R-346U

BUS-TRIP RELIABILITY DATA BANK REQUIREMENTS

TASK C REPORT

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PREFACE

This report describes the results of the Task C portion of the contract to "Develop the Ground Work and Prepare the Back-up Information Necessary for the Establishment of a Bus-TRIP Data Bank", performed under contract number DTRS-57-80-C-00007, issued on December 12, 1979 from the U.S. Department of Transportation (DOT), Transportation Systems Center (TSC).

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (concluded)

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF FIGURES (concluded)

LIST OF ABBREVIATIONS

ADB	Advanced Design Bus
AMG	American Motors General
APTA	American Public Transit Association
ARTIC	Articulated Bus
BART	Bay Area Rapid Transit (San Francisco, CA)
BEDB	Bus TRIP Experimental Data Bank
BREL	Bus Reliability Equipment List
COTA	Central Ohio Transit Authority (Columbus, OH)
CRT	Cathode Ray Tube
CTA	Chicago Transit Authority (Chicago, IL)
DOT	Department of Transportation
DRC	Dynamics Research Corporation
FLX	Grumman Flxible
GMC	General Motors Corporation
GPN	Generic Part Number
GSN	Generic Serial Number
MARTA	Metropolitan Atlanta Rapid Transit Authority (Atlanta, GA)
MDQS	Management Data Query System
METRO (Houston)	Houston Metropolitan Transit Authority (Houston, TX)
METRO (Seattle)	Municipality of Metropolitan Seattle (Seattle, WA)

LIST OF ABBREVIATIONS (concluded)

MTA	Baltimore Mass Transit Administration (Baltimore, MD)
NLC	New-Look Conventional
NYCTA	New York City Transit Authority (New York, NY)
PATCO	Port Authority Transit Corporation (Lindenwold, NJ)
PM	Preventive Maintenance
RIPTA	Rhode Island Public Transit Authority
RRV	Rapid Rail Vehicle
SCRTD	Southern California Rapid Transit District (Los Angeles, CA)
SEMTA	Southeastern Michigan Transportation Authority (Detroit, MI)
TIDS	Technical Integrated Data System
TRIP	Transit Reliability Information Program
TSC	Transportation Systems Center
UMTA	Urban Mass Transportation Administration
VIA	San Antonio Metropolitan Transit (San Antonio, TX)
VMS	Vehicle Maintenance System
WMATA	Washington Metropolitan Area Transit Authority (Washington, DC)

EXECUTIVE SUMMARY

This report describes the approach, conclusions, and recommendations for the definition of the reliability data bank required by the Bus Transit Reliability Information Program (Bus TRIP). This effort comprises Task C of the Bus TRIP contract. The areas addressed in this report are briefly described below.

- Characterization of Input Data

  Based on the information collected in Task A concerning the various types of transit bus reference, operating, maintenance, and repair, the requirements of the data bank were defined in order to address:

  - Data types and content,
  - Data frequency and format, and
  - Differences between Bus and Rapid Rail Vehicle (RRV) input data.

- Definition of Output Requirements

  Based on the Task A investigation of maintenance reporting systems used at transit bus properties, the output reporting requirements for the data bank were defined for:

- Report form and content and
- Report frequency and distribution.

- Bus TRIP Data Bank Configuration

  Based on the definition of input data characteristics and output reporting requirements, and using information obtained in Task 2 - RRV TRIP concerning the operation of the RRV TRIP data bank, and the Bus Reliability Equipment List (BREL), developed in Task B of this program, the general configuration and operating requirements for the full-scale Bus TRIP data bank were defined for:

  - Data submission,
  - Data preparation and processing,
  - Data verification,
  - Data organization and storage,
  - Data retrieval and analysis, and
  - Data reporting.

- Bus Experimental Data Bank (BEDB) Configuration

  Based on the full-scale Bus TRIP data bank configuration definition and the RRV TRIP Experimental Data Bank (EDB) currently in operation, the configuration and operating methods

for the Bus TRIP Experimental Data Bank (BEDB) were defined to test the final Bus TRIP Data Bank Configuration for:

- Data submission,
- Hard-copy data preparation and entry,
- Computer-readable input data translation and extraction,
- Data reformatting and cross-referencing,
- Data editing and error correction,
- Data storage,
- Equipment identification requirements,
- Data retrieval and analysis, and
- Data reporting.

- Bus TRIP Data Bank Operation

Using the full-scale Bus TRIP data bank configuration, characterization of input data, and potential reporting requirements, the operating requirements for the data bank were defined for:

- Projected data bank size,
- Projected operating cost factors,
- Data bank staffing, and
- Data bank sponsorship.

- Data Bank Benefits

  The anticipated benefits to be derived by Bus TRIP users were defined based on programs that may be supported by the Bus TRIP data bank, the proposed data bank output reports, and the projected cost factors for the full-scale data bank.

The conclusions from Task C can be summarized as follows.

- The major differences between RRV TRIP and Bus TRIP are:
  - The larger quantity of hard-copy input data for Bus TRIP
  - Different output reports (Bus TRIP consumable reports, etc...)
  - Vendor monitoring in Bus TRIP

- The large volume of hard-copy input data will require a larger number of data technicians than is needed in the RRV TRIP EDB.

- Vendor-specific reliability monitoring will add significantly to the benefits of Bus TRIP.

- Differences in the nature of the input data and output requirements will require modifications to the RRV TRIP EDB software, as it exists, in order to implement a Bus TRIP EDB.

The recommendations based on the above conclusions are listed below.

- A Bus TRIP EDB separate from the RRV TRIP EDB should be implemented, due to differences in the nature of the input data and output requirements.

- While Bus TRIP will employ the same Generic Part Number (GPN) approach used in RRV TRIP, the specific make-up of the GPN will be changed to more closely coincide with bus equipment.

- Methods for logging input data as received should be developed due to the large quantity of anticipated hard-copy input data.

- Engineering evaluation should be performed on the data input to the data bank "along the way" from input to storage to output.

SECTION 1 - INTRODUCTION

1.1 - BACKGROUND

RRV TRIP is a government-initiated response to the transit industry's need to collect and analyze rail transit vehicle reliability information on a national basis. The information to be generated by RRV TRIP would be disseminated to transit properties, equipment suppliers, and other prospective users to support, with "real-world" reliability statistics, on-going industry efforts directed toward:

- Reliability assessment,
- New equipment reliability specification,
- Product improvement,
- Railcar equipment standardization, and
- Rail transit vehicle operating and maintenance cost reduction.

The RRV TRIP contract was awarded to DRC in September 1978 by the DOT, TSC under contract DOT-TSC-1559.

In December 1979, DOT, TSC awarded another TRIP-related contract to DRC to identify and analyze transit bus reliability efforts. The goal of the Bus TRIP program is to use the existing RRV TRIP structure and its Experimental Data Bank (EDB) experience to develop the base that is necessary before an overall TRIP can accommodate bus utilization, consumption, maintenance, and repair data.

To achieve this goal, the Bus TRIP program was divided into five tasks, as follows:

- Task A - Appraise and evaluate incident and maintenance reporting systems used by bus transit systems in the United States.

- Task B - Establish the Bus Reliability Equipment List (BREL).

- Task C - Define the reliability data bank required by Bus TRIP.

- Task D - Define guidelines for the implementation and operation of Bus TRIP.

- Task E - Participate in a Bus TRIP project review and prepare the Bus TRIP final report.

Task C deals with the design of the Bus TRIP data bank based on Tasks A and B of Bus TRIP as well as Task 2 of (DOT,TSC 1559) RRV TRIP. Aspects of this task include characterization of input data; definition of output requirements; Bus TRIP data bank configuration; experimental data bank configuration; data bank size, costs, and staffing; and data bank benefits. The conclusions and recommendations of Task C will be used to define the guidelines for implementing and operating Bus TRIP (Task D).

Task C is divided into the following sections for discussion in this report:

- Characterization of input data,
- Definition of output requirements,
- Bus TRIP data bank configuration,
- EDB configuration,
- Data Bank Operation,
- Data Bank Benefits,
- Conclusions, and
- Recommendations.

1.2 - INPUT TO TASK C

Input to Task C was from Task A, Task B, and RRV TRIP Task 2 (TRIP Data Bank Scope and Definition, DRC Document No. E-4894U). The input from each task is described in the following subsections.

1.2.1 - Input from Task A

The information from Task A used for Task C was:

- Format, content, and estimated quantity of utilization, consumption, maintenance, and repair data for transit buses available from bus transit properties for data bank input;

- Format, content, and availability of reference data covering bus property, bus equipment characteristics, and operating policies to be stored in the data bank; and,

- Examples of reliability information and reports being generated by individual bus properties to be used for Bus TRIP output definition.

1.2.2 - Input from Task B

The information from Task B used for Task C was:

- Classification of bus equipment using a function-based Generic Part Numbering (GPN) approach as the basis for the organization of the data bank storage approach;

- Bus equipment GPN as the basis for the development of common formatting of data from several sources; and,

- BREL operating procedures for adding, deleting, or modifying equipment to be monitored as one facet of data bank operation.

1.2.3 - Input from RRV TRIP Task 2

The information from RRV TRIP Task 2 used for Task C was:

- RRV TRIP input data definition,
- RRV TRIP outputs definition,
- RRV TRIP data bank design requirements,
- RRV TRIP EDB configuration,
- RRV TRIP data bank operation/benefits.

SECTION 2 - CHARACTERIZATION OF INPUT DATA

As in the definition of the RRV TRIP data bank, the first major effort in defining the Bus TRIP data bank is to characterize the available transit bus operating, maintenance, and reference data which would be used as input to Bus TRIP. The characteristics of this available data including format, content, and commonality between properties provide the major input to the development of:

- Bus TRIP data bank configuration and operating requirements and

- Bus TRIP data bank output definition, including determination of types, content, and frequency of reports which could be produced.

Bus TRIP, similar to RRV TRIP, will use transit bus operating and maintenance data as input. This data already is being generated by the transit properties. Bus TRIP will collect and accept transit property data as is, thus imposing no additional requirements for generating data on these data sources. Bus TRIP will produce outputs and reports based on this predefined data.

Therefore, to characterize the available input data for the Bus TRIP data bank, the following areas were addressed.

- Characterization of Potential Input Data
  - Static (reference) and dynamic data types (and differences between Bus and RRV input data)
  - Bus TRIP generic assignment data types
  - Data formats, content, and frequency

- Data Verification Requirements
  - Data accuracy
  - Data validation

- Sample Forms from Properties

2.1 - INPUT DATA CHARACTERISTICS

As in RRV TRIP, the three general types of data that will be input to the Bus TRIP data bank include:

- Static (reference) data,
- Dynamic data, and
- Bus TRIP generic assignment data.

Static (reference) data is information that describes the configuration, characteristics, and operation of a transit system, vehicle type, or equipment on a vehicle type. This reference data will be used in the evaluation of the reports generated by Bus TRIP. Such information may be used to interpret differences in reliability-related performance of bus models based on passenger load and/or environmental conditions (such as climate, or terrain) and to interpret differences in reliability indicators of bus models based on the application of each model (such as operation on routes with numerous stops versus express routes).

Dynamic data consists of information covering the operations and maintenance (such as preventive and unscheduled repair) of transit buses. Dynamic data will provide the basis for determining reliability-related performance and maintenance requirements for transit buses. Dynamic data types include bus utilization information, bus consumables information (such as fuel, oil, coolant, and tires), road call information, and bus scheduled and unscheduled maintenance information.

Bus TRIP generic assignment data consists of data required for the operation of Bus TRIP software. This data

includes fleet tables for each property, parts lists for each property and each model, maintenance codes for each property, and vendor codes for each property. This data will allow Bus TRIP to assign Bus TRIP "generic" codes to property-specific codes. For example, the repair code to add antifreeze may be 03 in one property and 07 in another property. With the use of the table of maintenance codes for each property, Bus TRIP will record information to add antifreeze in "generic" code 05 rather than the property-specific codes.

The definitions of static and dynamic data characteristics, which are further detailed in the following subsections, cover the types and content of information that will be received by the full-scale Bus TRIP data bank. The Bus TRIP Experimental Data Bank (BEDB), however, will accept, process, and store only a limited number of these static and dynamic data types to restrict the quantity of data handled during the development and refinement of the Bus TRIP data bank.

2.1.1 - Static Data Characteristics

Static (reference) data will include information describing transit properties, vehicle types, and classes of

equipment. The definition of static data elements for Bus TRIP is based upon definitions developed for RRV TRIP, and is grouped as follows. (See Appendix A for specific definition.)

- Transit System Configuration
- Transit System Route Configuration
- Transit System Route Operating Information
- Vehicle Fleet Information
- Vehicle Specification Information
- Vehicle Configuration Information
- Hardware Specification Information

The major differences between Bus TRIP and RRV TRIP static data are listed below.

- Transit System Configuration

  Bus systems do not have power substations or track. This makes it unnecessary to specify wayside power voltage, substation number and spacing, and track gauge, construction, grades, and r-o-w locations.

- Transit System Route Configuration

  Bus systems do not have track, therefore, it is unnecessary to define the track profile and turnouts.

- Transit System Route Operating Information

  Buses are not operated in trains, therefore, it is impossible to specify train-consist data.

- Vehicle Fleet Information

  Buses are not operated in trains, therefore, it is unnecessary to specify vehicle subtypes.

- Vehicle Configuration Information

  Buses are composed of different functional systems and assemblies.

- Hardware Specification Information

  Buses have different components, therefore this reference data will be completely different from that specified for RRV TRIP.

Transit System Configuration Static Data (Figure A-1) provides summary reference information concerning the physical characteristics of an entire bus property. These characteristics include total route miles, average passenger stop spacing and number, passenger volume, total number of buses, and street types (collector, arterial, and freeway).

Transit System Route Configuration Static Data (Figure A-2) provides reference information concerning the specific route on a bus property over which a specific vehicle type may be operated. This information includes route miles, passenger stop spacing and number, and grades (maximum uphill and downhill). Such data will permit the comparison of the physical demands made on vehicles operating on different routes.

Transit System Route Operating Static Data (Figure A-3) provides reference information concerning the scheduled operation of vehicles on a specific route. This data includes operating speed data, headways, passenger stop dwell times, passenger load information, and the number of scheduled runs per day.

Vehicle Fleet Information Static Data (Figure A-4) provides reference information concerning the general characteristics of a bus model. This data includes the quantity of buses of that model, the bus manufacturer and year delivered, and the frequency of scheduled maintenance.

Vehicle Specification Information Static Data (Figure A-5) provides reference information concerning the physical characteristics and performance specification of a bus

model. This data includes performance information such as speed, acceleration, deceleration, and turning radius.

Vehicle Configuration Information Static Data (Figure A-6) provides reference information concerning the physical characteristics, types, capacities and ratings, and manufacturers of the major functional systems and major assemblies for each bus model. This information may be used to relate a specific type of hardware on a bus with respect to the reliability indicators for this equipment class for various bus models.

Hardware Specification Information Static Data (Figure A-7) provides detailed information, on a component-by-component basis, of the physical characteristics and intended application of this hardware. This data includes the quantity and type of component by bus model, manufacturer code, and part number, and component physical characteristics and capacities/ratings. With the aid of this data, reliability-related information could be interpreted for specific classes of equipment based on the configuration and design ratings of specific equipment types.

Vehicle and hardware static data on those vehicles being monitored by Bus TRIP will be obtained from vehicle parts books and maintenance manuals, as well as from vehicle specification documentation. As new vehicles and components are added to the Bus TRIP data bank, static data for this equipment will be collected and entered into the reference portion of the Bus TRIP data bank.

2.1.2 - Dynamic Data Characteristics

Dynamic data consisting of bus operating and maintenance information will be the basis for reliability-related analysis and associated reports output by the Bus TRIP data bank. Dynamic data is generated by a property during the bus revenue service, inspection, scheduled maintenance, and repair. This data will be collected, typically, on a monthly basis for input to Bus TRIP. Such data may be supplied in the following forms.

- Computer-readable formats from automated data collection systems:
  - Tape,
  - Disk, and
  - Punched cards.

- Hard-copy forms from manual data collection systems.

The dynamic data types that have been developed for Bus TRIP parallel those developed for RRV TRIP as follows. (The data elements are described in Appendix B.)

- Vehicle Utilization Information
- Vehicle Consumption Information
- Vehicle Road Call/Incident Information
- Vehicle Scheduled Maintenance Information
- Vehicle Repair Information
- Vehicle Component Repair Information

The major difference between Bus TRIP and RRV TRIP dynamic data types is the monitoring of consumables for buses: fuel, oil, coolant, and tires. Consumables can act as an indicator of engine and other hardware problems. For example, if a bus requires more than one gallon of coolant, there may be a cooling system problem. If a bus is consuming more fuel than usual, it may indicate an engine problem.

Other differences between Bus TRIP and RRV TRIP dynamic data include the addition of road call information for Bus

TRIP, as well as the addition of vendor information in the road call, scheduled maintenance, and repair dynamic data.

Vehicle Fleet Utilization Dynamic Data (Figure B-1 in Appendix B) provides information, on a periodic basis, concerning the number of miles and/or operating hours accumulated by individual buses in a fleet. This data is necessary for the calculation of maintenance and replacement rates such as Mean Miles Between Maintenance Actions and Mean Miles Between Replacements with respect to revenue service operation.

Vehicle Fleet Consumption Dynamic Data (Figure B-2) provides information on a periodic basis concerning the consumption of such items as fuel, oil, coolant, or tires. This data will be used to calculate miles per gallon of fuel, miles per quart of oil, and miles per gallon of coolant. These "economy" figures, along with the direct measures of consumables used, may be important factors for the indication of potential equipment problems.

Vehicle Road Call/Incident Dynamic Data (Figure B-3) provides information concerning reported equipment problems encountered during revenue service. This information may be used to compare suspected problems with actual repairs.

Vehicle Scheduled Maintenance Dynamic Data (Figure B-4) provides information concerning the periodic inspection and repair of buses. This data includes the inspection type; expendable components and supplies replaced (along with the vendor); and minor repair, including the replacement of components. From this data, equipment reliability with respect to scheduled maintenance frequency (mean miles between inspections) can be determined. By recording the vendor of the replacement parts, the reliability of parts from specific vendors can be monitored.

Vehicle Repair Dynamic Data (Figure B-5) provides the primary source of data for the Bus TRIP Data Bank. This data includes part replacement data, failure/defect description, and maintenance/repair action or no-trouble-found. From this data, unscheduled maintenance rates, equipment replacement rates, repair rates with no components replaced, and no-trouble-found rates can be calculated. These rates will be primary input for the reliability-related analysis and subsequent output from Bus TRIP. Again, monitoring replacement parts by vendor will aid in the determination of maintenance activity for parts from specific vendors.

Vehicle Component Repair Dynamic Data (Figure B-6) provides information concerning the repair of equipment that has been removed from a bus. This data includes the component or major assembly being repaired, the type of repair, and the component replaced during the repair. The equipment repaired should be linked to a specific bus, so there will be a complete view of the hardware failure mode and subsequent repair. If the equipment repaired is not linked to a specific bus, this repair data will still be stored in the Bus TRIP Data Bank to account for off-vehicle equipment repair, on an independent basis and the resources used to make the repair. For example, if an engine is removed from a bus and sent to an outside firm for repair, the details of that repair would be stored in the data bank.

An example of dynamic data (see reference 7) being collected by RRV TRIP is shown in Figure 2.1 through 2.4. Currently, there are four types of dynamic data records collected from each property for the RRV TRIP EDB. The four record types are:

- Utilization (mileage data)
- Scheduled Maintenance (inspection data)
- Repair (Unscheduled Maintenance data)
- Repair - Serial Numbers

RECORD NAME: UTILIZATION			TYPE – FORM – SEQ. 02 – A – 01
DATA NAME	**DATA DESCRIPTION**	**"ALL"**	
DATA BASE RECORD KEY	RECORD SEQUENCE	X	
	GENERIC PART NUMBER	X	
	GENERIC SERIAL NUMBER (Property; Veh. Ser,; Car No.)	X	
	DATE (DDMMYY)	X 1	
	SUBDATE	X 2	
	FORM CODE	X	
PERFR	Period Reported From Date		
PERTO	Period Reported To Date		
MIPER	Mileage, Period	3	
UMICM	Mileage, Cumulative	X	
OHPER	Operating Hours, Period		
UOHCM	Operating Hours, Cumulative		

NOTES

1. The KEY DATE is the date on which the cumulative mileage was recorded (see note 3).
2. Normally equals "0" (zero). A non-zero value indicates that an additional record(s) having different data, was entered with the same key.
3. Since the "Period" differs at each property, "cumulative" mileage was selected as the utilization indicator and is the basis for all reliability information derived by the TRIP EDB. This field is, therefore, blank in the EDB.

Figure 2.1 – RRV Utilization Record Description

RECORD NAME: SCHEDULED MAINTENANCE			TYPE – FORM – SEQ. 03 – C – 01
DATA NAME	**DATA DESXRIPTION**	**"ALL"**	
DATA BASE RECORD KEY	RECORD SEQUENCE	X	
	GENERIC PART NUMBER	X	
	GENERIC SERIAL NUMBER (Property; Veh. Ser.; Car No.)	X	
	DATE (DDMMYY)	1	
	SUBDATE	2	
	FORM CODE		
MMICM	Cumulative Miles		
MOHCM	Operating Hours		
MRPNO	Report Number		
INDTE	Inspection Date	X	
INTME	Inspection Time		
MNLOC	Maintenance Shop		
INTYP	Inspection Type		
MPRNO	Part Number		
REPNM	Part Name		
MGDCD	Generic Defect Code		
MGRDC	Generic Repair Code		
RELOC	Car Location		
MFDCD	Failure/Defect Code		
MRPCD	Maintenance Repair Code		
MQTYR	Quantity		
METME	Elapsed Time		
MLAHR	Labor Hours		
	NOTE:		
1.	Same as INDTE - ie: The date on which the inspection was performed.		
2.	Normally equal "0" (zero). A non-zero value indicates that an additional record(s) having different data, was entered with the same key.		

Figure 2.2 – RRV Scheduled Maintenance Record Description

RECORD NAME: REPAIR			TYPE – FORM – SEQ. 04 – D – 01
DATA NAME	DATA DESCRIPTION	"ALL"	
DATA BASE RECORD KEY	RECORD SEQUENCE	X	
	GENERIC PART NUMBER		
	GENERIC SERIAL NUMBER (Property; Veh. Ser.; Car No.)	X	
	DATE (DDMMYY)		
	SUBDATE	1	
	FORM CODE	2	
RMICM	Cumulative Mileage		
ROHCM	Cumulative Hours		
RRPNO	Report Number		
MNDTE	Maintenance Date	X	
RMNLC	Maintenance Location		
HRDCD	Hardware - ID		
PRTNO	Part Number	X	
PRTNM	Part Name		
PRTLC	Location on Car		
RGSCD	Generic Symptom Code		
RGDCD	Generic Defect Code		
RGSCD	Generic Repair Code	X	
RGDCD	Generic Test Code		
SYMCD	Symptom Code		
RFDCD	Failure Code		
NTFCD	Apparent Failure		
RMRCD	CRT – ACT (Repair Code)	X	
NORCD	Delay Code		
INSCD	Test Code		
RQTYR	Quanity		
RETME	Elapsed Time		
RLAHR	Labor Hours		

NOTE:

1. Same as MNDTE - ie: The date on which the maintenance was performed.
2. Normally equals "0" (zero). A non-zero value indicates that an additional record(s) having different data, was entered with the same key.

