VERIFICATION OF SCALE ACCURACY FOR LTPP SPS WIM SITES

U.S. Department of Transportation

Federal Highway Administration

Long-Term Pavement Performance

Serving Your Need for Durable Pavements

Definitions

- Diagnostics
- Calibration
- Autocalibration
- Field Verification Testing
- System Data Analysis

Diagnostics

The comparison of on-site traffic observations with “real time” WIM output, the thorough review of the WIM data, and the utilization of the WIM system’s diagnostic features to insure that all system components are working correctly

Calibration

The utilization of test trucks with known axle weights and axle spacings to determine adjustments to a WIM system's "calibration factors" such that the WIM weights accurately estimate static weights and the WIM spacings match those of the test trucks

Autocalibration

WIM system feature which, in theory, maintains a system in constant calibration as environmental and roadway conditions change

Field Verification Testing

The utilization of test trucks with known axle weights and axle spacings to determine whether or not a WIM system's accuracy is in conformance with functional requirements

System Data Analysis

The analysis of downloaded WIM data for the purpose of monitoring proper functioning of WIM system components and the monitoring of system accuracy

WIM System Types Considered

- Bending Plate
- Ceramic (Traditional) Piezo
- Load Cell
- Quartz Piezo

System Accuracy Verification Scenarios

Existing and newly installed WIM systems will have same accuracy requirements and same testing procedures, regardless of system type.

During field testing, any autocalibration feature of the system shall be set to its "normal" operating mode.

System Accuracy Standards

- Elements
- 95 Percent Confidence Limit of Error

Elements	95 Percent Confidence Limit of Error
Single axles	±20 percent
Tandem axles	±15 percent
Gross vehicle weights	±10 percent
Vehicle speed	±1 mph [2 km/h]
Axle spacing, length	±0.5 feet [150 mm]

System Accuracy Standards

- Over a speed range covering 80% of the truck traffic stream
- Over a temperature range that covers the 15th to 85th percentile pavement temperatures in the course of a year

Test Truck- Calibration

- Calibration Session- WIM system's factors are adjusted so that the test trucks' WIM weights best estimate the trucks' static weights

Test Truck- Verification

- Verification Session- Test trucks' WIM weights are statistically compared with their static weights to determine if error is within allowable tolerances

Pre-Test Data Review

- Prior to bringing out test truck, check minimum of one day's data for:
  - proper equipment operation
  - proper classification
  - reasonableness of weights and spacings
  - operating speeds of trucks

Examples of pre test data reports

- Invalid weight measurements
- Class by hour distributions
- Speed by hour distributions
- Gross weight distributions
- Weight & axle spacing distributions by speed

DISTRIBUTION OF WEIGHT VIOLATIONS AND INVALID MEASUREMENTS FOR VEHICLES CLASSES 4-15

SITE NO : 025 Location : NEWBERRY - 040, 28.9 Lane(s) : 1
DATE : 07/11/00 County : SBD State-ID : CA Direction : E

CLASSIFICATION	TOTAL VEHICLE COUNTED	VEHICLES WITH INVALID MEASURE	TOTAL VEHICLES WEIGHED	TOTAL VEHICLES OVERWT.	PERCENT VEHICLES OVERWT.	NUMBER OF WEIGHT VIOLATIONS: AXLE	TANDEM	GROSS	BRIDGE
4	18	0	18	1	6	0	1	0	1
5	174	3	171	1	1	1	0	0	0
6	24	2	22	3	14	0	3	0	3
7	0	0	0	0	0	0	0	0	0
8	42	1	41	1	2	1	0	0	0
9	2995	44	2951	1088	37	8	1057	588	1086
10	9	2	7	2	29	0	2	1	1
11	185	0	185	36	19	23	0	26	27
12	36	1	35	12	34	1	0	12	12
13	1	0	1	0	0	0	0	0	0
14	20	0	20	17	85	4	10	16	17
15	34	6	28	3	11	0	3	0	3
TOTALS	3538	59	3479	1164	33	38	1076	643	1150

NUMBER OF VEHICLES WITH DATA ERRORS : 4
SPEED : 4 WEIGHT : 0

PERCENT VEHICLES NOT CLASSFIED (CLASS 15) : 1.0

PERCENT VEHICLES WITH INVALID MEASUREMENTS : 1.7

DISTRIBUTION OF VEHICLE CLASSIFICATIONS BY HOUR OF DAY

SITE NO : 025 Location : NEWBERRY - 040, 28.9 Lane(s) : 1
DATE : 07/11/00 County : SBD State-ID : CA Direction : E

HOURLY SUMMARY — VEHICLE COUNTS

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTALS
0- 1	0	12	6	0	4	4	0	1	82	0	6	0	0	0	1	116
1- 2	0	16	4	0	1	1	0	1	104	0	6	0	0	0	1	134
2- 3	0	12	3	0	3	1	0	0	63	0	4	0	0	1	0	87
3- 4	0	15	4	1	2	0	0	1	81	0	9	1	0	0	1	115
4- 5	0	12	9	0	4	1	0	1	90	0	5	0	0	1	0	123
5- 6	0	21	7	1	5	1	0	0	83	1	9	0	0	0	0	128
QTR TOTALS	0	88	33	2	19	8	0	4	503	1	39	1	0	2	3	703
6- 7	0	28	16	0	7	1	0	3	105	0	7	0	0	0	1	168
7- 8	0	43	17	0	6	0	0	3	125	1	10	0	0	5	7	217
8- 9	0	74	27	1	9	0	0	4	129	0	3	0	0	0	1	248
9-10	0	75	31	2	8	1	0	3	126	0	8	0	0	4	2	260
10-11	0	96	35	1	14	1	0	1	133	1	9	1	0	0	0	292
11-12	0	110	24	1	12	1	0	3	103	0	16	3	0	3	3	279
QTR TOTALS	0	426	150	5	56	4	0	17	721	2	53	4	0	12	14	1464
12-13	0	94	22	2	15	2	0	5	111	0	7	2	0	1	5	266
13-14	0	92	31	5	16	0	0	0	129	1	9	5	0	3	2	293
14-15	0	70	42	1	18	2	0	2	169	0	7	1	0	1	1	314
15-16	0	79	34	0	12	0	0	3	168	0	8	5	0	0	3	312
16-17	0	60	24	0	17	2	0	1	151	2	5	3	0	0	2	267
17-18	0	42	27	2	11	2	0	2	158	1	7	4	0	0	3	259
QTR TOTALS	0	437	180	10	89	8	0	13	886	4	43	20	0	5	16	1711
18-19	0	43	29	1	7	1	0	2	166	0	6	2	0	0	3	260
19-20	0	40	17	0	6	1	0	3	153	1	10	3	1	1	1	237
20-21	0	28	8	0	12	0	0	2	149	0	5	0	0	0	1	205
21-22	0	31	12	0	7	1	0	0	150	1	5	1	0	0	1	209
22-23	0	20	9	0	6	0	0	1	149	0	10	3	0	0	1	199
23-24	0	13	8	0	8	1	0	0	120	0	14	2	0	0	0	166
QTR TOTALS	0	175	83	1	46	4	0	8	887	2	50	11	1	1	7	1276

