BRIDGE WIM USERS MANUAL

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OVERVIEW

This manual describes how to set up, operate and trouble-shoot the Bridge WIM system currently on loan to the Washington State Department of Transportation (WSDOT) from the Federal Highway Administration (FHWA). This document is intended to be used as a reference. The user should have some hands on training in the setup and operation of the equipment from a previous user before trying to operate the system by him/herself. If more information is needed than is available in this manual, look up the *Bridge Weigh In Motion System Users Manual* written by Bridge Weighing Systems, Inc., located in the file cabinets in the back of the van.

The operator of the WIM van should also have on hand a notebook for recording various pieces of information and a simple calculator for performing several mathematical computations during the setup of the equipment.

This manual is divided into the following sections:

- Introduction to Equipment,
- Equipment Setup,
- Introduction to the Computer,
- Computer Software,
- Trouble-shooting Assistance.

INTRODUCTION TO THE EQUIPMENT

The FHWA Bridge WIM system consists of the following parts:

- strain gages to be attached to the bridge,
- a signal conditioner,
- a DEC MINC computer,
- an analog to digital converter,
- axle sensors (tape switches and/or road tubes),
- a generator on the truck,
- an air conditioning unit on top of the truck.

Each of these pieces of equipment must be in place and functioning before the system can operate. All pieces of equipment can be found in the WIM van. The setup of the equipment is discussed in detail in the following chapter.

OVERVIEW OF THE SYSTEM

The Bridge WIM system operates by measuring the deflection of a bridge as trucks pass over it. To make the necessary calculations, the computer uses two types of input data:

- strain gage readings from the girders of the bridge, and
- axle sensor pulses as trucks approach the bridge.

The strain gage information tells the computer how far the bridge is deflecting at specified moments in time. The axle pulses tell the computer how fast the truck is going, how many axles the vehicle has, and what the spacing is between those axles.

The computer then calculates what loads are present given the deflection occurring and the location of the load (axle locations on the bridge) at any given point in time. It makes several (30 to 100) such calculations for each vehicle, and then computes the most likely actual loads based on the different calculations it has derived and a curve fitting routine.

THE ROLE OF EACH PIECE OF EQUIPMENT

As might be expected, the DEC MINC computer processes and stores the data collected by the various sensors, and performs the axle weight calculations. It is also used to perform additional calculations after the data collection has been completed.

The signal conditioner accepts the electronic, analog signals output from the strain gages on the bridge, clarifies them, and amplifies them for further processing.

Further processing begins by converting the analog signals to digital information capable of being stored and analyzed by the computer. This task is performed by the analog to digital converter which is included in the computer cabinet. Information from this device is written onto computer disk (automatically) for further use by computer programs.

Axle sensor (tape switch and/or road tube) information is also input into the signal conditioner, from which it is passed to the computer.

The generator mounted in the right rear compartment of the van provides power for both the computer and the air conditioning unit on top of the truck. The generator operates off its own fuel tank (located on top of the generator). A five gallon gasoline can is located in the generator compartment for refueling the generator's gasoline tank. The generator should be warmed up before turning on the computer and air conditioning devices. Air conditioning/heating is used to maintain the temperature in the van, and protect the computer from overheating or suffering from other temperature effects.

EQUIPMENT SETUP

STRAIN GAGES

The strain gages are the first equipment to be placed at the site. One gage should be placed on each girder of the bridge, with a maximum of six girders being instrumented per bridge. If the bridge has more than six girders, use the six girders most directly underneath the lanes of traffic you will be monitoring. Use your judgment on this, and be aware that having girders without strain gages does not significantly decrease the reliability of truck weight estimates.

The strain gages should be placed towards the middle of the span being used. They should be located somewhere in the middle one-third of the span (See Exhibit 1). Note: measure from the end of the span not the end of the bridge. All strain gages should be the same distance from the end of the span. This is very important.

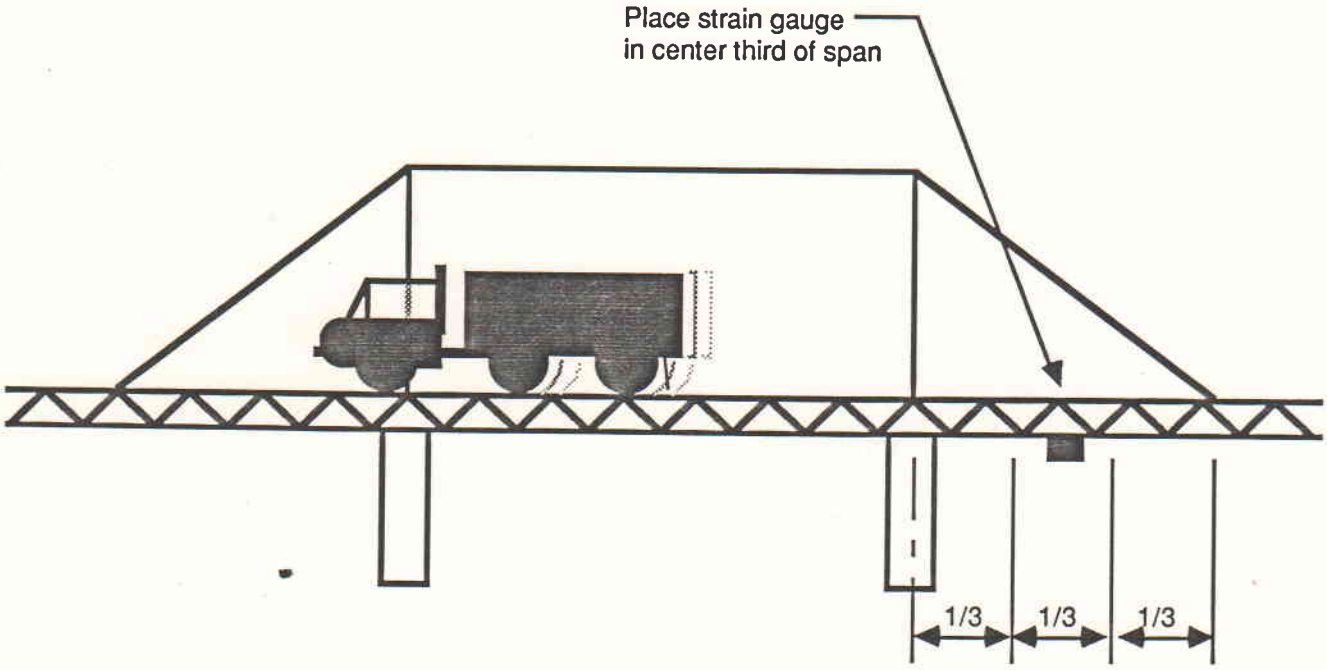
Attach the gages with a "C" or bar-clamp if possible. If this is not possible, obtain the permission of the Bridge Branch to drill the bridge and place anchor bolts. Note: this should only be requested by someone experienced with the bridge WIM system; it must be performed by qualified WSDOT personnel, and the written permission of the Bridge Branch of the Department must be obtained before drilling can occur.

When attaching the gages to the bridge, make sure they are secure, and provide them with strain relief so that accidental pulls on the attached wires will not damage the gages. Write down the number and location of each strain gage used. This information will be used later during the calibration of the equipment. These same gages should be used (and placed at the same locations) for any subsequent weighing to be done at this bridge. This will prevent the need for recalibration of the equipment for each subsequent weighing operation at that bridge. Also number the gages one through six (or however many are placed) starting with the right side of the roadway. These numbers are used for attaching cables between the gages and electronic equipment.

Attach to each of the gages a long thin cable from the available cables in the van, and run that cable to a convenient location beside the bridge. It will eventually be fed into an "S" box (see

Exhibit 1

Strain Gauge Location



"Appendix A"). From the "S" box, run a large cable to the left side of the van. At the van, the large cable attaches to another large cable that extends from the van's left side (driver's side). This cable is already attached to the signal conditioner inside the van. Note that there are two large cables that will extend from the van. Only one of these cables will connect to the "S" box cable.

The "S" box has room for four cables (use cables for gages 1 through 4). If six strain gages are used, the last two strain gage cables must be taken directly back to the WIM van rather than to the "S" box. These "extra" cables attach to other thin cables also located at the left side of the van. The cable for each gage should be placed in the appropriate spot in the "S" box or attached to the appropriately marked small cable extending from the van for the number of that gage (i.e., 1 through 6).

AXLE SENSORS

After the strain gages are in place (i.e., you prove it is possible to instrument the bridge), the axle sensors can be placed on the road. When heavy traffic volumes exist, axle sensors may be placed before the strain gages if this eases their installation (e.g., lower traffic volumes are present early in the morning.)

