CHAPTER 8
VEHICLE WEIGHT MEASUREMENTS

8.1 INTRODUCTION

Two types of scales were used to weigh vehicles during the study (Visser, Technical Memo No. 22/76). The Pavement Group used the scales to obtain a sampling of typical axle loads on the road sections under study. The majority of the weighings were made using a portable scale. The other scale was a sophisticated computerized weigh-in-motion system, capable of weighing vehicles while they are travelling at highway speeds. The latter experienced an abnormally high rate of failures during the entire project.

8.2 THE PORTABLE WHEEL-LOAD WEIGHER

Four General Electrodynamics model MD500 portable wheel-load weighers were acquired for the project. This make and model was selected on recommendation of the Texas Highway Department Instrument Section, which had used this particular scale for over twenty years with no abnormal maintenance problems. Another important consideration was the low cost of the instrument.

8.2.1 Description

Capacity	20,000 pounds
Resolution	20 pounds
Weight of instrument	46 pounds
Dimensions	20-1/2" x 10-1/2" x 3"
Ramp slope	30 degrees

8.2.2 Field Operation

Usually a vehicle is selected from the traffic stream and stopped for a weighing. A pair of instruments are used at the same time, one under each wheel or dual wheels on the same axle to read the total axle weight. This instrument was used only during daylight hours, with the assistance of the highway police. Complete operating details are given in a Project Instrumentation Operational Memo (Buller,"Port-

able Wheel Load Weigher"). Figure 8.1 shows a general view of the instrument; Figure 8.2 schematically shows data flow and the actual data form is illustrated in Table 8.1.

The crew used for this operation included two operators and a driver who provided assistance in positioning the vehicle on the scale.

8.2.3 *Maintenance*

This consisted mainly of repairing or replacing physically damaged parts which were broken when the instrument was spun along the road by irate drivers accelerating away very rapidly after a weighing. This also caused instruments to need recalibration. Calibration details are given in a Project Instrumentation Operational Memo (Buller, "Portable Wheel Load Weigher"). Recessing the instrument into the middle of a block of hard wood 2m x 30cm x 7 or 8 cm with a ramp at either end reduced the indicated damage.

8.3 *THE WEIGH-IN-MOTION SYSTEM (WIM)*

This is an electronic apparatus that measures, displays and records the dynamic weight, number of axles, length and speed of vehicles travelling at normal highway speeds. It also can be used to measure, display and record static wheel loads. The equipment was furnished by Unitech Inc.

It was difficult to maintain the WIM in the field. When the WIM was working it was used to provide data for the pavement performance and maintenance study group covering the distribution of axles over 24-hour periods (Visser and Moser, "Pavement Performance and Maintenance Experiments"). Figure 8.3 shows a truck passing over WIM sensors at a test location. The data route diagram for the system appears in Figure 8.4. A simplified block diagram of the complete system is given in Figure 8.5. Each block is described below.