DAILY SUMMARY — VEHICLE COUNTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTALS
TOTAL	0	1126	446	18	210	24	0	42	2997	9	185	36	1	20	40	5154
PERCENT	0.0	21.8	8.7	0.3	4.1	0.5	0.0	0.8	58.1	0.2	3.6	0.7	0.0	0.4	0.8	100.0

DISTRIBUTION OF VEHICLE SPEEDS BY HOUR OF DAY

SITE NO : 025 Location : NEWBERRY - 040, 28.9 Lane(s) : 1
DATE : 07/11/00 County : SBD State-ID : CA Direction : E

HOUR	SPEED RANGE, (mph) 00-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	> 85	TOTALS
0- 1	2	0	1	6	9	25	40	18	12	3	0	0	116
1- 2	0	2	3	4	8	18	45	23	18	11	0	2	134
2- 3	0	0	5	5	7	22	31	9	6	2	0	0	87
3- 4	0	1	2	5	11	25	35	18	12	4	2	0	115
4- 5	0	2	2	6	16	29	35	21	10	2	0	0	123
5- 6	1	2	6	11	10	25	47	8	12	6	0	0	128
QTR TOTALS	3	7	19	37	61	144	233	97	70	28	2	2	703
6- 7	0	2	7	18	19	24	51	26	16	4	1	0	168
7- 8	0	2	3	11	15	39	67	48	21	10	0	1	217
8- 9	0	0	3	14	23	59	69	41	28	9	1	1	248
9-10	0	1	2	17	23	50	70	49	35	13	0	0	260
10-11	0	0	0	9	18	51	95	59	40	15	5	0	292
11-12	2	0	3	9	15	46	78	61	44	17	3	1	279
QTR TOTALS	2	5	18	78	113	269	430	284	184	68	10	3	1464
12-13	0	3	2	8	13	43	90	48	42	14	2	1	266
13-14	0	0	1	22	15	40	100	52	37	21	3	2	293
14-15	0	2	1	13	20	57	96	59	50	13	3	0	314
15-16	0	0	2	10	36	79	84	49	36	11	4	1	312
16-17	0	0	1	13	31	54	83	43	32	9	1	0	267
17-18	0	1	6	16	28	55	82	38	25	5	2	1	259
QTR TOTALS	0	6	13	82	143	328	535	289	222	73	15	5	1711
18-19	1	1	1	16	14	46	82	59	27	7	5	1	260
19-20	0	0	3	10	25	42	92	34	22	8	1	0	237
20-21	0	1	3	9	24	46	67	31	21	3	0	0	205
21-22	0	0	3	12	14	42	67	34	26	5	6	0	209
22-23	0	0	3	6	8	47	70	34	26	4	1	0	199
23-24	0	1	2	6	11	40	50	30	10	12	4	0	166
QTR TOTALS	1	3	15	59	96	263	428	222	132	39	17	1	1276

SUMMARY	00-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	> 85	TOTALS
TOTAL	6	21	65	256	413	1004	1626	892	608	208	44	11	5154
PERCENT	0.1	0.4	1.3	5.0	8.0	19.5	31.5	17.3	11.8	4.0	0.9	0.2	100.0

DISTRIBUTION OF LANE COUNTS BY GROSS WEIGHT
SITE #025 - Newberry Jul 09, 2000
**** CLASS 9 **** (#Files = 7)

