Safety Analysis of Crash and Inspection Data for Commercial Vehicles

FINAL REPORT

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16. Abstract The project developed the multi-layer web-based and GIS-based application tool for NJDOT-BTS decision makers to locate high frequency and severity CMV crashes, evaluate CMV crashes and probe crash causality by establishing the link between crash and inspection records. The application has capabilities to perform simple analytical and statistical analysis on crash and inspection records in layer one such as frequency analysis, cross tab, and roadway histogram. Crash and inspection locations can be shown on the New Jersey map in the layer two – GIS analysis layer. The network screening layer, layer three, has the capabilities to rank CMV crash locations throughout the State and pinpoint locations where in need of further safety assessments. Crash rate, critical crash rate, severity rate, critical severity rate, and crash prediction methodologies were developed using AADT and AADTT to locate and rank crash sites. The link between crash and inspection data was established in the layer four, diagnosis and evaluation, to perform a cause and effect analysis on CMV crashes and identify carriers that have more recorded crashes by cross referencing with the inspection violations. The results can assist BTS staff and State police to assess the inspection procedure and identify carriers in need of routine examinations.			
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1. EXECUTIVE SUMMARY

In 2009, the NJDOT-BTS (New Jersey Department of Transportation-Bureau of Trucking Services) partnered with the Center for Advanced Infrastructure and Transportation (CAIT) of Rutgers University to develop *CISS* (Crash & Inspection Safety System), an advanced Web and GIS-based decision support software system. *CISS* is a powerful tool that provides a myriad of benefits for safety professionals in New Jersey for commercial vehicles. This application is a multi-layer decision support program for engineers, planners, and managers at the NJDOT-BTS and also State police officers to evaluate Commercial Motor Vehicle (CMV) crashes considering the historical inspection records and CMV carriers. More than identifying high frequency crash locations which merit further investigations and prioritizing them for potential safety improvements, *CISS* integrates statewide crash data, roadway characteristic data, and inspection data to perform intricate analytical analyses in network screening layer, provide exhaustive cause and effect analyses by establishing the link between crash and inspection records stimulated from Federal Motor Carrier Safety Administration (FMCSA) best practices (Comprehensive Safety Analysis 2010), and demonstrate it in a geospatial environment (GIS). These tools were developed with safety professionals' needs in mind and allow the users to control and monitor CMV crashes and hone inspection process.

2. BACKGROUND REVIEW

Various software applications (SafetyNet, Aspen, MCMIS) have been used at the federal level to collect and perform the preliminary analyses on crash and inspection records. The outcomes of these analyses are utilized by State police to monitor areas in need of frequent enforcements and allow the states to prepare the annual report for the Commercial Vehicle Safety Plan (CVSP) requested by Motor Carrier Safety Assistance Program (MCSAP).

In maintaining the CVSP requirements, the NJDOT-BTS launched the first phase of this project series, Roadside Inspection data and crash data analysis. The project MH-07-34-1 (first phase of this project) assessed the NJDOT- BTS requirements and developed a preliminary functional specification. This functional specification, which was approved by the BTS, was used as the basis for the establishment of the Crash & Inspection Safety System- CISS software developed in this phase. This multi-layer system was designed to provide the following major functionalities:

- Automate the existing manual calculations and analyses conducted by NJDOT-BTS on crash and inspection data.

- Provide customized filtering, assessments, and predefined reports in the tabular and GIS environments.
- Develop new evaluation methods to assess Commercial Motor Vehicle (CMV) crashes by establishing a relation between crash and inspection records.

3. PROJECT OBJECTIVE

This project was in response to the task order “A decision support system for safety analysis of crash and inspection data for commercial vehicles” announced by the NJDOT- BTS in 2009. The main objective of this project was to develop a decision support system, which assists system planners and Federal Motor Carrier Safety Administration (FMCSA) through a GIS-based interface to

- Identify locations with the high number of CMV crashes
- Analyze data in the tabular and geospatial environment
- Identify CMV on-fault crashes
- Correlate between crash and inspection data considering carrier’s information
- Calculate fatal CMV crash rate
- Identify locations in need of frequent monitoring

This application software generates the statistical data required by the Bureau of Truck Services (BTS) to create an annual document initiated by CVSP program and submitted it to FMCSA. This application presents the outcomes in both the tabular and geospatial forms in a user-friendly environment allowing for broader and more accurate investigations.

4. PROJECT APPROACH

4.1. Introduction

The project defined four major tasks to develop the CISS, the web and GIS-based software application, for NJDOT-BTS decision makers.

Task 1 – Develop the business and functional system specifications
Task 2 – Design multi-layer CISS system
Task 3 – Implement CISS Software and testing
Task 4 - Prepare the final report

Following the preliminary investigation and design performed in the first phase of this project, the business and functional specification of the software system were finalized and constructed in Task 1. In this task, several interviews with the future users of CISS application such as NJDOT_BTS staff and state police officers were performed to understand their requirements, dilemma, and future expectations. Upon the completion of this interview, the business and functional specifications were designed and outlined. The “Business Requirement Specification” (BRS) document was prepared and submitted to NJDOT-BTS and NJDOT-IT groups and the document was approved by these groups after their comments and feedbacks were reflected in the BRS document.

Task 2, which was benefited from Task 1 outcomes, designed and blueprinted the CISS interfaces, database links, functions, reports, and inputs/outputs procedure. The research team encountered many obstacles to link safety and inspection databases and to provide solutions to speed up the query processes considering the excessive number of data existed in the inspection and crash data together. The CISS, which was designed in four-layer, established a seamless connection between crash and inspection records and provided functionalities to evaluate and analyze crash and inspection data in tabular and geospatial formats.

In Task 3, the CISS was coded and developed based on the design outlined in Task 2. The system were gone under two beta testing internally (within the research team), and externally by NJDOT-BTS staff after training staff. The final version of the CISS system was presented to NJDOT-BTS staff at the end of September 2010. Finally, this document was prepared in response to Task 4 requirement recording all procedure, designs, blueprints, and functionalities undertaken to develop CISS application.

In following, the section presents the close look at the CISS design and its functionalities.

4.2. CISS Application Design

Applications are usually broken into logical chunks called "tiers", where every tier is assigned a role. Traditional applications consist only of 1 tier, which resides on the client machine, but web applications lend themselves to n-tiered approach by nature. Though many variations are possible, the most popular software architecture that CISS is based on is 3-tier software architecture. The name of each tier and its functionalities are as follows:

1. **Client Tier**: This is where users interact with the application. This application is thin client application, meaning thereby that all user input is marshaled to server

using HTTP steam. The server processes the data/request and sends back the response, which can be either the next step that the user has to take, or the result of an operation the user requested. This process goes on and on till user loges off.

2. **Middle Tier**: Here goes the business logic. All the processing on data takes place in this tier. User input is accepted, validated and if everything is ok the requested operation takes place. When required this tier connects to back-end database server to fetch/store data.

3. **Database Server**: All the data storage takes place in a relational database server. Relational databases are specialized pieces of software specially developed to store, query and manage huge amount of raw data very efficiently.

The benefit of this approach is that windows applications typically require little or no disk space on the client tier, upgrade automatically with new features, and integrate easily into other web procedures, such as email and searching. They also provide cross-platform compatibility (i.e., Windows, Mac, Linux, etc.) because they operate within a web browser window. Meanwhile the 3-tier application design provides us the capability of upgrading each tier independently without meddling with other tiers; therefore, the maintenance or any upgrades of the system's functionality would be an easy task to do.

4.3. CISS Overview

The CISS compiles two arrays of information to perform analysis on Commercial Motor Vehicle (CMV) crashes and violations; crash and inspection records. While, crash database comprises of three tables; crash, vehicle, event tables, inspection database contains ten tables; inspection, driver, vehicle, hazmat, shipper, violation, brake, radioactive, radiological, and radiation tables. The CISS has the capability to perform evaluations on CMV crashes and violations in different levels from the simple statistical analysis (e.g. frequency and cross tab analysis) to more sophisticated and complicated assessments (e.g. crash rate, crash and violation correlation assessments). In addition to the tabular presentation of results, the outcomes of analyses and queries can be presented in the geospatial format. Considering these different levels of capabilities, the CISS was designed in four layers;

- Layer 1 –Data Analysis
- Layer 2- Geographic Information System (GIS) Analysis
- Layer 3- Network Screening
- Layer 4- Diagnosis and Evaluation

Layer 1 performs basic analytical evaluations on crash and inspection records such as frequency analysis, cross tab, road histogram, and viewing/exporting crash reports. These analyses are being performed on data records filtered and initiated by users in the query builder interface. The outcomes of these queries are also presented in the GIS environment (layer 2).

The more complex analyses tools on CMV crashes were designed and integrated into the network screening layer, layer 3. These analytical tools were outlined by the objective of locating CMV crash sites where present more frequent and severe crashes compared with similar/homogeneous locations.

Layer 4 provides the link between inspection violation and crashes recorded under the same CMV carrier. This layer attempts to delineate the cause of CMV crashes by looking at the historical inspection data recorded under carriers involved in crashes.

More elaborate details on the layers functionalities are presented in the following subsection.

4.3.1. Layer 1: Data Analysis

This layer contains a design plan for CISS database and establishes a link between crash and inspection datasets. Based on this establishment, the basic analytical functionalities were designed and built into this layer giving users the capabilities to probe seamlessly through inspection and crash data and create reports in any formats in a user-friendly environment. These functionalities include frequency analysis, cross tab builder, crash roadway histogram, and viewing/exporting Inspection & Crash reports.

4.3.1.1 Database Design

Figure 1 demonstrates the databases and tables used by the CISS application. Different data tables exist in each database. CMV Crash data including crash and vehicle tables were usually extracted from the police report (NJTR-1 police form) filled in crash scenes; the data, then, were cleansed by BTS staff (e.g. carrier name) and imported into the crash module in the SAFETYNET. Simultaneously, inspection data were extracted from ASPEN and imported into the inspection module in the SAFETYNET. Therefore, CISS utilizes the SAFETYNET crash and inspection module databases for evaluations and assessments.

It is important to note that, the vehicle and driver tables exist in both databases (crash and inspection); so, a relationship between these two tables was created by matching their Vehicle Identification Number (VIN) and vehicle license number, as a unique

identifier/index. The vehicle and driver table for crash and inspection databases include only commercial vehicles.

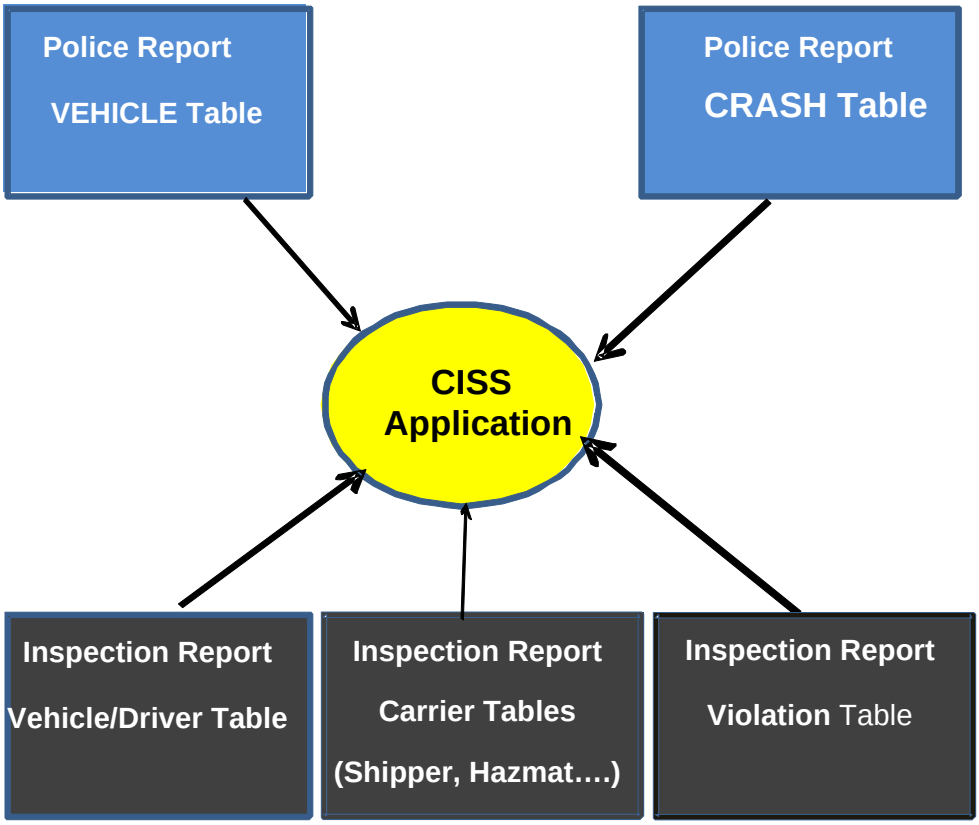


Figure 1 Overall Data structure

4.3.1.2. Functionality

One of the basic capabilities developed in this layer is data filtering. The filter module was designed in such a way that users can work with a subset of the entire dataset. The filter module allows a user to build logical expressions using existing variables, their possible values and logical operands. Filters can be shared with multiple users. Layer 1 performs some simple/basic analytical and statistical analyses such as;

Frequency Analysis

This function evaluates the crash and inspection data and provides the frequency or distribution of a single datum (variable), such as crash type, number of inspections per year, crash per year, or the alcohol involvement in crashes. The output includes the frequency, percentage, and their cumulative values. For instance, Figure 2

demonstrates the result of the evaluation on crashes based on their severities in Middlesex County for all commercial vehicles from year 2007 to 2009.

SNETCRASH.SEVERITY				
Value	Frequency	Cum. Frequency	Percentage	Cum. Percentage
Property Damage	1618	1618	60.42	60.42
Injury	1018	2636	38.01	98.43
Fatal	34	2670	1.27	99.7
NULL	8	2678	0.3	100

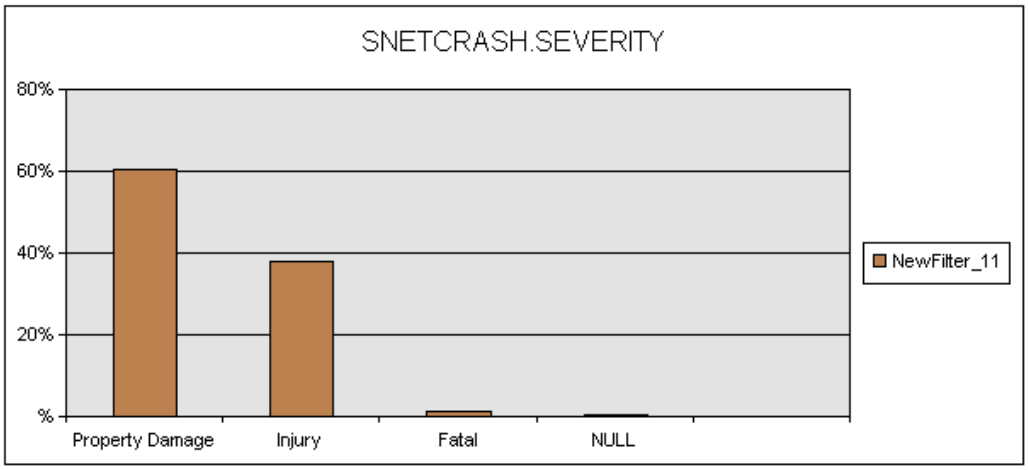


Figure 2 Frequency analysis function outcomes

Cross Tab

Cross tab creates tables of the filtered crash and inspection data with the desired column and row headings chosen from data tables. For instance, Figure 3 demonstrates the cross-section table for all CMV crashes occurred in the Middlesex County between 2007 and 2009 with the vehicle Body Type chosen as a row heading and crash year as a column heading.