Two axle sensors should be placed in each lane of traffic to be monitored. They should be of the same type (i.e., both tape switches or both road tubes), and should be placed parallel to each other and perpendicular to the road. Tape switches should only be placed in the wheel path closest to the shoulder. Measure the distance from the first axle sensor (i.e., the sensor hit first by the oncoming truck) to the second sensor and from the first sensor to the joint that marks the beginning of the bridge. The two sensors should be about six feet apart. This information will be input into the computer at the start of the data collection program. If road tubes are used, make sure the tubes are of equal length. Also, use as short a road tube as is practical. Make sure that the tubes are placed in such a manner as to reduce the amount of slap that occurs when an axle hits the tube. Use of the tape switches rather than road tubes is recommended whenever possible.

Attach short thin wires found in the van (identical to those attached to the strain gages) to the axle sensors, and run the wires to a "T" box (for road tubes, the wire connects to the "junior"

traffic counter box). Attach a longer thin cable to the "T" box, and run it to a "D" or "K" box. If you are instrumenting two lanes, you will need to follow the above directions twice. (A "T" box holds two input tape switch wires and has a place for one small output wire.)

The "K" box is a square keypad device. The keypad is used to input descriptive information about vehicles being weighed. It is an optional device when only one lane of traffic is being weighed. It is a mandatory device if two lanes are to be used. Pushing a keypad button causes a numeric code to be entered into the strain record of a truck being weighed. This number can be used to describe any attribute desired. The keypad labels are currently designed to indicate the style of truck being weighed (i.e., box, tanker, dump, etc.). The keypad may be used for other purposes.

If the axle sensor wires are hooked to the "D" box and the keypad will be used, run a large wire from the keypad (or "K" box) to the "D" box. Then run another large wire from the "D" box to the van. If the axle sensor wires are attached to the "K" box, the large wire from the "K" box can be run directly to the van.

When attaching wires to the "T" box, pay attention to the numbers on the box. The wire leading from the sensor that will be hit first by traffic goes into the connection marked TS1/TS3. The sensor closest to the bridge (i.e., hit second by approaching traffic) connects to TS2/TS4. The axle sensors in the lane expected to have the majority of truck traffic should be called sensors 1 and 2. The axle sensors in the less used lane should be called sensors 3 and 4.

THE GENERATOR

Shortly before the strain gage wiring hook-up is completed, start the generator. This is done by following the steps listed below:

- move the generator to its operating position;
- fill the gasoline tank;
- switch off auto throttle;
- switch on oil alert switch; and
- turn engine switch (ignition) key.

To set up the generator, release it from its restraining hooks. Next, either remove the generator from its cabinet (set it on the ground, two people are required for this), or spin it 90 degrees so that the controls on the front are accessible, and the exhaust vent points outward and is not blocked. If you spin the generator, use the two left-most restraining hooks to secure the generator. Note that electrical cables should not be attached between the van and the generator at this time. The equipment inside the van should be turned off. Leave the switches on the generator as they are currently set.

The generator operates off its own gas tank. A five gallon gas tank is included in the generator compartment for refueling the generator. The gas cap to the generator is located on top of the generator. The fuel gage on the top left of the generator will let you keep track of the fuel level in the tank as it fills.

To turn on the generator make sure there is sufficient gas in the tank, and that the "Oil Alert" switch is on (leave the auto throttle switch off). Then simply turn the key. Let the generator operate for ten to fifteen minutes. After the generator is warm, connect the electrical cords between the generator and the connections on the outside of the van. (The connections are about eye level above the rear tire on the left side of the van.) The electrical cords can be found in the generator compartment of the van. They are attached to the electrical plugs marked 19A on the generator. It does not matter which 19A plug is used for the computer outlet and which is used for the air conditioner. On the van, plug number 1 is for the computer. Plug number 2 is for the interior lights and the air conditioner.

When operating the generator, leave the automatic throttle turned off. This feature has proven unreliable when both the computer and air conditioner are operating for long periods of time.

COMPUTER

Before turning on the computer, turn on the air conditioning/heating unit attached to the ceiling of the van. (Note that the generator must be warm and the electrical plugs attached before

turning on the air conditioning.) The computer often does not work if the air in the van is cold or uncomfortably hot. Use the van's heater to assist warming the air initially if the van is very cold.

While the van is warming/cooling record the strain gage numbers and locations and the tape switch locations in the record book describing that bridge location. Then check to make sure all the pieces of electronics in the van are hooked up. The equipment in the van includes:

- the computer (including analog to digital converter),
- signal conditioner,
- CRT screen,
- keyboard,
- disk drive unit (contains two 8" floppy drives), and
- printer.

Its location in the van is shown in Exhibit 2. Check to be sure that no loose wires are apparent. In particular, check the connection between the keyboard and the CRT screen, as this frequently comes loose in transit between locations.

Place a "system" diskette in the left hand drive of the disk drive unit and close the door. Then turn on the power to the computer using the surge protector switch (a long gray box with six electrical outlets, located behind the signal conditioner).

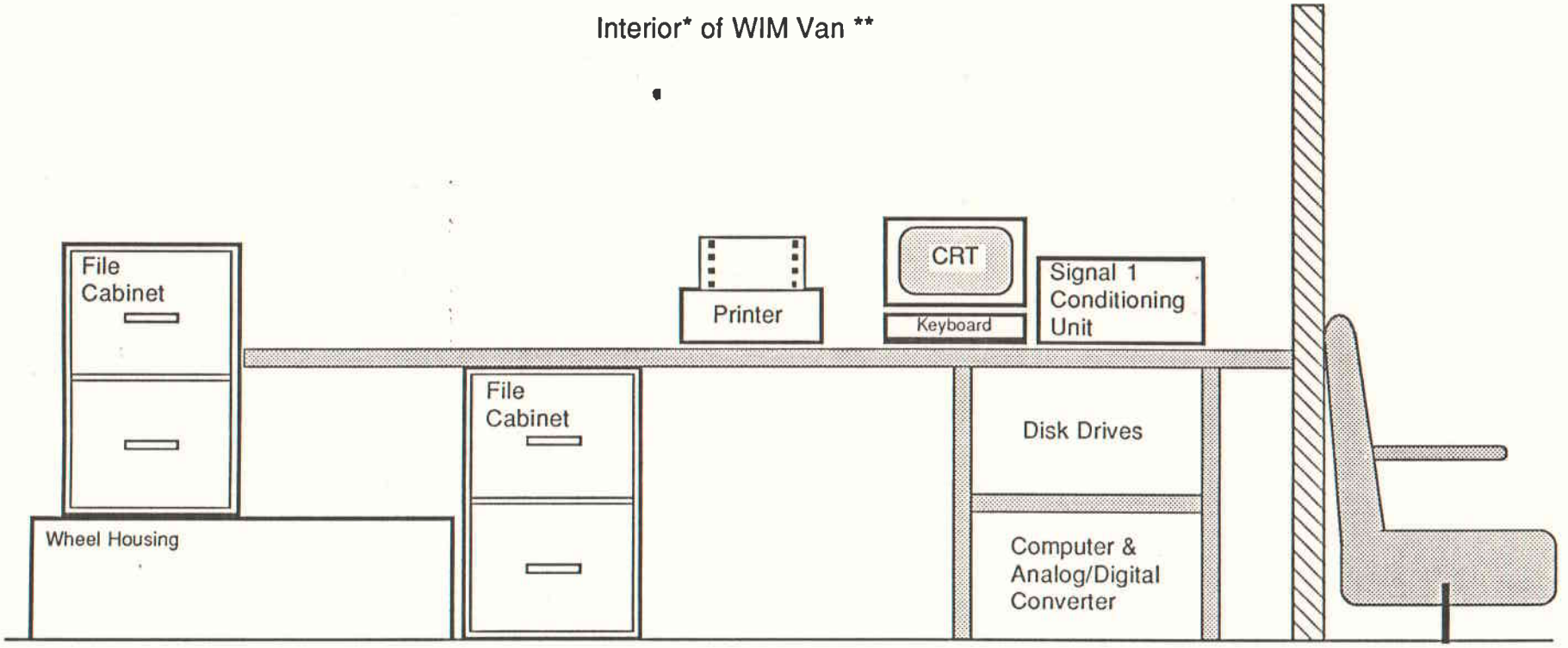
The computer should "beep" at you, and you should hear the disk drives spin. If everything goes as expected, the computer will print several lines of text and finally a single period (.) to indicate that you are at the operating system level and the computer is ready for your next command. At this point go to the section on "software" operation below.

If the system does not respond as indicated above, open the disk drive, take out the system disk, insert it and close the door. Then type **173000G**. This should "boot" (start) the system. If this fails, turn off the computer (at the surge protector), take out the system disk and replace it with a back-up system disk, and turn the computer on again.

If the machine still does not respond appropriately, turn to the "Trouble-Shooting" section at the back of this document.

Exhibit 2

Interior* of WIM Van **



* Viewed from side doors

** Two chairs are not shown in this figure

SIGNAL CONDITIONER

The signal conditioner clarifies and strengthens the information gathered by the strain gages and axle sensors. Before it can be used, however, the components have to be adjusted so that the conditioning unit provides the correct amount of signal voltage (gain) and uses the proper reference point to indicate when the strain gages are not under load (referred to as being "balanced").