	LANE #1			LANE #2			LANE #3			LANE #4			ALL		
Gross Wt Range	Count	%	Avg Speed	Count	%	Avg Speed	Count	%	Avg Speed	Count	%	Avg Speed	Count	%	Avg Speed
< 20.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
20.0 TO 24.9	1	0.0	57.3	0	0.0	0.0	0	0.0	0.0	8	0.0	62.0	9	0.0	61.5
25.0 TO 29.9	18	0.1	62.8	6	0.2	66.2	9	0.7	71.0	100	0.7	61.9	133	0.4	62.9
30.0 TO 34.9	80	0.5	60.2	22	0.9	65.8	37	3.1	67.7	455	3.2	61.9	594	1.7	62.2
35.0 TO 39.9	190	1.2	61.3	39	1.7	65.2	45	3.8	70.2	685	4.8	62.5	959	2.9	62.8
40.0 TO 44.9	382	2.4	61.0	76	3.4	65.4	71	6.0	68.5	841	5.9	61.5	1370	4.1	62.0
45.0 TO 49.9	625	4.0	61.2	107	4.7	66.0	81	6.8	67.3	1096	7.7	62.1	1909	5.7	62.2
50.0 TO 54.9	903	5.8	60.7	133	5.9	66.8	87	7.3	69.7	1195	8.4	62.4	2318	7.0	62.3
55.0 TO 59.9	1191	7.6	61.2	162	7.2	66.0	87	7.3	69.1	1117	7.9	62.1	2557	7.7	62.2
60.0 TO 64.9	1330	8.5	61.2	204	9.1	67.6	103	8.7	68.2	1114	7.9	62.5	2751	8.3	62.5
65.0 TO 69.9	1622	10.4	61.2	255	11.4	67.0	92	7.7	67.6	1307	9.2	62.5	3276	9.9	62.4
70.0 TO 74.9	2261	14.5	61.8	432	19.3	67.4	174	14.7	68.4	2239	15.9	62.6	5106	15.4	62.9
75.0 TO 79.9	4019	25.8	60.7	523	23.4	66.4	250	21.1	68.3	2910	20.6	61.5	7702	23.3	61.6
80.0 TO 84.9	2616	16.8	59.6	260	11.6	63.2	104	8.7	68.9	955	6.7	61.3	3935	11.9	60.5
85.0 TO 89.9	290	1.8	58.8	11	0.4	59.0	37	3.1	72.6	45	0.3	61.2	383	1.1	60.4
90.0 TO 94.9	6	0.0	60.2	0	0.0	0.0	2	0.1	74.0	4	0.0	64.4	12	0.0	63.9
>= 95.0	2	0.0	58.9	2	0.0	68.0	3	0.2	70.4	2	0.0	68.4	9	0.0	66.9
All	15536	47.0	60.9	2232	6.7	66.3	1182	3.5	68.7	14073	42.6	62.1	33023	100.0	62.1
Avg Gross Wt	69.6	n/a		67.8	n/a		64.7	n/a		63.0	n/a		66.5	n/a	
Standard Dev	11.9	n/a		12.3	n/a		15.2	n/a		14.6	n/a		13.7	n/a	
Avg Axle 1 Wt	11.3	n/a		10.8	n/a		11.6	n/a		11.1	n/a		11.2	n/a	
Standard Dev	0.8	n/a		0.9	n/a		1.0	n/a		0.8	n/a		0.8	n/a	

DISTRIBUTION OF AVERAGE WEIGHTS & SPACINGS BY SPEED
SITE #025 - Newberry Jul 09, 2000 (#Files = 7)
*** LANE #1 *** **** CLASS 9 ****

Speed Range	WEIGHTS: Axle 1 Left Wheel	Axle 1 Right Wheel	Steer Axle	Tractor Tandem Axles	Trailer Tandem Axles	Vehicle Gross	COUNTS: All	Over Weight	Percent Over Weight	SPACINGS: Tractor Tandem Axles	Trailer Tandem Axles
< 25.0	5.5	5.3	10.8	32.6	32.4	75.7	1	0	0.0	4.2	3.8
25.0 TO 29.9	5.9	5.6	11.5	33.2	32.5	77.1	1	0	0.0	4.4	4.0
30.0 TO 34.9	5.5	5.5	11.0	31.1	31.3	73.4	8	3	37.5	4.3	4.0
35.0 TO 39.9	5.7	5.8	11.5	30.8	31.4	73.8	46	12	26.0	4.3	4.5
40.0 TO 44.9	5.7	5.6	11.3	31.2	30.9	73.5	284	111	39.0	4.2	4.6
45.0 TO 49.9	5.6	5.6	11.3	31.4	30.9	73.7	931	454	48.7	4.3	4.5
50.0 TO 54.9	5.7	5.6	11.4	28.9	28.5	68.9	1339	470	35.1	4.3	4.5
55.0 TO 59.9	5.7	5.6	11.4	28.8	28.2	68.5	3419	1189	34.7	4.3	4.5
60.0 TO 64.9	5.7	5.6	11.3	29.6	28.6	69.6	5414	2015	37.2	4.3	4.5
65.0 TO 69.9	5.5	5.6	11.1	30.0	28.4	69.5	2606	889	34.1	4.3	4.6
70.0 TO 74.9	5.4	5.5	10.9	30.0	28.2	69.2	1150	358	31.1	4.3	4.7
>= 75.0	5.2	5.4	10.7	30.2	27.7	68.7	337	82	24.3	4.5	4.8
Average All	5.7	5.6	11.3	29.6	28.7	69.6	15536	5583	35.9	4.4	4.6
Standard Dev	0.4	0.4	0.8	5.7	6.7	11.9	n/a	n/a	n/a	0.2	1.7

Test Truck Procedures

- Selection
- Equipment
- Measurements
- Operation
- Speed Criteria
- Temperature Criteria
- Data Collection

Test Truck- Selection

- Two truck minimum; different loadings and configurations
- One 3S2 with air suspensions loaded as close to 80,000 lbs as possible
- Second 3S2 at < 70,000 lbs, or a configuration matching predominant truck operating through site

Test Truck- Equipment

- Suspensions in good condition
- Conventional tires at proper inflation
- Loads stable (no liquid loads)
- Start with full fuel tanks
- CB radio

Test Truck- Measurements

Record :

- Certified weights for gross weight and each axle/axle group before and after testing session
- Measured axle spacings

Test Truck- Operation

- Use safe turnaround points
- Stay in center of lane thru site
- Attempt to attain speed as requested by data collection crew via CB
- Maintain constant speed (no acceleration or deceleration) thru site
- Report approach and speed via CB (make no transmission through site)

Test Truck- Speed Range Criteria

Test truck runs to cover same speed range as that encompassed by +/- 80% of the truck traffic stream

Test Truck- Speed Criteria

- Minimum of 3 “speed points”
- Minimum of 15 mph spread between highest and lowest speed points
- Maximum of 15 mph between speed points
- Minimum of 2 passes each truck each speed point

Test Truck- Temperature Criteria

The test truck run pattern as described under "speed criteria" shall be repeated as many times as is feasible during a session in order to encompass the greatest range of pavement temperatures expected for a 24 hour period. One or more additional verification sessions will be necessary to cover seasonal variations of environmental conditions.