SNETVEHICLE.VehicleBodyType Row Primary	Column Primary SNETCRASH.CRASH_YEAR			
	2007	2008	2009	
NULL	188	138	115	441
Bus (seats for 9-15 people, including driver)	28	25	36	89
Bus (seats more than 15 people including driver)	75	59	63	197
Van/Enclosed Box	445	422	379	1246
Cargo Tank	48	77	40	165
Flatbed	86	72	90	248
Dump	79	86	74	239
Concrete Mixer	4	1	2	7
Auto Transporter	14	16	8	38
Garbage/Refuse	28	26	32	86
Grain/chips/gravel	11	5	9	25
Pole	30	29	15	74
Not applicable	23	27	23	73
Intermodal				
Logging				
Vehicle Towing another Vehicle			1	1
Other	20	15	32	67
	1079	998	919	

Figure 3 Cross Tab outcomes

Road histogram

Road Histogram divides a roadway into an equal length segment and calculates the frequency of crashes in each segment and creates a histogram. The roadway is identified either by its route number or SRI (Standard Route Identifier – used in the Straight Line Diagram - SLD). The user has the options to choose the years, segment length, start and end mileposts. For instance, Figure 4 shows the crash roadway histogram for all CMV crashes occurred in route 1 in the Middlesex County from milepost 12 to 16 between year 2007 and 2009. In this case study, the segment length is 0.5 miles. The horizon axis is the milepost and the vertical axis is a number of crashes**.**

SRI	MP Start	MP End	Crashes	Percentage
00000001	12	12.5	5	25.0%
00000001	12.5	13	2	10.0%
00000001	13.5	14	2	10.0%
00000001	14	14.5	4	20.0%
00000001	14.5	15	4	20.0%
00000001	15	15.5	3	15.0%

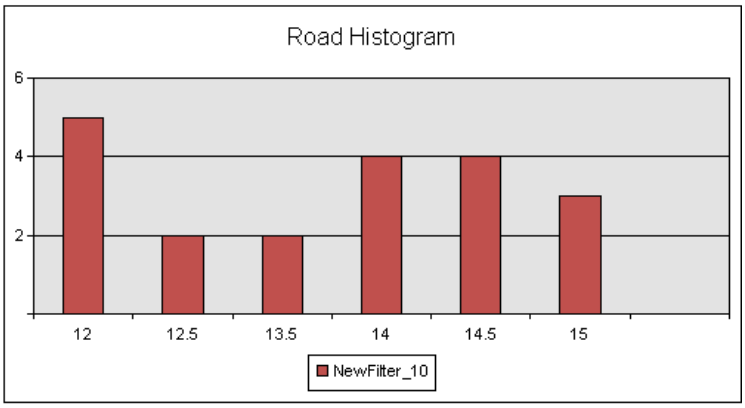


Figure 4 Roadway histogram outcomes

4.3.2. Layer2: Geographic Information System (GIS) Analysis

The GIS component of CISS provides mapping visualization and analysis capabilities. As demonstrated in Figure 5, crash locations and inspection locations can be viewed in New Jersey map based on the existing filter. Other pertinent spatial information is also hosted and visible during a GIS session including data in Table 1. CISS utilizes spatial components primarily provided by ESRI, but also integrates some mapping capabilities offered for free by Google Maps.

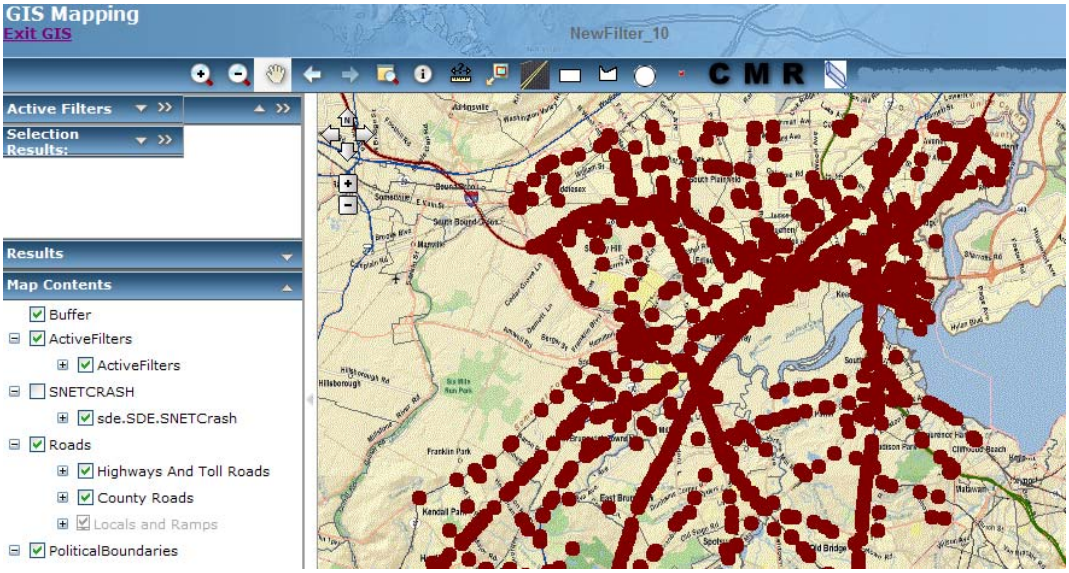


Figure 5 Snapshot of GIS for a filtered crash location

Table 1 Geospatial data

Name	Group	Source
Crash	n/a	Developed internally from DOT crash data
Inspection locations	n/a	Extracted from inspection database
Attractors	n/a	NJTPA
Bridges	n/a	NJ DOT
Highway and Toll Roads	Roads	NJ DOT
County Roads	Roads	NJ DOT
Locals and Ramps	Roads	NJ DOT
Bus Stops	n/a	NJ Transit
Rail Roads	n/a	NJGIN
Rivers	n/a	NJGIN
Statewide Commercial	Planning Regions	NJTPA
Coastal Centers	Planning Regions	NJTPA
Transit Villages	Planning Regions	NJTPA
Redevelopment Zones	Planning Regions	NJTPA
NJ Counties	Political Regions	NJGIN
NJ Municipalities	Political Regions	NJGIN
NJ 2002 Aerial Photos	Background	NJGIN Hosted
NJ 2007 Aerial Photos	Background	NJGIN Hosted

Since the crash data existed in the SAFETYNET were not contained the geocoded crash data, these data were extracted from Plan for Safety (P4S) database, the software developed by TSRC-CAIT at Rutgers. Four fields (Crash Date, Crash Time, Crash Location, and Officer Badge Number) from the Crash table in P4S were used to provide a link between P4S crash tables and SAFETYNET crash tables.

The CISS software system is not only the GIS-based application, but also the web-based system. To have these two capabilities in the CISS, the ESRI server (Web ADF) was initiated and hosted the GIS platform for CISS. This server consisted of ArcSDE and ArcGIS. *ESRI ArcSDE* provided the spatial database for hosting all data. This capability allowed to efficiently host and server large data sets. *ESRI ArcGIS server* provided the backbone for the GIS functionalities in the ESRI Web ADF. Figure 6 demonstrates this architecture.

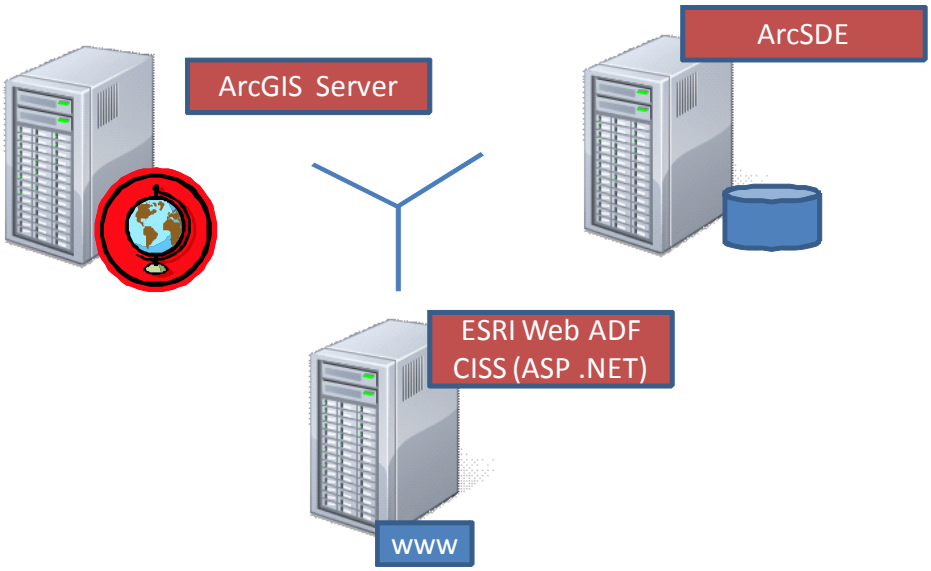


Figure 6 GIS server Architecture

4.3.3. Layer3: Network screening

Network screening layer identifies high frequency crash locations for all roadway types throughout New Jersey State considering traffic volumes traveled on those roadway systems. This layer has several evaluation tools to rank crash sites -a critical function that allows decision makers to prioritize and proactively address potential safety problem areas. In addition, the network screening layer calculates and forecasts the likelihood of occurrences of crashes using the historical data. The following functionalities were designed, developed, and integrated into this layer.

- Crash rate
- Critical crash rate
- Severity rates
- Critical severity rates
- Crash frequency prediction model

Crash rate, which is defined as a number of crashes per Million Vehicles Mile Traveled (MVMT) in a given period, is estimated using the Average Annual Daily Traffic (AADT), and the length of a roadway segment. Whereas, the CISS focuses on CMV crashes, the Average Annual Daily Truck Traffic (AADTT) consisted of all commercial vehicles traveling in a defined roadway segment has to be utilized. Since the AADTT was not

available for the majority of roadways, the crash rate was calculated and reported based on both the AADT and the AADTT. A dedicated interface was designed for users to enter AADTT into the system when it becomes available. Figure 7 shows this interface.

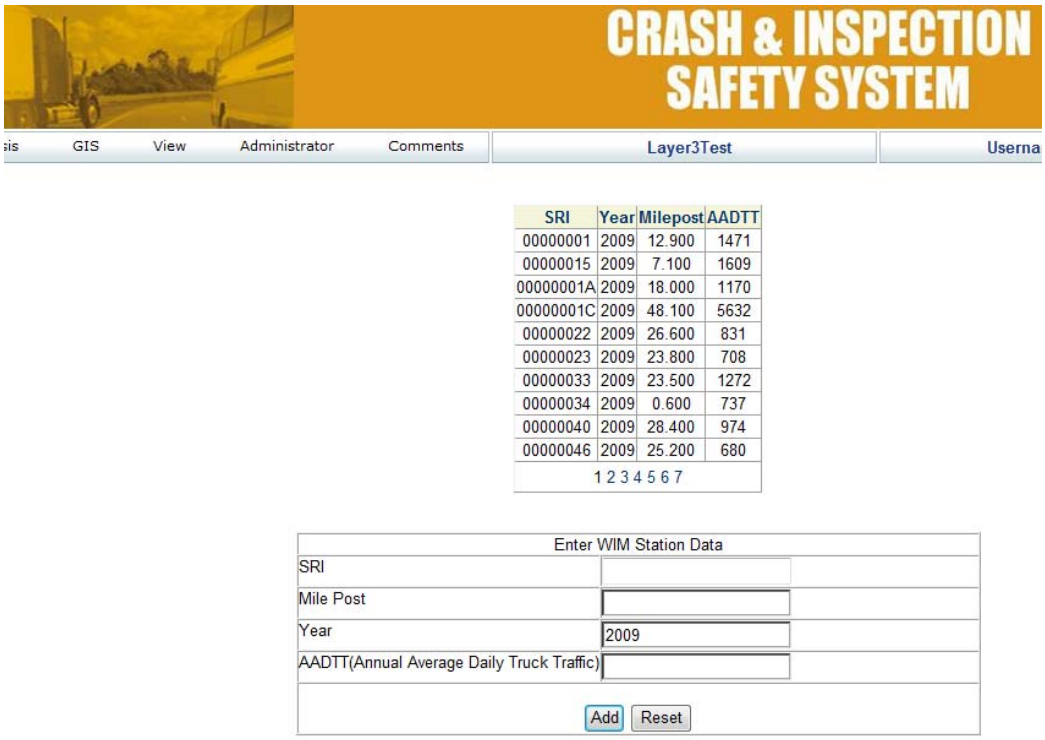


Figure 7 AADTT Data-entry interface

In order to split the roadway to homogenous parts and calculate the crash rate for every portion of the roadway, the roadways were divided into segments based on roadway functional class, AADT/AADTT, number of lanes (optional), and speed (optional).

Severity rate was estimated based on different levels of crash severities. Assorted weights were assigned to the four levels of severities; fatal, incapacitating (injury A), capacitated injuries (injury B), and property damage only (PDO). The weight of each category was estimated by multiplying a number of crashes on that category by its weight. Total weight was determined by adding the weights in each category together. The rest of the procedure (roadway segmentations, AADT/AADTT utilization) was the same as the crash rate calculation.

The critical crash rate was estimated by the comparison of the interested roadway segment crash rate with the average of crash rates for all roadway segments throughout the State that have the same following features of the interested roadway segment; the roadway functional class, AADT/AADTT, number of lanes (optional), and speed

(optional). For instance, if the interested roadway segment is classified in the principal urban arterials and has four lanes, the critical crash rate for this stretch is calculated by the ratio of the crash rate of this stretch of roadway to the average of crash rates for all roadway segments located in the principal urban arterials and had four lanes.

The calculation of critical severity rate was similar to the critical crash rate by this distinction that the severity rate was estimated for the interested roadway segment and compared with the average severity rate of all homogenous roadway segments.

The last tool in this layer was the crash frequency prediction model. This in-house crash modeling technique predicted the crash frequency for an interested roadway segment, corridors or networks. The crash frequency was predicted by utilizing the negative binomial regression model as a modeling technique, the physical condition of a roadway (AADT, roadway class function, number of lanes, median, shoulder, and speed limit) as independent variables, and the crash frequency as a dependent variable.

More discussions on the implementation process of each aforementioned procedure are presented in the appendix 1.