To set the "gain", follow the steps below.

1. Write down the numbers of the strain gages placed on the bridge and their calibration constants (called C). The calibration constants can be found in Exhibit 3.
2. Calculate the average of these constants (mean C).
3. The initial "gain" for each gage is calculated as 900 times that gage's calibration constant divided by the average constant computed above (900 * C / mean C).
4. Set the gain dial on the signal conditioning unit for each gage's initial "gain." To do this unlock the dial and spin it so that the hundreds digit appears in the window.
5. Now flip the calibration switch (see Exhibit 4) on the second panel from the left to the lower position, and the automatic/manual switch immediately to the left of the calibration switch to the manual position.
6. Use the COARSE and FINE tuning dials for each of the strain gage channels to place the tension/compression lights in the middle of the five lights.
7. Now plug the multimeter (or similar device) into the connector marked "Select 1" on the left-hand panel. Turn the selector dial to "Strain 1" and observe the reading on the multimeter as a truck goes over the bridge.
8. Move the select button to "Strain 2" and observe a reading as a truck passes over.

The objective is to achieve a maximum of five volts when a heavy truck goes over the bridge. If the voltage being output by the conditioner seems too high, recalculate the "gain" using

Exhibit 3
CALIBRATION CONSTANTS FOR STRAIN GAGES

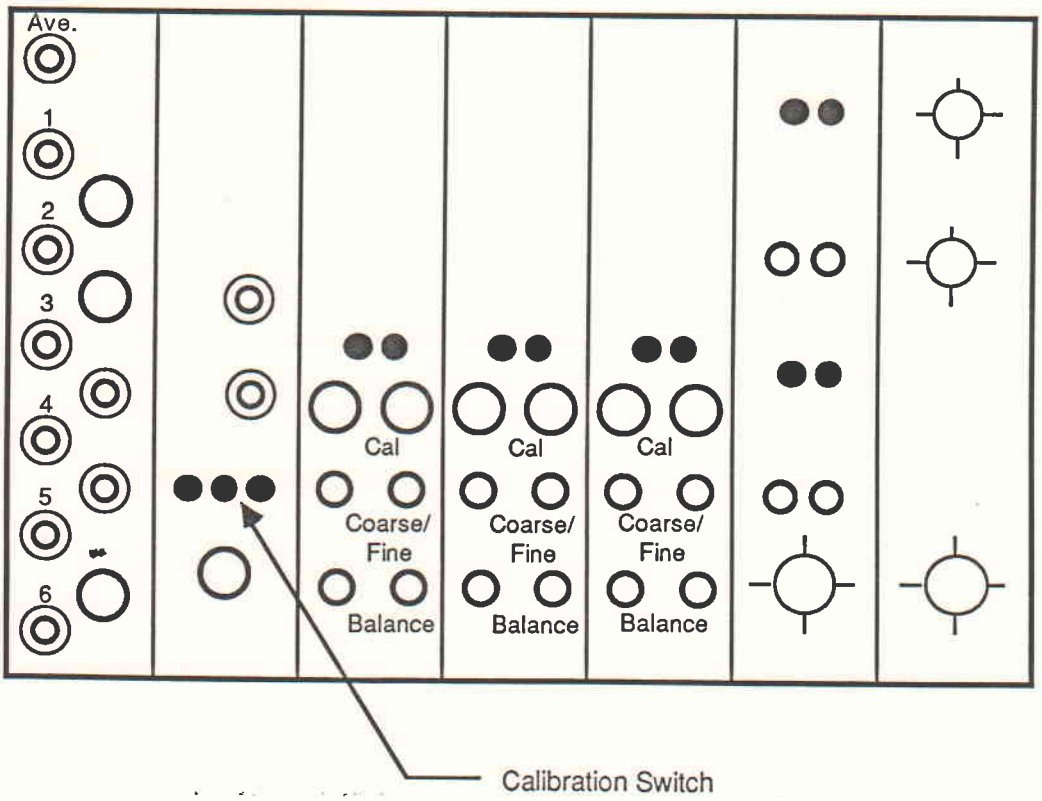
Gage Number	Calibration Factor
127B	126.52
129B	132.84
130B	120.91
131B	123.99
133B	132.10
134B	132.67
136B	125.73
137B	114.29
138B	120.36
140B	124.89
141B	120.05
142B	120.61
143B	113.98
153B	119.09
154B	128.13
155B	124.16
156B	132.26
157B	123.27
158B	120.20
159b	128.54
197B	121.76
223B	119.83
491B	125.96
496B	129.30
497B	124.91
498B	127.24
500B	142.55
503B	138.27
519B	159.32
525B	146.73
526B	190.56

a constant of 800 or lower, and adjust the "gain" dials as in step 4 above. Voltages higher than five volts will not be recorded correctly by the computer and will cause errors in the weight estimates for those trucks.

When the signal on the multimeter is satisfactory, recheck the balance of the gages, and then turn the calibration switch (see Exhibit 4) back to the middle position. Also place the "automatic/manual" switch immediately to the left of the calibration switch on "automatic."

When collecting strain information (i.e., when you are weighing trucks) periodically examine the strain gage lights to ensure that the gages are still functioning. Periodically a gage will fail. This is particularly true on bridges that have gages attached to anchor bolts (e.g., box girder bridges). When a gage fails, it will remain either positive or negative, regardless of when a vehicle passes over the bridge. When operating correctly, the gage will flutter between positive and negative until a vehicle passes and then show positive (tension). If a gage fails during operation, replace it, or note it, so that its effects can be minimized using weighting factors in the PFFF program.

Exhibit 4
Signal Conditioner



BNC Connectors

Switches

Cable Connections
to the Bridge

Adjustment Dial

INTRODUCTION TO THE COMPUTER

As stated earlier, this version of the Bridge WIM system uses a DEC MINC computer. It is based on the DEC PDP-11 computer, and runs an operating system called RT-11. The computer uses an RX-02 disk drive. This drive uses 8 inch single sided, double density, soft sectored floppy disks with a record length of 128 bytes. This information is necessary to know if you need to buy diskettes for the computer, or if you have problems with the computer and need to have it serviced.

Each floppy diskette can hold weight information for 400 trucks. Before starting to collect data, it is advisable that the system operator (van driver) make sure that enough floppy diskettes are on hand and properly formatted to collect the desired truck weight information. (See the FICREA instructions on page 18.)

On the computer, the left-hand disk drive (as you sit in the captain's chair and face the computer) is referred to as DY0. The right-hand disk drive is called DY1. The "system" disk should always be in the DY0 drive. The system disk has the computer's operating system stored on it as well as all of the programs needed to operate the Bridge WIM system.

Each diskette has a label. Use these labels to keep track of what information is stored on that particular floppy disk. Do not write directly on the floppy disk or on a label that is on the floppy disk. Write on the label and then place the label on the diskette. Pen pressure on a floppy disk can cause the diskette to become unusable.

When typing instructions to the computer or when responding to computer program prompts, use the **"DELETE" key** to erase typographical errors. This is the only method for backspacing that this computer understands.

Also be aware that the computer sometimes "forgets" to add a line feed after it asks a question. After waiting several seconds in case the computer is just slow, simply type your response over the top of whatever characters are on the last line on the screen.

COMPUTER SOFTWARE

All of the program software for operating the Bridge WIM system and for processing the collected information is included on the "system" disks. Three copies of the system disk are available. They are identical to each other, and are located in the lower file cabinet drawer in the back of the WIM van.

Programs that might be run during the course of a data collection effort include the following:

- FICREA,
- SIMPLE,
- BILINE,
- DP5,
- FIND,
- PFFF, and
- SUMARY.

FICREA is used to format and initialize data disks. BILINE and SIMPLE calculate the influence line of the bridge to be used (an input to the DP5 program) based on the dimensions and design of the bridge. DP5 is the program which the computer runs when it is actually collecting data. FIND is used to determine how much information is already stored on a diskette and how much room there is for additional information. PFFF is used to process the strain gage information collected at the bridge site into truck weight information. SUMARY provides a method for summarizing and outputting the weights calculated by the PFFF program. The execution of each of these programs is described below.

Before executing any of these programs, you should enter the time of day into the computer. This is done by typing:

TIME hh:mm:ss

starting at a system prompt (a period). Enter hours (hh) in military time, and include the two colons.

FICREA

The FICREA program prepares new floppy disks for use in the computer. To run this program, place a system disk in DY0, and place an unused floppy disk in DY1. Starting with a period (.) showing on the screen, type:

@DY0:FICREA

This program will format each disk and create the necessary files on it for storing truck weight information. It takes several minutes to prepare each diskette. The computer will write several lines to the CRT screen before it's done. Do not use the computer until it types the command

.DIR DY1:

and then performs that command and writes a period (.).

Each disk can hold enough information for 400 trucks, so make sure enough disks are ready to collect all the data you intend to collect, before you start the DP5 program.