Figure 2.3 – RRV Repair Record Description

RECORD NAME: REPAIR–SERIAL NUMBERS			TYPE – FORM – SEQ. 04 – D – 02
DATA NAME	DATA DESCRIPTION	"ALL"	
	RECORD SEQUENCE GENERIC PART NUMBER GENERIC SERIAL NUMBER (Property; Veh. Ser.; Car No.) DATE (DDMMYY) SUBDATE FORM CODE	X X X X X1 X	
SNREM SNINS REPPC	Serial Number OFF Serial Number ON Replacement Part Condition		
1.	NOTE: Normally equals "0" (zero). A non-zero value indicates that an additional record(s) having different data, was entered with the same key .		

Figure 2.4 – RRV Repair – Serial Numbers Record Description

There are two major divisions in each type of record in the EDB. The first is the Data Base Record Key. The information contained in the key serves primarily as a "label" for the record and defines the data base "address" where the record is stored or filed. The elements of the key can thus be used singly or collectively as selection criteria for extracting groups of or individual records from the data base. The Record Sequence and Form Code are fixed and identify the "type" of the record to the software so that the record can be processed. The Generic Part Number, Generic Serial Number (both described in Section 4.2), Date and Subdate are all derived from the data provided by the transit property.

The other major division of the record contains the individual fields onto which the data is stored. Each field is identified by a Data Name and stores the information identified by the Data Description.

Property-supplied data is identified by an X in the appropriate property column. An X in the "ALL" column indicates that all five RRV TRIP EDB properties (BART, CTA, NYCTA, PATCO, and WMATA) provide data for the field.

2.1.3 - Bus TRIP Generic Assignment Data Characteristics

Bus TRIP generic assignment data consists of information necessary for the uniform identification of bus equipment and maintenance actions. This data is divided into four types, similar to the RRV TRIP: fleet file, generic parts file, generic maintenance codes file, and generic vendor codes file.

The fleet file assigns a bus (model) series code to a given property code and bus number combination. Each record is composed of a property code and bus number from which Bus TRIP assigns a bus (model) series code. This bus series code enables buses to be grouped by bus models both within and across properties.

The generic parts file defines the correspondence between property-specific component numbers and Bus TRIP generic part numbers. Each record in this file is composed of a property code, a bus series code, and a property-specific component number. With these three pieces of information, Bus TRIP assigns a generic part number, enabling the translation of different property component codes to uniform Bus TRIP generic codes.

The generic maintenance codes file assigns a generic code to a property-specific maintenance code, covering four types of codes: defect, repair, symptom, and test. Each record in this file is composed of a property code, a code type indicator, and a property-specific code. With these three pieces of information, Bus TRIP assigns a generic maintenance code, enabling vehicle maintenance actions to be grouped both within and across properties.

The generic vendor codes file, which does not exist in RRV TRIP, assigns a generic vendor code to a property-specific vendor code. Each record in this file is composed of a property code and a property-specific vendor code. From these two codes, Bus TRIP assigns a generic vendor code, enabling the translation of different property vendor codes to uniform Bus TRIP generic codes. This file will be implemented by including vendor information in the consumption, road call, scheduled maintenance, and repair dynamic data (ex. report vendor ID along with a part repair/replacement).

2.2 - SAMPLE FORMS FOR INPUT TO BUS TRIP

There is a wide variety of forms on which the input data will be received from properties. The figures in

Appendix C are examples of hard-copy reference and dyanmic data that would be used for input to a Bus TRIP data bank.

For example, reference data on vehicle specification might be submitted to Bus TRIP in a form similar to Figure C-1. This form contains the information needed to compose the vehicle specification information (see Figure A-5) such as fleet (series) ID, manufacturer, number of buses in the series, dimensions, turning radius, etc. Such a form might also supply reference information on vehicle configuration (see Figure A-6) in the area of system manufacturer, type and capacity (ex. engine system: manufacturer - GM; type - 8V-71N; displacement - 567 cu. in.). Figure C-2 is another example of the forms in which vehicle reference information may be submitted.

Dynamic utilization (mileage) data may be supplied in a form similar to Figure C-3a, b, or in conjunction with dynamic consumption data, as shown in Figure C-4. Utilization and consumption data refer to mileage, fuel used, and oil used, recorded on a regular (usually daily) basis for each bus.

Dynamic road call/incident information may be submitted to Bus TRIP as shown in Figure C-5 or C-6. The information

collected on road calls/incidents will be used to correlate repair rates with road call rates.

Dynamic repair information may be submitted to Bus-TRIP as shown in Figure C-7 or C-8. Figure C-7 represents repair information, i.e. mileage, repair date, parts replaced, etc. as well as labor information concerning labor hours spent on effecting the repair. Figure C-8 represents a repair form that could be used by a property with an automated maintenance information system. The repair is codified and circled by the mechanic. However, with this type of form, other information such as mileage, parts replaced and labor data would have to be supplied on separate form.

SECTION 3 - DEFINITION OF OUTPUT REQUIREMENTS

The primary objective of the Bus TRIP data bank is to provide information on the reliability and utilization of transit buses operated in the United States. This objective will be achieved through the production and distribution of reports that present the operation analysis results and maintenance data that has been collected and stored in the data bank. The reports will present reference information on properties and vehicles as well as dynamic information describing utilization, consumption, inspections, road calls, and repairs.

Several bus properties investigated during Task A generate dynamic data, describing failure analysis, symptom/repair correlation, fuel economy, and parts consumed versus repairs effected (in addition to standard utilization and repair records). Based on this type of data generated by the properties, the reports produced by Bus TRIP will include component and vehicle reliability reports and vendor reliability, as well as periodic consumption (fuel and oil) utilization, inspection, road call, and repair reports.

Proposed report types that will be produced by Bus TRIP include the following.

- Monthly Reports, covering:
  - Utilization by bus, fleet, and property;
  - Inspections and road calls by bus, fleet, property, and system;
  - Consumption by bus, fleet, and property; and,
  - Repair by bus, fleet, property, industry, and system.

- Quarterly Reports, covering:
  - Reliability/maintainability by bus and system.

- Annual Reports covering:
  - Utilization by bus, fleet, property, and industry;
  - Inspections and road calls by bus, fleet, property, industry, and system;
  - Consumption by bus, fleet, property, and industry; and,
  - Repair by bus, fleet, property, industry, and system.

- Reference Information Reports, covering:
  - Bus properties system configuration, route configuration, and route operating information;
  - Vehicle types (bus models); and,
  - Equipment on each vehicle type.

- Special Reports, covering:
  - Vendor reliability by component and vendor;
  - Reliability/maintainability trends by component;
  - Equipment modification/retrofit; and,
  - Miscellaneous (covering analysis not reported routinely).

Examples of the proposed reports are given in Appendix D. These preliminary formats represent proposed outputs generated by the full-scale Bus TRIP data bank based on reference and dynamic input data described in Section 2 and Appendixes A and B that may be submitted to Bus TRIP. These report formats and contents will be modified, based on feedback from Bus TRIP participants. In addition, based on participant feedback, reports may be added or eliminated and their frequency may be changed.

3.1 - ROUTINE REPORTS

3.1.1 - Monthly Routine Reports

Proposed report types to be produced most frequently (monthly) will present summary information covering utilization, consumption, inspections and road calls, and repairs. Each report will cover the summary information by individual bus, fleet, property, and, where appropriate, system or component.

The proposed monthly reports to be produced by the Bus TRIP data bank are described as follows.

Monthly Utilization Report (Figures D-1 through D-3 in Appendix D) will present the cumulative number of miles operated, for the period reported and the preceding period for each bus (Figure C-1), each fleet (Figure C-2), and each property (Figure C-3). This mileage data will be used to determine inspection, road call, repair, and failure rates.

Monthly Consumption Report (Figures D-4 through D-6) will present fuel, oil, coolant, and tires consumption by volume and rate. This consumption data will be presented by bus (Figure C-4), by fleet (Figure C-5), and by property

(Figure C-6). It will be used to highlight potential maintenance problems, as well as to predict future fuel and oil consumption.

Monthly Inspection and Road Call Report (Figures D-7 through D-10) will present the number of inspections, miles per inspection, number of road calls, and miles per road call. The number of inspections will be separated by inspection type. The number of road calls will be separated by systems and number of road calls that caused a vehicle to be out-of-service. This report will identify systems that are generating the greatest number of road calls. The data will be presented by bus (Figure D-7), by fleet (Figure D-8), by property (Figure D-9), and by system (Figure D-10).

Monthly Repair Report (Figure D-11 through D-14) will present the number of repairs, number of preventive maintenance repairs, miles per nonpreventive maintenance repairs, number of part replacements, and miles per replacement. This data will be presented by bus (Figure D-11), by fleet (Figure D-12), by property (Figure D-13), and by system (Figure D-14). The report will be used to determine changes in repair and replacement rates, as well as to forecast future parts inventory and repair rates.

3.1.2 - Quarterly Routine Reports

Proposed report types to be produced quarterly will present summary information covering maintenance actions information by system (Figure D-15) and bus (Figure D-16). These reports will present the number of maintenance actions in the reporting period, mean miles between maintenance actions, maintenance actions/mile and repair times. This information will show reliability indicators for a component/system in revenue service.

3.1.3 - Annual Routine Reports

The annual reports cover the same information presented in the monthly routine reports, but in a graphical manner. These reports present both summary information monthly and for the entire year.

3.2 - REFERENCE INFORMATION REPORTS

To aid in the evaluation and comparison of information that will be presented in the routine monthly, quarterly, and annual reports produced by Bus TRIP, reference information reports will also be produced, presenting the static data stored in the data bank. These reports will

present data concerning the configuration characteristics and operating policies of transit systems and routes, and vehicle descriptions and equipment on vehicles. Reference information reports will be used for the comparison of operating requirements and conditions. They will permit the comparison of the configuration and physical characteristics of specific vehicle and equipment types as they relate to repair rates.

These reports will be produced in total on a one-time basis, since the static data may be collected only once. If updates of the static data are submitted, a reference information report will be produced to reflect the updated information. Additional reports will also be issued when a new property is added to Bus TRIP.

There are several types of reference reports that could be produced. Three of those are described below.

Transit Property Reference Report (Figure D-17) presents information covering system and route configuration and operating characteristics. The proposed content of this report includes total route miles, total fleet, average passenger stop spacing, and operating characteristics including average speed throughout system, trip time, and

passenger utilization. This report will provide summary information that will be used for the comparison of property configuration and will allow comparison of operating demands placed on each vehicle type.

Fleet Reference Report (Figure D-18) presents information concerning the physical and operating characteristic by fleet type. The proposed content of this report includes dimensions and weights; speed, acceleration, and deceleration performance; and, quantity and age of buses by fleet. Information presented in this report will be used to compare vehicle fleets based on their physical and performance characteristics as indicators of operating stress placed on these fleets.

Equipment Reference Report (Figure D-19) will be produced for each "generic" component, major assembly, subsystem, and functional system monitored by the Bus TRIP data bank. This report will describe, by vehicle type on which this equipment is used, information which includes the "generic" configuration of which this equipment is a part, quantity of units and manufacturer part number, physical characteristics, performance ratings, and current cost per unit. Information presented in this report will be used to compare and evaluate the routine reports for equipment

repairs, including physical characteristics as an indicator of reliability-related repair factors; manufacturer's identification information to identify reliability factors with respect to use of identical equipment in different applications (that is, on different vehicle types); and, the relative impact of replacement rates for this equipment based on unit cost.

3.3 - SPECIAL REQUEST REPORTS

In addition to routine and reference information reports, the Bus TRIP data bank will provide a limited number of special reports based on requests for information by Bus TRIP users. These special reports will utilize the full range of static and dynamic data stored in the Data Bank and may present information based on the following procedures for production of these reports:

- Retrieval of data stored in data bank, but not routinely reported (such as equipment modification/retrofit);

- Simultaneous retrieval of both static and dynamic data for presentation in a single report for purposes of comparison and analysis (such as

equipment unscheduled maintenance repair rates versus physical characteristics); and,

- Presentation of routine report information in a different format or covering a different time period.

Also, a property may submit data only for their special request. For example, if a bus property decides to test a different brand oil filter for one month, they may request a special report to be produced, based on detailed data collected during that test period.

Examples of potential special reports are shown in Appendix D. These outputs are described as follows.

Vendor Maintenance Actions Special Report (Figures D-20 and D-21) presents, by component (Figure D-20) and vendor (Figure D-21), reliability factors including mileage, number of maintenance actions, maintenance actions per miles, and mean miles between maintenance action. This data will be used to determine vendor performance and thus, vendor selection and quality. This data also may aid in forecasting inventory levels for specific components.

Maintenance Actions Trends Special Report (Figure D-22) presents, by component, reliability-related rates over a period of years for a component on a specific fleet and property. These trends will indicate a component's reliability over an extended period of time and will aid in the forecast of replacement rates and inventory levels.

Equipment Modification/Retrofit Special Report (Figure D-23) presents, in narrative form, a description of equipment modifications/retrofits on specific fleets or individual buses. Bus TRIP users could use this report to suggest equipment improvements to similar equipment that they operate. This report will be produced manually on the basis of narrative information supplied by the properties.

A number of different special report types may be produced from the static and dynamic data stored in the Bus TRIP data bank. The consideration that will be evaluated with respect to these reports is the cost associated with their production. Each special report, depending on its complexity, will require labor for the set-up of the data retrieval, analysis, and output format of the information and computer resources for the production of the report.

SECTION 4 - BUS TRIP DATA BANK CONFIGURATION

A major design requirement for the development of the RRV TRIP data bank configuration was ease of modification to accommodate data for other vehicle types, such as transit buses. That capability was the basis for the Bus TRIP program and, specifically, Task C: defining the modifications that would be necessary in the RRV TRIP data bank to accommodate buses. It was found that significant modifications to the existing RRV TRIP data bank will be necessary to provide this capability.

4.1 - DATA BANK OBJECTIVES AND FUNCTIONAL REQUIREMENTS

The objectives of the Bus TRIP data bank are essentially the same as those defined for RRV TRIP, as summarized below.

- Consolidate transit industry reliability efforts.
- Provide reliability information in a transit industry context.

- Provide maximum information output while minimizing burden on properties.

- Provide a comprehensive data source for:
  - Equipment reliability comparison,
  - New equipment specifications and procurement,
  - Product improvement programs, and
  - System analysis efforts.

To meet these objectives, the Bus TRIP data bank will include the following functional requirements (categorized in Figure 4.1).

- Data Submission
  - Bus property/data bank interface
  - Data logistics (receiving and shipping)

- Data Preparation and Processing
  - Hard-copy data entry
  - Magnetic tape data extraction
  - Standard data formatting
  - Data cross-referencing
  - Data editing
  - Error correction

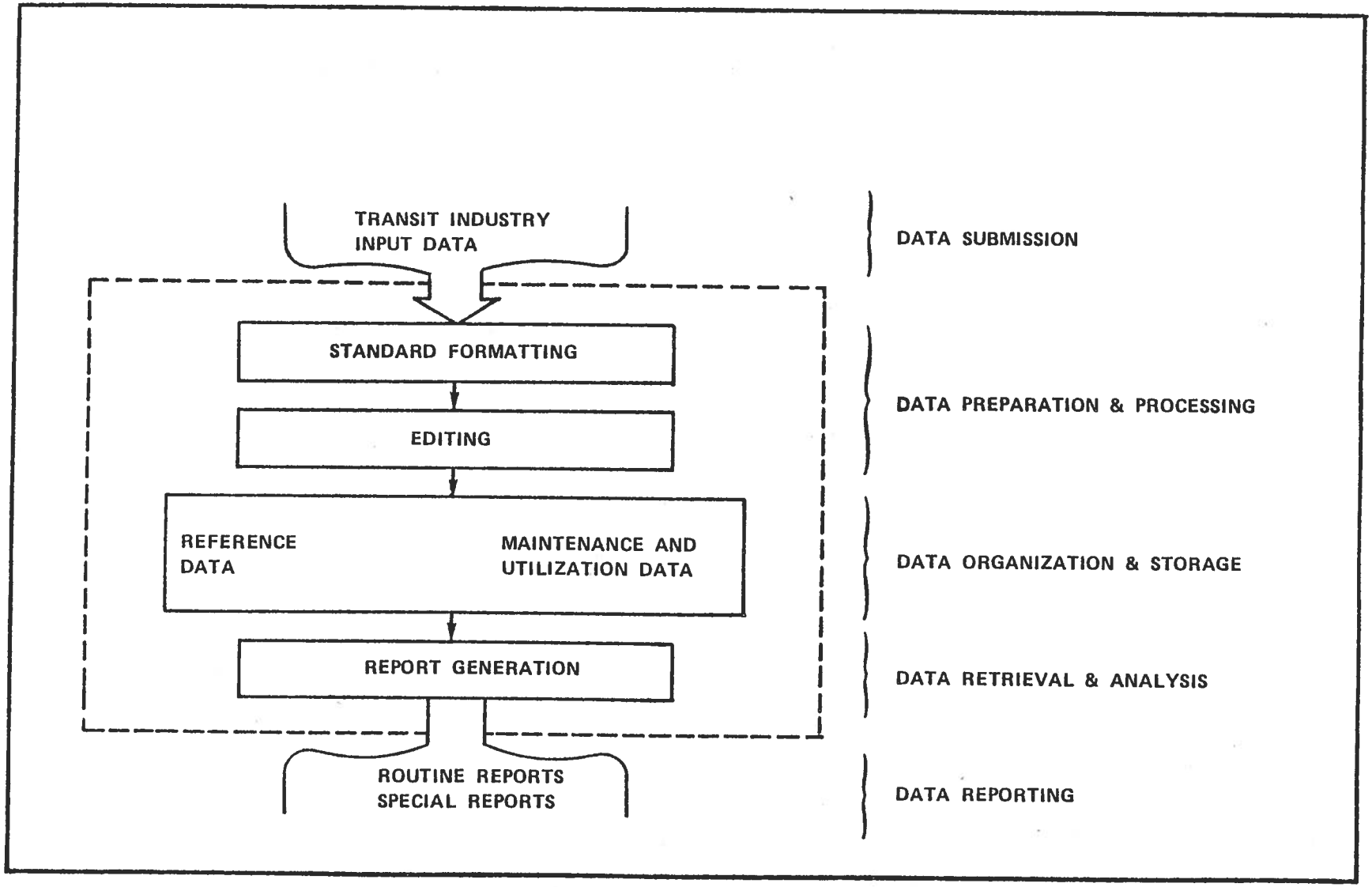


Figure 4.1 - Bus TRIP functional requirements.

- Data Organization and Storage
  - Data Base Update
  - Data Editing
  - Error Correction

- Data Retrieval and Analysis
  - Data Base Access
  - Routine Data Retrieval
  - Routine Data Analysis and report production
  - "Special request" data analysis and report production

- Data Reporting
  - Detailed tabular reports by system, property, and industry
  - Summary graphical and statistical reports
  - Routine reporting at periodic intervals
  - "Special requests", as required

To satisfy these functional requirements, the Bus TRIP data bank design, similar to RRV TRIP data bank, will include the following major functional modules.

- Input Data Processing, including:

  - The translation of data from its as-received format into the data bank input format,
  - The assignment of data bank record label elements to input data groups, and
  - Generation of a historical record of all data received.

- Data Verification, including:
  - Data accuracy following input data preparation and
  - Validity of data elements, both individually and in combination, with respect to pre-defined ranges of values.

- Data Storage, including:
  - Storing all input data by an organizational method permitting efficient retrieval and
  - Providing for the expansion of the volume of data to be stored.

- Output Generation, including:
  - The production of routine periodic reports and
  - The capability to produce special request reports.

4.2 - INPUT DATA PROCESSING

Data collected for input to the Bus TRIP data bank will be received in a variety of forms and on different types of media. The Bus TRIP staff should be able to prepare data received in any form for input to the data bank. Information received as hard-copy records will be converted to a computer-readable format by Bus TRIP software that accepts hard-copy data entered on-line. Data received in computer-readable form will be converted to a computer-readable format compatible with the Bus TRIP computer system.

A specific requirement of the Bus TRIP data bank is the ability to accept dynamic data (utilization, consumption, inspection, road call, and repair information) from each of the bus properties supplying data to the Bus TRIP data bank. Each property will provide data in its own format to minimize the effort required to participate in Bus TRIP.

Following the conversion of data supplied for Bus TRIP input, the "record label" elements will be assigned. These record labels will establish a uniform system of component identification that will be the basis for storing information on these components in a common data base. RRV

TRIP required a coding structure that accommodated all North American rapid rail vehicles. Bus TRIP will require the same type of coding structure to accommodate the majority of transit buses operated in the United States. These codes, called Generic Part Numbers (GPN), are a "standard index" into which component identities are translated, thus providing a uniform part numbering scheme compatible with automatic data processing.

The GPN concept was introduced during the development of RRV TRIP and has proven to be a very efficient method for the classification and identification of components. The GPN provides a uniform system of component identification which can be applied not only to rapid rail vehicles and transit buses, but to other types of transit vehicles such as light rail vehicles and Downtown People Movers. The GPN eventually will have the capability to merge components from various vehicle types into functional categories without sacrificing component identity. Since GPNs will be common to all vehicle types, a Generic Serial Number (GSN) was created during the development of RRV TRIP to differentiate between the GPN lists as they apply to a specific vehicle type. The GSN, which will be used in an identical manner for Bus TRIP, consists of three codes to identify the transit property, vehicle type (bus model), and vehicle number (property bus number).

To utilize the "generic" data base "index" approach, record labels will be assigned to each data record (a group of data describing utilization, consumption, inspections, road calls, and repairs) prior to its entry into the data bank. This record label assignment will be based on translating the data elements within a record to determine the key values that should be assigned.

4.3 - INPUT DATA VERIFICATION

Data prepared for data bank input will require verification for accuracy and validity. This procedure is essential to ensure the uniformity and quality of information stored in the Bus TRIP data bank. The verification procedure is equally important to assure Bus TRIP participants, including bus operators and manufacturers, that a true record of their operation and equipment is being stored in Bus TRIP. This procedure will not differ significantly for buses versus RRV's.

Since the volume of data expected for input to Bus TRIP is large, data verification will be handled by automated procedures to efficiently handle the quantity of data. Data validation will be accomplished through the comparison of input data to pre-determine ranges for each data element.