4.3.4. Layer 4: Diagnosis and Evaluation

In this layer, the causes of CMV crashes were investigated by probing through the historical inspection records, CMV carriers, and crash contributed circumstances. By establishing a relation between CMV inspection records and CMV crashes, the diagnosis and evaluation layer developed a tool to perform a cause and effect analysis on CMV crashes and identify carriers that have more recorded crashes by cross referencing with the inspection violations. The results can assist the BTS and State police to determine the focus areas from changing the procedure and the level of inspections to pinpoint carriers in need of routine examinations.

The Carrier Safety Measurement tool (CISS tool for layer4) was stimulated from the Comprehensive Safety Analysis 2010 (CSA 2010), initiative defined by FMCSA, to assess CMV carriers' and drivers' safety performance. This assessment tool integrated seven major features measuring carrier's safety index by evaluating CMV crash contributing circumstances and inspection violations recorded under that carrier. These measurement tools are as follows:

- Unsafe Driving
  The unsafe driving compares the carrier's historical inspection and crash records on careless or dangerous driving violations with other carriers' violations on unsafe driving.

- Fatigue Driving (Hours-Of-Service – HOS)
  The Fatigue Driving (HOS) assesses carriers records involved in any violations related to driver's illnesses, fatigues, or not operating under Hours-of-Service regulations and compares it with other carriers' violations on the fatigue driving.

- Driver Fitness
  The driver fitness measures drivers' qualification working for a specific carrier considering their driving experiences, training, or medical qualifications. The carrier's "driver fitness" violations are, then, compared with other carriers' fitness violations.

- Controlled Substances/Alcohol
  The Controlled Substances/Alcohol evaluates a number of carrier's violations related to the carrier's drivers' violations due to the usage of alcohol, illegal drugs, and misuse of prescription or over-the-counter medications recorded at the roadside inspection.

- Vehicle Maintenance
  The Vehicle Maintenance evaluates the procedure of CMV maintenance followed by carriers and compares the carrier's vehicle maintenance violations with other carriers.

- Cargo-Related
  The Cargo-Related evaluates a carrier's historical violation data related to the failure to properly prevent shifting loads, spilled or dropped cargo and unsafe handling of hazardous materials. The carrier's cargo-related violation is, then, compared with other carriers' violations in this category to rank the carrier in this measurement class.

- Crash Severity
  The Crash Severity measures a carrier historical crash data considering the crash frequencies and severities and compares with other carriers crash data.

More discussions on the methodologies and the implementation processes are discussed in the appendix 2.

SUMMARY AND RECOMMENDATIONS

The project developed the multi-layer web-based and GIS-based application tool for NJDOT-BTS decision makers to locate high frequency CMV crashes, evaluate CMV crashes and probe crash causality by establishing the link between crash and inspection records. The application has capabilities to perform simple analytical and statistical analysis on crash and inspection records in layer one such as frequency analysis, cross tab, and roadway histogram. Crash and inspection locations can be shown on the New Jersey map in the layer two – GIS analysis layer. The network screening layer, layer three, has the capabilities to rank CMV crash locations throughout the State and pinpoint locations where in need of further safety assessments. Crash rate, critical crash rate, severity rate, critical severity rate, and crash prediction methodologies were developed using AADT and AADTT to locate and rank crash sites. The link between crash and inspection data was established in the layer four, diagnosis and evaluation, to perform a cause and effect analysis on CMV crashes and identify carriers that have more recorded crashes by cross referencing with the inspection violations. The results can assist BTS and State police to assess the inspection procedure and identify carriers in need of routine examinations. The developed tool was presented to the BTS staff in two phases; 1) In the first phase, the BTS staff was trained to utilize the system and performed the beta testing; 2) the final product was delivered to BTS staff in the second phase after the presentation.

The research team believes that this system can promote the capabilities of the BTS staff and police officers to control and monitor CMV crashes throughout the State and manage their resources more effectively. The research team is confident that this goal can be maintained and the system capabilities can be enhanced, if the following recommendations will be taken into the effect:

- Updating procedure - the system has to be updated frequently in order to assist the BTS in monitoring CMV crashes and help police enforcements in locating high crash spots. It is recommended that an automated system is developed to import data into the CISS system automatically from SafetyNet and P4S in a defined time period (e.g. every week).

- Having AADTT for truck routes is a critical piece of information to locate high CMV crash location accurately. Though, the system compiled all available AADTT from Weight-In-Motion (WIM) stations and integrated into the system, the team would emphasize on collaborating with other authorities to collect this information in a broader spectrum.

- It was an original thought that the system would develop the canned-report required to be prepared by the BTS staff in a periodic time window. Though, the

cross tab tool was developed to maintain this need, the system can enhance its capabilities and design a user-friendly environment to create reports produced frequently by the BTS staff for internal or external (e.g. report to Federal) use.

- The system can be enhanced in the GIS layer to perform all analyses currently performed in the layer one directly in this layer. The experience shows that users would be more comfortable to perform analyses on the GIS map compared with building the logical filter (in layer one).

APPENDIX

APPENDIX 1

Crash rate implementation process

Crash rate for roadway segment is calculated using the following formula:

$$Crash\ rate\ for\ roadway\ segment = CR_s = \frac{Number\ of\ crashes\ (N)}{Exposure\ per\ million\ vehicle\ per\ Mile\ (MVMT)}$$

Where,

$$MVMT = Exposure\ per\ hundred\ million\ vehicle\ per\ Mile = \frac{AADT * Lenght\ of\ section\ segment(L) * Number\ of\ Years * 365}{1{,}000{,}000}$$

Critical Crash Rate implementation process

Critical Crash Rate for roadway segment is calculated using the following formula:

$$CR = ACR + K * \sqrt{\frac{ACR}{MVMT}} \pm \frac{1}{2MVMT}$$

Where,

CR= critical rate for roadway segment
K= 1.645 for 95% confidence level
ACR= Average crash rate for each functional class of road throughout state

$$MVMT - Exposure\ per\ million\ vehicle\ per\ Mile = \frac{AADT * Lenght\ of\ section\ segment\ (L) * Number\ of\ Years * 365}{1{,}000{,}000}$$

Idea behind this equation is that crashes are normally distributed around the crash rate mean for a given functional class of roadway.
At last, Critical crash ratio is determined as a ratio of crash rate of roadway segment to critical rate of class of roadway. *If this ratio is more than one, it means the site needs further consideration*.

$$CCR = \frac{CR_S}{CR} > 1$$

Severity Rate

Severity Rate for roadway segment is calculated using the following formula:

Severity Rate = $SR_s = \frac{Number\ of\ weighted\ crashes\ per\ road\ section(NW)}{Exposure\ per\ million\ vehicle\ per\ Mile(MVMT)}$

Where,

$NW = Number\ of\ weighted\ crashes\ per\ road\ section$ = Fatal*w1+ InjruryA*w2 + InjuryB*w3 + PDO*w4

$$Exposure\ per\ million\ vehicle\ per\ Mile(MVMT) = \frac{AADT * Lenght\ of\ section\ segment(L) * Number\ of\ Years * 365}{1{,}000{,}000}$$

Critical Severity Rate Methodology

Critical severity ratio follows same procedure as critical crash ratio; however, severity rate for each intersection or roadway segment (SR_s) and Statewide severity rate for all homogenous intersections or Statewide severity rate (ASR) for functional of roadway class obey the following equation:

$$SR_f = ASR + K*\sqrt{\frac{ASR}{HMVMT}} \pm \frac{1}{2HMVMT}$$

Where,

SR_f = Critical rate for roadway segment

K= 1.645 for 95% confidence level

ASR= Average severity rate for each functional class of road throughout state

$$MVMT = Exposure\ per\ million\ vehicle\ per\ Mile = \frac{AADT * Lenght\ of\ section\ segment(L) * Number\ of\ Years * 365}{1{,}000{,}000}$$

The critical severity ratio is determined by the following equation, in which ratio of more than one illustrates sites in need of further studies.

$$CSR = \frac{SR_S}{SR_f} > 1$$

Crash frequency Prediction Methodology

The in-house crash modeling technique predicts the crash frequency for interested roadway, corridors or networks. In order to implement the prediction model, the following steps were executed:

- Define an interested area (from a roadway to roadways in a city or a county).
- Divide roadway (or roadways) to homogeneous segments considering roadway functional class, speed, shoulder width, median, and number of lanes.
- Estimate number of crashes for each roadway segment using Negative binomial regression with a number of crashes as a dependent variable and roadway characteristics as independent variables.
- Define a year of prediction.
- Calculate the AADT growth and reflect the latest change in the roadway geometry.
- Predict the crash frequency for that specific period.
- Rank the crash sites.

APPENDIX 2

The interface for layer four, Diagnosis and evaluation, is depicted in the Figure 8. The seven measurement factors discussed in the section 4.3.4 were categorized into three major classes, as defined in the following:

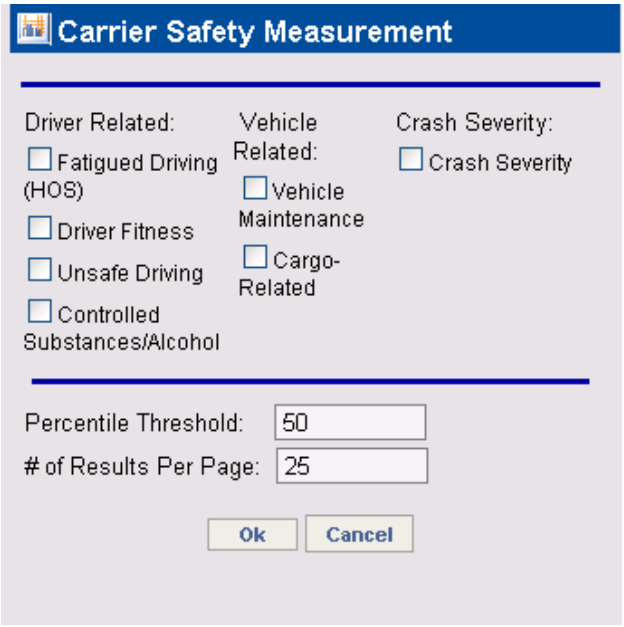


Figure 8 User Interface for Carrier Safety Measurement

- Driver Related
  - Unsafe Driving
  - Fatigue Driving (HOS)
  - Driver Fitness
  - Controlled Substances/Alcohol
- Vehicle Related
  - Vehicle Maintenance
  - Cargo-Related
- Crash Severity

This user-friendly environment provides users the capability to select their interested evaluation criteria. The assessments are performed and presented to users on those selected criteria. The exhaustive discussions on the methodology and the implementation processes for each measurement factor are presented in the following.

Unsafe Driving Measure

Methodology

This measure evaluates the performance of the carriers on unsafe driving criterion. The unsafe driving measure is defined in CSA2010 as: Operating CMVs in a dangerous or careless manner. The examples of violations are: speeding, reckless driving, improper lane change, and inattention. **Error! Reference source not found.** depicts a complete list of roadside inspection violations used in Layer4 (Carrier safety measurement).

In this methodology, Inspection database (using driver relevant violations recorded at SafetyNet), crash database (using contributing circumstances and other relevant information such as crash date), and the Power Units (PUs) of carriers were used to calculate the unsafe driving measure per carrier based on the following equation. Upon this calculation, the percentile rank for a specific carrier is calculated by a comparison with other carriers' unsafe driving violations categorized on that group (based on PU).

$$\text{Unsafe Driving measure per carrier} = \frac{\text{Sum over violation (Time Weight} * \text{Severity Weight)}}{\text{Carrier's Power Unit}}$$

Where,

Violation is defined as any violation recorded in any level of roadside inspections for unsafe driving (**Error! Reference source not found.**) during the past 24 months prior to the crash date. In cases that multiple counts of the same violation are recorded, one violation is counted per inspection in one site.

Severity Weight is assigned to each violation from 1 (less severe) to 10 (most severe). **Error! Reference source not found.** demonstrates these severity weights corresponded to each violation.

Time Weight is assigned to each violation based on the time elapsed between recorded violation and crash dates. Violations recorded during the past 6 months prior to the crash date receive a time weight of 3. Violations recorded within 6 to 12 months prior to the crash date receive a time weight of 2. All violations recorded older than 12 months (within 24 months prior to the crash date) receive a time weight of 1. The time weighting assignment puts more emphasis on recent violations.

Carrier's Power Unit (PU) is used to account for each carrier‘s level of exposure. The violations are normalized by the number of owned, term-leased,

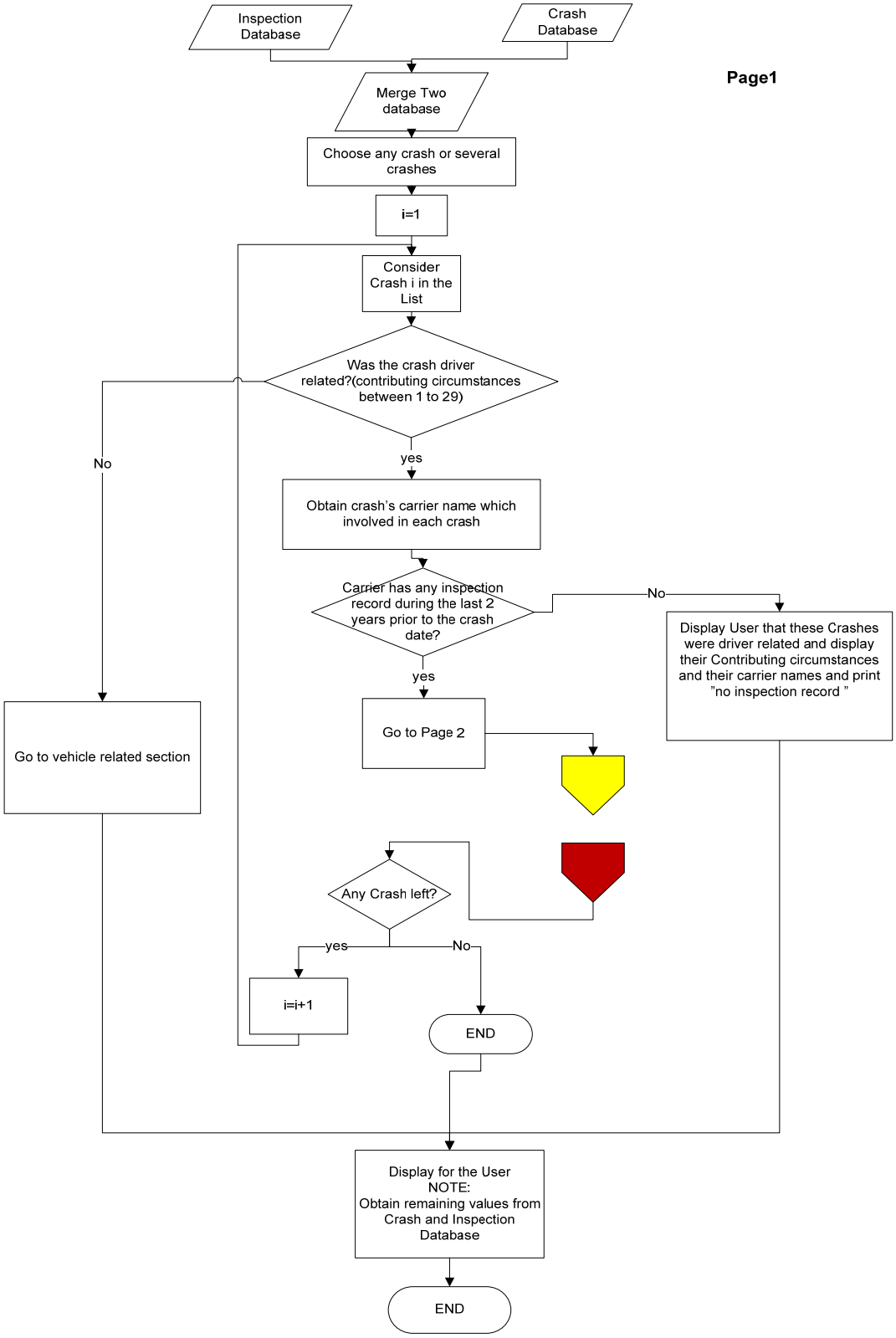
and trip-leased PUs (trucks, tractors, hazardous-material tank trucks, motor coaches, and school buses) recorded under that carrier.