SIMPLE AND BILINE

These two programs perform the same function for different types of bridges. They produce the information needed by the DP5 and PFFF programs (called the influence line) to convert strain gage and axle information into truck weight estimates. Either SIMPLE or BILINE must be executed once before the DP5 program can be used. For both programs,

- enter the requested values as real numbers (include decimals) unless specifically told that a value is an integer, and
- all responses to a question should be on the same line, separated by commas.

SIMPLE

SIMPLE is used to calculate the influence line for simply supported bridges. (Check with the Bridge Branch if you don't know if the bridge is simply supported.) To run the SIMPLE program, you will need the following information:

- a name you will give this bridge's influence line, limited to six digits in length;
- the length of the bridge span on which the strain gages are placed, in feet; and
- the distance from the bridge abutment to the strain gages, in feet.

Once this information is available, follow the procedure indicated below:

Starting with the computer on and running (the screen should show a period (.) at the cursor; if it doesn't and you need help getting the period, see "Trouble-shooting"), put the system disk in DY0 and a formatted disk in DY1, and then type:

```
RUN SIMPLE
```

The computer will ask you the name of the file you want to contain the influence line you are about to create. This name should take the following form:

```
DY1:xxxxxx.yyy
```

where xxxxxx can be any 6 or fewer alpha-numeric characters that describe that bridge to you (i.e., I405KC for a bridge on I-405 at the King County line), and yyy is the approximate length of the bridge span you will be using in feet. Note that yyy must be an integer number, do not use a decimal point.

The computer will now display:

```
INPUT LENGTH OF BRIDGE AND DISTANCE TO TRANSDUCERS
```

You should respond to this by typing the answers to this question and hitting the carriage return. Your answer should look something like this:

```
43.,21.5
```

where 43. is the length of the span in feet, and 21.5 is the distance from the end of the bridge to where the strain gages are attached.

The computer will then calculate the influence line, and write it onto the DY1 disk. It signals the end of the program by typing a period (.), signifying its return to the operating system.

BILINE

The BILINE program is used to calculate the influence line for all other types of bridges. For this program, you will need the following information:

- a name for the influence line you are calculating;
- the length of each span of the bridge, in feet;
- the approximate moment of inertia for each segment of each span of the bridge (you will have to calculate this from the bridge plans, or get someone in the bridge division to provide it for you). The units here do not matter, so long as they are consistent with each other;
- which supports on the bridge are fixed and which are simple; again, ask the bridge section if you need assistance; and
- the location of the strain gages (on which span they are located, and how far they are from the start of the bridge (not the span).

When this information is ready, place the system disk in DY0 and a formatted disk in DY1 and have the curser showing a period (.), then type:

RUN BILINE

The computer will respond:

GIVE NUMBER OF SPANS OF BRIDGE

Type an integer number and a carriage return. The computer then asks:

GIVE PROPERTIES OF SPAN 1:

 # OF DIF SECT, LENGTH, UNIFORM MOMENT OF INERTIA

If this bridge span has a uniform moment of inertia, answer all three questions on one line, such as:

1,55.,1200.

where the above would mean the span has one section, 55 feet long (note the decimal point) and has a moment of inertia of 1200 units (again note the decimal point).

If this bridge span has two or more sections (i.e., it changes moment of inertia somewhere in the span) answer only the first two parts of the computer's question (number of sections and span length) such as:

3,55.

which would mean 3 sections in this span, which are a total of 55 feet. The computer will then respond:

GIVE SECTION #, SECTION LENGTH, MOMENT OF INERTIA

You will respond with one line of numbers for each section on that span. Thus for the above input (3,55.) you would type three lines of numbers. Each line should give the section number, length in feet and moment of inertia.

For example, the response might be:

1,15.5,800.

2,25.,1000.

3,14.5,800.

Note that the length of each segment and the moment of inertia must include decimals.

The computer will then repeat the above questions for each span of the bridge. The computer will ask if the last span is identical to the first; if this is the case, it will input the last span's description for you. Upon completion of the span information, the computer will ask the following:

FIXED SUPPORTS (0=none, 1=first, 2=last, 3=both)

Answer this question by indicating whether the first and last bridge deck supports are fixed. This answer is an integer followed by a carriage return. The computer will then respond:

GIVE LOCATION OF GAGE

TYPE 1 FOR FIRST SPAN, 2 FOR 2ND....

Type the integer number which indicates the span on which the strain gages are located, (this is usually span 1).

The computer will then ask:

GIVE LENGTH FROM START OF BRIDGE

You should answer this by typing the total length, in feet, from the start of the bridge to the strain gages. Express this number as a decimal, such as:

21. (for 21 feet from the bridge abutment)

The program will then take a few minutes to compute the influence line. When it has completed this step it will print an * on the computer screen (note that it may forget to line feed here). After this * appears, type the name of the influence line with the format:

DY1:xxxxxx.yyy

where DY1 indicates the influence line should be saved on disk DY1, xxxxxx is a six digit alpha-numeric name you give the file, and yyy is the distance of the bridge, expressed as an integer, in feet.

The computer will then save the file and indicate it has completed the BILINE program by printing a period (.) on the screen.

DP5

This program can be run after the influence line program (either SIMPLE or BILINE) is completed. Before you begin DP5, however, there are several other steps you should follow to ensure the data collection will go smoothly. These steps are

- format and initialize a sufficient number of floppy disks to store the data to be collected (see page 18);
- copy the influence diagram you just created onto each of the floppy disks you are about to store data on (see below);
- make sure the strain gages and tape switches are hooked up and working; and
- balance the signal conditioner (page 11);

Copying the Influence Line

The influence line data file created by SIMPLE or BILINE should be included on each of the formatted diskettes you will be using to collect weight information. To place this file on the newly formatted disks, perform the following steps:

- copy the influence line from the original DY1 diskette it was written to onto the DY0 system diskette; and
- copy the file from the system diskette onto each of the newly formatted diskettes.

To copy a file, start with a period on the screen, and type the following:

COPY DY#:XXXXXX.YYY DY#:XXXXXX.YYY (followed by a carriage return)

where # indicates on which disk drive the data set is located. The first data set is the old data set. The second data set is the location the new data set is to be copied to. For example, if the influence line I405KC.023 is located on DY1, and you want to copy it to several diskettes, first type:

```
COPY DY1:I405KC.023 DY0:I405KC.023
```

This puts a second copy of the file on the system disk. Now replace the disk in DY1 with one of the newly formatted diskettes, and type:

```
COPY DY0:I405KC.023 DY1:I405KC.023
```

After the computer has written a period on the screen, replace the disk in DY1 with the next newly formatted diskette, and type the last command again. Repeat this as many times as you have diskettes for this bridge.

Running DP5

Now that the diskettes are ready to contain the collected weight information, you may start the data collection program DP5. At this point in time you should make sure that the strain gages and axle sensors are working, and balance the signal conditioner (see Operating the Signal Conditioner). When this is completed, you are ready to start the data collection program.

To run DP5 you will need the following information:

- the distance in feet between tape switches 1 and 2 and between switches 3 and 4 (if used);
- the distances between switches 1 and 3 and the beginning of the bridge (in feet);
- the minimum strain you want recorded, usually 0.10 to 0.3 volts;
- the number of trucks whose weight has been previously recorded on this data disk;
- the length of the bridge span (in feet) on which the strain gages are located;

- whether you want to observe the computer estimate truck weights as it collects the strain gage information;
- whether you want to use the keypad when you collect truck weight information;
- the rate at which you want strain gage information recorded (explained below);
- the number of lanes (1 or 2) from which you will collect information;
- the number of strain gages (channels) attached to the bridge;
- the name of the influence line file;
- the length of the influence line;
- the calibration factor to be used (explained later); and,
- the number of sample points you want the processing program to skip before processing the strain information (used if the bridge is skewed at an angle from the roadway).

To start DP5, type:

RUN DP5,

starting with a (.) on the screen. After you start the program, the computer will prompt you for the above information. It will first ask for the date. Note that when you respond to this request, only one digit is allotted for the year so that January 12, 1986, is entered as **01126**.

DP5 allows three different options for controlling data collection. In the first, you may change the system defaults for maximum consecutive axle spacing allowed for one vehicle, maximum axle spacing for cars, maximum total truck length (distance between the first and last axles on a vehicle), number of lanes for data collection, and the number of strain gages attached to the bridge. The second option is to accept all of the system defaults for these inputs, and the final choice is to alter only the number of lanes and number of strain gages.

The following describes the sequence of inputs to the computer. All numbers should be input as real values (with decimal point, unless specifically indicated as an integer). All distances are in feet.

ICHANGE, SPACING, TS1-BRIDGE, MIN STRAIN, TRUCK, SPAN

ICHANGE -1 = change default vehicle lengths, number of lanes and number of gages.

0 = accept all system defaults (only one lane of traffic is collected.)

1 = change the number of lanes and/or number of strain gages.

SPACING = the distance between tapeswitches 1 and 2.

TS1-BRIDGE = distance between tapeswitch 1 and the bridge.

