17	47	49	49
45	45	42	26	14	20	17	39	105	85
80	73	115	142	155	31	34	49	71	52
40	50	58	54	34	29	13	24	19	10
* 23	52	55	36	16	36	71	19	27	38

CT1:RUN013.001

39	57	52	130	78	124	116	132	53	43
72	35	17	27	38	33	34	44	29	34
32	43	68	80	82	83	75	94	93	68
67	34	45	27	44	87	87	89	50	19
17	19	15	21	41	22	20	36	38	47
46	44	49	48	29	37	53	41		

RUN 18 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

57	58	59	52	42	41	5	27	42	29
51	59	60	52	47	37	16	34	106	111
98	71	45	63	87	28	18	54	54	47
33	31	28	30	14	11	27	42	85	72
66	57	93	51	41	20	25	39	54	37
48	45	54	49	32	28	16	32	25	15
* 21	49	51	38	20	44	88	45	53	59

CT1:RUN018.001

56	61	39	256	55	105	106	142	38	46
63	23	19	27	30	31	34	47	35	32
27	33	53	69	68	70	64	71	72	65
65	55	55	30	44	92	104	104	95	31
30	29	18	23	42	24	15	19	19	36
33	24	24	24	18	10	29	57		

TABLE 8-5 SUMMARY RESULTS OF ONE-TENTH MILE SEGMENTS, FIXED ROUTE

Run No.	Max Avg. Error (feet)	Segment Number	Run No.	Max Avg. Error (feet)	Segment Number
11	116	43	27	113	76
12	121	107	28	169	77
13	155	145	29	159	43
14	999**	75	30	135	43
15	127	74	31	390*	10
16	140	43	34	159	43
17	113	20	35	140	43
18	256	74	36	152	77
20	154	74	37	133	84
21	155	44	38	108	20
22	149	42	39	126	43
23	169	77	40	109	43
24	158	77	41	105	53
25	123	42	42	122	43
26	156	61	43	137	76

* 5th wheel error between CP2 and CP4 caused large error during segments 10 and 11.

** As noted in Table 6-5, and as recorded on the Run 14 log sheet, TA16 was erroneously not entered during Run 14. As noted in Table 4.3-2 of the Appendix, TA16 was inserted via card input during processing with the FRSYS routine. Inadvertently, however, the card input was not used when FRTEN was used to process Run 14. This allowed large errors to be generated when the vehicle was between TA16 and TA17. The fifth wheel value at TA17 was 6.64 miles. The three one-tenth mile segments which indicate large errors on Run 14 are the three segments ending in 6.4, 6.5, and 6.6 miles respectively. The street segment between TA16 and TA17 is 1466 feet in length which includes the three effected one-tenth mile segments which exhibited maximum errors of 743, ***, (the computer prints out *** if 999 feet is exceeded), and 752 feet respectively. As a result of the obvious card input error, these three large values may be disregarded as resulting from a data recording/processing error rather than an AVM error.

This error was discovered just prior to submittal, coincident with the unavailability of the HI^3 computer at Fort Worth.

summary of these data. The Appendix contains individual results obtained for each run. Note that of all data processed, the largest average error on any one-tenth mile segment on any run was 256 feet, nearly 200 feet less than the AVM specification.

8.2 AVM SYSTEM TEST RESULTS

The results obtained by simulating a complete AVM system through imposition of a 20-second polling interval and 5 percent communication errors are presented in this subsection. The timepoint performance results are also presented.

8.2.1 AVM System Vehicle Location

The results obtained by processing fixed route data through use of the FRSYS routine are summarized in Table 8-6. The cases in which no communication errors were present and in which a 5 percent communication error rate was simulated are both presented. Data processing problems associated with use of the FRSYS program are described in Table 8-7 and in subsection 8.3.

A total of 7,139 pseudo checkpoint samples were processed through the FRSYS routine. Runs 19 and 33 could not be processed. Run 20 (power failure and Run 32 (magnet lost from fifth wheel) were not processed. Table 8-7 summarizes all such problems associated with system level processing. A total of 320 pseudo checkpoints were processed manually, for a grand total of 7459 pseudo checkpoint samples. During the recording of fixed route test data it was observed that a total of 5 turns (TA events) were erroneously recorded or not recorded at all on six runs. In order to run these tapes through FRSYS (and FRTEN), card input data had to be utilized so that each and every TA event was available for processing each run. In cases in which a TA was not recorded on tape, it was inserted by use of one of the following processes:

1. On Run 14, TA 16 was inserted 478 feet (on the fifth wheel) after CP 35.

2. On Run 16, TA 24 was inserted 54 feet (on the fifth wheel) after TD 11.

3. On Run 21, first occurrence of TA 16 changed to TA 6.

4. On Run 24, TA 33 was deleted.

5. On Run 27, first occurrence of TD 10 changed to TA 10.

Items 1, 2, and 3 were noted on their respective data logs at the time of occurrence. Items 4 and 5 were not discovered until a dump of the recorded data was examined. All fixed route data processing anomalies are discussed in subsection 8.4.

TABLE 8-6 FIXED ROUTE AVM SYSTEM LOCATION ACCURACY RESULTS

Run No.	No. of Pseudo Checkpoints Processed	No Communication Errors			5% Communication Errors		
		Average Error (feet)	95% Error (feet)	99.5% Error (feet)	Average Error (feet)	95% Error (feet)	99.5% Error (feet)
11	307	48.96	104	150	48.63	104	150
12	306	51.48	106	138	50.75	106	138
13	283	48.78	111	177	48.98	111	177
14	234	44.88	98	108	44.74	98	108
15	219	46.14	125	131	46.06	125	131
16	200	41.22	97	123	40.78	97	123
17	260	43.43	94	121	42.82	94	121
18	322	53.05	108	303	53.61	108	303
19	*						
20	**						
21	272	42.59	128	165	43.36	128	165
22	239	45.50	125	140	46.87	125	140
23	252	47.70	127	169	48.57	127	169
24	239	51.25	146	177	51.25	144	177
25	241	50.17	133	216	50.76	135	227
26	238	43.62	105	188	44.30	107	188
27	240	43.20	96	126	42.23	101	126
28	259	39.30	82	116	39.85	103	125
29	261	39.97	90	123	40.01	90	123
30	257	43.50	82	110	43.70	88	110
31	259	54.62	129	407	54.37	129	406
32	***						
33	*						
34	289	41.22	87	199	40.80	87	199
35	255	39.05	83	128	38.74	87	128
36	229	47.85	109	154	48.20	116	154
37	247	50.84	117	151	51.07	117	151
38	222	54.62	91	867	53.75	91	867
39	281	55.81	109	383	55.82	109	383
40	269	46.50	90	267	46.58	90	267
41	329	37.26	80	116	37.37	80	116
42	231	45.44	94	150	44.80	94	150
43	225	58.52	138	243	58.46	138	243
Total	7459	48.09	105	188	46.79	105	188

* Bad Tape
** Power Failure
*** Lost Magnet

TABLE 8-7 FIXED ROUTE DATA PROCESSING ANOMALIES (FRSYS)

RUN NO.	PROBLEM	RESULT
14	Missed TA 16	Inserted TA 16 at FIFTH = 33678 feet*
16	Missed TA 24	Inserted TA 24 at TD 11**
19	Bad Tape, Couldn't dump in vehicle	No Results
20	Generator Stalled	Not Processed
24	TA 33 entered in error	Deleted TA 33
	Couldn't read past CP 62	39 PCP's Processed Manually
31	5th Wheel problem between CP3 and CP 4	406 foot errors ***
32	Lost magnet during run	Didn't process
33	Bad Tape, Couldn't dump in vehicle	No Results
34	Couldn't read past CP 37	122 PCP's Processed Manually
37	CP 30 entered in error	Deleted 2nd CP 30
38	CP 71 entered in error	Deleted 1st CP 71
40	Couldn't read past CP 36	119 PCP's Processed Manually
42	CP 40 Entered in error	Deleted 1st CP 40

* The value of FIFTH was estimated by adding the distance, (from the data base) from the preceding event marker to Turn 16, to the fifth wheel reading at the preceding event marker.

** TD 11 was approximately 54 feet from TA 24 and was a convenient entry point for inserting TA 24.

*** As noted on log sheet, 5th wheel gained over 300 feet between CP3 and CP4. The resulting errors were not modified and are included in Phase I results.

Table 8-8 contains typical results obtained as output data from the FRSYS routine when Run 28 was processed.

Figure 8-33 contains an error histogram and a cumulative error distribution of all AVM system location data which were processed. The impact of 5 percent communication errors is so small as to be imperceptible in these statistics so only one curve is shown, that corresponding to a perfect communication system. Reference to Table 8-6 supports the fact that the HI^3 communication error detection and correction technique proposed for Phase II works effectively to minimize the impact of communication errors on vehicle location accuracy. Figures 8-34 to 8-62 contain the plotted error statistics corresponding to each individual fixed route test run. Figure 8-63 contains a plot of the 259 pseudo checkpoints computed for Run 28.

Output data corresponding to each set of processed test data are contained in the Appendix.

8.2.2 AVM System Timepoint Performance Results

Each data run was also processed to determine the capability of the HI^3 AVM system to accurately determine the time of departure from timepoints. During each test run, 15 timepoints were marked, through use of the TD event marker, as the front bumper of the test vehicle passed the predetermined timepoint location. Including missed or erroneous data entries, these 33 runs resulted in a total of 418 timepoint samples which were processed. An additional 32 were processed manually from the run listings.

The time of departure error results obtained by processing 451 timepoints are summarized as follows:

In 95 percent of the samples, the error was less than 11 seconds

In 99.5 percent of the samples, the error was less than 24 seconds

Percent samples with error less than 15 seconds: 98.67 percent

Percent samples with error less than 60 seconds: 100 percent

Average error: 3.9 seconds

Maximum error: 42.5 seconds

Of the 451 timepoint performance computations, 226 involved the use of the Door Close event, and the AVM system algorithm involving the R1 dropout was used to process the remaining 225. Table 8-9 contains a typical set of output data on timepoint performance for Run 27. Table 8-10 contains a tabulation of the computed errors corresponding to each timepoint and each test run.

(Text continued on 8-86)

TABLE 8-8 AVM SYSTEM TEST RESULTS, RUN 28

RUN # 28 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH ST	SEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
1	396.	0:31.0	394.	3	CP 1	12396	4435	12413	4414	27
2	556.	0:51.0	554.	3	CP 1	12378	4276	12389	4256	22
3	994.	1:11.0	998.	4	TA 3	12370	3874	12375	3873	5
4	1332.	1:31.0	1334.	4	TA 3	12705	3831	12707	3821	10
5	1664.	1:51.0	1666.	4	CP 2	13035	3787	13027	3775	14
6	1964.	2:11.0	1968.	4	CP 2	13332	3748	13327	3736	13
7	2474.	2:31.0	2476.	4	CP 3	13838	3682	13822	3674	17
8	2970.	2:51.0	2970.	4	CP 3	14330	3618	14312	3613	18
9	3120.	3:11.0	3122.	4	CP 3	14479	3598	14463	3595	16
10	3120.	3:31.0	3122.	4	CP 3	14479	3598	14463	3595	16
11	3356.	3:51.0	3356.	4	CP 3	14713	3568	14695	3566	18
12	3650.	4:11.0	3652.	5	CP 4	15010	3522	15016	3521	6
13	3774.	4:31.0	3776.	5	CP 4	15132	3500	15138	3499	6
14	4128.	4:51.0	4134.	6	TA 4	15240	3771	15242	3788	17
15	4272.	5:11.0	4278.	6	TA 4	15260	3913	15262	3930	17
16	4272.	5:31.0	4278.	6	TA 4	15260	3913	15262	3930	17
17	4524.	5:51.0	4532.	6	CP 5	15295	4163	15305	4237	74
18	4792.	6:11.0	4802.	6	CP 6	15332	4428	15336	4458	30
19	5166.	6:31.0	5178.	6	CP 6	15384	4799	15378	4832	33
20	5166.	6:51.0	5178.	6	CP 6	15384	4799	15378	4832	33
21	5428.	7:11.0	5438.	6	CP 7	15420	5058	15419	5102	44
22	5862.	7:31.0	5872.	6	CP 8	15480	5488	15488	5554	66
23	6236.	7:51.0	6248.	6	CP 8	15532	5858	15537	5926	68
24	6458.	8:11.0	6468.	6	CP 8	15562	6078	15566	6145	67
25	6600.	8:31.0	6612.	6	CP 8	15582	6219	15585	6287	68
26	6670.	8:51.0	6680.	6	CP 8	15592	6288	15593	6355	67
27	7114.	9:11.0	7124.	6	CP 8	15653	6728	15651	6795	67
28	7648.	9:31.0	7660.	6	CP 8	15727	7257	15722	7326	69
29	8178.	9:51.0	8190.	6	CP10	15800	7781	15808	7832	51
30	8538.	10:11.0	8548.	6	CP11	15850	8138	15856	8176	38
31	8910.	10:31.0	8922.	7	CP11	15904	8526	15908	8547	21
32	9316.	10:51.0	9328.	7	CP11	15960	8928	15964	8949	21
33	9596.	11:11.0	9608.	7	CP11	15999	9206	16003	9226	20
34	9926.	11:31.0	9938.	7	CP12	16044	9533	16056	9608	75
35	9934.	11:51.0	9946.	7	CP12	16046	9541	16057	9616	75
36	9934.	12:11.0	9946.	7	CP12	16046	9541	16057	9616	75
37	10186.	12:31.0	10194.	8	TA 5	16185	9660	16276	9645	92
38	10248.	12:51.0	10256.	8	TA 5	16247	9655	16338	9638	92
39	10660.	13:11.0	10668.	8	CP13	16658	9623	16760	9594	106
40	11088.	13:31.0	11096.	8	CP14	17085	9590	17172	9564	90
41	11580.	13:51.0	11588.	8	CP15	17575	9552	17636	9525	66
42	12068.	14:11.0	12076.	8	CP16	18062	9514	18114	9510	52
43	12656.	14:31.0	12658.	9	TA 6	18113	8975	18104	8940	36
44	13172.	14:51.0	13176.	9	CP17	18112	8459	18104	8378	81
45	13570.	15:11.0	13572.	10	CP18	18094	7965	18061	7980	36
46	13722.	15:31.0	13724.	10	CP18	18070	7815	18042	7829	31
47	13722.	15:51.0	13724.	10	CP18	18070	7815	18042	7829	31
48	13984.	16:11.0	13988.	10	CP18	18028	7556	18007	7567	23
49	14286.	16:31.0	14292.	10	CP18	17981	7258	17968	7266	15

TABLE 8-8 AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

PCP	ODOM	TIME	FIFTH	STSEG	SSGS	AVM X	AVM Y	REF X	REF Y	ERROR
50	14740.	16:51.0	14744.	11	CP19	17907	6813	17914	6848	35
51	15040.	17:11.0	15038.	11	TA 7	17609	6849	17668	6844	59
52	15340.	17:31.0	15336.	11	TA 7	17311	6885	17372	6883	61
53	15648.	17:51.0	15636.	11	TA 7	17005	6922	17075	6922	70
54	15938.	18:11.0	15918.	11	TA 7	16717	6957	16795	6959	78
55	16200.	18:31.0	16180.	11	CP20	16457	6988	16490	6998	34
56	16570.	18:51.0	16544.	11	CP20	16090	7033	16129	7042	40
57	16990.	19:11.0	16958.	11	CP20	15673	7083	15718	7091	45
58	17260.	19:31.0	17228.	11	CP20	15404	7116	15450	7123	46
59	17568.	19:51.0	17538.	11	CP20	15099	7153	15142	7160	43
60	17572.	20:11.0	17544.	11	CP20	15095	7153	15136	7161	41
61	17874.	20:31.0	17838.	11	CP21	14795	7189	14842	7195	47
62	18080.	20:51.0	18042.	11	CP21	14590	7214	14639	7218	49
63	18080.	21:11.0	18042.	11	CP21	14590	7214	14639	7218	49
64	18392.	21:31.0	18342.	11	CP21	14281	7252	14341	7253	60
65	18528.	21:51.0	18480.	11	CP22	14145	7268	14154	7270	9
66	18528.	22:11.0	18480.	11	CP22	14145	7268	14154	7270	9
67	18654.	22:31.0	18604.	12	CP22	14058	7276	14030	7281	28
68	19140.	22:51.0	19074.	13	TA 8	13618	7409	13609	7412	9
69	19604.	23:11.0	19538.	13	CP23	13305	7752	13286	7750	19
70	20126.	23:31.0	20060.	14	TA 9	12931	8115	12909	8135	29
71	20214.	23:51.0	20150.	14	TA 9	12865	8173	12841	8194	31
72	20584.	24:11.0	20520.	15	TA10	12591	8421	12661	8354	96
73	20692.	24:31.0	20630.	15	TA10	12511	8494	12579	8428	94
74	20856.	24:51.0	20792.	15	CP24	12391	8605	12435	8560	62
75	21592.	25:11.0	21532.	15	CP24	11850	9104	11894	9065	58
76	22134.	25:31.0	22074.	15	CP25	11451	9471	11493	9437	54
77	22716.	25:51.0	22654.	16	CP25	11078	9892	11065	9828	65
78	23174.	26:11.0	23108.	17	TA11	11171	10238	11173	10111	127
79	23268.	26:31.0	23200.	17	TA11	11229	10312	11199	10199	116
80	23596.	26:51.0	23526.	18	TA12	11551	10278	11529	10277	22
81	23748.	27:11.0	23678.	18	TA12	11701	10258	11680	10255	21
82	24138.	27:31.0	24070.	18	TA12	12088	10207	12068	10198	21
83	24202.	27:51.0	24134.	18	TA12	12152	10198	12131	10189	22
84	24326.	28:11.0	24258.	18	CP26	12274	10182	12286	10166	20
85	24744.	28:31.0	24676.	18	CP26	12689	10127	12700	10104	25
86	24760.	28:51.0	24690.	18	CP26	12705	10125	12714	10101	25
87	25210.	29:11.0	25140.	18	CP27	13151	10066	13170	10046	27
88	25634.	29:31.0	25562.	19	TA13	13136	9685	13142	9650	35
89	25994.	29:51.0	25920.	19	CP28	13081	9329	13085	9263	66
90	26216.	30:11.0	26144.	19	CP28	13047	9110	13052	9041	69
91	26380.	30:31.0	26310.	19	CP29	13021	8948	13027	8901	47
92	26776.	30:51.0	26708.	19	CP29	12960	8557	12957	8509	48
93	26986.	31:11.0	26916.	19	CP29	12928	8349	12921	8304	45
94	27330.	31:31.0	27262.	20	TA14	12902	8006	12900	7971	35
95	27748.	31:51.0	27684.	21	TA15	13083	7757	13028	7765	55
96	27902.	32:11.0	27838.	21	TA15	13236	7734	13180	7742	56
97	27902.	32:31.0	27838.	21	TA15	13236	7734	13180	7742	56
98	28164.	32:51.0	28102.	21	TA15	13495	7695	13441	7702	54
99	28548.	33:11.0	28486.	21	CP30	13875	7638	13768	7654	108
100	28934.	33:31.0	28870.	22	CP30	14200	7595	14149	7609	52
101	29228.	33:51.0	29166.	22	CP30	14492	7560	14443	7575	51
102	29512.	34:11.0	29450.	22	CP30	14774	7526	14725	7541	51
103	29852.	34:31.0	29786.	22	CP30	15111	7486	15059	7502	54

TABLE 8-8 AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

PCP	ODOM	TIME	FIFTH	STSEG	SSGS	AVM X	AVM Y	REF X	REF Y	ERROR
104	30368.	34:51.0	30304.	22	CP31	15624	7424	15603	7435	23
105	30852.	35:11.0	30786.	22	CP32	16104	7366	16061	7381	45
106	31354.	35:31.0	31288.	22	CP32	16603	7306	16561	7332	49
107	31640.	35:51.0	31574.	22	CP33	16887	7272	16856	7293	37
108	31752.	36:11.0	31686.	22	CP33	16998	7258	16967	7278	36
109	31752.	36:31.0	31686.	22	CP33	16998	7258	16967	7278	36
110	31924.	36:51.0	31858.	22	CP33	17169	7238	17138	7254	34
111	32160.	37:11.0	32094.	22	CP33	17403	7210	17371	7221	33
112	32470.	37:31.0	32402.	22	CP34	17711	7173	17663	7174	48
113	32936.	37:51.0	32868.	22	CP34	18173	7117	18122	7093	56
114	33484.	38:11.0	33416.	22	CP35	18717	7051	18636	7044	81
115	33624.	38:31.0	33558.	23	CP35	18826	7013	18778	7039	54
116	33740.	38:51.0	33668.	23	TA16	18803	6899	18823	6974	77
117	34198.	39:11.0	34128.	24	TA16	18719	6469	18762	6518	65
118	34368.	39:31.0	34296.	24	TA16	18704	6299	18740	6352	64
119	34858.	39:51.0	34786.	24	TA16	18660	5812	18676	5866	56
120	35202.	40:11.0	35124.	25	TA17	18504	5625	18511	5626	7
121	35426.	40:31.0	35348.	25	CP36	18281	5653	18250	5663	32
122	35722.	40:51.0	35642.	25	CP36	17988	5691	17959	5703	31
123	35792.	41:11.0	35712.	25	CP36	17918	5700	17889	5712	31
124	35792.	41:31.0	35712.	25	CP36	17918	5700	17889	5712	31
125	35842.	41:51.0	35762.	25	CP36	17869	5706	17840	5719	31
126	35842.	42:11.0	35762.	25	CP36	17869	5706	17840	5719	31
127	35986.	42:31.0	35906.	25	CP37	17726	5724	17757	5730	31
128	36236.	42:51.0	36156.	25	CP37	17478	5756	17509	5762	31
129	36352.	43:11.0	36274.	25	CP37	17363	5771	17392	5777	29
130	36722.	43:31.0	36642.	25	CP37	16996	5818	17027	5824	31
131	36762.	43:51.0	36682.	25	CP37	16956	5823	16987	5829	31
132	37194.	44:11.0	37114.	25	CP38	16528	5877	16534	5884	9
133	37224.	44:31.0	37146.	25	CP38	16498	5881	16502	5888	8
134	37348.	44:51.0	37268.	25	CP39	16375	5897	16389	5902	14
135	37676.	45:11.0	37596.	25	CP39	16050	5938	16064	5946	16
136	37676.	45:31.0	37596.	25	CP39	16050	5938	16064	5946	16
137	37676.	45:51.0	37596.	25	CP39	16050	5938	16064	5946	16
138	37716.	46:11.0	37636.	25	CP39	16010	5943	16024	5951	16
139	37764.	46:31.0	37684.	25	CP39	15963	5949	15977	5957	16
140	38118.	46:51.0	38038.	25	CP40	15611	5994	15621	6005	14
141	38118.	47:11.0	38038.	25	CP40	15611	5994	15621	6005	14
142	38304.	47:31.0	38222.	25	CP40	15427	6018	15437	6023	11
143	38390.	47:51.0	38312.	25	CP40	15342	6029	15348	6031	6
144	38390.	48:11.0	38312.	25	CP40	15342	6029	15348	6031	6
145	38390.	48:31.0	38312.	25	CP40	15342	6029	15348	6031	6
146	38522.	48:51.0	38440.	26	TA18	15237	6065	15235	6056	9
147	38712.	49:11.0	38628.	26	TA18	15266	6253	15259	6243	12
148	38856.	49:31.0	38774.	28	TA19	15274	6380	15239	6385	35
149	39000.	49:51.0	38922.	28	TA19	15131	6401	15092	6406	39
150	39438.	50:11.0	39358.	28	TA19	14697	6464	14661	6469	36
151	39682.	50:31.0	39608.	29	TA20	14652	6241	14653	6252	11
152	39736.	50:51.0	39662.	29	TA20	14645	6188	14647	6199	11
153	40088.	51:11.0	40016.	29	TA21	14601	5838	14628	5785	59
154	40512.	51:31.0	40436.	31	TA22	14880	5682	14881	5694	12
155	40870.	51:51.0	40796.	31	TA22	14835	5327	14832	5337	10
156	41076.	52:11.0	41000.	31	CP43	14809	5122	14805	5116	7
157	41196.	52:31.0	41122.	31	CP43	14794	5003	14792	4995	8

TABLE 8-8 AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

PCP	ODOM	TIME	FIFTH	STSEG	SSGS	AVM X	AVM Y	REF X	REF Y	ERROR
158	41540.	52:51.0	41460.	32	TA23	14497	4991	14505	4985	10
159	41572.	53:11.0	41494.	32	TA23	14465	4995	14472	4989	9
160	41718.	53:31.0	41640.	32	TA23	14321	5014	14327	5005	10
161	41946.	53:51.0	41864.	32	CP44	14094	5044	14029	5040	65
162	42070.	54:11.0	41990.	32	CP44	13972	5060	13904	5059	68
163	42070.	54:31.0	41990.	32	CP44	13972	5060	13904	5059	68
164	42150.	54:51.0	42070.	32	CP44	13892	5070	13825	5071	67
165	42666.	55:11.0	42586.	32	CP45	13381	5137	13314	5146	67
166	43206.	55:31.0	43124.	32	CP46	12845	5208	12808	5206	37
167	43708.	55:51.0	43628.	33	CP46	12305	5279	12308	5269	10
168	43850.	56:11.0	43768.	33	CP46	12164	5299	12169	5287	13
169	43860.	56:31.0	43780.	33	CP46	12154	5300	12157	5288	12
170	43916.	56:51.0	43836.	33	CP46	12099	5308	12101	5295	13
171	44044.	57:11.0	43962.	33	CP46	11972	5325	11976	5311	14
172	44428.	57:31.0	44350.	33	CP46	11592	5378	11592	5359	19
173	44454.	57:51.0	44376.	33	CP46	11566	5382	11566	5362	20
174	44526.	58:11.0	44448.	33	CP47	11495	5392	11480	5374	23
175	44894.	58:31.0	44814.	33	CP47	11130	5443	11117	5425	22
176	45288.	58:51.0	45210.	33	CP48	10740	5497	10699	5483	43
177	45780.	59:11.0	45702.	33	CP49	10253	5565	10262	5542	24
178	46334.	59:31.0	46256.	33	CP49	9704	5642	9714	5623	21
179	46624.	59:51.0	46546.	33	CP50	9417	5682	9456	5660	44
180	46830.	60:11.0	46752.	33	CP50	9213	5710	9252	5688	44
181	46850.	60:31.0	46772.	33	CP50	9193	5713	9232	5690	45
182	47366.	60:51.0	47290.	33	CP51	8682	5784	8648	5769	37
183	47938.	61:11.0	47862.	33	CP52	8116	5863	8133	5841	27
184	48462.	61:31.0	48386.	34	CP52	7578	5917	7613	5906	36
185	48864.	61:51.0	48782.	35	TA24	7518	6211	7504	6217	15
186	49040.	62:11.0	48960.	35	TA24	7548	6385	7526	6394	23
187	49092.	62:31.0	49012.	35	TA24	7557	6436	7532	6446	26
188	49558.	62:51.0	49478.	35	CP53	7636	6896	7643	6934	38
189	49748.	63:11.0	49662.	36	TA25	7708	7028	7778	7019	70
190	50168.	63:31.0	50084.	36	TA25	8124	6973	8197	6964	73
191	50628.	63:51.0	50544.	36	CP55	8580	6913	8653	6907	73
192	50722.	64:11.0	50638.	36	CP55	8674	6901	8746	6896	72
193	51150.	64:31.0	51066.	36	CP55	9098	6844	9171	6845	73
194	51626.	64:51.0	51542.	36	CP56	9570	6782	9638	6774	68
195	51906.	65:11.0	51822.	36	CP57	9847	6745	9911	6728	66
196	52484.	65:31.0	52404.	36	CP57	10420	6670	10489	6654	70
197	52990.	65:51.0	52908.	36	CP57	10922	6603	10989	6590	68
198	53226.	66:11.0	53146.	37	CP57	11156	6573	11225	6560	70
199	53268.	66:31.0	53186.	37	CP57	11197	6567	11264	6555	68
200	53316.	66:51.0	53234.	37	CP57	11245	6561	11312	6549	68
201	53734.	67:11.0	53650.	37	CP57	11660	6506	11725	6496	65
202	54236.	67:31.0	54154.	37	CP58	12157	6441	12179	6439	22
203	54724.	67:51.0	54640.	37	CP59	12641	6377	12693	6386	52
204	55202.	68:11.0	55118.	37	CP60	13115	6315	13136	6324	22
205	55618.	68:31.0	55534.	37	CP61	13528	6260	13568	6255	40
206	55990.	68:51.0	55902.	38	TA26	13519	5923	13493	5894	38
207	56110.	69:11.0	56024.	38	TA26	13503	5804	13470	5774	44
208	56378.	69:31.0	56290.	38	CP62	13468	5538	13427	5468	81
209	56618.	69:51.0	56530.	38	CP62	13436	5300	13399	5230	79
210	56990.	70:11.0	56900.	38	CP63	13387	4931	13374	4864	68
211	57238.	70:31.0	57154.	39	TA27	13378	4704	13461	4695	83

TABLE 8-8 AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

FCF	ODOM	TIME	FIFTH	STSEG	SSGS	AVM X	AVM Y	REF X	REF Y	ERROR
212	57488.	70:51.0	57402.	39	TA27	13626	4669	13708	4674	82
213	57604.	71:11.0	57518.	39	CP65	13741	4653	13830	4660	89
214	57980.	71:31.0	57894.	39	CP65	14113	4601	14201	4600	88
215	58400.	71:51.0	58312.	40	CP66	14609	4535	14620	4541	12
216	58436.	72:11.0	58348.	40	CP66	14644	4531	14655	4536	12
217	58436.	72:31.0	58348.	40	CP66	14644	4531	14655	4536	12
218	58766.	72:51.0	58678.	40	CP66	14972	4489	14982	4490	10
219	59318.	73:11.0	59232.	40	CP66	15520	4419	15531	4414	12
220	59510.	73:31.0	59424.	40	CP66	15710	4395	15721	4387	13
221	59724.	73:51.0	59640.	40	CP67	15922	4368	15931	4366	9
222	60140.	74:11.0	60056.	40	CP68	16335	4316	16337	4319	3
223	60334.	74:31.0	60250.	40	CP68	16528	4291	16529	4290	1
224	60724.	74:51.0	60638.	40	CP68	16915	4242	16913	4233	9
225	60852.	75:11.0	60766.	40	CP68	17042	4226	17040	4214	12
226	60908.	75:31.0	60822.	40	CP69	17097	4219	17128	4201	35
227	61318.	75:51.0	61232.	40	CP69	17504	4168	17537	4163	33
228	61348.	76:11.0	61262.	40	CP69	17534	4164	17567	4160	33
229	61692.	76:31.0	61600.	41	TA28	17509	3847	17506	3833	14
230	61764.	76:51.0	61674.	41	TA28	17498	3775	17494	3760	15
231	62166.	77:11.0	62076.	42	CP70	17437	3332	17447	3372	41
232	62470.	77:31.0	62382.	43	TA29	17584	3173	17554	3177	30
233	62698.	77:51.0	62612.	43	TA29	17811	3152	17783	3155	28
234	63026.	78:11.0	62940.	43	TA29	18137	3121	18110	3125	27
235	63188.	78:31.0	63102.	43	TA29	18299	3106	18271	3110	28
236	63486.	78:51.0	63398.	43	TA29	18595	3078	18566	3083	29
237	63770.	79:11.0	63686.	44	TA30	18766	3190	18759	3181	11
238	63938.	79:31.0	63852.	44	TA30	18786	3356	18768	3347	20
239	64138.	79:51.0	64050.	44	TA30	18809	3555	18790	3545	30
240	64428.	80:11.0	64340.	44	CP72	18843	3843	18820	3816	35
241	64806.	80:31.0	64716.	44	CP72	18888	4218	18876	4187	33
242	65110.	80:51.0	65024.	45	TA31	18830	4446	18844	4443	14
243	65444.	81:11.0	65358.	45	TA31	18498	4485	18511	4474	17
244	65636.	81:31.0	65548.	45	CP73	18308	4507	18319	4499	13
245	65940.	81:51.0	65852.	45	CP73	18006	4543	18018	4541	12
246	66294.	82:11.0	66204.	45	CP73	17654	4584	17669	4590	16
247	66514.	82:31.0	66424.	45	CP74	17435	4610	17479	4613	44
248	66772.	82:51.0	66684.	45	CP74	17179	4640	17221	4644	42
249	66772.	83:11.0	66684.	45	CP74	17179	4640	17221	4644	42
250	66828.	83:31.0	66742.	45	CP74	17123	4646	17164	4650	41
251	67270.	83:51.0	67184.	45	CP75	16684	4698	16696	4706	14
252	67560.	84:11.0	67474.	45	CP75	16396	4731	16408	4746	19
253	67686.	84:31.0	67598.	45	CP75	16271	4746	16286	4763	22
254	67688.	84:51.0	67602.	45	CP75	16269	4746	16282	4764	22
255	67972.	85:11.0	67886.	46	CP75	16060	4771	16000	4803	68
256	68128.	85:31.0	68042.	46	CP75	15905	4793	15846	4824	66
257	68128.	85:51.0	68044.	46	CP75	15905	4793	15844	4825	68
258	68128.	86:11.0	68044.	46	CP75	15905	4793	15844	4825	68
259	68452.	86:31.0	68368.	46	CP76	15584	4839	15542	4860	46

Table 8-8 AVM SYSTEM TEST RESULTS, RUN 28(CONT'D)

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	20	7.72
10- 20	53	20.46
20- 30	35	13.51
30- 40	43	16.60
40- 50	27	10.42
50- 60	18	6.95
60- 70	32	12.36
70- 80	15	5.79
80- 90	7	2.70
90- 100	5	1.93
100- 110	2	0.77
110- 120	1	0.39
120- 130	1	0.39

CUMULATIVE ERRORS

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	20	7.72
20	73	28.19
30	108	41.70
40	151	58.30
50	178	68.73
60	196	75.68
70	228	88.03
80	243	93.82
90	250	96.53
100	255	98.46
110	257	99.23
120	258	99.61
130	259	100.00

AVERAGE ERROR = 39.30

STANDARD DEVIATION = 25.12

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

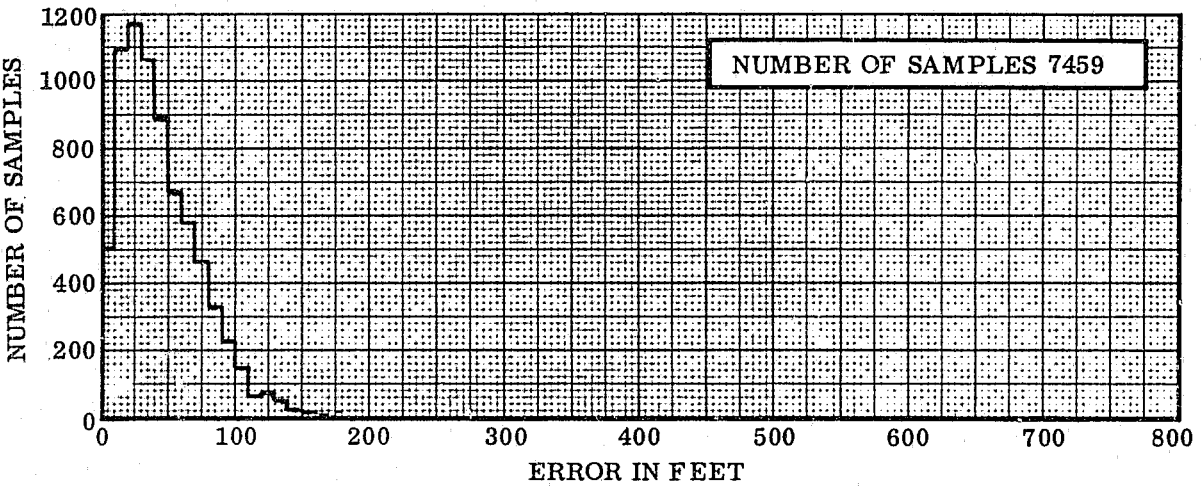
ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	20	7.72
10- 20	52	20.08
20- 30	34	13.13
30- 40	43	16.60
40- 50	26	10.04
50- 60	20	7.72
60- 70	33	12.74
70- 80	14	5.41
80- 90	7	2.70
90- 100	5	1.93
100- 110	2	0.77
110- 120	1	0.39
120- 130	2	0.77

CUMULATIVE ERRORS

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	20	7.72
20	72	27.80
30	106	40.93
40	149	57.53
50	175	67.57
60	195	75.29
70	228	88.03
80	242	93.44
90	249	96.14
100	254	98.07
110	256	98.84
120	257	99.23
130	259	100.00

AVERAGE ERROR = 39.85

STANDARD DEVIATION = 25.60



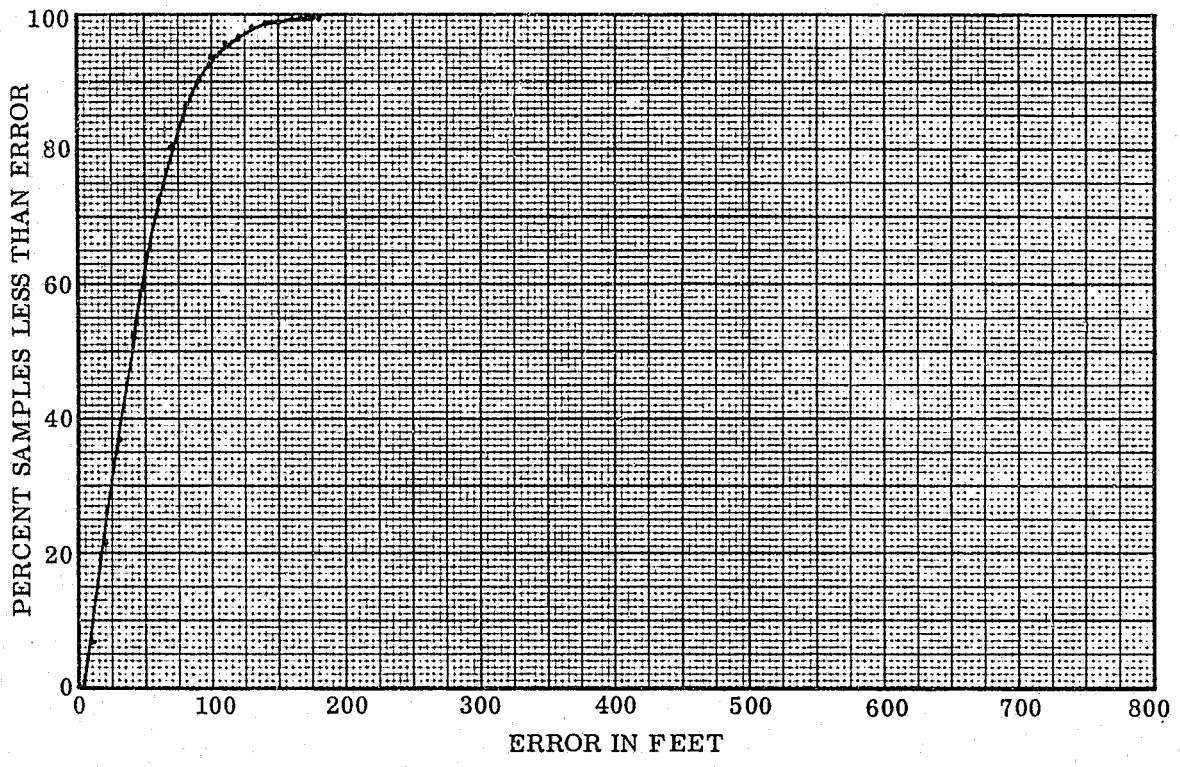
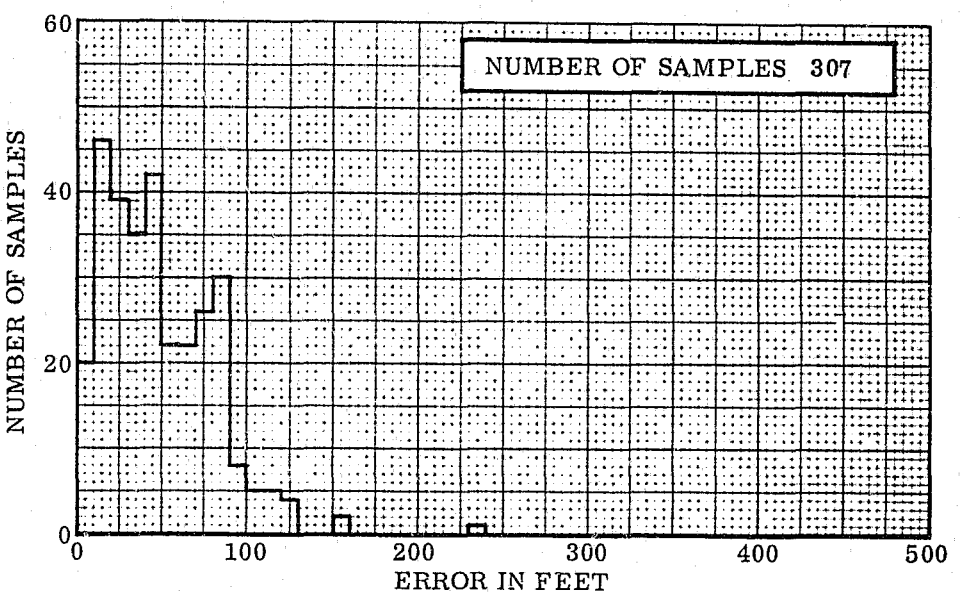


FIG. 8-33 FIXED ROUTE AVM SYSTEM ERRORS, ALL RUNS



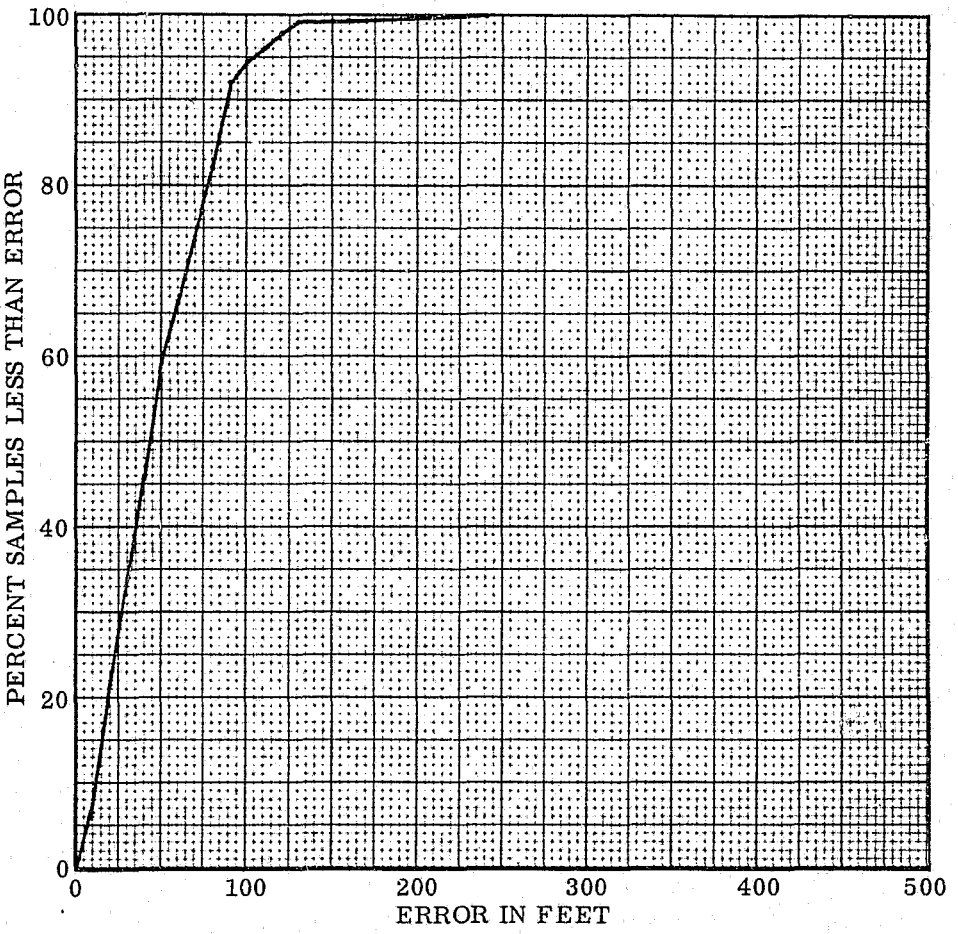


FIG. 8-34 FIXED ROUTE AVM SYSTEM ERRORS, RUN 11

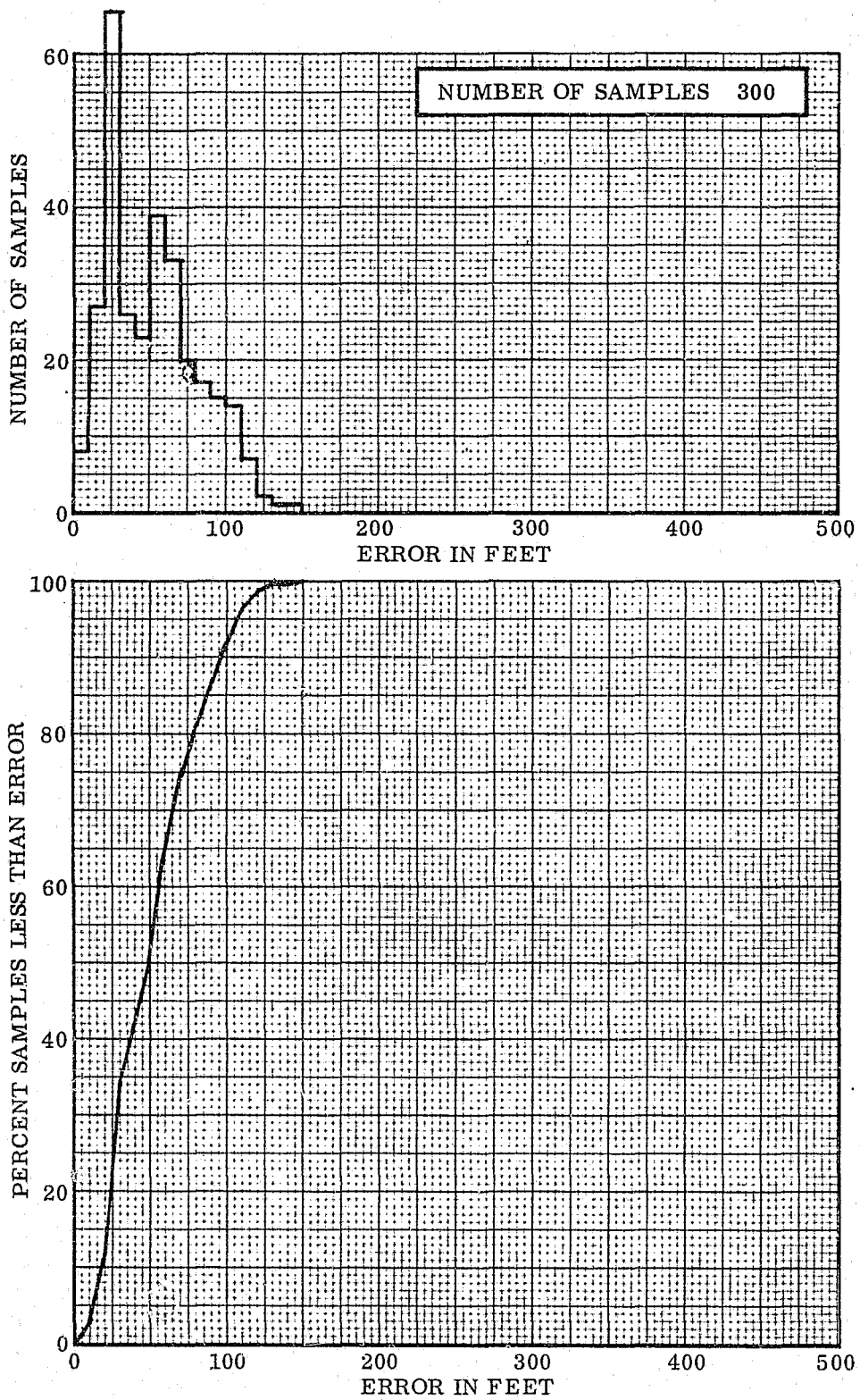


FIG. 8-35 FIXED ROUTE AVM SYSTEM ERRORS, RUN 12

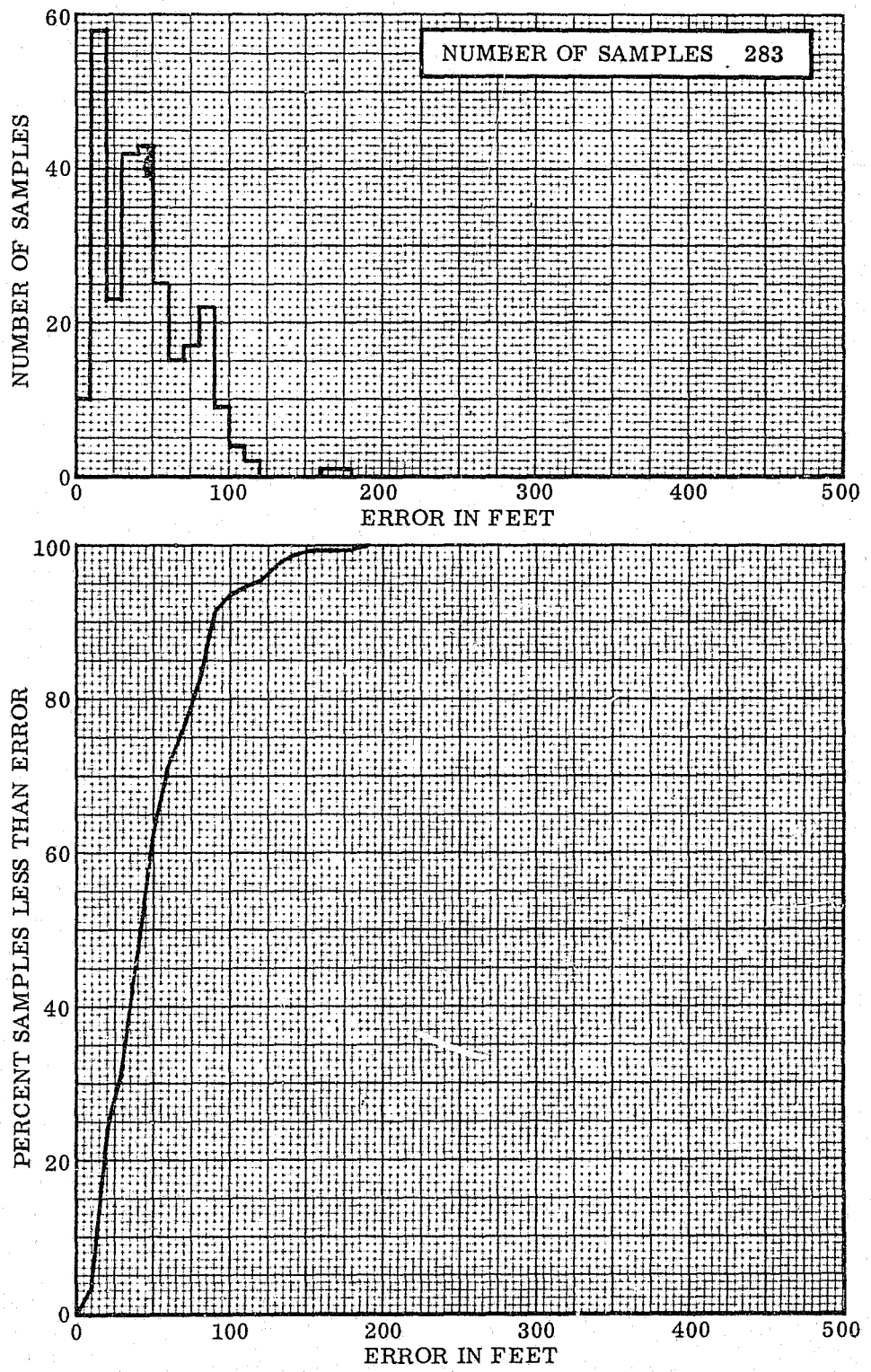


FIG. 8-36 FIXED ROUTE AVM SYSTEM ERRORS, RUN 13

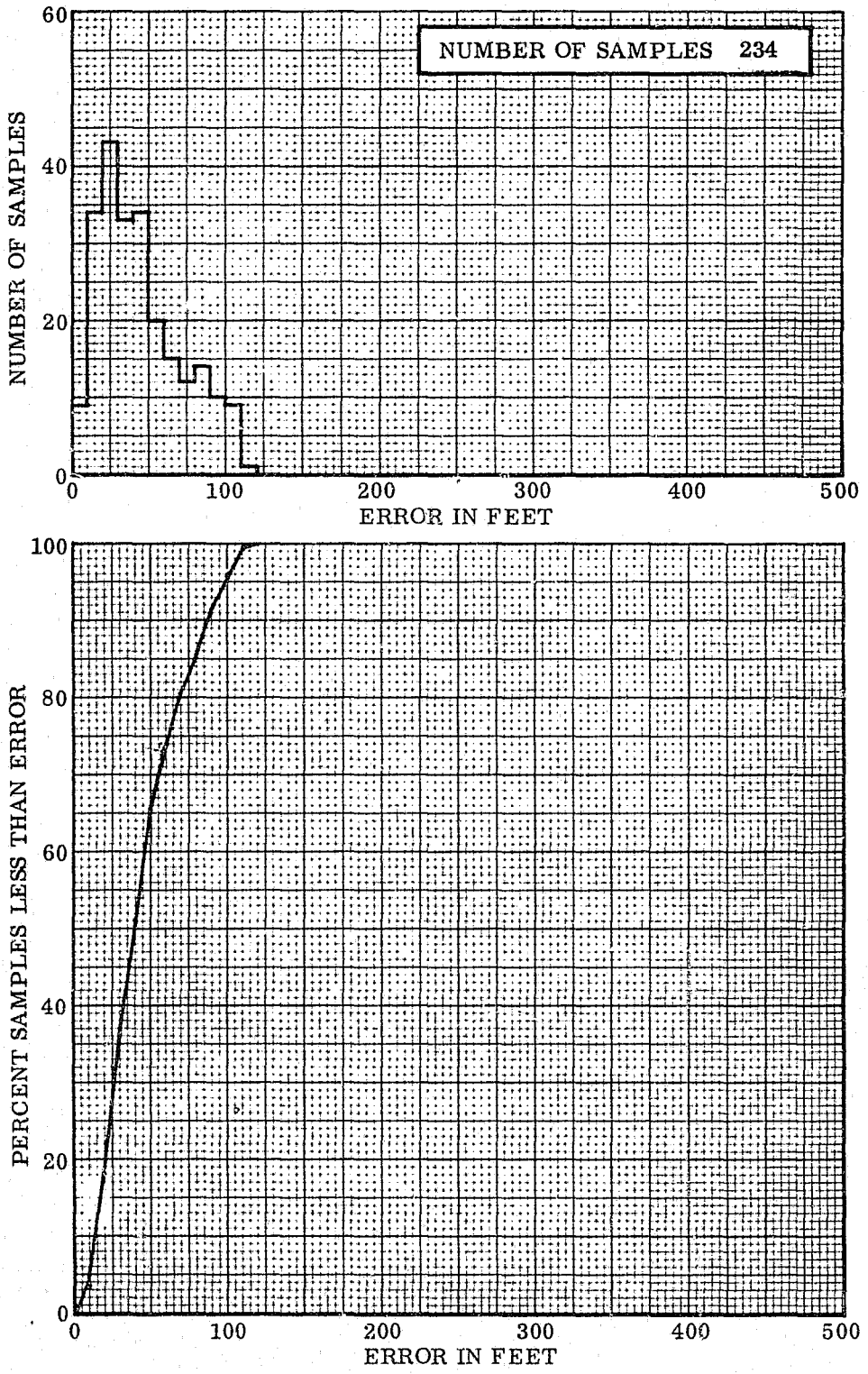


FIG. 8-37 FIXED ROUTE AVM SYSTEM ERRORS, RUN 14

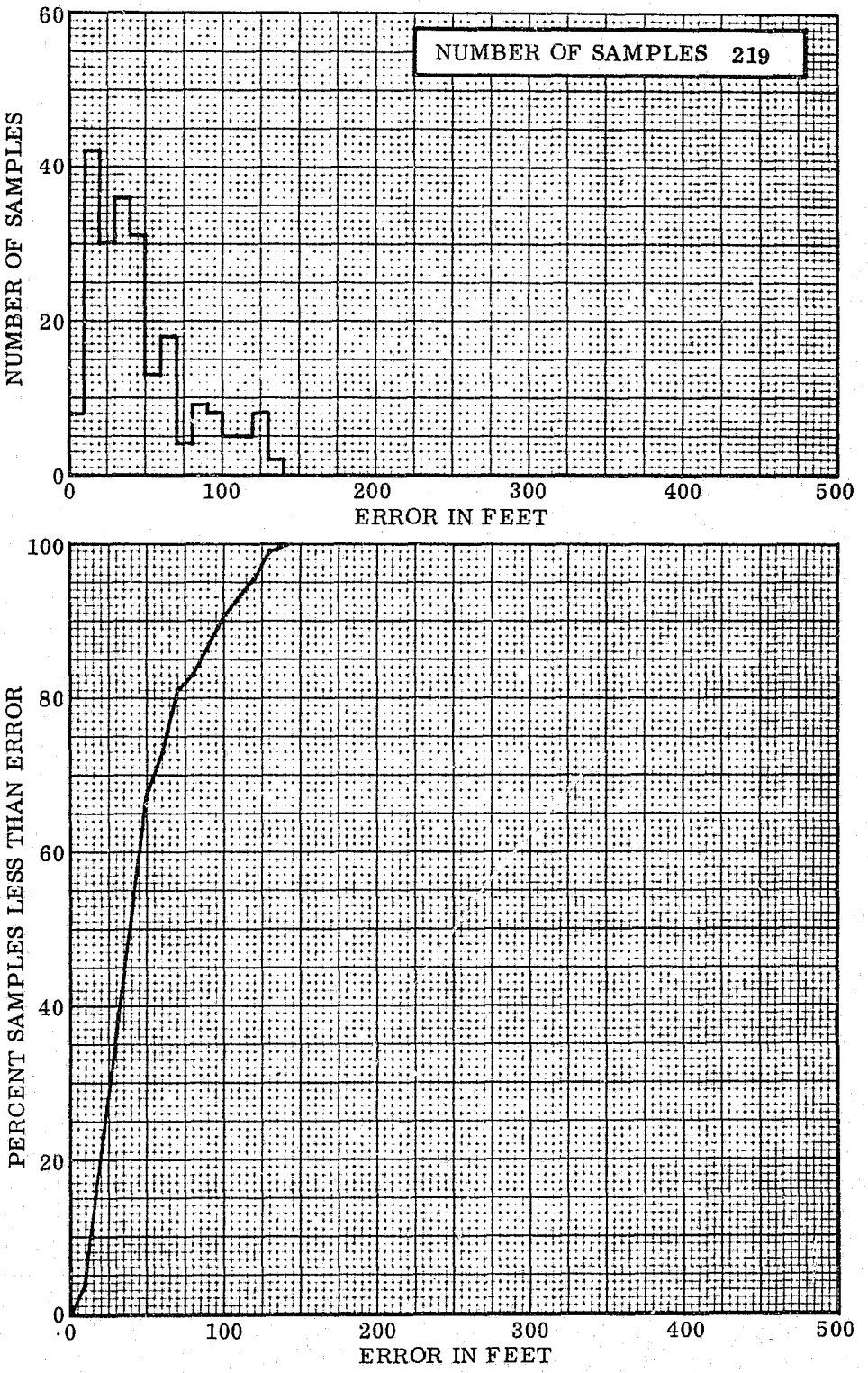


FIG. 8-38 FIXED ROUTE AVM SYSTEM ERRORS, RUN 15

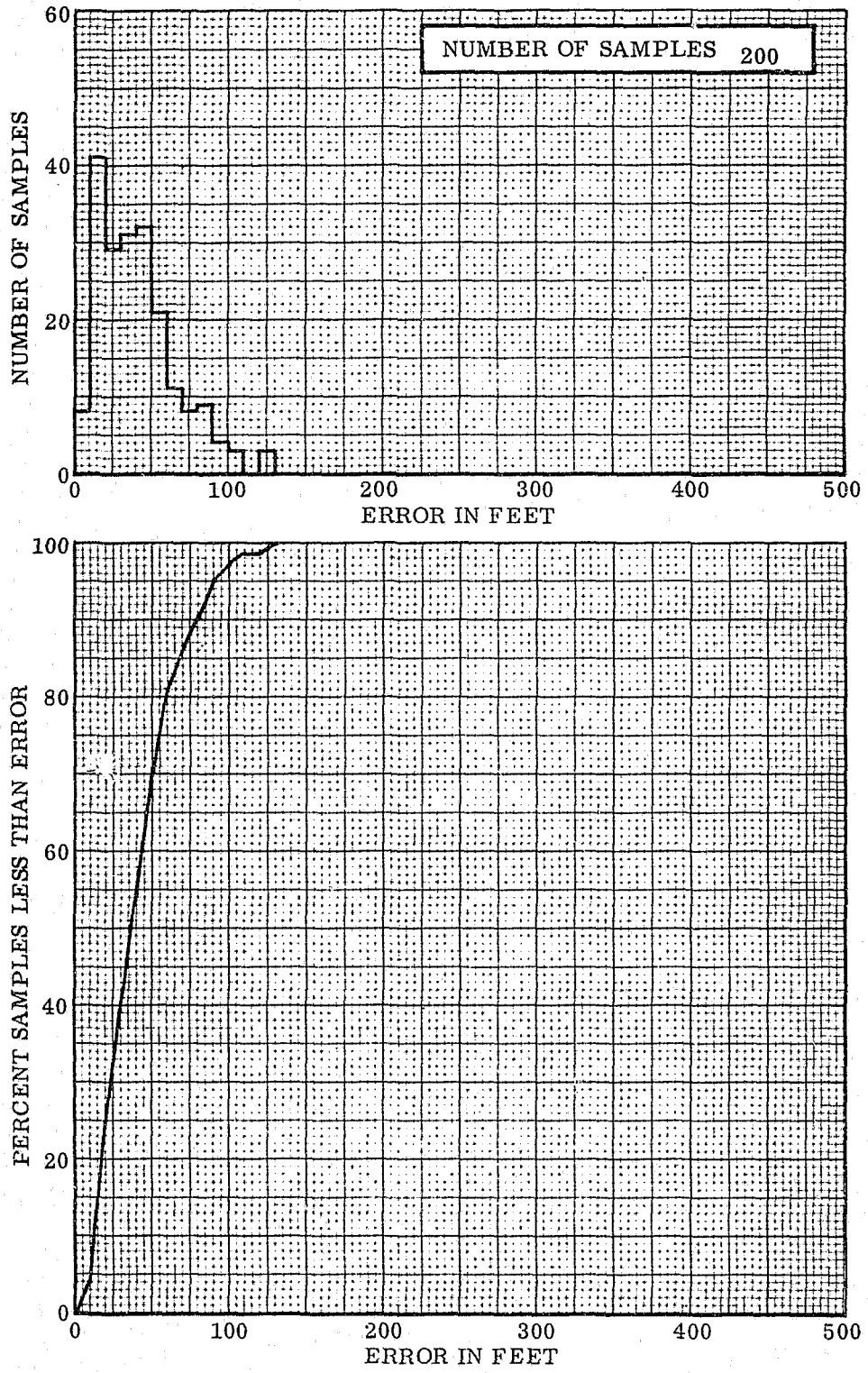


FIG. 8-39 FIXED ROUTE AVM SYSTEM ERRORS, RUN 16

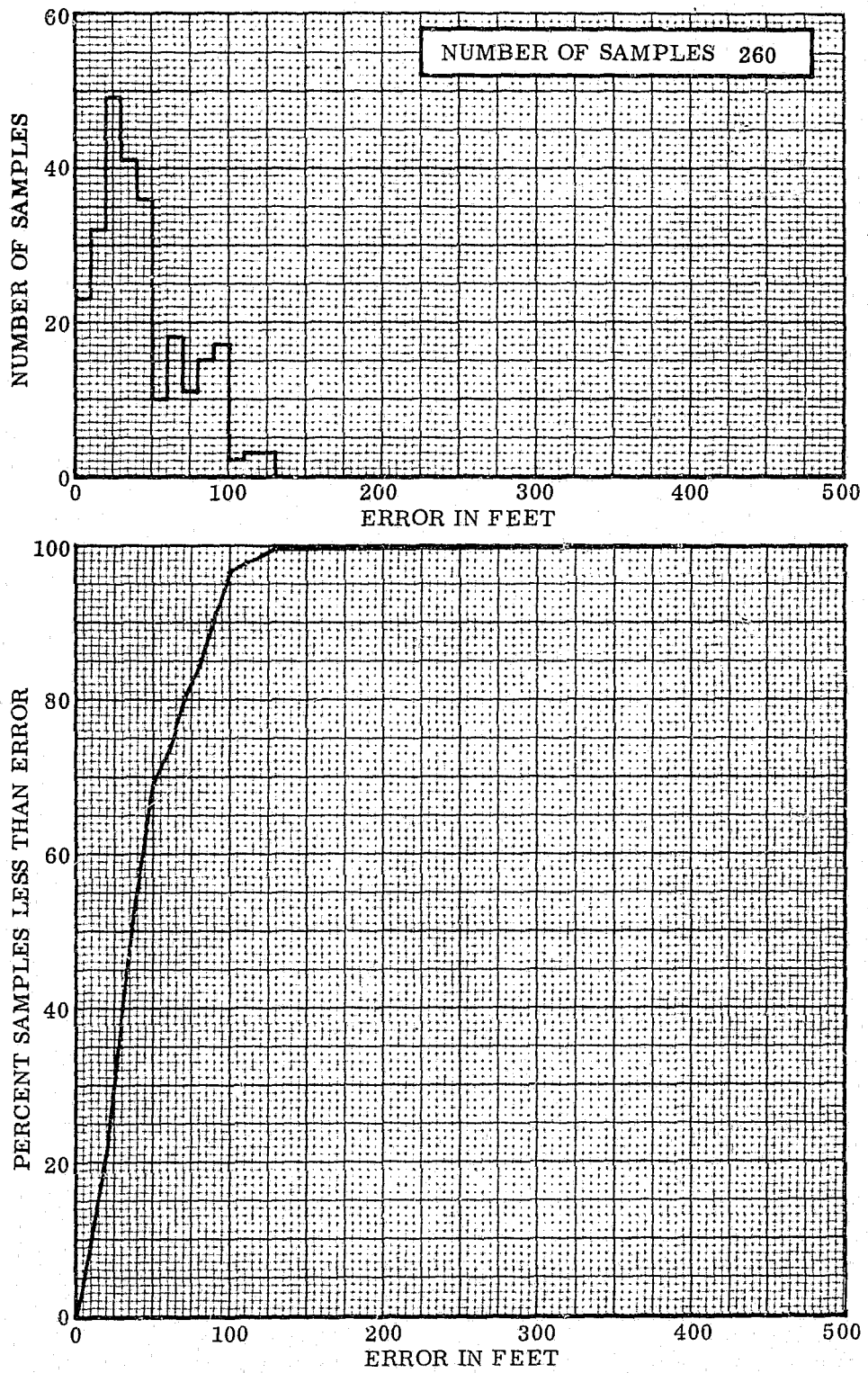


FIG. 8-40 FIXED ROUTE AVM SYSTEM ERRORS, RUN 17

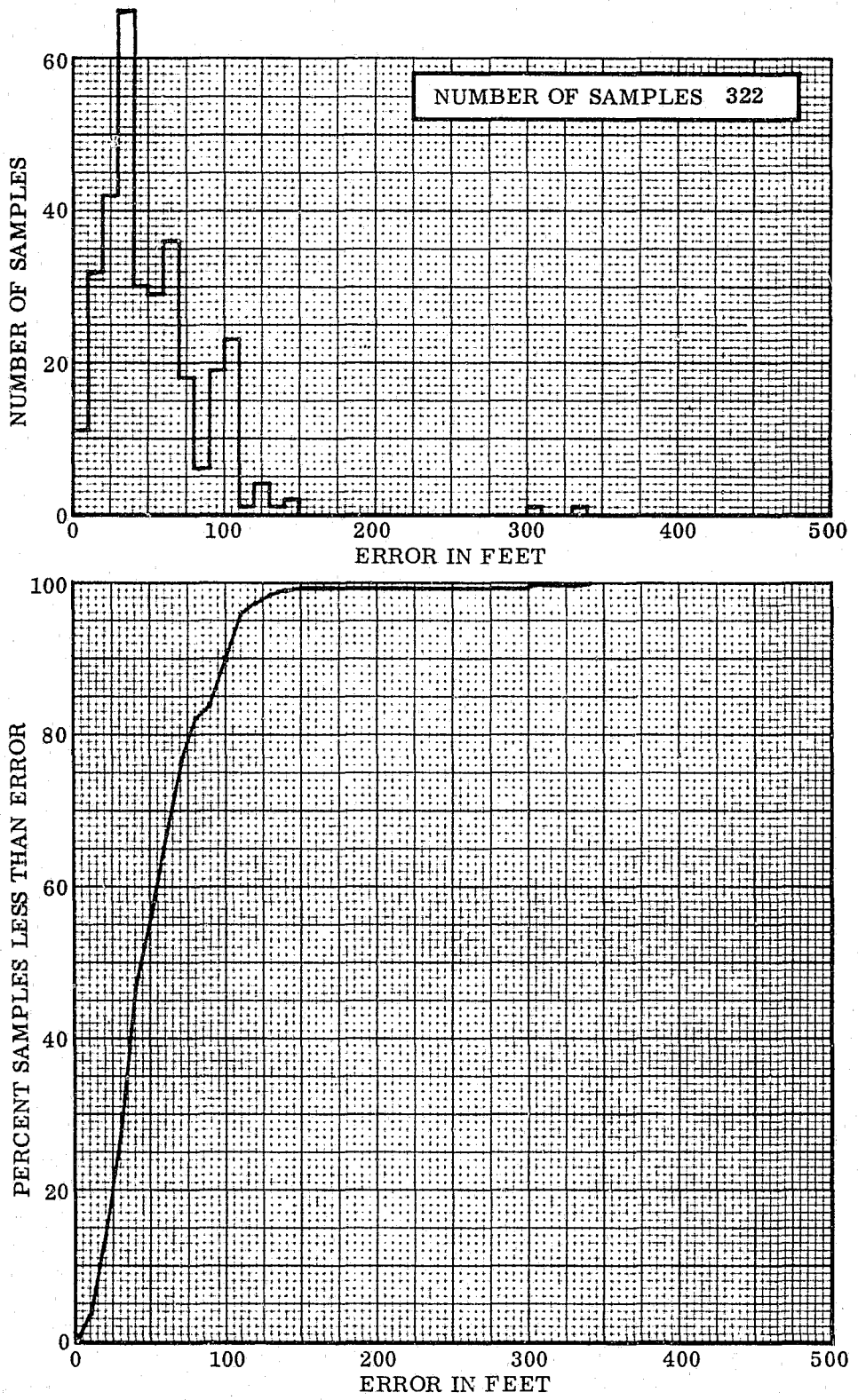


FIG. 8-41 FIXED ROUTE AVM SYSTEM ERRORS, RUN 18

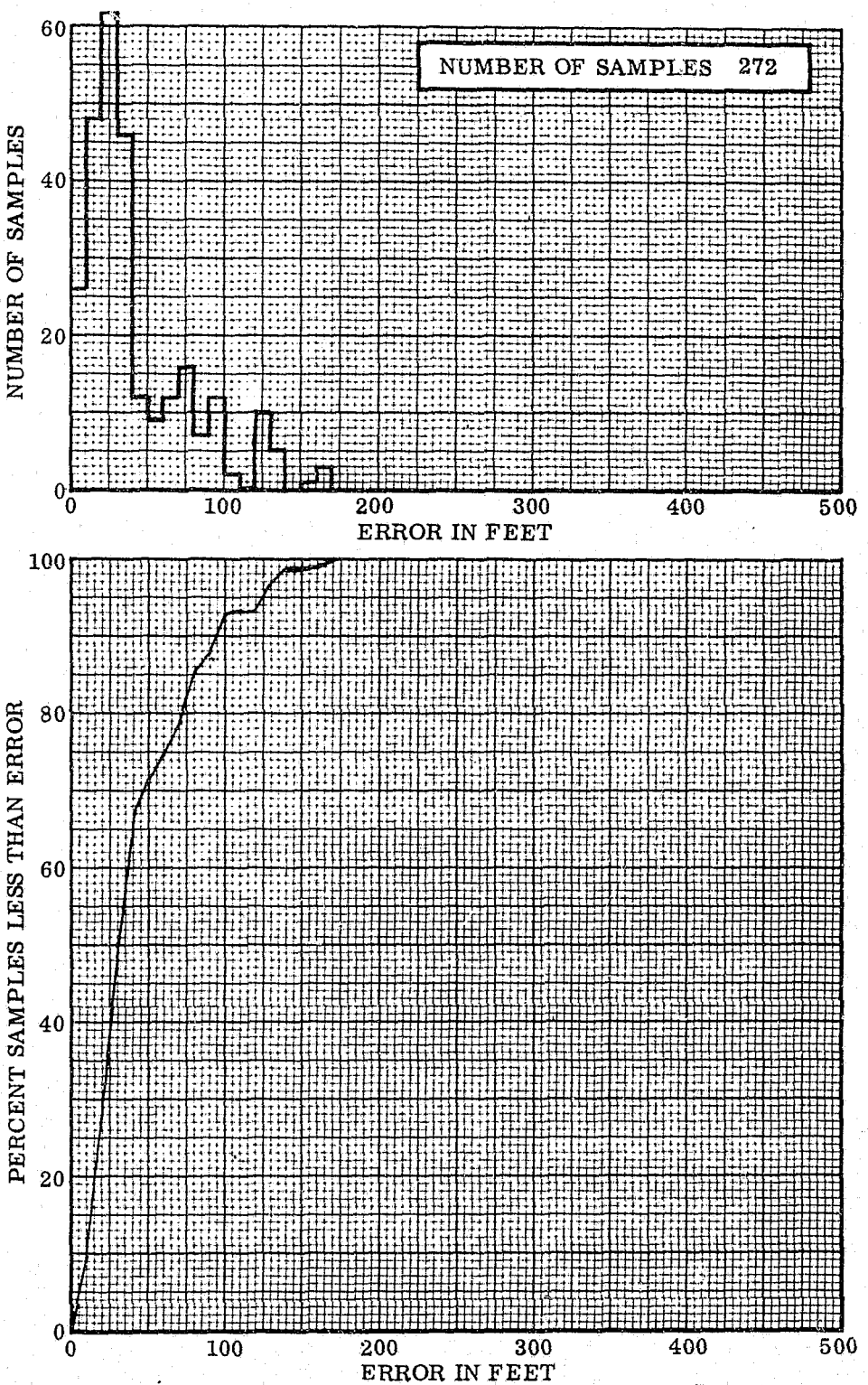


FIG. 8-42 FIXED ROUTE AVM SYSTEM ERRORS, RUN 21

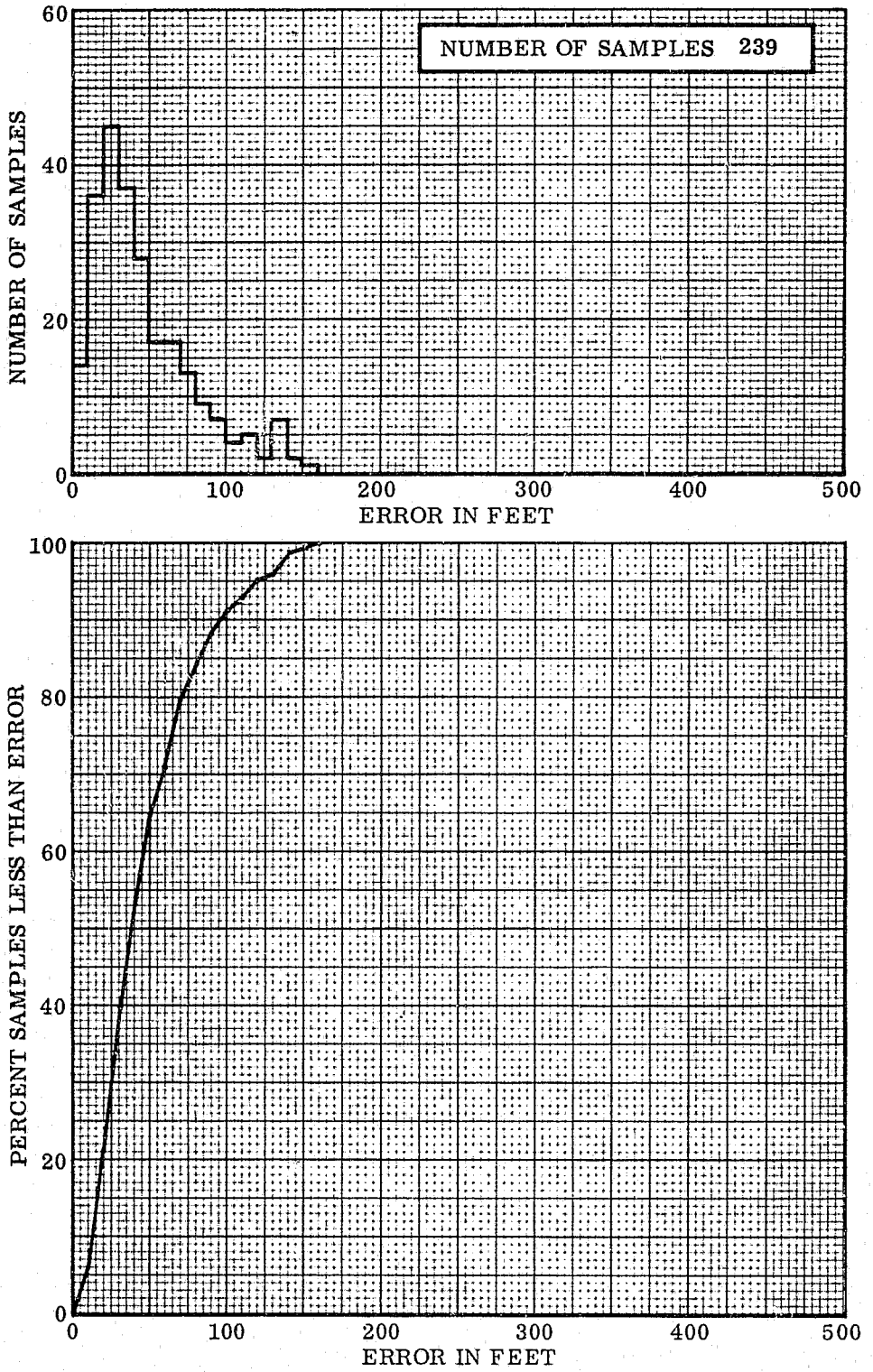


FIG. 8-43 FIXED ROUTE AVM SYSTEM ERRORS, RUN 22

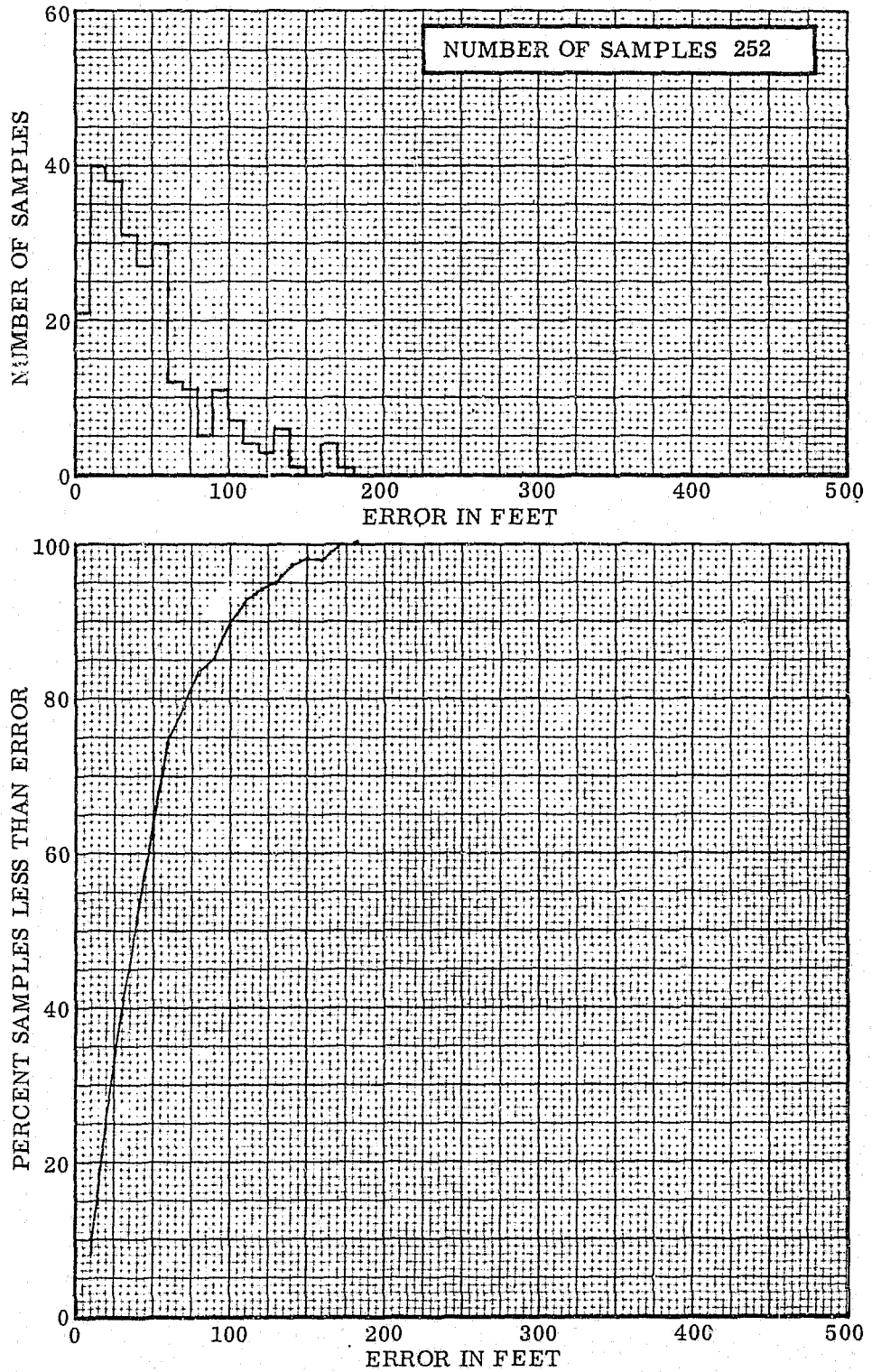


FIG. 8-44 FIXED ROUTE AVM SYSTEM ERRORS, RUN 23

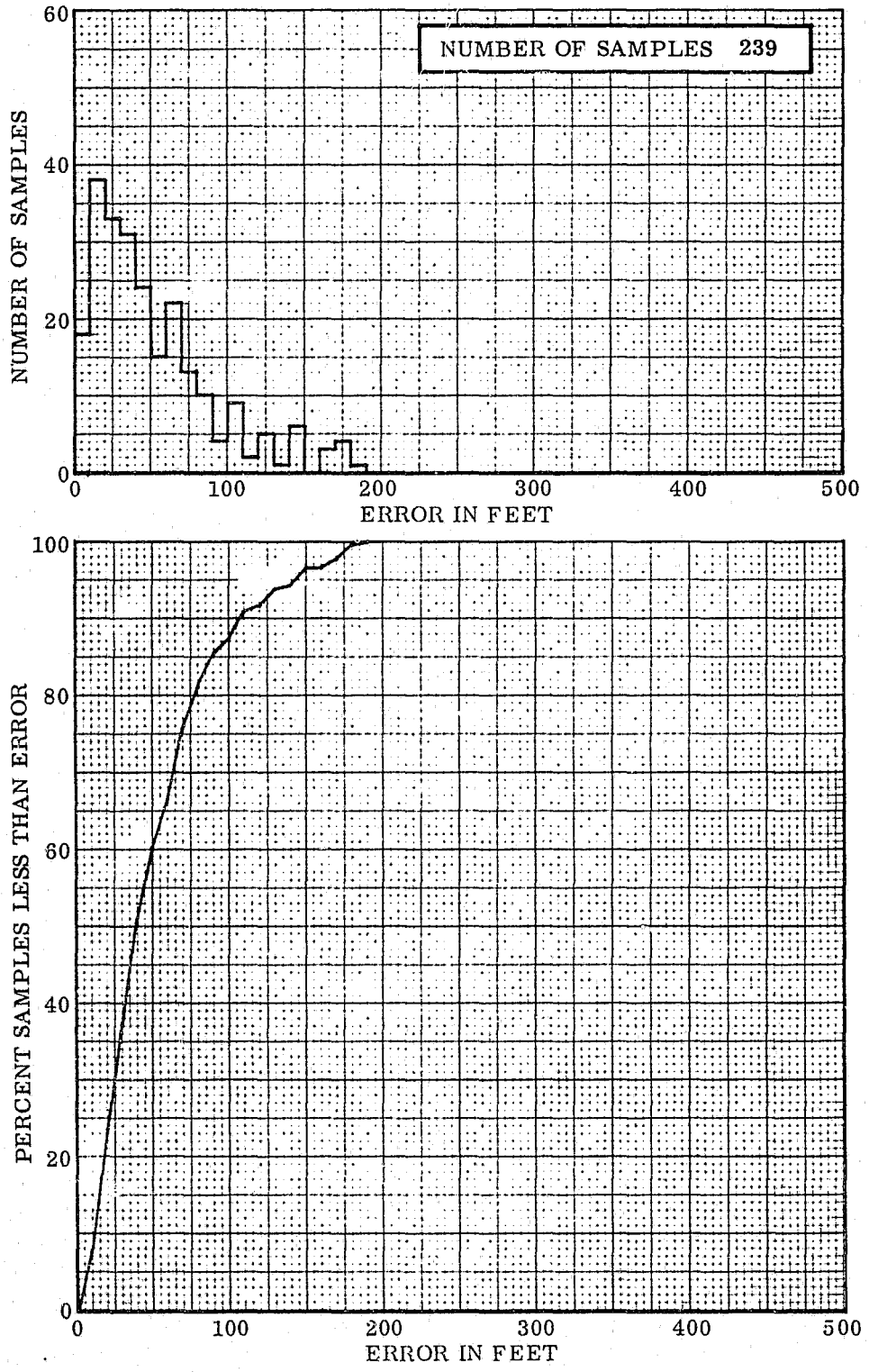


FIG. 8-45 FIXED ROUTE AVM SYSTEM ERRORS, RUN 24

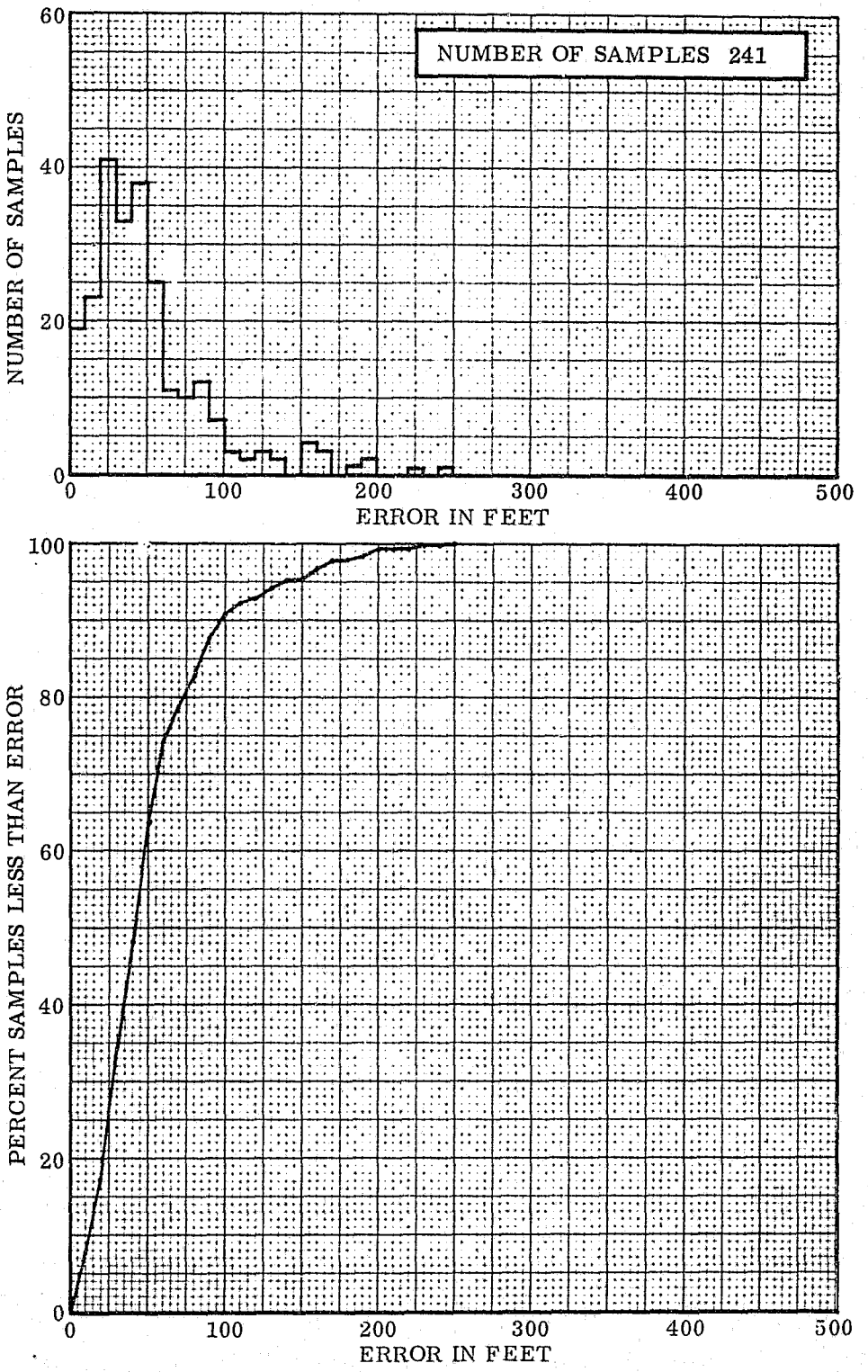


FIG. 8-46 FIXED ROUTE AVM SYSTEM ERRORS, RUN 25

CONTINUED

3 OF 8

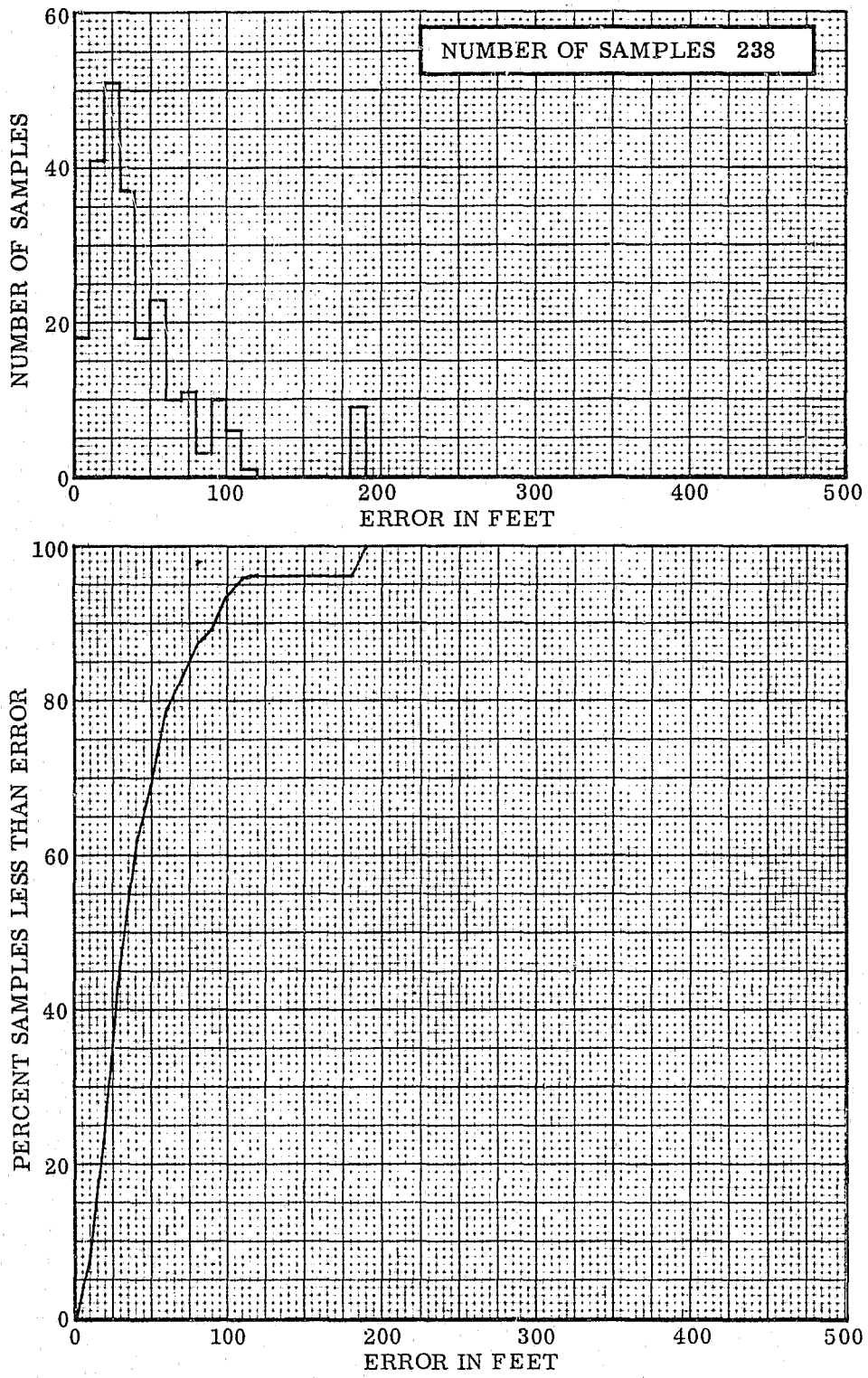


FIG. 8-47 FIXED ROUTE AVM SYSTEM ERRORS, RUN 26

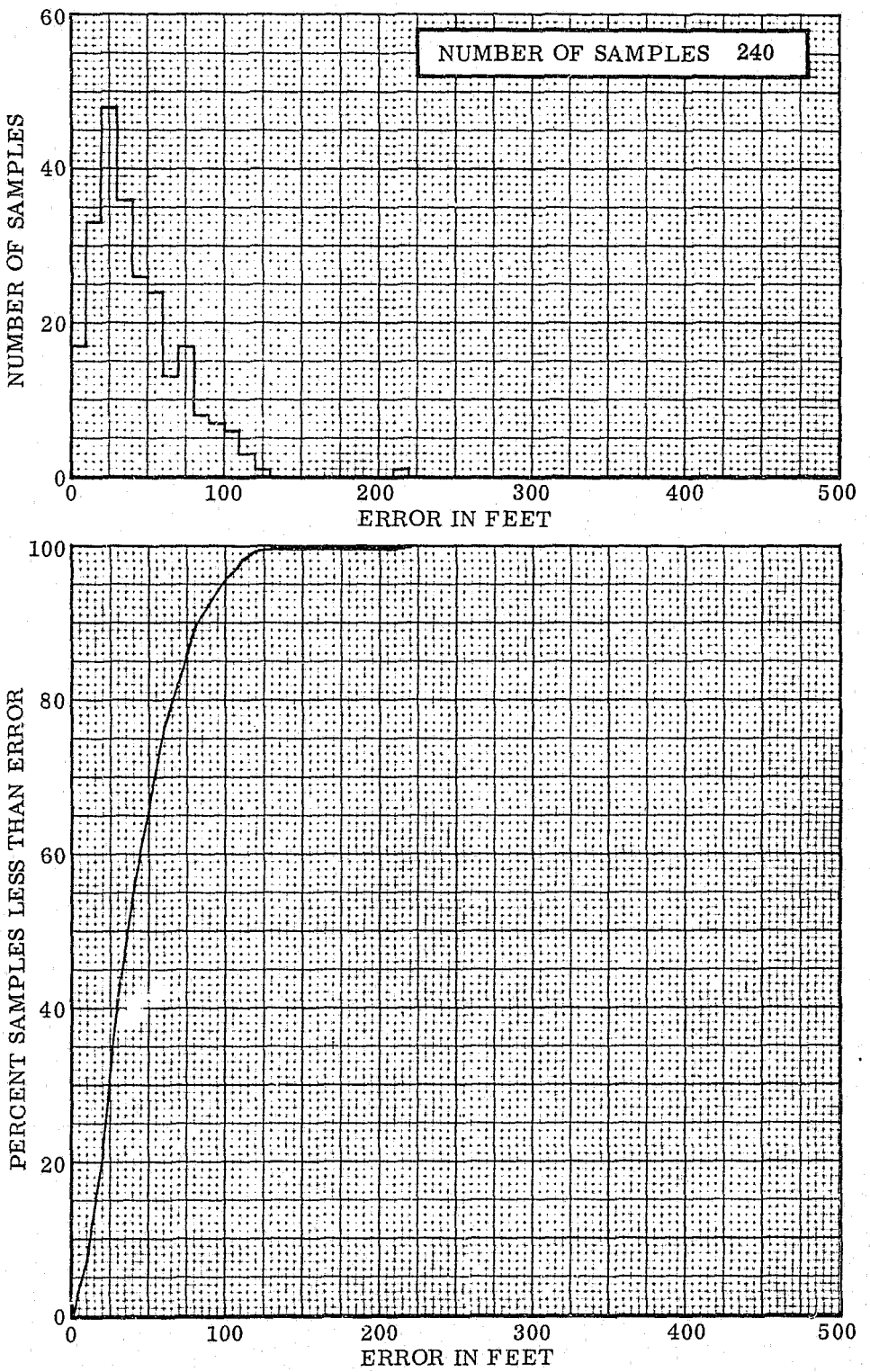


FIG. 8-48 FIXED ROUTE AVM SYSTEM ERRORS, RUN 27

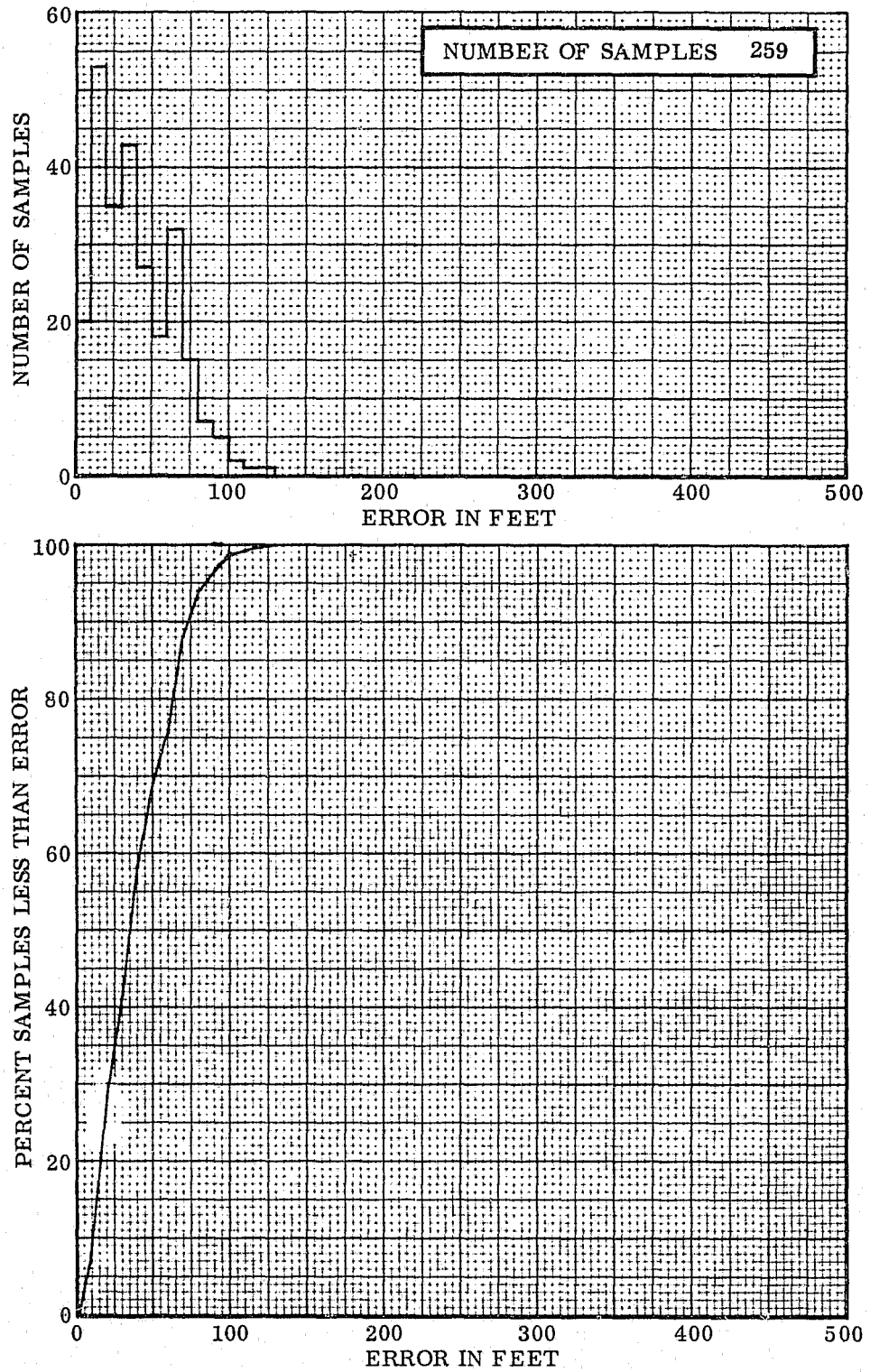


FIG. 8-49 FIXED ROUTE AVM SYSTEM ERRORS, RUN 28

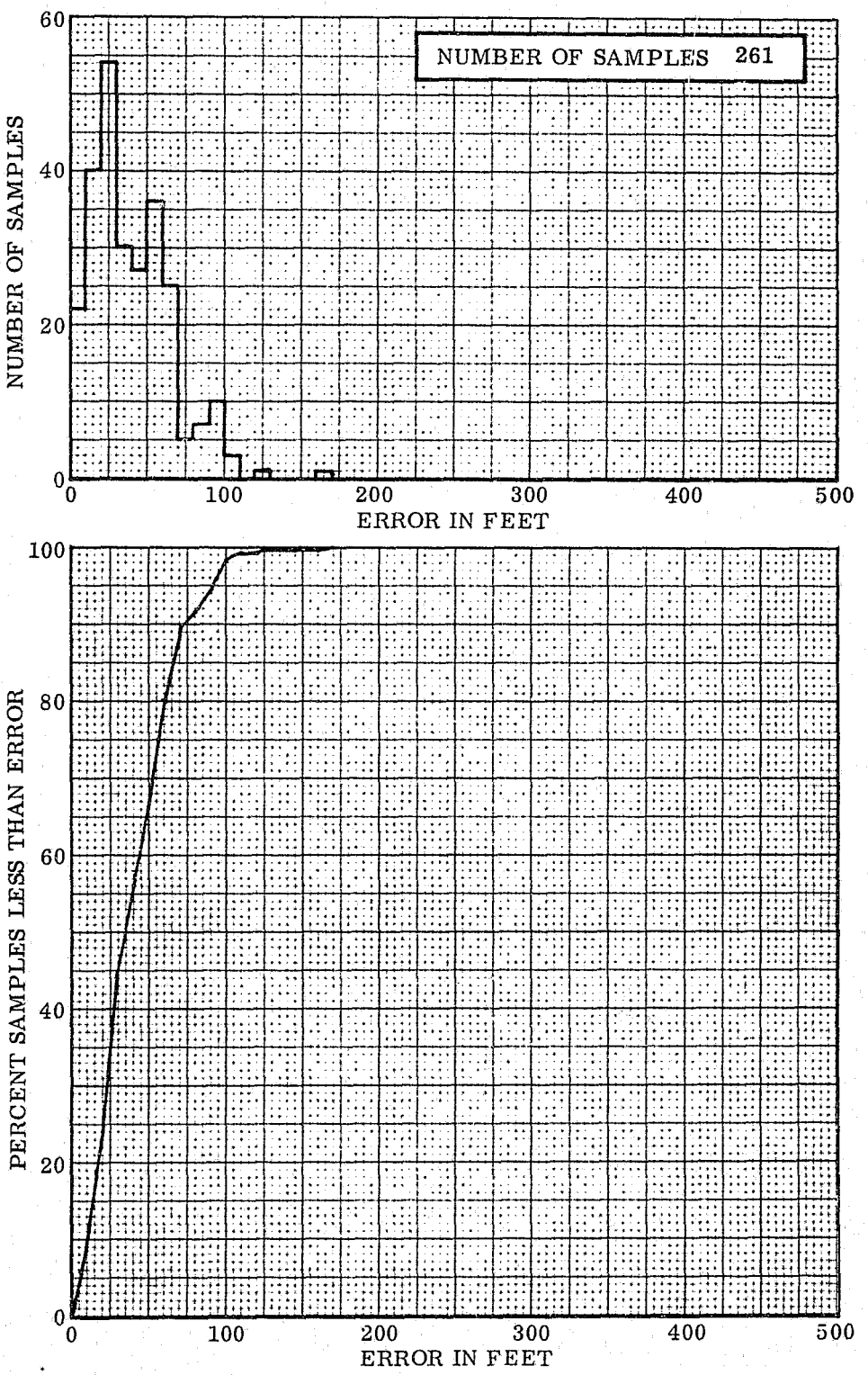


FIG. 8-50 FIXED ROUTE AVM SYSTEM ERRORS, RUN 29

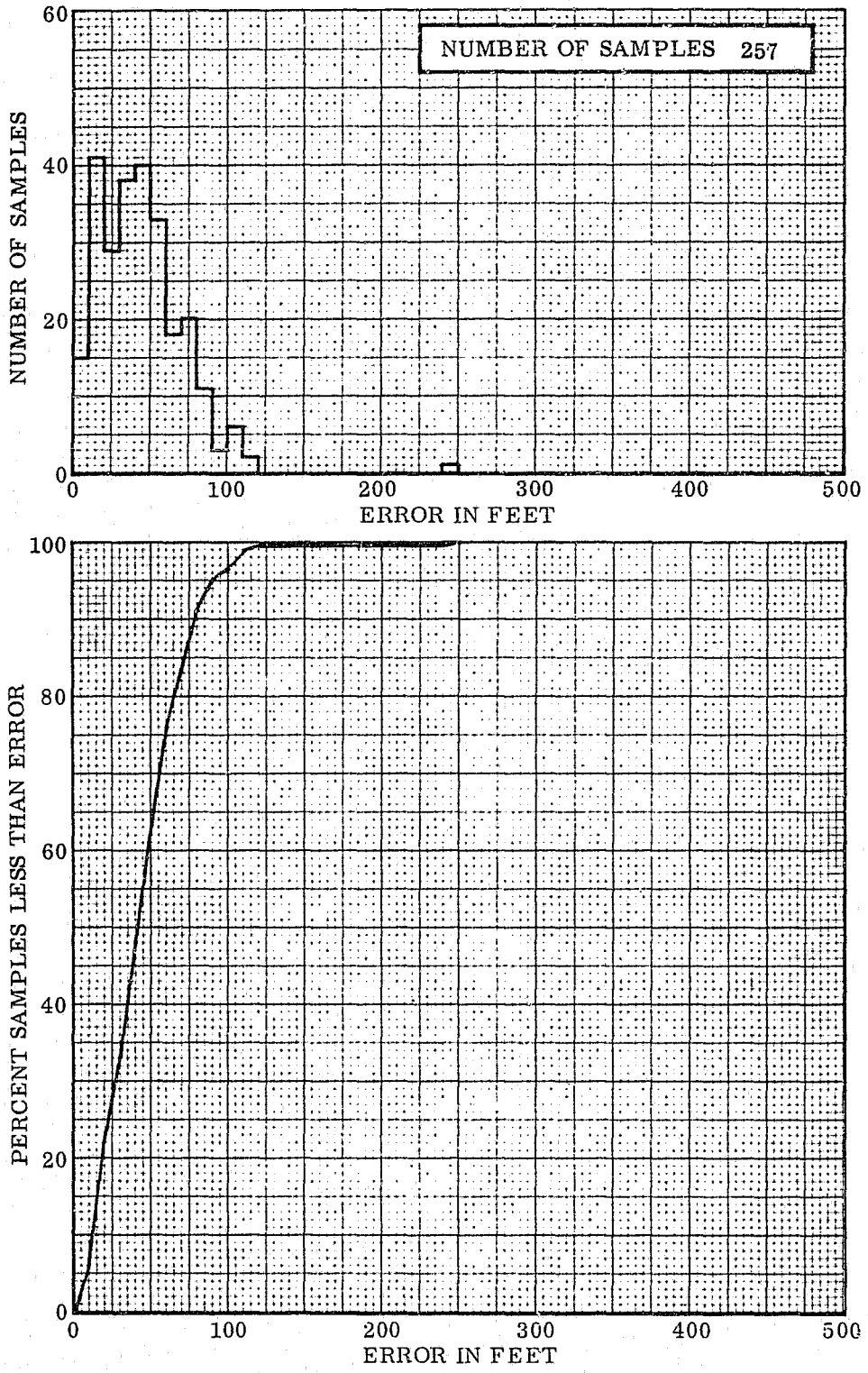


FIG. 8-51 FIXED ROUTE AVM SYSTEM ERRORS, RUN 30

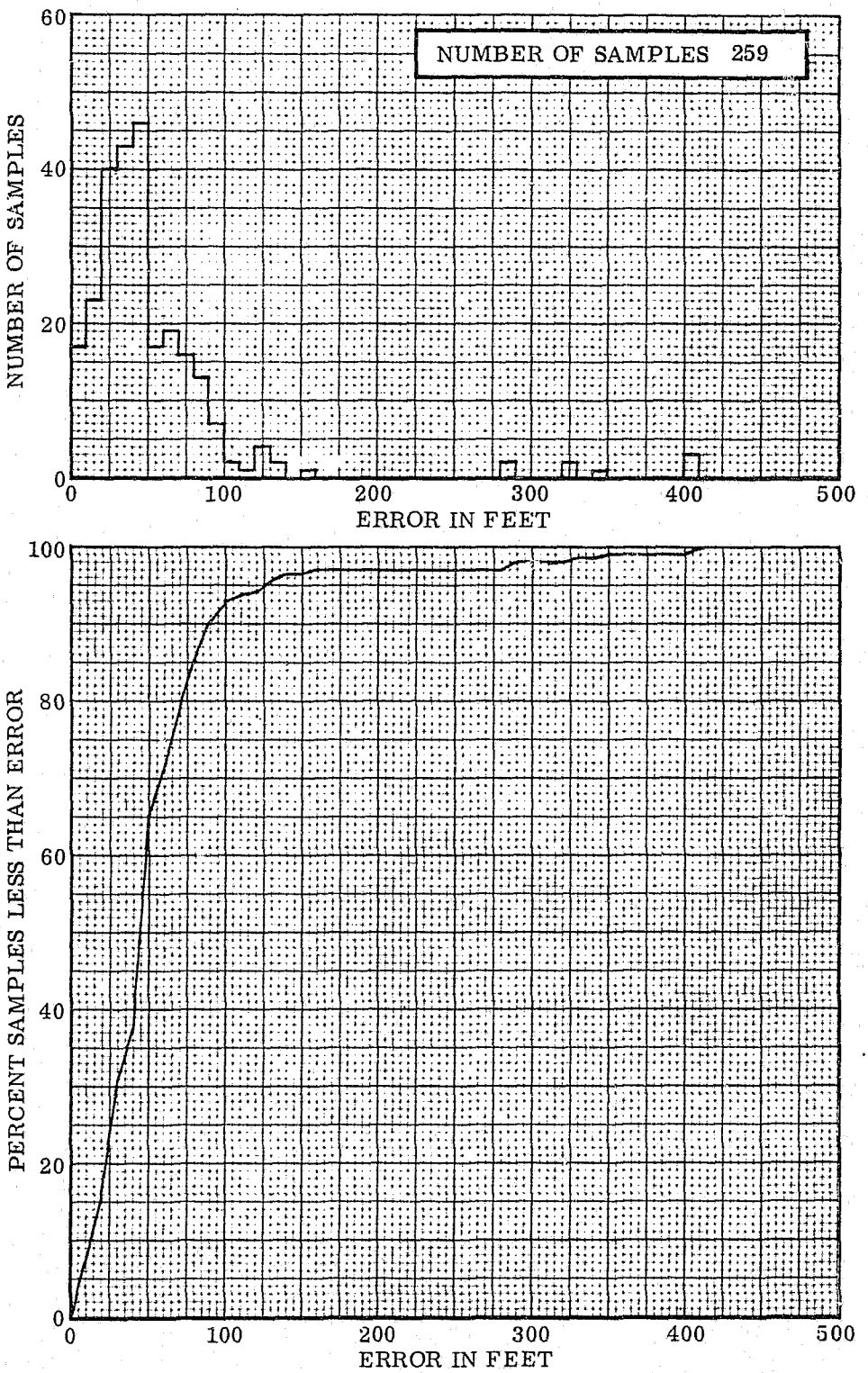
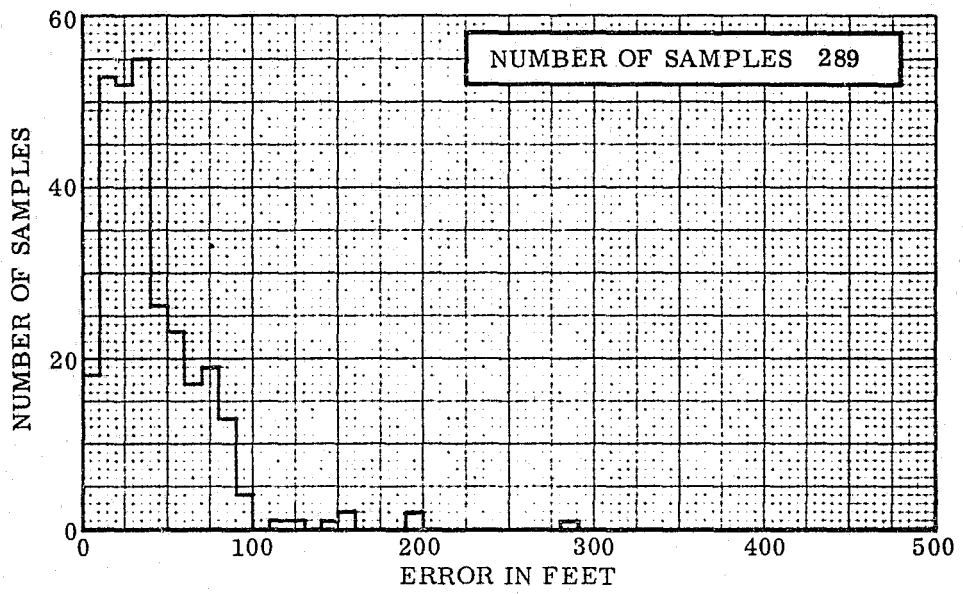