Implementation

The implementation procedure is as follows:

1. Probe through the contributed circumstances field in crash-vehicle table to define crashes recorded as a driver in-fault.
2. Find carriers assigned to those crashes. If the carrier has inspection records during the past 2 years prior to the crash date then proceed to the next step; otherwise the system gives a warning.
3. Categorize the carrier based on its power units (PU). Thus, the carrier's safety posture (for unsafe driving measure) is compared with other carriers within its group.
4. Find all available inspection violation records with at least three unsafe driving violations recorded during the past 2 years prior to the crash date (defined in the filter) for all carriers in the group.
5. Calculate the unsafe driving measure for each carrier from the aforementioned equation.
6. Rank all the unsafe driving measures in an ascending order.
7. Transform the rank values into percentiles.
8. Highlight carriers have the percentile value higher than the threshold.

The implementation flow chart is demonstrated in the Figure 9.


Page1
Inspection Database
Crash Database
Merge Two database
Choose any crash or several crashes
i=1
Consider Crash i in the List
Was the crash driver related?(contributing circumstances between 1 to 29)
No
yes
Obtain crash's carrier name which involved in each crash
Carrier has any inspection record during the last 2 years prior to the crash date?
No
yes
Display User that these Crashes were driver related and display their Contributing circumstances and their carrier names and print "no inspection record "
Go to Page 2
Go to vehicle related section
Any Crash left?
yes
No
i=i+1
END
Display for the User
NOTE:
Obtain remaining values from Crash and Inspection Database
END

Continued

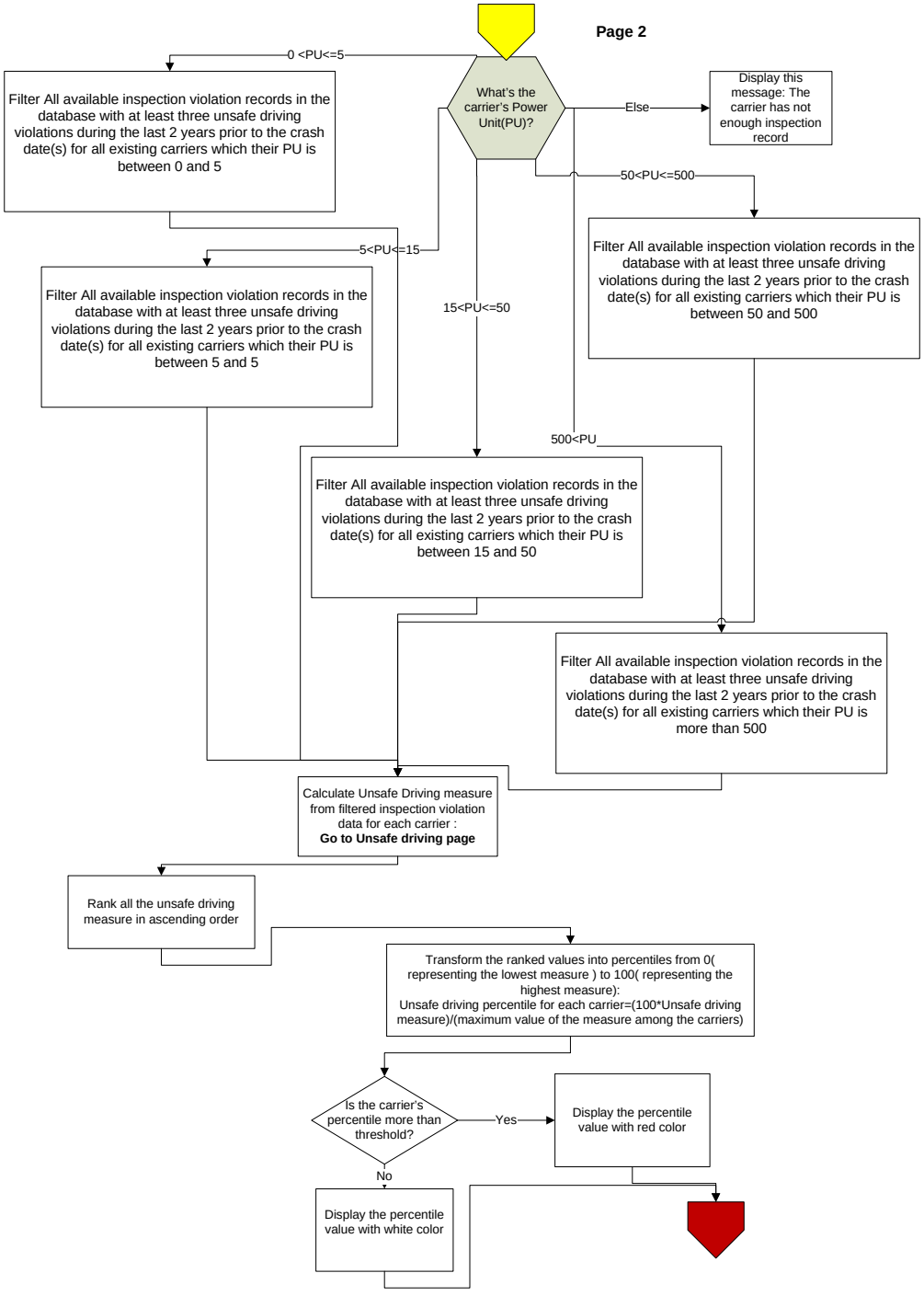


Figure 9 Unsafe driving measure – Implementation procedure

Fatigue Driving (HOS) Measure

Methodology

The fatigue driving measure is defined in CSA2010 as: Operating CMVs by drivers who are ill, fatigue, or in non-compliance with the Hours-Of-Service (HOS) regulations. Instances related to the Fatigue Driving (HOS) were distinguished from incidents where unconsciousness or an inability to react was noted as a consequence of the usage of alcohol, drugs, or other controlled substances. The examples of violations are: HOS, logbook, and operating a CMV while ill or fatigue. Table 4 demonstrates a complete list of roadside inspection Fatigue Driving violations used in Layer4 (Carrier safety measurement).

In this methodology, Inspection database (using driver relevant violations recorded at SafetyNet) and crash database (using contributing circumstances and other relevant information such as crash date) were used to calculate the fatigue driving measure per carrier based on the following equation. Upon this calculation, the percentile rank for a specific carrier is calculated by a comparison with other carriers' fatigue driving violations categorized in that group.

$$\text{Fatigued Driving (HOS) Measure} = \frac{\text{Sum over violations (Time Weight * Severity Weight)}}{\text{Number of time weighted relevant inspections}}$$

Where,

Violation is defined as any violation recorded in any level of roadside inspections for fatigue driving (Table 4) during the past 24 months prior to the crash date. In cases that multiple counts of the same violation are recorded, one violation is counted per inspection in one site.

Relevant Inspection is defined as any driver-related inspection in any level of inspection (Level 1, 2, 3 or 6).

Severity Weight is assigned to each violation from 1 (less severe) to 10 (most severe). Table 4 demonstrates these severity weights corresponded to each violation.

Time Weight is assigned to each violation based on the time elapsed between recorded violation and crash dates. Violations recorded during the past 6 months prior to the crash date receive a time weight of 3. Violations recorded within 6 to

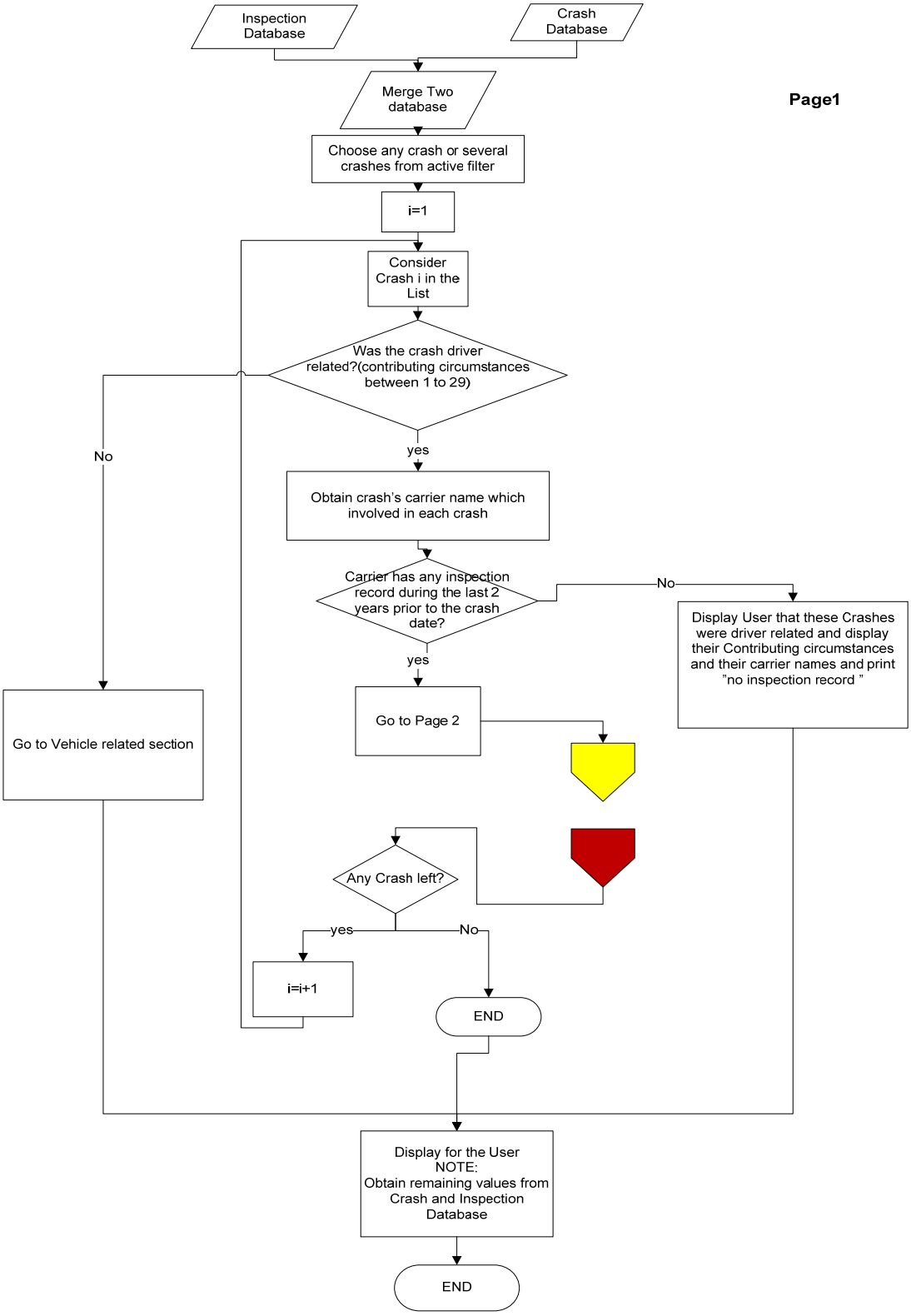
12 months prior to the crash date receive a time weight of 2. All violations recorded older than 12 months (within 24 months prior to the crash date) receive a time weight of 1. The time weighting assignment puts more emphasis on recent violations.

Implementation

The implementation procedure is as follows:

1. Probe through the contributed circumstances field in crash-vehicle table to define crashes recorded as a driver in-fault.
2. Find carriers assigned to those crashes. If the carrier has inspection records during the past 2 years prior to the crash date then proceed to the next step; otherwise the system gives a warning.
3. Categorize the carrier based on its number of driver relevant Inspections (Level 1, 2, 3 or 6). Thus, the carrier's safety posture (for fatigue driving measure) is compared with other carriers within its group.
4. Find all available inspection violation records with at least one fatigue driving (HOS) violation recorded during the past 2 years prior to the crash date (defined in the filter) for all carriers in the group.
5. Calculate the fatigue driving measure for each carrier from the aforementioned equation.
6. Rank all the fatigue driving measures in an ascending order.
7. Transform the rank values into percentiles.
8. Highlight carriers have the percentile value higher than the threshold.

The implementation flow chart is demonstrated in the Figure 10.


