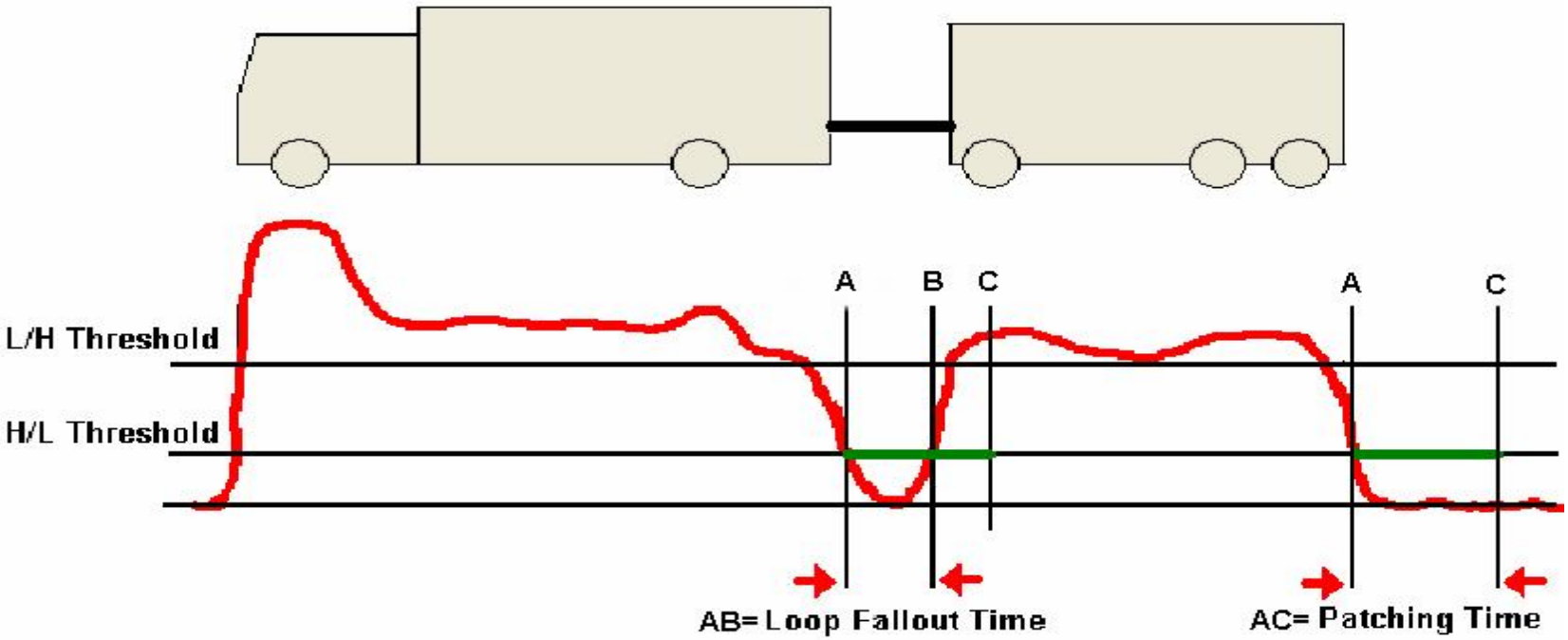
South African Pavement Design Method (SAPDM)

Post Calibration of Weigh-in-Motion Measurements for Systematic and Random Deviation