Input data which falls within these ranges will be accepted for data bank storage. Data which is not accepted will be returned for further action by Bus TRIP personnel. Bus TRIP personnel and participating properties jointly will define the ranges.

Use of ranges of input data will permit the efficient handling of information which changes very little over time. Data rejected after the initial screening and found, after examination, to be correct, will be input directly into the data bank.

Accuracy verification will ensure that the data has been translated correctly during input processing. Verification will be particularly important for data elements used to assign record labels. Accuracy verification will involve the comparison of data ready for data bank input with the same data as it was received from each property.

4.4 - DATA STORAGE

A very important requirement defined during the RRV TRIP data bank development was the organizational scheme for the data contained in the data bank. Through its experience

and success in the RRV TRIP program, this organizational method will be used, with minor modifications, in Bus TRIP. The organization of the data bank will largely effect the operation of the Bus TRIP system, including efficiency of adding and updating information contained in the data bank; expediency of producing routine reports; flexibility of data retrieval to provide special analysis and reports; and, cost of operation.

The requirements for Bus TRIP data bank storage are to:

- Store a large quantity of data in chronological order identified by GPN and GSN;

- Store reference data with recurring dynamic data by using the GPN/GSN approach;

- Maintain back-up storage for data in the data bank; and,

- Develop a data base structure that supports flexible and rapid data retrieval, avoiding the dupliction of data to support differing output requirements.

The data bank storage concept developed for RRV TRIP will be utilized in Bus TRIP, providing flexibility of data retrieval and efficient use of storage space. This "integrated data base" approach includes:

- Storage of all data in one central location, permitting efficient access to any data element or group of elements;

- Entry and storage of each unique data element only once to minimize storage space and entry time; and,

- Organization of all data tapes based on the logical relation of the record labels to maximize retrieval efficiency.

The use of an integrated data base organizational approach for the RRV TRIP Data Bank utilizes the GPN scheme as the primary record label for data identification. Bus TRIP will utilize the same GPN concept, providing efficient data storage based on a single data bank entry of each new data element. This will minimize data storage space. Retrievals and reports could be generated readily based on the organization of the sorted data by GPN, GSN, and date associated with the data.

4.5 - DATA RETRIEVAL AND ANALYSIS

The usefulness of the Bus TRIP data bank will depend, in part, on the promptness and flexibility with which the sorted data can be retrieved. Another very important factor will be the analysis techniques available to study the data.

The use of GPN and GSN as record labels will permit rapid retrieval of data that will be used for the generation of routine and special-request reports. Therefore, the data bank must have the following capabilities:

- Simultaneous retrieval of both static and dynamic data,
- Retrieval of data for special requests,
- Verification of retrieved data prior to report generation, and
- Restoration of older data stored off-line for special requests.

The techniques that will be available to analyze the data will be diverse due to the wide variation in data types. The following types of analysis could be used.

- Standard Statistical Techniques
  - Mean
  - Standard deviation
  - Least squares
  - Variance
  - Correlation
  - Curve-fitting

- Reliability/Maintainability Analysis
  - Failure rates
  - Failure analysis
  - Mean time between failure
  - Operational availability
  - Mean time between maintenance actions
  - Trends analysis

- Vendor Monitoring Analysis
  - Component reliability
  - Failure rates/vendor comparisons
  - Parts availability
  - Performance analysis

4.6 - DATA REPORTING

Reports to be generated by Bus TRIP will be of both routine and special-request types. The functional considerations for Bus TRIP output reporting include the following.

- Routine Reports at Regular Intervals
  - Tabular and graphical summaries of data: system, property, and industry
  - Arithmetic computations: sums, averages, and percentages
  - Statistical calculations: mean, standard deviation, and curve-fitting
  - Plotting: trend graphs, bar charts, histograms

- Special Requests
  - Component/vendor performance
  - Trends analysis
  - Prototype performance analysis
  - Equipment improvements/retrofits

To satisfy these considerations, Bus TRIP must be capable of rapid data retrieval as well as efficient and accurate analyses. Once routine output report formats are

finalized, programs to generate the reports will be standardized and executed at regular intervals. Special reports will be generated upon request.

SECTION 5 - BUS TRIP EXPERIMENTAL DATA BANK (BEDB)

5.1 - BUS TRIP EXPERIMENTAL DATA BANK (BEDB) CONFIGURATION OVERVIEW

The same approach used for the RRV TRIP implementation and operation of a Bus TRIP Experimental Data Bank will be used to develop, refine, and evaluate the operation, uses, benefits, and costs of such a system prior to the establishment of a full-scale data bank.

It is recommended that a BEDB should be implemented separate from the existing RRV TRIP data bank. It would not be advantageous to expand the existing RRV TRIP data bank to include buses due to the major equipment differences, as well as the different storage and reporting requirements. The development and implementation of a separate BEDB would permit on-going refinements without any impact on RRV TRIP operations and storage.

The BEDB will provide a means to evaluate and refine operational requirements and procedures, and to resolve unexpected situations that may be involved in the implementation of a full-scale Bus TRIP system. The following items describe the use of the BEDB:

- Aid in the refinement of data input requirements by collecting and processing sample field operating and maintenance data;

- Aid in the definition of the full-scale operating requirements by evaluating data storage and retrieval methods;

- Aid in the refinement of output requirements by generating reports that will be distributed to Bus TRIP participants for review and comment;

- Provide sample output reports which can be used by Bus TRIP participants for review and comment; and,

- Provide sample output reports which can be used by Bus TRIP participants to evaluate transit bus utilization, consumption, and reliability.

In order to evaluate and refine the design and operations of the full-scale Bus TRIP data bank, the BEDB must meet certain functional and operational requirements as follows.

- Accept transit bus operating, maintenance, and reference data in any form or format (hard-copy or computer-readable).

- Verify the data input by checking the accuracy and validity of the data.

- Provide data organization and storage for approximately 5000 buses, including standard data formatting, data cross-referencing, data editing, and demonstrating the ability to store estimated volume of data.

- Produce routine reports, reference information reports, and special request reports to provide the means for evaluating and refining the output formats and their content, and to provide industry reliability data for the participating bus properties, the federal government, bus manufacturers, and other users.

- Provide the capability of operating strictly according to the procedures and requirements defined for the full-scale Bus TRIP system in order to evaluate the proposed configuration realistically.

Based on the functional and operational requirements of the full-scale Bus TRIP data bank, as well as the RRV TRIP configuration, the BEDB configuration, shown in Figure 5.1, has been developed. In the development of the RRV TRIP EDB, it was proposed that DRC's Technical Integrated Data System (TIDS) be utilized as the EDB's major element. TIDS was augmented with input and output modules specifically tailored to RRV TRIP requirements.

Any data base management system (e.g. TIDS), specifically designed for configuration monitoring could have been used to handle input, storage and output of RRV TRIP data. However, the concept of using TIDS for the RRV TRIP EDB was based on its in-place capabilities, and the expectation of expending a minimum amount of effort and money on developing a data base management system to handle the input, storage, and output of RRV TRIP data. By using TIDS, effort could be expended in the development of RRV TRIP rather than in the development of a data base management system, which is a very lengthy and costly undertaking. By experience in operating the RRV TRIP EDB, TIDS has proven to be very capable of handling RRV TRIP input, storage, and output. Thus, the use of TIDS for the BEDB has been proposed by DRC.

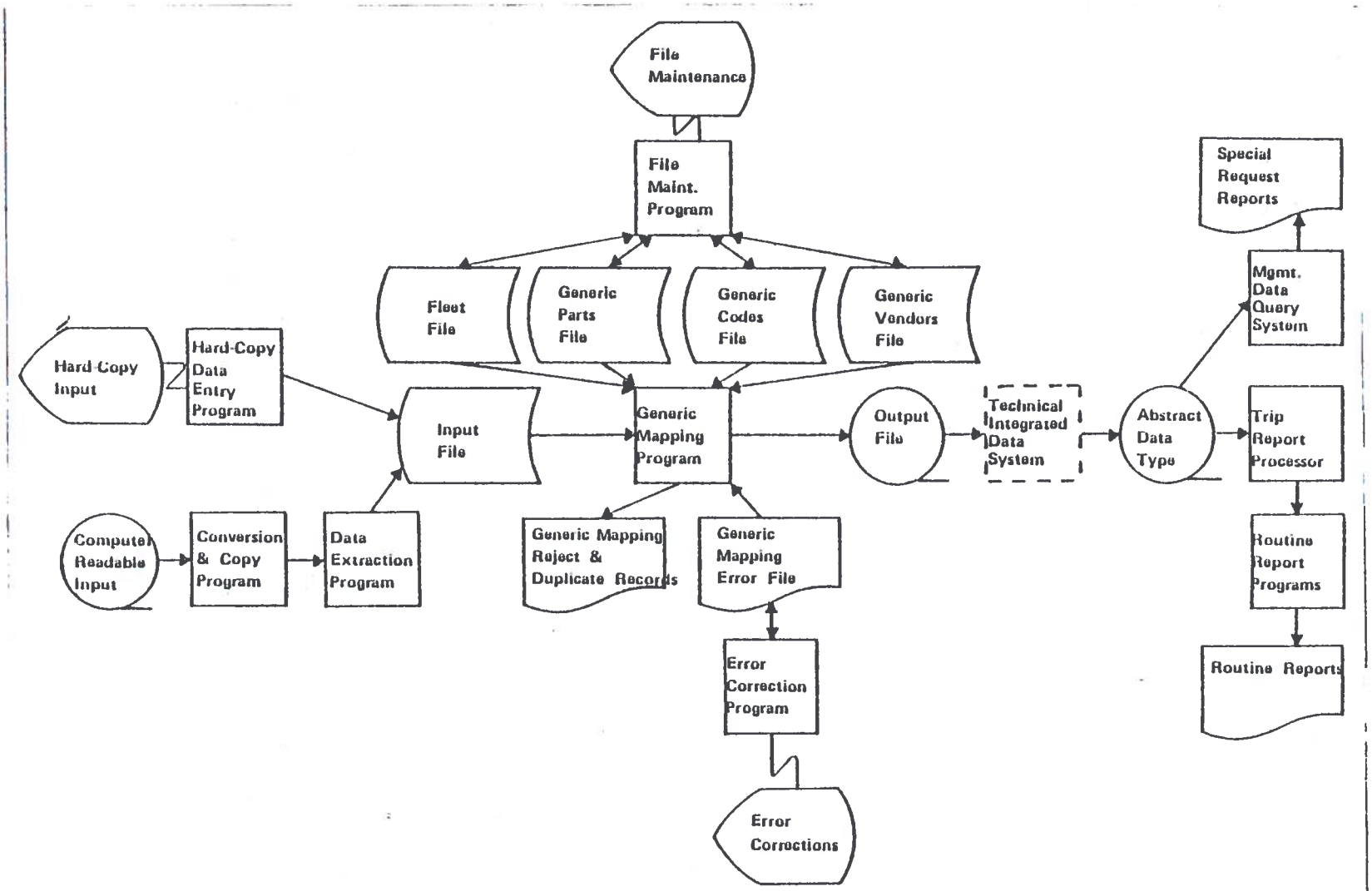


Figure 5.1 - Simplified Bus TRIP EDB system flow diagram.

5.1.1 - TIDS Overview

DRC has developed and is operating its Technical Integrated Data System (TIDS) under contract to the U.S. Government. TIDS utilizes the functional and operational approaches which have been discussed in this section as they pertain to Bus TRIP and its final configuration. The following description of TIDS shows how these requirements have been integrated through the various functional aspects of this operating system.

An overview of the operation of TIDS is shown in Figure 5.2. The four major elements which comprise this system are:

- Data Input

  It may be received from a variety of sources. Data may be in computer input form or may be processed for input by the DRC data processing personnel. Data may also be input from remote terminals at the customer's site. A duplicate record of all data in its "as received" form is made for historical purposes as a first step in data input. The data is then checked for "errors," or inconsistencies, with respect to

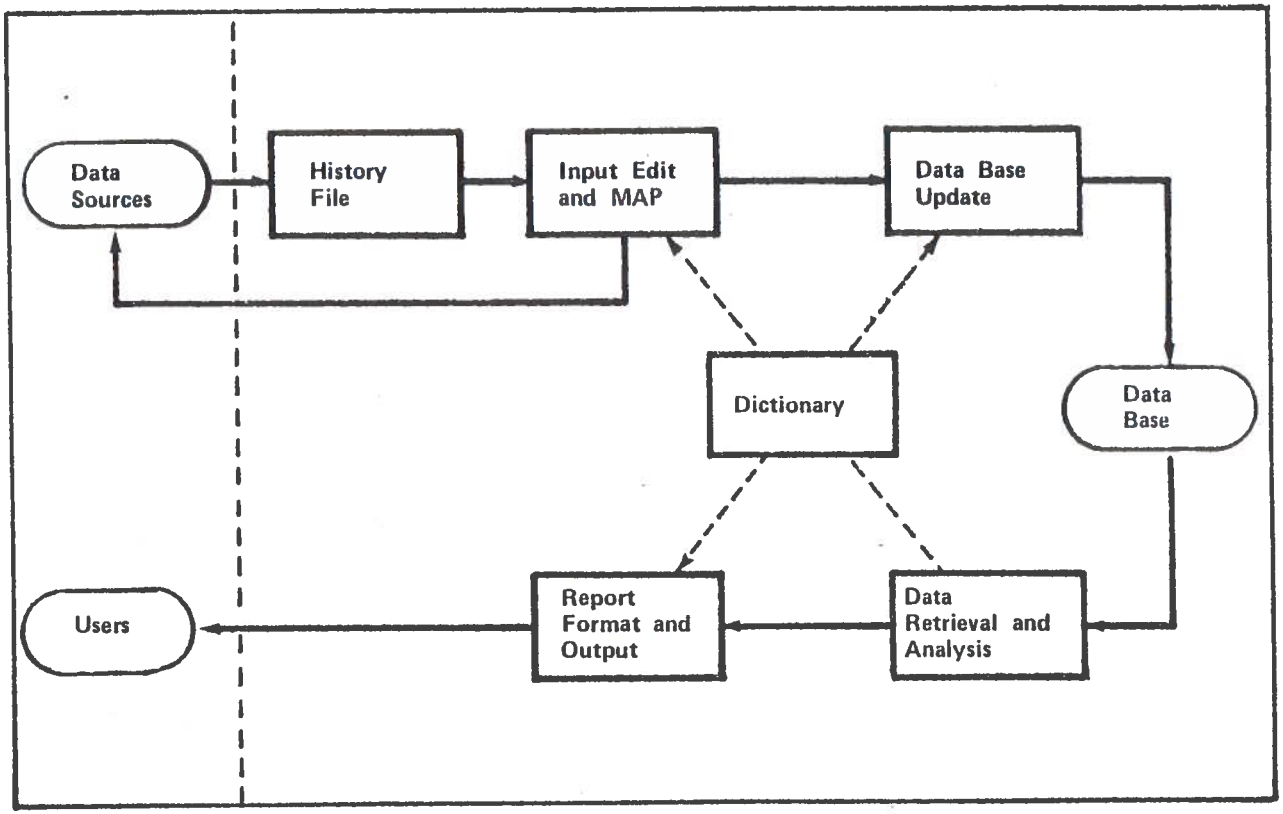


Figure 5.2 - DRC Technical Integrated Data System (TIDS).

predetermined data formats for ranges. Data is then reformatted to conform to the uniform organizational scheme of the data base.

- "Dictionary"

  This provides format instructions for data at all points in the system. This allows data to be received and input in any format by a system user without having to restructure the information. This also assures that data in the data base is identically formatted for ease of retrieval. The "Dictionary" also provides standard report and output formatting.

- Data Base

  The complete collection of all data in the system. This data has been checked for errors and formatted before it is entered into the data base. Data can be added or altered in the data base only by specified personnel. Data may be retrieved on a "read-only" basis.

- Data Output

  It is a flexible process for reporting and/or analyzing any or all of the data in the

system. Standard reports of selected data may be produced periodically. Comparisons can be made of any data type to any other type. Programs are also available for analytical evaluation of the data. Outputs may be transmitted to remote terminals automatically at preselected intervals.

TIDS is currently being successfully employed for the operation of the RRV TRIP EDB and for the operation of a large hardware-related data system, both including the storage and manipulation of large quantities of data. TIDS is capable of expansion as the quantity of data to be stored increases, and is designed for rapid and flexible retrieval of data.

The data bank configuration, which is selected for either the experimental or full-scale Bus TRIP system will utilize many, if not all, of the functional concepts of TIDS. DRC proposes, therefore, the use of TIDS as a data base management system for the BEDB and will evaluate TIDS as a candidate system for the full-scale Bus TRIP Data Bank configuration. The potential benefits that will accrue using this approach are:

- Use of a system currently used for the operation of the RRV TRIP EDB in the areas of data input storage and output;

- Use of a system already designed and developed for another U.S. Government program and currently used for multi-access and batch processing of reliability, configuration, and logistics data for a large hardware system;

- Capability of the system to provide expanded storage based on increasing qualities of input data and equipment to be tracked; and,

- Capability of the system to accept a wide variety of input data forms and formats, and provide flexible data retrieval and reporting.

5.1.2 - Bus TRIP Software

To implement TIDS for the BEDB, additional functional modules were required to address the specific input, storage, and output requirements of RRV TRIP. Bus TRIP will utilize the same functional modules which are divided into two general categories, as follows.

- Bus-specific modules will be developed to interface with TIDS to:
  - Process transit bus operating, maintenance, and reference data for input to TIDS; and
  - General routine and special reports based on data which is stored on the TIDS integrated data base.

- Modules developed for use by the existing TIDS software to:
  - Verify input data,
  - Input data to the TIDS data base, and
  - Retrieve data from TIDS.

RRV TRIP-specific software modules that have been developed to interface with TIDS will be used and augmented as needed. These modules include the following.

- Input Data Processing, including:
  - Conversion of hard-copy input data into computer- readable format;
  - Conversion of computer-readable input data into the format of the host computer;
  - Extraction and reformatting of all input data in computer-readable format into BEDB record formats;

- Assignment of standard record labels and generic codes to provide uniform data storage format, including Generic Part Numbers (GPN), Generic Serial Numbers (GSN), Generic Maintenance Codes, and Generic Vendor Codes;
- Verification of processed input data for accuracy; and,
- Maintenance of tables and files used for generic label and code assignment.

- Output Generation, including:
  - Reordering and reformatting of data retrieved from the TIDS data base;
  - Automated analysis of retrieved data to produce output reports;
  - Production of routine and reference information reports; and,
  - Production of special-request reports.

TIDS-related software modules that have been developed for use by the existing TIDS operating software include the following.

- Data Verification, including:
  - Validity of data prepared for TIDS input by comparison with data element acceptable ranges and
  - Verification of non-duplication of TIDS data base entry.

- Data Base Storage, including:
  - Description of data base record formats (Data Dictionary);
  - Description of data base input formats; and,
  - Description of data base record label elements.

- Data Retrieval, including:
  - Description of data base retrieval record formats; and
  - Description of retrieval record and element combinations.

The description of the application of TIDS to the BEDB together with development of additional software specifically oriented to the input and output of transit bus data, will be detailed in the following sections.

5.2 - DATA SUBMISSION

Data submission to Bus TRIP by bus properties will follow several functional and operational requirements. The functional requirements involve two major areas: one dealing with the bus property/data bank interface and the other dealing with the logistics of sending/receiving the data.

The bus property/data bank interface should include a contact person at each participating property that would be available to answer inquiries from data bank personnel concerning data collection and submission. The logistics of sending/receiving the data will include the interface between the contact person and data bank to confirm sending/receipt of data, as well as the operating requirements of data submission monitoring, data cataloging, and data transcription.

RRV TRIP operations are based on monthly receipt of utilization, inspection, and repair data. Bus TRIP should operate in the same manner--monthly receipt of utilization, consumption, trouble call, inspection, and repair information from participating bus properties. Monthly submission will provide a sufficient time period for

cataloging, transcribing, and entering data, whether it be hard-copy or computer-readable.

5.3 - INPUT DATA PREPARATION AND PROCESSING

The functional software modules that were developed for the RRV TRIP EDB will be utilized with modifications for the BEDB for input data conversion, formatting, and standardization. These modules include:

- Software and procedures to translate input data from hard-copy forms to a computer-readable format,
- Procedures and utility software to translate diversified computer-generated input data into a common host computer-readable format,
- Software to organize and reformat input data to common data types,
- Software to standardize data types into functional hardware categories by assigning "generic record labels" and "generic codes",

- Software and procedures to perform extensive input data verification, and

- Software and procedures to provide data security by using back-up, off-line storage techniques.

5.3.1 - Hard-Copy Data Preparation and Entry

Several of the bus properties that will participate in the BEDB program will submit data to the BEDB operations staff in their own hard-copy input forms (for examples, see Section 2.2). The data elements contained in this input data (covering static and dynamic data types: utilization, consumption, inspection, road call, repair information, etc.) will be converted to a computer-readable format by Bus TRIP software that accepts hard-copy input data entered on-line through a video display terminal (VDT). RRV TRIP EDB employs this arrangement for entering hard-copy data and the BEDB will employ this software with modifications to accommodate bus-related data types and elements.

The VDT terminal system provides the following capabilities:

- Menu-like selection of any screen formats into which bus property reference and dynamic data may be entered on-line into the BEDB,

- Data editing and error correction before data is entered into the BEDB, and

- Automatic generation of a specific record type as dictated by a screen format that is selected from the menu.

An example of a screen format that would be displayed on the VDT is shown in Figure 5.3. The data elements, indicated by underscoring, will be entered into the VDT "form" directly from the hard-copy form submitted by the bus property. The software in this VDT system has the capability to:

- Automatically enter data elements into the data record,

- Automatically translate data elements into codes, and

- Test for:
  - Valid alphanumeric characters based on the data type,
  - Valid data present in "required" data fields,
  - Right-justified and zero-filled numeric fields,
  - Valid property IDs,
  - Valid date fields (month $\leq$ 12, days $\leq$ 31, year $\leq$ current year),
  - Valid time fields (hours $\leq$ 24, minutes $\leq$ 59), and
  - Valid part numbers.

BUS TRIP EXPERIMENTAL DATA BANK

DYNAMIC REPAIR DATA

RECORD TYPE 04 FORM 0 SEQ 01

PROPERTY ID_____ BUS NO._____REPORT NUMBER

SYMPTOM CODE_____ DATE REPORT__/__/__ DELAY CODE_____

HDW-ID_____ PART NO._____

FAIL CODE_____ CRT-ACT____ TEST____ ELAP_____

Figure 5.3 - Sample VDT screen format.

After all tests are performed on the data, any errors that have been found during this process are listed. Then the user can correct the errors or discard the information completely. After the corrections are made and no subsequent errors are detected, the software sends the data to the appropriate file for data reformatting.