Inspection Database
Crash Database
Merge Two database
Page1
Choose any crash or several crashes from active filter
i=1
Consider Crash i in the List
Was the crash driver related?(contributing circumstances between 1 to 29)
No
yes
Obtain crash's carrier name which involved in each crash
Carrier has any inspection record during the last 2 years prior to the crash date?
No
Display User that these Crashes were driver related and display their Contributing circumstances and their carrier names and print "no inspection record "
yes
Go to Page 2
Go to Vehicle related section
Any Crash left?
yes
No
i=i+1
END
Display for the User
NOTE:
Obtain remaining values from Crash and Inspection Database
END

Continued

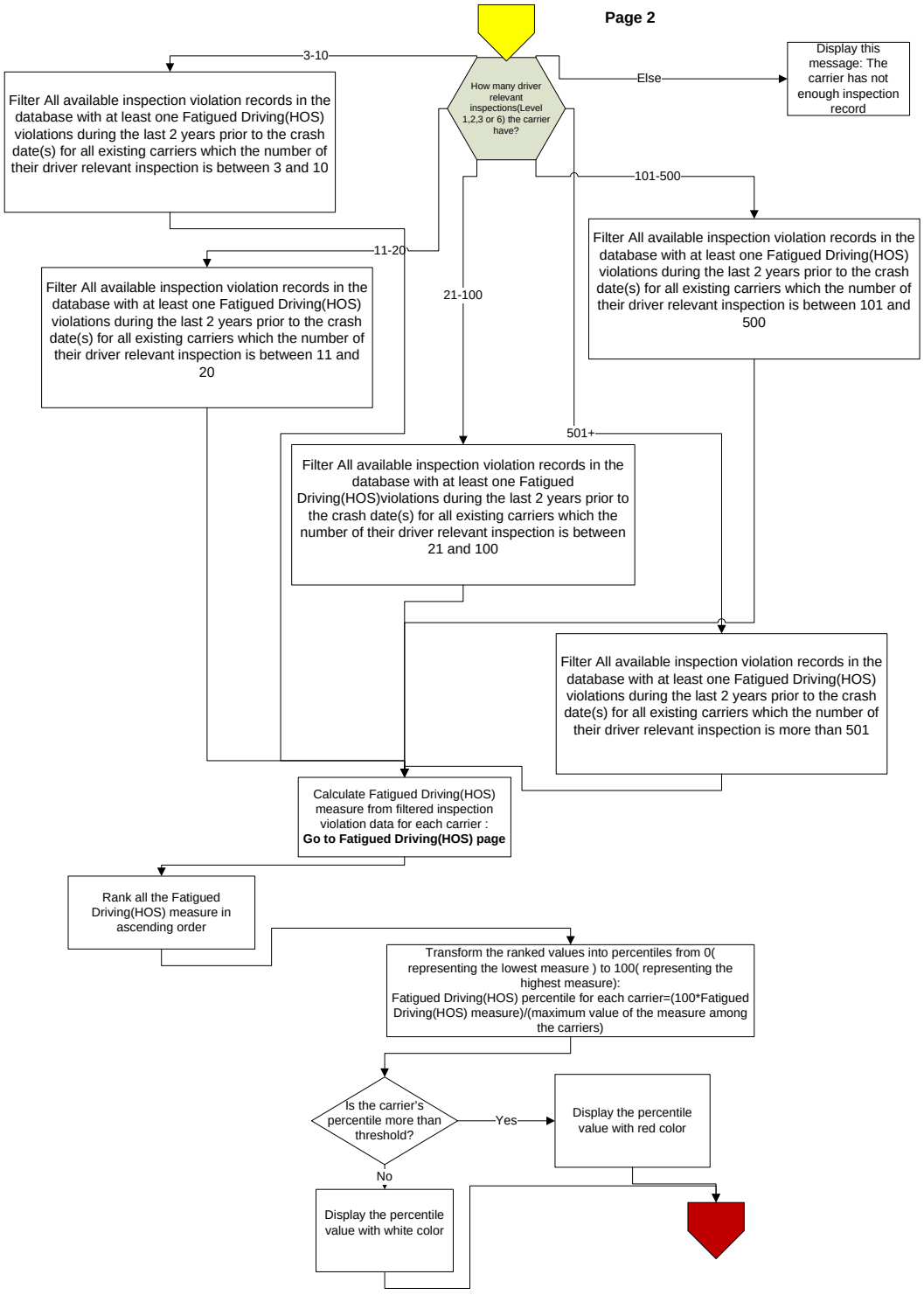


Figure 10 Fatigue Driving (HOS) measure - Implementation procedure

Driver Fitness Measure

Methodology

The driver fitness measure is defined in CSA2010 as: Operating CMVs by drivers who are unfit to operate a CMV due to the lack of training, experience, or medical qualifications. The examples of violations are: failing to have a valid and appropriate commercial driver's license and being medically unqualified to operate a CMV. Table 5 demonstrates a complete list of roadside inspection driver fitness violations used in Layer4 (Carrier safety measurement).

In this methodology, Inspection database (using driver relevant violations recorded at SafetyNet) and crash database (using contributing circumstances and other relevant information such as crash date) were used to calculate the driver fitness measure per carrier based on the following equation. Upon this calculation, the percentile rank for a specific carrier is calculated by a comparison with other carriers' driver fitness violations categorized in that group.

$$\text{Driver Fitness Measure} = \frac{\text{Sum over violation (Time Weight * Severity Weight)}}{\text{Number of time weighted relevant inspections}}$$

Where,

Violation is defined as any violation recorded in any level of roadside inspections for driver fitness (Table 5) during the past 24 months prior to the crash date. In cases that multiple counts of the same violation are recorded, one violation is counted per inspection in one site.

Relevant Inspection is defined as any driver-related inspection in any level of inspection (Level 1, 2, 3 or 6).

Severity Weight is assigned to each violation from 1 (less severe) to 10 (most severe). Table 5 demonstrates these severity weights corresponded to each violation.

Time Weight is assigned to each violation based on the time elapsed between recorded violation and crash dates. Violations recorded during the past 6 months prior to the crash date receive a time weight of 3. Violations recorded within 6 to 12 months prior to the crash date receive a time weight of 2. All violations recorded older than 12 months (within 24 months prior to the crash date) receive

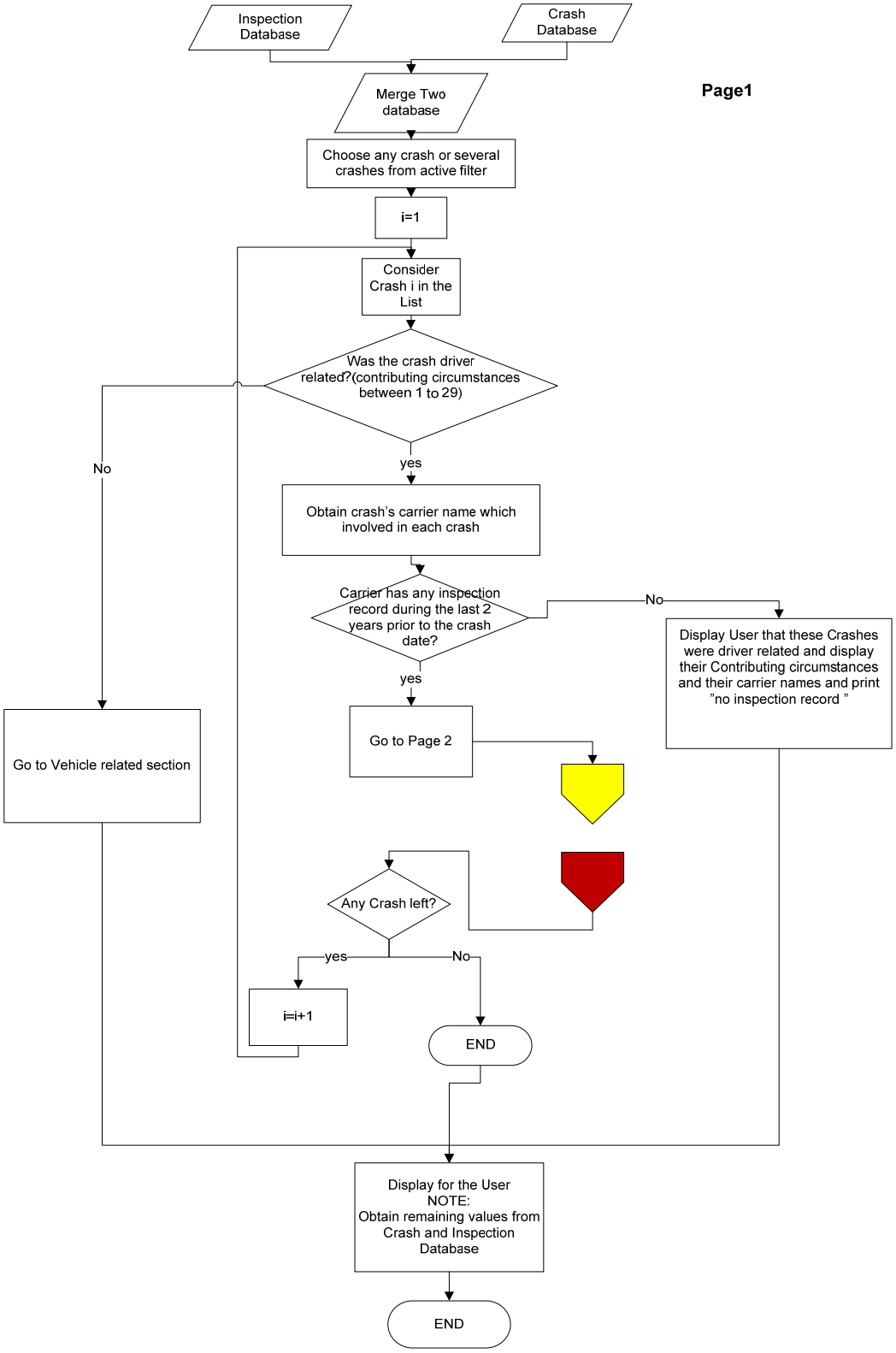
a time weight of 1. The time weighting assignment puts more emphasis on recent violations.

Implementation

The implementation procedure is as follows:

1. Probe through the contributed circumstances field in crash-vehicle table to define crashes recorded as a driver in-fault.
2. Find carriers assigned to those crashes. If the carrier has inspection records during the past 2 years prior to the crash date then proceed to the next step; otherwise the system gives a warning.
3. Categorize the carrier based on its number of driver relevant Inspections (Level 1, 2, 3 or 6). Thus, the carrier's safety posture (for driver fitness measure) is compared with other carriers within its group.
4. Find all available inspection violation records with at least one driver fitness violation recorded during the past 2 years prior to the crash date (defined in the filter) for all carriers in the group.
5. Calculate the driver fitness measure for each carrier from the aforementioned equation.
6. Rank all the driver fitness measures in an ascending order.
7. Transform the rank values into percentiles.
8. Highlight carriers have the percentile value higher than the threshold.

The implementation flow chart is demonstrated in the Figure 11.


Inspection Database
Crash Database
Merge Two database
Page1
Choose any crash or several crashes from active filter
i=1
Consider Crash i in the List
Was the crash driver related?(contributing circumstances between 1 to 29)
No
yes
Obtain crash's carrier name which involved in each crash
Carrier has any inspection record during the last 2 years prior to the crash date?
No
yes
Display User that these Crashes were driver related and display their Contributing circumstances and their carrier names and print "no inspection record "
Go to Page 2
Go to Vehicle related section
Any Crash left?
yes
No
i=i+1
END
Display for the User
NOTE:
Obtain remaining values from Crash and Inspection Database
END

Continued

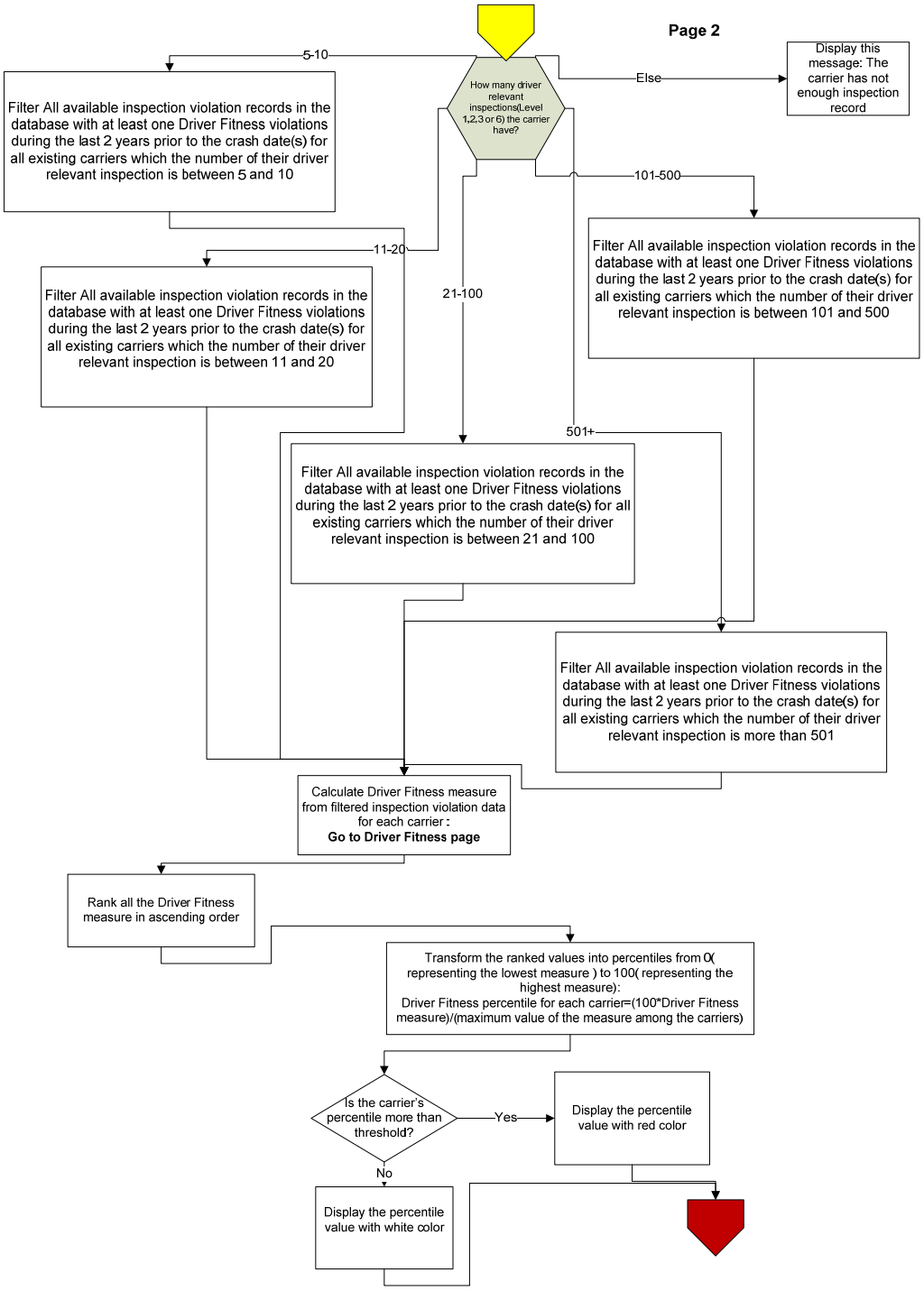


Figure 11 Driver Fitness measure - Implementation procedure

Controlled Substances/Alcohol Measure

Methodology

The controlled substances/alcohol measure is defined in CSA2010 as: Operating CMVs by drivers cited in roadside inspections for impairment due to alcohol, illegal drugs, and misuse of prescription or over-the-counter medications. The examples of violations are: use or possession of controlled substances or alcohol. Table 6 demonstrates a complete list of roadside inspection controlled substances/alcohol violations used in Layer4 (Carrier safety measurement).

In this methodology, Inspection database (using driver relevant violations recorded at SafetyNet) and crash database (using contributing circumstances and other relevant information such as crash date) were used to calculate the driver fitness measure per carrier based on the following equation. Upon this calculation, the percentile rank for a specific carrier is calculated by a comparison with other carriers' controlled substances/alcohol violations categorized in that group.

$$\text{Controlled Substances/Alcohol Measure} = \frac{\text{Sum over violation (Time Weight * Severity Weight)}}{\text{Number of time weighted relevant inspections}}$$

Where,

Violation is defined as any violation recorded in any level of roadside inspections for controlled substances/alcohol (Table 6) during the past 24 months prior to the crash date. In cases that multiple counts of the same violation are recorded, one violation is counted per inspection in one site.

Relevant Inspection is defined as any driver-related inspection in any level of inspection (Level 1, 2, 3 or 6).

Severity Weight is assigned to each violation from 1 (less severe) to 10 (most severe). Table 6 demonstrates these severity weights corresponded to each violation.

