

# **TRAFFIC DATA QUALITY (TDQ)**

## **Pooled Fund Study Update - NATMEC 2000**

Mark Flinner - Mn DOT - August 29, 2000

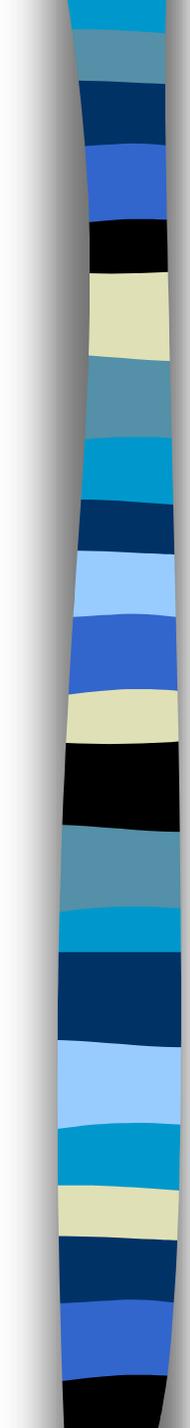
With Assistance From:

FHWA

The Participating States

Intelligent Decision Technologies Ltd.

In Motion Inc.



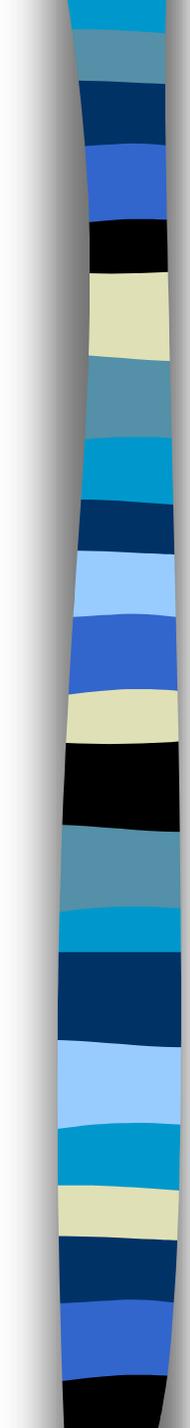
# This presentation will describe:

- Short history of the Traffic Data Editing Procedures pooled fund study
- Prototype software user interfaces for rule base testing
- Examples of data screening mechanisms that support “smart” and “dynamic” data screening processes
- Recommendations for future action

# Purpose of TDQ : Collaborate to Improve Our Understanding and to Develop Software Tools

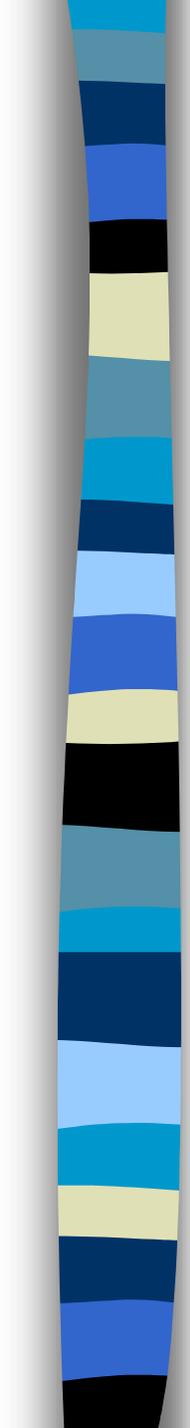


- Learn from each other
- Seek improved traffic data screening methods
- Build software that will be consistent, yet flexible



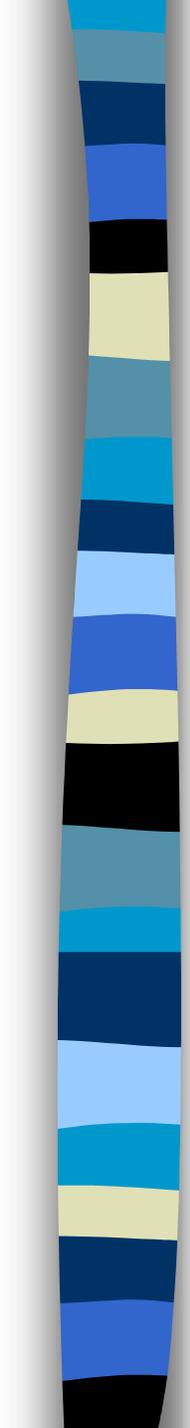
# Project Timeline (Historic)