Test Truck- WIM Data Recording

- Record existing calibration factors in effect for test session
- Record WIM "real time" display for each truck run:
  - Vehicle record number
  - Speed
  - Axle weights & Gross weight
  - Axle spacings
  - Temperature (if available)

Test Truck- Data Recording

In addition to recording the WIM data for each test truck pass, the following should also be recorded :

- The actual speed of the truck
- The actual temperature of the pavement

Examples of data recordings

- calibration factors
- columnar tabulation
- graphing gross weight “error by speed”
  - single truck
  - two trucks

```
Mode:0

Lane 1
Sensiti. W.-Pad(s). (right):  1008
Sensiti. W.-Pad      left  :  1059
Sensitivity  :  1470
Corr.-Fact. 1:  1070
Corr.-Fact. 2:  1090
Corr.-Fact. 3:  1100
Speed-Point 1:  4000
Speed-Point 2:  5500
Speed-Point 3:  7000
Sensiti. W.-Mats. :   400
Temp. coefficient :     0
Corr.-Fact. empty Vehicles:  1000


Mode:1

Weight select: 0 lbs
Length select:  feet
Speed  select:  mph
Number of Lanes: 4
Station code:    25

Distance Loop 1-2  lane 1:  1630

Length of Loop  1  lane 1:   570
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DAVE (CS 30)

SITE: 94 - GREENFIELD LANE NO: 4 (NB 2) DATE: 6/02/00

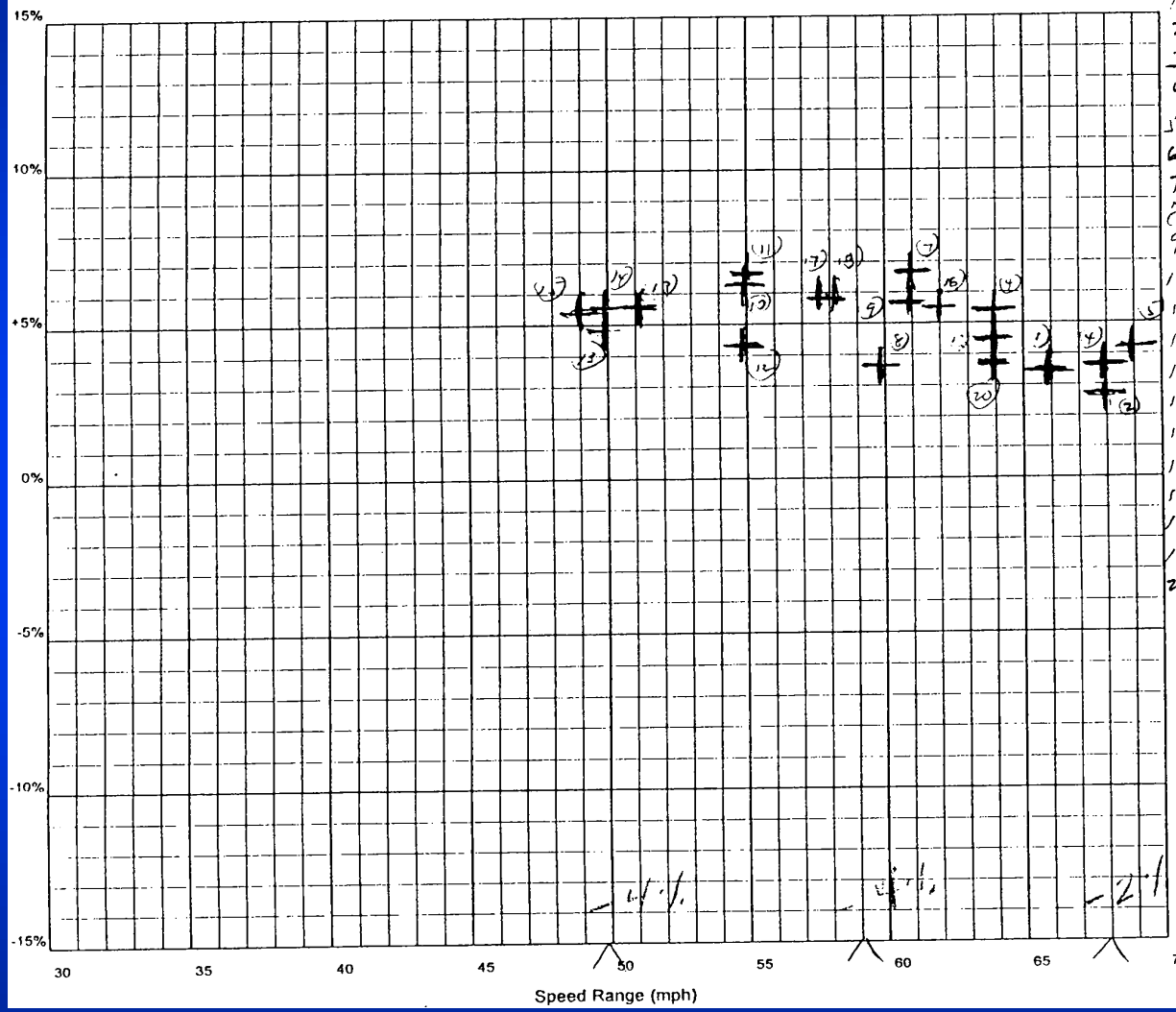
TEST TRUCK STATIC DATA:

	VEHICLE NUMBER		SPEED READ	SPEED CORR.	AXWT 1	AXWT 2/3	AXWT 4/5	GWV	AXSP 1/2	AXSP 2/3	AXSP 3/4	AXSP 4/5	TEMP *
					12.4	33.5	37.6	83.5	14.0	4.6	32.8	4.5	65.2
1	3976	08:01	65	66	12.1	34.9	39.4	86.5	13.8	4.5	32.5	4.4	[illegible]
2	4144	:10	68	68	11.9	34.4	39.6	85.8	14.1	4.6	32.9	4.5	64
3	4287	:19	63	64	12.3	35.4	39.7	87.4	13.8	4.5	32.3	4.4	62
4	4454	:30	68	68	11.8	36.7	39.1	86.6	13.9	4.5	32.5	4.5	63
5	4624	:39	70	69	11.8	34.9	40.4	87.0	14.2	4.7	33.3	4.5	64
6	4799	:50	64	64	12.6	35.2	40.3	88.0	14.0	4.6	32.8	4.5	63
7	4959	09:01	60	61	12.8	35.9	40.5	89.2	13.9	4.5	32.4	4.4	[illegible]
8	5221	:16	61	60	12.7	35.1	38.8	86.7	14.4	4.7	33.5	4.6	65
9	5424	:27	60	61	12.7	35.5	39.5	87.8	13.8	4.6	32.4	4.4	[illegible]
10	5590	:35	54	55	12.5	35.8	40.4	88.8	13.8	4.6	32.4	4.5	[illegible]
11	5757	:45	55	55	12.6	35.8	40.8	89.1	14.0	4.6	32.8	4.5	[illegible]
12	5950	:54	54	55	12.3	35.0	39.8	87.1	13.8	4.5	32.4	4.4	[illegible]
13	6109	10:02	50	50	11.9	34.7	40.9	87.6	14.0		32.8		
14	6305	:10	50	50	12.1	35.5	40.5	88.2	14.0		32.8		
15	6476	:19	49	50	11.9	35.3	40.8	88.0	13.8		32.2		
