TRACK "C"
CONCURRENT SESSION 1C - LTPP ISSUES

Presented at
National Traffic Data Acquisition Conference
Albuquerque, New Mexico

May 5-9, 1996

LTPP QUALITY CONTROL PROCEDURE FOR TRAFFIC DATA

Mark Hallenbeck
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LTPP Quality Control Procedure for Traffic Data

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LTPP Traffic Data Collection Requests Are:
- Preferred: Permanent, year round WIM
- Desirable: 4 Seasonal WIM per year + Permanent, year round AVC
- Minimum: 1 Year of AVC + 4 weekday/weekend WIM Counts

LTPP has no control over the equipment used, how the equipment is installed, or how it is operated and maintained

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Data collection equipment has not worked as well as advertised

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Traffic data volume is too high for most SHAs to perform conventional quality control efforts

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Historically, traffic data that did not look "right" were often arbitrarily changed to "correct" numbers

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LTPP Quality Control effort will
- Provide a significant reduction in the cost of QC testing
- Ensure the data submitted to LTPP are accurate

The LTPP Quality Control process is :
- Independent of the equipment vendor
- Independent of sensor type used --
- Usable by any SHA
- Consistently applied to all SHA data

The QC process compares summary raw data and statistics against expected values

Data that fail these tests are flagged for SHA staff review

Expected Values are based on:
- Known truck size and weight characteristics
- Site specific volume and weight characteristics

Preliminary Checks

Range and record format checks:
- Look for read/write errors in the data transmission process
- Ensure that the data submitted pertain to the appropriate site
- Ensure that the data collection equipment functioned as intended

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Second Level Checks - WIM
- Based on legal limits for five axle, tractor semi-trailer trucks
- And common characteristics of these vehicles

Second Level Checks - AVC
- Based on historic volume patterns (by vehicle class) at that site, and
- Equipment Operation (counted versus weighed vehicles)

All QC checks are performed for individual lanes

WIM QC looks at GVW Distribution for 5-Axle Tractor, Semi-Trailers:
- Loaded peak should be at or below 80,000 pounds GVW
- Unloaded peak should be between 28,000 & 36,000 pounds

WIM QC also examines the axle spacing of the drive tandems of these vehicles

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Other Potential WIM Errors Examined
- Too many overweight vehicles (percentage)
- Too many very light vehicles (percentage)

AVC Checks:
- Consecutive hours of zero volume
- Mid-day versus late night traffic volumes
- Daily measured volumes versus expected daily volumes
- Percentage of trucks within each vehicle classification

Program Plow:
- SHA collect traffic data
- SHA submits data to RCOC
- RCOC does QC processing
- Questionable data are flagged and returned to SHA for review
- SHA replies to RCOC
  - flags on valid data removed
  - invalid data left flagged
  - site parameters changed as needed
- Data are processed by the RCOCs and entered into the LTPP database

Ultimately the QC process should take place at the SHA level, prior to data submittal

STATUS AND AVAILABILITY OF LONG TERM PAVEMENT PERFORMANCE (LTPP) TRAFFIC DATA

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Presented at
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Processing of Traffic Data for LTPP

* 1990-1993 processed for GPS
* 1994 & 1995 in progress for GPS
* Limited SPS data processed to date

1990-l 993 LTPP traffic data for the General Pavement Study (GPS) have been processed.

Processing of the 1994 and 1995 traffic data for the GPS is in progress at this time.

Limited Special Pavement Study (SPS) data have been processed to date.

Accomplishing Data Processing

* 1990- 1993 data conducted by LTPP Regional Offices and Traffic Technical Assistance Contractor
* 1994 & 1995 data being processed by LTPP Regional Offices (expected completion date June 96)
* Still outstanding data submissions from states, for every year

1990-1993 QC was conducted by the Traffic Technical Assistance Contractor.

All other processing was conducted by the regional offices.

The expected completion date for 1994 and 1995 processing is June, 1996.

For every year, there still is outstanding data submissions.

Accomplishing Data Processing Continued...

* aim is to continuously improve timeliness of processing
* would like to move QC closer to data collection source (ideal would be bi-weekly processing at state level)
* All processing is completed in consultation with the states

The aim of LTPP is to improve the timeliness of processing which includes moving the QC process closer to the data collection source.

At the present time, all processing is completed in consultation with the states.

Overall Results for 1990- 1993

* 20% of submitted data fails QC processing
* Data quantity increases from 1990. 1993
* Preliminary indications for 19941’1995 are that this trend will continue

Twenty percent of the submitted traffic data fail the QC processing. This percentage has not significantly changed from 1990 through 1993.

However, the quantity of data has increased.

Preliminary indications for 1994/1995 are that this trend will continue.