- 9/96 - Kick-off Meeting - Governance and Roles
- 11/96-2/97 - 5 State Visits for Survey of Tools
- 5/97 - State Visit Findings Report Published (A.2)
- 3/97 - 6/97 - 4 Knowledge Engineering Sessions with State Experts re: WIM, Vehicle Class, Total Volume
- 9/97 - Executive Committee Meeting - “Try testing the Knowledge Base in A.3 Report.”
- 11/97 - Publish Refined Knowledge Base and Pseudo-code (A.3 Report)
- 3/98 - Executive Committee Meeting - “Wait to test the Knowledge Base in conjunction with production in two to four states using ALPHA version software.”



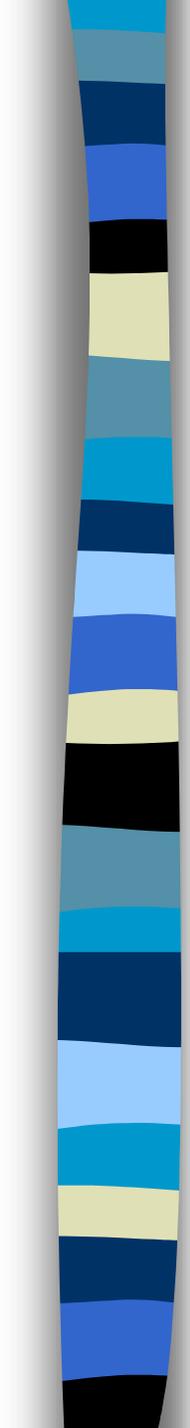
# When building a data screening tool, how sensitive do we need to be?

- Is your equipment working?
- What is your equipment designed to do?
- What precision do your users expect?
- How good are your data screening tools?
- How much time do you have?



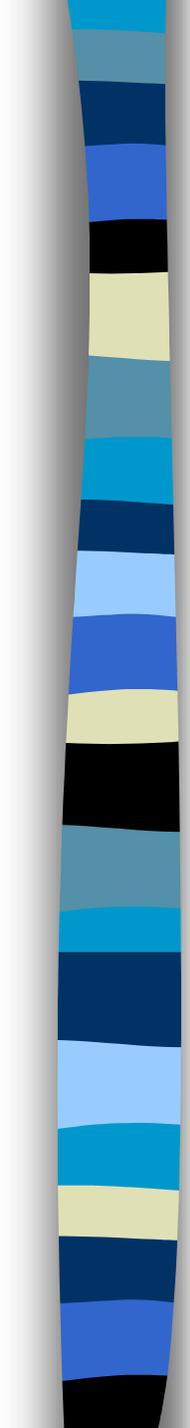
# We wanted the software to detect:

- Sensor malfunctions
- Indications of rough pavement conditions
- Data transmission errors
- Poor calibration of remotely collected speed, axle spacing and axle weights
- Unusual traffic conditions



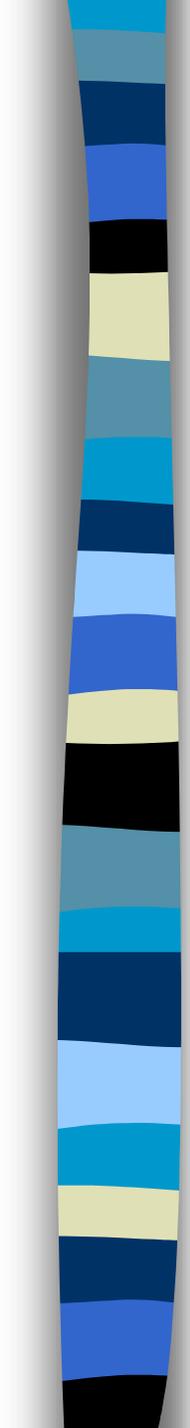
## We also wanted the software to:

- Process all rules automatically
- Capture and store expert knowledge of methods and site characteristics
- Supplement the analyst's (and protégé's) work, not to replace them
- Inform the analyst through feedback from TDQ upon rule “firing”