FIG. 8-62 FIXED ROUTE AVM SYSTEM ERRORS, RUN 31



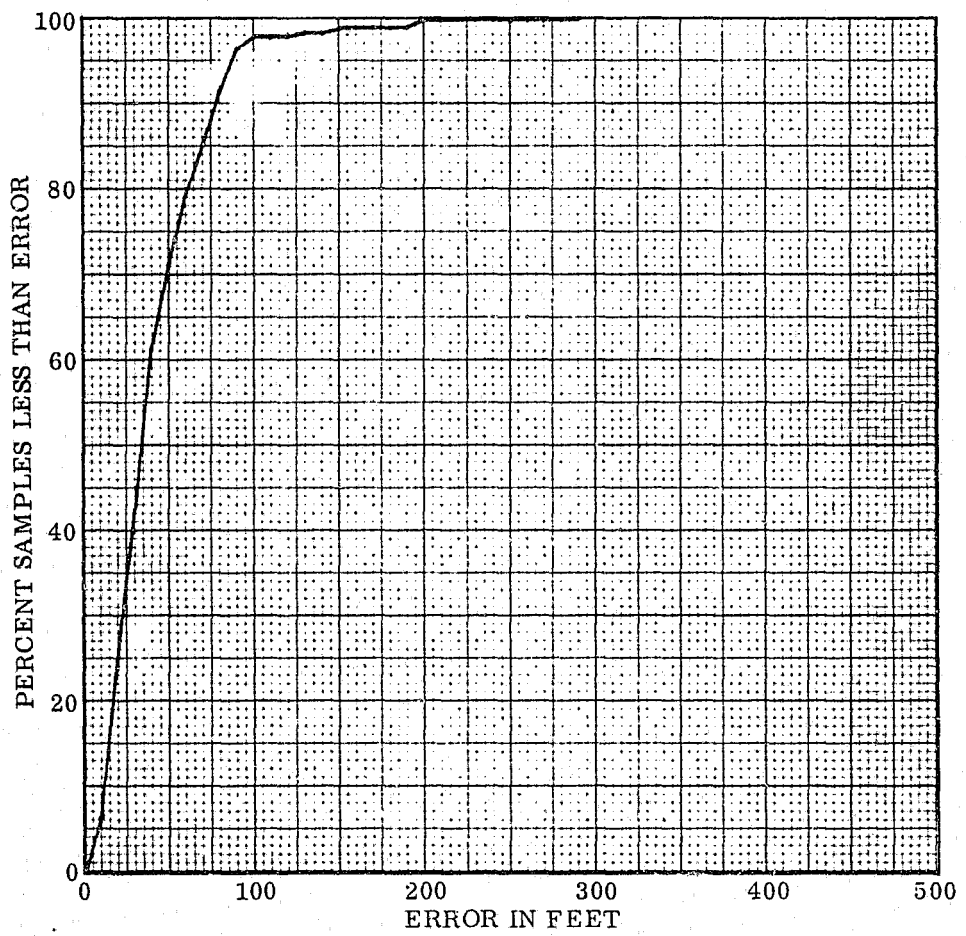


FIG. 8-53 FIXED ROUTE AVM SYSTEM ERRORS, RUN 34

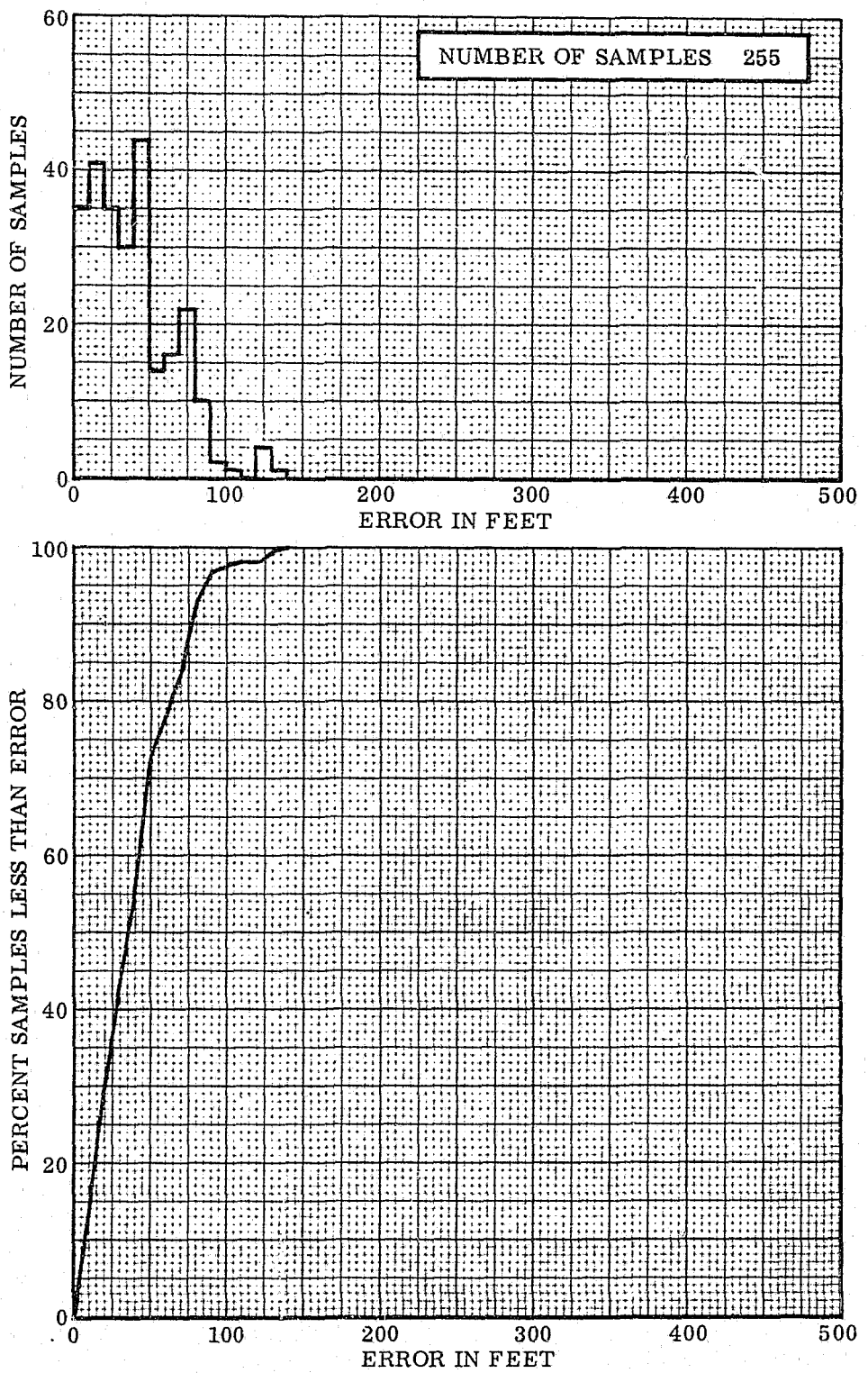


FIG. 8-54 FIXED ROUTE AVM SYSTEM ERRORS, RUN 35

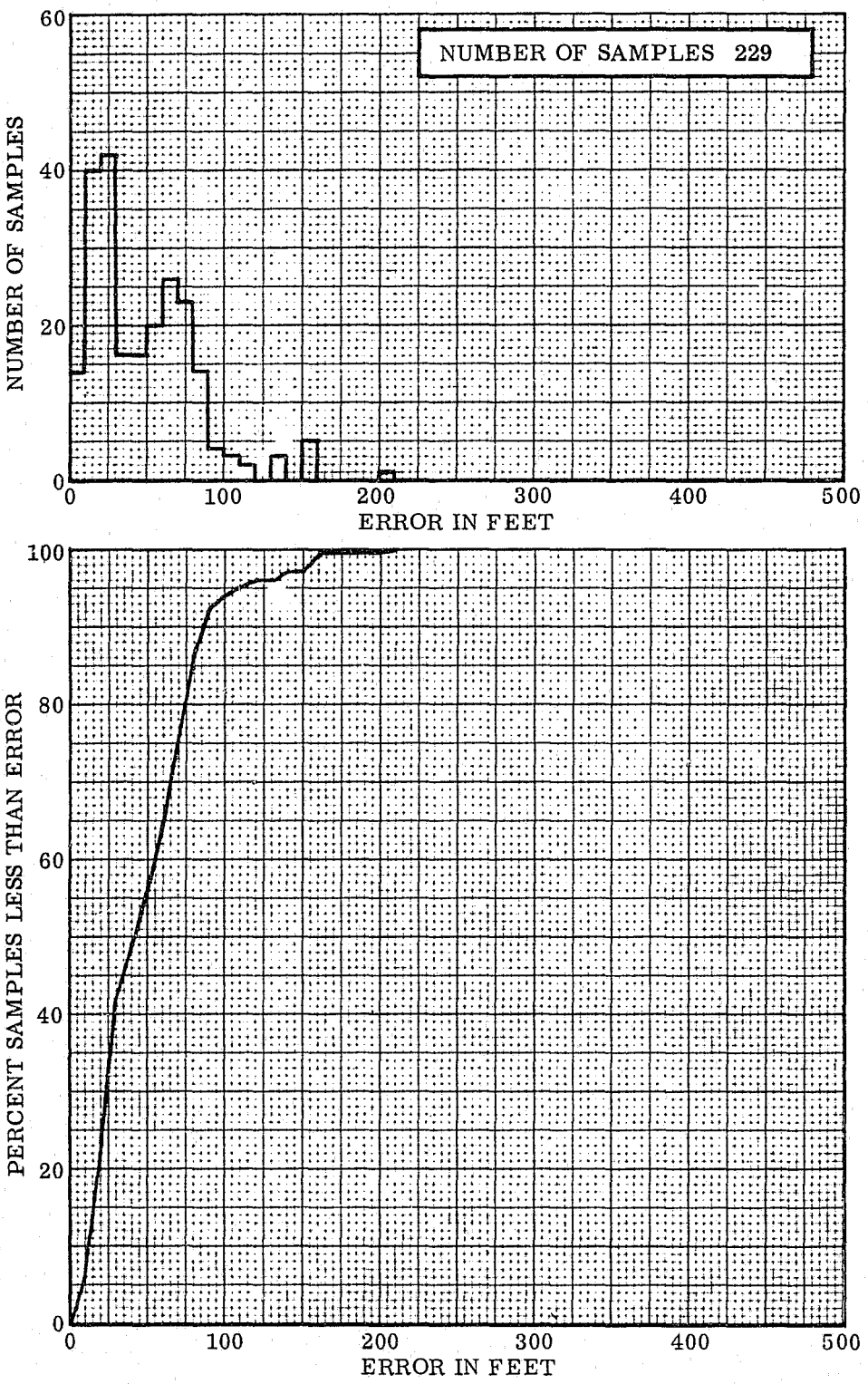


FIG. 8-55 FIXED ROUTE AVM SYSTEM ERRORS, RUN 36

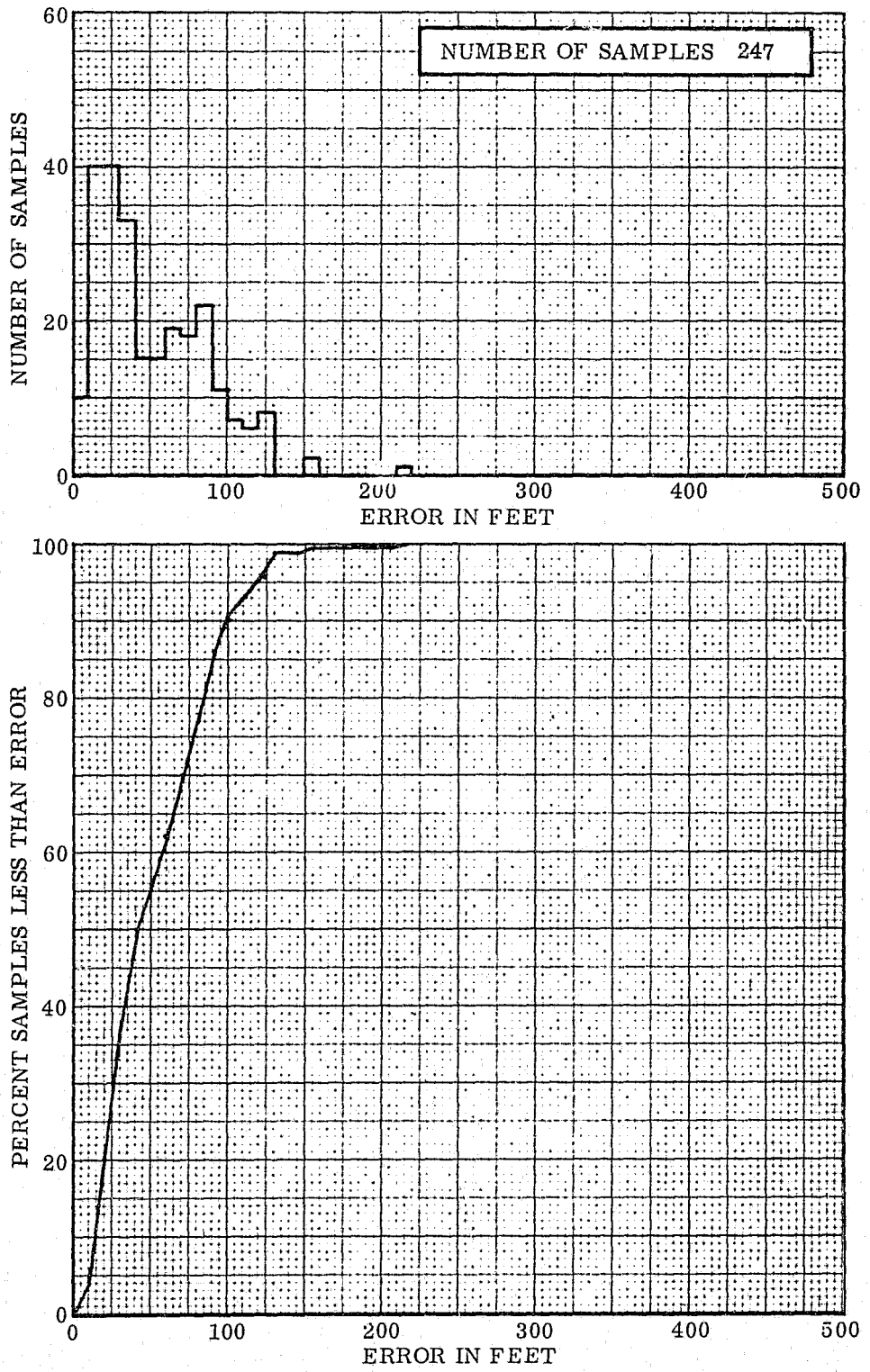
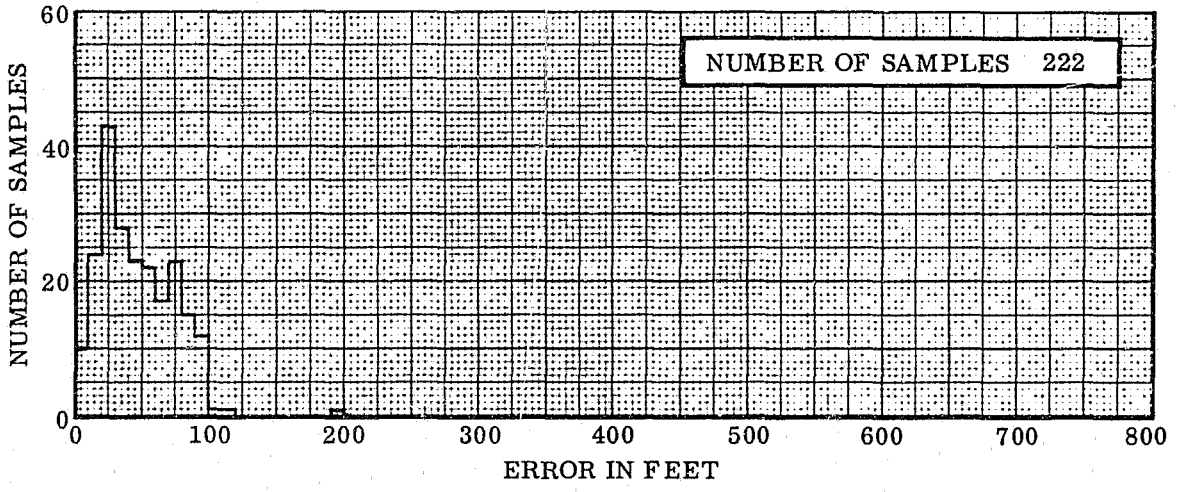


FIG. 8-56 FIXED ROUTE AVM SYSTEM ERRORS, RUN 37



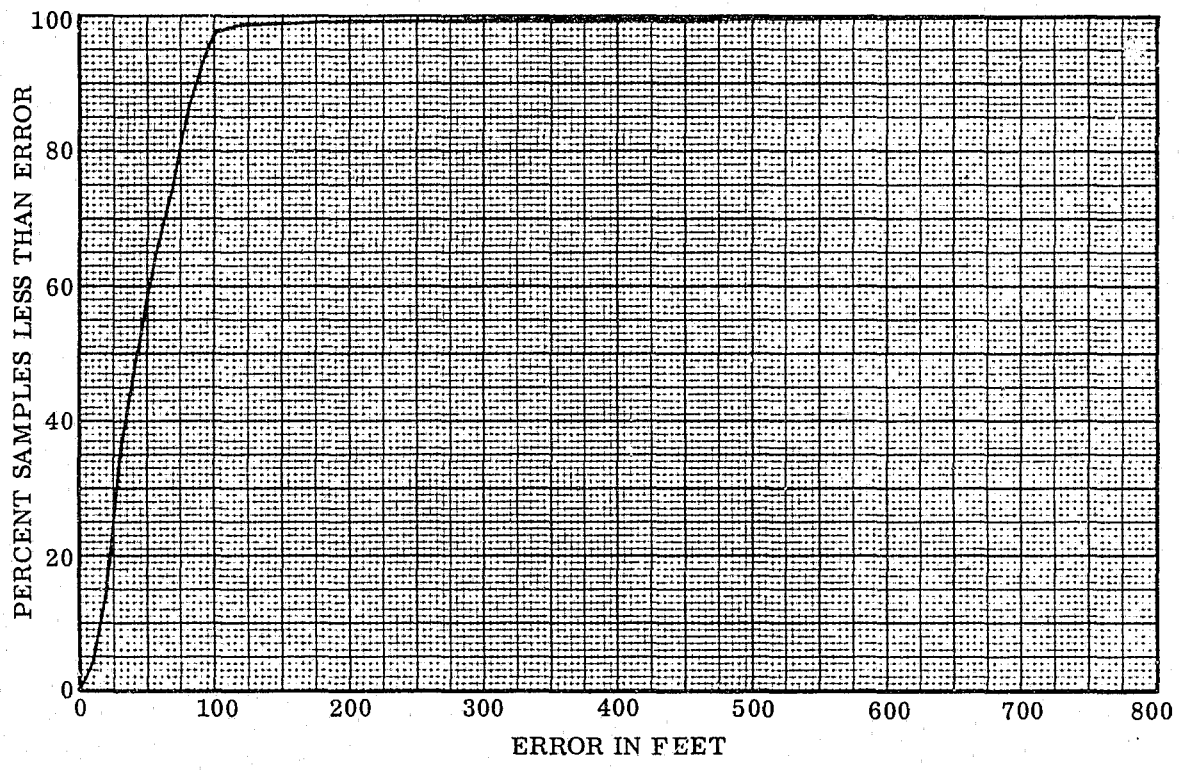
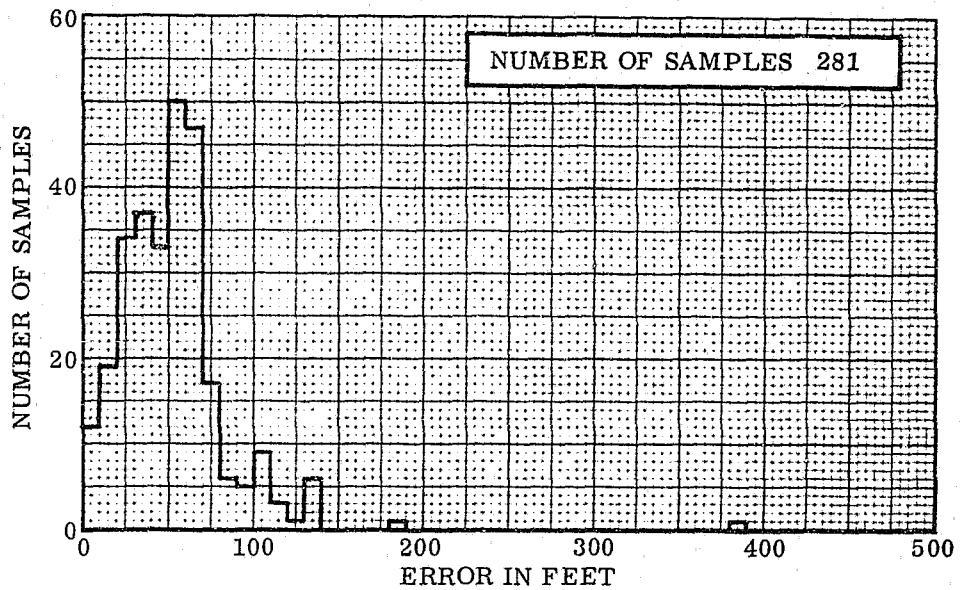


FIG. 8--57 FIXED ROUTE AVM SYSTEM ERRORS, RUN 38



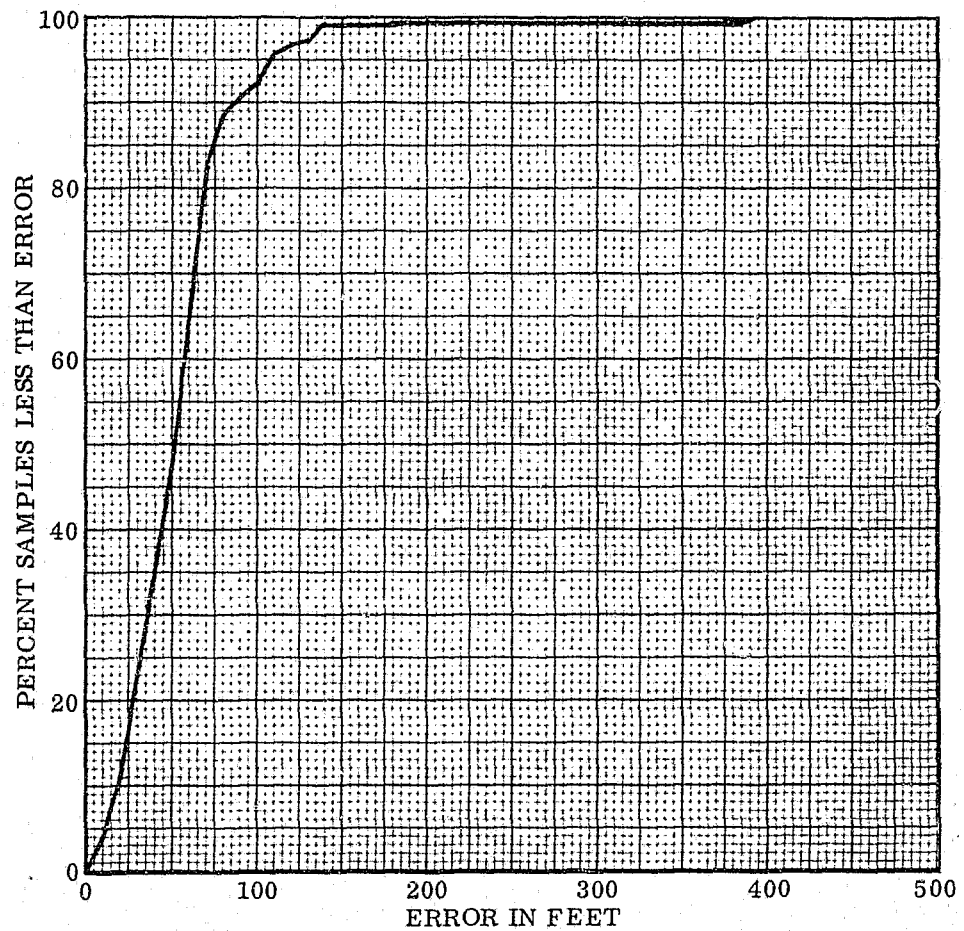


FIG. 8-58 FIXED ROUTE AVM SYSTEM ERRORS, RUN 39

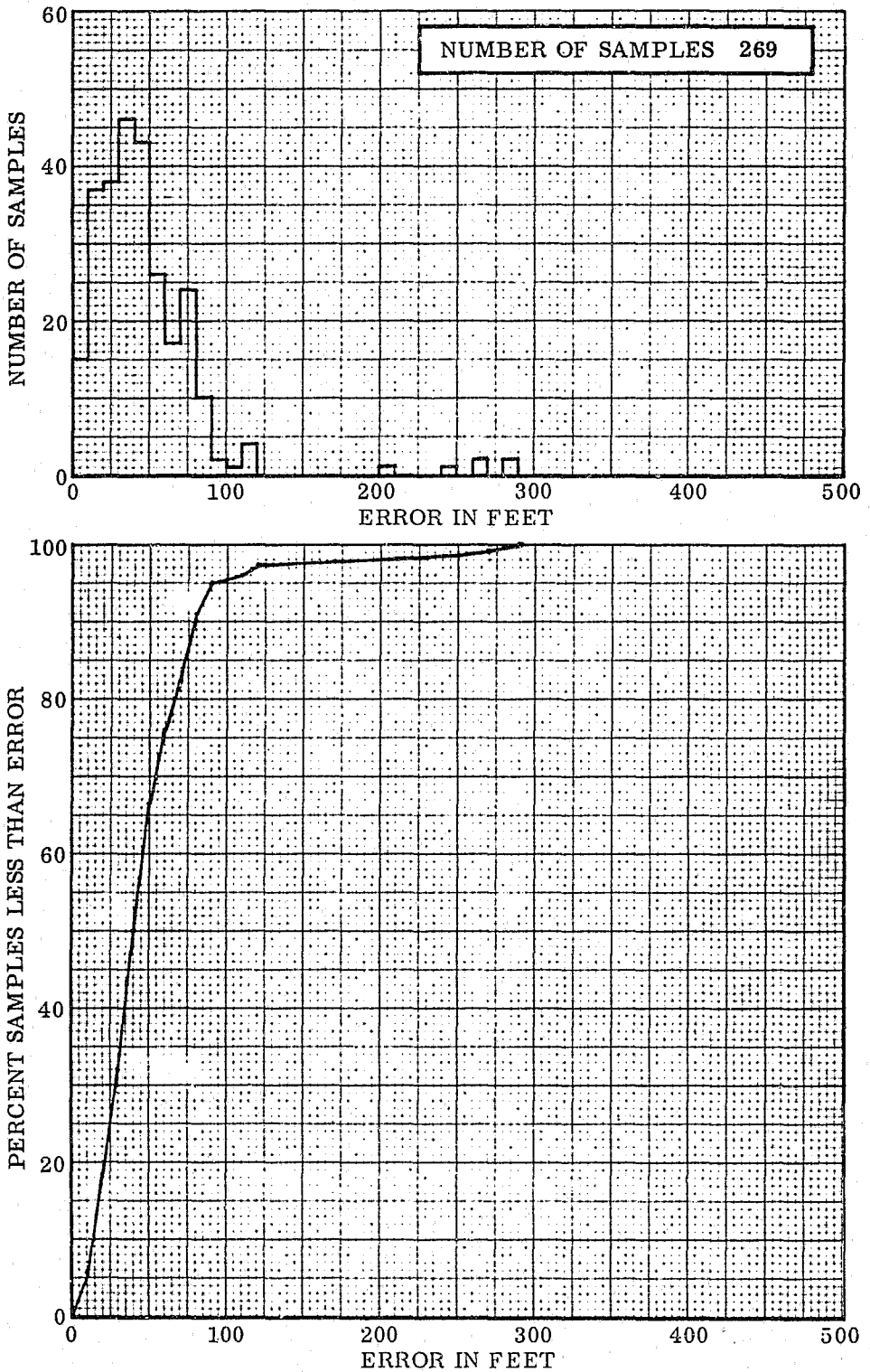
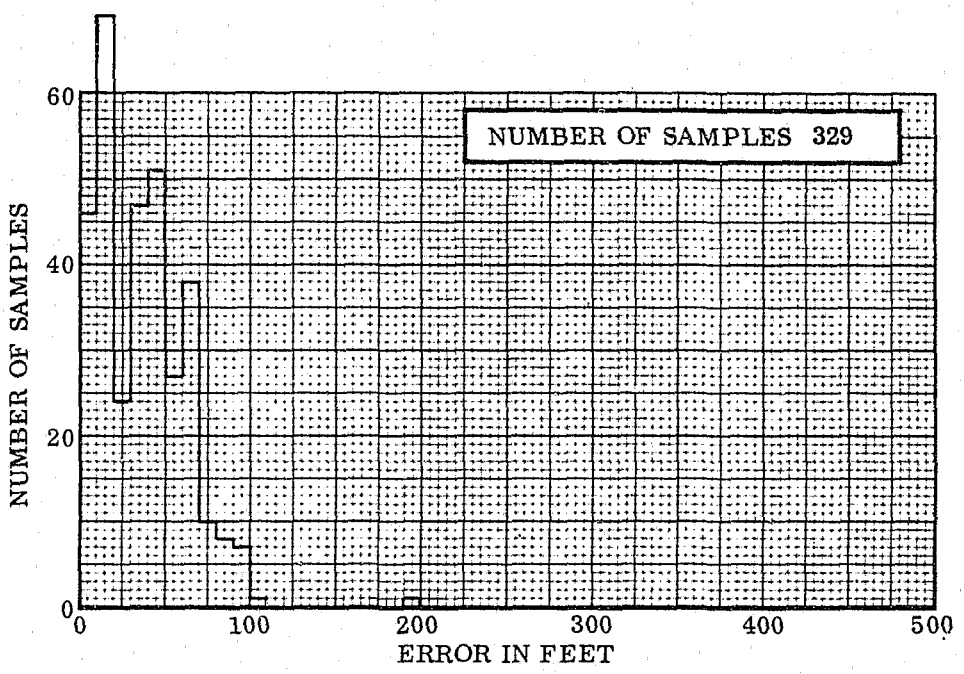


FIG. 8-59 FIXED ROUTE AVM SYSTEM ERRORS, RUN 40



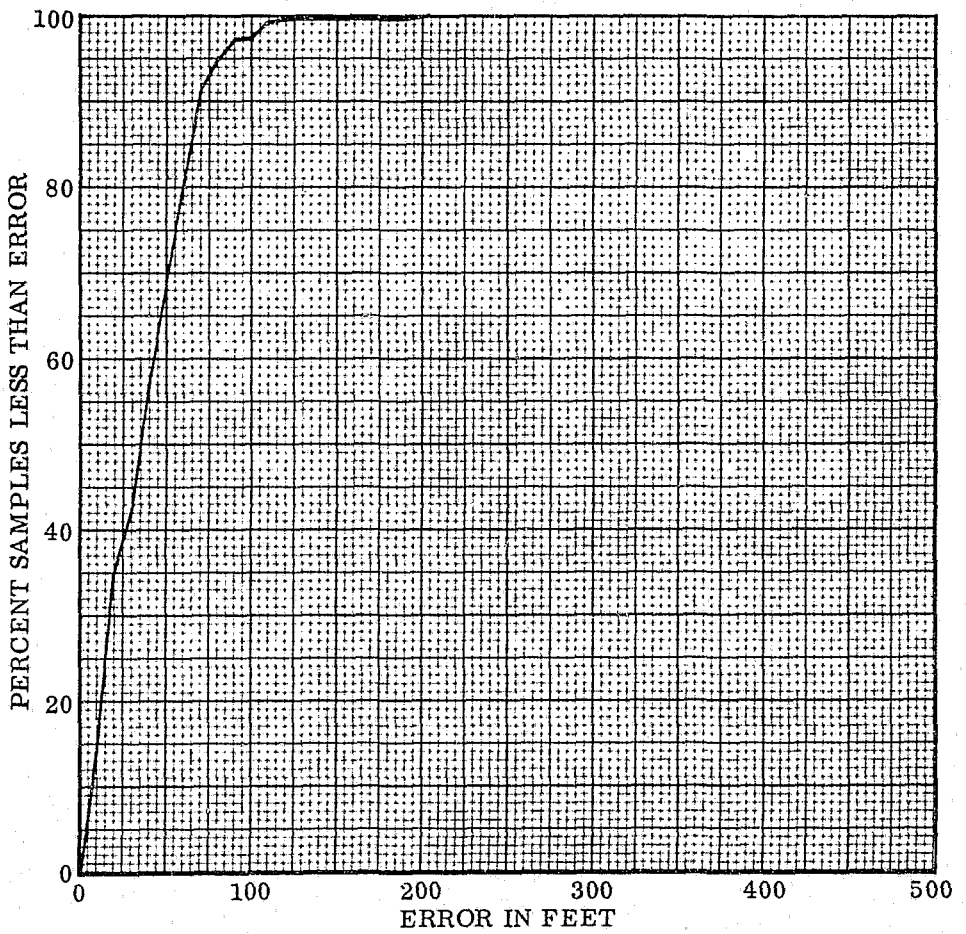


FIG. 8-60 FIXED ROUTE AVM SYSTEM ERRORS, RUN 41

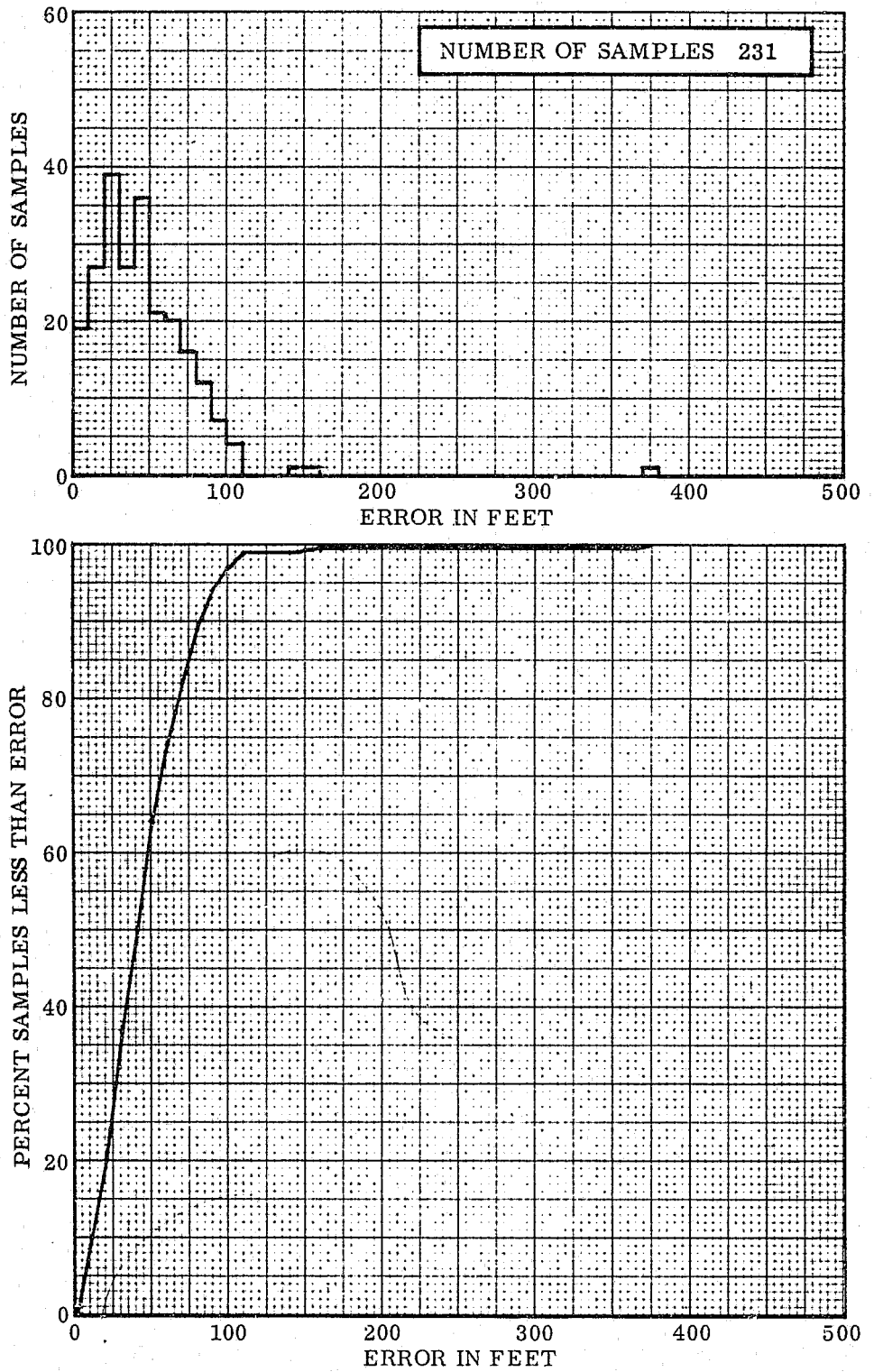
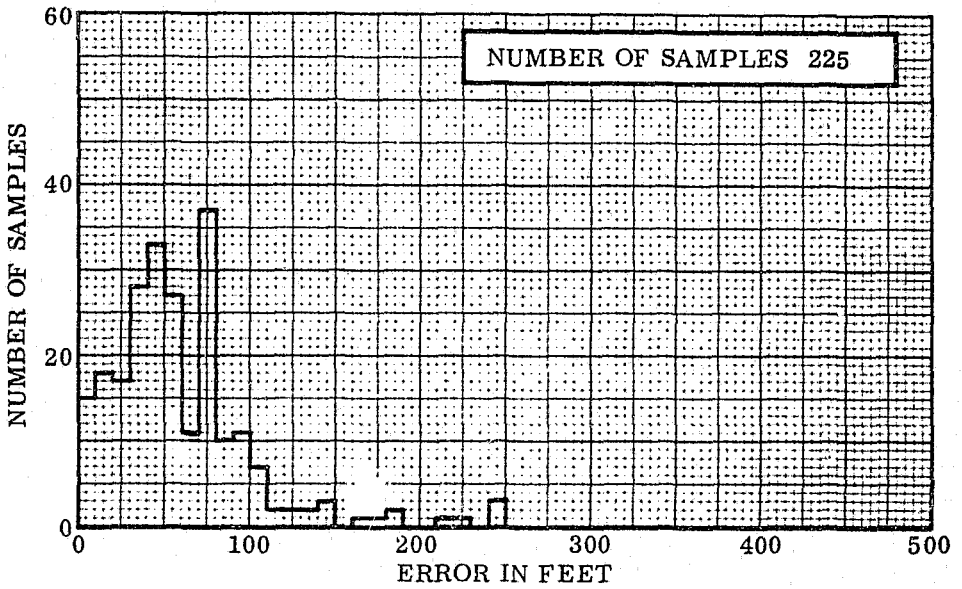


FIG. 8-61 FIXED ROUTE AVM SYSTEM ERRORS, RUN 42



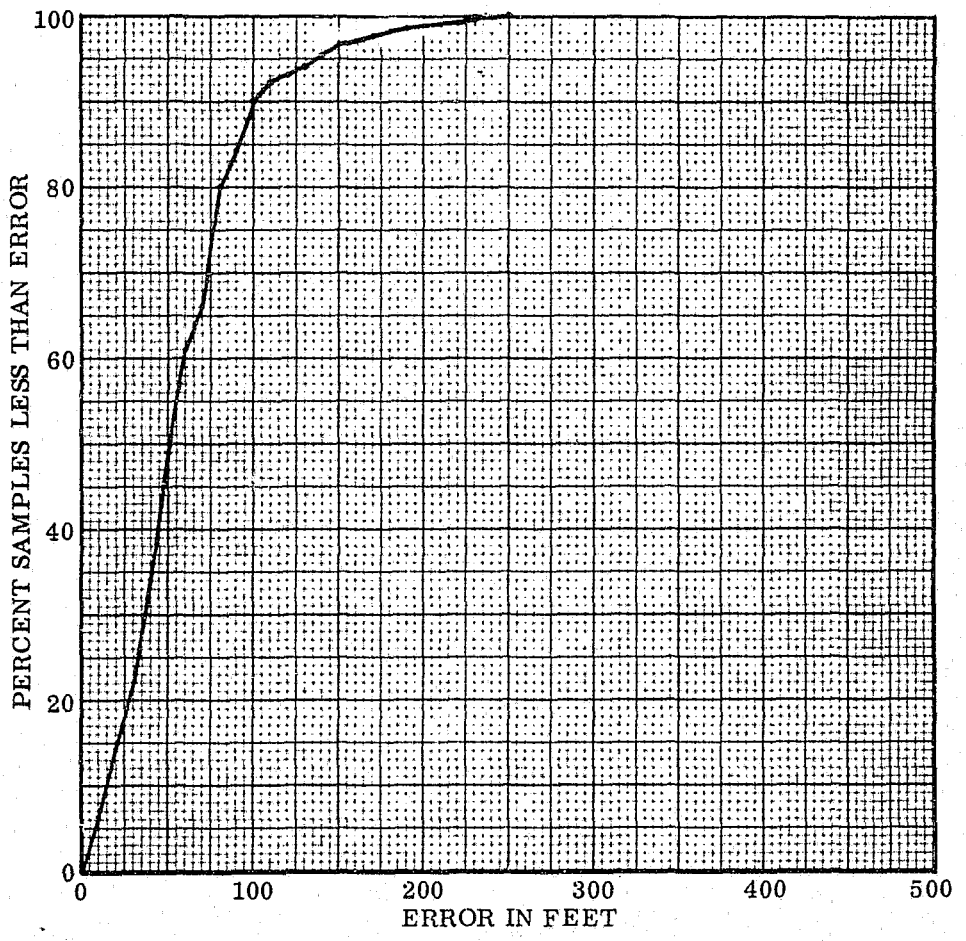


FIG. 8-62 FIXED ROUTE AVM SYSTEM ERRORS, RUN 43

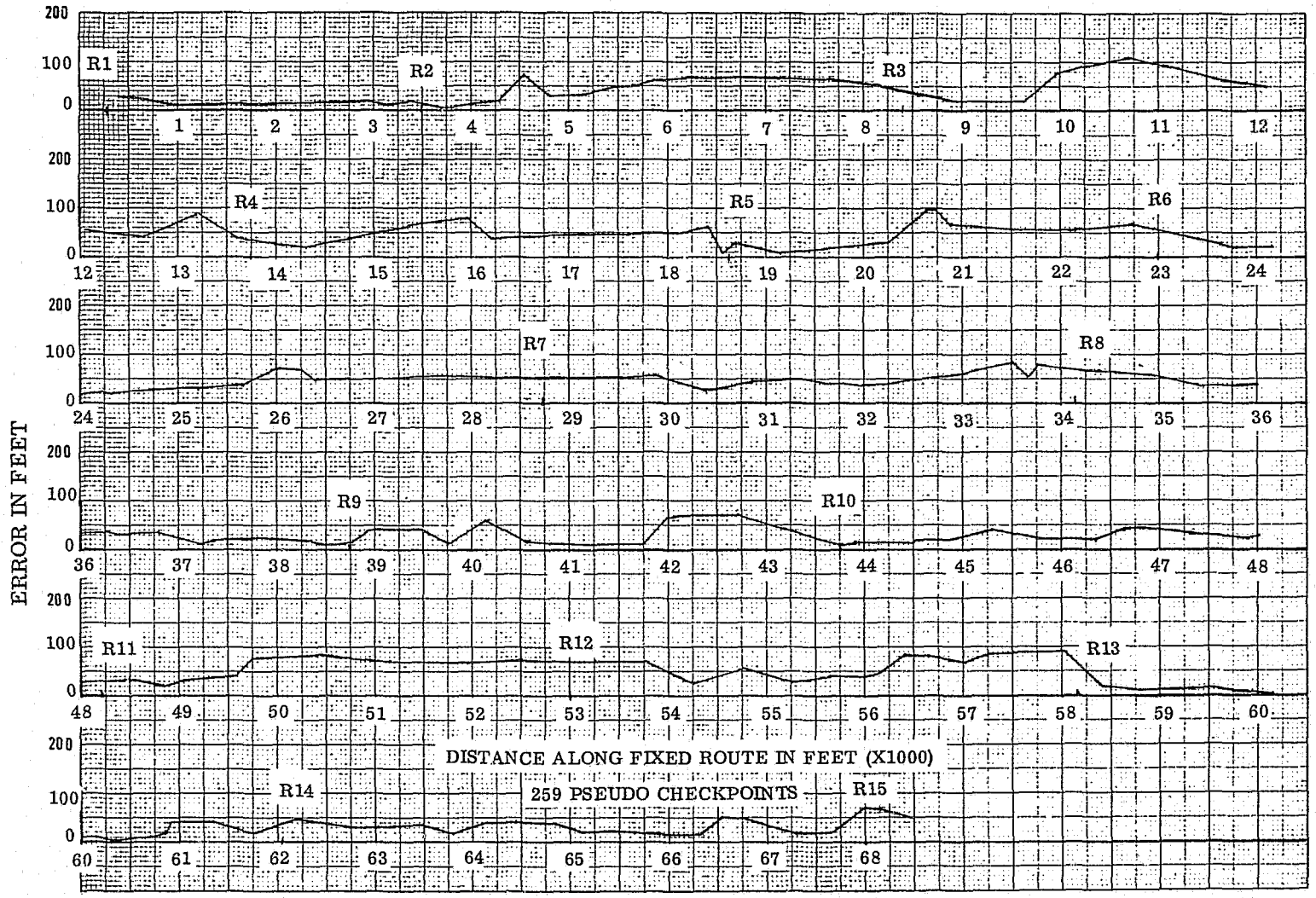


FIG. 8-63 AVM SYSTEM ERRORS PLOTTED VS. ROUTE DISTANCE, RUN 28

TABLE 8-9 TIMEPOINT PERFORMANCE OUTPUT DATA, RUN 27

RUN # 27 TIME POINT PERFORMANCE

TP#	OPEN MIN:SEC	CLOSE MIN:SEC	TOD MIN:SEC	TLR1D MIN:SEC	DELTAT SEC	ERROR SEC
1	0: 0.0	0: 0.0	0:37.5	0:46.0	7.0	1.5
2	4:52.0	0: 0.0	4:57.0	5: 3.0	7.0	-1.0
3	0: 0.0	0: 0.0	11: 5.0	11:11.5	7.0	-0.5
4	14:50.0	15: 7.5	15:16.5	15:20.0	5.0	-9.0
5	0: 0.0	0: 0.0	23: 2.0	23: 6.0	6.0	-2.0
6	26:40.0	26:43.0	26:29.0	26:31.0	2.0	14.0
7	0: 0.0	0: 0.0	32:30.5	32:29.5	-2.0	1.0
8	37:39.5	37:49.5	37:54.5	37:58.0	2.0	-5.0
9	47:55.5	48: 2.5	48: 6.0	48:12.0	9.0	-3.5
10	53:27.0	53:39.0	53:42.5	53:47.0	5.0	-3.5
11	57:12.0	57:16.5	57:20.0	57:23.5	5.0	-3.5
12	60:52.0	61: 5.5	61: 7.5	61: 6.5	1.0	-2.0
13	0: 0.0	0: 0.0	66:56.5	66:58.5	1.0	1.0
14	0: 0.0	0: 0.0	71:24.0	71:26.5	5.0	-2.5
15	0: 0.0	0: 0.0	80:16.0	80:20.5	5.0	-0.5

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	13.33
1- 2	4	26.67
2- 3	3	20.00
3- 4	3	20.00
5- 6	1	6.67
9- 10	1	6.67
14- 15	1	6.67

CUMULATIVE ERRORS

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	13.33
2	6	40.00
3	9	60.00
4	12	80.00
5	12	80.00
6	13	86.67
7	13	86.67
8	13	86.67
9	13	86.67
10	14	93.33
11	14	93.33
12	14	93.33
13	14	93.33
14	14	93.33
15	15	100.00

TABLE 8-10 TIMEPOINT PERFORMANCE ERRORS (SECONDS)

TP \ RUN	11	12	13	14	15	16	17	18	20	21	22	23	24	25	26
1	1.5	1.5	1.5	2.5	-0.5	-6.0	0.0	3.5	1.0	3.0	-9.0	-6.0	-2.5	-9.5	3.0
2	1.5	2.0	-2.0	-7.0	-4.0	-4.0	-8.0	-1.5	1.0	-1.0	0.0	-0.5	-5.0	-3.0	-5.5
3	-5.5	-4.0	-0.5	-4.0	-1.0	-5.0	-7.0	-8.0	-5.5	-6.0	-6.0	-6.0	-3.5	-6.0	0.0
4	-10.0	-12.0	-13.5	-8.0	-0.5	-14.0	-2.5	-2.5	-4.5	-7.0	0.0	0.0	-5.0	-6.0	-3.5
5	23.5	-27.5	42.5	-3.0	-2.5	-2.5	-4.0	-3.5	-2.0	-1.0	-3.0	-1.5	-4.5	-1.5	-2.0
6	0.0	-8.0	-4.5	-0.5	-4.5	-1.5	9.5	-14.5	-4.5	0.5	-1.0	0.0	12.5	R1D	12.0
7	0.0	0.5	1.5	-0.5	1.0	1.0	1.0	1.5	-9.0	1.5	2.0	-3.5	1.0	0.0	1.0
8	1.0	-5.5	-15.0	-0.5	-5.0	1.0	-6.0	-5.5	-5.0	-10.0	0.0	-8.5	-1.0	-11.0	-5.5
9	-5.5	-2.0	-3.0	-2.0	-3.5	-3.0	-2.0	-3.0	-3.0	-3.5	-3.0	4.5	-4.5	1.0	1.5
10	-5.0	-2.0	-4.5	-2.5	-3.5	-1.5	-2.0	-1.0	P	-4.5	-3.0	-0.5	-1.0	-1.0	-2.0
11	-2.5	-2.5	-2.0	-4.5	-3.0	-7.5	TD	-3.5	P	-3.5	-2.0	-4.0	-4.5	-3.0	-3.5
12	1.0	-0.5	0.0	-2.0	-3.0	-2.5	0.0	0.0	P	-0.5	-3.0	-0.5	-1.5	-3.0	-0.5
13	-2.0	-4.0	-6.0	-2.0	0.0	-10.0	-6.5	-2.0	P	-6.0	-7.0	-7.5	0.0	0.0	0.0
14	-3.0	-2.0	-2.0	-1.0	-3.0	3.0	-4.5	-2.5	P	-4.0	-4.0	-2.0	-4.0	6.0	-1.5
15	-1.0	0.0	0.0	-1.0	-7.5	-1.0	-2.0	-0.5	P	-0.5	-1.0	-2.5	-1.0	-1.0	TD

R1D - Missed R1 Dropout
P - Auxiliary Power Generator Failure
TD - Missed Event Marker

TABLE 8-10 TIMEPOINT PERFORMANCE ERRORS (SECONDS) (CONT'D)

TP \ RUN	27	28	29	30	31	32	34	35	36	37	38	39	40	41	42	43
1	1.5	-5.5	1.5	-8.5	-5.0	-8.0	-9.0	1.5	2.0	4.0	- 4.0	1.0	3.5	-5.5	2.0	2.0
2	-1.0	-1.0	-6.5	-7.0	2.5	-2.5	-4.0	2.0	-4.5	-3.5	-4.5	-4.5	-6.0	-3.5	-4.5	-5.5
3	-0.5	0.5	-8.0	-8.5	-6.5	-9.0	-7.0	0.5	0.0	-8.0	-5.5	-11.0	-11.0	-9.0	-9.0	-0.5
4	-9.0	-2.5	-4.0	-5.5	-5.0	-6.0	-1.0	-6.5	-7.0	-0.5	-5.5	-2.5	-8.0	-1.5	-3.5	-5.5
5	-2.0	-2.0	-2.0	-2.0	-1.5	-2.0	17.0	-1.5	-2.0	-2.0	-2.0	-6.0	-6.5	-8.0	-1.5	-1.5
6	14.0	1.5	-0.5	13.5	0.0	-0.5	0.0	0.0	0.5	-0.5	19.0	11.0	-0.5	0.0	0.5	-10.5
7	1.0	0.5	1.5	1.0	0.5	2.0	8.5	2.0	1.0	0.5	0.5	1.5	0.5	1.5	1.5	1.0
8	-5.0	0.0	0.5	0.0	-10.5	TD	0.0	-6.5	-4.5	-8.0	-6.0	-5.5	0.5	0.5	2.0	-5.5
9	-3.5	-4.0	-5.5	-3.5	-3.0	0.5	-3.0	-5.5	-2.5	-4.0	-4.0	-4.0	T	-4.5	-4.0	-1.0
10	-3.5	-4.0	-11.0	0.5	-5.0	-12.0	-1.0	-9.5	-1.5	-7.0	-5.5	-1.0	8.0	-5.0	-6.0	-6.5
11	-3.5	0.0	-7.5	-5.5	-3.5	-1.0	-6.0	-5.5	-4.5	-0.5	-3.5	-6.0	4.0	1.0	-4.0	-4.0
12	-2.0	-5.0	-0.5	-0.5	0.0	-11.0	0.0	-9.5	-3.0	-5.5	R1D	R1D	-3.0	R1D	4.0	R1D
13	1.0	0.0	-3.5	1.0	0.0	-5.5	-5.0	-5.0	-4.0	-4.5	-10.0	-9.0	1.0	-7.0	-4.5	1.0
14	-2.5	-3.0	-6.5	-1.0	-4.0	-5.0	-9.0	-2.0	-4.5	-2.0	2.0	-1.5	-3.0	-3.5	-5.0	-4.0
15	-0.5	-9.0	-0.5	-1.0	0.5	-1.5	-8.0	-1.5	-1.0	-1.0	-0.5	0.5	-1.0	3.0	-0.5	-1.0

T - Time Error on Tape
R1D - R1D Not Received
TD - Missed Event Marker

All anomalies are explained in Table 8-11. Note that a signpost failure between Runs 37 and 38 resulted in no R1D data at Timepoint 12 on Runs 38 through 43. In the Phase II system, an absence of R1D information would result in no computation of timepoint performance at that timepoint unless the bus door were first opened and then closed at the timepoint. The Phase II procedure was followed to the letter in Phase I in that timepoint performance at Timepoint 12 was only computed during Runs 40, 41, and 42 when the door close event was utilized. Table 8-12 contains composite timepoint error statistics for all fixed route runs.

Figure 8-64 contains a histogram and cumulative distribution of the absolute time-of-departure errors resulting from processing Runs 11 through 43. Figure 8-65 contains an error frequency density of these errors, with the sign preserved.

By using the Door Open event as an indication of time of arrival, the following results were obtained:

Number of Door Open Samples:	221 Samples
95 percentile value of (TOA-TD):	37 Seconds
99.5 percentile value of (TOA-TD):	56 Seconds
Average (TOA-TD):	16 Seconds.

Note that use of the Time of Door Open to indicate TOA has a built in error if the stop is a near side stop since the time during which the door is open is included.

The speed of the test vehicle while passing timepoints was computed for each case in which the Door Open/Door Close events were not utilized. Table 8-13 shows the results obtained. Note that the maximum vehicle speed of passage was 23 mph, a constraint imposed by both traffic and legal speed limits. In order to determine if there was a correlation between vehicle speed of passage and time of passage errors, a plot was constructed showing the time of passage error versus vehicle velocity. This plot, shown in Figure 8-65, indicates that the errors were rather uniformly distributed over the interval between 5 and 18 miles per hour. In particular, there is no indication that high (or low) speeds tend to produce larger errors. Note that all data shown in Figure 8-66 resulted from the use of the Region 1 dropout, and therefore would also apply to the proposed Phase II system with the odometer eliminated as described in Subsection 10.2.

The application of the Door Close event to determine time of passage as presented herein has been in strict accordance with the AVM specification. However, it is of interest to note the results obtained if one assumed that the vehicle passes the timepoint at the exact time of door closure. This would produce zero error in each case in which the Door Close event was employed. The effect on the overall error statistics obtained during Phase I would be as follows:

(Text continued on 8-93)

TABLE 8-11 TIMEPOINT ANOMALIES

RUN NO.	PROBLEM	RESULT
14	Couldn't process second cassette	4 TP's computed manually
17	Missed TD 11	14 TP's
19, 33	Couldn't process	No Results
20	Auxiliary power failure at CP 46	9 TP's
24	Couldn't process all tapes	3 TP's computed manually
24	First TD 12 entered early	Deleted with EE 12
25	Couldn't process all of tape	9 TP's computed manually
25	No R1D from TP 6 due to 0.5 second sampling interval	14 TP's
26	Missed TD 15	14 TP's
27	First TD 10 should be TA 10	Card input change
34	Couldn't process all of tape	7 TP's computed manually
34	DP 15 and DC 15 entered early	Deleted with EE 15
38, 39, 41, 43	No R1D from TP 12 due to signpost failure	Missed TP 12
40	Time record error at TD 6	Missed TP 6
40	Couldn't process all of second cassette	6 TP's computed manually
42	TD 15 entered early	Deleted with EE 15
43	Couldn't process all of second cassette	3 TP's computed manually

TABLE 8-12 COMPOSITE TIMEPOINT PERFORMANCE ERROR STATISTICS

ERROR FREQUENCY DENSITY		
Error* Interval	No. Samples	Percent Samples
0- 1	80	17.74
1- 2	79	17.52
2- 3	58	12.86
3- 4	49	10.86
4- 5	49	10.86
5- 6	39	8.65
6- 7	27	5.99
7- 8	13	2.88
8- 9	16	3.55
9-10	14	3.10
10-11	7	1.55
11-12	5	1.11
12-13	4	.89
13-14	2	.44
14-15	3	.67
15-16	1	.22
17-18	1	.22
19-20	1	.22
23-24	1	.22
27-28	1	.22
42-43	1	.22

CUMULATIVE ERRORS		
Error*	No. Samples LT Error	% Sample LT Error
1	80	17.74
2	159	35.25
3	217	48.12
4	266	58.98
5	315	69.84
6	354	78.49
7	381	84.48
8	394	87.36
9	410	90.91
10	424	94.01
11	431	95.57
12	436	96.67
13	440	97.56
14	442	98.00
15	445	98.67
16	446	98.89
18	447	99.11
20	448	99.33
24	449	99.56
28	450	99.78
43	451	100.00

* Error in Seconds

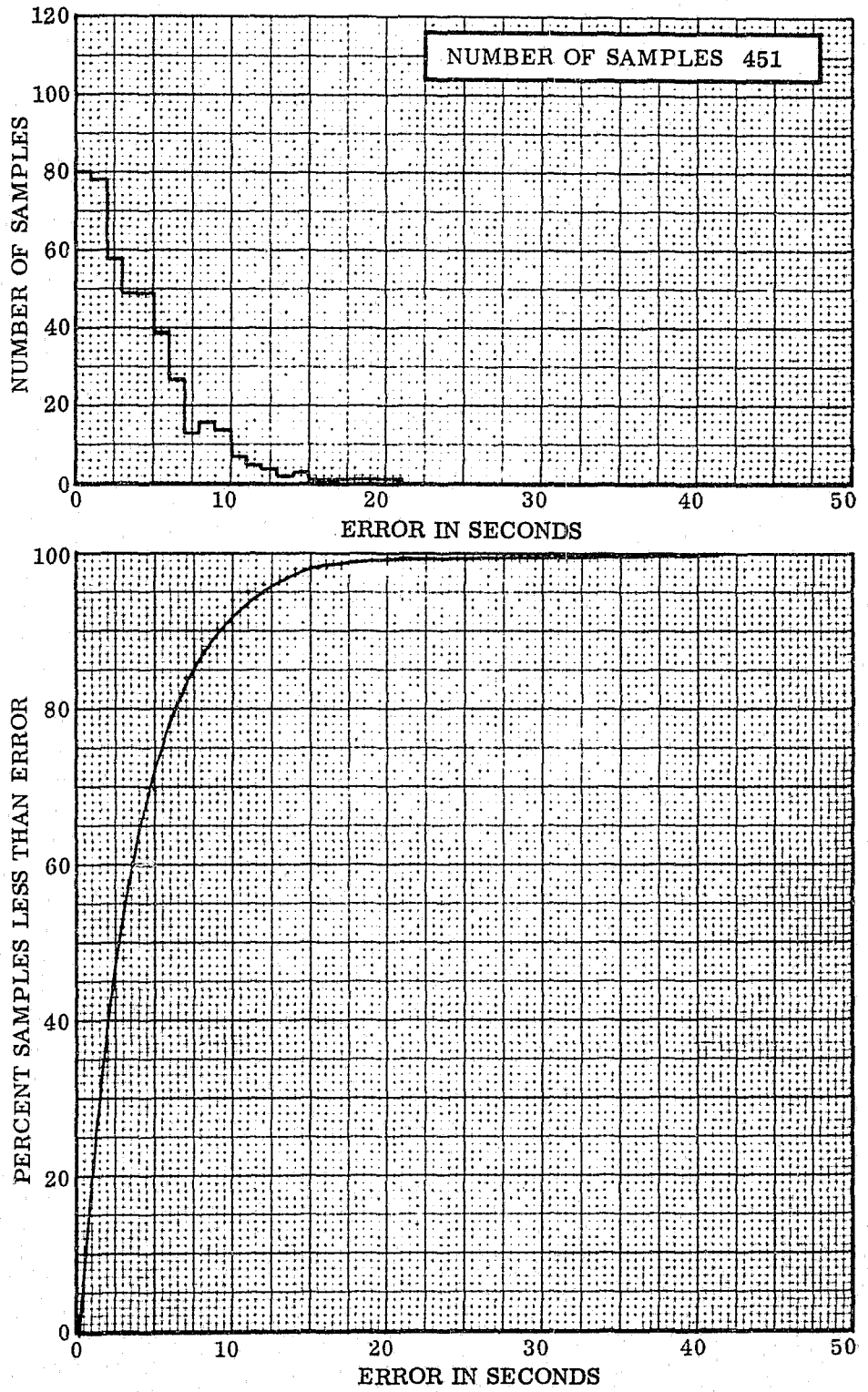


FIG. 8-64 FIXED ROUTE AVM SYSTEM TIMEPOINT PERFORMANCE

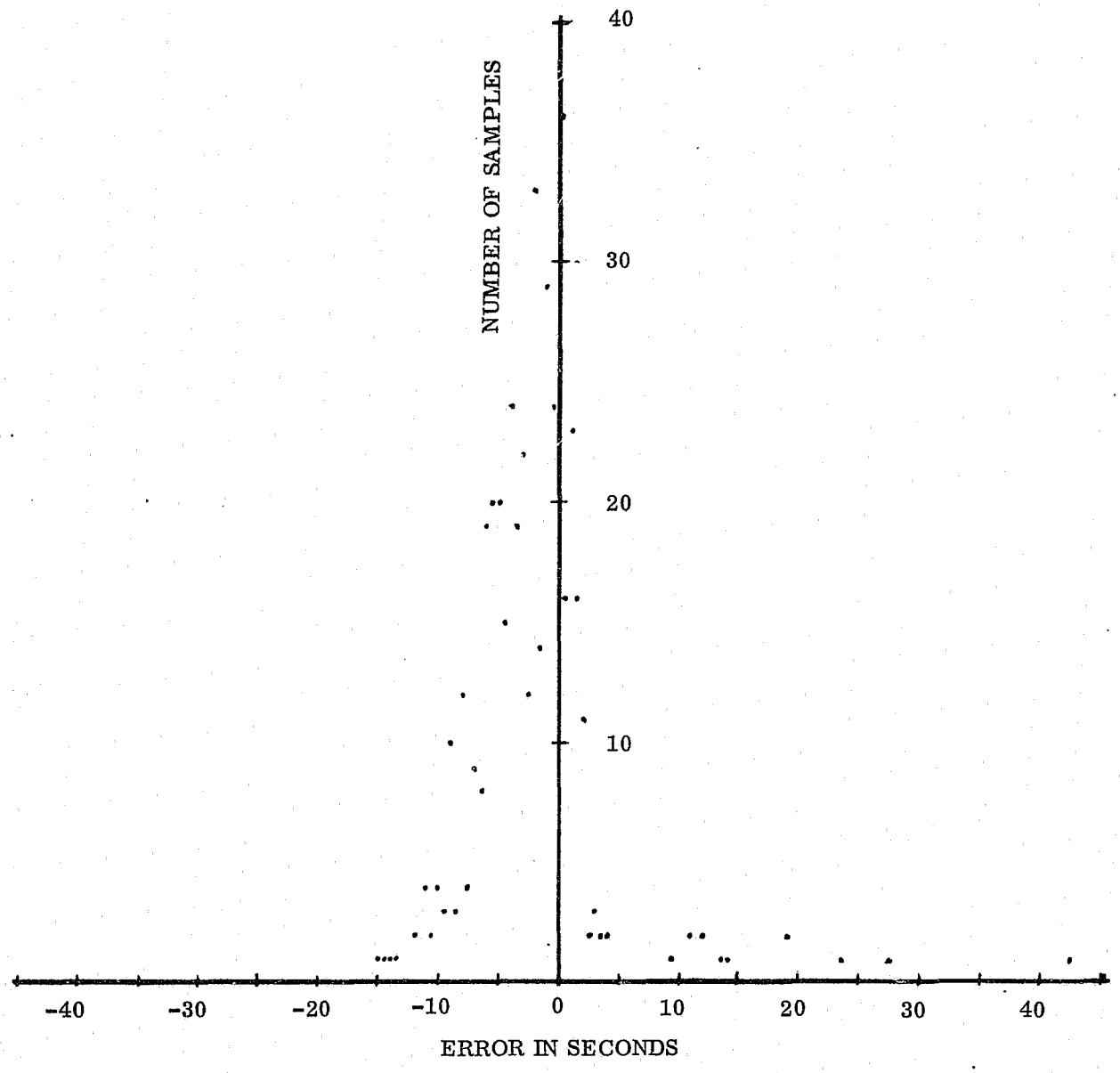


FIG. 8-65 TIMEPOINT ERROR FREQUENCY DENSITY

TABLE 8-13 AVERAGE SPEED OF TRAVEL PAST TIMEPOINTS

RUN	TIMEPOINT														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11	9.4	9.0				15.8	3.4	6.7				5.5		14.7	16.6
12	14.2	6.7					7.4		7.4			4.1		9.2	
13	6.9		8.3		4.0		8.9		5.5			17.8		7.5	15.2
14	7.5				17.1	16.2	12.6	8.2						6.7	13.5
15	18.2		17.1	12.5	17.4		7.9		9.8				6.1		
16		12.1			17.1	21.6	16.1	18.2		20.2	15.8				16.0
17	19.4				20.3		7.2			12.8		19.5			2.9
18	13.0	7.6			18.9		8.1			15.7		16.9		11.5	3.4
20	6.9	9.6			3.1										
21	11.1	11.1			12.2	12.7	8.0					18.5			13.2
22		9.8		8.1	13.9	15.1	13.7	16.2			9.5				15.1
23		12.2		11.4	14.3	12.5			5.3	9.4		22.7		8.3	
24	20.0						10.9	16.8	5.6	5.6		17.2	16.7		15.2
25		12.6			13.2		15.1		5.2	12.9			15.5		15.2
26	12.5		16.9		14.4	15.3	9.4		9.0	17.1		18.5	16.5	5.9	
27	16.9		15.4		15.7		7.6						15.9	9.1	20.4
28		6.1	18.2		15.4	12.2	10.6	7.6			15.2			10.5	
29	11.5				17.5	15.8	7.6	13.1				15.1			14.5
30					13.6	16.8	7.6	16.5		13.6		4.4	14.8	5.4	14.2
31		8.6			13.9	17.4	7.9					16.4	14.3		8.3
32		9.6			15.4	17.1	14.7	10.2	6.3		9.4				11.9
34		7.5		3.8		16.2		16.2	10.0	14.2		15.0			
35	14.7	8.8	14.9			16.6	12.6							10.1	15.6
36	14.0		9.0		14.6	13.8	7.7			17.5					15.3
37	10.5			14.3	15.8	13.2	7.7				8.8			9.2	15.1
38	13.3	11.8			13.5	12.9	10.4					18.4		7.1	15.5
39	12.8						7.4		10.0	11.3		8.6		6.3	3.4
40	13.7					15.5	7.9	10.1					7.5	6.4	13.0
41				4.4		4.0	7.6	18.0	8.8		2.8				11.7
42	15.8	11.3			14.8	12.5	8.4	15.5							16.8
43	16.4	11.6	7.3		16.1		11.0		8.5			17.7	13.4		15.0

AVERAGE SPEED IN MILES PER HOUR

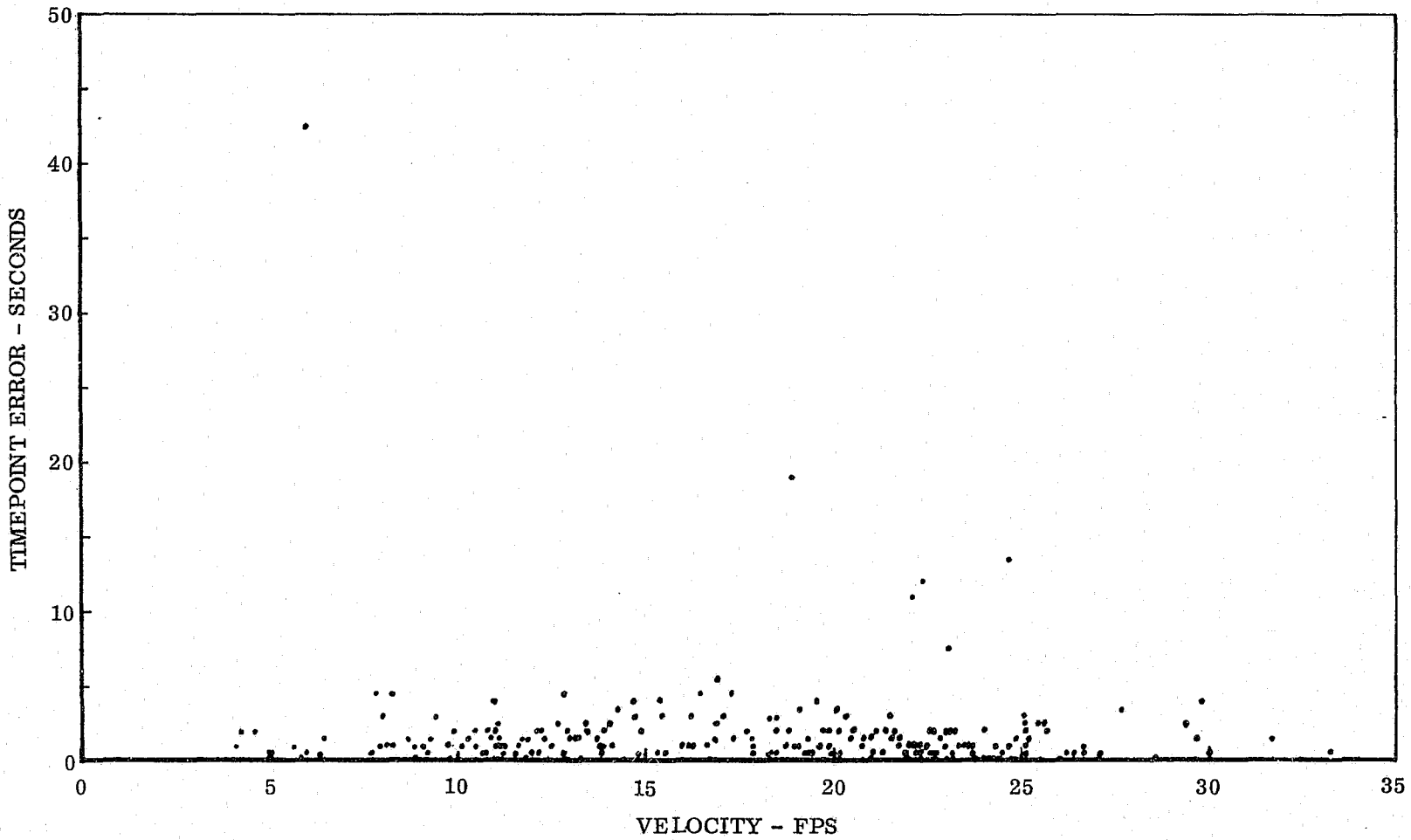


FIG. 8-66 FIXED ROUTE AVM SYSTEM ERRORS, RUN 25

Assuming use of DC event results in zero TOD error, then for 451 samples:

95 percent value of TOD error: 3.5 seconds
99.5 percent value of TOD error: 24 seconds

The error statistics obtained for the 225 samples in which the R1 dropout algorithm was used resulted in the following time-of-departure error statistics:

95 percent value of TOD error: 5 seconds
99.5 percent value of TOD error: 8 seconds.

8.3 FIXED ROUTE DATA PROCESSING ANOMALIES AND CORRECTIONS

Tables 8-2 and 8-7 summarized the problems encountered in processing fixed route data. The details of these problems and the procedures through which these data were ultimately processed are addressed in this subsection. Specific instances in which erroneous results were obtained by processing contaminated data records are also addressed.

8.3.1 Location Subsystem Data Processing

Five tapes, Runs 14, 24, 34, 40, and 43, could not be processed to completion as a result of the inability of the RT-11 operating system to read past erroneous data records. Figure 8-67 shows a typical record dump of the data between checkpoints CP37 and CP38 on Run 34. The eight data records beginning at time 56:04 and ending with the record having signpost code (68, 01) are not valid data. This is evident since (1) the event codes 54 099, 204, 205, etc. are meaningless; (2) the signpost codes are non-existent; (3) the odometer and fifth wheel values are obviously meaningless; and (4) the time does not change. Subsequently, the correct signpost code and incremented odometer and fifth wheel values are read from the tape.

The exact source of the bad data is unknown; however it obviously affects each word of the data record and is definitely not related to the location subsystem signposts or vehicle unit. The source is probably a transient induced by the 115 volt auxiliary AC power generator and it affected the transfer of data from the computer to the cassette. This is evident from the data since the correct signpost code and odometer and fifth wheel values are maintained in the ICU and correctly transferred to the cassette subsequent to the end of the erroneous data.

Figure 8-68 contains similar records from Runs 24, 40, and 43. In each instance, the event code entry is non-existent and time is incremented erroneously. In the cases of Runs 24 and 40, the signpost code are also non-existent. The fact that time is altered indicates that these are indeed data recording anomalies since time ticks are recorded on the cassette directly from the computer and are completely independent of the AVM system and the ICU.

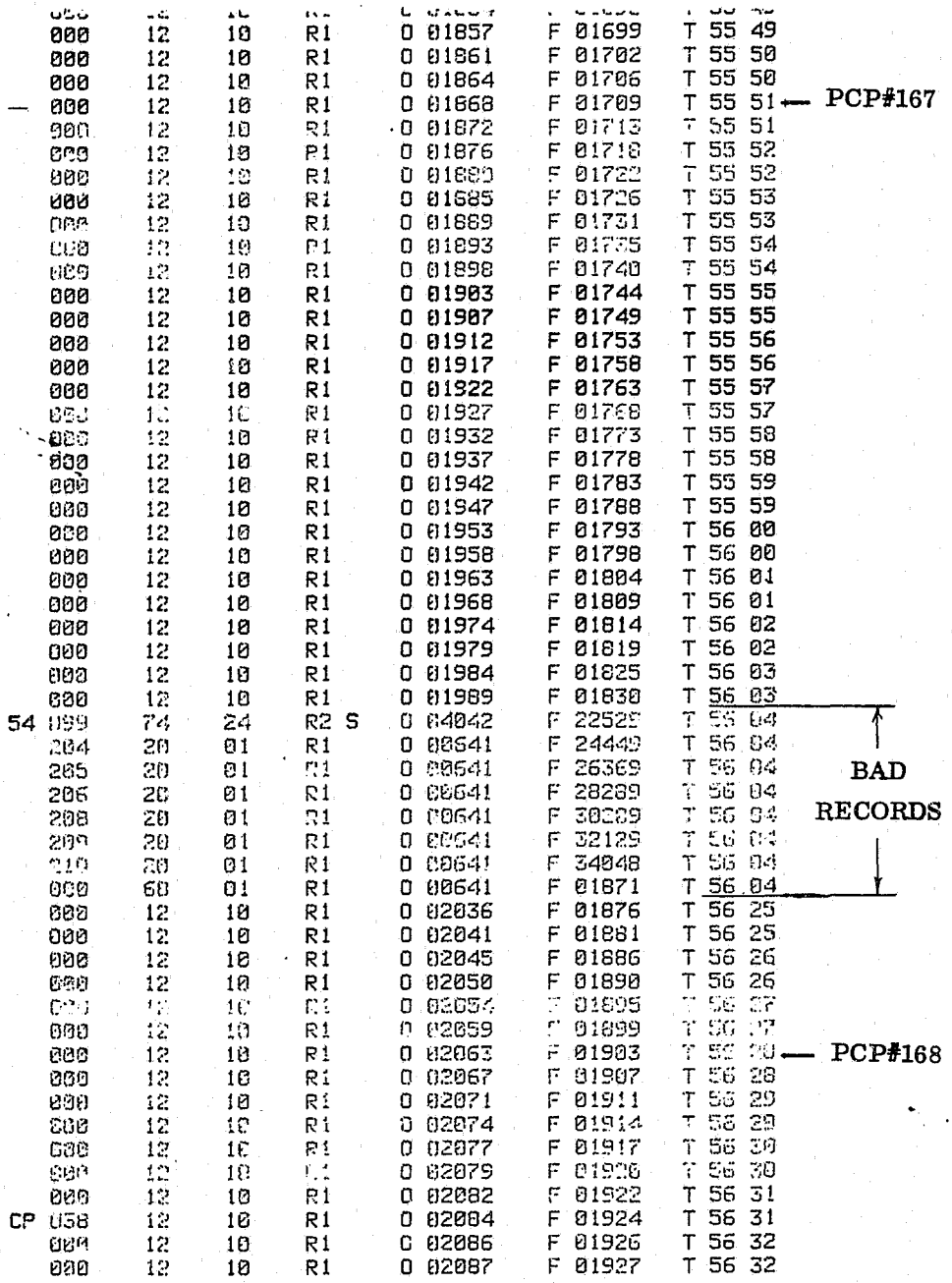


FIG. 8-67 PARTIAL LISTING SHOWING BAD RECORDS, RUN 34

```
000    16    11    R1       0 03930    F 11661    T 67 16
000    16    11    R1       0 03935    F 11666    T 67 17
045    01    12    R* A     0 02059    F 00466    T 67 17
045    01    12    R2 W     0 02059    F 00496    T 68 08
045    01    12    R* H     0 02059    F 00526    T 68 08
045    01    12    R* A     0 02059    F 00556    T 68 08
045    01    12    R2 W     0 02059    F 00586    T 68 08
045    01    12    R3 N     0 02059    F 00616    T 68 08
045    01    12    R1 D     0 02059    F 00646    T 68 08
000    01    12    R1       0 02059    F 11707    T 68 08
000    16    11    R1       0 03982    F 11713    T 68 08
000    16    11    R1       0 03987    F 11718    T 68 08
```

Run #24

```
   000    15    16    R2 S    0 02892    F 02800    T 50 22
   000    15    16    R2 S    0 02892    F 02800    T 50 22
EE 120    13    37    R1      0 03823    F 43780    T 50 22
   120    13    03    R1      0 02053    F 47620    T 50 22
   120    13    03    R1      0 02053    F 51460    T 50 22
   120    13    03    R1      0 02053    F 55300    T 50 22
   120    13    03    R1      0 02053    F 59140    T 50 22
   120    13    03    R1      0 02053    F 62980    T 50 22
   120    13    03    R1      0 02053    F 01285    T 50 22
   120    13    03    R1      0 02053    F 05125    T 50 22
   120    13    03    R1      0 02053    F 08965    T 50 22
   120    13    03    R1      0 02053    F 12805    T 50 22
   140    13    03    R1      0 02053    F 02800    T 50 22
   000    15    16    R2 S    0 02892    F 02800    T 53 02
```

PCP #151

Run #40

```
000    19    13    R1       0 03765    F 11843    T 62 40
000    19    13    R1       0 03771    F 11850    T 62 40
000    19    13    R1       0 03777    F 11856    T 62 41
000    19    13    R1       0 03783    F 11862    T 62 41
063    19    13    R1       0 03789    F 11937    T 62 42
000    19    13    R1       0 03864    F 11942    T 62 48
000    19    13    R1       0 03869    F 11947    T 62 49
000    19    13    R1       0 03874    F 11952    T 62 49
```

Run #43

FIG. 8-68 PARTIAL LISTINGS SHOWING BAD RECORDS, RUNS 24, 40, and 43

As a result of being able to read these cassettes with a different operating system, a complete record dump was made of each tape on which processing problems were experienced. The required data were then extracted manually from those listings (such as those shown in Figure 8-67 and 68) and the location error data recorded manually. Tables 8-14, -15, -16, -17 and 18 contain location subsystem results which were obtained by manual processing of data from Runs 14, 24, 34, 40 and 43. These results have been incorporated in Table 8-1.

Data processing errors were also experienced on run 25. These were traced to bad data records as shown in Figure 8-69. However, although the computer was able to read this tape, the location errors computed for checkpoints 26 through 30 were incorrect, as a result of the erroneous records beginning just after TD006. Recalling that the HI^3 Phase I system determines fixed route location based on elapsed odometer distance from a reset signpost, one notes from Figure 8-69 that signpost (6, 6) R1 was initially received at time 26:08.00. This was the correct reset point. However, due to the erroneous interjection of the code (6, 8)R1 for five records beginning at time 26:17:05, the data processing routine uses the record at time 26:36:05 (re-occurrence of (6, 6)R1) as the reset point for computation of checkpoint 26 through 30.

Table 8-19 contains the correct values of the errors corresponding to CP26-CP30. When corrected, the location subsystem results for run 25 should be as follows:

Corrected Results for Run 25, FRLS: 76 Samples

	Corrected Results	Incorrect Results
Average Error:	50.18 Feet	62.84 Feet
95% Error:	135 Feet	244 Feet
99.5% Error:	216 Feet	309 Feet

As noted previously, checkpoints 37, 38, 39 and 40 were not processed by FRLS during Runs 39, 40, 41, 42 and 43 as a result of the simulation of an off-route condition during the passage of those checkpoints. These checkpoints were processed manually and the results are shown in Table 8-20. The 306 foot error at CP40 on Run 42 resulted from entering CP40 late after initially entering it early and subsequently entering on EE40. As a result, the last CP40 entry was delayed. This action was recorded on the Test Data Log in the presence of the TSC monitor.

With the inclusion of all location subsystem data (including those having all tape errors corrected, the data in Table 8-20 and the correct value for CP3).

(Text continued on 8-104)

TABLE 8-14 FIXED ROUTE LOCATION SUBSYSTEM ERROR STATISTICS, RUN 14

ERROR FREQUENCY DENSITY RUN 14a

Error Interval	No. Samples	Percent of Samples
0- 10	5	6.57
10- 20	8	10.52
20- 30	11	14.47
30- 40	14	18.42
40- 50	4	5.26
50- 60	9	11.24
60- 70	5	6.57
70- 80	5	6.57
80- 90	7	9.21
90-100	3	3.94
100-110	3	3.94
110-120	2	2.63

CUMULATIVE ERRORS RUN 14a

Error	Samples LT Error	Percent Samples LT Error
10	5	6.57
20	13	17.10
30	24	31.57
40	38	50.00
50	42	55.26
60	51	67.10
70	56	73.68
80	61	80.26
90	68	89.47
100	71	93.42
110	74	97.36
120	76	100.00

TABLE 8-15 FIXED ROUTE LOCATION SUBSYSTEM
ERROR STATISTICS, RUN 24

ERROR FREQUENCY DENSITY RUN 24a

Error Interval	No. Samples	Percent of Samples
0- 10	1	1.61
10- 20	13	17.33
20- 30	14	18.66
30- 40	14	18.66
40- 50	5	8.06
50- 60	10	13.33
60- 70	4	6.45
70- 80	2	3.23
80- 90	2	3.23
90-100	1	1.61
100-110	2	3.23
120-130	1	1.61
130-140	2	3.23
140-150	2	3.23
170-180	1	1.61
1500-1510	1	1.61

Cumulative Errors Run 24a

Error	Samples LT Error	Percent Samples LT Error
10	1	1.61
20	14	17.33
30	28	37.33
40	42	56.00
50	47	62.66
60	57	76.00
70	61	81.33
80	63	84.00
90	65	86.66
100	66	88.00
110	68	90.66
120	68	90.66
130	69	92.00
140	71	94.66
150	73	97.33
160	73	97.33
170	73	97.33
180	74	98.66
1510	75	100.00

TABLE 8-16 FIXED ROUTE LOCATION SUBSYSTEM
ERROR STATISTICS, RUN 34a

ERROR FREQUENCY DENSITY RUN 34a

Error Interval	No. Samples	Percent of Samples
0- 10	1	1.33
10- 20	11	14.66
20- 30	14	18.66
30- 40	12	16.00
40- 50	11	14.66
50- 60	5	6.66
60- 70	6	8.0
70- 80	5	6.66
80- 90	3	4.0
90-100	4	5.33
110-120	2	2.66
130-140	1	1.33

Cumulative Errors Run 34a

Error	Samples LT Error	Percent Samples LT Error
10	1	1.33
20	12	16.00
30	26	34.66
40	38	50.66
50	49	65.33
60	54	72.00
70	60	80.00
80	65	86.66
90	68	90.66
100	72	96.00
110	72	96.00
120	74	98.66
130	74	98.66
140	75	100.00

TABLE 8-17 FIXED ROUTE LOCATION SUBSYSTEM
ERROR STATISTICS, RUN 40a

ERROR FREQUENCY DENSITY RUN 40a

Error Interval	No. Samples	Percent of Samples
0- 10	4	5.26
10- 20	6	7.89
20- 30	12	15.78
30- 40	12	15.78
40- 50	11	14.47
50- 60	11	14.47
60- 70	4	5.26
70- 80	7	9.21
80- 90	4	5.26
90-100	1	1.31
100-110	1	1.31
110-120	2	2.63
170-180	1	1.31

Cumulative Errors Run 40a

Error	Samples LT Error	Percent Samples LT Error
10	4	5.26
20	10	13.15
30	22	28.94
40	34	44.73
50	45	59.21
60	56	73.68
70	60	78.94
80	67	88.15
90	71	93.42
100	72	94.73
110	73	96.05
120	75	98.65
180	76	100.00

TABLE 8-18 FIXED ROUTE LOCATION SUBSYSTEM
ERROR STATISTICS, RUN 43a

ERROR FREQUENCY DENSITY RUN 43a

Error Interval	No. Samples	Percent of Samples
0- 10	3	4.0
10- 20	3	4.0
20- 30	6	8.0
30- 40	8	10.66
40- 50	14	18.66
50- 60	9	12.0
60- 70	2	2.66
70- 80	12	16.00
80- 90	3	4.0
90-100	5	6.66
100-110	5	6.66
110-120	1	1.33
120-130	1	1.33
130-140	1	1.33
140-150	1	1.33
180-190	1	1.33

CUMULATIVE ERRORS RUN 43a

Error	Samples LT Error	Percent Samples LT Error
10	3	4.00
20	6	8.00
30	12	16.00
40	20	26.66
50	34	45.33
60	43	57.33
70	45	60.00
80	57	76.00
90	60	80.00
100	65	86.66
110	70	93.33
120	71	94.66
130	72	96.00
140	73	97.33
150	74	98.66
190	75	100.00

```
   000    06    06    R3 E   O 03357    F 11389    T 26 07
   000    06    06    R3 E   O 03362    F 11394    T 26 07
   000    06    06    R1     O 03368    F 11399    T 26 08
   000    06    06    R1     O 03374    F 11405    T 26 08
   000    06    06    R1     O 03379    F 11410    T 26 09
   000    06    06    R1     O 03385    F 11416    T 26 09
   000    06    06    R1     O 03391    F 11422    T 26 10
   000    06    06    R1     O 03396    F 11427    T 26 10
   000    06    06    R1     O 03402    F 11433    T 26 11
   000    06    06    R1     O 03408    F 11439    T 26 11
   000    06    06    R1     O 03413    F 11444    T 26 12
   000    06    06    R1     O 03419    F 11450    T 26 12
   000    06    06    R1     O 03425    F 11456    T 26 13
   000    06    06    R1     O 03431    F 11461    T 26 13
   000    06    06    R1     O 03436    F 11467    T 26 14
   000    06    06    R1     O 03442    F 11472    T 26 14
   000    06    06    R1     O 03447    F 11478    T 26 15
   000    06    06    R1     O 03453    F 11483    T 26 15
   000    06    06    R1     O 03458    F 11488    T 26 16
   000    06    06    R1     O 03463    F 11493    T 26 16
TD 006    06    06    R1     O 03468    F 11498    T 26 17
-------------------------------------------------------------
   000    06    08    R1     O 03473    F 10196    T 26 17
   000    06    08    R1     O 02158    F 10201    T 26 34
   000    06    08    R1     O 02163    F 10206    T 26 35
   000    06    08    R1     O 02169    F 10211    T 26 35
   000    06    08    R1     O 02174    F 10217    T 26 36
-------------------------------------------------------------
   000    06    06    R1     O 03497    F 11526    T 26 36
   000    06    06    R1     O 03501    F 11531    T 26 38
   000    06    06    R1     O 03506    F 11535    T 26 38
   000    06    06    R1     O 03511    F 11539    T 26 39
   000    06    06    R1     O 03515    F 11544    T 26 39
   000    06    06    R1     O 03520    F 11549    T 26 40
TA 012    06    06    R1     O 03524    F 11553    T 26 40
   000    06    06    R1     O 03529    F 11557    T 26 41
   000    06    06    R1     O 03533    F 11562    T 26 41
   000    06    06    R1     O 03538    F 11566    T 26 42
   000    06    06    R1     O 03543    F 11571    T 26 42
   000    06    06    R1     O 03547    F 11576    T 26 43
   000    06    06    R1     O 03552    F 11580    T 26 43
   000    06    06    R1     O 03557    F 11585    T 26 44
   000    06    06    R1     O 03562    F 11590    T 26 44
   000    06    06    R1     O 03568    F 11595    T 26 45
   000    06    06    R1     O 03572    F 11600    T 26 45
   000    06    06    R1     O 03578    F 11605    T 26 46
```

ERROR RECORDS

FIG. 8-69 RECORDING ERRORS, RUN 25

TABLE 8-19 CORRECTED CHECKPOINT ERRORS, RUN 25

Checkpoint	ODOM (CP) (Count)	ODOM (R6) (Count)	SP	SEG	INCREM (feet)	Comp X	Comp Y	Error
26	3997	3368	6	18	979	12206	10192	19
27	373	3368	6	18	1923	13141	10068	34
28	630	3368	6	19	460	13124	9606	52
29	903	3368	6	19	1006	13040	9067	30
30	2026	3368	6	21	955	13833	7645	135

On Run 24, the following overall location subsystem results were obtained:

Number of Samples: 2313 of a possible 2326 (99.44% of recorded data)
95 Percent of Errors Less than: 106 feet
99.5 Percent of Errors Less than: 146 feet.

TABLE 8-20 LOCATION SUBSYSTEM ERRORS FOR CHECKPOINTS 37-40 ON RUNS 39-43 WHILE "OFF ROUTE" CONDITION WAS SIMULATED

Run \ Checkpoint	Location Error in Feet			
	37	38	39	40
39	24	26	16	17
40	22	28	18	27
41	10	26	11	15
42	36	60	41	306
43	13	26	6	12

8.3.2 AVM System Data Processing

As in the case of FRLS, Runs 24, 34, 40 and 43 could not be processed to completion through the use of FRSYS. However, the data which could not be processed via the use of FRSYS was processed manually using the exact same algorithm. The results obtained are contained in Tables 8-21 through 8-24. These results have been incorporated in Table 8-6.

An anomaly was also detected in the results obtained for Run 18. FRSYS produced an error of 12321 feet at PCP'(2). Manual processing of these data resulted in an error of 18 feet. In processing the cassette data, the value of AVM y only was in error with all other values correct. The 18 foot value was incorporated in Table 8-6.

When Run 25 was processed by use of FRSYS, the bad records noted in Figure 8-69 resulted in erroneous results for PCP 77 through PCP 97. As discussed in subsection 8.3.1, the use of the later reset value of R8 was partially at fault. The erroneous record also made it appear as if the odometer had rolled over an additional 4096 (2^{12}) counts. This was offset to some extent by the use of the later reset point. Table 8-25 contains the correct results for these pseudo checkpoints as computed manually using the correct reset point and the correct odometer values. Details of these computations are included in the appendix.

TABLE 8-21 FIXED ROUTE AVM SYSTEM ERRORS, RUN 24

ERROR FREQUENCY DENSITY RUN 24

Error Interval	No. Samples	Percent of Samples
0- 10	18	7.53
10- 20	38	15.90
20- 30	33	13.81
30- 40	31	12.97
40- 50	24	10.04
50- 60	15	6.28
60- 70	22	9.21
70- 80	13	5.44
80- 90	10	4.18
90-100	4	1.67
100-110	9	3.77
110-120	2	8.37
120-130	5	2.09
130-140	1	0.42
140-150	6	2.51
160-170	3	1.26
170-180	4	1.67
180-190	1	0.42

Cumulative Errors Run 24

Error	Samples LT Error	Percent Samples LT Error
10	18	7.53
20	56	23.43
30	89	37.24
40	120	50.21
50	144	60.25
60	159	66.53
70	181	75.73
80	194	81.17
90	204	85.36
100	208	87.03
110	217	90.79
120	219	91.63
130	224	93.72
140	225	94.14
150	231	96.65
170	234	97.91
180	238	99.58
180-190	239	100.00

TABLE 8-22 FIXED ROUTE AVM SYSTEM ERRORS, RUN 34

ERROR FREQUENCY DENSITY RUN 34

Error Interval	No. Samples	Percent of Samples
0- 10	19	6.59
10- 20	52	18.05
20- 30	52	18.05
30- 40	55	19.09
40- 50	27	9.37
50- 60	23	7.98
60- 70	17	5.90
70- 80	19	6.59
80- 90	13	4.51
90-100	4	1.38
110-120	1	.34
120-130	1	.34
140-150	1	.34
150-160	2	.69
190-200	2	.69
280-290	1	.34

Cumulative Errors Run 34

Error	Samples LT Error	Percent Samples LT Error
10	19	6.59
20	71	24.65
30	123	42.70
40	178	61.80
50	205	71.18
60	228	79.16
70	245	85.06
80	264	91.66
90	277	96.18
100	281	97.56
120	282	97.91
130	283	98.26
150	284	98.61
160	286	99.30
200	288	100.00
280-290	289	

TABLE 8-23 AVM SYSTEM ERRORS, RUN 40

ERROR FREQUENCY DENSITY RUN 40

Error Interval	No. Samples	Percent of Samples
0- 10	14	5.2
10- 20	37	13.75
20- 30	37	13.75
30- 40	48	17.84
40- 50	43	15.98
50- 60	26	9.66
60- 70	17	6.31
70- 80	24	8.92
80- 90	10	3.71
90-100	2	.74
100-110	1	.37
110-120	4	1.48
200-210	1	.37
240-250	1	.37
260-270	2	.74
280-290	2	.74

Cumulative Errors Run 40

Error	Samples LT Error	Percent Samples LT Error
10	14	5.2
20	51	18.95
30	88	32.7
40	136	50.5
50	179	66.54
60	205	76.2
70	222	82.5
80	246	91.44
90	256	95.16
100	258	95.91
110	259	96.28
120	263	97.76
210	264	98.14
250	265	98.51
270	267	99.25
290	269	100.00

TABLE 8-24 FIXED ROUTE AVM SYSTEM ERRORS, RUN 43

ERROR FREQUENCY DENSITY RUN 43

Error Interval	No. Samples	Percent of Samples
0- 10	15	6.66
10- 20	18	8.0
20- 30	17	7.5
30- 40	28	12.44
40- 50	33	14.66
50- 60	27	12.0
60- 70	11	4.8
70- 80	32	14.22
80- 90	11	4.88
90-100	10	4.44
100-110	7	3.11
110-120	2	.88
120-130	2	.88
130-140	2	.88
140-150	3	1.33
180-190	2	.88
220-230	1	.44
210-220	1	.44
240-250	3	1.33

Cumulative Errors Run 43

Error	Samples LT Error	Percent Samples LT Error
10	15	6.66
20	33	14.66
30	50	22.22
40	78	34.66
50	111	49.33
60	138	61.33
70	149	66.22
80	181	80.44
90	192	85.33
100	202	89.77
110	209	92.88
120	211	93.77
130	213	94.66
140	215	95.55
150	218	96.88
190	220	97.77
220	221	98.22
230	222	98.66
250	225	100.00

TABLE 8-25 MANUALLY CORRECTED AVM SYSTEM ERROR RESULTS, RUN 25

ERROR FREQUENCY DENSITY

Error Interval	No. Samples	Percent Samples	Error	No. Samples LT Error	% Samples LT Error
0- 10	18	7.46	10	18	7.46
10- 20	23	9.54	20	41	17.01
20- 30	42	17.43	30	83	34.43
30- 40	33	13.69	40	116	48.13
40- 50	39	16.18	50	155	64.31
50- 60	24	9.95	60	171	74.27
60- 70	11	4.56	70	190	78.83
70- 80	10	4.14	80	200	82.98
80- 90	12	4.98	90	212	87.96
90-100	8	3.32	100	220	91.28
100-110	2	0.83	110	222	92.16
110-120	2	0.83	120	224	92.85
120-130	3	1.24	130	227	94.19
130-140	3	1.24	140	230	95.43
150-160	3	1.24	160	233	96.68
160-170	3	1.24	170	236	97.92
180-190	1	0.41	190	237	98.34
190-200	2	0.83	200	239	99.17
210-220	1	0.41	220	240	99.59
220-230	1	0.41	230	241	100.0

9. SPECIAL CASE TESTS

The HI^3 location subsystem was subjected to a large number of special case tests, both in Fort Worth and in Philadelphia, in order to assess its performance under the most stringent urban conditions. These tests provided results which supplement the data obtained during random- and fixed-route testing. Special Case Tests have been grouped into three generic categories:

Special Urban Conditions
Special Environmental Conditions
Special Vehicle Related Conditions.

9.1 SPECIAL URBAN CONDITIONS

The random route area assigned to HI^3 in Philadelphia included a full spectrum of conditions which provided a comprehensive test of the location subsystem technique used by HI^3. The area, shown in Figure 3-12, included the Reading Railroad terminal and eight elevated steel railroad crossings, two of which were over 250 feet long. At two separate locations, the entire roadway was covered by portions of parking garages, one for a distance of 297 feet. Electric trolleys operated on both 11th and 12th streets through the entire random route area. Reference to Figure 3-13 will show the building structures in the area which included many miles of highrise "canyons". The area also included narrow streets (Wood Street is only 18 feet wide curb-to-curb), wide boulevards (Vine Street is eight lanes wide (134 feet) with three separate medians); Market Street is 63 feet wide, curb-to-curb, with numerous metal traffic standards extending completely across the roadway. Although most available utility poles were metal, a wide variety of poles and configurations were used. On Wood Street, three wooden poles with overhead wires were used. Street patterns in the area varied, all North-South streets were one-way, and only Vine and Market streets were two-way. Since the HI^3 location system operates independent of the direction of vehicle travel, this traffic engineering pattern offered no problems.

Special tests categories under Special Urban Conditions were designed to determine the effects of the following items:

1. Large metallic structures
2. Freeway overpasses and tunnels
3. Buildings extending over roadways
4. Narrow streets and deep canyons
5. Wide boulevards, open areas, parks, and malls

6. Trolley and other overhead wires

7. Signpost mounting conditions.

9.1.1 Large Metallic Structures

All ten (10) Random Route tests included tests under the Reading Railroad Terminal on Filbert Street, under the steel reinforced parking garage on 8th Street, and under railroad tunnels on Cherry, Race, and Vine Streets. Table 9-1 contains a list of the location errors associated with TSC checkpoints which were located near these elevated metal structures. Not only are there no errors exceeding 179 feet at these locations, but the repeatability of the location region is demonstrated by the extremely low variance in the errors incurred at each checkpoint. Additional data relating to large metallic structures are discussed in subsequent paragraphs in this section.

9.1.2 Freeway Overpasses and Tunnels

The data presented in Table 9-1 is also applicable to demonstrate the fact that the HI^3 location subsystem performed within specification in the vicinity of overpasses and tunnels. In addition, special tests were performed to demonstrate the ability of the HI^3 location subsystem to generate location regions within tunnels and for signposts to propagate energy through tunnels and under overpasses. Figure 9-1 contains data taken during Random Route Test 10 during travel West on Filbert Street beneath the Reading Railroad Terminal. As shown in the figure, signposts were installed on street light poles near each end of the tunnel. Three different location regions were received by the vehicle while moving through the tunnel at the locations shown (to scale) in the figure.

A similar test involved installation of a signpost in the center of the 297-foot long covered roadway on 8th Street between Filbert and Arch. The signpost was installed, as shown in Figure 9-2, by simply setting the signpost on 2 by 12-inch wooden walkway with the antenna extended downward between two 2- by 12-inch boards. This signpost (15, 16) created a Region 1 location region within the tunnel and produced overlap regions in conjunction with signposts (16, 16) to the North and (13, 16) to the South. Data obtained during Random Route Test Run 8 are also shown in Figure 9-3. The vehicle was traveling South on 8th after passing signpost (16, 16) at 8th and Cherry. At the intersection of 8th and Arch, the vehicle received a Level 3 from signpost (15, 16) in the tunnel and declared a new location region (16, 16) R3S, 230 feet from signpost (15, 16). While the vehicle stopped, the location toggled to a (16, 16) R2S and a (15, 16) R3N. Just under the tunnel entrance, a Region 1 from signpost (15, 16) was declared. 144 feet from signpost (15, 16), a (15, 16) R3N was declared followed by a (15, 16) R1 at a distance of 128 feet from signpost (15, 16). This code was stored throughout the remainder of the tunnel until a (15, 16) R2S was declared 194 feet south of signpost (15, 16). The location error incurred during this run is shown plotted in Figure 9-3.

