FIELD EVALUATION OF FHWA VEHICLE CLASSIFICATION CATEGORIES

Executive Summary

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15. Supplementary Notes Mr. John H. Wyman is Director of the Maine Facility and was Principal Investigator of this project. Mr. Edward Kashuba was the FHWA Contract Manager.

16. Abstract

Four systems are available, programmable to classify vehicles to the FHWA scheme. In a study conducted by the Maine Facility (Lyles, Wyman; July 31, 1982; Evaluation of Vehicle Classification Equipment) a scheme "E" was selected from five candidate schemes and recommended to the FHWA for adoption as a standard. In order to correct logic errors in that scheme and to add categories for motorcycles and buses the classification scheme "E" logic has been changed and a new scheme called "F" has been evolved. This scheme "F" has been evaluated and appears workable as a classification scheme at about 95% classification accuracy. The I.R.D. unit is a permanent all weather system. The Golden-River unit is a semi-permanent, clear road system only. The Streeter-Amet unit and the G.K. Inst. units are clear road systems using pneumatic tubes only. The fifth system tested, a Sarasota unit classifies by road loops to 7 length categories only. Sarasota expects to have the same electronic package operating from road tubes with scheme E or F programs available after January, 1985. All systems operated satisfactorily during the three month test period within the limitations listed under the Detailed Evaluation.

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1.0 INTRODUCTION

Vehicle classification data are extremely important as planning information for use by the various States' Transportation Departments in their efforts to allocate costs associated with highway damage and repair. Such data is also important for use by the Road Planning and Design Engineers. The volume of such data required makes automatic collection of it imperative, as manual collection becomes a much too lengthy and costly operation.

The Maine Facility under a study entitled, Evaluation of Vehicle Classification Equipment, Lyles and Wyman, September 1982 reviewed five possible classification schemes. Classes in these five schemes ranged from 7 to 32 categories. A scheme with 14 categories and called scheme "E" was selected as the most likely candidate to provide the best compromise for collection of data with the optimum number of vehicle classes of interest.

The FHWA Office of Highway Planning and the various states reviewed the vehicle classes chosen in scheme "E". After this review certain changes and additions to the scheme were suggested.

The FHWA Office of Highway Planning then requested an agency to review the proposed changes and also undertake a study of the accuracy and quality of the available equipment to record such data in the field.

The Materials and Research Division of the Maine Department of Transportation received a contract to perform this study.

2.0 STATEMENT OF WORK

The object of this project study was to evaluate the ability of presently available automatic vehicle classifiers to accurately identify the vehicle types in the FHWA classification scheme.

In addition a review of the scheme "E" was required with attention to any possible corrections and changes needed to bring the scheme into conformity with the changes suggested in the FHWA review. Scheme "E" is shown in detail in Table 1.

After revision of the scheme as required, development of decision rules shall be undertaken to permit the writing of logic programs for each system to permit sorting of vehicles to the final scheme.

TABLE 1
CLASSIFICATION SCHEME "E"

Vehicle Categories	Description	Proposed Rule
E-1	Passenger cars, light trucks, vans	Axles = 2 and wheelbase $\leq$ 10'
E-2	Heavy-duty pick-ups, delivery trucks, 2A6T's	Axles = 2 and wheelbase $>$ 10'
E-3	Cars and light trucks with one-or-two-axle trailers	Axles = 3 or 4 and 1,2 spacing $\leq$ 10' and 5.5' $<$ 2,3 spacing $<$ 22'
E-4	Three-axle SU trucks	Axles = 3 and not E-3
E-5	Trucks and semi-trailers - 2S2	Axles = 4 and not E-3 and 3' $\leq$ 3,4 spacing $\leq$ 10'
E-6	Four-axle SU trucks	Axles = 4 and not E-3 and 3' $\leq$ 2,3 spacing $\leq$ 5'
E-7	Other four-axle combinations	Axles = 4 and not E-3, E-5, and E-6
E-8	Trucks and semi-trailers - 3S2	Axles = 5 and 2' $\leq$ 4,5 spacing $\leq$ 10'
E-9	Other five-axle combinations	Axles = 5 and not E-8 and 3' $\leq$ 2,3 spacing $\leq$ 5'
E-10	Trucks and semi-trailers plus full trailers - 2S1-2	Axles = 5 and not E-8 or E-9
E-11	Trucks and semi-trailers plus full trailers - 3S1-2	Axles = 6 and 5,6 spacing $>$ 7'
E-12	Trucks and semi-trailers - 3S3	Axles = 6 and not E-11 and 4,5 spacing $\leq$ 6'
E-13	Other six-axle combinations	Axles = 6 and not E-11 or E-12
E-14	Other seven-or-more-axle combinations	Axles = 7 or more

Undertake an evaluation of the equipment supplied by five companies who had agreed to supply their systems with logic programs either to scheme "E" or with the changes suggested by the FHWA.