Dr SC van As

Typical WIM Station



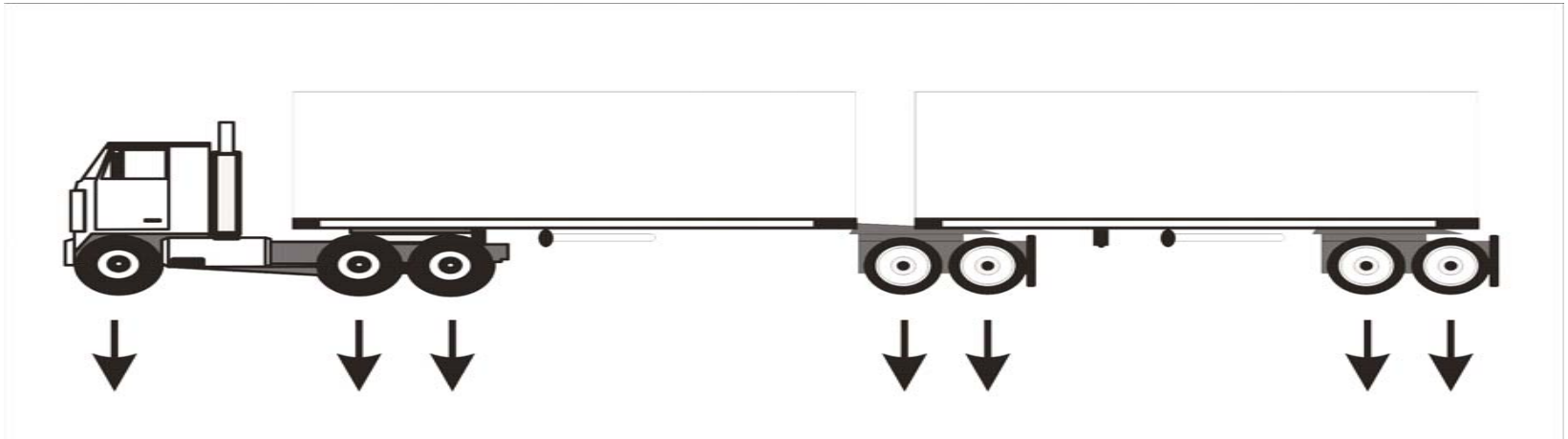
WIM Adjustment for Systematic Deviation

- Available Calibration Methods
  - On-site calibration of WIM equipment
  - Automatic self-calibration
  - Post-processing calibration
- Why post-processing calibration?
  - Difficult to undertake full-scale on-site calibration
  - WIM calibration tends to “drift” over time
- Development of method
  - Developed by BKS – Dr Martin Slavik and Mr Gerhard de Wet
  - With support by Dr Christo van As