Main reasons data were flagged (19904993)

* of the 20% flagged, the most frequent reasons are
  - WIM data are "over-calibrated"
  - Format checks (8 consecutive hours of zero volumes, l AM volume < 1PM volume)
  - Wide variation between volumes from the AVC data and WIM data
  - Discrepancies in class distributions

"Over-calibration" does not mean the SHA goes out and calibrates the device to often; this term is used to describe the situation when the GVW distribution for Vehicle Class 9's are shifted to the right and the average weight for the loaded and/or unloaded Vehicle Class 9's are higher than their expected values.

Format checks are designed for traffic at typical sites; in some low volume sites or sites containing atypical traffic patterns, these checks are ignored. For example, a Nevada site between Los Angeles and Las Vegas had 1 AM volumes greater than 1PM volumes. This was reasonable for this site.

Impact of SHA Review

* 2% of the flagged records are unflagged upon review
* typical fixes include adjusting WIM data with calibration factors supplied by the SHA

For most cases, the SHA aggrees with the Regions on which data to flag.

If the data is “over-calibrated”, a state can give an adjustment factor to adjust the weight data. The SHA usually gets this factor from a nearby weigh station.

Categories of Data Availability

* for AVC and for WIM
  - at least one day
  - one day per quarter
  - one weekday and one weekend day per quarter

1. At least one **day in the year.** This is the least restrictive category denoting the number of test sections for which at least one day of AVC or WIM data is available during the indicated year.

2. At least one day of data in each quarter. This category provides a rough measure of the degree to which the available data captures seasonal variations.

3. At least one weekday and weekend day per quarter. In the classifications provided in the this table, this is the most restrictive category, which potentially provides the traffic data needed to capture all of the significant temporal effects required to accurately estimate the total traffic over monthly or annual intervals.

Number of LTPP Sites with traffic monitoring data in the CTDB

Year	At Least One Day		At Least One Day per Qtr		At Least One Weekday and One Weekend Day Per Qtr	
	AVC	WIM	AVC	WIM	AVC	WIM
1990	111	31	1	0	1	0
1991	210	121	91	5	90	5
1992	277	270	121	71	118	63
1993	337	264	154	53	150	49
Total Sites	488	409	252	111	247	100

These categories are not mutually exclusive. If a test section has enough data to fall into either category 2 or 3, then it is also represented in the next lower category.

The row labeled "TOTAL SITES" represents an aggregate count of test sections with data within each category across the years 1990 to 1993.

Current % of Test Sections Represented

	At Least One Day		At Least One Day per Qtr		At Least One Weekday and One Weekend Day Per Qtr	
	AVC	WIM	AVC	WIM	AVC	WIM
Current % of test sites represented	63%	52%	32%	14%	32%	13%

The current percentage of test sections with traffic data in the CTDB is based on 780 total test sections.

Findings from Processed Data

* individual states tend to have very good results or very poor results; no in-between
* traffic sampling is not practiced or not achieved (There aren't any quarterly results- there are 10 days of data or 300 days of data)
* the quantity of data has increased; however, quality of data has remained the same

Ongoing Data Processing

* More states are submitting 1994 & 1995 data
* Indications are that the quality of 1994 & 1995 data remain the same,
* from the limited SPS data processed to date, the quality and quantity of data are improved compared to GPS sites- the standard of traffic data needed for SPS is higher than for GPS

Availability of LTPP Traffic Data

* IMS
  - 1990- 1993 traffic data are uploaded (excluding da. resubmittals)
  - No current uploads of historical traffic data
* CTDB
  - 1990-1993traffic data are uploaded including most data resubmittals

The last upload of historical data occurred several years ago.

Data Requests

* Standard data request form for both IMS and CTDB data
* Who to contact?

Contact Barbara Ostrom

Customer Relations- LTPP IMS

(703) 285-25 14

Anticipated Schedule

* 1994 & 1995 data processed by June 96
* SPS data processed by June 96 .
* processing and availability more timely after the backlog
* IMS traffic data upload by September 96
* data always available via Barbara Ostrom

COMPARISON OF HISTORICAL ESTIMATES WITH MONITORED ESAL'S AT LTPP SITES

H.K (Kris) Gupta
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Presented at
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Albuquerque, New Mexico

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COMPARISON OF

HISTORICAL ESTIMATES WITH MONITORED ESAL's

BY

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The two earlier presentations covered how the traffic data provided by the Long Term Pavement Performance (LTPP) participants is processed using the Quality Control (QC) Software developed by the LTPP's Traffic contractor and gave an indication of the 1990-93 data that has passed the QC process and is available to the researchers. One of the key products of summary data that is loaded into the database is an yearly estimate of Equivalent Single Axle Load (ESAL), applied to the Test Section(s), which directly Impact the Pavement Performance.