5.3.2 - Computer-Readable Input Data Translation and Extraction

If input data is provided in a computer-readable format, it will be translated into the host computer's format and the appropriate data types will be extracted. Since magnetic tapes may be generated by computers different from the host computer, they must be translated into a host computer-readable format. This translation will be accomplished using existing utility software that converts one type of computer-generated data into the format used by the BEDB computer.

Once this conversion is completed, the necessary input data elements will be extracted per each property's pre-defined record layout and rearranged into the Bus TRIP data types (utilization, consumption, inspection, road call, repair, etc.). In order to develop the software necessary

to extract the desired data elements, each property will provide a detailed description of the formats in which the data has been recorded.

In order to provide both data security and accountability, a permanent, magnetic tape copy will be made of data at several points in the input process, as follows.

- Magnetic tapes of input data supplied by bus properties will be retained in permanent storage following conversion into the host computer-readable format.

- Permanent copies will be made of reformatted data prepared from either magnetic tape or hard-copy input data after this data has been assigned record labels.

- Permanent copies of all data which is entered into the Bus TRIP data bank will be made, including a "log" of the date and content of each group of data bank data records.

5.3.3 - Data Reformatting and Cross-Referencing

After the input data has been converted to the host computer-readable formats from either property-supplied hard-copy or magnetic tape, the data will be reformatted into a standard (or generic) form. This standard formatting involves the assignment of a GPN and GSN to each property-specific data record.

The GPN is a code which classifies a component by the function it provides, the location of the component and the classification of the component by type. RRV TRIP has employed the GPN structure as shown in Figure 5.4. Bus TRIP will utilize a modified GPN due to the nature of differences between RRVs and buses. From experience in developing the Transit Vehicle Equipment Lists in RRV TRIP and the BREL, as part of Bus TRIP Task B, it has been found that the level of detail originally specified in the GPN is not necessary due to two factors. One factor deals with the inability of most transit property maintenance information systems to handle such a detailed part numbering approach. The second factor is the tremendous amount of effort and time that must be devoted in order to develop a reliability equipment list using such a detailed part numbering approach. For these reasons, Bus TRIP will use a similar, but improved GPN

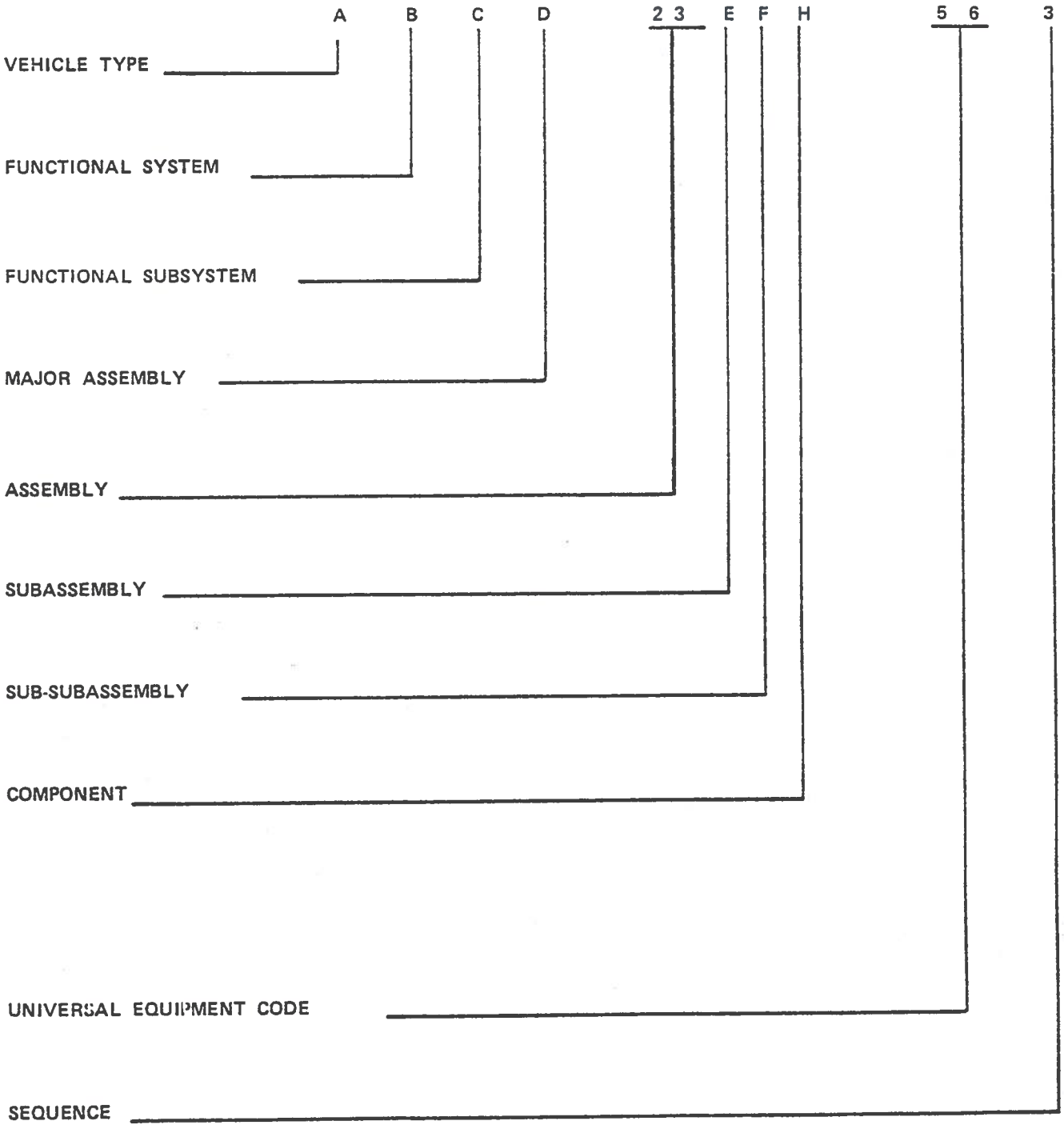


Figure 5.4 - Generic part number.

approach designed to accommodate the most extensive BREL (i.e., articulated buses). The exact structure of the Bus TRIP GPN will be developed during Bus TRIP Task B - Establish Bus Reliability Equipment Lists.

The GSN is a code consisting of the transit property ID, the bus model designation, and the bus number. Bus TRIP will utilize the same GSN approach as that used in RRV TRIP. Whereas a GPN alone identifies a component by standard attributes, the GPN in combination with a GSN identifies a specific component used on a specific bus. The GPN and GSN are the first two elements of the data record label.

Figure 5.5 illustrates the process of assigning a GPN and GSN to a data record and the reformatting of certain data elements to form the data record label. This process is accomplished through the use of the fleet file (described in Section 2.1.3) and the BREL which is being developed as part of Bus TRIP Task B. The fleet file is a listing of valid bus numbers for a given property ID and bus model designation.

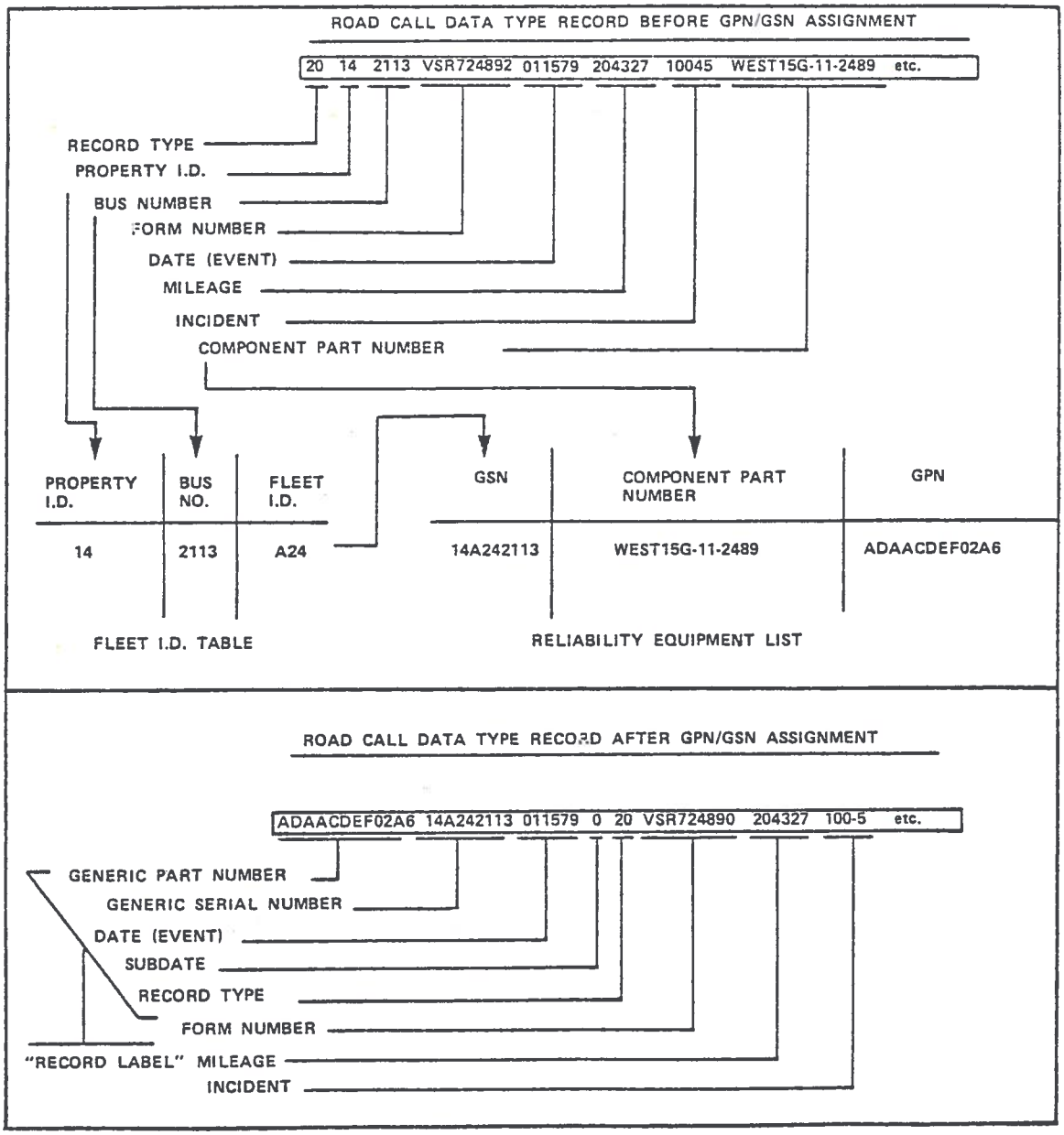


Figure 5.5 - Road call data type record before and after GPN and GSN assignment.

The BREL, which will be described in the Task B Report, is a listing of GPNs and corresponding property and manufacturer part numbers of the components on a specific bus model that will be monitored by the Bus TRIP data bank. The BREL for a specific bus model is identified by a GSN.

The entire record label consists of:

- Generic Part Number,
- Generic Serial Number,
- Date,
- Subdate (used only if there are two or more records with the same GPN, GSN, and date), and
- Record Type.

The process of developing the record label for dynamic data is summarized in the following steps.

- The "Record Type" field is checked to determine the type of record being processed and, therefore, the format of the data contained in the record.

- The "Property ID" field is encoded.

- The encoded "Property ID" is combined with the "Bus Number" field to search the Fleet File for "Fleet ID".

- The three data elements above are combined to form the "Generic Serial Number".

- The encoded "Property ID" and "Fleet ID" are combined with the "Part Number" field to search the Generic Parts List File for the "Generic Part Number" which is also part of the data record label.

- The encoded "Property ID" is combined with the property-specific symptom code, defect code, repair code, and test fields to search the Generic Maintenance Codes File for the "Generic Maintenance Codes" respectively.

- The encoded "Property ID" is combined with the property-specific vendor code to search the Generic Vendor Codes File for the "Generic Vendor Code".

The subdate element of the record label is set to zero unless there are two or more records with the same GPN, GSN, and Date. Should this occur, the subdate element would be incremented to account for multiple records.

The entire record label provides a unique description of the data record and, as such, is the mechanism by which the various records are integrated into a common data base. The individual elements of the record label can be used independently or in combination to support efficient data access, retrieval, and the basis for analysis.

If no errors are detected during this process of assigning the record label elements, the data record is successfully reformatted into the Bus Data Bank format. Any incorrect combination of Property ID, Bus Number, and Component Part Number will result in a "not found" situation against the Fleet File and/or BREL, and an error message will be generated. Translation of the property-specific maintenance codes into the Bus TRIP generic codes cannot be accomplished until the record label assignment process has been completed.

Several types of error conditions and associated corrective procedures that could result from attempted GPN and GSN assignment are shown in Figure 5.6.

Different property codes describing maintenance activities will be assigned a generic code representing the same activity. This assignment will be done using a similar technique described for GPN assignment. For example, a typical symptom might be "doors will not open." At Seattle METRO, the code for this symptom might be 0711; at CTA, the code might be 063; and at RIPTA, the code might be 152. These codes will be cross-referenced to a single Bus TRIP generic code (e.g., 5102). The generic codes will become the basis for data retrieval, output generation, and technical analysis.

Those data types that cannot be assigned record labels and/or generic codes will be corrected and resubmitted for Bus data bank reformatting. All data types that were assigned record labels and generic codes are, at this point in the procedure, ready for the data editing/verification procedures in the operation of the BEDB.

ERROR CONDITION	MEANING	CORRECTIVE ACTION
PROPERTY/CAR NOT FOUND	The input car number is not in the fleet file for the given input property; i.e., taken together, property/car is an invalid combination.	A. Check the input data for incorrect car number. B. Check the fleet files; it may need to be updated.
PROPERTY NOT IN FLEET FILE	This property has not been defined with fleets in the fleet file. (At present, the properties on file with fleets are: PATCO, BART, CTA, GCRTA, NYCTA, WMATA.	Update the fleet file with fleet/ car information for this property.
GENERIC PART NOT FOUND	The component number for the given property, car (= fleet) does not exist in the GPL file.	A. Check the input data for property; car (= fleet), component number correctness. B. Check the GPL; it may need to be updated.
PROPERTY/FLEET NOT FOUND	The input fleet-id is invalid for this property. (Applies to reference data only.)	A. Check the input data for incorrect fleet-id. B. Check the fleet file; it may need to be updated.
FAILURE CODE NOT FOUND REPAIR CODE NOT FOUND	The given property/local-code combination does not exist in the standard codes file.	A. Check the input data code(s) for correctness. B. Check the standard codes files; it may need to be updated.

Figure 5.6 - Error conditions resulting from attempted GPN/GSN assignment.

5.3.4 - Data Editing and Error Correction

Data editing and verification will be performed on all data that has been processed for entry into the Bus data bank as in the RRV TRIP data bank. This verification will insure that accurate and valid data is being stored in the Bus data bank. The BEDB, as in RRV TRIP, will utilize the Data Dictionary module of TIDS to provide this editing function. The Data Dictionary is the master format or description file for data being input, stored, or retrieved from the data base. To provide this master format control capability, the Data Dictionary contains the following.

- Complete description of all data base record types, including:
  - Data elements in each record type,
  - Sequence of data elements in each record type, and
  - Field length of all data elements.

- Complete listing of all valid GPNs monitored in the data bank (that is, Master Reliability Equipment List).

- Data element editing information, including:
  - List of elements which require tolerance or range, checking of their contents, and
  - Tolerance ranges for data elements which require this checking procedure.

Error checking should place in two modules in the BEDB similar to the RRV TRIP EDB. The first editing module determines if the data input format is recognized by the Data Dictionary. Recognition is based on the presence of a description of the input data format in the Dictionary and also upon the verification of the GPNs that is being monitored. This module also has the ability to screen numeric data through the use of tolerance checking. The data is checked for numerical content and is validated against tolerance limits initially specified. Tolerance validation is not required for all data items, but it can be specified as necessary for any numeric data item being processed without any changes to the system software.

The second editing module updates the data in the Bus TRIP data bank. Once the input data has been validated for correct format and tolerance ranges, the record label elements (GPN, GSN, Date, Subdate, Record Type) are compared to data already stored in the data base in order to duplicate entries.

Data that does not pass the editing criteria will be corrected by Bus TRIP data bank personnel, with possible assistance from the property supplying the data. Only those data elements that are in error will be included in the error correction process. This procedure minimizes processing costs by resubmitting, through the editing procedures, only those data elements that did not pass the editing criteria.

When property assistance is required for error correction, and depending on the volume of corrections that have to be made, new data to correct these errors will either be solicited by phone (for a small quantity of errors), or by a hard-copy listing (for larger quantities of errors) that will be sent to the property for resolution. All error listings sent to properties for error resolution will be monitored so there will not be a backlog of uncorrected data for processing into the data bank.

5.4 - DATA STORAGE

Through the use of TIDS, the BEDB can be defined as an integrated data based on the following characteristics.

- All data will be stored in one central location allowing easy access to any data item.

- The data base consists of data logically related by GPN and in chronological order to permit rapid and efficient reporting.
- Reference and dynamic data can be stored by GPN in order to organize data related to the same equipment.

These storage characteristics were defined in the RRV TRIP EDB configuration and have proven to be an important objective in the operation of the RRV TRIP EDB. The centralized storage of data permits the efficient retrieval and analysis of different data types. For example, since reference and dynamic data are stored by GPN, reference data could be analyzed on the basis of dynamic data parameters such as fleet mileage or fuel consumed.

The BEDB, similar to the RRV TRIP EDB, will be arranged in chronological order by GPN and GSN. This logical arrangement of the data provides a "filing cabinet" of data with a "folder" for each unique part. All "folders" are in order by part numbers and of each part, all occurrences are grouped together. The data in the "folder" is in

chronological order by most recent to oldest occurrence for each serial number to facilitate quick access to more recent data. For example, all air conditioners that failed or required routine maintenance during a given month would be stored together, with the most recent failures/repairs accessed first.

Each unique data type is identified and stored in the data bank using a record label, permitting direct access and retrieval of each data type. This "indexed sequential" organization allows random access to the specific data items desired without having to read all the sorted data to locate that data item. This direct access capability is provided by the Data Dictionary which describes the type, content, and relationship of all the data stored in the data bank.

Along with the organization of data storage, the capability of data editing/update must be provided. Updating can be easily accomplished since the description of the format and content of the stored data is contained in the Data Dictionary. The Dictionary is flexible and permits the addition, deletion, or modification of data formats by non-programming personnel. Therefore, the data bank operators can change input, storage, and retrieval requirements without modifying the system software.

In order to provide the Data Dictionary with update capability, a separate module was developed for the RRV TRIP data bank. A similar module will be utilized for the Bus TRIP data bank and it includes the following features:

- Update of Data Dictionary entries (add/delete/modify) including record types, content descriptions, and tolerance values, and

- Output reporting of Data Dictionary content and modifications.

5.4.1 - Equipment Identification Requirements

Even though Bus TRIP will be utilizing the same storage method as used in RRV TRIP, the following areas in regard to specific equipment identification should be covered:

- Quantity of bus equipment to be monitored,

- Number of equipment categories, and

- Differences in general equipment types between buses and rapid rail vehicles.

As described in the Task A Report - DRC # E-5455U, Bus TRIP will monitor five transit bus types, as listed on the following page.

- Advanced Design Buses
  - General Motors
  - Grumman Flxible

- New-Look Conventional Buses
  - General Motors
  - Grumman Flxible

- Articulated Buses
  - AMG/MAN

These five types will be monitored in operation at five or six properties that will be recommended for participation in a Bus TRIP EDB. (Initially, Chicago, Detroit (SEMTA), Houston, Los Angeles, Providence, and Seattle have been recommended.) The number of buses that will be monitored at the recommended properties totals approximately 5000-7000. An estimate of the number of records that will be stored in the data bank based on 7000 buses is given in Section 6.1.

The specific equipment that will be monitored on those five bus types will be determined as part of Bus TRIP Task B. The monitored equipment will be chosen from the following list of equipment categories. (It is anticipated that 3 systems will be monitored, initially, by the BEDB.)

1. Doors and Door Controls
2. Air Comfort System
3. Communications Equipment
4. Electrical System
5. Engine System
6. Brake System
7. Automatic Vehicle Monitoring
8. Suspension, Steering, and Tires
9. Drive Train
10. Fuel Supply System
11. Body and Structures
12. Safety Equipment
13. Fare Collection

The differences in general equipment types between buses and rapid rail vehicles is shown in Figure 5.7. The bus and RRV functional systems are similar with the exception of safety equipment and fare collection.

Bus	Rapid Rail Vehicle
Vehicle	Vehicle
Doors and door controls	Doors and door controls
Air comfort system	Air comfort system
Communications equipment	Communications equipment
Electrical system	Auxiliary electrical
system	
Engine system	Propulsion system
Brake system	Friction brake system
Automatic vehicle monitoring	ATO/ATC
Suspension, steering, and tires	Truck and suspension
Drive train	Couplers and draft gear
Fuel supply system	Power collection equipment
Body & structures	Car body and structures
Safety equipment	
Fare collection	

Figure 5.7 - Bus and RRV equipment categories.

5.5 - DATA RETRIEVAL AND ANALYSIS

The data base can be accessed by specifying the record label. For example, if Chicago wishes to know the number of repairs that were done on its fleet of GMC T8H-603 for front axles during June 1980, as well as the amount of fuel consumed by that fleet, the following information must be specified.

- Two RECORD TYPES will be needed:
  - Unscheduled maintenance records and
  - Consumption records to determine the amount of fuel.

- The DATE for these RECORD TYPES, which must fall in the range of 6/1/80 through 6/30/80.

- The GENERIC SERIAL NUMBER containing:
  - The Property ID for Chicago and
  - The Fleet ID for the GMC T8H-603.

- The GENERIC PART NUMBER for front axles.

Once this data is selected from the data bank, it will be sorted on RECORD TYPE to separate the unscheduled maintenance records from the consumption records. After the

sort is completed, a count of the repairs recorded on the unscheduled maintenance will yield the number of repairs on front axles. By summing the fuel figures contained in the consumption records, the total amount of fuel for the fleet of GMC T8H-603 is determined.

The types of analysis that can be done on the retrieved data are varied due to the diversification of the data types that are being stored. This analysis falls into, but is not limited to, the following categories.

- Standard Statistical Techniques
  - Mean
  - Standard Deviation
  - Least Squares
  - Variance
  - Correlation
  - Curve-Fitting

- Reliability/Maintainability Analysis
  - Failure Rates
  - Failure Analysis
  - Mean Time Between Failure
  - Operational Availability
  - Mean Time Between Maintenance Actions
  - Trends Analysis

- Vendor Monitoring Analysis
  - Component Reliability
  - Failure Rates/Vendor
  - Parts Availability
  - Performance Analysis
  - Equipment Improvement/Retrofit Analysis

5.6 - DATA REPORTING

The generation of both routine and special output reports, as in RRV TRIP, will be performed as shown in Figure 5.8. Routine reports will be issued at intervals, the frequency of which will be determined at the beginning of BEDB operation. These periodic reports will be generated on a scheduled basis by the computer operations staff within the Bus TRIP data bank facility. The computer operations staff will execute scheduled report programs, and submit the reports to the Bus TRIP data bank personnel for review, including valid data content and valid analysis. Following this review, these reports will be distributed to Bus TRIP users.