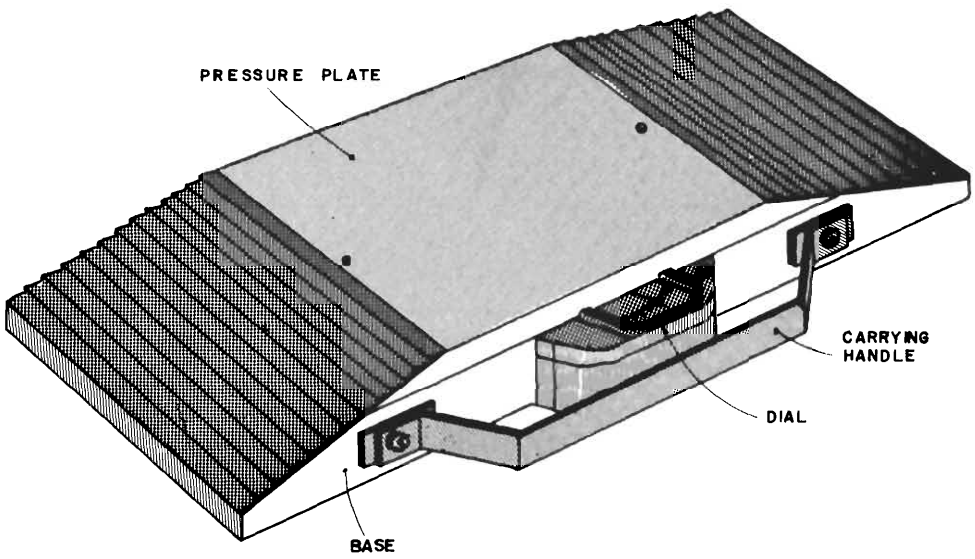


FIGURE 8.1 - PORTABLE WEIGHER GENERAL VIEW

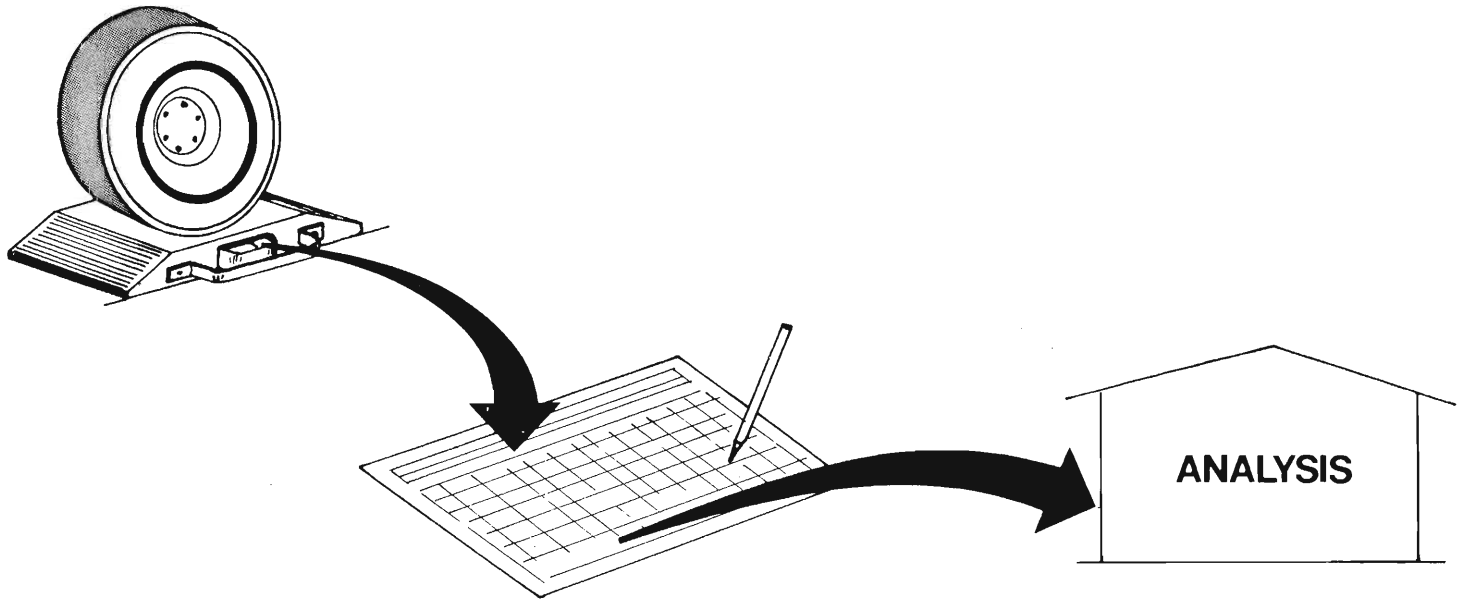


FIGURE 8.2 - PORTABLE WHEEL-LOAD WEIGHER DATA ROUTE DIAGRAM

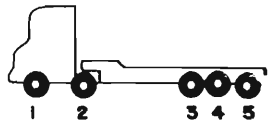
MT-GEIPOT / PICR

FICHA DE CAMPO · BALANÇAS PORTÁTEIS

FOLHA Nº	DATA
OPERADOR	

INSTRUÇÕES DO PERFURADOR

CAMPOS NUMÉRICOS DEVEM SER PERFURADOS ALINHADOS À DIREITA



DUPLICAR COLUNAS 1 A 8 - INCLUSIVE

RODOVIA	SEÇÃO	CARGA	SENTIDO	CLASSE	VEÍC.	ANO FAB.	CARGA POR RODA (LBS.) ESQ. 1	DIR. 1	ESQ. 2	DIR. 2	ESQ. 3	DIR. 3	ESQ. 4	DIR. 4	ESQ. 5	DIR. 5	ESQ. 6	DIR. 6
1 2 3 4 5 6 7 8	-	--	--	--	--	----	----	----	----	----	----	----	----	-- --	----	69 70 71 72 73	74 75 76 77 78	