MIN STRAIN = a decimal value between .10 and .5, used to trigger which values are heavy enough to be weighed, enter .10 unless there is a specific reason to do otherwise.

TRUCK = the number of the next truck to be stored on that disk. An integer. (A disk can contain 400 truck records, the first truck weighed is number 1, the last is number 400. It is possible to use part of a disk, and then use the rest of that disk on a later date. Use program FIND to determine the last truck record written on a previously used disk.)

SPAN = the length of the span on which the strain gages are located, input as an integer.

For example, input for this line might look like the following:

0,3.45,6.75,0.15,1,40

PROCESS, KEYPAD, SAMPLING RATE

PROCESS = 0 if weights are only to be processed later (an integer).

= 1 if you desire to see estimates of the truck weights being collected while they are collected, as well as being processed later for analysis (an integer).

KEYPAD = 0 (an integer) if keypad input is accepted but not mandatory.

= 1 (an integer) if keyboard input is mandatory.

SAMPLING RATE = the rate at which the strain gages are interrogated by the computer. Input an integer between 40 (for long bridges) and 60 (for short bridges).

The input might look like:

1,0,50

MAX AXLE SPACING, MAX CAR LENGTH, MAX TRUCK LENGTH NN (Only requested if ICHANGE = -1)

MAX AXLE SPAC = the maximum spacing allowed between two axles on any vehicle, the default is 37.1 feet.

MAX CAR SPAC = defines what is a car versus a two axle truck. The default is that car spacing is less than 12.1 feet.

MAX TRUCK LEN = defines the total length allowed between first and last axles on a truck. Default is 65 feet. It should be 80 feet.

NN = a parameter used internally by the program; enter 150 as an integer.

An example is as follows:

37,5,12.2,80.0,150

LANES, NCHAN. (only asked if ICHANGE = -1 or 1)

LANES = number of lanes data will be collected in (1 or 2), 1 is default. Input as an integer.

NCHAN = number of strain gages attached to the bridge, default is 4. Enter as an integer.

An example input is as follows:

1,6

LANE 2 TS SPACING, TS3-BRIDGE. (if LANES above = 2)

TS SPACING = spacing between tapeswitches 3 and 4

TS3-BRIDGE = distance from tape switch 3 and the beginning of the bridge.

An example input is:

6.5,8.33

NAME OF FILE WITH INFLUENCE LINE. (only requested in PROCESS = 1 above)

FILE NAME = the file name DY1:XXXXXX.YYY copied onto the data collection disks before the beginning of the DP5 program.

LENGTH OF INFLUENCE LINE, CALIBRATION, SAMPLES

LENGTH OF INFLUENCE LINE = integer length of the influence line (xxx from the file name). Enter the length of the instrumented span.

CALIBRATION = the calibration factor obtained from a calibration truck or previous calibration of this bridge. (If this is the first time at this bridge, start with a calibration factor of 0.10, and see the PFFF program instructions later in this document.

SAMPLES = the number of data points that are recorded by the computer that should be discarded during processing to account for problems occurring due to skew of the bridge. Enter 0, if little skew is present, 1 or 2 if the bridge is heavily skewed (up to 45 degrees, over 45 degrees, and you should not use the bridge).

For example:

45,0.26,0

Input is now complete, and the system will automatically begin collecting truck weight information at this point. Note that if you make a typing mistake, use the "**DELETE" key** on the computer to remove the unwanted characters. This must be done before you type a carriage return. Any other backspace key will cause errors in the program and you will have to reenter the entire DP5 input data.

Note that the WIM system will automatically look for trucks in lane 1 (axle sensors 1 and 2). To weigh a truck in lane 2, press the **"LANE 2" button** on the keypad immediately before the truck reaches axle sensor 3. The **"LANE 2" button** causes the system to look for the next (and only the next) vehicle to be in lane 2. After examining the next vehicle to cross sensors 3 and 4, the system again begins monitoring sensors 1 and 2.

Stopping Data Collection (ending DP5)

To stop the execution of DP5 for any reason, depress the white button marked **"DATA IN"** on the main MINC console (not the computer keyboard) marked "Digital Input." The following text will appear on the screen:

CHANGES? -1 START OVER 0 STOP 1 MINOR CHANGES

The next step is to PUSH THE **"DATA IN" BUTTON** A SECOND TIME to return the switch to its original position. Then type the appropriate number to indicate your desired option.

-1 Causes the DP5 program to execute again, but asks for all input data again.

0 Causes the computer to stop execution and return to the operating system (i.e., a period appears on the screen).

1 Causes the computer to ask the following question:

PROCESS, KEYPAD, # of SAMPLES, CALIBRATION

The answer to these should all be placed on one line, separated by commas. Possible answers are:

PROCESS	0	=	weights will be shown as information is collected
	1	=	weights will not be shown
KEYPAD	0	=	keypad accepted but not mandatory
	1	=	keypad is mandatory
# of SAMPLES		=	number of strain samples discarded during processing (0 to 5)
CALIBRATION		=	new calibration constant

FIND

The program FIND is used to query a data disk to determine the truck number that was last stored on the disk. In this way, truck data collection at a site can be stopped and started as

desired using the same data disk. To use program FIND, start at the operating system prompt (a period) and type:

RUN FIND

The program will examine the data disk in drive DY1 at the time of execution, and print on the screen the number of the last truck weighed.

PFFF

The PFFF program is used to process the collected strain gage information into truck weights and to calculate calibration factors for individual bridges. It differs from the processing that can be done during data collection in two major areas:

- it performs a more sophisticated analysis, providing some checks against bad data points; and
- it produces the data set needed to make tables for printing vehicle and axle weight summaries.

To run the PFFF program the following information is necessary:

- name of the influence line;
- number of lanes of data collected;
- number of strain gages recorded;
- weighting factors for individual strain gages (to discount some strain gages and reduce the effects of two vehicles on the bridge at the same time);
- the length of the influence line;
- the number of samples to discard if the bridge is skewed;
- the length of the bridge span used;
- the number of the truck record where any calibration truck weights are stored;
- the weight of any calibration trucks;
- a previously determined calibration factor (if any); and
- the numbers of the trucks to be processed.

To start the program, type:

RUN PFFF

The computer will respond:

NAME OF INFLUENCE LINE?

Type the name of the influence line calculated by the SIMPLE or BILINE program at the time of data collection (Use the form **DY1:xxxxxx.yyy**). The computer then asks:

HOW MANY LANES?

Type an integer (1 or 2) response. The computer then asks:

HOW MANY CHANNELS WERE RECORDED?

Type an integer for the number of strain gages that were attached to the bridge during data collection. The next question is:

ENTER THE WEIGHTING FACTORS FOR LANE #

This is an option which allows you to discount the strain gage readings from some of the gages on the bridge. It is usually used when trying to subtract the effects of a second vehicle being on the bridge at the same time as the truck you are weighing. You may include any numbers here that you wish, although weighing factors of 1.0 for all gages are recommended by the manufacturer. Enter one real number for every strain gage used during data collection. Enter all responses on one line, separated by commas. A possible response for a four gage bridge would be:

1.0,1.0,1.0,1.0

The program then responds:

LENGTH OF INFL.LINE, SAMPLES, SPAN

Enter the length of the influence line as an integer followed by a comma. Then enter the number of samples (an integer) you want the analysis delayed (0 for most bridges, a maximum of five for a heavily skewed bridge), and then the length of the bridge span in feet as a real number. An example response might be:

50,0,50.0

The computer responds:

DISPLAY RESULTS? 1=YES, 0=NO

This option lets you watch on the screen as the computer calculates each truck's axle and gross weights. Enter the response as an integer.

DISPLAY AVERAGE STRAIN RECORD? 1=YES, 0=NO

This option shows you an XY plot of the strain record versus time for each truck whose weight is being calculated. Enter your response as an integer.

CALIBRATION TRUCK USED? 1=YES, O=NO

Answering this question **YES** will cause the computer to compute a calibration factor for this bridge. If this is the first time you are at this bridge, you will need to follow this option. If you already have a calibration constant for this bridge from previous work, answer the question with a zero. Either response should be entered as an integer. If you answer **NO** you will skip the next three questions.

WHAT IS THE ACTUAL TEST TRUCK WEIGHT?

Enter the actual gross weight of the test truck, as a real number. The number should be entered in hundreds of pounds (i.e., 100,000 lbs = 100.0).

HOW MANY PASSES OF TEST TRUCK?

Enter the number of times the test truck crossed the instrumented span as an integer. If two lanes were used, the program will also ask:

HOW MANY PASSES OF TEST TRUCK IN LANE1? LANE 2?

Answer this with two integers, separated by commas.

WHAT ARE THEIR ID'S

As the computer records each truck's strain gage information, it will assign a number to that truck. The numbers range from 1 to 400. Enter the assigned number for each of the test truck passes over the bridge. Enter the numbers as integers, separated by commas.

WHAT IS/ARE CALIBRATION FACTORS?

