



TRC8704

Evaluation of Portable Scales

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Final Report

1988

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Arkansas State Highway and Transportation Department
Materials and Research Division

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1. Report No.		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle EVALUATION OF PORTABLE SCALES				5. Report Date April 1988	
				6. Performing Organization Code	
7. Author(s) P. C. McLeod and M. A. Gross				8. Performing Organization Report No.	
9. Performing Organization Name and Address University of Arkansas Graduate Institute of Technology P. O. Box 3017 Little Rock, AR 72203				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. TRC 8704	
12. Sponsoring Agency Name and Address Arkansas State Highway & Transportation Department P. O. Box 2261 Little Rock, AR 72203				13. Type of Report and Period Covered FINAL REPORT	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract The objective of this study was to determine whether or not weight scales were commercially available that would satisfy the needs of AHTD for truck weight enforcement. None were found that were immediately available for purchase. However, Transportation Technology, Inc. has a unit that will be available when they solve their distributor problems and Streeter/Richardson should have one on the market within 6 months. Both of these units are portable weigh-only systems and when available should satisfy AHTD requirements.					
17. Key Words			18. Distribution Statement NO RESTRICTIONS		
9. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages	22. Price

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Chapter One

INTRODUCTION

Truck weight limits in Arkansas are 80,000 pounds gross weight and 34,000 pounds per axle weight. These limits are enforced by the Arkansas State Highway and Transportation Department Highway Police by means of static scales at ports of entry and by using portable scales moved by automobile to various locations. The portable scales currently being used are General Electrodynamics Corporation MD-400 series hydraulic platform scales. The MD-400 scales are 3.25 inches high and weigh 47 lbs each.

Several limitations have been encountered with the MD-400 scales, and the Arkansas Highway Police are interested in overcoming the limitations to develop a more efficient portable weight enforcement operation. The major limitations with portable hydraulic platform scales are the weight, the need for approach ramps, the lack of electronic readout or memory, the time required to weigh each truck, and the danger involved in placing the scale under the truck wheel and reading the scale.

The purpose of this study was to determine if a more acceptable instrument is available commercially and to make recommendations regarding the type of instrument to be implemented in the truck weight enforcement program. If an appropriate instrument is not available, recommendations are to be made regarding development of a suitable instrument.

Chapter Two

SUMMARY OF PRODUCT INFORMATION

Manufacturer Contacts

Twenty-eight manufacturers in thirteen states were contacted in the fall of 1986. Product information was obtained from these companies, and the information was compiled and reviewed with the Arkansas Highway Police. The following Table I indicates the capabilities of instruments appropriate for portable truck weight enforcement. All of these scales are platform scales. Depending upon the model and the manufacturer, the scales use either electronic load cells or hydraulic bladders or tubes with dial readings (such as the MD-400) or a transducer with an electronic output as indicated in Table I.

In addition to the manufacturer contacts, the states of Utah and Texas were contacted to determine the results of their studies of truck weight enforcement. The state of Texas has tested portable scales over a two and a half year period demonstrating and certifying single axle wheel-weighers. As a result of the 2 and 1/2 year study, Texas has determined that the Intercomp single wheel weigher Model PT300 should be implemented in the truck weight enforcement program. Although Texas implemented this platform scale, the Arkansas Highway Police have also investigated this product and were not satisfied with the performance nor with the service. The state of Utah has conducted

TABLE I

COMPANY	MODEL	WEIGHT RANGE (lbs)	INCREMENT	ACCURACY	READOUT	HEIGHT	COMMENTS
General Electrodynamics Corp.	MD-400 Series	10 lb --> 100 lb					
		2 lb --> 20 lb (option)	± 1%	Analog dial	3 1/4"		
General Electrodynamics Corp.	MD-500 Series	50 lb --> 100 lb	± 1%	Analog dial	3 1/8"		
		20K					
General Electrodynamics Corp.	MD-500 Series	10 lb --> 50 lb	± 1%	Digital (LCD)	3 1/8"		Can be connected to common readout "totalizer"
		20K					
General Electrodynamics Corp.	LP-500 Series	50 lb	± 1%	Analog dial	3/4"		
		20K					
Loadometer	WL-101	50 lb	± 0.5% (full scale)	Analog dial	0.79"		
		20K					
	WL-205	50 lb		Analog dial	3.10"		
		20K					
	WL-204	20 lb		Analog dial	3.10"		
		10K					
Measurement System Int.	MSI-5200 Series	10 lbs, 20 lbs or 50 lbs	± 1%	Digital (LED)	3.5"		Remote totalizing indicator available
		15K					