Time Weight is assigned to each violation based on the time elapsed between recorded violation and crash dates. Violations recorded during the past 6 months prior to the crash date receive a time weight of 3. Violations recorded within 6 to 12 months prior to the crash date receive a time weight of 2. All violations

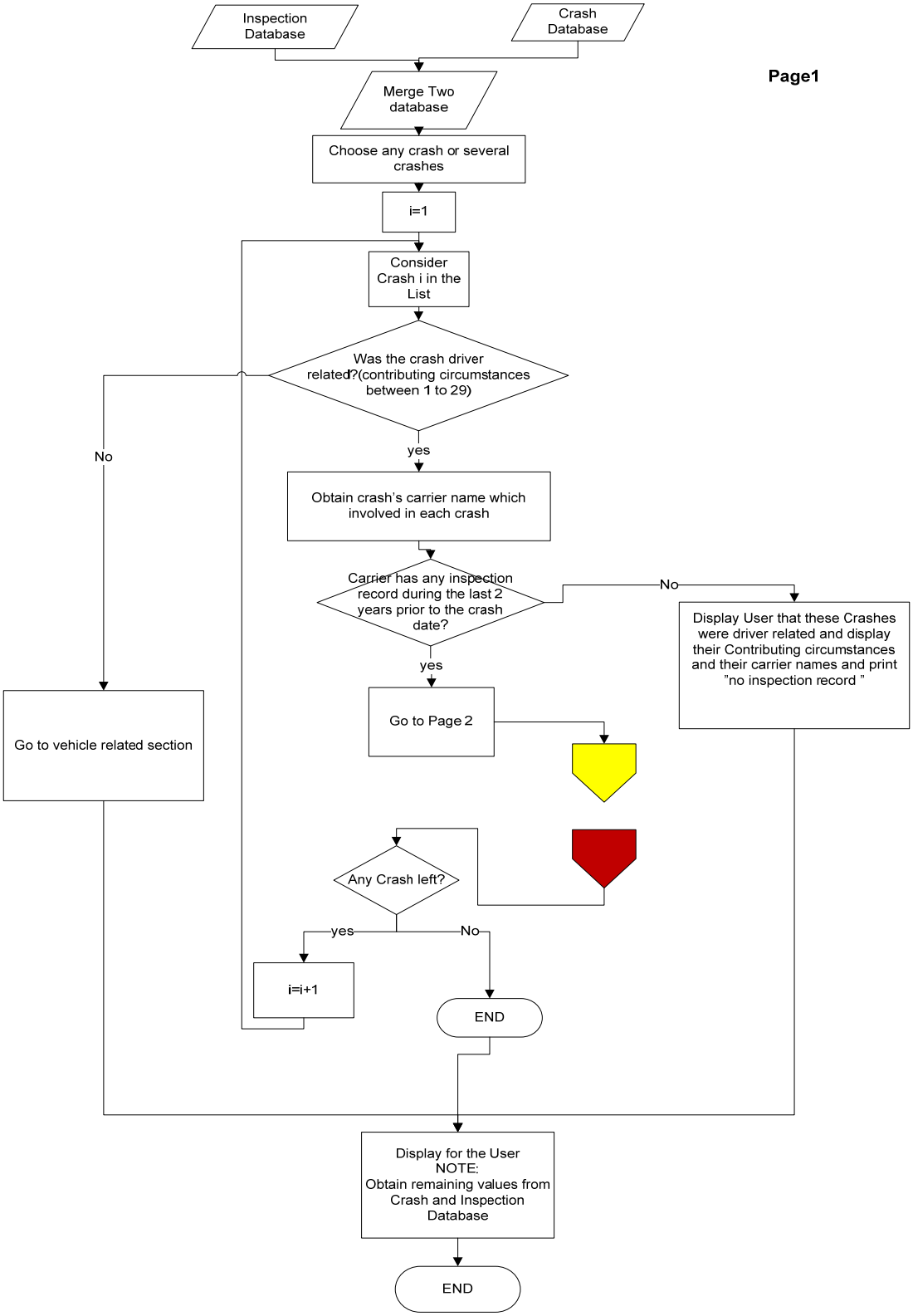
recorded older than 12 months (within 24 months prior to the crash date) receive a time weight of 1. The time weighting assignment puts more emphasis on recent violations.

Implementation

The implementation procedure is as follows:

1. Probe through the contributed circumstances field in crash-vehicle table to define crashes recorded as a driver in-fault.
2. Find carriers assigned to those crashes. If the carrier has inspection records during the past 2 years prior to the crash date then proceed to the next step; otherwise the system gives a warning.
3. Categorize the carrier based on its number of driver relevant Inspections (Level 1, 2, 3 or 6). Thus, the carrier's safety posture (for Controlled Substances/Alcohol measure) is compared with other carriers within its group.
4. Find all available inspection violation records with at least one Controlled Substances/Alcohol violation recorded during the past 2 years prior to the crash date (defined in the filter) for all carriers in the group.
5. Calculate the Controlled Substances/Alcohol measure for each carrier from the aforementioned equation.
6. Rank all the Controlled Substances/Alcohol measures in an ascending order.
7. Transform the rank values into percentiles.
8. Highlight carriers have the percentile value higher than the threshold.

The implementation flow chart is demonstrated in the Figure 12.


Page1
Inspection Database
Crash Database
Merge Two database
Choose any crash or several crashes
i=1
Consider Crash i in the List
Was the crash driver related?(contributing circumstances between 1 to 29)
No
yes
Obtain crash's carrier name which involved in each crash
Carrier has any inspection record during the last 2 years prior to the crash date?
No
yes
Display User that these Crashes were driver related and display their Contributing circumstances and their carrier names and print "no inspection record "
Go to Page 2
Go to vehicle related section
Any Crash left?
yes
No
i=i+1
END
Display for the User
NOTE:
Obtain remaining values from Crash and Inspection Database
END

Continued

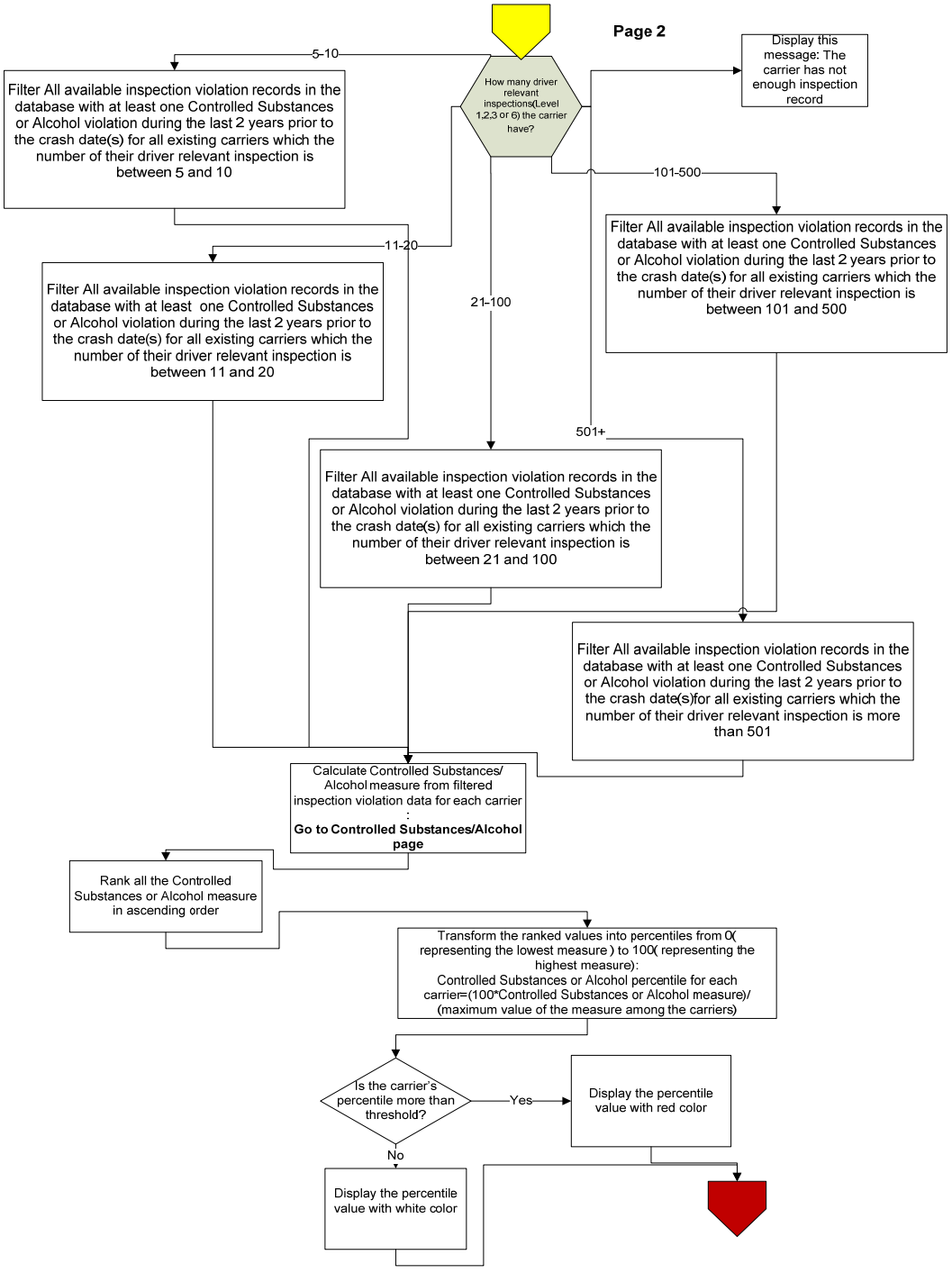


Figure 12 Controlled Substances/Alcohol measure - Implementation procedure

Vehicle Maintenance Measure

Methodology

The vehicle maintenance measure is defined in CSA2010 as: Failure to properly maintain a CMV. The examples of violations are: brakes, lights, and other mechanical defects, and failure to make required repairs. Table 7 demonstrates a complete list of roadside inspection vehicle maintenance violations used in Layer4 (Carrier safety measurement).

In this methodology, Inspection database (using vehicle-related violations recorded at SafetyNet) and crash database (using contributing circumstances and other relevant information such as crash date) were used to calculate the vehicle maintenance measure per carrier based on the following equation. Upon this calculation, the percentile rank for a specific carrier is calculated by a comparison with other carriers' vehicle maintenance violations categorized in that group.

$$\text{Vehicle Maintenance Measure} = \frac{\text{Sum over violation (Time Weight * Severity Weight)}}{\text{Number of time weighted relevant inspections}}$$

Where,

Violation is defined as any violation recorded in any level of roadside inspections for vehicle maintenance (Table 7) during the past 24 months prior to the crash date. In cases that multiple counts of the same violation are recorded, one violation is counted per inspection in one site.

Relevant Inspection is defined as any vehicle-related inspection in any level of inspection (Level 1, 2, 5 or 6).

Severity Weight is assigned to each violation from 1 (less severe) to 10 (most severe). Table 7 demonstrates these severity weights corresponded to each violation.

Time Weight is assigned to each violation based on the time elapsed between recorded violation and crash dates. Violations recorded during the past 6 months prior to the crash date receive a time weight of 3. Violations recorded within 6 to 12 months prior to the crash date receive a time weight of 2. All violations recorded older than 12 months (within 24 months prior to the crash date) receive

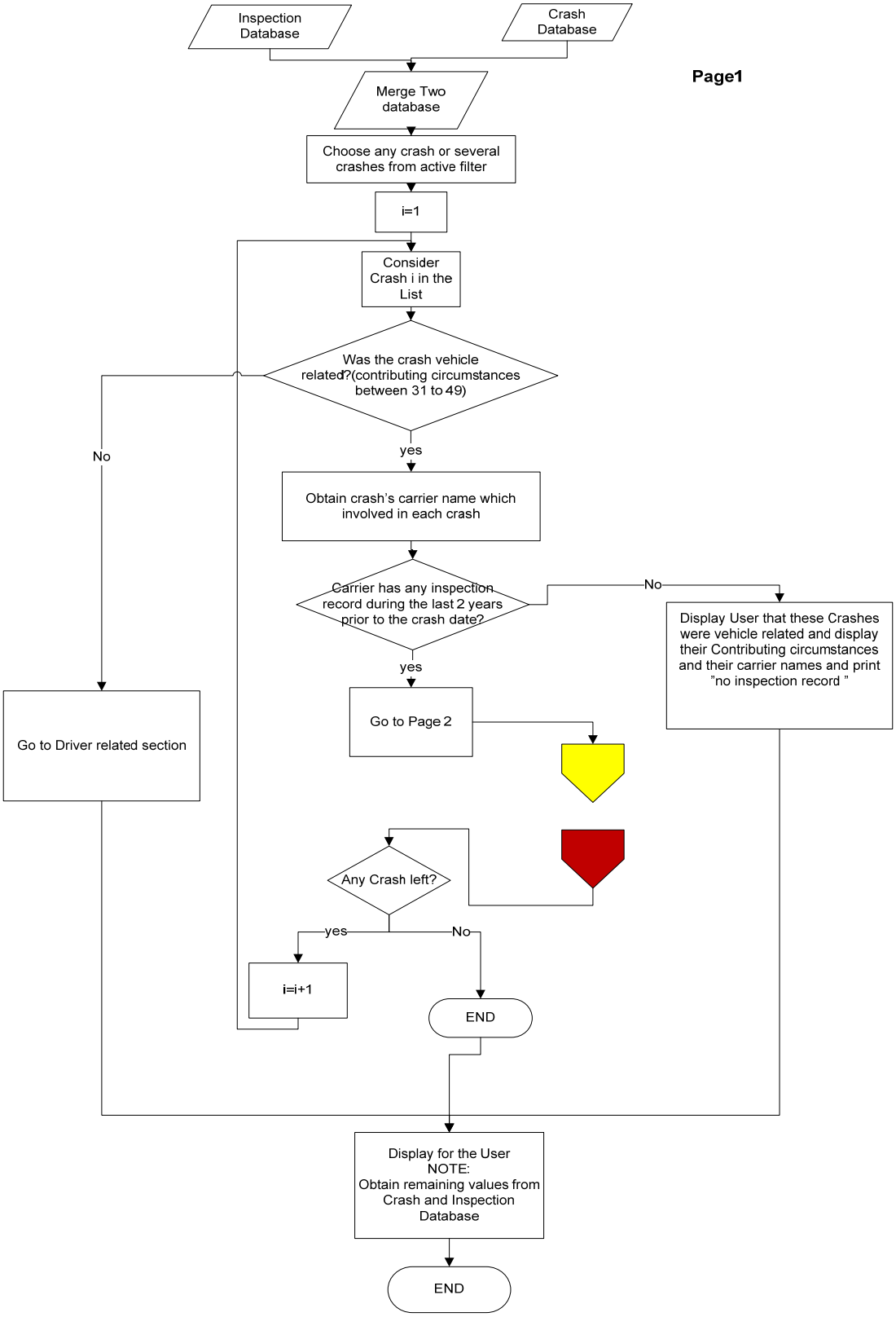
a time weight of 1. The time weighting assignment puts more emphasis on recent violations.