TABLE 9-1 RANDOM ROUTE LOCATION ERRORS NEAR LARGE METALLIC STRUCTURES

*Checkpoint / Run No.	Under 8th St. Tunnel		At Edge of Reading Terminal Tunnel on Filbert		Near Railroad Overpass on Cherry		Near Railroad Overpass on Race			Near Railroad Overpass on Vine	
	P2	S16	P35	S24	S49	S50	P9	P52	S13	P23	P31
1	145		22				40	7		71	86
2	145		22				40	7		71	86
3	145		22				40	7		71	86
4	145		22				40	7		71	86
5	145		22				40	120		71	179
6		10		20	0	40			8		
7		10		20	0	71			8		
8		10		20	0	40			8		
9		10		20	0	40			8		
10		10		20	0	160			8		

* Primary Checkpoints are denoted Pnn

Secondary Checkpoints are denoted Snn

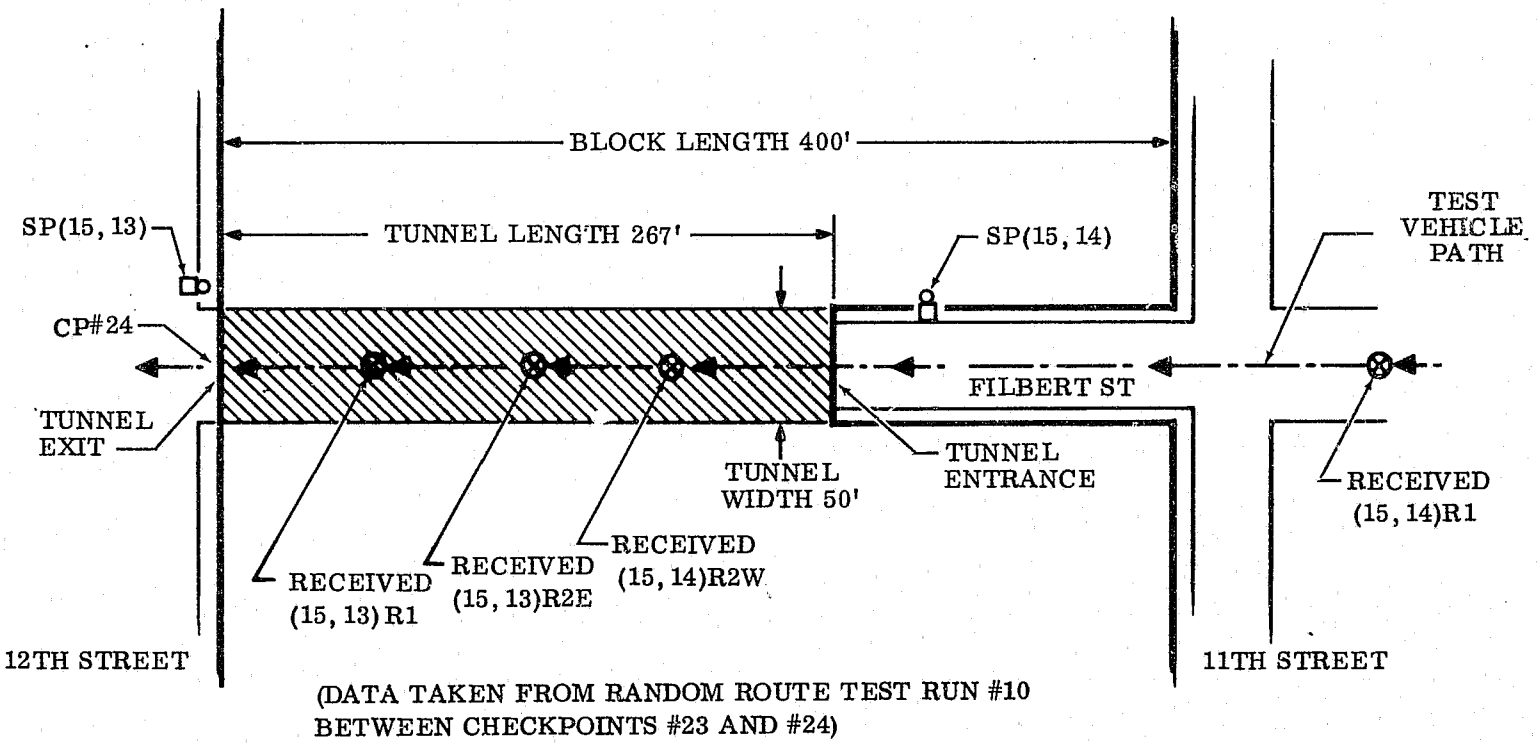


FIG. 9-1 FILBERT STREET TUNNEL TESTS

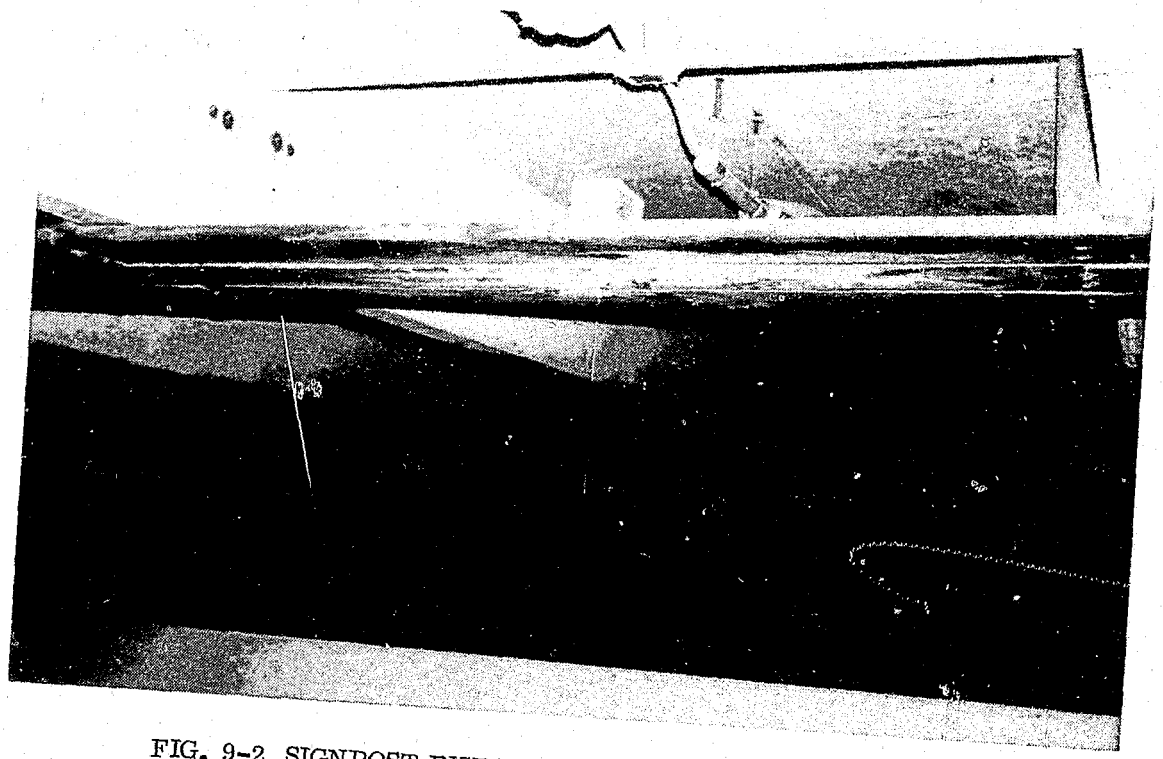


FIG. 9-2 SIGNPOST INSTALLATION IN 8TH STREET TUNNEL

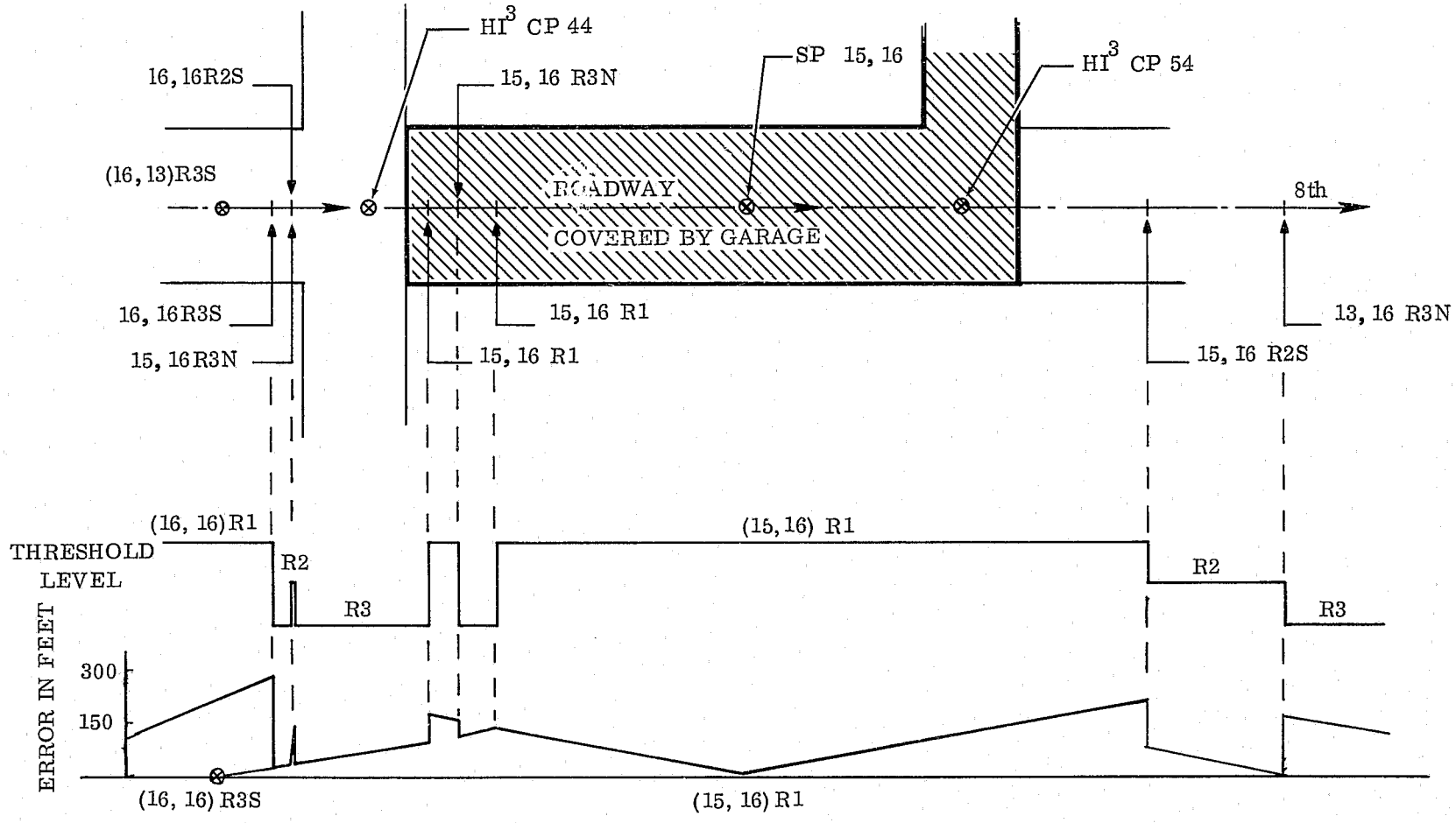


FIG. 9-3 8TH STREET TUNNEL TESTS

The effect of the tunnel in this latter case was to slightly reduce the distance from the signpost at which the specified signal level was received. For this reason, the signpost within the tunnel was located closer (520 feet) to the adjacent signpost than the average for the remainder of the random route area. However, this simple procedure still allowed the location subsystem error specification to be met in the confines of so restrictive a situation. It is noted that there were no poles available for mounting a signpost within the 8th Street tunnel. The adaptability of HI^3 signposts to virtually any mounting environment was demonstrated in this case.

9.1.3 Buildings Extending Over Roadways

The ability of the HI^3 location subsystem to meet the multi-user AVM performance specifications in the presence of buildings which extend over roadways was adequately demonstrated in the two preceding special case tests. Additional data pertinent to this situation are discussed in subsequent paragraphs in terms of parking garages.

9.1.4 Narrow Streets and Deep "High Rise" Canyons

The ability of the HI^3 location subsystem to meet multi-user AVM performance specifications on narrow streets and in deep canyons formed by high-rise buildings was repeatedly demonstrated during Random Route tests. Many TSC checkpoints were located along narrow streets which were framed by high-rise buildings. Notable among these were secondary checkpoints 8, 11, 23, 24, 25, 37, and 55, which were located on streets 27-, 26-, 50-, 5-, 26-, and 25-feet wide respectively, and framed on each side by multistory buildings which were constructed 10 to 20 feet from the curb line. Table 9-2 is a summary of the location errors recorded at these checkpoints during all five secondary random route test runs.

Table 9-2 HI^3 LOCATION SUBSYSTEM PERFORMANCE ON NARROW STREETS IN HIGH-RISE AREA

	Secondary Checkpoint						
Run No.	S8	S11	S23	S24	S25	S37	S55
6	153	0	77	20	61	89	0
7	153	0	77	20	61	89	0
8	153	225	226	20	61	89	0
9	153	0	77	20	139	89	0
10	153	225	77	20	139	89	0
	Location Error in Feet						

Figure 9-4 contains a plot of location error as a function of vehicle location recorded during Random Route Test Run 10 traveling East on Race Street through the heart of Philadelphia's Chinatown. Along this stretch of Race Street, the roadway is only 25 feet wide, and both sides of the street are wall-to-wall buildings at least three stories high. It is noted that, even in this extremely narrow canyon, the location error is less than 300 feet over 98 percent of this roadway.

9.1.5 Wide Boulevards, Open Areas, Parks, and Malls

The area on Vine Street between 9th and 11th Streets is representative of this type of area. Vine Street itself consists of eight traffic lanes separated into four separate roadways by three raised medians. The total curb-to-curb width is 134 feet. The 9th-Street end is totally open on all sides with no buildings. However, 10th Street, which crosses Vine perpendicularly, is only 27 feet wide, curb-to-curb, and is solidly framed by two- and three-story buildings, on both sides.

Figure 9-5 contains data obtained during Random Route Test Run 1 between 9th; and 11th Streets, eastbound on Vine. Signposts (12, 8) and (12, 10) were located on the center medians at 11th and 9th Streets, respectively, and were separated by 880 feet. Signposts (19, 15) and (17, 15) were located on 10th Street at Wood and Spring Streets, respectively, and separated by 700 feet. At only two locations along this stretch of Vine Street, corresponding to less than 6% of the roadway shown, did the location error exceed 300 feet.

These data show that the performance of the HI^3 location subsystem is not degraded in areas containing wide boulevards and open areas and that the use of signposts on narrow streets (10th Street) opening onto open areas (Vine Street) is effective in the formation of location regions. Additional data on this same area is discussed in paragraph 9.7 which is directed to a discussion of vehicles making U-Turns.

9.1.6 Trolley and Other Overhead Wires

Both 11th and 12th Streets had trolleys operating from overhead wires. Typical signpost installations near these wires, as well as near other overhead wires are shown in Figure 3-13. Secondary checkpoints 9, 17, 18, 19, 20, 24, 28, 29, 37, 38, 39, 40, 46, 52, 53, 57, and 60 were all on 11th and 12th Streets within 15 feet of overhead trolley wires. The data taken on Random Route Test Runs 6 through 10 for these 17 checkpoints is summarized as follows:

Total number of samples: 84
Number of samples with error < 250 feet: 82(97.62%)
Maximum error among samples: 376 feet
Average location error: 81 feet
95% confidence error: 241 feet
Percent samples with less than 450 feet errors: 100

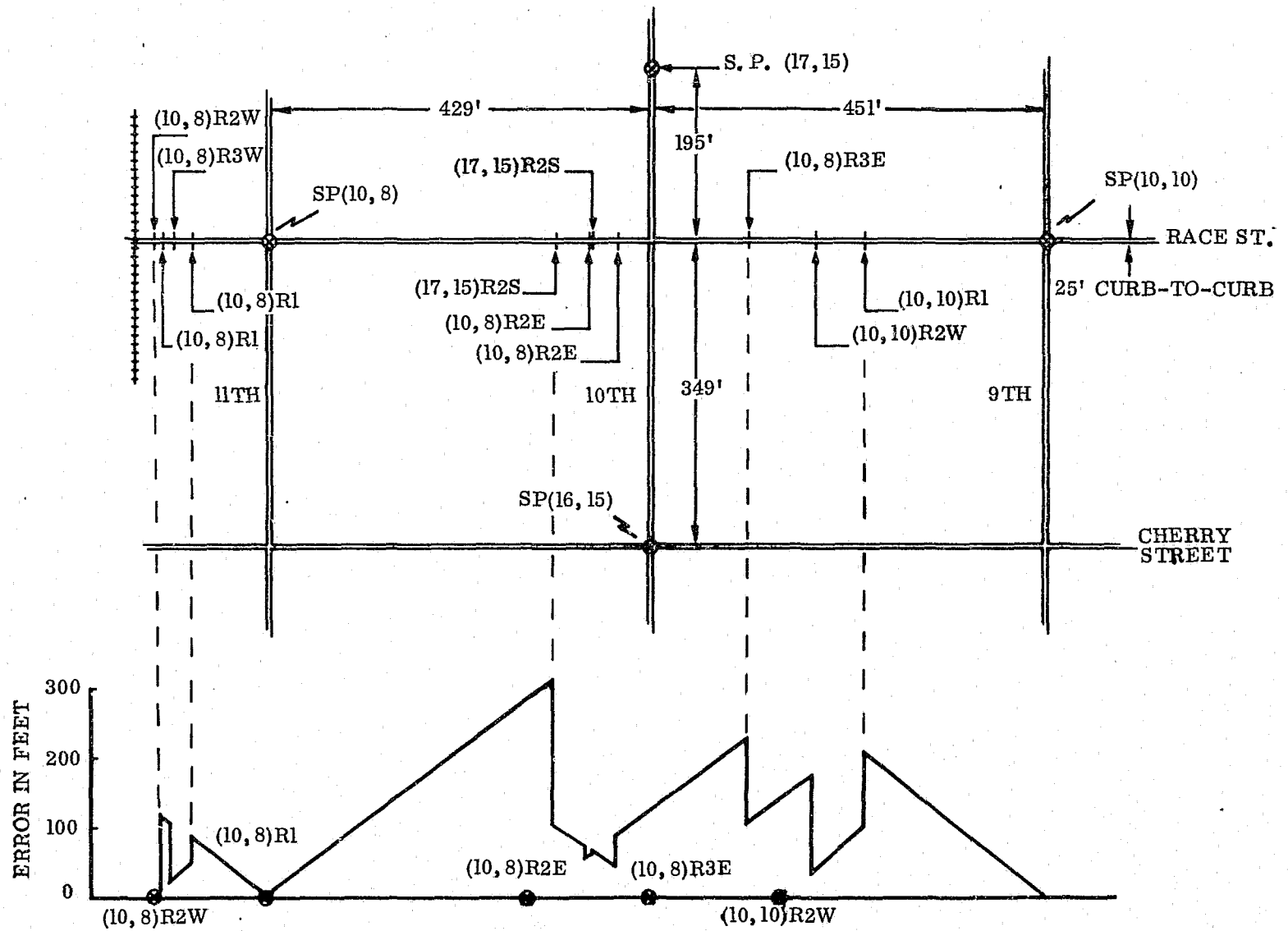
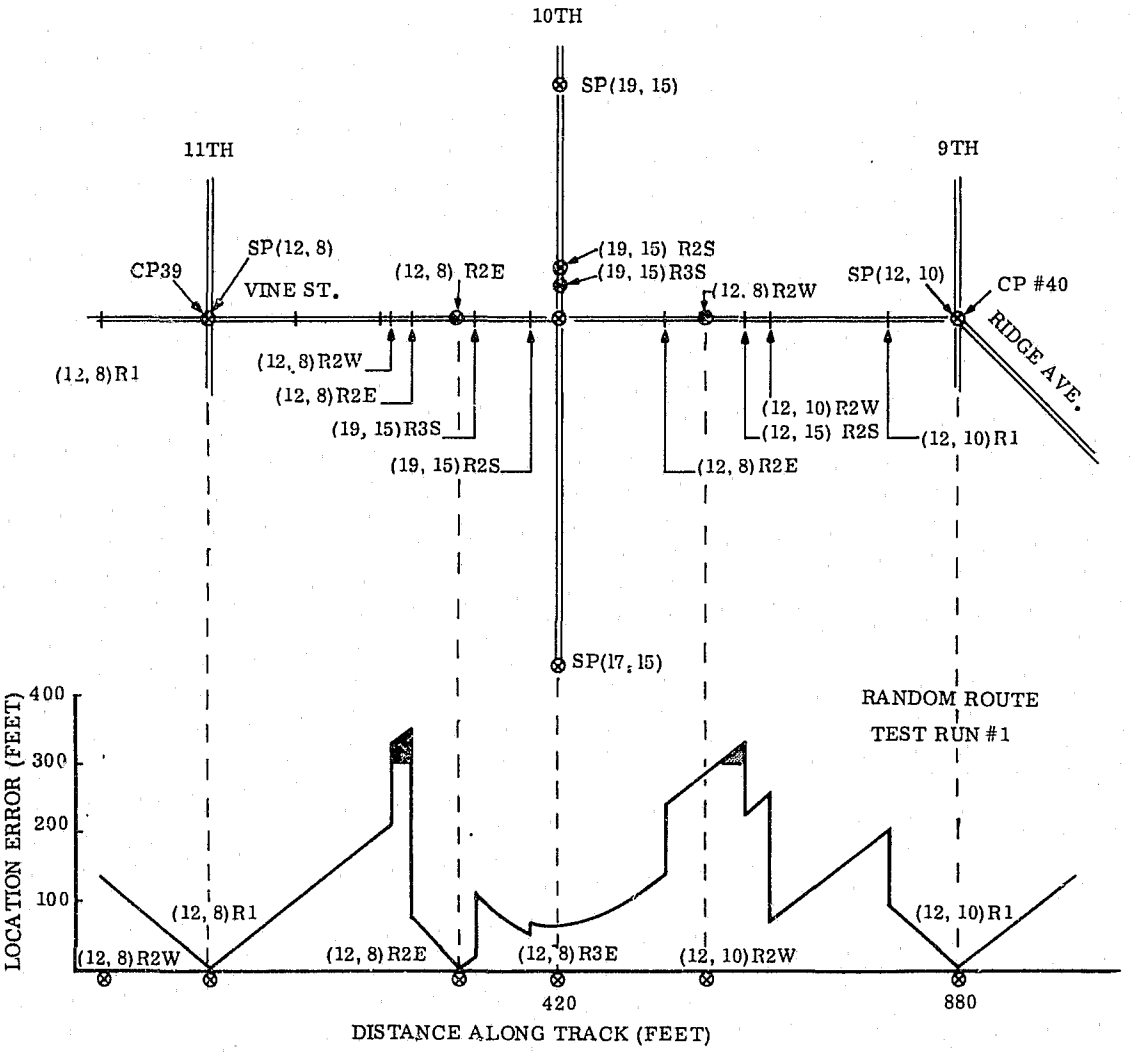


FIG. 9-4 NARROW ROADWAY TESTS



*(12, 8)R3E; (12, 8)R3W, (19, 15)R3S and (19, 15)R2S ARE OFFSET NORTH OF THE EAST BOUND LINE OF VINE.

FIG. 9-5 WIDE BOULEVARD TESTS

These results are consistent with the overall results obtained during random route tests and show that trolley wires and other overhead wires, e.g., those near Wood and Pearl Streets, had no effect on the performance of the HI^3 location subsystem.

9.1.7 Signpost Mounting Conditions

Figure 3-13 contains photographs of all HI^3 signpost installations in Philadelphia. In most instances, signposts were mounted 18 to 26 feet above the roadway. However, some signposts (19, 15), (19, 16), and (15, 13) were mounted less than 16 feet above the ground. Photographs of 12 different installations in Philadelphia are shown in Figure 9-6. These installations were simply dictated by the availability of permanently installed poles owned either by the City of Philadelphia or by the Philadelphia Electric Company. HI^3 contracted pole agreements with both of these organizations prior to installation.

At a given distance from a HI^3 signpost, the strength of the signal received from the signpost is relatively independent of the signpost height above the ground. This relationship is illustrated in Figure 9-7 which contains a plot of the distances, from a signpost, where a Region 1 was received for signpost heights of 20, 22.5, and 25 feet above the ground. The test vehicle was utilized during these tests, and the signpost was approached from two opposite directions. These data were taken in Fort Worth during Special Test Runs 19 through 36. The average and standard deviation of the R1 radius for all of 10 samples taken were 245 feet and 26 feet, respectively. This latter value is very close to the 18-foot standard deviation in R1 boundary location for all 15 fixed route signposts.

These tests show that the HI^3 location subsystem can be utilized in any type of installation without modification to any part of the location subsystem. Height is not critical, and the unit can be attached to any space available on the pole, preferably out of reach of passersby. And, on poles with overhead wires, flexible mounting specifications will permit the installation to adhere to OSHA safety requirements concerning the minimum space between power wires and items mounted on the pole.

A second item of consideration is the effect of local structures near the signpost; in particular, buildings which are very close to the signpost. Figures 9-8 and 9-9 contain contour plots of data obtained during special tests in Philadelphia under the following conditions:

Wide open streets with no buildings near the signpost

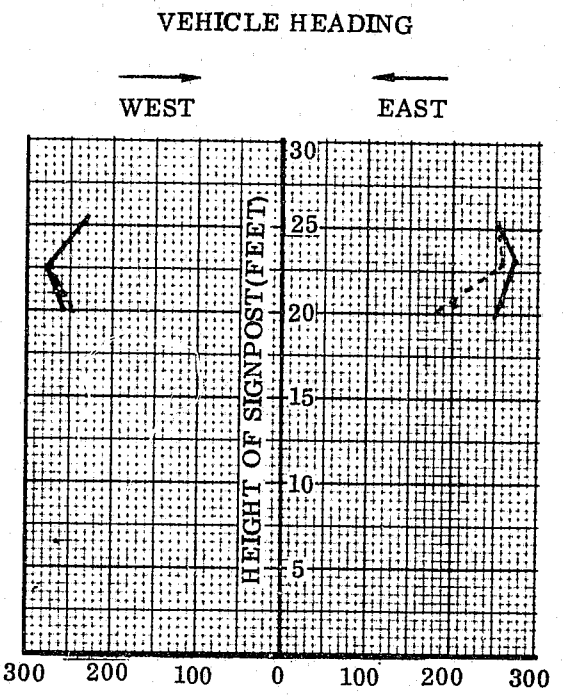
Narrow streets with tall buildings on all sides and very close to the signpost.

The same signpost was utilized and antennas mounted at the same height, 23 feet, during both sets of measurements although the poles were quite different, as shown

(Text continued on 9-16)



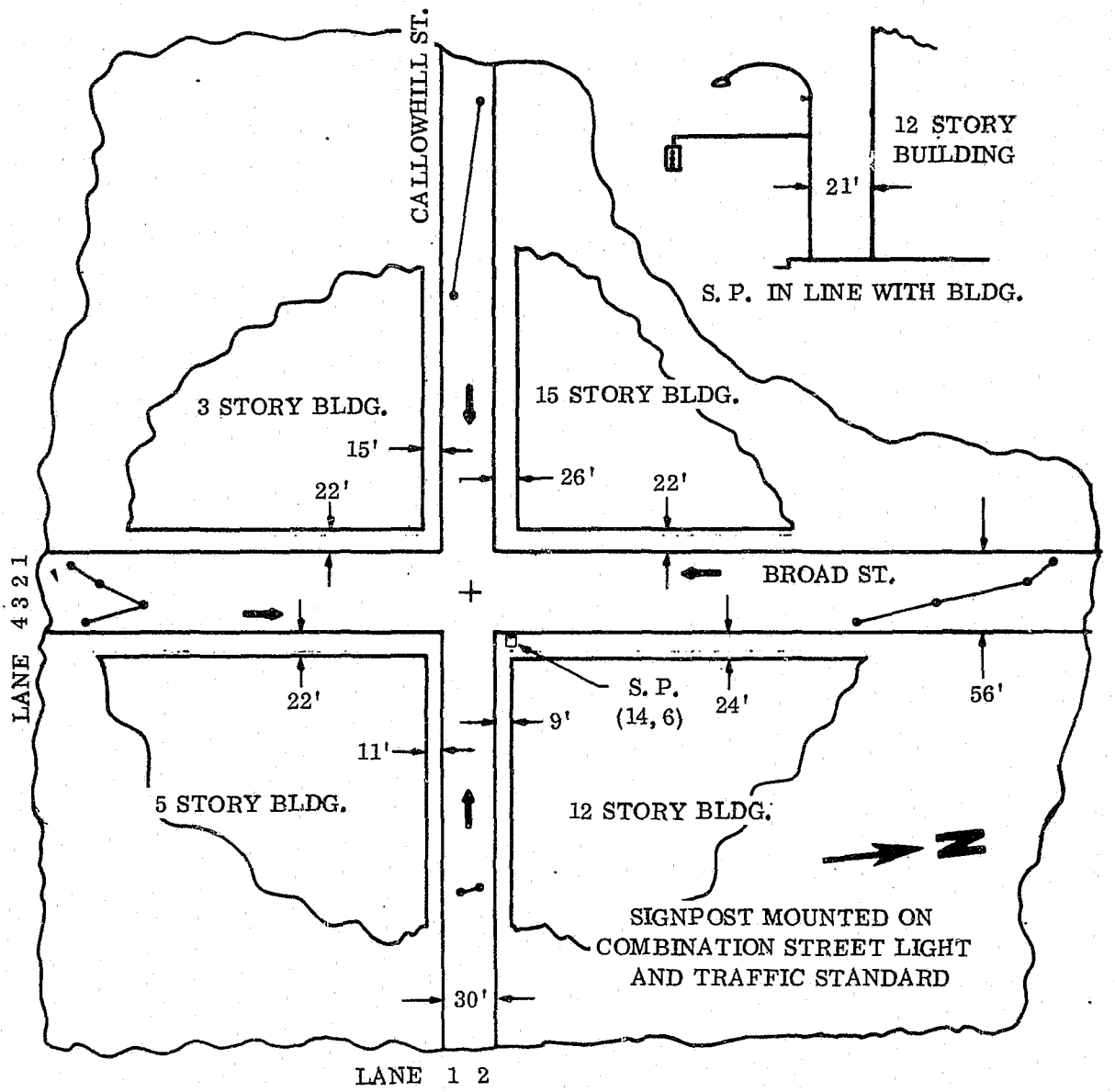
FIG. 9-6 A VARIETY OF SIGNPOST INSTALLATIONS



Run #	Vehicle Heading	Signpost Height (feet)	R1 Radius (feet)
19	West	25	222
20	East	25	240
29	West	22.5	270
30	East	22.5	250
31	West	22.5	270
32	East	22.5	260
33	West	20	260
34	East	20	180
35	West	20	250
36	East	20	250

$\mu(R1_{West}) = 254'$	$\mu(R1_{East}) = 236'$	$\mu(R1) = 245'$
$\sigma_{R1_{West}} = 18'$	$\sigma_{(R1_{East})} = 28'$	$\sigma_{(R1)} = 26'$

FIG. 9-7 SIGNPOST HEIGHT TEST RESULTS



DENOTES LEVEL 1 CONTOUR

FIG. 9-8 SIGNPOST REGION 1 CONTOUR, NARROW STREETS

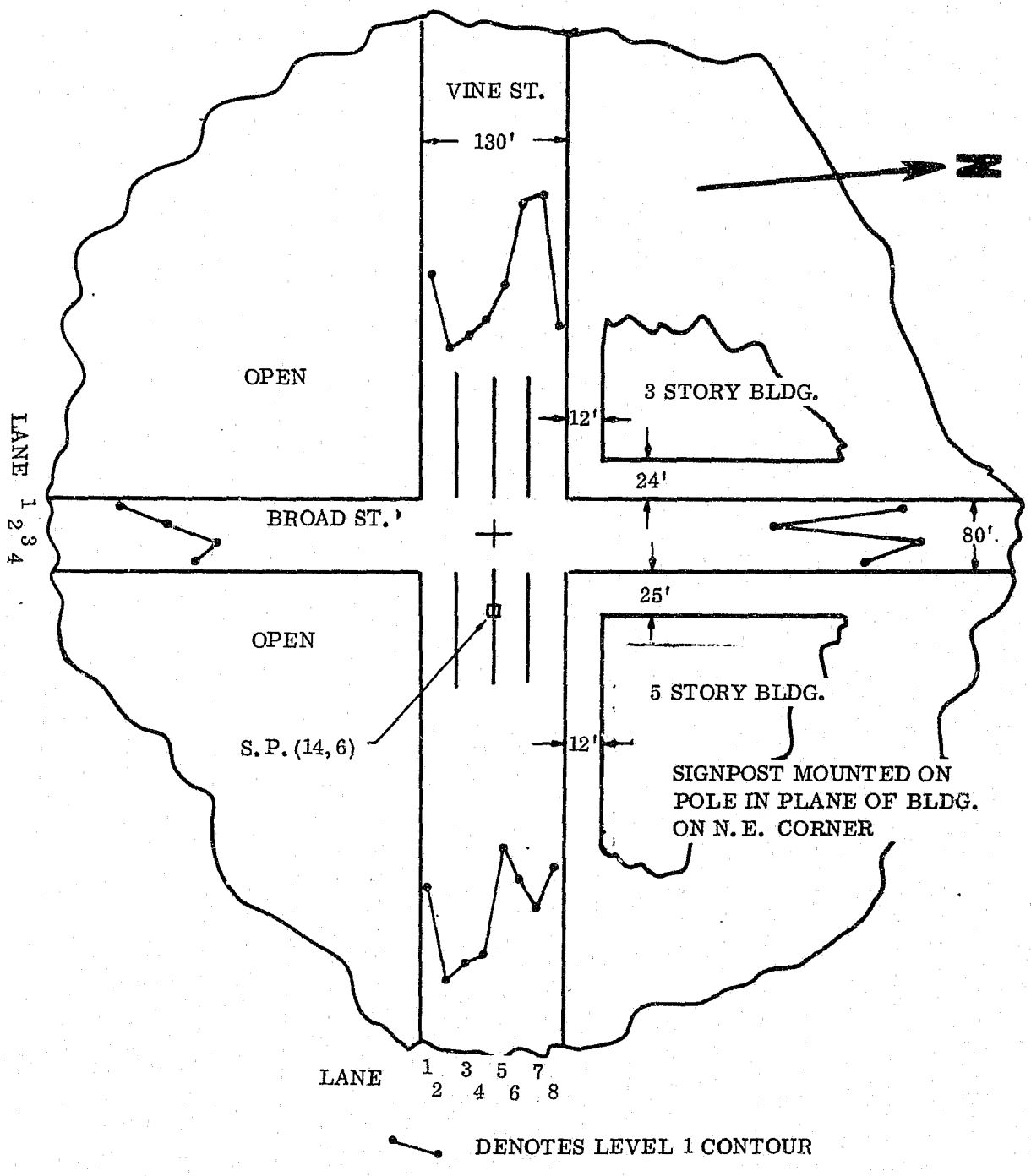


FIG. 9-9 SIGNPOST REGION 1 CONTOUR, WIDE STREETS

in Figure 9-6. Data were taken in all driving lanes heading in all possible directions, the latter being limited because Callowhill is one-way in both directions leading into Broad. There were no other crossing two-way streets in the Center City region of Philadelphia which included a narrow street.

Table 9-3 contains the data obtained during these tests. Where possible, both R1 and R1 dropout data were recorded. The mean and standard deviations of the two sets of data were as follows:

At Broad and Callowhill (Narrow Streets - Congested Structures)

μ = 179 feet
σ = 42 feet

At Broad and Vine (Wide Streets - No Large Structures)

μ = 206 feet
σ = 49 feet

Both Sets of Data Combined

μ = 224 feet
σ = 46 feet

These data show the consistency obtained from the HI^3 location subsystem under quite different installation conditions. In one case the signpost was only 21 feet from a 12-story building. In the other case, there were no structures within 77 feet of the signpost.

9.2 SPECIAL ENVIRONMENTAL CONDITIONS

Special tests categorized under Special Environmental Conditions included the following:

Power substations electromagnetic interference

RF survey

Electromagnetic interference from trolleys

Temperature environment

Traffic and weather

Signpost battery drain.

TABLE 9-3 SIGNPOST LEVEL 1 CONTOUR DATA

Broad and Vine St. 12-15-76 2025-2135 HRS
Temp = 46°
Dry

ODOMETER SETTING : 1 Foot Per Pulse

LANE	HEADING	Odometer Reading			ΔR in feet	ΔR out feet
		At R1	At Center of Intersection	At R1D		
1	South	0419	645	853	226	208
2	South	488	641	822	153	181
3	North	713	866	1101	153	234
4	North	602	767	973	165	206
1	East	1298	1442	1636	144	194
2	East	1509	1610	1856	101	246
3	East	408	517	755	109	238
4	East	1290	1409	1643	119	234
5	West	466	641	776	175	135
6	West	379	509	751	190	182
7	West	1793	2000	2188	207	188
8	West	658	843	956	185	113

BROAD & CALLOWHILL
ODOMETER SETTING : 2 Feet Per Pulse

1	West	401	477	-	152	-
2	West	128	189	-	150	-
1	East	341	416	-	150	-
2	East	698	823	-	250	-
1	South	15	163	264	296	202
2	South	198	340	434	284	188
3	North	107	190	310	166	240
4	North	70	168	268	196	200

NOTE : Odometer Calibration 0.2 Percent Low.

9.2.1 Power Substation EMI

These tests were conducted at the intersection of 11th and Noble. As shown in Figure 9-10, both the Southwest and Northwest corners of this intersection are covered by power substations. The tests were conducted by operating the test vehicle against signpost (15, 13) which was mounted on a street light on the Southwest corner. Table 9-4 contains the results obtained. The signpost was successfully received and decoded on each and every pass. When the test vehicle was located near the Reading Railroad crossing, on 11th Street, an overlap region between signpost (15, 13) and signpost (19, 13) was recorded. Signpost (19, 13) was located approximately 680 feet South on 11th Street. A strong 60 cycle hum could be distinctly heard emitting from the substation as far as 1 block away. The overall results obtained during this test document the fact that 60-cycle EMI has no perceptable effect on the HI^3 location subsystem.

9.2.2 RF Survey

A survey of in-band RF energy at 49.860 MHz was conducted in order to establish the background level of in-band radio frequency interference. Data were taken manually through use of a special RF signal strength meter and a calibrated attenuator. The test vehicle and test location subsystem antenna were used during the tests. The calibrated attenuator was adjusted so as to produce midscale on the meter which had previously been calibrated at -81.5 dBm. Tests were conducted at a number of locations throughout the random and fixed route test areas in downtown Philadelphia. Table 9-5 contains the results of this survey. Signal levels below -81.5 dBm were estimated from the meter by calibrating it with the attenuator and a calibrated signal source. The receiver in the RF survey meter was a standard vehicle unit signpost receiver.

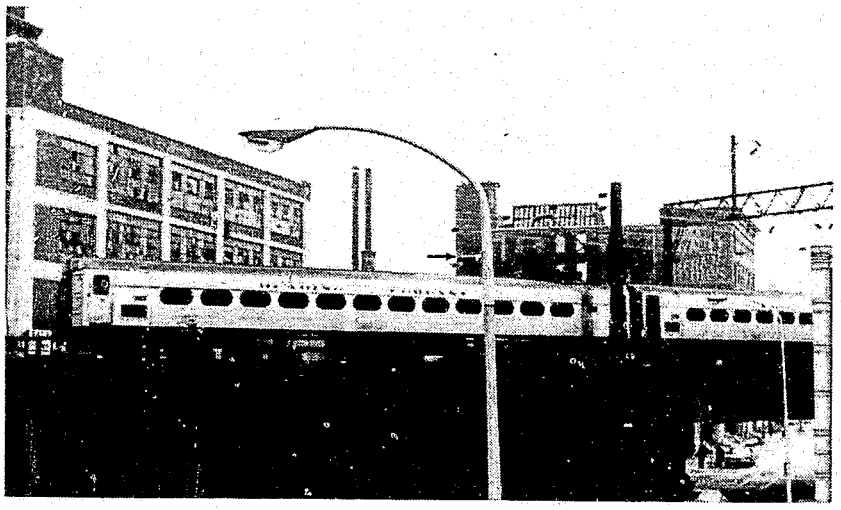
With signposts installed, the indicated level of attenuation was required in order to produce midscale deflection of the meter. The attenuation required was, of course, dependent on the distance to the signpost.

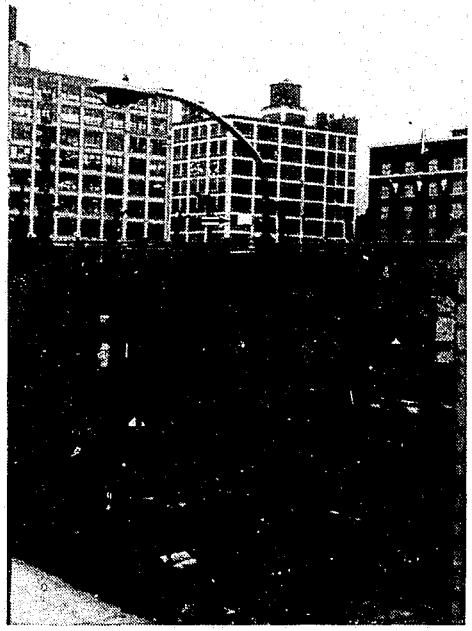
In the vicinity of the power substation at 11th and Noble streets, the in-band energy was -88 dBm. No perceptable difference was observed when a train passed nearby. The most significant source of in-band energy was ignition noise; however, this was quite spurious and difficult to quantify. The RF noise produced by the test vehicle was approximately -80 dBm at the receiver at 49 MHz contrasted with -49 dBm at a similar 27-MHz receiver. In the few instances, automobiles passing directly by the test vehicle produced a transient signal as high as -76 dBm. However, in no case was the presence of ignition noise correlatable to any location error.

9.2.3 EMI From Trolleys

On a number of occasions, the test vehicle followed or was followed by trolleys operating from overhead wires. In these cases, visual observation of







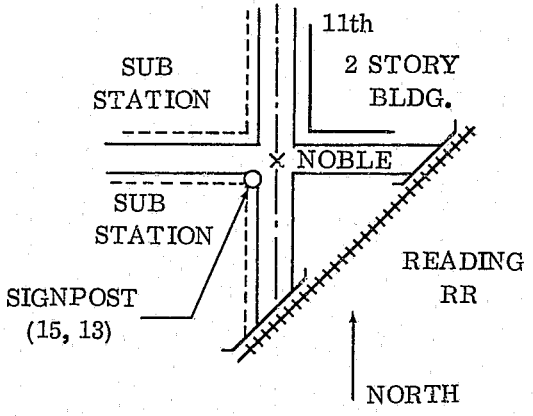


FIG. 9-10 POWER SUBSTATION TEST CONFIGURATION

TABLE 9-4 TEST DATA TAKEN NEAR POWER SUBSTATION

RUN #	HEADING	ODOM (R1) (feet)	ODOM (center of Intersection) (feet)	R (feet)
1	E	126	224	98
2	E	274	376	102
3	E	302	374	72
4	N	102	214	112
5	N	368	498	130
6	S	100	198	98
7	W	160	402	242

TABLE 9-5 PHILADELPHIA RF SURVEY 12-15-76

FREQUENCY 49.860 MHz EXCEPT AS NOTED

TIME	LOCATION	REMARKS	SIGNAL LEVEL (dBm)
1940	Broad and Hamilton	Attenuator Removed	-83
1943	12th and Hamilton		-88
1952	9th and Spring Garden		-88
1955	11th and Noble	Signpost Installed	* (34 dB atten for 0.5 ma)
	30 feet from signpost		
1957	11th and Noble	Signpost Removed	-88
2006	Broad and Callowhill	Signpost Installed	* (55 dB for 0.5 ma)
2008	Broad and Callowhill	Signpost Removed	-88
2012	Broad and Spring Garden		-88
2015	15th and Ridge		-88
2035	16th and Vine		-88
2036	17th and Vine		-88
2038	18th and Hamilton		-88
2039	19th and Spring Garden		-88
2043	Ben Franklin Parkway Circle	Near Signpost 6, 6	-80
2044	22nd and Ben Franklin P.W.		-88
2045	19th and Cherry		
2050	18th and Market	No cars within 1 block	-88 to -78
2051		Cars passing 150' away	-88
2052		Cars passing in next lane	-81.5 to -76
2053		Cars passing 2 lanes away	-88 to -87
2055		Many cars passing simultaneously	-83
2210	4th and Vine		
12-16-76			
1020	11th and Noble	Motor On	-80
1020	11th and Noble	at 27 MHz - Motor On	-49
1021	11th and Noble	Motor Off	-88
1022	11th and Noble	at 27 MHz - Motor Off	-80
0530	15th and Market	Heavy Traffic - Motor Off	-88 to -76

*With signpost installed, attenuation was increased to provide mid scale deflection of the meter corresponding to -81.5 d BM. The attenuation necessary depends on the distance to the signpost.

sparking at the trolley wire connection occurred. During Random Route Run 1, as noted in the test log, the test vehicle followed directly behind a trolley heading South on 12th Street from CP 45 to CP 46. Reference to Run 1 test data in Table 5-1 will indicate that the location errors associated with these two checkpoints were not influenced by the presence of the trolley since the error was the same for Runs 1, 2, 3, and 4 and no trolley was present during those latter runs. On Run 4, a trolley followed directly behind the test vehicle from CP 25 through CP 28. Again, reference to Table 5-1 will indicate that the presence of the trolley during Run 4 did not influence the location error since the errors incurred at CP 25, 26, 27, and 28 were exactly the same in 17 out of 20 cases. It is concluded from those tests that the HI^3 AVM system can operate without degradation in performance near, and most probably on, electric trolleys.

9.2.4 Temperature Environment

A series of tests were performed in order to establish the ability of the HI^3 signpost to operate over a wide variation in temperature. The results of these tests are presented in Table 9-6.

Each HI^3 signpost used in Phase I was checked for operation over the temperature range -25°C to +50°C in the environmental chamber. These tests were not part of the special case tests; however, the results are directly applicable to Phase I and Phase II. These tests were conducted by using the field strength meter which includes a built-in signpost decoder to monitor the signpost output while the signpost was in the chamber. During this test, the signal strength meter was at room temperature and the test was simply a go, no-go type test which was based on the ability to decode the signpost code over the temperature range. The purpose of the test was to assure that the signposts were operating over the expected temperature range. Note that the signal strength meter is normally battery operated.

Subsequent to these tests, during the process of adjusting the vehicle units for use in Phase I, the receiver in the signal strength meter was used as a reference; however, it was connected to a 12-volt power supply at the time the clock frequency was being determined. As a result, the clock frequency in both Vehicle Unit 1 and 2 were erroneously set a few kilohertz too high (204 KHz versus 198 KHz). This error caused no problem at normal temperatures; however, at lower temperatures, the signpost FSK frequencies change within a design tolerance. This design tolerance is within the capture bandwidths of the correctly adjusted vehicle unit. However, in this case, the capture bandwidth of the erroneously adjusted vehicle units was too narrow. Hence, during Runs 1 through 5, as the temperature decreased, some degradation in system performance resulted.

As noted in the random route data log in the Appendix, this error was discovered and corrected between Runs 5 and 6, with the highly significant results previously described in Section 5 of this volume.

TABLE 9-6 HOFFMAN SIGNPOST PARAMETERS VS. TEMPERATURE

		49.860 MHz Signpost SP-03				27.095 MHz Signpost SP-02			
Temperature °C	Source Voltage Volts	RF Freq. MHz	RF P-P Out Volts	% MOD	F_{low} KHz	RF Freq. MHz	RF P-P Out Volts	% MOD	F_{low} KHz
+20	11.6	49.860 437	1.80	.2	3.776	27.094 528	2.05	.24	3.275
+20	11.4	49.860 430	1.75	.2	3.249	27.094 520	1.95	.24	3.240
+20	11.2	49.860 411	1.70	.2	3.210	27.094 492	1.95	.24	3.205
+20	13.34	49.860 283	1.50	.25	2.981	27.094 397	1.80	.2	2.956
+20	9.86	49.860 743	2.10	.2	3.544	27.093 802	2.15	.3	3.563
0	11.6	49.861 280	1.75	.2	3.261	27.094 517	2.00	.24	3.272
0	11.4	49.861 133	1.70	.2	3.228	27.094 490	1.98	.24	3.229
0	11.2	49.861 122	1.60	.2	3.195	27.094 483	1.93	.24	3.195
-20	11.6	49.861 875	1.70	.25	3.259	27.094 486	1.90	.26	3.281
-20	11.4	49.861 876	1.66	.25	3.225	27.094 473	1.85	.26	3.728
-20	11.2	49.861 849	1.63	.25	3.193	27.094 427	1.70	.26	3.192
+50	11.6	49.859 001	1.78	.18	3.274	27.094 566	2.05	.26	3.270
+50	11.4	49.858 976	1.75	.18	3.241	27.094 553	2.00	.26	3.237
+50	11.2	49.858 965	1.70	.168	3.211	27.094 546	1.95	.24	3.203
+50						27.094 571	2.10	.26	3.302

Data taken with Textronix 485 Oscilloscope with signpost inside of Standard Environmental Systems, Inc. model TB/2 Environmental Chamber.

At first, it was believed that signpost failures produced the problems observed in Run 5 since the same type of problem was observed during preliminary calibration of the system. Isolation and correction of the vehicle frequency adjustment problem shed new light on this problem, and it is now documented that HI^3 experienced only one signpost failure during the 90 days in which the 41 signposts were installed in Philadelphia. That failure occurred during extremely cold weather when a mica capacitor failed in signpost (16, 11) on the night of 16 January between fixed route Runs 37 and 38. The failure was possibly due to a faulty capacitor which could not stand the thermal shock of the temperature dropping 11 degrees in less than three hours during the period in which the signpost failed. As a result of this failure and tests run on signposts to be installed in Labrador, these mica capacitors are being replaced with ceramic capacitors.

Table 9-7 contains data taken on a HI^3 vehicle unit during operation over the temperature range between $-25^{o}C$ and $65^{o}C$ at source voltages between 11 and 14 volts DC. As in the case of the signpost, a standard environmental system, Model TB12 environmental chamber, was utilized. These data show that the Level 3 and Level 2 thresholds do not change with temperature over the $-25^{o}C$ to $+65^{o}C$ operating range and over a source voltage range from 11 to 14 volts. The Level 1 threshold varied a total of 1.5 dB over this same range. However, this change represents only a few feet since this level change is associated with the steepest portion of the RF field produced by the signpost.

9.2.5 Weather, Traffic, and Time of Day

A total of 10 random route, 33 fixed route, and approximately four full days of special case tests were performed in Philadelphia. At no time was any test delayed as a result of weather, traffic conditions, or the time of day. Table 9-8 reflects the weather and traffic conditions and the start and finish times of each formal test run. Figure 9-11 contains photographs taken during fixed route Runs 18, 19, and 34 and one taken when the "off-route" signposts were being installed during $5^{o}F$ weather after completing Run 38.

The only problems created by the weather involved the 5th wheel. These included (1) a shorted connector caused by water on Run 26, (2) loss of a magnet during Run 32, probably because of roadway ice ruts, and (3) an accumulation of up to 1/4 inch of ice and slush on the 5th wheel as shown in Figure 9-11. An average accumulation of 1/8-inch increase in the radius of this 13-inch radius wheel produces an error since the wheel would turn 1 percent fewer revolutions per foot, or, on the basis of assuming a total distance traveled of 68,000 feet, a total of 100 fewer revolutions. This difference would produce an error (shorter indicated distance traveled by the 5th wheel) of 681 feet. A comparison of odometer and 5th wheel distances for the fixed route indicated that this buildup of snow and ice in conjunction with some sliding of the 5th wheel did indeed cause the 5th wheel to lose distance during those runs where the centers of streets were icy.

TABLE 9-7 HI^3 SIGNPOST RECEIVER TEMPERATURE CHARACTERISTICS

Temperature °C	Input Voltage Volts	Minimum Decode Level db	Maximum Decode Level db	Level #1 db	Level #2 db	Level #3 db	*Level #1 Drop Out db
+25	11.0	66	10	38	53	63	< 4
+25	12.5	66	7	38	53	63	< 4
+25	14.0	66	10	38	50	63	< 4
0	11.0	65	10	39	53	63	
0	12.5	65	10	39	53	63	
0	14.0	63	12	39	53	63	< 4
-25	11.0	62.5	21	39.5	53	63	
-25	12.5	62.5	18	39.5	53	63	< 4
-25	14.0	62.5	23	39.5	53	63	< 4
+50	11.0	65	19	37.5	53	63	< 4
+50	12.5	65	17	37.5	53	63	
+50	14.0	65	20	37.5	53	63	
+65	11.0	64	29	37	53	63	6
+65	11.5	65	24	37	53	63	6
+65	12.5	65	19	37	53	63	6
+65	14.0	63	24	37	53	63	6

*Note : Level #1 drop out occurs at high signal levels due to saturated mixer characteristics.

Test Configuration

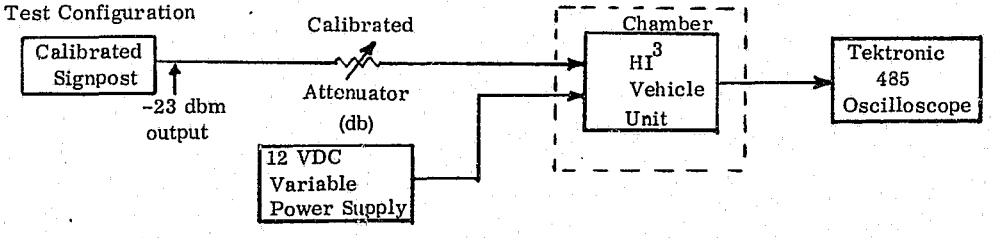


TABLE 9-8 HI[3] TEST DATA (WEATHER, TEMPERATURE, AND TIME)

Run #	Temperature °F	Weather	Traffic	Start Time Hrs. Min.	End Time Hrs. Min.
1	48	Wet Streets	Heavy	15:41	17:15
2	48	Wet Streets	Heavy	17:35	18:48
3	46	Wet Streets	Moderate	18:56	20:05
4	45	Wet Streets	Moderate	20:25	21:50
5	41	Wet Streets	Light	21:56	22:57
6	28	Dry	Moderate	09:45	10:55
7	34	Dry	Heavy	11:05	12:35
8	36	Dry	Heavy	12:40	14:09
9	38	Dry	Moderate	14:20	15:35
10	36	Dry	Heavy	17:05	18:18
11	24	Dry	Moderate	13:10	14:50
12	25	Dry	Moderate	15:00	16:37
13	24	Dry	Heavy	16:50	18:20
14	24	Dry	Moderate	20:25	21:40
15	23	Dry	Light	22:00	23:10
16	23	Dry	Light	23:20	00:30
17	30	Dry	Moderate	08:50	10:15
18	32	Snowing	Heavy	10:20	12:00
19	31	Snowing	Heavy	13:30	15:35
20	32	Snowing	Heavy	16:00	17:30
21	33	2" Slush	Moderate	18:00	19:30
22	33	2" Slush Freezing Rain	Light	20:40	21:55
23	32	Freezing Rain	Light	22:00	23:20
24	32	Freezing Rain	Light	23:30	00:45
25	32	Light Rain	Light	00:50	02:10
26	33	Slush	Moderate	10:35	12:00
27	34	Slush	Moderate	12:10	13:22
28	38	Slush	Moderate	13:30	14:55
29	37	Slush	Moderate	15:00	16:20
30	34	Slush	Heavy	17:15	18:38
31	34	Slush	Moderate	18:45	20:10
32	32	Slush	Light	20:25	21:50
33	26	Snow	Light	10:10	12:25
34	26	Snow	Moderate	12:35	14:05
35	26	Snow	Moderate	14:15	15:35
36	28	Snow	Heavy	15:50	17:05
37	26	Slush	Heavy	17:15	18:30
38	15	Slush	Moderate	20:40	21:50
39	8	Ice	Light	10:15	11:45
40	8	Ice	Light	12:15	13:40
41	12	Ice	Moderate	15:35	17:15
42	12	Ice	Moderate	18:55	20:10
43	12	Ice	Light	20:30	21:40



FIG. 9-11 INCLEMENT WEATHER TEST CONDITIONS

CONTINUED

4 OF 8

9.3 SPECIAL VEHICLE RELATED CONDITIONS

During the Phase I test program, a number of tests were conducted to assess the limitations, if any, and capabilities of the HI^3 AVM System in terms of special conditions which pertain to the AVM-equipped vehicle. HI^3 selected a large motor home for use as a test vehicle for two reasons: (1) it provided an ideal working space for the DAS and for observers during tests and demonstrations, and (2) it was an ideal simulation for a bus in terms of height, width, and maneuverability. The success achieved through use of the Phase I test vehicle makes it a logical choice for use during Phase II test program in Los Angeles as a test and calibration vehicle.

Special vehicle related tests were categorized as follows:

Vehicle velocity

U-Turns

Parking Garages.

9.3.1 Vehicle Velocity

During the random route and fixed route tests in Philadelphia, the test vehicle operated under prevailing traffic conditions and speed limits. As a result, the vehicle was rarely able to exceed a speed of 30 miles per hour during formal tests. In order to demonstrate the performance of the HI^3 LS at speeds much greater than 30 mph, a series of special tests were conducted in Fort Worth, Texas, on 27 October 1976. Two types of tests were conducted. The first involved making repeated passes at a constant speed by a signpost mounted on a street light and recording the distance from the signpost at which the R1 boundary was detected. These tests (Special Case Runs 17 through 28) covered speeds from 10 to 48 mph. Higher velocity tests were performed by attaching a signpost to the top of another vehicle and subsequently driving the two vehicles toward each other at constant speeds. By recording these speeds and the location, ODOM (R1), at which the R1 was received, and the location, ODOM(P), at which the vehicles passed, the actual R1 radius associated with the relative velocity between the test vehicle and the signpost could be computed. The value of the odometer at the occurrence of the R1 was automatically recorded by the data recording software. Passage of the two vehicles was recorded by use of a CP event code.

The geometry involved in the latter test is shown in Figure 9-12. If it is assumed that the test vehicle was traveling at a speed of V_{TV} and the signpost at a speed of V_{SP}, then the actual vehicle velocity relative to the signpost is

$$V_R = V_{TV} + V_{SP} .$$

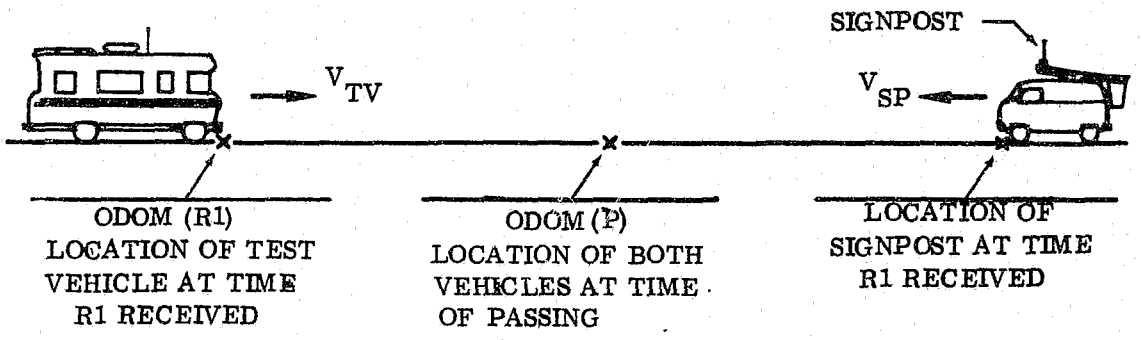


FIG. 9-12 VEHICLE VELOCITY TEST CONFIGURATION

During the period of time between receipt of the R1 by the test vehicle and the passing of the two vehicles, the test vehicle traveled a distance of

$$D_{TV} = ODOM(P) - ODOM(R1).$$

The time required to travel this distance is

$$R = \frac{D_{TV}}{V_{TV}}.$$

During the same time period, the signpost traveled a distance of $D_{SP} = T \times V_{SP}$. The actual R1 distance is given by

$$R1 = D_{TV} + D_{SP} = D_{TV} + T \times V_{SP} = D_{TV} + D_{TV} \frac{V_{SP}}{V_{TV}}$$

or

$$R1 = D_{TV} \quad 1 + V_{SP}/V_{TV}$$

$$R1 = \quad ODOM(P) - ODOM(R1) \quad (1 + V_{SP}/V_{TV}).$$

This last relationship was used to compute the R1 distances shown in Table 9-9 for the case of two vehicles. The slightly shorter R1 value that resulted during Runs 43 through 49 are primarily attributed to the manner in which the signpost was mounted on top of a van. The signpost height was only 9 feet above the ground. Note that the average R1 radius is 216 feet for the data in Figure 9-9 and the standard deviation is less than 54 feet, including the effect of both vehicle speed and the height difference of the vehicle-mounted signpost. The standard deviation of the pole-mounted signpost tests was 37 feet while that of the vehicle-mounted signpost tests was 22.8. The results show that the HI^3 AVM System performance is not degraded at any speed contemplated for either fixed or random route vehicles.

9.3.2 Vehicle Making U-Turns

The HI^3 AVM System is independent of the direction of travel of the vehicle. No dead-reckoning is performed, and no application of location history is made in computing subsequent locations. Each vehicle simply computes and stores its most current location as it determined by the 18-BIT location region code. The process of making a U-Turn in no way affects the performance of the HI^3 system. This fact was demonstrated during a special test conducted on Vine Street between 9th and 10th Streets. Figure 9-13 reflects the path of the vehicle on a scale drawing of the street, which is 134 feet wide. The small solid circles on the vehicle path indicate the occurrence of a new location region code. The locations of these HI^3 test and calibration checkpoints 14, 15, and 17 are also

TABLE 9-9 VEHICLE VELOCITY TESTS

Run #	Heading	V_{TV} mph	V_{SP} mph	V_R mph	R1 Radii Feet	Odometer CAL Feet per pulse
17	West	10	NA	10	280	10
18	East	10	NA	10	290	2
19	West	20	NA	20	272	2
20	East	20	NA	20	298	2
21	West	30	NA	30	*	10
22	East	30	NA	30	*	10
23	West	40	NA	40	240	10
24	East	40	NA	40	170	10
25	West	45	NA	45	240	10
26	East	45	NA	45	260	10
27	West	48	NA	48	210	10
28	East	40	NA	40	260	10
43	East	20	0	20	190	10
44	East	20	20	40	180	10
45	East	30	30	60	160	10
46	East	40	40	80	140	10
47	East	40	45	85	191	10
48	East	48	50	98	163	10
49	East	48	54	102	127	10

* Experienced problem recording output of odometer

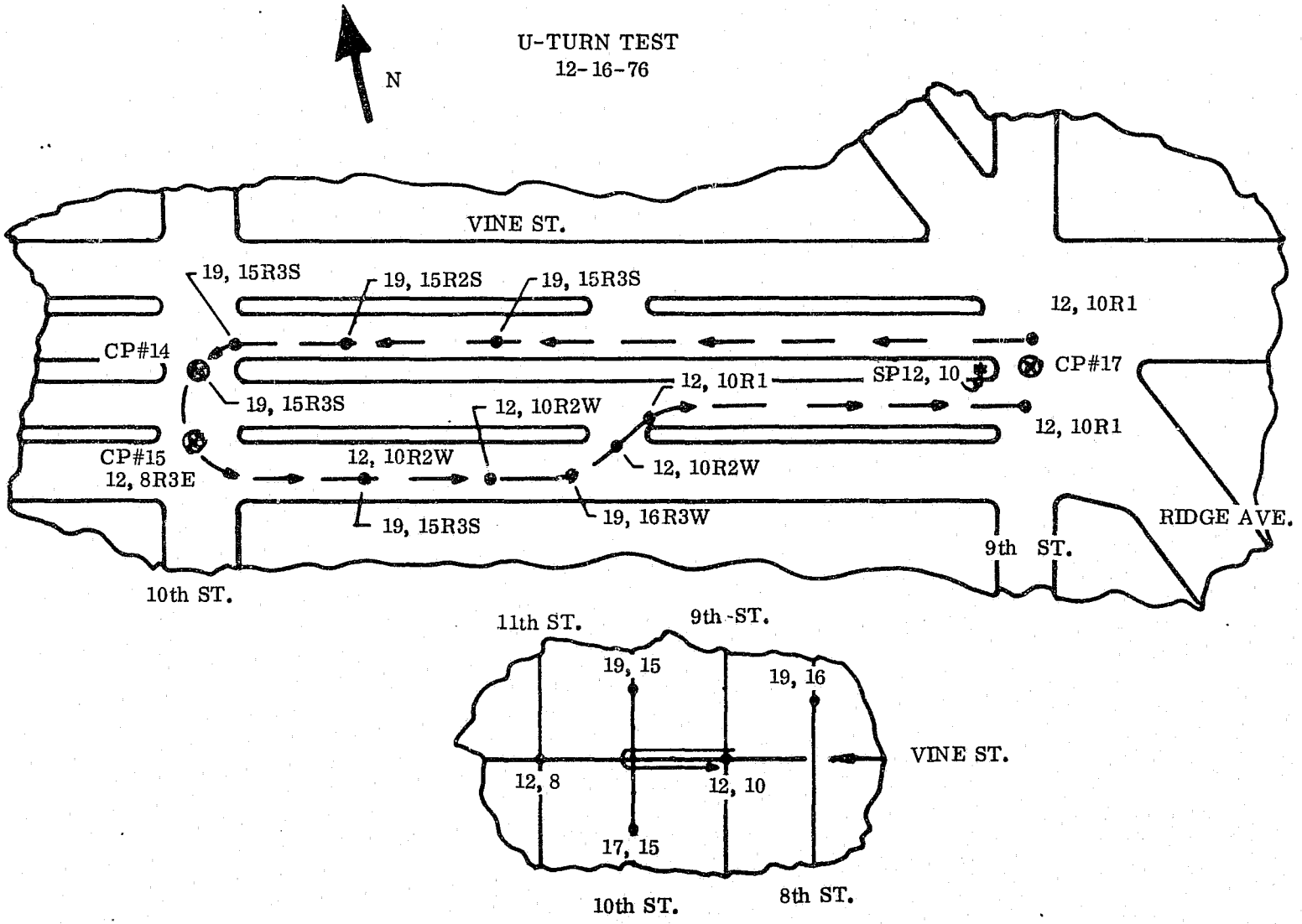


FIG. 9-13 VEHICLE U-TURN TESTS

indicated. The inset is the street geometry and the location of signposts and location region coordinates. Table 9-10 contains a listing of the U-Turn Test Data.

9.3.3 Parking Lots and Garages

During normal activities of a random route vehicle, particularly a police car, the vehicle may be required to enter parking lots and parking garages, pass through alleys, etc. The HI^3 random route location subsystem provides accurate location data on vehicles in these situations. Where an AVM-equipped vehicle enters a parking garage, the storage register in the vehicle maintains the last location region code until the unit is turned off. When it is turned back on and driven back onto the street, the vehicle unit picks up a new location region code as its current location. This fact was demonstrated by driving into the covered roadway area on Filbert Street near 8th Street shown in Figure 9-14. At the location designated CP 99, the vehicle was parked and the power to the vehicle unit was cycled, clearing the location storage register. The vehicle was then driven East. CP 98 was entered as the vehicle left the garage to record the odometer value. The odometer value at the occurrence of the first location region code was also recorded. The resulting data are shown in the figure. This data demonstrated the capability of detecting a valid location region code (in this case an overlap code), within less than 270 feet after leaving a completely covered garage. It is significant to note that the HI^3 AVM system does not require that the first location region be a Region 1. The system responds equally well to location region created by use of the overlap technique.

In paragraph 9.1.2, it was shown that coverage within a covered garage can be easily obtained by placing a HI^3 signpost within the covered area. This arrangement allows, for example, all cars leaving a fleet vehicle garage to be accurately located from the instant their systems are turned on.

9.3.4 Vehicle Unit Power Requirements

During special tests conducted in Fort Worth, the Phase I test vehicle unit was tested to determine its power drain. The source voltage was 12-5 volts DC and the total current drawn was 201-212 milliamps, with the vehicle unit operating under operational conditions. This resulted in a power drain of 2.59 watts.

TABLE 9-10 U-TURN TEST DATA

	000	12	10	R1	D	03394	F	00000	T	04 42
CP	017	12	10	R1	D	03434	F	00000	T	04 44
	000	19	15	R3 S	D	03726	F	00000	T	04 55
	000	19	15	R2 S	D	03812	F	00000	T	04 58
	000	19	15	R3 S	D	03885	F	00000	T	05 03
	000	19	15	R2 S	D	03880	F	00000	T	05 05
	000	19	15	R2 E	D	03880	F	00000	T	05 06
	000	19	15	R2 S	D	03880	F	00000	T	05 07
CP	014	19	15	R3 S	D	03880	F	00000	T	05 11
	000	19	15	R2 E	D	03880	F	00000	T	05 13
	000	12	10	R3 W	D	03880	F	00000	T	05 14
	000	19	15	R2 S	D	03880	F	00000	T	05 15
	000	12	08	R3 E	D	03880	F	00000	T	05 18
	000	19	15	R2 S	D	03880	F	00000	T	05 19
CP	015	12	08	R3 E	D	03913	F	00000	T	05 24
	000	12	10	R2 W	D	03999	F	00000	T	05 29
	000	19	15	R3 S	D	04002	F	00000	T	05 30
	000	12	10	R2 W	D	04064	F	00000	T	05 32
	000	19	16	R3 W	D	00033	F	00000	T	05 35
	000	12	10	R2 W	D	00091	F	00000	T	05 37
	000	12	10	R1	D	00117	F	00000	T	05 38
CP	017	12	10	R1	D	00332	F	00000	T	06 04

U-TURN TEST
12-16-76
G. Grunder
B. Klein

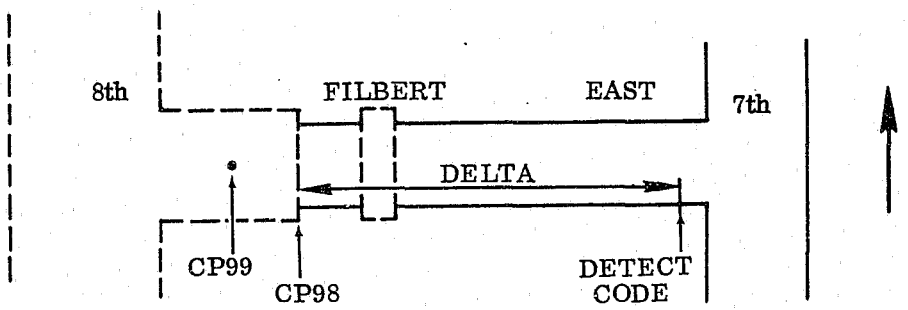


FIG. 9-14 PARKING GARAGE TEST CONFIGURATION

10. SPECIAL PHASE II CONSIDERATIONS

The HI^3 proposals for the Multi-User AVM System were submitted to TSC on 14 October 1975. Contract go-ahead was received on 2 September 1976. During this 11-month period and during the period in which Phase I was conducted, HI^3 was continuously involved in specific and general studies which may have a direct bearing on Phase II of the Multi-User AVM Program. A number of items considered are briefly discussed in this section.

10.1 RELATIONSHIP BETWEEN PHASE I AND PHASE II EQUIPMENT

The location subsystem equipment used during Phase I tests was functionally identical to that proposed for use in Phase II. Specific differences are discussed in this section.

10.1.1 Signposts

The signposts proposed in HI^3 proposal of 14 October 1975 were Model SP-02 which operated at 27.095 MHz. Phase I tests were conducted through the use of signpost Model SP-03 which operates at 49.860 MHz. Model SP-03 signposts are proposed for use in Phase II. Other than minor component replacement and new printed circuit board layout with an etched loading coil designed for use at 49.860 MHz, no signpost design changes are contemplated for Phase II. The loading coil used during Phase I was designed to operate at 27.095 MHz and was modified for operation at 49.860 MHz. HI^3 signposts were connected to batteries on 27 September 1976. Except for a two day period during which they were modified to operate at 49.860 MHz, these 41 signposts were operated continuously from that date through 31 March 1977, when this report went to press. During that 183 day period only one signpost failure occurred, as discussed in Subsection 8.2. That failure occurred on the 111th day of operation.

The design MTBF of the HI^3 signpost is 100,000 hours. Operation of 41 signposts for 183 days corresponds to 180,072 signpost hours of operation. If, as is commonly assumed, a second failure is assumed to have occurred on the 183rd day, one computes an observed failure rate of 2 signposts in 180,072 hours or 1 failure in 95,000 hours, very close to the design MTBF.

10.1.2 Vehicle Units

During Phase I, a separate Interface Controller Unit (ICU) was used to interface the vehicle unit to the computer. In Phase II, all functions incorporated in the ICU would be incorporated on a single communication interface board within the vehicle unit. The primary reason for use of the ICU was to accommodate the odometer and fifth wheel inputs. If the odometer is eliminated from the HI^3 AVM system, the communication interface becomes significantly simpler. Subsection 10.2 contains the rationale for elimination of the odometer. No vehicle unit failures occurred during Phase I. Between random route runs 5 and 6, both vehicle units were found to have erroneously set clock frequencies; however, this was not considered a failure.

10.1.3 Auxiliary Equipment

In Phase I, the CRT keyboard was used to simulate the opening and closing of the bus door. In Phase II, this function would be performed by use of a door position sensor and direct interface to the vehicle unit.

10.2 DESIRABILITY OF ELIMINATING ODOMETER

A number of AVM or AVL systems are currently installed in transit systems. These include the CTA in Chicago, and systems in Zurich, Paris, Hamburg, and London. In each of these systems, odometers are used to determine the distance of a bus along a route from a reference point. The reference points are determined either through (1) being manually reset (Paris' SECAMA system), (2) use of electronic signposts (CTA, Zurich's VBZ, and Hamburg's HVV) and (3) London's optical inverse proximity system. These systems are common to the extent that all use odometers and all are limited to fixed route vehicles. In all of these systems, one key cost element is the design, development, installation, and maintenance of the odometer system.

The development of a true random route AVM system has required a significant departure from the technology utilized in these fixed route systems. The HI^3 random route system, for example, can provide all of the information required of a fixed route system; however, the inverse is not true.

In the interest of making all vehicle units (for use in both random and fixed-route vehicles) identical, in terms of location processing, HI^3 has conducted a study into the cost-benefit of eliminating the odometer. The results of this study are summarized below.

In the Phase II system originally proposed, only fixed-route vehicles would incorporate the odometer. In those vehicles, the odometer would perform the following two functions:

a. Accumulate the elapsed distance along the route from the last signpost.

b. Set a flag when the vehicle has traveled 600 feet from the last R1. This flag signifies that the last R1 dropout has occurred.

Both of these functions can be eliminated by providing complete signpost coverage along the fixed route. The advantages associated with this are many, and they include

1. Timepoints may be moved without requiring movement of any signposts.
2. All multi-user vehicle unit location processors are identical.

3. Non-recurring design costs associated with the odometer system are eliminated.

4. Installation costs of odometer systems are eliminated.

5. Logistics and maintenance problems associated with the odometer are eliminated.

6. Maintenance and logistics are simplified with the multi-user system through increased commonality.

7. Costs of the additional required signposts are less than the cost of providing an odometer system in all fixed-route bases.

8. Software is simplified.

9. All signposts in the system are identical; i.e., there are no differences between "random route", "fixed route", or "timepoint" signposts.

10.2.1 Method of Computing Location and Timepoint Performance Without Using an Odometer

If overlapping signposts are installed along each fixed route, the location of fixed route vehicles is obtained in exactly the same manner as is that of the random route vehicles. Each location region along the route is assigned a pair of X, Y coordinates which are part of the base station data base. Thus, receipt of an 18-bit code location region at the base station allows the bus to be located to within the specified system accuracy.

In the all-signpost system, timepoint performance could be computed as often as each new signpost is received. The vehicle would sense a timepoint through the signpost code. One approach would be that signposts near timepoints would have a logical 1 in the most significant bit. Recall from subsection 3.2.1 that only the four least significant bits are utilized in determining overlap codes. After having sensed a level 1 (Region 1) from a timepoint signpost, a fixed route vehicle would record the time at which the next overlap code was received in the vehicle. This time would be used in exactly the same manner as the TLR1D was used during Phase I. This process is illustrated in Figure 10-1.

At the base station, predetermined values of ΔT_L would be stored for each timepoint and for each direction of bus travel that the timepoint must service. For example, if it is assumed that signpost (71, 8) is used as a "timepoint" signpost at timepoint 15, then a data base file (TPTABL) would provide two values of ΔT; $\Delta T(N)$ that corresponds to the average time required for a bus to travel from the timepoint to the TLR1D point when it is heading north and $\Delta T(S)$ that corresponds to the average time required for a bus to travel from the timepoint to the TLR1D point when it is heading south. Note that the bus must transmit only the single TLR1D time (or the time the door is closed), as in Phase I;

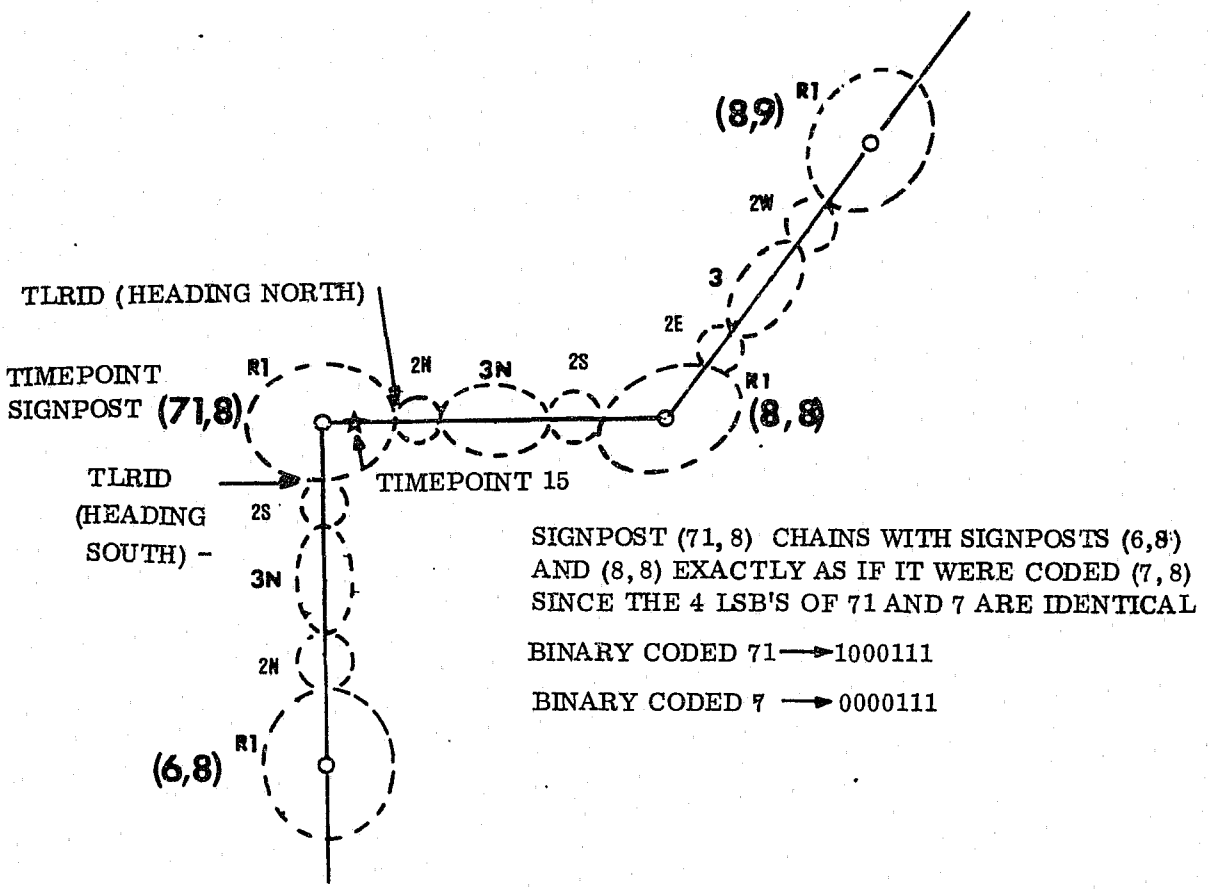


FIG. 10-1 USE OF HI^3 SIGNPOSTS TO PROVIDE FIXED ROUTE VEHICLE LOCATION AND TIMEPOINT PERFORMANCE

however, it need not store or transmit the 12-14 bit odometer code. Consequently, the odometer storage register and all associated odometer logic can be eliminated from the fixed-route vehicle units, and the communication technique is simplified. Furthermore, a significant gain in the flexibility of timepoint selection is achieved since timepoints may be selected without requiring movement of any signposts.

10.2.2 Cost Benefit of Eliminating Odometers

From an economic point of view, the elimination of the odometer from the fixed route system is beneficial, particularly as the number of vehicles is increased. An analysis of this cost benefit follows:

1. Non-recurring Costs - These costs are independent of the number of vehicles. They include engineering and development costs associated with the odometer system. No additional non-recurring costs are incurred by expanding the signpost system.

2. Recurring Costs - If a cost per vehicle of $40 per installed odometer system is assumed and a cost of $70 per installed signpost, one can establish the following relationship:

   $$\text{Delta Recurring Cost} = 70N_{SP} - 40N_V$$

   An analysis of the designated SCRTD lines 7, 21, 26, 29, 83, and 89 indicates a total of 70 miles would require signpost coverage. The total route miles of all these lines is 102.7 miles; from this distance was subtracted the 29.3 miles which occurs within the random route area and 3.7 miles which are common to more than one route. The installation of a signpost every 1000 feet along this 70 miles would require 370 signposts and meet the LS and system accuracy specification at all points along the routes. Thus, for Phase II

   N_V = 200 fixed route vehicles

   and

   N_{SP} = 370 signposts

   which results in a total Delta Recurring Cost of $17,900.

3. Cost Saving - In order to compute the cost saving achieved by eliminating the odometer, the amount bid in the Phase II cost proposal for Fixed Route and Timepoint signposts must be subtracted from the recurring costs. Since 260 units were proposed, the net recurring saving is

   $18,200 - 17,900 = $300.

   To this value must be added the saving in non-recurring cost, $10,000. The result is a total saving of $10,300 that results from elimination of the odometer, without loss in performance.

4. Additional Cost Savings - Additional areas in which use of a signpost-only system (no odometers) would provide cost savings include:

   a) Training - Simpler system involves less training for maintenance.

   b) Maintenance - No in-vehicle maintenance, just replace vehicle units.

   c) Spares - Fewer required since all units are identical.

   d) Software - Simpler coding and simpler maintenance.

   e) Quantity buy - More signposts allow per-unit cost savings.

The inclusion of this change involves no design changes in the HI^3 vehicle unit used in Phase I since the odometer was accumulated within the ICU, not in the vehicle unit. Thus, use of a signpost-only system during Phase II allows the vehicle unit location region processor to be even more identical to the Phase I system than originally proposed.

10.3 FCC REQUIREMENTS AND STATUS OF HI^3 EQUIPMENT

Operation of HI^3 signposts Model SP-03 requires certification by the FCC pursuant to Subpart D of Part 15 of the current FCC Rules and Regulations. To be certified under Part 15 as a low-power device, the signpost must meet the specified technical requirements and be certified through the process set forth in Subpart B of Part 15.

Model SP-03 signposts certification requires that a set of simple measurements be taken; however, the calibrated equipment necessary to conduct these measurements is not available at HI^3. For this reason, HI^3 provided test units to Approved Test Engineering Laboratory of Chatsworth, California. That laboratory has provided the technical data necessary for certification by the FCC, which has been applied for.

HI^3 has held numerous meetings with FCC personnel with regard to AVM. The HI^3 AVM system installed at Huntington Beach, California, is certified by the FCC under Part 15 under the rules in force at the time of manufacture of that 27.095 MHz system. In the near future HI^3 intends to petition the FCC for a nationwide dedicated signpost frequency. We believe such a step would be beneficial to the government.

10.4 FEDERAL, STATE, AND LOCAL REQUIREMENTS FOR PHASE II

Installation of Phase II equipment will involve obtaining permits for the use of space on existing street light and/or utility poles in the cities of Los Angeles, Santa Monica, Culver City, and Beverly Hills, and the County of Los Angeles. Well over 90 percent of these poles will be in the City of Los Angeles.

HI^3 has initiated the process of obtaining pole agreements from the organizations and municipalities involved. Our success rate in obtaining similar agreements from the Cities of Huntington Beach, Los Angeles, Santa Monica, and Vernon, California, Palm Beach, Florida, Fort Worth, Texas, and Philadelphia, Pennsylvania has been 100 percent. We have provided engineering data to these organizations and demonstrated full compliance with state and Federal Occupational Safety Hazards Act in terms of both equipment and installation procedures.

10.5 NATIONWIDE MULTI-USER AVM

Within the confines of a given city or metropolis, the HI^3 Multi-User AVM System can provide AVM benefits to all potential users within the area, regardless of type. Since all users may simultaneously share the same signpost system, proliferation of users does not result in the requirement for additional signposts. Different users may or may not utilize a common communication link. Generally, users would utilize their own assigned mobile radio frequencies. Since the great majority of vehicle fleets operate in the VHF or higher bands, the spatial distance over which a particular vehicle can be located is limited by the achievable mobile radio coverage, generally line-of-sight. For example, frequencies assigned to vehicle fleets in the UHF band are generally limited to use over approximately a 35-mile radius.

As a result of these limitations imposed by mobile communications, there has been little emphasis on having different cities or metropolises having a common signpost frequency. For example, a PUD truck which normally operates in Los Angeles might be required to operate temporarily in San Diego. Unless the truck's mobile radio was initially equipped to operate at the frequency assigned to that fleet in San Diego, it would not be able to communicate directly with the San Diego fleet base station. Therefore, the primary reason for having signposts in Los Angeles and San Diego operate on the same frequency would be one of economics, i.e., common design and common parts allow reduced costs.

If, however, a vehicle fleet has the capability of operating inter-city or even nationwide, it would be highly advantageous, if not necessary, that all such cities be provided with a common-frequency signpost system. Assuming that communication with different base stations is available over long range (for example at HF), communication to a base station can be maintained, and a common signpost frequency would allow the location of such a vehicle to be known within each city. It is assumed that a vehicle operating in this mode would come under the control of a local base station upon entry into a coverage area. The attainment of this capability by use of a HI^3 AVM system operating at 49.860 MHz is currently achievable without design change to the location subsystem. Nationwide operation at 49.860 MHz is currently acceptable to the FCC. However, since operation at 49.860 MHz is on a suffrage basis, it seems reasonable that the expansion of a signpost AVM system to many cities would certainly be sufficient justification for licensing of a single narrow-band dedicated frequency.

However, provisions to obtain location subsystem coverage in non-urban areas, especially on long cross-country routes between cities can best be achieved through use of a hybrid system which would incorporate the proven economic and technical benefits of the HI^3 signpost approach with a wide-area AVM system such as Loran. Such a hybrid system would take advantage of the useable signal-to-noise ratios achievable through the use of Loran in non-urban areas and the proven signpost technology in urban areas.

Major drawbacks to an urban Loran system has always been (1) high vehicle unit costs and (2) costs associated with providing some type of augmentation of the Loran system to overcome the signal-to-noise problems associated with the urban environment. If Loran is only used for wide-area, non-urban coverage, then only those vehicles which are required to operate in non-urban areas would require the Loran portion of the system. As a result, the cost benefits and superior urban operation of the signpost system are provided to all urban vehicles as well as those which operate inter-city and use Loran during inter-city operation. Vehicles which operate only cross country or whose location, intra-city, is not of importance, might only incorporate the Loran portion of the system.

The development of a hybrid signpost-triangulation AVM system is not new to HI^3. In December of 1975, HI^3 (then Information Identification, Inc.) began the development of a hybrid signpost - AM Phase AVM System for the Justice Department, under contract to The Aerospace Corporation as part of a Cargo Security System for PUD trucks. This system involves the use of a triad of phase-locked AM stations as a basic source for a triangulation location system. Overlapping signposts were also used (1) as a reference for testing the AM Phase system and (2) as a means of augmenting the AM Phase system in fade zones. This system was successfully pilot tested in Los Angeles, Santa Monica, and Vernon, California in the Spring of 1976. A single base station provided control of the hybrid AVM system through the use of a shared voice communication link in the participating trucking company.

HI^3 is currently under contract to produce an operational Cargo Security System to be installed in 40 PUD trucks operating in a 400 square mile area of greater Los Angeles including 40 different municipalities in Los Angeles and Orange counties. Radio stations KFI, KNX, and KPOL provide the phase locked AM carriers and 331 signposts provide location updates and fade-zone augmentation. This system is scheduled to become operational in June of 1977 at which time an extensive 12-month evaluation period will commence.

The purpose of this discussion is to show that the development of a hybrid AVM system using signposts in the cities and Loran in the country is not just a concept, for the groundwork has already been carefully laid. Such

a system can be developed without technical risk since wide-area, vehicle location in non-urban areas through use of Loran is proven and vehicle location in urban areas through use of the HI^3 signpost AVM is proven. The development of a hybrid vehicle unit consisting of plug-in optional modules and the use of modular software would allow the use of a considerable amount of existing hardware and algorithms and would culminate in a nation-wide system which would meet the technical specifications of both urban and non-urban AVM yet not impose the costs of non-urban AVM on the high percentage of users which operate only on a metropolitan basis.

10.6 HI^3 RANDOM ROUTE LOCATION SUBSYSTEM SUPPLEMENTARY ANALYSIS

In the interest of determining more explicitly the distribution of errors for the random route configuration of the HI^3 location subsystem, the program RRTEN was modified to print out the error statistics for all samples obtained during Run 6. This procedure resulted in the processing of 8304 samples with the following pertinent results:

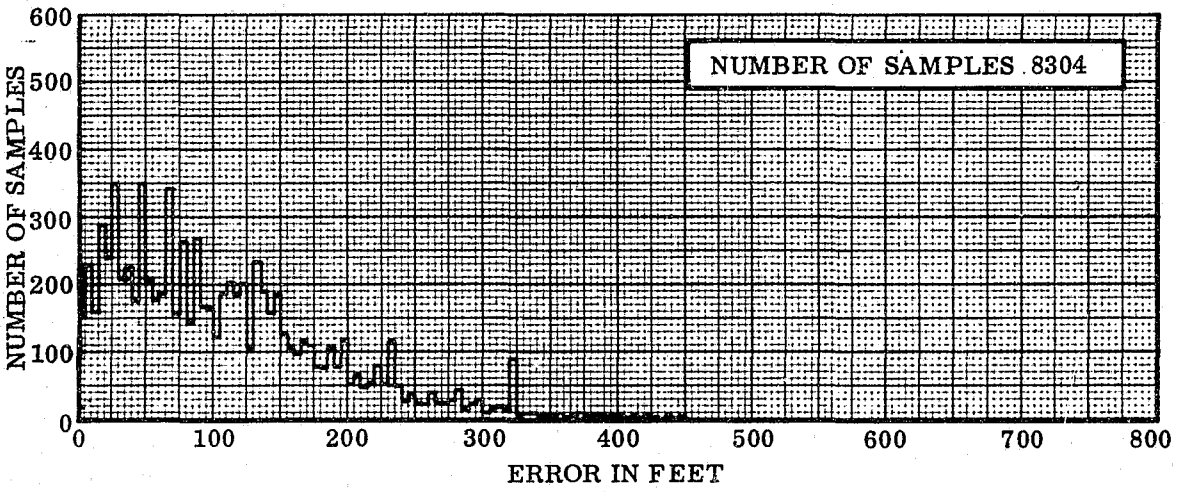
50 percent of samples less than: 94 feet.
95 percent of samples less than: 274 feet.
99.5 percent of samples less than: 389 feet.

The overall results are shown plotted in Figure 10-2. The distribution function is virtually identical to the composite error distribution obtained for 2235 pseudo checkpoint samples and shown in Figure 5-16. That curve is replotted in Figure 10-2 to illustrate their similarities. The density function which most closely approximates the error frequency density appears to be of the Raylergh form

$$f(x) = xe^{-\frac{x^2}{2\alpha^2}},$$

although a few errors having a value of zero are observed.

Other parameters of interest relative to the HI^3 location subsystem are the distribution of overlap region sizes. These parameters could not be explicitly determined from Phase I data because the passage of each signpost was not marked and the occurrence of cross-track overlaps partially obscured the occurrence of on-track overlaps. However, an approximation to these distributions was obtained by analyzing the listings of recorded data from Random Route Runs 6 through 10. The distances from the checkpoints which were located near signposts to the first occurrence of Region 2's and Region 3's was determined. Of the 5 runs analyzed, 116 such occurrences were observed. Of these, 91 occurrences involved receiving a region 2 after having passed through a Region 1 and 25 occurrences involved receiving a Region 3 after passing through a Region 1. 64 occurrences of Region 2 to Region 3 transitions (equivalent to Region 2 widths) were also analyzed. The distributions of these three distances



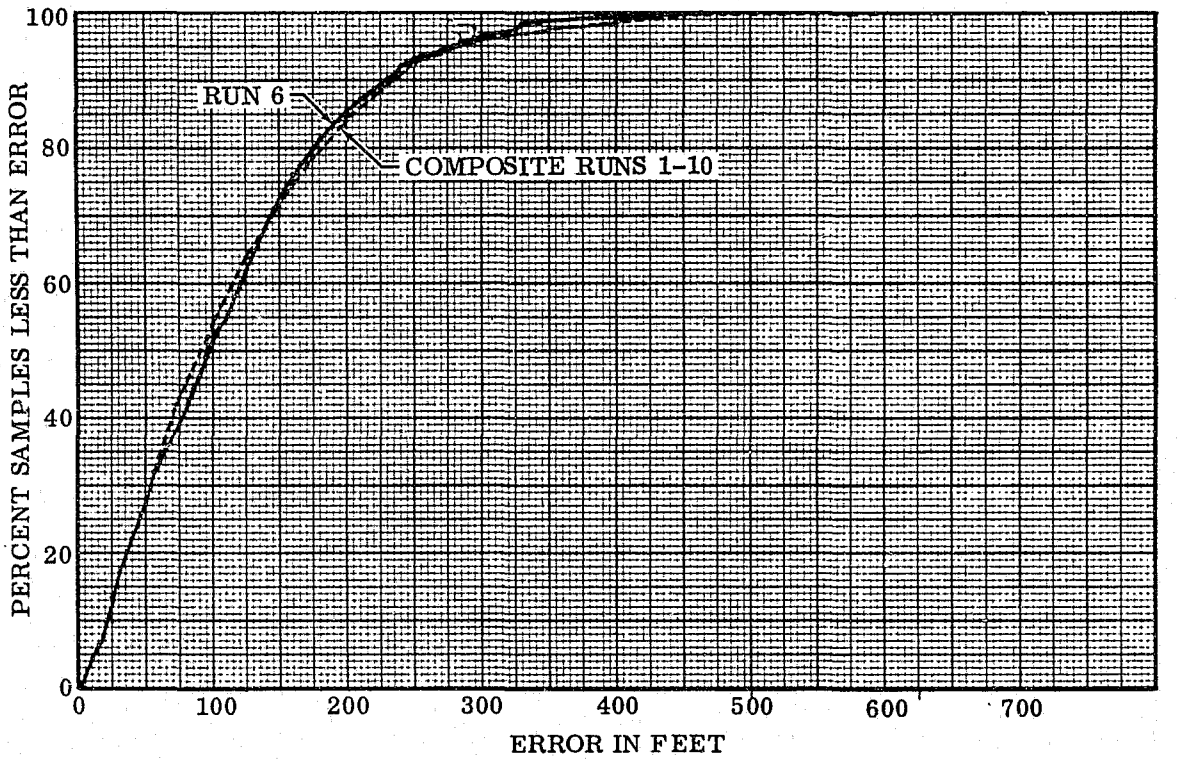


FIG. 10-2 HI^3 RANDOM ROUTE LOCATION SUBSYSTEM ERROR DISTRIBUTION

are plotted in Figure 10-3. Note that the distance from signpost-to-Region 2 or Region 3 is half of a region width, since it is on one side of a signpost whereas the Region 2-to-Region 3 width represents the width of a full region. As a result of the presence of cross-track overlaps at intersections, it was impossible to determine widths of Region 3's.

10.7 SPECIAL PHASE II CONSIDERATIONS

HI^3 has initiated or completed a number of activities which relate directly to achieving all cost and schedule milestones on Phase II. For example, HI^3 has digitized every intersection in the entire Los Angeles basin and has these on file on diskettes at Fort Worth. Computer programs to print these X, Y coordinates and intersection names, delete and add intersections, etc. are currently available at HI^3. Digitization was accomplished in exactly the same manner used by MITRE to digitize the intersections in Philadelphia.

As mentioned in subsection 10.3, the HI^3 location subsystem requires no FCC license. HI^3 has recently applied for and received an experimental license for use of two UHF frequencies in the Los Angeles area for communication between AVM equipped vehicles and a base station. Thus, we understand the mechanism and timing necessary to obtain all necessary FCC permits.

As mentioned in subsection 10.4, HI^3 has extensive experience in obtaining pole agreements from municipalities and utility companies. We have already initiated the process in 40 municipalities in Los Angeles and Orange Counties in conjunction with the Cargo Security System. Installation of the signposts for that system will be accomplished in April and May of 1977 and although temporary (12 months) this will lay the groundwork necessary for proceeding directly with the Phase II pole agreements upon go-ahead. Hoffman's Corporate engineering and manufacturing facility in El Monte, California will be the base of these operations.

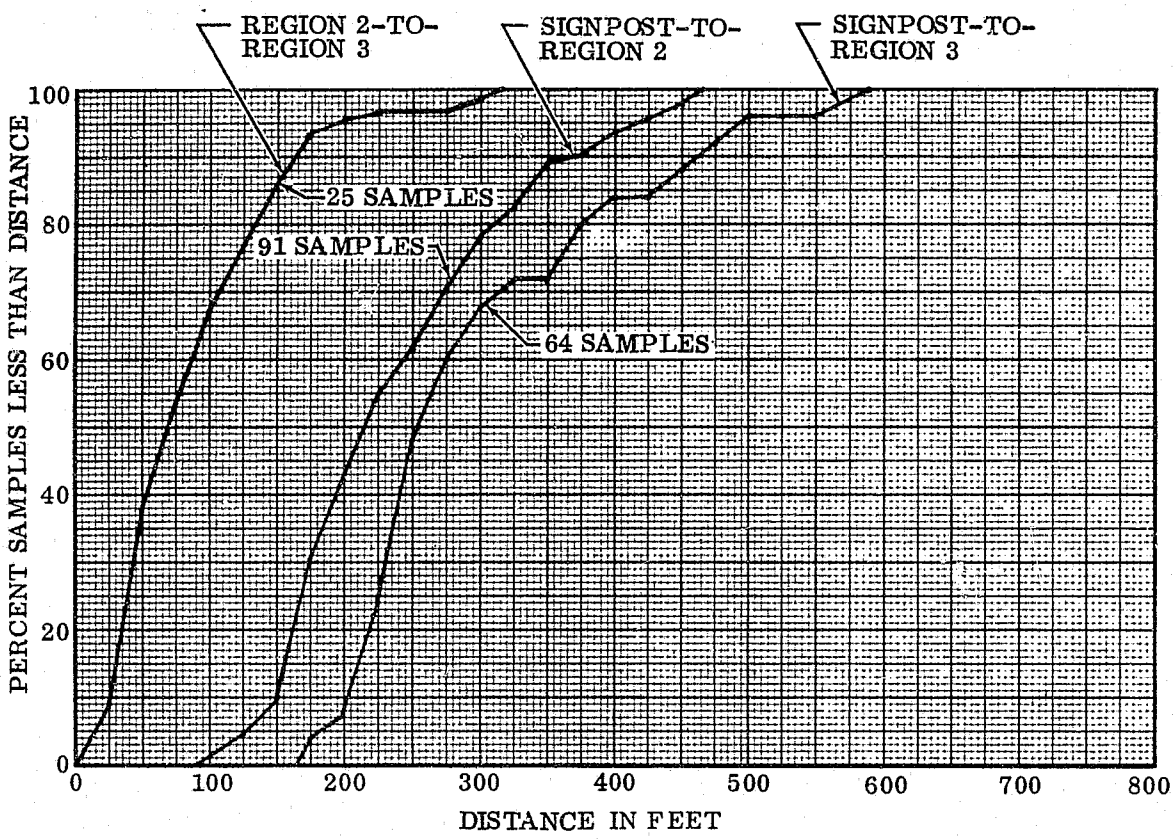


FIG. 10-3 HI^3 RANDOM ROUTE LOCATION SUBSYSTEM REGION WIDTH DATA SECONDARY RUNS 6 THROUGH 10

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Volume II: Appendix

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FINAL REPORT

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Kendall Square
Cambridge MA 02142

16. Abstract

A comprehensive test of a direct proximity electronic signpost AVM system was conducted under operational conditions in downtown Philadelphia. Tests involved operation of a test vehicle while operating as a random route vehicle; e.g., police, taxi, and a fixed route vehicle; e.g., a transit bus. During random route tests, the vehicle operated on an unrestricted basis in a designated area in which the Hoffman overlapping signpost AVM system was installed. The vehicle's location was computed every 0.5 second by the AVM system and compared with its actual location at designated "checkpoints" in the random route area. In the random route tests, the system showed the capability of locating the vehicle to within 282 feet, at 95 percent of the sample points under a wide range of urban and environmental conditions.

Fixed route tests involved operation as a transit bus. An odometer and 15 signposts provided the vehicle's location to within 105 feet at 95% of the sample points along a 13 mile route. The time of passage of designated bus schedule "timepoint" was automatically determined to within 11 seconds 95 percent of the time.

This report contains two volumes. Volume I constitutes the test results.

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PREFACE

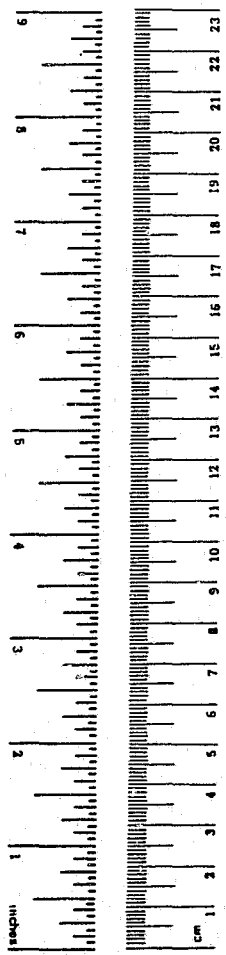
During the winter of 1976-77, four different techniques for automatically locating land vehicles were tested in both the low- and high-rise regions in Philadelphia, Pa. The tests were carried out by four different companies under separate contracts to the United States Department of Transportation, Transportation Systems Center. The tests were designed to evaluate the techniques for their applicability as location subsystems for automatic vehicle monitoring systems. This document represents one of the contractors' final report. A summary report on all systems tested is available as Report No. UMTA-MA-06-0041-77-2. This report describes the Phase I program which involved the installation and test of the Hoffman AVM System. Dr. George W. Gruver, the program director for Hoffman, prepared the report and personally conducted most of the testing. Ron Waits developed all of the program software and processed the test data. Jerry McKinney was in charge of the location and test equipment deployment and also performed most of the driving during formal tests.

We want to thank all of the technical, program, and contract personnel at the DOT. In particular the personnel in the offices of Messrs Blood, Symes, and Nelson were very helpful and enthusiastic. A special thanks is given to Bernie Kliem, our technical monitor and Joe Herlihy, who helped monitor our test. Also, Mr. Jack Ludwick of the Mitre Corporation helped make our software task much easier. We would also like to thank the many people in the City of Philadelphia who assisted us in deploying and housing our equipment.

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



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

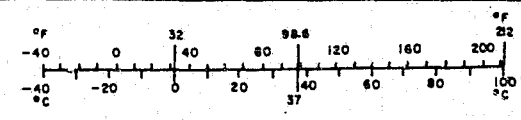


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1. INTRODUCTION

The application of Automatic Vehicle Monitoring (AVM) to enhance the management of mobile resources has, in recent years, become a subject of continued interest to all types of fleet vehicle operations. Transit, police, cargo, and mining operations have been involved in the development of AVM systems and are currently gathering data pertinent to quantifying the cost/benefits of AVM in a variety of commercial and service operations.

The United States Department of Transportation (DOT) has been interested in AVM for nearly a decade; this interest being directed, in particular, to improving transit and para-transit management activities. Under the sponsorship of the Urban Mass Transportation Authority (UMTA), the DOT is currently attempting to quantify the improvements which AVM can provide to transit, para-transit, and other types of fleet operations. This report contains the interim results obtained by Hoffman Information Identification Inc. (HI^3) of Fort Worth, Texas, as a contractor to the Transportation Systems Center of the DOT on the UMTA Multi-User AVM Contract DOT-TSC-1237. This report covers the activities of Phase I which involved the installation and test of a HI^3 AVM System in the City of Philadelphia during the winter of 1976-1977. These tests represent the most extensive tests ever performed on an AVM system which can locate vehicles which operate either as fixed-route vehicles (transit) or as random-route vehicles (police, para-transit, taxi, etc.).

Volume I of this report contains a description of all test configurations, test procedures, location algorithms, data processing, and test results. This Appendix contains the test log sheets, test data and detailed data processing results corresponding to all Phase I tests.

Section 2 of this Appendix is an executive summary of the Phase I program. Section 3 contains pertinent random-route data and data processing results. Section 4 contains fixed-route data and data processing results.

2. EXECUTIVE SUMMARY

In September 1976, the Transportation Systems Center of the U. S. Department of Transportation entered into contracts with four companies for the design, development and deployment of a multi-user Automatic Vehicle Monitoring (AVM) System which can be deployed in any city. Hoffman Information Identification Incorporated (HI^3) of Fort Worth, Texas, a wholly owned subsidiary of Hoffman Electronics Corporation, was one of these four companies. The program, sponsored by the Urban Mass Transportation Administration (UMTA) is referred to as Multi-User AVM since it is intended to provide AVM benefits to a multiplicity of users, including those fleets of vehicles which generally travel on fixed routes (transit) and those which may travel random routes (taxis, para-transit, dial-a-ride, police, pick-up and delivery, etc.).

The objectives of the Multi-User AVM program were to design, implement, and operate a multi-user AVM system in Los Angeles for the purpose of making a quantitative evaluation of AVM effectiveness, first for transit and para-transit, and second for other AVM users. From the outset, the program was divided into two phases. Phase I, which Hoffman completed on 28 February 1977, involved the demonstration and test of each contractor's vehicle location subsystem in Philadelphia, Pa. Phase II, which will be performed by one of the four contractors, will include the design, development, implementation, test, and operational support of a modern transit management system using a reliable, economical AVM system. The Phase II program will be conducted in conjunction with the Southern California Rapid Transit District (SCRTD) and other users, to be specified, in the Los Angeles area. The primary objective set for Phase I was that of quantifying through formal controlled tests, the ability of each contractor's AVM system to meet specified vehicle location and bus time-of-passage requirements.

The results presented in Volume I of this report show that the HI^3 AVM system proposed for Phase II can provide a transit dispatcher with the location of all buses to within an accuracy of 105 feet 95 percent of the time. The average error in bus location was less than 50 feet for all Phase I tests. As an aid to providing improved service through adherence to schedule, the HI^3 AVM system can provide the time-of-passage of buses to within 11 seconds for 95 percent of the occurrences in which the bus fleet passes predesignated "timepoints." The average time-of-passage error for Phase I was 3.9 seconds. The same HI^3 AVM system can provide a dispatcher with the location of each unit of a fleet of random route vehicles, e.g., police, taxi, etc., to within 282 feet 95 percent of the time.

The overall goal of HI^3 during Phase I was to demonstrate the reliable and accurate performance of the HI^3 nationwide AVM system under conditions to be expected in the operation of a multi-user AVM system in any city in the United States. During previous UMTA AVM development programs, beginning

in 1970 with the "Monitor CTA" and including tests of several different location techniques in Philadelphia in 1972, UMTA and TSC developed a high degree of understanding of the requirements for a multi-user AVM system. In establishing the Statement of Work for Phase I, these requirements were translated into an explicit set of vehicle location test requirements. In response to these requirements, HI^3 prepared a Location Subsystem Test Requirements Plan which formed the basis for all Phase I tests, data processing and analyses.

Phase I tests were divided into two primary categories: (1) random route tests, and (2) fixed route tests. Volume I of this report is organized in the same order in which HI^3 tests were conducted. A third category involved special case tests. These tests were conducted at various times throughout Phase I in Fort Worth, Texas, and in Philadelphia, Pa.

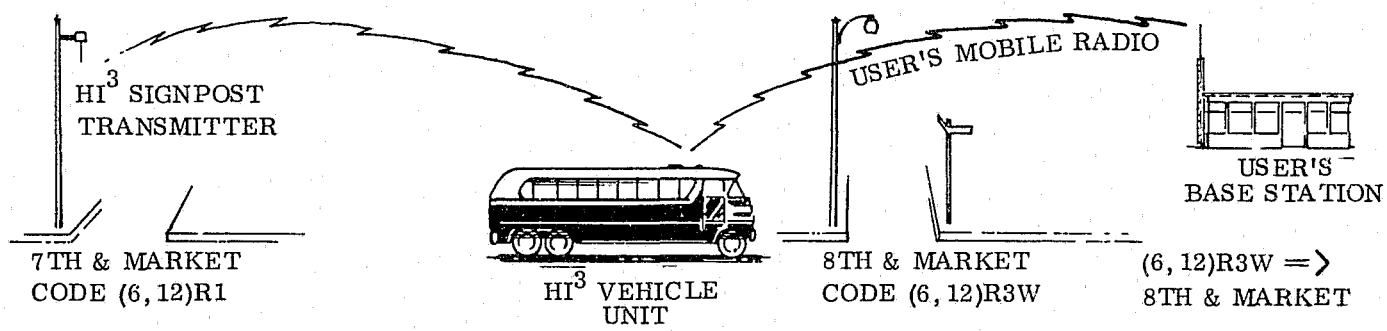
2.1 HI^3 AVM TECHNIQUE

HI^3 proposed to use a direct proximity signpost AVM system during Phase II and all Phase I tests were conducted through the use of Phase II signpost system. As illustrated in Figure 2-1, the HI^3 AVM system receives basic location information, in the vehicle, as a result of the vehicle equipment receiving digitally coded RF transmissions from electronic "signposts." Each signpost transmits a unique 16-BIT code which represents an address (or an X, Y coordinate) in the city analogous to visual street sign identification. The vehicle's proximity to one or more of the signposts results in a simple location region code being stored in the vehicle. This location region code is transmitted to the base station over a mobile radio under base station computer control. At the base station, a simple table look-up by the computer determines a unique street address or X, Y coordinate pair as the vehicle's current location.

HI^3 signposts are battery powered and transmit at a frequency of 49.860 MHz. As a result of the extremely low power output requirements, they may be operated without a license as low power devices under Part 15 of the FCC rules. The use of lithium batteries provides a 7-10 year operating lifetime without battery replacement, and this is achieved over the temperature environment from -55 to 175 degrees F.

When installed in a city, all users (transit, para-transit, taxi, police, pick-up and delivery, etc.) simultaneously share the use of the HI^3 signpost system. This is illustrated in Figure 2-2. Although a number of companies have proposed the use of signposts, a unique feature of the HI^3 approach is the use of overlapping signposts to create additional location regions, thereby reducing the number of signposts required to achieve a specified location accuracy within a given area.

The overlap technique has been previously tested by HI^3 in Los Angeles as part of the Cargo Security System and an overlapping signpost AVM system developed by HI^3 is currently operational in the Huntington Beach, California Police Department. Although proven during those two programs, the UMTA



SIGNPOST SYSTEM PROVIDES EACH VEHICLE WITH LOCATION REGION CODE

LOCATION REGION CODE IS TRANSMITTED TO USER'S BASE STATION OVER USER'S ASSIGNED MOBILE RADIO FREQUENCY

USER'S BASE STATION TRANSLATES LOCATION REGION CODE INTO A UNIQUE STREET ADDRESS

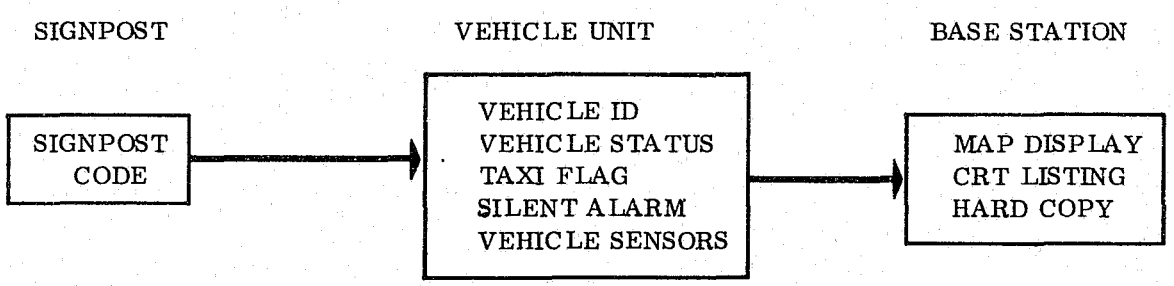


FIG. 2-1 HI3 MULTI-USER AVM BASIC PRINCIPLE OF OPERATION

DIRECT RF PROXIMITY SIGNPOSTS PROVIDE ALL USER VEHICLES WITH LOCATION ADDRESSES AND ARE BASIC SOURCE OF BUS SCHEDULE INFORMATION.