16	6652	:27	61	62	12.4	35.6	40.1	88.1	13.7		32.3		
17	6865	:37	59	58	12.4	36.0	39.9	88.4	14.3		33.4		
18	7037	:46	57	58	12.3	35.6	40.4	88.4	13.9		32.4		
19	7229	:55	52	51	12.0	35.4	40.9	88.2	14.1		33.2		
20	7389	11:04	65	64	12.1	35.6	39.1	86.7	14.3		33.5		

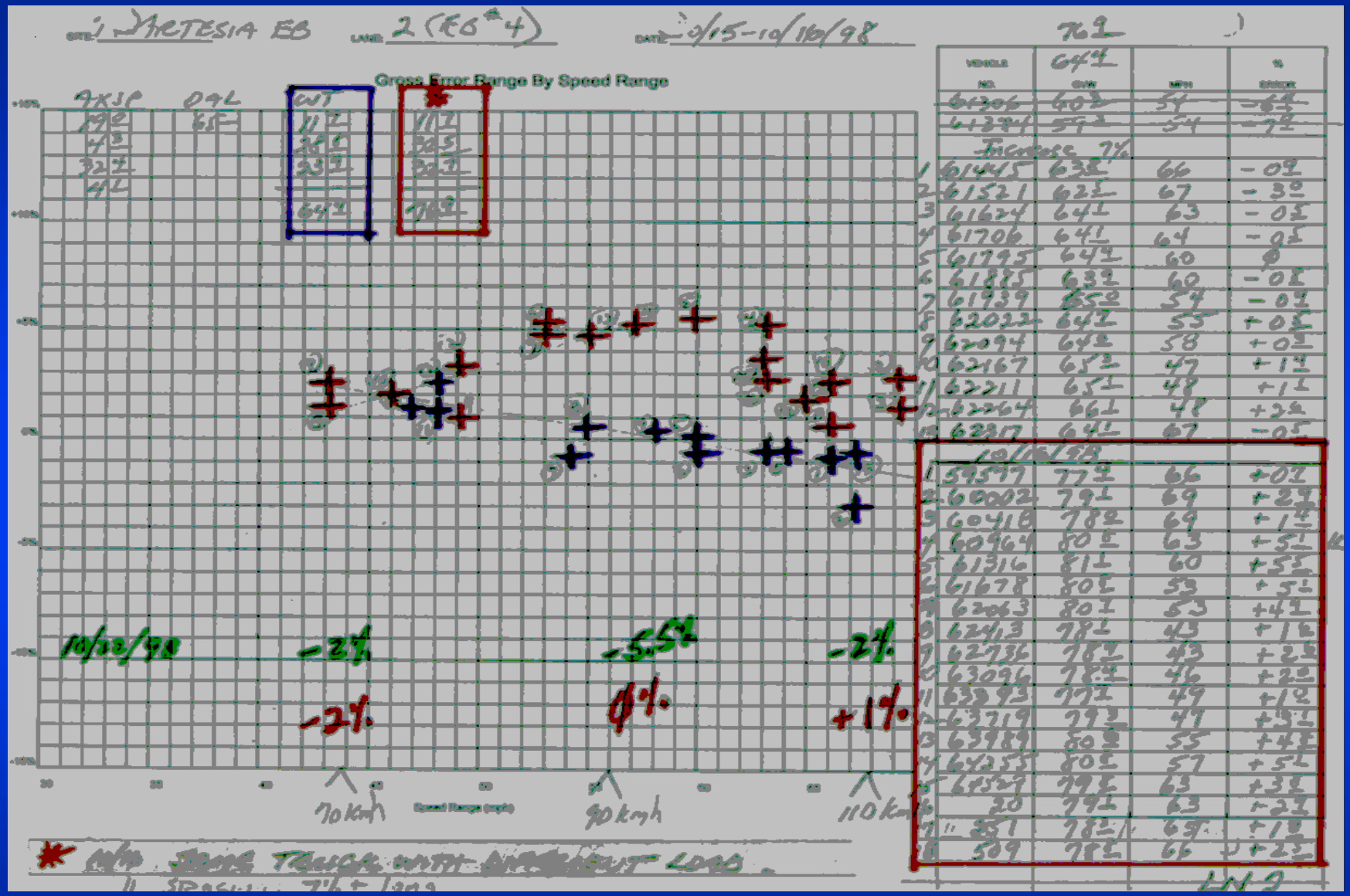
* RECORD "WIM" DISPLAYED TEMP AND ACTUAL TEMP MEASURED.

SITE: 94 - GREENVILLE LANE: 4 (NB 2) DATE: 6/02/00

GROSS ERROR RANGE BY SPEED RANGE



	VEHICLE NO.	83.5 GVW	MPH	% ERROR
1	3976	86.5	66	+3.6
2	4144	85.8	68	+2.8
3	4287	87.4	64	+4.7
4	4454	86.6	68	+3.7
5	4624	87.0	69	+4.2
6	4799	88.0	64	+5.4
7	4959	89.2	61	+6.8
8	5221	86.7	60	+3.8
9	5434	87.8	61	+5.1
10	5590	88.8	55	+6.3
11	5757	89.1	55	+6.7
12	5950	87.1	55	+4.3
13	6109	87.6	50	+4.9
14	6305	88.2	50	+5.6
15	6476	88.0	50	+5.4
16	6652	88.1	62	+5.5
17	6805	88.4	58	+5.9
18	7037	88.4	58	+5.9
19	7229	88.2	51	+5.6
20	7389	86.7	64	+3.8


Gross Error Range By Speed Range
70 km/h
90 km/h
110 km/h

Examples of data capture

- Real time- to “log” file or printer
- Individual vehicle records stored in system files

06/02/2000 SITE 94 CT TRANSPORT TRUCK NB#1

(7624) LANE NB#1 TYPE 9 GVW 85.8 kips LENGTH 63 ft
18-K ESAL 3.353 SPEED 66 mph MAX GVW 80.0 kips Fri Jun 02 11:14:29.43 2000

UNIT	SEPARATION (ft)	LEFT WT (kips)	RIGHT WT (kips)	TOTAL WT (kips)	ALLOWABLE (kips)
1	OVER GVW	5.9	6.2	12.1	20.0
2*	13.8	8.2	8.1	16.3	17.0
3*	4.6	7.9	9.6	17.5	17.0
4*	32.5	9.4	9.8	19.2	17.0
5*	4.4	10.0	10.6	20.6	17.0

(7882) LANE NB#1 TYPE 9 GVW 88.7 kips LENGTH 65 ft
18-K ESAL 3.832 SPEED 67 mph MAX GVW 80.0 kips Fri Jun 02 11:25:20.58 2000

UNIT	SEPARATION (ft)	LEFT WT (kips)	RIGHT WT (kips)	TOTAL WT (kips)	ALLOWABLE (kips)
1	OVER GVW	5.3	6.1	11.4	20.0
2*	14.2	8.9	8.6	17.5	17.0
3*	4.7	8.6	9.1	17.8	17.0
4*	33.2	10.3	10.0	20.3	17.0
5*	4.5	10.6	11.2	21.8	17.0

(8105) LANE NB#1 TYPE 9 GVW 85.1 kips LENGTH 63 ft
18-K ESAL 3.297 SPEED 66 mph MAX GVW 80.0 kips Fri Jun 02 11:35:47.99 2000

UNIT	SEPARATION (ft)	LEFT WT (kips)	RIGHT WT (kips)	TOTAL WT (kips)	ALLOWABLE (kips)
1	OVER GVW	5.1	5.8	11.0	20.0
2*	13.8	8.3	8.6	17.0	17.0
3*	4.6	8.1	9.1	17.2	17.0
4*	32.4	9.6	9.7	19.2	17.0
5*	4.5	10.2	10.6	20.8	17.0

(8407) LANE NB#1 TYPE 9 GVW 84.6 kips LENGTH 64 ft
18-K ESAL 3.122 SPEED 68 mph MAX GVW 80.0 kips Fri Jun 02 11:46:24.63 2000

UNIT	SEPARATION (ft)	LEFT WT (kips)	RIGHT WT (kips)	TOTAL WT (kips)	ALLOWABLE (kips)