Weight

WSA 5000-4 10K	50 lb	Analog dial	2 1/4"
WSA 5000-9 10K	50 lb	Analog dial	2 1/4"
WSA 5000- 10K 11	50 lb	Analog dial	2 1/4"
WSA 10,000 20K -5	100 lb	Analog dial	2 1/4"
WSA 10,000 20K -10	100 lb	Analog dial	2 1/4"
WSA 10,000 20K -12	100 lb	Analog dial	2 1/4"

Intercomp

PT300 20K 10, 20, or 50 lbs \pm 1% of reading

Digital (LED) 3"

Totalizer available.
Can be used in rollover mode. AHTD has tried this product. The performance & service was unsatisfactory.

an ongoing study of weigh-in-motion products and has not pursued implementing a weigh-in-motion instrument as a single-axle enforcement tool. The Utah studies have concentrated upon obtaining truck weight and characteristic data for highway design and planning purposes.

As the lack of an appropriate instrument became apparent by early 1987, and the literature was monitored for new technology, an alternative to platform scale single-axle weighing was devised. However, since the pursuit of this alternative technology was outside the scope of the project, and the desired instrumentation was obviously not commercially available, G.I.T. reported this information to the Arkansas Highway and Transportation Department and offered to conclude the study at this point. The TRC subcommittee advised GIT to pursue the study of using the capacitance mat (normally used in weigh-in-motion instruments) as a component of a weight enforcement instrument.

Based upon weigh-in-motion (WIM) instruments used as planning tools, and combining this technology with permanent installation of screening devices reportedly used in Georgia (Civil Engineering Magazine, November 1986) the alternative pursued was to use the capacitance mat of a WIM and simplified electronics as a screening device. This methodology would allow trucks to slowly pass over the capacitance mat, being weighed while they are moving. If the truck were indicated as overweight, it would be reweighed on the portable wheel weighers as presently used. This method would allow all trucks to be screened quickly and only those being shown as overweight

stopped and weighed. The results of this technique are elimination of long queues and weighing of more trucks during the same time period with the same number of personnel.

The Planning Division of the Arkansas Highway and Transportation Department owns a Streeter-Richardson Model 5150 XT Weigh-in-Motion instrument. This instrument includes a capacitance mat used with induction loops and a personal computer with software to calculate and record speed, axle weight, total weight, axle spacing, total length, and violations of the Bridge Formula and speed limits.

Since all of this information is not necessary for a weight enforcement screening instrument, the output signal from the capacitance mat was recorded by tapping into the circuit as shown in Figure 1. Size 14 military connectors were required to fabricate a patch cable to tap into the transducer cable at the junction box and transfer the signal to a Racal reel-to-reel instrumentation recorder. This data collection procedure was applied at an actual in-progress weighing on Interstate 30 North at a location just south of Benton.

The frequency cut off of the recorder that was available was below 100 kHz making the amplitude of the recorded data about equal to the noise level. Trucks crossing the capacitance pad (transducer) could be visually observed on an oscilloscope when the tape was played back, but no accurate measurements could be re-established. Figure 2 is an artists version of the data, seen on the oscilloscope. The signal is about what was expected from an "L-C" oscillator. Looking at Figure 2A the oscillator frequency is constant at 100 kHz until the