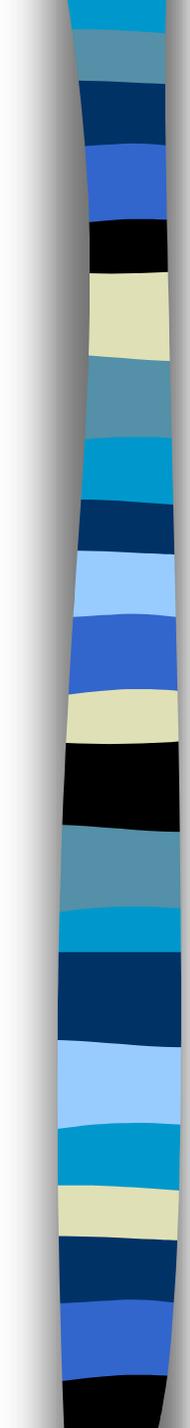
# Task A of TDQ identified two general types of data:

- Per vehicle record
- Aggregate data (hourly, daily, weekly) and (wheel path, lane, direction, site)



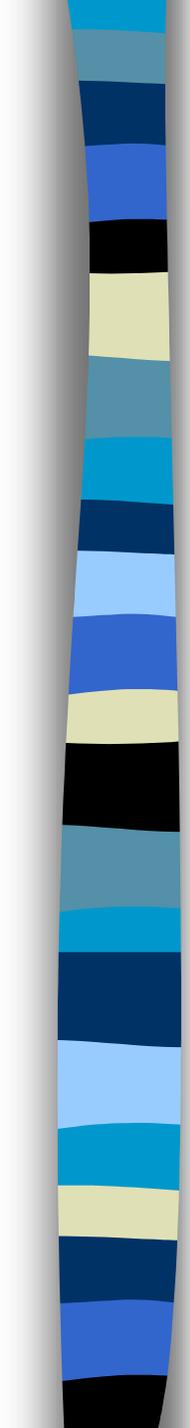
# TDQ software implementation created two additional rule application categories:

- Global Application - Acceptance parameters applied the same across all sites (ie: Type 9 axle spacings)
- Station Profile - Parameters are set based upon site / direction / lane specific data (ie: Friday ADT directional split)



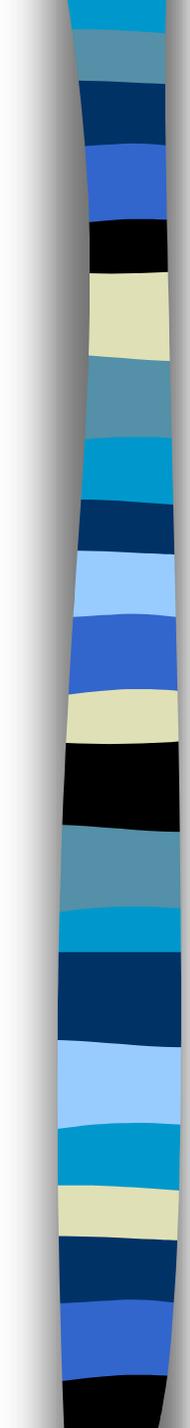
# TDQ comparison values are from two sources:

- Analyst input based upon analysis of previous data from site and/or vehicle characteristics
- TDQ derived, data parameter values based upon previously reviewed and summarized data for the same site, day of week, month, year, data qualification flag values



# TDQ uses additional data fields in an extended “W” record

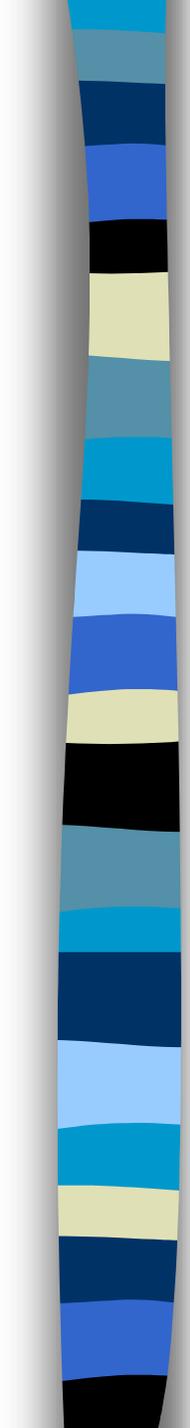
- Minute
- Second
- Vehicle speed
- Vehicle length
- Front overhang
- Rear overhang
- Type of sensor array (wheel path, consecutive, full lane)
- Left or right / lead or trailing sensor weights for each axle



