# Comprehensive Safety Analysis (CSA) 2010
# Safety Measurement System (SMS) Methodology Version 1.2
# Revised March 2010

## Appendix A

**Violation Severity by BASIC**

### *Overview*

The tables in this Appendix contain a breakdown of all FMCSRs and HMRs that can lead to roadside violations, with each table representing a unique BASIC. A severity weight is assigned to each regulation and reflects its relevance to crash risk. Within each BASIC, the regulations are grouped based on their attributes so that similar violations can be assigned the same severity weights. Severity weights, discussed in more detail below, are not comparable across the BASICs.

### *Interpretation of the Severity Weights*

The violation severity weights in the tables that follow have been converted into a scale from 1 to 10, where 1 represents the lowest crash risk and 10 represents the highest crash risk relative to the other violations in the BASIC. Because the weights reflect the relative importance of each violation only within each particular BASIC, they cannot be compared meaningfully across the various BASICs. Therefore, a 5 in one BASIC is not equivalent to a 5 in another BASIC, but the 5 does represent the midpoint between a crash risk of 1 and 10 within the same BASIC. The "Violation Group" column in each table identifies the group to which each violation has been assigned. Each violation within a violation group is assigned the same severity weight.

### *Derivation of the Severity Weights*

The severity weights for each violation were derived through the following six-step process:

1. **BASIC Mapping**—All roadside safety-related violations were mapped to an appropriate BASIC so the severity weight analysis could be conducted on each individual BASIC.

2. **Violation Grouping**—All violations in each BASIC were placed into groups of similar violations based on the judgment of enforcement subject matter experts. These groups, listed in the 'Violation Group' column in each table, make it possible to incorporate otherwise rarely cited violations into the robust statistical analysis used to derive the severity weights. The violation grouping also ensured that similar types of violations received the same severity weight.

3. **Crash Occurrence Analysis**—Statistical analysis was performed to quantify the extent of the relationship between crash involvement on the one hand, and violation rates in each violation group, within each BASIC, on the other hand. A driver approach was used in this analysis. This approach was followed due to strong demonstrable relationships between driver crashes and violations documented in prior research at the Volpe Center. The earlier research was conducted in support of FMCSA's CRWG, the CSA 2010 Initiative's predecessor. Based on the conclusions from this past research, the Volpe Center developed a Driver Information Resource (DIR) for FMCSA. The DIR uses individual crash and inspection reports from all states to construct multi-year driver safety histories on individual drivers. Multivariate negative binomial regression models were used to quantify the strength of relationships between driver violations rates in individual violation groups and crash involvement.

4. **Crash Consequences Analysis**—This analysis incorporates crash consequences attributable to the violation groups based on findings from the Violation Severity Assessment Study (VSAS).[5] The VSAS quantifies the crash risk associated with individual FMCSR and HMR violations in terms of comparable dollar values. These comparable dollar values represent the increased social cost attributable to the presence of a violation. Together, the regression analysis (Step 3) and VSAS findings make it possible to address total crash risk in terms of both crash occurrence and crash consequence.

5. **Subject Matter Expert Review**—Enforcement subject matter experts reviewed the results derived purely from the statistical approaches described in Steps 3 and 4. Modifications were made to the severity weights based on input from the subject matter experts. This approach helps to compensate for the limitations of the statistical analysis, such as lack of statistical significance of rarely cited violations.

6. **CSMS Effectiveness Test**—Various severity weighting schemes developed in Steps 1 through 5 were applied to the CSMS to provide an empirical evaluation of the weighting schemes. The empirical evaluation, or "CSMS Effectiveness Test," was modeled after the SafeStat Effectiveness Test.[6] The CSMS Effectiveness Test was accomplished through the following actions: (1) performing a simulated CSMS run that calculates carrier percentile ranks for each BASIC using historical data; (2) examining each carrier's crash involvement over the immediate 18 months after the simulated CSMS timeframe, and (3) observing the relationship between the percentile ranks in each BASIC and the subsequent post-CSMS carrier crash rates. The CSMS Effectiveness Test provides an environment to evaluate various severity weight schemes in terms of their impact in identifying high-risk carriers. It also provides a means of testing other weight schemes, such as the OOS weight, to help optimize CSMS's effectiveness.

This six-step process made it possible to develop a conceptual framework for the CSMS in the form of violation groupings and associated severity weights. The associated severity weights were based on both empirical analysis and valuable accumulated knowledge from field experts. The data-driven component of the process, in particular, differentiates the CSMS from SafeStat and addresses some of the recent criticisms of the SafeStat algorithm.

Tables 1 through 6 list all of the violations in the CSMS, with the first two columns of each table identifying each violation by regulatory part and its associated definition. The third column in each table identifies the violation group to which each violation is assigned, followed by the violation groups' severity weights in the fourth column.

[5] *Violations Severity Assessment Study Final Report* (October 2007). Prepared for FMCSA by John A. Volpe National Transportation Systems Center.

[6] SafeStat Motor Carrier Safety Status Measurement System Methodology: Version 8.6 (January 2004). Prepared for FMCSA by John A. Volpe National Transportation Systems Center. Chapter 7: SafeStat Evaluation.