WIM Adjustment for Systematic Deviation

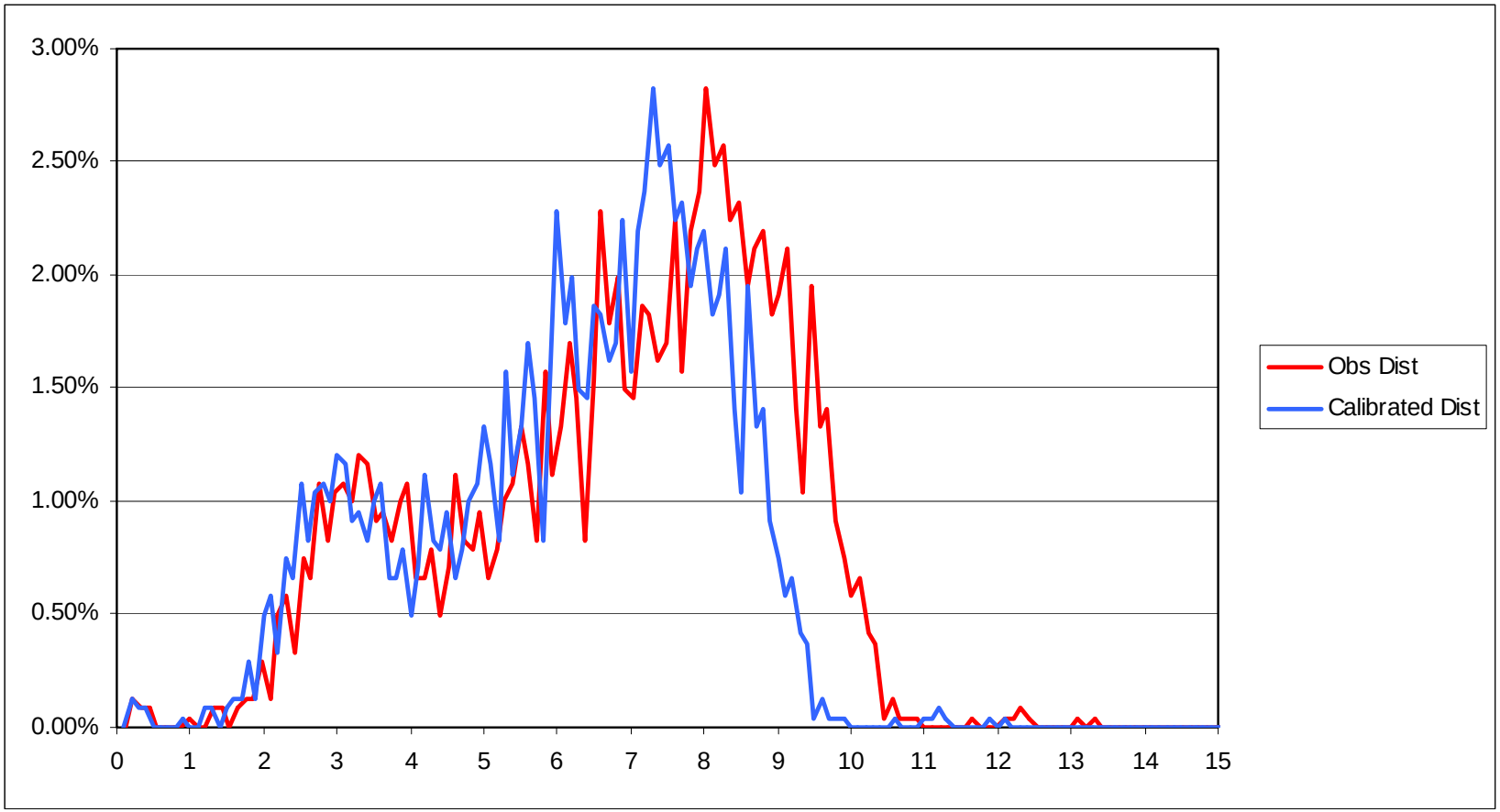
- Alternative post-processing methods
  - (FA) Front-axle method
    - Inadequate data to calibrate
    - Problem with load transfer to front axle
  - (TT) Truck-tractor method
    - Less sensitive than the Front-Axle method for load transfer
    - TT method now recommended for general application
  - Other methods
    - Various methods were extensively tested
    - TT method found to provide best results

WIM Systematic Deviation Adjustment– TT Method



- TT method – Truck selection
  - 6-7 Axle articulated heavy vehicles (double rear axles on tractor)
  - Average “calibrated” axle load 6.5 to 8.5 tons per axle
- TT method – Calibrated
  - Calibrate for target tractor load of 21.8 ton
- TT method – Conditions
  - Calibration factor within limits (0.8 to 1.2)
  - Front axle load standard deviation within limits
  - Tractor load standard deviation within limits