TABLE 8.1 - PORTABLE SCALE FIELD DATA RECORDING FORM

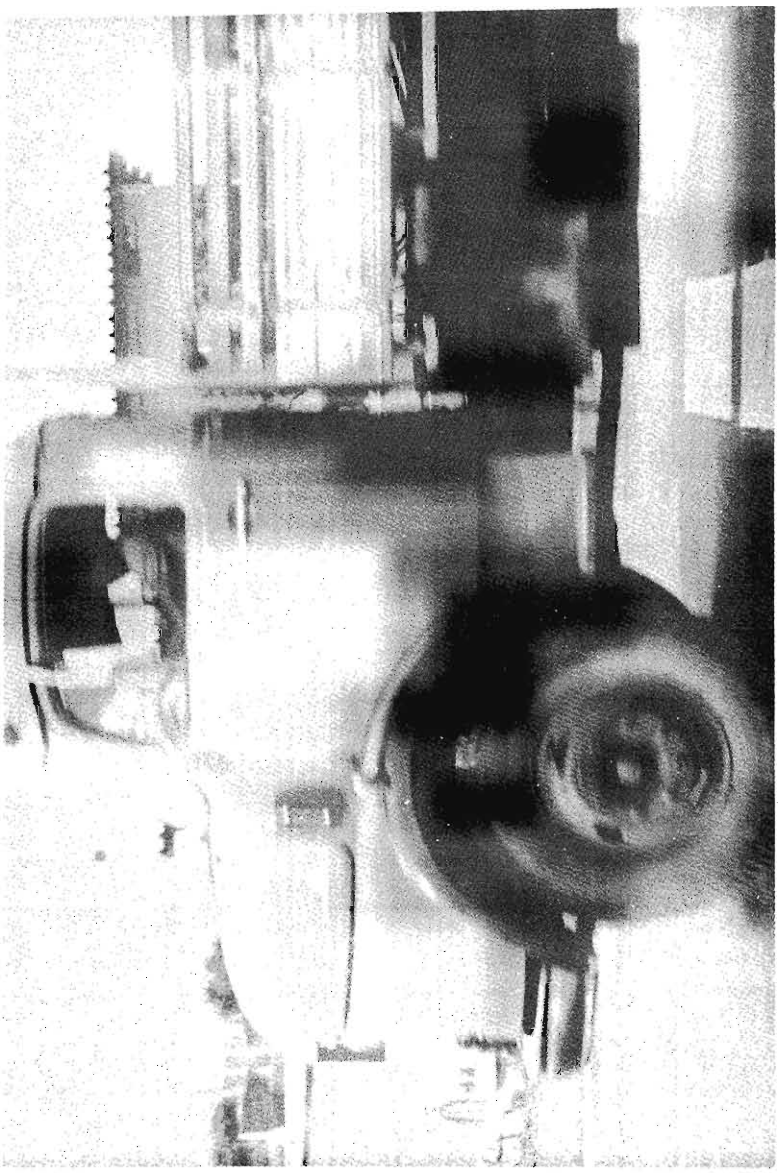


FIGURE 8.3 - TRUCK PASSING OVER WIM SITE

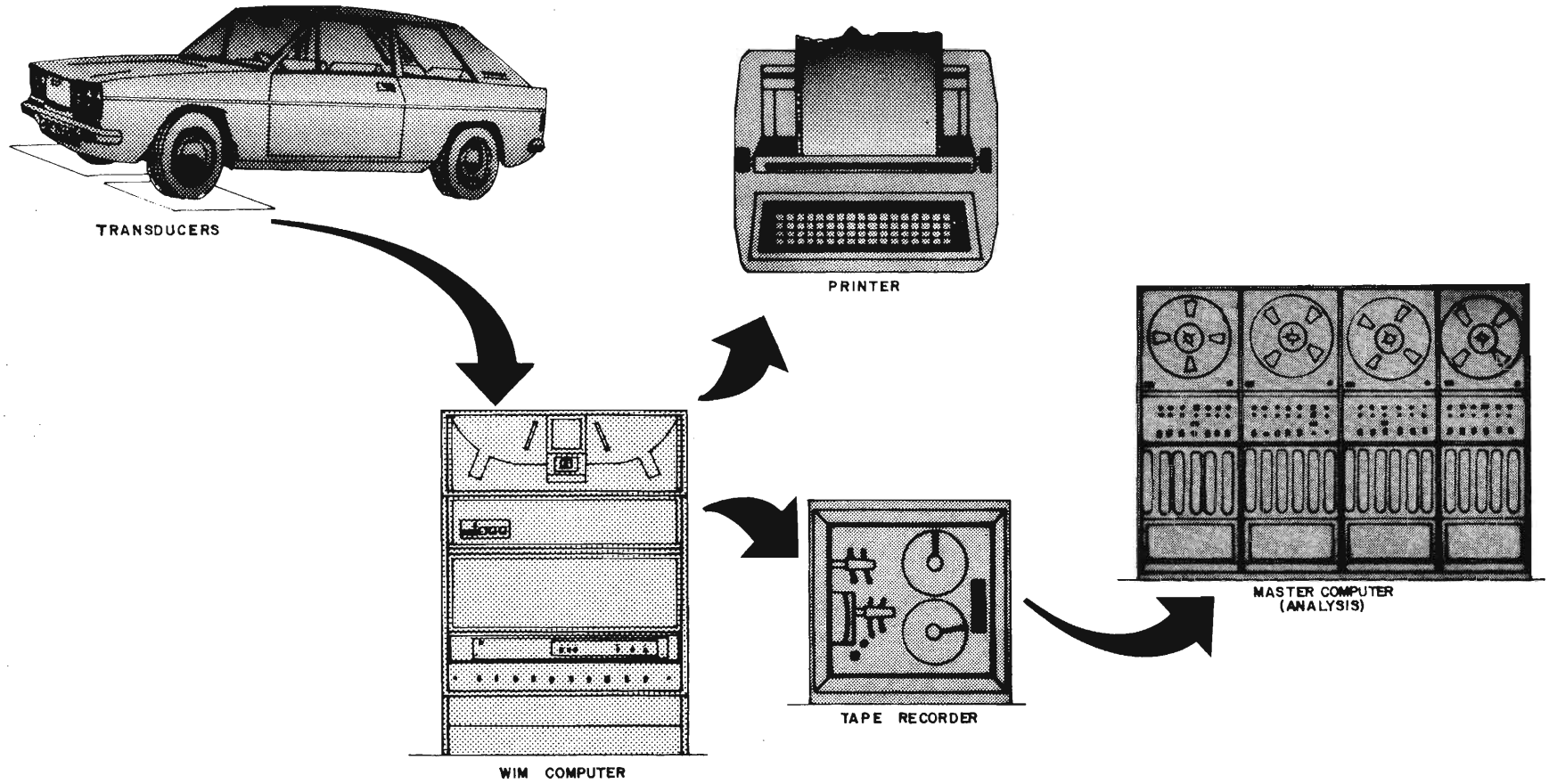


FIGURE 8.4 - WEIGH-IN-MOTION DATA ROUTE DIAGRAM

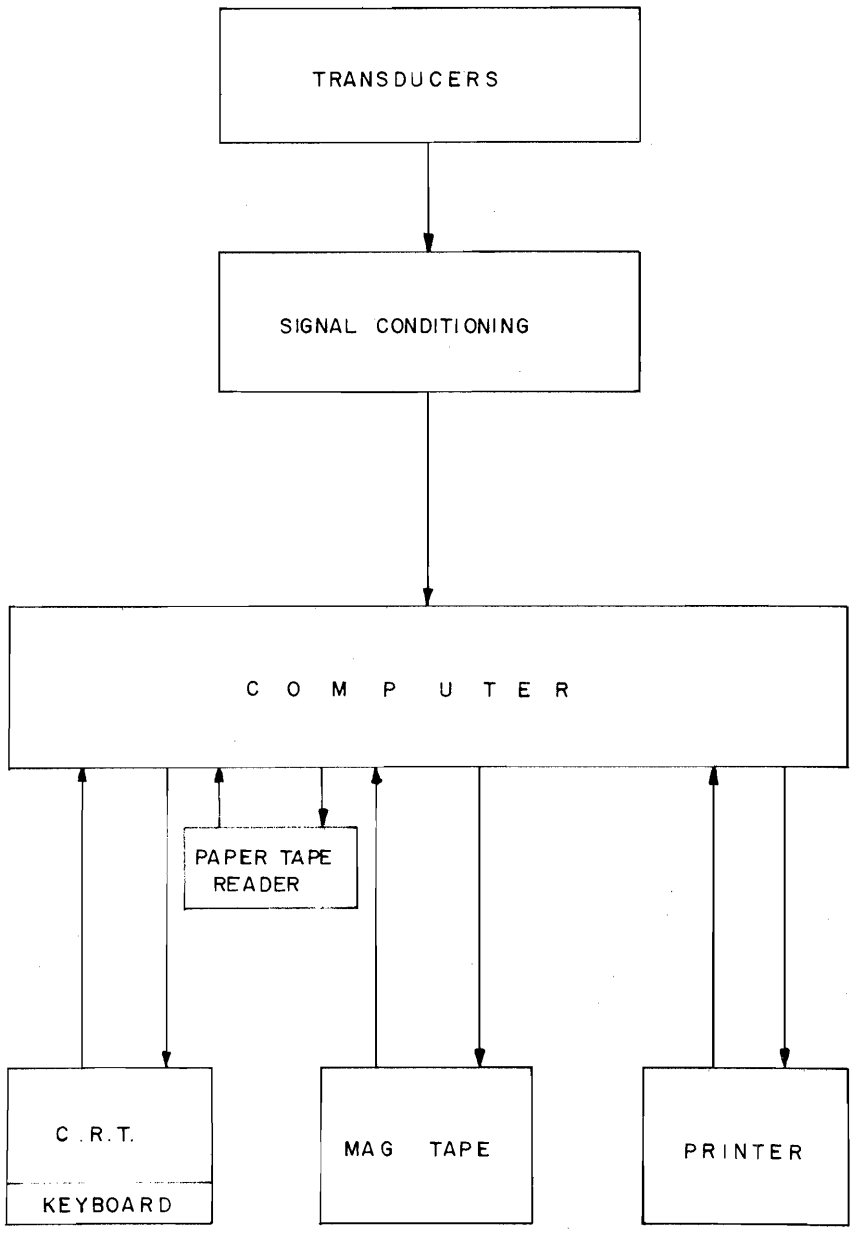


FIGURE 8.5 - SIMPLIFIED BLOCK DIAGRAM FOR WIM SYSTEM

8.3.1 *Sensors*

These are the components that are installed in the road pavement. They are used to collect data from a passing vehicle. They present it in the form of analog signals to the system. Two types of sensors were used:

A) Load Transducers

Two load-cell transducers were employed to collect weight and axle data, one for each wheel path. Each transducer consists of sixteen load-cells, eight of which are active and eight temperature-compensating. They are connected in a bridge configuration with four in each arm of the bridge. The arrangement is shown in Figure 8.6. The bridge is energized by a constant voltage and under "no load" conditions, gives a zero output. When a load is applied to the active load-cells, their resistance value is changed in proportion to the load applied and the bridge outputs a voltage in the same proportion. This signal voltage is then routed to the signal-conditioning unit.

B) Inductive Loops

These were used to collect speed and vehicle length data and to inform the computer of the "presence" of a vehicle over the transducers. Three loops were used: the first two provided the speed pulses and the third measured the vehicle length and informed the computer of the vehicle's presence.

The layout of the sensor installation is shown in Figure 8.7 and described in a Project Instrumentation Memo (Buller, "Weigh-In-Motion System") which also gives details on the method of making the installation. Figures 8.8 through 8.11 show various stages of the installation.

Calibration procedures for the sensor is covered in a Project Instrumentation Operational Memo (Buller, "Weigh-In-Motion System").

8.3.2 *The Signal Conditioning Unit*

This unit converts the analog signals from the sensors into a digital form that the computer recognizes.

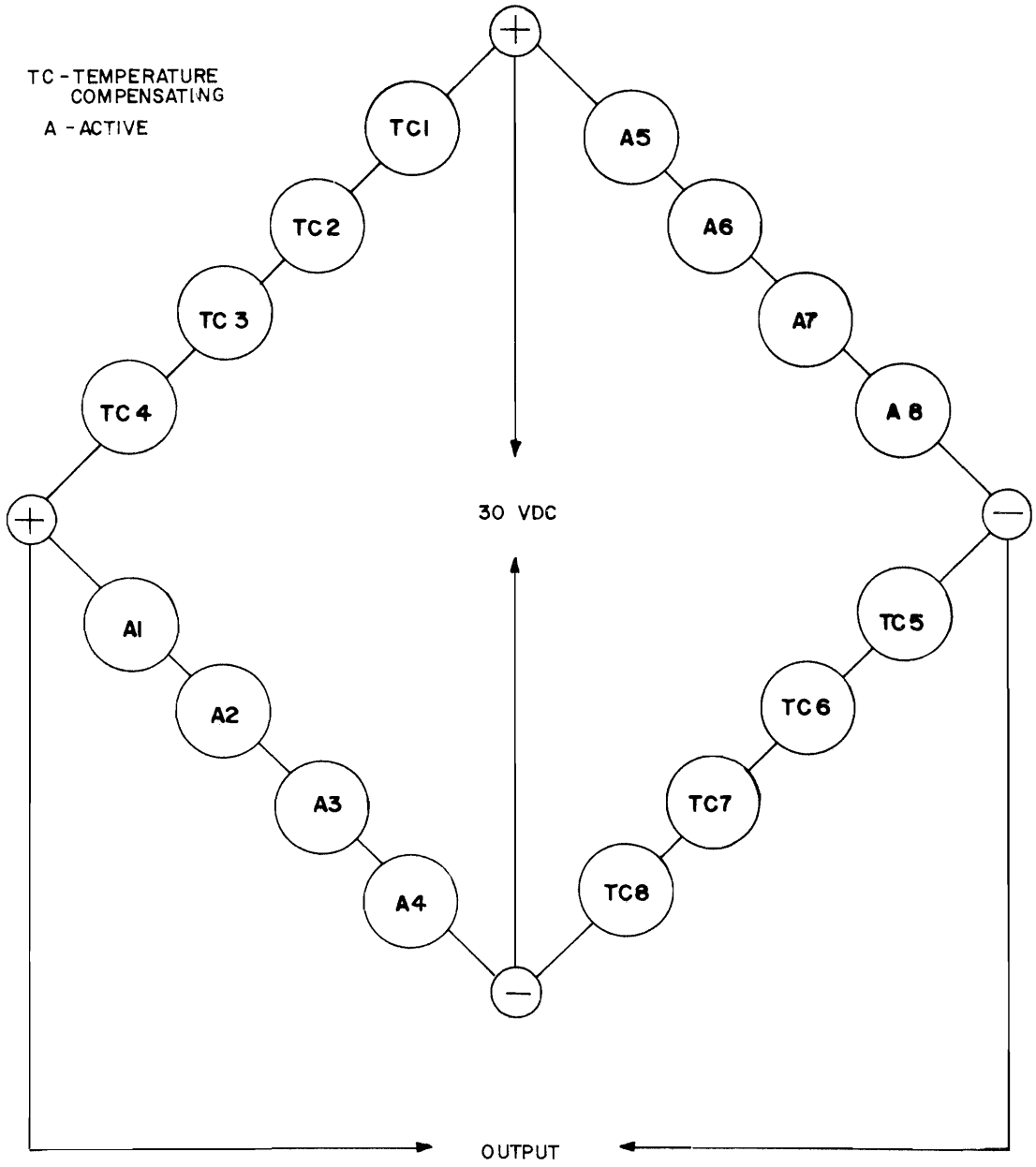


FIGURE 8.6 - LOAD CELLS BRIDGE ARRANGEMENT

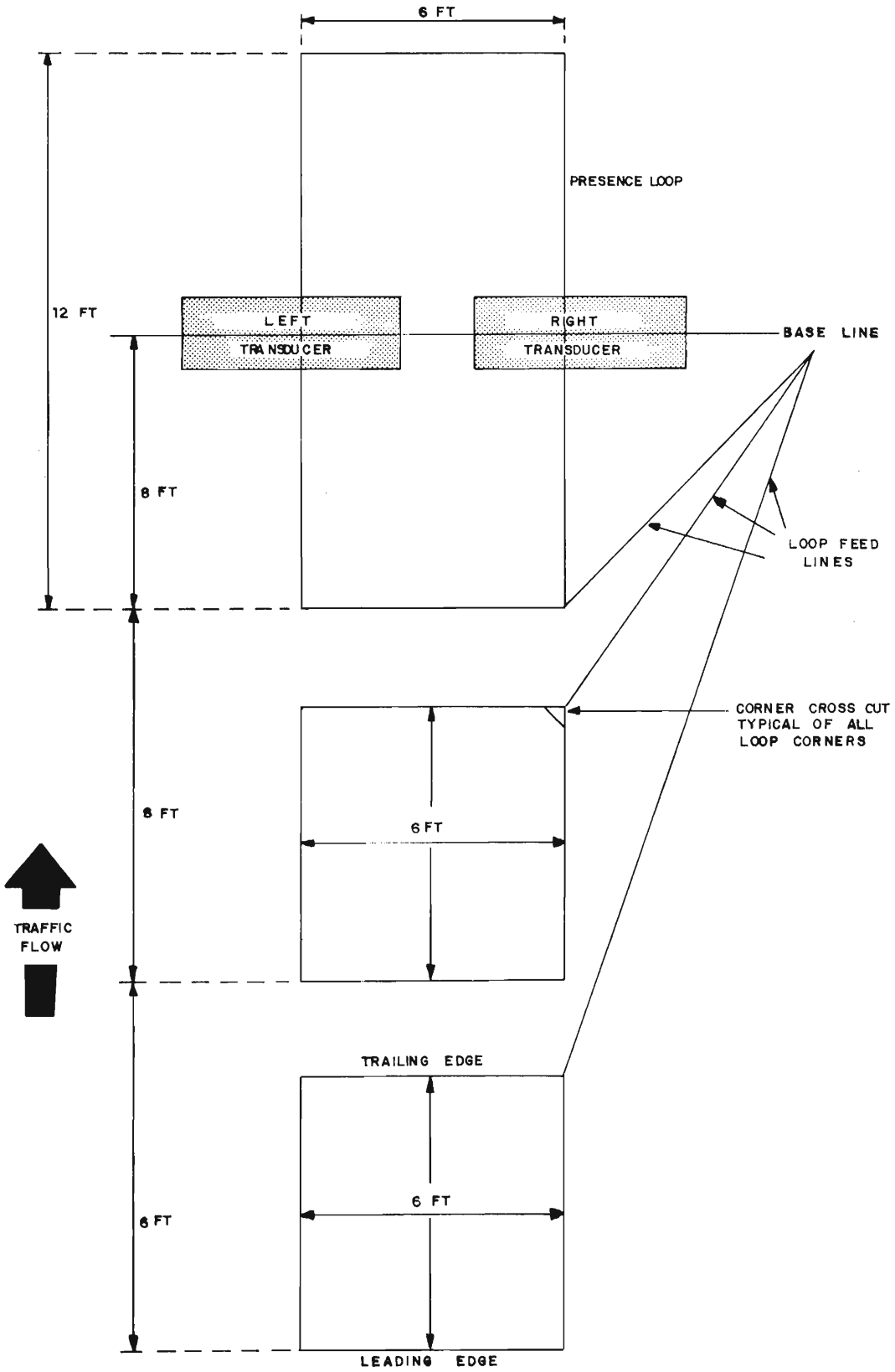


FIGURE 8.7 - TRANSDUCER INSTALLATION LAYOUT

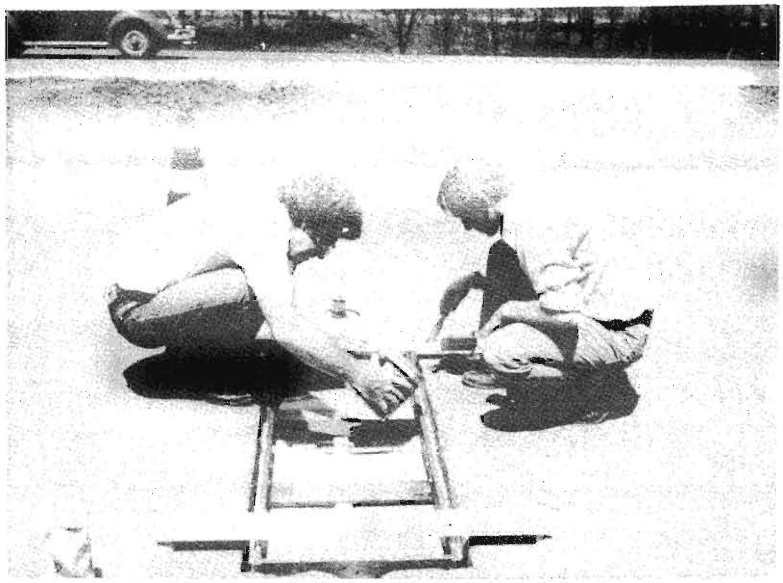


FIGURE 8.8 - TECHNICIANS LEVELLING TRANSDUCER SUPPORT STRUCTURE

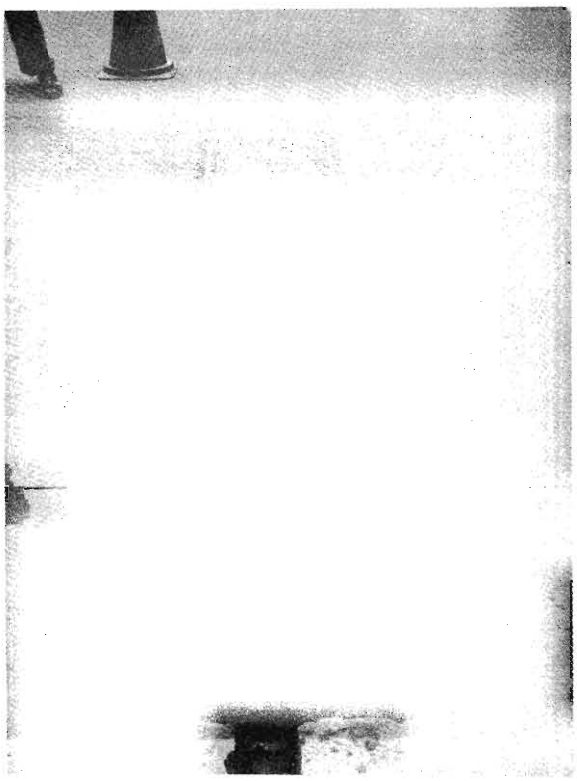


FIGURE 8.9 - INSTALLATION OF TRANSDUCER SUPPORT STRUCTURE

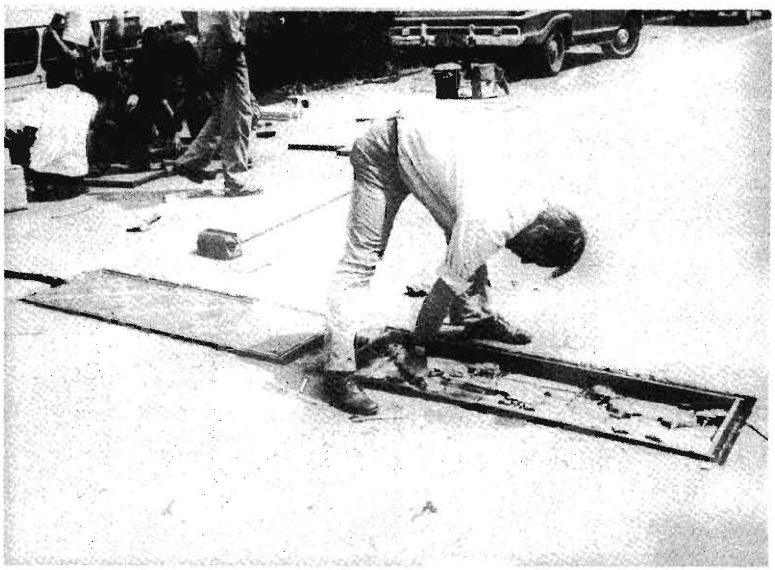


FIGURE 8.10 - TECHNICIAN ADJUSTING LOAD TRANSDUCER POSITION

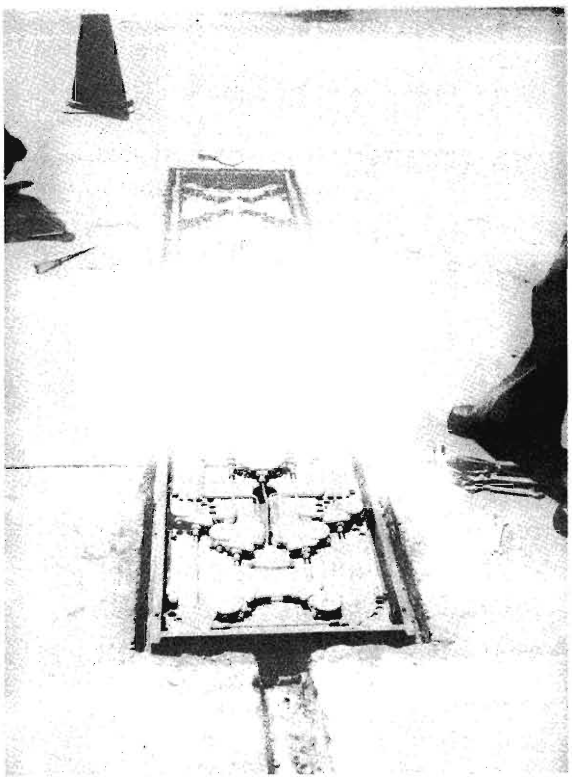


FIGURE 8.11 - LOAD TRANSDUCERS READY TO BE COVERED WITH PRESSURE PLATES

8.3.3 *The Computer*

The computer accepts the digital data from the signal conditioning unit, performs the required calculations to allow it to feed the data out in units of weight, length and speed. It also commands the operation of peripheral units at the appropriate times and produces the time-of-day for display and recording.

8.3.4 *The Video Unit (CRT)*

This unit receives data from the computer on command and displays the information in alphanumeric form.

8.3.5 *The Keyboard*

The keyboard is used by the operator to communicate with the computer and to enter additional data such as the vehicle class, site code number, and operator code number.

8.3.6 *The Magnetic Tape Unit*

This unit records the selected data on magnetic tape on command, providing that it receives correct data. The unit has data checking capability.

8.3.7 *The Printer*