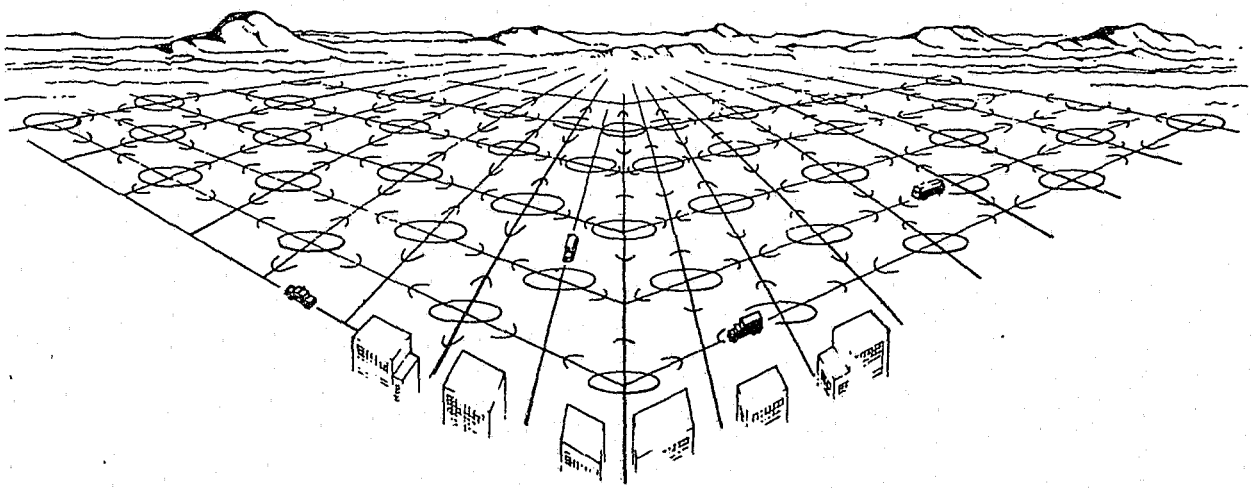


FIG. 2-2 HI^3 MULTI-USER AVM BASIC APPROACH

Phase I test program required the most comprehensive demonstration of the HI^3 overlap technique to date. The results obtained proved conclusively that the HI^3 AVM system proposed for Phase II can meet or exceed all of the location subsystem and system level specifications set forth in the UMTA Multi-User AVM Specification. In addition, the HI^3 AVM system is a nationwide system and can be operated in any city (where 99.99% of users operate) and can be interfaced with a Loran receiver for special "over the road" applications. The nationwide feature is a result of the use of 49.860 MHz which is applicable throughout the United States.

2.2 PHASE I TEST PROGRAM

The Phase I test program involved the installation of a HI^3 AVM location subsystem in Philadelphia to provide random-route coverage of an area and fixed-route coverage of a simulated bus route. The area and the route were selected by TSC. The location subsystem was to provide a basic location accuracy of at least 300 feet at 95 percent and 450 feet at 99.5 percent of all locations in the random route coverage area and along the specified fixed route. In order to establish the performance of the HI^3 location subsystem, a test vehicle, in which was installed a HI^3 AVM vehicle unit, was repeatedly driven over routes selected by TSC while recording on cassettes every half-second, the output of the vehicle unit location register. During each test run, manual event markers were used to mark (record on cassette) the passage of physical landmarks called "checkpoints." Checkpoints were designated by TSC after installation of the location subsystem was complete. The X, Y coordinates of these checkpoints become the reference against which the performance of the AVM system was measured. During off-line data processing, the radial error between the X, Y coordinates of the checkpoint and the X, Y coordinates as computed through use of the AVM technology was computed. For example, during each of 10 random route test runs, each of which was over 11 miles in length, the passage of 62-63 checkpoints was recorded. All information necessary to compute the X, Y coordinates of the vehicle, as determined by the AVM system, were also recorded on cassette. At the end of 10 such runs, the cassettes were processed to determine the location error at each point. The processing was identical to that proposed for Phase II.

Fixed route tests involved the same activities as random route tests, however, an odometer was used to determine the vehicle's location along the fixed route after being automatically reset at signposts spaced approximately one mile apart along the route. In addition to the marking of TSC checkpoints, manual entries were made to document passage of the vehicle by "timepoints" which were designated by TSC to represent typical transit route timepoints. Further, the opening and closing of the door was simulated at approximately one-half of the 15 timepoints on each of 33 fixed route test runs. During off-line processing, the location errors and the errors between the actual time of passage by each timepoint and the time of passage estimated by use of the AVM system were computed. The AVM system was to determine the time of passage of the vehicle at timepoints to ± 15 seconds for 95 percent and ± 60 seconds for 99.5 percent of all such occurrences.

A total of 10 random route test runs were performed. This resulted in 622 checkpoint samples at which location errors were computed. When these same data were also processed through an AVM system simulation a total of 2235 samples were obtained corresponding to 1 sample every 20 seconds during the 10 runs. This simulation included the injection of communication errors into 5 percent of the samples. The HI^3 Phase II technique for detection and correction of these errors was simulated. Two different random routes were traveled involving passage through tunnels, along narrow streets through high-rise "canyons" and along wide boulevards. All tests were conducted under normal traffic conditions in downtown Philadelphia. A TSC Monitor was in the test vehicle during all tests.

A total of 33 fixed route test runs were performed over a 13 mile route. Each test provided data at 76 checkpoints and 15 timepoints. When processed through the AVM system simulation, a total of 7459 pseudo checkpoint samples were obtained.

Formal demonstrations of the HI^3 AVM system were conducted in Philadelphia on 15 and 28 December 1976 for UMTA personnel and their guests. These demonstrations involved operation of the HI^3 test vehicle in the random route area with 6-8 observers on board. All such demonstrations involved operation as a random-route vehicle with the vehicle location being provided in a real-time on the on-board CRT. All demonstrations were 100 percent successful.

2.3 TEST RESULTS

All random route and fixed route data taken during the Phase I tests were processed by HI^3 to determine the AVM systems performance. Data processing was performed off-line using an exact simulation of the proposed Phase II location subsystem and AVM communication system. These data show conclusively that the HI^3 AVM system can meet or exceed all performance criteria set for Phase II. These results are summarized in Table 2-1.

Figure 2-3 contains cumulative error distributions of random route and fixed route test data results. When translated into an operational system for random route vehicles, these data indicate that under similar urban conditions, a police dispatcher would know, with a 95 percent confidence level, the location of each and every AVM-equipped vehicle to within 282 feet. Similarly, the fixed route data indicates that a bus dispatcher would have at his fingertips the location and schedule performance of every bus on all routes to within 105 feet and to within 11 seconds at a 95 percent confidence level. The application of this information to providing increased service, improved response time, better schedule adherence, etc., forms the basis for the entire Phase II program.

TABLE 2-1 SUMMARY RESULTS OF PHASE I TESTING

	Specification (feet)	HI[3] Results (feet)
LOCATION SUBSYSTEM LOCATION ACCURACY:		
Random Route: 622 samples		
95% of samples less than	300	242
99.5% of samples less than	450	461
Average error, all samples	---	91
Maximum Average Error Over One-Tenth Mile Segment	450	315
Fixed Route: 2313 samples		
95% of all samples less than	300	107
99.5% of all samples less than	450	156
Average error, all samples	---	50
Maximum Average Error Over One-Tenth Mile Segment:	450	256
AVM SYSTEM LOCATION ACCURACY:		
Random Route: 2235 samples		
95% of samples less than	300	282
99.5% of samples less than	450	464
Average error, all samples	---	114
Fixed Route: 7459 samples		
95% of samples less than	300	105
99.5% of samples less than	450	188
Average error, all samples	---	48
	Specification (seconds)	HI[3] Results (seconds)
AVM TIMEPOINT PERFORMANCE: 451 samples		
95% of samples less than	15	11
99.5% of samples less than	60	24
Average error	--	3.9

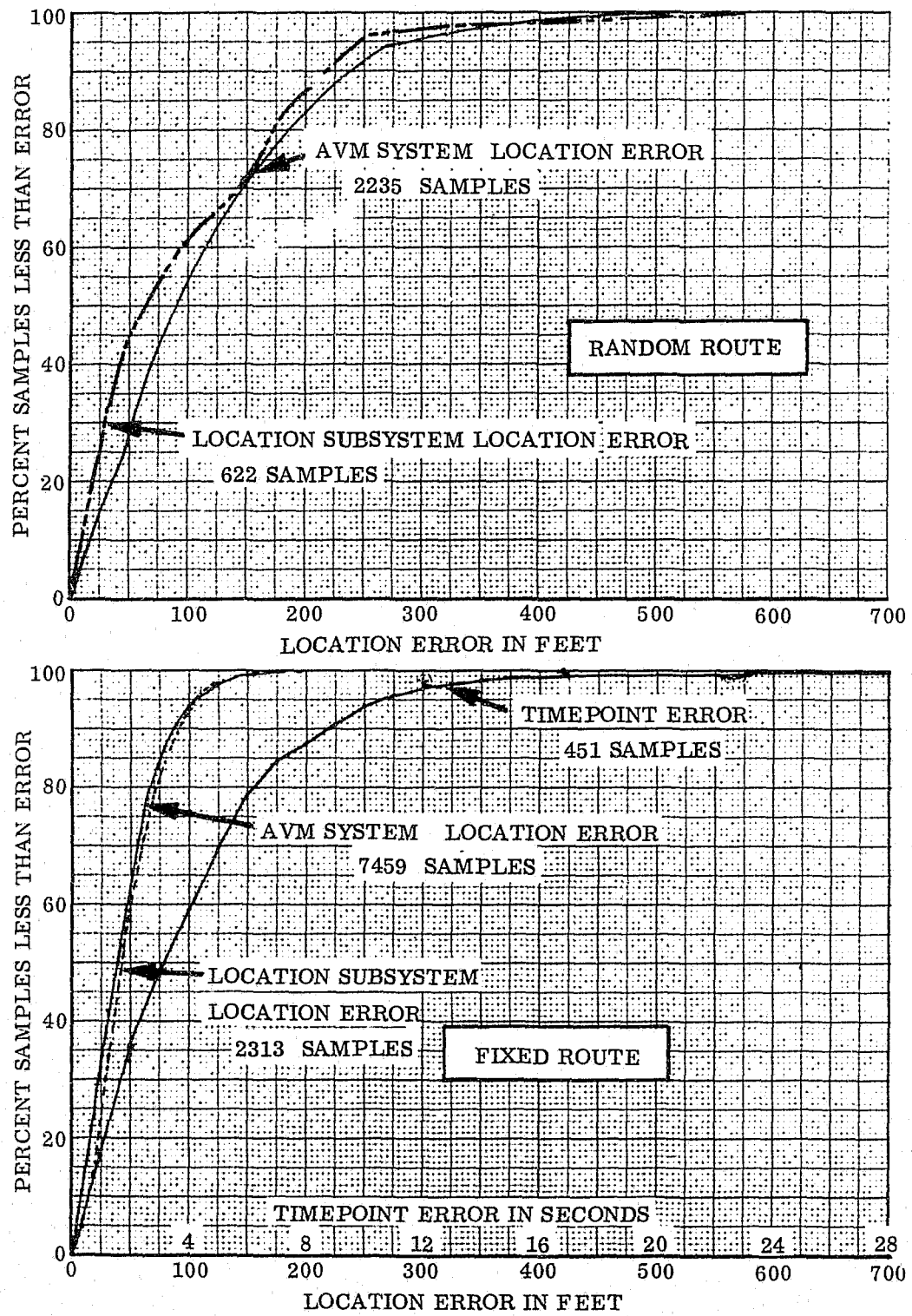


FIG. 2-3 DEMONSTRATED AVM SYSTEM PERFORMANCE

3. RANDOM ROUTE

3.1 RANDOM ROUTE TESTS

3.1.1 Random Route Log Sheets

During each test run, a log sheet was filled out describing the test conditions and any anomalies observed during the test run. Test log sheets for Random Route Runs 1-10 are contained in this subsection.

Hoffman

TEST DATA LOG

TEST RUN NO. 1 SHEET NO. 1 OF 1

TYPE OF TEST: Random Route DATE: 12-7-76 START 1341 COMP: 1715

BRIEF NARRATIVE DESCRIPTION OF TEST Rush Hour Traffic. Wet Streets, Approx 50°F
No Rain During Run
Elapse Time 1 HR 34 MIN.

ROUTE IDENTIFICATION: TSC Route (Primary)

EVENT MARKER NUMBER: 1 – 63 IN ORDER:
C.P. 30 Event Marker Hit Early (Approx 75') used EE30
C.P. 45 Following Trolley
C.P 56 Following Bus

Test delayed 24 hours due to discovery of Vehicle Unit audio pass band out of tolerance. Resulted in degraded ability to decode signposts at temperatures below freezing. Signpost FSK frequencies change with temperature. Vehicle unit was sent to Fortworth with a signpost to determine problem. Solution is to reset Vehicle Unit Audio passband to provide 6 percent design passband tolerance. Unit was providing only 4% variation in capture band.

Provider TSC monitor following items 4. List of HI² Town Intersections
1. Listing of Signpost Data Base
2. Map showing current signpost deployment
3. Identification of Primary Checkpoints

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 2

VEHICLE UNIT THRESHOLD LEVELS: 1 -59dBm 2 -72dBm 3 -82 dBm

ODOMETER CAL: 997 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 48° PRECIPITATION: Clear ROAD CONDITIONS: Wet

TEST TAPE NO(S). 1-1 ; 1-2 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1 hour 34 min

TEST DIRECTOR George W. Hoffman

TSC MONITOR Ed W.A. Klein

TEST DATA LOG

START TIME 1735 END TIME 1848

TEST RUN NO. 2 SHEET NO. 1 OF 1

TYPE OF TEST: Hoffman Random Route DATE: 12-7-76

BRIEF NARRATIVE DESCRIPTION OF TEST TEMP 47° ~~Road Floor Raw~~ STREETS DRY,

ROUTE IDENTIFICATION: TSC Primary

EVENT MARKER NUMBER: 1-63 - IN ORDER - NO ERRORS IN ENTRY

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 2

VEHICLE UNIT THRESHOLD LEVELS: 1 -59dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 997 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 48°F PRECIPITATION: NONE ROAD CONDITIONS: Wet

TEST TAPE NO(S). 2-1 ; 2-2 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1 HR- 13 MIN.

TEST DIRECTOR George W. Young

TSC MONITOR Ed W.A. Klein

TEST DATA LOG

Time Start 1856 Time End 2005

TEST RUN NO. 3 SHEET NO. 1 OF 1

TYPE OF TEST: Hoffman Random Route DATE: 12-7-76

BRIEF NARRATIVE DESCRIPTION OF TEST

TEMP 46° @ VEHICLE

ROUTE IDENTIFICATION: TSC Primary

EVENT MARKER NUMBER: 1-63

ERROR - AT 2222 TA34 WAS ENTERED INSTEAD OF TA44 CORRECTION MADE BY ENTERING EE34 and entering TA44

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 2

VEHICLE UNIT THRESHOLD LEVELS: 1 -59 dBm 2 -72 dBm 3 -82 dBm

ODOMETER CAL: 797 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: ~~Off/On~~ Off OTHER:

TEMPERATURE: 46° PRECIPITATION: NONE ROAD CONDITIONS: Wet

TEST TAPE NO(S). 3-1 ; 3-1 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1 hour 9 min

TEST DIRECTOR George W. Gray

TSC MONITOR Bernard A. Klein

TEST DATA LOG

TEST RUN NO. 4 SHEET NO. 1 OF 1

TYPE OF TEST: Hoffman London Route DATE: 12-7-76

BRIEF NARRATIVE DESCRIPTION OF TEST Time Start 2025 End 2150
Temp 46°F, Dry Windy.

ROUTE IDENTIFICATION: TSC Primary Route

EVENT MARKER NUMBER: 1-63 as assigned
Time 31 Min 41 Sec at C.P. 25 thru C.P. 28 Trolley car following directly behind test vehicle.

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 2

VEHICLE UNIT THRESHOLD LEVELS: 1 -59 dBm 2 -72 dBm 3 -82 dBm

ODOMETER CAL: 997 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 45° PRECIPITATION: none ROAD CONDITIONS: Wet

TEST TAPE NO(S). 4-1 / 4-2 FILE NO. 1

SAMPLE RATE: 0.5 /

RUN TIME: 1Hr-25 Min. TEST DIRECTOR George Uhrmann

TSC MONITOR R. W. A. Khan

TEST DATA LOG

TEST RUN NO. 5 SHEET NO. 1 OF 1

TYPE OF TEST: Hoffman Random Route DATE: 12-7-76

BRIEF NARRATIVE DESCRIPTION OF TEST START 2156 END 2257
TEMP 41°F

ROUTE IDENTIFICATION: TSC Primary

9 MILES 3,559 FEET

EVENT MARKER NUMBER: 1-63 in Sequence

Attempted high speed run - limited by traffic lights and turns.

During Runs 1-5 on 12-7-76, the TSC checkpoint coordinates were not loaded in the data recording software.

Tapes 5-1 and 5-2 contain previously recorded data, which should be ignored after end of file point on log RANDOM.

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 2

VEHICLE UNIT THRESHOLD LEVELS: 1 -59dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 997 FPP 2 5TH WHEEL CAL Y FPP X

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 41°F PRECIPITATION: None ROAD CONDITIONS: Wet

TEST TAPE NO(S). 5-1 and 5-2 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1 hour 1 Min

TEST DIRECTOR George W. Brown

TSC MONITOR Randy A. Klein

START 0945
END 1055

TEST DATA LOG

TEST RUN NO. 6 SHEET NO. 1 OF 2

TYPE OF TEST: Random Route (Hoffman) DATE: 12-14-76

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: TSC Secondary Random Route

EVENT MARKER NUMBER: 1-62 in order

Test delayed 3 days in order to send Vehicle Unit to Fort Worth to lower clock frequency to compensate for normal drift in equipment VCO frequencies with temperature. Normally, equipment CSK frequencies are set using a standard HI³ vehicle receiver and field strength meter combination. Equipment operation in temperature chamber is checked with this test unit. HI³ vehicle units have their clock frequency set at 204 KHz as does the test unit. However, the test unit is battery operated and as a result of the current requirements of the field strength meter, the battery voltage drops to approximately 10 volts, thereby causing the test unit clock frequency to drop to 198 KHz. As the equipment operates at lower temperatures this 198 KHz frequency provides adequate system bandwidth for receiving and decoding the equipment. Since the normal vehicle units operate from the vehicle battery, their voltage remains at approximately 13.5 volts and their clock frequency remains at 204 KHz. By testing the vehicle units with cold-soaked equipment, it was found that their clock frequency should be initially set at 198 KHz. This adjustment was made and calibration tests made in Philadelphia ~~to demonstrate design operation was achieved~~

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -59dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL X FPP 1

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 28° PRECIPITATION: None ROAD CONDITIONS: Dry

TEST TAPE NO(S). 6-1 and 6-2 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1hr 10 min

TEST DIRECTOR George W. Brown

TSC MONITOR Sandia N. Klein

DISTANCE 3-4280

TEST DATA LOG

TEST RUN NO. 6 SHEET NO. 2 OF 2

TYPE OF TEST: Random Route (Hoffman) DATE: 12-14-76

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: TSC Route (Secondary)

EVENT MARKER NUMBER: Three signposts coded 19,13; 15,13; and 8,7 were also taken to Fort Worth with the vehicle unit. These signposts were found to be working perfectly and were not modified. On 12-13-76 they were reinstalled at their normal locations.

At approximately 8AM on 12-13-76 the street light at the northwest corner of Race and 9th street was hit by a bus and the HI² vehicle unit and pole removed by the Philadelphia street light repair crew. As of 1630 on 12-13-76, the disposition of the signpost was being traced by Mrs. W. Bedient of the City of Philadelphia Street Lighting Department. HI² personnel recoded a spare signpost with the code (8,10) of the removed signpost and installed same at 1200 on 12-13-76.

TSC CHECKPOINTS NOT LOADED IN COMPUTER

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1-59 2-72 3-82

ODOMETER CAL: 999 FPP 2 5TH WHEEL CAL 2 FPP 2

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: PRECIPITATION: ROAD CONDITIONS:

TEST TAPE NO(S). 6-1 and 6-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME:

TEST DIRECTOR George W. Hoover

TSC MONITOR Bernard W. Klein

START 1105
END 1235

TEST DATA LOG

TEST RUN NO. 7 SHEET NO. 1 OF 1

TYPE OF TEST: Hoffman Random Route DATE: 12-14-76

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: TSC Route (Secondary)

EVENT MARKER NUMBER: 1-62 in order

TSC CHECKPOINTS NOT LOADED IN COMPUTER

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -57dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 999 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 34° PRECIPITATION: Nine ROAD CONDITIONS: Dry

TEST TAPE NO(S). 7-1 and 7-2 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1hr 30min

TEST DIRECTOR George W Gramo

TSC MONITOR Sam L. A Klum

DISTANCE 3-934C

TEST DATA LOG 12 40
14 00

TEST RUN NO. 8 SHEET NO. 1 OF

TYPE OF TEST: Hoffman Random Route DATE: 12-14-76

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: TSC Route (Secondary)

EVENT MARKER NUMBER: 1-62 in order

TSC CHECKPOINTS NOT LOADED IN COMPUTER

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1-59dBm 2-72dBm 3 - 82dBm

ODOMETER CAL: 373 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 36°-37° PRECIPITATION: NONE ROAD CONDITIONS: DRY

TEST TAPE NO(S). 8-1 and 8-2 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1HR - 29 MIN

DISTANCE 3 - 4137

TEST DIRECTOR George Sinnen

TSC MONITOR Gerald Williams

TEST DATA LOG

14 20
15 35

TEST RUN NO. 9 SHEET NO. 1 OF 1

TYPE OF TEST: Hoffman Random Route DATE: 12-14-76

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: TSC Route (Secondary)

EVENT MARKER NUMBER: 1-62 in order

TSC CHECKPOINTS NOT LOGGED IN COMMENTS

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -82dBm 2 -72dBm 3 - 82dBm

ODOMETER CAL: 379 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: Off/On off OTHER:

TEMPERATURE: 58°F PRECIPITATION: NONE ROAD CONDITIONS: DRY

TEST TAPE NO(S). 9-1 and 9-2 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1 HR - 15 MIN.

DISTANCE 9-4170

TEST DIRECTOR George W. Grover

TSC MONITOR Richard L. Klein

START 1705
END 1818

TEST DATA LOG

TEST RUN NO. 10 SHEET NO. 1 OF

TYPE OF TEST: Hoffman Radom Route DATE: 12-14-76

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: TSC Route (Secondary)

EVENT MARKER NUMBER: 1-62 in order
TSC checkpoints not loaded in computer
Note: after CP 20 insert: ~~Go straight Turn left on 11th~~
Turn right on wood
Turn right on 10th
after CP 52 insert: ~~right on 10th~~ right on wood 2nd

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1-59dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL X FPP X

R1 DROPOUT SWITCH: Off/On Off OTHER:

TEMPERATURE: 36° PRECIPITATION: None ROAD CONDITIONS: Dry

TEST TAPE NO(S). 10-1 and 10-2 FILE NO. 1

SAMPLE RATE: 0.5

RUN TIME: 1 hr. 13 min

DISTANCE 9 mi 4990

TEST DIRECTOR George S Hruven

TSC MONITOR Tom P & A. Klein

3.1.2 Random Route Test Data

This subsection contains a complete dump of the data recorded during Random Route Run 7 and the first page of the similar dumps of Runs 1-6 and 8-10. Only those records which contain (1) a change in signpost region code or (2) an event marker are shown in these dumps. A complete dump of every record of Run 4 fills 218 pages.

.L CT0:DUMPUM.LDA

.ST14156 Primary

RUN 001 SAMPLE RATE 00.5 YEAR 76 MONTH 12 DAY 07 HOUR 15 MIN 41

	FIFTH WHEEL FEET/PULSE 0002				ODOMETER FEET/PULSE 0002		
TA	064	00	00	R1	0 00000	F 00000	T 02 39
	000	06	12	R1	0 00076	F 00000	T 03 07
CP	001	06	12	R1	0 00189	F 00000	T 03 50
	000	06	12	R2 N	0 00271	F 00000	T 03 59
	000	06	12	R3 N	0 00338	F 00000	T 04 06
	000	08	12	R2 S	0 00360	F 00000	T 04 09
	000	08	12	R3 S	0 00368	F 00000	T 04 10
	000	08	12	R2 S	0 00406	F 00000	T 04 14
	000	08	12	R2 N	0 00483	F 00000	T 04 26
	000	08	12	R1	0 00483	F 00000	T 04 31
	000	08	12	R2 N	0 00483	F 00000	T 04 34
	000	08	12	R2 S	0 00485	F 00000	T 04 54
	000	08	12	R2 N	0 00487	F 00000	T 04 56
	000	08	12	R1	0 00487	F 00000	T 04 57
	000	08	12	R2 N	0 00487	F 00000	T 04 58
	000	08	12	R1	0 00487	F 00000	T 04 59
	000	08	12	R2 N	0 00487	F 00000	T 05 02
	000	08	12	R1	0 00489	F 00000	T 05 04
	000	06	12	R3 N	0 00507	F 00000	T 05 09
	000	08	12	R1	0 00513	F 00000	T 05 10
TA	045	08	12	R1	0 00546	F 00000	T 05 17
	000	08	12	R2 W	0 00652	F 00000	T 05 30
	000	08	12	R2 N	0 00693	F 00000	T 05 35
	000	08	12	R2 W	0 00705	F 00000	T 05 36
	000	08	12	R3 W	0 00712	F 00000	T 05 37
	000	15	16	R2 N	0 00730	F 00000	T 05 41
	000	08	10	R2 E	0 00731	F 00000	T 05 42
	000	15	16	R2 N	0 00741	F 00000	T 05 48
	000	08	10	R3 E	0 00751	F 00000	T 05 50
	000	08	10	R2 E	0 00754	F 00000	T 05 50
TA	044	08	10	R2 E	0 00764	F 00000	T 05 52
	000	15	16	R1	0 00777	F 00000	T 05 55
CP	002	15	16	R1	0 00922	F 00000	T 06 11
	000	15	16	R2 S	0 00937	F 00000	T 06 13
	000	06	12	R3 W	0 01134	F 00000	T 06 44
TA	063	06	12	R3 W	0 01137	F 00000	T 06 45
	000	06	10	R2 E	0 01197	F 00000	T 06 54
	000	06	10	R1	0 01242	F 00000	T 06 59
	000	06	10	R2 E	0 01252	F 00000	T 07 00
	000	06	10	R1	0 01262	F 00000	T 07 01
CP	003	06	10	R1	0 01362	F 00000	T 07 11
	000	06	10	R2 W	0 01480	F 00000	T 07 26
	000	06	10	R1	0 01485	F 00000	T 07 26
CP	004	13	15	R1	0 01602	F 00000	T 07 43
	000	06	10	R3 W	0 01610	F 00000	T 07 44
	000	06	08	R2 E	0 01712	F 00000	T 07 55
	000	06	08	R1	0 01740	F 00000	T 07 58
TA	060	06	08	R1	0 01821	F 00000	T 08 21
TA	050	06	08	R1	0 01986	F 00000	T 08 48

.L CT0:DUMPUM.LDA Primary

.ST 14156

RUN 002 SAMPLE RATE 00.5 YEAR 76 MONTH 12 DAY 07 HOUR 17 MIN 31

	FIFTH WHEEL	FEET/PULSE	0002			ODOMETER	FEET/PULSE	0002
	000	04	12	R3 N	D	00171	F 00000	T 00 37
	000	00	00	R1	D	00000	F 00000	T 00 47
TA	064	00	00	R1	D	00000	F 00000	T 00 54
	000	06	12	R1	D	00115	F 00000	T 01 21
CP	001	06	12	R1	D	00199	F 00000	T 01 35
	000	08	12	R2 S	D	00399	F 00000	T 01 54
	000	08	12	R1	D	00494	F 00000	T 02 04
TA	045	08	12	R1	D	00551	F 00000	T 02 46
	000	08	12	R2 N	D	00658	F 00000	T 02 59
	000	08	12	R2 W	D	00664	F 00000	T 03 00
	000	08	12	R2 N	D	00669	F 00000	T 03 00
	000	08	12	R2 W	D	00684	F 00000	T 03 02
	000	08	12	R2 N	D	00704	F 00000	T 03 04
	000	08	10	R2 E	D	00750	F 00000	T 03 13
	000	15	16	R2 N	D	00751	F 00000	T 03 15
	000	08	12	R3 W	D	00758	F 00000	T 03 20
TA	044	08	10	R2 E	D	00763	F 00000	T 03 24
	000	15	16	R2 N	D	00767	F 00000	T 03 25
	000	08	12	R3 W	D	00769	F 00000	T 03 26
	000	15	16	R1	D	00782	F 00000	T 03 29
CP	002	15	16	R1	D	00925	F 00000	T 03 47
	000	15	16	R2 S	D	00979	F 00000	T 03 53
	000	13	16	R3 N	D	01063	F 00000	T 04 03
TA	063	13	16	R3 N	D	01137	F 00000	T 04 27
	000	06	12	R2 W	D	01137	F 00000	T 04 27
	000	06	10	R3 E	D	01141	F 00000	T 04 31
	000	06	10	R2 E	D	01147	F 00000	T 04 33
	000	06	10	R3 E	D	01153	F 00000	T 04 34
	000	06	12	R2 W	D	01164	F 00000	T 04 37
	000	06	12	R3 W	D	01169	F 00000	T 04 38
	000	06	10	R2 E	D	01186	F 00000	T 04 43
	000	06	12	R3 W	D	01258	F 00000	T 04 56
	000	06	10	R2 E	D	01262	F 00000	T 04 58
	000	06	10	R1	D	01263	F 00000	T 04 58
	000	06	10	R3 E	D	01264	F 00000	T 04 59
	000	06	10	R1	D	01264	F 00000	T 05 06
	000	06	12	R3 W	D	01281	F 00000	T 05 33
	000	06	10	R1	D	01284	F 00000	T 05 34
	000	06	10	R2 E	D	01294	F 00000	T 05 35
	000	06	10	R1	D	01310	F 00000	T 05 37
CP	003	06	10	R1	D	01365	F 00000	T 05 44
	000	06	10	R2 W	D	01475	F 00000	T 05 59
	000	06	10	R1	D	01477	F 00000	T 05 59
	000	06	10	R2 W	D	01485	F 00000	T 06 07
	000	06	10	R1	D	01497	F 00000	T 06 09

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.L CT0:DUMPUM.LDA

.ST 14156

RUN 003  SAMPLE RATE 00.5  YEAR 76  MONTH 12  DAY 07  HOUR 18  MIN 56

FIFTH WHEEL FEET/PULSE  0002    ODOMETER FEET/PULSE  0002
TA 064     00     00     R1      D 00000    F 00000   T 01 13
   000     06     12     R1      D 00096    F 00000   T 01 31
CP 001  ✓  06     12     R1      D 00207    F 00000   T 01 45
   000     08     12     R3 S    D 00364    F 00000   T 02 01
   000     06     12     R2 N    D 00376    F 00000   T 02 02
   000     06     12     R3 N    D 00381    F 00000   T 02 03
   000     08     12     R2 S    D 00421    F 00000   T 02 06
   000     06     12     R2 N    D 00432    F 00000   T 02 07
   000     08     12     R2 S    D 00438    F 00000   T 02 08
   000     08     12     R1      D 00523    F 00000   T 02 16
TA 045     08     12     R1      D 00553    F 00000   T 02 29
   000     10     12     R3 S    D 00573    F 00000   T 02 57
   000     08     12     R1      D 00595    F 00000   T 03 00
   000     08     12     R2 N    D 00670    F 00000   T 03 09
   000     08     12     R2 W    D 00675    F 00000   T 03 09
   000     08     12     R1      D 00679    F 00000   T 03 10
   000     08     10     R3 E    D 00732    F 00000   T 03 15
   000     08     10     R2 E    D 00762    F 00000   T 03 19
   000     08     10     R3 E    D 00764    F 00000   T 03 20
   000     15     16     R2 N    D 00771    F 00000   T 03 26
TA 044     15     16     R2 N    D 00771    F 00000   T 03 29
   000     08     12     R3 W    D 00771    F 00000   T 03 31
   000  ✓  15     16     R1      D 00783    F 00000   T 03 42
CP 002  ✓  15     16     R1      D 00938    F 00000   T 04 01
   000     15     16     R2 S    D 00962    F 00000   T 04 04
   000     15     00     R3 S    D 01000    F 00000   T 04 09
   000     06     10     R2 E    D 01145    F 00000   T 04 27
   000     06     10     R3 E    D 01147    F 00000   T 04 27
TA 063     06     10     R3 E    D 01152    F 00000   T 04 29
   000     06     10     R2 E    D 01163    F 00000   T 04 31
   000     06     12     R2 W    D 01168    F 00000   T 04 32
   000     06     12     R3 W    D 01177    F 00000   T 04 34
   000     06     10     R2 E    D 01190    F 00000   T 04 36
   000     06     10     R3 E    D 01194    F 00000   T 04 36
   000     06     10     R2 E    D 01205    F 00000   T 04 38
   000     06     10     R1      D 01265    F 00000   T 04 45
   000     06     10     R2 E    D 01274    F 00000   T 04 46
   000     06     12     R3 W    D 01279    F 00000   T 04 46
   000     06     10     R2 E    D 01284    F 00000   T 04 47
   000  ✓  06     10     R1      D 01289    F 00000   T 04 47
CP 003  ✓  06     10     R1      D 01375    F 00000   T 04 56
   000     06     10     R2 W    D 01506    F 00000   T 05 11
   000     06     10     R1      D 01510    F 00000   T 05 12
   000     06     10     R2 W    D 01524    F 00000   T 05 16
   000     06     08     R3 E    D 01588    F 00000   T 05 36
   000  ✓  13     15     R2 N    D 01605    F 00000   T 05 38
CP 004  ✓  13     15     R2 N    D 01616    F 00000   T 05 39
   000     13     15     R1      D 01619    F 00000   T 05 40
   000     06     10     R3 W    D 01623    F 00000   T 05 40
   000     06     08     R2 E    D 01668    F 00000   T 05 47
   000     06     08     R3 E    D 01675    F 00000   T 05 48
   000     06     08     R1      D 01724    F 00000   T 05 54
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.L CT0:DUMPUM.LDA
.ST 14156
RUN 004  SAMPLE RATE 00.5  YEAR 76  MONTH 12  DAY 07  HOUR 20  MIN 36

FIFTH WHEEL FEET/PULSE  0002    ODOMETER FEET/PULSE  0002
TA 058    00    00    R1      D 00000    F 00000    T 00 37
EE 058    00    00    R1      D 00006    F 00000    T 00 47
   000    06    12    R1      D 00125    F 00000    T 01 04
TA 064    06    12    R1      D 00160    F 00000    T 01 10
CP 001    06    12    R1      D 00202    F 00000    T 01 17
   000    08    12    R3 S    D 00369    F 00000    T 01 33
   000    08    12    R2 S    D 00375    F 00000    T 01 34
   000    08    12    R3 S    D 00385    F 00000    T 01 35
   000    06    12    R2 N    D 00406    F 00000    T 01 37
   000    08    12    R3 S    D 00411    F 00000    T 01 37
   000    06    12    R2 N    D 00427    F 00000    T 01 39
   000    08    12    R2 S    D 00437    F 00000    T 01 40
   000    08    12    R2 N    D 00473    F 00000    T 01 43
   000    08    12    R2 S    D 00498    F 00000    T 01 46
   000    08    12    R1      D 00512    F 00000    T 01 47
TA 045    08    12    R1      D 00561    F 00000    T 01 54
   000    08    12    R2 W    D 00685    F 00000    T 02 11
   000    08    12    R2 N    D 00694    F 00000    T 02 12
   000    08    12    R2 W    D 00716    F 00000    T 02 15
   000    10    12    R3 S    D 00728    F 00000    T 02 16
   000    15    16    R2 N    D 00743    F 00000    T 02 18
   000    08    10    R3 E    D 00768    F 00000    T 02 22
   000    08    10    R2 E    D 00771    F 00000    T 02 22
   000    08    10    R3 E    D 00773    F 00000    T 02 23
TA 044    08    10    R3 E    D 00780    F 00000    T 02 24
   000    15    16    R1      D 00787    F 00000    T 02 26
CP 002    15    16    R1      D 00935    F 00000    T 02 46
   000    15    16    R2 S    D 00973    F 00000    T 02 52
   000    15    16    R3 S    D 00995    F 00000    T 02 55
TA 063    15    16    R3 S    D 01149    F 00000    T 03 20
   000    06    12    R2 W    D 01155    F 00000    T 03 21
   000    06    12    R3 W    D 01161    F 00000    T 03 23
   000    06    12    R2 W    D 01167    F 00000    T 03 24
   000    06    12    R3 W    D 01172    F 00000    T 03 25
   000    06    10    R2 E    D 01202    F 00000    T 03 30
   000    06    10    R1      D 01255    F 00000    T 03 37
   000    06    10    R3 E    D 01271    F 00000    T 03 39
   000    06    10    R1      D 01275    F 00000    T 03 39
   000    06    08    R3 E    D 01376    F 00000    T 04 21
CP 003    06    08    R3 E    D 01381    F 00000    T 04 22
   000    06    10    R1      D 01386    F 00000    T 04 23
   000    06    10    R2 E    D 01504    F 00000    T 04 38
   000    06    10    R2 W    D 01509    F 00000    T 04 38
   000    06    10    R3 W    D 01578    F 00000    T 05 08
   000    06    08    R2 E    D 01602    F 00000    T 05 12
CP 004    13    15    R2 N    D 01608    F 00000    T 05 13
   000    06    08    R2 E    D 01618    F 00000    T 05 14
   000    06    08    R3 E    D 01625    F 00000    T 05 15
   000    06    08    R2 E    D 01644    F 00000    T 05 18
   000    06    10    R3 W    D 01665    F 00000    T 05 20
   000    06    10    R2 W    D 01669    F 00000    T 05 21
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.L CT0:DUMPUM.LDA

.ST 14156

RUN 005  SAMPLE RATE 00.5  YEAR 76  MONTH 12  DAY 07  HOUR 23  MIN 56

FIFTH WHEEL FEET/PULSE  0002    ODOMETER FEET/PULSE  0002
TA 064     00     00     R1      D 00000    F 00000    T 00 18
EE 064     00     00     R1      D 00000    F 00000    T 00 23
   000     06     12     R1      D 00132    F 00000    T 00 44
TA 064  /  06     12     R1      D 00185    F 00000    T 01 13
CP 001  J  06     12     R1      D 00208    F 00000    T 01 16
   000     08     12     R2 S    D 00461    F 00000    T 01 40
   000     08     12     R1      D 00516    F 00000    T 01 45
TA 045     08     12     R1      D 00556    F 00000    T 01 49
   000     06     12     R3 N    D 00572    F 00000    T 01 52
   000     08     12     R1      D 00575    F 00000    T 01 53
   000     08     12     R2 W    D 00667    F 00000    T 02 04
   000     08     12     R1      D 00672    F 00000    T 02 04
   000     08     12     R2 N    D 00678    F 00000    T 02 05
   000     08     12     R2 W    D 00704    F 00000    T 02 07
   000     08     12     R2 N    D 00709    F 00000    T 02 08
   000     08     12     R3 W    D 00763    F 00000    T 02 15
   000     08     10     R2 E    D 00767    F 00000    T 02 16
TA 044     08     12     R3 W    D 00775    F 00000    T 02 19
   000  /  15     16     R1      D 00785    F 00000    T 02 21
CP 002  J  15     16     R1      D 00943    F 00000    T 02 40
   000     15     16     R2 S    D 00956    F 00000    T 02 42
TA 063     15     16     R2 S    D 01141    F 00000    T 03 04
   000     06     12     R3 W    D 01147    F 00000    T 03 05
   000     06     12     R2 W    D 01156    F 00000    T 03 06
   000     06     10     R2 E    D 01162    F 00000    T 03 07
   000     06     10     R1      D 01254    F 00000    T 03 19
   000     06     10     R2 E    D 01262    F 00000    T 03 20
   000  J  06     10     R1      D 01274    F 00000    T 03 21
CP 003  J  06     10     R1      D 01371    F 00000    T 03 33
   000     06     08     R3 E    D 01478    F 00000    T 03 45
   000  /  06     10     R1      D 01509    F 00000    T 03 49
   000  J  06     10     R2 W    D 01510    F 00000    T 03 50
CP 004  J  13     15     R2 N    D 01606    F 00000    T 04 18
   000     06     10     R3 W    D 01610    F 00000    T 04 19
   000     06     08     R2 E    D 01642    F 00000    T 04 23
   000     06     10     R3 W    D 01646    F 00000    T 04 24
   000     06     08     R2 E    D 01676    F 00000    T 04 27
   000     06     08     R1      D 01707    F 00000    T 04 31
   000     06     08     R2 E    D 01728    F 00000    T 04 34
   000     06     08     R1      D 01741    F 00000    T 04 35
TA 060     06     08     R1      D 01826    F 00000    T 04 56
TA 050     06     08     R1      D 01981    F 00000    T 05 16
   000  J  15     14     R1      D 01993    F 00000    T 05 18
CP 005  J  15     14     R1      D 02007    F 00000    T 05 21
   000     15     11     R3 E    D 02217    F 00000    T 05 48
TA 049     15     11     R3 E    D 02224    F 00000    T 05 50
CP 006     15     11     R3 E    D 02299    F 00000    T 06 03
   000     15     13     R2 S    D 02353    F 00000    T 06 12
   000     15     13     R3 S    D 02364    F 00000    T 06 16
TA 059     15     13     R3 S    D 02391    F 00000    T 06 21
   000     06     08     R3 W    D 02403    F 00000    T 06 24
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Secondary

B.K. 12/15/76

.L CTO:DUMPUM.LDA

.ST 14156

RUN 006 SAMPLE RATE 00.5 YEAR 76 MONTH 12 DAY 14 HOUR 09 MIN 45

FIFTH WHEEL FEET/PULSE 0002 ODOMETER FEET/PULSE 0002

	000	06	12	R1		□	00122	F	00000	T	01	07
TA	064	06	12	R1		□	00210	F	00000	T	01	16
CP	001	06	12	R1		□	00239	F	00000	T	01	20
	000	08	12	R3	S	□	00398	F	00000	T	01	33
	000	08	12	R1		□	00495	F	00000	T	01	41
CP	002	08	12	R1		□	00587	F	00000	T	01	56
	000	08	12	R2	N	□	00702	F	00000	T	02	12
	000	08	12	R1		□	00723	F	00000	T	02	14
	000	08	12	R3	N	□	00733	F	00000	T	02	15
	000	10	12	R1		□	00852	F	00000	T	02	33
	000	10	12	R2	S	□	00857	F	00000	T	02	39
	000	10	12	R1		□	00861	F	00000	T	02	40
	000	10	12	R2	S	□	00877	F	00000	T	02	43
	000	10	12	R1		□	00890	F	00000	T	02	44
CP	003	10	12	R1		□	00935	F	00000	T	02	50
TA	029	10	12	R1		□	00998	F	00000	T	02	57
	000	10	12	R2	S	□	01080	F	00000	T	03	04
	000	10	12	R2	N	□	01093	F	00000	T	03	05
TA	080	10	12	R2	N	□	01119	F	00000	T	03	07
	000	12	12	R1		□	01209	F	00000	T	03	15
TA	019	12	12	R1		□	01268	F	00000	T	04	17
	000	12	12	R2	W	□	01339	F	00000	T	04	27
	000	12	12	R1		□	01348	F	00000	T	04	28
CP	004	12	12	R1		□	01352	F	00000	T	04	29
TA	018	19	16	R2	S	□	01410	F	00000	T	04	37
	000	12	10	R3	E	□	01446	F	00000	T	04	42
	000	19	16	R2	S	□	01478	F	00000	T	04	45
	000	17	16	R2	N	□	01484	F	00000	T	04	45
	000	19	16	R3	S	□	01490	F	00000	T	04	46
	000	17	16	R1		□	01526	F	00000	T	04	49
CP	005	17	16	R2	S	□	01727	F	00000	T	05	08
	000	17	16	R3	S	□	01787	F	00000	T	05	19
	000	16	16	R2	N	□	01799	F	00000	T	05	21
	000	16	16	R3	N	□	01809	F	00000	T	05	22
	000	16	16	R2	N	□	01855	F	00000	T	05	28
	000	16	16	R1		□	01859	F	00000	T	05	28
	000	16	16	R2	S	□	02017	F	00000	T	05	48
	000	15	16	R3	N	□	02020	F	00000	T	05	49
TA	044	15	16	R3	N	□	02066	F	00000	T	06	25
	000	15	16	R1		□	02079	F	00000	T	06	28
CP	006	15	16	R1		□	02088	F	00000	T	06	30
	000	08	10	R3	E	□	02098	F	00000	T	06	32
	000	08	12	R2	W	□	02112	F	00000	T	06	34
	000	08	10	R2	N	□	02184	F	00000	T	06	42
	000	08	10	R1		□	02221	F	00000	T	06	45
	000	08	10	R2	W	□	02372	F	00000	T	06	58
	000	08	10	R1		□	02377	F	00000	T	06	59
CP	007	08	10	R1		□	02416	F	00000	T	07	03
	000	08	10	R2	W	□	02430	F	00000	T	07	04
	000	08	08	R3	E	□	02499	F	00000	T	07	13

LISTING OF RECORDED RANDOM ROUTE TEST DATA

RUN 007 SAMPLE RATE 00.5 YEAR 76 MONTH 12 DAY 14 HOUR

FIFTH WHEEL FEET/PULSE 0002 ODOMETER FEET/PULSE 0002

	000	06	12	R1		O 00116	F 00000	T 00 50		000	06	08	R1		O 02997	F 00000	T 11 33
TA	064	06	12	R1		O 00206	F 00000	T 01 37	CP	009	06	08	R1		O 03076	F 00000	T 11 41
CP	001	06	12	R1		O 00262	F 00000	T 01 44		000	06	08	R2	W	O 03182	F 00000	T 11 59
	000	06	12	R2	N	O 00338	F 00000	T 01 51		000	06	06	R3	E	O 03193	F 00000	T 12 02
	000	08	12	R2	S	O 00379	F 00000	T 01 54		000	06	08	R2	W	O 03238	F 00000	T 12 08
	000	06	12	R2	N	O 00403	F 00000	T 01 56		000	06	06	R3	E	O 03295	F 00000	T 12 25
	000	06	12	R3	N	O 00416	F 00000	T 01 57		000	06	06	R1		O 03449	F 00000	T 12 43
	000	06	12	R2	N	O 00452	F 00000	T 02 00	CP	010	06	06	R1		O 03476	F 00000	T 13 14
	000	08	12	R2	S	O 00469	F 00000	T 02 02	TA	058	06	06	R1		O 03529	F 00000	T 13 36
	000	08	12	R1		O 00509	F 00000	T 02 26		000	06	06	R2	N	O 03615	F 00000	T 14 01
CP	002	08	12	R1		O 00582	F 00000	T 02 40		000	08	06	R2	S	O 03692	F 00000	T 14 08
	000	08	12	R2	N	O 00683	F 00000	T 03 14	CP	011	08	06	R2	S	O 03786	F 00000	T 14 20
	000	08	12	R1		O 00687	F 00000	T 03 14		000	08	06	R1		O 03803	F 00000	T 14 33
	000	08	12	R2	N	O 00707	F 00000	T 03 18		000	16	11	R1		O 04042	F 00000	T 15 13
	000	08	12	R1		O 00714	F 00000	T 03 19		000	10	06	R2	S	O 00045	F 00000	T 15 27
	000	08	12	R2	N	O 00717	F 00000	T 03 20		000	10	06	R1		O 00091	F 00000	T 15 54
	000	08	12	R1		O 00720	F 00000	T 03 21	TA	022	10	06	R1		O 00139	F 00000	T 16 00
	000	08	12	R3	N	O 00730	F 00000	T 03 24	CP	012	10	06	R1		O 00155	F 00000	T 16 04
	000	08	12	R2	N	O 00741	F 00000	T 03 26		000	10	06	R2	E	O 00251	F 00000	T 16 28
	000	10	12	R3	S	O 00744	F 00000	T 03 27		000	10	06	R3	W	O 00251	F 00000	T 16 29
	000	08	12	R2	N	O 00761	F 00000	T 04 00		000	10	07	R1		O 00390	F 00000	T 16 54
	000	10	12	R3	S	O 00786	F 00000	T 04 06		000	10	07	R2	W	O 00507	F 00000	T 17 04
	000	10	12	R2	S	O 00848	F 00000	T 04 15		000	10	07	R3	E	O 00523	F 00000	T 17 06
	000	10	12	R1		O 00852	F 00000	T 04 16	CP	013	10	07	R3	E	O 00529	F 00000	T 17 06
	000	10	12	R2	S	O 00856	F 00000	T 04 16		000	10	08	R1		O 00544	F 00000	T 17 08
	000	10	12	R1		O 00860	F 00000	T 04 17		000	10	08	R2	E	O 00795	F 00000	T 17 44
	000	10	12	R2	S	O 00872	F 00000	T 04 18		000	17	15	R2	S	O 00815	F 00000	T 18 05
	000	10	12	R1		O 00883	F 00000	T 04 20		000	16	15	R3	N	O 00818	F 00000	T 18 06
	000	10	12	R2	S	O 00885	F 00000	T 04 21		000	10	08	R2	E	O 00845	F 00000	T 18 09
	000	10	12	R1		O 00888	F 00000	T 04 22		000	10	08	R3	E	O 00868	F 00000	T 18 12
CP	003	10	12	R1		O 00929	F 00000	T 05 16		000	10	10	R2	W	O 00877	F 00000	T 18 13
TA	029	10	12	R1		O 00948	F 00000	T 05 19		000	10	10	R1		O 00994	F 00000	T 18 25
	000	10	12	R2	N	O 01053	F 00000	T 05 30	CP	014	10	10	R1		O 01038	F 00000	T 18 29
	000	10	12	R3	N	O 01116	F 00000	T 05 35		000	10	10	R2	E	O 01188	F 00000	T 18 43
TA	080	10	12	R3	N	O 01123	F 00000	T 05 36	TA	028	10	10	R3	E	O 01243	F 00000	T 19 33
	000	12	12	R2	S	O 01155	F 00000	T 05 38		000	17	16	R2	S	O 01312	F 00000	T 19 39
	000	12	12	R1		O 01222	F 00000	T 05 45		000	16	16	R3	N	O 01327	F 00000	T 19 41
TA	019	12	12	R1		O 01266	F 00000	T 06 01		000	16	16	R2	N	O 01386	F 00000	T 19 46
CP	004	12	12	R1		O 01351	F 00000	T 06 12		000	16	16	R1		O 01392	F 00000	T 19 47
	000	12	12	R2	W	O 01387	F 00000	T 06 16	CP	015	16	16	R1		O 01426	F 00000	T 19 50
TA	018	12	12	R2	W	O 01416	F 00000	T 06 21		000	15	16	R3	N	O 01572	F 00000	T 20 04
	000	19	16	R2	S	O 01426	F 00000	T 06 23		000	15	16	R1		O 01601	F 00000	T 20 06
	000	19	16	R3	S	O 01459	F 00000	T 06 26	CP	016	15	16	R1		O 01693	F 00000	T 20 15
	000	19	16	R2	S	O 01471	F 00000	T 06 27		000	15	16	R2	S	O 01803	F 00000	T 20 25
	000	17	16	R2	N	O 01477	F 00000	T 06 28		000	13	16	R3	N	O 01898	F 00000	T 20 34
	000	17	16	R1		O 01523	F 00000	T 06 31	TA	063	13	16	R3	N	O 01976	F 00000	T 20 43
	000	10	10	R3	E	O 01636	F 00000	T 07 13		000	06	12	R2	W	O 01978	F 00000	T 20 45
	000	17	16	R1		O 01636	F 00000	T 07 14		000	06	10	R3	E	O 01985	F 00000	T 20 46
CP	005	17	16	R1		O 01721	F 00000	T 07 27		000	06	10	R2	E	O 02036	F 00000	T 20 54
	000	16	16	R3	N	O 01801	F 00000	T 07 34		000	06	10	R1		O 02085	F 00000	T 20 58
	000	16	16	R2	N	O 01836	F 00000	T 07 37		000	06	10	R2	E	O 02136	F 00000	T 21 02
	000	16	16	R1		O 01846	F 00000	T 07 38		000	06	10	R1		O 02149	F 00000	T 21 03
	000	15	16	R2	N	O 02011	F 00000	T 07 57		000	06	10	R2	W	O 02320	F 00000	T 22 00
	000	16	16	R3	S	O 02046	F 00000	T 08 03		000	06	08	R2	E	O 02434	F 00000	T 22 45
TA	044	16	16	R3	S	O 02059	F 00000	T 08 06		000	06	10	R3	W	O 02450	F 00000	T 22 47
	000	15	16	R1		O 02070	F 00000	T 08 08		000	13	21	R1		O 02455	F 00000	T 22 47
	000	08	12	R2	W	O 02077	F 00000	T 08 10		000	06	08	R2	E	O 02466	F 00000	T 22 48
CP	006	08	12	R2	W	O 02080	F 00000	T 08 10		000	06	10	R3	W	O 02484	F 00000	T 22 50
	000	08	10	R3	E	O 02087	F 00000	T 08 12		000	06	08	R2	E	O 02502	F 00000	T 22 51
	000	08	10	R2	E	O 02167	F 00000	T 08 21		000	06	08	R1		O 02526	F 00000	T 22 53
	000	08	10	R2	N	O 02173	F 00000	T 08 22		000	06	08	R2	E	O 02574	F 00000	T 22 57
	000	08	10	R2	E	O 02179	F 00000	T 08 22		000	06	08	R1		O 02589	F 00000	T 22 59
	000	08	10	R1		O 02214	F 00000	T 08 26	TA	060	06	08	R1		O 02650	F 00000	T 23 41
CP	007	08	10	R1		O 02408	F 00000	T 08 45	CP	017	06	08	R1		O 02764	F 00000	T 23 57
	000	08	10	R2	W	O 02441	F 00000	T 08 48		000	15	14	R1		O 02824	F 00000	T 24 04
	000	08	10	R3	W	O 02481	F 00000	T 08 57		000	08	08	R2	S	O 02977	F 00000	T 24 20
TA	042	08	10	R3	W	O 02497	F 00000	T 09 01		000	08	08	R1		O 03021	F 00000	T 24 25
	000	15	15	R1		O 02509	F 00000	T 09 04	CP	018	08	08	R1		O 03026	F 00000	T 24 25
	000	16	15	R3	S	O 02522	F 00000	T 09 08		000	16	14	R1		O 03158	F 00000	T 24 41
	000	15	15	R2	N	O 02529	F 00000	T 09 09	CP	019	16	14	R1		O 03282	F 00000	T 25 00
	000	15	15	R1		O 02533	F 00000	T 09 10		000	10	08	R2	W	O 03290	F 00000	T 25 01
CP	008	15	15	R1		O 02674	F 00000	T 09 25		000	10	08	R1		O 03325	F 00000	T 25 05
	000	13	15	R3	N	O 02711	F 00000	T 09 31		000	10	08	R3	W	O 03340	F 00000	T 25 07
	000	13	15	R2	N	O 02830	F 00000	T 11 05		000	10	08	R1		O 03345	F 00000	T 25 07
	000	15	15	R3	S	O 02833	F 00000	T 11 06		000	10	08	R2	N	O 03484	F 00000	T 25 20
	000	13	15	R2	N	O 02838	F 00000	T 11 07		000	10	08	R1		O 03489	F 00000	T 25 20
	000	15	15	R3	S	O 02838	F 00000	T 11 09		000	10	08	R2	N	O 03498	F 00000	T 25 21
TA	061	13	15	R1		O 02856	F 00000	T 11 16		000	12	08	R3	S	O 03515	F 00000	T 25 23
	000	06	10	R2	W	O 02883	F 00000	T 11 21		000	10	08	R2	N	O 03526	F 00000	T 25 24
	000	06	08	R2	E	O 02909	F 00000	T 11 25		000	12	08	R3	S	O 03534	F 00000	T 25 25
	000	06	10	R2	W	O 02915	F 00000	T 11 25		000	12	08	R2	S	O 03549	F 00000	T 25 27
	000	06	08	R2	E	O 02941	F 00000	T 11 28		000	10	08	R3	N	O 03556	F 00000	T 25 28
	000	06	08	R1		O 02952	F 00000	T 11 29		000	12	08	R2	S	O 03558	F 00000	T 25 29
	000	06	08	R2	E	O 02964	F 00000	T 11 30		000	10	08	R3	N	O 03561	F 00000	T 25 30
	000	06	08	R3	E	O 02975	F 00000	T 11 31		000	12	08	R2	S	O 03562	F 00000	T 25 30

LISTING OF RECORDED RANDOM ROUTE TEST DATA (CONT'D)

	000	10	08	R3	N	0	03564	F	00000	T	35	32	TA	002	19	13	R1	0	02529	F	00000	T	35	08
	000	10	08	R2	N	0	03569	F	00000	T	35	34		000	12	07	R2	E	0	02636	F	00000	T	35	26
	000	12	08	R3	S	0	03570	F	00000	T	35	34		000	19	13	R2	S	0	02637	F	00000	T	35	30
	000	12	08	R2	S	0	03578	F	00000	T	35	38		000	12	07	R2	W	0	02637	F	00000	T	35	36
CP	020	12	08	R2	S	0	03603	F	00000	T	36	15		000	12	07	R2	E	0	02637	F	00000	T	35	36
	000	12	08	R1		0	03610	F	00000	T	26	16		000	19	13	R2	S	0	02637	F	00000	T	35	40
TA	013	12	08	R1		0	03705	F	00000	T	26	28		000	12	07	R2	E	0	02637	F	00000	T	35	43
	000	12	08	R2	W	0	03762	F	00000	T	26	33		000	19	13	R2	S	0	02637	F	00000	T	35	45
	000	12	08	R1		0	03769	F	00000	T	26	34		000	12	07	R2	E	0	02637	F	00000	T	35	46
	000	19	15	R3	S	0	03820	F	00000	T	26	38		000	19	13	R2	S	0	02637	F	00000	T	35	58
	000	12	08	R2	E	0	03876	F	00000	T	27	15		000	12	07	R2	E	0	02637	F	00000	T	36	00
TA	015	12	08	R2	E	0	03891	F	00000	T	27	17		000	19	13	R2	S	0	02637	F	00000	T	36	04
	000	17	15	R2	N	0	03904	F	00000	T	27	19		000	12	07	R2	E	0	02637	F	00000	T	36	04
	000	19	15	R3	S	0	03941	F	00000	T	27	24		000	19	13	R2	S	0	02637	F	00000	T	36	06
	000	17	15	R1		0	03945	F	00000	T	27	24		000	12	07	R2	E	0	02637	F	00000	T	36	06
	000	17	15	R2	N	0	03960	F	00000	T	27	26		000	19	13	R2	S	0	02642	F	00000	T	36	11
	000	17	15	R1		0	03971	F	00000	T	27	27		000	12	07	R1		0	02645	F	00000	T	36	12
	000	19	15	R3	S	0	03981	F	00000	T	27	28		000	12	07	R2	E	0	02653	F	00000	T	36	13
	000	17	15	R1		0	03987	F	00000	T	27	28		000	12	07	R2	W	0	02667	F	00000	T	36	15
CP	021	17	15	R1		0	04052	F	00000	T	27	34		000	12	06	R3	E	0	02671	F	00000	T	36	16
	000	17	15	R3	S	0	00070	F	00000	T	28	20		000	12	07	R2	W	0	02679	F	00000	T	36	17
	000	17	15	R2	S	0	00102	F	00000	T	28	24		000	17	13	R3	N	0	02687	F	00000	T	36	18
	000	16	15	R3	N	0	00121	F	00000	T	28	26	CP	028	17	13	R3	N	0	02696	F	00000	T	36	19
	000	16	15	R2	N	0	00155	F	00000	T	28	29		000	12	07	R2	W	0	02742	F	00000	T	36	24
	000	17	15	R3	S	0	00166	F	00000	T	28	30		000	17	13	R2	N	0	02769	F	00000	T	36	26
	000	16	15	R1		0	00196	F	00000	T	28	32		000	17	13	R1		0	02774	F	00000	T	36	27
CP	022	16	15	R1		0	00308	F	00000	T	29	00		000	10	07	R3	N	0	02885	F	00000	T	37	13
	000	15	15	R3	N	0	00351	F	00000	T	29	11		000	17	13	R1		0	02885	F	00000	T	37	14
	000	15	15	R2	N	0	00434	F	00000	T	29	21		000	10	07	R3	N	0	02885	F	00000	T	37	15
	000	16	15	R3	S	0	00438	F	00000	T	29	22		000	17	13	R1		0	02885	F	00000	T	37	15
	000	15	15	R2	N	0	00448	F	00000	T	29	23		000	10	07	R3	N	0	02885	F	00000	T	37	21
	000	15	15	R3	N	0	00455	F	00000	T	29	24		000	17	13	R1		0	02885	F	00000	T	37	26
	000	15	15	R1		0	00460	F	00000	T	29	25		000	12	07	R3	S	0	02885	F	00000	T	37	33
	000	15	15	R2	S	0	00585	F	00000	T	29	36		000	17	13	R1		0	02885	F	00000	T	37	34
	000	15	15	R1		0	00595	F	00000	T	29	38		000	12	07	R3	S	0	02949	F	00000	T	37	50
TA	052	15	15	R1		0	00603	F	00000	T	29	39		000	17	13	R1		0	02954	F	00000	T	37	50
	000	15	15	R2	S	0	00606	F	00000	T	29	40		000	17	13	R3	S	0	03036	F	00000	T	37	58
	000	15	15	R2	W	0	00626	F	00000	T	29	44		000	17	13	R2	S	0	03077	F	00000	T	38	08
	000	15	14	R3	E	0	00639	F	00000	T	29	46		000	16	13	R3	N	0	03079	F	00000	T	38	08
	000	15	14	R2	E	0	00682	F	00000	T	29	51		000	17	13	R2	S	0	03083	F	00000	T	38	09
CP	023	15	14	R2	E	0	00784	F	00000	T	30	02		000	16	13	R3	N	0	03086	F	00000	T	38	10
	000	15	14	R1		0	00787	F	00000	T	30	03		000	16	13	R1		0	03147	F	00000	T	38	24
	000	15	13	R2	E	0	00981	F	00000	T	30	35		000	16	13	R3	N	0	03147	F	00000	T	38	24
	000	15	13	R1		0	01015	F	00000	T	30	39		000	16	13	R1		0	03147	F	00000	T	38	26
CP	024	15	13	R1		0	01053	F	00000	T	31	24		000	17	13	R3	S	0	03147	F	00000	T	38	27
	000	15	13	R2	W	0	01178	F	00000	T	31	41		000	16	13	R1		0	03148	F	00000	T	38	28
	000	15	13	R3	W	0	01212	F	00000	T	31	44		000	16	13	R3	N	0	03148	F	00000	T	38	28
CP	025	15	13	R3	W	0	01250	F	00000	T	31	48		000	16	13	R1		0	03152	F	00000	T	38	30
TA	047	15	13	R3	W	0	01283	F	00000	T	31	50		000	32	27	R1		0	03213	F	00000	T	38	51
	000	08	06	R2	S	0	01335	F	00000	T	32	02		000	16	13	R1		0	03213	F	00000	T	38	52
	000	08	06	R1		0	01364	F	00000	T	32	07		000	32	27	R1		0	03213	F	00000	T	38	57
	000	16	11	R1		0	01630	F	00000	T	32	46		000	16	13	R1		0	03213	F	00000	T	38	58
	000	10	06	R1		0	01770	F	00000	T	33	04	CP	029	16	13	R1		0	03265	F	00000	T	39	15
	000	10	06	R2	N	0	01866	F	00000	T	33	14		000	08	07	R1		0	03310	F	00000	T	39	22
CP	026	10	06	R2	N	0	01882	F	00000	T	33	16		000	16	13	R2	S	0	03319	F	00000	T	39	23
	000	10	06	R1		0	01887	F	00000	T	33	16		000	15	13	R3	N	0	03321	F	00000	T	39	24
	000	10	06	R2	N	0	01903	F	00000	T	33	16		000	16	13	R2	S	0	03322	F	00000	T	39	24
	000	10	06	R1		0	01913	F	00000	T	33	19		000	08	07	R2	W	0	03323	F	00000	T	39	25
	000	10	06	R2	N	0	01923	F	00000	T	33	20		000	16	13	R3	S	0	03331	F	00000	T	39	30
	000	12	06	R3	S	0	01957	F	00000	T	33	23		000	08	07	R1		0	03331	F	00000	T	39	30
	000	10	06	R2	N	0	01962	F	00000	T	33	24		000	16	13	R3	S	0	03331	F	00000	T	39	31
	000	10	06	R3	N	0	01979	F	00000	T	33	26		000	08	07	R1		0	03331	F	00000	T	39	32
	000	12	06	R2	S	0	01987	F	00000	T	33	27		000	16	13	R1		0	03331	F	00000	T	39	34
	000	12	06	R1		0	02016	F	00000	T	33	31		000	08	07	R1		0	03331	F	00000	T	39	35
	000	12	06	R2	N	0	02213	F	00000	T	34	14		000	16	13	R3	S	0	03331	F	00000	T	39	36
	000	14	06	R2	S	0	02223	F	00000	T	34	15		000	08	07	R1		0	03331	F	00000	T	39	37
	000	14	06	R3	S	0	02228	F	00000	T	34	16		000	16	13	R3	S	0	03331	F	00000	T	39	37
CP	027	14	06	R3	S	0	02259	F	00000	T	34	19		000	08	07	R1		0	03331	F	00000	T	39	38
	000	12	06	R2	N	0	02278	F	00000	T	34	21		000	16	13	R3	S	0	03331	F	00000	T	39	39
	000	14	06	R2	S	0	02297	F	00000	T	34	23		000	08	07	R1		0	03331	F	00000	T	39	40
TA	001	14	06	R2	S	0	02308	F	00000	T	34	25		000	15	13	R3	N	0	03331	F	00000	T	39	44
	000	19	11	R1		0	02312	F	00000	T	34	26		000	15	13	R2	N	0	03331	F	00000	T	39	45
	000	19	11	R2	S	0	02320	F	00000	T	34	28		000	08	07	R1		0	03331	F	00000	T	39	46
	000	19	11	R1		0	02322	F	00000	T	34	28		000	15	13	R3	N	0	03331	F	00000	T	39	47
	000	12	06	R3	N	0	02345	F	00000	T	34	32		000	08	07	R1		0	03331	F	00000	T	39	50
	000	19	11	R1		0	02358	F	00000	T	34	34		000	15	13	R3	N	0	03331	F	00000	T	39	51
	000	19	13	R2	W	0	02390	F	00000	T	34	37		000	08	07	R1		0	03331	F	00000	T	39	53
	000	19	11	R3	E	0	02395	F	00000	T	34	37		000	16	13	R3	S	0	03331	F	00000	T	39	54
	000	19	13	R1		0	02434	F	00000	T	34	43		000	08	07	R1		0	03331	F	00000	T	39	55
	000	19	13	R2	W	0	02449	F	00000	T	34	45		000	16	13	R3	S	0	03345	F	00000	T	40	00
	000	19	13	R1		0	02454	F	00000	T	34	45		000	08	07	R1		0	03347	F	00000	T	40	01
	000	19	13	R2	W	0	02464	F	00000	T	34	47	TA	040	16	13	R3	S	0	03350	F	00000	T	40	02
	000	19	13	R1		0	02483	F	00000	T	34	48		000	08	07	R1		0	03351	F	00000	T	40	02

LISTING OF RECORDED RANDOM ROUTE TEST DATA (CONT'D)

	000	16	15	R1		D	03353	F	00000	T	40	03		000	08	07	R1		D	01865	F	00000	T	48 25
	000	08	07	R1		D	03358	F	00000	T	40	05	TA	040	08	07	R1		D	01869	F	00000	T	48 26
	000	08	07	R2	W	D	03417	F	00000	T	40	13		000	08	07	R2	N	D	01879	F	00000	T	48 28
	000	08	06	R2	E	D	03426	F	00000	T	40	15		000	16	13	R3	S	D	01887	F	00000	T	48 30
	000	08	06	R3	E	D	03434	F	00000	T	40	16		000	15	13	R2	N	D	01925	F	00000	T	48 35
	000	08	07	R2	W	D	03437	F	00000	T	40	17		000	15	13	R1		D	01931	F	00000	T	48 36
	000	08	07	R3	W	D	03444	F	00000	T	40	18		000	15	13	R2	N	D	01936	F	00000	T	48 37
	000	08	07	R2	W	D	03446	F	00000	T	40	19		000	15	13	R1		D	01953	F	00000	T	48 46
	000	08	06	R3	E	D	03451	F	00000	T	40	20	CP	037	15	13	R1		D	01970	F	00000	T	49 09
	000	08	06	R1		D	03493	F	00000	T	40	25		000	15	13	R2	N	D	01995	F	00000	T	49 39
	000	08	06	R3	E	D	03514	F	00000	T	40	27		000	15	13	R1		D	01995	F	00000	T	49 42
	000	08	06	R1		D	03525	F	00000	T	40	28		000	15	13	R2	N	D	02010	F	00000	T	50 12
TA	039	08	06	R1		D	03572	F	00000	T	41	11		000	15	13	R1		D	02027	F	00000	T	50 19
	000	16	11	R1		D	03729	F	00000	T	41	28		000	15	13	R2	S	D	02136	F	00000	T	51 22
	000	10	06	R1		D	03884	F	00000	T	41	52		000	15	13	R1		D	02137	F	00000	T	51 24
CP	030	10	06	R1		D	03908	F	00000	T	41	55		000	15	13	R2	S	D	02143	F	00000	T	51 27
	000	10	06	R2	N	D	03993	F	00000	T	42	06		000	15	13	R1		D	02144	F	00000	T	51 27
	000	10	06	R1		D	04001	F	00000	T	42	07		000	60	55	R1		D	02148	F	00000	T	51 36
	000	10	06	R2	N	D	04018	F	00000	T	42	09		000	15	13	R1		D	02148	F	00000	T	51 37
	000	12	06	R3	S	D	04073	F	00000	T	42	15		000	15	13	R3	S	D	02179	F	00000	T	51 51
	000	12	06	R2	S	D	04078	F	00000	T	42	16		000	15	13	R2	S	D	02191	F	00000	T	51 52
	000	10	06	R3	N	D	00007	F	00000	T	42	25		000	15	13	R3	S	D	02195	F	00000	T	51 53
	000	12	06	R1		D	0001B	F	00000	T	42	29		000	15	13	R2	S	D	02206	F	00000	T	51 54
CP	031	12	06	R1		D	00051	F	00000	T	42	48	CP	038	13	13	R3	N	D	02214	F	00000	T	51 56
TA	007	12	06	R1		D	00114	F	00000	T	43	48	TA	059	13	13	R3	N	D	02233	F	00000	T	52 00
	000	12	06	R2	E	D	00193	F	00000	T	43	58		000	06	06	R2	E	D	02311	F	00000	T	52 11
	000	12	06	R1		D	00197	F	00000	T	43	58		000	06	06	R1		D	02352	F	00000	T	52 14
	000	12	06	R2	E	D	00214	F	00000	T	44	00	TA	058	06	06	R1		D	02456	F	00000	T	53 04
	000	12	07	R3	W	D	00232	F	00000	T	44	03		000	06	06	R2	N	D	02584	F	00000	T	53 20
	000	12	06	R2	E	D	00238	F	00000	T	44	04		000	08	06	R3	S	D	02623	F	00000	T	53 27
	000	12	07	R3	W	D	00244	F	00000	T	44	05		000	08	06	R2	S	D	02623	F	00000	T	53 28
	000	12	07	R2	W	D	00250	F	00000	T	44	18		000	08	06	R3	S	D	02623	F	00000	T	53 31
	000	12	07	R3	W	D	00265	F	00000	T	44	21		000	08	06	R2	S	D	02623	F	00000	T	53 35
	000	12	07	R2	W	D	00311	F	00000	T	44	26		000	08	06	R3	S	D	02647	F	00000	T	53 41
	000	12	08	R3	W	D	00321	F	00000	T	44	27		000	08	06	R2	S	D	02667	F	00000	T	53 43
	000	12	07	R1		D	00326	F	00000	T	44	27		000	08	06	R1		D	02740	F	00000	T	53 51
	000	12	06	R2	E	D	00364	F	00000	T	44	30		000	16	11	R1		D	02978	F	00000	T	54 11
	000	12	07	R2	W	D	00371	F	00000	T	44	31		000	10	06	R2	S	D	03089	F	00000	T	54 24
	000	12	07	R1		D	00384	F	00000	T	44	32		000	10	06	R1		D	03142	F	00000	T	54 36
	000	12	08	R2	W	D	00398	F	00000	T	44	33		000	10	06	R2	N	D	03262	F	00000	T	54 47
	000	12	08	R3	W	D	00413	F	00000	T	44	34		000	12	06	R3	S	D	03310	F	00000	T	54 50
	000	12	07	R1		D	00421	F	00000	T	44	34		000	12	06	R2	S	D	03351	F	00000	T	54 53
	000	12	07	R2	E	D	00451	F	00000	T	44	36		000	12	06	R1		D	03404	F	00000	T	54 58
	000	12	08	R3	W	D	00459	F	00000	T	44	37	TA	007	12	06	R1		D	03476	F	00000	T	55 09
	000	12	08	R2	W	D	00474	F	00000	T	44	38		000	12	06	R2	E	D	03567	F	00000	T	55 20
	000	12	08	R1		D	00490	F	00000	T	44	39		000	12	07	R3	W	D	03606	F	00000	T	55 24
	000	12	08	R2	W	D	00497	F	00000	T	44	39		000	12	06	R1		D	03612	F	00000	T	55 24
	000	12	08	R1		D	00504	F	00000	T	44	40		000	12	06	R3	E	D	03617	F	00000	T	55 25
CP	032	12	08	R1		D	00526	F	00000	T	44	41	CP	039	12	06	R3	E	D	03709	F	00000	T	55 38
	000	12	08	R2	E	D	00724	F	00000	T	45	05		000	12	07	R1		D	03714	F	00000	T	55 38
	000	17	15	R3	N	D	00732	F	00000	T	45	06		000	24	15	R1		D	03750	F	00000	T	55 42
	000	19	15	R2	S	D	00755	F	00000	T	45	08		000	12	07	R1		D	03756	F	00000	T	55 42
TA	015	19	15	R2	S	D	00792	F	00000	T	45	13		000	12	08	R3	W	D	03831	F	00000	T	55 48
	000	17	15	R3	N	D	00799	F	00000	T	45	14		000	12	07	R1		D	03838	F	00000	T	55 48
	000	17	15	R2	N	D	00814	F	00000	T	45	17		000	12	07	R3	E	D	03846	F	00000	T	55 49
	000	17	15	R3	N	D	00831	F	00000	T	45	19		000	12	08	R1		D	03861	F	00000	T	55 50
	000	17	15	R2	N	D	00839	F	00000	T	45	20		000	12	07	R3	E	D	03883	F	00000	T	55 51
CP	033	17	15	R3	N	D	00846	F	00000	T	45	21		000	48	35	R1		D	03891	F	00000	T	55 52
	000	17	15	R1		D	00875	F	00000	T	45	25		000	12	08	R1		D	03906	F	00000	T	55 53
	000	17	15	R2	S	D	01031	F	00000	T	45	50	CP	040	12	08	R1		D	03940	F	00000	T	55 55
	000	17	15	R1		D	01038	F	00000	T	45	51		000	12	08	R2	E	D	04088	F	00000	T	56 10
	000	16	15	R3	N	D	01107	F	00000	T	45	59	CP	041	12	08	R3	E	D	00062	F	00000	T	56 20
	000	16	15	R2	N	D	01182	F	00000	T	46	07		000	19	15	R2	S	D	00125	F	00000	T	56 25
	000	16	15	R1		D	01186	F	00000	T	46	08		000	12	10	R2	W	D	00169	F	00000	T	56 29
	000	16	15	R2	N	D	01191	F	00000	T	46	09		000	19	16	R3	W	D	00200	F	00000	T	56 31
	000	16	15	R1		D	01193	F	00000	T	46	09		000	12	10	R1		D	00219	F	00000	T	56 33
CP	034	16	15	R1		D	01251	F	00000	T	46	17	CP	042	12	10	R1		D	00296	F	00000	T	56 39
	000	32	31	R1		D	01340	F	00000	T	46	28	TA	017	12	10	R1		D	00336	F	00000	T	56 42
	000	15	15	R3	N	D	01356	F	00000	T	46	29		000	17	16	R3	N	D	00371	F	00000	T	56 45
TA	042	15	15	R3	N	D	01419	F	00000	T	46	37		000	17	16	R2	N	D	00590	F	00000	T	57 01
	000	15	15	R2	N	D	01431	F	00000	T	46	39	TA	038	17	16	R2	N	D	00650	F	00000	T	57 52
	000	08	08	R2	E	D	01445	F	00000	T	46	42		000	16	16	R3	N	D	00698	F	00000	T	57 57
	000	08	08	R1		D	01449	F	00000	T	46	42		000	10	12	R2	W	D	00751	F	00000	T	58 01
	000	17	17	R*	C	D	01469	F	00000	T	46	45		000	10	12	R1		D	00812	F	00000	T	58 05
	000	08	08	R1		D	01504	F	00000	T	46	48	TA	029	10	12	R1		D	00864	F	00000	T	58 25
CP	035	08	08	R1		D	01689	F	00000	T	47	23		000	10	12	R2	N	D	00985	F	00000	T	58 40
	000	08	08	R2	W	D	01734	F	00000	T	47	28	TA	080	10	12	R2	N	D	01004	F	00000	T	58 42
	000	08	07	R1		D	01785	F	00000	T	47	34		000	10	12	R3	N	D	01029	F	00000	T	58 45
CP	036	08	07	R1		D	01830	F	00000	T	48	12	CP	043	10	12	R3	N	D	01041	F	00000	T	58 47
	000	08	06	R3	E	D	01849	F	00000	T	48	18		000	12	12	R1		D	01156	F	00000	T	59 05
	000	08	07	R1		D	01850	F	00000	T	48	19	TA	019	12	12	R1		D	01183	F	00000	T	59 08
	000	04	03	R3	S	D	01863	F	00000	T	48	24		000	12	12	R2	W	D	01321	F	00000	T	59 26

LISTING OF RECORDED RANDOM ROUTE TEST DATA (CONT'D)

CP	044	12	12	R2	W	0	01342	F	00000	T	59	51		000	19	13	R3	S	0	00680	F	00000	T	71	28
	000	12	10	R3	E	0	01420	F	00000	T	59	58		000	12	07	R2	W	0	00695	F	00000	T	71	30
	000	12	10	R2	E	0	01466	F	00000	T	60	01		000	19	13	R3	S	0	00700	F	00000	T	71	30
	000	17	16	R3	N	0	01505	F	00000	T	60	04		000	12	07	R2	W	0	00706	F	00000	T	71	31
	000	12	10	R1		0	01538	F	00000	T	60	07		000	19	13	R3	S	0	00716	F	00000	T	71	32
CP	045	12	10	R1		0	01562	F	00000	T	60	09		000	17	13	R2	N	0	00737	F	00000	T	71	34
	000	12	10	R2	W	0	01755	F	00000	T	60	23		000	17	13	R1		0	00741	F	00000	T	71	34
	000	12	10	R3	W	0	01777	F	00000	T	60	24	CP	053	17	13	R1		0	00896	F	00000	T	71	51
	000	12	08	R2	E	0	01791	F	00000	T	60	25		000	17	13	R2	N	0	00946	F	00000	T	71	58
	000	19	15	R3	S	0	01904	F	00000	T	60	35		000	17	13	R1		0	00950	F	00000	T	71	58
	000	12	08	R2	W	0	01946	F	00000	T	60	39	TA	023	17	13	R1		0	00981	F	00000	T	72	03
	000	12	08	R1		0	01951	F	00000	T	60	40		000	10	07	R1		0	00999	F	00000	T	72	07
	000	12	08	R2	W	0	01966	F	00000	T	60	41		000	10	07	R3	E	0	01126	F	00000	T	72	19
	000	12	08	R1		0	01971	F	00000	T	60	42		000	10	08	R1		0	01136	F	00000	T	72	20
	000	12	08	R2	W	0	02030	F	00000	T	60	49		000	10	08	R2	W	0	01145	F	00000	T	72	21
TA	012	12	08	R1		0	02032	F	00000	T	60	50		000	10	08	R1		0	01148	F	00000	T	72	22
	000	12	08	R3	N	0	02060	F	00000	T	60	55		000	10	07	R3	E	0	01156	F	00000	T	72	24
	000	12	08	R2	W	0	02071	F	00000	T	60	57		000	10	08	R1		0	01156	F	00000	T	72	24
	000	12	08	R1		0	02074	F	00000	T	60	57	CP	054	10	08	R1		0	01197	F	00000	T	72	54
	000	12	08	R3	N	0	02086	F	00000	T	60	59		000	10	08	R2	E	0	01423	F	00000	T	74	12
CP	046	12	08	R3	N	0	02105	F	00000	T	61	01	TA	026	10	08	R2	E	0	01426	F	00000	T	74	13
	000	12	08	R2	W	0	02115	F	00000	T	61	03		000	16	15	R3	N	0	01441	F	00000	T	74	15
	000	12	08	R3	N	0	02119	F	00000	T	61	03		000	17	15	R2	S	0	01447	F	00000	T	74	16
	000	14	08	R1		0	02157	F	00000	T	61	09		000	16	15	R3	N	0	01468	F	00000	T	74	19
	000	14	08	R3	S	0	02159	F	00000	T	61	10		000	16	15	R2	N	0	01507	F	00000	T	74	26
TA	003	14	08	R2	S	0	02162	F	00000	T	61	10		000	16	15	R1		0	01514	F	00000	T	74	27
	000	14	08	R3	S	0	02167	F	00000	T	61	11		000	16	15	R2	N	0	01518	F	00000	T	74	28
	000	12	08	R2	N	0	02185	F	00000	T	61	15		000	16	15	R1		0	01522	F	00000	T	74	28
	000	19	15	R1		0	02276	F	00000	T	61	25		000	16	15	R2	S	0	01688	F	00000	T	75	30
TA	004	19	15	R1		0	02394	F	00000	T	62	10		000	16	15	R1		0	01698	F	00000	T	75	32
CP	047	19	15	R1		0	02438	F	00000	T	62	16		000	16	15	R2	S	0	01702	F	00000	T	75	32
	000	19	15	R2	S	0	02591	F	00000	T	63	26		000	15	15	R3	N	0	01712	F	00000	T	75	33
	000	17	15	R3	N	0	02595	F	00000	T	63	26		000	15	15	R2	N	0	01740	F	00000	T	75	36
	000	17	15	R2	N	0	02635	F	00000	T	63	30		000	15	15	R3	N	0	01753	F	00000	T	75	38
	000	17	15	R1		0	02656	F	00000	T	63	32		000	15	15	R1		0	01775	F	00000	T	75	41
CP	048	17	15	R1		0	02745	F	00000	T	63	41		000	15	15	R2	N	0	01795	F	00000	T	75	44
	000	16	15	R3	N	0	02855	F	00000	T	64	13		000	15	15	R1		0	01821	F	00000	T	75	47
	000	17	15	R2	S	0	02862	F	00000	T	64	14	P	055	15	15	R1		0	01865	F	00000	T	75	52
	000	16	15	R3	N	0	02866	F	00000	T	64	14		000	15	15	R2	S	0	02034	F	00000	T	76	21
	000	17	15	R2	S	0	02898	F	00000	T	64	19		000	13	15	R3	N	0	02082	F	00000	T	76	28
	000	16	15	R3	N	0	02906	F	00000	T	64	20		000	15	15	R2	S	0	02088	F	00000	T	76	29
	000	16	15	R1		0	02965	F	00000	T	64	30		000	15	15	R3	S	0	02093	F	00000	T	76	30
TA	033	16	15	R1		0	03033	F	00000	T	64	38		000	13	15	R2	N	0	02096	F	00000	T	76	31
	000	16	15	R2	W	0	03139	F	00000	T	64	54		000	15	15	R3	S	0	02097	F	00000	T	76	59
	000	16	14	R3	E	0	03150	F	00000	T	64	55		000	13	15	R2	N	0	02109	F	00000	T	77	02
	000	16	14	R1		0	03253	F	00000	T	65	11		000	15	15	R3	S	0	02117	F	00000	T	77	03
	000	16	14	R3	E	0	03265	F	00000	T	65	13		000	13	15	R2	N	0	02127	F	00000	T	77	05
	000	16	14	R1		0	03276	F	00000	T	65	15		000	13	15	R1		0	02137	F	00000	T	77	08
CP	049	16	14	R1		0	03317	F	00000	T	65	20		000	13	15	R2	N	0	02138	F	00000	T	77	08
	000	16	14	R2	W	0	03376	F	00000	T	65	27	A	061	13	15	R2	N	0	02141	F	00000	T	77	10
	000	16	13	R2	E	0	03381	F	00000	T	65	28		000	13	15	R1		0	02144	F	00000	T	77	11
CP	050	08	07	R3	N	0	03399	F	00000	T	65	30		000	06	08	R3	E	0	02147	F	00000	T	77	17
	000	16	13	R2	E	0	03416	F	00000	T	65	32		000	13	15	R1		0	02150	F	00000	T	77	18
	000	16	13	R1		0	03435	F	00000	T	65	34	P	056	13	15	R1		0	02151	F	00000	T	77	18
	000	10	06	R3	S	0	03653	F	00000	T	66	58		000	06	10	R3	W	0	02162	F	00000	T	77	21
CP	051	10	06	R3	S	0	03657	F	00000	T	66	59		000	06	10	R2	W	0	02167	F	00000	T	77	22
	000	16	11	R1		0	03687	F	00000	T	67	02		000	06	08	R2	E	0	02175	F	00000	T	77	24
TA	030	16	11	R1		0	03710	F	00000	T	67	13		000	06	08	R3	E	0	02191	F	00000	T	77	26
	000	10	06	R1		0	03839	F	00000	T	67	39		000	06	08	R2	E	0	02216	F	00000	T	77	29
	000	10	06	R2	N	0	03974	F	00000	T	67	51		000	06	08	R1		0	02258	F	00000	T	77	33
	000	12	06	R3	S	0	04029	F	00000	T	67	57		000	06	08	R2	E	0	02264	F	00000	T	77	34
	000	10	06	R2	N	0	04042	F	00000	T	67	59		000	06	08	R1		0	02281	F	00000	T	77	35
	000	10	06	R3	N	0	04046	F	00000	T	67	59	CP	057	06	08	R1		0	02366	F	00000	T	78	20
	000	12	06	R2	S	0	04050	F	00000	T	68	00		000	06	08	R2	W	0	02436	F	00000	T	78	30
	000	12	06	R1		0	00003	F	00000	T	68	06		000	06	08	R1		0	02444	F	00000	T	78	31
	000	12	06	R2	N	0	00196	F	00000	T	69	21		000	06	08	R2	W	0	02575	F	00000	T	78	49
	000	14	06	R3	S	0	00201	F	00000	T	69	22		000	06	06	R3	E	0	02575	F	00000	T	78	52
	000	14	06	R2	S	0	00250	F	00000	T	69	28		000	06	08	R2	W	0	02575	F	00000	T	78	56
	000	12	06	R2	N	0	00258	F	00000	T	69	29		000	06	06	R3	E	0	02575	F	00000	T	78	57
	000	12	06	R3	N	0	00261	F	00000	T	69	30		000	06	06	R1		0	02708	F	00000	T	79	20
TA	001	12	06	R3	N	0	00270	F	00000	T	69	31		000	06	06	R2	E	0	02714	F	00000	T	79	21
	000	14	06	R2	S	0	00272	F	00000	T	69	32		000	06	06	R1		0	02726	F	00000	T	79	22
	000	19	11	R1		0	00275	F	00000	T	69	32	CP	058	06	06	R1		0	02768	F	00000	T	79	26
	000	19	13	R3	W	0	00339	F	00000	T	69	41	TA	058	06	06	R1		0	02821	F	00000	T	80	08
	000	19	13	R1		0	00400	F	00000	T	69	47		000	15	11	R1		0	03058	F	00000	T	80	59
TA	002	19	13	R1		0	00493	F	00000	T	70	07		000	06	06	R1		0	00190	F	00000	T	85	15
CP	052	19	13	R1		0	00539	F	00000	T	70	21	TA	058	06	06	R1		0	00272	F	00000	T	85	38
	000	12	07	R1		0	00607	F	00000	T	70	29	CP	059	06	06	R1		0	00322	F	00000	T	86	06
	000	19	13	R2	S	0	00616	F	00000	T	70	31		000	06	06	R2	E	0	00367	F	00000	T	86	11
	000	12	07	R2	E	0	00639	F	00000	T	71	24		000	06	06	R3	E	0	00397	F	00000	T	86	48
	000	19	13	R3	S	0	00647	F	00000	T	71	25		000	06	06	R2	E	0	00421	F	00000	T	86	51
	000	12	07	R2	W	0	00652	F	00000	T	71	25		000	06	06	R3	E	0	00468	F	00000	T	86	55
	000	17	13	R3	N	0	00666	F	00000	T	71	27		000	06	08	R1		0	00625	F	00000	T	87	09
	000	12	07	R2	W	0	00670	F	00000	T	71	27	CP	060	06	08	R1		0	00723	F	00000	T	87	21