If you did not use a calibration truck, enter the calibration factor (include a decimal point) here. If you used two lanes, enter both numbers on one line separated by commas. If you used a calibration truck, the computer will not ask this question but will simply print the calibration (factor(s) it has just calculated.

PROCESS TRUCKS___THROUGH___ (-KSTART=START OVER; 0=STOP)

This request asks for the numbers of the trucks you wish to process. Answer with two integer numbers (low number first) separated by commas indicating the range of vehicles whose weights you want processed. A complete disk is processed by typing:

1,400

A disk can be processed as many times as you desire. The computer simply writes over the previously calculated weights. As a result, if you wish to experiment with different strain gage weightings or calibration factors you may restart the PFFF program by typing a negative number

followed by a comma and a positive number. Typing two zeros separated by commas (**0,0**) causes the PFFF program to stop and send you back to the computer's operating system. Do this when you have completed processing.

After the computer has finished processing the truck numbers you requested it will again ask you this question. You may give it another range of truck numbers, exit the program, restart or, if you have more than one disk of truck weights you wish to process, insert a second (or other) disk into the DYI disk drive, and answer the ***PROCESS TRUCKS*** request again with 1,400 or whatever numbers are appropriate. (Note each disk is numbered 1 through 400. The machine does not number from 401 to 800 for a second disk at one location.)

SUMARY

The SUMARY program calculates various tabular summaries of the truck weight information you have collected. It can also be used to produce a printout of all the truck weights on a disk on the printer in the van. This program can also be used to summarize truck weights from more than one diskette. The operation of this program is rather complicated, so the instructions included in original *Bridge WIM Users Manual* are included in "Appendix B" of this manual.

When using "Appendix B," be aware that the file used to record strain gage information is referred to as FT14, the processed truck weights are stored in FT15 and the SUMARY program produces file FT17, which includes summarized truck weight information.

TROUBLE-SHOOTING ASSISTANCE

This section details the steps you can take to determine why the WIM system is not operating the way you expect it to, and what steps you can take to make it work correctly again. This chapter is broken into the following sections:

- Computer Frozen,
- Program Fails During Execution,
- Computer Won't Boot,
- Typing Errors,
- Generator Problems, and
- Getting Back to the Operating System.

COMPUTER FROZEN

When the computer was previously operating and suddenly stops, you have three basic options; try them in the order listed below.

1) If the DP5 program was running at the time the computer froze, depress the **"P" key**. This will often restart the program.

2) Check to make sure that the **"DIGITAL IN" switch** on the MINC console is not depressed. This key will not inhibit use of the keyboard, but it will prevent the system from processing the information you type in. The computer will simply respond ***CHANGES? -1 START OVER,*** *etc.*

3) If the above doesn't work, press the **"BREAK" key**. The computer should respond by printing an "@" on the screen. Type **173000G** (do not type a carriage return; also note that the last three digits are zeros, not the letter O "oh"). This should re-boot the system. You will have to restart the program you were running after the system finishes re-booting.

4) If the system does not respond to the **"BREAK" key**, turn the computer off and leave it off for 30 seconds. Then restart the computer.

PROGRAM FAILS DURING EXECUTION

If a program (other than DP5) fails during execution, the first option is to hit several **carriage returns.** (Remember that the computer sometimes "forgets" to add a line feed after it asks a question; this is not a "failure," just poor programming. For these cases, just type on top of the last line on the screen.) After you hit several **carriage returns**, the computer may continue operating where it left off, or show a period. If you get a period, this indicates that you are back to the operating system, and can restart the program by typing **RUN** and the program name.

If the computer does not respond to the carriage returns, hit the **"BREAK" key** on the keyboard once. This should cause the computer to print an "@" on the screen. Now type **173000G** (using three zeros, not the letter O "oh"). Do not use a carriage return. The system will reboot. After the boot is completed, you will be back at the operating system (a period showing on the screen), and can restart the program you were attempting to run.

COMPUTER WON'T BOOT

If the computer will not boot successfully, first check to make sure all cable connections are intact, particularly between the keyboard and the computer and the electrical cord between the van and the generator. Then try the following steps in the order listed.

1) Reinsert the system disk in DY0, hit the **"BREAK" key** and type **173000G** (do not type a carriage return);

2) Replace the system disk with another system disk and hit the **"BREAK" key** and type **173000G** (using three zeros, not the letter O "oh") (do not type a carriage return);

3) Turn off the computer using the surge protector switch behind the signal conditioner, wait 30 seconds and turn the computer back on again with the alternative system disk in DY0.

If the computer still won't boot, listen to see if the disk drives spin when you try to boot the system. If the drives do not spin briefly, you have probably blown a disk drive fuse. Extra

fuses are located in the filing cabinets in the back of the van. You may want to bring the computer back to the shop and get some assistance replacing the fuse.

If the disk drives spin but you get a number on the screen (usually six digits, starting with a 7) instead of the boot up messages and a period, the machine is probably too cold. In these cases, turn on the van's engine and heater and increase the temperature of the van's interior. Let the computer warm up for about fifteen minutes in the warm to hot air, then try to boot the machine again. If this fails, wait another fifteen minutes and try again. If this fails, bring the computer back to the shop for testing.

TYPING ERRORS

If the typing errors are noticed before a carriage return is hit, the **"DELETE" key** will allow you to backspace over the errors and retype them. If the error is noticed after a carriage return you will have to either restart the program (depress the **"DIGITAL IN" switch** or **"BREAK" key** followed by **173000G**) (using three zeros, not the letter O "oh") or simply retype the input line if the computer detected the error and rejected the input.

GENERATOR PROBLEMS

The primary causes for generator malfunctions (generator shut-down, electricity interruption, etc.) are lack of gasoline and incomplete warm-up. First check the level of gasoline in the tank using the gas gage located on top of the generator. The generator tank holds three gallons.

If the gas tank is full, check to be sure the "oil alert" switch has not been tripped automatically, indicating a lack of oil. If this is not the case restart the machine with the load monitoring switch turned off and all equipment inside the van turned off. Let the machine run for 15 minutes before restarting the equipment in the van.

GETTING BACK TO THE OPERATING SYSTEM

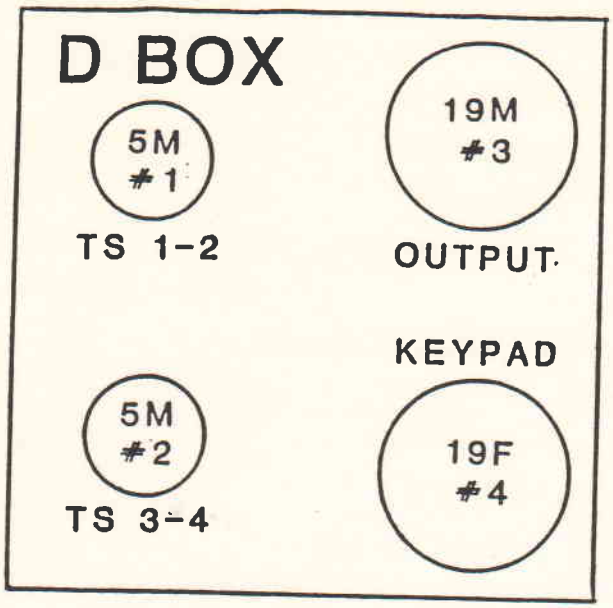
You may get to the operating system in one of several ways: the successful completion of a program, the interruption of a program, or the "booting" of the system. To interrupt a

program, use the **"BREAK" key** on the right side of the keyboard. After typing the **"BREAK,"** the computer will respond with an "@" and you need to type **173000G** (using three zeros, not the letter O "oh") to get to the operating system from this point.

If you are in the middle of data collection, you may exit the DP5 program gracefully by pushing in the **"DIGITAL IN" button** on the computer itself, then pushing the button again, and typing a zero (**0**). This will cause the computer to terminate DP5.