WIM Adjustment for Random Deviation

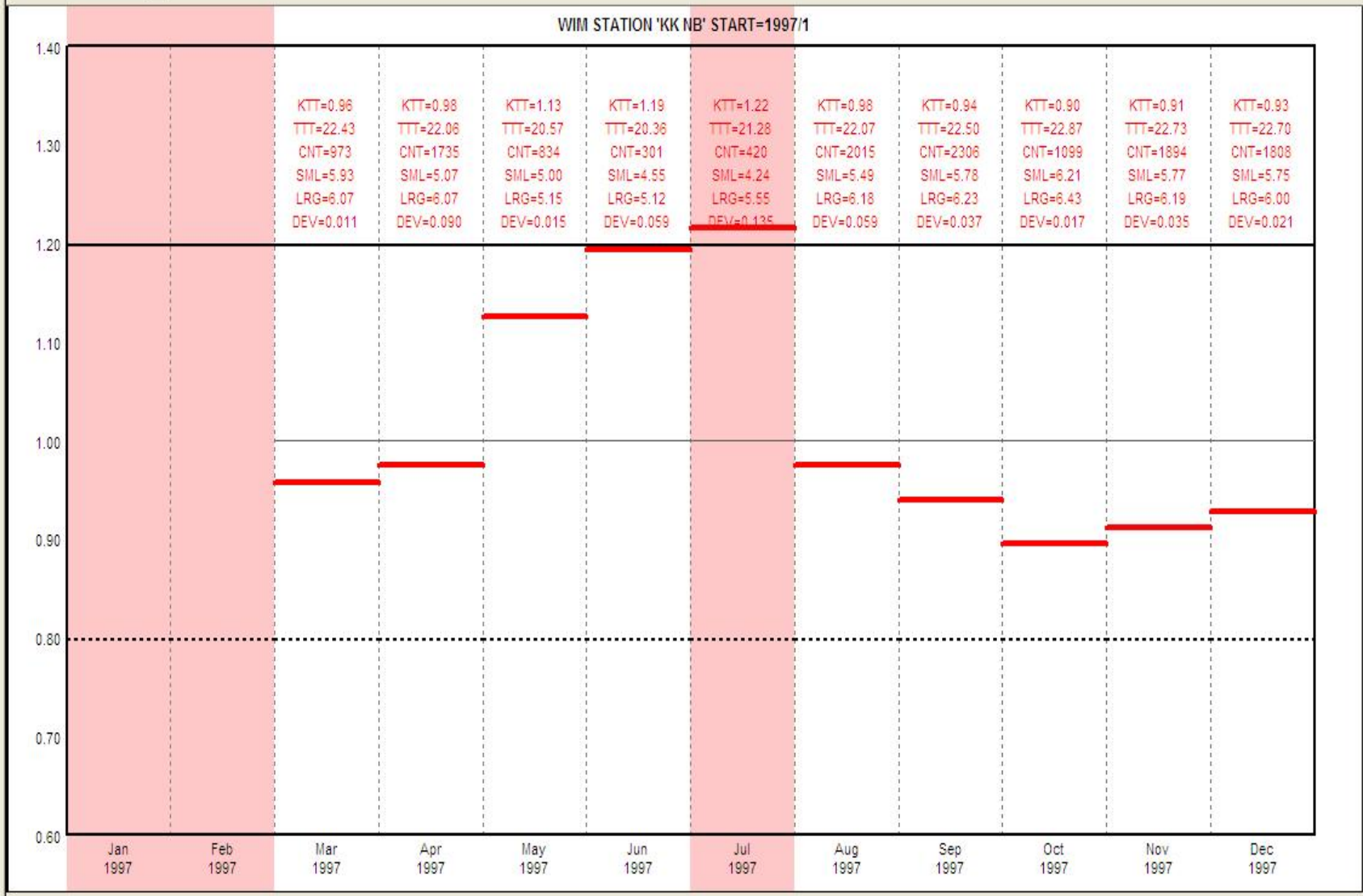


WIM Time-Span Exclusions

File View Graph Tools Help

N1
- PB NB
- PB SB
- KK NB
- KK SB

Time View



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WIM Adjustment for Random Deviation

- Axle load distribution
  - WIM Random errors and variation in dynamic loads result in:
    - Measured axle distribution wider than actual static load distribution
    - Particularly at higher end of distribution
    - Results in overestimation of percentage “overloaded” axles
- Basic adjustment methodology
  - Observed axle load measurements is the sum of
    - Static load of the axle plus
    - WIM error and dynamic impact
  - If information on WIM error and dynamic impact is known
    - Then such impact can be “subtracted” from observed axle loads
    - To provide the static load of the axle