LISTING OF RECORDED RANDOM ROUTE TEST DATA (CONT'D)

```
    000    06    0B    R2 E   D 00886    F 00000    T 88 39
    000    06    0B    R3 E   D 00904    F 00000    T 88 42
    000    06    0B    R2 E   D 00909    F 00000    T 88 43
    000    13    15    R1     D 00941    F 00000    T 89 23
    000    06    0B    R3 E   D 00944    F 00000    T 89 24
    000    06    0B    R2 E   D 00970    F 00000    T 89 27
    000    06    10    R3 W   D 00977    F 00000    T 89 28
    000    06    10    R2 W   D 01000    F 00000    T 89 31
    000    06    0B    R3 E   D 01009    F 00000    T 89 33
    000    06    10    R2 W   D 01012    F 00000    T 89 33
    000    06    10    R3 W   D 01023    F 00000    T 89 41
    000    06    10    R2 W   D 01036    F 00000    T 89 56
    000    06    10    R1     D 01047    F 00000    T 90 03
    000    06    10    R2 W   D 01047    F 00000    T 90 08
    000    06    10    R1     D 01047    F 00000    T 90 41
    000    06    10    R2 W   D 01047    F 00000    T 90 43
    000    06    10    R1     D 01047    F 00000    T 90 44
    000    06    10    R2 W   D 01047    F 00000    T 90 49
    000    06    10    R1     D 01047    F 00000    T 90 57
    000    06    10    R2 W   D 01047    F 00000    T 90 59
    000    06    10    R1     D 01047    F 00000    T 91 02
    000    06    10    R2 W   D 01047    F 00000    T 91 04
    000    06    10    R1     D 01053    F 00000    T 91 08
    000    06    10    R2 W   D 01091    F 00000    T 92 01
    000    06    10    R1     D 01098    F 00000    T 92 02
CP  061    06    10    R1     D 01171    F 00000    T 92 55
    000    06    10    R2 E   D 01251    F 00000    T 93 34
    000    06    10    R1     D 01260    F 00000    T 93 35
    000    06    10    R2 E   D 01278    F 00000    T 93 38
    000    06    10    R1     D 01280    F 00000    T 93 39
    000    06    10    R2 E   D 01287    F 00000    T 93 40
    000    06    10    R3 E   D 01312    F 00000    T 94 01
    000    06    10    R2 E   D 01312    F 00000    T 94 04
    000    06    10    R3 E   D 01370    F 00000    T 94 21
    000    06    10    R2 E   D 01392    F 00000    T 94 24
    000    06    10    R3 E   D 01408    F 00000    T 94 26
    000    06    12    R2 W   D 01428    F 00000    T 94 28
    000    06    12    R1     D 01505    F 00000    T 94 35
CP  062    06    12    R1     D 01631    F 00000    T 94 46
TA  064    06    12    R1     D 01650    F 00000    T 94 49
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.L CTO:DUMPUM.LDA Secondary

B.K. 12/15/76

.ST 14156

RUN 008 SAMPLE RATE 00.5 YEAR 76 MONTH 12 DAY 14 HOUR 12 MIN 40

FIFTH WHEEL		FEET/PULSE	0002		ODOMETER	FEET/PULSE	0002
000	06	12	R1		00127	F 00000	T 00 26
TA 064	06	12	R1		00219	F 00000	T 01 10
CP 001	06	12	R1		00247	F 00000	T 01 14
000	06	12	R2	N	00323	F 00000	T 01 22
000	08	12	R3	S	00386	F 00000	T 01 27
000	06	12	R2	N	00454	F 00000	T 01 32
000	08	12	R1		00523	F 00000	T 01 38
CP 002	08	12	R1		00590	F 00000	T 02 15
000	08	12	R2	N	00714	F 00000	T 02 31
000	08	12	R1		00741	F 00000	T 02 33
000	08	12	R2	N	00753	F 00000	T 02 34
000	10	12	R3	S	00758	F 00000	T 02 35
000	08	12	R2	N	00778	F 00000	T 02 37
000	10	12	R3	S	00797	F 00000	T 02 41
000	10	12	R2	S	00856	F 00000	T 03 32
000	10	12	R1		00873	F 00000	T 03 35
CP 003	10	12	R1		00941	F 00000	T 03 43
TA 029	10	12	R1		00956	F 00000	T 03 46
000	10	12	R2	S	01045	F 00000	T 03 55
000	10	12	R2	N	01058	F 00000	T 03 56
TA 080	12	12	R3	S	01119	F 00000	T 04 01
000	10	12	R2	N	01125	F 00000	T 04 02
000	12	12	R2	S	01178	F 00000	T 04 06
000	12	12	R1		01232	F 00000	T 04 20
TA 019	12	12	R1		01274	F 00000	T 04 25
CP 004	12	12	R1		01361	F 00000	T 04 36
000	19	16	R2	S	01396	F 00000	T 04 41
000	12	12	R2	W	01407	F 00000	T 04 42
TA 018	12	12	R2	W	01416	F 00000	T 04 44
000	12	10	R3	E	01438	F 00000	T 04 48
000	19	16	R2	S	01464	F 00000	T 04 51
000	17	16	R3	N	01474	F 00000	T 04 52
000	17	16	R2	N	01490	F 00000	T 04 53
000	17	16	R1		01526	F 00000	T 04 56
000	17	16	R2	S	01656	F 00000	T 05 23
000	17	16	R1		01656	F 00000	T 05 29
000	10	10	R3	E	01727	F 00000	T 05 45
CP 005	10	10	R3	E	01732	F 00000	T 05 45
000	17	16	R2	S	01736	F 00000	T 05 46
000	16	16	R3	N	01796	F 00000	T 05 52
000	16	16	R2	N	01850	F 00000	T 05 56
000	17	16	R3	S	01856	F 00000	T 05 57
000	16	16	R1		01869	F 00000	T 05 58
000	16	16	R2	N	01901	F 00000	T 06 00
000	15	16	R3	N	02028	F 00000	T 06 14
000	16	16	R2	S	02052	F 00000	T 06 37
000	15	16	R3	N	02058	F 00000	T 06 39
TA 044	15	16	R3	N	02070	F 00000	T 06 41
000	15	16	R2	N	02084	F 00000	T 06 44
000	15	16	R1		02087	F 00000	T 06 44
CP 006	15	16	R1		02092	F 00000	T 06 45
000	08	12	R2	W	02098	F 00000	T 06 46
000	08	12	R3	W	02109	F 00000	T 06 48

Secondary

B.K. 12/15/76

.L CT0:DUMPUM.LDA

.ST 14156

RUN 009 SAMPLE RATE 00.5 YEAR 76 MONTH 12 DAY 14 HOUR 14 MIN 20

	FIFTH WHEEL FEET/PULSE 0002				ODOMETER FEET/PULSE 0002		
TP CP	000	06	12	R1	D 00117	F 00000	T 00 38
CP	064	06	12	R1	D 00215	F 00000	T 00 51
CP	001	06	12	R1	D 00237	F 00000	T 00 54
	000	06	12	R2 N	D 00335	F 00000	T 01 02
	000	08	12	R3 S	D 00365	F 00000	T 01 04
	000	06	12	R2 N	D 00388	F 00000	T 01 05
	000	08	12	R2 S	D 00410	F 00000	T 01 07
	000	08	12	R3 S	D 00423	F 00000	T 01 08
	000	06	12	R2 N	D 00445	F 00000	T 01 10
	000	06	12	R3 N	D 00456	F 00000	T 01 11
	000	08	12	R2 S	D 00465	F 00000	T 01 13
	000	08	12	R1	D 00510	F 00000	T 01 40
CP	002	08	12	R1	D 00579	F 00000	T 01 50
	000	08	12	R2 N	D 00702	F 00000	T 02 07
	000	10	12	R3 S	D 00710	F 00000	T 02 08
	000	08	12	R1	D 00718	F 00000	T 02 09
	000	08	12	R2 N	D 00732	F 00000	T 02 10
	000	10	12	R3 S	D 00749	F 00000	T 02 12
	000	08	12	R2 N	D 00762	F 00000	T 02 14
	000	10	12	R3 S	D 00786	F 00000	T 02 23
	000	08	12	R2 N	D 00792	F 00000	T 02 24
	000	10	12	R3 S	D 00795	F 00000	T 02 25
	000	10	12	R2 S	D 00854	F 00000	T 02 34
	000	10	12	R1	D 00865	F 00000	T 02 35
	000	10	12	R2 S	D 00875	F 00000	T 02 36
	000	10	12	R1	D 00886	F 00000	T 02 37
CP	003	10	12	R1	D 00931	F 00000	T 02 41
TA	029	10	12	R1	D 00951	F 00000	T 02 44
	000	10	12	R2 S	D 01042	F 00000	T 02 52
	000	10	12	R2 N	D 01049	F 00000	T 02 52
TA	080	10	12	R2 N	D 01119	F 00000	T 02 57
	000	12	12	R1	D 01227	F 00000	T 03 17
TA	019	12	12	R1	D 01268	F 00000	T 03 22
CP	004	19	16	R2 S	D 01353	F 00000	T 03 32
	000	12	12	R1	D 01358	F 00000	T 03 33
	000	12	12	R2 W	D 01404	F 00000	T 03 38
TA	018	12	12	R2 W	D 01415	F 00000	T 03 40
	000	19	16	R2 S	D 01418	F 00000	T 03 41
	000	12	12	R2 W	D 01430	F 00000	T 03 43
	000	19	16	R2 S	D 01437	F 00000	T 03 44
	000	12	12	R3 W	D 01452	F 00000	T 03 45
	000	17	16	R2 N	D 01495	F 00000	T 03 49
	000	17	16	R3 N	D 01501	F 00000	T 03 49
	000	17	16	R2 N	D 01516	F 00000	T 03 50
	000	17	16	R1	D 01531	F 00000	T 03 51
	000	17	16	R2 N	D 01666	F 00000	T 04 12
	000	16	16	R3 N	D 01666	F 00000	T 04 13
	000	17	16	R2 S	D 01666	F 00000	T 04 13
	000	17	16	R2 N	D 01666	F 00000	T 04 14

.L CT0:DUMPUM.LDA

Empirical Demo.

.ST 14156

RUN 010 SAMPLE RATE 00.5 YEAR 76 MONTH 12 DAY 14 HOUR 17 MIN 05

	FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002			
	000	06	12	R1		00116	F 00000	T	01 20
TA	064	06	12	R1		00193	F 00000	T	02 11
CP	001	06	12	R1		00234	F 00000	T	02 16
	000	06	12	R2	N	00350	F 00000	T	02 27
	000	06	12	R3	N	00370	F 00000	T	02 29
	000	06	12	R2	N	00394	F 00000	T	02 34
	000	08	12	R3	S	00395	F 00000	T	02 35
	000	06	12	R2	N	00396	F 00000	T	02 47
	000	08	12	R3	S	00396	F 00000	T	02 49
	000	06	12	R2	N	00396	F 00000	T	02 51
	000	08	12	R3	S	00396	F 00000	T	02 52
	000	06	12	R2	N	00396	F 00000	T	03 06
	000	08	12	R3	S	00396	F 00000	T	03 09
	000	06	12	R2	N	00396	F 00000	T	03 18
	000	08	12	R3	S	00396	F 00000	T	03 18
	000	06	12	R2	N	00396	F 00000	T	03 19
	000	08	12	R3	S	00396	F 00000	T	03 20
	000	06	12	R2	N	00399	F 00000	T	03 22
	000	08	12	R3	S	00404	F 00000	T	03 23
	000	08	12	R2	S	00404	F 00000	T	03 34
	000	06	12	R2	N	00404	F 00000	T	03 34
	000	06	12	R3	N	00404	F 00000	T	03 36
	000	06	12	R2	N	00404	F 00000	T	03 36
	000	06	12	R3	N	00404	F 00000	T	03 37
	000	06	12	R2	N	00405	F 00000	T	03 38
	000	06	12	R3	N	00411	F 00000	T	03 40
	000	06	12	R2	N	00422	F 00000	T	03 44
	000	08	12	R3	S	00424	F 00000	T	03 45
	000	08	12	R2	S	00437	F 00000	T	04 21
	000	08	12	R1		00503	F 00000	T	05 20
CP	002	08	12	R1		00566	F 00000	T	06 14
	000	08	12	R2	N	00612	F 00000	T	06 24
	000	08	12	R1		00623	F 00000	T	06 26
	000	08	12	R2	N	00664	F 00000	T	06 40
	000	08	12	R1		00667	F 00000	T	06 40
	000	08	12	R2	N	00681	F 00000	T	06 43
	000	08	12	R1		00697	F 00000	T	06 46
	000	08	12	R2	N	00703	F 00000	T	06 47
	000	08	12	R1		00705	F 00000	T	06 47
	000	10	12	R3	S	00730	F 00000	T	06 52
	000	08	12	R2	N	00754	F 00000	T	06 58
	000	10	12	R3	S	00770	F 00000	T	07 04
	000	08	12	R2	N	00770	F 00000	T	07 45
	000	08	12	R3	N	00770	F 00000	T	07 46
	000	10	12	R2	S	00814	F 00000	T	08 03
	000	10	12	R3	S	00817	F 00000	T	08 03
	000	10	12	R2	S	00832	F 00000	T	08 05
	000	10	12	R1		00840	F 00000	T	08 06
	000	10	12	R2	S	00866	F 00000	T	08 09
	000	10	12	R1		00870	F 00000	T	08 10
CP	003	10	12	R1		00914	F 00000	T	08 18
TA	029	10	12	R1		00929	F 00000	T	08 20

3.2 RANDOM ROUTE DATA PROCESSING RESULTS

3.2.1 Location Subsystem (Checkpoint) Results

This subsection contains the results obtained by processing random route test data for Runs 1-10 through use of the CPMAIN program. A complete listing of the CPMAIN output for Run 4 is included. The error frequency density and cumulative error statistics for each of the other nine runs are also included.

Two data sheets are shown for Run 10. The first includes only 42 checkpoints. This run was processed by the computer. Note the occurrence of an error in the 1350-1375 foot range. This error is not a valid checkpoint, for it was processed at Checkpoint 44 which was erroneously entered for Turn 44 between Checkpoints 5 and 6 as noted in Table 5-13 of Volume I of this report and in Table 3.3-1 of this Appendix. The second data sheet for Run 10 includes the results of manually computing the errors at Checkpoints 42 through 62 for Run 10 which could not be processed as a result of tape read errors.

RANDOM ROUTE RUN 4 CPMAIN OUTPUT

T M-LAR LISTING

CP	X(CP)	Y(CP)	LOCATION	REGION	X(SP)	Y(SP)	ERROR
1	8180	5707	6,12	R1	[illegible]	5673	32
2	7635	6154	[illegible]	R1	[illegible]	[illegible]	145
3	7321	5782	[illegible]	R3E	6865	7846	460
4	6852	7846	13,10	R2N	6865	7846	13
5	6455	6268	13,14	R1	6321	6307	139
6	6009	6222	15,13	R1	6026	6358	137
7	5585	6389	8, 6	R3S	5585	6389	0
8	5705	7100	16,11	R1	5553	7099	152
9	6369	7383	10, 7	R1	6379	7344	40
10	7500	7204	10,10	R1	7500	7204	0
11	8211	7127	10,12	R2W	8069	7104	143
12	8298	7738	12,12	R1	8321	7721	28
13	7515	7919	12,10	R1	7591	7859	96
14	6741	8159	12, 8	R3N	6739	8205	46
15	7147	8153	19,15	R1	7147	8153	0
16	7969	7159	10,10	R3E	7969	7159	0
17	7891	6661	16,16	R1	7910	6813	156
18	6956	6572	15,15	R2N	6956	6572	0
19	6580	6988	16,14	R1	6427	7006	154
20	6655	7544	10, 8	R2N	6656	7528	16
21	6714	7933	12, 8	R1	6714	7933	0
22	7157	8093	19,15	R1	7147	8153	60
23	6464	8014	12, 7	R1	6523	7974	71
24	5867	8275	12, 6	R1	5837	8045	231
25	6296	8232	19,13	R1	6300	8282	50
26	6239	7764	17,13	R1	6219	7561	203
27	6156	7203	16,13	R3N	6170	7301	98
28	6075	6713	8, 7	R1	6298	6690	224
29	5684	6934	[illegible], 6	R1	5644	6735	202
30	5809	7838	12, 6	R1	5837	8045	208
31	6456	7919	12, 7	R1	6523	7974	86
32	7090	7702	17,15	R1	7090	7458	244
33	6996	6930	16,15	R1	6996	6930	0
34	6920	6239	15,15	R1	6909	6376	137
35	6316	6285	15,14	R1	6321	6307	22
36	5756	6411	15,11	R3E	5585	6389	172
37	5705	7100	16,11	R1	5553	7099	152
38	5809	7838	12, 6	R2S	5801	7837	8
39	6710	7886	12, 8	R1	6714	7933	47

CT1:RUN004.001

40	7589	7840	12,10	R1	7591	7859	19
41	7969	7159	10,10	R3E	7969	7159	0
42	7444	6878	8,10	R3N	7444	6878	0
43	6958	6590	15,15	R3N	6956	6572	18
44	6580	6988	16,14	R1	6427	7006	154
45	6102	6886	16,17	R1	6122	7042	157

RANDOM ROUTE RUN 4 CPMAIN OUTPUT

46	5996	6139	15,13	R1	6026	6358	221
47	5553	6009	0, 6	R1	5553	6009	0
48	5585	6389	8, 6	R3S	5585	6389	0
49	5705	7100	16,11	R1	5553	7099	152
50	5809	7838	12, 6	R1	5837	8045	208
51	6239	7764	17,13	R1	6219	7561	203
52	6507	7341	10, 7	R3E	6503	7335	7
53	7055	7276	16,15	R3N	7045	7181	95
54	7715	7176	10,10	R2E	7785	7154	73
55	7891	6661	16,16	R1	7910	6813	153
56	7837	6109	15,16	R2S	7814	5989	122
57	7561	5756	6,10	R1	7321	5782	241
58	6865	5846	13,15	R1	6842	5691	156
59	5988	5938	6, 8	R2W	6135	5934	147
60	5988	5938	6, 8	R3W	5988	5938	0
61	6865	5846	13,15	R1	6842	5691	156
62	7561	5756	6,10	R1	7321	5782	241
63	8176	5673	6,12	R1	8176	5673	0

EVENT	MIN SEC	
58	0:47	VALID

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	20	31.75%
25-	50	5	7.94%
50-	75	4	6.35%
75-	100	4	6.35%
100-	125	1	1.59%
125-	150	6	9.52%
150-	175	11	17.46%
200-	225	7	11.11%
225-	250	4	6.35%
450-	475	1	1.59%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCE... ERROR
0	13	20.63%
25	20	31.75%
50	26	41.27%
75	29	46.03%
100	33	52.38%
125	34	53.97%
150	40	63.49%
175	51	80.95%
225	58	92.06%
250	62	98.41%
475	63	100.00%

RANDOM ROUTE RUN 4 CPMAIN OUTPUT

SOFTED ERROR VALUES

ERROR	CP #		
0	7	153	17
0	10	153	55
0	15	154	19
0	16	154	44
0	18	156	58
0	21	156	61
0	33	157	45
0	41	172	36
0	42	202	29
0	47	203	26
0	48	203	51
0	60	208	30
0	63	208	50
7	52	221	46
8	38	224	28
13	4	231	24
16	20	241	57
18	43	241	62
19	40	244	32
22	35	460	3
28	12		
32	1		
40	9		
46	14		
47	39		
50	25		
60	22		
71	23		
73	54		
86	31		
95	53		
96	13		
98	27		
122	55		
137	6		
137	34		
139	5		
143	11		
145	2		
147	59		
152	8		
152	37		
152	49		

AVERAGE ERROR = 103.05
STANDARD DEVIATION = 92.83
ELAPSED TIME = 86:17
ELAPSED DISTANCE = 0.00 (FIFTH WHEEL)
ELAPSED DISTANCE = 39758.00 (ODOMETER)

RANDOM ROUTE ERROR STATISTICS, RUN 1

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	21	33.87%
25- 50	7	11.29%
50- 75	3	4.84%
75- 100	3	4.84%
100- 125	1	1.61%
125- 150	6	9.68%
150- 175	11	17.74%
175- 200	1	1.61%
200- 225	6	9.68%
225- 250	2	3.23%
450- 475	1	1.61%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	13	20.97%
25	21	33.87%
50	29	46.77%
75	31	50.00%
100	34	54.84%
125	35	56.45%
150	41	66.13%
175	52	83.87%
200	53	85.48%
225	59	95.16%
250	61	98.39%
475	62	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 2

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	22	34.92%
25- 50	6	9.52%
50- 75	3	4.76%
75- 100	3	4.76%
100- 125	1	1.59%
125- 150	6	9.52%
150- 175	9	14.29%
200- 225	7	11.11%
225- 250	4	6.35%
350- 375	1	1.59%
450- 475	1	1.59%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	14	22.22%
25	22	34.92%
50	29	46.03%
75	31	49.21%
100	34	53.97%
125	35	55.56%
150	41	65.08%
175	50	79.37%
225	57	90.48%
250	61	96.83%
375	62	98.41%
475	63	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 3

'ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	18	29.03%
25-	50	7	11.29%
50-	75	3	4.84%
75-	100	3	4.84%
100-	125	1	1.61%
125-	150	5	8.06%
150-	175	11	17.74%
200-	225	8	12.90%
225-	250	2	3.23%
250-	275	1	1.61%
275-	300	1	1.61%
300-	325	1	1.61%
450-	475	1	1.61%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	12	19.35%
25	18	29.03%
50	26	41.94%
75	28	45.16%
100	31	50.00%
125	32	51.61%
150	37	59.68%
175	48	77.42%
225	56	90.32%
250	58	93.55%
275	60	96.77%
325	61	98.39%
475	62	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 4

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	20	31.75%
25-	50	5	7.94%
50-	75	4	6.35%
75-	100	4	6.35%
100-	125	1	1.59%
125-	150	6	9.52%
150-	175	11	17.46%
200-	225	7	11.11%
225-	250	4	6.35%
450-	475	1	1.59%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	13	20.63%
25	20	31.75%
50	26	41.27%
75	29	46.03%
100	33	52.38%
125	34	53.97%
150	40	63.49%
175	51	80.95%
225	58	92.06%
250	62	98.41%
475	63	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 5

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	21	32.81%
25- 50	4	6.25%
50- 75	3	4.69%
75- 100	1	1.56%
100- 125	2	3.12%
125- 150	7	10.94%
150- 175	8	12.50%
175- 200	2	3.12%
200- 225	6	9.37%
225- 250	4	6.25%
275- 300	1	1.56%
350- 375	2	3.12%
425- 450	1	1.56%
450- 475	1	1.56%
550- 575	1	1.56%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	15	23.44%
25	21	32.81%
50	26	40.62%
75	28	43.75%
100	29	45.31%
125	31	48.44%
150	38	59.37%
175	46	71.87%
200	48	75.00%
225	54	84.37%
250	58	90.62%
275	59	92.19%
375	61	95.31%
450	62	96.87%
475	63	98.44%
575	64	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 6

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	26	41.94%
25- 50	8	12.90%
50- 75	5	8.06%
75- 100	8	12.90%
100- 125	3	4.84%
125- 150	1	1.61%
150- 175	3	4.84%
175- 200	5	8.06%
225- 250	1	1.61%
275- 300	1	1.61%
400- 425	1	1.61%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	22	35.48%
25	27	43.55%
50	35	56.45%
75	39	62.90%
100	47	75.81%
125	50	80.65%
150	51	82.26%
175	54	87.10%
200	59	95.16%
250	60	96.77%
300	61	98.39%
425	62	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 7

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	36	11.74%
25-	50	4	6.45%
50-	75	7	11.29%
75-	100	11	17.74%
100-	125	2	3.23%
150-	175	4	6.45%
175-	200	5	8.06%
225-	250	1	1.61%
250-	275	1	1.61%
275-	300	1	1.61%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	22	35.48%
25	27	43.55%
50	31	50.00%
75	37	59.68%
100	48	77.42%
125	50	80.65%
175	54	87.10%
200	59	95.16%
250	60	96.77%
275	61	98.39%
300	62	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 8

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	25	40.98%
25-	50	7	11.48%
50-	75	7	11.48%
75-	100	8	13.11%
100-	125	1	1.64%
150-	175	3	4.92%
175-	200	4	6.56%
225-	250	3	4.92%
250-	275	1	1.64%
300-	325	1	1.64%
400-	425	1	1.64%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	21	34.43%
25	26	42.62%
50	33	54.10%
75	39	63.93%
100	47	77.05%
125	48	78.69%
175	51	83.61%
200	55	90.16%
225	56	91.80%
250	59	96.72%
325	60	98.36%
425	61	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 9

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	26	41.27%
25- 50	5	7.94%
50- 75	7	11.11%
75- 100	9	14.29%
100- 125	2	3.17%
125- 150	2	3.17%
150- 175	3	4.76%
175- 200	6	9.52%
225- 250	1	1.59%
250- 275	1	1.59%
9950- 9975	1	1.59%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	20	31.75%
25	26	41.27%
50	32	50.79%
75	38	60.32%
100	47	74.60%
125	49	77.78%
150	51	80.95%
175	54	85.71%
200	60	95.24%
250	61	96.83%
275	62	98.41%
9975	63	100.00%

RANDOM ROUTE ERROR STATISTICS, RUN 10

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	12	28.57%
25- 50	5	11.90%
50- 75	3	7.14%
75- 100	6	14.29%
100- 125	1	2.38%
125- 150	2	4.76%
150- 175	4	9.52%
175- 200	2	4.76%
225- 250	2	4.76%
250- 275	1	2.38%
275- 300	1	2.38%
350- 375	1	2.38%
375- 400	1	2.38%
1350- 1375	1	2.38%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	9	21.43%
25	13	30.95%
50	17	40.48%
75	20	47.62%
100	26	61.90%
125	27	64.29%
150	29	69.05%
175	33	78.57%
200	35	83.33%
225	36	85.71%
250	38	90.48%
300	39	92.86%
375	40	95.24%
400	41	97.62%
1375	42	100.00%

3.2.2 AVM System (Pseudo Checkpoint) Results

This subsection contains results obtained by processing random route Runs 1-10 through use of the RRSL program. Complete results are presented for Random Route Run4 . The tabular output error frequency density and cumulative error statistics for each of the other nine runs are presented. Following the RRSL results obtained by processing Run 10 are the results of computing the location errors at pseudo checkpoints which could not be processed by RRSL. This data is followed by the tabulated error statistics for the case of 0 and 5 percent communication errors.

RANDOM ROUTE AVM SYSTEM RUN 1

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	31	11.52%
25- 50	39	14.50%
50- 75	39	14.50%
75- 100	36	13.38%
100- 125	24	8.92%
125- 150	12	4.46%
150- 175	23	8.55%
175- 200	14	5.20%
200- 225	24	8.92%
225- 250	12	4.46%
250- 275	7	2.60%
300- 325	1	0.37%
325- 350	2	0.74%
350- 375	1	0.37%
425- 450	1	0.37%
450- 475	1	0.37%
550- 575	1	0.37%
600- 625	1	0.37%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	2	0.74%
25	32	11.90%
50	70	26.02%
75	111	41.26%
100	147	54.65%
125	171	63.57%
150	181	67.29%
175	205	76.21%
200	219	81.41%
225	242	89.96%
250	254	94.42%
275	261	97.03%
325	262	97.40%
350	264	98.14%
375	265	98.51%
450	266	98.88%
475	267	99.26%
575	268	99.63%
625	269	100.00%

AVERAGE ERROR = 115.44
STANDARD DEVIATION = 91.16
ELAPSED TIME = 5400

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	31	11.52%
25- 50	39	14.50%
50- 75	38	14.13%
75- 100	36	13.38%
100- 125	23	8.55%
125- 150	12	4.46%
150- 175	23	8.55%
175- 200	16	5.95%
200- 225	24	8.92%
225- 250	12	4.46%
250- 275	7	2.60%
300- 325	1	0.37%
325- 350	2	0.74%
350- 375	1	0.37%
425- 450	1	0.37%
450- 475	1	0.37%
550- 575	1	0.37%
600- 625	1	0.37%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	2	0.74%
25	32	11.90%
50	70	26.02%
75	110	40.89%
100	146	54.28%
125	169	62.83%
150	179	66.54%
175	203	75.46%
200	219	81.41%
225	242	89.96%
250	254	94.42%
275	261	97.03%
325	262	97.40%
350	264	98.14%
375	265	98.51%
450	266	98.88%
475	267	99.26%
575	268	99.63%
625	269	100.00%

AVERAGE ERROR = 116.19
STANDARD DEVIATION = 91.29
ELAPSED TIME = 5400

RANDOM ROUTE AVM SYSTEM RUN 2

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	47	20.52%
25- 50	36	15.72%
50- 75	30	13.10%
75- 100	18	7.86%
100- 125	18	7.86%
125- 150	14	6.11%
150- 175	16	6.99%
175- 200	15	6.55%
200- 225	4	1.75%
225- 250	5	2.18%
250- 275	6	2.62%
275- 300	6	2.62%
300- 325	5	2.18%
325- 350	2	0.87%
350- 375	3	1.31%
400- 425	1	0.44%
425- 450	1	0.44%
450- 475	1	0.44%
475- 500	1	0.44%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	2	0.87%
25	49	21.40%
50	84	36.68%
75	114	49.78%
100	131	57.21%
125	150	65.50%
150	164	71.62%
175	179	78.17%
200	194	84.72%
225	200	87.34%
250	203	88.65%
275	210	91.70%
300	215	93.89%
325	220	96.07%
350	222	96.94%
375	225	98.25%
425	226	98.69%
450	227	99.13%
475	228	99.56%
500	229	100.00%

AVERAGE ERROR = 110.45

STANDARD DEVIATION = 99.21

ELAPSED TIME = 4819

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	48	20.96%
25- 50	36	15.72%
50- 75	30	13.10%
75- 100	18	7.86%
100- 125	18	7.86%
125- 150	14	6.11%
150- 175	16	6.99%
175- 200	15	6.55%
200- 225	4	1.75%
225- 250	4	1.75%
250- 275	6	2.62%
275- 300	6	2.62%
300- 325	5	2.18%
325- 350	2	0.87%
350- 375	3	1.31%
400- 425	1	0.44%
425- 450	1	0.44%
450- 475	1	0.44%
475- 500	1	0.44%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	2	0.87%
25	50	21.83%
50	85	37.12%
75	115	50.22%
100	132	57.64%
125	151	65.94%
150	165	72.05%
175	180	78.60%
200	195	85.15%
225	200	87.34%
250	203	88.65%
275	210	91.70%
300	215	93.89%
325	220	96.07%
350	222	96.94%
375	225	98.25%
425	226	98.69%
450	227	99.13%
475	228	99.56%
500	229	100.00%

AVERAGE ERROR = 109.47

STANDARD DEVIATION = 99.18

ELAPSED TIME = 4819

RANDOM ROUTE AVM SYSTEM RUN 3

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	31	15.50%
25- 50	32	16.00%
50- 75	26	13.00%
75- 100	15	7.50%
100- 125	21	10.50%
125- 150	13	6.50%
150- 175	18	9.00%
175- 200	10	5.00%
200- 225	11	5.50%
225- 250	8	4.00%
250- 275	4	2.00%
275- 300	3	1.50%
300- 325	1	0.50%
325- 350	2	1.00%
350- 375	2	1.00%
375- 400	1	0.50%
400- 425	1	0.50%
550- 575	1	0.50%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	3	1.50%
25	31	15.50%
50	63	31.50%
75	89	44.50%
100	104	52.00%
125	125	62.50%
150	139	69.50%
175	157	78.50%
200	166	83.00%
225	177	88.50%
250	186	93.00%
275	189	94.50%
300	192	96.00%
325	193	96.50%
350	195	97.50%
375	197	98.50%
400	198	99.00%
425	199	99.50%
575	200	100.00%

AVERAGE ERROR = 113.59
STANDARD DEVIATION = 92.84
ELAPSED TIME = 4111

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	31	15.50%
25- 50	32	16.00%
50- 75	27	13.50%
75- 100	15	7.50%
100- 125	21	10.50%
125- 150	13	6.50%
150- 175	18	9.00%
175- 200	10	5.00%
200- 225	11	5.50%
225- 250	8	4.00%
250- 275	4	2.00%
275- 300	3	1.50%
300- 325	1	0.50%
325- 350	1	0.50%
350- 375	2	1.00%
375- 400	1	0.50%
400- 425	1	0.50%
550- 575	1	0.50%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	3	1.50%
25	31	15.50%
50	63	31.50%
75	90	45.00%
100	105	52.50%
125	126	63.00%
150	140	70.00%
175	158	79.00%
200	167	83.50%
225	178	89.00%
250	187	93.50%
275	190	95.00%
300	193	96.50%
325	194	97.00%
350	195	97.50%
375	197	98.50%
400	198	99.00%
425	199	99.50%
575	200	100.00%

AVERAGE ERROR = 112.29
STANDARD DEVIATION = 91.61
ELAPSED TIME = 4111

RANDOM ROUTE AVM SYSTEM RUN 4

PSEUDO CP #	ERROR	TIME	ODOMETER
1	352	2:12	703
2	51	2:32	836
3	41	2:52	988
4	79	3:12	1122
5	12	3:32	1231
6	57	3:52	1352
7	57	4:12	1352
8	181	4:32	1462
9	73	4:52	1558
10	19	5:12	1611
11	93	5:32	1775
12	3	5:52	1823
13	376	6:12	1954
14	15	6:32	2068
15	21	6:52	2212
16	153	7:12	2296
17	44	7:32	2428
18	91	7:52	2525
19	32	8:12	2610
20	10	8:32	2621
21	31	8:52	2749
22	150	9:12	2904
23	18	9:32	2970
24	120	9:52	3104
25	241	10:12	3252
26	384	10:32	3366
27	85	10:52	3533
28	67	11:12	3543
29	66	11:32	3712
30	195	11:52	3902
31	129	12:12	4085
32	46	12:32	181
33	150	12:52	330
34	6	13:12	394
35	38	13:32	576
36	420	13:52	726
37	16	14:12	924
38	22	14:32	1048
39	32	14:52	1073
40	74	15:12	1261
41	69	15:32	1264
42	52	15:52	1275
43	341	16:12	1464
44	138	16:32	1671
45	76	16:52	1813
46	25	17:12	1931
47	66	17:32	2091
48	53	17:52	2151
49	221	18:12	2235
50	153	18:32	2334
51	137	18:52	2342
52	137	19:12	2342
53	138	19:32	2479
54	244	19:52	2696
55	171	20:12	2792
56	258	20:32	2955
57	217	20:52	3110
58	181	21:12	3199
59	59	21:32	3373
60	10	21:52	3554
61	243	22:12	3721
62	13	22:32	3836

RANDOM ROUTE AVM SYSTEM RUN 4 (CONT'D)

			ODOMETER
62	13	22:32	3836
63	326	22:52	3966
64	194	23:12	26
65	34	23:32	88
66	13	23:52	112
67	4	24:12	270
68	86	24:32	381
69	121	24:52	485
70	66	25:12	608
71	41	25:32	776
72	68	25:52	879
73	201	26:12	946
74	201	26:32	946
75	55	26:52	1023
76	70	27:12	1166
77	70	27:32	1166
78	124	27:52	1250
79	296	28:12	1437
80	53	28:32	1622
81	27	28:52	1631
82	209	29:12	1722
83	319	29:32	1853
84	404	29:52	1998
85	165	30:12	2108
86	72	30:32	2133
87	72	30:52	2133
88	255	31:12	2260
89	33	31:32	2415
90	178	31:52	2488
91	85	32:12	2574
92	91	32:32	2719
93	226	32:52	2851
94	162	33:12	2993
95	58	33:32	3045
96	166	33:52	3152
97	155	34:12	3259
98	298	34:32	3371
99	83	34:52	3374
100	124	35:12	3476
101	179	35:32	3641
102	89	35:52	3686
103	182	36:12	3794
104	107	36:32	3930
105	63	36:52	32
106	71	37:12	219
107	65	37:32	340
108	32	37:52	489
109	55	38:12	610
110	0	38:32	773
111	34	38:52	936
112	64	39:12	1083
113	62	39:32	1206
114	172	39:52	1340
115	66	40:12	1394
116	164	40:32	1511
117	43	40:52	1558
118	78	41:12	1665
119	6	41:32	1800
120	92	41:52	1937
121	221	42:12	2094
122	168	42:32	2225
123	52	42:52	2382

RANDOM ROUTE AVM SYSTEM RUN 4 (CONT'D)			ODOMETER
125	169	43:32	2589
126	82	43:52	2692
127	99	44:12	2877
128	65	44:32	3078
129	58	44:52	3083
130	48	45:12	3117
131	91	45:32	3309
132	179	45:52	3355
133	242	46:19	3451
134	215	46:39	3636
135	265	46:59	3824
136	81	47:19	3885
137	81	47:39	3885
138	150	47:59	4003
139	72	48:19	37
140	209	48:39	151
141	15	48:59	228
142	208	49:19	340
143	28	49:39	463
144	97	50:13	580
145	97	50:47	580
146	97	51:21	580
147	97	51:55	580
148	97	52:29	580
149	97	53: 3	580
150	97	53:37	580
151	97	54:12	580
152	97	54:46	580
153	97	55:20	580
154	97	55:54	580
155	97	56:28	580
156	97	57: 2	580
157	97	57:36	580
158	59	57:56	599
159	29	58:16	614
160	16	58:36	637
161	127	58:56	799
162	63	59:16	831
163	65	59:36	875
164	10	59:56	1017
165	110	60:16	1134
166	10	60:36	1254
167	306	60:56	1383
168	230	61:16	1520
169	179	61:36	1665
170	11	61:56	1781
171	100	62:16	1781
172	133	62:36	1847
173	148	62:56	1986
174	106	63:16	2007
175	106	63:36	2007
176	61	63:56	2046
177	111	64:16	2189
178	28	64:36	2192
179	52	64:56	2234
180	8	65:16	2379
181	8	65:36	2379
182	137	65:56	2452
183	167	66:16	2599
184	29	66:36	2722
185	182	66:56	2824
186	145	67:16	2977
187	123	67:36	2988

RANDOM ROUTE AVM SYSTEM RUN 4 (CONT'D)

			ODOMETER
188	111	67:56	
189	207	68:16	3129
190	297	68:36	3275
191	42	68:56	3403
192	205	69:16	3548
193	21	69:36	3701
194	25	69:56	3761
195	226	70:16	3887
196	287	70:36	3917
197	111	70:56	3976
198	95	71:16	3989
199	163	71:36	50
200	168	71:56	216
201	73	72:16	331
202	51	72:36	448
203	153	72:56	602
204	89	73:16	754
205	59	73:36	916
206	70	73:56	1054
207	60	74:16	1105
208	117	74:36	1250
209	226	74:56	1422
210	157	75:16	1546
211	118	75:36	1714
212	57	75:56	1745
213	259	76:16	1864
214	112	76:36	1976
215	187	76:56	2014
216	68	77:16	2180
217	6	77:36	2211
218	144	78:16	3874
219	43	78:36	4058
220	54	78:56	135
221	54	79:16	135
222	59	79:36	191
223	155	79:56	378
224	105	80:16	556
225	229	80:36	723
226	62	80:56	823
227	62	81:16	823
228	185	81:36	972

SIMULATED ERRORS

EUDO CP #	ERROR	TIME	ODOMETER
1	352	2:12	703
2	51	2:34	851 *
3	41	2:52	988
4	79	3:14	1134
5	12	3:32	1231
6	57	3:52	1352
7	57	4:12	1352
8	181	4:32	1462
9	73	4:52	1558
10	19	5:12	1611
11	93	5:32	1775
12	3	5:52	1823
13	376	6:12	1954
14	15	6:32	2068 *
15	21	6:52	2212
16	67	7:14	2309
17	44	7:32	2428
18	91	7:52	2525

RANDOM ROUTE AVM SYSTEM RUN 4 (CONT'D)			ODOMETER
19	32	8:12	2610
20	10	8:32	2621
21	31	8:52	2749
22	150	9:12	2904
23	18	9:32	2970
24	120	9:52	3104
25	241	10:14	3268
26	384	10:32	3366
27	85	10:52	3533
28	67	11:12	3543
29	66	11:32	3712
30	195	11:52	3902
31	129	12:12	4085
32	46	12:32	181
33	150	12:52	330
34	6	13:12	394
35	38	13:32	576
36	420	13:52	726
37	16	14:12	924
38	22	14:34	1048
39	32	14:52	1073
40	74	15:12	1261
41	69	15:32	1264
42	52	15:52	1275
43	341	16:12	1464
44	138	16:32	1671
45	76	16:52	1813
46	25	17:12	1931
47	66	17:32	2091
48	53	17:52	2151
49	221	18:12	2235
50	153	18:32	2334
51	137	18:52	2342
52	137	19:12	2342
53	138	19:32	2479
54	244	19:52	2696*
55	171	20:12	2792
56	92	20:34	2975
57	217	20:52	3110
58	181	21:12	3199
59	59	21:32	3373*
60	10	21:52	3554
61	50	22:14	3740
62	13	22:32	3836
63	326	22:52	3966
64	194	23:12	26
65	34	23:32	88
66	13	23:52	112
67	4	24:12	270
68	86	24:32	381
69	121	24:52	485
70	66	25:12	608
71	41	25:32	776
72	68	25:52	879
73	201	26:12	946
74	201	26:32	946
75	55	26:52	1023
76	70	27:12	1166
77	70	27:32	1166
78	124	27:52	1250
79	296	28:12	1437
80	53	28:32	1622
81	27	28:52	1631

RANDOM	ROUTE	AVM SYSTEM RUN 4 (CONT'D)	ODOMETER
83	319	29:32	1853
84	404	29:52	1998
85	165	30:12	2108
86	72	30:32	2133
87	72	30:52	2133
88	255	31:12	2260
89	33	31:32	2415
90	178	31:52	2488
91	85	32:12	2574
92	91	32:32	2719
93	226	32:52	2851
94	162	33:12	2993
95	58	33:32	3045
96	166	33:52	3152
97	155	34:12	3259
98	298	34:32	3371
99	83	34:52	3374
100	124	35:12	3476
101	179	35:32	3641
102	89	35:52	3686
103	182	36:12	3794
104	107	36:32	3930
105	63	36:52	32
106	71	37:12	219
107	65	37:32	340
108	32	37:52	489
109	55	38:12	610
110	0	38:32	773
111	34	38:52	936
112	64	39:12	1083
113	62	39:32	1206
114	172	39:52	1340 *
115	66	40:12	1394
116	164	40:34	1525
117	43	40:52	1558
118	78	41:12	1665
119	6	41:32	1800
120	92	41:52	1937
121	221	42:12	2094
122	168	42:32	2225
123	52	42:52	2382
124	67	43:12	2535
125	169	43:32	2589
126	82	43:52	2692
127	99	44:12	2877
128	65	44:32	3078
129	58	44:52	3083
130	48	45:12	3117
131	91	45:32	3309
132	179	45:52	3355
133	242	46:19	3451
134	215	46:39	3636
135	265	46:59	3824
136	81	47:19	3885
137	81	47:39	3885
138	150	47:59	4003
139	72	48:19	37
140	209	48:39	151
141	15	49: 1	234
142	208	49:19	340
143	28	49:39	463
144	97	50:13	580
145	97	50:47	580

CONTINUED

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RANDOM ROUTE AVM SYSTEM RUN 4 (CONT'D)			ODOMETER
146	97	51:21	580
147	97	51:55	580
148	97	52:29	580
149	97	53: 3	580
150	97	53:55	580
151	97	54:12	580
152	97	54:46	580
153	97	55:20	580
154	97	55:54	580
155	97	56:28	580
156	97	57: 2	580
157	97	57:36	580
158	59	57:56	599
159	29	58:16	614
160	16	58:36	637
161	127	58:56	799
162	63	59:16	831
163	65	59:36	875
164	10	59:56	1017
165	110	60:16	1134
166	10	60:36	1254
167	306	60:56	1383
168	230	61:16	1520
169	179	61:36	1665 *
170	11	61:56	1781
171	100	62:18	1781
172	133	62:36	1847
173	148	62:56	1986
174	106	63:16	2007
175	106	63:36	2007
176	61	63:56	2046
177	111	64:16	2189
178	28	64:36	2192
179	52	64:56	2234
180	8	65:16	2379
181	8	65:36	2379
182	137	65:56	2452
183	167	66:16	2599
184	29	66:36	2722
185	182	66:56	2824
186	145	67:16	2977
187	123	67:36	2988
188	111	67:56	2994
189	207	68:16	3129
190	297	68:36	3275 *
191	42	68:56	3403
192	172	69:18	3558
193	21	69:36	3701
194	25	69:56	3761
195	226	70:16	3887
196	287	70:36	3917
197	111	70:56	3976
198	95	71:16	3989
199	163	71:36	50
200	168	71:56	216
201	73	72:16	331
202	51	72:36	448
203	153	72:56	602
204	89	73:16	754
205	59	73:36	916
206	70	73:56	1054
207	60	74:16	1105
208	117	74:36	1250

RANDOM ROUTE AVM SYSTEM RUN 4 (CONT'D)			ODOMETER
208	117	74:36	1250
209	226	74:56	1422
210	157	75:16	1546
211	118	75:36	1714
212	57	75:56	1745
213	259	76:16	1864
214	112	76:36	1976
215	187	76:56	2014
216	68	77:16	2180
217	6	77:36	2211
218	144	78:16	3874
219	43	78:36	4058
220	54	78:58	135
221	54	79:16	135
222	59	79:36	191
223	155	79:56	378
224	105	80:18	577
225	229	80:36	723
226	62	80:56	823
227	62	81:16	823
228	185	81:36	972

RANDOM ROUTE AVM SYSTEM RUN 4

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	25	10.96%
25- 50	23	10.09%
50- 75	52	22.81%
75- 100	34	14.91%
100- 125	17	7.46%
125- 150	11	4.82%
150- 175	20	8.77%
175- 200	12	5.26%
200- 225	10	4.39%
225- 250	8	3.51%
250- 275	3	1.32%
275- 300	4	1.75%
300- 325	2	0.88%
325- 350	2	0.88%
350- 375	1	0.44%
375- 400	2	0.88%
400- 425	2	0.88%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	1	0.44%
25	27	11.84%
50	49	21.49%
75	100	43.86%
100	135	59.21%
125	151	66.23%
150	165	72.37%
175	182	79.82%
200	194	85.09%
225	204	89.47%
250	212	92.98%
275	215	94.30%
300	219	96.05%
325	221	96.93%
350	223	97.81%
375	224	98.25%
400	226	99.12%
425	228	100.00%

AVERAGE ERROR = 111.65
STANDARD DEVIATION = 84.63
ELAPSED TIME = 4784

5% COMMUNICATION ERROR

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	25	10.96%
25- 50	23	10.09%
50- 75	50	21.93%
75- 100	33	14.47%
100- 125	17	7.46%
125- 150	11	4.82%
150- 175	20	8.77%
175- 200	12	5.26%
200- 225	11	4.82%
225- 250	9	3.95%
250- 275	4	1.75%
275- 300	4	1.75%
300- 325	2	0.88%
325- 350	2	0.88%
350- 375	1	0.44%
375- 400	2	0.88%
400- 425	2	0.88%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	1	0.44%
25	27	11.84%
50	48	21.05%
75	98	42.98%
100	132	57.89%
125	148	64.91%
150	162	71.05%
175	179	78.51%
200	191	83.77%
225	202	88.60%
250	211	92.54%
275	215	94.30%
300	219	96.05%
325	221	96.93%
350	223	97.81%
375	224	98.25%
400	226	99.12%
425	228	100.00%

AVERAGE ERROR = 113.75
STANDARD DEVIATION = 85.61
ELAPSED TIME = 4784

RANDOM ROUTE AVM SYSTEM RUN 5

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	30	17.54%
25- 50	19	11.11%
50- 75	25	14.62%
75- 100	14	8.19%
100- 125	14	8.19%
125- 150	10	5.85%
150- 175	9	5.26%
175- 200	9	5.26%
200- 225	10	5.85%
225- 250	3	1.75%
250- 275	10	5.85%
275- 300	1	0.58%
300- 325	3	1.75%
325- 350	4	2.34%
350- 375	1	0.58%
375- 400	4	2.34%
425- 450	2	1.17%
450- 475	1	0.58%
700- 725	2	1.17%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	2	1.17%
25	31	18.13%
50	53	30.99%
75	74	43.27%
100	88	51.46%
125	102	59.65%
150	113	66.08%
175	124	72.51%
200	130	76.02%
225	140	81.87%
250	144	84.21%
275	153	89.47%
300	155	90.64%
325	157	91.81%
350	161	94.15%
375	162	94.74%
400	166	97.08%
450	168	98.25%
475	169	98.83%
725	171	100.00%

AVERAGE ERROR = 131.19
STANDARD DEVIATION = 123.78
ELAPSED TIME = 3445

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	30	17.54%
25- 50	20	11.70%
50- 75	25	14.62%
75- 100	14	8.19%
100- 125	14	8.19%
125- 150	10	5.85%
150- 175	9	5.26%
175- 200	9	5.26%
200- 225	10	5.85%
225- 250	3	1.75%
250- 275	10	5.85%
275- 300	1	0.58%
300- 325	3	1.75%
325- 350	4	2.34%
375- 400	4	2.34%
425- 450	2	1.17%
450- 475	1	0.58%
700- 725	2	1.17%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	2	1.17%
25	31	18.13%
50	54	31.58%
75	75	43.86%
100	89	52.05%
125	103	60.23%
150	114	66.67%
175	125	73.10%
200	131	76.61%
225	141	82.46%
250	145	84.80%
275	154	90.06%
300	156	91.23%
325	158	92.40%
350	162	94.74%
400	166	97.08%
450	168	98.25%
475	169	98.83%
725	171	100.00%

AVERAGE ERROR = 129.31
STANDARD DEVIATION = 122.87
ELAPSED TIME = 3445

RANDOM ROUTE AVM SYSTEM RUN 6

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	28	13.59%
25- 50	33	16.02%
50- 75	29	14.08%
75- 100	23	11.17%
100- 125	14	6.80%
125- 150	27	13.11%
150- 175	11	5.34%
175- 200	8	3.88%
200- 225	5	2.43%
225- 250	9	4.37%
250- 275	3	1.46%
275- 300	6	2.91%
300- 325	4	1.94%
350- 375	1	0.49%
400- 425	3	1.46%
425- 450	2	0.97%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	2	0.97%
25	30	14.56%
50	62	30.10%
75	91	44.17%
100	113	54.85%
125	127	61.65%
150	154	74.76%
175	165	80.10%
200	173	83.98%
225	178	86.41%
250	187	90.78%
275	190	92.23%
300	196	95.15%
325	200	97.09%
375	201	97.57%
425	204	99.03%
450	206	100.00%

AVERAGE ERROR = 113.21
STANDARD DEVIATION = 93.08
ELAPSED TIME = 4141

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	28	13.59%
25- 50	33	16.02%
50- 75	29	14.08%
75- 100	24	11.65%
100- 125	14	6.80%
125- 150	26	12.62%
150- 175	10	4.85%
175- 200	8	3.88%
200- 225	5	2.43%
225- 250	9	4.37%
250- 275	3	1.46%
275- 300	6	2.91%
300- 325	5	2.43%
350- 375	1	0.49%
400- 425	3	1.46%
425- 450	2	0.97%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	2	0.97%
25	30	14.56%
50	62	30.10%
75	91	44.17%
100	114	55.34%
125	128	62.14%
150	154	74.76%
175	164	79.61%
200	172	83.50%
225	177	85.92%
250	186	90.29%
275	189	91.75%
300	195	94.66%
325	200	97.09%
375	201	97.57%
425	204	99.03%
450	206	100.00%

AVERAGE ERROR = 113.67
STANDARD DEVIATION = 93.93
ELAPSED TIME = 4141

RANDOM ROUTE AVM SYSTEM RUN 7

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	32	12.31%
25- 50	32	12.31%
50- 75	35	13.46%
75- 100	31	11.92%
100- 125	35	13.46%
125- 150	19	7.31%
150- 175	21	8.08%
175- 200	15	5.77%
200- 225	6	2.31%
225- 250	14	5.38%
250- 275	5	1.92%
275- 300	6	2.31%
300- 325	1	0.38%
350- 375	1	0.38%
375- 400	3	1.15%
400- 425	3	1.15%
475- 500	1	0.38%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
25	33	12.69%
50	65	25.00%
75	99	38.08%
100	130	50.00%
125	166	63.85%
150	184	70.77%
175	205	78.85%
200	220	84.62%
225	228	87.69%
250	243	93.46%
275	245	94.23%
300	251	96.54%
325	252	96.92%
375	253	97.31%
400	256	98.46%
425	259	99.62%
500	260	100.00%

AVERAGE ERROR = 116.33
STANDARD DEVIATION = 89.38
ELAPSED TIME = 5161

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	32	12.31%
25- 50	33	12.69%
50- 75	36	13.85%
75- 100	31	11.92%
100- 125	35	13.46%
125- 150	19	7.31%
150- 175	20	7.69%
175- 200	14	5.38%
200- 225	6	2.31%
225- 250	14	5.38%
250- 275	5	1.92%
275- 300	6	2.31%
300- 325	1	0.38%
350- 375	1	0.38%
375- 400	3	1.15%
400- 425	3	1.15%
475- 500	1	0.38%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
25	33	12.69%
50	66	25.38%
75	101	38.85%
100	132	50.77%
125	168	64.62%
150	186	71.54%
175	206	79.23%
200	220	84.62%
225	228	87.69%
250	243	93.46%
275	245	94.23%
300	251	96.54%
325	252	96.92%
375	253	97.31%
400	256	98.46%
425	259	99.62%
500	260	100.00%

AVERAGE ERROR = 115.31
STANDARD DEVIATION = 89.35
ELAPSED TIME = 5161

RANDOM ROUTE AVM SYSTEM RUN 8

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	27	10.63%
25-	50	46	18.11%
50-	75	36	14.17%
75-	100	26	10.24%
100-	125	19	7.48%
125-	150	20	7.87%
150-	175	23	9.06%
175-	200	13	5.12%
200-	225	13	5.12%
225-	250	11	4.33%
250-	275	9	3.54%
275-	300	3	1.18%
300-	325	1	0.39%
325-	350	1	0.39%
375-	400	3	1.18%
400-	425	1	0.39%
425-	450	1	0.39%
475-	500	1	0.39%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	3	1.18%
25	28	11.02%
50	74	29.13%
75	109	42.91%
100	135	53.15%
125	155	61.02%
150	176	69.29%
175	197	77.56%
200	210	82.68%
225	224	88.19%
250	235	92.52%
275	243	95.67%
300	246	96.85%
325	247	97.24%
350	248	97.64%
400	251	98.82%
425	252	99.21%
450	253	99.61%
500	254	100.00%

AVERAGE ERROR = 114.63

STANDARD DEVIATION = 89.67

ELAPSED TIME = 5141

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL		NUMBER POINTS	PERCENT OF POINTS
0-	25	27	10.63%
25-	50	47	18.50%
50-	75	37	14.57%
75-	100	27	10.63%
100-	125	19	7.48%
125-	150	20	7.87%
150-	175	23	9.06%
175-	200	13	5.12%
200-	225	13	5.12%
225-	250	11	4.33%
250-	275	7	2.76%
275-	300	3	1.18%
300-	325	1	0.39%
325-	350	1	0.39%
375-	400	3	1.18%
400-	425	1	0.39%
425-	450	1	0.39%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	3	1.18%
25	28	11.02%
50	75	29.53%
75	111	43.70%
100	138	54.33%
125	158	62.20%
150	179	70.47%
175	200	78.74%
200	213	83.86%
225	227	89.37%
250	238	93.70%
275	244	96.06%
300	247	97.24%
325	248	97.64%
350	249	98.03%
400	252	99.21%
425	253	99.61%
450	254	100.00%

AVERAGE ERROR = 111.47

STANDARD DEVIATION = 85.82

ELAPSED TIME = 5141

RANDOM ROUTE AVM SYSTEM RUN 9

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	27	11.74%
25- 50	31	13.48%
50- 75	35	15.22%
75- 100	31	13.48%
100- 125	22	9.57%
125- 150	23	10.00%
150- 175	19	8.26%
175- 200	12	5.22%
200- 225	13	5.65%
225- 250	8	3.48%
250- 275	2	0.87%
275- 300	1	0.43%
300- 325	1	0.43%
325- 350	1	0.43%
350- 375	2	0.87%
400- 425	2	0.87%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	1	0.43%
25	28	12.17%
50	59	25.65%
75	93	40.43%
100	124	53.91%
125	149	64.78%
150	169	73.48%
175	189	82.17%
200	201	87.39%
225	214	93.04%
250	221	96.09%
275	223	96.96%
300	224	97.39%
325	226	98.26%
375	228	99.13%
425	230	100.00%

AVERAGE ERROR = 108.83
STANDARD DEVIATION = 76.97
ELAPSED TIME = 4601

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	27	11.74%
25- 50	31	13.48%
50- 75	35	15.22%
75- 100	31	13.48%
100- 125	23	10.00%
125- 150	23	10.00%
150- 175	19	8.26%
175- 200	12	5.22%
200- 225	12	5.22%
225- 250	8	3.48%
250- 275	2	0.87%
275- 300	1	0.43%
300- 325	1	0.43%
325- 350	1	0.43%
350- 375	2	0.87%
400- 425	2	0.87%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
0	1	0.43%
25	28	12.17%
50	59	25.65%
75	93	40.43%
100	124	53.91%
125	150	65.22%
150	170	73.91%
175	190	82.61%
200	202	87.83%
225	214	93.04%
250	221	96.09%
275	223	96.96%
300	224	97.39%
325	226	98.26%
375	228	99.13%
425	230	100.00%

AVERAGE ERROR = 108.45
STANDARD DEVIATION = 76.68
ELAPSED TIME = 4601

RANDOM ROUTE AVM SYSTEM RUN 10

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	15	9.80%
25- 50	21	13.73%
50- 75	30	19.61%
75- 100	21	13.73%
100- 125	13	8.50%
125- 150	17	11.11%
150- 175	11	7.19%
175- 200	6	3.92%
200- 225	6	3.92%
225- 250	5	3.27%
250- 275	1	0.65%
275- 300	3	1.96%
325- 350	1	0.65%
375- 400	1	0.65%
425- 450	1	0.65%
775- 800	1	0.65%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
25	17	11.11%
50	42	27.45%
75	67	43.79%
100	87	56.86%
125	102	66.67%
150	118	77.12%
175	129	84.31%
200	134	87.58%
225	140	91.50%
250	145	94.77%
275	146	95.42%
300	149	97.39%
350	150	98.04%
400	151	98.69%
450	152	99.35%
800	153	100.00%

AVERAGE ERROR = 109.42
STANDARD DEVIATION = 94.81
ELAPSED TIME = 3063

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NUMBER POINTS	PERCENT OF POINTS
0- 25	13	8.50%
25- 50	21	13.73%
50- 75	30	19.61%
75- 100	22	14.38%
100- 125	13	8.50%
125- 150	17	11.11%
150- 175	11	7.19%
175- 200	7	4.58%
200- 225	6	3.92%
225- 250	5	3.27%
250- 275	1	0.65%
275- 300	3	1.96%
325- 350	1	0.65%
375- 400	1	0.65%
425- 450	1	0.65%
775- 800	1	0.65%

CUMULATIVE ERRORS

ERROR FEET	# ERRORS LT FEET	PERCENT ERRORS
25	15	9.80%
50	40	26.14%
75	65	42.48%
100	86	56.21%
125	101	66.01%
150	117	76.47%
175	128	83.66%
200	134	87.58%
225	140	91.50%
250	145	94.77%
275	146	95.42%
300	149	97.39%
350	150	98.04%
400	151	98.69%
450	152	99.35%
800	153	100.00%

AVERAGE ERROR = 111.07
STANDARD DEVIATION = 94.46
ELAPSED TIME = 3063

MANUALLY PROCESSED RANDOM ROUTE AVM SYSTEM
ERRORS, RUN 10

PCP	ERROR	TIME	ODOM	
154	0	53:34	1032	
5	267	53:54	1538	
6	293	54:14	1618	
7	562	54:34	1626	
8	341	54:54	1700	
9	22	55:14	2150	
160	73	55:34	2590	
1	253	55:54	3006	
2	269	56:14	3588	
3	117	56:34	4222	
4	309	56:54	4578	
5	385	57:14	4984	
6	30	57:34	5248	
7	178	57:54	5336	
8	36	58:14	5426	
9	118	58:34	5958	PCP'=158'
170	182	58:54	6022	
1	171	59:14	6266	
2	30	59:34	6646	
3	126	59:54	6838	
4	67	60:14	7240	
5	52	60:34	7260	
6	58	60:54	7620	
7	229	61:14	7888	
8	228	61:34	7964	
9	80	61:54	8454	
180	92	62:14	8988	
1	89	62:34	9370	
2	62	62:54	9578	
3	123	63:14	9646	
4	269	63:34	10050	
5	82	63:54	10274	
6	35	64:14	10596	
7	56	64:34	10824	
8	291	64:54	11140	
9	20	65:14	11470	
190	109	65:34	11920	PCP'=109'
1	99	65:54	11930	
2	15	66:14	12030	
3	208	66:34	12506	

MANUALLY PROCESSED RANDOM ROUTE AVM SYSTEM
ERRORS, RUN 10 (CONT'D)

PCP	ERROR	TIME	ODOM
194	38	66:54	12744
5	222	67:14	12946
6	169	67:34	13356
7	566	67:54	13754
8	48	68:14	14038
9	48	68:34	14038
200	297	73:14	17368
1	93	73:34	17638
2	91	73:54	17982
3	35	74:14	18028
4	88	74:34	18166
5	86	74:54	18464
6	62	75:14	18918
7	39	75:34	19408
8	53	75:54	19794
9	8	76:14	19856
210	21	76:14	19868

RANDOM ROUTE RUN 10 AVM SYSTEM ERRORS

No Communication Errors

Error Frequency Density	No. Samples
0- 25	21
25- 50	30
50- 75	38
75-100	30
100-125	17
125-150	18
150-175	13
175-200	8
200-225	8
225-250	8
250-275	5
275-300	5
300-325	1
325-350	2
375-400	2
425-450	1
550-575	2
775-800	1

5% Communication Errors

Error Frequency Density	No. Samples
0- 25	21
25- 50	30
50- 75	38
75-100	30
100-125	16
125-150	18
150-175	14
175-200	8
200-225	8
225-250	8
250-275	5
275-300	5
300-325	1
325-350	2
375-400	2
425-450	1
550-575	2
775-800	1

Cumulative Error Distribution

Error	No. Samples LT Error	Percent Samples LT Error
25	21	10.00
50	51	24.29
75	89	42.38
100	119	56.67
125	136	64.76
150	154	73.33
175	167	79.52
200	175	83.33
225	183	87.14
250	191	90.95
275	196	93.33
306	201	95.71
325	202	96.19
350	204	97.14
400	206	98.10
450	207	98.57
575	209	99.52
800	210	100.00

Cumulative Error Distribution

Error	No. Samples LT Error	Percent Samples LT Error
25	21	10.00
50	51	24.29
75	89	42.38
100	119	56.67
125	135	64.28
150	153	72.86
175	167	79.52
200	175	83.33
225	183	87.14
250	191	90.95
275	196	93.33
300	201	95.71
325	202	96.19
350	204	97.14
400	206	98.10
450	207	98.57
575	209	99.52
800	210	100.00

3.2.3 Random Route One-Tenth Mile Averages

This subsection contains the results obtained by processing Random Route Runs 1-10 through use of the RRTEN program. The format is as follows:

Street Segment No:

1 2 3 4 5 6 7 8 9 10

11 12 13 14 .....

Average Errors Over One-Tenth Mile Segments of Random Route Runs 1, 2 and 3

RUN 1 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

59	179	113	102	122	214	106	227	184	56
73	114	96	84	188	51	115	226	78	105
258	100	151	205	367	84	142	152	171	75
* 79	47	154	136	110	158	90	114	161	103

CT1:RUN001.001

122	93	188	173	93	116	117	105	75	75
197	119	57	57	102	128	121	94	113	125
193	118	131	73	137	137	147	105	119	68
51	111	111	155	129	74	204	67	124	114
131	75	122	115	85	121	148	135	174	78

RUN 2 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

168	99	127	76	179	90	75	83	98	68
91	89	51	55	227	43	76	158	106	175
146	114	89	209	358	105	99	142	139	104
86	71	127	144	94	140	76	85	143	146
*198	134	179	60	75	117	225	123	71	83

CT1:RUN002.001

149	89	122	144	194	70	153	161	142	255
208	389	145	119	81	110	73	231	172	71
102	93	132	90	195	142	76	239	67	102
120	79	99	149	115	69	61	96	223	114
74									

RUN 3 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

126	81	57	68	84	102	133	51	72	28
173	152	78	140	45	85	83	236	80	102
88	117	165	142	154	113	324	129	207	125
116	93	70	161	94	71	148	146	146	173
*176	95	129	117	121	181	121	103	151	131

CT1:RUN003.001

110	125	107	129	112	200	96	139	52	335
113	118	110	143	106	104	177	139	116	73
188	62	115	151	110	152	66	99	98	119
81	83	107	81	88	71	77	97	89	

Average Errors Over One-Tenth Mile Segments of Random Route Runs 4, 5 and Composite

RUN 4 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

144	134	95	78	103	80	125	65	75	57
77	263	120	76	169	85	116	202	64	81
148	70	87	166	259	105	112	111	119	151
74	85	114	135	94	160	83	236	190	132
*162	148	129	122	94	100	145	94	87	87

CT1:RUN004.001

123	88	80	125	100	93	113	88	158	160
147	149	110	64	107	139	186	191	116	66
54	118	113	156	118	62	141	91	72	148
63	88	95	80	108	44	76	172	149	101

RUN 5 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

253	149	127	108	75	93	102	295	160	85
46	89	84	78	208	119	212	142	248	139
177	153	93	174	437	359	174	185	97	104
139	106	164	228	103	180	115	125	188	191
231	177	285	102	97	115	270	91	60	119
*110	117	167	147	83	149	194	214	134	75

CT1:RUN005.001

85	151	101	41	153	155	330	406	103	65
139	69	101	149	145	135	85	148	110	119
163	88	60	50	39	82	126	117	88	

COMPOSITE PRIMARY RUNS 1-5
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

150	128	104	87	113	116	108	144	118	59	
92	141	85	112	167	107	120	193	115	120	
163	110	117	179	315	153	170	144	147	112	
99	80	126	161	99	142	102	141	166	149	
178	129	182	115	96	126	176	103	89	99	
138	107	86	120	118	128	135	139	139	190	
149	185	119	88	117	129	182	214	125	69	
107	114	114	140	139	113	114	129	94	120	
112	82	97	95	87	77	98	123	145	97	74

Average Errors Over One-Tenth Mile Segments of Random Route Runs 6, 7 and 8

RUN 6 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

138	68	71	189	140	145	96	182	83	168
106	128	110	92	139	96	62	247	115	103
62	59	77	95	97	194	162	94	117	107
75	98	152	51	63	90	122	89	101	93
*125	115	181	80	103	119	121	158	85	109

CT1:RUN006.001

117	63	99	128	77	49	89	59	77	78
228	141	266	72	81	117	131	167	100	80
94	69	75	94	89	86	104	127	141	109
132	90	97	105	83	158	91	96	125	78
67									

RUN 7 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

92	71	76	134	82	132	103	136	102	110
110	115	80	105	84	214	73	199	75	106
113	74	69	51	103	160	171	45	108	85
*118	85	154	60	73	109	134	130	133	171

CT1:RUN007.001

134	81	185	65	144	114	132	160	98	106
77	135	135	90	163	59	86	132	68	83
77	107	165	312	65	98	93	157	101	119
175	88	72	93	84	171	122	112	57	48
123	129	236	121	125	56	154	52	95	129
105	83								

RUN 8 RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

117	83	98	72	97	117	159	119	92	136
63	139	59	93	164	88	58	226	49	82
76	50	104	93	85	162	176	78	91	81
* 71	68	174	57	49	89	161	117	123	61

CT1:RUN008.001

106	126	123	91	113	85	101	161	146	59
85	147	142	171	121	54	125	150	78	116
73	205	63	466	75	72	77	94	84	106
51	133	77	77	94	158	77	94	237	129
157	102	89	82	218	81	109	42	67	145
77	124								

Average Errors Over One-Tenth Mile Segments of Random Route Runs 9, 10 and Composite

```
RUN  9   RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

  67    83    85   116   116   158   124   101    94   122
  65    83    90    99   149    84    73   154   138   104
  77    76    70    80   107   184   165    60   119    86
  55   108   146   108    50   117   110   110   100    92
*138   104   175   112   129    91   133    90   122    69
 CT1:RUN009.001

 112   108    98   135    77    67   180    85   108   107
 156   119   276    86    91   135   119   156    80   152
 119   131   103    79   109   132    99    97   162   101
 110   142    67   163    96    82    72    94   131    73
  71

RUN 10   RANDOM ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

  55    76    49   118   117   122    96   128   100   120
 100    96    89   122   106    45    98   124   122    74
  69    94   151    75    85   184   177    87    91   106
 166    68    89   143    77    66    99   109    82    87
*119   166    90   133   160   103   141   117   182   176
 CT1:RUN010.001

  95   100   148    84   120   180    57    83   149    98
TERR 61 ILLEGAL MEMORY REFERENCE
IN    ROUTINE ".MAIN."  LINE 40

COMPOSITE SECONDARY RUNS 6-10
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

 94    76    76   126   110   134   115   133    94   131
 89   112    86   102   128   105    73   190   100    94
 79    71    94    79    95   177   170    73   105    93
 97    85   143    84    62    94   125   111   108   101
124   118   151    96   130   102   126   137   127   104
 97   110   124   122   112    82   107   102    96    96
134   143   193   234    78   106   105   144    91   114
110   105    82    86    94   137   101   108   149    97
131   116   122   118   131    94   107    71   105   106    80   104
```

3.3 RANDOM ROUTE DATA PROCESSING REQUIREMENTS

During the recording of random route data, three manual entry errors occurred which required special consideration during data processing. These errors and the necessary considerations are described in Table 3.3.1. It is also noted that the second cassette on Run 10 could not be processed. As noted in Volume I , Section 5.4 , the last 21 checkpoints of this run were processed manually from the dump.

Random Route Data Processing Anomalies

RUN NO.	PROBLEM	SOLUTION
1	TA63 entered twice after CP56	Deleted last TA63 prior to CP57 via card input in RRSL and RRTEN
9	CP64 entered instead of TA64 at beginning of run	Changed occurance of CP63 to TA64 via card input in RPMAIN, RRSL, and RRTEN
10	CP44 entered instead of TA44 after CP5	Changed CP44 to TA44 via card input to CPMAIN, RRSL, and RRTEN
10	CP61 entered instead of TA61 after CP55	Changed CP61 to TA61 via card input in CPMAIN, RRSL, and RRTEN
10	Couldn't process data from second cassette	Manually computed results from dump.

4. FIXED ROUTE

4.1 FIXED ROUTE TESTS

4.1.1 Fixed Route Test Log Sheets

A log sheet describing the test conditions and any anomalies was filled out at the completion of each test run. Copies of each fixed route test log sheet are contained in this subsection.

TEST DATA LOG

Start Time 1310
End Time 1450
24°

TEST RUN NO. 11 SHEET NO. 1 OF 1

TYPE OF TEST: Fixed Route DATE: 13 JAN 1977

BRIEF NARRATIVE DESCRIPTION OF TEST

Ran Hoffman Fixed Route containing 15 time points and 76 checkpoints.

ROUTE IDENTIFICATION: Begin at Rittenhouse Square and end at 13th and Walnut.

EVENT MARKER NUMBER: Timepoints 1-15 in order
Checkpoints 1-76 in order

TSC checkpoints not loaded in Hoffman software
TP3 - Door Closed
TP4 - Door Closed
TP5 - Door Closed
TP9 Door Closed
TP10 Door Closed
TP11 Door Closed
TP13 Door Closed

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off (On) OTHER:

TEMPERATURE: 24°F PRECIPITATION: N.A. ROAD CONDITIONS: Dry

TEST TAPE NO(S). 11-1 & 11-2 FILE NO.

SAMPLE RATE: 0.5 second

RUN TIME: 100 min.

Elapsed Distance 13mi 38' 00mm
13mi 84' 5th

TEST DIRECTOR George L. Gruver

TSC MONITOR Bernard A. Klein

TEST DATA LOG

Start Time 1500
End Time 1637

TEST RUN NO. 12 SHEET NO. 1 OF 1

TYPE OF TEST: Fixed Route DATE: 1-13-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: Hoffman Fixed Route

EVENT MARKER NUMBER: Time Point 1-15 in order
TSC Checkpoint 1-76 in order
Don Elwood AT
TP 3
TP 4
TP 5
TP 6
TP 8
TP 10
TP 11
TP 13

Heavy traffic

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 972 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 25°/14° PRECIPITATION: No ROAD CONDITIONS: Dry

TEST TAPE NO(S). 12-1 & 12-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR George W. Hoyer

RUN TIME: 97 min

TSC MONITOR Bonnie W. H. Klein

Elapsed Distance 12mi 4979.0 Dan
12mi 5253 5th

TEST DATA LOG

START 1650 -
END 1820

TEST RUN NO. 13 SHEET NO. 1 OF 1

TYPE OF TEST: FIXED ROUTE DATE: 1-13-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: Hoffman Fixed Route

EVENT MARKER NUMBER: TIME POINTS 1-15 IN ORDER
Checkpoints 1-76 IN ORDER

Door closed at
TP 2
TP 4
TP 6
TP 8
TP 10
TP 11
TP 13

Heavy Traffic

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 24°F PRECIPITATION: NO ROAD CONDITIONS: Icy

TEST TAPE NO(S). 13-1 and 13-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR George Shuster

RUN TIME: 90 min

TSC MONITOR Bernd W. A. Klein

Elapsed Distance - Odom 13 90

" " 5th 13 129

START 2025
END 2140

TEST DATA LOG

TEST RUN NO. 17 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-13-77.

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: HI³ FIXED ROUTE

EVENT MARKER NUMBER: Time Points 1-15 in order
Checkpoints 1-16 in order.

Door Close AT Time points:
TP 2
TP 3 Missed Time #16
TP 4
TP 9 Error {TP 15 at ODOM = 2110
TP 10 {EP 15 at ODOM = 2190
TP 11
TP 12
TP 13

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off (On) OTHER:

TEMPERATURE: 24°F PRECIPITATION: None ROAD CONDITIONS: Dry

TEST TAPE NO(S). 14-1 and 14-2 FILE NO.

SAMPLE RATE: 0.5 TEST DIRECTOR

RUN TIME: 75 min TSC MONITOR George W Brown

DISTANCE: Odom 12 mi 5245'
5th 13 mi 4' Gerald W Klein

START 2200
END 2210

TEST DATA LOG

TEST RUN NO. 15 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ Fixed Route DATE: 1-13-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: HI³ Fixed Route

EVENT MARKER NUMBER: Time Points 1-15 in Sequence
Checkpoints 1-76 in Sequence

Door Closed 4P
TP 2
TP 6
TP 8
TP 10
TP 11
TP 12
TP 14
TP 15

1. Marked CP 25 wrong
Removed with EE 25

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 23° F PRECIPITATION: None ROAD CONDITIONS: Dry

TEST TAPE NO(S). 15-1 and 15-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR George Green

RUN TIME: ~~0~~ 70 min

TSC MONITOR Ben W A. Khan

Elapsed Distance
ODOM 13mi 1575'
5th 13mi 17'

START 2320 1/13/77
END 0030 1/14/77

TEST DATA LOG

TEST RUN NO. 16 SHEET NO. 1 OF 1

TYPE OF TEST: FIXED ROUTE DATE: 1-13-77.

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: Hoffman Fixed Route

EVENT MARKER NUMBER: Time Points 1–15 in order
Checkpoints 1–76 in order

Door Closed AT
TP 1
TP 3
TP 4
TP 9
TP 12
TP 13
TP 14

1. Input TP 11 in error instead of Turn 24. Removed TD 11 with EE 11. First TD 11 entry is correct.
2. Missed Turn 24
3. Hit TD 15 in error at Odom = 2066 (11th TP) Removed with EE 15.

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 23° PRECIPITATION: none ROAD CONDITIONS: Dry

TEST TAPE NO(S). 16-1 and 16-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 70'' TEST DIRECTOR George W. Brown

Distance: ODom 12mi 5172'
5th 12mi 5255' TSC MONITOR Ronald A. Klein

START 0850
END 1015

TEST DATA LOG

TEST RUN NO. 17 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ Fixed Route DATE: 1-14-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:
Door Close AT
TP 2
TP 3
TP 4
TP 6
TP 8
TP 9
TP 13
TP 14

TSC Time-points 1-15 in order
TSC Checkpoints 1-76 in order
Missed TD 11 ENTRY

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 30°F PRECIPITATION: None ROAD CONDITIONS: Dry

TEST TAPE NO(S). 17-1 & 17-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 45 min

TEST DIRECTOR George W. Green

TSC MONITOR Ben & W.A. Klein

Distance: ODOM 12mi 5074
5TH 12mi 5245

TEST DATA LOG START 1020 END 1200

TEST RUN NO. 18 SHEET NO. 1 OF 1

TYPE OF TEST: Fixed Route DATE: 1-14-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door closed AT	1.	HWY TA 20 ≈ 150 feet left
TP 3		
TP 4	2.	Missed CP 43
TP 6		
TP 8	3.	Snowing hard at CP 40
TP 9		
TP 11	4	Pictures on WAIANT.
TP 13		
TP		
TP		

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -87

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 32-30° PRECIPITATION: Snowing ROAD CONDITIONS: Dry - THEN WET

TEST TAPE NO(S). 18-1 & 18-2 FILE NO.

SAMPLE RATE: 0-5

RUN TIME: 100 Min

DISTANCE: ODOM 12-5140
5TH 12-5248

TEST DIRECTOR George W Hinson

TSC MONITOR Bernd D.A. Klein

TEST DATA LOG

START 1330
END 1535

TEST RUN NO. 19 SHEET NO. 1 OF 1

TYPE OF TEST: FIXED Route DATE: 1-14-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION: Hoffman Fixed Route

EVENT MARKER NUMBER:

Door Closed AT
TP 8
TP 9
TP 10
TP 12
TP 14

1. HIT CP 2 ± 50' late
2. Some sticking of 5th wheel.
3. HIT TA 20' ± 50' late
4. Stopped recording at Post office for 2-3 minutes. Turned into Post office Entry at 30th & Market.

- SNOW ACCUMULATION ≈ 1-2" - SNOW+SLUSH STUCK TO 5TH WHEEL — A 1/2" BUILD-UP OF SNOW CONTRIBUTED UP TO 0.88% ERROR (AS A REDUCTION)
- TIME POINTS - STOPPING & PASSING WAS CHOOSEN BY TRAFFIC AND SET OF LIGHTS!

5. SUBSEQUENTLY FOUND THAT TAPE WOULD NOT DUMP WITH PRUMP ROUTINE! BK. Hoffman

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.:

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -87

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 31-32° PRECIPITATION: SNOWING ROAD CONDITIONS: Snowy & Wet

TEST TAPE NO(S). 19-1 & 19-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 2 HR - 05 MIN

DISTANCE: ODOM 13mi 201
5th <13mi

TEST DIRECTOR Donald J. Grunebach

TSC MONITOR B. Kulcinski

TEST DATA LOG

START 1600
END 1730

TEST RUN NO. 20 SHEET NO. 1 OF 1

TYPE OF TEST: Fixed Route DATE: 1-14-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door Closed AT
TP 4
TP 7
TP 8
TP 9

1. Missed CP 37
2. Generator stopped just after CP #46 at time 1730 hours.

Incomplete Run
TERMINATED 1730

5TH WHEEL DISTANCE & ODOMETER UNKNOWN - INDICATORS WENT BLANK WHEN POWER FAILED.

3. TAPE's DUMPED SUCCESSFULLY THROUGH CP 46 USING "FDUMP". HOWEVER, ABILITY TO TRANSFER TO HAS. TAPE (DUE TO LACK OF END-OF-FILE) TO BE DETERMINED BK 1/19/77

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 32 PRECIPITATION: Snowing ROAD CONDITIONS: 1/2-1 inch slush

TEST TAPE NO(S). 20-1 & 20-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR George W. Brewer

RUN TIME: 1 HR - 30 MIN

TSC MONITOR B. W.A. Klein

DISTANCE: ODOM _____ ?

5th _____ ?

TEST DATA LOG

START 18:00
END 19:30

TEST RUN NO. 21 SHEET NO. 1 OF 1

TYPE OF TEST: Fixed Rate DATE: 1-14-77

BRIEF NARRATIVE DESCRIPTION OF TEST — NOTE CONCERNING THE OPERATION OF THE 5TH WHEEL IN THE SNOW. WHERE THE 5TH WHEEL RUNS THE SNOW/SLUSH IS 3" TO 5" PLUS LARGE BUMPS — PILED UP BY THE VEHICLES — THIS CAUSES THE 5TH WHEEL TO BOUNCE — IN ADDITION, THE 5TH WHEEL WILL PICK UP SNOW = 1/4" THK AND THE SHED IT AT ABOUT 15 MPH. THE 5TH WHEEL, DURING DECELERATION OF THE TEST VEHICLE, WILL SLIDE LEFT OR RIGHT!

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door closed AT
TP 3
TP 4
TP 8
TP 9
TP 10
TP 11
TP 13
TP 14

1. MANUAL FIX — TO CONTROL THE BUTTERFLY ON THE AUTOMATIC CHOKE — WIRED OPEN!
2. OD ODOM = 4800 HIT CP66 IN error and CP 7 Wrong load. Removed both with EE. Hit CP7 at right Place but missed CP6 completely.
3. Entered CP11 in error at location of CP11. Removed with EE. Missed CP11.
4. Entered TA16 in error at TA6 (Missed TA6)
5. Entered CP26 early, deleted with EE.
6. CP47 in error.

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -8?

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off (On) OTHER:

TEMPERATURE: 33°F PRECIPITATION: Lt. Snow ROAD CONDITIONS: 2" Snow & Slush

TEST TAPE NO(S). 21-1 and 21-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR George Thurman

RUN TIME: 90 min

TSC MONITOR Bernd W.A. Klein

DISTANCE: ODOM 13mi 347
5TH 13mi 4799

TEST DATA LOG START 2040 END 2155

TEST RUN NO. 22 SHEET NO. 1 OF 1

TYPE OF TEST: HS³ Fixed Route DATE: 1-14-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door closed AT
TP 1
TP 3
TP 9
TP 10
TP 12
TP 13
TP 14

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 579 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 33° PRECIPITATION: Freezing Rain & Snow ROAD CONDITIONS: 1-2 inches Sleet

TEST TAPE NO(S). 22-1 and 22-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 HR - 15 MIN.

Distance: 0 POM 13⁴-350'
5TH 12⁴-9280'

TEST DIRECTOR George L. Grover

TSC MONITOR Bernd U.A. Klein

START 2200
end 2220

TEST DATA LOG

TEST RUN NO. 23 SHEET NO. 1 OF _____

TYPE OF TEST: HI³ Fixed Route DATE: 1-14-77.

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door Closed At
TP1
TP3
TP7
TP9
TP11
TP13
TP15

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off (On) OTHER:

TEMPERATURE: 32° PRECIPITATION: Freezing Rain ROAD CONDITIONS: 1-2 inches Slush

TEST TAPE NO(S). 23-1 and 23-2 FILE NO.

SAMPLE RATE: 0-5

RUN TIME: 80 Min

Distance: Odometer 13-419

5th wheel 12-1366

TEST DIRECTOR Gerard W. Hunt

TSC MONITOR Bernard W.A. Klein

START: 23:30
End: 00:45

TEST DATA LOG

TEST RUN NO. 24 SHEET NO. 1 OF 1

TYPE OF TEST: HHS Fixed Route DATE: 1-14-77 / 1-15-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door Closed at
TP 2
TP 3
TP 4
TP 5
TP 6
TP 11
TP 14
TP

1. marked CP 51 60' left
2. Entered TD12 twice. Removed one with EE.
3. 5th Wheel calibration affected by build up of slush on roadways

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 972 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 32° F PRECIPITATION: Freezing rain ROAD CONDITIONS: 2 inches of slush

TEST TAPE NO(S). 24-1 and 24-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 76 min. 1 HR 15 MIN TEST DIRECTOR George W. Green

Distance: Odometer 13 M - 916' TSC MONITOR Bernard A. Klein

5th 12 M - 606'

START 0050
END 0210

TEST DATA LOG

TEST RUN NO. 25 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ Fixed Route DATE: 1-15-76

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door Closed AT
TP1
TP3
TP4
TP8
TP12
TP14

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.:

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 32°F PRECIPITATION: Light Rain ROAD CONDITIONS: 1/2-to-1 inch Slush

TEST TAPE NO(S). 25-1 and 25-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 HR. - 20 MIN.

DISTANCE: Odometer 12mi 338
5th: 12mi 4764

TEST DIRECTOR George W. George

TSC MONITOR Barbara W.A. Wilson

TEST DATA LOG

START 1035
END 1200

TEST RUN NO. 26 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-15-78

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door closed AT
TP 2
TP 4
TP 6
TP 8
TP 11
TP
SP
1

1. at 1112 5th wheel stopped counting at 6 min 771 feet
Odometer ≈ 6 min 1119 feet
2. stopped vehicle — found wet connector at 5th wheel. Repaired, and reran 5th wheel to 6 min 914 feet (200 feet less than Odometer) CA CP34 (Odom – 5th) error 198 feet
Added Computer Telephone moving 5th wheel counting up load and effect on recording, only on display read out and test.
3 Missed Time Point 15. (DID NOT ENTER VA TERMINAL)

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1-53 2-72 3-82

ODOMETER CAL: 771 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off (On) OTHER:

TEMPERATURE: 37° F PRECIPITATION: NONE ROAD CONDITIONS: WET & SLUSH

TEST TAPE NO(S). 26-1 and 26-2 FILE NO.

SAMPLE RATE: 0.5 TEST DIRECTOR

RUN TIME: 1 HR - 25 MIN TSC MONITOR W.A. Klein

Distance: odometer 13 mi 179
5th wheel

TEST DATA LOG

START 1210
END 1322

TEST RUN NO. 27 SHEET NO. 1 OF _____

TYPE OF TEST: HI³ Fixed Route DATE: 1-15-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door closed AT 1. Entered CP 48 too soon - removed with EE.
TP 2
TP 4
TP 5
TP 8
TP 9
TP 10
TP 11
TP 12

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 - 55 2 - 72 3 - 87

ODOMETER CAL: 9 79 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 34°F PRECIPITATION: None ROAD CONDITIONS: Wet 5/a3 8/4

TEST TAPE NO(S). 27-1 and 27-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 hr 12 min (72 min)

Distance; Odometer 13 Mi 80

5th Wheel

TEST DIRECTOR George Grover

TSC MONITOR Ben W. A. Klein

TEST DATA LOG

START 1330
END 1455

TEST RUN NO. 28 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED Route DATE: 1-15-77.

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door Closed AT
TP 1
TP 4
TP 9
TP 10
TP 13
TP 15
TP

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 38° F PRECIPITATION: None ROAD CONDITIONS: wet slush

TEST TAPE NO(S). 28-1 and 28-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR George Chevra

RUN TIME: 1 hr 25 min

TSC MONITOR Bernd W. A. Klein

Distance: Odometer 13 mi 0 ft.
5th Wheel

TEST DATA LOG

START 1500
END 1620

TEST RUN NO. 29 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-15-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door Closed AT
TP 2
TP 3
TP 4
TP 9
TP 10
TP 11
TP 13
TP 14

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 37° F PRECIPITATION: NONE ROAD CONDITIONS: WET & SLUSH

TEST TAPE NO(S). 29-1 and 29-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 Hr - 20 MIN TEST DIRECTOR George H. Gruver

Distance: Odometer 13 miles 8' TSC MONITOR Bob Wilson

5th Wheel

TEST DATA LOG

START 1715
END 1838

TEST RUN NO. 30 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-15-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Closed Door AT
TP1
TP2
TP3
TP4
TP6
TP9
TP11

1. Entered CP10 contained in TA10 as ODOM = 4108 Plus x(4098)
Missed TA 10-

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1-55 2-72 3-82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 34° F PRECIPITATION: None ROAD CONDITIONS:

TEST TAPE NO(S). 30-1 and 30-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR Gary W. Thurber

RUN TIME: 1 hour 23 min.

TSC MONITOR Sandra A. Klein

Distance: odometer 13 Mi 48'
5th Wheel

TEST DATA LOG

START 1845
END 2010

TEST RUN NO. 31 SHEET NO. 1 OF 2

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-15-77.

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Closed Door AT
TP 1
TP 2
TP 8
TP 9
TP 11
TP 14

1. Noted X300 foot jump in 5th wheel after CP#3 on both DMI and CRT.

2. ADDITIONAL DATA SHEET 2OF2
B. Klein 1/18/77

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 Bm 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 34°-32° PRECIPITATION: None ROAD CONDITIONS: Wet

TEST TAPE NO(S). 31-1 and 31-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR George W. Gleave

RUN TIME: 1 HR 25 MIN

TSC MONITOR Fred W. A. Klein

Distance: Odometer 13mi 5210 ft
5th Wheel 13mi 270 ft

Run #31 TEST DATA LOG CONTINUED! SHEET 2 OF 2

HI³ FIXED ROUTE S. Khan 1/18/77

	Q	5	
CP2	757	759	Δ = 2x2 = 4'
CP3	1134	1135	Δ = 1x2 = 2'
0333.5	1268	1268	Δ = 0 0'
0334.5	1277	1281	Δ = 4x2 = 8'
0335.5	1287	1296	Δ = 9x2 = 18'
0336.5	1298	1314	Δ = 16x2 = 32'
0338.5	1315	1341	Δ = 26x2 = 52'
0340.5	1332	1369	Δ = 37x2 = 74'
0342.5	1350	1399	Δ = 49x2 = 98'
350.5	1426	1522	Δ = 96x2 = 192'
400.5	1506	1649	Δ = 144x2 = 288' ←
356.5	1472	1598	Δ = 126x2 = 252
5..5	1490	1625	Δ = 135x2 = 270
401.5	1513	1658	Δ = 145x2 = 290'
359.5	1498	1637	Δ = 139x2 = 278

For a period of 27 seconds, covering a distance of 464 feet, the 5th wheel gained 298 feet (Maximum of two points - checkpoints.

Between 03 min 33.5 sec and 4' 00.5" 5th wheel gained 298 feet on the odometer that 300 feet in 27 seconds or 11.1 feet per second or ~~simulation~~

$27\overline{)300}^{11.1}$ $\frac{60}{8} = 7.5$ miles per hour faster than the odometer. Note 11.1 feet per second is more than 1 extra resolution per second.

TEST DATA LOG START 2025 END 2150

TEST RUN NO. 32 SHEET NO. 1 OF 4

TYPE OF TEST: HI FIXED ROUTE DATE: 1-15-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:
Closed Door AT
TP1
TP3
TP4
TP10
TP12
TP13

1. Most Roadway glazed wet noted that 5th wheel was leaving many dents after roads were highly glazed. BK

after completing run, checked calibration and found 5th wheel to be 1874 versus 1000 for odometer. Inspection showed that one of the eight magnets on the fifth wheel was missing. On 1-16-77 replaced magnet and checked calibration. Results were: odometer - 1004 feet
5th wheel - 1000 feet.
with test made in ≈ 1/4 - 1/2 inches of slush with up to 0.25 inches of slush build up on 5th wheel.
SEE ALSO CALIBRATION SHEETS + RECALIBRATION! BK

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off (On) OTHER:

TEMPERATURE: 32 F PRECIPITATION: None ROAD CONDITIONS: Wet - Frozen

TEST TAPE NO(S). 32-1 and 32-2 FILE NO.

SAMPLE RATE: 0.5 TEST DIRECTOR George W. Gunn

RUN TIME: 1 Hr 25 MIN TSC MONITOR Richard W. A. Klein

DISTANCE: Odometer 13 MI 160
5th Wheel 12 MI 279

TEST RUN #32 TEST DATA LOG

Allenair Street Odometer Cal. 1-15-77

2340 hours

Street dry except on edge. SHEET 2 OF 4

(Run #1) - West Edge - some ice & slush

5th wheel coated = ¼-½ inch of ice

odometer - 1004'

5th wheel 874'

odom	5th	Δ
0	0	
180	122	18
208	180	28
266	230	36
308	268	40
350	304	46
384	332	52
418	362	56
462	400	62
496	430	66
540	470	70
574	500	74
636	552	82
670	582	88
722	628	94
1004	874	130'

Run #1

(Run #2) 5th wheel clean

Street clean

odom = 1006'

5th = 826'

Found one magnet missing

should record data dry 7/8

note 7/8 x 1004 = 878.5'

7/8 x 1006 = 880'

B. Klein 1/15/77

NIGHT CALIBRATION DATA — AFTER RUN #32 WHEN CONSISTENT LARGER 5th WHEEL ERROR (SMALLER READINGS WERE OBSERVED! BK

1025 hours

TEST DATA LOG

TEST RUN NO. #32 CONTINUED SHEET NO. #3 OF 4

TYPE OF TEST: Special DATE: 1-16-76

BRIEF NARRATIVE DESCRIPTION OF TEST Odometer and 5th Wheel calibration AFTER RUN #32

ROUTE IDENTIFICATION: Reference A. Test 1000' runs Snowing and slush on ground. After replacing magnet on fifth wheel

EVENT MARKER NUMBER: See attached Sheet.

CP 1 0000 000

↓

CP 2 1004 1000 ← on display

See attached Dump.

MAGNET REPLACING TIME = 20 MINUTES

5th WHEEL WAS WIPED CLEAN PRIOR TO CALIBRATION AT THE END OF THE 1000' ABOUT 1/2" OF SNOW AND ICE HAD ACCUMULATED. 5th WHEEL HAS SLITTERING/SLIDING TENDENCY - OBSERVED THROUGH REAR WINDOW OF WINNEBAGO!

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 2 -72 3 -82

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 33° F PRECIPITATION: Snowing ROAD CONDITIONS: icy

TEST TAPE NO(S). N.A. FILE NO.

SAMPLE RATE: 0.5

RUN TIME: NA

TEST DIRECTOR George W. Group

TSC MONITOR Ron W. A. Klein

TEST DATA LOG

TEST RUN #32 CONTINUED SHEET 4 OF 4