This is an optional unit which can print the data as displayed on the CRT in the same format as the display. The format is as follows:

```
PESQUISA DE PESAGEM - KM 01 - BR 040.....(1)
0189    1529HRS      12/05/77 .....(2)
  1        2             3     .....(3)
D1659    3750        3700=9050.....(4)
E1650    3600        3850=9050.....(5)
 3300    7300        7500      .....(6)
```

```
          3.2       1.7          .....(7)
   18114PB   5.0DE      11.1CC    46.9KMH,.....(8)
   CLASSE DO EIXO = 5  .....(9)
```

Line (1) - is operator entered data giving a heading and the site location.

Line (2) - gives the equipment originated record number, time-of-day and the date.

Line (3) - shows the number of axles.

Line (4) - gives individual and total right-wheel weights.

Line (5) - gives individual and total left-wheel weights.

Line (6) - gives total axle weights.

8.3.8 *The Paper Tape Reader*

This is required for loading a program or diagnostic into the computer and is located at the top of the computer cabinet.

8.3.9 *Field Operation*

Items 8.3.2 through 8.3.8, described above, were installed in a trailer as shown in Figures 8.12 to 8.14. A functional description, details of the trailer installation and site selection guidelines are covered in a Project Technical Memo (Buller, "Weigh-In-Motion System").

The equipment requires an electricity supply of 115 volts at 60 Hz, provided by a 4 K.V.A. diesel generator set. This supply voltage was monitored by a voltmeter mounted inside the trailer. The generator set was transported in the trailer's tow-vehicle.