Examples of specific rule  
implementations and parameter  
settings

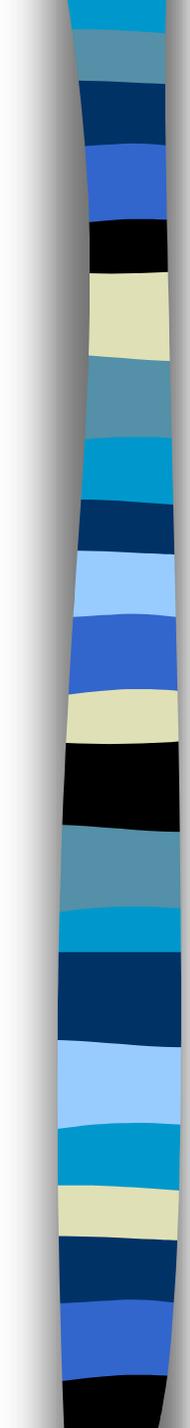
Sample TDQ Analysis report  
from 9/27/1999

(please see attached illustrations  
at end of slide show)



# TDQ software development accomplishments

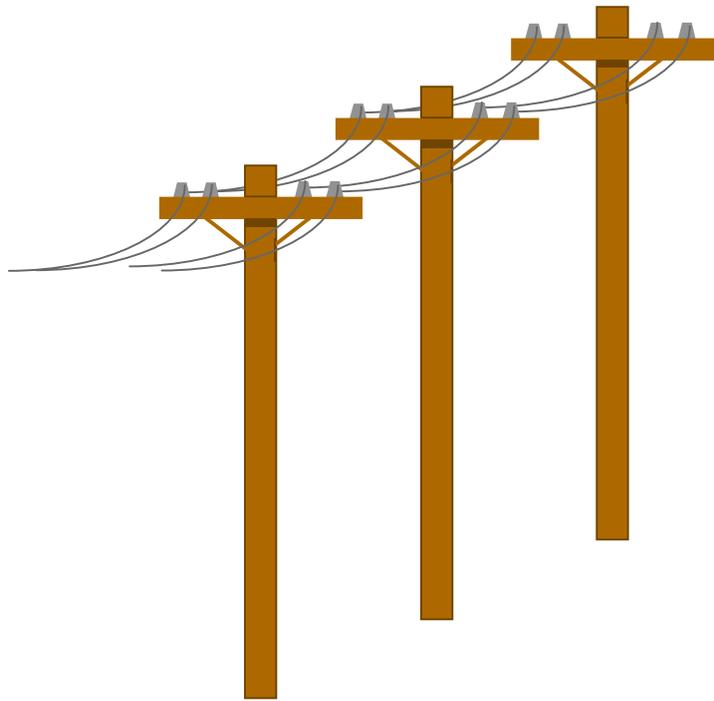
- Provides a logical framework for future programming efforts
- Provides a meaningful role for the analyst
- Allows scenario testing using temporary settings for acceptance parameters
- Permits “dynamic” updating of comparison values



# Future work needed (if continuing present course):

- Fix logical inconsistencies
- Through testing with real data, identify rule interactions
- Identify redundancies in the rule base
- Expand implementation of rule base if deficiencies are found
- Identify additional rules
- Improve interface and permit batch processing for production

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These settings apply to all sites/lanes but may be changed in this dialog window.

### Global Vehicle Parameters

Rule Name	Min	Max	Units	ID
<b>Extreme Hourly Volume per Lane</b>	0	2500	Vehicles	7
Number of Axles Min/Max	2	13	Axles	13
Front Overhang Out of Range	0.5	20.0	Feet	16
Rear Overhang Out of Range	0.0	25.0	Feet	17
Extreme Speed	0	100	Miles Per Hour	22
Extreme Axle Spacing	0	50	Feet	24
Minimum First Axle Space	2.0	10.0	Feet	25
Minimum Subsequent Axle Space	2.5	10.0	Feet	26
Minimum Spacing Between Axle Groups	8.0	20.0	Feet	27
3S-2 Drive Tandem Spacing	3.25	5.50	Feet	30
Average 3S-2 Drive Tandem Spacing	4.00	4.75	Feet	87

Upon highlighting, each rule has an explanation displayed in the box below...

Each minimum and maximum value can be changed using the slider bar below...