Implementation

The implementation procedure is as follows:

1. Probe through the contributed circumstances field in crash-vehicle table to define crashes recorded as vehicle-defect or vehicle-related crashes.
2. Find carriers assigned to those crashes. If the carrier has inspection records during the past 2 years prior to the crash date then proceed to the next step; otherwise the system gives a warning.
3. Categorize the carrier based on its number of vehicle relevant Inspections (Level 1, 2, 5 or 6). Thus, the carrier's safety posture (for vehicle maintenance) is compared with other carriers within its group.
4. Find all available inspection violation records with at least one vehicle maintenance violation recorded during the past 2 years prior to the crash date (defined in the filter) for all carriers in the group.
5. Calculate the vehicle maintenance measure for each carrier from the aforementioned equation.
6. Rank all the vehicle maintenance measures in an ascending order.
7. Transform the rank values into percentiles.
8. Highlight carriers have the percentile value higher than the threshold.

The implementation flow chart is demonstrated in the Figure 13.


Inspection Database
Crash Database
Page1
Merge Two database
Choose any crash or several crashes from active filter
i=1
Consider Crash i in the List
Was the crash vehicle related?(contributing circumstances between 31 to 49)
No
yes
Obtain crash's carrier name which involved in each crash
Carrier has any inspection record during the last 2 years prior to the crash date?
No
yes
Display User that these Crashes were vehicle related and display their Contributing circumstances and their carrier names and print "no inspection record "
Go to Page 2
Go to Driver related section
Any Crash left?
yes
No
i=i+1
END
Display for the User
NOTE:
Obtain remaining values from Crash and Inspection Database
END

Continued

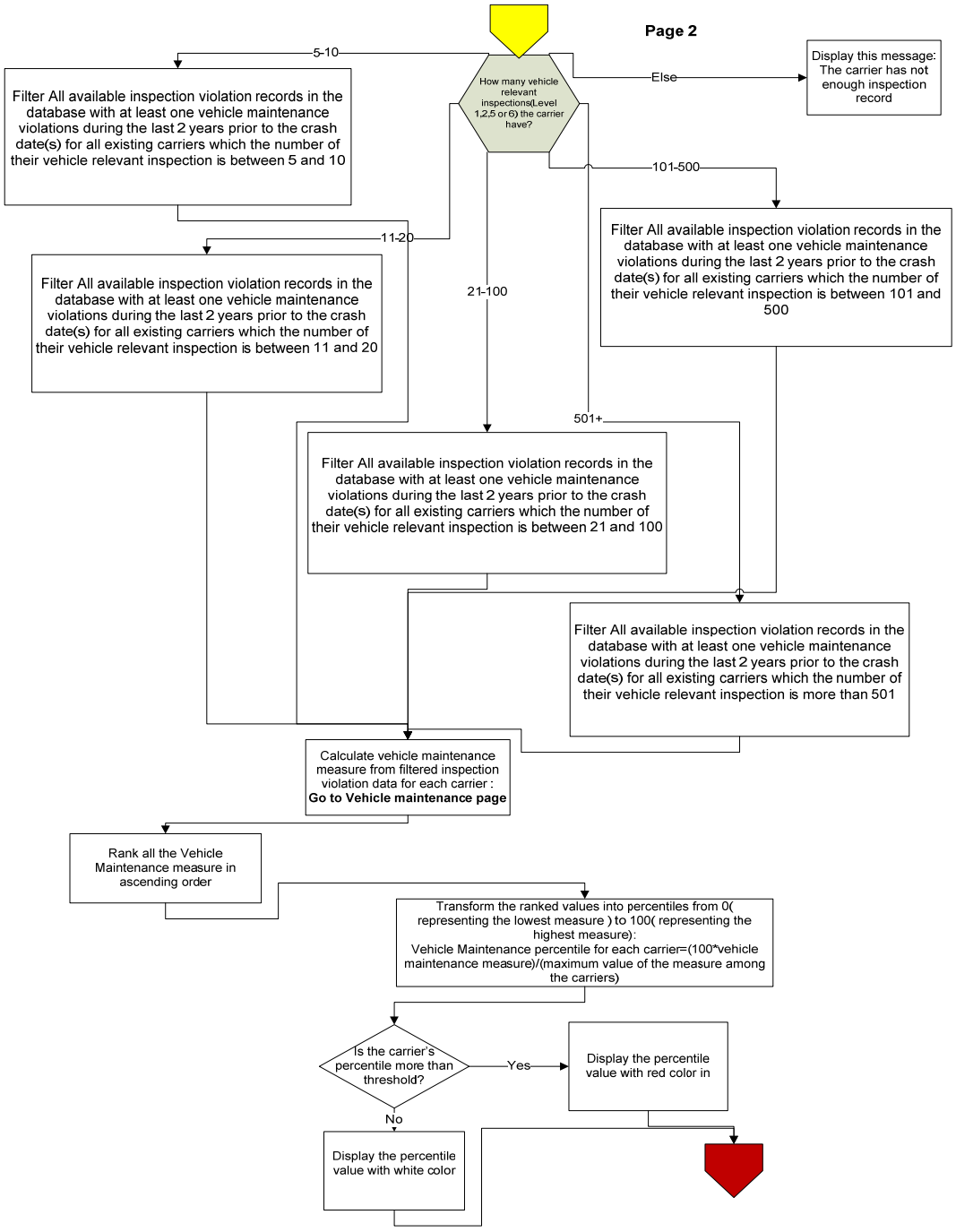


Figure 13 Vehicle Maintenance measure – Implementation procedure

Cargo-Related Measure

Methodology

The cargo-related measure is defined in CSA2010 as: Failure to properly prevent shifting loads, spilled or dropped cargo and unsafe handling of hazardous materials on a CMV. The examples of violations are: improper load securement, cargo retention, and hazardous material handling. Table 8 demonstrates a complete list of roadside inspection cargo-related violations used in Layer4 (Carrier safety measurement).

In this methodology, Inspection database (using vehicle-related violations recorded at SafetyNet) and crash database (using contributing circumstances and other relevant information such as crash date) were used to calculate the cargo-related measure per carrier based on the following equation. Upon this calculation, the percentile rank for a specific carrier is calculated by a comparison with other carriers' cargo-related violations categorized in that group.

$$\text{Cargo - Related Measure} = \frac{\text{Sum over violation (Time Weight * Severity Weight)}}{\text{Number of time weighted relevant inspections}}$$

Where,

Violation is defined as any violation recorded in any level of roadside inspections for cargo-related (Table 8) during the past 24 months prior to the crash date. In cases that multiple counts of the same violation are recorded, one violation is counted per inspection in one site.

Relevant Inspection is defined as any vehicle-related inspection in any level of inspection (Level 1, 2, 5 or 6).

Severity Weight is assigned to each violation from 1 (less severe) to 10 (most severe). Table 8 demonstrates these severity weights corresponded to each violation.

Time Weight is assigned to each violation based on the time elapsed between recorded violation and crash dates. Violations recorded during the past 6 months prior to the crash date receive a time weight of 3. Violations recorded within 6 to 12 months prior to the crash date receive a time weight of 2. All violations recorded older than 12 months (within 24 months prior to the crash date) receive

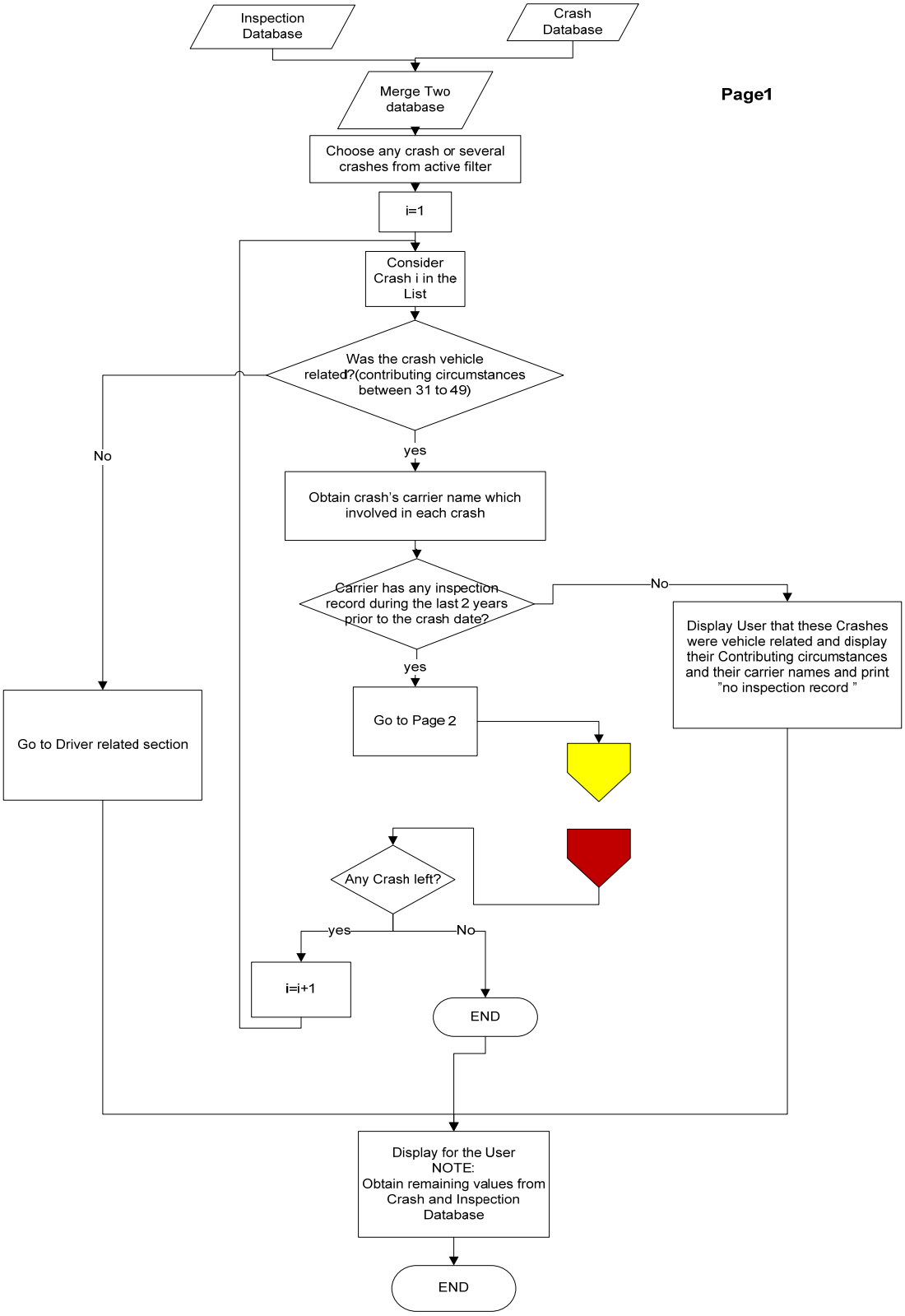
a time weight of 1. The time weighting assignment puts more emphasis on recent violations.

Implementation

The implementation procedure is as follows:

1. Probe through the contributed circumstances field in crash-vehicle table to define crashes recorded as vehicle-defect or vehicle-related crashes.
2. Find carriers assigned to those crashes. If the carrier has inspection records during the past 2 years prior to the crash date then proceed to the next step; otherwise the system gives a warning.
3. Categorize the carrier based on its number of vehicle relevant Inspections (Level 1, 2, 5 or 6). Thus, the carrier's safety posture (for cargo-related) is compared with other carriers within its group.
4. Find all available inspection violation records with at least one cargo-related violation recorded during the past 2 years prior to the crash date (defined in the filter) for all carriers in the group.
5. Calculate the cargo-related measure for each carrier from the aforementioned equation.
6. Rank all the cargo-related measures in an ascending order.
7. Transform the rank values into percentiles.
8. Highlight carriers have the percentile value higher than the threshold.

The implementation flow chart is demonstrated in the Figure 14.


Inspection Database
Crash Database
Merge Two database
Page1
Choose any crash or several crashes from active filter
i=1
Consider Crash i in the List
Was the crash vehicle related?(contributing circumstances between 31 to 49)
No
yes
Obtain crash's carrier name which involved in each crash
Carrier has any inspection record during the last 2 years prior to the crash date?
No
Display User that these Crashes were vehicle related and display their Contributing circumstances and their carrier names and print "no inspection record "
yes
Go to Page 2
Go to Driver related section
Any Crash left?
yes
No
i=i+1
END
Display for the User
NOTE:
Obtain remaining values from Crash and Inspection Database
END

Continued

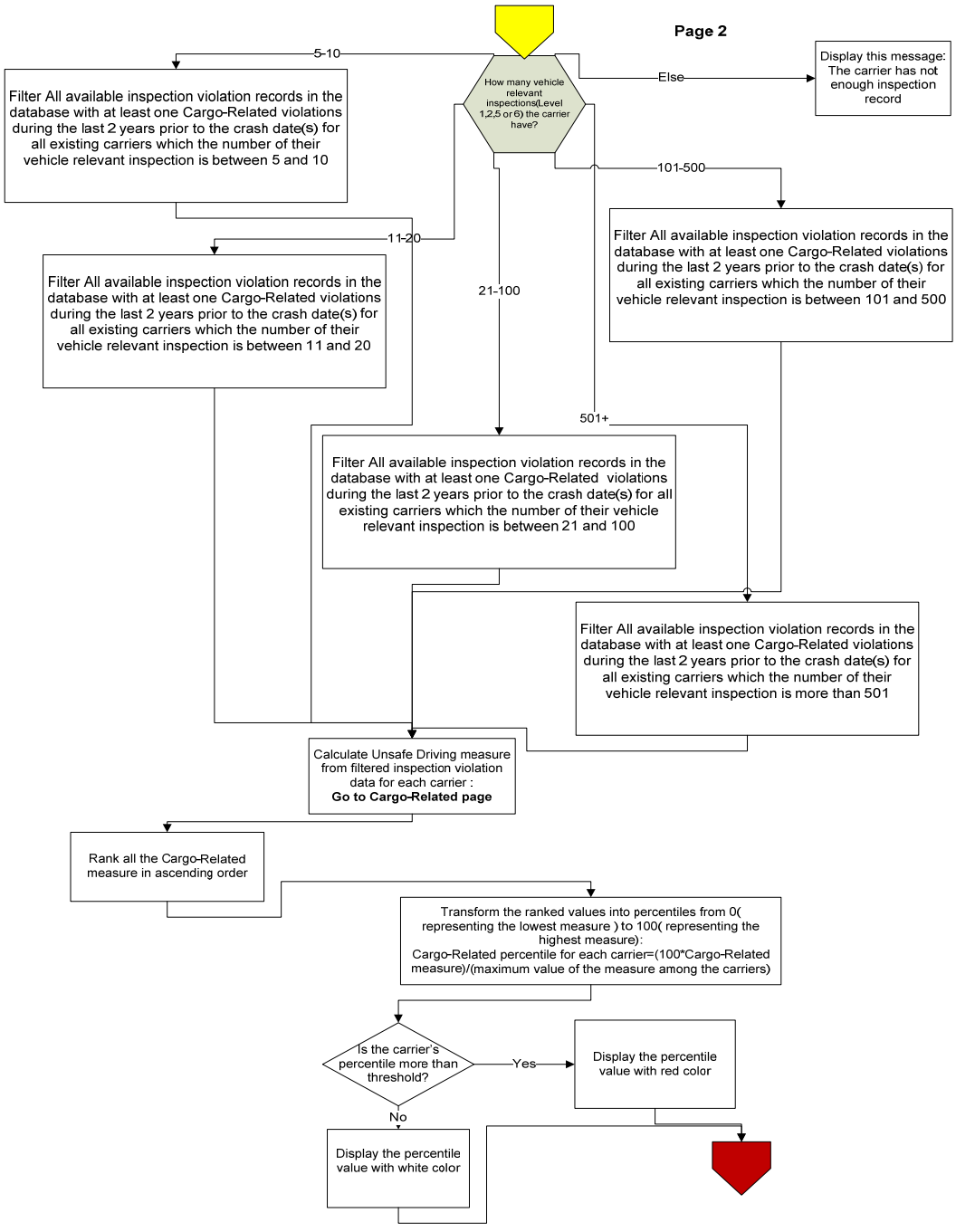


Figure 14 Cargo-Related measure – Implementation Procedure

Crash Severity Measure

Methodology

The crash severity measure is defined in CSA2010 as: History or pattern of high crash including frequency and severity derived from state crash reports. In this methodology, crash database and carrier size (Power Unit – PU) were used to calculate the crash severity measure per carrier based on the following equation. Upon this calculation, the percentile rank for a specific carrier is calculated by a comparison with other carriers' crash severity measure categorized in that group.

$$\text{Crash Severity per carrier} = \frac{\text{Sum over Crash (Time Weight} * \text{Severity Weight)}}{\text{Carriers Power Unit}}$$

Where,

Crash is considered as a reportable crash when one of the following conditions was occurred;

- one fatality
- one injury where the injured person was taken to a medical facility for immediate medical attention
- a vehicle was towed as a consequence of crash.