Transducer support frames were installed in the pavement at six sites in central Brazil. The weight transducers were installed immediately prior to a period of operation and removed immediately afterwards, leaving the frames filled with asphaltic concrete. Each of the installed sites was monitored over a seven-day period for twenty-four hours per day by three operators. The operating procedure is detailed in a Project Instrumentation (Operational) Memo (Buller, "Weigh-In-Motion System") which describes the three modes of operation, namely: manual, automatic and static. The Memo also gives calibration procedures, programming instructions, preventive maintenance and in-field trouble-

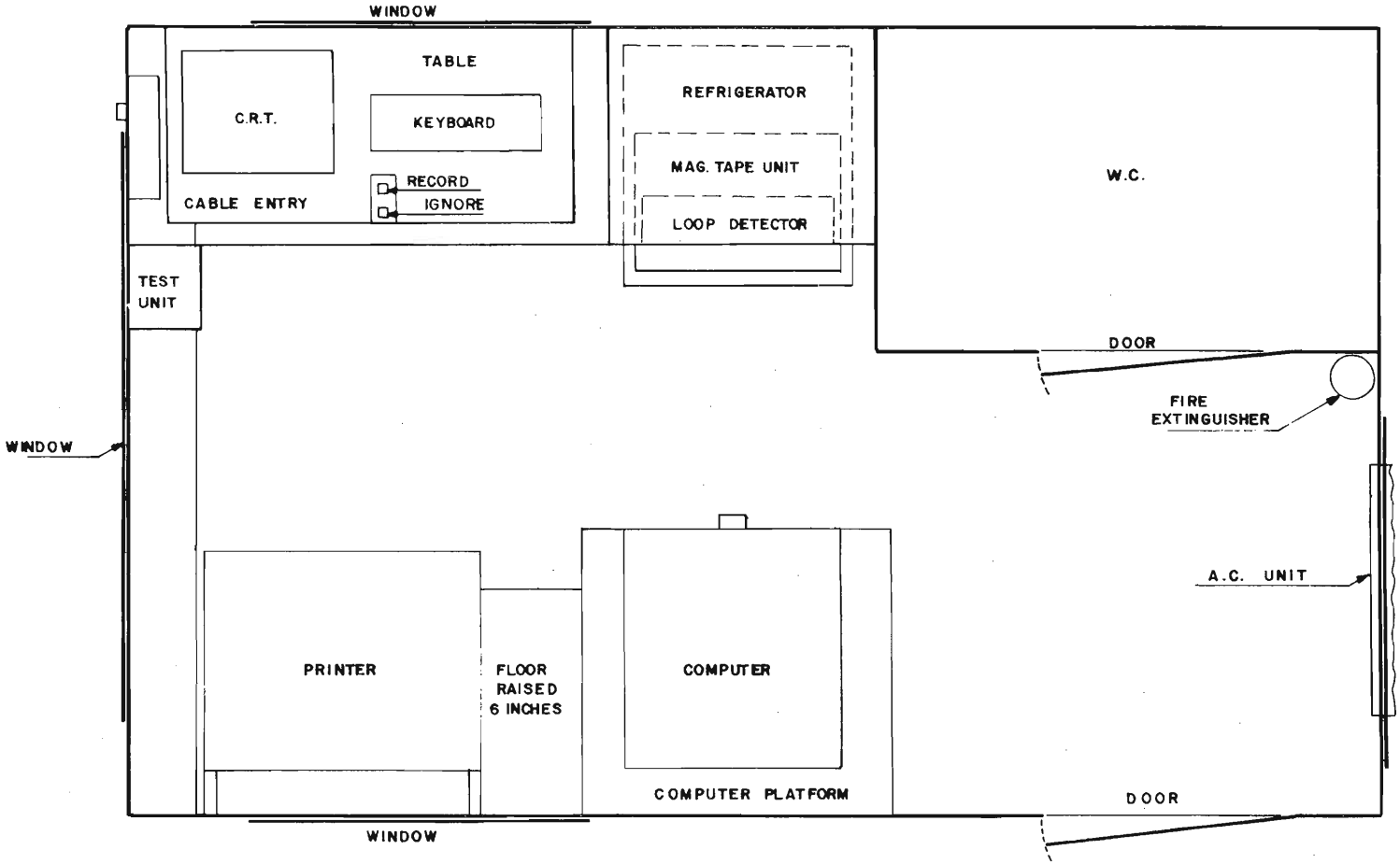


FIGURE 8.12 - TRAILER LAYOUT

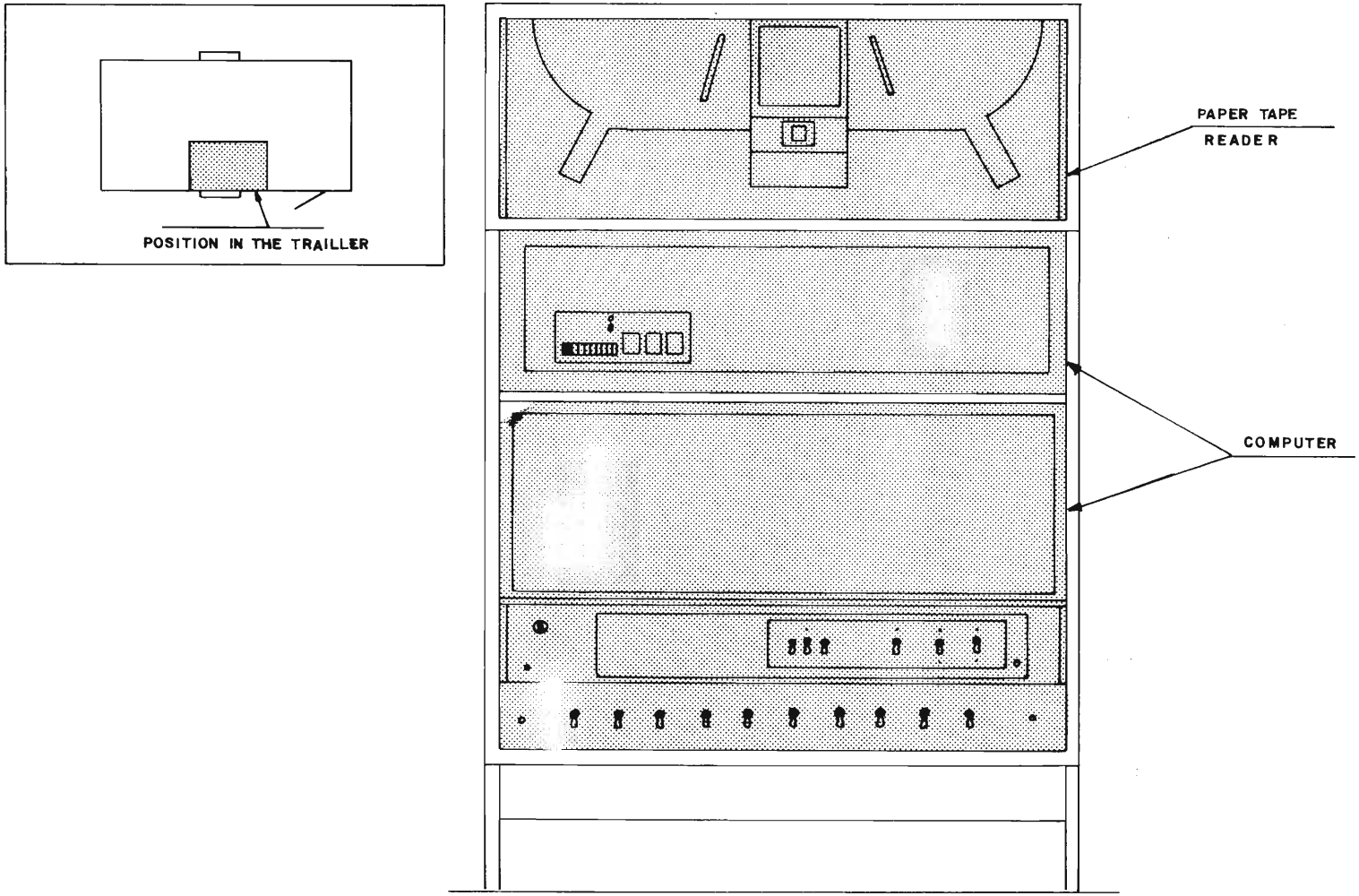


FIGURE 8.13 - COMPUTER RACK

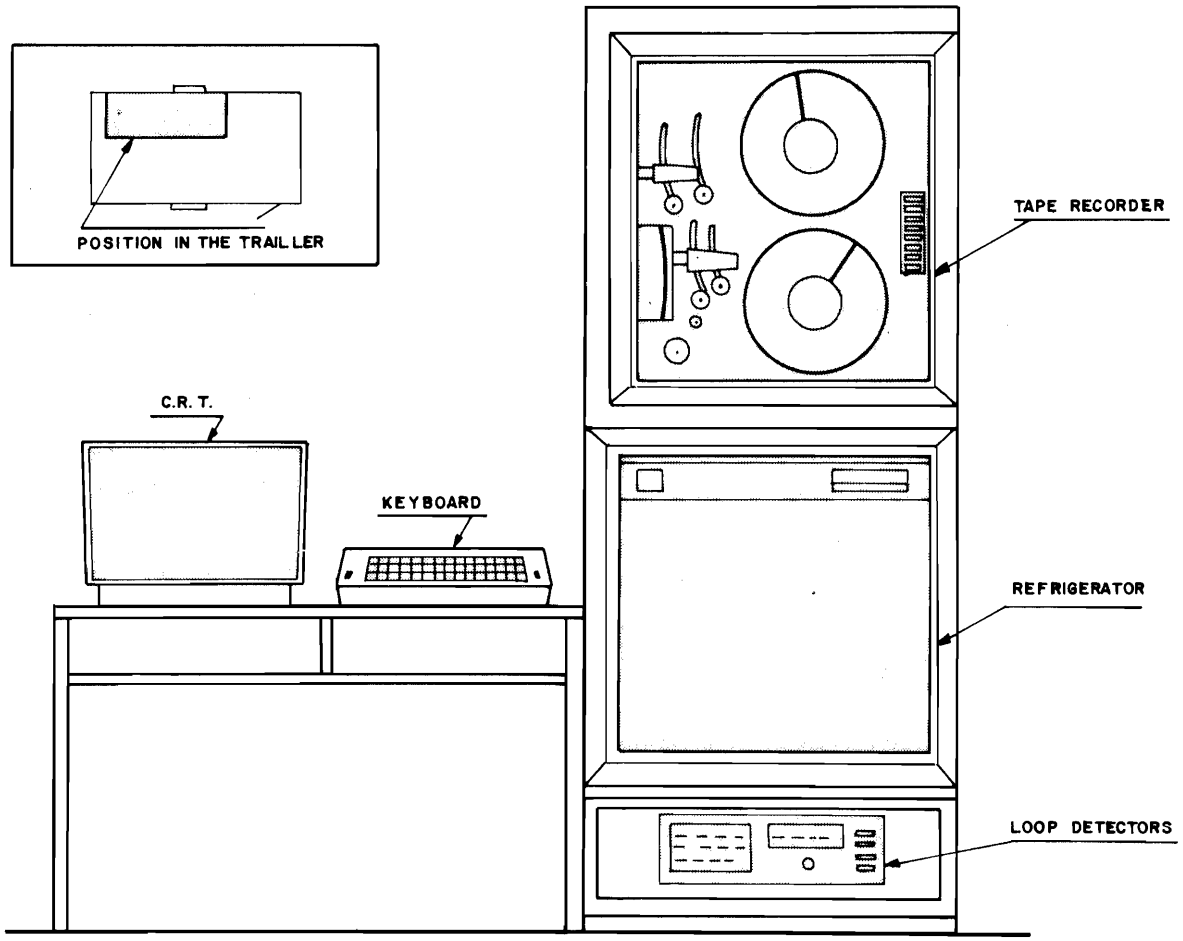


FIGURE 8.14 - PERIPHERAL EQUIPMENT

shooting guidelines.

8.3.10 *Maintenance*

The WIM system used during the study required repairs so frequently that its use was restricted to virtually a single trip to the six established test locations. Even on this single trip the data collection was frequently interrupted by malfunctions. The general opinion was that the equipment needed more development before it could be considered reliable.

The computer and peripheral equipment were designed to be operated at a permanent installation and consequently did not withstand the vibration that they were subjected to while being towed over thousands of kilometers of rough roads. This caused problems in the computer that remained unsolved even after several visits by technical personnel from Data General do Brasil, representative in Brazil for Data General Co., which manufactured the computer. Furthermore, all of the equipment was designed to be used in an air-conditioned clean atmosphere and was adversely affected following subjection to the dust-laden atmosphere of field work. Calibrating the sensors was always a problem and many load-cells had to be changed during the short operation period.

In brief, the WIM system experienced all the hardware and software problems that frequently occur with prototype equipment.

A discussion of some of the problems encountered with the equipment is presented in a Project Instrumentation Memo (Buller, "Weigh-In-Motion System").

8.3.11 *Recommended Maintenance Facilities*

One electronics engineer
One electronics technician (senior)
Oscilloscope
Digital Multimeter
Tools.