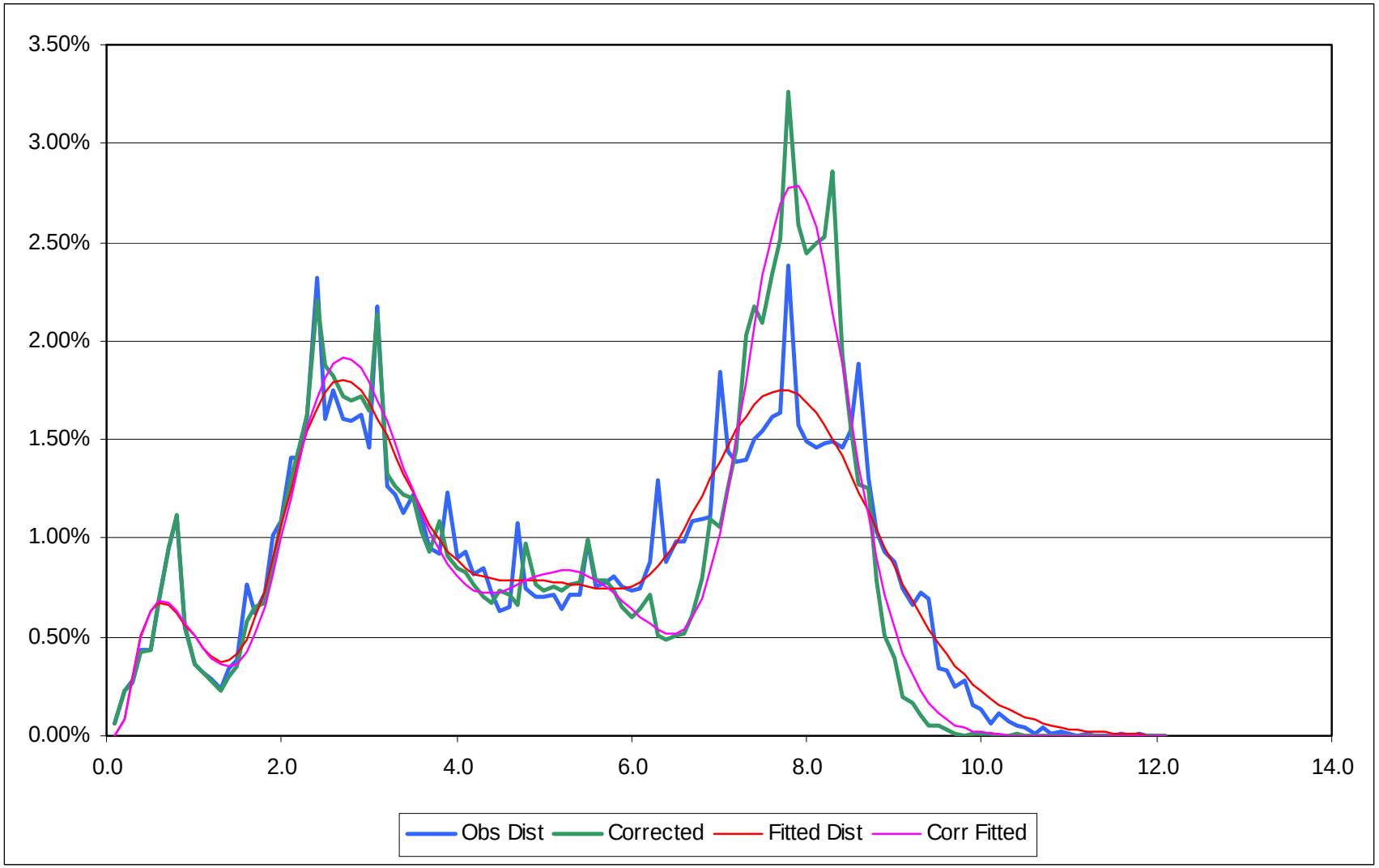
WIM Adjustment for Random Deviation

- Mixed Log-Normal Distribution methodology
  - This methodology was first tested and applied
  - Fitted Mixed Log-Normal distribution to observed axle loads
  - WIM error/dynamic deviation also follows a Log-Normal distribution
  - Statistics to adjust observed distributions for error based on:
    - Central Limit Theorem
- Issue with method
  - Method statistical sound, but difficult to apply
  - Iterative algorithm required for fitting Mixed Log-Normal Distribution
    - “Expectation-Maximization” (EM) algorithm
  - Disadvantage of algorithm is that a good initial solution is required
  - Required a significant manual input