Special requests will be submitted to the Bus TRIP Data Bank personnel. Report formats and algorithms will be

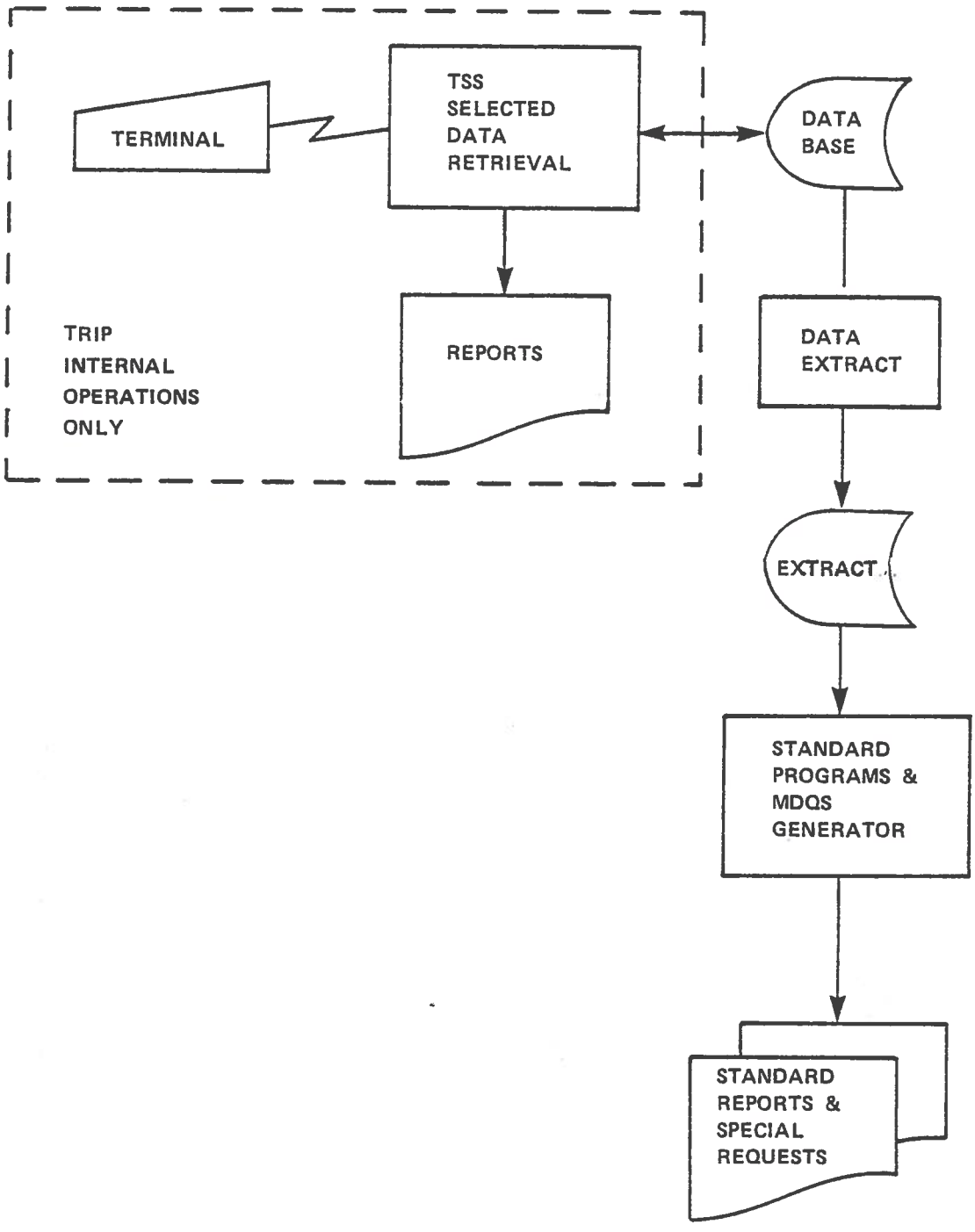


Figure 5.8 - EDB output generation.

developed to support these requests along with projected completion dates for report production to satisfy the requests.

Similar to RRV TRIP in supporting output generation requirements that should occur during the operation of the BEDB, a Management Data Query System (MDQS) will be utilized for rapid response to output requirements. MDQS is a Honeywell input/output system that will provide report generating flexibility for the Bus TRIP data bank with little or no new development effort.

MDQS will be utilized during the initial operation of the BEDB for generating both routine and special reports. The use of such an input/output system will permit rapid and efficient modification of the format and content of all report types without requiring extensive software reprogramming.

When routine report formats are finalized, MDQS generation procedures will be converted to standard output generation programs. While MDQS provides maximum flexibility for output reporting, its generalized nature makes it less cost-effective than standard programs for repetitive production of the same report type.

The use of MDQS will provide the Bus TRIP data bank staff with the following capabilities:

- Development of new formats without requiring the development of major software modules;
- Ability to manipulate retrieved data, including totaling and subtotaling criteria;
- Specification of retrieval selection criteria; and,
- Application of new algorithms to satisfy new requests for reliability analyses.

5.7 - BEDB INITIALIZATION

Following the development of the additional software modules that will be added to TIDS for buses rather than RRVs, the data bank will be initialized with data, including format descriptions, editing criteria, and output generation procedures required for BEDB operation.

5.7.1 - Input Data Processing

All the necessary files - Fleet File, Generic Parts File, Generic Maintenance Codes File, and Generic Vendor Codes File - used for the assignment of the "record label" elements must be established. In the case of the Fleet File, all bus numbers chosen for the BEDB, the fleet that they belong to, and the property ID will have to be entered into the file. In the case of the Generic Parts File, the parts list for the components chosen to be monitored by the BEDB have to be assigned a GPN and along with a property ID and fleet ID have to be entered into the file. The Generic Maintenance Codes File will contain all property-specific maintenance codes (for symptom, defect, repair, and test) and their associated standard Bus TRIP code. The Generic Vendor Codes File will contain all property-specific vendor codes and their associated standard Bus TRIP code.

5.7.2 - Data Editing/Storage

As previously described, the "controller" of the editing and storage functions will be the Data Dictionary module of the TIDS software to be used by the BEDB (see Figure 5.1). The types of data necessary for the Data Dictionary will be:

- The Master Reliability Equipment List (all GPNs to be monitored);

- A complete description of data types (dynamic data types, including utilization, consumption, inspection, road call, and repair; and reference data types) and their data elements; and,

- All the data items to be checked for tolerance ranges and the tolerance ranges for each element.

5.7.3 - Report Generation

Based upon the preliminary output requirements definition, together with those types of data that will be collected for the BEDB, preliminary report generation procedures will be developed using MDQS for the inital reports to be generated by the BEDB. These procedures will be submitted for review by the recipients of the reports. These reporting procedures will reflect recommendations made prior to the first production of reports from the BEDB.

5.7.4 - Data Processing Equipment

If the BEDB is implemented at DRC, the in-house computer system will be used (see Figure 5.9). This system

consists of a Honeywell 66/20 central processor and a wide variety of peripheral equipment. This system provides both batch and time-sharing capabilities.

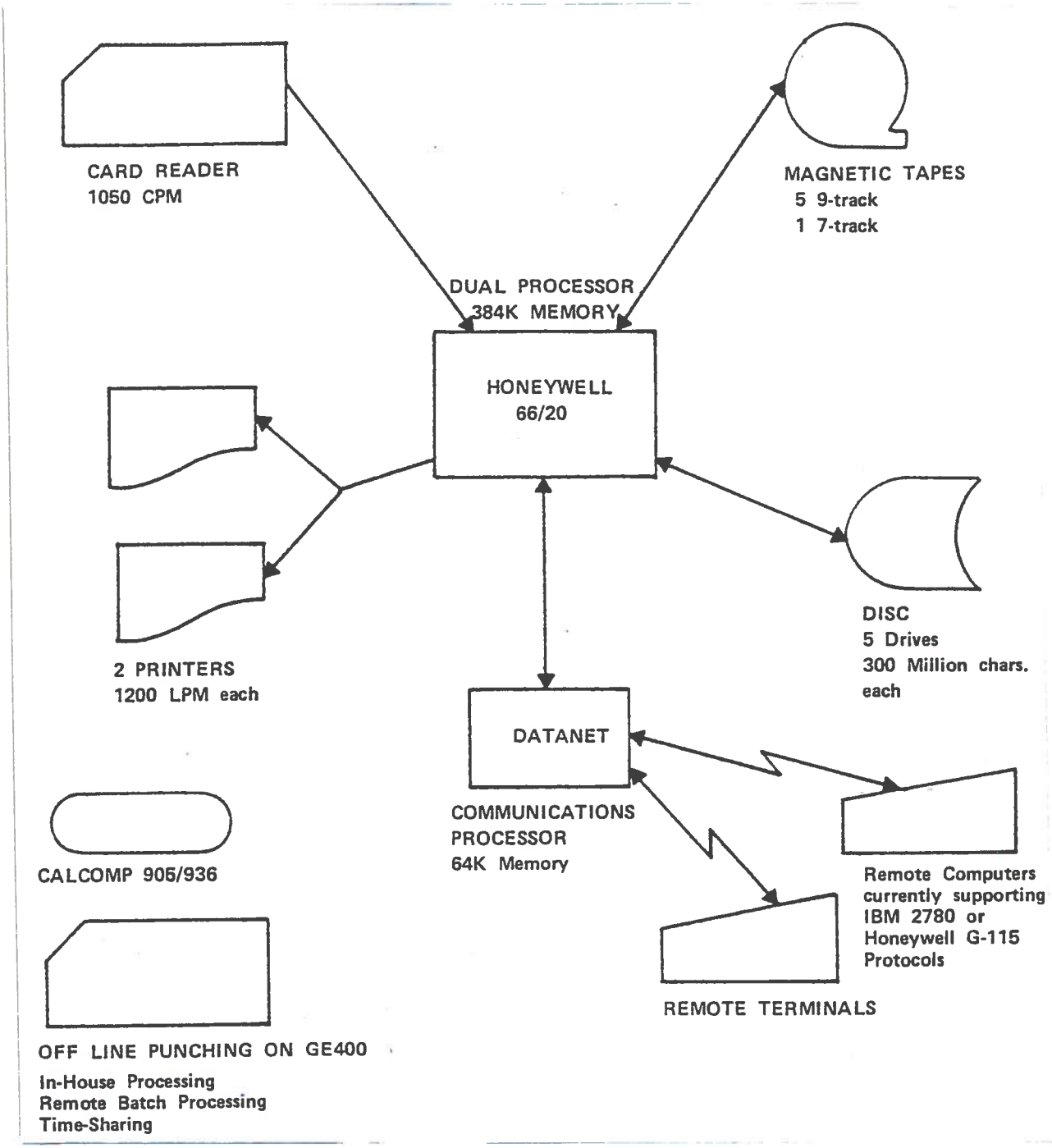


Figure 5.9 - H-66/20 computer facility.

SECTION 6 - DATA BANK OPERATION

The operating requirements of a full-scale Bus TRIP Data Bank will be determined by the services that Bus TRIP will provide to bus properties. The production of the data bank will involve:

- Processing and storage of bus reliability performance data,
- Utilization of analytic techniques to interpret this data, and
- Issuing routine and special reports describing the reliability performance of the monitored equipment.

The quantity and media of input data, along with the level of detail and frequency of the output reports (hard-copy or computer-readable form) will determine the following factors of Bus TRIP operations:

- Data bank size,
- Operating cost factors,
- Data bank staffing, and
- Data bank sponsorship.

The following sections of this chapter consider each of these factors separately.

6.1 - PROJECTED DATA BANK SIZE

The size of the Bus TRIP data bank depends upon two factors. The first factor is the number of buses that will be monitored by Bus TRIP. The second factor deals with the type of analyses that will be performed by Bus TRIP (see Section 5.5 for proposed types of data analyses). The following two estimates of data bank size are based on these two factors. (Due to the evolution of the Bus TRIP program, it is not expected that the whole industry - 965 bus properties - would eventually be participants in Bus TRIP. Therefore, the following estimates do not include a data bank size based on all transit buses in the United States).

COLLECT AND STORE DATA FROM THE 10 PROPERTIES VISITED DURING TASK A

This estimate is based on the ADBs, NLCs, and ARTICs operating at the following properties that were visited in Task A.

1. Atlanta, GA (MARTA)
2. Baltimore, MD (MTA)
3. Chicago, IL (CTA)
4. Columbus, OH (COTA)
5. Detroit, MI (SEMTA)
6. Houston, TX (METRO)
7. Los Angeles, CA (SCRTD)
8. Providence, RI (RIPTA)
9. San Antonio, TX (VIA)
10. Seattle, WA (METRO)

Assuming that bus data (for all systems on a bus) is produced at the rate of 0.33 records/bus/day (with a record being one of the following: utilization, consumption, inspection, road call, or repair record) and using the total of 11,210 buses (only ADB, NLC, and ARTIC) among the 10 properties, the data bank should be capable of storing:

0.33 record/bus/day x 11,210 buses x 365 days/year ≈ 1,350,000 records/year.

COLLECT AND STORE DATA FROM THE SIX INITIAL CANDIDATE PROPERTIES

This estimate is based on the ADBs, NLCs, and ARTICs operating at the six properties recommended for participation in Bus TRIP.

Assuming again that bus data is produced at the rate of 0.33 records/bus/day, and using the total of 7,000 buses

(only ADB, NLC, and ARTIC) among the six properties, the data bank should be capable of storing:

0.33 record/bus/day x 7,000 buses x 365 days/year ≈ 843,000 records/year.

6.2 - PROJECTED OPERATING COST FACTORS

Cost estimates will be separated into three categories:

- Data input,
- Data storage, and
- Data output.

6.2.1 - Data Input

Cost estimates for data input are separated into labor costs for hard-copy input preparation and entry; and computer charges for computer-readable input entry and extraction. Each estimate will be based on both 10 and six properties. (These estimates are based on the experience of the RRV TRIP EDB.)

HARD-COPY INPUT PREPARATION AND ENTRY

These estimates are based on labor-hours necessary to prepare and enter hard-copy input data. Assuming that 120 hours/month/5000 records are consumed in this activity, and the burdened labor-rate is $20/hour:

$$\text{10 properties: } \frac{\text{120 hours}}{\text{5000 records}} \times \text{1,350,000 records/year} \times \$20/\text{hour} \approx \$648{,}000/\text{year}.$$

$$\text{6 properties: } \frac{\text{120 hours}}{\text{5000 records}} \times \text{843,000 records/year} \times \$20/\text{hour} \approx \$405{,}000/\text{year}.$$

COMPUTER-READABLE INPUT ENTRY AND EXTRACTION

These estimates are based on the computer cost of entering and extracting computer-readable input data (there is practically no labor time involved in this activity). Assuming that it costs $50/10,000 records/month for entry and extraction:

$$\text{10 properties: } \frac{\$50/10{,}000 \text{ records}}{\text{1 month}} \times \text{12 months} \times \text{1,350,000 records/year} \approx \$81{,}000/\text{year}.$$

$$\text{6 properties: } \frac{\$50/10{,}000 \text{ records}}{\text{1 month}} \times \text{12 months} \times \text{843,000 records/year} \approx \$51{,}000/\text{year}.$$

6.2.2 - Data Storage

These estimates are based on the cost of storing the data. Assuming that it costs $.000065/character/month and there are approximately 85 characters/record:

10 properties: $.000065/character/month x 12 months x 85 char/record x 1,340,000 records/year ≈ $90,000/year.

6 properties: $.000065/character/month x 12 months x 85 char/record x 843,000 records/year ≈ $56,000/year.

6.2.3 - Data Output

At this point in time, it is not possible to estimate the costs associated with output reports. This is due to the fact that once Bus TRIP begins operation, the output reports will be constantly reformatted until the reports are finalized for routine production. The experience with RRV TRIP EDB output reporting has shown that once routine reports are finalized, their production costs will be minimal. However, as long as the reports are being reformatted and refined, each new report must be treated as a special-request report, thus requiring additional clerical and engineering personnel to generate such reports. This mode of operation-constant reformatting and refining-is very costly.

6.3 - DATA BANK STAFFING

The staffing requirements to operate the data bank is proportional to the quantity of records to be input and output. Through the property investigation (Task A), it was learned that approximately 30 percent of the bus data collected nationally is processed by automated means. This percentage is compared with the 70 percent of the RRV data collected that is processed by automated means. Therefore, the input data for Bus TRIP will be largely hard-copy, thus requiring a larger number of personnel than was estimated for RRV TRIP. Also, a larger quantity of data will be handled by Bus TRIP than is to be handled by RRV TRIP.

Based on these factors, the staffing requirements for Bus TRIP should be as shown in Figure 6.1.

Thus, due to the large quantity of hard-copy input, there will be a significant number of data-entry personnel required for the operation of Bus TRIP.

No. Buses Monitored	Manager	Engineer	Programmer	Data Entry	Output Generation	System Operation	Total
3000 (initial year)	1	1-1/2	1	4	1-1/2	1	10
5000	1	1-1/2	1/2	6	1-1/2	1	11.50
7000 (6 properties)	1	1-1/2	1/2	8	2	1-1/2	14.50
11,000 (10 properties)	1	2	1/2	12	3	2	20.50

Figure 6.1 - Staffing requirements for Bus TRIP (number of people by category).

6.4 - DATA BANK SPONSORSHIP

Sponsorship of the long-term Bus TRIP data bank will involve the support of the various aspects of its operation, including:

- Supply of data to the data bank,
- Data bank operation, and
- Output report generation, including:
  - Routine reports and
  - Special Reports.

Implicit sponsorship of Bus TRIP will be provided by organizations supplying data to the data bank. The cost of collecting, duplicating, and transmitting static and dynamic data to TRIP by transit properties will provide both the basis for operating the data bank, and the "front-end" support for this operation. If other groups begin to participate in Bus TRIP, such as equipment manufacturers, they will implicitly add program sponsorship through their supplying of data.

Because of the national nature of Bus TRIP, it seems appropriate that the U.S. Government should provide the major sponsorship for the operation of the Data Bank. The

Bus TRIP effort has addressed a much wider scope than that which could, or would, be supported by any single data source. In addition, through TRIP, the government can provide a valuable "tool" to be used by the transit industry to assist in a self-improvement effort to enhance equipment reliability.

The production of outputs and reports is an area which may be sponsored by both the U.S. Government and users of the Bus TRIP data bank. It is anticipated that the generation of routine reports will be included by the sponsorship, by the government, or the operation of the data bank itself. The generation of special reports, however, may require the evaluation of a possible user charge, depending on the complexity and cost of these special investigations. While many special reports will undoubtedly be of a straight-forward nature, and therefore involve no such charge, extensive analyses of large quantities of data for the production of a special report will require not only significant labor but also computer resources. The cost support for these larger reports could, potentially, be provided by the requesting user.

SECTION 7 - DATA BANK BENEFITS

While the costs of Bus TRIP can be estimated based on EDB operation, the benefits to be gained from Bus TRIP will be realized over long periods of time. The benefits of Bus TRIP application to specification development and product improvement programs may be determined only after data concerning the performance of new bus equipment is received after introduction into revenue service.

The benefits of the use and application of Bus TRIP will be realized in each area supported by the system. Bus TRIP may be utilized to aid in specification development and procurement of new buses by providing realistic reliability statistics on existing bus equipment. The reliability statics may be in the form of simple reliability indicators, such as repair actions/mile, or more specific figures, such as mean miles between failures or failures/mile. By having reliable statistics prior to acquisition, new equipment can be integrated into the maintenance process more quickly and replacement parts inventory can be based on past experience.

Another benefit of Bus TRIP will be to provide information on second-source vendor performance. This

reliability information may aid bus properties in selecting parts vendors by describing past reliability and quality of parts from specific vendors. The long-term implications of monitoring vendor reliability will be reduced maintenance costs as well as improved overall reliability.

Bus TRIP will provide maintenance procedures information as well as information on equipment modifications or retrofits in the industry. Thus, Bus TRIP will be a forum for the transfer of information from bus property to bus property. If property 001 has designed a new brake lining that has proven to have a longer life than the original linings on a specific bus model, property 002, which operates the same equipment, may wish to contact property 001 about using its newly developed brake lining.

Besides identifying the major equipment reliability problems, Bus TRIP will have the capability to identify subtle equipment problems as well. In total, Bus TRIP will provide useful support for transit bus properties to review the equipment reliability experience of other operators using similar or identical vehicles. Also, Bus TRIP will provide potentially valuable support for smaller properties

that do not have the resources to provide engineering services but could use Bus TRIP for reliability assessment through the availability both of routine and special-request report types.

The costs of the Bus TRIP system, which are defined in relation to the benefits derived from the program, will include:

- Data generation,
- Data submission,
- Data processing,
- Data reporting, and
- Special requests.

Data generation costs will be determined by examining the labor required by each data source to provide input data for Bus TRIP and the associated labor cost for this effort, yielding a cost per item or per data collection period. Data collection costs will be readily calculated based on the form in which data is generated and the cost to transfer this data to the Bus TRIP processing facility, including shipping or electronic transmission. Data processing costs will be determined based on the form in which data is received (e.g., hard-copy, computer- readable) and its

quantity. Costs will be calculated for input and storage per datum. Data reporting expense will be readily calculated from the costs of computer operation, required labor, and material required to produce each type of output. Costing for special requests will be developed on a case-by-case basis and will include computer, data processing, and technical labor costs. A complete record of the cost of each and every special request will be kept and can be used as a reference for cost estimations of new requests.

SECTION 8 - CONCLUSIONS

The objectives of Task C were to define the final configuration of the Bus TRIP data bank and to insure the compatibility between the Bus TRIP and RRV TRIP. The results from the definition of the Bus TRIP data bank configuration have lead to the following conclusions.

- The major differences between Bus TRIP and RRV TRIP include:
  - Larger quantity of hard-copy input data for Bus TRIP
  - Additional dynamic data types: consumables and road calls
  - Vendor monitoring through dynamic data types

- The large volume of hard-copy input data will make the input process more difficult and costly than has been experienced in the RRV TRIP EDB. This large quantity of hard-copy input data will require additional data entry personnel, as well as additional time to prepare, verify, and enter this data.

- The larger number of dynamic data types will require larger storage space in the computer. Currently, RRV TRIP EDB dynamic data types include utilization, scheduled maintenance (inspection), and repair. Bus TRIP dynamic data types will include utilization, consumption, inspection, road call, and repair information.