The companies are:

1. Golden-River Corp.
2. I.R.D.-C.M.I. Dearborn
3. Sarasota Automation
4. Streeter-Amet
5. G.K. Instrument Co. Ltd.

The equipment is to be evaluated by two means. One, by a check to determine the classification accuracy and two, by a longer term test of approximately one to two weeks of operation, to determine the ability of the equipment to operate over typical field data collection periods, without problems or failures.

Tests are to be run on a rural two lane road and on the Interstate system.

3.0 SYSTEMS AVAILABLE FOR TEST

Table 2 shows the characteristic of the five systems available for test. Lane capacity, type of sensors used, approximate cost, and data available on read out are provided in chart form with other characteristics of interest.

In order to provide data inputs from the road for processing by the microprocessor systems certain in road sensors are required. Technical details of the operation of inductance loops and other sensors are given in considerable detail in a report by Lyles-Wyman, FHWA/P1/80/006 dated August 31, 1980 entitled, "Evaluation of Speed Monitoring Systems" conducted by the Maine Facility, Materials and Research Division of the Maine Department of Transportation and sponsored by the FHWA Office of Highway Planning under contract DOT-FH-11-9401.

Briefly, in order for a system to provide a classification ability an axle count and the speed of the vehicle must be available to the system.

Several different methods are used to collect such data. The I.R.D. system uses two inductance loops to obtain speed information and a permanently installed magnetic type axle counter. This axle counter also provides information on dual wheels.

TABLE 2
CHARACTERISTICS OF SYSTEMS

SYS. #	COMPANY & MODEL	# CLASS.	LANES CAP.	APPROX. COST**	SENSORS	RECORDING MEDIUM	POWER SOURCE	PRINT OUT		READOUT	
								Ind. Veh.	Sum. Tables		
1	C.M.I. Dearborn IRD Class.	14	2 4 6	21,000 24,500 30,500	Ind. Axle Loops Counter	Solid State Bat. Protected	120v 60 Hertz A.C.	yes	yes	Class	Speed Length Axle Spacing
2	Golden River Weighman MK-3	14	1*	25,000	Ind. Axle Loops Counter	Solid State Bat. Protected	6v D.C. Bat.	yes	yes	Class	Speed Weight Length
3	Streeter-Amet 141A 140A	13	1	3,875	Pneu. tubes	Cassette Tape	12v D.C. Bat.	no	yes	Class	--
4	G.K. Instrument Model 6000	14	1	3,090	Pneu. tubes	Solid State	12v D.C. Bat.	no	yes	Class	--
5	Sarasota VC 1900	7	1	4,600	Ind. Loops	Solid State	12v D.C. Bat.	no	yes	Lengths	Speed

* One lane per pad.
** See appendix II for details of costs. Cost of installation of permanent axle counter not included in estimate.

The Golden-River system uses two inductance loops and a pad type axle counter. (This pad also permits axle weight recording, but an evaluation of this ability was not conducted as a part of this study).

The Streeter-Amet and the G.K. Instrument systems use two pneumatic tubes or hoses stretched across a single lane.

The Sarasota system uses two inductance loops and thus classifies by vehicle lengths only.

4.0 REVIEW OF CLASSIFICATION SCHEMES

As a result of the study of the comments received on the FHWA and the states review of the original scheme "E" a new scheme labeled for reference scheme "F" was developed so as to provide the correction of some logic errors in the original scheme "E" and also to permit the addition of motorcycles and buses to the classification list. Scheme "F" is shown in flow chart form on Tables 3 thru 3F.

5.0 EVALUATION

The testing and evaluation consisted of three phases. One, an initial review of each system to ascertain that all systems worked as received. All systems had some problems which were resolved during this phase. Phase two, which was called 'Proof Testing', was a check made of each systems' ability to classify correctly. Testing for this phase was conducted on U.S. Route 2 at the Maine Facility where a trailer for recording equipment and photographic equipment was available. This test was done on each system by observing the passage of approximately 500 vehicles of all classes thru the system and photographs were also made where required and analyzed to aid in clarifying decisions as to classification categories.

Since each system uses slightly different logic; i.e., some use scheme "E" and some incorporated the additions of scheme "F", the test was performed to check each systems' ability to classify correctly to its own logic scheme.

Phase three, the volume test runs, were conducted over several 24 hour periods either on U.S. Route 2 for the permanent I.R.D. and the semi-permanent Golden-River system or on Interstate 95 northbound at Pittsfield for the road tube systems. Inductive loops for the Sarasota system were available at the Route 2 site so the volume tests on this system were also carried out there. The results of these tests are summarized on Table 4.