WIM Adjustment for Random Deviation

- "Expectation-Maximization-Smoothing" (EMS) algorithm
  - Applies a numeric technique using so-called "deconvolution" method
    - Wim errors basically "convolutes" or distorts the static load
    - Deconvolution removes this convolution from data
    - Central limit theorem is a special case
  - Numeric method does not require fitting of Log-Normal distributions
    - Can also be solved by means of Expectation-Maximization
  - Problem is that deconvolution is very sensitive to "noise" in data
    - Can only be used when data relatively free of noise
  - This problem is solved by incorporation of smoothing algorithm
    - Smoothing intended to remove noise from data

WIM Adjustment for Random Deviation



WIM Time-Span Exclusions

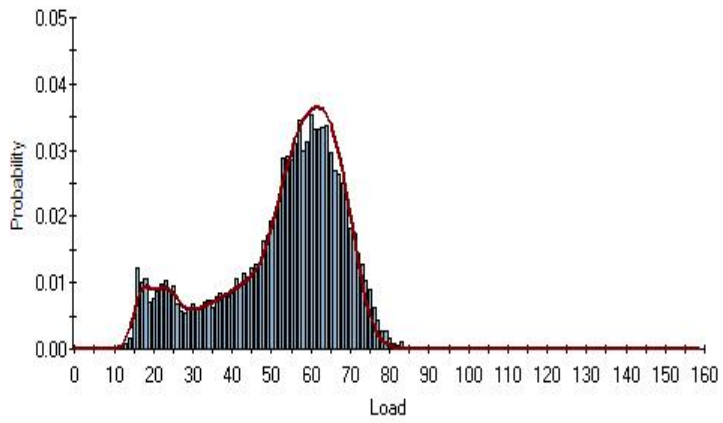
File View Graph Tools Help

N1
- PB NB
- PB SB
- KK NB
- KK SB

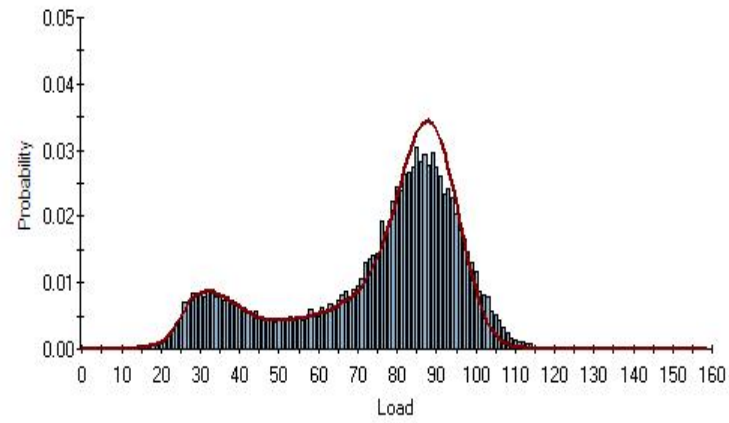
Histogram View | January 2006 | All | Original

Vehicles in Division = 24221, Duration of count = 31.0, Target = 31.0, Calibrated Count = 24221