This presentation is basically a comparison of a typical State's estimates that were used for Designing the Test Section to their estimates of the ESAL's applied since construction (Termed historical) and the ESAL's estimated using monitored data from the instrumented sites (Termed Monitored). Please, note that **I am calling ESAL's developed from monitored data also estimates** since the equipment rarely works all the time and missing days have to be estimated.

The data shows wide variations among the sites. Comparisons of selected sites among the four AASHTO (American Association of State Highway and Transportation Officials) Regions also show similar findings, i.e. there is **no** correlation between the monitored and the estimated loading patterns.

It may be noted that the State selected had a maintenance contract with the vendor to Calibrate the site at least once a year and make repairs as needed. Consequently, the Gumption can be made that monitored data is of (reasonably) good quality.

AASHO Design Equation:

The current AASHTO design procedures were developed from the American Association of State Highway Official's (AASHO) Road Test conducted in the late fifty's. The design equations for both flexible and rigid pavements are fairly complicated and cover better than a page each. However, they still follow the format of the basic relationships shown in the (extremely) simplified version of the equation(s):

$$\mathbf{Wt.} = \mathbf{F(S, M, P, E)} \quad \text{... (Equation 1)}$$

Where:

Wt.= Weights converted to Equiv. Single Axle Loads (ESAL).

S = Factors related to Structural Design (FWD etc.).

M = Relates to Material types and their properties.

P = Performance Criteria (Serviceability Index, profile, Condition surveys etc.).

E = Environmental Factors.

It basically says that Axle Weights and their frequencies converted into ESAL's (Wt.) determine the pavement structure. The pavement structure thickness is a function of the following factors:

- How the materials are combined to provide the required structural strength (S).
- The properties of the materials under consideration (M).
- Performance criteria to be used (Concept of Serviceability Index was derived from the road user's definition of pavement failure, i.e. fatigue).
- And other environmental factors including the amount of rain, temperature extremes and drainage.

This is certainly a very simplistic explanation but shows that load data is clearly half the story and to determine Pavement Performance we need good quality Axle Weights data. I will be talking, primarily about the Weights, i.e. left side of the equation.

Site #1: Major Collector (R)

Desia n		150	KESALs
Most recent State Estimate - 1990		468	KESALs
1991 Weight Days	**31**	154	KESALs
1992 Weight Days	226	172	KESALs
1993 Weight Days	135	202	KESALs

Figure 1

This slide shows a Rural (R) Major Collector. Please, note the Design value of 150, Compared to the historical estimate of 468 versus monitored values that vary from 154 to 202 KESAL' s. It may also be noted that the Years Weight Days indicate the number of days for which the actual observations were available for expansion to the yearly KESAL's.

Site #2: Major Collector (R)

Design		130	KESALs
Most recent State Estimate - 1990		613	KESALs
1991 Weight Days	31	18	KESALs
1992 Weight Days	308	29	KESALs
1993 Weight Days	304	39	KESALs

Figure 2

This slide **shows** another Rural Major Collector. This site seems to **tell** an entirely different story. Please, note **the Design value of 130,** compared **to** the **historical** estimate of **613.** Apparently the impression has been that the facility is subjected to quite heavy loads. The monitored data shows that actual loadings may be less than 10% of the historical estimates. As you can see, anybody trying to determine the performance of this site will be way off the mark.

Site #3: Principal Arterial (R)

Design		127	KESALs
Most recent State Estimate - 1990		1298	KESALs
1991 Weight Days	31	256	KESALs
1992 Weight Days	307	418	KESALs
1993 Weight Days	341	243	KESALs

Figure 3

This slide shows a Rural (R) Principal Arterial. Note the disparity in estimates once again. The facility **is** carrying at least twice the design loads.

Site #4: Principal Arterial (U)

Design		484	KESALs
Most recent State Estimate - 1990		174	KESALs
1991 Weight Days	31	166	KESALs
1992 Weight Days	262	225	KESALs
1993 Weight Days	182	247	KESALs

Figure 4

This slide shows an Urban (U) Principal Arterial. It appears that the facility may have been over designed **i.e.** monitored loading estimates are almost half The analysis implications for pavement performance analysis are again obvious.

Site #5: Rural Interstate

Design		127	KESALs
Most recent State Estimate - 1990		2879	KESALs
1991 Weight Days	23'	423	KESALs
1992 Weight Days	307	468	KESALs
1993 Weight Days	109	416	KESALs

Figure 5

This slide shows a Rural Interstate Route. The actual loadings in this case are almost three times the design value but almost one sixth of what someone estimated (thought) the route was carrying.

Site #6: Rural Interstate

Design		832	KESALs
Most recent State Estimate - 1990		4635	KESALs
1991 Weight Days	31	1476	KESALs
1992 Weight Days	31	1850	KESALs
1993 Weight Days	96	740	KESALs

Figure 6

Here is another example of the Rural Interstate. Please, note the big variation in the estimates based on monitored data, The estimates based on 96 days of data put the design figure almost on target. My guess is that this could be a highly seasonal site and the estimates are strongly influenced by the specific days for which the monitored data is available.