SCHEME " F " FLOW CHART

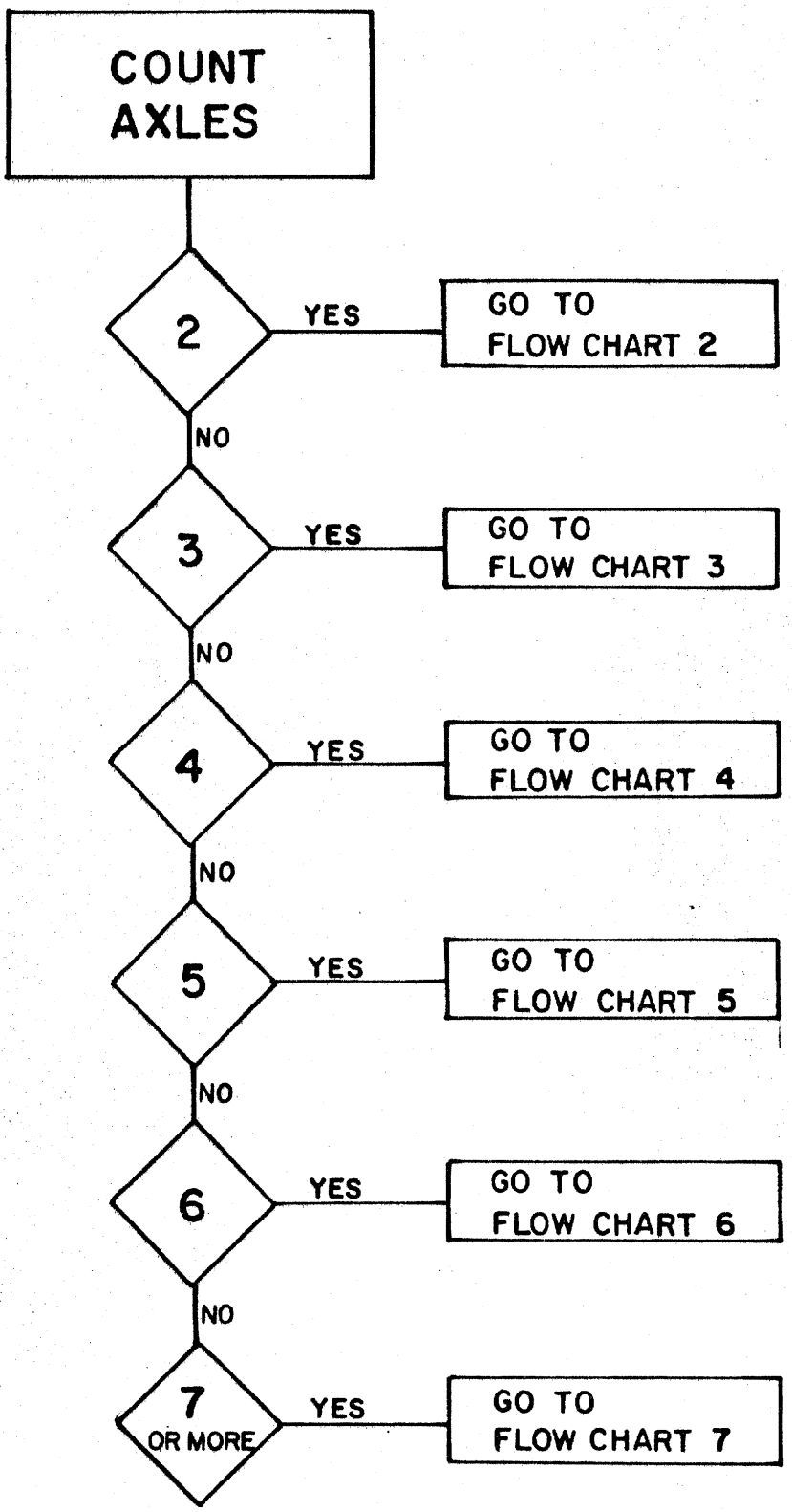

TABLE 3

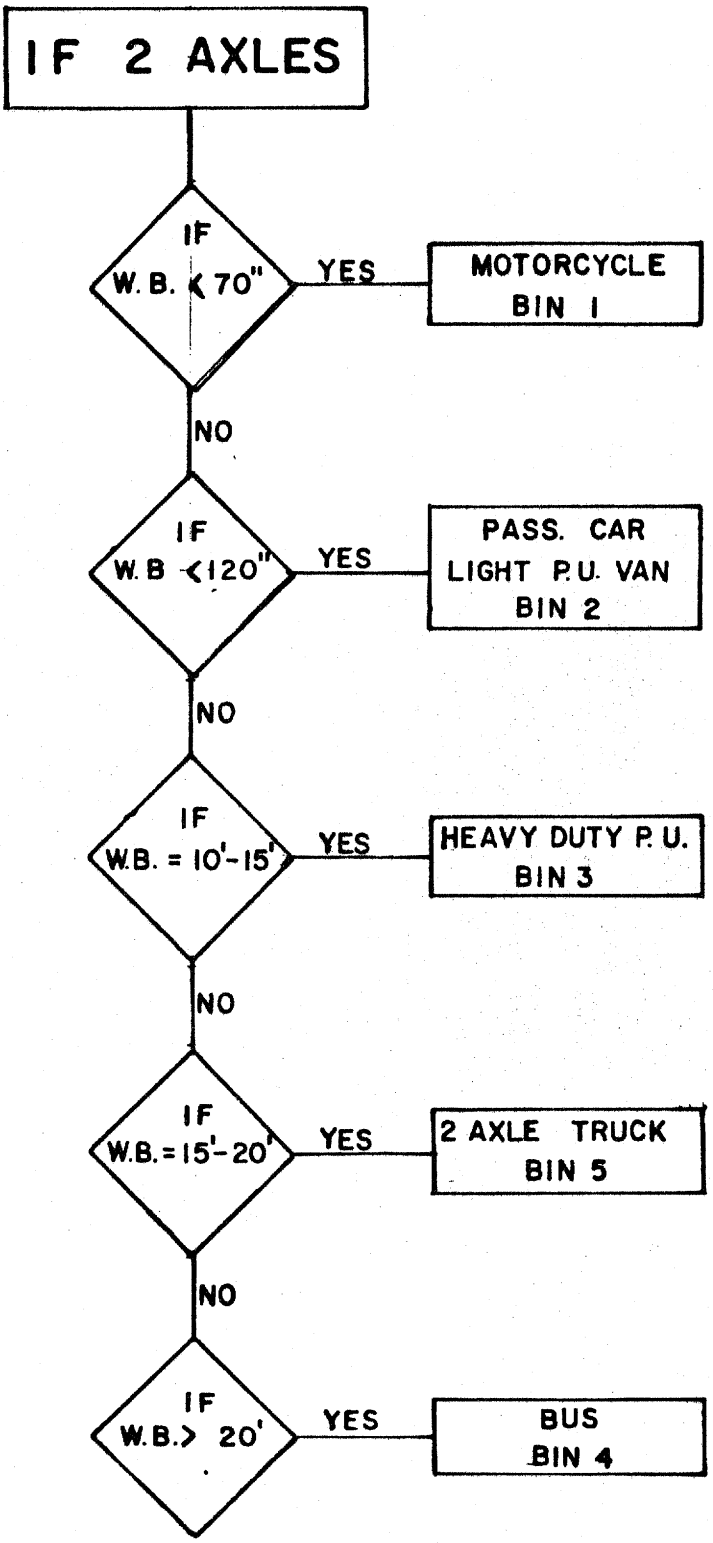
IF 2 AXLES
IF W.B. < 70"
YES
MOTORCYCLE BIN 1
NO
IF W.B < 120"
YES
PASS. CAR LIGHT P.U. VAN BIN 2
NO
IF W.B. = 10'-15'
YES
HEAVY DUTY P.U. BIN 3
NO
IF W.B. = 15'-20'
YES
2 AXLE TRUCK BIN 5
NO
IF W.B. > 20'
YES
BUS BIN 4