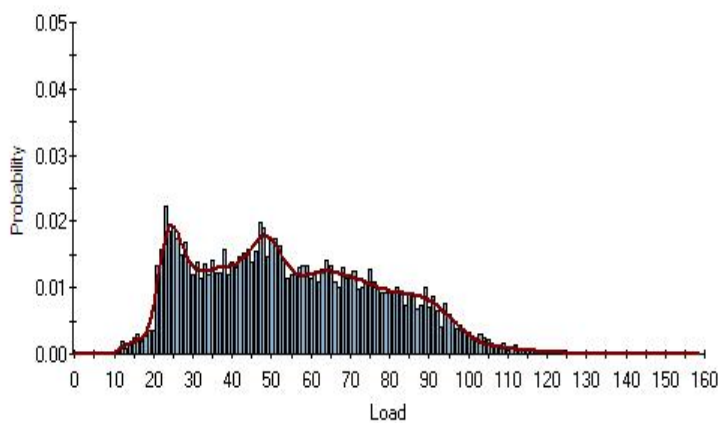
Steering



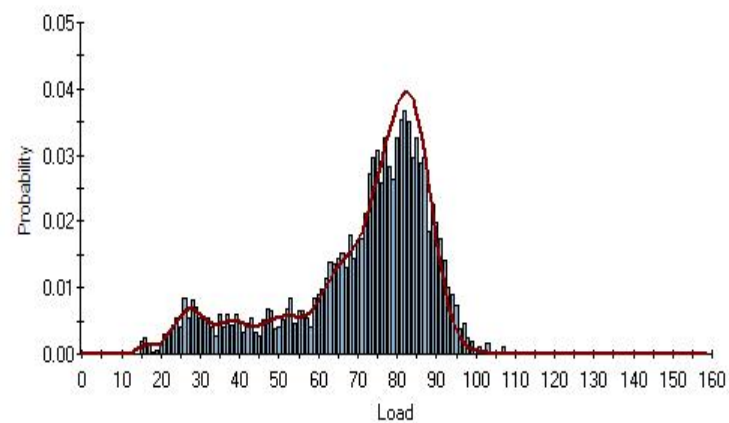
Tandem



Single



Tridem



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WIM Time-Span Exclusions

File View Graph Tools Help

N1
- PB NB
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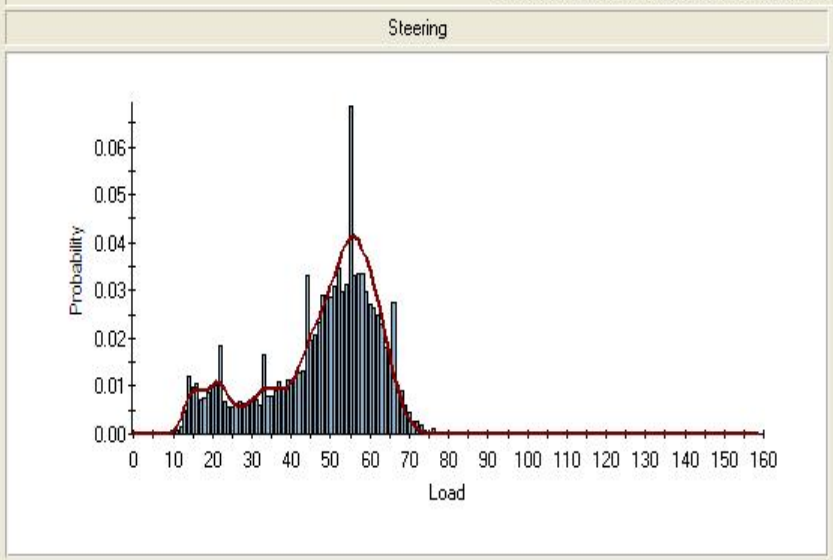
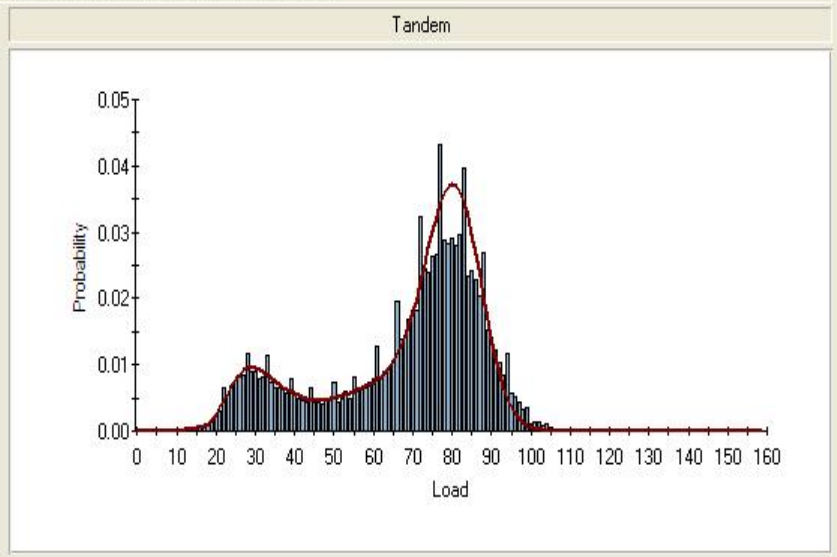
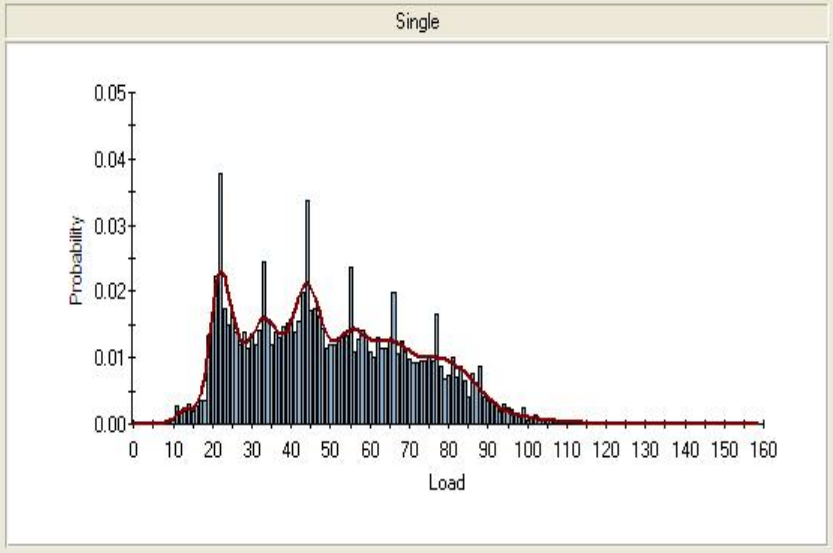
- KK NB
- KK SB