1	OVER GVW	5.1	5.7	10.8	20.0
2*	14.0	8.5	8.4	16.9	17.0
3*	4.5	8.1	9.3	17.4	17.0
4*	33.0	9.8	9.3	19.0	17.0
5*	4.5	9.7	10.7	20.4	17.0

(8634) LANE NB#1 TYPE 9 GVW 87.8 kips LENGTH 64 ft
18-K ESAL 3.688 SPEED 62 mph MAX GVW 80.0 kips Fri Jun 02 11:55:27.07 2000

UNIT	SEPARATION (ft)	LEFT WT (kips)	RIGHT WT (kips)	TOTAL WT (kips)	ALLOWABLE (kips)
1	OVER GVW	5.8	6.2	12.0	20.0
2*	14.2	8.7	8.5	17.2	17.0
3*	4.7	8.2	9.3	17.6	17.0
4*	33.3	10.0	10.0	20.0	17.0
5*	4.5	10.0	11.0	21.0	17.0

(8898) LANE NB#1 TYPE 9 GVW 86.1 kips LENGTH 65 ft
18-K ESAL 3.353 SPEED 62 mph MAX GVW 80.0 kips Fri Jun 02 12:05:23.78 2000

UNIT	SEPARATION (ft)	LEFT WT (kips)	RIGHT WT (kips)	TOTAL WT (kips)	ALLOWABLE (kips)
1	OVER GVW	5.4	6.4	11.7	20.0
2*	14.3	8.5	8.3	16.8	17.0
3*	4.6	8.3	8.9	17.2	17.0

4,	6,	2,	0,	0,	0,	6,	1,	9,	84.8,	64.5,	62.8,	196,	5.4,	6.6,	8.5,	9.6,	10.2,	8.4,	9.9,	4.3,	9.1,	9.8,	35.6,	8.4,	8.7,	4.1,
4,	6,	2,	0,	0,	0,	32,	3,	9,	79.2,	68.0,	60.3,	68,	4.6,	4.9,	7.3,	8.5,	15.8,	7.8,	8.7,	4.1,	9.1,	9.0,	29.8,	9.1,	9.6,	4.0,
1,	6,	2,	0,	0,	1,	9,	4,	5,	23.7,	32.9,	65.2,	0,	4.6,	4.2,	7.0,	7.7,	20.3,	,	,	,	,	,	,	,	,	,
1,	6,	2,	0,	0,	1,	16,	5,	9,	74.9,	71.5,	57.2,	4,	6.2,	5.3,	9.0,	8.6,	20.3,	9.7,	9.1,	4.2,	6.2,	6.5,	33.6,	7.6,	6.3,	4.1,
1,	6,	2,	0,	0,	3,	32,	18,	9,	69.8,	70.1,	57.8,	0,	5.8,	5.3,	7.9,	6.7,	19.5,	7.8,	7.8,	4.2,	7.0,	6.4,	29.0,	7.8,	6.7,	4.0,
1,	6,	2,	0,	0,	5,	9,	24,	9,	64.4,	68.8,	55.9,	0,	5.2,	5.2,	8.9,	6.7,	17.3,	8.7,	7.4,	4.2,	5.0,	5.8,	30.1,	6.4,	4.7,	4.1,
4,	6,	2,	0,	0,	5,	40,	26,	9,	81.1,	69.1,	57.8,	196,	5.4,	6.1,	8.6,	9.6,	16.9,	8.2,	9.2,	4.2,	7.7,	8.3,	31.7,	9.0,	8.7,	4.0,
4,	6,	2,	0,	0,	5,	43,	27,	9,	77.0,	72.0,	62.1,	0,	4.9,	6.1,	7.8,	8.8,	19.1,	7.4,	9.0,	4.3,	8.7,	8.6,	31.9,	7.2,	8.0,	4.1,
1,	6,	2,	0,	0,	6,	37,	33,	9,	68.4,	76.1,	70.8,	0,	5.5,	5.3,	8.4,	7.2,	17.6,	9.0,	7.5,	4.4,	6.1,	4.9,	34.0,	7.4,	6.7,	4.1,
1,	6,	2,	0,	0,	6,	45,	38,	9,	35.2,	72.6,	70.8,	0,	5.3,	5.0,	4.0,	3.4,	20.6,	4.2,	4.0,	4.3,	2.2,	2.2,	32.8,	2.2,	2.0,	4.0,
1,	6,	2,	0,	0,	7,	6,	41,	9,	77.9,	70.7,	67.7,	0,	5.6,	5.5,	7.7,	8.2,	19.8,	8.4,	8.4,	4.2,	8.4,	7.5,	33.0,	9.1,	8.6,	4.1,
4,	6,	2,	0,	0,	7,	12,	42,	9,	82.4,	74.5,	60.3,	196,	5.8,	6.4,	8.6,	8.7,	20.2,	8.6,	8.8,	4.2,	9.0,	7.9,	31.0,	9.5,	8.4,	4.0,
1,	6,	2,	0,	0,	8,	28,	45,	9,	73.5,	76.3,	62.1,	0,	5.8,	5.7,	7.2,	6.5,	19.6,	7.6,	7.7,	4.2,	8.3,	7.5,	32.8,	9.0,	7.8,	4.1,