The hourly volume in any lane will be reported as anomalous if exceeds this global extreme maximum:

1000 Vehicles 3000 2500

Set

This dialog window lists all rules, implementation status, and A3 Report cross reference

Rule Name	Active	Interim A3	ID
Zero Volume for an Hour	X	V2	6
Extreme Hourly Volume per Lane	X	V4	7
1:00 AM to 2:00 AM Volume vs. 1:00 PM to 2:00 PM Volume	X	V32	8
No Classification Data	X	C1	9
Record Contains Valid Date	X	W51	10
Record Contains Valid Lane Number	X	W52	11
Record Contains Valid Class Number	X	W53	12
Number of Axles Min/Max	X	C24	13
Wheelbase Exceeds Value for Class	X	W36	14
GVW Exceeds Value for Class	X	W39	15
Front Overhang Out of Range	X	W28	16
Rear Overhang Out of Range	X	W26	17
Sum of Axle Spaces > or = Recorded Vehicle Length	X	W30	18
Record Contains Off-Scale Warning	X	W24	19
Wheelpath Imbalance Exceeds Threshold	X	W46	20
Vehicle Exceeding Speed Min/Max	X	C35	21

Any vehicle of this class having a recorded wheelbase greater than this maximum will be flagged:

Active during Analysis

Truck classification “fleet” parameters apply across all sites but vary by classification.

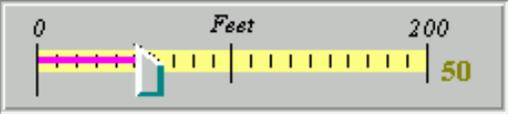
**Vehicle Class Parameters** [X]



Select Vehicle Class: 7 -- Single Unit Trucks with 4 or more axles

Rule Name	Axle	Min	Max	Units	ID
Wheelbase Exceeds Value for Class		0	50	Feet	14
GVW Exceeds Value for Class		0	80000	Pounds	15
Axle Spacings vs. Min/Max Default Values for Class	AB	6	35	Feet	28
Axle Spacings vs. Min/Max Default Values for Class	BC	2	20	Feet	28
Axle Spacings vs. Min/Max Default Values for Class	CD	2	20	Feet	28
Axle Spacings vs. Min/Max Default Values for Class	DE	2	20	Feet	28
Axle Weights vs. Min/Max Default Values for Class	A	3000	25000	Pounds	29
Axle Weights vs. Min/Max Default Values for Class	B	2000	25000	Pounds	29
Axle Weights vs. Min/Max Default Values for Class	C	2000	25000	Pounds	29
Axle Weights vs. Min/Max Default Values for Class	D	2000	25000	Pounds	29
Axle Weights vs. Min/Max Default Values for Class	E	2000	25000	Pounds	29

Any vehicle of this class having a recorded wheelbase greater than this maximum will be flagged:



Set

These parameters are specific to site and are evaluated using various units.

The screenshot shows the 'Station Profile' window for site '001016' at 'US 71 NW of Bemidji'. A table lists various rules with their minimum and maximum values and units. The rule 'Daily Ratio of Class 9 to 8 by Lane vs. History' is highlighted, and a detailed view below explains its function and shows a tolerance range from -1.0 to 1.0.

Rule Name	Min	Max	Units	ID
Hourly Combined Volume vs. Recent History	-70	70	Vehicles	92
Daily Combined Volume vs. Recent History	-500	500	Vehicles	93
Daily Directional Volume vs. History	-300	300	Vehicles	94
Daily Percent Distribution by Lane vs. History	-5	5	Percent	95
Daily Volume Binned to One Class vs. History	-100	100	Percent	96
Daily Ratio of Class 2 to 3 vs. History	-0.5	0.5	Factor	99
<b>Daily Ratio of Class 9 to 8 by Lane vs. History</b>	-1.0	1.0	Factor	100
Daily Ratio of Class 9 to 8 by Direction vs. History	-1.0	1.0	Factor	101
Daily Sum of Class 8 and 9 vs. History	-30	30	Vehicles	102
Daily Class 8 Directional Split vs. History	-25	25	Percent	103
Daily Class 9 Directional Split vs. History	-5	5	Percent	104
Daily Sum of Class 8 and 9 Directional Split vs. History	-5	5	Percent	105
Daily Directional Split of Sum of Class 4 thru 13 vs. History	-5	5	Percent	107
Monthly Directional Split of Sum of Class 4 thru 13 vs. History	-3	3	Percent	109