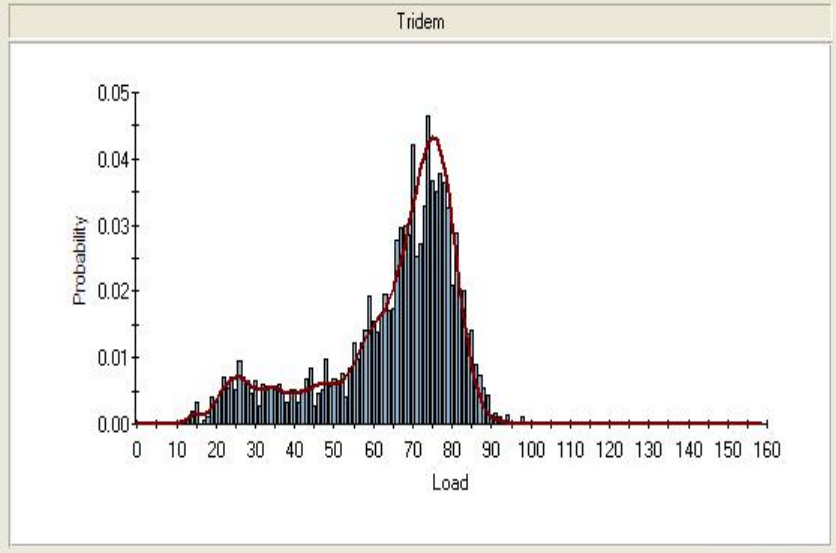
Histogram View | January 2006 | All | Calibrated

Vehicles in Division = 24221, Duration of count = 31.0, Target = 31.0, Calibrated Count = 24221









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