1,	6,	2,	0,	0,	8,	44,	48,	9,	63.6,	68.5,	57.8,	0,	6.1,	6.7,	7.4,	6.9,	16.1,	7.7,	7.9,	4.3,	3.9,	5.2,	33.6,	5.1,	6.2,	4.0,
4,	6,	2,	0,	0,	9,	52,	52,	4,	37.2,	46.8,	65.9,	0,	4.9,	5.2,	8.5,	9.5,	25.9,	3.9,	5.0,	4.0,	,	,	,	,	,	,
4,	6,	2,	0,	0,	10,	17,	53,	9,	76.4,	66.7,	57.8,	4,	4.9,	5.3,	7.6,	8.2,	17.6,	7.6,	8.2,	4.2,	8.6,	7.6,	30.9,	9.0,	8.8,	4.0,
2,	6,	2,	0,	0,	10,	44,	56,	3,	6.7,	19.8,	69.0,	0,	2.0,	1.9,	1.3,	1.4,	14.2,	,	,	,	,	,	,	,	,	,
4,	6,	2,	0,	0,	12,	39,	61,	9,	75.3,	66.7,	62.1,	0,	5.6,	5.8,	7.4,	8.6,	17.1,	7.7,	8.9,	4.1,	7.7,	8.9,	31.7,	7.5,	6.7,	4.0,
1,	6,	2,	0,	0,	12,	48,	62,	9,	79.2,	69.2,	59.0,	68,	5.6,	5.5,	8.3,	8.6,	18.8,	8.8,	9.4,	4.2,	7.9,	7.9,	31.0,	7.8,	8.9,	4.1,
1,	6,	2,	0,	0,	13,	7,	64,	9,	45.1,	65.8,	57.2,	0,	5.5,	5.2,	4.3,	4.3,	16.3,	4.6,	4.6,	4.1,	4.0,	3.6,	30.3,	4.5,	3.9,	4.0,
1,	6,	2,	0,	0,	13,	15,	65,	9,	43.7,	69.1,	57.8,	0,	5.1,	5.8,	4.3,	4.1,	17.2,	4.7,	4.7,	4.3,	3.6,	3.1,	32.5,	4.4,	3.4,	4.1,
1,	6,	2,	0,	0,	13,	34,	66,	9,	77.8,	73.2,	62.1,	0,	5.6,	6.1,	8.4,	8.0,	17.3,	8.7,	8.2,	4.2,	7.5,	6.7,	32.0,	8.8,	9.3,	4.0,
1,	6,	2,	0,	0,	14,	32,	70,	9,	64.2,	71.9,	65.9,	0,	5.7,	4.7,	7.1,	7.1,	19.8,	8.0,	6.9,	4.3,	6.3,	5.2,	31.7,	7.2,	5.5,	4.1,
1,	6,	2,	0,	0,	14,	50,	72,	9,	76.2,	77.8,	65.2,	0,	5.6,	5.4,	7.6,	7.6,	20.6,	8.1,	8.2,	4.2,	8.3,	7.9,	34.8,	8.4,	8.5,	4.1,
4,	6,	2,	0,	0,	15,	29,	74,	9,	72.8,	67.1,	60.9,	0,	5.2,	6.3,	7.1,	7.9,	16.3,	7.1,	8.2,	4.2,	7.1,	7.7,	28.4,	7.6,	8.0,	4.0,
1,	6,	2,	0,	0,	16,	2,	77,	9,	43.2,	69.2,	64.0,	0,	6.1,	5.6,	5.0,	4.5,	17.2,	5.1,	4.6,	4.3,	3.1,	3.1,	30.3,	3.4,	2.1,	4.1,
1,	6,	2,	0,	0,	19,	40,	87,	9,	62.7,	69.8,	65.2,	0,	5.9,	5.6,	6.9,	6.3,	17.9,	7.8,	6.3,	4.2,	5.1,	4.7,	32.7,	6.6,	6.9,	4.1,
1,	6,	2,	0,	0,	19,	50,	88,	12,	55.1,	75.3,	57.8,	0,	4.3,	4.8,	4.9,	4.5,	19.9,	5.3,	5.0,	4.3,	4.1,	3.8,	16.5,	5.0,	4.5,	12.5,
1,	6,	2,	0,	0,	19,	59,	89,	9,	81.8,	74.7,	62.1,	196,	5.4,	5.4,	8.7,	8.4,	19.1,	9.1,	9.2,	4.2,	8.7,	8.0,	32.9,	8.4,	9.9,	4.0,
1,	6,	2,	0,	0,	20,	38,	91,	5,	16.3,	26.6,	57.8,	0,	4.0,	3.5,	4.8,	3.8,	15.3,	,	,	,	,	,	,	,	,	,
4,	6,	2,	0,	0,	20,	44,	92,	3,	7.9,	15.2,	64.0,	0,	2.6,	1.9,	1.4,	1.9,	10.5,	,	,	,	,	,	,	,	,	,
4,	6,	2,	0,	0,	20,	53,	93,	9,	36.1,	73.7,	82.0,	0,	4.8,	5.2,	3.3,	4.4,	18.3,	3.5,	3.9,	4.1,	2.0,	2.4,	32.7,	2.9,	3.0,	3.9,
4,	6,	2,	0,	0,	21,	6,	94,	5,	21.1,	34.1,	52.2,	0,	3.6,	4.1,	6.5,	6.7,	21.2,	,	,	,	,	,	,	,	,	,
4,	6,	2,	0,	0,	21,	7,	96,	3,	7.5,	16.0,	52.8,	0,	1.8,	2.2,	1.7,	1.6,	11.5,	,	,	,	,	,	,	,	,	,