```
.L FRUMP.LDA

.ST 14156

RUN 001  SAMPLE RATE 00.5  YEAR 77  MONTH 01  DAY 16  HOUR 10  MIN 25

FIFTH WHEEL FEET/PULSE  0002    ODOMETER FEET/PULSE  0002
CP 001     00     00     R1      O 00000    F 00000   T 00 03
TA 002     00     00     R1      O 00057    F 00057   T 00 17
TA 003     00     00     R1      O 00100    F 00101   T 00 21
TA 004     00     00     R1      O 00140    F 00140   T 00 24
TA 005     00     00     R1      O 00181    F 00180   T 00 28
TA 006     00     00     R1      O 00220    F 00220   T 00 31
TA 006     00     00     R1      O 00258    F 00257   T 00 35
TA 006     00     00     R1      O 00295    F 00295   T 00 38
TA 007     00     00     R1      O 00322    F 00321   T 00 41
TA 001     00     00     R1      O 00353    F 00353   T 00 44
TA 001     00     00     R1      O 00384    F 00384   T 00 47
TA 001     00     00     R1      O 00419    F 00419   T 00 50
TA 001     00     00     R1      O 00447    F 00446   T 00 53
TA 001     00     00     R1      O 00472    F 00471   T 00 56
TA 001     00     00     R1      O 00495    F 00494   T 01 00
CP 002     00     00     R1      O 00502    F 00500   T 01 03
DO 085     42     85     R2 E    O 01365    F 21845   T 08 03
DO 085
```

DATA DUMP AS DESCRIBED ON SHEET 3 OF 4

1/16/77 B. Klein

TEST DATA LOG

START 1010
END 1225

TEST RUN NO. 33 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ Fixed Route DATE: 1-16-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door closed AT
TP 4
TP 8
TP 9
TP 10
TP 11
TP 12
TP 13
TP 14

1. Tried 3 times to input D010 but would not show on display and that cassette was not turning for period of 10-30 seconds then D010 was displayed and cassette started turning.

2. Subsequently found that failure to yield tape prior to start of run caused inability to dump tape with the FRUMP routine.

B.K 1/18/77

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 dBm 2 -72 3 -92

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 26° F PRECIPITATION: SNOW ROAD CONDITIONS: 1/2-1 INCH SLUSH

TEST TAPE NO(S). 33-1 and 33-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 hour 15 min

ODOMETER DISTANCE 13 mi 238'

5TH WHEEL DISTANCE

TEST DIRECTOR George W. Gruver

TSC MONITOR Bernard J. A. Klein

TEST DATA LOG

START 1235
END 1405

TEST RUN NO. 34 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ Fixed Route DATE: 1-16-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door Closed R1
TP 1
TP 3
TP 5
TP 7
TP 13
TP 14
TP 15

1. HIT DO 2, DC 2, and TD 2 at Broad in error. Entered EG 2 three times. Entered TD 2 correctly at 13th.
2. Entered DO 15 and DC 15 at 11th in error. Entered EG 15 Times. HIT DO 15, DC 15, and TD 15 correctly at 12th.

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.:

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -87dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 26° F PRECIPITATION: Snowing ROAD CONDITIONS: 1 INCH SLUSH

TEST TAPE NO(S). 34-1 and 34-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR George Brunn

RUN TIME: 1 Hour 30 Min

TSC MONITOR Ben W.A. Klein

odometer Distance 13mi 364'

5th Wheel Distance

TEST DATA LOG

START 1415
END 1535

TEST RUN NO. 35 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-16-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

DOOR CLOSED AT:

TP4
TP5
TP6
TP 9
TP10
TP11
TP12
TP13

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55 dBm 2 -72 dBm 3 -82 dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 26° F PRECIPITATION: SNOWING ROAD CONDITIONS: 1 INCH OF SLUSH

TEST TAPE NO(S). 35-1 and 35-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 hour 20 MIN

ODOMETER DISTANCE 13 mi 738'

5TH Wheel Distance 12 mi 4952'

TEST DIRECTOR George W. Gruver

TSC MONITOR E. G. A. Klein

TEST DATA LOG START 1500 END 1705

TEST RUN NO. 36 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-16-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:
TP 2
TP 4
TP 8
TP 9
TP 11
TP 12
TP 13
TP 14

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 28°-26°F PRECIPITATION: Light Blowing Snow ROAD CONDITIONS: 1 INCH SLUSH

TEST TAPE NO(S). 36-1 and 36-2 FILE NO.

SAMPLE RATE: 0.5 TEST DIRECTOR George W Grant

RUN TIME: 27' TSC MONITOR R. W. A. Klein

ODOMETER DISTANCE [redacted] Bmiles 170

5th Wheel Distance [redacted] 12mi 5100

TEST DATA LOG

START 1715
END 1830

TEST RUN NO. 37 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-16-87

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door Closed AT
TP2
TP3
TP8
TP9*
TP10
TP12
TP13

1. Entered CP30 after TP7 in addition to the normal location.
Entered CE30 after CP31
2.* AT TP9. Vehicle Failed to stop after Door was open. Closed Door and entered TP9 while moving.

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1-55dBm 2-72dBm 3-82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 892 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 26°F PRECIPITATION: None ROAD CONDITIONS: 1/2-1 INCH of SLUSH

TEST TAPE NO(S). 37-1 and 37-2 FILE NO.

SAMPLE RATE: 0.5

TEST DIRECTOR Georgia Grant

RUN TIME: 1 hour 15 min

TSC MONITOR B. W. Klein

Elapsed Odometer Distance 17mi 260

Elapsed 5th Axle Distance

TEST DATA LOG START 2040 END 2150

TEST RUN NO. 38 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-16-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Door closed AT 1-Entered CPT1 acid²PTln
TP3 ≈ 2 blocks early used EE 71.
TP4 Entered CPT1 correctly.
TP8
TP9
TP 10
TP 11
TP 13

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -552 Bm 2 -728 Bm 3 -824 Bm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 15° F PRECIPITATION: NONE ROAD CONDITIONS: 1 inch S/ns

TEST TAPE NO(S). 38-1 and 38-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1H-10MIN TEST DIRECTOR George W. Gruver

ODOMETER DISTANCE 12mi 250' TSC MONITOR Robert W. Klein

5th wheel Distance 12mi 5000'

START 1015
END 1135

TEST DATA LOG

TEST RUN NO. 39 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-17-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

DOOR CLOSED AT
TP 2
TP 3
TP 4
TP 5
TP 6
TP 8
TP 11
TP 13

1. Overnight temperatures (cryogenic) went 0°F with wind chill factor -42°F.

2. Entered CP 27 at 20th St. in error (should have been past point to 19th). Entered FF 27 and then entered CP 27 at correct location

4. Received overlays from 13,16 and 15,16 at 7th and Market as off-route declaration.
13,16 at 7th and Pine Street
15,16 at 7th and Filbert.

5. Entered CP 58 ≈ 50 feet late

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE 0° PRECIPITATION: NONE ROAD CONDITIONS: ICE and SLUSH

TEST TAPE NO(S). 39-1 and 39-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1HR - 30 MIN TEST DIRECTOR George W. Irvine

DISTANCE: Odometer 13 mi 220 TSC MONITOR Edward A. Kelly
5th wheel 12 mi 5125

TEST DATA LOG

START 1205
END 1340

TEST RUN NO. 40 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-11-77

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

DOOR ~~CLOSED~~ CLOSED AT
TP 2
TP 3
TP 4
TP 5
TP 10
TP 11
TP 12

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 8°F PRECIPITATION: none ROAD CONDITIONS: ice and slush

TEST TAPE NO(S). 40-1 and 40-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 hour 25 min. TEST DIRECTOR Lloyd W. Hynes

Elapsed Distance Odometer 13mi 220 ~~TSC~~ 5TH 12mi 5190 TSC MONITOR Bernard A. Khan

TEST DATA LOG START 1535 END 1715

TEST RUN NO. 41 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-17-77.

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:
Door Closed at
TP 1
~~TP 2~~
TP 3
TP 10
TP 12
TP 13
TP 14

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/(On) OTHER:

TEMPERATURE: 12° F PRECIPITATION: NONE ROAD CONDITIONS: Wet/Icy

TEST TAPE NO(S). 41-1 and 41-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 Hr - 40 Min. TEST DIRECTOR George W. Stevens

Odometer Distance 13 mi 130' TSC MONITOR Brad V. A. Klein

5th Wheel Distance

TEST DATA LOG START 1855 END 2010

TEST RUN NO. 42 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-17-77.

BRIEF NARRATIVE DESCRIPTION OF TEST

ROUTE IDENTIFICATION:

EVENT MARKER NUMBER:

Closed Door AT
TP 3
TP 4
TP 9
TP 10
TP 11
TP 12
TP 13

I Entered CP40 at 12th in error. Entered EE40. Entered CP40 correctly at 13th.

2. Hit TP15 1 blank only. Entered EE15 and then TD150 as corrected location.

EQUIPMENT UTILIZED/TEST CONDITION: VEHICLE UNIT NO.: 1

VEHICLE UNIT THRESHOLD LEVELS: 1 -55dBm 2 -72dBm 3 -82dBm

ODOMETER CAL: 979 FPP 2 5TH WHEEL CAL 872 FPP 2

R1 DROPOUT SWITCH: Off/On OTHER:

TEMPERATURE: 12° F PRECIPITATION: None ROAD CONDITIONS: wet/icy Roding

TEST TAPE NO(S). 42-1 and 42-2 FILE NO.

SAMPLE RATE: 0.5

RUN TIME: 1 HR 15 MIN TEST DIRECTOR George W. Greene

ELAPSED DISTANCE ODometer 13mi 200 5th Wheel TSC MONITOR Bonita A. Thom

START 2030
END 2140

TEST DATA LOG

TEST RUN NO. 43 SHEET NO. 1 OF 1

TYPE OF TEST: HI³ FIXED ROUTE DATE: 1-17-77

EVENT MARKER NUMBER ~~(CONTACT)~~: FP

Door Closed AT
TP 4
TP 6
TP 8
TP 10
TP 11
TP 14

odometer Cal 979 FPP 3
5th wheel Cal 872 FPP 3
L1 = -55 dBm
L2 = -72 dBm
L3 = -82 dBm
Vehicle Unit #1
EI propane Switch ON
Temperature: 12°F
Road Conditions: Dry - to - icy
Precipitation: NONE
Sample Rate: 0.5 sec.

TEST TAPES: 43-1 and 43-2

Elapsed odometer: 13 mi. 150 feet
Elapsed 5th wheel:

RUN TIME: 1 hour 10 min

FILE NO.

REMARKS: RAN OUT OF THE 'NOMINAL' DATA SHEETS BL

Test Director George W. Young

TSC monitor Bernard W. Kline

4.1.2 Fixed Route Test Data

This subsection contains a complete listing of the data recorded during Fixed Route Run 27 . As in the case of random route data , only records which contain signpost code changes and event markers are listed. The first page of data recorded during Runs 11-18 , 20-32 , and 34-43 are also included. Runs 19 and 33 were identified as bad tapes at the time of the tests. Runs 41-43 were run to replace these Runs plus Run 32 , during which a magnet was lost from the fifth wheel.

Typical Fixed Route Data Listing

L SAMP.LOG

.ST 14155

1/18/77 B. Klein

RUN 027 SAMPLE RATE 00.5 /SEC 77 MONTH 01 DAY 15 HOUR 12 MIN 10

FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002																		
TR	001	00	00	R1		D	00004	F	00004	T	00	13		000	14	03	R1		D	02974	F	02996	T	47 22
TR	002	00	00	R1		D	00074	F	00075	T	00	23		000	14	03	R1	D	D	02990	F	02912	T	47 35
	000	17	13	R1		D	00114	F	00112	T	00	29		000	14	03	R1		D	02992	F	02914	T	47 35
	000	17	13	R1	D	D	00119	F	00117	T	00	29		000	14	03	R1	D	D	02999	F	02922	T	47 37
	000	17	13	R1		D	00124	F	00122	T	00	29		000	14	03	R1		D	03003	F	02926	T	47 38
29	001	17	13	R1		D	00134	F	00132	T	00	30	TR	019	14	03	R1		D	03035	F	02957	T	47 42
TD	001	17	13	R1		D	00219	F	00215	T	00	37		000	14	03	R1	D	D	03043	F	02971	T	47 44
	000	17	13	R1	D	D	00255	F	00253	T	00	40		000	14	03	R1		D	03051	F	02974	T	47 44
	000	17	13	R1		D	00251	F	00259	T	00	40	DD	009	14	03	R1		D	03103	F	03027	T	47 52
	000	17	13	R1	D	D	00274	F	00271	T	00	41	DD	009	14	03	R1		D	03105	F	03030	T	47 59
	000	17	13	R1		D	00280	F	00277	T	00	42	TD	009	14	03	R1		D	03122	F	03046	T	48 03
	000	17	13	R1	D	D	00325	F	00323	T	00	45		000	14	03	R1	D	D	03137	F	03052	T	48 05
	000	17	13	R1		D	00332	F	00330	T	00	46		000	14	03	R1		D	03142	F	03057	T	48 05
TR	003	17	13	R1		D	00471	F	00470	T	01	23		000	14	03	R1	D	D	03193	F	03103	T	48 09
29	002	17	13	R1		D	00755	F	00755	T	02	09		000	14	03	R1		D	03199	F	03115	T	48 09
29	003	17	13	R1		D	01139	F	01139	T	02	33	TR	020	14	09	R1		D	03279	F	03203	T	48 23
	000	14	05	R1		D	01754	F	01753	T	04	05	29	041	14	03	R1		D	03531	F	03462	T	49 12
29	004	14	05	R1	D	D	01757	F	01756	T	04	05	TR	021	14	03	R1		D	03552	F	03509	T	49 27
	000	14	05	R1		D	01773	F	01772	T	04	07	29	042	14	03	R1		D	03737	F	03717	T	49 39
DD	002	14	05	R1		D	01869	F	01868	T	04	43	TR	022	14	09	R1		D	03759	F	03795	T	49 47
DD	002	14	05	R1		D	01870	F	01870	T	04	51	29	043	14	03	R1		D	03931	F	04054	T	50 27
TD	002	14	05	R1		D	01894	F	01894	T	04	56	TR	023	14	03	R1		D	03173	F	04195	T	50 55
	000	14	05	R1	D	D	01910	F	01910	T	04	59	29	044	14	03	R1		D	03505	F	04529	T	51 13
TR	004	14	05	R1		D	01913	F	01913	T	04	59	29	045	14	03	R1		D	03342	F	04354	T	52 12
	000	14	05	R1	D	D	01930	F	01931	T	05	02	29	046	14	03	R1		D	03127	F	05119	T	52 15
	000	14	05	R1		D	01933	F	01931	T	05	03		000	15	11	R1		D	01395	F	05105	T	52 25
29	005	14	05	R1		D	02159	F	02159	T	05	25		000	15	11	R1	D	D	01197	F	05123	T	53 07
29	006	14	05	R1		D	02397	F	02393	T	05	59		000	15	11	R1		D	01115	F	05135	T	53 07
29	007	14	05	R1		D	02595	F	02596	T	07	05		000	15	11	R1	D	D	01545	F	05557	T	53 19
	000	10	05	R3	N	D	02602	F	02602	T	07	35		000	15	11	R1		D	01550	F	05572	T	53 13
29	008	10	05	R3	N	D	02992	F	02991	T	08	05	DD	010	15	11	R1		D	01572	F	05593	T	53 23
29	009	10	05	R3	N	D	03535	F	03533	T	09	37	DD	010	15	11	R1		D	01572	F	05593	T	53 35
29	010	10	05	R3	N	D	03339	F	03377	T	10	03		000	15	11	R1	D	D	01574	F	05595	T	53 37
29	011	10	05	R3	N	D	03935	F	04003	T	10	23		000	15	11	R1		D	01576	F	05597	T	53 33
	000	15	13	R1		D	00278	F	04378	T	10	50	TD	010	15	11	R1		D	01530	F	05602	T	53 39
TD	003	15	13	R1		D	03415	F	04507	T	11	04		000	15	11	R1	D	D	01515	F	05537	T	53 43
	000	15	13	R1	D	D	03417	F	04533	T	11	05		000	15	11	R1		D	01522	F	05543	T	53 44
	000	15	13	R1		D	03453	F	04514	T	11	07	29	047	15	11	R1		D	01799	F	05812	T	54 14
	000	15	13	R1	D	D	03505	F	04595	T	11	10	29	048	15	11	R1		D	02192	F	06131	T	54 43
	000	15	13	R1		D	03513	F	04591	T	11	11	DE	049	15	11	R1		D	02153	F	06190	T	54 49
	000	14	13	R3	N	D	03532	F	04734	T	11	23	29	049	15	11	R1		D	02329	F	06352	T	55 00
29	012	14	13	R3	N	D	03821	F	04912	T	11	33	29	050	15	11	R1		D	02915	F	06939	T	55 49
TR	005	14	13	R3	N	D	03993	F	04993	T	11	51	29	051	15	11	R1		D	03193	F	07213	T	56 05
29	013	14	13	R3	N	D	01113	F	05201	T	12	20	29	052	15	11	R1		D	03513	F	07535	T	56 27
29	014	14	13	R3	N	D	01332	F	05419	T	12	43		000	19	13	R1		D	03545	F	07571	T	56 35
29	015	14	13	R3	N	D	01554	F	05651	T	12	07	DD	011	19	13	R1		D	03795	F	07320	T	57 03
29	016	14	13	R3	N	D	01796	F	05373	T	13	25	DD	011	19	13	R1		D	03900	F	07326	T	57 13
TR	006	14	13	R3	N	D	01951	F	05039	T	13	39		000	19	13	R1	D	D	03902	F	07323	T	57 13
29	017	14	13	R3	N	D	02160	F	05543	T	14	13		000	19	13	R1		D	03903	F	07329	T	57 14
29	018	14	13	R3	N	D	02511	F	05593	T	14	22	TD	011	19	13	R1		D	03913	F	07339	T	57 15
	000	12	05	R1		D	02542	F	05725	T	14	33	TR	024	19	13	R1		D	03931	F	07359	T	57 19
DD	001	12	05	R1		D	02758	F	05942	T	14	49		000	19	13	R1	D	D	03913	F	07353	T	57 20
DD	001	12	05	R1		D	02758	F	05842	T	15	05		000	19	13	R1		D	03914	F	07358	T	57 20
TD	001	12	05	R1		D	02779	F	05851	T	15	15	29	053	19	13	R1		D	03923	F	07123	T	57 13
	000	12	05	R1	D	D	02813	F	05897	T	15	19	29	054	19	13	R1		D	03252	F	08371	T	58 02
	000	12	05	R1		D	02820	F	05903	T	15	19	TR	025	19	13	R1		D	03275	F	08391	T	58 05
29	019	12	05	R1		D	03227	F	07311	T	16	03	29	055	19	13	R1		D	03502	F	08719	T	58 31
TR	007	12	05	R1		D	03307	F	07389	T	16	12	29	056	19	13	R1		D	01125	F	08213	T	58 35
29	020	12	05	R1		D	03976	F	08041	T	17	41	29	057	19	13	R1		D	01103	F	08322	T	58 43
29	021	12	05	R1		D	03632	F	08783	T	20	03		000	15	11	R1		D	01359	F	10079	T	58 31
29	022	12	05	R1		D	01022	F	09159	T	21	55		000	15	11	R1	D	D	01953	F	10093	T	58 35
	000	05	03	R1		D	01103	F	09219	T	22	13		000	15	11	R1		D	01957	F	10097	T	58 35
TD	005	05	03	R1		D	01249	F	09377	T	23	00	DD	012	15	11	R1		D	02109	F	10229	T	58 43
	000	05	03	R1	D	D	01297	F	09424	T	23	04		000	15	11	R1	D	D	02115	F	10235	T	58 51
	000	05	03	R1		D	01303	F	09430	T	23	05		000	15	11	R1		D	02115	F	10235	T	58 51
TR	008	05	03	R1		D	01323	F	09450	T	23	07		000	15	11	R1	D	D	02115	F	10235	T	58 59
29	023	05	03	R1		D	01595	F	09722	T	23	24		000	15	11	R1		D	02115	F	10235	T	58 59
TR	009	05	03	R1		D	01729	F	09854	T	23	33	DD	012	15	11	R1		D	02115	F	10235	T	59 01
TD	010	05	03	R1		D	02053	F	10190	T	24	25		000	15	11	R1	D	D	02117	F	10237	T	59 02
29	024	05	03	R1		D	02206	F	10332	T	25	03		000	15	11	R1		D	02113	F	10239	T	59 03
29	025	05	03	R1		D	02922	F	10949	T	25	45	TD	012	15	11	R1		D	02120	F	10240	T	59 03
	000	05	05	R3	E	D	03213	F	11343	T	25	09	29	058	15	11	R1		D	02551	F	10573	T	59 33
TR	011	05	05	R3	E	D	03245	F	11370	T	25	11	29	059	15	11	R1		D	02755	F	10977	T	59 31
	000	05	05	R1		D	03329	F	11453	T	25	13	29	050	15	11	R1		D	03041	F	11152	T	59 01
TD	005	05	05	R1		D	03424	F	11547	T	25	27	29	051	15	11	R1		D	03211	F	11331	T	59 17
	000	05	05	R1	D	D	03434	F	11557	T	25	29	TR	025	15	11	R1		D	03259	F	11333	T	59 35
	000	05	05	R1		D	03436	F	11559	T	25	29	29	052	15	11	R1		D	03536	F	11555	T	59 17
DD	005	05	05	R1		D	03150	F	11573	T	25	33	29	053	15	11	R1		D	03315	F	11925	T	59 13
DD	005	05	05	R1		D	03150	F	11573	T	25	41	29	054	15	11	R1		D	03951	F	12030	T	54 57
TR	012	05	05	R1		D	03135	F	11509	T	25	51	TR	027	15	11	R1		D	04027	F	12147	T	55 17
29	026	05	05	R1		D	03910	F	12052	T	27	35	29	055	15	11	R1		D	00141	F	12359	T	55 09
29	027	05	05	R1		D	03020	F	12539	T	28	49	29	055	15	11	R1		D	00355	F	12582	T	55 33
TR	013	05	05	R1		D	00345	F	12554	T	29	44		000	13	13	R1		D	00453	F	12559	T	55 41
29	028	05	05	R1		D	00581	F	12799	T	29	09		000	13	13	R1	D	D	00550	F	12755	T	55 19
29	029	05	05	R1		D	00949	F	13084	T	29	50		000	13	13	R1		D	00555	F	12772	T	55 49
TR	014	05	05	R1		D	01232	F	13447	T	30	22	TD	013	13	13	R1		D	00535	F	12902	T	55 52
TR	015	05	05	R1		D	01531	F	13750	T	30	45		000	13	13	R1	D	D	00504	F	12921	T	55 54
29	030	05	05	R1		D	01974	F	14194	T	32	05		000	13	13	R1		D	00509	F	12925	T	55 55
	000	15	13	R1		D	02092	F	14313	T	32	15	29	057	13	13	R1		D	01135	F	13351	T	59 35
	000	15	13	R1	D	D	02205	F	14425	T	32	27	29	058	13	13	R1		D	01337	F	13554	T	59 54
	000	15	13	R1		D	02209	F	14430	T	32	29	29	059	13	13	R1		D	01909	F	14026	T	59 15
TD	007	15	13	R1		D	02213	F	14434	T	32	29	TR	029	13	13	R1		D	02050	F	14255	T	70 07
29	031	15	13	R1		D	02579	F	14399	T	33	52	29	070	13	13	R1		D	02259	F	14473	T	70 43
29	032	15	13	R1		D	03093	F	15319	T	34	26		000	03	07	R1		D	02375	F	14599	T	70 52
29	033	15	13	R1		D	03434	F	15553	T	34	53		000	03	07	R1	D	D	02338	F	14502	T	70 53
29	034	15	13	R1		D	03387	F	15104	T	35	37		000	03	07	R1		D	02395	F	14503	T	70 54
29	035	15	13	R1		D	00210	F	00170	T	35	50	TD	014	03	07	R1		D	02539	F	14723	T	71 19
TR	016	15	13	R1		D	00474	F	00493	T	37	09		000	03	07	R1	D	D	02525	F	14740	T	71 22
	000	12	10	R3	U	D	00501	F	00429	T	37	12	TR	029	03	07	R1		D	02529	F	14743	T	71 22
	000	12	10	R1		D	00729	F	00558	T	37	30	29	071	03	07	R1		D	03150	F	15377	T	72 59
DD	003	12	10	R1		D	00750	F	00579	T	37	37	TR	030	03	07	R1		D	03191	F	15419	T	73 28
DD	003	12	10	R1		D	00771	F	00599	T	37	47	29	072	03	07	R1		D	03440	F	15659	T	74 41
TD	008	12	10	R1		D	00814	F	00743	T	37	52	TR	031	03	07	R1		D	03801	F	16099	T	75 31
	000	12	10	R1	D	D	00949	F	00772	T	37	55	29	073	03	07	R1		D	04295	F	16315	T	75 19
	000	12	10	R1		D	00949	F	00777	T	37	55	29	074	03	07	R1		D	03447	F	00330	T	77 59
TR	017	12	10	R1		D	01173	F	01100	T	41	35	29	075	03	07	R1		D	03339	F	00322	T	79 13
29	035	12	10	R1		D	01334	F	01259	T	41	52		000	02	05	R3	E	D	01995	F	01023	T	79 31
29	037	12	10	R1		D	01519	F	01543	T	42	33		000	10	05	R1		D	01249	F	01181	T	30 03
29	038	12	10	R1		D	02045	F	01971	T	44	13	TD	015	10	05	R1		D	01332	F	01254	T	30 11
29	039	12	10	R1		D	02235	F	02222	T	45	05		000	10	05	R1	D	D	01379	F	01311	T	30 15
29	040	12	10	R1		D	02590	F	02515	T	46	14		000	10	05	R1		D	01394	F	01317	T	30 15
TR	018	12	10	R1		D	02999	F	02923	T	47	13	29	076	10	05	R1		D	01459	F	01391	T	30 22
	000	14	09	R1		D	02955	F	02995	T	47	20	TR	032	10	05	R1		D	01552	F	01493	T	30 33
	000	14	09	R1	D	D	02971	F	02993	T	47	21	DD	095	42	05	R2	E	D	01355	F	21945	T	35 29

.L FRUMP.LDA

.ST 14156

RUN 011 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 13 HOUR 13 MIN 10

	FIFTH WHEEL		FEET/PULSE	0002		ODOMETER	FEET/PULSE	0002
	000	00	00	R1	D	00000	F 00001	T 00 00
	000	00	00	R1		00000	F 00001	T 00 01
TA	001	00	00	R1		00012	F 00014	T 00 16
TA	002	00	00	R1		00081	F 00082	T 00 28
	000	17	13	R1		00128	F 00128	T 00 35
CP	001	17	13	R1	D	00140	F 00140	T 00 36
	000	17	13	R1		00144	F 00144	T 00 37
TD	001	17	13	R1		00229	F 00229	T 00 55
	000	17	13	R1	D	00260	F 00260	T 00 58
	000	17	13	R1		00266	F 00266	T 00 58
	000	17	13	R1	D	00300	F 00300	T 01 01
	000	17	13	R1		00305	F 00305	T 01 02
	000	17	13	R1	D	00321	F 00321	T 01 03
	000	17	13	R1		00326	F 00326	T 01 04
TA	003	17	13	R1		00476	F 00476	T 01 56
CP	002	17	13	R1		00763	F 00764	T 02 44
CP	003	17	13	R1		01146	F 01145	T 03 23
	000	14	06	R1		01758	F 01757	T 04 12
	000	14	06	R1	D	01769	F 01767	T 04 13
CP	004	14	06	R1		01773	F 01772	T 04 13
	000	14	06	R1	D	01898	F 01896	T 04 32
	000	14	06	R1		01901	F 01899	T 04 33
TD	002	14	06	R1		01904	F 01902	T 04 33
	000	14	06	R1	D	01913	F 01912	T 04 35
TA	004	14	06	R1		01915	F 01915	T 04 36
	000	14	06	R1	D	01937	F 01937	T 04 39
	000	14	06	R1		01941	F 01941	T 04 40
	000	14	06	R1	D	01960	F 01961	T 04 42
	000	14	06	R1		01966	F 01966	T 04 42
CP	005	14	06	R1		02167	F 02167	T 05 43
CP	006	14	06	R1		02391	F 02393	T 06 32
CP	007	14	06	R1		02603	F 02604	T 08 13
CP	008	14	06	R1		02887	F 02887	T 08 41
	000	14	08	R3	W	03369	F 03369	T 09 54
CP	009	14	08	R3	W	03542	F 03542	T 10 12
CP	010	14	08	R3	W	03880	F 03880	T 10 40
CP	011	14	08	R3	W	00005	F 04100	T 12 34
	000	15	13	R1		00285	F 04380	T 13 55
	000	15	13	R1	D	00310	F 04405	T 13 57
	000	15	13	R1		00315	F 04410	T 13 58
	000	15	13	R1	D	00340	F 04435	T 14 00
	000	15	13	R1		00345	F 04440	T 14 01
DD	003	15	13	R1		00391	F 04486	T 14 15
DC	003	15	13	R1		00391	F 04486	T 14 40
TD	003	15	13	R1		00421	F 04516	T 14 45
	000	15	13	R1	D	00442	F 04537	T 14 47
	000	15	13	R1		00448	F 04543	T 14 48
	000	15	13	R1	D	00496	F 04591	T 14 51
	000	15	13	R1		00503	F 04598	T 14 52

.L FRUMP.LDA

.ST 14156

RUN 012 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 13 HOUR 15 MIN 00

FIFTH WHEEL FEET/PULSE 0002						ODOMETER FEET/PULSE 0002						
TA	001	00	00	R1		□	00009	F	00010	T	00	29
TA	002	00	00	R1		□	00079	F	00080	T	00	40
	000	17	13	R1		□	00112	F	00112	T	00	45
	000	17	13	R1	D	□	00121	F	00121	T	00	46
	000	17	13	R1		□	00126	F	00126	T	00	46
CP	001	17	13	R1	D	□	00136	F	00136	T	00	47
	000	17	13	R1		□	00141	F	00141	T	00	48
TD	001	17	13	R1		□	00225	F	00225	T	00	56
	000	17	13	R1	D	□	00262	F	00262	T	01	00
	000	17	13	R1		□	00267	F	00267	T	01	00
	000	17	13	R1	D	□	00273	F	00272	T	01	01
	000	17	13	R1		□	00279	F	00278	T	01	01
	000	17	13	R1	D	□	00320	F	00320	T	01	05
	000	17	13	R1		□	00326	F	00326	T	01	05
TA	003	17	13	R1		□	00469	F	00471	T	01	51
CP	002	17	13	R1		□	00759	F	00763	T	02	33
CP	003	17	13	R1		□	01129	F	01135	T	03	22
	000	14	06	R1		□	01743	F	01751	T	04	57
	000	14	06	R1	D	□	01756	F	01764	T	04	58
CP	004	14	06	R1		□	01762	F	01770	T	04	58
TD	002	14	06	R1		□	01888	F	01897	T	05	30
TA	004	14	06	R1	D	□	01901	F	01911	T	05	33
	000	14	06	R1		□	01903	F	01914	T	05	33
	000	14	06	R1	D	□	01946	F	01958	T	05	39
	000	14	06	R1		□	01952	F	01963	T	05	40
CP	005	14	06	R1		□	02149	F	02162	T	06	37
CP	006	14	06	R1		□	02378	F	02390	T	07	03
CP	007	14	06	R1		□	02589	F	02603	T	07	57
CP	008	14	06	R1		□	02867	F	02880	T	08	33
	000	14	06	R2	E	□	03356	F	03370	T	09	53
CP	009	14	06	R2	E	□	03522	F	03538	T	10	08
CP	010	14	06	R2	E	□	03863	F	03881	T	11	11
CP	011	14	06	R2	E	□	04077	F	04095	T	11	34
	000	15	13	R1		□	00265	F	04379	T	12	06
	000	15	13	R1	D	□	00291	F	04405	T	12	26
	000	15	13	R1		□	00292	F	04407	T	12	27
DD	003	15	13	R1		□	00370	F	04485	T	12	44
DC	003	15	13	R1		□	00370	F	04485	T	13	22
TD	003	15	13	R1		□	00390	F	04505	T	13	26
	000	15	13	R1	D	□	00424	F	04538	T	13	29
	000	15	13	R1		□	00430	F	04545	T	13	30
	000	15	13	R1	D	□	00479	F	04594	T	13	33
	000	15	13	R1		□	00487	F	04602	T	13	34
CP	012	15	13	R1		□	00796	F	04912	T	14	35
TA	005	15	13	R1		□	00867	F	04982	T	15	31
CP	013	15	13	R1		□	01086	F	05201	T	16	54
CP	014	15	13	R1		□	01309	F	05425	T	17	24
CP	015	15	13	R1		□	01532	F	05649	T	17	41

George Williams 1-4-77 B. Klein 1/14/77

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.ST 14156

RUN 013 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 13 HOUR 16 MIN 50

	FIFTH WHEEL	FEET/PULSE	0002			ODOMETER	FEET/PULSE	0002
TA	001	00	00	R1		00107	F 00108	T 00 43
TA	002	00	00	R1		00176	F 00178	T 00 52
	000	17	13	R1		00212	F 00212	T 00 57
	000	17	13	R1	D	00215	F 00215	T 00 58
	000	17	13	R1		00219	F 00219	T 00 58
	000	17	13	R1	D	00226	F 00226	T 00 59
	000	17	13	R1		00230	F 00230	T 01 00
	000	17	13	R1	D	00241	F 00241	T 01 01
CP	001	17	13	R1		00245	F 00245	T 01 02
TD	001	17	13	R1		00321	F 00322	T 01 29
	000	17	13	R1	D	00362	F 00363	T 01 33
	000	17	13	R1		00368	F 00369	T 01 34
	000	17	13	R1	D	00401	F 00402	T 01 36
	000	17	13	R1		00408	F 00409	T 01 37
	000	17	13	R1	D	00421	F 00422	T 01 38
	000	17	13	R1		00429	F 00429	T 01 38
TA	003	17	13	R1		00573	F 00575	T 01 51
CP	002	17	13	R1		00863	F 00866	T 02 21
CP	003	17	13	R1		01234	F 01238	T 03 55
	000	14	06	R1		01832	F 01836	T 05 44
	000	14	06	R1	D	01857	F 01861	T 05 47
CP	004	14	06	R1		01862	F 01865	T 05 47
DD	002	14	06	R1		01987	F 01991	T 06 01
	000	14	06	R1	D	01987	F 01991	T 06 08
DC	002	14	06	R1		01987	F 01991	T 06 08
TD	002	14	06	R1		01992	F 01996	T 06 10
	000	14	06	R1	D	02006	F 02011	T 06 13
TA	004	14	06	R1		02008	F 02014	T 06 14
	000	14	06	R1	D	02029	F 02035	T 06 17
	000	14	06	R1		02033	F 02039	T 06 17
	000	14	06	R1	D	02052	F 02058	T 06 19
	000	14	06	R1		02057	F 02063	T 06 20
CP	005	14	06	R1		02260	F 02266	T 06 36
CP	006	14	06	R1		02485	F 02492	T 07 02
CP	007	14	06	R1		02693	F 02699	T 07 48
CP	008	14	06	R1		02974	F 02981	T 08 13
CP	009	14	06	R1		03630	F 03638	T 11 43
CP	010	14	06	R1		03973	F 03981	T 12 15
CP	011	14	06	R1		00093	F 04196	T 13 29
	000	15	13	R1		00370	F 04473	T 14 01
TD	003	15	13	R1		00504	F 04608	T 14 30
	000	15	13	R1	D	00517	F 04620	T 14 31
	000	15	13	R1		00523	F 04626	T 14 32
	000	15	13	R1	D	00535	F 04639	T 14 33
	000	15	13	R1		00542	F 04645	T 14 33
	000	15	13	R1	D	00590	F 04693	T 14 37
	000	15	13	R1		00596	F 04700	T 14 37
CP	012	15	13	R1		00902	F 05006	T 15 18

.ST 14156

RUN 014 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 13 HOUR 20 MIN 25

	FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002					
	000	00	00	R1	D	0	00000	F	00000	T	00 00
	000	00	00	R1		0	00000	F	00000	T	00 01
TA	001	00	00	R1		0	00008	F	00009	T	00 20
TA	002	00	00	R1		0	00084	F	00084	T	00 31
	000	17	13	R1		0	00104	F	00102	T	00 34
	000	17	13	R1	D	0	00119	F	00117	T	00 36
	000	17	13	R1		0	00123	F	00121	T	00 37
	000	17	13	R1	D	0	00132	F	00130	T	00 38
	000	17	13	R1		0	00135	F	00132	T	00 39
CP	001	17	13	R1		0	00140	F	00139	T	00 40
TD	001	17	13	R1		0	00227	F	00225	T	01 05
	000	17	13	R1	D	0	00259	F	00257	T	01 08
	000	17	13	R1		0	00264	F	00262	T	01 09
	000	17	13	R1	D	0	00279	F	00277	T	01 10
	000	17	13	R1		0	00284	F	00282	T	01 11
	000	17	13	R1	D	0	00301	F	00299	T	01 12
	000	17	13	R1		0	00306	F	00304	T	01 13
	000	17	13	R1	D	0	00325	F	00323	T	01 14
	000	17	13	R1		0	00331	F	00329	T	01 15
TA	003	17	13	R1		0	00475	F	00474	T	01 57
CP	002	17	13	R1		0	00768	F	00767	T	02 46
CP	003	17	13	R1		0	01144	F	01141	T	03 25
	000	14	06	R1		0	01746	F	01742	T	05 06
CP	004	14	06	R1	D	0	01773	F	01769	T	05 08
	000	14	06	R1		0	01779	F	01775	T	05 08
DD	002	14	06	R1		0	01867	F	01863	T	05 25
DC	002	14	06	R1		0	01867	F	01863	T	05 29
TD	002	14	06	R1		0	01901	F	01897	T	05 36
TA	004	14	06	R1	D	0	01915	F	01912	T	05 38
	000	14	06	R1		0	01918	F	01915	T	05 39
	000	14	06	R1	D	0	01937	F	01935	T	05 42
	000	14	06	R1		0	01940	F	01938	T	05 42
CP	005	14	06	R1		0	02168	F	02165	T	06 00
CP	006	14	06	R1		0	02396	F	02392	T	06 18
CP	007	14	06	R1		0	02607	F	02603	T	07 06
CP	008	14	06	R1		0	02881	F	02876	T	07 30
	000	14	08	R2	W	0	03374	F	03369	T	08 58
CP	009	14	08	R2	W	0	03546	F	03540	T	09 11
CP	010	14	08	R2	W	0	03895	F	03890	T	09 37
CP	011	14	08	R2	W	0	00012	F	04104	T	09 52
	000	15	13	R1		0	00292	F	04383	T	10 17
DD	003	15	13	R1		0	00396	F	04487	T	10 30
DC	003	15	13	R1		0	00396	F	04487	T	10 39
TD	003	15	13	R1		0	00417	F	04508	T	10 43
	000	15	13	R1	D	0	00494	F	04586	T	10 48
	000	15	13	R1		0	00502	F	04594	T	10 49
CP	012	15	13	R1		0	00826	F	04918	T	11 17
TA	005	15	13	R1		0	00892	F	04983	T	11 24
CP	013	15	13	R1		0	01113	F	05203	T	11 42
CP	014	15	13	R1		0	01339	F	05428	T	12 09
CP	015	15	13	R1		0	01563	F	05653	T	12 26
CP	016	15	13	R1		0	01787	F	05877	T	12 43
TA	006	15	13	R1		0	01952	F	06041	T	12 58
CP	017	15	13	R1		0	02455	F	06543	T	13 32
CP	018	15	13	R1		0	02513	F	06602	T	13 44

George
1-14-77
B. Kl
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George Wolfe
1-14-77
B. Klein 1/14/77

.L FRUMP.LDA

.ST 14156

RUN 015 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 13 HOUR 22 MIN 00

	FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002				
	000	00	00	R1	D	00002	F	00002	T	00 00
	000	00	00	R1		00002	F	00002	T	00 01
TA	001	00	00	R1		00013	F	00014	T	00 09
TA	002	00	00	R1		00079	F	00079	T	00 18
	000	17	13	R1		00115	F	00114	T	00 22
	000	17	13	R1	D	00137	F	00136	T	00 24
CP	001	17	13	R1		00143	F	00143	T	00 25
TD	001	17	13	R1		00225	F	00224	T	00 31
	000	17	13	R1	D	00265	F	00264	T	00 34
	000	17	13	R1		00272	F	00271	T	00 34
	000	17	13	R1	D	00315	F	00314	T	00 37
	000	17	13	R1		00322	F	00322	T	00 38
TA	003	17	13	R1		00474	F	00475	T	01 23
CP	002	17	13	R1		00764	F	00766	T	02 12
CP	003	17	13	R1		01142	F	01143	T	02 51
	000	14	06	R1		01739	F	01742	T	03 36
CP	004	14	06	R1	D	01769	F	01771	T	03 38
	000	14	06	R1		01776	F	01778	T	03 39
DD	002	14	06	R1		01871	F	01874	T	03 50
DC	002	14	06	R1		01874	F	01876	T	03 52
TD	002	14	06	R1		01897	F	01900	T	03 56
TA	004	14	06	R1	D	01910	F	01914	T	03 59
	000	14	06	R1		01913	F	01917	T	03 59
	000	14	06	R1	D	01927	F	01932	T	04 02
	000	14	06	R1		01931	F	01936	T	04 02
	000	14	06	R1	D	01957	F	01961	T	04 05
	000	14	06	R1		01962	F	01967	T	04 06
CP	005	14	06	R1		02163	F	02168	T	04 21
CP	006	14	06	R1		02397	F	02403	T	04 41
CP	007	14	06	R1		02596	F	02602	T	05 29
CP	008	14	06	R1		02882	F	02888	T	05 54
	000	14	08	R2	W	03360	F	03368	T	07 12
CP	009	14	08	R2	W	03538	F	03546	T	07 25
CP	010	14	08	R2	W	03876	F	03884	T	07 52
CP	011	14	08	R2	W	04095	F	04104	T	08 07
	000	15	13	R1		00282	F	04388	T	08 54
TD	003	15	13	R1		00406	F	04512	T	09 04
	000	15	13	R1	D	00436	F	04542	T	09 07
	000	15	13	R1		00442	F	04548	T	09 07
	000	15	13	R1	D	00483	F	04589	T	09 10
	000	15	13	R1		00491	F	04597	T	09 11
CP	012	15	13	R1		00810	F	04917	T	09 38
TA	005	15	13	R1		00882	F	04988	T	09 47
CP	013	15	13	R1		01098	F	05204	T	11 06
CP	014	15	13	R1		01321	F	05426	T	11 37
CP	015	15	13	R1		01545	F	05652	T	11 56
CP	016	15	13	R1		01767	F	05875	T	12 11
TA	006	15	13	R1		01935	F	06042	T	12 25
CP	017	15	13	R1		02435	F	06543	T	12 58
CP	018	15	13	R1		02492	F	06600	T	13 11

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.ST 14156

RUN 016 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 13 HOUR 23 MIN 2

FIFTH WHEEL FEET/PULSE 0002						ODOMETER FEET/PULSE 0002						
TA	001	00	00	R1		D	00010	F	00011	T	00	11
TA	002	00	00	R1		D	00079	F	00080	T	00	20
	000	17	13	R1		D	00117	F	00116	T	00	24
	000	17	13	R1	D	D	00138	F	00136	T	00	26
CP	001	17	13	R1		D	00143	F	00141	T	00	27
DD	001	17	13	R1		D	00189	F	00188	T	00	35
DC	001	17	13	R1		D	00189	F	00188	T	00	40
TD	001	17	13	R1		D	00223	F	00222	T	00	46
	000	17	13	R1	D	D	00273	F	00271	T	00	50
	000	17	13	R1		D	00279	F	00278	T	00	51
	000	17	13	R1	D	D	00306	F	00305	T	00	53
	000	17	13	R1		D	00313	F	00311	T	00	53
	000	17	13	R1	D	D	00327	F	00325	T	00	54
	000	17	13	R1		D	00333	F	00332	T	00	55
TA	003	17	13	R1		D	00477	F	00477	T	01	07
CP	002	17	13	R1		D	00764	F	00765	T	01	34
CP	003	17	13	R1		D	01138	F	01138	T	02	08
	000	14	06	R1		D	01753	F	01753	T	02	59
	000	14	06	R1	D	D	01760	F	01760	T	03	00
CP	004	14	06	R1		D	01766	F	01766	T	03	00
TD	002	14	06	R1		D	01897	F	01897	T	03	14
TA	004	14	06	R1		D	01909	F	01910	T	03	17
	000	14	06	R1	D	D	01912	F	01913	T	03	17
	000	14	06	R1		D	01914	F	01915	T	03	18
CP	005	14	06	R1		D	02165	F	02166	T	03	38
CP	006	14	06	R1		D	02391	F	02393	T	03	59
CP	007	14	06	R1		D	02602	F	02604	T	04	56
CP	008	14	06	R1		D	02882	F	02884	T	05	20
	000	14	08	R3	W	D	03361	F	03363	T	06	33
CP	009	14	08	R3	W	D	03539	F	03541	T	06	48
CP	010	14	08	R3	W	D	03889	F	03892	T	07	14
CP	011	14	08	R3	W	D	00002	F	04101	T	07	28
	000	15	13	R1		D	00290	F	04389	T	07	53
DD	003	15	13	R1		D	00376	F	04475	T	08	03
DC	003	15	13	R1		D	00376	F	04475	T	08	11
TD	003	15	13	R1		D	00409	F	04509	T	08	16
	000	15	13	R1	D	D	00429	F	04529	T	08	17
	000	15	13	R1		D	00436	F	04535	T	08	18
	000	15	13	R1	D	D	00443	F	04543	T	08	18
	000	15	13	R1		D	00450	F	04550	T	08	19
	000	15	13	R1	D	D	00496	F	04596	T	08	22
	000	15	13	R1		D	00504	F	04604	T	08	22
CP	012	15	13	R1		D	00818	F	04918	T	08	49
TA	005	15	13	R1		D	00889	F	04988	T	09	00
CP	013	15	13	R1		D	01106	F	05203	T	09	26
CP	014	15	13	R1		D	01329	F	05428	T	09	52
CP	015	15	13	R1		D	01567	F	05666	T	10	11
CP	016	15	13	R1		D	01775	F	05874	T	10	25
TA	006	15	13	R1		D	01943	F	06042	T	10	38
CP	017	15	13	R1		D	02445	F	06544	T	11	10
CP	018	15	13	R1		D	02501	F	06600	T	11	21

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.ST 14156

B. Klein 1/18/77

RUN 017 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 14 HOUR 08 MIN 50

	FIFTH WHEEL	FEET/PULSE	0002			ODOMETER	FEET/PULSE	0002
	000	00	00	R1	D	00001	F 00000	T 00 00
	000	00	00	R1		00001	F 00000	T 00 01
TA	001	00	00	R1		00024	F 00025	T 00 16
TA	002	00	00	R1		00095	F 00095	T 00 24
CP	001	00	00	R1		00154	F 00153	T 00 30
	000	17	13	R1		00166	F 00166	T 00 31
TD	001	17	13	R1		00236	F 00235	T 00 36
	000	17	13	R1	D	00278	F 00277	T 00 39
	000	17	13	R1		00285	F 00284	T 00 40
	000	17	13	R1	D	00299	F 00299	T 00 41
	000	17	13	R1		00307	F 00306	T 00 41
	000	17	13	R1	D	00314	F 00314	T 00 42
	000	17	13	R1		00322	F 00321	T 00 42
	000	17	13	R1	D	00338	F 00337	T 00 43
	000	17	13	R1		00346	F 00345	T 00 44
TA	003	17	13	R1		00491	F 00491	T 00 55
CP	002	17	13	R1		00776	F 00779	T 01 23
CP	003	17	13	R1		01153	F 01155	T 02 00
	000	14	06	R1		01765	F 01766	T 03 37
CP	004	14	06	R1	D	01779	F 01781	T 03 38
	000	14	06	R1		01786	F 01788	T 03 39
DD	002	14	06	R1		01858	F 01860	T 03 51
DC	002	14	06	R1		01859	F 01861	T 03 58
	000	14	06	R1	D	01905	F 01907	T 04 06
TD	002	14	06	R1		01908	F 01911	T 04 06
TA	004	14	06	R1		01924	F 01928	T 04 09
	000	14	06	R1	D	01928	F 01932	T 04 09
	000	14	06	R1		01931	F 01936	T 04 10
	000	14	06	R1	D	01974	F 01979	T 04 14
	000	14	06	R1		01981	F 01986	T 04 14
CP	005	14	06	R1		02178	F 02183	T 04 32
CP	006	14	06	R1		02402	F 02407	T 04 55
CP	007	14	06	R1		02614	F 02620	T 05 46
	000	10	06	R3	N	02620	F 02625	T 05 46
CP	008	10	06	R3	N	02893	F 02898	T 06 14
CP	009	10	06	R3	N	03547	F 03553	T 07 40
CP	010	10	06	R3	N	03889	F 03896	T 08 08
CP	011	10	06	R3	N	00009	F 04111	T 08 39
	000	15	13	R1		00298	F 04400	T 09 11
	000	15	13	R1	D	00317	F 04419	T 09 13
	000	15	13	R1		00321	F 04423	T 09 14
DD	003	15	13	R1		00356	F 04458	T 09 22
DC	003	15	13	R1		00371	F 04475	T 10 56
TD	003	15	13	R1	D	00424	F 04528	T 11 03
	000	15	13	R1		00430	F 04533	T 11 04
	000	15	13	R1	D	00452	F 04555	T 11 06
	000	15	13	R1		00457	F 04561	T 11 06
	000	15	13	R1	D	00503	F 04607	T 11 11
	000	15	13	R1		00508	F 04612	T 11 11
CP	012	15	13	R1		00823	F 04927	T 11 44

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.ST 14156

B. Klein 9/16

RUN 018 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 14 HOUR 10 MIN 20

		FIFTH WHEEL FEET/PULSE 0002				ODOMETER FEET/PULSE 0002				
TA	001	00	00	R1		D 00009	F 00009	T	00	17
TA	002	00	00	R1		D 00081	F 00082	T	00	30
	000	17	13	R1		D 00134	F 00133	T	00	37
	000	17	13	R1	D	D 00145	F 00144	T	00	38
CP	001	17	13	R1		D 00151	F 00150	T	00	38
TD	001	17	13	R1		D 00225	F 00225	T	00	47
	000	17	13	R1	D	D 00261	F 00260	T	00	50
	000	17	13	R1		D 00267	F 00266	T	00	51
	000	17	13	R1	D	D 00314	F 00314	T	00	55
	000	17	13	R1		D 00317	F 00317	T	00	56
	000	17	13	R1	D	D 00325	F 00324	T	00	57
	000	17	13	R1		D 00327	F 00327	T	00	58
TA	003	17	13	R1		D 00478	F 00479	T	01	44
CP	002	17	13	R1		D 00782	F 00786	T	02	41
CP	003	17	13	R1		D 01142	F 01145	T	03	17
	000	14	06	R1		D 01734	F 01737	T	04	58
	000	14	06	R1	D	D 01745	F 01748	T	05	00
	000	14	06	R1		D 01748	F 01751	T	05	00
	000	14	06	R1	D	D 01782	F 01785	T	05	02
CP	004	14	06	R1		D 01765	F 01768	T	05	03
TD	002	14	06	R1		D 01897	F 01901	T	05	28
TA	004	14	06	R1		D 01907	F 01912	T	05	30
	000	14	06	R1	D	D 01910	F 01915	T	05	31
	000	14	06	R1		D 01913	F 01918	T	05	31
	000	14	06	R1	D	D 01932	F 01938	T	05	34
	000	14	06	R1		D 01937	F 01944	T	05	34
CP	005	14	06	R1		D 02158	F 02166	T	06	37
CP	006	14	06	R1		D 02383	F 02392	T	07	03
CP	007	14	06	R1		D 02595	F 02604	T	07	58
CP	008	14	06	R1		D 02878	F 02888	T	08	25
	000	14	08	R3	W	D 03362	F 03374	T	10	03
CP	009	14	08	R3	W	D 03528	F 03541	T	10	50
CP	010	14	08	R3	W	D 03859	F 03884	T	12	23
CP	011	14	08	R3	W	D 04088	F 04103	T	12	40
	000	15	13	R1		D 00275	F 04386	T	13	51
DD	003	15	13	R1		D 00367	F 04479	T	14	05
DC	004	15	13	R1		D 00367	F 04479	T	14	26
TD	003	15	13	R1		D 00392	F 04504	T	14	34
	000	15	13	R1	D	D 00448	F 04560	T	14	38
	000	15	13	R1		D 00455	F 04567	T	14	39
	000	15	13	R1	D	D 00476	F 04588	T	14	40
	000	15	13	R1		D 00483	F 04595	T	14	41
CP	012	15	13	R1		D 00805	F 04920	T	15	10
TA	005	15	13	R1		D 00870	F 04983	T	15	21
CP	013	15	13	R1		D 01090	F 05204	T	16	48
CP	014	15	13	R1		D 01314	F 05428	T	17	18
CP	015	15	13	R1		D 01537	F 05653	T	18	46
CP	016	15	13	R1		D 01766	F 05883	T	19	19
TA	006	15	13	R1		D 01923	F 06044	T	20	08

should be 003

BAD/DELETED DATA

.L FRUMP.LDA

.ST 14156

B. Klein 1/18/

RUN 019 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 14 HOUR 13 MIN 30

FIFTH WHEEL	FEET/PULSE	0002		ODOMETER	FEET/PULSE	0002
000	00	12	R1	00810	F 00240	T 00 17
000	00	14	R1	00840	F 00240	T 00 17
000	00	17	R1	00870	F 00240	T 00 17
000	00	19	R1	00900	F 00240	T 00 17
000	00	22	R1	00930	F 00240	T 00 17
000	00	24	R1	00960	F 00240	T 00 17
000	00	27	R1	00990	F 00240	T 00 17
000	00	30	R1	01020	F 00240	T 00 17
000	00	33	R1	00026	F 00240	T 00 17
000	00	36	R1	00056	F 00240	T 00 17
000	00	39	R1	00086	F 00240	T 00 17
000	00	42	R1	00116	F 00240	T 00 17
000	00	44	R3 S	00146	F 00000	T 00 17
000	00	00	R1	00000	F 00046	T 00 17
000	96	81	R1	00078	F 00752	T 00 42
000	00	84	R1	00566	F 00240	T 00 52
000	00	87	R1	00596	F 00240	T 00 52
000	00	90	R1	00626	F 00240	T 00 52
000	00	93	R1	00656	F 00240	T 00 52
000	00	96	R1	00686	F 00240	T 00 52
000	00	99	R1	00716	F 00240	T 00 52
000	00	03	R1	00746	F 00240	T 00 52
000	00	06	R1	00776	F 00240	T 00 52
000	00	10	R1	00806	F 00240	T 00 52
000	00	13	R1	00836	F 00240	T 00 52
008	00	17	R2 N	00866	F 00240	T 00 53
008	00	20	R2 N	00896	F 00240	T 00 53
008	00	24	R2 N	00926	F 00240	T 00 53
008	00	27	R2 N	00956	F 00240	T 00 53
008	01	03	R2 N	00986	F 00243	T 00 53
008	01	06	R2 N	01016	F 00240	T 00 53
008	01	09	R2 N	00022	F 00240	T 00 53
008	01	11	R2 N	00052	F 00243	T 00 53
008	01	13	R2 N	00082	F 00240	T 00 53
008	33	16	R2 N	00112	F 28656	T 00 53
008	01	18	R2 N	00142	F 00240	T 00 53
008	01	19	R2 N	00172	F 00240	T 00 53
008	01	21	R2 N	00202	F 00240	T 00 53
008	01	23	R2 N	00232	F 00240	T 00 53
008	01	25	R2 N	00262	F 00240	T 00 53
008	01	26	R2 N	00292	F 00240	T 00 53
008	01	28	R2 N	00322	F 00240	T 00 53
008	01	30	R2 N	00352	F 00240	T 00 53
008	01	31	R2 N	00382	F 00240	T 00 53
008	01	32	R2 N	00412	F 00240	T 00 53
008	01	34	R2 N	00442	F 00240	T 00 53
008	01	35	R2 N	00502	F 00240	T 01 10
000	20	01	R1	00000	F 00162	T 01 59
000	17	13	R1	00163	F 00162	T 02 10
008	01	35	R2 N	00018	F 00240	T 02 19

.L FRUMP.LDA

.ST 14156

B. Kliem 11/18/77

RUN 020 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 14 HOUR 16 MIN 00

	FIFTH WHEEL		FEET/PULSE	0002		ODOMETER	FEET/PULSE	0002
TA	001	00	00	R1		00008	F 00010	T 00 10
TA	002	00	00	R1		00079	F 00079	T 00 22
	000	17	13	R1		00099	F 00098	T 00 25
	000	17	13	R1	D	00103	F 00102	T 00 26
	000	17	13	R1		00107	F 00106	T 00 26
	000	17	13	R1	D	00115	F 00113	T 00 27
	000	17	13	R1		00119	F 00117	T 00 28
	000	17	13	R1	D	00126	F 00124	T 00 29
	000	17	13	R1		00129	F 00127	T 00 29
CP	001	17	13	R1		00139	F 00137	T 00 32
TD	001	17	13	R1		00224	F 00222	T 00 59
	000	17	13	R1	D	00261	F 00259	T 01 03
	000	17	13	R1		00267	F 00264	T 01 03
	000	17	13	R1	D	00284	F 00282	T 01 05
	000	17	13	R1		00290	F 00287	T 01 05
	000	17	13	R1	D	00314	F 00311	T 01 07
	000	17	13	R1		00320	F 00317	T 01 08
TA	003	17	13	R1		00473	F 00471	T 01 55
	000	17	12	R3	E	00476	F 00473	T 01 56
CP	002	17	12	R3	E	00767	F 00764	T 02 41
CP	003	17	12	R3	E	01143	F 01139	T 04 08
	000	14	06	R1		01758	F 01751	T 05 55
	000	14	06	R1	D	01770	F 01763	T 05 56
CP	004	14	06	R1		01775	F 01769	T 05 57
TD	002	14	06	R1		01905	F 01898	T 06 16
TA	004	14	06	R1		01916	F 01909	T 06 18
	000	14	06	R1	D	01922	F 01916	T 06 19
	000	14	06	R1		01925	F 01919	T 06 19
	000	14	06	R1	D	01943	F 01938	T 06 22
	000	14	06	R1		01947	F 01942	T 06 22
	000	14	06	R1	D	01961	F 01956	T 06 24
	000	14	06	R1		01966	F 01960	T 06 24
CP	005	14	06	R1		02166	F 02159	T 07 40
CP	006	14	06	R1		02398	F 02390	T 08 16
CP	007	14	06	R1		02605	F 02597	T 10 04
	000	10	06	R3	N	02613	F 02604	T 10 05
CP	008	10	06	R3	N	02887	F 02878	T 12 10
CP	009	10	06	R3	N	03540	F 03529	T 18 01
CP	010	10	06	R3	N	03885	F 03871	T 19 15
CP	011	10	06	R3	N	00001	F 04081	T 20 05
	000	15	13	R1		00273	F 04352	T 22 34
	000	15	13	R1	D	00276	F 04355	T 22 37
	000	15	13	R1		00277	F 04355	T 22 37
	000	15	13	R1	D	00282	F 04360	T 23 01
	000	15	13	R1		00282	F 04360	T 23 01
	000	15	13	R1	D	00282	F 04360	T 23 04
	000	15	13	R1		00282	F 04360	T 23 05
DD	003	15	13	R1		00394	F 04475	T 24 54
DC	003	15	13	R1		00394	F 04475	T 25 14
TD	003	15	13	R1		00414	F 04495	T 25 20
	000	15	13	R1	D	00447	F 04526	T 25 25
	000	15	13	R1		00450	F 04530	T 25 25

.L FRUMP.LDR

.ST 14156

1/18/77 B. Klein

RUN 021 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 14 HOUR 18 MIN 00

FIFTH WHEEL	FEET/PULSE	0002		ODOMETER	FEET/PULSE	0002
TA 001	00	00	R1	D 00002	F 00002	T 00 05
TA 002	00	00	R1	D 00079	F 00079	T 00 18
000	17	13	R1	D 00107	F 00105	T 00 22
000	17	13	R1 D	D 00111	F 00109	T 00 22
000	17	13	R1	D 00115	F 00112	T 00 23
000	17	13	R1 D	D 00128	F 00124	T 00 24
000	17	13	R1	D 00132	F 00128	T 00 25
CP 001	17	13	R1	D 00136	F 00132	T 00 25
TD 001	17	13	R1	D 00218	F 00214	T 00 38
000	17	13	R1 D	D 00262	F 00257	T 00 42
000	17	13	R1	D 00268	F 00262	T 00 43
000	17	13	R1 D	D 00273	F 00267	T 00 43
000	17	13	R1	D 00278	F 00272	T 00 44
000	17	13	R1 D	D 00305	F 00299	T 00 46
000	17	13	R1	D 00311	F 00305	T 00 47
000	17	13	R1 D	D 00323	F 00316	T 00 48
000	17	13	R1	D 00328	F 00322	T 00 48
TA 003	17	13	R1	D 00473	F 00466	T 01 19
CP 002	17	13	R1	D 00765	F 00756	T 02 14
CP 003	17	13	R1	D 01145	F 01132	T 02 59
000	14	06	R1	D 01742	F 01723	T 04 42
000	14	06	R1 D	D 01752	F 01734	T 04 43
000	14	06	R1	D 01757	F 01738	T 04 43
CP 004	14	06	R1 D	D 01775	F 01757	T 04 45
000	14	06	R1	D 01780	F 01761	T 04 46
TD 002	14	06	R1	D 01905	F 01885	T 05 00
TA 004	14	06	R1	D 01914	F 01896	T 05 02
000	14	06	R1 D	D 01920	F 01901	T 05 03
000	14	06	R1	D 01922	F 01904	T 05 03
000	14	06	R1 D	D 01937	F 01919	T 05 06
000	14	06	R1	D 01940	F 01922	T 05 06
CP 005	14	06	R1	D 02172	F 02153	T 06 17
CP 006	14	06	R1	D 02400	F 02378	T 06 46
CP 007	14	06	R1	D 02553	F 02529	T 07 04
EE 006	14	06	R1	D 02583	F 02558	T 07 11
EE 007	14	06	R1	D 02583	F 02558	T 07 22
CP 007	14	06	R1	D 02608	F 02583	T 07 37
000	10	06	R3 N	D 02614	F 02590	T 07 38
CP 008	10	06	R3 N	D 02896	F 02869	T 08 18
CP 009	10	06	R3 N	D 03554	F 03521	T 10 52
CP 010	10	06	R3 N	D 03894	F 03859	T 11 55
CP 111	10	06	R3 N	D 00019	F 04078	T 12 16
EE 111	10	06	R3 N	D 00072	F 04131	T 12 29
000	15	13	R1	D 00303	F 04359	T 13 18
DD 003	15	13	R1	D 00408	F 04465	T 13 34
DC 003	15	13	R1	D 00408	F 04465	T 14 01
TD 003	15	13	R1	D 00430	F 04486	T 14 07
000	15	13	R1 D	D 00471	F 04526	T 14 12
000	15	13	R1	D 00474	F 04529	T 14 18

.L FRUMP.LDA

.ST 14156

B. Klein 1/18/77

RUN 022 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 14 HOUR 20 MIN 40

	FIFTH WHEEL	FEET/PULSE	0002		ODOMETER	FEET/PULSE	0002
TA	001	00	00	R1	00010	F 00010	T 00 07
TA	002	00	00	R1	00073	F 00072	T 00 17
	000	17	13	R1	00119	F 00115	T 00 23
	000	17	13	R1 D	00132	F 00128	T 00 24
CP	001	17	13	R1	00136	F 00131	T 00 25
DD	001	17	13	R1	00174	F 00169	T 00 35
DC	001	17	13	R1	00174	F 00169	T 00 41
TD	001	17	13	R1	00217	F 00211	T 00 50
	000	17	13	R1 D	00254	F 00247	T 00 55
	000	17	13	R1	00258	F 00251	T 00 56
	000	17	13	R1 D	00316	F 00308	T 01 02
	000	17	13	R1	00320	F 00312	T 01 03
TA	003	17	13	R1	00473	F 00465	T 01 55
CP	002	17	13	R1	00765	F 00749	T 02 44
CP	003	17	13	R1	01142	F 01113	T 03 27
	000	14	06	R1	01744	F 01703	T 05 13
	000	14	06	R1 D	01749	F 01708	T 05 14
	000	14	06	R1	01754	F 01714	T 05 14
	000	14	06	R1 D	01768	F 01727	T 05 16
CP	004	14	06	R1	01772	F 01731	T 05 16
TD	002	14	06	R1	01905	F 01863	T 05 33
TA	004	14	06	R1 D	01917	F 01876	T 05 36
	000	14	06	R1	01920	F 01878	T 05 36
	000	14	06	R1 D	01939	F 01898	T 05 40
	000	14	06	R1	01943	F 01902	T 05 40
CP	005	14	06	R1	02130	F 02133	T 06 45
CP	006	14	06	R1	02401	F 02351	T 07 11
CP	007	10	06	R3 N	02612	F 02560	T 08 05
CP	008	10	06	R3 N	02893	F 02837	T 08 33
CP	009	10	06	R3 N	03556	F 03493	T 10 14
CP	010	10	06	R3 N	03892	F 03827	T 11 17
CP	011	10	06	R3 N	00015	F 04043	T 11 39
	000	15	13	R1	00295	F 04313	T 12 52
DD	003	15	13	R1	00400	F 04421	T 13 05
DC	003	15	13	R1	00409	F 04430	T 13 30
TD	003	15	13	R1	00434	F 04454	T 13 36
	000	15	13	R1 D	00514	F 04532	T 13 44
	000	15	13	R1	00520	F 04537	T 13 44
CP	012	15	13	R1	00836	F 04846	T 14 15
TA	005	15	13	R1	00913	F 04920	T 14 26
CP	013	15	13	R1	01129	F 05128	T 15 49
CP	014	15	13	R1	01355	F 05350	T 16 19
CP	015	15	13	R1	01582	F 05569	T 16 39
CP	016	15	13	R1	01813	F 05794	T 16 58
TA	006	15	13	R1	01976	F 05953	T 17 14
CP	017	15	13	R1	02481	F 06445	T 17 54
CP	018	15	13	R1	02540	F 06504	T 18 04
	000	12	06	R1	02668	F 06627	T 18 17
	000	12	06	R1 D	02724	F 06682	T 18 22
	000	12	06	R1	02729	F 06687	T 18 22

.L FRUMP

.L FRUMP.LDA

.ST 14156

B. Klein 1/18/77

RUN 023 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 14 HOUR 22 MIN 00

FIFTH WHEEL	FEET/PULSE	0002			ODOMETER	FEET/PULSE	0002
TA 001	00	00	R1		D 00006	F 00006	T 00 24
TA 002	00	00	R1		D 00080	F 00077	T 00 36
000	17	13	R1		D 00105	F 00101	T 00 40
000	17	13	R1	D	D 00109	F 00104	T 00 41
000	17	13	R1		D 00113	F 00108	T 00 41
000	17	13	R1	D	D 00117	F 00112	T 00 42
000	17	13	R1		D 00121	F 00115	T 00 42
000	17	13	R1	D	D 00139	F 00132	T 00 44
CP 001	17	13	R1		D 00143	F 00137	T 00 45
DD 001	17	13	R1		D 00194	F 00187	T 00 53
DC 001	17	13	R1		D 00195	F 00188	T 01 03
TD 001	17	13	R1		D 00221	F 00213	T 01 09
000	17	13	R1	D	D 00264	F 00254	T 01 13
000	17	13	R1		D 00270	F 00260	T 01 13
000	17	13	R1	D	D 00306	F 00295	T 01 16
000	17	13	R1		D 00312	F 00301	T 01 17
000	17	13	R1	D	D 00330	F 00318	T 01 18
000	17	13	R1		D 00335	F 00324	T 01 19
TA 003	17	13	R1		D 00476	F 00454	T 02 10
CP 002	17	13	R1		D 00765	F 00747	T 03 01
CP 003	17	13	R1		D 01139	F 01108	T 03 34
000	14	06	R1		D 01745	F 01707	T 04 27
000	14	06	R1	D	D 01751	F 01713	T 04 27
000	14	06	R1		D 01757	F 01719	T 04 28
CP 004	14	06	R1	D	D 01776	F 01737	T 04 29
000	14	06	R1		D 01782	F 01743	T 04 30
TD 002	14	06	R1		D 01908	F 01867	T 04 42
TA 004	14	06	R1		D 01919	F 01881	T 04 45
000	14	06	R1	D	D 01922	F 01883	T 04 45
000	14	06	R1		D 01925	F 01886	T 04 46
000	14	06	R1	D	D 01943	F 01904	T 04 49
000	14	06	R1		D 01947	F 01907	T 04 49
CP 005	14	06	R1		D 02174	F 02131	T 05 11
CP 006	14	06	R1		D 02403	F 02359	T 05 33
CP 007	14	06	R1		D 02614	F 02567	T 06 21
000	10	06	R3	N	D 02621	F 02574	T 06 22
CP 008	10	06	R3	N	D 02996	F 02947	T 07 43
CP 009	10	06	R3	N	D 03553	F 03499	T 09 37
CP 010	10	06	R3	N	D 03901	F 03838	T 10 41
CP 011	10	06	R3	N	D 04022	F 04053	T 11 07
000	15	13	R1		D 00291	F 04319	T 12 04
000	15	13	R1	D	D 00367	F 04395	T 12 12
000	15	13	R1		D 00372	F 04399	T 12 12
DD 003	15	13	R1		D 00409	F 04436	T 12 18
DC 003	15	13	R1		D 00410	F 04437	T 12 50
TD 003	15	13	R1		D 00433	F 04459	T 12 56
000	15	13	R1	D	D 00473	F 04503	T 13 00

.L PUMP.LDH

.ST 14156 1/18/77 B. Klein

RUN 024 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 14 HOUR 23 MIN 30

	FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002				
TA	001	00	00	R1		0 00006	F	00006	T	00 26
TA	002	00	00	R1		0 00074	F	00073	T	00 38
	000	17	13	R1		0 00108	F	00104	T	00 43
	000	17	13	R1	D	0 00131	F	00126	T	00 46
	000	17	13	R1		0 00135	F	00130	T	00 46
CP	001	17	13	R1		0 00139	F	00134	T	00 47
	000	17	13	R1	D	0 00145	F	00141	T	00 48
	000	17	13	R1		0 00149	F	00144	T	00 48
TD	001	17	13	R1		0 00222	F	00215	T	01 10
	000	17	13	R1	D	0 00259	F	00251	T	01 14
	000	17	13	R1		0 00263	F	00256	T	01 15
TA	033	17	13	R1		0 00473	F	00463	T	02 07
EE	033	17	13	R1		0 00509	F	00501	T	02 14
TA	003	17	13	R1		0 00520	F	00511	T	02 16
CP	002	17	13	R1		0 00762	F	00749	T	03 00
CP	003	17	13	R1		0 01139	F	01115	T	04 24
	000	14	06	R1		0 01758	F	01724	T	06 23
	000	14	06	R1	D	0 01771	F	01736	T	06 24
CP	004	14	06	R1		0 01776	F	01741	T	06 25
DD	002	14	06	R1		0 01882	F	01846	T	06 38
DC	002	14	06	R1		0 01886	F	01850	T	06 42
TD	002	14	06	R1		0 01904	F	01868	T	06 47
TA	004	14	06	R1		0 01914	F	01879	T	06 49
	000	14	06	R1	D	0 01925	F	01890	T	06 52
	000	14	06	R1		0 01927	F	01892	T	06 52
CP	005	14	06	R1		0 02171	F	02135	T	08 04
CP	006	14	06	R1		0 02400	F	02362	T	08 42
CP	007	14	06	R1		0 02607	F	02567	T	09 35
	000	10	06	R3	N	0 02619	F	02579	T	09 37
CP	008	10	06	R3	N	0 02895	F	02855	T	10 01
CP	009	10	06	R3	N	0 03556	F	03509	T	11 38
CP	010	10	06	R3	N	0 03896	F	03846	T	12 40
CP	011	10	06	R3	N	0 00022	F	04067	T	13 00
	000	15	13	R1		0 00295	F	04338	T	13 27
DD	003	15	13	R1		0 00405	F	04447	T	13 40
DC	003	15	13	R1		0 00412	F	04454	T	13 49
TD	003	15	13	R1		0 00431	F	04473	T	13 52
	000	15	13	R1	D	0 00520	F	04560	T	14 00
	000	15	13	R1		0 00525	F	04566	T	14 00
CP	012	15	13	R1		0 00838	F	04875	T	14 34
TA	005	15	13	R1		0 00915	F	04950	T	14 45
CP	013	15	13	R1		0 01133	F	05165	T	16 10
CP	014	15	13	R1		0 01358	F	05388	T	16 38
CP	015	15	13	R1		0 01584	F	05609	T	16 59
CP	016	15	13	R1		0 01810	F	05832	T	17 18
TA	006	15	13	R1		0 01979	F	05995	T	17 36
CP	017	15	13	R1		0 02489	F	06491	T	18 16
CP	018	15	13	R1		0 02544	F	06545	T	18 26
	000	12	06	R1		0 02677	F	06675	T	18 39
DD	004	12	06	R1		0 02799	F	06795	T	18 53
DC	004	12	06	R1		0 02800	F	06797	T	19 13
TD	004	12	06	R1		0 02811	F	06807	T	19 18
	000	12	06	R1	D	0 02840	F	06836	T	19 22
	000	12	06	R1		0 02846	F	06842	T	19 22

.L FRUMP.LDA

.ST 14156

B. Klein 11/18/77

RUN 025 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 15 HOUR 00 MIN 50

		FIFTH WHEEL FEET/PULSE 0002				ODOMETER FEET/PULSE 0002			
TA	001	00	00	R1		0 00009	F 00009	T 00	35
TA	002	00	00	R1		0 00086	F 00083	T 00	47
	000	17	13	R1		0 00114	F 00109	T 00	51
	000	17	13	R1	D	0 00137	F 00131	T 00	53
CP	001	17	13	R1		0 00141	F 00135	T 00	54
DD	001	17	13	R1		0 00196	F 00190	T 01	01
DC	001	17	13	R1		0 00198	F 00191	T 01	19
TD	001	17	13	R1		0 00224	F 00217	T 01	28
	000	17	13	R1	D	0 00263	F 00256	T 01	32
	000	17	13	R1		0 00269	F 00261	T 01	33
	000	17	13	R1	D	0 00306	F 00298	T 01	36
	000	17	13	R1		0 00311	F 00303	T 01	37
	000	17	13	R1	D	0 00328	F 00320	T 01	38
	000	17	13	R1		0 00333	F 00325	T 01	39
TA	003	17	13	R1		0 00480	F 00470	T 01	55
CP	002	17	13	R1		0 00769	F 00756	T 02	40
CP	003	17	13	R1		0 01140	F 01124	T 03	08
	000	14	06	R1		0 01751	F 01732	T 04	47
	000	14	06	R1	D	0 01758	F 01739	T 04	48
	000	14	06	R1		0 01764	F 01745	T 04	48
	000	14	06	R1	D	0 01771	F 01752	T 04	49
CP	004	14	06	R1		0 01778	F 01758	T 04	49
TD	002	14	06	R1		0 01906	F 01887	T 05	02
TA	004	14	06	R1		0 01924	F 01905	T 05	05
	000	14	06	R1	D	0 01927	F 01908	T 05	06
	000	14	06	R1		0 01929	F 01911	T 05	06
CP	005	14	06	R1		0 02177	F 02155	T 05	30
CP	006	14	06	R1		0 02401	F 02377	T 05	50
	000	10	06	R3	N	0 02613	F 02589	T 06	40
CP	007	10	06	R3	N	0 02615	F 02591	T 06	40
CP	008	10	06	R3	N	0 02895	F 02870	T 07	12
CP	009	10	06	R3	N	0 03556	F 03527	T 08	48
CP	010	10	06	R3	N	0 03902	F 03872	T 09	53
CP	011	10	06	R3	N	0 00020	F 04085	T 10	12
	000	15	13	R1		0 00302	F 04366	T 10	35
DD	003	15	13	R1		0 00406	F 04468	T 10	46
DC	003	15	13	R1		0 00411	F 04474	T 10	58
TD	003	15	13	R1		0 00432	F 04493	T 11	04
	000	15	13	R1	D	0 00474	F 04536	T 11	08
	000	15	13	R1		0 00480	F 04542	T 11	09
	000	15	13	R1	D	0 00525	F 04587	T 11	12
	000	15	13	R1		0 00532	F 04593	T 11	13
CP	012	15	13	R1		0 00837	F 04897	T 11	40
TA	005	15	13	R1		0 00919	F 04976	T 11	54
CP	013	15	13	R1		0 01132	F 05187	T 13	21
CP	014	15	13	R1		0 01359	F 05412	T 13	52
CP	015	15	13	R1		0 01583	F 05634	T 14	11
CP	016	15	13	R1		0 01808	F 05857	T 14	28
TA	006	15	13	R1		0 01980	F 06026	T 14	44
CP	017	15	13	R1		0 02482	F 06520	T 15	21

.L FRUMP.LDA

.ST 14156

B. Klein 1/18/17

RUN 026 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 15 HOUR 10 MIN 35

	FIFTH WHEEL	FEET/PULSE	0002		ODOMETER	FEET/PULSE	0002
TA	001	00 00	R1		00000	F 00000	T 00 10
TA	002	00 00	R1		00079	F 00078	T 00 29
	000	17 13	R1		00097	F 00095	T 00 31
	000	17 13	R1	D	00134	F 00131	T 00 35
CP	001	17 13	R1		00138	F 00136	T 00 36
TD	001	17 13	R1		00217	F 00214	T 00 45
	000	17 13	R1	D	00259	F 00256	T 00 49
	000	17 13	R1		00265	F 00262	T 00 49
	000	17 13	R1	D	00271	F 00267	T 00 50
	000	17 13	R1		00277	F 00273	T 00 50
	000	17 13	R1	D	00318	F 00315	T 00 55
	000	17 13	R1		00322	F 00318	T 00 55
TA	003	17 13	R1		00470	F 00469	T 01 35
CP	002	17 13	R1		00764	F 00763	T 02 32
CP	003	17 13	R1		01142	F 01138	T 03 07
	000	14 06	R1		01739	F 01734	T 04 43
	000	14 06	R1	D	01746	F 01741	T 04 44
	000	14 06	R1		01752	F 01747	T 04 44
CP	004	14 06	R1	D	01771	F 01765	T 04 46
	000	14 06	R1		01776	F 01771	T 04 46
DD	002	14 06	R1		01876	F 01871	T 04 58
DC	002	14 06	R1		01876	F 01871	T 05 09
TD	002	14 06	R1		01901	F 01898	T 05 15
TA	004	14 06	R1	D	01913	F 01909	T 05 17
	000	14 06	R1		01915	F 01912	T 05 17
CP	005	14 06	R1		02163	F 02160	T 05 39
CP	006	14 06	R1		02397	F 02394	T 06 00
CP	007	14 06	R1		02603	F 02599	T 06 48
CP	008	14 06	R1		02890	F 02885	T 07 18
	000	14 08	R2	W	03373	F 03367	T 08 35
CP	009	14 08	R2	W	03547	F 03539	T 08 49
CP	010	14 08	R2	W	03838	F 03830	T 09 20
CP	011	14 08	R2	W	00014	F 04101	T 09 39
	000	15 13	R1		00294	F 04380	T 10 03
TD	003	15 13	R1		00421	F 04507	T 10 14
	000	15 13	R1	D	00455	F 04540	T 10 17
	000	15 13	R1		00460	F 04546	T 10 17
	000	15 13	R1	D	00506	F 04591	T 10 21
	000	15 13	R1		00513	F 04598	T 10 21
CP	012	15 13	R1		00823	F 04912	T 10 51
TA	005	15 13	R1		00905	F 04993	T 11 05
CP	013	15 13	R1		01124	F 05204	T 12 23
CP	014	15 13	R1		01353	F 05433	T 12 55
CP	015	15 13	R1		01577	F 05656	T 13 13
CP	016	15 13	R1		01805	F 05883	T 13 32
TA	006	15 13	R1		01969	F 06046	T 13 48
CP	017	15 13	R1		02472	F 06546	T 14 28
CP	018	15 13	R1		02529	F 06603	T 14 38

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.L FRUMP.LDR

.ST 1+155
    28
RUN 023  SAMPLE RATE 00.5  YEAR 77  MONTH 01  DAY 15  HOUR 13  MIN 30

FIFTH WHEEL FEET/PULSE  0002    ODOMETER FEET/PULSE  0002
TR 001    00    00    R1      D 00011    F 00012   T 00 06
TR 002    00    00    R1      D 00073    F 00073   T 00 15
   000    17    13    R1      D 00105    F 00104   T 00 19
DP 001    17    13    R1   D  D 00140    F 00139   T 00 23
   000    17    13    R1      D 00145    F 00145   T 00 23
DD 001    17    13    R1      D 00198    F 00197   T 00 31
DD 001    17    13    R1      D 00198    F 00197   T 00 40
TD 001    17    13    R1      D 00222    F 00221   T 00 45
   000    17    13    R1   D  D 00254    F 00252   T 00 49
   000    17    13    R1      D 00271    F 00269   T 00 50
   000    17    13    R1   D  D 00273    F 00277   T 00 50
   000    17    13    R1      D 00235    F 00234   T 00 51
   000    17    13    R1   D  D 00330    F 00329   T 00 54
   000    17    13    R1      D 00337    F 00335   T 00 54
TR 003    17    13    R1      D 00477    F 00477   T 01 07
DP 002    17    13    R1      D 00765    F 00766   T 01 41
DP 003    17    13    R1      D 01141    F 01142   T 02 22
   000    14    06    R1      D 01741    F 01741   T 03 35
DP 004    14    06    R1      D 01768    F 01769   T 03 53
TD 002    14    06    R1      D 01898    F 01899   T 04 32
TR 004    14    06    R1   D  D 01913    F 01916   T 04 35
   000    14    06    R1      D 01916    F 01919   T 04 35
   000    14    06    R1   D  D 01930    F 01933   T 04 33
   000    14    06    R1      D 01933    F 01936   T 04 33
DP 005    14    06    R1      D 02161    F 02164   T 05 41
DP 006    14    06    R1      D 02333    F 02332   T 06 09
DP 007    14    06    R1      D 02596    F 02601   T 06 58
DP 008    14    06    R1      D 02830    F 02835   T 07 26
   000    14    03    R3   W  D 03363    F 03369   T 08 53
DP 010    14    03    R3   W  D 03331    F 03336   T 09 35
DP 011    14    03    R3   W  D 00001    F 04103   T 09 51
   000    15    13    R1      D 00237    F 04333   T 10 18
   000    15    13    R1   D  D 00328    F 04431   T 10 22
   000    15    13    R1      D 00332    F 04434   T 10 22
TD 003    15    13    R1      D 00411    F 04513   T 10 37
   000    15    13    R1   D  D 00440    F 04542   T 10 40
   000    15    13    R1      D 00446    F 04548   T 10 40
   000    15    13    R1   D  D 00496    F 04598   T 10 44
   000    15    13    R1      D 00502    F 04604   T 10 45
DP 012    15    13    R1      D 00811    F 04914   T 11 24
TR 005    15    13    R1      D 00839    F 04990   T 12 16
DP 013    15    13    R1      D 01108    F 05209   T 12 58
DP 014    15    13    R1      D 01332    F 05432   T 13 29
DP 015    15    13    R1      D 01553    F 05659   T 13 57
DP 016    15    13    R1      D 01736    F 05836   T 13 57
TR 006    15    13    R1      D 01946    F 06044   T 14 11
DP 017    15    13    R1      D 02452    F 06550   T 14 45
DP 018    15    13    R1      D 02506    F 06603   T 14 54
   000    12    06    R1      D 02636    F 06734   T 15 05
DD 004    12    06    R1      D 02755    F 06852   T 15 20
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B. Klein 1/18/77

.DT 14156

B. Klein 11/18/77

RUN 029 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 15 HOUR 15 MIN 00

	FIFTH WHEEL	FEET/PULSE	0002		ODOMETER	FEET/PULSE	0002
TA	001	00	00	R1	D 00006	F 00007	T 00 03
TA	002	00	00	R1	D 00073	F 00079	T 00 17
	000	17	13	R1	D 00107	F 00107	T 00 20
	000	17	13	R1 D	D 00133	F 00132	T 00 23
	000	17	13	R1	D 00138	F 00137	T 00 23
	000	17	13	R1 D	D 00149	F 00149	T 00 24
	000	17	13	R1	D 00155	F 00154	T 00 25
TD	001	17	13	R1	D 00234	F 00234	T 00 31
	000	17	13	R1 D	D 00259	F 00259	T 00 33
	000	17	13	R1	D 00266	F 00266	T 00 33
	000	17	13	R1 D	D 00302	F 00301	T 00 35
	000	17	13	R1	D 00306	F 00306	T 00 37
	000	17	13	R1 D	D 00330	F 00330	T 00 39
	000	17	13	R1	D 00335	F 00334	T 00 40
TA	003	17	13	R1	D 00470	F 00470	T 01 21
CP	002	17	13	R1	D 00764	F 00766	T 02 21
CP	003	17	13	R1	D 01138	F 01140	T 03 50
	000	10	06	R3 N	D 01557	F 01558	T 05 21
	000	14	06	R1	D 01726	F 01728	T 05 41
	000	14	06	R1 D	D 01746	F 01747	T 05 42
	000	14	06	R1	D 01752	F 01753	T 05 43
CP	004	14	06	R1 D	D 01764	F 01765	T 05 44
	000	14	06	R1	D 01771	F 01771	T 05 44
DD	002	14	06	R1	D 01850	F 01851	T 05 54
DC	002	14	06	R1	D 01853	F 01854	T 06 04
TD	002	14	06	R1	D 01898	F 01899	T 06 11
	000	14	06	R1 D	D 01907	F 01909	T 06 12
TA	004	14	06	R1	D 01910	F 01912	T 06 13
	000	14	06	R1 D	D 01916	F 01919	T 06 14
	000	14	06	R1	D 01919	F 01922	T 06 14
	000	14	06	R1 D	D 01926	F 01929	T 06 15
	000	14	06	R1	D 01930	F 01933	T 06 16
	000	14	06	R1 D	D 01962	F 01966	T 06 19
	000	14	06	R1	D 01969	F 01971	T 06 19
CP	005	14	06	R1	D 02157	F 02159	T 06 35
CP	006	14	06	R1	D 02385	F 02388	T 06 54
CP	007	14	06	R1	D 02597	F 02600	T 07 39
CP	008	14	06	R1	D 02878	F 02880	T 08 07
CP	009	14	06	R1	D 03529	F 03532	T 09 39
CP	010	14	06	R1	D 03874	F 03878	T 10 06
CP	011	14	06	R1	D 04089	F 04093	T 10 22
	000	15	13	R1	D 00279	F 04378	T 11 25
	000	15	13	R1 D	D 00304	F 04403	T 11 27
	000	15	13	R1	D 00310	F 04409	T 11 28
DD	003	15	13	R1	D 00378	F 04479	T 11 41
DC	003	15	13	R1	D 00378	F 04479	T 12 01
TD	003	15	13	R1	D 00411	F 04513	T 12 09
	000	15	13	R1 D	D 00441	F 04542	T 12 11
	000	15	13	R1	D 00447	F 04548	T 12 12
	000	15	13	R1 D	D 00497	F 04598	T 12 15
	000	15	13	R1	D 00504	F 04606	T 12 16
CP	012	15	13	R1	D 00810	F 04912	T 12 43
TA	005	15	13	R1	D 00882	F 04983	T 12 53

.L FRUMP.LDA

.ST 14156

1/18/77 B. Klein

RUN 030 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 15 HOUR 17 MIN 15

	FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002		
TA 001	00	00	R1		D 00006	F 00007	T 00 12	
TA 002	00	00	R1		D 00076	F 00077	T 00 21	
000	17	13	R1		D 00103	F 00102	T 00 25	
000	17	13	R1	D	D 00134	F 00132	T 00 28	
CP 001	17	13	R1		D 00138	F 00137	T 00 29	
DD 001	17	13	R1		D 00170	F 00170	T 00 37	
DC 001	17	13	R1		D 00170	F 00170	T 00 43	
TD 001	17	13	R1		D 00221	F 00221	T 00 52	
000	17	13	R1	D	D 00258	F 00258	T 00 55	
000	17	13	R1		D 00264	F 00263	T 00 56	
000	17	13	R1	D	D 00275	F 00274	T 00 57	
000	17	13	R1		D 00281	F 00280	T 00 57	
000	17	13	R1	D	D 00316	F 00315	T 01 00	
000	17	13	R1		D 00322	F 00321	T 01 01	
TA 003	17	13	R1		D 00475	F 00475	T 01 16	
CP 002	17	13	R1		D 00760	F 00760	T 01 51	
CP 003	17	13	R1		D 01140	F 01139	T 02 23	
000	14	06	R1		D 01748	F 01746	T 03 55	
CP 004	14	06	R1		D 01767	F 01765	T 03 57	
000	14	06	R1	D	D 01774	F 01772	T 03 57	
000	14	06	R1		D 01780	F 01778	T 03 58	
DD 002	14	06	R1		D 01866	F 01864	T 04 08	
DC 002	14	06	R1		D 01869	F 01868	T 04 18	
TD 002	14	06	R1		D 01899	F 01898	T 04 25	
TA 004	14	06	R1		D 01913	F 01912	T 04 29	
000	14	06	R1	D	D 01914	F 01914	T 04 31	
000	14	06	R1		D 01915	F 01916	T 04 31	
CP 005	14	06	R1		D 02163	F 02163	T 05 43	
CP 006	14	06	R1		D 02393	F 02392	T 06 07	
CP 007	14	06	R1		D 02604	F 02604	T 07 01	
000	10	06	R3	N	D 02608	F 02607	T 07 02	
CP 008	10	06	R3	N	D 02883	F 02881	T 08 22	
CP 009	10	06	R3	N	D 03544	F 03539	T 10 12	
CP 010	10	06	R3	N	D 03883	F 03879	T 11 20	
CP 011	10	06	R3	N	D 00011	F 04101	T 11 41	
000	15	13	R1		D 00293	F 04383	T 12 53	
000	15	13	R1	D	D 00322	F 04412	T 12 55	
000	15	13	R1		D 00328	F 04418	T 12 56	
DD 003	15	13	R1		D 00399	F 04489	T 13 07	
DC 003	15	13	R1		D 00399	F 04489	T 13 27	
TD 003	15	13	R1		D 00417	F 04507	T 13 35	
000	15	13	R1	D	D 00510	F 04600	T 13 44	
000	15	13	R1		D 00517	F 04607	T 13 44	
CP 012	15	13	R1		D 00827	F 04916	T 14 15	
TA 005	15	13	R1		D 00901	F 04988	T 14 25	
CP 013	15	13	R1		D 01113	F 05200	T 15 54	
CP 014	15	13	R1		D 01342	F 05429	T 16 26	

L FRUMP.LDA

.ST 14156

RUN 031 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 15 HOUR 18 MIN 45

B. Klein 1/18/77

	FIFTH WHEEL FEET/PULSE		0002			ODOMETER FEET/PULSE		0002			
TA	001	00	00	R1		0	00010	F	00010	T	00 12
TA	002	00	00	R1		0	00076	F	00077	T	00 23
	000	17	13	R1		0	00122	F	00121	T	00 29
	000	17	13	R1	D	0	00135	F	00134	T	00 31
	000	17	13	R1		0	00139	F	00138	T	00 31
CP	001	17	13	R1		0	00143	F	00142	T	00 32
DO	001	17	13	R1		0	00181	F	00180	T	00 41
DC	001	17	13	R1		0	00187	F	00186	T	00 44
TD	001	17	13	R1		0	00223	F	00222	T	00 49
	000	17	13	R1	D	0	00269	F	00269	T	00 54
	000	17	13	R1		0	00275	F	00274	T	00 54
	000	17	13	R1	D	0	00299	F	00298	T	00 57
	000	17	13	R1		0	00303	F	00303	T	00 57
	000	17	13	R1	D	0	00312	F	00312	T	00 58
	000	17	13	R1		0	00317	F	00317	T	00 59
TA	003	17	13	R1		0	00470	F	00471	T	01 52
	000	17	13	R1		0	00686	F	00688	T	02 37
	000	17	13	R1		0	00690	F	00691	T	02 38
	000	17	13	R1		0	00694	F	00695	T	02 38
	000	17	13	R1		0	00699	F	00700	T	02 39
	000	17	13	R1		0	00703	F	00705	T	02 39
	000	17	13	R1		0	00708	F	00709	T	02 40
	000	17	13	R1		0	00713	F	00715	T	02 40
	000	17	13	R1		0	00718	F	00719	T	02 41
	000	17	13	R1		0	00723	F	00725	T	02 41
	000	17	13	R1		0	00729	F	00730	T	02 42
	000	17	13	R1		0	00734	F	00736	T	02 42
	000	17	13	R1		0	00740	F	00741	T	02 43
	000	17	13	R1		0	00746	F	00747	T	02 43
	000	17	13	R1		0	00751	F	00753	T	02 44
CP	002	17	13	R1		0	00757	F	00759	T	02 44
	000	17	13	R1		0	00763	F	00765	T	02 45
	000	17	13	R1		0	00769	F	00770	T	02 45
	000	17	13	R1		0	00774	F	00776	T	02 46
	000	17	13	R1		0	00780	F	00781	T	02 46
	000	17	13	R1		0	00785	F	00787	T	02 47
	000	17	13	R1		0	00790	F	00791	T	02 47
	000	17	13	R1		0	00795	F	00797	T	02 48
	000	17	13	R1		0	00800	F	00801	T	02 48
	000	17	13	R1		0	00804	F	00806	T	02 49
	000	17	13	R1		0	00809	F	00810	T	02 49
	000	17	13	R1		0	00813	F	00814	T	02 50
	000	17	13	R1		0	00817	F	00818	T	02 50
	000	17	13	R1		0	00821	F	00823	T	02 51
	000	17	13	R1		0	00825	F	00827	T	02 51
	000	17	13	R1		0	00829	F	00831	T	02 52
	000	17	13	R1		0	00834	F	00835	T	02 52
	000	17	13	R1		0	00838	F	00839	T	02 53
	000	17	13	R1		0	00842	F	00843	T	02 53
	000	17	13	R1		0	00846	F	00847	T	02 54

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.ST 14156

RUN 032 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 15 HOUR 20 MIN 20

	FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002							
TA	001	00	00	R1		O	00007	F	00008	T	00	11
TA	002	00	00	R1		O	00076	F	00077	T	00	26
	000	17	13	R1		O	00107	F	00105	T	00	31
	000	17	13	R1	D	O	00110	F	00109	T	00	31
	000	17	13	R1		O	00114	F	00112	T	00	32
CP	001	17	13	R1	D	O	00137	F	00136	T	00	35
	000	17	13	R1		O	00141	F	00139	T	00	35
DO	001	17	13	R1		O	00182	F	00180	T	00	42
DC	001	17	13	R1		O	00184	F	00183	T	00	59
TD	001	17	13	R1		O	00222	F	00221	T	01	07
	000	17	13	R1	D	O	00256	F	00255	T	01	10
	000	17	13	R1		O	00261	F	00260	T	01	11
	000	17	13	R1	D	O	00306	F	00305	T	01	15
	000	17	13	R1		O	00312	F	00310	T	01	15
	000	17	13	R1	D	O	00329	F	00327	T	01	17
	000	17	13	R1		O	00335	F	00333	T	01	17
TA	003	17	13	R1		O	00474	F	00473	T	02	03
CP	002	17	13	R1		O	00761	F	00760	T	02	56
CP	003	17	13	R1		O	01140	F	01137	T	03	33
	000	14	06	R1		O	01745	F	01740	T	05	28
	000	14	06	R1	D	O	01750	F	01745	T	05	28
	000	14	06	R1		O	01755	F	01750	T	05	29
CP	004	14	06	R1	D	O	01771	F	01765	T	05	30
	000	14	06	R1		O	01775	F	01770	T	05	31
TD	002	14	06	R1		O	01898	F	01892	T	05	45
TA	004	14	06	R1	D	O	01915	F	01910	T	05	50
	000	14	06	R1		O	01917	F	01912	T	05	51
	000	14	06	R1	D	O	01936	F	01932	T	05	54
	000	14	06	R1		O	01939	F	01935	T	05	55
CP	005	14	06	R1		O	02166	F	02161	T	07	01
CP	006	14	06	R1		O	02397	F	02391	T	07	26
CP	007	14	06	R1		O	02605	F	02599	T	08	21
CP	008	14	06	R1		O	02892	F	02884	T	08	51
CP	009	14	06	R1		O	03548	F	03538	T	10	24
CP	010	14	06	R1		O	03888	F	03878	T	11	35
CP	011	14	06	R1		O	00013	F	04099	T	11	56
	000	15	13	R1		O	00298	F	04382	T	13	11
	000	15	13	R1	D	O	00324	F	04408	T	13	13
	000	15	13	R1		O	00329	F	04413	T	13	14
DO	003	15	13	R1		O	00399	F	04483	T	13	23
DC	003	15	13	R1		O	00401	F	04485	T	13	41
TD	003	15	13	R1		O	00421	F	04505	T	13	50
	000	15	13	R1	D	O	00516	F	04600	T	13	59
	000	15	13	R1		O	00523	F	04607	T	13	59
CP	012	15	13	R1		O	00827	F	04910	T	14	32
TA	005	15	13	R1		O	00902	F	04984	T	14	42
CP	013	15	13	R1		O	01120	F	05199	T	15	07
CP	014	15	13	R1		O	01343	F	05422	T	15	33
CP	015	15	13	R1		O	01575	F	05654	T	15	56
CP	016	15	13	R1		O	01790	F	05868	T	16	15

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.ST 14156 1/18/77 S. Klein

RUN 034 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 16 HOUR 12 MIN 35

	FIFTH WHEEL FEET/PULSE		0002			ODOMETER FEET/PULSE		0002
TA 001	00	00	R1		□ 00008	F 00009	T 00 09	
TA 002	00	00	R1		□ 00076	F 00076	T 00 19	
CP 001	17	13	R1		□ 00133	F 00131	T 00 26	
DD 001	17	13	R1		□ 00178	F 00176	T 00 34	
DC 001	17	13	R1		□ 00181	F 00179	T 00 40	
TD 001	17	13	R1		□ 00222	F 00219	T 00 49	
000	17	13	R1	D	□ 00253	F 00251	T 00 52	
000	17	13	R1		□ 00259	F 00256	T 00 53	
000	17	13	R1	D	□ 00312	F 00310	T 00 57	
000	17	13	R1		□ 00318	F 00315	T 00 58	
TA 003	17	13	R1		□ 00471	F 00469	T 01 48	
CP 002	17	13	R1		□ 00758	F 00753	T 02 44	
CP 003	17	13	R1		□ 01130	F 01122	T 03 19	
DD 002	17	13	R1		□ 01563	F 01551	T 04 16	wrong intersection
DC 002	17	13	R1		□ 01565	F 01553	T 04 41	
TD 002	17	13	R1		□ 01586	F 01574	T 04 49	
EE 002	17	13	R1		□ 01686	F 01673	T 05 01	
EE 002	17	13	R1		□ 01708	F 01695	T 05 03	
EE 002	17	13	R1		□ 01731	F 01717	T 05 05	
000	14	06	R1		□ 01753	F 01739	T 05 07	
CP 004	14	06	R1	D	□ 01769	F 01755	T 05 09	
000	14	06	R1		□ 01773	F 01759	T 05 09	
TD 002	14	06	R1		□ 01897	F 01883	T 05 33	
000	14	06	R1	D	□ 01912	F 01898	T 05 36	
TA 004	14	06	R1		□ 01914	F 01901	T 05 36	
CP 005	14	06	R1		□ 02167	F 02153	T 06 00	
CP 006	14	06	R1		□ 02397	F 02382	T 06 21	
CP 007	14	06	R1		□ 02606	F 02589	T 07 09	
000	10	06	R3	N	□ 02612	F 02595	T 07 10	
CP 008	10	06	R3	N	□ 02888	F 02870	T 07 43	
CP 009	10	06	R3	N	□ 03544	F 03526	T 10 02	
CP 010	10	06	R3	N	□ 03879	F 03860	T 10 35	
CP 011	10	06	R3	N	□ 00001	F 04077	T 10 50	
000	15	13	R1		□ 00290	F 04365	T 11 12	
000	15	13	R1	D	□ 00319	F 04394	T 11 14	
000	15	13	R1		□ 00324	F 04400	T 11 15	
DD 003	15	13	R1		□ 00390	F 04465	T 11 23	
DC 003	15	13	R1		□ 00399	F 04475	T 11 36	
TD 003	15	13	R1		□ 00422	F 04498	T 11 43	
000	15	13	R1	D	□ 00455	F 04530	T 11 46	
000	15	13	R1		□ 00462	F 04537	T 11 46	
000	15	13	R1	D	□ 00506	F 04581	T 11 49	
000	15	13	R1		□ 00514	F 04589	T 11 50	
CP 012	15	13	R1		□ 00822	F 04897	T 12 16	
TA 005	15	13	R1		□ 00902	F 04975	T 12 24	
CP 013	15	13	R1		□ 01117	F 05187	T 13 44	
CP 014	15	13	R1		□ 01338	F 05409	T 14 15	
CP 015	15	13	R1		□ 01570	F 05640	T 14 33	
CP 016	15	13	R1		□ 01791	F 05861	T 14 49	
TA 006	15	13	R1		□ 01961	F 06029	T 15 04	
CP 017	15	13	R1		□ 02464	F 06529	T 15 40	
CP 018	15	13	R1		□ 02524	F 06588	T 15 49	
000	12	06	R1		□ 02659	F 06722	T 16 02	
TD 004	12	06	R1		□ 02788	F 06851	T 16 56	

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RUN 035 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 16 HOUR 14 MIN 15

	FIFTH WHEEL	FEET/PULSE	0002			ODOMETER	FEET/PULSE	0002
TA	001	00	00	R1		00007	F 00008	T 00 06
TA	002	00	00	R1		00078	F 00078	T 00 21
	000	17	13	R1		00120	F 00119	T 00 29
CP	001	17	13	R1		00134	F 00132	T 00 30
	000	17	13	R1	D	00138	F 00136	T 00 31
	000	17	13	R1		00143	F 00141	T 00 31
TD	001	17	13	R1		00221	F 00218	T 00 39
	000	17	13	R1	D	00260	F 00256	T 00 42
	000	17	13	R1		00266	F 00261	T 00 43
	000	17	13	R1	D	00321	F 00313	T 00 47
	000	17	13	R1		00327	F 00319	T 00 48
TA	003	17	13	R1		00474	F 00465	T 01 31
CP	002	17	13	R1		00767	F 00753	T 02 24
CP	003	17	13	R1		01140	F 01122	T 02 56
	000	14	06	R1		01744	F 01720	T 04 37
	000	14	06	R1	D	01750	F 01726	T 04 38
	000	14	06	R1		01757	F 01733	T 04 38
CP	004	14	06	R1	D	01770	F 01745	T 04 39
	000	14	06	R1		01777	F 01752	T 04 40
TD	002	14	06	R1		01903	F 01877	T 05 01
TA	004	14	06	R1	D	01920	F 01895	T 05 04
	000	14	06	R1		01922	F 01898	T 05 05
	000	14	06	R1	D	01959	F 01934	T 05 10
	000	14	06	R1		01963	F 01938	T 05 10
CP	005	14	06	R1		02171	F 02143	T 05 28
CP	006	14	06	R1		02403	F 02370	T 05 49
CP	007	14	06	R1		02612	F 02576	T 06 39
	000	10	06	R3	N	02615	F 02580	T 06 40
CP	008	10	06	R3	N	02890	F 02854	T 07 05
CP	009	10	06	R3	N	03547	F 03506	T 08 49
CP	010	10	06	R3	N	03886	F 03842	T 10 01
CP	011	10	06	R3	N	00016	F 04063	T 10 26
	000	15	13	R1		00295	F 04339	T 11 12
TD	003	15	13	R1		00430	F 04471	T 11 25
	000	15	13	R1	D	00470	F 04511	T 11 28
	000	15	13	R1		00476	F 04517	T 11 29
	000	15	13	R1	D	00518	F 04558	T 11 32
	000	15	13	R1		00525	F 04565	T 11 33
CP	012	15	13	R1		00837	F 04875	T 12 00
TA	005	15	13	R1		00908	F 04944	T 12 53
CP	013	15	13	R1		01130	F 05160	T 13 23
CP	014	15	13	R1		01352	F 05379	T 13 52
CP	015	15	13	R1		01584	F 05609	T 14 12
CP	016	15	13	R1		01822	F 05846	T 14 31
TA	006	15	13	R1		01973	F 05995	T 14 45
CP	017	15	13	R1		02476	F 06492	T 15 26
CP	018	15	13	R1		02534	F 06551	T 15 40
	000	12	06	R1		02662	F 06675	T 15 52
DD	004	12	06	R1		02784	F 06796	T 16 06
DC	004	12	06	R1		02786	F 06798	T 16 42
TD	004	12	06	R1		02811	F 06823	T 16 49
	000	12	06	R1	D	02840	F 06852	T 16 52

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.ST 14156 1/18/77 B. Klein

RUN 036 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 16 HOUR 15 MIN 50

	FIFTH WHEEL	FEET/PULSE	0002			ODOMETER	FEET/PULSE	0002
TA	001	00	00	R1		00009	F 00010	T 00 13
TA	002	00	00	R1		00071	F 00071	T 00 22
	000	17	13	R1		00120	F 00118	T 00 29
	000	17	13	R1	D	00129	F 00127	T 00 30
CP	001	17	13	R1		00134	F 00132	T 00 30
TD	001	17	13	R1		00220	F 00218	T 00 39
	000	17	13	R1	D	00255	F 00252	T 00 42
	000	17	13	R1		00260	F 00257	T 00 43
	000	17	13	R1	D	00316	F 00313	T 00 48
	000	17	13	R1		00322	F 00319	T 00 48
TA	003	17	13	R1		00473	F 00470	T 01 35
CP	002	17	13	R1		00764	F 00756	T 02 26
CP	003	17	13	R1		01145	F 01134	T 03 01
	000	14	06	R1		01742	F 01728	T 04 45
	000	14	06	R1	D	01748	F 01734	T 04 45
	000	14	06	R1		01754	F 01739	T 04 46
CP	004	14	06	R1	D	01771	F 01756	T 04 47
	000	14	06	R1		01776	F 01762	T 04 48
DD	002	14	06	R1		01885	F 01869	T 05 00
DC	002	14	06	R1		01891	F 01875	T 05 07
TD	002	14	06	R1		01911	F 01896	T 05 11
	000	14	06	R1	D	01921	F 01906	T 05 13
	000	14	06	R1		01923	F 01908	T 05 14
TA	004	14	06	R1		01926	F 01911	T 05 14
	000	14	06	R1	D	01939	F 01925	T 05 17
	000	14	06	R1		01943	F 01929	T 05 17
	000	14	06	R1	D	01969	F 01955	T 05 20
	000	14	06	R1		01975	F 01960	T 05 21
CP	005	14	06	R1		02172	F 02156	T 05 38
CP	006	14	06	R1		02405	F 02388	T 05 58
CP	007	14	06	R1		02615	F 02597	T 06 47
	000	10	06	R2	N	02617	F 02599	T 06 47
CP	008	10	06	R2	N	02900	F 02881	T 07 15
CP	009	10	06	R2	N	03558	F 03535	T 08 54
CP	010	10	06	R2	N	03898	F 03872	T 09 59
CP	011	10	06	R2	N	00026	F 04093	T 10 20
	000	15	13	R1		00310	F 04376	T 10 43
	000	15	13	R1	D	00372	F 04437	T 10 49
	000	15	13	R1		00376	F 04441	T 10 49
TD	003	15	13	R1		00439	F 04503	T 11 08
	000	15	13	R1	D	00527	F 04588	T 11 15
	000	15	13	R1		00534	F 04596	T 11 16
CP	012	15	13	R1		00842	F 04900	T 11 43
TA	005	15	13	R1		00917	F 04972	T 11 57
CP	013	15	13	R1		01134	F 05188	T 13 22
CP	014	15	13	R1		01360	F 05410	T 13 54
CP	015	15	13	R1		01585	F 05634	T 14 12
CP	016	15	13	R1		01809	F 05853	T 14 29

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RUN 037 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 16 HOUR 17 MIN 15

	FIFTH WHEEL	FEET/PULSE	0002			ODOMETER	FEET/PULSE	0002	
TA	001	00	00	R1		0 00005	F 00006	T 00 06	
TA	002	00	00	R1		0 00075	F 00076	T 00 17	
	000	17	13	R1		0 00123	F 00122	T 00 23	
	000	17	13	R1	D	0 00131	F 00129	T 00 24	
CP	001	17	13	R1		0 00135	F 00133	T 00 25	
	000	17	13	R1	D	0 00147	F 00146	T 00 27	
	000	17	13	R1		0 00151	F 00149	T 00 27	
TD	001	17	13	R1		0 00219	F 00217	T 00 39	
	000	17	13	R1	D	0 00258	F 00256	T 00 43	
	000	17	13	R1		0 00263	F 00261	T 00 43	
	000	17	13	R1	D	0 00274	F 00271	T 00 44	
	000	17	13	R1		0 00279	F 00276	T 00 45	
	000	17	13	R1	D	0 00333	F 00330	T 00 50	
	000	17	13	R1		0 00338	F 00335	T 00 50	
TA	003	17	13	R1		0 00478	F 00476	T 01 40	
CP	002	17	13	R1		0 00770	F 00765	T 02 29	
CP	003	17	13	R1		0 01143	F 01134	T 03 10	
DC	007	00	68	R1		0 02135	F 22930	T 03 50	← error record
	000	17	13	R1		0 01583	F 01571	T 04 08	
	000	14	06	R1		0 01743	F 01730	T 05 07	
	000	14	06	R1	D	0 01749	F 01736	T 05 07	
	000	14	06	R1		0 01755	F 01742	T 05 08	
CP	004	14	06	R1	D	0 01772	F 01759	T 05 09	
	000	14	06	R1		0 01778	F 01765	T 05 10	
DD	002	14	06	R1		0 01894	F 01880	T 05 24	
DC	002	14	06	R1		0 01896	F 01882	T 05 29	
	000	14	06	R1	D	0 01897	F 01884	T 05 29	
	000	14	06	R1		0 01899	F 01885	T 05 30	
TD	002	14	06	R1		0 01910	F 01897	T 05 32	
	000	14	06	R1	D	0 01919	F 01908	T 05 34	
	000	14	06	R1		0 01922	F 01910	T 05 35	
TA	004	14	06	R1		0 01941	F 01930	T 05 38	
CP	005	14	06	R1		0 02172	F 02155	T 05 58	
CP	006	14	06	R1		0 02395	F 02377	T 06 19	
CP	007	14	06	R1		0 02610	F 02590	T 07 12	
CP	008	14	06	R1		0 02894	F 02873	T 08 27	
	000	14	08	R3	W	0 03377	F 03353	T 09 58	
CP	009	14	08	R3	W	0 03556	F 03531	T 10 15	
CP	010	14	08	R3	W	0 03894	F 03868	T 10 45	
CP	011	14	08	R3	W	0 00021	F 04091	T 11 03	
	000	15	13	R1		0 00311	F 04379	T 11 48	
	000	15	13	R1	D	0 00327	F 04395	T 11 49	
	000	15	13	R1		0 00333	F 04400	T 11 50	
DD	003	15	13	R1		0 00409	F 04476	T 12 03	
DC	003	15	13	R1		0 00409	F 04476	T 12 30	
TD	003	15	13	R1		0 00428	F 04494	T 12 38	
	000	15	13	R1	D	0 00522	F 04586	T 12 46	
	000	15	13	R1		0 00529	F 04593	T 12 46	
CP	012	15	13	R1		0 00839	F 04901	T 13 14	

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.ST 14156

1/18/77 B. Kliem

RUN 038 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 16 HOUR 20 MIN 40

		FIFTH WHEEL FEET/PULSE 0002				ODOMETER FEET/PULSE 0002			
TA	001	00	00	R1		0 00007	F 00008	T 00 15	
TA	002	00	00	R1		0 00079	F 00079	T 00 27	R1
	000	17	13	R1		0 00123	F 00121	T 00 33	
	000	17	13	R1	D	0 00137	F 00134	T 00 35	
CP	001	17	13	R1		0 00141	F 00139	T 00 35	
TD	001	17	13	R1		0 00228	F 00224	T 00 44	
	000	17	13	R1	D	0 00261	F 00258	T 00 47	
	000	17	13	R1		0 00267	F 00264	T 00 47	
TA	003	17	13	R1		0 00471	F 00467	T 01 25	
CP	002	17	13	R1		0 00767	F 00760	T 02 15	
CP	003	17	13	R1		0 01145	F 01133	T 02 49	
	000	14	06	R1		0 01767	F 01750	T 03 43	
CP	004	14	06	R1	D	0 01778	F 01761	T 03 44	
	000	14	06	R1		0 01784	F 01766	T 03 45	
	000	14	06	R1	D	0 01910	F 01891	T 03 58	
TD	002	14	06	R1		0 01913	F 01894	T 03 58	
TA	004	14	06	R1	D	0 01924	F 01906	T 04 01	
	000	14	06	R1		0 01927	F 01909	T 04 01	
CP	005	14	06	R1		0 02176	F 02157	T 05 11	
CP	006	14	06	R1		0 02403	F 02383	T 05 47	
CP	007	14	06	R1		0 02617	F 02596	T 06 27	
CP	008	14	06	R1		0 02896	F 02873	T 06 51	
	000	14	08	R3	W	0 03390	F 03365	T 07 36	
CP	009	14	08	R3	W	0 03560	F 03533	T 08 23	2X
CP	010	14	08	R3	W	0 03901	F 03872	T 08 53	
CP	011	14	08	R3	W	0 00023	F 04089	T 09 11	
	000	15	13	R1		0 00315	F 04379	T 09 36	
	000	15	13	R1	D	0 00374	F 04437	T 09 44	
	000	15	13	R1		0 00376	F 04440	T 09 44	
DD	003	15	13	R1		0 00415	F 04479	T 09 55	
DC	003	15	13	R1		0 00415	F 04479	T 10 01	
TD	003	15	13	R1		0 00440	F 04503	T 10 07	
	000	15	13	R1	D	0 00453	F 04516	T 10 08	
	000	15	13	R1		0 00457	F 04520	T 10 09	
	000	15	13	R1	D	0 00472	F 04535	T 10 10	
	000	15	13	R1		0 00478	F 04540	T 10 11	
	000	15	13	R1	D	0 00512	F 04574	T 10 14	
	000	15	13	R1		0 00518	F 04580	T 10 14	
CP	012	15	13	R1		0 00845	F 04906	T 10 45	
TA	005	15	13	R1		0 00916	F 04975	T 10 54	
CP	013	15	13	R1		0 01131	F 05187	T 12 02	
CP	014	15	13	R1		0 01363	F 05418	T 12 36	
CP	015	15	13	R1		0 01591	F 05643	T 12 57	
CP	016	15	13	R1		0 01814	F 05866	T 13 15	
TA	006	15	13	R1		0 01987	F 06035	T 13 34	

.L FRUMP.LDA

.ST 14156 11/18/77 B. Klein

RUN 039 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 17 HOUR 10 MIN 15

	FIFTH WHEEL	FEET/PULSE	0002			ODOMETER	FEET/PULSE	0002
	000	00	00	R1	D	00000	F 00000	T 00 00
	000	00	00	R1		00000	F 00000	T 00 01
TA	001	00	00	R1		00006	F 00006	T 00 23
TA	002	00	00	R1		00076	F 00075	T 00 34
CP	001	00	00	R1		00140	F 00137	T 00 43
	000	17	13	R1		00149	F 00147	T 00 44
TD	001	17	13	R1		00223	F 00220	T 00 54
	000	17	13	R1	D	00261	F 00258	T 00 58
	000	17	13	R1		00268	F 00264	T 00 58
	000	17	13	R1	D	00320	F 00316	T 01 02
	000	17	13	R1		00326	F 00323	T 01 03
TA	003	17	13	R1		00473	F 00470	T 01 45
CP	002	17	13	R1		00763	F 00759	T 02 32
CP	003	17	13	R1		01144	F 01137	T 03 06
	000	14	06	R1		01761	F 01749	T 04 00
CP	004	14	06	R1	D	01773	F 01761	T 04 01
	000	14	06	R1		01778	F 01766	T 04 02
DD	002	14	06	R1		01885	F 01871	T 04 13
DC	002	14	06	R1		01892	F 01879	T 04 22
TD	002	14	06	R1		01908	F 01895	T 04 27
	000	14	06	R1	D	01919	F 01907	T 04 29
TA	004	14	06	R1		01922	F 01910	T 04 29
CP	005	14	06	R1		02176	F 02164	T 05 35
CP	006	14	06	R1		02399	F 02386	T 05 59
CP	007	14	06	R1		02612	F 02596	T 06 57
CP	008	14	06	R1		02895	F 02879	T 07 24
	000	14	08	R2	W	03383	F 03362	T 08 45
CP	009	14	08	R2	W	03553	F 03531	T 09 03
CP	010	14	08	R2	W	03892	F 03869	T 09 31
CP	011	14	08	R2	W	00020	F 04092	T 10 26
	000	15	13	R1		00302	F 04371	T 10 54
	000	15	13	R1	D	00306	F 04376	T 10 55
	000	15	13	R1		00311	F 04380	T 10 55
	000	15	13	R1	D	00330	F 04399	T 10 58
	000	15	13	R1		00333	F 04402	T 10 58
	000	15	13	R1	D	00347	F 04417	T 11 02
	000	15	13	R1		00349	F 04418	T 11 02
DD	003	15	13	R1		00353	F 04421	T 11 05
DC	003	15	13	R1		00358	F 04427	T 11 20
TD	003	15	13	R1		00403	F 04472	T 11 31
	000	15	13	R1	D	00470	F 04538	T 11 38
	000	15	13	R1		00476	F 04544	T 11 38
	000	15	13	R1	D	00509	F 04577	T 11 41
	000	15	13	R1		00516	F 04583	T 11 41
CP	012	15	13	R1		00841-	F 04906	T 12 13
TA	005	15	13	R1		00915	F 04978	T 12 21

.ST 14156

RUN 040 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 17 HOUR 12 MIN 15

1/18/77
B. Klein

		FIFTH WHEEL FEET/PULSE 0002				ODOMETER FEET/PULSE 0002			
TA	001	00	00	R1		00004	F 00004	T	00 06
TA	002	00	00	R1		00073	F 00073	T	00 16
	000	17	13	R1		00130	F 00128	T	00 23
	000	17	13	R1	D	00135	F 00133	T	00 23
CP	001	17	13	R1		00139	F 00137	T	00 24
TD	001	17	13	R1		00215	F 00213	T	00 31
	000	17	13	R1	D	00252	F 00249	T	00 35
	000	17	13	R1		00256	F 00254	T	00 35
	000	17	13	R1	D	00266	F 00263	T	00 36
	000	17	13	R1		00271	F 00268	T	00 37
	000	17	13	R1	D	00275	F 00272	T	00 37
	000	17	13	R1		00280	F 00277	T	00 38
	000	17	13	R1	D	00322	F 00319	T	00 42
	000	17	13	R1		00327	F 00324	T	00 42
TA	003	17	13	R1		00472	F 00470	T	01 17
CP	002	17	13	R1		00763	F 00760	T	02 07
CP	003	17	13	R1		01140	F 01136	T	02 39
	000	14	06	R1		01753	F 01746	T	04 22
	000	14	06	R1	D	01765	F 01757	T	04 23
CP	004	14	06	R1		01771	F 01763	T	04 24
DD	002	14	06	R1		01870	F 01862	T	04 35
DC	002	14	06	R1		01870	F 01862	T	04 46
TD	002	14	06	R1		01901	F 01893	T	04 52
	000	14	06	R1	D	01913	F 01905	T	04 54
TA	004	14	06	R1		01915	F 01908	T	04 54
CP	005	14	06	R1		02166	F 02158	T	05 18
CP	006	14	06	R1		02396	F 02388	T	05 38
CP	007	14	06	R1		02605	F 02596	T	06 30
CP	008	14	06	R1		02887	F 02877	T	06 58
	000	14	06	R2	E	03370	F 03358	T	08 20
CP	009	14	06	R2	E	03547	F 03535	T	09 19
CP	010	14	06	R2	E	03890	F 03875	T	09 55
CP	011	14	06	R2	E	00010	F 04090	T	10 17
	000	15	13	R1		00293	F 04373	T	11 16
	000	15	13	R1	D	00319	F 04399	T	11 18
	000	15	13	R1		00324	F 04404	T	11 19
DD	003	15	13	R1		00355	F 04434	T	11 32
DC	003	15	13	R1		00355	F 04434	T	11 47
TD	003	15	13	R1		00423	F 04502	T	11 58
	000	15	13	R1	D	00500	F 04578	T	12 04
	000	15	13	R1		00506	F 04585	T	12 05
CP	012	15	13	R1		00828	F 04906	T	12 42
TA	005	15	13	R1		00903	F 04979	T	12 52
CP	013	15	13	R1		01123	F 05197	T	13 31
CP	014	15	13	R1		01346	F 05419	T	13 51
CP	015	15	13	R1		01574	F 05645	T	14 47
CP	016	15	13	R1		01802	F 05872	T	15 13
TA	006	15	13	R1		01962	F 06031	T	15 33
CP	017	15	13	R1		02479	F 06543	T	16 14
CP	018	15	13	R1		02533	F 06597	T	16 27
	000	12	06	R1		02663	F 06726	T	16 39
	000	12	06	R1	D	02669	F 06732	T	16 40
	000	12	06	R1		02674	F 06737	T	16 40
	000	12	06	R1	D	02695	F 06758	T	16 42

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.Z CT1:

.ST 1444

.L FRUMP.LDA                                    1/18/77 B. Klein

.ST 14156

RUN 041  SAMPLE RATE 00.5  YEAR 77  MONTH 01  DAY 17  HOUR 15  MIN 35

FIFTH WHEEL FEET/PULSE  0002    ODOMETER FEET/PULSE  0002
   000    00    00   R1 D   0 00000   F 00000   T 00 00
   000    00    00   R1     0 00000   F 00000   T 00 01
TA 001    00    00   R1     0 00007   F 00008   T 00 12
TA 002    00    00   R1     0 00075   F 00076   T 00 21
   000    17    13   R1     0 00109   F 00107   T 00 26
   000    17    13   R1 D   0 00112   F 00111   T 00 26
   000    17    13   R1     0 00116   F 00115   T 00 27
CP 001    17    13   R1     0 00132   F 00130   T 00 29
   000    17    13   R1 D   0 00136   F 00134   T 00 29
   000    17    13   R1     0 00140   F 00139   T 00 30
DO 001    17    13   R1     0 00185   F 00183   T 00 38
DC 001    17    13   R1     0 00187   F 00185   T 00 43
TD 001    17    13   R1     0 00221   F 00219   T 00 48
   000    17    13   R1 D   0 00263   F 00260   T 00 52
   000    17    13   R1     0 00269   F 00266   T 00 53
   000    17    13   R1 D   0 00315   F 00313   T 00 56
   000    17    13   R1     0 00323   F 00320   T 00 57
TA 003    17    13   R1     0 00475   F 00473   T 01 10
CP 002    17    13   R1     0 00768   F 00764   T 01 45
CP 003    17    13   R1     0 01137   F 01130   T 02 17
   000    14    06   R1     0 01742   F 01732   T 03 09
   000    14    06   R1 D   0 01744   F 01733   T 03 10
   000    14    06   R1     0 01745   F 01735   T 03 10
   000    14    06   R1 D   0 01750   F 01739   T 03 12
   000    14    06   R1     0 01751   F 01741   T 03 12
   000    14    06   R1 D   0 01771   F 01761   T 03 23
   000    14    06   R1     0 01773   F 01763   T 03 24
CP 004    14    06   R1     0 01775   F 01765   T 03 24
DO 002    14    06   R1     0 01902   F 01891   T 03 48
DC 002    14    06   R1     0 01902   F 01891   T 04 10
TD 002    14    06   R1     0 01910   F 01899   T 04 14
   000    14    06   R1 D   0 01920   F 01911   T 04 16
   000    14    06   R1     0 01923   F 01914   T 04 16
TA 004    14    06   R1     0 01927   F 01918   T 04 17
CP 005    14    06   R1     0 02175   F 02165   T 04 49
CP 006    14    06   R1     0 02404   F 02393   T 05 09
CP 007    14    06   R1     0 02612   F 02600   T 06 00
CP 008    14    06   R1     0 02896   F 02883   T 07 07
   000    14    08   R3 W   0 03385   F 03371   T 07 59
CP 009    14    08   R3 W   0 03553   F 03539   T 08 47
CP 010    14    08   R3 W   0 03898   F 03882   T 09 15
CP 011    14    08   R3 W   0 00021   F 04099   T 09 31
   000    15    13   R1     0 00298   F 04377   T 10 39
   000    15    13   R1 D   0 00330   F 04408   T 10 41
   000    15    13   R1     0 00336   F 04414   T 10 42
   000    15    13   R1 D   0 00347   F 04425   T 10 43
   000    15    13   R1     0 00353   F 04430   T 10 43
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.DT 14156

D. Irwin 7/10/11

RUN 042 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 17 HOUR 13 MIN 55

FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002		
000	00	00	R1	D	O 00000	F 00000	T 00 00
000	00	00	R1		O 00000	F 00000	T 00 01
TA 001	00	00	R1		O 00012	F 00013	T 00 10
TA 002	00	00	R1		O 00075	F 00076	T 00 19
000	17	13	R1		O 00131	F 00129	T 00 26
CP 001	17	13	R1		O 00135	F 00134	T 00 27
000	17	13	R1	D	O 00140	F 00138	T 00 27
000	17	13	R1		O 00144	F 00143	T 00 28
TD 001	17	13	R1		O 00219	F 00217	T 00 34
000	17	13	R1	D	O 00261	F 00259	T 00 38
000	17	13	R1		O 00267	F 00265	T 00 38
000	17	13	R1	D	O 00327	F 00326	T 00 43
000	17	13	R1		O 00334	F 00332	T 00 44
TA 003	17	13	R1		O 00471	F 00469	T 01 11
CP 002	17	13	R1		O 00768	F 00766	T 02 02
CP 003	17	13	R1		O 01142	F 01137	T 02 38
000	14	05	R1		O 01761	F 01754	T 03 31
000	14	06	R1	D	O 01766	F 01758	T 03 32
CP 004	14	05	R1		O 01771	F 01764	T 03 32
TD 002	14	05	R1		O 01905	F 01897	T 03 47
000	14	06	R1	D	O 01918	F 01911	T 03 50
TA 004	14	06	R1		O 01921	F 01914	T 03 50
CP 005	14	06	R1		O 02167	F 02160	T 05 01
CP 006	14	06	R1		O 02398	F 02391	T 05 22
CP 007	14	05	R1		O 02606	F 02599	T 05 39
CP 008	14	06	R1		O 02890	F 02882	T 06 37
CP 009	14	06	R1		O 03547	F 03537	T 08 14
CP 010	14	06	R1		O 03890	F 03878	T 08 52
CP 011	14	06	R1		O 00012	F 04097	T 09 08
000	15	13	R1		O 00294	F 04377	T 10 11
DD 003	15	13	R1		O 00398	F 04482	T 10 24
DC 003	15	13	R1		O 00398	F 04482	T 10 35
TD 003	15	13	R1		O 00426	F 04509	T 10 44
000	15	13	R1	D	O 00458	F 04540	T 10 47
000	15	13	R1		O 00465	F 04547	T 10 47
000	15	13	R1	D	O 00515	F 04597	T 10 51
000	15	13	R1		O 00523	F 04604	T 10 51
CP 012	15	13	R1		O 00828	F 04909	T 11 22
TA 005	15	13	R1		O 00903	F 04983	T 11 32
CP 013	15	13	R1		O 01120	F 05197	T 11 57
CP 014	15	13	R1		O 01346	F 05422	T 12 28
CP 015	15	13	R1		O 01569	F 05644	T 12 46
CP 016	15	13	R1		O 01794	F 05869	T 13 03
TA 006	15	13	R1		O 01963	F 06036	T 13 18
CP 017	15	13	R1		O 02469	F 06539	T 13 56
CP 018	15	13	R1		O 02525	F 06595	T 14 05
000	12	06	R1		O 02557	F 06726	T 14 19
DD 004	12	06	R1		O 02779	F 06947	T 14 31
DC 004	12	06	R1		O 02783	F 06951	T 14 37
TD 004	12	06	R1		O 02790	F 06959	T 14 41
000	12	06	R1	D	O 02816	F 06985	T 14 45
000	12	06	R1		O 02820	F 06988	T 14 45
CP 019	12	06	R1		O 03241	F 07309	T 15 18
TA 007	12	06	R1		O 03316	F 07382	T 15 27
CP 020	12	06	R1		O 03983	F 08048	T 17 21

.L FRUMP.LDA

.ST 14156

B. Klein 1/18/77

RUN 043 SAMPLE RATE 00.5 YEAR 77 MONTH 01 DAY 17 HOUR 20 MIN 30

	FIFTH WHEEL FEET/PULSE 0002					ODOMETER FEET/PULSE 0002				
	000	00	00	R1	D	00000	F	00000	T	00 00
	000	00	00	R1		00000	F	00000	T	00 01
TA	001	00	00	R1		00007	F	00007	T	00 09
TA	002	00	00	R1		00075	F	00074	T	00 18
	000	17	13	R1		00121	F	00119	T	00 23
	000	17	13	R1	D	00126	F	00124	T	00 24
CP	001	17	13	R1		00132	F	00129	T	00 24
TD	001	17	13	R1		00217	F	00214	T	00 31
	000	17	13	R1	D	00258	F	00255	T	00 35
	000	17	13	R1		00264	F	00261	T	00 35
	000	17	13	R1	D	00326	F	00323	T	00 40
	000	17	13	R1		00332	F	00329	T	00 41
TA	003	17	13	R1		00471	F	00468	T	01 09
CP	002	17	13	R1		00762	F	00757	T	02 02
CP	003	17	13	R1		01137	F	01131	T	02 44
	000	14	06	R1		01756	F	01747	T	04 22
CP	004	14	06	R1	D	01768	F	01758	T	04 23
	000	14	06	R1		01773	F	01764	T	04 24
	000	14	06	R1	D	01904	F	01894	T	04 39
	000	14	06	R1		01907	F	01897	T	04 39
TD	002	14	06	R1		01909	F	01900	T	04 40
	000	14	06	R1	D	01917	F	01908	T	04 41
TA	004	14	06	R1		01920	F	01911	T	04 42
CP	005	14	06	R1		02165	F	02155	T	05 08
CP	006	14	06	R1		02392	F	02381	T	05 58
CP	007	14	06	R1		02604	F	02592	T	06 28
CP	008	14	06	R1		02389	F	02375	T	06 53
	000	14	08	R2	W	03373	F	03357	T	07 47
CP	009	14	08	R2	W	03548	F	03532	T	08 16
CP	010	14	08	R2	W	03386	F	03368	T	08 46
CP	011	14	08	R2	W	00015	F	04092	T	09 06
	000	15	13	R1		00295	F	04372	T	10 14
TD	003	15	13	R1		00422	F	04497	T	10 45
	000	15	13	R1	D	00461	F	04536	T	10 48
	000	15	13	R1		00467	F	04542	T	10 49
	000	15	13	R1	D	00497	F	04571	T	10 51
	000	15	13	R1		00503	F	04577	T	10 52
CP	012	15	13	R1		00330	F	04904	T	11 26
TA	005	15	13	R1		00902	F	04974	T	11 35
CP	013	15	13	R1		01127	F	05197	T	12 56
CP	014	15	13	R1		01351	F	05420	T	13 26
CP	015	15	13	R1		01576	F	05645	T	13 44
CP	016	15	13	R1		01800	F	05868	T	14 00
TA	006	15	13	R1		01963	F	06029	T	14 14
CP	017	15	13	R1		02467	F	06529	T	14 53
CP	018	15	13	R1		02530	F	06591	T	15 04
	000	12	06	R1		02662	F	06723	T	15 18
	000	12	06	R1	D	02669	F	06729	T	15 19
	000	12	06	R1		02675	F	06736	T	15 19
	000	12	06	R1	D	02712	F	06772	T	15 22

4.2 FIXED ROUTE DATA PROCESSING RESULTS

4.2.1 Location Subsystem (Checkpoint) and AVM System (Timepoint) Results

This subsection contains a complete listing of the output of the FRLS program for the Fixed Route Run 27. The checkpoint and timepoint error frequency density and cumulative error distribution tabular outputs are presented for all other fixed route runs. Timepoint data were obtained during location subsystem processing as a programming convenience, however, timepoint performance is the same for both location subsystem and system level algorithms in the HI^3 system. Three location error sheets are provided for Runs 14, 24, 34, 40, and 43. The first shows the result of running raw data through the FRLS program. The second sheet contains the manually computed results for those runs which contained tape read errors and the third sheet gives the overall error statistics for all checkpoints on that run.

FIXED ROUTE RUN # 27 CHECKPOINT ERRORS

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
1	12431	4529	1	3	40.	12413.	4580.	54.
2	12895	3792	1	4	559.	12886.	3807.	18.
3	13632	3698	1	4	1305.	13626.	3711.	14.
4	14904	3541	2	5	26.	14871.	3547.	34.
5	15277	4035	2	6	449.	15263.	3934.	102.
6	15334	4441	2	6	905.	15326.	4385.	56.
7	15383	4869	2	6	1321.	15384.	4797.	72.
8	15475	5453	2	6	1895.	15463.	5366.	88.
9	15644	6735	2	6	3203.	15644.	6661.	74.
10	15736	7421	2	6	3891.	15739.	7342.	79.
11	15809	7838	2	6	4335.	15801.	7782.	57.
12	16042	9499	3	7	1086.	16035.	9460.	40.
13	16512	9618	3	8	372.	16435.	9641.	80.
14	16941	9578	3	8	810.	16872.	9607.	75.
15	17368	9554	3	8	1274.	17334.	9571.	38.
16	17811	9507	3	8	1718.	17777.	9536.	45.
17	18095	8454	3	9	1009.	18112.	8501.	50.
18	18109	8343	3	9	1117.	18112.	8393.	50.
19	17929	6962	4	10	1170.	17926.	6915.	47.
20	16580	6988	4	11	1395.	16525.	6981.	56.
21	15087	7167	4	11	2899.	15032.	7161.	56.
22	14282	7260	4	11	3679.	14257.	7255.	25.
23	13313	7718	5	13	551.	13339.	7715.	26.
24	12500	8500	5	15	401.	12450.	8552.	72.
25	11590	9350	5	15	1633.	11544.	9387.	58.
26	12190	10181	6	18	943.	12170.	10196.	25.
27	13151	10036	6	18	1895.	13114.	10072.	52.
28	13130	9554	6	19	440.	13127.	9626.	72.
29	13052	9039	6	19	974.	13045.	9099.	60.
30	13699	7663	6	21	930.	13808.	7649.	110.
31	15123	7495	7	22	1172.	15148.	7482.	28.
32	15948	7393	7	22	2012.	15982.	7381.	36.
33	16627	7326	7	22	2684.	16649.	7301.	33.
34	17500	7204	7	22	3590.	17548.	7193.	50.
35	18345	7054	7	22	4488.	18440.	7085.	100.
36	18300	5657	8	25	297.	18347.	5646.	49.
37	17779	5728	8	25	865.	17784.	5718.	12.
38	16908	5840	8	25	1719.	16937.	5826.	32.
39	16427	5897	8	25	2221.	16439.	5889.	14.
40	15645	6003	8	25	3009.	15658.	5989.	19.
41	14638	6127	9	29	427.	14627.	6043.	85.
42	14717	5780	9	30	248.	14842.	5763.	126.
43	14816	5222	9	31	632.	14811.	5131.	91.
44	14055	5037	9	32	771.	14024.	5053.	35.
45	13388	5138	9	32	1443.	13357.	5141.	31.
46	12862	5200	9	32	2013.	12792.	5215.	71.

FIXED ROUTE RUN #27 CHECKPOINT ERRORS (CONT'D)

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
47	11518	5369	10	33	810.	11543.	5386.	30.
48	10787	5472	10	33	1448.	10911.	5474.	124.
49	10462	5513	10	33	1888.	10475.	5535.	26.
50	9558	5647	10	33	2860.	9513.	5669.	50.
51	8740	5757	10	33	3616.	8764.	5774.	29.
52	8145	5840	10	33	4250.	8136.	5861.	23.
53	7537	6481	11	35	538.	7560.	6454.	35.
54	7652	6971	11	35	1036.	7645.	6945.	27.
55	8320	6948	11	36	609.	8264.	6955.	57.
56	9345	6825	11	36	1655.	9301.	6818.	45.
*57	9894	6731	11	36	2211.	9852.	6745.	45.
CT1:RUN027.001								
58	12136	6444	12	37	1184.	12134.	6444.	2.
59	12561	6405	12	37	1594.	12541.	6391.	25.
60	13099	6331	12	37	2164.	13106.	6316.	16.
61	13452	6271	12	37	2504.	13443.	6272.	9.
62	13455	5695	12	38	528.	13494.	5733.	55.
63	13388	5138	12	38	1088.	13421.	5178.	51.
64	13372	4812	12	38	1378.	13382.	4890.	79.
65	13787	4668	12	39	367.	13721.	4656.	67.
66	14242	4594	12	39	815.	14165.	4595.	77.
67	15770	4381	13	40	1366.	15740.	4392.	32.
68	16152	4347	13	40	1768.	16139.	4341.	14.
69	17121	4202	13	40	2712.	17076.	4222.	50.
70	17491	3736	13	41	410.	17495.	3756.	21.
71	18691	3072	14	43	1294.	18713.	3068.	23.
72	18782	3565	14	44	521.	18813.	3581.	35.
73	18484	4477	14	45	448.	18469.	4489.	19.
74	17621	4597	14	45	1344.	17579.	4593.	42.
75	16706	4705	14	45	2228.	16701.	4696.	10.
76	15624	4856	15	46	420.	15656.	4830.	42.

FIXED ROUTE RUN #27 CHECKPOINT ERRORS (CONT'D)

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	2	2.63
10- 20	9	11.84
20- 30	11	14.47
30- 40	12	15.79
40- 50	9	11.84
50- 60	14	18.42
60- 70	1	1.32
70- 80	9	11.84
80- 90	3	3.95
90- 100	2	2.63
100- 110	2	2.63
120- 130	2	2.63

CUMULATIVE ERRORS

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	2	2.63
20	11	14.47
30	22	28.95
40	34	44.74
50	43	56.58
60	57	75.00
70	58	76.32
80	67	88.16
90	70	92.11
100	72	94.74
110	74	97.37
120	74	97.37
130	76	100.00

AVERAGE ERROR	=	48.10	
STANDARD DEVIATION	=	27.26	
ELAPSED TIME	=	80: 0	
ELAPSED DISTANCE	=	68512.	(5TH WHEEL)
ELAPSED DISTANCE	=	68650.	(ODOMETER)

FIXED ROUTE LS RUN 11

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 11a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	2	2.63
10- 20	8	10.53
20- 30	15	19.74
30- 40	6	7.89
40- 50	11	14.47
50- 60	4	5.26
60- 70	9	11.84
70- 80	9	11.84
80- 90	6	7.89
90- 100	2	2.63
100- 110	2	2.63
120- 130	2	2.63

CUMULATIVE ERRORS RUN 11a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	2	2.63
20	10	13.16
30	25	32.89
40	31	40.79
50	42	55.26
60	46	60.53
70	55	72.37
80	64	84.21
90	70	92.11
100	72	94.74
110	74	97.37
120	74	97.37
130	76	100.00

FIXED ROUTE LS RUN 11

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 11b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	13.33
1- 2	5	33.33
2- 3	2	13.33
3- 4	1	6.67
5- 6	3	20.00
10- 11	1	6.67
23- 24	1	6.67

CUMULATIVE ERRORS RUN 11b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	13.33
2	7	46.67
3	9	60.00
4	10	66.67
5	10	66.67
6	13	86.67
7	13	86.67
8	13	86.67
9	13	86.67
10	13	86.67
11	14	93.33
24	15	100.00

CONTINUED

6 OF 8

FIXED ROUTE LS RUN 12

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 12a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	2	2.63
10- 20	6	7.89
20- 30	15	19.74
30- 40	6	7.89
40- 50	4	5.26
50- 60	9	11.84
60- 70	7	9.21
70- 80	7	9.21
80- 90	5	6.58
90- 100	7	9.21
100- 110	4	5.26
110- 120	1	1.32
120- 130	1	1.32
130- 140	1	1.32
140- 150	1	1.32

CUMULATIVE ERRORS RUN 12a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	2	2.63
20	8	10.53
30	23	30.26
40	29	38.16
50	33	43.42
60	42	55.26
70	49	64.47
80	56	73.68
90	61	80.26
100	68	89.47
110	72	94.74
120	73	96.05
130	74	97.37
140	75	98.68
150	76	100.00

FIXED ROUTE LS RUN 12

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 12b**

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	20.00
1- 2	1	6.67
2- 3	5	33.33
4- 5	2	13.33
5- 6	1	6.67
8- 9	1	6.67
12- 13	1	6.67
27- 28	1	6.67

CUMULATIVE ERRORS **RUN 12b**

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	20.00
2	4	26.67
3	9	60.00
4	9	60.00
5	11	73.33
6	12	80.00
9	13	86.67
13	14	93.33
28	15	100.00

FIXED ROUTE LS RUN 13

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 13a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	1	1.32
10- 20	8	10.53
20- 30	13	17.11
30- 40	8	10.53
40- 50	11	14.4777
50- 60	7	9.21
60- 70	6	7.89
70- 80	8	10.53
80- 90	5	6.58
90- 100	4	5.26
100- 110	2	2.63
110- 120	2	2.63
140- 150	1	1.32

CUMULATIVE ERRORS RUN 13a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	1	1.32
20	9	11.84
30	22	28.95
40	30	39.47
50	41	53.95
60	48	63.16
70	54	71.05
80	62	81.58
90	67	88.16
100	71	93.42
110	73	96.05
120	75	98.68
130	75	98.68
140	75	98.68
150	76	100.00

FIXED ROUTE LS RUN 13

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 13b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	20.00
1- 2	2	13.33
2- 3	3	20.00
3- 4	1	6.67
4- 5	2	13.33
6- 7	1	6.67
13- 14	1	6.67
15- 16	1	6.67
42- 43	1	6.67

CUMULATIVE ERRORS RUN 13b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	20.00
2	5	33.33
3	8	53.33
4	9	60.00
5	11	73.33
6	11	73.33
7	12	80.00
14	13	86.67
15	13	86.67
16	14	93.33
43	15	100.00

FIXED ROUTE LS RUN 14

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 14a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	4	7.41
10- 20	7	12.96
20- 30	9	16.67
30- 40	11	20.37
40- 50	1	1.85
50- 60	5	9.26
60- 70	5	9.26
70- 80	5	9.26
80- 90	4	7.41
90- 100	1	1.85
100- 110	2	3.70

CUMULATIVE ERRORS RUN 14a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	4	7.41
20	11	20.37
30	20	37.04
40	31	57.41
50	32	59.26
60	37	68.52
70	42	77.78
80	47	87.04
90	51	94.44
100	52	96.30
110	54	100.00

MANUALLY PROCESSED FIXED ROUTE LS DATA, RUN 14

FIXED ROUTE RUN# CHECKPOINT ERRORS

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
55	8320	6948	11	36	577	8232	6959	89
56	9345	6825	11	36	1615	9261	6823	84
57	9894	6731	11	36	2155	9796	6753	100
58	12136	6444	12	37	1178	12128	6445	8
59	12561	6405	12	37	1560	12507	6395	55
60	13099	6331	12	37	2140	13082	6319	21
61	13452	6271	12	37	2464	13403	6377	49
62	13455	5695	12	38	486	13500	5774	91
63	13388	5138	12	38	1046	13426	5219	89
64	13372	4812	12	38	1338	13388	4930	119
65	13787	4668	12	39	337	13691	4660	96
66	14242	4594	12	39	781	14131	4559	116
67	15770	4381	13	40	1368	15742	4392	30
68	16152	4347	13	40	1770	16141	4341	13
69	17121	4202	13	40	2702	17066	4224	59
70	17491	3956	13	41	408	17495	3751	22
71	18691	3072	14	43	1232	18651	3073	40
72	18782	3565	14	44	459	18806	3520	51
73	18484	4477	14	45	386	18531	4482	47
74	17621	4597	14	45	1272	17650	4585	31
75	16706	4705	14	45	2170	16758	4690	54
76	15624	4856	15	46	430	15646	4831	33

LOCATION SUBSYSTEM ERROR STATISTICS, RUN 14

ERROR FREQUENCY DENSITY RUN 14a

Error Interval	No. Samples	Percent of Samples
0- 10	5	6.57
10- 20	8	10.52
20- 30	11	14.47
30- 40	14	18.42
40- 50	4	5.26
50- 60	9	11.24
60- 70	5	6.57
70- 80	5	6.57
80- 90	7	9.21
90-100	3	3.94
100-110	3	3.94
110-120	2	2.63

CUMULATIVE ERRORS RUN 14a

Error	Samples LT Error	Percent Samples LT Error
10	5	6.57
20	13	17.10
30	24	31.57
40	38	50.00
50	42	55.26
60	51	67.10
70	56	73.68
80	61	80.26
90	68	89.47
100	71	93.42
110	74	97.36
120	76	100.00

FIXED ROUTE LS RUN 14

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 14b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	27.27
2- 3	3	27.27
3- 4	1	9.09
4- 5	2	18.18
7- 8	1	9.09
8- 9	1	9.09

CUMULATIVE ERRORS RUN 14b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	27.27
2	3	27.27
3	6	54.55
4	7	63.64
5	9	81.82
6	9	81.82
7	9	81.82
8	10	90.91
9	11	100.00

FIXED ROUTE LS RUN 15

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 15a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	4	5.26
10- 20	8	10.53
20- 30	11	14.47
30- 40	8	10.53
40- 50	14	18.42
50- 60	7	9.21
60- 70	5	6.58
70- 80	2	2.63
80- 90	6	7.89
90- 100	3	3.95
100- 110	5	6.58
110- 120	2	2.63
140- 150	1	1.32

CUMULATIVE ERRORS RUN 15a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	4	5.26
20	12	15.79
30	23	30.26
40	31	40.79
50	45	59.21
60	52	68.42
70	57	75.00
80	59	77.63
90	65	85.53
100	68	89.47
110	73	96.05
120	75	98.68
130	75	98.68
140	75	98.68
150	76	100.00

FIXED ROUTE LS RUN 15

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 15b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	20.00
1- 2	2	13.33
2- 3	1	6.67
3- 4	5	33.33
4- 5	2	13.33
5- 6	1	6.67
7- 8	1	6.67

CUMULATIVE ERRORS RUN 15b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	20.00
2	5	33.33
3	6	40.00
4	11	73.33
5	13	86.67
6	14	93.33
7	14	93.33
8	15	100.00

FIXED ROUTE LS RUN 16

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 16a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	3	3.95
10- 20	12	15.79
20- 30	12	15.79
30- 40	3	3.95
40- 50	11	14.47
50- 60	10	13.16
60- 70	7	9.21
70- 80	4	5.26
80- 90	8	10.53
90- 100	2	2.63
100- 110	3	3.95
110- 120	1	1.32

CUMULATIVE ERRORS RUN 16a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	3	3.95
20	15	19.74
30	27	35.53
40	30	39.47
50	41	53.95
60	51	67.11
70	58	76.32
80	62	81.58
90	70	92.11
100	72	94.74
110	75	98.68
120	76	100.00

FIXED ROUTE LS RUN 16

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 16b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	1	6.67
1- 2	4	26.67
2- 3	2	13.33
3- 4	2	13.33
4- 5	1	6.67
5- 6	1	6.67
6- 7	1	6.67
7- 8	1	6.67
10- 11	1	6.67
14- 15	1	6.67

CUMULATIVE ERRORS RUN 16b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	1	6.67
2	5	33.33
3	7	46.67
4	9	60.00
5	10	66.67
6	11	73.33
7	12	80.00
8	13	86.67
9	13	86.67
10	13	86.67
11	14	93.33
12	14	93.33
13	14	93.33
14	14	93.33
15	15	100.00

FIXED ROUTE LS RUN 17

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY **RUN 17a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	4	5.26
10- 20	6	7.89
20- 30	17	22.37
30- 40	11	14.47
40- 50	6	7.89
50- 60	3	3.95
60- 70	5	6.58
70- 80	4	5.26
80- 90	10	13.16
90- 100	6	7.89
100- 110	2	2.63
110- 120	2	2.63

CUMULATIVE ERRORS **RUN 17a**

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	4	5.26
20	10	13.16
30	27	35.53
40	38	50.00
50	44	57.89
60	47	61.84
70	52	68.42
80	56	73.68
90	66	86.84
100	72	94.74
110	74	97.37
120	76	100.00

FIXED ROUTE LS RUN 17

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 17b**

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	14.29
1- 2	1	7.14
2- 3	4	28.57
4- 5	2	14.29
6- 7	2	14.29
7- 8	1	7.14
8- 9	1	7.14
9- 10	1	7.14

CUMULATIVE ERRORS **RUN 17b**

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	14.29
2	3	21.43
3	7	50.00
4	7	50.00
5	9	64.29
6	9	64.29
7	11	78.57
8	12	85.71
9	13	92.86
10	14	100.00

FIXED ROUTE LS RUN 18

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY **RUN 18a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	2	2.67
10- 20	3	4.00
20- 30	12	16.00
30- 40	12	16.00
40- 50	10	13.33
50- 60	9	12.00
60- 70	8	10.67
70- 80	5	6.67
80- 90	3	4.00
90- 100	3	4.00
100- 110	4	5.33
110- 120	1	1.33
120- 130	2	2.67
130- 140	1	1.33

CUMULATIVE ERRORS **RUN 18a**

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	2	2.67
20	5	6.67
30	17	22.67
40	29	38.67
50	39	52.00
60	48	64.00
70	56	74.67
80	61	81.33
90	64	85.33
100	67	89.33
110	71	94.67
120	72	96.00
130	74	98.67
140	75	100.00

FIXED ROUTE LS RUN 18

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 18b**

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	20.00
1- 2	2	13.33
2- 3	3	20.00
3- 4	4	26.67
5- 6	1	6.67
8- 9	1	6.67
14- 15	1	6.67

CUMULATIVE ERRORS **RUN 18b**

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	20.00
2	5	33.33
3	8	53.33
4	12	80.00
5	12	80.00
6	13	86.67
7	13	86.67
8	13	86.67
9	14	93.33
10	14	93.33
11	14	93.33
12	14	93.33
13	14	93.33
14	14	93.33
15	15	100.00

FIXED ROUTE LS RUN 20

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 20a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
10- 20	3	6.67
20- 30	6	13.33
30- 40	5	11.11
40- 50	10	22.22
50- 60	4	8.89
60- 70	3	6.67
70- 80	4	8.89
80- 90	3	6.67
90- 100	1	2.22
100- 110	2	4.44
110- 120	1	2.22
120- 130	1	2.22
140- 150	1	2.22
160- 170	1	2.22

CUMULATIVE ERRORS RUN 20a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
20	3	6.67
30	9	20.00
40	14	31.11
50	24	53.33
60	28	62.22
70	31	68.89
80	35	77.78
90	38	84.44
100	39	86.67
110	41	91.11
120	42	93.33
130	43	95.56
140	43	95.56
150	44	97.78
160	44	97.78
170	45	100.00

FIXED ROUTE LS RUN 20

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 20b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
1- 2	2	22.22
2- 3	1	11.11
3- 4	1	11.11
4- 5	2	22.22
5- 6	2	22.22
9- 10	1	11.11

CUMULATIVE ERRORS RUN 20b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
2	2	22.22
3	3	33.33
4	4	44.44
5	6	66.67
6	8	88.89
7	8	88.89
8	8	88.89
9	8	88.89
10	9	100.00

FIXED ROUTE LS RUN 21

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 21a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	7	9.59
10- 20	11	15.07
20- 30	13	17.81
30- 40	14	19.18
40- 50	6	8.22
50- 60	8	10.96
60- 70	4	5.48
70- 80	3	4.11
80- 90	1	1.37
90- 100	2	2.74
100- 110	2	2.74
130- 140	1	1.37
140- 150	1	1.37

CUMULATIVE ERRORS RUN 21a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	7	9.59
20	18	24.66
30	31	42.47
40	45	61.64
50	51	69.86
60	59	80.82
70	63	86.30
80	66	90.41
90	67	91.78
100	69	94.52
110	71	97.26
120	71	97.26
130	71	97.26
140	72	98.63
150	73	100.00

FIXED ROUTE LS RUN 21

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 21b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	20.00
1- 2	3	20.00
3- 4	3	20.00
4- 5	2	13.33
6- 7	2	13.33
7- 8	1	6.67
10- 11	1	6.67

CUMULATIVE ERRORS RUN 21b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	20.00
2	6	40.00
3	6	40.00
4	9	60.00
5	11	73.33
6	11	73.33
7	13	86.67
8	14	93.33
9	14	93.33
10	14	93.33
11	15	100.00

FIXED ROUTE LS RUN 22

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 22a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	5	6.58
10- 20	10	13.16
20- 30	11	14.47
30- 40	10	13.16
40- 50	14	18.42
50- 60	9	11.84
60- 70	6	7.89
70- 80	3	3.95
80- 90	1	1.32
90- 100	2	2.63
100- 110	2	2.63
120- 130	1	1.32
130- 140	1	1.32
150- 160	1	1.32

CUMULATIVE ERRORS RUN 22a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	5	6.58
20	15	19.74
30	26	34.21
40	36	47.37
50	50	65.79
60	59	77.63
70	65	85.53
80	68	89.47
90	69	90.79
100	71	93.42
110	73	96.05
120	73	96.05
130	74	97.37
140	75	98.68
150	75	98.68
160	76	100.00

FIXED ROUTE LS RUN 22

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 22b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	20.00
1- 2	3	20.00
2- 3	3	20.00
3- 4	3	20.00
6- 7	1	6.67
7- 8	1	6.67
9- 10	1	6.67

CUMULATIVE ERRORS RUN 22b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	20.00
2	6	40.00
3	9	60.00
4	12	80.00
5	12	80.00
6	12	80.00
7	13	86.67
8	14	93.33
9	14	93.33
10	15	100.00

FIXED ROUTE LS RUN 23

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY **RUN 23a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	6	7.89
10- 20	10	13.16
20- 30	16	21.05
30- 40	8	10.53
40- 50	10	13.16
50- 60	7	9.21
60- 70	6	7.89
70- 80	1	1.32
80- 90	2	2.63
90- 100	4	5.26
110- 120	1	1.32
120- 130	1	1.32
130- 140	1	1.32
140- 150	2	2.63
170- 180	1	1.32

CUMULATIVE ERRORS **RUN 23a**

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	6	7.89
20	16	21.05
30	32	42.11
40	40	52.63
50	50	65.79
60	57	75.00
70	63	82.89
80	64	84.21
90	66	86.84
100	70	92.11
110	70	92.11
120	71	93.42
130	72	94.74
140	73	96.05
150	75	98.68
160	75	98.68
170	75	98.68
180	76	100.00

FIXED ROUTE LS RUN 23

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 23b**

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	5	33.33
1- 2	1	6.67
2- 3	2	13.33
3- 4	1	6.67
4- 5	2	13.33
6- 7	2	13.33
7- 8	1	6.67
8- 9	1	6.67

CUMULATIVE ERRORS **RUN 23b**

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	5	33.33
2	6	40.00
3	8	53.33
4	9	60.00
5	11	73.33
6	11	73.33
7	13	86.67
8	14	93.33
9	15	100.00

FIXED ROUTE LS RUN 24

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 24a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	1	1.61
10- 20	7	11.29
20- 30	9	14.52
30- 40	13	20.97
40- 50	5	8.06
50- 60	9	14.52
60- 70	4	6.45
70- 80	2	3.23
80- 90	2	3.23
90- 100	1	1.61
100- 110	2	3.23
120- 130	1	1.61
130- 140	2	3.23
140- 150	2	3.23
170- 180	1	1.61
1500-1510	1	1.61

CUMULATIVE ERRORS RUN 24a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	1	1.61
20	8	12.90
30	17	27.42
40	30	48.39
50	35	56.45
60	44	70.97
70	48	77.42
80	50	80.65
90	52	83.87
100	53	85.48
110	55	88.71
120	55	88.71
130	56	90.32
140	58	93.55
150	60	96.77
160	60	96.77
170	60	96.77
180	61	98.39
1510	62	100.00

MANUALLY PROCESSED FIXED ROUTE IS ERRORS, RUN 24

FIXED ROUTE RUN# CHECKPOINT ERRORS

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
64	13372	4812	12	38	1400	13379	4869	57
65	13787	4668	12	39	399	13753	4652	38
66	14242	4594	12	39	867	14217	4587	26
67	15770	4381	13	40	1408	15782	4386	13
68	16152	4347	13	40	1770	16141	4341	13
69	17121	4202	13	40	2740	17104	4219	24
70	17491	3736	13	41	449	17490	3723	13
71	18691	3072	14	43	1256	18675	3071	16
72	18782	3565	14	44	489	18809	3557	28
73	14484	4477	14	45	422	18495	4486	14
74	17621	4597	14	45	1328	17595	4592	26
75	16706	4705	14	45	2220	16709	4695	10
76	15624	4856	15	46	448	15629	4834	23

FIXED ROUTE LOCATION SUBSYSTEM
ERROR STATISTICS, RUN 24

ERROR FREQUENCY DENSITY RUN 24a

Error Interval	No. Samples	Percent of Samples
0- 10	1	1.61
10- 20	13	17.33
20- 30	14	18.66
30- 40	14	18.66
40- 50	5	8.06
50- 60	10	13.33
60- 70	4	6.45
70- 80	2	3.23
80- 90	2	3.23
90-100	1	1.61
100-110	2	3.23
120-130	1	1.61
130-140	2	3.23
140-150	2	3.23
170-180	1	1.61
1500-1510	1	1.61

Cumulative Errors Run 24a

Error	Samples LT Error	Percent Samples LT Error
10	1	1.61
20	14	17.33
30	28	37.33
40	42	56.00
50	47	62.66
60	57	76.00
70	61	81.33
80	63	84.00
90	65	86.66
100	66	88.00
110	68	90.66
120	68	90.66
130	69	92.00
140	71	94.66
150	73	97.33
160	73	97.33
170	73	97.33
180	74	98.66
1510	75	100.00

FIXED ROUTE LS RUN 24
TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 24b

ERROR INTERVAL		NO. OF SAMPLES	PERCENT OF SAMPLES
1-	2	4	33.33
2-	3	1	8.33
3-	4	1	8.33
4-	5	3	25.00
5-	6	2	16.67
12-	13	1	8.33

CUMULATIVE ERRORS RUN 24b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
2	4	33.33
3	5	41.67
4	6	50.00
5	9	75.00
6	11	91.67
7	11	91.67
8	11	91.67
9	11	91.67
10	11	91.67
11	11	91.67
12	11	91.67
13	12	100.00

FIXED ROUTE LS RUN 25

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 25a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
.0- 10	1	4.00
10- 20	2	8.00
20- 30	5	20.00
30- 40	1	4.00
40- 50	5	20.00
50- 60	4	16.00
60- 70	3	12.00
70- 80	1	4.00
80- 90	1	4.00
90- 100	2	8.00

CUMULATIVE ERRORS RUN 25a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	1	4.00
20	3	12.00