TABLE 3 a

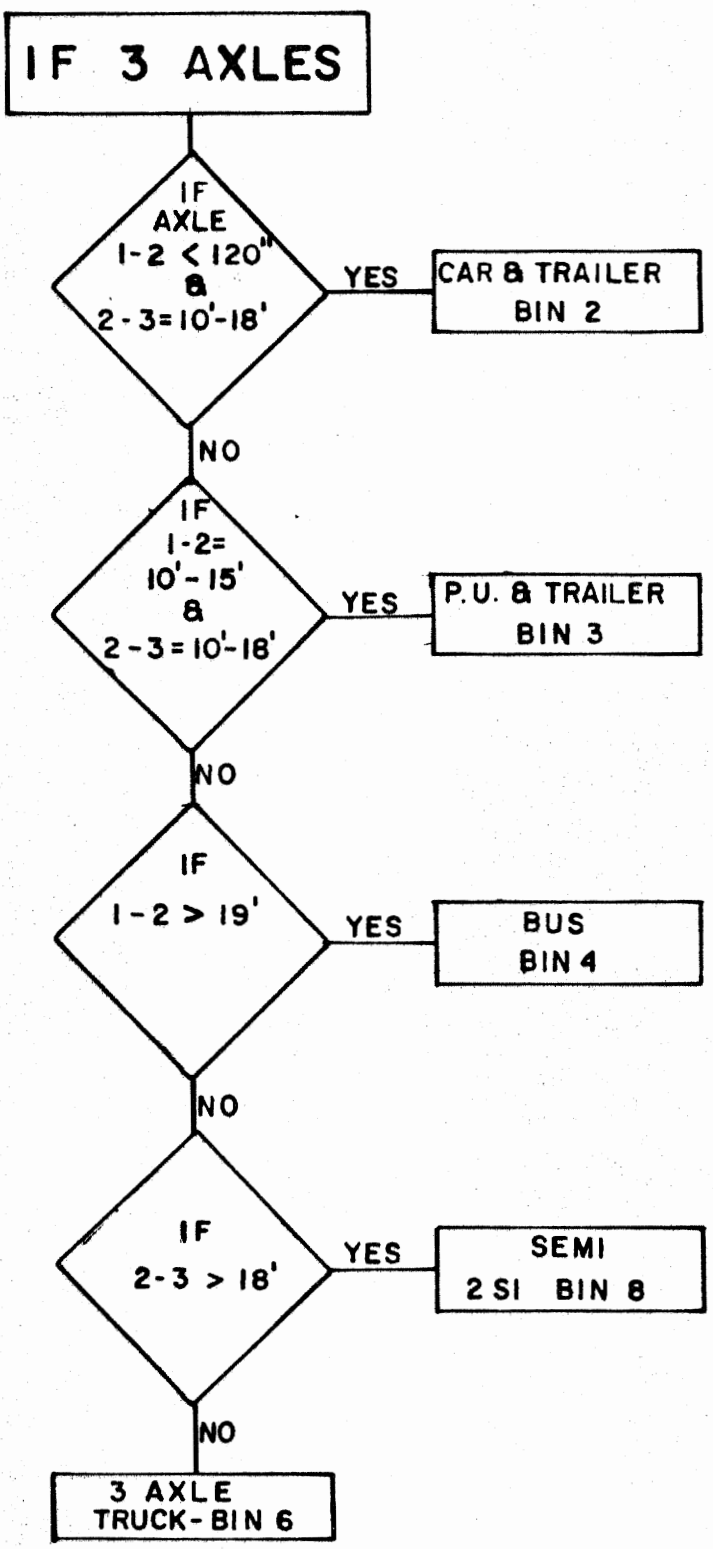
IF 3 AXLES
IF AXLE 1-2 < 120" & 2-3=10'-18'
YES
CAR & TRAILER BIN 2
NO
IF 1-2= 10'-15' & 2-3=10'-18'
YES
P.U. & TRAILER BIN 3
NO
IF 1-2 > 19'
YES
BUS BIN 4
NO
IF 2-3 > 18'
YES
SEMI 2 SI BIN 8
NO
3 AXLE TRUCK-BIN 6