4,	6,	2,	0,	0,	21,	42,	98,	9,	76.6,	62.1,	65.2,	0,	5.5,	6.4,	7.2,	8.6,	9.8,	6.9,	8.1,	4.2,	8.8,	8.0,	31.7,	8.0,	8.5,	4.0
1,	6,	2,	0,	0,	21,	48,	99,	4,	29.7,	42.5,	62.8,	0,	5.1,	5.0,	7.6,	6.2,	24.1,	3.0,	2.6,	4.1,	,	,	,	,	,	
1,	6,	2,	0,	0,	21,	54,	100,	4,	43.1,	47.2,	65.2,	0,	6.3,	7.1,	10.1,	8.2,	26.7,	5.2,	6.0,	3.9,	,	,	,	,	,	
2,	6,	2,	0,	0,	21,	57,	102,	2,	6.3,	13.7,	75.8,	0,	1.6,	2.2,	1.3,	1.0,	8.8,	,	,	,	,	,	,	,	,	
1,	6,	2,	0,	0,	22,	27,	103,	9,	55.6,	68.7,	60.3,	0,	6.0,	5.8,	7.2,	6.6,	19.8,	7.7,	7.7,	4.1,	3.6,	3.0,	33.1,	3.8,	3.8,	4.0

Use of Test Truck Data

- For calibration of WIM system
- For verification of system performance requirements

Test Truck Data Analysis- Weight Calibration

The analyst uses the plots of the “error by speed” graphs to determine proper adjustments to the system’s weight scaling factors so that the system best estimates static weights. The analyst should consider patterns of individual axle and/or wheel weights as well as the calibration features of the system to best utilize the test truck data.

Test Truck Data Analysis- Performance Verification

Allowable percentage of error statistics determined for :

- Overall system accuracy- data from all test truck runs used
- Specialized tests
  - Speed- data from each designated speed range used as a subset
  - Temperature- data from each designated temperature range used as a subset

Test Truck Data Analysis- Performance Verification

Acceptance based upon allowable percentage of error for :

- steer axle
- single axles other than steer axle
- all tandem axles
- GVW
- axle spacings
- speed

Statistical Methods

- For the total population the normal distribution is used ($x \pm 1.96 * \sigma$)
- Analysis of temperature and speed subsets will use Student's t-statistic due to small sample size for ($x \pm t * \sigma$)

Example Calculation

	Measured Static Weights	WIM X	WIM σ
Single Axle	12.0	11.6	0.2
Tandems 1 + 2	58.8	56.4	1.8
Gross	70.8	68.5	1.5

	Range	Percent	X = ± 1.96*σ
Single Axle	9.6 – 14.4	±20	11.4 – 11.8
Tandems 1 + 2	50.0 – 67.6	±15	52.9 – 59.9
Gross	63.7 – 77.9	±10	65.6 – 71.4

Consequences of Verification Failure

- Determine if failure is due to test truck characteristics
- Determine if equipment is out of calibration
- Determine if failure is due to pavement conditions
- Consult with FHWA on next step(s)