Site #7: Urban Interstate

Design		650	KESALs
Most recent State Estimate - 1990		5444	KESALs
1992 Weight Days	71	1116	KESALs
1993 Weight Days	209	1536	KESALs

Figure 7

Finally, here is an Urban Interstate. Once again the site is carrying two to three times the design loadings but almost a quarter of the historical estimates.

To make sure that the selected State was not unique we selected a few sites in different States in each of the four AASHTO Regions and found that the observations noted for the selected State were similar for the rest of the country. The tables for the AASHTO Regions are listed below:

LTPP TEST SITES

YEARS			AASHTO REGION ONE				
			SITE 1	SITE 2	SITE 3	SITE 4	SITE 5
		DESIGN KESAL	89	72	10	900	320
YEARS	HISTORICAL	1986	53	44	24	—	860
		1987	142	44	26	—	890
		1988	196	85	29	620	930
		1989	199	96	29	680	960
		1990	150	85	41	720	990
	MONITORED	1991		87	0	1744	1232
		1992	135	52	68	1439	1585
		1993	137	80	37	799	890

Figure 8 (AASHTO Region 1)

LTPP TEST SITES

		AASHTO REGION TWO				
		SITE 1	SITE 2	SITE 3	SITE 4	SITE 5
	DESIGN KESALS	50	86	199	74	400
YEARS – HISTORICAL	1986	171	340	419	65	444
	1987	37	162	464	98	587
	1988	40	173	475	107	585
	1989	40	180	334	119	479
	1990	—	—	—	—	—
YEARS – MONITORED	1991	—	—	67	59	305
	1992	60	386	—	—	—
	1993	70	301	69	75	394

Figure 9 (AASHTO Region 2)

LTPP TESTS SITES

		AASHTO REGION THREE					
		SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6
	DESIGN KESAL	180	484	650	99	127	283
YEARS – HISTORICAL	1986	2483	444	4478	194	1431	141
	1987	2673	446	4491	184	1540	144
	1988	2767	441	4220	189	2537	152
	1989	2946	456	4973	197	2727	157
	1990	—	468	5224	—	2879	161
YEARS – MONITORED	1991	—	167	—	430	435	153
	1992		225	1118		484	189
	1993	458	247	1213	428	416	262

Figure 10 (AASHTO Region 3)

LTPP TEST SITES

			AASHTO REGION FOUR					
			SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6
		DESIGN KESAL	60	8	46	118	180	95
YEARS	HISTORICAL	1986	112	—	79	110	197	260
		1987	144	62	70	116	216	283
		1988	99	62	73	120	225	262
		1989	105	63	77	122	242	277
		1990	110	78	93	126	262	324
	MONITORED	1991	—	—	—	—	—	46
		1992	34	50	144	77	72	91
		1993	72	45	75	77	68	107

Figure 11 (AASHTO Region 4)

BOTTOM LINE:

- **CRITICAL ELEMENT:** Weight data is very critical not only for LTPP but also for State's use in pavement design, pavement management and related activities.

- **KNOW VERY LITTLE:** The facts are we and by that I mean "collectively" we know very little about the loads that are being applied to the pavements. We have been counting and analyzing traffic since the 40's and feel comfortable with it. However, weights and classification are a different matter.

- **NEED YEAR AROUND DATA:** Analysis of (limited) sites to date indicate that patterns are very site specific and that traffic must be sampled for each day of the week, in each month of the year to characterize the day of week and seasonal variations in traffic.

- **DETERMINING EFFECTIVE MONITORING SCHEDULES:** At the LTPP sites where we have data for most of the year, we are and will continue to analyze to see what the data tells us, i.e. patterns and how to expand short duration Automatic Vehicle Classification (AVC) and weight data.

Finally, I would like to encourage all of you to do the same for your other WIM/AVC sites--too much money is at stake for us not to do that. Five years ago the Strategic Highway Research Program (SHRP) estimated that thirty billion dollars were spent on pavements each year in the United States alone. I am sure the figures arc higher by now. It is evident that a lot of decisions are being made based on an extremely limited understanding of loadings that the pavements are being subjected to. We need, actually, have to turn this situation around to assure effective use of limited construction dollars.

Acknowledgments: This paper is based on the traffic data provided by the States participating in the LTPP Experiment. The data was processed by the Regional Contractors using software developed specifically for LTPP needs. I just happen to have the privilege to take their data and present it at this conference. I owe my thanks to the LTPP participants and a large number of LTPP staff members who were instrumental in developing the basic data for this presentation.

POTENTIAL IMPACT ON FUTURE DIRECTION

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