TABLE 3b

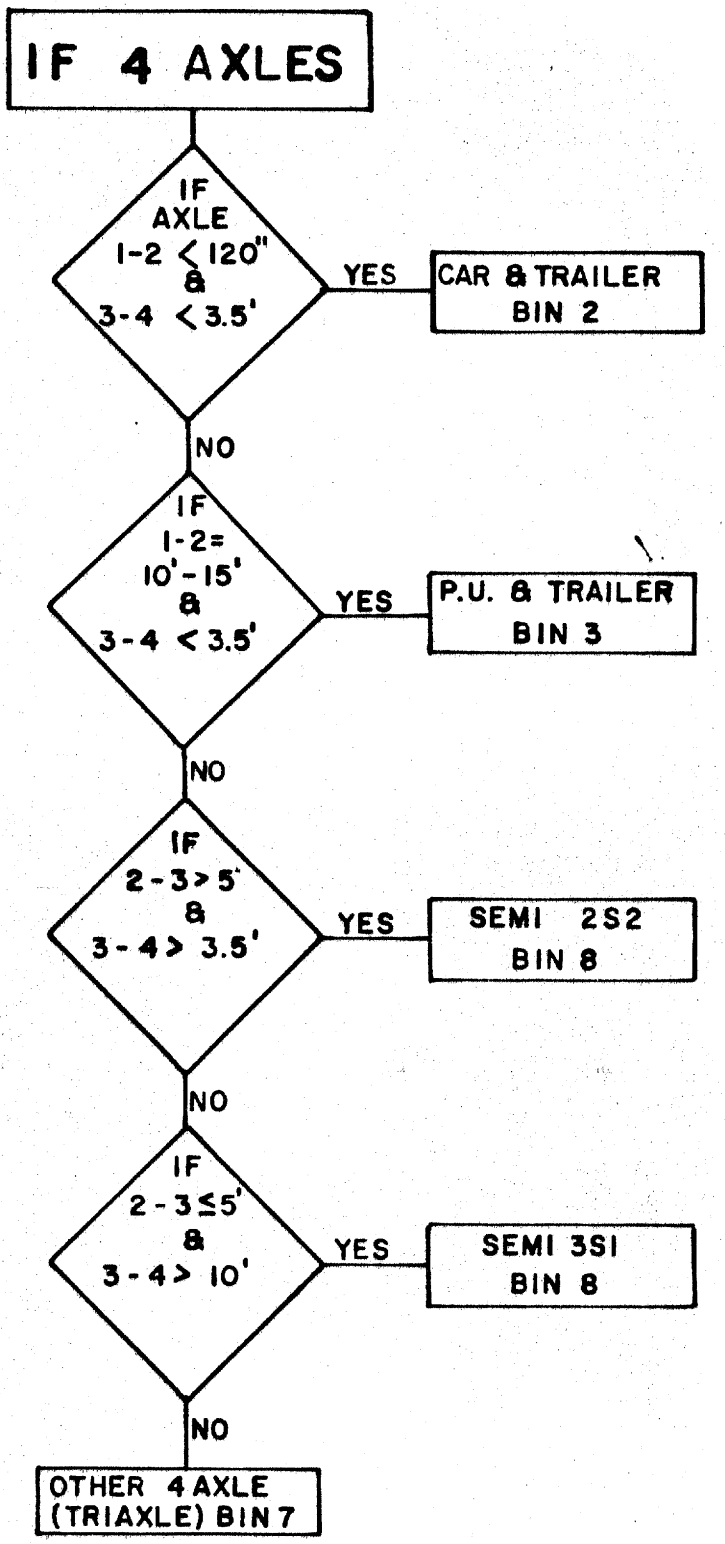
IF 4 AXLES
IF AXLE 1-2 < 120" & 3-4 < 3.5'
YES
CAR & TRAILER BIN 2
NO
IF 1-2= 10'-15' & 3-4 < 3.5'
YES
P.U. & TRAILER BIN 3
NO
IF 2-3> 5' & 3-4> 3.5'
YES
SEMI 2S2 BIN 8
NO
IF 2-3≤5' & 3-4> 10'
YES
SEMI 3SI BIN 8
NO
OTHER 4 AXLE (TRIAXLE) BIN 7