- The addition of the generic vendor codes file will add to the cost and processing time of Bus TRIP in two areas: assignment of generic vendor codes to property-specific vendor codes; and maintenance of the generic vendor codes file.

- Due to the great variability of the dynamic data coming from the properties, a larger amount of time must be spent in data preparation, verification, and entry.

- Monitoring the reliability performance of replacement equipment supplied by second-source vendors, in addition to Original Equipment Manufacturer (OEM), will add significantly to the usefulness of Bus TRIP.

- The operation of Bus TRIP must be flexible to consider the following.
  - The data input subsystem should readily accommodate new input formats: magnetic tape, hard-copy.
  - The Bus TRIP dictionary (that is, GPN, GSN, Generic Maintenance Codes, Generic Vendor Codes) should be easily modified to include:
    - Continuous addition,
    - Infrequent modification, and
    - Periodic deletion
  - Routine reports should be modified easily.
  - Special reports should be easily implemented by the operator.

- At present, a BEDB could not be implemented without modification to the existing RRV TRIP EDB software due to the following factors:
  - Differences in reference data formats,
  - Differences in dynamic data types and formats,
  - Differences in internal data characteristics,
  - Different GPN approach,
  - Different equipment types, and
  - Different output reports.

SECTION 9 - RECOMMENDATIONS

Based on the conclusions presented in the previous chapter, the following recommendations are given.

- A Bus TRIP EDB should be implemented separate from the RRV TRIP EDB, because of the following reasons.
  - The operation of the Bus EDB can be developed and refined without impact on RRV TRIP.
  - Significant modifications would have to be made to the existing RRV TRIP software due to the differences in equipment, input data, data storage methods and data report generation.

- The specific make-up of the GPN will be changed to more closely coincide with bus equipment. While the same GPN approach developed for RRV TRIP will be used for Bus TRIP, this revised approach, defined in Task B, will provide a more efficient scheme for data identification.

- The large quantity of anticipated hard-copy input data that will be submitted to Bus TRIP, requires a systematic approach to input data logging.

- The data submitted to Bus TRIP should be continuously monitored through all stages of input to output in terms of standard statistics and reliability/maintainability factors. This will require access to the data base by engineering personnel to perform these analyses just after input, prior to storage in standard formats, prior to output, and after output.

LIST OF REFERENCES

1. DRC Report No. E-4894U - Transit Reliability Information Program (TRIP); Task 2 Draft Report, January 18, 1979.

2. DRC Report No. E-5234U - Transit Reliability Information Program (TRIP); Preliminary Experimental Data Bank Program Maintenance Manual, October 19, 1979.

3. DRC Report No. E-5235U - Transit Reliability Information Program (TRIP); Draft Experimental Data Bank User's Manual, October 19, 1979.

4. DRC Report No. E-5361U - Transit Reliability Information Program (TRIP); Generic Maintenance Action Codes, February 5, 1980.

5. DRC Report No. E-5418U - Presentation Materials for the Critical Design Review of the Transit Reliability Information Program (TRIP), March 31, 1980.

6. DRC Report No. E-5455U - Develop the Ground Work and Prepare the Back-Up Information Necessary for the Establishment of a Bus-TRIP Data Bank; Task A Draft Report, April 11, 1980.

7. DRC Report No. E-5564U - Transit Reliability Information Program (TRIP) Experimental Data Bank (EDB) Special Report No. 3, July 18, 1980.

8. Contract Award, No. DTRS-57-80-C-00007, Develop the Ground Work and Prepare the Back-Up Information necessary for the Establishment of a Bus-TRIP Data Bank, issued by DOT/TSC, December 12, 1979.

APPENDIX A

REFERENCE DATA FORMATS

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	
System Miles: Total	N	3	MI
Street Construction:			
Percent on Collector Street	N	2	PERCENT
Percent on Arterial Street	N	2	PERCENT
Percent on Freeway	N	2	PERCENT
Stops: Number	N	3	STOPS
: Average Spacing	N	5	FT
Passenger Volume: Average	N	6	PAX/HR
: Base	N	6	PAX/HR
: Peak	N	6	PAX/HR
Buses: Total	N	4	VEH
: Available for Service, Daily	N	4	VEH/DAY
: Required for Service, Daily	N	4	VEH/DAY

Figure A-1 Reference data transit property system configuration.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	
Route ID	A/N	4	
Route Miles, Total	N	2	MI
Stops : Number	N	2	STOPS
: Average Spacing	N	5	FT
: Minimum Spacing	N	4	FT
: Maximum Spacing	N	5	FT
Grades : Percent of Route	N	2	PERCENT
: Maximum Uphill Grade	N	3	% GRADE
: Maximum Downhill Grade	N	3	% GRADE

Figure A-2 Reference data transit property route configuration.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	
Route ID	A/N	4	
Speed : Scheduled	N	2	MI/HR
: Average	N	2	MI/HR
Headway: Minimum	N	3	SEC
: Maximum	N	3	SEC
Dwell, Station: Maximum	N	3	SEC
: Minimum	N	3	SEC
: Average	N	2	SEC
Scheduled Runs: Number, Buses	N	3	BUSES
Load Factor : Base, Actual	N	3	
: Peak, Actual	N	3	
: Maximum	N	3	

Figure A-3 Reference data transit property route operating information.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	
Fleet ID	A/N	4	
Total Number of Buses	N	3	BUSES
Bus Numbers: Low	N	5	BUS NO.
: High	N	5	BUS NO.
: Increment	N	1	-
Bus Manufacturer	A	16	
First Year in Service	N	4	YEAR
Scheduled Maintenance, Routine : Mileage Interval	N	5	MI
: Time Interval	N	2	WEEKS
, Major : Mileage Interval	N	5	MI
: Time Interval	N	2	WEEKS

Figure A-4 Reference data transit vehicle fleet information.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	
Fleet ID	A/N	4	
Number of Buses	N	3	BUSES
Bus Manufacturer	A	16	
Dimensions: Length	N	4	FT
: Width	N	4	FT
: Height	N	4	FT
: Wheelbase	N	4	FT
Turning Radius : Wheels	N	3	FT
: Body Corner	N	4	FT
Speed : Maximum	N	2	MI/HR
: Maximum Operating	N	2	MI/HR
Acceleration : Nominal	N	3	MI/HR/SEC
: Maximum	N	3	MI/HR/SEC
: Minimum	N	3	MI/HR/SEC
Deceleration : Minimum	N	3	MI/HR/SEC
: Maximum	N	3	MI/HR/SEC
: Nominal	N	3	MI/HR/SEC
: Emergency	N	3	MI/HR/SEC
Jerk Rate, Nominal	N	3	$MI/HR/SEC^2$
Weight : Empty	N	5	LB
: Seated Load	N	5	LB
: Normal Standing Load	N	6	LB
: Crush Load	N	6	LB

Figure A-5 Reference data transit vehicle specification information.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	-
Fleet ID	A/N	4	-
Subfleet ID	A	1	-
Number of Buses	N	3	BUSES
Bus Manufacturer	A	16	-
Doors: Front; Manufacturer	A	16	-
: Rear; Manufacturer	A	16	-
Air Comfort; Heating;			
: : Manufacturer	A	16	
: Ventilation: No. of Blowers	N	1	BLOWERS
: : Manufacturer	A	16	
: : Capacity, Total	N	3	CFM
: : Fresh Air Make-Up	N	2	%
: Air Conditioning : Capacity	N	2	TONS
: : Manufacturer	A	16	
Electrical : Generator : Type	A	4	-
: : Cold Output	N	3	AMPS
: : Cold Output	N	3	VOLTS
: Starter : Type	A	4	
: : No-Load Voltage	N	2	VOLTS
: : Manufacturer	A	16	
Engine : Model	N	6	
: Displacement	N	3	CU. IN.
: Manufacturer	A	16	
Brakes: Front : Type	A	12	
: : Manufacturer	A	16	
: Rear: Type	A	12	
: : Manufacturer	A	16	
Suspension, Steering, Tires:			
Front Axle, Type	A	12	
Manufacturer	A	16	
Rear Axle, Type	A	12	
Differential Lubricant Capacity	N	2	PINTS
Manufacturer	A	16	
Steering Gear Transfer Box. Type	A	12	
Manufacturer	A	16	
Power Steering Gear, Type	A	12	
Manufacturer	A	16	
Wheels, Type	A	8	
Manufacturer	A	16	
Tires, Type	A	8	
Manufacturer	A	16	
Transmission : Type	A	12	
: Manufacturer	A	16	
: Driveshaft Type	A	12	
: Manufacturer	A	16	

Figure A-6 Reference data transit vehicle configuration information.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Fuel Supply : Tank, Capacity	N	3	GALLONS
: Fuel Filter, Primary, Type	A	12	
: , Manufacturer	A	16	
: , Secondary, Type	A	12	
: , Manufacturer	A	16	

Figure A-6 Reference data transit vehicle configuration information (concluded).

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	
Fleet ID	A/N	4	
Part Nomenclature	A/N	40	
Manufacturer	A	16	
Manufacturer's Part Number	A/N	24	
Property Number : Part	A/N	16	
: Stock	A/N	16	
: MIS Code	A/N	16	
Quantity in Service	N	6	PARTS
Failure Rate : Nom. Spec.	N	6	MMBF
: Last Reported	N	6	MMBF
Next Higher Assy. P/N	A/N	24	
Cost Per Part: OEM	N	5	$
: Latest	N	5	$
Physical Characteristics: L x W x H	N	12	IN
: Weight	N	5	LB
Performance: Capacity/Rating, Nominal & Units	A/N	10	
: Capacity/Rating, Overload & Units	A/N	10	
Number in Service	N	6	PARTS

Figure A-7 Reference data hardware specification information.

APPENDIX B

DYNAMIC DATA FORMATS

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	-
Fleet ID	A/N	4	-
Bus Number	N	5	
Date, Reporting	N	6	MO/DY/YR
Period Reported: From (Date)	N	6	MO/DY/YR
: To (Date)	N	6	MO/DY/YR
Mileage: Period	N	6	MI
: Cumulative	N	7	MI
Operating Hours[1] : Period	N	4	HR'S
: Cumulative	N	5	HR'S

[1]If Mileage not Required.

Figure B-1 Dynamic data transit vehicle utilization.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	-
Fleet ID	A/N	4	-
Bus Number	N	5	
Date, Reporting	N	6	MO/DY/YR
Period Reported: From	N	6	MO/DY/YR
: To	N	6	MO/DY/YR
Fuel Consumed	N	6	GALLONS
Vendor	A	5	-
Oil Consumed	N	4	QTS
Vendor	A	5	-
Coolant Consumed	N	4	GALLONS
Vendor	A	5	-
Tires	N	2	TIRES
Vendor	A	5	-

Figure B-2 Dynamic data transit vehicle consumption information.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	-
Fleet ID	A/N	4	-
Bus Number	N	5	-
Date, Report	N	6	MO/DY/YR
Mileage, Cumulative	N	7	MI
Operating Hours, Cumulative[1]	N	6	HR'S
Report Number, Reference	A/N	8	-
Road Call/Incident: Date	N	6	MO/DY/YR
: Time	N	4	HR/MIN
When Discovered	A/N	2	(CODE)
Where Discovered	A/N	8	-
Trouble Symptom	A/N	4	(CODE)
Consequence to Vehicle or Coach	A/N	2	(CODE)
Related Report Number	A/N	8	-
Affected Hardware	A/N	8	(CODE)
Incident Narrative	A/N	120	-

[1] If Mileage not Reported.

Figure B-3 Dynamic data transit vehicle road call/incident information.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	-
Fleet ID	A/N	4	-
Bus Number	N	5	-
Date, Report	N	6	MO/DY/YR
Mileage, Cumulative	N	7	MI
Operating Hours, Cumulative[1]	N	6	HR'S
Report Number, Reference	A/N	8	-
Inspection: Date	N	6	MO/DY/YR
: Time	N	4	HR/MIN
: Maintenance Shop	A/N	4	(CODE)
Inspection Type	A/N	4	(CODE)
"Expendable" Supplies	-	-	-
Part: Number	A/N	16	-
: Name	A/N	24	-
: Vendor	A	16	-
Location on Car	A/N	8	-
Quantity	N	2	-
Unit of Measure	A	4	-
Repairs	-	-	-
Part: Number	A/N	16	-
: Name	A/N	24	-
: Vendor	A	16	-
Location on Car	A/N	8	-
Failure/Defect Code	A/N	4	(CODE)
Maint./Repair Code	A/N	4	(CODE)
Quantity Replaced	N	2	
Elapsed Time	N	5	HR'S
Labor Hours	N	5	LBR HR'S

[1] If Mileage Not Reported.

Figure B-4 Dynamic data transit vehicle scheduled maintenance information.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	-
Fleet ID	A/N	4	-
Bus Number	N	5	-
Date, Report	N	6	MO/DY/YR
Mileage, Cumulative	N	7	MI
Operating Hours, Cumulative[1]	N	6	HR'S
Report Number, Reference	A/N	8	-
Maintenance : Date	N	6	MO/DY/YR
: Location (Shop)	A/N	4	(CODE)
Part: Number	A/N	16	-
: Name	A/N	24	-
: Vendor	A	16	-
: Location on Car	A/N	8	-
Failure/Defect Code	A/N	4	(CODE)
Primary/Secondary Failure Code	A/N	1	(CODE)
Maint./Repair Code	A/N	4	(CODE)
Serial Number: Removed	N	16	-
: Replaced	N	2	-
Quantity Replaced	N	2	-
Replacement Part Condition (New/Used/Second)	A	1	(N/U/R)
Inspection Code	A/N	4	(CODE)
Elapsed Time	N	5	HR'S
Labor Hours	N	5	LBR HRS

[1]If Mileage not Reported.

Figure B-5 Dynamic data transit vehicle repair information.

DATA ELEMENT	DATA TYPE	FIELD LENGTH	UNITS
Transit Property ID	A	2	-
Fleet ID	A/N	4	-
Bus Number, Removed From	N	5	-
Date, Report	N	6	MO/DY/YR
Report Number, Reference	A/N	8	-
Part (Repaired): Number	A/N	16	-
: Name	A/N	24	-
: Vendor	A	16	-
: Location on Car	A/N	8	-
: Serial No.	A/N	16	-
Maintenance : Date	N	6	MO/DY/YR
: Location (Shop)	A/N	4	(CODE)
: Type (Unit/Batch)	A	1	(U/B)
Part Removal : Report No., Reference	A/N	8	-
: Failure/Defect Code			
Part Repair	-	-	-
: Failure/Defect Code	A/N	4	(CODE)
: Part : Number	A/N	16	-
: Name	A/N	24	-
: Vendor	A	16	-
: Quantity	N	2	-
: Maint./Repair Code	A/N	4	(CODE)
Elapsed Time	N	5	HR'S
Labor Hours	N	5	LBR HR'S

Figure B-6 Dynamic data transit vehicle component repair.

APPENDIX C

STATIC AND DYNAMIC DATA EXAMPLES

VEHICLE MAINTENANCE-SURFACE

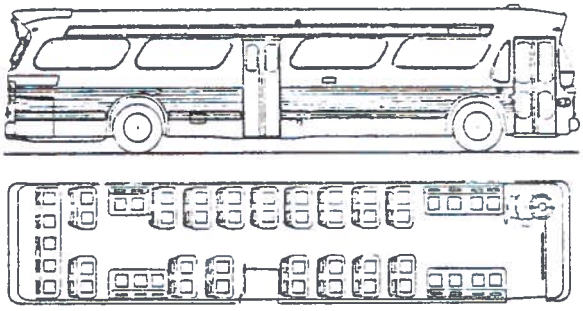
VEHICLE TECHNICAL DATA

FOR VEHICLE: 7557

YEAR:	1973
MANUFACTAURERS ID:	GM TDH5307A
WEIGHT:	22,907
WIDTH:	8' 5 3/4"
LENGTH:	40' 0"
WHEEL BASE:	284 3/4"
TURNING RADIUS:	42' 3"
SEATS:	50
BUSES IN SERIES:	483
AREA ASSIGNMENT:	267-North Park
ENGINE:	GM-8V-71N
DISPLACEMENT:	567.0 Cu In
COMPRESSION:	18.7 to 1
POWER/RPM:	239 @ 2000
TRANSMISSION:	ALLISON VS-1
AXLE RATIO:	5.57 to 1
FUEL CAPACITY:	125
GOVERNOR SPEED:	45-50 MPH
DELCO REMY AMPS:	300
AIR CONDITIONING:	YES

Figure C-1 Reference vehicle specification information (CTA).

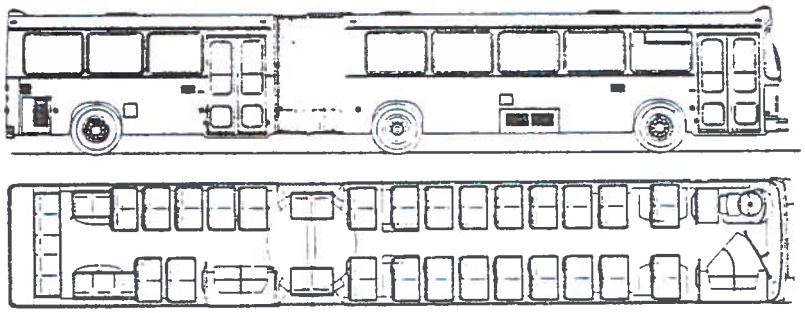
GM



SERIES	YEAR	LENGTH	WIDTH	SEATS	WHEEL BASE	TURNING RADIUS
40-51	1973	40'-0"	8'-5 3/4"	50	284 3/4"	42'-3"
52-58	1976	*40'-6"	8'-5 3/4"	50	284 3/4"	42'-7"
800-804	1965	40'-0½"	8'-6"	50	285"	43'-6"
1000-1524	1972	40'-0"	8'-5 3/4"	50	284 3/4"	42'-3"
7412-7944	1973	40'-0"	8'-5 3/4"	50	284 3/4"	42'-3"
9000-9599	1975	*40'-6"	8'-5 3/4"	50	284 3/4"	42'-7"
9607-9799	1976	*40'-6"	8'-5 3/4"	50	284 3/4"	42'-7"

*Energy absorbing bumper

AM General/M-A-N

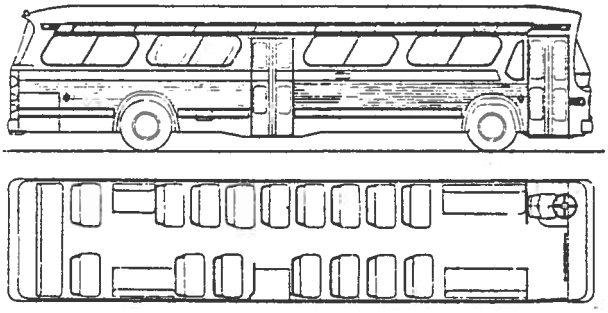


SERIES	YEAR	LENGTH	WIDTH	SEATS	WHEEL BASE	TURNING RADIUS
7000-7019	1979	55' - 0 5/16"	8' - 6"	64	Tractor: 222 7/16" Trailer: 255½"	41' - 4"

Note: Turning radius given for the outside front corner of bus.

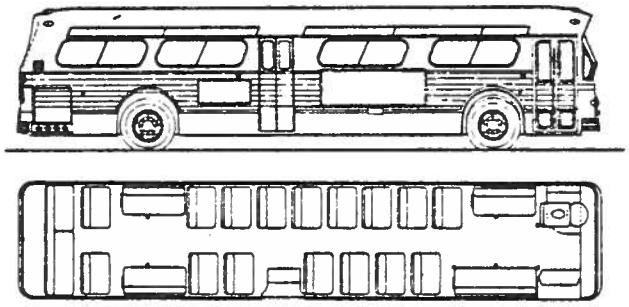
Figure C-2 Reference vehicle specification and fleet tables information (CTA).

GM



SERIES	YEAR	LENGTH	WIDTH	SEATS	WHEEL BASE	TURNING RADIUS
300-449	1962-63	40'-0 1/2"	8'-5 3/4"	50	284 3/4"	42'-0"

Flxible



SERIES	YEAR	LENGTH	WIDTH	SEATS	WHEEL BASE	TURNING RADIUS
26-31	1966	35'-1 15/16"	8'-6"	42	225"	35'-7"
3000-3239	1965	40'-3 1/8"	8'-6"	50	285"	42'-5"
3240-3244	1965	40'-3 1/8"	8'-6"	50	285"	42'-5"
3306-3449	1966	35'-1 15/16"	8'-6"	42	225"	35'-7"
3500-3699	1966-67	40'-2 7/8"	8'-6"	50	285"	42'-5"
3700-3729	1969	40'-0 15/16"	8'-0"	50	285"	40'-6"
3730-3875	1968	40'-0 15/16"	8'-6"	50	285"	40'-11"

Figure C-2 Reference vehicle specification and fleet tables information (CTA) (continued).

Technical data

Bus nos.	No. of buses 1-1-79	Series code	Mfgr. & Model no.	Weight	Fuel tank capacity	Governor speed (mph)	Axle ratio	Engine Data				Transmission		Delco Remy Alternator Output
								Mfgr. & Model no.	Horsepower RPM	Displacement	Compression ratio	Mfg.	Model no.	
26 - 31	6	07	FLX F2D6V351-1	30,158	125	45 - 50	5.57 to 1	GM-6V-71N	176 @ 2100	425.6 cu. in.	18.7 to 1	Spicer	184	300
40 - 51	* 12	01	GM 10N5307A	22,907	125	60 - 65	5-4/7 to 1	GM-8V-71N	239 @ 2000	567.0 cu. in.	18.7 to 1	Allison	VS-1	300
52 - 58	* 7	02	GM 10N5307A	23,493	125	45 - 50	5-4/7 to 1	GM-8V-71N	239 @ 2000	567.0 cu. in.	18.7 to 1	Allison	VS-1	300
300 - 449	70	03	GM 10N5301	20,700	86	45 - 50	5-1/7 to 1	GM-6V-71N	173 @ 2000	425.6 cu. in.	18.7 to 1	Allison	VH	220
800 - 804	* 5	08	GM 10N5303	21,870	120	60 - 65	5-1/7 to 1	GM-6V-71N	173 @ 2000	425.6 cu. in.	18.7 to 1	Allison	VH-9	300
1000 - 1534	*534	10	GM 10N5307A	22,955	125	45 - 50	5-4/7 to 1	GM-8V-71N	239 @ 2000	567.0 cu. in.	18.7 to 1	Allison	VS-1	300
3000 - 3239	74	30	FLX F2D6V401-1	21,230	66	45 - 50	5-4/7 to 1	GM-6V-71N	176 @ 2100	425.6 cu. in.	18.7 to 1	Spicer	184	300
3240 - 3244	* 5	32	FLX F2D6V401-1	23,520	120	60 - 65	4.00 - 5.51 2 - speed	GM-6V-71N	211 @ 2000	425.6 cu. in.	18.7 to 1	Spicer	184	300
3100 - 3449	14	13	FLX F2D6V351-1	20,158	125	45 - 50	5.57 to 1	GM-6V-71N	176 @ 2100	425.6 cu. in.	18.7 to 1	Spicer	184	300
3500 - 3699	186	35	FLX F2D6V401-1	21,030	125	45 - 50	5-4/7 to 1	GM-6V-71N	176 @ 2100	425.6 cu. in.	18.7 to 1	Spicer	184	300
3700 - 3729	25	37	FLX F2D6VE401-1	20,440	125	45 - 50	5-1/7 to 1	DD-6V-71N	173 @ 2000	425.6 cu. in.	18.7 to 1	Allison	VH-9	300
3730 - 3875	146	37	FLX F2D6VE401-1	20,694	125	45 - 50	5-1/7 to 1	DD-6V-71N	173 @ 2000	425.6 cu. in.	18.7 to 1	Allison	VH-9	300
7000 - 7019	* 20	70	AMC/MAN SC220-10255	36,400	100	50 - 55	5.22 to 1	** MAN D2546HTUM	224 @ 2200	696.421 cu.in.	18.0 to 1	Bosh	874	*** 270
7412 - 7494	*483	74	GM 10N5307A	22,907	123	45 - 50	5-4/7 to 1	GM-8V-71N	239 @ 2000	567.0 cu. in.	18.7 to 1	Allison	VS-1	300
7495 - 7944	* 50	76	GM 10N5307A	12,907	125	50 - 55	5-4/7 to 1	GM-8V-71N	265 @ 2100	567.0 cu. in.	18.7 to 1	Allison	VS-1	300
9000 - 9599	*600	90	GM 10N5307A	23,493	125	45 - 50	5-4/7 to 1	GM-8V-71N	239 @ 2100	567.0 cu. in.	18.7 to 1	Allison	VS-1	300
9600 - 9799	*193	96	GM 10N5307A	23,493	125	45 - 50	5-4/7 to 1	GM-8V-71N	239 @ 2000	567.0 cu. in.	18.7 to 1	Allison	VS-1	300
Total	1420													

* Air conditioned
** 6 cylinder horizontal incline turbocharged 4 stroke
*** 24 Volt D.C.