30	8	32.00
40	9	36.00
50	14	56.00
60	18	72.00
70	21	84.00
80	22	88.00
90	23	92.00
100	25	100.00

FIXED ROUTE LS RUN 25

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 25b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
1- 2	1	20.00
3- 4	1	20.00
6- 7	2	40.00
9- 10	1	20.00

CUMULATIVE ERRORS RUN 25b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
2	1	20.00
3	1	20.00
4	2	40.00
5	2	40.00
6	2	40.00
7	4	80.00
8	4	80.00
9	4	80.00
10	5	100.00

FIXED ROUTE LS RUN 26

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 26a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	6	7.89
10- 20	10	13.16
20- 30	17	22.37
30- 40	11	14.47
40- 50	13	17.11
50- 60	7	9.21
60- 70	6	7.89
70- 80	1	1.32
80- 90	1	1.32
90- 100	2	2.63
100- 110	1	1.32
110- 120	1	1.32

CUMULATIVE ERRORS **RUN 26a**

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	6	7.89
20	16	21.05
30	33	43.42
40	44	57.89
50	57	75.00
60	64	84.21
70	70	92.11
80	71	93.42
90	72	94.74
100	74	97.37
110	75	98.68
120	76	100.00

FIXED ROUTE LS 26

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 26b**

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	21.43
1- 2	3	21.43
2- 3	2	14.29
3- 4	3	21.43
5- 6	2	14.29
12- 13	1	7.14

CUMULATIVE ERRORS **RUN 26b**

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	21.43
2	6	42.86
3	8	57.14
4	11	78.57
5	11	78.57
6	13	92.86
7	13	92.86
8	13	92.86
9	13	92.86
10	13	92.86
11	13	92.86
12	13	92.86
13	14	100.00

FIXED ROUTE LS RUN 27

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 27a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	2	2.63
10- 20	9	11.84
20- 30	11	14.47
30- 40	12	15.79
40- 50	9	11.84
50- 60	14	18.42
60- 70	1	1.32
70- 80	9	11.84
80- 90	3	3.95
90- 100	2	2.63
100- 110	2	2.63
120- 130	2	2.63

CUMULATIVE ERRORS RUN 27a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	2	2.63
20	11	14.47
30	22	28.95
40	34	44.74
50	43	56.58
60	57	75.00
70	58	76.32
80	67	88.16
90	70	92.11
100	72	94.74
110	74	97.37
120	74	97.37
130	76	100.00

FIXED ROUTE LS RUN 27

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 27b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	13.33
1- 2	4	26.67
2- 3	3	20.00
3- 4	3	20.00
5- 6	1	6.67
9- 10	1	6.67
14- 15	1	6.67

CUMULATIVE ERRORS RUN 27b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	13.33
2	6	40.00
3	9	60.00
4	12	80.00
5	12	80.00
6	13	86.67
7	13	86.67
8	13	86.67
9	13	86.67
10	14	93.33
11	14	93.33
12	14	93.33
13	14	93.33
14	14	93.33
15	15	100.00

FIXED ROUTE LS RUN 28

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY **RUN 28a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	5	6.67
10- 20	10	13.33
20- 30	11	14.67
30- 40	8	10.67
40- 50	13	17.33
50- 60	5	6.67
60- 70	8	10.67
70- 80	5	6.67
80- 90	5	6.67
90- 100	2	2.67
100- 110	2	2.67
110- 120	1	1.33

CUMULATIVE ERRORS **RUN 28a**

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	5	6.67
20	15	20.00
30	26	34.67
40	34	45.33
50	47	62.67
60	52	69.33
70	60	80.00
80	65	86.67
90	70	93.33
100	72	96.00
110	74	98.67
120	75	100.00

FIXED ROUTE LS RUN 28

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 28b**

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	5	33.33
1- 2	2	13.33
2- 3	1	6.67
3- 4	2	13.33
4- 5	2	13.33
5- 6	2	13.33
9- 10	1	6.67

CUMULATIVE ERRORS **RUN 28b**

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	5	33.33
2	7	46.67
3	8	53.33
4	10	66.67
5	12	80.00
6	14	93.33
7	14	93.33
8	14	93.33
9	14	93.33
10	15	100.00

FIXED ROUTE LS RUN 29

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY **RUN 29a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	4	5.41
10- 20	10	13.51
20- 30	11	14.86
30- 40	15	20.27
40- 50	9	12.16
50- 60	6	8.11
60- 70	8	10.81
70- 80	1	1.35
80- 90	5	6.76
90- 100	3	4.05
100- 110	1	1.35
120- 130	1	1.35

CUMULATIVE ERRORS **RUN 29a**

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	4	5.41
20	14	18.92
30	25	33.78
40	40	54.05
50	49	66.22
60	55	74.32
70	63	85.14
80	64	86.49
90	69	93.24
100	72	97.30
110	73	98.65
120	73	98.65
130	74	100.00

FIXED ROUTE LS RUN 29
TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 29b**

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	4	26.67
1- 2	2	13.33
2- 3	1	6.67
3- 4	1	6.67
4- 5	1	6.67
5- 6	1	6.67
6- 7	2	13.33
7- 8	1	6.67
8- 9	1	6.67
11- 12	1	6.67

CUMULATIVE ERRORS **RUN 29b**

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	4	26.67
2	6	40.00
3	7	46.67
4	8	53.33
5	9	60.00
6	10	66.67
7	12	80.00
8	13	86.67
9	14	93.33
10	14	93.33
11	14	93.33
12	15	100.00

FIXED ROUTE LS RUN 30

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 30a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	3	3.95
10- 20	10	13.16
20- 30	12	15.79
30- 40	9	11.84
40- 50	11	14.47
50- 60	13	17.11
60- 70	7	9.21
70- 80	5	6.58
80- 90	3	3.95
100- 110	2	2.63
120- 130	1	1.32

CUMULATIVE ERRORS RUN 30a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	3	3.95
20	13	17.11
30	25	32.89
40	34	44.74
50	45	59.21
60	58	76.32
70	65	85.53
80	70	92.11
90	73	96.05
100	73	96.05
110	75	98.68
120	75	98.68
130	76	100.00

FIXED ROUTE LS RUN 30

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 30b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	20.00
1- 2	4	26.67
2- 3	1	6.67
3- 4	1	6.67
5- 6	2	13.33
7- 8	1	6.67
8- 9	2	13.33
13- 14	1	6.67

CUMULATIVE ERRORS RUN 30b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	20.00
2	7	46.67
3	8	53.33
4	9	60.00
5	9	60.00
6	11	73.33
7	11	73.33
8	12	80.00
9	14	93.33
10	14	93.33
11	14	93.33
12	14	93.33
13	14	93.33
14	15	100.00

FIXED ROUTE LS RUN 31

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY **RUN 31a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	2	2.63
10- 20	4	5.26
20- 30	12	15.79
30- 40	15	19.74
40- 50	10	13.16
50- 60	4	5.26
60- 70	9	11.84
70- 80	3	3.95
80- 90	7	9.21
90- 100	5	6.58
100- 110	2	2.63
110- 120	1	1.32
120- 130	1	1.32
400- 410	1	1.32

CUMULATIVE ERRORS **RUN 31a**

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	2	2.63
20	6	7.89
30	18	23.68
40	33	43.42
50	43	56.58
60	47	61.84
70	56	73.68
80	59	77.63
90	66	86.84
100	71	93.42
110	73	96.05
120	74	97.37
130	75	98.68
410	76	100.00

FIXED ROUTE LS RUN 31

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 31b

ERROR INTERVAL		NO. OF SAMPLES	PERCENT OF SAMPLES
0-	1	5	33.33
1-	2	1	6.67
2-	3	1	6.67
3-	4	2	13.33
4-	5	1	6.67
5-	6	3	20.00
6-	7	1	6.67
10-	11	1	6.67

CUMULATIVE ERRORS RUN 31b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	5	33.33
2	6	40.00
3	7	46.67
4	9	60.00
5	10	66.67
6	13	86.67
7	14	93.33
8	14	93.33
9	14	93.33
10	14	93.33
11	15	100.00

FIXED ROUTE LS RUN 32

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 32a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	5	6.67
10- 20	11	14.67
20- 30	10	13.33
30- 40	16	21.33
40- 50	9	12.00
50- 60	8	10.67
60- 70	4	5.33
70- 80	3	4.00
80- 90	3	4.00
90- 100	4	5.33
100- 110	1	1.33
120- 130	1	1.33

CUMULATIVE ERRORS RUN 32a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	5	6.67
20	16	21.33
30	26	34.67
40	42	56.00
50	51	68.00
60	59	78.67
70	63	84.00
80	66	88.00
90	69	92.00
100	73	97.33
110	74	98.67
120	74	98.67
130	75	100.00

FIXED ROUTE LS RUN 32

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 32b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	14.29
1- 2	2	14.29
2- 3	3	21.43
5- 6	2	14.29
6- 7	1	7.14
8- 9	1	7.14
9- 10	1	7.14
11- 12	1	7.14
12- 13	1	7.14

CUMULATIVE ERRORS RUN 32b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	14.29
2	4	28.57
3	7	50.00
4	7	50.00
5	7	50.00
6	9	64.29
7	10	71.43
8	10	71.43
9	11	78.57
10	12	85.71
11	12	85.71
12	13	92.86
13	14	100.00

FIXED ROUTE LS RUN 34

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY **RUN 34a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
10- 20	3	8.11
20- 30	6	16.22
30- 40	5	13.51
40- 50	6	16.22
50- 60	3	8.11
60- 70	5	13.51
70- 80	3	8.11
80- 90	2	5.41
90- 100	3	8.11
130- 140	1	2.70

CUMULATIVE ERRORS **RUN 34a**

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
20	3	8.11
30	9	24.32
40	14	37.84
50	20	54.05
60	23	62.16
70	28	75.68
80	31	83.78
90	33	89.19
100	36	97.30
110	36	97.30
120	36	97.30
130	36	97.30
140	37	100.00

MANUALLY PROCESSED FIXED ROUTE LS ERRORS, RUN 34

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
38	16908	5840	8	25	1751	16905	5830	10
39	16427	5897	8	25	2253	16407	5893	20
40	15645	6003	8	25	3043	15624	5993	23
41	14638	6127	9	29	351	14637	6119	8
42	14717	5780	9	30	160	14754	5771	38
43	14816	5222	9	31	552	14821	5210	13
44	14055	5037	9	32	705	14089	5045	35
45	13388	5138	9	32	1373	13427	5132	39
46	12862	5200	9	32	1951	12854	5207	11
47	11518	5369	10	33	818	11535	5387	25
48	10787	5472	10	33	1550	10810	5488	28
49	10462	5513	10	33	1892	10471	5535	24
51	8740	5757	10	33	3628	8752	5775	22
52	8145	5840	10	33	4280	8106	5865	46
53	7537	6481	11	35	526	7558	6443	43
54	7652	6971	11	35	1028	7643	6937	35
55	8320	6948	11	36	611	8266	6955	54
56	9345	6825	11	36	1651	9297	6819	93
57	9894	6731	11	36	2213	9854	6745	42
58	12136	6444	12	37	1168	12118	6446	18
59	12561	6405	12	37	1574	12521	6393	42
60	13099	6331	12	37	2154	13096	6318	13
61	13452	6271	12	37	2490	13429	6274	23
62	13455	5695	12	38	510	13497	5751	70
63	13388	5138	12	38	1078	13422	5188	60
64	13372	4812	12	38	1372	13383	4896	85
65	13787	4668	12	39	375	13729	4655	59
66	14242	4594	12	39	821	14171	4594	71
67	15770	4381	13	40	1516	15889	4373	119
68	16152	4347	13	40	1772	16143	4341	11
69	17121	4202	13	40	2724	17088	4221	38
70	17491	3736	13	41	416	17494	3750	14
71	18691	3072	14	43	1230	18650	3074	41
72	18782	3565	14	44	477	18808	3537	38
73	18484	4477	14	45	412	18505	4485	22
74	17621	4597	14	45	1316	17607	4590	16
75	16706	4705	14	45	2220	16709	4695	115
76	15624	4856	15	46	430	15646	4831	33

FIXED ROUTE LOCATION SUBSYSTEM
ERROR STATISTICS, RUN 34a

ERROR FREQUENCY DENSITY RUN 34a

Error Interval	No. Samples	Percent of Samples
0- 10	1	1.33
10- 20	11	14.66
20- 30	14	18.66
30- 40	12	16.00
40- 50	11	14.66
50- 60	5	6.66
60- 70	6	8.0
70- 80	5	6.66
80- 90	3	4.0
90-100	4	5.33
110-120	2	2.66
130-140	1	1.33

Cumulative Errors Run 34a

Error	Samples LT Error	Percent Samples LT Error
10	1	1.33
20	12	16.00
30	26	34.66
40	38	50.66
50	49	65.33
60	54	72.00
70	60	80.00
80	65	86.66
90	68	90.66
100	72	96.00
110	72	96.00
120	74	98.66
130	74	98.66
140	75	100.00

FIXED ROUTE LS RUN 34

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY 34b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	25.00
1- 2	1	12.50
4- 5	1	12.50
7- 8	1	12.50
8- 9	1	12.50
9- 10	1	12.50
17- 18	1	12.50

CUMULATIVE ERRORS 34b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	25.00
2	3	37.50
3	3	37.50
4	3	37.50
5	4	50.00
6	4	50.00
7	4	50.00
8	5	62.50
9	6	75.00
10	7	87.50
11	7	87.50
12	7	87.50
13	7	87.50
14	7	87.50
15	7	87.50
16	7	87.50
17	7	87.50
18	8	100.00

FIXED ROUTE LS RUN 35

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 35a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	6	8.00
10- 20	10	13.33
20- 30	15	20.00
30- 40	10	13.33
40- 50	9	12.00
50- 60	7	9.33
60- 70	9	12.00
70- 80	3	4.00
80- 90	3	4.00
90- 100	2	2.67
130- 140	1	1.33

CUMULATIVE ERRORS RUN 35a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	6	8.00
20	16	21.33
30	31	41.33
40	41	54.67
50	50	66.67
60	57	76.00
70	66	88.00
80	69	92.00
90	72	96.00
100	74	98.67
110	74	98.67
120	74	98.67
130	74	98.67
140	75	100.00

FIXED ROUTE LS RUN 35

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY **RUN 35b**

ERROR INTERVAL		NO. OF SAMPLES	PERCENT OF SAMPLES
0-	1	2	13.33
1-	2	3	20.00
2-	3	3	20.00
5-	6	3	20.00
6-	7	2	13.33
9-	10	2	13.33

CUMULATIVE ERRORS **RUN 35b**

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	13.33
2	5	33.33
3	8	53.33
4	8	53.33
5	8	53.33
6	11	73.33
7	13	86.67
8	13	86.67
9	13	86.67
10	15	100.00

FIXED ROUTE LS RUN 36

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 36a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	6	7.89
10- 20	6	7.89
20- 30	13	17.11
30- 40	9	11.84
40- 50	9	11.84
50- 60	7	9.21
60- 70	7	9.21
70- 80	6	7.89
80- 90	5	6.58
100- 110	2	2.63
110- 120	3	3.95
120- 130	1	1.32
130- 140	1	1.32
150- 160	1	1.32

CUMULATIVE ERRORS RUN 36a.

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	6	7.89
20	12	15.79
30	25	32.89
40	34	44.74
50	43	56.58
60	50	65.79
70	57	75.00
80	63	82.89
90	68	89.47
100	68	89.47
110	70	92.11
120	73	96.05
130	74	97.37
140	75	98.68
150	75	98.68
160	76	100.00

FIXED ROUTE LS RUN 36

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 36b

ERROR INTERVAL		NO. OF SAMPLES	PERCENT OF SAMPLES
0-	1	2	13.33
1-	2	3	20.00
2-	3	3	20.00
3-	4	1	6.67
4-	5	5	33.33
7-	8	1	6.67

CUMULATIVE ERRORS RUN 36b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	13.33
2	5	33.33
3	8	53.33
4	9	60.00
5	14	93.33
6	14	93.33
7	14	93.33
8	15	100.00

FIXED ROUTE LS RUN 37

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 37a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	5	6.58
10- 20	4	5.26
20- 30	16	21.05
30- 40	7	9.21
40- 50	9	11.84
50- 60	7	9.21
60- 70	9	11.84
70- 80	3	3.95
80- 90	6	7.89
90- 100	3	3.95
100- 110	2	2.63
110- 120	3	3.95
120- 130	1	1.32
140- 150	1	1.32

CUMULATIVE ERRORS RUN 37a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	5	6.58
20	9	11.84
30	25	32.89
40	32	42.11
50	41	53.95
60	48	63.16
70	57	75.00
80	60	78.95
90	66	86.84
100	69	90.79
110	71	93.42
120	74	97.37
130	75	98.68
140	75	98.68
150	76	100.00

FIXED ROUTE LS RUN 37

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 37b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	4	26.67
1- 2	1	6.67
2- 3	2	13.33
3- 4	1	6.67
4- 5	3	20.00
5- 6	1	6.67
7- 8	1	6.67
8- 9	2	13.33

CUMULATIVE ERRORS RUN 37b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	4	26.67
2	5	33.33
3	7	46.67
4	8	53.33
5	11	73.33
6	12	80.00
7	12	80.00
8	13	86.67
9	15	100.00

FIXED ROUTE LS RUN 38

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 38a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	1	1.32
10- 20	10	13.16
20- 30	7	9.21
30- 40	8	10.53
40- 50	10	13.16
50- 60	9	11.84
60- 70	9	11.84
70- 80	5	6.58
80- 90	7	9.21
90- 100	6	7.89
100- 110	2	2.63
110- 120	2	2.63

CUMULATIVE ERRORS RUN 38a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	1	1.32
20	11	14.47
30	18	23.68
40	26	34.21
50	36	47.37
60	45	59.21
70	54	71.05
80	59	77.63
90	66	86.84
100	72	94.74
110	74	97.37
120	76	100.00

FIXED ROUTE LS RUN 38

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 38b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	14.29
2- 3	2	14.29
3- 4	1	7.14
4- 5	3	21.43
5- 6	3	21.43
6- 7	1	7.14
10- 11	1	7.14
19- 20	1	7.14

CUMULATIVE ERRORS RUN 38b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	14.29
2	2	14.29
3	4	28.57
4	5	35.71
5	8	57.14
6	11	78.57
7	12	85.71
8	12	85.71
9	12	85.71
10	12	85.71
11	13	92.86
20	14	100.00

FIXED ROUTE LS RUN 39

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 39a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
10- 20	2	2.78
20- 30	7	9.72
30- 40	11	15.28
40- 50	16	22.22
50- 60	13	18.06
60- 70	9	12.50
70- 80	4	5.56
80- 90	3	4.17
90- 100	1	1.39
100- 110	3	4.17
110- 120	1	1.39
130- 140	1	1.39
140- 150	1	1.39

CUMULATIVE ERRORS RUN 39a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
20	2	2.78
30	9	12.50
40	20	27.78
50	36	50.00
60	49	68.06
70	58	80.56
80	62	86.11
90	65	90.28
100	66	91.67
110	69	95.83
120	70	97.22
130	70	97.22
140	71	98.61
150	72	100.00

FIXED ROUTE LS RUN 39

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 39b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	1	7.14
1- 2	4	28.57
2- 3	1	7.14
4- 5	2	14.29
5- 6	1	7.14
6- 7	2	14.29
9- 10	1	7.14
11- 12	2	14.29

CUMULATIVE ERRORS RUN 39b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	1	7.14
2	5	35.71
3	6	42.86
4	6	42.86
5	8	57.14
6	9	64.29
7	11	78.57
8	11	78.57
9	11	78.57
10	12	85.71
11	12	85.71
12	14	100.00

FIXED ROUTE LS RUN 40

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 40a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	1	2.78
10- 20	1	2.78
20- 30	2	5.56
30- 40	8	22.22
40- 50	9	25.00
50- 60	7	19.44
70- 80	4	11.11
80- 90	1	2.78
90- 100	1	2.78
100- 110	1	2.78
110- 120	1	2.78

CUMULATIVE ERRORS RUN 40a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	1	2.78
20	2	5.56
30	4	11.11
40	12	33.33
50	21	58.33
60	28	77.78
70	28	77.78
80	32	88.89
90	33	91.67
100	34	94.44
110	35	97.22
120	36	100.00

MANUALLY PROCESSED FIXED ROUTE LS DATA, RUN 40

FIXED ROUTE RUN# 40 CHECKPOINT ERRORS

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
37	17779	5728	8	25	1804	17758	5720	22
38	16908	5840	8	25	2670	16899	5829	14
39	16427	5897	8	25	3164	16409	5893	18
40	15645	6003	8	25	3960	15699	5994	55
41	14638	6127	9	29	1058	14637	6122	5
42	14717	5780	9	30	1572	14770	5770	54
43	14816	5222	9	31	2252	14820	5202	20
44	14055	5037	9	32	3208	14089	5045	35
45	13388	5138	9	32	3888	13415	5133	27
46	12862	5200	9	32	4450	12858	5207	8
47	11518	5369	10	33	824	11529	5388	22
48	10787	5472	10	33	1562	10798	5490	21
49	10462	5513	10	33	1894	10469	5536	24
50	4558	5647	10	33	2878	9495	5692	68
51	8740	5757	10	33	3634	8746	5776	20
52	8145	5840	10	33	4270	8116	5864	38
53	1537	6481	11	35	866	7553	6415	68
54	7652	6971	11	35	1370	7639	6912	60
55	8320	6948	11	36	2092	8252	6957	69
56	9345	6825	11	36	3124	9275	6822	70
57	9894	6731	11	36	3676	9822	6749	74
58	12136	6444	11	37	5994	12120	6446	16
59	12561	6405	11	37	6388	12511	6395	51
60	13099	6331	11	37	6964	13082	6319	21
61	13452	6271	11	37	7296	13411	6276	41
62	13455	5695	11	38	7940	13499	5770	87
63	13388	5138	11	38	8508	13425	5207	78
64	13372	4812	11	38	8794	13387	4924	113
65	13787	4668	11	39	9362	13703	4659	84
66	14242	4594	11	39	9824	14161	4595	81
67	15770	4381	13	40	1378	15752	4390	20
68	16152	4347	13	40	1772	16144	4341	10
69	17121	4202	13	40	2586	16950	4238	175
70	17491	3956	13	41	3628	17492	3738	2
71	18691	3072	13	43	1494	18638	3075	53
72	18782	3565	13	44	2072	18806	3524	48
73	18484	4477	13	45	3392	18517	4484	34
74	17621	4597	13	45	4286	17619	4589	8
75	16706	4705	13	45	5186	16735	4692	32
76	15624	4856	14	46	440	15636	4833	26

FIXED ROUTE LOCATION SUBSYSTEM
ERROR STATISTICS, RUN 40a

ERROR FREQUENCY DENSITY RUN 40a

Error Interval	No. Samples	Percent of Samples
0- 10	4	5.26
10- 20	6	7.89
20- 30	12	15.78
30- 40	12	15.78
40- 50	11	14.47
50- 60	11	14.47
60- 70	4	5.26
70- 80	7	9.21
80- 90	4	5.26
90-100	1	1.31
100-110	1	1.31
110-120	2	2.63
170-180	1	1.31

Cumulative Errors Run 40a

Error	Samples LT. Error	Percent Samples LT Error
10	4	5.26
20	10	13.15
30	22	28.94
40	34	44.73
50	45	59.21
60	56	73.68
70	60	78.94
80	67	88.15
90	71	93.42
100	72	94.73
110	73	96.05
120	75	98.65
180	76	100.00

FIXED ROUTE LS RUN 40

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 40b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	3	37.50
3- 4	1	12.50
6- 7	2	25.00
8- 9	1	12.50
11- 12	1	12.50

CUMULATIVE ERRORS RUN 40b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	3	37.50
2	3	37.50
3	3	37.50
4	4	50.00
5	4	50.00
6	4	50.00
7	6	75.00
8	6	75.00
9	7	87.50
10	7	87.50
11	7	87.50
12	8	100.00

FIXED ROUTE LS RUN 41

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 41a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	7	9.72
10- 20	14	19.44
20- 30	7	9.72
30- 40	9	12.50
40- 50	13	18.06
50- 60	6	8.33
60- 70	11	15.28
70- 80	2	2.78
80- 90	1	1.39
90- 100	1	1.39
110- 120	1	1.39

CUMULATIVE ERRORS RUN 41a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	7	9.72
20	21	29.17
30	28	38.89
40	37	51.39
50	50	69.44
60	56	77.78
70	67	93.06
80	69	95.83
90	70	97.22
100	71	98.61
110	71	98.61
120	72	100.00

FIXED ROUTE LS RUN 41

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 41b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	14.29
1- 2	3	21.43
3- 4	3	21.43
4- 5	1	7.14
5- 6	2	14.29
7- 8	1	7.14
8- 9	1	7.14
9- 10	1	7.14

CUMULATIVE ERRORS RUN 41b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	14.29
2	5	35.71
3	5	35.71
4	8	57.14
5	9	64.29
6	11	78.57
7	11	78.57
8	12	85.71
9	13	92.86
10	14	100.00

FIXED ROUTE LS RUN 42

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 42a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	4	5.56
10- 20	6	8.33
20- 30	10	13.89
30- 40	9	12.50
40- 50	11	15.28
50- 60	8	11.11
60- 70	7	9.72
70- 80	4	5.56
80- 90	6	8.33
90- 100	3	4.17
100- 110	2	2.78
110- 120	1	1.39
130- 140	1	1.39

CUMULATIVE ERRORS RUN 42a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	4	5.56
20	10	13.89
30	20	27.78
40	29	40.28
50	40	55.56
60	48	66.67
70	55	76.39
80	59	81.94
90	65	90.28
100	68	94.44
110	70	97.22
120	71	98.61
130	71	98.61
140	72	100.00

FIXED ROUTE LS RUN 42

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 42b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	2	14.29
1- 2	2	14.29
2- 3	2	14.29
3- 4	1	7.14
4- 5	4	28.57
5- 6	1	7.14
6- 7	1	7.14
9- 10	1	7.14

CUMULATIVE ERRORS RUN 42b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	2	14.29
2	4	28.57
3	6	42.86
4	7	50.00
5	11	78.57
6	12	85.71
7	13	92.86
8	13	92.86
9	13	92.86
10	14	100.00

FIXED ROUTE LS RUN 43

LOCATION ERROR IN FEET

ERROR FREQUENCY DENSITY RUN 43a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	1	1.72
20- 30	5	8.62
30- 40	5	8.62
40- 50	13	22.41
50- 60	9	15.52
60- 70	2	3.45
70- 80	10	17.24
80- 90	3	5.17
90- 100	5	8.62
100- 110	2	3.45
110- 120	1	1.72
120- 130	1	1.72
140- 150	1	1.72

CUMULATIVE ERRORS RUN 43a

ERROR	# SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	1	1.72
20	1	1.72
30	6	10.34
40	11	18.97
50	24	41.38
60	33	56.90
70	35	60.34
80	45	77.59
90	48	82.76
100	53	91.38
110	55	94.83
120	56	96.55
130	57	98.28
140	57	98.28
150	58	100.00

MANUALLY PROCESSED FIXED ROUTE LS DATA, RUN 43

FIXED ROUTE RUN# CHECKPOINT ERRORS

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
64	13372	4812	11	38	1272	13396	4995	185
65	13787	4668	11	39	331	13686	4661	101
66	14242	4594	11	39	787	14137	4598	105
67	15770	4281	13	40	1390	15764	4389	10
68	16152	4347	13	40	1782	16153	4339	8
69	17121	4202	13	40	2732	17096	4220	31
70	17491	3736	13	41	432	17629	3735	138
71	18691	3072	14	43	1202	18621	3076	70
72	18782	3565	14	44	435	18803	3495	73
73	14484	4477	14	45	390	18527	4482	43
74	17621	4597	14	45	1264	17658	4584	39
75	16706	4705	14	45	2194	16604	4707	102
76	15624	4856	15	46	426	15650	4831	36

FIXED ROUTE LOCATION SUBSYSTEM
ERROR STATISTICS, RUN 43a

ERROR FREQUENCY DENSITY RUN 43a

Error Interval	No. Samples	Percent of Samples
0- 10	3	4.0
10- 20	3	4.0
20- 30	6	8.0
30- 40	8	10.66
40- 50	14	18.66
50- 60	9	12.0
60- 70	2	2.66
70- 80	12	16.00
80- 90	3	4.0
90-100	5	6.66
100-110	5	6.66
110-120	1	1.33
120-130	1	1.33
130-140	1	1.33
140-150	1	1.33
180-190	1	1.33

CUMULATIVE ERRORS RUN 43a

Error	Samples LT Error	Percent Samples LT Error
10	3	4.00
20	6	8.00
30	12	16.00
40	20	26.66
50	34	45.33
60	43	57.33
70	45	60.00
80	57	76.00
90	60	80.00
100	65	86.66
110	70	93.33
120	71	94.66
130	72	96.00
140	73	97.33
150	74	98.66
190	75	100.00

FIXED ROUTE LS RUN 43

TIMEPOINT ERROR IN SECONDS

ERROR FREQUENCY DENSITY RUN 43b

ERROR INTERVAL	NO. OF SAMPLES	PERCENT OF SAMPLES
0- 1	1	9.09
1- 2	3	27.27
2- 3	1	9.09
4- 5	1	9.09
5- 6	3	27.27
6- 7	1	9.09
10- 11	1	9.09

CUMULATIVE ERRORS RUN 43b

ERROR	NO. OF SAMPLES LT ERROR	PERCENT OF SAMPLES LT ERROR
1	1	9.09
2	4	36.36
3	5	45.45
4	5	45.45
5	6	54.55
6	9	81.82
7	10	90.91
8	10	90.91
9	10	90.91
10	10	90.91
11	11	100.00

4.2.2 AVM System (Pseudo Checkpoint) Results

This subsection contains a complete output listing of the FRSYS program corresponding to Fixed Route Run 28. This is followed by the error frequency density and cumulative error tabular outputs of FRSYS for all other fixed route runs. Data corresponding to the case of "no communication" errors and to the case in which 5 percent communication errors are simulated are presented. In the cases of Runs 24, 34, 40, and 43, at least three sheets are provided. The first sheet is the results obtained by processing the raw data through FRSYS. The second sheet contains the results computed manually for those pseudo checkpoints which could not be processed by FRSYS due to tape read errors. The third sheet contains the overall resulting error statistics. The last sheet in the sub section contains the results of imposing a 5 percent communication error rate on the manually computed data.

AVM SYSTEM TEST RESULTS, RUN 28

RUN # 28 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	ST	SEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
1	396.	0:31.0	394.	3		CP 1	12396	4435	12413	4414	27
2	556.	0:51.0	554.	3		CP 1	12378	4276	12389	4256	22
3	994.	1:11.0	998.	4		TA 3	12370	3874	12375	3873	5
4	1332.	1:31.0	1334.	4		TA 3	12705	3831	12707	3821	10
5	1664.	1:51.0	1666.	4		CP 2	13035	3787	13027	3775	14
6	1964.	2:11.0	1968.	4		CP 2	13332	3748	13327	3736	13
7	2474.	2:31.0	2476.	4		CP 3	13838	3682	13822	3674	17
8	2970.	2:51.0	2970.	4		CP 3	14330	3618	14312	3613	18
9	3120.	3:11.0	3122.	4		CP 3	14479	3598	14463	3595	16
10	3120.	3:31.0	3122.	4		CP 3	14479	3598	14463	3595	16
11	3356.	3:51.0	3356.	4		CP 3	14713	3568	14695	3566	18
12	3650.	4:11.0	3652.	5		CP 4	15010	3522	15016	3521	6
13	3774.	4:31.0	3776.	5		CP 4	15132	3500	15138	3499	6
14	4128.	4:51.0	4134.	6		TA 4	15240	3771	15242	3788	17
15	4272.	5:11.0	4278.	6		TA 4	15260	3913	15262	3930	17
16	4272.	5:31.0	4278.	6		TA 4	15260	3913	15262	3930	17
17	4524.	5:51.0	4532.	6		CP 5	15295	4163	15305	4237	74
18	4792.	6:11.0	4802.	6		CP 6	15332	4428	15336	4458	30
19	5166.	6:31.0	5178.	6		CP 6	15384	4799	15378	4832	33
20	5166.	6:51.0	5178.	6		CP 6	15384	4799	15378	4832	33
21	5428.	7:11.0	5438.	6		CP 7	15420	5058	15419	5102	44
22	5862.	7:31.0	5872.	6		CP 8	15480	5488	15488	5554	66
23	6236.	7:51.0	6248.	6		CP 8	15532	5858	15537	5926	68
24	6458.	8:11.0	6468.	6		CP 8	15562	6078	15566	6145	67
25	6600.	8:31.0	6612.	6		CP 8	15582	6219	15585	6287	68
26	6670.	8:51.0	6680.	6		CP 8	15592	6288	15593	6355	67
27	7114.	9:11.0	7124.	6		CP 8	15653	6728	15651	6795	67
28	7648.	9:31.0	7660.	6		CP 8	15727	7257	15722	7326	69
29	8178.	9:51.0	8190.	6		CP10	15800	7781	15808	7832	51
30	8538.	10:11.0	8548.	6		CP11	15850	8138	15856	8176	38
31	8910.	10:31.0	8922.	7		CP11	15904	8526	15908	8547	21
32	9316.	10:51.0	9328.	7		CP11	15960	8928	15964	8949	21
33	9596.	11:11.0	9608.	7		CP11	15999	9206	16003	9226	20
34	9926.	11:31.0	9938.	7		CP12	16044	9533	16056	9608	75
35	9934.	11:51.0	9946.	7		CP12	16046	9541	16057	9616	75
36	9934.	12:11.0	9946.	7		CP12	16046	9541	16057	9616	75
37	10186.	12:31.0	10194.	8		TA 5	16185	9660	16276	9645	92
38	10248.	12:51.0	10256.	8		TA 5	16247	9655	16338	9638	92
39	10660.	13:11.0	10668.	8		CP13	16658	9623	16760	9594	106
40	11088.	13:31.0	11096.	8		CP14	17085	9590	17172	9564	90
41	11580.	13:51.0	11588.	8		CP15	17575	9552	17636	9525	66
42	12068.	14:11.0	12076.	8		CP16	18062	9514	18114	9510	52
43	12656.	14:31.0	12658.	9		TA 6	18113	8975	18104	8940	36
44	13172.	14:51.0	13176.	9		CP17	18112	8459	18104	8378	81
45	13570.	15:11.0	13572.	10		CP18	18094	7965	18061	7980	36
46	13722.	15:31.0	13724.	10		CP18	18070	7815	18042	7829	31
47	13722.	15:51.0	13724.	10		CP18	18070	7815	18042	7829	31
48	13984.	16:11.0	13988.	10		CP18	18028	7556	18007	7567	23
49	14286.	16:31.0	14292.	10		CP18	17981	7258	17968	7266	15

AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

PCF	ODOM	TIME	FIFTH	STSEG	SSGS	AVM X	AVM Y	REF X	REF Y	ERROR
50	14740.	16:51.0	14744.	11	CP19	17907	6813	17914	6848	35
51	15040.	17:11.0	15038.	11	TA 7	17609	6849	17668	6844	59
52	15340.	17:31.0	15336.	11	TA 7	17311	6885	17372	6883	61
53	15648.	17:51.0	15636.	11	TA 7	17005	6922	17075	6922	70
54	15938.	18:11.0	15918.	11	TA 7	16717	6957	16795	6959	78
55	16200.	18:31.0	16180.	11	CP20	16457	6988	16490	6998	34
56	16570.	18:51.0	16544.	11	CP20	16090	7033	16129	7042	40
57	16990.	19:11.0	16958.	11	CP20	15673	7083	15718	7091	45
58	17260.	19:31.0	17228.	11	CP20	15404	7116	15450	7123	46
59	17568.	19:51.0	17538.	11	CP20	15099	7153	15142	7160	43
60	17572.	20:11.0	17544.	11	CP20	15095	7153	15136	7161	41
61	17874.	20:31.0	17838.	11	CP21	14795	7189	14842	7195	47
62	18080.	20:51.0	18042.	11	CP21	14590	7214	14639	7218	49
63	18080.	21:11.0	18042.	11	CP21	14590	7214	14639	7218	49
64	18392.	21:31.0	18342.	11	CP21	14281	7252	14341	7253	60
65	18528.	21:51.0	18480.	11	CP22	14145	7268	14154	7270	9
66	18528.	22:11.0	18480.	11	CP22	14145	7268	14154	7270	9
67	18654.	22:31.0	18604.	12	CP22	14058	7276	14030	7281	28
68	19140.	22:51.0	19074.	13	TA 8	13618	7409	13609	7412	9
69	19604.	23:11.0	19538.	13	CP23	13305	7752	13286	7750	19
70	20126.	23:31.0	20060.	14	TA 9	12931	8115	12909	8135	29
71	20214.	23:51.0	20150.	14	TA 9	12865	8173	12841	8194	31
72	20584.	24:11.0	20520.	15	TA10	12591	8421	12661	8354	96
73	20692.	24:31.0	20630.	15	TA10	12511	8494	12579	8428	94
74	20856.	24:51.0	20792.	15	CP24	12391	8605	12435	8560	62
75	21592.	25:11.0	21532.	15	CP24	11850	9104	11894	9065	58
76	22134.	25:31.0	22074.	15	CP25	11451	9471	11493	9437	54
77	22716.	25:51.0	22654.	16	CP25	11078	9892	11065	9828	65
78	23174.	26:11.0	23108.	17	TA11	11171	10238	11173	10111	127
79	23268.	26:31.0	23200.	17	TA11	11229	10312	11199	10199	116
80	23596.	26:51.0	23526.	18	TA12	11551	10278	11529	10277	22
81	23748.	27:11.0	23678.	18	TA12	11701	10258	11680	10255	21
82	24138.	27:31.0	24070.	18	TA12	12088	10207	12068	10198	21
83	24202.	27:51.0	24134.	18	TA12	12152	10198	12131	10189	22
84	24326.	28:11.0	24258.	18	CP26	12274	10182	12286	10166	20
85	24744.	28:31.0	24676.	18	CP26	12689	10127	12700	10104	25
86	24760.	28:51.0	24690.	18	CP26	12705	10125	12714	10101	25
87	25210.	29:11.0	25140.	18	CP27	13151	10066	13170	10046	27
88	25634.	29:31.0	25562.	19	TA13	13136	9685	13142	9650	35
89	25994.	29:51.0	25920.	19	CP28	13081	9329	13085	9263	66
90	26216.	30:11.0	26144.	19	CP28	13047	9110	13052	9041	69
91	26380.	30:31.0	26310.	19	CP29	13021	8948	13027	8901	47
92	26776.	30:51.0	26708.	19	CP29	12960	8557	12957	8509	48
93	26986.	31:11.0	26916.	19	CP29	12928	8349	12921	8304	45
94	27330.	31:31.0	27262.	20	TA14	12902	8006	12900	7971	35
95	27748.	31:51.0	27684.	21	TA15	13083	7757	13028	7765	55
96	27902.	32:11.0	27838.	21	TA15	13236	7734	13180	7742	56
97	27902.	32:31.0	27838.	21	TA15	13236	7734	13180	7742	56
98	28164.	32:51.0	28102.	21	TA15	13495	7695	13441	7702	54
99	28548.	33:11.0	28486.	21	CP30	13875	7638	13768	7654	108
100	28934.	33:31.0	28870.	22	CP30	14200	7595	14149	7609	52
101	29228.	33:51.0	29166.	22	CP30	14492	7560	14443	7575	51
102	29512.	34:11.0	29450.	22	CP30	14774	7526	14725	7541	51
103	29852.	34:31.0	29786.	22	CP30	15111	7486	15059	7502	54

AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

PCP	ODOM	TIME	FIFTH	STSEG	SSGS	AVM X	AVM Y	REF X	REF Y	ERROR
104	30368.	34:51.0	30304.	22	CP31	15624	7424	15603	7435	23
105	30852.	35:11.0	30786.	22	CP32	16104	7366	16061	7381	45
106	31354.	35:31.0	31288.	22	CP32	16603	7306	16561	7332	49
107	31640.	35:51.0	31574.	22	CP33	16887	7272	16856	7293	37
108	31752.	36:11.0	31686.	22	CP33	16998	7258	16967	7278	36
109	31752.	36:31.0	31686.	22	CP33	16998	7258	16967	7278	36
110	31924.	36:51.0	31858.	22	CP33	17169	7238	17138	7254	34
111	32160.	37:11.0	32094.	22	CP33	17403	7210	17371	7221	33
112	32470.	37:31.0	32402.	22	CP34	17711	7173	17663	7174	48
113	32936.	37:51.0	32868.	22	CP34	18173	7117	18122	7093	56
114	33484.	38:11.0	33416.	22	CP35	18717	7051	18636	7044	81
115	33624.	38:31.0	33558.	23	CP35	18826	7013	18778	7039	54
116	33740.	38:51.0	33668.	23	TA16	18803	6899	18823	6974	77
117	34198.	39:11.0	34128.	24	TA16	18719	6469	18762	6518	65
118	34368.	39:31.0	34296.	24	TA16	18704	6299	18740	6352	64
119	34858.	39:51.0	34786.	24	TA16	18660	5812	18676	5866	56
120	35202.	40:11.0	35124.	25	TA17	18504	5625	18511	5626	7
121	35426.	40:31.0	35348.	25	CP36	18281	5653	18250	5663	32
122	35722.	40:51.0	35642.	25	CP36	17988	5691	17959	5703	31
123	35792.	41:11.0	35712.	25	CP36	17918	5700	17889	5712	31
124	35792.	41:31.0	35712.	25	CP36	17918	5700	17889	5712	31
125	35842.	41:51.0	35762.	25	CP36	17869	5706	17840	5719	31
126	35842.	42:11.0	35762.	25	CP36	17869	5706	17840	5719	31
127	35986.	42:31.0	35906.	25	CP37	17726	5724	17757	5730	31
128	36236.	42:51.0	36156.	25	CP37	17478	5756	17509	5762	31
129	36352.	43:11.0	36274.	25	CP37	17363	5771	17392	5777	29
130	36722.	43:31.0	36642.	25	CP37	16996	5818	17027	5824	31
131	36762.	43:51.0	36682.	25	CP37	16956	5823	16987	5829	31
132	37194.	44:11.0	37114.	25	CP38	16528	5877	16534	5884	9
133	37224.	44:31.0	37146.	25	CP38	16498	5881	16502	5888	8
134	37348.	44:51.0	37268.	25	CP39	16375	5897	16389	5902	14
135	37676.	45:11.0	37596.	25	CP39	16050	5938	16064	5946	16
136	37676.	45:31.0	37596.	25	CP39	16050	5938	16064	5946	16
137	37676.	45:51.0	37596.	25	CP39	16050	5938	16064	5946	16
138	37716.	46:11.0	37636.	25	CP39	16010	5943	16024	5951	16
139	37764.	46:31.0	37684.	25	CP39	15963	5949	15977	5957	16
140	38118.	46:51.0	38038.	25	CP40	15611	5994	15621	6005	14
141	38118.	47:11.0	38038.	25	CP40	15611	5994	15621	6005	14
142	38304.	47:31.0	38222.	25	CP40	15427	6018	15437	6023	11
143	38390.	47:51.0	38312.	25	CP40	15342	6029	15348	6031	6
144	38390.	48:11.0	38312.	25	CP40	15342	6029	15348	6031	6
145	38390.	48:31.0	38312.	25	CP40	15342	6029	15348	6031	6
146	38522.	48:51.0	38440.	26	TA18	15237	6065	15235	6056	9
147	38712.	49:11.0	38628.	26	TA18	15266	6253	15259	6243	12
148	38856.	49:31.0	38774.	28	TA19	15274	6380	15239	6385	35
149	39000.	49:51.0	38922.	28	TA19	15131	6401	15092	6406	39
150	39438.	50:11.0	39358.	28	TA19	14697	6464	14661	6469	36
151	39682.	50:31.0	39608.	29	TA20	14652	6241	14653	6252	11
152	39736.	50:51.0	39662.	29	TA20	14645	6188	14647	6199	11
153	40088.	51:11.0	40016.	29	TA21	14601	5838	14628	5785	59
154	40512.	51:31.0	40436.	31	TA22	14880	5682	14881	5694	12
155	40870.	51:51.0	40796.	31	TA22	14835	5327	14832	5337	10
156	41076.	52:11.0	41000.	31	CP43	14809	5122	14805	5116	7
157	41196.	52:31.0	41122.	31	CP43	14794	5003	14792	4995	0

AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

PCP	ODOM	TIME	FIFTH	STSEG	SSGS	AVM X	AVM Y	REF X	REF Y	ERROR
158	41540.	52:51.0	41460.	32	TA23	14497	4991	14505	4985	10
159	41572.	53:11.0	41494.	32	TA23	14465	4995	14472	4989	9
160	41718.	53:31.0	41640.	32	TA23	14321	5014	14327	5005	10
161	41946.	53:51.0	41864.	32	CP44	14094	5044	14029	5040	65
162	42070.	54:11.0	41990.	32	CP44	13972	5060	13904	5059	68
163	42070.	54:31.0	41990.	32	CP44	13972	5060	13904	5059	68
164	42150.	54:51.0	42070.	32	CP44	13892	5070	13825	5071	67
165	42666.	55:11.0	42586.	32	CP45	13381	5137	13314	5146	67
166	43206.	55:31.0	43124.	32	CP46	12845	5208	12808	5206	37
167	43708.	55:51.0	43628.	33	CP46	12305	5279	12308	5269	10
168	43850.	56:11.0	43768.	33	CP46	12164	5299	12169	5287	13
169	43860.	56:31.0	43780.	33	CP46	12154	5300	12157	5288	12
170	43916.	56:51.0	43836.	33	CP46	12099	5308	12101	5295	13
171	44044.	57:11.0	43962.	33	CP46	11972	5325	11976	5311	14
172	44428.	57:31.0	44350.	33	CP46	11592	5378	11592	5359	19
173	44454.	57:51.0	44376.	33	CP46	11566	5382	11566	5362	20
174	44526.	58:11.0	44448.	33	CP47	11495	5392	11480	5374	23
175	44894.	58:31.0	44814.	33	CP47	11130	5443	11117	5425	22
176	45288.	58:51.0	45210.	33	CP48	10740	5497	10699	5483	43
177	45780.	59:11.0	45702.	33	CP49	10253	5565	10262	5542	24
178	46334.	59:31.0	46256.	33	CP49	9704	5642	9714	5623	21
179	46624.	59:51.0	46546.	33	CP50	9417	5682	9456	5660	44
180	46830.	60:11.0	46752.	33	CP50	9213	5710	9252	5688	44
181	46850.	60:31.0	46772.	33	CP50	9193	5713	9232	5690	45
182	47366.	60:51.0	47290.	33	CP51	8682	5784	8648	5769	37
183	47938.	61:11.0	47862.	33	CP52	8116	5863	8133	5841	27
184	48462.	61:31.0	48386.	34	CP52	7578	5917	7613	5906	36
185	48864.	61:51.0	48782.	35	TA24	7518	6211	7504	6217	15
186	49040.	62:11.0	48960.	35	TA24	7548	6385	7526	6394	23
187	49092.	62:31.0	49012.	35	TA24	7557	6436	7532	6446	26
188	49558.	62:51.0	49478.	35	CP53	7636	6896	7643	6934	38
189	49748.	63:11.0	49662.	36	TA25	7708	7028	7778	7019	70
190	50168.	63:31.0	50084.	36	TA25	8124	6973	8197	6964	73
191	50628.	63:51.0	50544.	36	CP55	8580	6913	8653	6907	73
192	50722.	64:11.0	50638.	36	CP55	8674	6901	8746	6896	72
193	51150.	64:31.0	51066.	36	CP55	9098	6844	9171	6845	73
194	51626.	64:51.0	51542.	36	CP56	9570	6782	9638	6774	68
195	51906.	65:11.0	51822.	36	CP57	9847	6745	9911	6728	66
196	52484.	65:31.0	52404.	36	CP57	10420	6670	10489	6654	70
197	52990.	65:51.0	52908.	36	CP57	10922	6603	10989	6590	68
198	53226.	66:11.0	53146.	37	CP57	11156	6573	11225	6560	70
199	53268.	66:31.0	53186.	37	CP57	11197	6567	11264	6555	68
200	53316.	66:51.0	53234.	37	CP57	11245	6561	11312	6549	68
201	53734.	67:11.0	53650.	37	CP57	11660	6506	11725	6496	65
202	54236.	67:31.0	54154.	37	CP58	12157	6441	12179	6439	22
203	54724.	67:51.0	54640.	37	CP59	12641	6377	12693	6386	52
204	55202.	68:11.0	55118.	37	CP60	13115	6315	13136	6324	22
205	55618.	68:31.0	55534.	37	CP61	13528	6260	13568	6255	40
206	55990.	68:51.0	55902.	38	TA26	13519	5923	13493	5894	38
207	56110.	69:11.0	56024.	38	TA26	13503	5804	13470	5774	44
208	56378.	69:31.0	56290.	38	CP62	13468	5538	13427	5468	81
209	56618.	69:51.0	56530.	38	CP62	13436	5300	13399	5230	79
210	56990.	70:11.0	56900.	38	CP63	13387	4931	13374	4864	68
211	57238.	70:31.0	57154.	39	TA27	13378	4704	13461	4695	83

AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

PCP	ODOM	TIME	FIFTH	STSEG	SSGS	AVM X	AVM Y	REF X	REF Y	ERROR
212	57488.	70:51.0	57402.	39	TA27	13626	4669	13708	4674	82
213	57604.	71:11.0	57518.	39	CP65	13741	4653	13830	4660	89
214	57980.	71:31.0	57894.	39	CP65	14113	4601	14201	4600	88
215	58400.	71:51.0	58312.	40	CP66	14609	4535	14620	4541	12
216	58436.	72:11.0	58348.	40	CP66	14644	4531	14655	4536	12
217	58436.	72:31.0	58348.	40	CP66	14644	4531	14655	4536	12
218	58766.	72:51.0	58678.	40	CP66	14972	4489	14982	4490	10
219	59318.	73:11.0	59232.	40	CP66	15520	4419	15531	4414	12
220	59510.	73:31.0	59424.	40	CP66	15710	4395	15721	4387	13
221	59724.	73:51.0	59640.	40	CP67	15922	4368	15931	4366	9
222	60140.	74:11.0	60056.	40	CP68	16335	4316	16337	4319	3
223	60334.	74:31.0	60250.	40	CP68	16528	4291	16529	4290	1
224	60724.	74:51.0	60638.	40	CP68	16915	4242	16913	4233	9
225	60852.	75:11.0	60766.	40	CP68	17042	4226	17040	4214	12
226	60908.	75:31.0	60822.	40	CP69	17097	4219	17128	4201	35
227	61318.	75:51.0	61232.	40	CP69	17504	4168	17537	4163	33
228	61348.	76:11.0	61262.	40	CP69	17534	4164	17567	4160	33
229	61692.	76:31.0	61600.	41	TA28	17509	3847	17506	3833	14
230	61764.	76:51.0	61674.	41	TA28	17498	3775	17494	3760	15
231	62166.	77:11.0	62076.	42	CP70	17437	3332	17447	3372	41
232	62470.	77:31.0	62382.	43	TA29	17584	3173	17554	3177	30
233	62698.	77:51.0	62612.	43	TA29	17811	3152	17783	3155	28
234	63026.	78:11.0	62940.	43	TA29	18137	3121	18110	3125	27
235	63188.	78:31.0	63102.	43	TA29	18299	3106	18271	3110	28
236	63486.	78:51.0	63398.	43	TA29	18595	3078	18566	3083	29
237	63770.	79:11.0	63686.	44	TA30	18766	3190	18759	3181	11
238	63938.	79:31.0	63852.	44	TA30	18786	3356	18768	3347	20
239	64138.	79:51.0	64050.	44	TA30	18809	3555	18780	3545	30
240	64428.	80:11.0	64340.	44	CP72	18843	3843	18820	3816	35
241	64806.	80:31.0	64716.	44	CP72	18888	4218	18876	4187	33
242	65110.	80:51.0	65024.	45	TA31	18830	4446	18844	4443	14
243	65444.	81:11.0	65358.	45	TA31	18498	4485	18511	4474	17
244	65636.	81:31.0	65548.	45	CP73	18308	4507	18319	4499	13
245	65940.	81:51.0	65852.	45	CP73	18006	4543	18018	4541	12
246	66294.	82:11.0	66204.	45	CP73	17654	4584	17669	4590	16
247	66514.	82:31.0	66424.	45	CP74	17435	4610	17479	4613	44
248	66772.	82:51.0	66684.	45	CP74	17179	4640	17221	4644	42
249	66772.	83:11.0	66684.	45	CP74	17179	4640	17221	4644	42
250	66828.	83:31.0	66742.	45	CP74	17123	4646	17164	4650	41
251	67270.	83:51.0	67184.	45	CP75	16684	4698	16696	4706	14
252	67560.	84:11.0	67474.	45	CP75	16396	4731	16408	4746	19
253	67686.	84:31.0	67598.	45	CP75	16271	4746	16286	4763	22
254	67688.	84:51.0	67602.	45	CP75	16269	4746	16282	4764	22
255	67972.	85:11.0	67886.	46	CP75	16060	4771	16000	4803	68
256	68128.	85:31.0	68042.	46	CP75	15905	4793	15846	4824	66
257	68128.	85:51.0	68044.	46	CP75	15905	4793	15844	4825	68
258	68128.	86:11.0	68044.	46	CP75	15905	4793	15844	4825	68
259	68452.	86:31.0	68368.	46	CP76	15584	4839	15542	4860	46

AVM SYSTEM TEST RESULTS, RUN 28 (CONT'D)

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	20	7.72
10- 20	53	20.46
20- 30	35	13.51
30- 40	43	16.60
40- 50	27	10.42
50- 60	18	6.95
60- 70	32	12.36
70- 80	15	5.79
80- 90	7	2.70
90- 100	5	1.93
100- 110	2	0.77
110- 120	1	0.39
120- 130	1	0.39

CUMULATIVE ERRORS

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	20	7.72
20	73	28.19
30	108	41.70
40	151	58.30
50	178	68.73
60	196	75.68
70	228	88.03
80	243	93.82
90	250	96.53
100	255	98.46
110	257	99.23
120	258	99.61
130	259	100.00

AVERAGE ERROR = 39.30

STANDARD DEVIATION = 25.12

ERROR FREQUENCY DENSITY

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	20	7.72
10- 20	52	20.08
20- 30	34	13.13
30- 40	43	16.60
40- 50	26	10.04
50- 60	20	7.72
60- 70	33	12.74
70- 80	14	5.41
80- 90	7	2.70
90- 100	5	1.93
100- 110	2	0.77
110- 120	1	0.39
120- 130	2	0.77

CUMULATIVE ERRORS

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	20	7.72
20	72	27.80
30	106	40.93
40	149	57.53
50	175	67.57
60	195	75.29
70	228	88.03
80	242	93.44
90	249	96.14
100	254	98.07
110	256	98.84
120	257	99.23
130	259	100.00

AVERAGE ERROR = 39.85

STANDARD DEVIATION = 25.60

FIXED ROUTE AVM SYSTEM RUN 11

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 11a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	20	6.51
10- 20	46	14.98
20- 30	38	12.38
30- 40	32	10.42
40- 50	42	13.68
50- 60	23	7.49
60- 70	24	7.82
70- 80	28	9.12
80- 90	30	9.77
90- 100	7	2.28
100- 110	5	1.63
110- 120	5	1.63
120- 130	4	1.30
150- 160	2	0.65
210- 220	1	0.33

CUMULATIVE ERRORS RUN 11a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	20	6.51
20	66	21.50
30	104	33.88
40	136	44.30
50	178	57.98
60	201	65.47
70	225	73.29
80	253	82.41
90	283	92.18
100	290	94.46
110	295	96.09
120	300	97.72
130	304	99.02
140	304	99.02
150	304	99.02
160	306	99.67
170	306	99.67
180	306	99.67
190	306	99.67
200	306	99.67
210	306	99.67
220	307	100.00

AVERAGE ERROR = 48.96

STANDARD DEVIATION = 31.68

FIXED ROUTE AVM SYSTEM RUN 11
LOCATION ERROR IN FEET
5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 11b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	20	6.51
10- 20	46	14.98
20- 30	39	12.70
30- 40	35	11.40
40- 50	42	13.68
50- 60	22	7.17
60- 70	22	7.17
70- 80	26	8.47
80- 90	30	9.77
90- 100	8	2.61
100- 110	5	1.63
110- 120	5	1.63
120- 130	4	1.30
150- 160	2	0.65
230- 240	1	0.33

CUMULATIVE ERRORS RUN 11b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	20	6.51
20	66	21.50
30	105	34.20
40	140	45.60
50	182	59.28
60	204	66.45
70	226	73.62
80	252	82.08
90	282	91.86
100	290	94.46
110	295	96.09
120	300	97.72
130	304	99.02
140	304	99.02
150	304	99.02
160	306	99.67
240	307	100.00

AVERAGE ERROR = 48.63
STANDARD DEVIATION = 32.02

FIXED ROUTE AVM SYSTEM RUN 12
LOCATION ERROR IN FEET
NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 12a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	8	2.67
10- 20	27	9.00
20- 30	67	22.33
30- 40	26	8.67
40- 50	23	7.67
50- 60	39	13.00
60- 70	33	11.00
70- 80	20	6.67
80- 90	17	5.67
90- 100	15	5.00
100- 110	14	4.67
110- 120	7	2.33
120- 130	2	0.67
130- 140	1	0.33
140- 150	1	0.33

CUMULATIVE ERRORS RUN 12a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	8	2.67
20	35	11.67
30	102	34.00
40	128	42.67
50	151	50.33
60	190	63.33
70	223	74.33
80	243	81.00
90	260	86.67
100	275	91.67
110	289	96.33
120	296	98.67
130	298	99.33
140	299	99.67
150	300	100.00
AVERAGE ERROR	=	51.48
STANDARD DEVIATION	=	30.28

FIXED ROUTE AVM SYSTEM RUN 12

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 12b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	3.33
10- 20	27	9.00
20- 30	70	23.33
30- 40	26	8.67
40- 50	20	6.67
50- 60	39	13.00
60- 70	33	11.00
70- 80	19	6.33
80- 90	17	5.67
90- 100	14	4.67
100- 110	14	4.67
110- 120	7	2.33
120- 130	2	0.67
130- 140	1	0.33
140- 150	1	0.33

CUMULATIVE ERRORS RUN 12b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	3.33
20	37	12.33
30	107	35.67
40	133	44.33
50	153	51.00
60	192	64.00
70	225	75.00
80	244	81.33
90	261	87.00
100	275	91.67
110	289	96.33
120	296	98.67
130	298	99.33
140	299	99.67
150	300	100.00
AVERAGE ERROR	=	50.75
STANDARD DEVIATION	=	30.50

FIXED ROUTE AVM SYSTEM RUN 13

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY **RUN 13 a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	3.53
10- 20	58	20.49
20- 30	23	8.13
30- 40	42	14.84
40- 50	43	15.19
50- 60	25	8.83
60- 70	15	5.30
70- 80	17	6.01
80- 90	22	7.77
90- 100	9	3.18
100- 110	4	1.41
110- 120	2	0.71
120- 130	5	1.77
130- 140	4	1.41
140- 150	2	0.71
170- 180	1	0.35
180- 190	1	0.35

CUMULATIVE ERRORS **RUN 13a**

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	3.53
20	68	24.03
30	91	32.16
40	133	47.00
50	176	62.19
60	201	71.02
70	216	76.33
80	233	82.33
90	255	90.11
100	264	93.29
110	268	94.70
120	270	95.41
130	275	97.17
140	279	98.59
150	281	99.29
160	281	99.29
170	281	99.29
180	282	99.65
190	283	100.00

AVERAGE ERROR = 48.78

STANDARD DEVIATION = 32.74

FIXED ROUTE AVM SYSTEM RUN 13

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS
ERROR FREQUENCY DENSITY **RUN 13b**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	3.53
10- 20	59	20.85
20- 30	22	7.77
30- 40	42	14.84
40- 50	41	14.49
50- 60	25	8.83
60- 70	15	5.30
70- 80	18	6.36
80- 90	22	7.77
90- 100	10	3.53
100- 110	4	1.41
110- 120	2	0.71
120- 130	5	1.77
130- 140	4	1.41
140- 150	2	0.71
170- 180	1	0.35
180- 190	1	0.35

CUMULATIVE ERRORS **RUN 13b**

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	3.53
20	69	24.38
30	91	32.16
40	133	47.00
50	174	61.48
60	199	70.32
70	214	75.62
80	232	81.98
90	254	89.75
100	264	93.29
110	268	94.70
120	270	95.41
130	275	97.17
140	279	98.59
150	281	99.29
160	281	99.29
170	281	99.29
180	282	99.65
190	283	100.00

AVERAGE ERROR = 48.98
STANDARD DEVIATION = 32.93

FIXED ROUTE AVM SYSTEM RUN 14

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 14a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	9	3.85
10- 20	34	14.53
20- 30	44	18.80
30- 40	33	14.10
40- 50	32	13.68
50- 60	18	7.69
60- 70	17	7.26
70- 80	12	5.13
80- 90	14	5.98
90- 100	11	4.70
100- 110	9	3.85
110- 120	1	0.43

CUMULATIVE ERRORS RUN 14a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	9	3.85
20	43	18.38
30	87	37.18
40	120	51.28
50	152	64.96
60	170	72.65
70	187	79.91
80	199	85.04
90	213	91.03
100	224	95.73
110	233	99.57
120	234	100.00

AVERAGE ERROR = 44.88

STANDARD DEVIATION = 27.13

FIXED ROUTE AVM SYSTEM RUN 14

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 14b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	9	3.85
10- 20	34	14.53
20- 30	43	18.38
30- 40	33	14.10
40- 50	34	14.53
50- 60	20	8.55
60- 70	15	6.41
70- 80	12	5.13
80- 90	14	5.98
90- 100	10	4.27
100- 110	9	3.85
110- 120	1	0.43

CUMULATIVE ERRORS RUN 14b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	9	3.85
20	43	18.38
30	86	36.75
40	119	50.85
50	153	65.38
60	173	73.93
70	188	80.34
80	200	85.47
90	214	91.45
100	224	95.73
110	233	99.57
120	234	100.00
AVERAGE ERROR	=	44.74
STANDARD DEVIATION	=	26.86

FIXED ROUTE AVM SYSTEM RUN 15

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 15a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	9	4.11
10- 20	38	17.35
20- 30	29	13.24
30- 40	38	17.35
40- 50	34	15.53
50- 60	14	6.39
60- 70	17	7.76
70- 80	4	1.83
80- 90	9	4.11
90- 100	7	3.20
100- 110	5	2.28
110- 120	5	2.28
120- 130	8	3.65
130- 140	2	0.91

CUMULATIVE ERRORS RUN 15a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	9	4.11
20	47	21.46
30	76	34.70
40	114	52.05
50	148	67.58
60	162	73.97
70	179	81.74
80	183	83.56
90	192	87.67
100	199	90.87
110	204	93.15
120	209	95.43
130	217	99.09
140	219	100.00

AVERAGE ERROR = 46.14

STANDARD DEVIATION = 31.47

FIXED ROUTE AVM SYSTEM RUN 15

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 15b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	8	3.65
10- 20	42	19.18
20- 30	30	13.70
30- 40	36	16.44
40- 50	31	14.16
50- 60	13	5.94
60- 70	18	8.22
70- 80	4	1.83
80- 90	9	4.11
90- 100	8	3.65
100- 110	5	2.28
110- 120	5	2.28
120- 130	8	3.65
130- 140	2	0.91

CUMULATIVE ERRORS RUN 15b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	8	3.65
20	50	22.83
30	80	36.53
40	116	52.97
50	147	67.12
60	160	73.06
70	178	81.28
80	182	83.11
90	191	87.21
100	199	90.87
110	204	93.15
120	209	95.43
130	217	99.09
140	219	100.00

AVERAGE ERROR = 46.05

STANDARD DEVIATION = 31.94

FIXED ROUTE AVM SYSTEM RUN 16

LOCATION ERROR IN FEET
NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 16a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	7	3.50
10- 20	41	20.50
20- 30	30	15.00
30- 40	31	15.50
40- 50	31	15.50
50- 60	21	10.50
60- 70	10	5.00
70- 80	8	4.00
80- 90	11	5.50
90- 100	4	2.00
100- 110	3	1.50
120- 130	3	1.50

CUMULATIVE ERRORS RUN 16a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	7	3.50
20	48	24.00
30	78	39.00
40	109	54.50
50	140	70.00
60	161	80.50
70	171	85.50
80	179	89.50
90	190	95.00
100	194	97.00
110	197	98.50
120	197	98.50
130	200	100.00
AVERAGE ERROR	=	41.22
STANDARD DEVIATION	=	25.23

FIXED ROUTE AVM SYSTEM RUN 16

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 16b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	0	4.00
10- 20	41	20.50
20- 30	29	14.50
30- 40	31	15.50
40- 50	32	16.00
50- 60	21	10.50
60- 70	11	5.50
70- 80	8	4.00
80- 90	9	4.50
90- 100	4	2.00
100- 110	3	1.50
120- 130	3	1.50

CUMULATIVE ERRORS RUN 16b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	8	4.00
20	49	24.50
30	78	39.00
40	109	54.50
50	141	70.50
60	162	81.00
70	173	86.50
80	181	90.50
90	190	95.00
100	194	97.00
110	197	98.50
120	197	98.50
130	200	100.00

AVERAGE ERROR = 40.78

STANDARD DEVIATION = 24.95

FIXED ROUTE AVM SYSTEM RUN 17

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY **RUN 17a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	24	9.20
10- 20	31	11.88
20- 30	49	18.77
30- 40	41	15.71
40- 50	33	12.64
50- 60	10	3.83
60- 70	19	7.28
70- 80	11	4.21
80- 90	16	6.13
90- 100	19	7.28
100- 110	2	0.77
110- 120	3	1.15
120- 130	3	1.15

CUMULATIVE ERRORS **RUN 17a**

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	24	9.20
20	55	21.07
30	104	39.85
40	145	55.56
50	178	68.20
60	188	72.03
70	207	79.31
80	218	83.52
90	234	89.66
100	253	96.93
110	255	97.70
120	258	98.85
130	261	100.00
AVERAGE ERROR	=	43.43
STANDARD DEVIATION	=	28.97

FIXED ROUTE AVM SYSTEM RUN 17
LOCATION ERROR IN FEET
5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 17b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	23	8.81
10- 20	32	12.26
20- 30	49	18.77
30- 40	41	15.71
40- 50	36	13.79
50- 60	10	3.83
60- 70	18	6.90
70- 80	11	4.21
80- 90	15	5.75
90- 100	17	6.51
100- 110	2	0.77
110- 120	3	1.15
120- 130	3	1.15
2400-2410	1	0.38

CUMULATIVE ERRORS RUN 17b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	23	8.81
20	55	21.07
30	104	39.85
40	145	55.56
50	181	69.35
60	191	73.18
70	209	80.08
80	220	84.29
90	235	90.04
100	252	96.55
110	254	97.32
120	257	98.47
130	260	99.62
2410	261	100.00

AVERAGE ERROR = 51.89
STANDARD DEVIATION = 148.85

FIXED ROUTE AVM SYSTEM RUN 18

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 18a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	2	0.69
10- 20	28	9.69
20- 30	33	11.42
30- 40	56	19.38
40- 50	29	10.03
50- 60	32	11.07
60- 70	32	11.07
70- 80	18	6.23
80- 90	6	2.08
90- 100	19	6.57
100- 110	24	8.30
110- 120	1	0.35
120- 130	4	1.38
130- 140	1	0.35
140- 150	2	0.69
300- 310	1	0.35
330- 340	1	0.35

CUMULATIVE ERRORS RUN 18a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	2	0.69
20	30	10.38
30	63	21.80
40	119	41.18
50	148	51.21
60	180	62.28
70	212	73.36
80	230	79.58
90	236	81.66
100	255	88.24
110	279	96.54
120	280	96.89
130	284	98.27
140	285	98.62
150	287	99.31
310	288	99.65
320	288	99.65
330	288	99.65
340	289	100.00

AVERAGE ERROR = 55.91

STANDARD DEVIATION = 37.01

FIXED ROUTE AVM SYSTEM RUN 18
LOCATION ERROR IN FEET
5% COMMUNICATION ERRORS
ERROR FREQUENCY DENSITY RUN 18b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	3	1.04
10- 20	29	10.03
20- 30	32	11.07
30- 40	58	20.07
40- 50	29	10.03
50- 60	29	10.03
60- 70	33	11.42
70- 80	18	6.23
80- 90	6	2.08
90- 100	19	6.57
100- 110	23	7.96
110- 120	1	0.35
120- 130	4	1.38
130- 140	1	0.35
140- 150	2	0.69
300- 310	1	0.35
330- 340	1	0.35

CUMULATIVE ERRORS RUN 18b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	3	1.04
20	32	11.07
30	64	22.15
40	122	42.21
50	151	52.25
60	180	62.28
70	213	73.70
80	231	79.93
90	237	82.01
100	256	88.58
110	279	96.54
120	280	96.89
130	284	98.27
140	285	98.62
150	287	99.31
160	287	99.31
310	288	99.65
320	288	99.65
330	288	99.65
340	289	100.00

AVERAGE ERROR = 55.37
STANDARD DEVIATION = 37.12

FIXED ROUTE AVM SYSTEM RUN 21

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 21a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	26	9.56
10- 20	48	17.65
20- 30	62	22.79
30- 40	46	16.91
40- 50	12	4.41
50- 60	9	3.31
60- 70	12	4.41
70- 80	17	6.25
80- 90	7	2.57
90- 100	12	4.41
100- 110	2	0.74
120- 130	10	3.68
130- 140	5	1.84
150- 160	1	0.37
160- 170	3	1.10

CUMULATIVE ERRORS RUN 21a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	26	9.56
20	74	27.21
30	136	50.00
40	182	66.91
50	194	71.32
60	203	74.63
70	215	79.04
80	232	85.29
90	239	87.87
100	251	92.28
110	253	93.01
120	253	93.01
130	263	96.69
140	268	98.53
150	268	98.53
160	269	98.90
170	272	100.00

AVERAGE ERROR = 42.59

STANDARD DEVIATION = 35.55

FIXED ROUTE AVM SYSTEM RUN 21

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 21b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	27	9.93
10- 20	44	16.18
20- 30	62	22.79
30- 40	44	16.18
40- 50	12	4.41
50- 60	11	4.04
60- 70	14	5.15
70- 80	17	6.25
80- 90	8	2.94
90- 100	12	4.41
100- 110	2	0.74
120- 130	10	3.68
130- 140	4	1.47
140- 150	1	0.37
150- 160	1	0.37
160- 170	3	1.10

CUMULATIVE ERRORS RUN 21b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	27	9.93
20	71	26.10
30	133	48.90
40	177	65.07
50	189	69.49
60	200	73.53
70	214	78.68
80	231	84.93
90	239	87.87
100	251	92.28
110	253	93.01
120	253	93.01
130	263	96.69
140	267	98.16
150	268	98.53
160	269	98.90
170	272	100.00
AVERAGE ERROR	=	43.36
STANDARD DEVIATION	=	35.76

FIXED ROUTE AVM SYSTEM RUN 22

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 22a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	16	6.69
10- 20	37	15.48
20- 30	46	19.25
30- 40	31	12.97
40- 50	28	11.72
50- 60	18	7.53
60- 70	15	6.28
70- 80	14	5.86
80- 90	9	3.77
90- 100	6	2.51
100- 110	3	1.26
110- 120	4	1.67
120- 130	2	0.84
130- 140	8	3.35
140- 150	2	0.84

CUMULATIVE ERRORS RUN 22a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	16	6.69
20	53	22.18
30	99	41.42
40	130	54.39
50	158	66.11
60	176	73.64
70	191	79.92
80	205	85.77
90	214	89.54
100	220	92.05
110	223	93.31
120	227	94.98
130	229	95.82
140	237	99.16
150	239	100.00

AVERAGE ERROR = 45.50

STANDARD DEVIATION = 33.20

CONTINUED

7 OF 8

FIXED ROUTE AVM SYSTEM RUN 22

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 22b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	14	5.86
10- 20	36	15.06
20- 30	45	18.83
30- 40	32	13.39
40- 50	28	11.72
50- 60	17	7.11
60- 70	17	7.11
70- 80	13	5.44
80- 90	9	3.77
90- 100	7	2.93
100- 110	4	1.67
110- 120	5	2.09
120- 130	2	0.84
130- 140	7	2.93
140- 150	2	0.84
150- 160	1	0.42

CUMULATIVE ERRORS RUN 22b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	14	5.86
20	50	20.92
30	95	39.75
40	127	53.14
50	155	64.85
60	172	71.97
70	189	79.08
80	202	84.52
90	211	88.28
100	218	91.21
110	222	92.89
120	227	94.98
130	229	95.82
140	236	98.74
150	238	99.58
160	239	100.00

AVERAGE ERROR = 46.87

STANDARD DEVIATION = 33.78

FIXED ROUTE AVM SYSTEM RUN 23

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY **RUN 23a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	21	8.33
10- 20	40	15.87
20- 30	38	15.08
30- 40	31	12.30
40- 50	27	10.71
50- 60	30	11.90
60- 70	12	4.76
70- 80	11	4.37
80- 90	5	1.98
90- 100	11	4.37
100- 110	7	2.78
110- 120	4	1.59
120- 130	3	1.19
130- 140	6	2.38
140- 150	1	0.40
160- 170	4	1.59
170- 180	1	0.40

CUMULATIVE ERRORS **RUN 23a**

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	21	8.33
20	61	24.21
30	99	39.29
40	130	51.59
50	157	62.30
60	187	74.21
70	199	78.97
80	210	83.33
90	215	85.32
100	226	89.68
110	233	92.46
120	237	94.05
130	240	95.24
140	246	97.62
150	247	98.02
160	247	98.02
170	251	99.60
180	252	100.00

AVERAGE ERROR = 47.70

STANDARD DEVIATION = 36.82

FIXED ROUTE AVM SYSTEM RUN 23

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 23b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	21	8.33
10- 20	40	15.87
20- 30	36	14.29
30- 40	31	12.30
40- 50	27	10.71
50- 60	29	11.51
60- 70	11	4.37
70- 80	13	5.16
80- 90	5	1.98
90- 100	11	4.37
100- 110	8	3.17
110- 120	4	1.59
120- 130	4	1.59
130- 140	6	2.38
140- 150	1	0.40
160- 170	4	1.59
170- 180	1	0.40

CUMULATIVE ERRORS RUN 23b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	21	8.33
20	61	24.21
30	97	38.49
40	128	50.79
50	155	61.51
60	184	73.02
70	195	77.38
80	208	82.54
90	213	84.52
100	224	88.89
110	232	92.06
120	236	93.65
130	240	95.24
140	246	97.62
150	247	98.02
160	247	98.02
170	251	99.60
180	252	100.00

AVERAGE ERROR = 48.57

STANDARD DEVIATION = 37.28

FIXED ROUTE AVM SYSTEM RUN 24

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 24a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	8	4.00
10- 20	27	13.50
20- 30	26	13.00
30- 40	27	13.50
40- 50	24	12.00
50- 60	13	6.50
60- 70	20	10.00
70- 80	13	6.50
80- 90	10	5.00
90- 100	4	2.00
100- 110	9	4.50
110- 120	2	1.00
120- 130	5	2.50
130- 140	1	0.50
140- 150	6	3.00
160- 170	3	1.50
170- 180	2	1.00

CUMULATIVE ERRORS RUN 24a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	8	4.00
20	35	17.50
30	61	30.50
40	88	44.00
50	112	56.00
60	125	62.50
70	145	72.50
80	158	79.00
90	168	84.00
100	172	86.00
110	181	90.50
120	183	91.50
130	188	94.00
140	189	94.50
150	195	97.50
160	195	97.50
170	198	99.00
180	200	100.00

AVERAGE ERROR = 54.80

STANDARD DEVIATION = 38.79

FIXED ROUTE AVM SYSTEM RUN 24

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 24b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	5.00
10- 20	27	13.50
20- 30	25	12.50
30- 40	25	12.50
40- 50	25	12.50
50- 60	12	6.00
60- 70	20	10.00
70- 80	13	6.50
80- 90	9	4.50
90- 100	4	2.00
100- 110	10	5.00
110- 120	2	1.00
120- 130	6	3.00
130- 140	1	0.50
140- 150	6	3.00
160- 170	3	1.50
170- 180	2	1.00

CUMULATIVE ERRORS RUN 24b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	5.00
20	37	18.50
30	62	31.00
40	87	43.50
50	112	56.00
60	124	62.00
70	144	72.00
80	157	78.50
90	166	83.00
100	170	85.00
110	180	90.00
120	182	91.00
130	188	94.00
140	189	94.50
150	195	97.50
160	195	97.50
170	198	99.00
180	200	100.00

AVERAGE ERROR = 55.06

STANDARD DEVIATION = 39.36

MANUALLY PROCESSED FIXED ROUTE

RUN # 24 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
201	57242	68:08	56318	38	CD62	13398	5007	13388	4987	22
202	57980	68:08	56556	38	CD64	13367	4775	13359	4715	61
203	57808	68:08	56882	39	TA27	13618	4671	13645	4680	29
204	57892	68:27	56966	39	TA27	13702	4659	13728	4673	30
205	58038	68:47	57112	39	CP65	13846	4639	13879	4652	34
206	58488	69:07	57556	39	CP66	14292	4577	14315	4584	24
207	58952	62:27	58018	40	CP66	14776	4514	14773	4520	7
208	59274	69:47	58338	41	CP66	15095	4474	15090	4476	5
209	59400	70:07	58462	41	CP66	15220	4458	15212	4459	8
210	59590	70:27	58650	41	CP66	15409	4434	15399	4433	10
211	59884	70:47	58936	41	CP66	15701	4397	15692	4392	10
212	59898	71:07	58950	41	CP66	15715	4395	15696	4391	19
213	60088	71:27	59134	41	CP67	15903	4371	15913	4368	10
214	60496	71:47	59536	41	CP68	16308	4319	16320	4322	12
215	60910	72:07	59930	41	CP68	16897	4245	16710	4264	188
216	61428	72:27	60472	41	CP69	17233	4203	17286	4187	55
217	61750	72:47	60744	41	CP69	17552	4162	17557	4161	5
218	62136	73:07	61110	41	TA28	17500	3788	17501	3796	8
219	62570	73:27	61542	42	CP70	17429	3380	17448	3381	19
220	62710	73:47	61680	42	CP70	17397	3241	17432	3244	35
221	63068	74:07	62034	43	TA29	17730	3160	17732	3161	2
222	63400	74:27	62354	43	TA29	18060	3129	18051	3131	9
223	63708	74:47	62650	43	TA29	18367	3100	18345	3104	22
224	64086	75:07	63026	43	TA30	18743	3065	18753	3079	17
225	64382	75:27	63322	44	TA30	18786	3349	18771	3375	30
226	64560	75:47	63498	44	TA30	18806	3526	18781	3351	177
227	64560	76:07	63498	44	TA30	18806	3526	18781	3351	177
228	64838	76:27	63772	44	CP72	18839	3801	18819	3812	23
229	65170	76:47	64102	44	CP72	18878	4131	18869	4138	11
230	65504	77:07	64434	45	TA31	18888	4440	18878	4440	10
231	65868	77:27	64798	45	TA31	18527	4482	18516	4474	14
232	65876	77:47	64808	45	TA31	18519	4483	18506	4475	15
233	66264	78:07	65192	45	CP73	18153	4528	18125	4527	8
234	66680	78:27	65606	45	CP73	17720	4577	17715	4584	9
235	67166	78:47	66088	45	CP74	17237	4633	17220	4644	20
236	67710	79:07	66684	45	CP75	16697	4697	16641	4714	59
237	68170	79:27	69088	45	CP75	16240	4750	16240	4770	20
238	68642	79:47	69576	46	CP75	15834	4804	15776	4835	66
239	69056	80:07	67966	46	CP76	15425	4863	15418	4867	8

FIXED ROUTE AVM SYSTEM ERRORS, RUN 24

ERROR FREQUENCY DENSITY RUN 24

Error Interval	No. Samples	Percent of Samples
0- 10	18	7.53
10- 20	38	15.90
20- 30	33	13.81
30- 40	31	12.97
40- 50	24	10.04
50- 60	15	6.28
60- 70	22	9.21
70- 80	13	5.44
80- 90	10	4.18
90-100	4	1.67
100-110	9	3.77
110-120	2	8.37
120-130	5	2.09
130-140	1	0.42
140-150	6	2.51
160-170	3	1.26
170-180	4	1.67
180-190	1	0.42

Cumulative Errors Run 24

Error	Samples LT Error	Percent Samples LT Error
10	18	7.53
20	56	23.43
30	89	37.24
40	120	50.21
50	144	60.25
60	159	66.53
70	181	75.73
80	194	81.17
90	204	85.36
100	208	87.03
110	217	90.79
120	219	91.63
130	224	93.72
140	225	94.14
150	231	96.65
170	234	97.91
180	238	99.58
180-190	239	100.00

RESULT OF MANUAL PROCESSING PCP 77 THROUGH 97 FOR RUN 25 TO CORRECT FOR RECORDING ERROR

PCP	ODOM (PCP)* -ODOM (R1)	INCREM INCREM	SEG STSEG	AVM X	AVM Y	REF X	REF Y	ERROR
76	56	56	17	11098	10144	11129	9961	185
77	464	185	18	11419	10296	11381	10298	38
78	798	519	18	11750	10252	11708	10251	42
79	1168	889	18	12119	10204	12068	10192	52
80	1214	935	18	12164	10198	12113	10148	71
81	1478	1199	18	12427	10163	12405	10106	61
82	1760	1481	18	12701	10126	12680	10087	44
83	1888	1609	18	12834	10109	12807	10047	68
84	2268	12	19	13193	10049	13193	10047	2
85	2652	396	19	13134	9670	13145	9678	14
86	2958	702	19	13087	9367	13094	9322	46
87	3238	982	19	13044	9091	13053	9049	43
88	3536	1280	19	12998	8796	13005	8777	20
89	3792	1536	19	12959	8543	12961	8530	13
90	"	1536	19	12959	8543	12961	8530	13
91	3920	1664	19	12939	8417	12939	8404	13
92	4322	291	20	12903	8017	12902	8003	14
93	4866	314	21	13199	7740	13127	7750	73
94	4986	434	21	13317	7722	13247	7731	71
95	4986	434	21	13317	7722	13247	7731	71
96	5218	666	21	13546	7688	13475	7697	72
97	5586	1034	21	13911	7633	13770	7654	72
98	248	248	22	14230	7592	14197	7604	35

* ODOM (R6) = 23120 feet. A value of 8192 feet was added to the 23120 feet to compensate for the record error.

FIXED ROUTE AVM SYSTEM RUN 25

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 25a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	13	17.11
10- 20	8	10.53
20- 30	10	13.16
30- 40	5	6.58
40- 50	6	7.89
50- 60	6	7.89
60- 70	7	9.21
70- 80	3	3.95
80- 90	8	10.53
90- 100	4	5.26
100- 110	2	2.63
110- 120	1	1.32
120- 130	2	2.63
140- 150	1	1.32

CUMULATIVE ERRORS RUN 25a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	13	17.11
20	21	27.63
30	31	40.79
40	36	47.37
50	42	55.26
60	48	63.16
70	55	72.37
80	58	76.32
90	66	86.84
100	70	92.11
110	72	94.74
120	73	96.05
130	75	98.68
140	75	98.68
150	76	100.00
AVERAGE ERROR =		47.70
STANDARD DEVIATION =		35.05

FIXED ROUTE AVM SYSTEM RUN 25

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 25b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	15	19.74
10- 20	7	9.21
20- 30	9	11.84
30- 40	5	6.58
40- 50	7	9.21
50- 60	6	7.89
60- 70	6	7.89
70- 80	3	3.95
80- 90	7	9.21
90- 100	4	5.26
100- 110	2	2.63
110- 120	1	1.32
120- 130	2	2.63
130- 140	1	1.32
140- 150	1	1.32

CUMULATIVE ERRORS RUN 25b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	15	19.74
20	22	28.95
30	31	40.79
40	36	47.37
50	43	56.58
60	49	64.47
70	55	72.37
80	58	76.32
90	65	85.53
100	69	90.79
110	71	93.42
120	72	94.74
130	74	97.37
140	75	98.68
150	76	100.00
AVERAGE ERROR	=	47.61
STANDARD DEVIATION	=	36.37

FIXED ROUTE AVM SYSTEM RUN 26

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY **RUN 26a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	18	7.56
10- 20	41	17.23
20- 30	51	21.43
30- 40	37	15.55
40- 50	18	7.56
50- 60	23	9.66
60- 70	10	4.20
70- 80	11	4.62
80- 90	3	1.26
90- 100	10	4.20
100- 110	6	2.52
110- 120	1	0.42
180- 190	9	3.78

CUMULATIVE ERRORS **RUN 26a**

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	18	7.56
20	59	24.79
30	110	46.22
40	147	61.76
50	165	69.33
60	188	78.99
70	198	83.19
80	209	87.82
90	212	89.08
100	222	93.28
110	228	95.80
120	229	96.22
130	229	96.22
140	229	96.22
150	229	96.22
160	229	96.22
170	229	96.22
180	229	96.22
190	238	100.00
AVERAGE ERROR	=	43.62
STANDARD DEVIATION	=	38.03

FIXED ROUTE AVM SYSTEM RUN 26

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 26b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	16	6.72
10- 20	39	16.39
20- 30	50	21.01
30- 40	40	16.81
40- 50	19	7.98
50- 60	23	9.66
60- 70	11	4.62
70- 80	11	4.62
80- 90	3	1.26
90- 100	9	3.78
100- 110	7	2.94
110- 120	1	0.42
180- 190	9	3.78

CUMULATIVE ERRORS RUN 26b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	16	6.72
20	55	23.11
30	105	44.12
40	145	60.92
50	164	68.91
60	187	78.57
70	198	83.19
80	209	87.82
90	212	89.08
100	221	92.86
110	228	95.80
120	229	96.22
130	229	96.22
140	229	96.22
150	229	96.22
160	229	96.22
170	229	96.22
180	229	96.22
190	238	100.00
AVERAGE ERROR	=	44.30
STANDARD DEVIATION	=	37.87

FIXED ROUTE AVM SYSTEM RUN 27

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 27a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	17	7.08
10- 20	33	13.75
20- 30	48	20.00
30- 40	36	15.00
40- 50	26	10.83
50- 60	24	10.00
60- 70	13	5.42
70- 80	17	7.08
80- 90	8	3.33
90- 100	7	2.92
100- 110	6	2.50
110- 120	3	1.25
120- 130	1	0.42
210- 220	1	0.42

CUMULATIVE ERRORS RUN 27a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	17	7.08
20	50	20.83
30	98	40.83
40	134	55.83
50	160	66.67
60	184	76.67
70	197	82.08
80	214	89.17
90	222	92.50
100	229	95.42
110	235	97.92
120	238	99.17
130	239	99.58
140	239	99.58
150	239	99.58
160	239	99.58
170	239	99.58
180	239	99.58
190	239	99.58
200	239	99.58
210	239	99.58
220	240	100.00

AVERAGE ERROR = 43.20

STANDARD DEVIATION = 28.79

FIXED ROUTE AVM SYSTEM RUN 27

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 27b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	16	6.67
10- 20	33	13.75
20- 30	51	21.25
30- 40	35	14.58
40- 50	25	10.42
50- 60	25	10.42
60- 70	12	5.00
70- 80	16	6.67
80- 90	8	3.33
90- 100	7	2.92
100- 110	7	2.92
110- 120	3	1.25
120- 130	1	0.42
210- 220	1	0.42

CUMULATIVE ERRORS RUN 27b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	16	6.67
20	49	20.42
30	100	41.67
40	135	56.25
50	160	66.67
60	185	77.08
70	197	82.08
80	213	88.75
90	221	92.08
100	228	95.00
110	235	97.92
120	238	99.17
130	239	99.58
140	239	99.58
150	239	99.58
160	239	99.58
170	239	99.58
180	239	99.58
190	239	99.58
200	239	99.58
210	239	99.58
220	240	100.00

AVERAGE ERROR = 43.23

STANDARD DEVIATION = 28.96

FIXED ROUTE AVM SYSTEM RUN 28

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 28a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	20	7.72
10- 20	53	20.46
20- 30	35	13.51
30- 40	43	16.60
40- 50	27	10.42
50- 60	18	6.95
60- 70	32	12.36
70- 80	15	5.79
80- 90	7	2.70
90- 100	5	1.93
100- 110	2	0.77
110- 120	1	0.39
120- 130	1	0.39

CUMULATIVE ERRORS RUN 28a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	20	7.72
20	73	28.19
30	108	41.70
40	151	58.30
50	178	68.73
60	196	75.68
70	228	88.03
80	243	93.82
90	250	96.53
100	255	98.46
110	257	99.23
120	258	99.61
130	259	100.00

AVERAGE ERROR = 39.30

STANDARD DEVIATION = 25.12

FIXED ROUTE AVM SYSTEM RUN 28

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 28b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	20	7.72
10- 20	52	20.08
20- 30	34	13.13
30- 40	43	16.60
40- 50	26	10.04
50- 60	20	7.72
60- 70	33	12.74
70- 80	14	5.41
80- 90	7	2.70
90- 100	5	1.93
100- 110	2	0.77
110- 120	1	0.39
120- 130	2	0.77

CUMULATIVE ERRORS RUN 28b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	20	7.72
20	72	27.80
30	106	40.93
40	149	57.53
50	175	67.57
60	195	75.29
70	228	88.03
80	242	93.44
90	249	96.14
100	254	98.07
110	256	98.84
120	257	99.23
130	259	100.00
AVERAGE ERROR	=	39.85
STANDARD DEVIATION	=	25.60

FIXED ROUTE AVM SYSTEM RUN 29

LOCATION ERROR IN FEET
NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 29a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	21	8.05
10- 20	39	14.94
20- 30	56	21.46
30- 40	30	11.49
40- 50	28	10.73
50- 60	34	13.03
60- 70	26	9.96
70- 80	6	2.30
80- 90	7	2.68
90- 100	10	3.83
100- 110	2	0.77
120- 130	1	0.38
160- 170	1	0.38

CUMULATIVE ERRORS RUN 29a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	21	8.05
20	60	22.99
30	116	44.44
40	146	55.94
50	174	66.67
60	208	79.69
70	234	89.66
80	240	91.95
90	247	94.64
100	257	98.47
110	259	99.23
120	259	99.23
130	260	99.62
140	260	99.62
150	260	99.62
160	260	99.62
170	261	100.00

AVERAGE ERROR = 39.97
STANDARD DEVIATION = 25.30

FIXED ROUTE AVM SYSTEM RUN 29

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 29b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	22	8.43
10- 20	40	15.33
20- 30	54	20.69
30- 40	30	11.49
40- 50	27	10.34
50- 60	36	13.79
60- 70	25	9.58
70- 80	5	1.92
80- 90	7	2.68
90- 100	10	3.83
100- 110	3	1.15
120- 130	1	0.38
160- 170	1	0.38

CUMULATIVE ERRORS RUN 29b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	22	8.43
20	62	23.75
30	116	44.44
40	146	55.94
50	173	66.28
60	209	80.08
70	234	89.66
80	239	91.57
90	246	94.25
100	256	98.08
110	259	99.23
120	259	99.23
130	260	99.62
140	260	99.62
150	260	99.62
160	260	99.62
170	261	100.00
AVERAGE ERROR	=	40.01
STANDARD DEVIATION	=	25.66

FIXED ROUTE AVM SYSTEM RUN 30

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 30a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	14	5.83
10- 20	40	16.67
20- 30	29	12.08
30- 40	31	12.92
40- 50	32	13.33
50- 60	34	14.17
60- 70	17	7.08
70- 80	22	9.17
80- 90	11	4.58
90- 100	2	0.83
100- 110	5	2.08
110- 120	2	0.83
240- 250	1	0.42

CUMULATIVE ERRORS RUN 30a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	14	5.83
20	54	22.50
30	83	34.58
40	114	47.50
50	146	60.83
60	180	75.00
70	197	82.08
80	219	91.25
90	230	95.83
100	232	96.67
110	237	98.75
120	239	99.58
250	240	100.00

AVERAGE ERROR = 44.05

STANDARD DEVIATION = 28.19

FIXED ROUTE AVM SYSTEM RUN 30
LOCATION ERROR IN FEET
5% COMMUNICATION ERRORS
ERROR FREQUENCY DENSITY RUN 30b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	15	6.25
10- 20	39	16.25
20- 30	27	11.25
30- 40	34	14.17
40- 50	31	12.92
50- 60	33	13.75
60- 70	18	7.50
70- 80	20	8.33
80- 90	11	4.58
90- 100	3	1.25
100- 110	6	2.50
110- 120	2	0.83
240- 250	1	0.42

CUMULATIVE ERRORS RUN 30b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	15	6.25
20	54	22.50
30	81	33.75
40	115	47.92
50	146	60.83
60	179	74.58
70	197	82.08
80	217	90.42
90	228	95.00
100	231	96.25
110	237	98.75
120	239	99.58
130	239	99.58
140	239	99.58
150	239	99.58
160	239	99.58
170	239	99.58
180	239	99.58
190	239	99.58
200	239	99.58
210	239	99.58
220	239	99.58
230	239	99.58
240	239	99.58
250	240	100.00

AVERAGE ERROR = 44.26
STANDARD DEVIATION = 28.52

FIXED ROUTE AVM SYSTEM RUN 31
LOCATION ERROR IN FEET
NO COMMUNICATION ERRORS
ERROR FREQUENCY DENSITY RUN 31a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	17	6.56
10- 20	23	8.88
20- 30	40	15.44
30- 40	43	16.60
40- 50	46	17.76
50- 60	17	6.56
60- 70	19	7.34
70- 80	16	6.18
80- 90	13	5.02
90- 100	7	2.70
100- 110	2	0.77
110- 120	1	0.39
120- 130	4	1.54
130- 140	2	0.77
150- 160	1	0.39
280- 290	2	0.77
320- 330	2	0.77
340- 350	1	0.39
400- 410	3	1.16

CUMULATIVE ERRORS RUN 31a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	17	6.56
20	40	15.44
30	80	30.89
40	123	47.49
50	169	65.25
60	186	71.81
70	205	79.15
80	221	85.33
90	234	90.35
100	241	93.05
110	243	93.82
120	244	94.21
130	248	95.75
140	250	96.53
150	250	96.53
160	251	96.91
290	253	97.68
330	255	98.46
350	256	98.84
410	259	100.00

AVERAGE ERROR = 54.62
STANDARD DEVIATION = 59.77

FIXED ROUTE AVM SYSTEM RUN 31
LOCATION ERROR IN FEET
5% COMMUNICATION ERRORS
ERROR FREQUENCY DENSITY RUN 31b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	18	6.95
10- 20	24	9.27
20- 30	41	15.83
30- 40	42	16.22
40- 50	44	16.99
50- 60	17	6.56
60- 70	18	6.95
70- 80	17	6.56
80- 90	13	5.02
90- 100	7	2.70
100- 110	2	0.77
110- 120	1	0.39
120- 130	4	1.54
130- 140	2	0.77
150- 160	1	0.39
280- 290	2	0.77
320- 330	2	0.77
340- 350	1	0.39
400- 410	3	1.16

CUMULATIVE ERRORS RUN 31b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	18	6.95
20	42	16.22
30	83	32.05
40	125	48.26
50	169	65.25
60	186	71.81
70	204	78.76
80	221	85.33
90	234	90.35
100	241	93.05
110	243	93.82
120	244	94.21
130	248	95.75
140	250	96.53
160	251	96.91
290	253	97.68
330	255	98.46
410	259	100.00

AVERAGE ERROR = 54.37
STANDARD DEVIATION = 59.87

FIXED ROUTE AVM SYSTEM RUN 34

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 34a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	8	4.79
10- 20	34	20.36
20- 30	19	11.38
30- 40	26	15.57
40- 50	14	8.38
50- 60	17	10.18
60- 70	14	8.38
70- 80	16	9.58
80- 90	12	7.19
90- 100	4	2.40
140- 150	1	0.60
190- 200	2	1.20

CUMULATIVE ERRORS RUN 34a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	8	4.79
20	42	25.15
30	61	36.53
40	87	52.10
50	101	60.48
60	118	70.66
70	132	79.04
80	148	88.62
90	160	95.81
100	164	98.20
110	164	98.20
120	164	98.20
130	164	98.20
140	164	98.20
150	165	98.80
160	165	98.80
170	165	98.80
180	165	98.80
190	165	98.80
200	167	100.00

AVERAGE ERROR = 45.42

STANDARD DEVIATION = 31.26

FIXED ROUTE AVM SYSTEM RUN 34

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 34b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	9	5.39
10- 20	34	20.36
20- 30	18	10.78
30- 40	24	14.37
40- 50	15	8.98
50- 60	15	8.98
60- 70	15	8.98
70- 80	18	10.78
80- 90	12	7.19
90- 100	4	2.40
140- 150	1	0.60
190- 200	2	1.20

CUMULATIVE ERRORS RUN 34b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	9	5.39
20	43	25.75
30	61	36.53
40	85	50.90
50	100	59.88
60	115	68.86
70	130	77.84
80	148	88.62
90	160	95.81
100	164	98.20
110	164	98.20
120	164	98.20
130	164	98.20
140	164	98.20
150	165	98.80
160	165	98.80
170	165	98.80
180	165	98.80
190	165	98.80
200	167	100.00

AVERAGE ERROR = 45.72

STANDARD DEVIATION = 31.56

MANUALLY PROCESSED FIXED ROUTE

RUN # 34 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
168	36894	56:28	36524	25	CP37	16947	5824	16982	5831	35
169	36948	56:48	36678	25	CP38	16893	5831	16896	5841	10
170	37264	57:08	36942	25	CP38	16574	5871	16584	5878	12
171	37398	57:28	37076	25	CP38	16417	5892	16451	5894	34
172	37486	57:48	37162	25	CP39	16360	5899	16381	5903	21
173	37848	58:08	37520	25	CP39	16000	5945	16027	5951	28
174	37848	58:28	37522	25	CP39	16000	5945	16025	5952	26
175	38160	58:48	37828	25	CP39	15691	5985	15721	5993	115
176	38294	59:08	37964	25	CP40	15558	6002	15579	6009	22
177	38472	59:28	38138	25	CP40	15382	6024	15406	6026	24
178	38738	59:48	38398	26	TA18	15251	6158	15244	6120	39
179	38856	60:08	38516	27	TA18	15269	6275	15259	6237	39
180	39044	60:28	38708	28	TA19	15225	6388	15196	6392	29
181	39400	60:48	39062	28	TA19	14872	6439	14845	6443	27
182	39620	61:08	39280	29	TA19	14678	6440	14630	6475	57
183	39838	61:28	39500	29	TA20	14650	6224	14708	6257	67
184	39896	61:48	39558	29	TA20	14643	6166	14715	6199	70
185	40206	62:08	39866	29	CP41	14604	5858	14605	5867	9
186	40550	62:28	40206	30	CP42	14866	5760	14826	5766	40
187	40564	62:48	40218	30	CP42	14880	5759	14838	5763	42
188	40640	63:08	40290	31	TA22	14882	5692	14885	5722	30
189	40858	63:28	40506	31	TA22	14854	5476	14856	5508	32
190	41066	63:48	40712	31	TA22	14828	5270	14827	5304	34
191	41204	64:08	40850	31	CP43	14811	5133	14808	5146	13
192	41394	64:28	41038	32	CP43	14779	4954	14789	4959	11
193	41660	64:48	41296	32	TA23	14515	4989	14552	4980	38
194	41736	65:08	41372	32	TA23	14440	4999	14476	4989	37
195	41904	65:28	41536	32	TA23	14273	5021	14313	5007	42
196	42274	65:48	41904	32	CP44	13907	5069	13873	5065	34
197	42674	66:08	42302	32	CP44	13510	5121	13480	5124	30
198	42892	66:28	42516	32	CP45	13294	5149	13259	5153	35
199	43180	66:48	47804	32	CP45	13008	5187	12973	5187	35
200	43194	67:08	42816	32	CP45	12994	5189	12961	5188	33
201	43572	67:28	43188	32	CP46	12620	5238	12634	5229	23
202	44014	67:48	43626	33	CP46	12170	5298	12199	5283	33
203	44440	68:08	44050	33	CP46	11748	5357	11799	5336	37
204	44878	68:28	44486	33	CP47	11315	5418	11322	5469	51
205	45362	68:48	44966	33	CP47	10836	5485	10895	5687	155
206	45836	69:08	45440	33	CP49	10366	5550	10357	5528	24

RUN # 34 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
207	46354	69:28	45958	33	CP49	9853	5622	9844	5601	23
208	46970	69:48	46576	33	CP49	9243	5707	9232	5687	23
209	47018	70:08	46624	33	CP49	9196	5713	9185	5694	22
210	47142	70:28	46746	33	CP49	9073	5730	9064	5711	21
211	47600	70:48	47900	33	CP51	8619	5794	8609	5775	21
212	48106	71:08	47708	33	CP51	8118	5864	8106	5845	22
213	48578	71:28	48176	34	CP52	7654	5913	7690	5896	40
214	48696	71:48	48294	34	CP52	7537	5920	7573	5911	37
215	48764	72:08	48358	34	TA24	7469	5924	7470	5930	6
216	49214	72:28	48802	35	TA24	7545	6368	7524	6371	21
217	49718	72:48	49304	35	CP53	7631	6864	7634	6896	32
218	50036	73:08	49612	36	TA25	7804	7016	7848	7010	44
219	50522	73:28	50088	36	CP55	8286	6952	8342	6945	56
220	50880	73:48	50436	36	CP55	8640	6905	8687	6904	47
221	51088	74:08	50644	36	CP55	8847	6878	8894	6879	47
222	51422	74:28	50972	36	CP55	9178	6834	9220	6840	42
223	50694	74:48	51242	36	CP56	9447	6799	9493	6800	46
224	52058	75:08	51596	36	CP56	9800	6751	9842	6740	36
225	52232	75:28	51770	36	CP57	9981	6728	10019	6715	40
226	52662	75:48	52198	36	CP57	10413	6671	10444	6661	33
227	53032	76:08	52566	36	CP57	10774	6624	10809	6614	36
228	53298	76:28	52828	37	CP57	11023	6590	11069	6561	47
229	53750	76:48	53280	37	CP57	11472	6532	11517	6523	46
230	54224	77:08	53750	37	CP57	11942	6470	11983	6464	41
231	54720	77:28	54244	37	CP57	12434	6405	12453	6415	21
232	55220	77:48	54738	37	CP59	12929	6339	12965	6349	37
233	55692	78:08	55208	37	CP60	13397	6277	13248	6306	152
234	56056	78:28	55564	38	TA26	13538	6062	13821	6060	283
235	56338	78:48	55846	38	TA26	13501	5782	13472	5782	29
236	56708	79:08	56224	38	CP62	13452	5416	13347	5351	123
237	57140	79:28	56644	38	CP63	13395	4987	13378	4936	51
238	57278	79:48	56780	38	CP64	13377	4851	13366	4766	86
239	57492	80:08	56996	39	TA27	13426	4697	13428	4698	2
240	57768	80:28	57266	39	TA27	13699	4659	13716	4674	23
241	58016	80:48	57514	39	CP65	13945	4625	13871	4654	79
242	58356	81:08	57848	39	CP66	14276	4579	14349	4579	23
243	58538	81:28	58030	40	CP66	14496	4549	14529	4554	33
244	58696	81:48	58188	40	CP66	14653	4529	14686	4532	33
245	59144	82:08	58632	40	CP66	15097	4474	15125	4471	28
246	59604	82:28	59090	40	CP66	15554	4416	15579	4408	26

RUN # 34 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
247	59774	82:48	59260	40	CP66	15722	4394	15747	4384	27
248	59776	83:08	59262	40	CP66	15724	4394	15749	4384	27
249	60126	83:28	59604	40	CP67	16072	4349	16082	4353	11
250	60538	83:48	60010	40	CP68	16481	4298	16481	4298	0
251	60830	84:08	60298	40	CP68	16770	4261	16766	4255	7
252	61128	84:28	60592	40	CP68	17066	4224	17058	4211	15
253	61128	84:48	60592	40	CP68	17066	4224	17058	4211	15
254	61372	85:08	60834	40	CP69	17308	4192	17340	4182	34
255	61576	85:08	61036	40	CP69	17510	4167	17541	4163	31
256	61630	85:48	61088	41	TA28	17559	4157	17556	4135	22
257	61718	86:08	61176	41	TA28	17545	4070	17542	4049	21
258	62004	86:28	61458	41	TA28	17500	3788	17497	3771	17
259	62298	86:48	61748	41	CP70	17453	3498	17461	3486	9
260	62536	87:08	61982	42	CP70	17430	3257	17433	3254	4
261	62538	87:28	61984	42	CP70	17431	3255	17433	3252	4
262	62562	87:48	62010	42	CP70	17428	3230	17429	3226	4
263	62882	88:08	62330	43	TA29	17702	3163	17696	3164	6
264	63290	88:28	62732	43	TA29	18108	3125	18096	3127	8
265	63558	88:48	63000	43	TA29	18375	3100	18363	3102	12
266	63910	89:08		43		18725	3067	18752	3064	27
267	64174	89:28	63612	44	TA30	18780	3299	18968	3325	29
268	64370	89:48	63806	44	TA30	18803	3494	18779	3519	35
269	64370	90:08	63806	44	TA30	18803	3494	18779	3519	35
270	64568	90:28	63996	44	CP72	18826	3690	18805	3715	33
271	64868	90:48	64296	44	CP72	18861	3988	18850	4012	26
272	65208	91:08	64634	44	CP72	18901	4326	18900	4346	20
273	65496	91:28	64926	45	TA31	18739	4457	18725	4455	14
274	65710	91:48	65138	45	TA31	18527	4482	18514	4474	15
275	65992	92:08	65420	45	CP73	18 6	4515	18226	4513	20
276	66310	92:28	65736	45	CP73	17931	4552	17913	4556	18
277	66704	92:48	66128	45	CP74	17539	4598	17555	4605	17
278	66962	93:08	66384	45	CP74	17283	4628	17307	4634	25
279	67020	93:28	66442	45	CP74	17225	4635	17243	4642	19
280	67052	93:48	66474	45	CP74	17194	4639	17212	4645	19
281	67318	94:08	66738	45	CP74	16929	4670	16949	4676	21
282	67624	94:28	67042	45	CP75	16625	4705	16623	4717	12
283	67716	94:48	67134	45	CP75	16534	4715	16532	4729	14
284	67938	95:08	67352	45	CP75	16313	4742	16316	4759	17
285	68054	95:28	67468	45	CP75	16198	4755	16201	4776	21

RUN # 34 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
286	68352	95:48	67764	46	CP75	15959	4786	15907	4816	60
287	68402	96:08	67814	46	CP75	15910	4793	15858	4823	57
288	68402	96:28	67814	46	CP75	15910	4793	15858	4823	60
289	68574	96:48	67984	46	CP75	15739	4817	15689	4847	58
290		97:08						15383	4869	
291										
292										

FIXED ROUTE AVM SYSTEM ERRORS, RUN 34

ERROR FREQUENCY DENSITY RUN 34

Error Interval	No. Samples	Percent of Samples
0- 10	19	6.59
10- 20	52	18.05
20- 30	52	18.05
30- 40	55	19.09
40- 50	27	9.37
50- 60	23	7.98
60- 70	17	5.90
70- 80	19	6.59
80- 90	13	4.51
90-100	4	1.38
110-120	1	.34
120-130	1	.34
140-150	1	.34
150-160	2	.69
190-200	2	.69
280-290	1	.34

Cumulative Errors Run 34

Error	Samples LT Error	Percent Samples LT Error
10	19	6.59
20	71	24.65
30	123	42.70
40	178	61.80
50	205	71.18
60	228	79.16
70	245	85.06
80	264	91.66
90	277	96.18
100	281	97.56
120	282	97.91
130	283	98.26
150	284	98.61
160	286	99.30
200	288	100.00
280-290	289	

FIXED ROUTE AVM SYSTEM RUN 35

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 35a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	35	13.73
10- 20	41	16.08
20- 30	35	13.73
30- 40	30	11.76
40- 50	44	17.25
50- 60	14	5.49
60- 70	16	6.27
70- 80	22	8.63
80- 90	10	3.92
90- 100	2	0.78
100- 110	1	0.39
120- 130	4	1.57
130- 140	1	0.39

CUMULATIVE ERRORS RUN 35a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	35	13.73
20	76	29.80
30	111	43.53
40	141	55.29
50	185	72.55
60	199	78.04
70	215	84.31
80	237	92.94
90	247	96.86
100	249	97.65
110	250	98.04
120	250	98.04
130	254	99.61
140	255	100.00

AVERAGE ERROR = 39.05

STANDARD DEVIATION = 26.94

FIXED ROUTE AVM SYSTEM RUN 35

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 35b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	35	13.73
10- 20	44	17.25
20- 30	37	14.51
30- 40	30	11.76
40- 50	39	15.29
50- 60	14	5.49
60- 70	16	6.27
70- 80	21	8.24
80- 90	9	3.53
90- 100	4	1.57
100- 110	1	0.39
120- 130	4	1.57
130- 140	1	0.39

CUMULATIVE ERRORS RUN 35b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	35	13.73
20	79	30.98
30	116	45.49
40	146	57.25
50	185	72.55
60	199	78.04
70	215	84.31
80	236	92.55
90	245	96.08
100	249	97.65
110	250	98.04
120	250	98.04
130	254	99.61
140	255	100.00
AVERAGE ERROR	=	38.74
STANDARD DEVIATION	=	27.27

FIXED ROUTE AVM SYSTEM RUN 36
LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 36a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	14	6.11
10- 20	40	17.47
20- 30	42	18.34
30- 40	16	6.99
40- 50	16	6.99
50- 60	20	8.73
60- 70	26	11.35
70- 80	23	10.04
80- 90	14	6.11
90- 100	4	1.75
100- 110	3	1.31
110- 120	2	0.87
130- 140	3	1.31
150- 160	5	2.18
200- 210	1	0.44

CUMULATIVE ERRORS RUN 36a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	14	6.11
20	54	23.58
30	96	41.92
40	112	48.91
50	128	55.90
60	148	64.63
70	174	75.98
80	197	86.03
90	211	92.14
100	215	93.89
110	218	95.20
120	220	96.07
130	220	96.07
140	223	97.38
150	223	97.38
160	228	99.56
210	229	100.00

AVERAGE ERROR = 47.85
STANDARD DEVIATION = 34.08

FIXED ROUTE AVM SYSTEM RUN 36

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 36b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	14	6.11
10- 20	40	17.47
20- 30	43	18.78
30- 40	16	6.99
40- 50	16	6.99
50- 60	19	8.30
60- 70	26	11.35
70- 80	21	9.17
80- 90	13	5.68
90- 100	5	2.18
100- 110	3	1.31
110- 120	3	1.31
130- 140	4	1.75
150- 160	5	2.18
200- 210	1	0.44

CUMULATIVE ERRORS RUN 36b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	14	6.11
20	54	23.58
30	97	42.36
40	113	49.34
50	129	56.33
60	148	64.63
70	174	75.98
80	195	85.15
90	208	90.83
100	213	93.01
110	216	94.32
120	219	95.63
130	219	95.63
140	223	97.38
150	223	97.38
160	228	99.56
210	229	100.00
AVERAGE ERROR	=	48.20
STANDARD DEVIATION	=	34.90

FIXED ROUTE AVM SYSTEM RUN 37

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 37a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	4.05
10- 20	39	15.79
20- 30	40	16.19
30- 40	34	13.77
40- 50	16	6.48
50- 60	16	6.48
60- 70	20	8.10
70- 80	17	6.88
80- 90	22	8.91
90- 100	9	3.64
100- 110	7	2.83
110- 120	6	2.43
120- 130	8	3.24
150- 160	2	0.81
210- 220	1	0.40

CUMULATIVE ERRORS RUN 37a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	4.05
20	49	19.84
30	89	36.03
40	123	49.80
50	139	56.28
60	155	62.75
70	175	70.85
80	192	77.73
90	214	86.64
100	223	90.28
110	230	93.12
120	236	95.55
130	244	98.79
160	246	99.60
220	247	100.00

AVERAGE ERROR = 50.84

STANDARD DEVIATION = 35.07

FIXED ROUTE AVM SYSTEM RUN 37

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 37b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	4.05
10- 20	40	16.19
20- 30	40	16.19
30- 40	33	13.36
40- 50	15	6.07
50- 60	15	6.07
60- 70	19	7.69
70- 80	18	7.29
80- 90	22	8.91
90- 100	11	4.45
100- 110	7	2.83
110- 120	6	2.43
120- 130	8	3.24
150- 160	2	0.81
210- 220	1	0.40

CUMULATIVE ERRORS RUN 37b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	4.05
20	50	20.24
30	90	36.44
40	123	49.80
50	138	55.87
60	153	61.94
70	172	69.64
80	190	76.92
90	212	85.83
100	223	90.28
110	230	93.12
120	236	95.55
130	244	98.79
160	246	99.60
170	246	99.60
180	246	99.60
190	246	99.60
200	246	99.60
210	246	99.60
220	247	100.00

AVERAGE ERROR = 51.07

STANDARD DEVIATION = 35.37

FIXED ROUTE AVM SYSTEM RUN 38
LOCATION ERROR IN FEET
NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 38a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	4.50
10- 20	24	10.81
20- 30	43	19.37
30- 40	28	12.61
40- 50	23	10.36
50- 60	22	9.91
60- 70	17	7.66
70- 80	23	10.36
80- 90	15	6.76
90- 100	12	5.41
100- 110	1	0.45
110- 120	1	0.45
190- 200	1	0.45
860- 870	1	0.45
870- 880	1	0.45

CUMULATIVE ERRORS RUN 38a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	4.50
20	34	15.32
30	77	34.68
40	105	47.30
50	128	57.66
60	150	67.57
70	167	75.23
80	190	85.59
90	205	92.34
100	217	97.75
110	218	98.20
120	219	98.65
130	219	98.65
870	221	99.55
880	222	100.00

AVERAGE ERROR = 54.62
STANDARD DEVIATION = 82.30

FIXED ROUTE AVM SYSTEM RUN 38

LOCATION ERROR IN FEET
5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 38b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	9	4.05
10- 20	29	13.06
20- 30	44	19.82
30- 40	29	13.06
40- 50	21	9.46
50- 60	20	9.01
60- 70	16	7.21
70- 80	21	9.46
80- 90	15	6.76
90- 100	12	5.41
100- 110	1	0.45
110- 120	2	0.90
190- 200	1	0.45
860- 870	1	0.45
870- 880	1	0.45

CUMULATIVE ERRORS RUN 38b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	9	4.05
20	38	17.12
30	82	36.94
40	111	50.00
50	132	59.46
60	152	68.47
70	168	75.68
80	189	85.14
90	204	91.89
100	216	97.30
110	217	97.75
120	219	98.65
200	220	99.10
870	221	99.55
880	222	100.00

AVERAGE ERROR = 53.75
STANDARD DEVIATION = 82.57

FIXED ROUTE AVM SYSTEM RUN 39

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 39a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	12	4.27
10- 20	19	6.76
20- 30	34	12.10
30- 40	37	13.17
40- 50	33	11.74
50- 60	50	17.79
60- 70	47	16.73
70- 80	17	6.05
80- 90	6	2.14
90- 100	5	1.78
100- 110	9	3.20
110- 120	3	1.07
120- 130	1	0.36
130- 140	6	2.14
180- 190	1	0.36
380- 390	1	0.36

CUMULATIVE ERRORS RUN 39a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	12	4.27
20	31	11.03
30	65	23.13
40	102	36.30
50	135	48.04
60	185	65.84
70	232	82.56
80	249	88.61
90	255	90.75
100	260	92.53
110	269	95.73
120	272	96.80
130	273	97.15
140	279	99.29
150	279	99.29
160	279	99.29
170	279	99.29
180	279	99.29
190	280	99.64
390	281	100.00

AVERAGE ERROR = 52.67

STANDARD DEVIATION = 34.57

FIXED ROUTE AVM SYSTEM RUN 39

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 39b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	12	4.27
10- 20	19	6.76
20- 30	34	12.10
30- 40	39	13.88
40- 50	33	11.74
50- 60	48	17.08
60- 70	45	16.01
70- 80	17	6.05
80- 90	7	2.49
90- 100	6	2.14
100- 110	9	3.20
110- 120	3	1.07
120- 130	1	0.36
130- 140	6	2.14
180- 190	1	0.36
380- 390	1	0.36

CUMULATIVE ERRORS RUN 39b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	12	4.27
20	31	11.03
30	65	23.13
40	104	37.01
50	137	48.75
60	185	65.84
70	230	81.85
80	247	87.90
90	254	90.39
100	260	92.53
110	269	95.73
120	272	96.80
130	273	97.15
140	279	99.29
150	279	99.29
160	279	99.29
170	279	99.29
180	279	99.29
190	280	99.64
390	281	100.00

AVERAGE ERROR = 52.69

STANDARD DEVIATION = 34.75

FIXED ROUTE AVM SYSTEM RUN 40

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 40a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	4	2.67
10- 20	14	9.33
20- 30	18	12.00
30- 40	33	22.00
40- 50	32	21.33
50- 60	25	16.67
60- 70	7	4.67
70- 80	13	8.67
80- 90	2	1.33
90- 100	2	1.33

CUMULATIVE ERRORS RUN 40a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	4	2.67
20	18	12.00
30	36	24.00
40	69	46.00
50	101	67.33
60	126	84.00
70	133	88.67
80	146	97.33
90	148	98.67
100	150	100.00

AVERAGE ERROR = 42.65

STANDARD DEVIATION = 19.07

FIXED ROUTE AVM SYSTEM RUN 40
LOCATION ERROR IN FEET
5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY **RUN 40b**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	4	2.67
10- 20	13	8.67
20- 30	20	13.33
30- 40	34	22.67
40- 50	34	22.67
50- 60	24	16.00
60- 70	5	3.33
70- 80	12	8.00
80- 90	1	0.67
90- 100	3	2.00

CUMULATIVE ERRORS **RUN 40b**

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	4	2.67
20	17	11.33
30	37	24.67
40	71	47.33
50	105	70.00
60	129	86.00
70	134	89.33
80	146	97.33
90	147	98.00
100	150	100.00

AVERAGE ERROR = 42.03
STANDARD DEVIATION = 18.77

MANUALLY PROCESSED AVM SYSTEM

RUN # 40 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
152	19276	53:17	19184	25	CP40	15289	6036	15315	6035	26
153	19405	53:37	19311	26	TA18	15265	6243	15256	6215	29
154	19443	53:57	19348	27	TA18	15270	6285	15266	6289	6
155	19541	54:17	19448	28	TA19	15376	6395	15113	6402	263
156	19695	54:37	19601	28	TA19	14872	6439	14809	6448	64
157	19829	54:57	19736	29	TA20	14672	6393	14671	6393	1
158	19880	55:17	19787	29	TA20	14658	6291	14659	6293	2
159	19951	55:37	19859	29	TA20	14641	6150	14641	6149	1
160	20131	55:57	20039	29	TA21	14596	5793	14537	5783	60
161	20280	56:17	20188	30	CP42	14886	5758	14603	5766	283
162	20280	56:37	20188	30	CP42	14886	5758	14603	5766	283
163	20374	56:57	20279	31	TA22	14867	5575	14870	5612	37
164	20520	57:17	20424	31	TA22	14830	5286	14830	5320	34
165	20524	57:37	20428	21	TA22	14829	5278	14828	5312	34
166	20659	57:57	20563	31	CP43	14795	5010	14796	5030	20
167	20676	58:17	20579	31	CP43	14791	4976	14792	4998	22
168	20855	58:37	20754	32	TA23	14417	5002	14496	4987	80
169	20910	58:57	20808	32	TA23	14308	5016	14388	4999	82
170	21038	59:17	20937	32	TA23	14054	5049	14132	5029	81
171	21104	59:37	21003	32	CP44	13923	5067	13928	5057	11
172	21113	59:57	21012	32	CP44	13906	5069	13911	5059	11
173	21117	60:17	21016	32	CP44	13898	5070	13903	5060	11
174	21213	60:37	21112	32	CP44	13707	5095	13713	5089	8
175	21402	60:57	21300	32	CP45	13332	5144	13342	5143	10
176	21591	61:17	21488	32	CP45	12958	5207	12970	5187	23
177	21591	61:37	21488	32	CP45	12958	5207	12970	5141	67
178	21650	61:57	21547	32	CP45	12841	5209	12852	5201	14
179	21884	62:17	21779	32	CP46	12377	5270	12424	5255	49
180	22063	62:37	21958	33	CP46	12052	5315	12068	5300	22
181	22075	62:57	21969	33	CP46	12028	5318	12047	5303	25
182	22224	63:17	22118	33	CP46	11733	5359	11751	5340	26
183	22271	63:37	22166	33	CP46	11640	5372	11656	5352	26
184	22339	63:57	22234	33	CP47	11505	5391	11492	5373	22
185	22359	64:17	22254	33	CP47	11466	5397	11453	5378	23
186	22496	64:37	22390	33	CP47	11194	5435	11183	5416	22
187	22539	64:57	22432	33	CP47	11109	5446	11100	5428	20
188	22681	65:17	22573	33	CP47	10828	5486	10821	5467	22
189	22893	65:37	22784	33	CP49	10408	5544	10399	5521	25
190	23205	65:57	23096	33	CP50	9790	5630	9586	5643	204
191	23380	66:17	23271	33	CP51	9443	5679	9504	5654	66

RUN # 40 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
192	23683	66:37	23574	33	CP51	8843	5763	8904	5735	67
193	23973	66:57	23863	33	CP52	8269	5843	8263	5824	20
194	24257	67:17	24146	34	TA24	7732	5909	7736	5891	18
195	24344	67:37	24233	34	TA24	7559	5919	7563	5912	8
196	24393	67:57	24280	35	CP53	7470	5932	7474	5968	36
197	24650	68:17	24536	35	CP54	7557	6439	7542	6504	67
198	24850	68:37	24736	35	CP54	7625	6833	7634	6894	62
199	24964	68:57	24847	36	CP55	7683	7032	7721	7027	38
200	25215	69:17	25099	36	CP55	8180	6966	8219	6961	39
201	25429	69:37	25312	36	CP56	8605	6910	8676	6905	1
202	25506	69:57	25388	36	CP56	8757	6890	8827	6887	70
203	25701	70:17	25583	36	CP56	9144	6839	9214	6841	70
204	25703	70:37	25585	36	CP55	9148	6838	9222	6840	74
205	25703	70:57	25685	36	CP56	9148	6838	9414	6813	267
206	26014	71:17	25895	36	CP56	9765	6757	9828	6742	84
207	26095	71:37	25977	36	CP57	9925	6736	9999	6718	76
208	26362	71:57	26243	36	CP57	10454	6666	10527	6650	74
209	26577	72:17	26457	36	CP57	10881	6609	10952	6596	72
210	26757	72:37	26637	37	CP57	11238	6562	11309	6550	72
211	26831	72:57	26710	37	CP57	11384	6543	11453	6531	70
212	26931	73:17	26809	37	CP57	11583	6517	11650	6506	68
213	26931	73:37	26809	37	CP57	11583	6517	11650	6506	68
214	27104	73:57	26981	37	CP57	11926	6472	12031	6457	106
215	27318	74:17	27194	37	CP58	12350	6416	12365	6423	17
216	27513	74:37	27388	37	CP59	12737	6365	12785	6374	49
217	27697	74:57	27571	37	CP60	13102	6317	13117	6328	19
218	27799	75:17	27673	37	CP60	13304	6290	13318	6294	15
219	27835	75:37	27710	37	CP60	13370	6281	13391	6281	21
220	27865	75:57	27740	37	CP61	13435	6272	13476	6268	41
221	28011	76:17	27882	38	TA26	13543	6095	13527	6063	36
222	28134	76:37	28005	38	TA26	13510	5852	13480	5822	42
223	28146	76:57	28017	38	TA26	13507	5828	13475	5798	44
224	28290	77:17	28161	38	CP62	13469	5542	13428	5467	85
225	28473	77:37	28342	38	CP63	13421	5180	13387	5110	78
226	28590	77:57	28458	38	CP63	13390	4948	13375	4878	72
227	28734	78:17	28603	39	TA27	13403	4701	13487	4693	84
228	28820	78:37	28689	39	TA27	13573	4677	13659	4679	86
229	28875	78:57	28744	39	TA27	13682	4662	13768	4670	86
230	29068	79:17	28934	39	CP65	14064	4609	14142	4610	78
231	29266	79:37	29131	40	CP66	14520	4547	14535	4553	16

RUN # 40 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
232	29338	79:57	29203	40	CP66	14663	4529	14678	4533	16
233	29575	80:17	29438	40	CP66	15133	4469	15143	4468	10
234	29832	80:37	29695	40	CP66	15643	4404	15652	4397	11
235	29878	80:57	29740	40	CP66	15734	4393	15741	4385	11
236	29879	81:17	29742	40	CP66	15736	4342	15745	4384	12
237	30080	81:37	29941	40	CP67	16135	4342	16150	4347	16
238	30269	81:57	30128	40	CP68	16510	4294	16514	4292	4
239	30335	82:17	30195	40	CP68	16641	4278	16646	4273	7
240	30549	82:37	30408	40	CP68	17066	4224	17068	4209	15
241	30549	82:57	30408	40	CP68	17066	4224	17068	4209	15
242	30627	83:17	30526	40	CP69	17221	4204	17331	4182	112
243	30775	83:37	30634	40	CP69	17514	4167	17546	4162	32
244	30845	83:57	30702	41	TA28	17545	4068	17543	4054	14
245	30974	84:17	30830	41	TA28	17504	3813	17502	3801	12
246	31081	84:37	30936	41	CP70	17470	3602	17474	3599	5
247	31216	84:57	31071	42	CP70	17439	3350	17442	3330	20
248	31349	85:17	31205	43	TA29	17529	3178	17566	3176	37
249	31595	85:37	31450	43	TA29	18018	3133	18055	3131	37
250	31815	85:57	31670	43	TA29	18456	3092	18493	3090	37
251	31847	86:17	31702	43	TA	18520	3085	18557	3084	37
252	31960	86:37	31817	43	TA30	18745	3065	18754	3104	40
253	32057	86:57	31913	43	TA30	18774	3250	18766	3296	47
254	32140	87:17	32000	44	TA30	18793	3414	18776	3469	58
255	32279	87:37	32131	44	CP72	18826	3690	18807	3729	43
256	32445	86:57	32297	44	CP72	18865	4018	18857	4057	40
257	32609	87:17	32459	44	CP72	18914	4435	18905	4376	60
258	32766	87:37	32618	45	TA31	18693	4463	18653	4461	40
259	32824	87:57	32676	45	TA31	18578	4476	18538	4472	43
260	32947	88:17	32798	45	CP73	18334	4505	18304	4502	30
261	33046	88:37	32897	45	CP73	18137	4528	18107	4529	30
262	33271	88:57	33122	45	CP73	17690	4580	17662	4591	30
263	33287	89:17	33137	45	CP73	17658	4584	17632	4595	28
264	33305	89:37	33155	45	CP74	17623	4588	17615	4598	13
265	33495	89:57	33345	45	CP74	17245	4633	17238	4642	11
266	33695	90:17	33544	45	CP74	16917	4679	16842	4689	14
267	33875	90:37	33723	45	CP75	16490	4721	16464	4739	32
268	33964	90:57	33812	45	CP75	16401	4742	16288	4763	115
269	33964	91:17	33812	45	CP75	16401	4742	16288	4763	115
270	34043	91:37	33891	45	CP75	16250	4760	16131	4785	112
271	34249	91:57	34095	46	CP75	15961	4786	15727	4842	241

AVM SYSTEM ERROR STATISTICS, RUN 40

ERROR FREQUENCY DENSITY RUN 40

Error Interval	No. Samples	Percent of Samples
0- 10	14	5.2
10- 20	37	13.75
20- 30	37	13.75
30- 40	48	17.84
40- 50	43	15.98
50- 60	26	9.66
60- 70	17	6.31
70- 80	24	8.92
80- 90	10	3.71
90-100	2	.74
100-110	1	.37
110-120	4	1.48
200-210	1	.37
240-250	1	.37
260-270	2	.74
280-290	2	.74

Cumulative Errors Run 40

Error	Samples LT Error	Percent Samples LT Error
10	14	5.2
20	51	18.95
30	88	32.7
40	136	50.5
50	179	66.54
60	205	76.2
70	222	82.5
80	246	91.44
90	256	95.16
100	258	95.91
110	259	96.28
120	263	97.76
210	264	98.14
250	265	98.51
270	267	99.25
290	269	100.00

FIXED ROUTE AVM SYSTEM RUN 41

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY **RUN 41a**

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	46	13.98
10- 20	69	20.97
20- 30	24	7.29
30- 40	47	14.29
40- 50	51	15.50
50- 60	27	8.21
60- 70	38	11.55
70- 80	10	3.04
80- 90	8	2.43
100- 110	7	2.13
110- 120	1	0.30
190- 200	1	0.30

CUMULATIVE ERRORS **RUN 41a**

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	46	13.98
20	115	34.95
30	139	42.25
40	186	56.53
50	237	72.04
60	264	80.24
70	302	91.79
80	312	94.83
90	320	97.26
100	320	97.26
110	327	99.39
120	328	99.70
130	328	99.70
140	328	99.70
150	328	99.70
160	328	99.70
170	328	99.70
180	328	99.70
190	328	99.70
200	329	100.00
AVERAGE ERROR	=	37.26
STANDARD DEVIATION	=	25.74

FIXED ROUTE AVM SYSTEM RUN 41

LOCATION ERROR IN FEET
5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 41b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	47	14.29
10- 20	68	20.67
20- 30	25	7.60
30- 40	46	13.98
40- 50	49	14.89
50- 60	27	8.21
60- 70	38	11.55
70- 80	9	2.74
80- 90	8	2.43
90- 100	1	0.30
100- 110	8	2.43
110- 120	1	0.30
190- 200	1	0.30
****-****	1	0.30

CUMULATIVE ERRORS RUN 41b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	47	14.29
20	115	34.95
30	140	42.55
40	186	56.53
50	235	71.43
60	262	79.64
70	300	91.19
80	309	93.92
90	317	96.35
100	318	96.66
110	326	99.09
120	327	99.39
130	327	99.39
140	327	99.39
150	327	99.39
160	327	99.39
170	327	99.39
180	327	99.39
190	327	99.39
200	328	99.70

FIXED ROUTE AVM SYSTEM RUN 42
LOCATION ERROR IN FEET
NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 42a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	18	7.79
10- 20	26	11.26
20- 30	38	16.45
30- 40	26	11.26
40- 50	38	16.45
50- 60	20	8.66
60- 70	24	10.39
70- 80	17	7.36
80- 90	10	4.33
90- 100	7	3.03
100- 110	3	1.30
110- 120	1	0.43
140- 150	1	0.43
150- 160	1	0.43
370- 380	1	0.43

CUMULATIVE ERRORS RUN 42a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	18	7.79
20	44	19.05
30	82	35.50
40	108	46.75
50	146	63.20
60	166	71.86
70	190	82.25
80	207	89.61
90	217	93.94
100	224	96.97
110	227	98.27
120	228	98.70
130	228	98.70
140	228	98.70
150	229	99.13
370	230	99.57
380	231	100.00

AVERAGE ERROR = 45.44
STANDARD DEVIATION = 34.42

FIXED ROUTE AVM SYSTEM RUN 42

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 42b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	19	8.23
10- 20	27	11.69
20- 30	39	16.88
30- 40	27	11.69
40- 50	36	15.58
50- 60	21	9.09
60- 70	20	8.66
70- 80	16	6.93
80- 90	12	5.19
90- 100	7	3.03
100- 110	4	1.73
140- 150	1	0.43
150- 160	1	0.43
370- 380	1	0.43

CUMULATIVE ERRORS RUN 42b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	19	8.23
20	46	19.91
30	85	36.80
40	112	48.48
50	148	64.07
60	169	73.16
70	189	81.82
80	205	88.74
90	217	93.94
100	224	96.97
110	228	98.70
120	228	98.70
130	228	98.70
140	228	98.70
150	229	99.13
370	230	99.57
380	231	100.00

AVERAGE ERROR = 44.80

STANDARD DEVIATION = 34.56

FIXED ROUTE AVM SYSTEM RUN 43

LOCATION ERROR IN FEET

NO COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 43a

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	5.38
10- 20	15	8.06
20- 30	16	8.60
30- 40	20	10.75
40- 50	31	16.67
50- 60	27	14.52
60- 70	6	3.23
70- 80	30	16.13
80- 90	10	5.38
90- 100	6	3.23
100- 110	5	2.69
110- 120	2	1.08
120- 130	2	1.08
130- 140	2	1.08
140- 150	3	1.61
220- 230	1	0.54

CUMULATIVE ERRORS RUN 43a

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	5.38
20	25	13.44
30	41	22.04
40	61	32.80
50	92	49.46
60	119	63.98
70	125	67.20
80	155	83.33
90	165	88.71
100	171	91.94
110	176	94.62
120	178	95.70
130	180	96.77
140	182	97.85
150	185	99.46
220	185	99.46
230	186	100.00

AVERAGE ERROR = 54.89

STANDARD DEVIATION = 32.86

FIXED ROUTE AVM SYSTEM RUN 43

LOCATION ERROR IN FEET

5% COMMUNICATION ERRORS

ERROR FREQUENCY DENSITY RUN 43b

ERROR INTERVAL	NO. SAMPLES	PERCENT OF SAMPLES
0- 10	10	5.38
10- 20	16	8.60
20- 30	16	8.60
30- 40	19	10.22
40- 50	30	16.13
50- 60	27	14.52
60- 70	6	3.23
70- 80	30	16.13
80- 90	10	5.38
90- 100	6	3.23
100- 110	5	2.69
110- 120	3	1.61
120- 130	2	1.08
130- 140	2	1.08
140- 150	2	1.08
170- 180	1	0.54
220- 230	1	0.54

CUMULATIVE ERRORS RUN 43b

ERROR #	SAMPLES LT ERROR	PERCENT SAMPLES LT ERROR
10	10	5.38
20	26	13.98
30	42	22.58
40	61	32.80
50	91	48.92
60	118	63.44
70	124	66.67
80	154	82.80
90	164	88.17
100	170	91.40
110	175	94.09
120	178	95.70
130	180	96.77
140	182	97.85
150	184	98.92
160	184	98.92
170	184	98.92
180	185	99.46
230	186	100.00

AVERAGE ERROR = 55.22

STANDARD DEVIATION = 33.71

MANUALLY PROCESSED FIXED ROUTE

RUN # 43 SYSTEM LOCATION ERRORS (NO COMMUNICATION ERRORS)

PCP	ODOM	TIME	FIFTH	STSEG	SSG5	AVM X	AVM Y	REF X	REF Y	ERROR
186	56382	62:10	56154	38	CP62	13490	5697	13447	5617	91
187	56706	62:41	56480	38	CP62	13447	5376	13417	5293	88
188	57232	63:07	57002	38	CP64	13378	4855	13354	4673	184
189	57380	63:27	57156	38	TA27	13358	4707	13454	4696	97
190	57670	63:47	57444	39	TA27	13644	4667	13740	4672	96
191	57680	64:07	57456	39	TA27	13654	4666	13752	4671	108
192	58042	64:27	57816	39	CP65	14013	4615	14111	4615	98
193	58366	64:47	58136	40	CP66	14417	4560	14436	4567	20
194	58784	65:07	58556	40	CP66	14831	4507	14852	4509	21
195	59280	65:27	59048	40	CP66	15324	4445	15339	4441	16
196	59682	65:47	59450	40	CP66	15722	4394	15737	4386	17
197	60094	66:07	59860	40	CP67	16131	4342	16138	4348	9
198	60580	66:27	60342	40	CP68	16613	4281	16607	4279	6
199	61116	66:47	60878	40	CP69	17145	4214	17171	4197	31
200	61540	67:07	61296	41	TA28	17559	4155	17558	4147	8
201	61686	67:27	61622	41	TA28	17507	3831	17506	3826	5
202	62144	67:47	61894	41	CP70	17463	3559	17470	3561	7
203	62440	68:07	62190	42	CP70	17436	3452	17434	3267	185
204	62750	68:27	62506	43	TA29	17604	3172	17674	3166	70
205	63184	68:47	62938	43	TA29	18036	3131	18104	3126	68
206	63482	69:07	63232	43	TA29	18333	3103	18397	3099	64
207	63736	69:27	63488	43	TA29	18586	3080	18652	3076	66
208	63932	69:46	63684	44	TA30	18755	3093	18746	3168	76
209	64268	70:06	64018	44	TA30	18795	3426	18726	3501	102
210	64594	70:26	64342	44	CP72	18833	3750	18847	3996	246
211	64976	70:46	64720	44	CP72	18878	4129	18904	4370	242
212	65168	71:06	64912	44	CP72	18900	4319	18933	4560	243
213	65240	71:26	64986	44	TA31	18909	4391	18898	4438	48
214	65596	71:46	65344	45	TA31	18606	4473	18542	4472	64
215	65608	72:06	65356	45	TA31	18594	4474	18530	4473	64
216	65904	72:26	65560	45	CP73	18300	4509	18260	4508	40
217	66272	72:46	66016	45	CP73	17935	4552	17897	4559	39
218	66752	73:06	66496	45	CP74	17458	4608	17418	4621	42
219	67058	73:26	66800	45	CP74	17154	4643	17369	4627	216
220	67416	73:46	67156	45	CP74	16798	4685	16763	4698	37
221	67416	74:06	67156	45	CP74	16798	4685	16763	4698	37
222	67590	74:26	67330	45	CP75	16625	4705	16597	4720	32
223	68052	74:46	67790	45	CP75	16166	4759	16141	4784	35
224	68524	75:06	68260	46	CP75	15706	4822	15676	4849	40

FIXED ROUTE AVM SYSTEM ERRORS, RUN 43

ERROR FREQUENCY DENSITY RUN 43

Error Interval	No. Samples	Percent of Samples
0- 10	15	6.66
10- 20	18	8.0
20- 30	17	7.5
30- 40	28	12.44
40- 50	33	14.66
50- 60	27	12.0
60- 70	11	4.8
70- 80	32	14.22
80- 90	11	4.88
90-100	10	4.44
100-110	7	3.11
110-120	2	.88
120-130	2	.88
130-140	2	.88
140-150	3	1.33
180-190	2	.88
220-230	1	.44
210-220	1	.44
240-250	3	1.33

Cumulative Errors Run 43

Error	Samples LT Error	Percent Samples LT Error
10	15	6.66
20	33	14.66
30	50	22.22
40	78	34.66
50	111	49.33
60	138	61.33
70	149	66.22
80	181	80.44
90	192	85.33
100	202	89.77
110	209	92.88
120	211	93.77
130	213	94.66
140	215	95.55
150	218	96.88
190	220	97.77
220	221	98.22
230	222	98.66
250	225	100.00

RESULTS OF IMPOSING 5 PERCENT COMMUNICATION ERROR RATE ON MANUALLY COMPUTED DATA FROM RUNS 24, 34, 40, AND 43

Run No.	PCP * Number	Error with No Communication Errors	Error with 5% Communication Errors
24	233	8	7
34	171	34	34
34	192	11	40
34	233	152	4
34	261	4	4
34	288	60	60
40	171	11	34
40	192	67	68
40	233	10	12
40	261	30	29
43	192	98	86

* The PCP number on which communication errors were simulated were those determined by the use of the Random Number Table in FRSYS.

4.2.3 Fixed Route One-Tenth Mile Averages

Output data from the FRTEN program are presented herein for each Fixed Route data run. Each entry corresponds to the average error for all samples taken over 528 foot segments of the run. The format is as follows:

Segment	Segment ----------	Segment
1	2	10
Segment	Segment ----------	Segment
11	12	20

.

.

.

On Run 14, Segments 74, 75, and 76 produced average errors of 743, >999, and 752 feet. As explained fully in Section 8 of Volume I, analysis of the individual records in these segments indicate no single error of that magnitude. As was observed and verified in one or two other instances, it is assumed that these errors resulted from a tape read error. Note that the errors associated with these same three street segments on the other runs do not approach these values. For example, the maximum average value computed for the other 28 runs over any of these three street segments was 73 feet.

On Run 31, Segments 10 and 11 have errors of 390 and 329 feet respectively. These errors occurred in the region in which 5th wheel errors were observed and noted on the log sheet.

RUN 11 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

65	55	46	37	22	20	32	54	69	57
79	86	82	71	79	59	8	15	76	100
72	58	26	24	60	30	15	47	50	46
39	37	40	46	27	12	25	41	80	47
46	38	116	32	26	45	48	60	88	72
73	50	40	39	30	26	14	14	20	15
* 18	43	51	61	57	32	29	26	14	8

CT1:RUN011.001

11	10	69	46	49	10	12	6	66	82
81	20	17	26	26	24	23	40	31	27
31	32	49	57	73	74	63	79	79	72
71	34	64	28	51	86	96	107	110	58
57	53	39	44	71	54	6	8	22	140
34	28	29	29	13	20	37	55		

RUN 12 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

42	35	27	25	25	25	30	61	62	60
94	98	89	83	86	41	17	43	93	105
82	71	28	53	46	26	14	74	74	55
26	23	21	19	29	15	23	58	96	51
50	53	109	95	84	29	40	61	82	69
69	34	45	56	49	37	21	23	21	11
* 24	66	54	62	53	23	22	25	22	10

CT1:RUN012.001

11	4	53	38	13	33	15	23	52	63
47	22	32	25	113	27	30	38	22	26
29	34	53	69	75	76	81	98	96	88
88	51	65	51	71	102	121	115	88	62
64	57	53	60	76	60	31	42	49	65
57	59	64	61	50	56	75	61		

RUN 13 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

28	25	18	16	14	13	4	34	25	31
59	61	60	43	44	19	2	36	65	87
76	57	23	39	60	30	17	47	49	49
45	45	42	26	14	20	17	39	105	85
80	73	115	142	155	31	34	49	71	52
40	50	58	54	34	29	13	24	19	10
* 23	52	55	36	16	36	71	19	27	38

CT1:RUN013.001

39	57	52	130	78	124	116	132	53	43
72	35	17	27	38	33	34	44	29	34
32	43	68	80	82	83	75	94	93	68
67	34	45	27	44	87	87	89	50	19
17	19	15	21	41	22	20	36	38	47
46	44	49	48	29	37	53	41		

RUN 14 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

22	10	14	19	24	23	10	41	42	26
61	75	67	40	32	25	6	10	81	104
80	66	39	36	74	33	20	23	25	23
15	14	14	16	23	9	37	78	96	66
62	55	127	48	21	39	41	48	81	68
58	53	53	45	16	16	14	12	21	15
6	40	82	743	***	752	98	44	61	65
57	53	37	37	29	43	32	37	36	36
28	15	17	30	36	32	31	34	30	25
19	55	75							

RUN 15 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

31	29	20	14	8	6	12	56	14	42
60	61	48	48	43	28	16	45	98	112
87	67	47	82	48	19	15	22	20	18
15	14	12	17	13	12	55	108	71	69
63	104	96	87	65	40	49	75	79	67
74	31	57	37	35	13	19	29	14	8
26	62	38	32	17	38	32	16	38	33
30	45	49	127	83	125	101	110	50	55
72	13	22	32	39	31	38	36	23	56
* 19	25	40	45	46	44	47	53	57	58

CT1:RUN015.001

39	36	27	32	61	85	90	91	24	20
21	26	26	39	43	14	34	35	39	44
33	46	45	33	21	38	61			

RUN 16 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

40	28	24	21	17	16	39	73	51	54
80	86	76	66	59	53	25	39	96	114
81	73	45	63	69	29	16	35	35	32
26	26	25	22	10	8	11	25	114	81
78	74	140	39	35	29	34	51	69	54
36	38	49	50	40	27	15	24	23	17
27	56	55	47	35	10	16	18	16	14
13	12	54	31	70	16	26	20	98	84
59	22	21	36	47	41	32	21	27	31
45	47	55	66	65	67	72	84	77	53
* 53	20	37	9	35	60	58	56	42	30

CT1:RUN016.001

30	23	16	27	48	31	23	34	40	48
42	45	50	44	17	30	50	50		

RUN 17 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

105	98	93	86	82	43	41	80	50	61
89	91	78	78	76	32	29	57	97	113
87	63	43	83	40	25	37	45	43	34
29	27	27	14	33	28	77	73	46	45
38	67	77	15	19	41	42	74	70	62
58	35	49	47	45	23	28	31	17	21
42	73	49	33	16	15	13	10	29	24
* 26	37	46	6	47	9	8	42	92	91

CT1:RUN017.001

46	13	20	25	27	19	38	35	30	32
25	40	60	61	63	65	66	73	62	54
40	50	28	38	57	101	92	96	10	8
12	10	5	32	27	14	4	2	25	33
19	27	20	14	9	27	54			

RUN 18 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

57	58	59	52	42	41	5	27	42	29
51	59	60	52	47	37	16	34	106	111
98	71	45	63	87	28	18	54	54	47
33	31	28	30	14	11	27	42	85	72
66	57	93	51	41	20	25	39	54	37
48	45	54	49	32	28	16	32	25	15
* 21	49	51	38	20	44	88	45	53	59

CT1:RUN018.001

56	61	39	256	55	105	106	142	38	46
63	23	19	27	30	31	34	47	35	32
27	33	53	69	68	70	64	71	72	65
65	55	55	30	44	92	104	104	95	31
30	29	18	23	42	24	15	19	19	36
33	24	24	24	18	10	29	57		