TABLE 3c

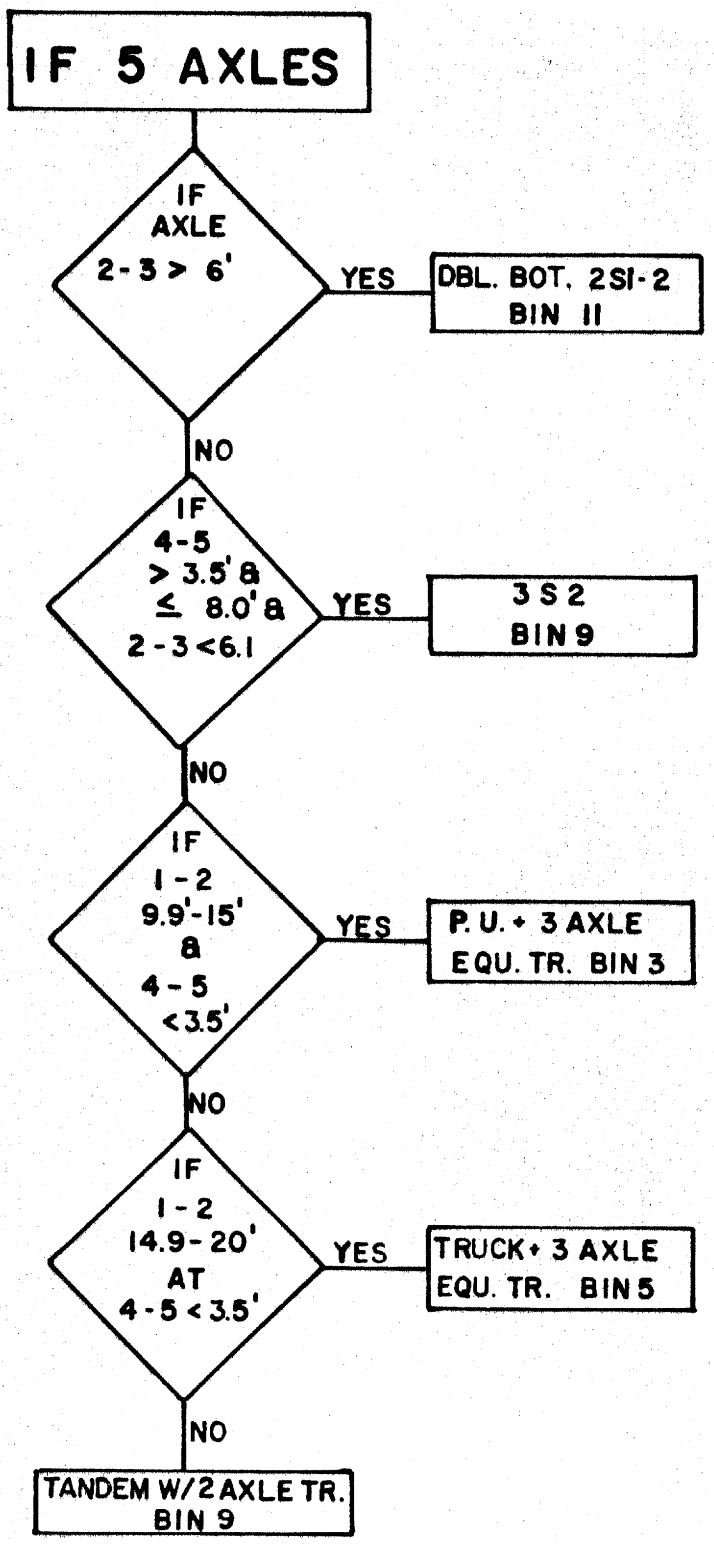
IF 5 AXLES
IF AXLE 2-3 > 6'
YES
DBL. BOT. 2SI-2 BIN 11
NO
IF 4-5 > 3.5' & ≤ 8.0' & 2-3 < 6.1
YES
3 S 2 BIN 9
NO
IF 1-2 9.9'-15' & 4-5 < 3.5'
YES
P.U. + 3 AXLE EQU. TR. BIN 3
NO
IF 1-2 14.9-20' AT 4-5 < 3.5'
YES
TRUCK + 3 AXLE EQU. TR. BIN 5
NO
TANDEM W/2 AXLE TR. BIN 9

TABLE 3 d

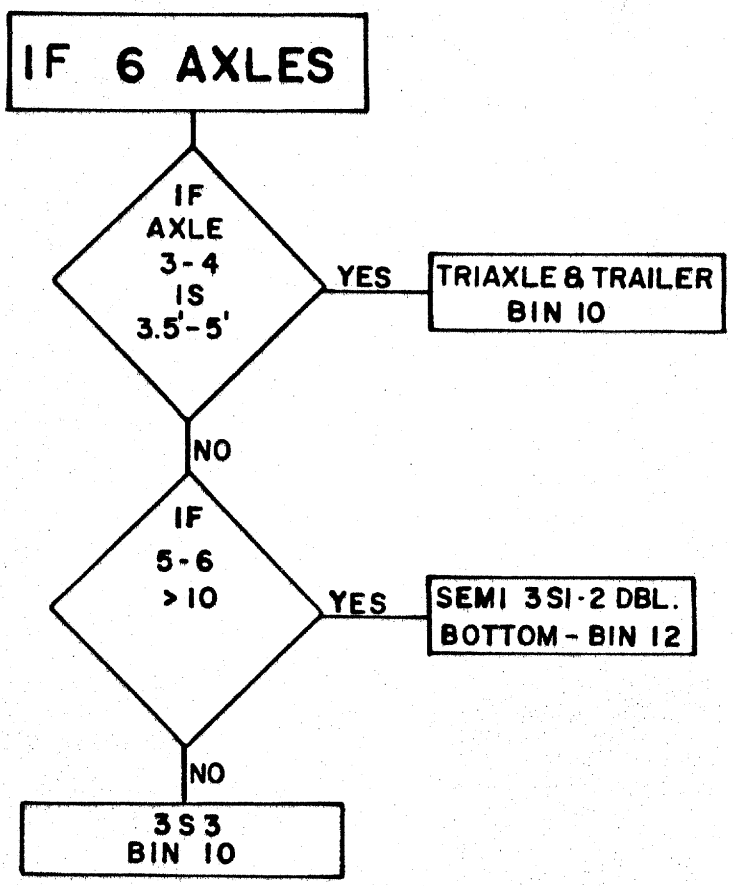
IF 6 AXLES
IF AXLE 3-4 IS 3.5'-5'
YES
TRIAXLE & TRAILER BIN 10
NO
IF 5-6 > 10
YES
SEMI 3S1-2 DBL. BOTTOM - BIN 12
NO
3S3 BIN 10