Figure C-2 Reference vehicle specification and fleet tables information (CTA) (concluded).

REPORT OF VEHICLE MILES OPERATED - MONTH OF: _____

YEAR: _____

VEHICLE NO.	MILEAGE	VEHICLE NO.	MILEAGE	VEHICLE NO.	MILEAGE	VEHICLE NO.	MILEAGE
9		1322		1722		1920	
29		1406		1725		1921	
47		1503		1726		1974-L	
48		1504		1727		1975-L	
49		1505		1729		1976-L	
51		1519		1733		1977-L	
52		1537		1801		1978-L	
53		1538		1802		2015	
54		1539		1803		2019	
55		1540		1804		2043	
56		1541		1805		2046	
420		1542		1806		2128	
822		1543		1807		2140	
824		1544		1808		2145	
825		1545		1809		2146	
826		1546		1810		2161	
1224		1547		1811		2164	
1268		1548		1812		7932-L	
1270		1549		1813		7933-L	
1271		1618		1814		7934-L	
1272		1619		1815		7935-L	
1273		1620		1816		7936-L	
1274		1622		1817		7953-L	
1275		1623		1818		7954-L	
1317		1721		1819		7955-L	

Grand Total Vehicle Mileage See Page 2

1. List all Vehicles in fleet on each report, inactive as well as active.
2. Report separately by vehicle number, mileage operated in the delivery of vehicles purchased. Identify as delivery mileage in report above.

NOTES: _____

WE CERTIFY THAT ABOVE REPORT INCLUDES ALL NON-REVENUE AND REVENUE MILES RUN BY OUR VEHICLES EQUIPPED WHOLLY OR PARTIALLY WITH TIRES OWNED BY THE GOODYEAR TIRE & RUBBER COMPANY INCORPORATED.

FIRM NAME _____

Figure C-3a Dynamic utilization information (SEMTA).

REPORT OF VEHICLE MILES OPERATED - MONTH OF: _____

Page 2

YEAR: _____

VEHICLE NO.	MILEAGE	VEHICLE NO.	MILEAGE	VEHICLE NO.	MILEAGE	VEHICLE NO.	MILEAGE
7956-L							
7957-L							
7958-L							
7959-L							

Grand Total Vehicle Mileage _____

1. List all vehicles in fleet on each report, inactive as well as active.

2. Report separately by vehicle number, mileage operated in the delivery of vehicles purchased. Identify as delivery mileage in report above.

NOTES: _____

_____

_____

WE CERTIFY THAT ABOVE REPORT INCLUDES ALL NON-REVENUE AND REVENUE MILES RUN BY OUR VEHICLES EQUIPPED WHOLLY OR PARTIALLY WITH TIRES OWNED BY THE GOODYEAR TIRE & RUBBER COMPANY INCORPORATED.

FIRM NAME SEMTA/Oakland Division _____

BY _____ TITLE Secretary, Maintenance Manager

Figure C-3b Dynamic utilization information (SEMTA).

daily & monthly fuel & oil & miles summary

MI	INS MI	ACC MI	FUEL	OIL	MI	INS MI	ACC MI	FUEL	OIL	DATE	MI	INS MI	ACC MI	FUEL	OIL	MI	INS MI	ACC MI	FUEL	OIL
										1										
										2										
										3										
										4										
										5										
										6										
										7										
										8										
										ST										
										9										
										10										
										11										
										12										
										13										
										14										
										15										
										16										
										ST										
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										21										
										22										
										23										
										24										
										ST										
										25										
										26										
										27										
										28										
										29										
										30										
										31										
										T										

Figure C-4 Dynamic consumption information (SEMTA).

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
MECHANICAL ROAD SUPERVISOR REPORT

Date:_____ Time On:_____ Time Off:_____ Signature:_____

Disp. No.	Run/ Line	Bus No.	Oper. Bdg. No.	Location of Bus	Trouble Reported	Trouble Found	Div. No.	Time Red'd	Time Rec'd

C-8

Figure C-5. Dynamic road call/incident information (SCRTD).

METRO MCC-100

TROUBLE CALL

TROUBLE CALL NO.
TC 07250

COACH NO.	ROUTE NO.	RUN NO.	OPERATOR I.D. NO.	DATE REPORTED

NO.	DESCRIPTION OF PROBLEM
1	
2	
3	
4	

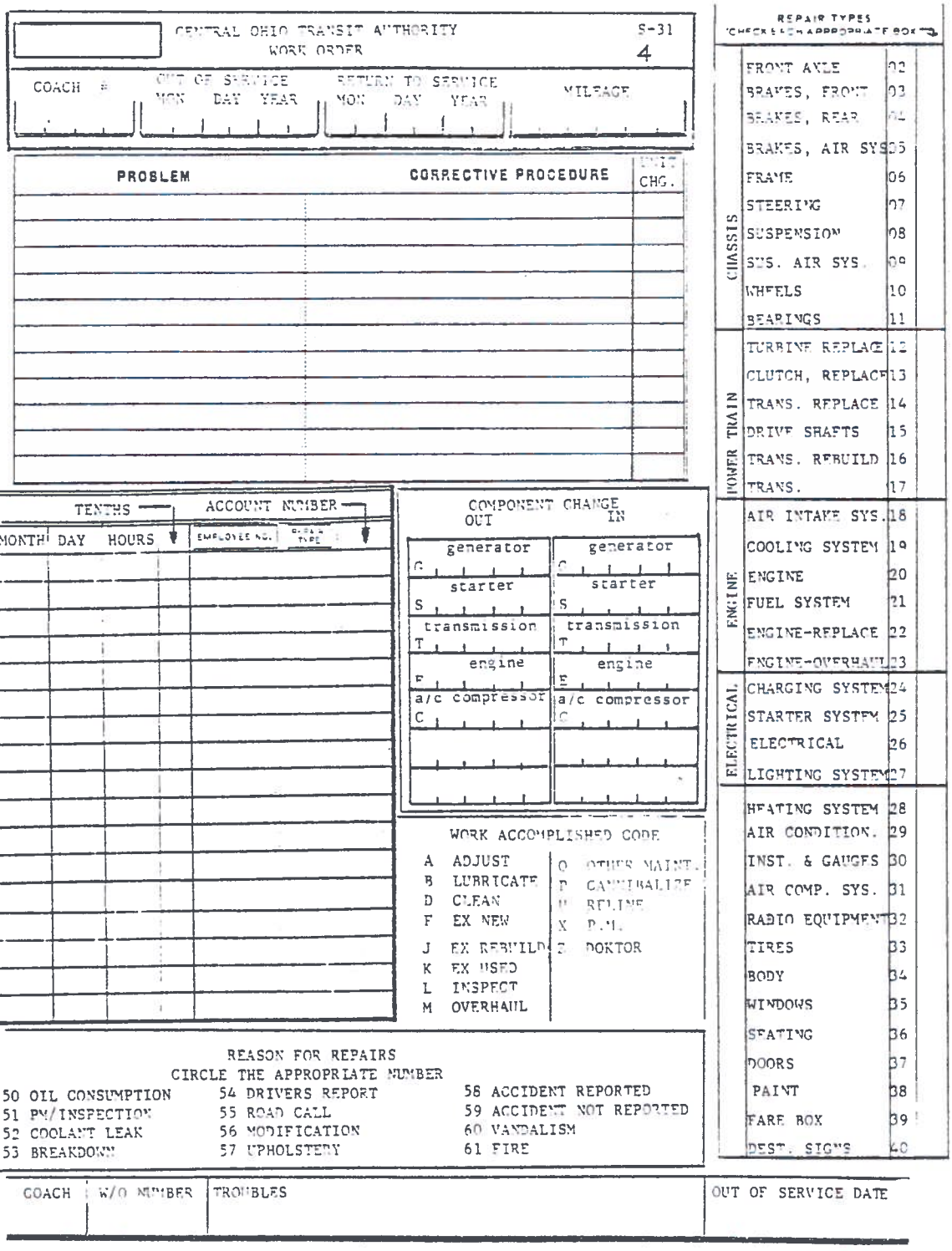
LOCATION OF COACH		HEADING ☐N ☐S ☐E ☐W
ACTION REQUESTED ☐ COACH CHANGE ☐ ROAD CALL ☐ BOTH	CALL RECEIVED BY	TIME RECEIVED : ☐AM ☐PM

MECHANIC SENT		
NUMBER	WRECKER/VEHICLE NO.	TIME DUE : ☐AM ☐PM
OPERATOR SENT		
NAME	RELIEF COACH NO.	TIME DUE : ☐AM ☐PM

0751 (Rev. 6/79)

MAINTENANCE

Figure C-6 Dynamic road call/incident information (METRO (Seattle)).



CENTRAL OHIO TRANSIT AUTHORITY — S-31
WORK ORDER — 4

COACH # | OUT OF SERVICE MON DAY YEAR | RETURN TO SERVICE MON DAY YEAR | MILEAGE

PROBLEM	CORRECTIVE PROCEDURE	UNIT CHG.

TENTHS | ACCOUNT NUMBER

MONTH	DAY	HOURS	EMPLOYEE NO.	CLOCK TYPE

COMPONENT CHANGE

OUT	IN
generator G	generator G
starter S	starter S
transmission T	transmission T
engine E	engine E
a/c compressor C	a/c compressor C

WORK ACCOMPLISHED CODE

A ADJUST
B LUBRICATE
D CLEAN
F EX NEW
J EX REBUILD
K EX USED
L INSPECT
M OVERHAUL
O OTHER MAINT.
P CANNIBALIZE
R RELINE
X P.M.
Z DOKTOR

REASON FOR REPAIRS
CIRCLE THE APPROPRIATE NUMBER

50 OIL CONSUMPTION
51 PM/INSPECTION
52 COOLANT LEAK
53 BREAKDOWN
54 DRIVERS REPORT
55 ROAD CALL
56 MODIFICATION
57 UPHOLSTERY
58 ACCIDENT REPORTED
59 ACCIDENT NOT REPORTED
60 VANDALISM
61 FIRE

REPAIR TYPES
CHECK & ENTER APPROPRIATE BOX →

CHASSIS	FRONT AXLE	02
	BRAKES, FRONT	03
	BRAKES, REAR	04
	BRAKES, AIR SYS	05
	FRAME	06
	STEERING	07
	SUSPENSION	08
	SUS. AIR SYS.	09
	WHEELS	10
	BEARINGS	11
POWER TRAIN	TURBINE REPLACE	12
	CLUTCH, REPLACE	13
	TRANS. REPLACE	14
	DRIVE SHAFTS	15
	TRANS. REBUILD	16
	TRANS.	17
ENGINE	AIR INTAKE SYS.	18
	COOLING SYSTEM	19
	ENGINE	20
	FUEL SYSTEM	21
	ENGINE-REPLACE	22
	ENGINE-OVERHAUL	23
ELECTRICAL	CHARGING SYSTEM	24
	STARTER SYSTEM	25
	ELECTRICAL	26
	LIGHTING SYSTEM	27
	HEATING SYSTEM	28
	AIR CONDITION.	29
	INST. & GAUGES	30
	AIR COMP. SYS.	31
	RADIO EQUIPMENT	32
	TIRES	33
	BODY	34
	WINDOWS	35
	SEATING	36
	DOORS	37
	PAINT	38
	FARE BOX	39
	DEST. SIGNS	40

COACH	W/O NUMBER	TROUBLES	OUT OF SERVICE DATE

Figure C-7a Dynamic repair information (COTA).

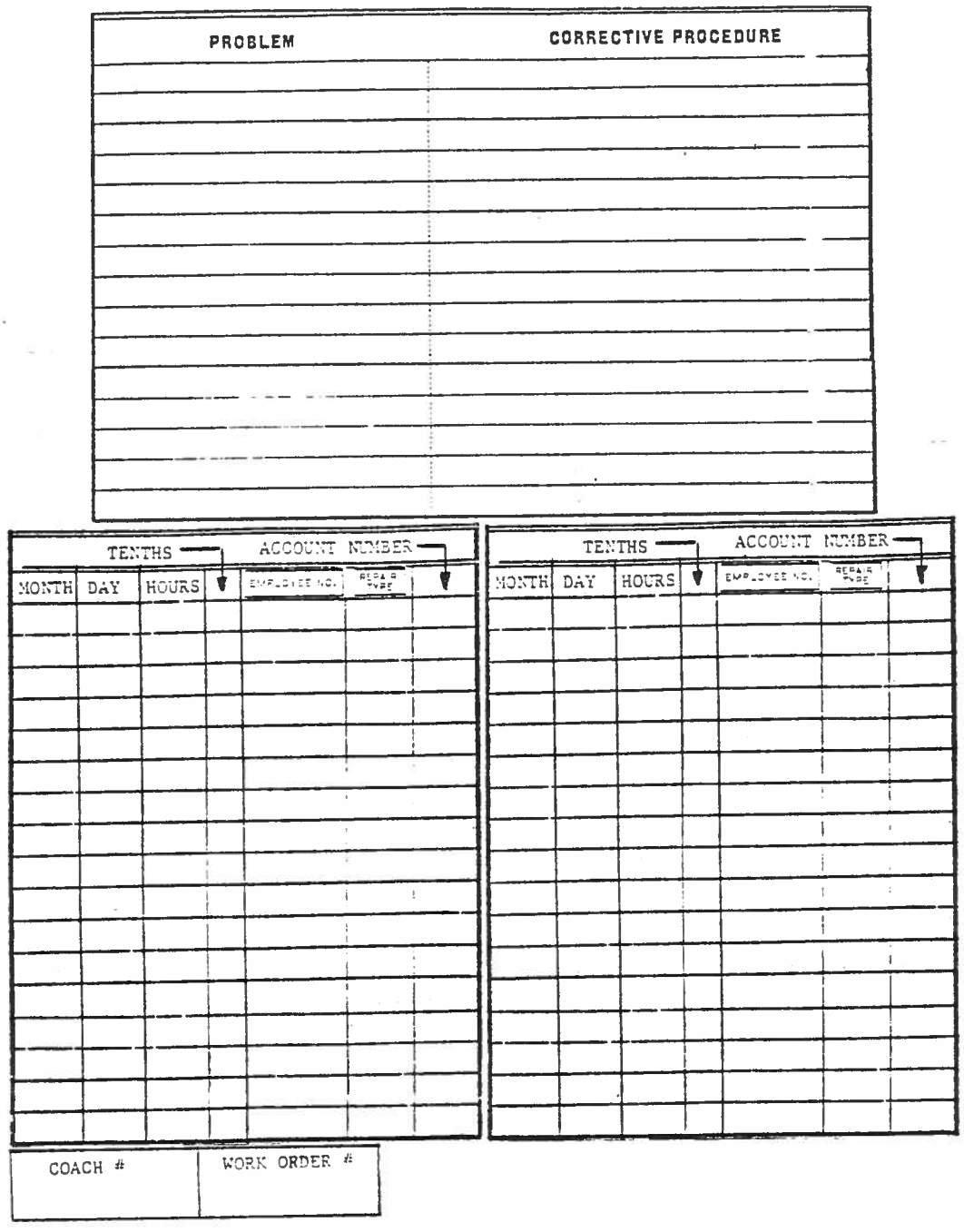


Figure C-7b Dynamic repair information (COTA).

METRO COACH REPAIR RECORD

• WRITE MECHANIC NO. BY REPAIR COMPLETED • CIRCLE REPAIR

☐ = CHECK IF COACH IS UNABLE FOR TRIPPER | COACH NO.

05- Brakes - General
05-96 Replace Brake Cylinder
05-126 Lube and Adjust Brakes
05-126 Replace Brake Appl. Valve
05-127 Rplc. Diaphragm (Per Cia.)
05-130 Replace Slack Adjuster
05-131 Reline Frt. Brakes (2 Wheels)
05-131 Reline Rear Brakes (1 Wheel)
05-132 Replace Spring in Brakes
05-133 Adjust/Lube Handbrake
05-413 Clean Brake Drums
05-414 Tapplev Test
05-415 Rplc., Repr./Adj. Brake Ped.
05-457 Rebuild Slack Adjuster
05-467 Repair Hill Holder
02- Axle/Differential - General
02-100 Replace Partial Axle
02-101 Replace Differential
02-107 Replace U-Joints
02-202 Replace Differential Gasket
02-400 Tighten Bolts (Axle Differ.)
02-405 Replace Axle Seal in Wheel
02-406 Replace Repair Axle Plate
02-407 Replace/Adj. Wheel Bearing
02-468 Rplc. King Pin Grease Fitting
35- Steering - General
35-230 Balance Wheel/Tire
35-275 Adjust Steering
35-276 Replace Tie Rod Ends
35-400 Tighten Bolts in Steering
35-460 Add Fluid or Lube Steering
35-463 Rplc. King Pins & Bushings
35-469 Rplc. Power Steering Line
35-470 Replace Steering Engine
35-471 Align Front End
33- Suspension - General
33-269 Adjust Suspension
33-270 Replace Air Bag
33-272 Replace Level Valve
33-273 Replace Shock Absorbers
33-274 Rplc. Shk. Absorber Bushing
33-400 Tighten Bolts in Suspension
33-449 Rplc./Repr. Brace Rods or Link
33-472 Replace Level Link
21- Tires and Wheels - General
21-229 Replace Tire/Wheel
21-230 Balance Wheel
21-400 Tighten Wheel Bolts

15- Cooling System - General
15-72 Add Coolant
15-158 Lube Cooling System
15-187 Replace/Tighten Water Line
15-208 Replace Radiator
15-209 Replace Shutter Stat
15-210 Replace Water Pump
15-260 Replace/Repair Bracket
15-400 Tighten or Replace Bolts
15-435 Replace/Repair Surge Tank
15-436 Replace/Repair Fan Shroud
15-459 Repair Shutters
13- Fuel System - General
13-187 Replace/Tighten Line
13-202 Replace Fuel Gasket
13-203 Replace Fuel Filter
13-204 Replace Fuel Pump
01- Air System - General
01-90 Replace Air Compressor
01-95 Adjust Air Regulator
01-99 Rplc., Repair Spitter Valve
01-187 Replace/Tighten Line
01-400 Tighten Bolts or Clamps
01-401 Rplc. Comp. Base Gasket
01-402 Replace/Repair Air Dryer
01-403 Rplc. Air Comp. Air Govern.
22- Service Change
23- Farebox - General
23-232 Replace Farebox
73-452 Check Accident Damage
75- Vandalism
79-453 Clean Coach Interior

12- Engine - General
12-71 Add Engine Oil
12-187 Replace Tighten Line
12-195 Replace Starter
12-198 Overhaul Engine
12-201 Tune Engine
12-400 Tighten Engine Bolts
12-430 Replace Injectors
12-431 Replace Fan Hub Seal
12-432 Replace Air Filter
12-433 Replace Valve Cover Gasket
12-434 Rplc. Engine Oil Pan Gasket
12-438 Repair/Clean Air Intake
12-473 Rplc. Acc. Drive Cover Gask.
12-474 Rplc. Hand Hole Cover Gask.
12-475 Rebuild Fan Unit Complete
12-476 Adjust Valves
12-477 Replace Engine
12-478 Steam Clean
16- Clutch - General
16-172 Adjust Clutch
11- Transmission - General
11-77 Add Torque Fluid
11-134 Adjust Linkage
11-156 Replace/Repair Cable
11-172 Adj. Clutch or Transmission
11-179 Rplc. Transmission Governor
11-180 Replace/Repair Mag. Valve
11-183 Replace Shift Ram
11-187 Rplc., Repair/Tighten Line
11-400 Tighten Bolts in Transmission
11-423 Rplc. Trans. Seal, O-Ring
11-424 Rplc. Trans. Inner Seal
11-425 Replace Transmission
11-426 Replace Transmission Filter
11-427 Replace Trans. Oil Cooler
11-429 Replace/Repair Quill Shaft
11-430 Adj. Transmission Governor
11-431 Chg./Repr. Valve in Trans.
37- Exhaust System - General
37-293 Rplc./Tighten Bolts or Clamps
37-294 Replace Muffler
37-400 Tighten Bolts on Muffler

03- Body/Chassis - General
03-260 Replace Chassis Bracket
03-403 Fill Window Washer
03-409 Repair/Secure Body Panel
03-479 Lube/Adjust Body Hinges
03-480 Straighten Turntable
06- Doors - General
06-139 Repair/Adjust Door
06-158 Lube Door
06-304 Repair Door Interlock
06-416 Rplc. Adj. Door Sensor Edge
06-481 Repair Door Controls
06-482 Repr./Adj. Wheel Chair Lift
09- Swipes - General
09-160 Replace Wiper Arm or Blade
09-165 Adj. Wiper Arm and Travel
09-421 Tighten Wiper Controls
09-483 Repr./Rplc. Fluid Container
09-484 Repair Windshield Washer
10- Directional Signals - General
10-113 Rplc. Bulb in Turn Signals
10-122 Repair Turn Signal Wiring
10-167 Replace Flasher
10-169 Repair Socket
31- Mirrors - General
31-257 Replace Mirror
31-400 Tighten Mirror Bolts
31-446 Repair Mirror
80- Windows - General
80-299 Repair Window Frame
80-300 Replace Window Glass
80-301 Clean Window
80-400 Tighten Window Bolts
80-454 Lube/Adj./Free Up Window
80-455 Apply Sealant to Window
80-461 Rplc. Windshield or Wipers