The daily ratio of class 9 vehicles to class 8 vehicles in a lane will be reported as anomalous if the number of class 9s per one class 8 differs from the historical minimum or maximum ratio by more than these tolerances:

minus *Factor* plus  
-1.0 1.0

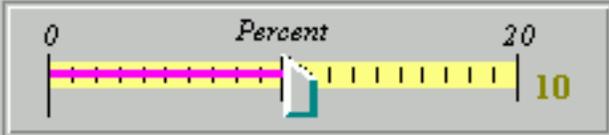
Set Refresh Export

## Individual vehicle record rule results may be evaluated on a cumulative basis.

**Vehicle Error Limits**

Rule Name	Min	Max	Units	ID
Percent of Vehicles With GVW Out of Range for Class	0	1	Percent	60
Percent of Vehicles With Invalid Class	0	8	Percent	61
Percent of Records With Invalid Dates	0	0	Percent	64
Percent of Records With Invalid Lane	0	0	Percent	65
Percent of Class 9s With Front Axle Weight Flags	0	1	Percent	72
Percent of Class 11s With Front Axle Weight Flags	0	1	Percent	73
Percent of Records With Vendor Warning Codes	0	15	Percent	74
Percent of Vehicles Where GVW Is Not = Sum of Axle Weights	0	0	Percent	75
Percent of Vehicles With Overhang Flags	0	1	Percent	76
Percent of Vehicles Where Length < Wheelbase	0.0	0.5	Percent	77
<b>Percent of Records With Off-Scale Warnings</b>	0	10	Percent	80
Percent of Vehicles With Wheelpath Imbalance	0	3	Percent	82
Percent of Vehicles that Exceed Extreme Max Speed	0	3	Percent	83
Percent of Vehicles Slower Than Speed Min	0	5	Percent	84
Percent of Vehicles Faster Than Speed Max	0	5	Percent	85
Percent of Heavy Class 6 Vehicles With Close Follower	0	1	Percent	86

The daily percent of vehicle records containing a vendor's off-scale warning will be reported as anomalous if it exceeds this maximum:



0 Percent 20 10

Set

An important GVW “central tendency” rule requires 200 or more Type 9’s in one or more weeks. As with most site specific rules, previously accepted, historical data provides the system with a basis to compute a comparison value.

**Station Profile** [X]

001016 US 71 NW of Bemidji

Rule Name	Min	Max	Units	ID
Daily Ratio of Class 9 to 8 by Lane vs. History	-1.0	1.0	Factor	100
Daily Ratio of Class 9 to 8 by Direction vs. History	-1.0	1.0	Factor	101
Daily Sum of Class 8 and 9 vs. History	-30	30	Vehicles	102
Daily Class 8 Directional Split vs. History	-25	25	Percent	103
Daily Class 9 Directional Split vs. History	-5	5	Percent	104
Daily Sum of Class 8 and 9 Directional Split vs. History	-5	5	Percent	105
Daily Directional Split of Sum of Class 4 thru 13 vs. History	-5	5	Percent	107
Monthly Directional Split of Sum of Class 4 thru 13 vs. History	-3	3	Percent	109
<b>Unloaded Class 9 GVW Distribution Peak Shift</b>	-4.0	4.0	Percent	111
Loaded Class 9 GVW Distribution Peak Shift	-4.0	4.0	Percent	112
Loaded vs. Unloaded Class 9 GVW Distribution Peaks	-1.0	1.0	Percent	113
Incidental Class 9 GVW Distribution Peak Shift	-4.0	4.0	Percent	114
Unloaded Class 11 GVW Distribution Peak Shift	-4.0	4.0	Percent	115
Loaded Class 11 GVW Distribution Peak Shift	-4.0	4.0	Percent	116

A shift in the unloaded GVWs for class 9 vehicles will be reported if the central tendency of the input data is not within these percents of the historical central tendency

minus      Percent      plus

-4.0      0.0      4.0

Set      Refresh      Export

**Historical values are filtered prior to being used to calculate comparison values or for graphical display against incoming data.**

**Search Filters**

**DAILY HISTORY FILTER**

Search Criteria:

- Same Day of Week As Day Being Analyzed
- Same Month of Year As Day Being Analyzed
- Same Calendar Designation As Day Being Analyzed