TABLE 3e

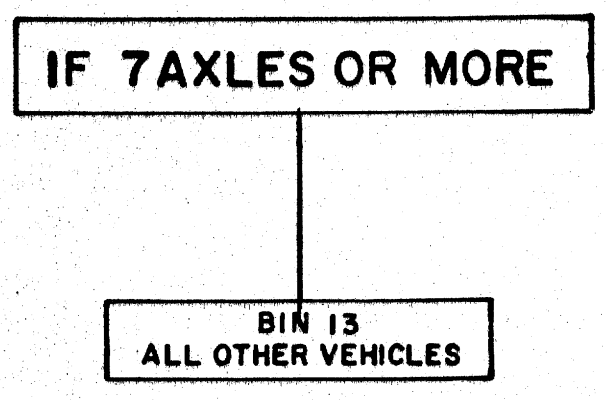

TABLE 3f

TABLE 4
AVAILABLE EQUIPMENT SUMMARY

System	Portability	Lanes	Environment	App. Cost[7]	Data Line Modem	Can Use Scheme "F"	Ind. Veh. Printout	Proof Test % Class Correct	Road Test Qual.[6]
I.R.D. Classifier	Permanent[1]	2 4 6	Year round	21,000 24,500 30,500	yes	yes	yes	91.2	OK
Golden River Weighman	Semi-[2]	1	Clear Roads	25,000	yes	yes	yes	95.9	OK
Streeter-Amet Traficomp 141A[5]	Portable-Tubes	1	Clear Roads	3,875	yes	yes	no by bins	93.5	OK
G.K. Instrument 6000	Portable-Tubes	1	Clear Roads	3,090	yes	yes	no by bins	95.5	OK
Sarasota VC-1900	Seni-Loops[3]	1	Year round	4,600	yes	no by veh. lengths only[4]	no by bins only	98.4	OK

Note 1: Loops and permanent axle counter. Cost of installation of permanent axle counters not included in cost estimates.
Note 2: Loops and removable axle counter.
Note 3: Loops only - temp. surface loops can be used.
Note 4: Sarasota informs us that they will have A1900 system operating on pneumatic tubes, classifying to Scheme "F" by Jan. 1985.
Note 5: Streeter-Amet will have available a traficomp II model 24 system using solid state programming and memory instead of the cassette type programming and memory device. Unfortunately the system was not available in time for evaluation.
Note 6: Road test qual. (quality) indicates systems performance rating under volume runs.
Note 7: See Appendix II for details of costs.

All systems survived both the phase two and the phase three tests without electronic failures. All systems had problems with missed counts. The road tube types, the Streeter-Amet and the G.K. Instrument were particularly susceptable to missed counts at slower speeds (under 20 mph) and when in queues. This problem is delt with at length in the full final report.

The I.R.D. system is a year round permanent system as is the Sarasota system (vehicle lengths only). The three other systems are clear road systems only.

Results of the testing indicate that scheme "F" is an acceptable classification system and one for which suitable logic programs can be developed for those systems using micro-processor techniques.

The FHWA Office of Highway Planning ran a computer check of scheme "F" using data supplied by the State of Washington on some 12,927 vehicle classified by types. One error in logic in scheme "F" was identified and corrected. The data was again compared by computer which indicated that scheme "F" would provide an acceptable classification system having an accuracy averaging well over 95% and better in the larger truck types.

In summary then, within the limitations spelled out in the full report, the four systems that classified by axles should provide acceptable systems for use in collecting field classification data. Where classification by length is acceptable the Sarasota system would provide an acceptable year round system.

6.0 RECOMMENDATIONS FOR EQUIPMENT IMPROVEMENT

While three different types of axle sensors were tested during this evaluation all three had serious limitations. Either high cost (the I.R.D. permanent sensor and the Golden-River axle pad, or seasonal use the pad and pneumatic tubes). The road tubes also have a short life as reported in the previous study, but they tend to fail gradually during a test run making the data collected during the run suspect.

Clearly, it is apparent that the development of a low cost, preferably permanent or at least all weather axle counter, should be high on the agenda for future FHWA or industry support.

It is recommended that work be funded for development in this area. With the FHWA requirement that the various states

provide vehicle classification data on a routine basis a system with a more reliable axle counter should have top priority.

Such a sensor should be able to withstand the higher A.A.D.T.'s and also be impervious to deliberate attempts by vehicle operators to damage it.

In conclusion the importance of further work being undertaken by research or manufacturing facilities should be stressed. The classification accuracy needs improvement. The missed vehicle count problem needs investigation and finally instrument programming and data retrival systems need to be further simplified to provide more foolproof systems for easier field set up and operation.