APPENDIX A

VISUAL DESCRIPTION OF CONNECTOR BOXES FOR THE BRIDGE WIM SYSTEM



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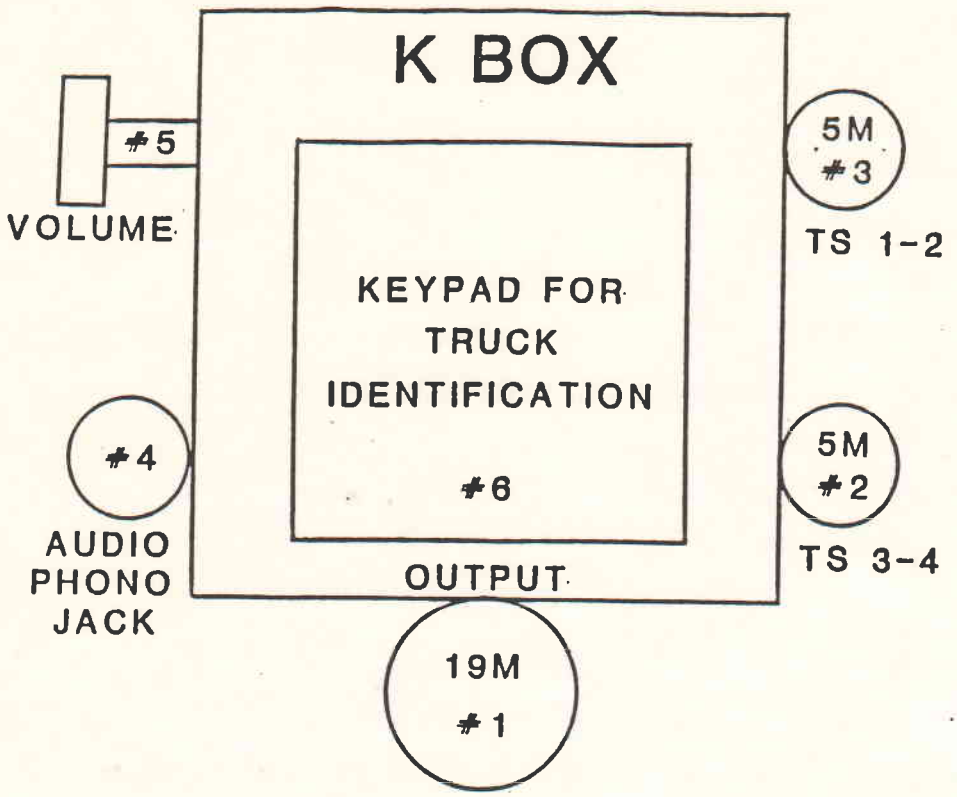
D Box Wiring List

1A - 3E - 4E
1C - 3N - 4N
2B - 3C - 4C
2D - 3P - 4P
1E - 2E - 3V - 4V

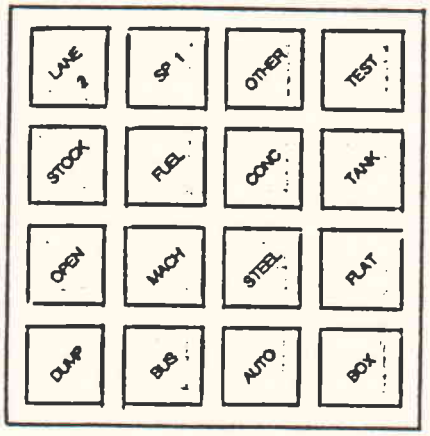
3A - 4A
3B - 4B
3D - 4D
3F - 4F
3G - 4G
3H - 4H
3J - 4J
3K - 4K
3L - 4L
3M - 4M
3R - 4R
3S - 4S
3T - 4T
3U - 4U



K BOX WIRING LIST

1E - 3A
1N - 3C
1C - 2B
1P - 2D
1B - 5,1
5,2 - 4,1
1R - 4,3
1K - 6J
1A - 6G
1L - 6H
1M - 6F
1F - 6N
1H - 6M
1T - 6L
1S - 6K
1V - 2E - 3E - 4,2 - 5,3 - 6E

KEYPAD LABELING



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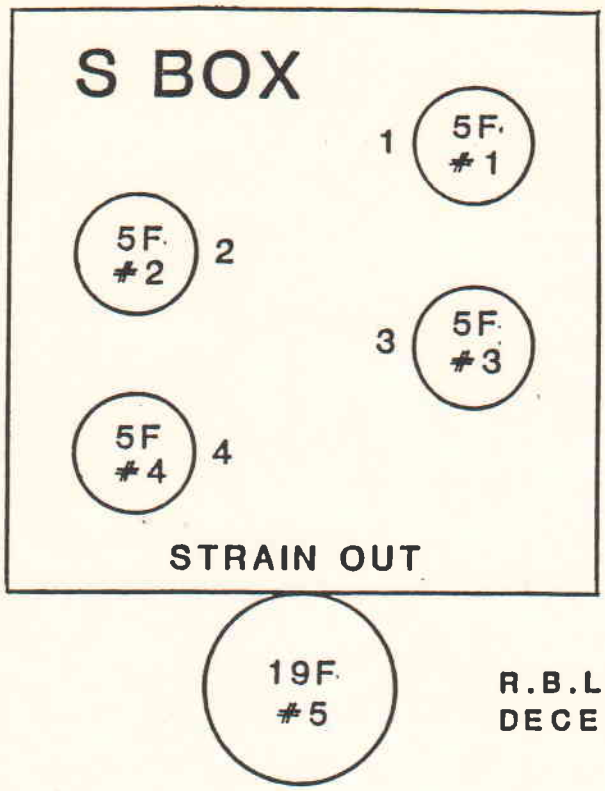

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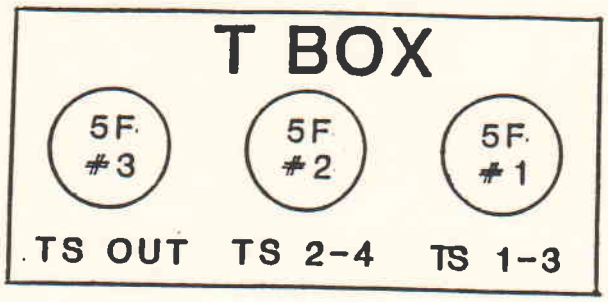
S Box Wiring List

5L - 1A White	5E - 3A White
5U - 1B Green	5R - 3B Green
5M - 1C Black	5F - 3C Black
5N - 1D Red	5P - 3D Red
5V - 1F Shield	5V - 3E Shield
5D - 2A White	5K - 4A White
5C - 2B Green	5H - 4B Green
5A - 2C Black	5G - 4C Black
5B - 2D Red	5J - 4D Red
5V - 2E Shield	5V - 4E Shield

Use 2 pair shielded wire with all shields going to 5V



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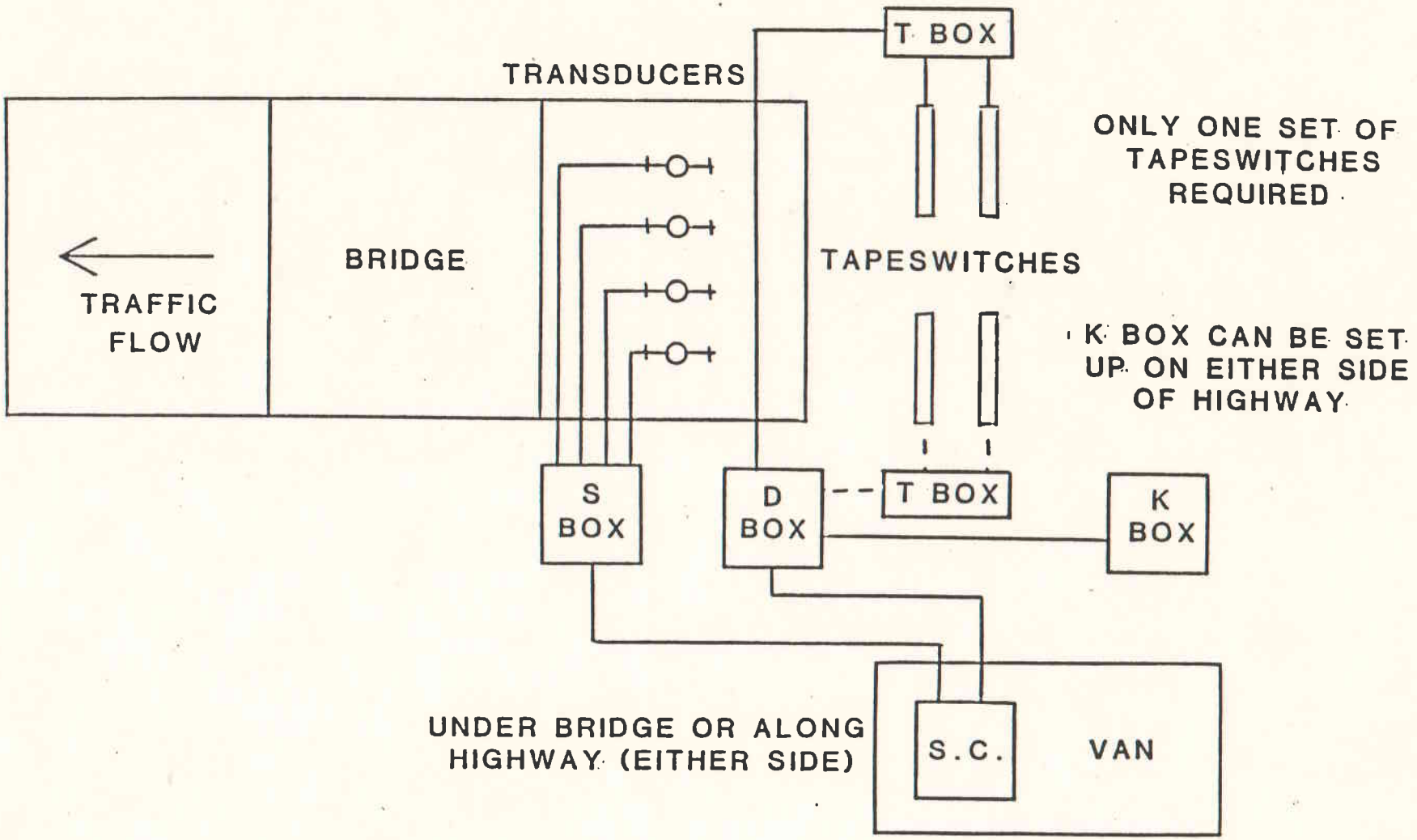
T Box Wiring List