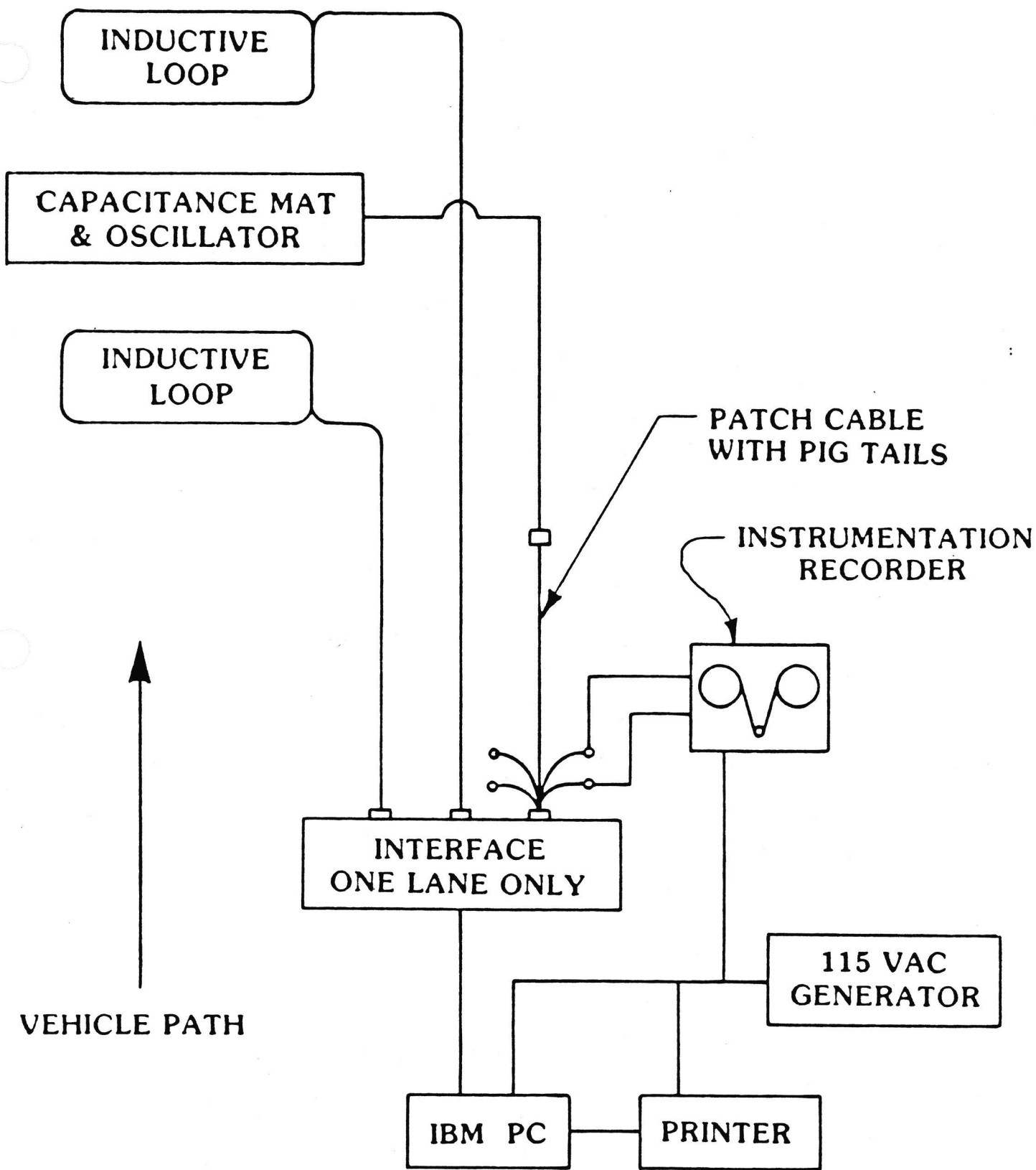
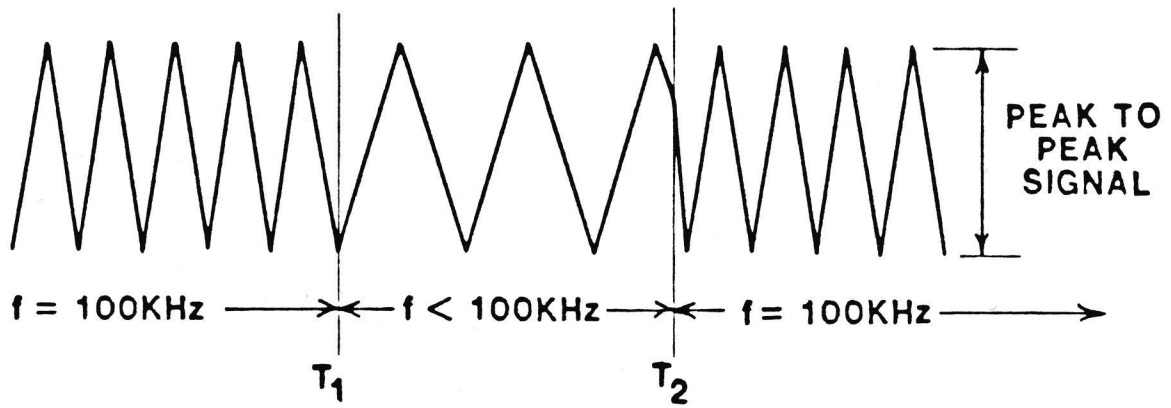
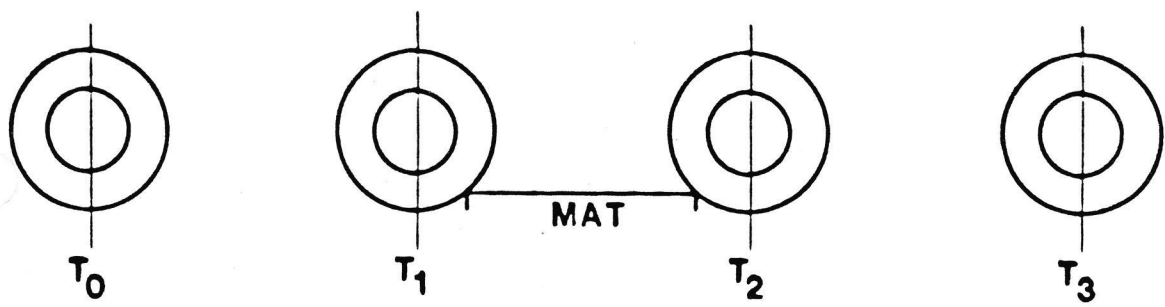
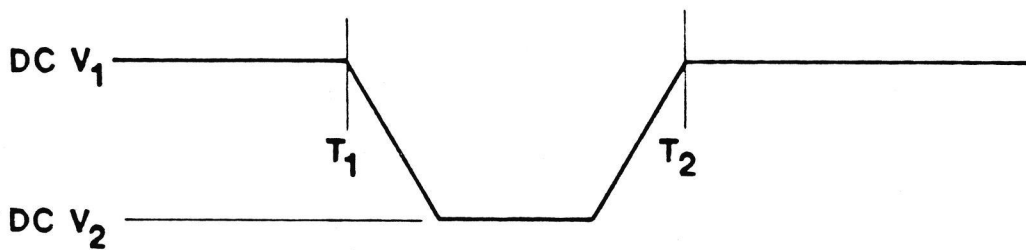


