

Federal Motor Carrier Safety Administration



Enforcement Update

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NAS RECOMMENDATIONS

Develop and test an Item Response Theory (IRT) 1 model for carrier safety • Improve quality of Motor Carrier Management 2 Information System (MCMIS) data 3 Collect additional data • Make more user-friendly technical resources 4 available to public Conduct additional study to better understand if 5 percentiles should be publically available Use absolute and relative measures to prioritize 6 carriers for intervention

RECOMMENDATION 1

Item Response Theory (IRT)

- An established, documented statistical approach.
- Tests data and identifies correlations—will inform the Agency and:
 - Provide statistical support for what violations to include, safety weightings and time weightings.
 - Account for the probability of being selected for inspection.
 - Provide for a multi-dimensional model, which could redefine BASICs.
 - Adapt to changes over time.
 - Address other concerns raised.
- Two years is needed due to the complexity and amount of data in the model.

RECOMMENDATION 1

Item Response Theory (cont.)

Rank	Expert Opinion/Ad Hoc Analysis	Item Response Theory
1	Speeding 15+	Speeding 6-10
2	Speeding 11-14	Speeding 11-14
3	Speeding 6-10	Speeding 15+

- The model can see things not apparent to our expert judgement.
- Policy calls will still need to made.
- General construct of the Safety Measurement System (SMS) may remain the same, but Behavior Analysis and Safety Improvement Categories (BASICS) may change, etc.

IRT: FACTOR ANALYSIS

Goals

1) Define the aspects of safety to be used in the IRT model

- Leverage the statistical relationships that exist between violations within the inspection data
- Define new BASICs (or categories) that have the potential to more effective at finding unsafe carriers than the current BASIC structure.
- 2) Improve the interpretability and ease of fitting of the model by reducing the number of items included:
 - Running a full IRT model could take over a month.
 - Considering pooling the information of multiple violations into a single item.
 - Fewer items makes it more likely that an IRT model would meet FMCSA's programmatic requirements.

IRT: EXPLORATORY FACTOR ANALYSIS

Comparison of Violations Composition between Six-Factor PCA and BASICs

BASIC	Factor 1: Roadside Inspection	Factor 2: Traffic Stop	Factor 3: Non Cargo HM	Factor 4: Cargo HM	Factor 5: Hours of Service	Factor 6: Full Inspection
Unsafe Driving		23 (37%)	3 (14%)			
Hours of Service		12 (19%)			12 (75%)	
Driver Fitness	1 (1%)	3 (4%)				
Controlled Substances/ Alcohol		2 (3%)			4 (25%)	
Vehicle Maintenance	76 (99%)	23 (37%)				16 (89%)
Hazmat			19 (86%)	16 (100%)		2 (11%)
Total Number of Violations with Factor Loading Above 0.4	77 (100%)	63 (100%)	22 (100%)	16 (100%)	16 (100%)	18 (100%)

Principal Component Analysis – how well identified factors line up with existing BASICs. Sample of 10,000 carriers, 737 of 899 violations cited in 2 year period.

- Only 212 violations loaded strongly (remainder cited at lower frequency).
- Factor 3 & 4 both show HM violations, distinction depends on type of transport (cargo tank versus non-cargo tank).
- Factor 1 & 6 both show maintenance violations, distinction; depends on inspection level (full versus walk around) – inspection level showing up as a factor.

IRT: SMALL SCALE MODELING

Preliminary Results

- Results from the small-scale model are not drastically different from the results we are seeing from SMS:
 - Carriers with the worse safety measures are still appearing at the top of the list, and carriers with the best safety measures are still at the bottom.
 - IRT gives a greater level of detail on these measures, and a higher level of certainty in how they are ranked.
- The IRT model is giving us a more detailed view of the impact of a violation on safety.

IRT: SMALL SCALE MODELING

Preliminary Results (cont.)

Fairness

- Due to the granularity of the data provided, the IRT model may offer FMCSA more opportunities to address carriers with less data.
- IRT also offers FMCSA the opportunity to explore a more dynamic understanding of data sufficiency.
- The added flexibility would allow the Agency to move away from rigid thresholds, instead opting for a more empirical approach.
- This approach would also offer more opportunity for a dialogue with industry and safety experts to come to a mutually agreedupon idea of what standards should be applied.

IRT: SMALL SCALE MODELING

Preliminary Results (cont.)

- Accounting for geographic disparity
 - The IRT model allows us to evaluate the extent and impact of any geographic disparities.
 - Given the scale of the data to run on a regular basis, any adjustments would have to be applied sparingly.
 - Adding these layers in would increase model complexity.

RECOMMENDATION 2

Improve Quality of MCMIS Data

2

Improve quality of MCMIS data

FMCSA Actions:

- Improve registration data (Unified Registration System).
- Consider external sources of data (International Registration Plan/International Fuel Tax Association).
- Consider voluntary reporting of data (vehicle miles traveled).
- Conduct outreach with motor carrier industry.
- Improve inspection software.
- Implement recommendations from Federal Advisory Committee to review Police Accident Reports (PARs).

DATA ISSUES

- Data availability and quality:
 - Power units (PUs)
 - Vehicle miles traveled (VMT)
 - Utilization
- Assess carrier information outside of safety data for potential use in IRT model.
- Assessment Categories:
 - Availability
 - Quality
 - Relationships to other carrier information

DATA ISSUES

- PUs, VMT, and Utilization are all potential components of an exposure measure that could be incorporated into an inspection model component of an IRT model.
- Develop an inspection model using these and potentially other carrier characteristics to evaluate IRT model performance.
 - Other factors to explore: carrier age, new entrant status, cargo type, number of drivers, location of operations, prepass enrollment, etc.

DATA: POWER UNIT (PU)

- ~75 percent of carriers have a consistent number of PUs over an 18-month window.
- Using an 18-month average removes the small number of anomalies due to errors in reporting.
- VMT is variable for carriers with the same number of PUs reflecting a variation in carrier operations and potential exposure.
- The upward limit of physically possible operation of 250,000 VMT/PU is reflected in the data.

ELECTRONIC LOGGING DEVICE STATISTICS

HOURS-OF-SERVICE COMPLIANCE IMPROVES WITH ELD ROLLOUT



Since Commercial Vehicle Safety Alliance (CVSA) Out-of-Service criteria went into effect, less than 1% (17,651) of all driver inspections (2,267,514) have resulted in the driver being cited for operating without a required electronic logging device (ELD) or grandfathered automated on-board recording device (AOBRD).

ELD IMPACTS ON SMS

HOS Categories:	Nov 17 2017	Nov 30 2018	Difference	% Change
	(Pre-ELD)	(Post-ELD)		
# of Inspections with HOS Compliance Viol	516,055	458,779	57,276	-11%
# of carriers with a HOS Compliance Percentile	44,428	39,001	5,427	-12%
# of carriers with Alert HOS Compliance BASIC	25,025	23,063	1,962	-8%

HOS Measure at the 65 Percentile Threshold:	Nov 17 2017	Nov 30 2018	Difference	% Change
	(Pre-ELD)	(Post-ELD)		
SEG 1: 3 to 10 Insp.	2.293	2.026	0.267	-12%
SEG2: 11-20 Insp.	1.455	1.192	0.263	-18%
SEG 3: 21-100 Insp.	1.158	0.860	0.297	-26%
SEG 4: 101-500 Insp.	0.786	0.498	0.288	-37%
SEG 5: 501+ Insp.	0.234	0.180	0.055	-23%