```
RUN 20   FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

  19    6   20   26   33   35   28   53   57   52
  73   86   84   70   73   48    7   15   62   83
  45   34   13   12   38   30   19   54   65   71
* 53   61   61   54   28    8   30   48  116   83
 CT1:RUN020.001

  83   66  111   64   61   20   24   23   37    9
   7   79   96   64   50   46   36   47   42   36
  48   73   93   46   25   51   66   61   53   16
  12   30  103  154   83  127  131  146   75   70
49152.0 49152.0     0.0     0.0     0.0     0.0     20      0
?ERR 12 FLOATING ZERO DIVIDE
IN   ROUTINE ".MAIN."  LINE 148
```

```
RUN 21   FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

  29   16   14   17   24   30   11   21   41   69
  29   30   23   17   11    5   10   17   76   87
  62   39    7   18   49   27   22   65   81   75
  54   68   69   60   21   11   14   78   85   91
  94   90  109  155  126   21   17   35   31   15
  32   89  109   31   36   22   26   40   30   30
  39   82   71   58   42   29   37   29   32   28
* 28   70   66  123   89  126  109  117   61   63
 CT1:RUN021.001

  77   21   28   32   24   31   66   61   32   56
  25   16   22   23   15   15   23   24   25   28
  20   24   22    8   35   53   39   30   17   12
   9    9   16   22    2    6    9    2   22   27
   7    8   14   18   25   15   57
```

RUN 22 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	49	33	21	13	10	12	6	13	13	14
	41	39	26	18	19	9	7	30	52	71
	38	16	19	34	39	40	47	65	89	73
	76	91	84	53	16	21	23	116	112	120
	85	149	65	45	22	25	23	44	18	22
	63	72	89	66	66	46	60	53	46	72
	92	96	75	43	21	32	27	17	13	25
	71	74	101	69	135	127	138	63	73	83
*	29	23	22	24	20	42	68	20	58	37

CT1:RUN022.001

	31	40	40	24	29	44	45	34	25	20
	19	24	20	37	35	29	36	30	21	10
	9	22	25	12	28	20	30	23	34	33
	39	31	49	63	49	48				

.

RUN 23 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	15	4	18	22	17	22	6	30	13	13
	23	32	21	14	9	9	22	25	41	53
	34	20	43	42	43	58	55	71	97	89
	85	103	90	56	14	22	14	107	104	107
	100	152	64	43	38	24	17	47	25	13
	45	69	71	49	54	36	48	55	54	70
	88	84	56	23	29	67	15	30	29	21
*	11	95	106	120	144	150	169	108	96	127

CT1:RUN023.001

	64	28	20	22	21	32	75	37	53	46
	28	39	52	53	39	37	43	39	32	26
	15	18	22	33	40	47	40	17	7	7
	10	31	37	17	44	31	47	26	33	42
	39	38	52	72	57	56				

.

```
RUN 24   FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

  25   55   32   16   15   20   30   55   48   51
  64   62   52   41   44   23   12   24   53   67
  40   23   24   34   30   31   34   72  100   89
  76   97   87   54    4   19   55   75  102  105
 102  136  124   57   49   28   13   35   21    8
  35   71   99   57   66   33   49   60   40   57
  77  109   98   63   64   32   31   23   16   22
  32   94   90  136  122  156  158  129  100  115
* 93   15   23   21   25   30   61   54   49   42
 CT1:RUN024.001

  25   37   46   50   43   47   49   43   31   27
  16   20   19   18
.

RUN 25   FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

  34   13   13   12    8    4    9   37   27   24
  50   53   42   28   25   16    6   21   61   83
  53   40    7   26   42   39   43   77  102   97
  84  100   83   68    5   16    8   74   98   96
  90  123
.
 CT1:RUN025.001
?ILL CMD?
.
```

RUN 26 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	16	3	18	27	34	34	7	30	39	14
	32	40	38	24	29	9	5	4	61	77
	60	42	12	10	45	30	16	52	70	78
	51	66	68	64	27	16	12	20	101	91
	87	71	150	80	31	22	26	30	49	34
	19	89	95	64	34	26	9	28	31	25
	156	62	75	54	41	23	39	14	16	17
	16	12	19	20	22	36	25	38	39	38
*	23	14	21	26	25	23	25	49	30	24

CT1:RUN026.001

	23	27	38	48	51	50	41	57	57	56
	56	21	28	11	31	57	61	58	52	27
	25	22	24	33	35	14	14	25	26	30
	26	16	19	20	10	11	20	58		

RUN 27 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	46	34	17	12	9	12	40	60	59	68
	88	87	78	74	66	30	9	26	67	78
	50	28	6	31	36	23	34	64	78	71
	64	71	66	34	7	16	22	84	70	70
	60	105	98	37	33	31	30	57	67	49
	41	41	69	50	50	30	32	39	29	36
	51	86	75	29	21	38	38	12	29	14
	15	51	34	105	62	113	95	90	34	33
*	64	14	22	61	71	21	34	41	27	40

CT1:RUN027.001

	16	24	42	53	58	48	43	45	42	39
	11	20	16	10	36	57	58	67	35	29
	30	19	13	41	8	37	27	27	24	33
	22	17	16	21	42	18	53			

RUN 28 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	23	8	13	15	17	16	8	28	50	38
	63	67	67	67	46	33	20	57	90	102
	76	58	35	46	64	29	16	56	67	62
	40	43	42	47	12	13	22	42	85	59
	57	57	135	21	21	24	31	50	63	45
	35	56	75	55	52	34	25	45	37	36
	50	71	63	66	57	23	31	30	24	12
*	15	7	33	16	44	13	8	14	67	65

CT1:RUN028.001

	44	13	19	22	37	22	34	44	36	33
	21	28	56	71	73	73	69	68	68	67
	62	33	45	30	52	77	88	84	24	11
	12	7	2	16	25	21	31	29	19	25
	34	20	14	19	42	25	27	62		

RUN 29 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	38	23	12	11	9	15	11	41	10	14
	41	42	36	34	26	22	22	46	91	97
	70	49	20	51	44	28	39	67	79	73
	65	68	62	43	17	20	18	70	57	54
	50	81	159	58	49	23	15	17	32	35
	41	43	65	24	26	17	20	31	27	28
	36	71	55	52	29	27	32	24	8	11
	13	19	59	11	50	23	8	28	55	59
*	34	13	20	22	27	19	43	51	38	47

CT1:RUN029.001

	31	22	34	40	41	37	27	26	31	50
	35	43	49	34	55	85	97	98	15	5
	8	13	7	20	33	10	41	46	56	66
	59	54	61	50	31	47	63			

RUN 30 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	24	8	13	14	20	17	25	43	50	36
	49	71	62	47	41	31	11	18	79	104
	70	51	20	20	59	31	23	67	77	83
	60	68	69	76	33	8	28	48	72	67
	65	59	120	20	21	32	34	45	68	51
	39	48	60	75	68	64	48	56	53	51
	52	79	97	71	48	20	16	10	10	9
*	15	17	68	21	29	47	21	25	42	40

CT1:RUN030.001

	33	13	20	23	24	23	28	52	28	31
	38	28	43	50	57	62	65	70	70	49
	50	19	41	10	28	59	63	61	59	35
	37	25	21	28	40	24	9	17	18	33
	37	36	42	43	16	20	41	43		

RUN 31 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	48	47	45	40	99	312	159	43	61	390
	329	89	89	70	69	61	29	17	49	103
	105	73	49	27	60	37	17	28	46	55
	45	37	40	46	18	6	15	1	86	81
	79	73	107	126	26	25	32	29	56	63
	39	21	40	66	44	43	22	24	38	25
	23	33	77	68	37	12	54	54	27	43
	29	35	113	34	118	71	126	102	113	47
*	46	76	13	21	33	39	32	32	32	27

CT1:RUN031.001

	34	28	36	45	49	49	55	57	51	54
	55	43	32	26	24	58	76	83	78	51
	30	32	18	16	38	27	13	2	2	17
	30	15	21	25	22	9	20	36		

RUN 34 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

88	74	64	61	58	52	30	62	40	45
71	73	70	57	71	51	25	33	70	94
67	49	10	23	50	27	16	45	54	57
45	54	55	52	24	11	7	17	159	77
71	55	146	61	56	21	15	22	34	16
25	86	97	36	32	16	21	24	26	24
39	74	77	58	47	22	33			

RUN 35 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

55	38	27	19	13	7	8	26	22	12
43	45	36	28	26	10	5	14	49	76
51	23	7	21	44	37	36	68	80	80
63	73	78	67	19	11	12	15	76	86
84	77	140	31	33	22	22	37	54	42
33	127	128	51	45	39	19	25	32	30
35	72	70	68	63	24	20	37	34	29
* 39	43	66	16	41	16	10	22	62	58

CT1:RUN035.001

38	13	19	27	28	26	34	55	21	38
38	26	21	34	45	44	43	50	50	68
63	30	43	23	39	68	76	67	32	22
20	8	4	16	10	6	9	5	7	22
12	6	6	10	25	19	29			

RUN 36 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	57	34	26	17	8	6	2	34	13	7
	24	23	16	14	12	10	8	30	82	92
	63	45	12	40	38	24	31	54	61	62
	61	68	69	42	17	14	20	51	75	74
	71	98	92	38	37	24	19	44	43	22
	37	59	79	38	40	30	33	46	61	55
	51	98	88	40	22	43	43	12	23	14
	17	85	99	132	93	152	128	139	78	70
	104	24	23	20	24	18	42	48	21	43
*	25	42	53	62	65	67	69	69	70	69

CT1:RUN036.001

	56	40	36	29	52	82	86	85	22	15
	14	9	5	19	19	33	65	68	28	33
	31	25	22	32	45	39	48			

.

RUN 37 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	64	45	23	18	15	13	12	49	22	20
	26	39	29	16	15	4	21	24	88	105
	78	72	30	29	59	30	27	58	71	72
	55	66	75	70	27	10	30	53	96	82
	80	64	115	58	51	22	21	32	43	26
	18	80	94	49	41	56	108	31	38	39
	52	84	77	43	12	51	56	23	33	31
	27	73	36	133	71	119	103	121	59	59
*	80	18	19	22	26	20	35	52	20	38

CT1:RUN037.001

	25	45	60	66	62	65	66	61	66	79
	71	53	47	36	60	81	92	79	38	24
	22	12	3	20	14	6	12	12	21	37
	20	15	15	14	21	17	28			

.

RUN 38 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

48	45	29	18	11	7	39	56	67	49
79	82	75	52	56	40	26	33	90	108
69	51	8	24	50	28	27	59	67	66
57	66	72	60	37	27	38	50	61	53
54	53	95	34	35	26	26	41	49	29
24	67	87	35	29	24	17	28	19	15
36	73	74	42	14	57	63	23	40	34
31	24	91	45	62	19	42	32	96	88
64	58	63	79	88	80	49	29	96	37
* 21	52	65	72	70	70	77	82	80	78

CT1:RUN038.001

68	42	49	24	48	74	79	79	34	25
21	14	5	32	17	5	20	18	19	31
17	15	13	14	18	16	36			

RUN 39 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

106	97	88	77	63	54	34	46	55	46
68	69	62	56	61	18	4	12	67	79
53	30	4	16	38	28	23	56	61	65
65	67	70	71	41	31	57	70	55	57
54	36	126	52	44	69	213	25	37	22
6	76	97	55	47	44	36	55	47	47
53	81	87	58	47	16	31	25	17	15
* 16	25	28	108	67	126	116	114	58	59

CT1:RUN039.001

97	36	25	21	23	20	31	56	20	36
28	29	49	61	65	58	49	47	45	42
38	61	33	10	34	66	66	61	55	47
45	45	38	42	50	31	30	22	38	65
55	55	56	52	34	43	51	39		

```
RUN 40   FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

  68   60   50   42   32   29   28   69   41   48
  73   72   67   48   49   22   12   25   69   82
  66   39   12   25   36   26   22   53   54   49
  42   45   42   27   54   33   46   52   51   45
  44   46  109   13   21   37   37   55   65   48
  34   53   76   40   37   26   21   35   30   30
  44   80   83   55   39   16   31   23   16   17
  23
.
 CT1:RUN040.001
?ILL CMD?

.
```

```
RUN 41   FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

  44   16   14   12    7   10    7   22   11   13
  19   35   32   17    7    2    1   32   78   82
  58   46    6   13   31   28   22   49   52   49
  40   42   44   41   16   11   17   51   96   60
  61   62  105   96   92   26   27   42   62   47
  48   48   53   73   71   71   65   69   65   62
* 62   84   90   55   25   25   45   10   11   12

 CT1:RUN041.001

  14   11   48   35   32   45   30   38   38   38
  14   10   16   31   31   35   33   42   44   39
  47   25   32   43   48   45   38   40   40   38
  37   13   14    7   23   55   65   62   58   25
  21   19   13   24   50   26   13    4    3   15
  18    5    7    6   29   30   20   67
.
```

RUN 42 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	75	64	41	37	34	32	39	55	57	61
	84	83	77	66	59	34	8	25	79	92
	66	45	14	34	42	23	26	48	49	48
	39	41	46	30	17	15	30	52	85	69
	65	53	122	43	41	21	15	31	40	17
	9	73	95	58	55	47	23	37	42	43
	56	84	88	50	16	69	76	34	55	46
	36	29	66	13	34	21	16	31	42	44
	24	13	20	26	26	19	36	62	20	32
*	23	57	63	71	74	75	71	64	63	61

CT1:RUN042.001

36	29	34	29

RUN 43 FIXED ROUTE
AVERAGE ERROR IN FEET OVER ONE-TENTH MILE SEGMENTS

	62	44	34	29	21	23	33	77	68	57
	78	76	67	58	46	16	3	27	79	79
	52	33	14	42	36	22	30	53	54	48
	40	42	42	14	26	17	41	72	80	79
	72	93	112	25	28	32	28	55	60	37
	35	55	82	56	57	40	40	49	43	44
	53	89	80	50	34	33	36	14	12	8
	10	32	46	121	79	137	125	128	59	59
	91	76	80	90	90	81	54	39	79	37
*	22	64	63	70	74	71	72	76	75	73

CT1:RUN043.001

61	37	41	43	63

4.2.4 Off Route Declaration

During Fixed Route Runs 38-43, a pair of signposts were installed along the fixed route between CP 36 and CP 37. When the AVM system records a code from either of these signposts, it was programmed to declare that the bus was off route. These results are shown in this section and are the output listings of the FRLS program. The values of the location errors incurred while the off route condition was being simulated are computed and presented in Section 8 of Volume I.

FIXED ROUTE RUN # 39 CHECKPOINT ERRORS OFF ROUTE DECLARATION

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
1	12431	4529	16	3	72.	12410.	4548.	29.
2	12895	3792	1	4	483.	12811.	3817.	88.
3	13632	3698	1	4	1245.	13567.	3718.	68.
4	14904	3541	2	5	24.	14869.	3547.	36.
5	15277	4035	2	6	469.	15266.	3953.	82.
6	15334	4441	2	6	915.	15328.	4395.	46.
7	15383	4869	2	6	1341.	15387.	4817.	52.
8	15475	5453	2	6	1907.	15465.	5377.	76.
9	15644	6735	2	6	3223.	15647.	6681.	54.
10	15736	7421	2	6	3901.	15741.	7352.	69.
11	15809	7838	2	6	4349.	15803.	7796.	43.
12	16042	9499	3	7	1078.	16034.	9452.	48.
13	16512	9618	3	8	368.	16431.	9641.	84.
14	16941	9578	3	8	820.	16882.	9606.	66.
15	17368	9554	3	8	1268.	17328.	9571.	43.
16	17811	9507	3	8	1732.	17791.	9535.	35.
17	18095	8454	3	9	1021.	18112.	8489.	39.
18	18109	8343	3	9	1127.	18112.	8383.	40.
19	17929	6962	4	10	1172.	17926.	6913.	49.
20	16580	6988	4	11	1399.	16521.	6981.	59.
21	15087	7167	4	11	2913.	15018.	7163.	69.
22	14282	7260	4	11	3703.	14233.	7258.	49.
23	13313	7718	5	13	529.	13354.	7699.	45.
24	12500	8500	5	15	387.	12460.	8542.	58.
25	11590	9350	5	15	1607.	11564.	9369.	32.
26	12190	10181	6	18	955.	12182.	10195.	16.
27	13151	10036	6	18	1521.	12743.	10121.	417.
27	13151	10036	6	18	1917.	13136.	10069.	36.
28	13130	9554	6	19	466.	13123.	9601.	47.
29	13052	9039	6	19	1004.	13041.	9069.	32.
30	13699	7663	6	21	952.	13830.	7645.	132.
31	15123	7495	7	22	1176.	15152.	7481.	32.
32	15948	7393	7	22	2028.	15997.	7379.	51.
33	16627	7326	7	22	2702.	16667.	7299.	48.
34	17500	7204	7	22	3590.	17548.	7193.	50.
35	18345	7054	7	22	4492.	18444.	7085.	103.
36	18300	5657	8	25	311.	18334.	5647.	35.

BUS NO. 39 OFF ROUTE AT 15,16 TIME: 41:57 FIFTH: 35314. ODOM: 35554.
BUS NO. 39 OFF ROUTE AT 13,16 TIME: 42: 3 FIFTH: 35402. ODOM: 35642.
BUS NO. 39 OFF ROUTE AT 15,16 TIME: 42: 4 FIFTH: 35416. ODOM: 35658.
BUS NO. 39 OFF ROUTE AT 13,16 TIME: 42: 6 FIFTH: 35448. ODOM: 35690.
BUS NO. 39 OFF ROUTE AT 15,16 TIME: 42: 7 FIFTH: 35466. ODOM: 35706.
BUS NO. 39 OFF ROUTE AT 13,16 TIME: 42: 9 FIFTH: 35500. ODOM: 35742.

41	14638	6127	9	29	445.	14625.	6025.	103.
42	14717	5780	9	30	266.	14860.	5761.	144.
43	14816	5222	9	31	656.	14807.	5107.	115.
44	14055	5037	9	32	795.	14000.	5057.	59.
45	13388	5138	9	32	1471.	13330.	5145.	59.
*46	12862	5200	9	32	2043.	12762.	5219.	101.

CT1:RUN039.001

47	11518	5369	10	33	822.	11531.	5388.	23.
48	10787	5472	10	33	1556.	10804.	5489.	24.
49	10462	5513	10	33	1896.	10467.	5536.	24.
50	9558	5647	10	33	2864.	9509.	5670.	54.
51	8740	5757	10	33	3632.	8748.	5776.	20.
52	8145	5840	10	33	4274.	8112.	5864.	41.
53	7537	6481	11	35	520.	7557.	6437.	49.

FIXED ROUTE RUN # 40 CHECKPOINT ERRORS OFF ROUTE DECLARATION

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
1	12431	4529	1	3	18.	12416.	4602.	75.
2	12895	3792	1	4	521.	12849.	3812.	51.
3	13632	3698	1	4	1275.	13596.	3714.	39.
4	14904	3541	2	5	36.	14881.	3545.	24.
5	15277	4035	2	6	465.	15265.	3949.	86.
6	15334	4441	2	6	925.	15329.	4405.	36.
7	15383	4869	2	6	1343.	15387.	4819.	50.
8	15475	5453	2	6	1907.	15465.	5377.	76.
9	15644	6735	2	6	3227.	15648.	6685.	50.
10	15736	7421	2	6	3913.	15742.	7364.	57.
11	15809	7838	2	6	4345.	15802.	7792.	47.
12	16042	9499	3	7	1070.	16033.	9444.	56.
13	16512	9618	3	8	362.	16425.	9642.	90.
14	16941	9578	3	8	808.	16870.	9607.	77.
15	17368	9554	3	8	1264.	17324.	9572.	47.
16	17811	9507	3	8	1720.	17779.	9536.	43.
17	18095	8454	3	9	1017.	18112.	8493.	43.
18	18109	8343	3	9	1125.	18112.	8385.	42.
19	17929	6962	4	10	1154.	17929.	6931.	31.
20	16580	6988	4	11	1379.	16541.	6979.	40.
21	15087	7167	4	11	2881.	15049.	7159.	38.
22	14282	7260	4	11	3661.	14275.	7253.	10.
23	13313	7718	5	13	527.	13355.	7697.	47.
24	12500	8500	5	15	375.	12469.	8534.	46.
25	11590	9350	5	15	1615.	11558.	9374.	40.
26	12190	10181	6	18	933.	12160.	10198.	34.
27	13151	10036	6	18	1895.	13114.	10072.	52.
28	13130	9554	6	19	436.	13128.	9630.	76.
29	13052	9039	6	19	978.	13045.	9095.	56.
30	13699	7663	6	21	932.	13810.	7648.	112.
31	15123	7495	7	22	1162.	15138.	7483.	19.
32	15948	7393	7	22	2006.	15976.	7382.	30.
33	16627	7326	7	22	2684.	16649.	7301.	33.
34	17500	7204	7	22	3580.	17538.	7194.	40.
35	18345	7054	7	22	4492.	18444.	7085.	103.
36	18300	5657	8	25	311.	18334.	5647.	35.

BUS NO. 40 OFF ROUTE AT 13,16 TIME: 44:38 FIFTH: 35436. ODOM: 35602.
BUS NO. 40 OFF ROUTE AT 15,16 TIME: 44:40 FIFTH: 35500. ODOM: 35666.

FIXED ROUTE RUN # 41 CHECKPOINT ERRORS OFF ROUTE DECLARATION

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR		
1	12431	4529	1	3	46.	12413.	4574.	49.		
2	12895	3792	1	4	573.	12900.	3806.	15.		
3	13632	3698	1	4	1311.	13632.	3710.	12.		
4	14904	3541	2	5	66.	14910.	3540.	6.		
5	15277	4035	2	6	505.	15271.	3989.	46.		
6	15334	4441	2	6	963.	15334.	4443.	2.		
7	15383	4869	2	6	1379.	15392.	4855.	17.		
8	15475	5453	2	6	1947.	15470.	5417.	36.		
9	15644	6735	2	6	3261.	15652.	6718.	19.		
10	15736	7421	2	6	3951.	15748.	7402.	23.		
11	15809	7838	2	6	4389.	15808.	7835.	3.		
12	16042	9499	3	7	1070.	16033.	9444.	56.		
13	16512	9618	3	8	364.	16427.	9642.	88.		
14	16941	9578	3	8	820.	16882.	9606.	66.		
15	17368	9554	3	8	1264.	17324.	9572.	47.		
16	17811	9507	3	8	1710.	17769.	9537.	52.		
17	18095	8454	3	9	1055.	18112.	8455.	17.		
18	18109	8343	3	9	1133.	18112.	8377.	34.		
19	17929	6962	4	10	1158.	17928.	6927.	35.		
20	16580	6988	4	11	1379.	16541.	6979.	40.		
21	15087	7167	4	11	2887.	15044.	7160.	44.		
22	14282	7260	4	11	3675.	14261.	7255.	22.		
23	13313	7718	5	13	567.	13328.	7727.	18.		
24	12500	8500	5	15	391.	12458.	8545.	62.		
25	11590	9350	5	15	1635.	11543.	9388.	60.		
26	12190	10181	6	18	949.	12176.	10196.	20.		
27	13151	10036	6	18	1905.	13124.	10070.	44.		
28	13130	9554	6	19	446.	13126.	9620.	66.		
29	13052	9039	6	19	982.	13044.	9091.	52.		
30	13699	7663	6	21	916.	13794.	7651.	96.		
31	15123	7495	7	22	1210.	15185.	7477.	65.		
32	15948	7393	7	22	2046.	16015.	7377.	69.		
33	16627	7326	7	22	2720.	16685.	7297.	65.		
34	17500	7204	7	22	3602.	17560.	7191.	62.		
35	18345	7054	7	22	4508.	18460.	7083.	118.		
36	18300	5657	8	25	295.	18349.	5645.	51.		
BUS NO. 41 OFF ROUTE AT 13,16					TIME:	50:39	FIFTH:	35356.	ODOM:	35488.
BUS NO. 41 OFF ROUTE AT 15,16					TIME:	50:52	FIFTH:	35460.	ODOM:	35592.
BUS NO. 41 OFF ROUTE AT 13,16					TIME:	50:56	FIFTH:	35562.	ODOM:	35694.
*41	14638	6127	9	29	349.	14637.	6121.	7.		
CT1:RUN041.001										
42	14717	5780	9	30	166.	14760.	5771.	44.		
43	14816	5222	9	31	558.	14820.	5204.	18.		
44	14055	5037	9	32	699.	14095.	5044.	41.		
45	13388	5138	9	32	1375.	13425.	5132.	37.		
46	12862	5200	9	32	1935.	12869.	5205.	9.		
47	11518	5369	10	33	806.	11547.	5385.	33.		
48	10787	5472	10	33	1544.	10816.	5487.	33.		
49	10462	5513	10	33	1870.	10493.	5532.	37.		
50	9558	5647	10	33	2850.	9523.	5668.	41.		
51	8740	5757	10	33	3596.	8784.	5771.	46.		
52	8145	5840	10	33	4256.	8130.	5862.	27.		
53	7537	6481	11	35	528.	7558.	6445.	42.		
54	7652	6971	11	35	1036.	7645.	6945.	27.		
55	8320	6948	11	36	617.	8272.	6954.	49.		
56	9345	6825	11	36	1661.	9307.	6817.	39.		
57	9894	6731	11	36	2213.	9854.	6745.	43.		

FIXED ROUTE RUN # 42 CHECKPOINT ERRORS OFF ROUTE DECLARATION

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR
1	12431	4529	1	3	8.	12417.	4612.	84.
2	12895	3792	1	4	529.	12857.	3811.	43.
3	13632	3698	1	4	1277.	13598.	3714.	37.
4	14904	3541	2	5	20.	14865.	3548.	40.
5	15277	4035	2	6	451.	15263.	3936.	100.
6	15334	4441	2	6	913.	15327.	4393.	48.
7	15383	4869	2	6	1329.	15385.	4805.	64.
8	15475	5453	2	6	1897.	15464.	5368.	86.
9	15644	6735	2	6	3211.	15645.	6669.	66.
10	15736	7421	2	6	3897.	15740.	7348.	73.
11	15809	7838	2	6	4333.	15801.	7780.	59.
12	16042	9499	3	7	1068.	16032.	9442.	58.
13	16512	9618	3	8	354.	16417.	9642.	98.
14	16941	9578	3	8	806.	16868.	9607.	79.
15	17368	9554	3	8	1252.	17312.	9573.	59.
16	17811	9507	3	8	1702.	17761.	9538.	59.
17	18095	8454	3	9	995.	18112.	8515.	63.
18	18109	8343	3	9	1107.	18112.	8403.	60.
19	17929	6962	4	10	1168.	17927.	6917.	45.
20	16580	6988	4	11	1379.	16541.	6979.	40.
21	15087	7167	4	11	2889.	15042.	7160.	46.
22	14282	7260	4	11	3675.	14261.	7255.	22.
23	13313	7718	5	13	549.	13341.	7714.	28.
24	12500	8500	5	15	399.	12452.	8550.	70.
25	11590	9350	5	15	1621.	11553.	9378.	46.
26	12190	10181	6	18	963.	12190.	10194.	13.
27	13151	10036	6	18	1903.	13122.	10071.	45.
28	13130	9554	6	19	458.	13125.	9608.	55.
29	13052	9039	6	19	1006.	13040.	9067.	30.
30	13699	7663	6	21	960.	13838.	7644.	140.
31	15123	7495	7	22	1166.	15142.	7483.	22.
32	15948	7393	7	22	2008.	15978.	7382.	32.
33	16627	7326	7	22	2694.	16659.	7300.	41.
34	17500	7204	7	22	3592.	17550.	7192.	52.
35	18345	7054	7	22	4496.	18448.	7084.	107.
36	18300	5657	8	25	253.	18391.	5640.	93.
BUS NO. 42 OFF ROUTE AT 15:16					TIME:	40:16	FIFTH:	35306. ODOM: 35478.
41	14638	6127	9	29	335.	14639.	6134.	8.
42	14717	5780	9	30	154.	14748.	5772.	33.
43	14816	5222	9	31	540.	14822.	5222.	6.
44	14055	5037	9	32	693.	14101.	5043.	46.
45	13388	5138	9	32	1361.	13439.	5130.	51.
46	12862	5200	9	32	1923.	12881.	5204.	20.
47	11518	5369	10	33	812.	11541.	5386.	29.
48	10787	5472	10	33	1552.	10808.	5488.	27.
49	10462	5513	10	33	1900.	10463.	5536.	24.
50	9559	5647	10	33	2872.	9501.	5671.	62.
51	8740	5757	10	33	3646.	8734.	5778.	21.
52	8145	5840	10	33	4272.	8114.	5864.	39.
53	7537	6481	11	35	494.	7553.	6411.	72.
54	7652	6971	11	35	1008.	7640.	6918.	55.
55	8320	6948	11	36	589.	8244.	6958.	77.
56	9345	6825	11	36	1619.	9265.	6823.	80.
*57	9894	6731	11	36	2189.	9830.	6748.	66.
CT1:RUN042.001								
58	12136	6444	11	37	1162.	12112.	6447.	24.
59	12561	6405	11	37	1576.	12523.	6393.	40.

FIXED ROUTE RUN # 43 CHECKPOINT ERRORS OFF ROUTE DECLARATION

CP#	X(CP)	Y(CP)	SP#	SEG.	INCREM	COMP X	COMP Y	ERROR		
1	12431	4529	1	3	22.	12415.	4598.	71.		
2	12895	3792	1	4	537.	12865.	3810.	36.		
3	13632	3698	1	4	1287.	13608.	3713.	28.		
4	14904	3541	2	5	24.	14869.	3547.	36.		
5	15277	4035	2	6	457.	15264.	3942.	94.		
6	15334	4441	2	6	911.	15327.	4391.	50.		
7	15383	4869	2	6	1335.	15386.	4811.	58.		
8	15475	5453	2	6	1905.	15465.	5376.	78.		
9	15644	6735	2	6	3223.	15647.	6681.	54.		
10	15736	7421	2	6	3899.	15741.	7350.	71.		
11	15809	7838	2	6	4349.	15803.	7796.	43.		
12	16042	9499	3	7	1070.	16033.	9444.	56.		
13	16512	9618	3	8	366.	16429.	9642.	86.		
14	16941	9578	3	8	814.	16876.	9607.	71.		
15	17368	9554	3	8	1264.	17324.	9572.	47.		
16	17811	9507	3	8	1712.	17771.	9537.	50.		
17	18095	8454	3	9	989.	18112.	8521.	69.		
18	18109	8343	3	9	1115.	18112.	8395.	52.		
19	17929	6962	4	10	1150.	17929.	6934.	28.		
20	16580	6988	4	11	1379.	16541.	6979.	40.		
21	15087	7167	4	11	2885.	15046.	7160.	42.		
22	14282	7260	4	11	3653.	14283.	7252.	8.		
23	13313	7718	5	13	551.	13339.	7715.	26.		
24	12500	8500	5	15	411.	12443.	8558.	82.		
25	11590	9350	5	15	1633.	11544.	9387.	58.		
26	12190	10181	6	18	939.	12166.	10197.	29.		
27	13151	10036	6	18	1901.	13120.	10071.	47.		
28	13130	9554	6	19	440.	13127.	9626.	72.		
29	13052	9039	6	19	986.	13043.	9087.	48.		
30	13699	7663	6	21	942.	13820.	7647.	122.		
31	15123	7495	7	22	1180.	15156.	7481.	35.		
32	15948	7393	7	22	2022.	15992.	7380.	45.		
33	16627	7326	7	22	2698.	16663.	7299.	45.		
34	17500	7204	7	22	3590.	17548.	7193.	50.		
35	18345	7054	7	22	4494.	18446.	7085.	105.		
36	18300	5657	8	25	301.	18343.	5646.	45.		
BUS NO. 43 OFF ROUTE AT 13,16					TIME: 41: 5		FIFTH: 35406.		ODOM:	35576.
BUS NO. 43 OFF ROUTE AT 15,16					TIME: 41: 9		FIFTH: 35478.		ODOM:	35650.
BUS NO. 43 OFF ROUTE AT 13,16					TIME: 41:11		FIFTH: 35510.		ODOM:	35680.
41	14638	6127	9	29	443.	14625.	6027.	101.		
42	14717	5780	9	30	264.	14858.	5761.	142.		
43	14816	5222	9	31	654.	14808.	5109.	113.		
44	14055	5037	9	32	797.	13998.	5057.	61.		
45	13388	5138	9	32	1469.	13332.	5144.	57.		
46	12862	5200	9	32	2033.	12772.	5218.	91.		
47	11518	5369	10	33	744.	11608.	5377.	91.		
48	10787	5472	10	33	1476.	10883.	5478.	96.		
49	10462	5513	10	33	1820.	10543.	5525.	82.		
50	9558	5647	10	33	2782.	9590.	5658.	34.		
51	8740	5757	10	33	3560.	8819.	5766.	80.		
52	8145	5840	10	33	4202.	8184.	5855.	41.		
53	7537	6481	11	35	490.	7552.	6407.	75.		
54	7652	6971	11	35	1012.	7641.	6922.	51.		
55	8320	6948	11	36	589.	8244.	6958.	77.		
56	9345	6825	11	36	1627.	9273.	6822.	72.		
57	9894	6731	11	36	2179.	9820.	6750.	76.		

4.3 FIXED ROUTE DATA PROCESSING REQUIREMENTS

During the recording of fixed route data, a number of manual entry errors occured. These errors are noted in Table 4.3-1. The resulting card input changes necessary for processing these data are delineated in Table 4.3-2.

FIXED ROUTE DATA PROCESSING ANOMALIES

RUN NO.	PROBLEM	SOLUTION
14	Missed TA16	Inserted at approximate fifth wheel reading
14	TD15 entered early	Deleted first occurrence of TD15
15	CP25 entered early	Deleted first occurrence of CP25
17	Missed TD11	None, event not processed
18	Missed CP43	None, event not processed
19	Couldn't process tape	None, event not processed
20	Missed CP37	None, event not processed
	Generator stalled after CP46	None, not processed by FRTEN and FRSYS
21	Entered CP66 for CP6	Replaced CP66 with CP6
	Entered CP26 early	Deleted first CP26
	Entered CP47 early	Deleted first CP47
	Entered CP111 for CP11	Replaced CP111 with CP 11
	Missed CP36, CP47 and CP49	None, events not processed
	Entered TA16 for TA6	Replaced TA16 with TA6
24	TA33 entered for TA3	Replaced TA33 with TA3
24	TD12 entered early	Delete first TD12
26	Missed TD15	None, event not processed
27	TD10 entered for TA10	Replaced TD10 with TA10
27	Missed CP48	None, event not processed
28	Missed CP9	None, event not processed
29	Missed CP1 and CP28	None, event not processed
31	5th Wheel problem between CP3 and CP4	None, data processed
32	Lost magnet from 5th wheel	None, not processed by FRSYS or FRTEN
33	Couldn't process tape	None, not processed
34	Garbage record after CP37	None, CP38-CP76 processed manually
34	DO2, DC2, and TD2 entered early	Deleted first DO2, DC2, and TD2
37	DC7 entered for DC1	Deleted DC7
37	CP30 entered twice	Deleted second CP30
38	CP71 entered early	Delete first CP71
39	CP27 entered early	Delete first CP27
40	Couldn't process past CP40 due to bad record	None, CP41-76 processed manually
42	CP40 entered in error	Delete first CP40
43	Couldn't process past CP62 with FRLS	None, CP63-76 processed manually

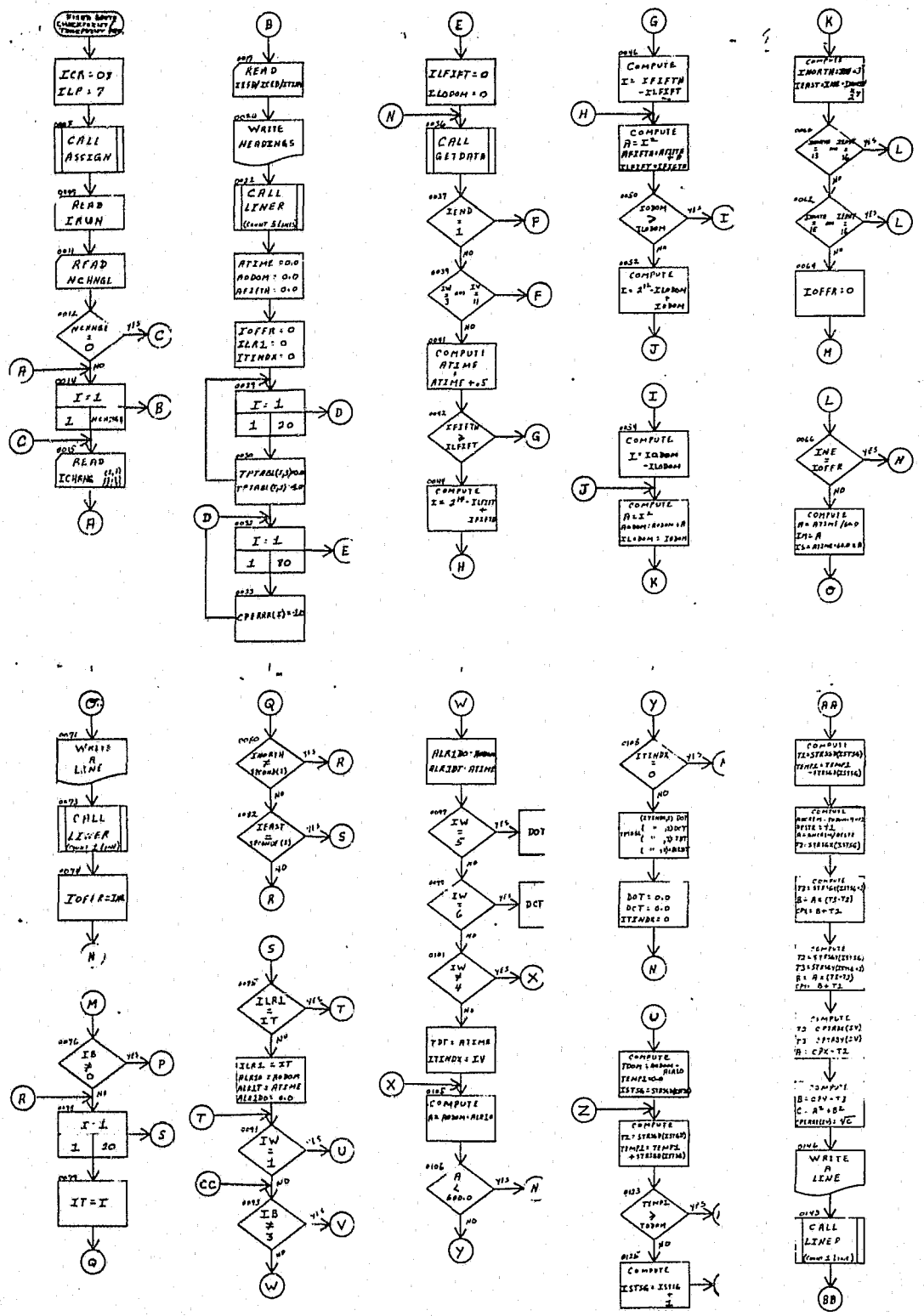
CARD INPUT CHANGES FOR HI^3 DATA PROCESSING

RUN	CHANGES	FRIS	FRSYS/ FRTEN	RECORDED ON LOG SHEET
14	Insert TA16 at FIFTH = 33678	N.A.		Yes
16	Change 2nd TD11 to TA24	N.A.		Yes
21	Delete 1st CP7			Yes
21	Replace CP66 with CP6			Yes
21	Delete 1st CP26			Yes
21	Replace 1st TA16 with TA6	N.A.		Yes
21	Replace CP111 with CP11			Yes
21	Delete 1st CP47			Yes
24	Delete TA33	N.A.		No, but EE33 on tape
27	Replace 1st TD10 with TA10			No, observed on listing
30	Replace 2nd CP10 with TA10			Yes
32	Replace 1st TD13 with DO13		N.A.	No, observed on listing
34	Delete 1st DO2		N.A.	Yes
34	Delete 1st DC2		N.A.	Yes
34	Delete 1st TD2		N.A.	Yes
34	Delete CP128			Not entered by operator, Error record
37	Delete 1st DC7		N.A.	No, observed on listing
37	Delete 2nd CP30			Yes
38	Delete 1st CP71			Yes
39	Replace 2nd TA18 with TA19	N.A.		No, observed on listing
39	Delete 1st CP27			Yes
42	Delete 1st CP40			Yes
42	Delete 1st TD5		N.A.	Yes

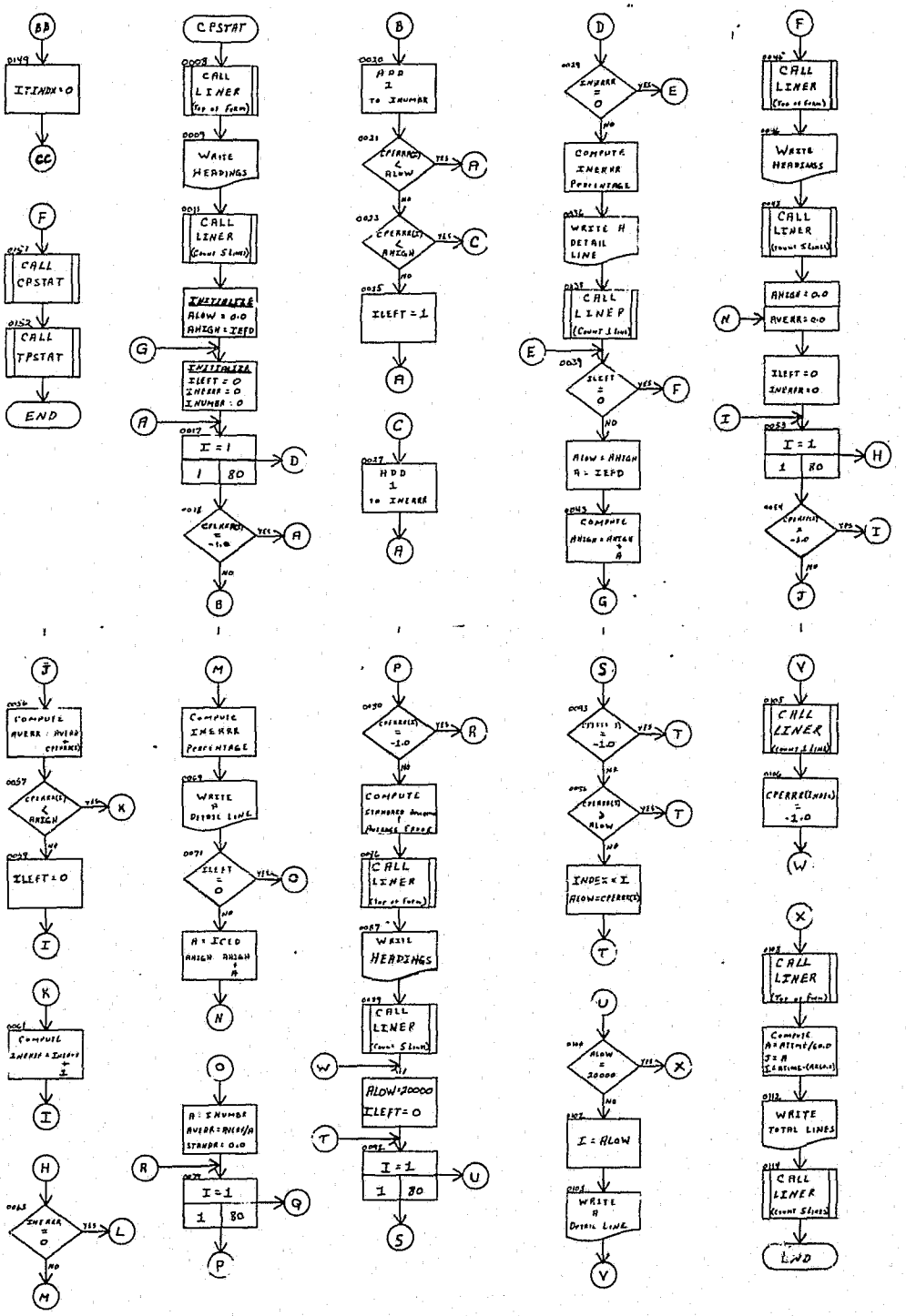
4.4 FRLS AND FRSYS FLOW CHARTS

Flow charts of computer programs CPMAIN and RRSL were included in Section 4 of Volume I. Flow charts of computer programs FRLS and FRSYS are presented in this subsection. Detailed software documentation of all Phase I software were delivered under separate cover to TSC and MITRE.

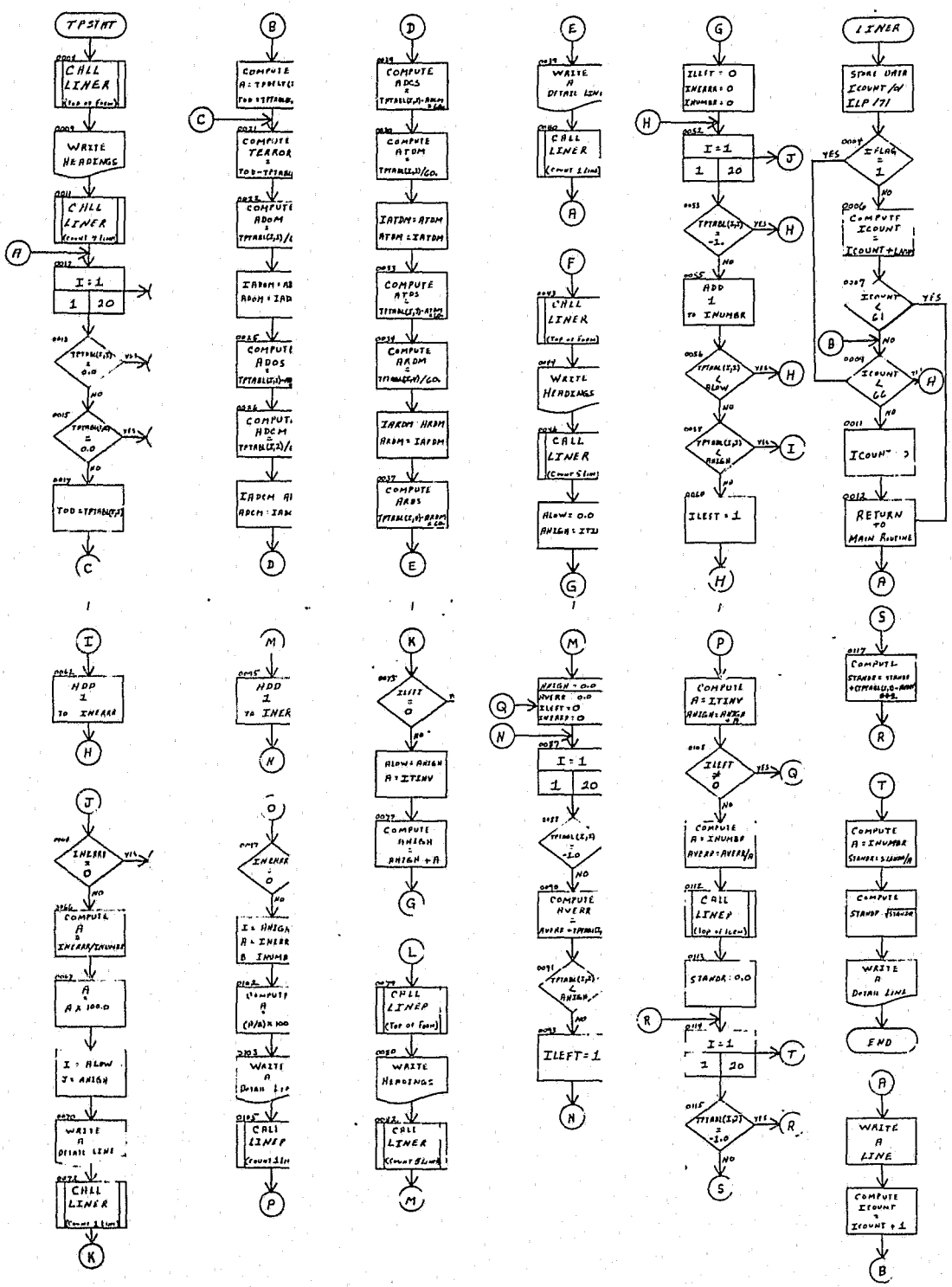
FLOW CHART OF PROGRAM FRIS



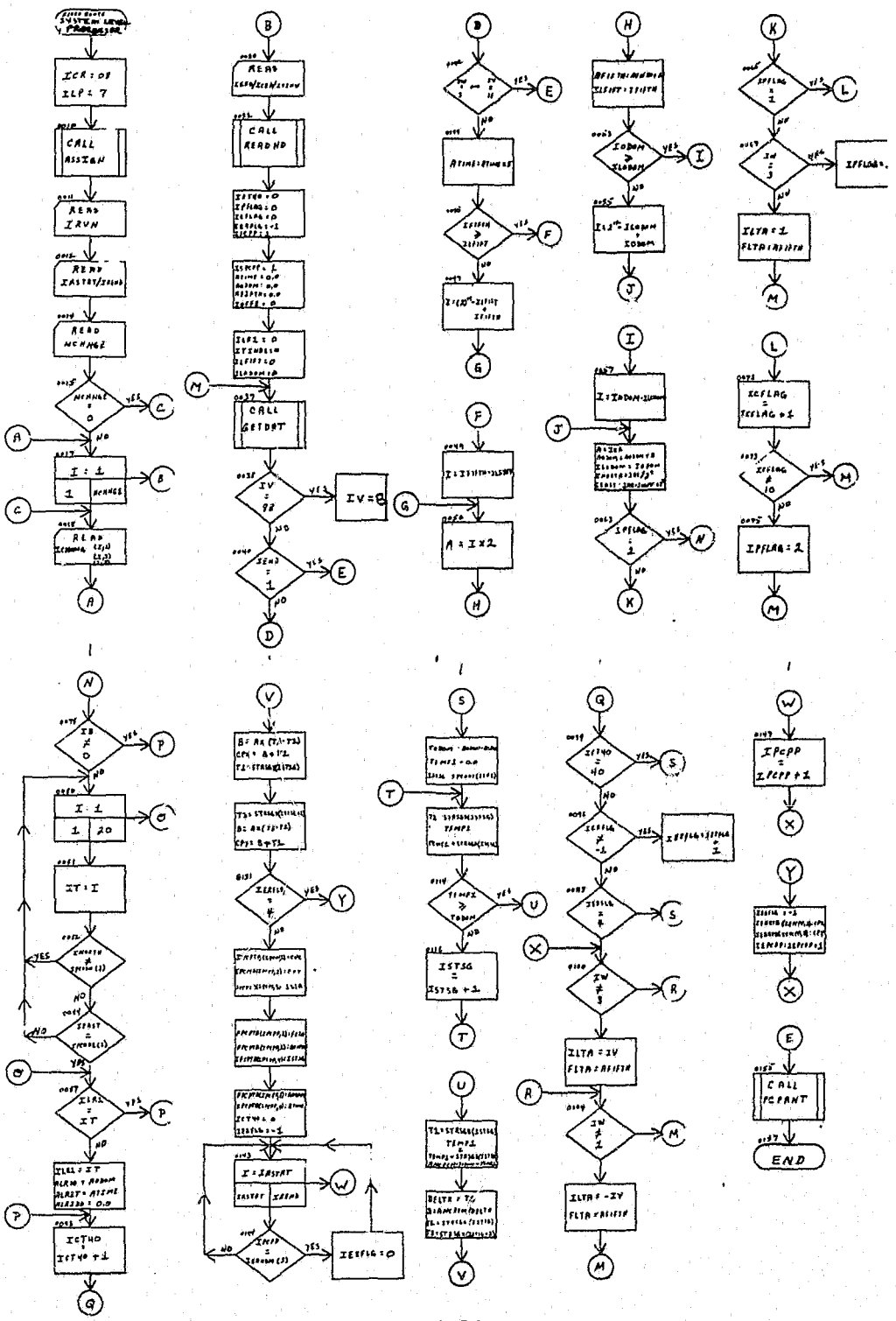
FLOW CHART OF PROGRAM FRLS (CONT'D)



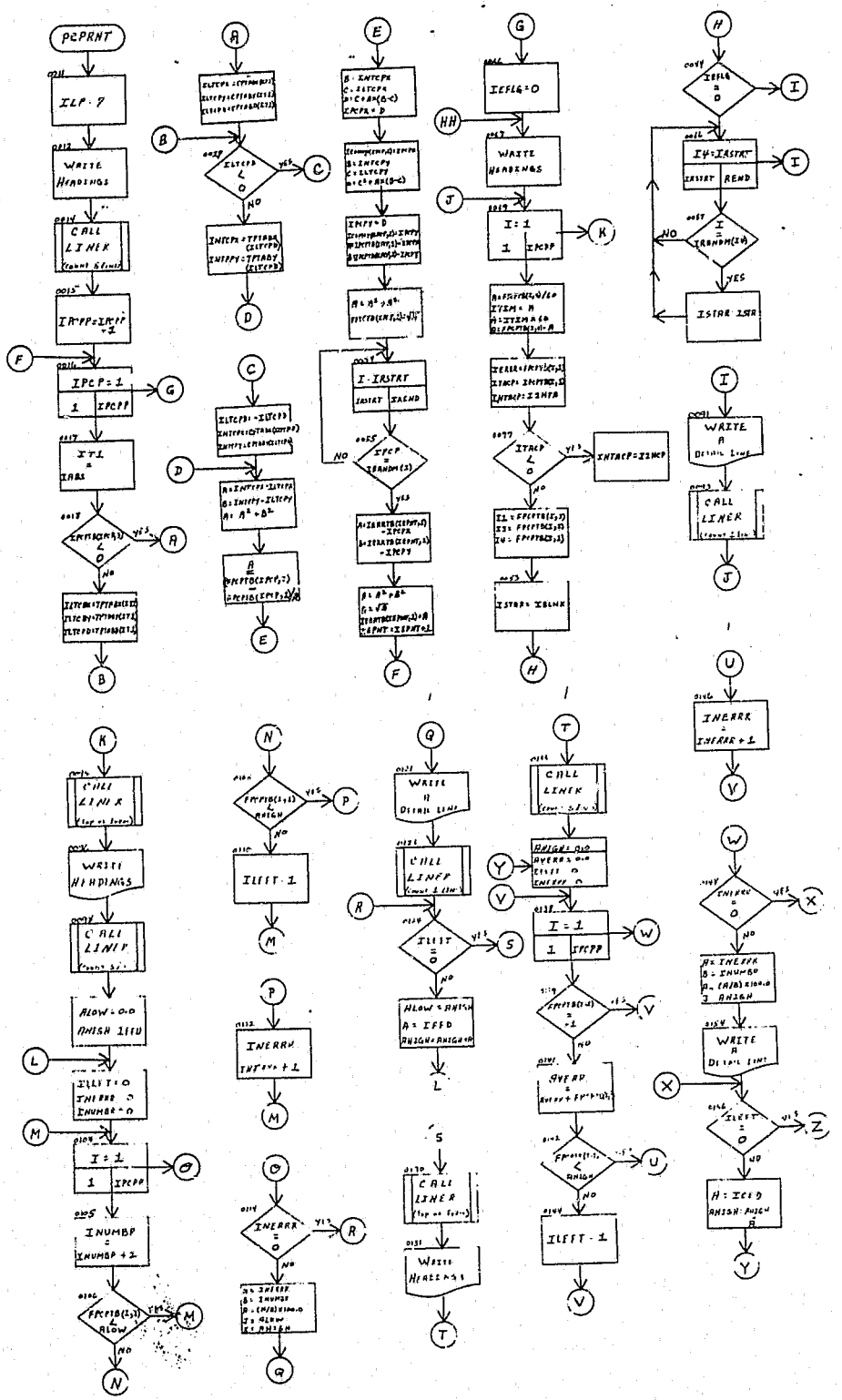
FLOW CHART OF PROGRAM FRLS (CONT'D)



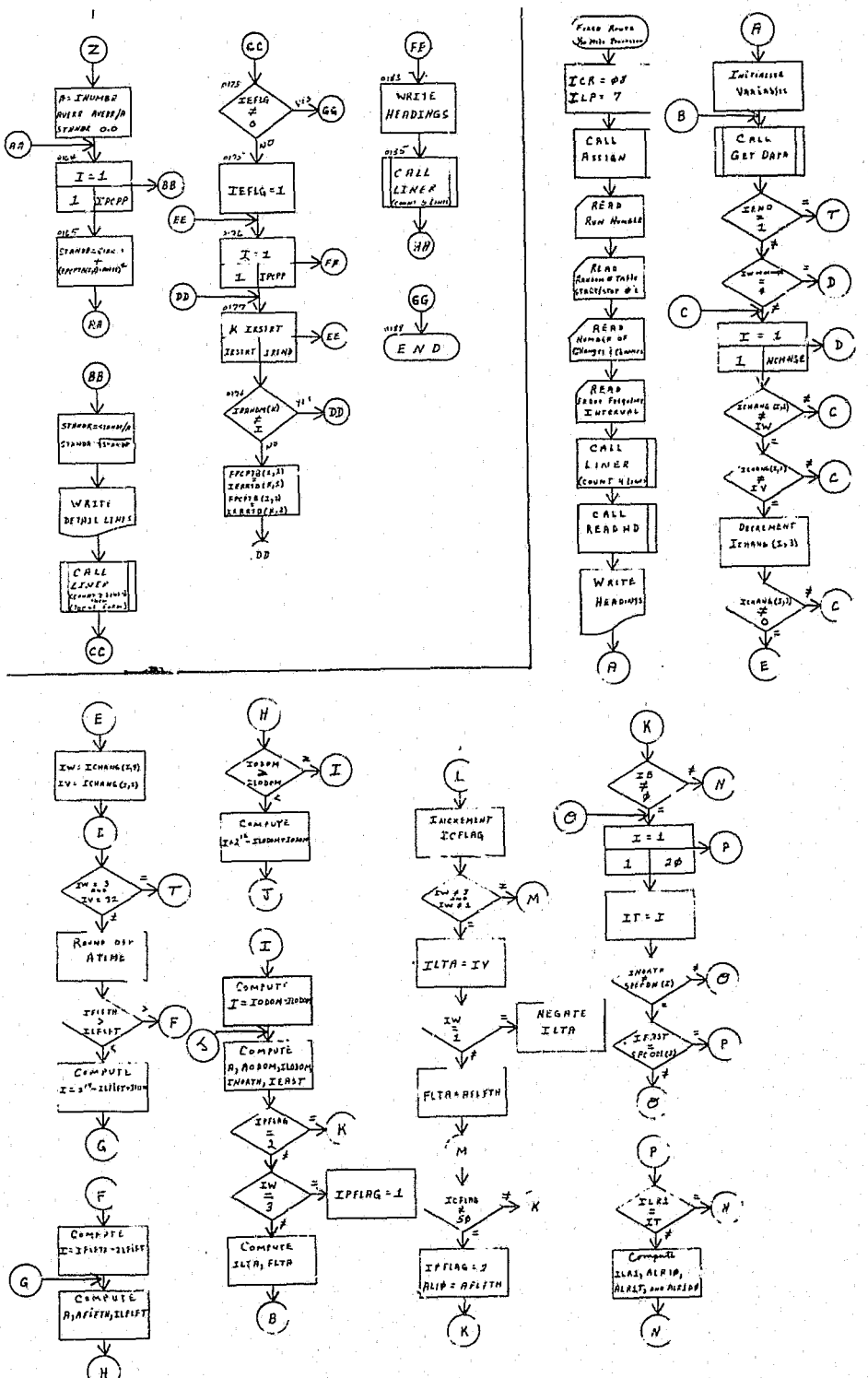
FLOW CHART OF PROGRAM FRSYS



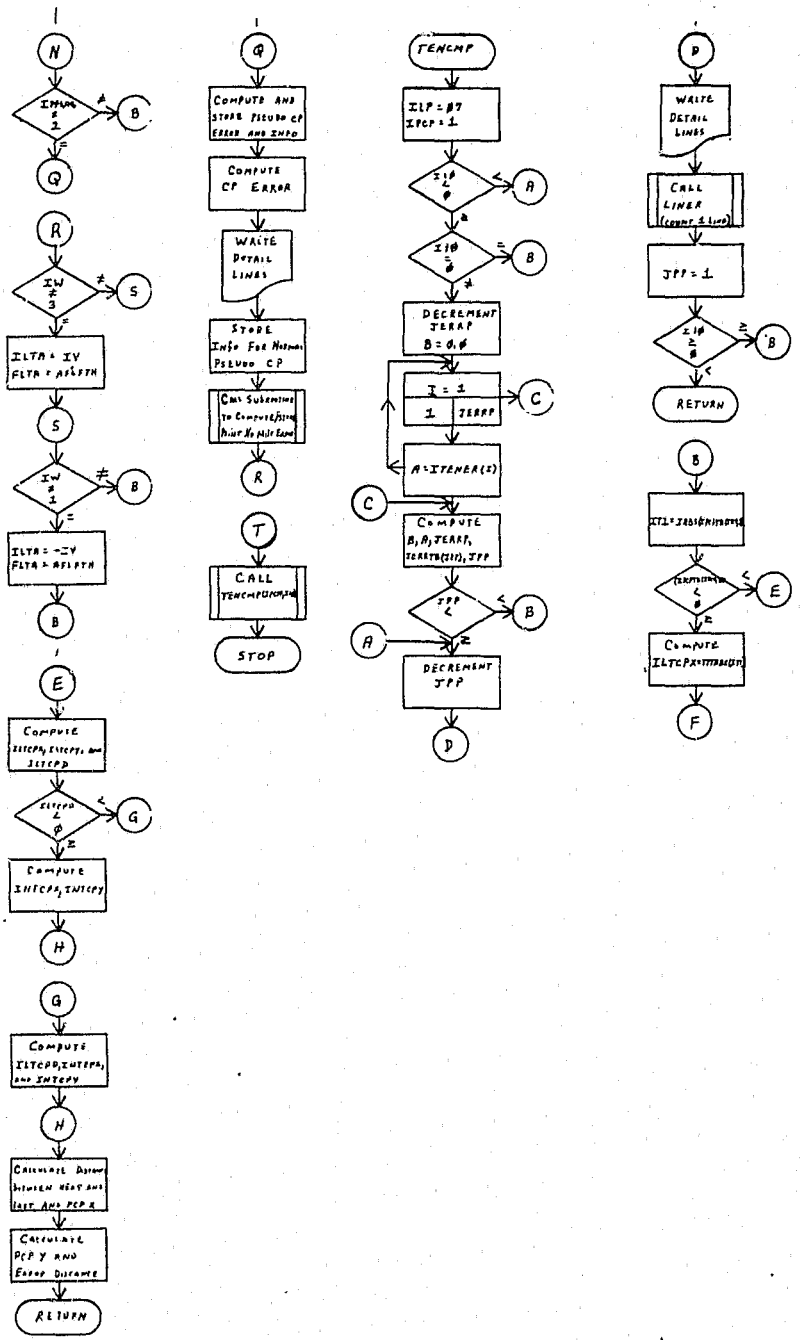
FLOW CHART OF PROGRAM FRSYS (CONT'D)



FLOW CHART OF PROGRAM FRSYS (CONT'D) AND FRTEN



FLOW CHART OF PROGRAM FRTEN (CONT'D)



5. REPORT OF INVENTIONS APPENDIX

After a diligent review of the work performed under this contract, no innovation, discovery, or invention was made; however, a number of previous concepts were practically demonstrated for the first time. The previous concepts demonstrated are briefly described below.

1. Use of Signposts Operating at 49.86 MHz

Operation of signposts at 49.86 MHz was conceived by HI[3] at the time the FCC proposed to open the 49 MHz band for use under Part 15. Operation in this band was formally authorized on 12 February 1976 under FCC Docket 20119. Use of this frequency was formally proposed to be tested during Phase I in Hoffman's response to TSC questions dated 15 April 1976. The use of 49.86 MHz signposts is described on pages 3-1 to 3-6 and 10-6 and 10-7 of Volume I. The first practical demonstration of the use of signposts operating at 49.86 MHz was performed under this contract.

2. Hole-Filling Technique for Use with Overlapping Signposts

The use of a double grid of signposts to fill in the holes left when only a single grid is used was first proposed by Hoffman in 1975 for use with the Cargo Security System and again in 1975 for use with the Dallas AVM system. However, the concept was not practically demonstrated until Phase I of this contract. Figure 3-14 on page 3-26 of Volume I illustrates this concept.

3. Automatic Reset of Odometer Using Region 1 of Signpost

The concept of resetting the odometer automatically using Region 1 of the signpost was proposed as part of Hoffman's proposal dated 14 October 1975. It was first practically demonstrated under this contract. The concept is described on pages 6-8, 6-12, 6-13, and 7-4 of Volume I.

4. Determination of Time Point Passage Through Use of the Region 1 Dropout

The concept of using Region 1 dropout to determine time point passage was proposed as part of Hoffman's proposal dated 14 October 1975. It was first practically demonstrated under this contract. The concept is described on pages 6-12, 6-13, 6-14, 6-15, and 7-7 of Volume I.

5. Random Route and Fixed Route Data Recording Software

The software used to record random route and fixed route vehicle location data on cassettes was developed during Phase I of this contract. This software is described on pages 3-19, 3-20, 6-6, 6-7, 6-8, and 6-9 of Volume I.

6. Interface Control Unit (ICU) Hardware

The Interface Control Unit was developed under this contract for the express purpose of recording AVL data on cassette. The ICU is described on pages 3-16 through 3-19 and 6-1 through 6-6 of Volume I.

7. Random Route and Fixed Route Data Processing Software

The random route and fixed route data processing software, consisting of computer programs CPMAIN, RRSL, RRTEN, FROUTE, FRSYS, and FRTEN, were developed under this contract. The algorithms used for automatic vehicle location were not developed under this contract; however, the algorithms which were associated with generating a reference location from the fifth-wheel and turn indications were developed under this contract. Software is described in Sections 3, 4, 6, and 7 of Volume I.

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