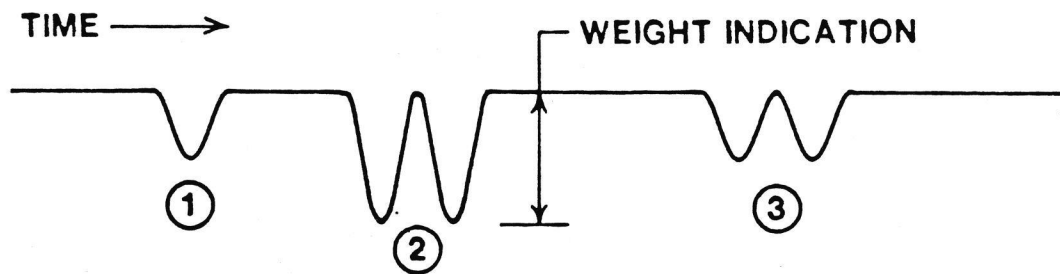
FIGURE 1. RECORDER CONNECTION TO STREETER-RICHARDSON MODEL 5150XT WIM SYSTEM



A. OSCILLATOR SIGNAL



B. RECTIFIED & FILTERED OSCILLATOR SIGNAL



- ① FRONT WHEELS OF TRACTOR
- ② DUAL AXLES OF TRACTOR
- ③ DUAL AXLES OF TRAILER

C. SIGNAL FROM 18 WHEEL TRUCK

tire contacts the mat. The oscillator frequency goes down as the truck's weight begins to increase the capacitance of the mat by reducing the spacing between the electrodes. The oscillator frequency varies as a function of

$$1/ \quad LC$$

where

L is inductance, and

C is capacitance.

If the signal was rectified and filtered it would look similar to Figure 2B. The difference between DCV_1 , and DCV_2 represents the axle weight/2. Figure 2C shows a series of events that represent the signal produced by a 5 axle truck passing over the mat. Signals like 2C are produced in the WIM mat unit by applying the frequency from the oscillator to a frequency voltage converter. The converted signal is applied to a 12 bit analog-to-digital converter for computer compatibility. The signals described above could have been easily recorded if a wider band instrument had been available.

The recommendation by the TRC that we begin and construct a weigh-only system was hindered by late delivery of the Streeter-Richardson instrument. Later scheduling problems restricted progress

as it appeared that our scheduling always conflicted with the Department's efforts to utilize this WIM system to collect data. Also, during this time, information was presented on a new instrument that appeared to meet the Department's criteria. The instrument was being developed by Transportation Technology, Inc. and will eventually be marketed by Streeter Richardson. Also, Streeter Richardson is currently conducting research to develop a piezoelectric mat to be used in lieu of the capacitance mat for WIM and screening applications. Both of these developments should be followed closely and demonstrations should be arranged for AHTD officials at the appropriate time.

Chapter Three

FINDINGS AND CONCLUSIONS

Instrumentation for truck weight screening is available only in the "weigh-in-motion" (WIM) systems. WIM systems are meant for overall traffic assessment for highway planning. They are very expensive and they require the use of a van to carry the equipment and to provide for environmental protection. It was concluded that no portable wheel-weighing instrument is currently commercially available and acceptable to the Arkansas Highway and Transportation Department Highway Police. However, research is currently being conducted to develop a device for weight screening applications. This screening device would utilize either a capacitance mat or a piezo electric cable. No further action should be taken until one of these devices is available for testing.