1D - 3A - 3B
2D - 3C - 3D
1E - 2E - 3E



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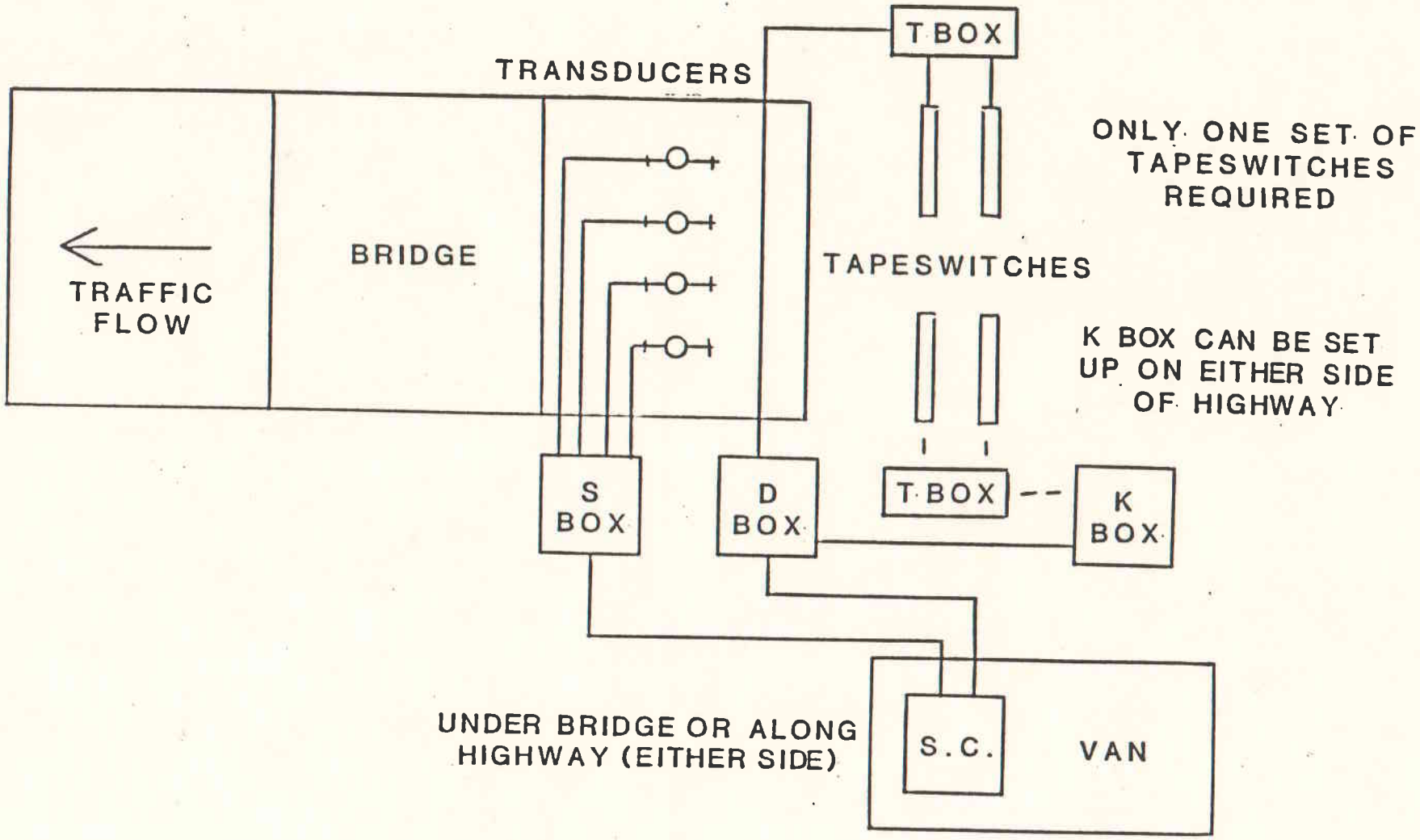
SET UP CONFIGURATION B



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SET UP CONFIGURATION E

APPENDIX B

SUMARY PROGRAM

AS DESCRIBED BY BRIDGE WEIGHING SYSTEMS

.RUN SUMARY

This will load the program SUMARY.SAV into the computer. The program will display the following on the CRT screen:

Line 1: TABULATE RESULTS (1) OR LIST INDIVIDUAL TRUCK RESULTS (0)

1 Provides summary tables separating vehicles by weights and hauling category and by weights and axle configuration; histograms for arrival times, vehicle velocity and vehicle length are obtained.

0 Provides a single line printout for each vehicle falling in the selected group; groups are defined by limits on gross weight, by visual hauling information, or by axle configuration.

If the 0 option is chosen proceed to line 13.

Line 2: PRINTED FORMAT:
(2) 5 KIP INCR TO 105
(1) 5 KIP INCR TO 90
(0) 10 KIP INCR TO 90
(-1) 10 KIP INCR TO 150

The data is stored in 5 kip increments on File 17. Gross weights greater than 150 kips are grouped together in the category of 150 kips and greater.

Line 3: READ SUMMARY FILE 17 (1) OR PROCESSING RESULTS 15 (0)?

1 The tables stored in File 17 can be read, printed or combined;

0 The processing results stored in File 15 can be listed or stored on File 17;

-1 The program will go to line ***.

Line 4: PRINTOUT RESULTS AS FREQUENCY (1) OR NUMBER (0)

1 Results will be printed as frequencies (per 1000)

0 The actual count will be printed.

Line 5: STATISTICS FOR TRUCKS____THROUGH____(-ISTART=PRINT)

This line will appear only if option 0 was chosen in line 3. The beginning and ending truck numbers are requested. The

program will begin reading the data from File 15 as soon as the ending truck number is entered so be sure that the proper disk with File 15 is in DY1:; This line will be repeated once all of the requested trucks have been read; a minus ISTART will exit this loop and line 6 will be printed.

Line 6: NUMBER OF TABLES TO ADD

The number (quantity) of tables stored on File 17 that are to be summed; data read from File 15 from line 5 will also be summed; enter a 0 (zero) to go to line 8.

Line 7: GIVE ID NUMBERS (NEG. ID WILL SUBTRACT THAT TABLE)

The ID numbers of the tables stored in File 17 are requested for summing. A negative sign in front of an ID number will cause that table to be subtracted from the other tables.

Line 8: PRINT(POS VALUE-TABLE NUMBER),STORE(0),STOP(-1)

36 The table that will be printed will be given this table number in the title;

0 The table that has been created will be stored on File 17;

-1 the program will stop.

Line 9: ENTER TITLE (64 CHARACTERS)

The title of the table to be printed or stored is requested. This line will not appear if the number of tables read (added) as requested in line 6 is 1 (one). To change a title of a table stored on File 17 give a 3 for line 6 then add and subtract an additional table in line 7.

Line 10: IID FOR FILE STORING (IID=-1 FILE17 ID LISTING; 0 STOP)

ID Give ID number for record on file 17;

0 Stop program;

-1 Provide a listing of the titles of the tables stored in File 17; the number of trucks in each table is also listed. Proceed to line 12.

Line 11: USE NEW TITLE ? (0) YES, (1) NO

0 The title input in line 9 will be used;

1 The title of the previous table stored at that ID will be retained.

Line 12: LIST FILE 17 START,STOP (START=0 START OVER;START=-1 STOP)

START Beginning ID for listing;
= 0 to start over at line 2;
= -1 to stop the program.

STOP Ending ID for listing.

Line 13: SEARCH BY GROSS WEIGHT(1), AXLE CONFIGURATION(2),
LOAD CATEGORY(3), AXLE CONFIGURATION AND WEIGHT(4),
LOAD CATEGORY AND WEIGHT(5) OR STOP(-1)? ENTER NUMBER

This line can be reached only by entering a 0 in line 1. The user is asked to identify the type of search desired. The program will search using limits on gross weight (for example all gross weights between 45 and 55 kips), using a particular axle configuration by entering the proper code, using the visual hauling category (keypad input) by entering the proper code, and by using either the axle configuration or visual hauling category and limits on gross weight. For example, all 3S-2 vehicles with gross weights between 60 and 80 kips can be listed by choosing option 4 and specifying weight limits of 60 and 80 kips.

After entering the option for line 13 the program will then ask for the axle configuration code (if requested), the visual hauling category code (if requested), and the gross weight limits (if requested).

Line 14: SEARCH TRUCKS____TO____(-START TO STOP)

Enter the beginning and ending truck ID numbers for the search. A negative beginning number will stop the search by the specified group and return the program to line 13 for another search.

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