26- Coach Interiors/Signs - Gen.
26-152 Lube Sign
26-237 Replace Sign
26-238 Replace Seat
26-239 Repair Sign
26-240 Repair/Clean Seat
26-240 Replace Seat Cushion
26-400 Tighten Interior Bolts
26-437 Secure Stanchion or Railing
26-438 Secure/Repair Flooring
26-439 Repair/Replace Curtain
26-440 Rplc./Repr. Transfer Cutter
26-441 Replace Wheel Blocks
26-442 Replace Fire Extinguisher
26-460 Replace Translator
26-485 Replace Run Card Holder
26-486 Inside Clean
29- Speedometer - General
29-156 Rplc., Repr. Sodomtr. Cable
29-246 Replace Speedometer Head
29-247 Rplc. Speedometer Sender
29-443 Rplc. Sodomtr. Plastic Disk
32- Throttle - General
32-134 Adjust Throttle Linkage
32-156 Lube Throttle
32-447 Rplc. Throttle Air Cylinder
32-448 Rplc./Repld. Throttle Pedal
36- Heater - General
36-158 Lube Heater
36-161 Replace Heater Motor
36-282 Adjust/Repair Gradustat
36-288 Repair Heater Controls
36-400 Tighten Bolts in Heater Syst.
36-451 Repr./Tighten Valve in Heater
36-487 Replace Heater Core
81- Driver Seat - General
81-158 Lube Driver Seat
81-238 Replace Driver Seat
81-400 Tighten Driver Seat Bolts
81-488 Replace Driver Seat Adjment.
81-489 Rplc. Driver Seat Air Hose

04- Electrical System - General
04-113 Replace Bulb
04-117 Adjust Headlamp
04-118 Replace Headlamp
04-122 Repair Wiring or Connector
04-124 Replace/Repair Switch
04-169 Repr./Clean Plugs or Sockets
04-247 Replace Sender
04-254 Replace/Repair Relay
04-410 Replace Light Ballast
04-411 Rplc., Repr. Buzzer or Bell
04-412 Rplc., Repr. Gauge or Meter
04-457 Replace Light Fixture
04-462 Reset Switch or Circuit Brkr.
14-122 Repair Ignition Wiring
30- Horn - General
30-122 Repair Horn Wiring
30-444 Clean/Lube/Adjust Horn
30-445 Replace Horn Contacts
08- Battery - General
08-149 Adj. Battery Tie-Down Straps
08-155 Replace Battery
08-156 Replace/Repair Cable
08-157 Clean, Tighten Cable or Term.
08-418 Add Battery Fluid
08-419 Charge Batteries
08-420 Repr., Adjust Battery Box
08-490 Jump Start Coach
07- Generator/Regulator - Gen.
07-149 Adjust Belts
07-150 Repr./Adj. Voltage Regulator
07-151 Rplc., Repr. Alt. or Gen.
07-152 Replace Regulator
07-417 Repack Alternator Bearing
07-491 Replace Idler Pulley
07-492 Replace Artic Belts
24- Radio - General
24-235 Replace Radio

REMARKS | DATE COMPLETED MO DY YR | FOREMAN SIGNATURE

10

Figure C-8 Dynamic repair information (METRO (Seattle)).

APPENDIX D

PROPOSED REPORT FORMATS

Report Type: BMU 01
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

BUS NUMBER	FLEET-ID (MANUF-MODEL)	CUMULATIVE MILES	MILES THIS PERIOD	MILES LAST PERIOD	MILES LAST YEAR
101	GMC-T8H203	100,000	5,000	7,000	65,000
102	GMC-T8H203	300,000	2,000	3,000	15,000
103	GMC-T8H203	50,000	1,000	900	0
ALL	GMC-T8H203	450,000	8,000	10,900	70,000
201	FLX-5310281	150,000	5,000	5,000	60,000
202	FLX-5310281	400,000	6,000	4,000	50,000
ALL	FLX-5310281	550,000	11,000	9,000	110,000
301	AMG-SG220	50,000	5,000	4,000	0
ALL	AMG-SG220	50,000	5,000	4,000	0

Figure D-1 Transit reliability information program transit bus monthly utilization.

Report Type: BMU 02
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

FLEET ID (MANUF-MODEL)	ACTIVE BUSES	TOTAL CUM MILES	CUM MILES/BUS	MILES THIS PERIOD	MILES/BUS THIS PERIOD	MILES LAST PERIOD	MILES/BUS LAST RECORD
GMC-T8H203	100	2,500,000	25,000	210,000	2,100	300,000	3,000
AMG-SG220	20	100,000	5,000	10,000	500	8,000	400
ALL	120	2,600,000	21,667	220,000	18,33	308,000	2,567

Figure D-2 Transit reliability information program transit bus monthly utilization.

Report Type: BMU 03
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

ALL PROPERTIES

PROPERTY	FLEET-ID (MANUF-MODEL)	ACTIVE BUSES	TOTAL CUM MILES	CUM MILES/ BUS	MILES THIS PERIOD	MILES/BUS THIS PERIOD	MILES LAST PERIOD	MILES/BUS LAST PERIOD
00001	GMC-T8H203	100	2,500,000	25,000	210,000	2,100	300,000	3,000
00002	GMC-T8H203	75	1,200,000	16,000	100,000	1,333	100,000	1,333
00003	FLX-5310281	150	3,000,000	20,000	250,000	1,668	300,000	2,000
ALL		325	4,700,000	14,462	560,000	1,723	700,000	2,154

Figure D-3 Transit reliability information program transit bus monthly utilization.

Report Type: BMC 01
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

BUS NUMBER	FLEET-ID (MANUF MODEL)	MILES THIS PERIOD	TOTAL FUEL (GAL)	MILES/ GAL	MPG LAST PERIOD	TOTAL OIL (QT)	MILES/ QUART	MPQ LAST PERIOD	TOTAL COOLANT	MILES/ QUART	MPQ LAST PERIOD	TIRES REPLACED
101	GMC-7811203	15,000	4,100	3.66	3.50	30	500	480	7.5	2,000	1,500	1
102	GMC-7811203	20,000	5,000	4.00	4.50	33	600	610	5.0	4,000	4,050	0
ALL	GMC-7811203	35,000	9,100	3.85	4.00	63	556	545	12.5	2,800	2,775	1
203	AMC SG220	30,000	10,000	3.00	3.00	63	475	476	6.0	5,000	5,000	3
ALL	AMC SG220	30,000	10,000	3.00	3.00	63	475	476	6.0	5,000	5,000	3

Figure D-4 Transit reliability information program transit bus monthly consumption.

Report Type: BMC 02
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

FLEET-ID (MANUF-MODEL)	ACTIVE BUSES	MILES THIS PERIOD	TOTAL FUEL (GAL)	MILES/ GAL	MPG LAST PERIOD	TOTAL OIL (QT)	MILES/ QT	MPQ LAST PERIOD	TOTAL COOLANT	MILES/ QT	MPQ LAST PERIOD	TIRES REPLACED
GMC-78H203	100	1,750,000	455,000	3.85	4.00	3,150	556	545	625	2,800	2,775	50
AMG-SG220	30	900,000	300,000	3.00	3.00	1,890	476	476	180	5,000	5,000	45
ALL	130	2,650,000	755,000	3.51	3.77	5,040	526	529	805	3,292	3,288	95

Figure D-5 Transit reliability information program transit bus monthly consumption.

Report Type: BMC 03
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

ALL PROPERTIES

PROPERTY	FLEET ID (MANUF-MODEL)	ACTIVE BUSES	MILES THIS PERIOD	TOTAL FUEL (GAL)	MILES/ GAL	TOTAL OIL (QT)	MILES/ QT	TOTAL COOLANT	MILES/ QT	TIRES REPLACED
0001	GMC-7BH203	100	1,750,000	455,000	3.85	3,150	556	625	2,800	50
0002	FLX-5310281	50	1,000,000	250,000	4.00	1,667	600	625	1,600	30
ALL		150	2,750,000	705,000	3.90	4,817	571	1,250	2,200	80

Figure D-6 Transit reliability information program transit bus monthly consumption.

Report Type: BMIR 01
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

BUS NUMBER	FLEET-ID (MANUF-MODEL)	MILES THIS PERIOD	TOTAL INSPECTIONS	INSPECTION TYPES/SYSTEMS	MILES/ INSP	TOTAL ROAD CALLS	SYSTEM INVOLVED	MILES/ROAD CALL	NO. OUT-OF-SERVICE ROAD CALLS
101	GMC-T8H203	15,000	5	A–Brakes B–Safety	3,000	0			
102	GMC-T8H203	10,000	2	C–24K F–Torque Converter	5,000	1	Xmission	10,000	1
All	GMC-T8H203	25,000	7		3,571	1		25,000	1

Figure D-7 Transit reliability information program transit bus monthly inspections and road calls.

Report Type: BMIR 02
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

FLEET-ID (MANUF-MODEL	ACTIVE BUSES	TOTAL MILES	TOTAL INSPECTIONS	MILES/ INSP	TOTAL ROAD CALLS	MILES/ ROAD CALL	NO. OUT-OF-SERVICE ROAD CALLS
GMC-T8H203	100	1,260,000	360	3,671	60	26,000	30
FLX 6310281	50	1,000,000	250	4,000	200	5,000	150
All	150	2,260,000	600	3,760	260	9,000	180

Figure D-8 Transit reliability information program transit bus monthly inspections and road calls.

Report Type: BMIR 03
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

ALL PROPERTIES

PROPERTY	FLEET-ID (MANUF-MODEL)	ACTIVE BUSES	MILES THIS PERIOD	TOTAL INSPECTIONS	MILES/ INSP	TOTAL ROAD CALLS	MILES/ ROAD CALL	NO. OUT-OF SERVICE ROAD CALLS
0001	GMC-T8H203	200	583,333	118	4,944	195	2,991	70
0002	AMG-SG220	100	350,000	100	3,500	50	7,000	10
All		300	933,333	218	4,281	245	3,810	80

Figure D-9 Transit reliability information program transit bus monthly inspections and road calls.

Report Type: BMIR 04
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

SYSTEM: ENGINE

PROPERTY	FLEET ID (MANUF-MODEL)	ACTIVE BUSES	MILES THIS PERIOD	TOTAL INSPECTIONS	INSPECTION TYPE	MILES/BUS/ INSP	TOTAL ROAD CALLS
0001	GMC-T8H203	150	438,000	100	A-50 B-25 C-25	4,380	106
0002	GMC-T8H203	100	350,000	75	A-25 B-10 C-15 D-25	4,667	75
All		250	788,000	175	A-75 B-35 C-40 D-25	4,503	181

Figure D-10 Transit reliability information program transit bus monthly inspections and road calls.

Report Type: BMR 01
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

BUS NUMBER	FLEET-ID (MANUF-MODEL)	MILES THIS PERIOD	TOTAL REPAIRS	NO. PM REPAIRS	SYSTEMS REPAIRED	MILES/NON-PM REPAIR	TOTAL REPLACEMENTS	MILES/ REPLACEMENT
101	FLX-6310281	2,100	4	1	1–Body 3–Engine	700	2	1,050
102	FLX-6310281	3,000	2	2	2–A/C	–	4	750
103	FLX-6310281	2,500	4	0	2–Brakes 2–Body	625	3	833
All	FLX-6310281	7,600	10	3	3–Body 2–Brakes 2–A/C 3–Engine	1,086	9	844
201	AMG-SG220	4,000	4	2	1–Brakes 2–Engine 1–A/C	2,000	5	800
All	AMG-SG220	4,000	4	2	1–Brakes 2–Engine 1–A/C	2,000	6	800

Figure D-11 Transit reliability information program transit bus monthly repair information.

Report Type: BMR 02
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

FLEET-ID (MANUF MODEL)	ACTIVE BUSES	MILES THIS PERIOD	TOTAL REPAIRS	NO. PM REPAIRS	MILES/NON-PM REPAIR	TOTAL REPLACEMENTS	MILES/ REPL
FLX-5310281	50	150,000	170	51	1,261	153	980
GMC-T8H203	100	200,000	200	50	1,333	100	2,000
AMG-SG220	25	100,000	75	30	2,222	40	2,500
All	175	450,000	445	131	1,433	293	1,536

Figure D-12 Transit reliability information program transit bus monthly repair information.

Report Type: BMR 03
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page NO: 01

ALL PROPERTIES

PROPERTY	FLEET-ID (MANUF-MODEL)	ACTIVE BUSES	MILES THIS PERIOD	TOTAL REPAIRS	NO. PM REPAIRS	MILES/NON-PM REPAIR	TOTAL REPLACEMENTS	MILES/ REPLACEMENT
0001	GMC-T8H203	100	300,000	150	75	4,000	100	3,000
0003	All	175	450,000	445	131	1,433	293	1,536
All		275	750,000	595	206	1,928	393	1,908

Figure D-13 Transit reliability information program transit bus monthly repair information.

Report Type: BMR 04
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

SYSTEM: DOORS AND DOOR CONTROLS

PROPERTY	FLEET ID (MANUF-MODEL)	ACTIVE BUSES	MILES THIS PERIOD	TOTAL REPAIRS	NO. PM REPAIRS	TOTAL REPLACEMENTS
0001	GMC-T8H203	100	300,000	20	10	10
0002	GMC-T8H203	150	500,000	50	10	5
0003	GMC-T8H203	25	50,000	10	2	5
All	GMC-T8H203	275	850,000	80	22	20

Figure D-14 Transit reliability information program transit bus monthly repair information.

Report Type: BQRM 01
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY: xxxxx

BUS NUMBER	FLEET-ID (MANUF-MODEL)	MILES THIS PERIOD	NO. MAINT. ACTS	MEAN MILES BETWEEN M. ACTS	NO. MAINT ACTS/ YEAR	MMBMA OVER BUS LIFE
101	AMG SG220	2,000	2	1,000	6	5,000
102	AMG SG220	3,000	1	3,000	8	4,500
All	AMG-SG220	5,000	3	1,667	13	4,692

Figure D-15 Transit reliability information program transit bus quarterly maintenance actions.

Report Type: BORM 04
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

SYSTEM: BRAKES

PROPERTY	FLEET ID (MANUF MODEL)	ACTIVE BUSES	MILES THIS PERIOD	NO. OF MAINT. ACTS	MMBMA	NO. M. A./1ES/ YEAR	M. A./RES/ MILE	TOTAL REPAIR TIME	MEAN TIME TO REPAIR
0001	AMG SG220	50	100,000	5	20,000	20	0.000017	800	40
0002	AMG SG220	25	100,000	7	14,286	24	0.000020	1200	50
All	AMG SG220	75	200,000	12	16,667	44	0.000018	2000	45

Figure D-16 Transit reliability information program transit bus quarterly maintenance actions.

Report Type: RR 01
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY ID	TOTAL ROUTE MILES	TOTAL FLEET	AVG SPEED (MPH)	AVG HEADWAY (MIN)	AVG STOP SPACING (FT)	AVG TRIP TIME	AVG PAX/ HOUR	MAXIMUM GRADE (°)
001	50	25	20	10	25	15	75	10
002	200	100	25	10	1000	30	100	10
003	100	50	20	25	1500	25	30	5
All	350	175	22	15	842	23	68	8

Figure D-17. Transit reliability information program transit bus transit property reference information.

Report Type: RR 02
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

FLEET ID (MANUF-MODEL)	ACTIVE BUSES	YEAR IN SERVICE	DIMENSIONS LENGTH	HEIGHT	WIDTH	WHEELBASE	MAX SPEED (MPH)	NOM. ACCEL (MPHPS)	NOM DECEL (MPHPS)	WEIGHT EMPTY	FULL
FLX-5310281	140	1974	40'-0	8'-0	9'-0	286"	60	3.0	5.0	20,600	26,600
GMC-T8H203	100	1976	40'-½"	8'-¼"	9'-0	284¼"	60	3.0	5.0	23,000	29,000

Figure D-18 Transit reliability information program transit bus fleet reference information.

Report Type: RR 03
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PART NUMBER	PART NAME	NEXT HIGHER ASSY.	SYSTEM	TOTAL QTY
	Battery Assy.	Low Voltage Power Storage	Electrical	3

FLEET-ID (MANUF-MODEL)	TOTAL QTY IN SERVICE	VENDOR CODE	MFGR PART NO.	DIMENSIONS			WEIGHT (LB)	RATING		LATEST ($) COST/UNIT
				LENGTH	WIDTH	HEIGHT		NOM	MAX	
GMC-T8H203	50	02	123AB68	34	16	10	20	24v	40v	150
FLX-5310281	25	05	5412AB	35	15	12	21	28v	40v	200
AMG-SG220	100	71	5513A8	40	18	12	25	30v	45v	350

Figure D-19 Transit reliability information program transit bus equipment reference information.

Report Type: SR 01
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

COMPONENT: BRAKE DRUM

VENDOR	PART NUMBER	PROPERTY	FLEET-ID	ACTIVE BUSES	MILES THIS PERIOD	NO. MAINT. ACTS	MAINT. ACTS/ MILE	MEAN MILES BETWEEN MAINT. ACTS
01	A2B3XYZ	001	GMC-78H203	50	125,000	5	.00004	25,000
02	CDEF3520	005	FLX-5310281	20	60,000	10	.00017	6,000

Figure D-20 Transit reliability information program transit bus special report vendor maintenance actions.

Report Type: SR 02

Reporting Period:

From: MM/DD/YY

To: MM/DD/YY

Report No: 001

Report Date: MM/DD/YY

Page No: 01

VENDOR: xxxxx

COMPONENT	PART NO.	PROPERTY	FLEET-ID	ACTIVE BUSES	MILES THIS PERIOD	NO. MAINT ACT	MEAN MILES BETWEEN MAINT ACT
Brake Lining	AG5370X	002	GMC-T8H203	25	75,000	3	25,000
Brake Shoe	AP6580Y	002	AMG-SG220	10	35,000	1	35,000

Figure D-21 Transit reliability information program transit bus special report vendor maintenance actions.

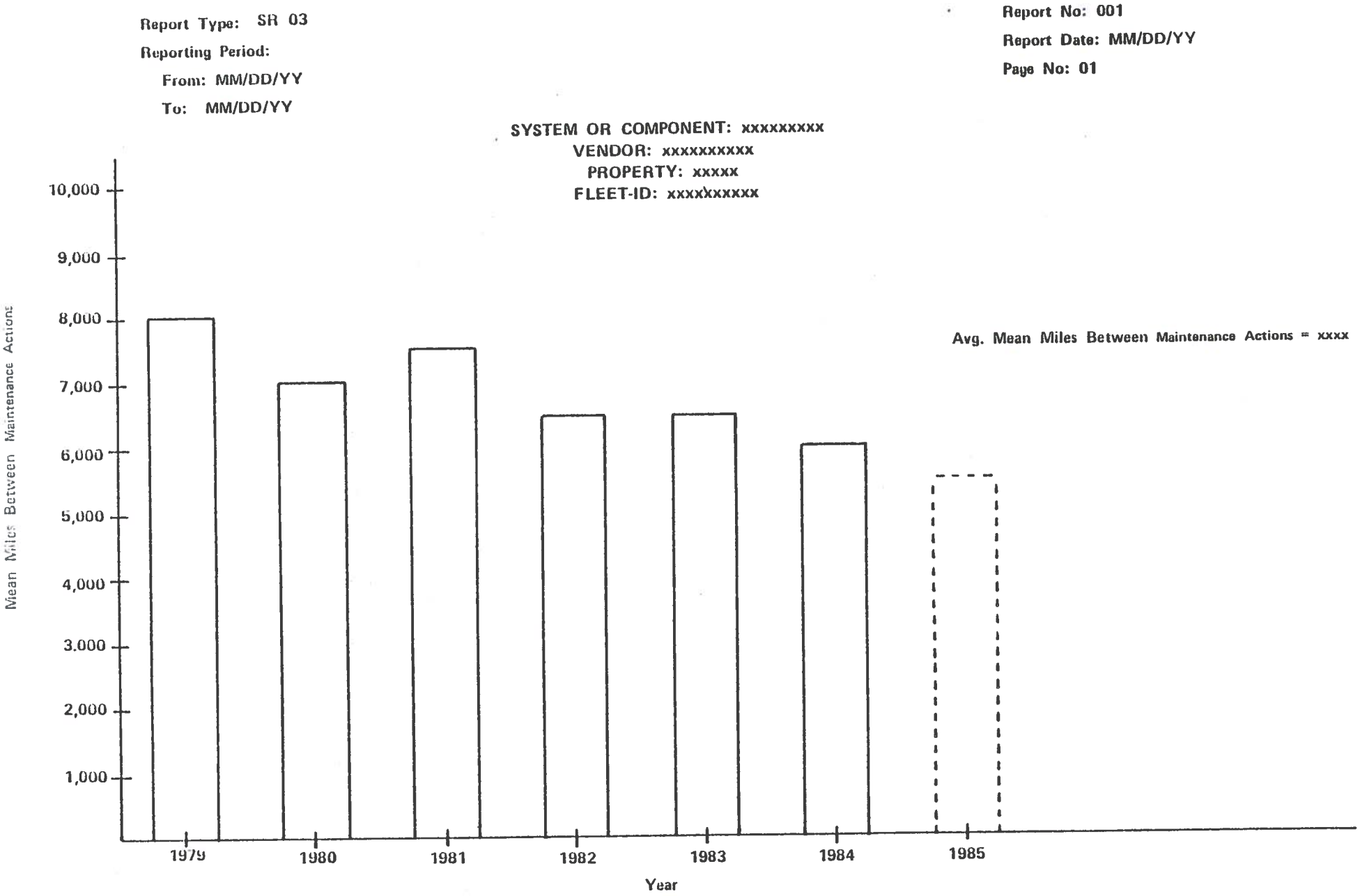


Figure D-22 Transit reliability information program transit bus special report maintenance actions trends.

Report Type: SR 04
Reporting Period:
From: MM/DD/YY
To: MM/DD/YY

Report No: 001
Report Date: MM/DD/YY
Page No: 01

PROPERTY	FLEET-ID (MANUF-MODEL)	SYSTEM MODIFY/RETROFIT	NARRATIVE-MODIFICATION/RETROFIT
001	GMC-T8H203	A/C	Moved compressor to top rear of bus and added engine thermostat to keep temperature high enough
003	FLX-5310281	Brake	Developed new brake lining composed of substance 105.

Figure D-23 Transit reliability information program transit bus equipment modification/retrofit.