Qualifications to Include:

- Days With Typical Traffic Pattern
- Days Considered Atypical Due To Weather
- Days Considered Atypical Due To Construction
- Days With An Accident-Related Anomaly
- Days When Equipment Malfunction Is Suspected
- Days When Equipment Miscalibration Is Suspected
- Days Considered Anomalous For Other Reasons
- Days For Which A Determination Of Typicality Is Pending

**SPECIAL HISTORIES**

Recent Data Rules Use:

- 4 Previous Weeks
- 6 Previous Weeks
- 8 Previous Weeks

Monthly Rules Use:

- Previous 4 Weeks
- Same 4 Weeks (+ or - 1) In Previous Year

Reset

< Back    Next >    Cancel

**More than one box may be checked and one may use different filter settings in subsequent analysis runs.**

Analysis report displays all parameter settings and reports on rule outcomes where unexpected values were encountered. All GVW distribution analysis is reported.

```
sta23w814 - Notepad
File Edit Search Help
Abnormal average steering axle weight for Mid-GUV class 11s
Excessive percent of vehicles with axle weight problems
The hourly combined volume varies significantly from recent history
The combined volume varies significantly from recent history
The directional volume varies significantly from history
The volume binned to class 11 varies significantly from history
The ratio of class 9 to 8 by lane varies significantly from history
The ratio of class 9 to 8 by direction varies significantly from history
The sum of class 8 and 9 varies significantly from history
The class 8 directional split varies significantly from history
The class 9 directional split varies significantly from history
The directional split of the sum of class 8 and 9s varies significantly from history
The directional split of the sum of classes 4 through 13 varies significantly from history
```

```
Analysis of Gross Vehicle Weight Distributions. Dir. 3, Lane 1 is "missing" a Loaded Class 9 peak...
Dir: 3 Lane: 1 Insufficient sample -- less than 200 class 11 vehicles in this lane.
Dir: 3 Lane: 1 The loaded class 9 peak is anomalous -- Current = 30000.00 Expected Range = 72000 to 80000
Dir: 3 Lane: 1 Unloaded Class 9 Peak -- Current = 30000.00 Historical = 30000.00 Shift = 0.00
Dir: 3 Lane: 1 Loaded Class 9 Peak -- Current: 30000.00 Historical: 30000.00 Shift: 0.00
Dir: 3 Lane: 2 Insufficient sample -- less than 200 class 9 vehicles in this lane.
Dir: 3 Lane: 2 Insufficient sample -- less than 200 class 11 vehicles in this lane.
Dir: 7 Lane: 1 Insufficient sample -- less than 200 class 11 vehicles in this lane.
Dir: 7 Lane: 1 Unloaded Class 9 Peak -- Current = 30000.00 Historical = 30000.00 Shift = 0.00
Dir: 7 Lane: 1 Loaded Class 9 Peak -- Current: 76109.68 Historical: 75871.17 Shift: 0.31
```

**Unloaded and Loaded Class 9 peak shifted less than 4% therefore WIM calibration is OK.**

```
Analysis completed.
09/27/99 11:31:55
```

GENERAL PARAMETERS:

```
7=0.00,2500.00; 13=2.00,13.00; 16=0.50,20.00; 17=0.00,25.00; 22=0.00,100.00; 24=0.00,50.00; 25=2.00,10.00; 26=
```

ERROR LIMITS:

```
53=30.00; 60=1.00; 61=5.00; 64=0.00; 65=0.00; 72=1.00; 73=1.00; 74=15.00; 75=0.00; 76=1.00; 77=0.50; 80=10.00;
```

CLASS DEFAULTS:

```
14^3=0.00,30.00; 14^4=0.00,85.00; 14^5=0.00,51.00; 14^6=0.00,48.00; 14^7=0.00,50.00; 14^8=0.00,80.00; 14^9=0.00,80.00; 28^12^BC=2.00,60.00; 28^12^CD=2.00,60.00; 28^12^DE=2.00,20.00; 28^12^EF=2.00,60.00; 28^13^AB=6.00,30.00; 28^13^BC=2.00,60.00; 29^10^G=2000.00,25000.00; 29^10^H=2000.00,25000.00; 29^11^A=7000.00,15000.00; 29^11^B=2000.00,25000.00;
```