Crash Severity Weight assigns more weight on crashes with more severity. For example, a fatal or injury crashes are weighted more than a tow-away crashes. A hazmat release also increases the weighting of a crash, as shown in Table below:

Table 2 Crash Severity Weights

Crash Type	Crash Severity Weight
Involves tow-away but no injury or fatality	1
Involves injury or fatality	2
Involves a hazmat release	Crash Severity Weight (from above) + 1

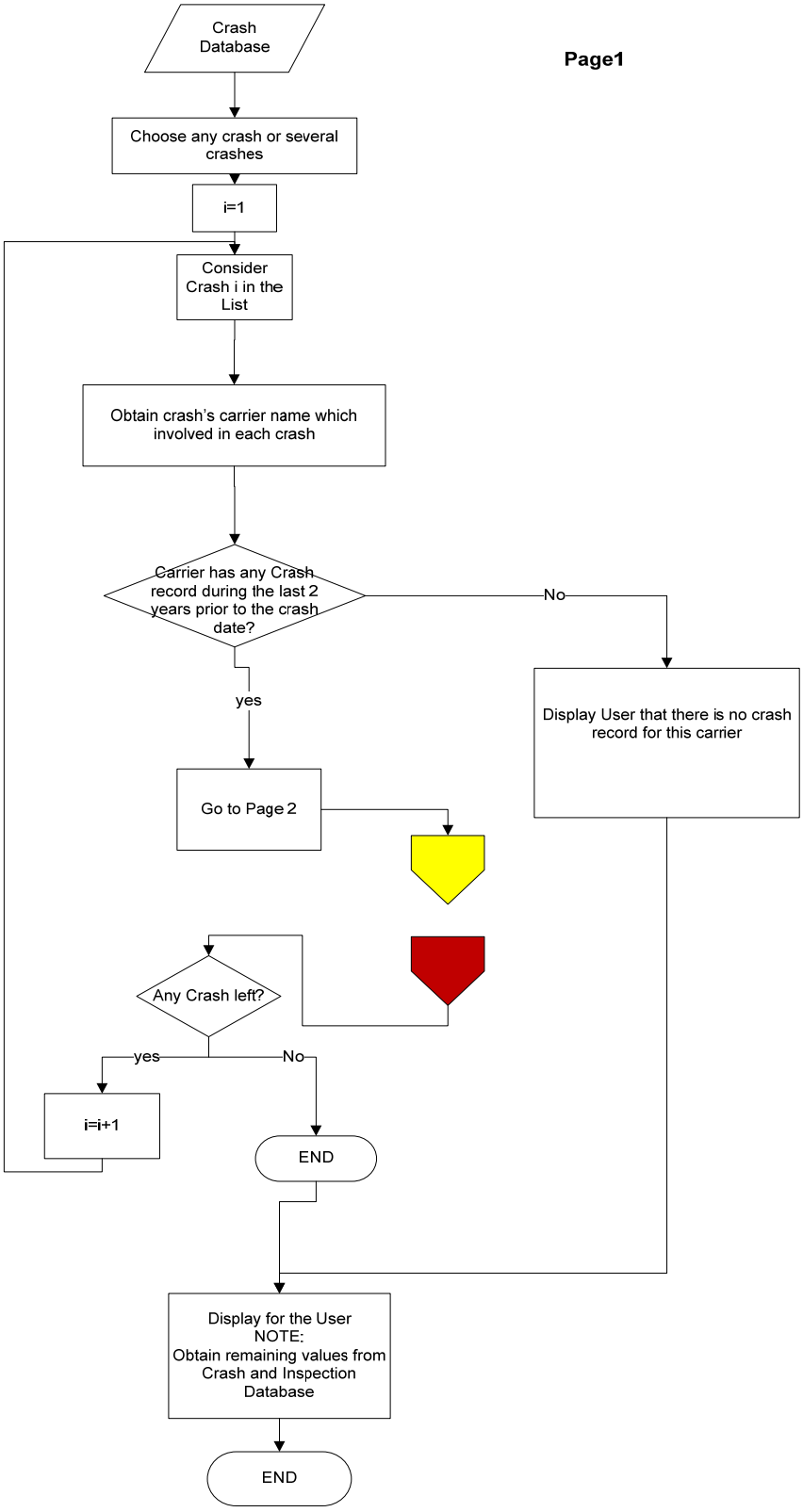
Time Weight is assigned to each crashes based on the time elapsed between recorded crashes and interested crash dates. Crashes recorded during the past 6 months prior to the interested crash date receive a time weight of 3. Crashes recorded within 6 to 12 months prior to the interested crash date receive a time weight of 2. All crashes recorded older than 12 months (within 24 months prior to the interested crash date) receive a time weight of 1. The time weighting assignment puts more emphasis on recent crashes.

Implementation

The implementation procedure is as follows:

1. Probe through the crash records. If the carrier has crash records during the past 2 years prior to the interested date then proceed to the next step; otherwise the system gives a warning.
2. Categorize the carrier based on its power units (PU). Thus, the carrier's safety posture (for unsafe driving measure) is compared with other carriers within its group.
3. Find all available crash records with at least one fatality, one injury, or tow-away recorded during the past 2 years prior to the crash date (defined in the filter) for all carriers in the group.
4. Calculate the crash severity measure for each carrier from the aforementioned equation.
5. Rank all the crash severity measures in an ascending order.
6. Transform the rank values into percentiles.
7. Highlight carriers have the percentile value higher than the threshold.

The implementation flow chart is demonstrated in the Figure 15.


Crash Database
Page1
Choose any crash or several crashes
i=1
Consider Crash i in the List
Obtain crash's carrier name which involved in each crash
Carrier has any Crash record during the last 2 years prior to the crash date?
No
yes
Display User that there is no crash record for this carrier
Go to Page 2
Any Crash left?
yes
No
i=i+1
END
Display for the User
NOTE:
Obtain remaining values from Crash and Inspection Database
END

Continued

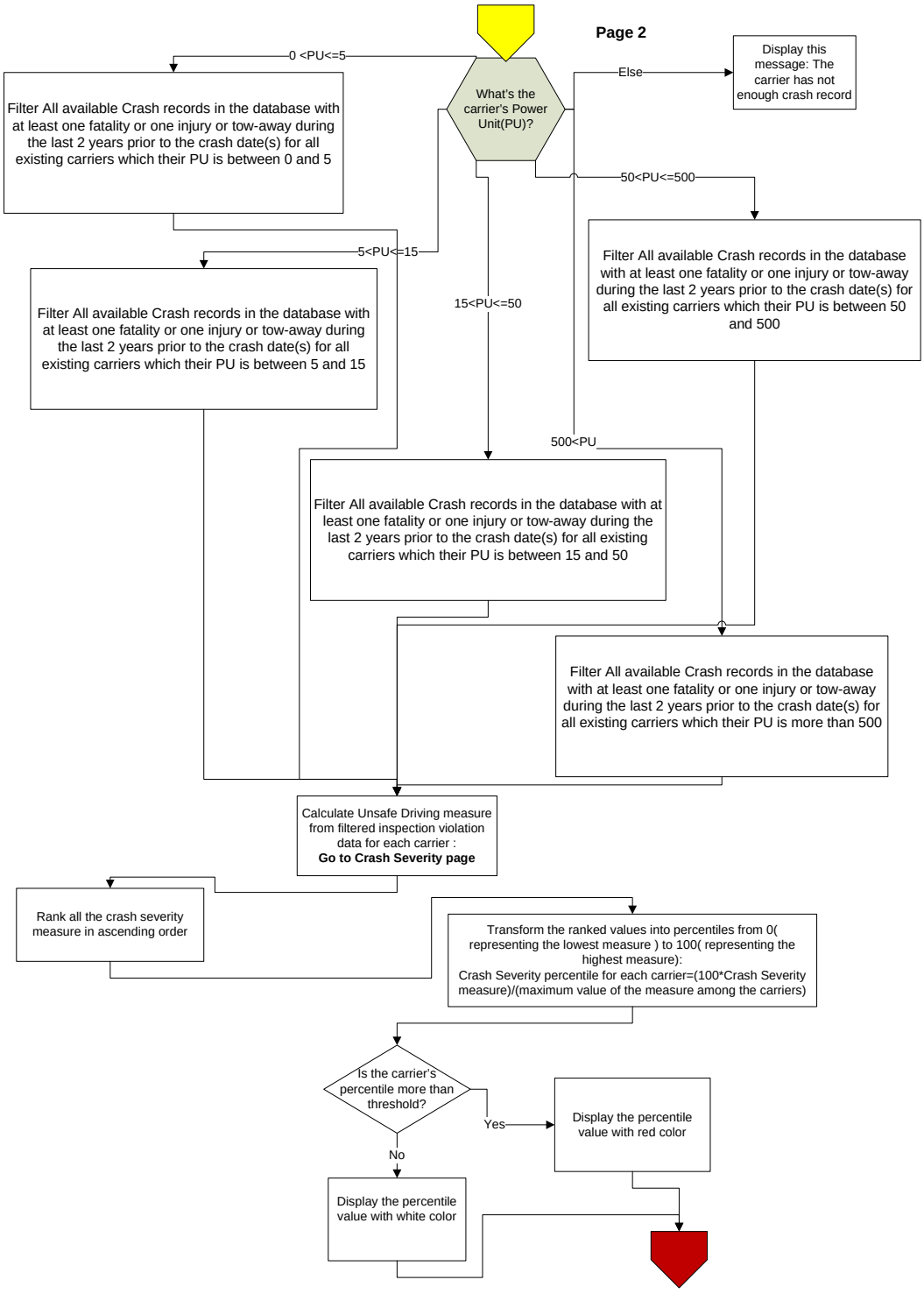


Figure 15 Crash Severity measure – Implementation procedure

Table 3 Unsafe Driving Violations

Section	Violation Description Shown on Driver/Vehicle Examination Report Given to CMV Driver after Roadside Inspection	Violation Group Description	Violation Severity Weight
177.800(d)	Unnecessary delay in HM transportation to destination	HM Related	1
390.17DT	Operating a CMV while texting	Texting	10
390.20	Failing to properly secure parked vehicle	Other Driver Violations	1
392.2C	Failure to obey traffic control device	Dangerous Driving	5
392.2DH	Headlamps - Failing to dim when required	Misc Violations	3
392.2FC	Following too close	Dangerous Driving	5
392.2LC	Improper lane change	Dangerous Driving	5
392.2LV	Lane Restriction violation	Misc Violations	3
392.2P	Improper passing	Dangerous Driving	5
392.2PK	Unlawfully parking and/or leaving vehicle in the roadway	Other Driver Violations	1
392.2R	Reckless driving	Reckless Driving	10
392.2RR	Railroad Grade Crossing violation	Dangerous Driving	5
392.2S	Speeding	Speeding Related	5
392.2-SLLS1	State/Local Laws - Speeding 1-5 miles per hour over the speed limit	Speeding 1	1
392.2-SLLS2	State/Local Laws - Speeding 6-10 miles per hour over the speed limit	Speeding 2	4
392.2-SLLS3	State/Local Laws - Speeding 11-14 miles per hour over the speed limit	Speeding 3	7
392.2-SLLS4	State/Local Laws - Speeding 15 or more miles per hour over the speed limit	Speeding 4	10
392.2-SLLSWZ	State/Local Laws - Speeding work/construction zone	Speeding 4	10
392.2-SLLT	State/Local Laws - Operating a CMV while texting	Texting	10
392.2T	Improper turns	Dangerous Driving	5
392.2Y	Failure to yield right of way	Dangerous Driving	5
392.6	Scheduling run to necessitate speeding	Speeding Related	5
392.10(a)(1)	Failing to stop at railroad crossing—bus	Dangerous Driving	5
392.10(a)(2)	Failing to stop at railroad crossing—chlorine	Dangerous Driving	5
392.10(a)(3)	Failing to stop at railroad crossing—placard	Dangerous Driving	5
392.10(a)(4)	Failing to stop at railroad crossing—HM cargo	Dangerous Driving	5
392.14	Failed to use caution for hazardous condition	Dangerous Driving	5
392.16	Failing to use seat belt while operating CMV	Seat Belt	7
392.22(a)	Failing to use hazard warning flashers	Other Driver Violations	1
392.60(a)	Unauthorized passenger on board CMV	Other Driver Violations	1
392.62	Unsafe bus operations	Other Driver Violations	1
392.62(a)	Bus—Standees forward of the standee line	Other Driver Violations	1
392.71(a)	Using or equipping a CMV with radar detector	Speeding Related	5
397.3	State/local laws ordinances regulations	HM Related	1
397.13	Smoking within 25 feet of HM vehicle	HM Related	1
398.4	Driving of vehicle—migrant workers	Other Driver Violations	1

Table 4 Fatigued Driving (HOS) Violations

Section	Violation Description Shown on Driver/Vehicle Examination Report Given to CMV Driver after Roadside Inspection	Violation Group Description	Violation Severity Weight
392.2H	State/Local Hours of Service (HOS)	Hours	7
392.3	Operating a CMV while ill/fatigued	Jumping OOS/Driving Fatigued	10
395.1(h)(1)	15, 20, 70/80 HOS violations (Alaska-Property)	Hours	7
395.1(h)(2)	15, 20, 70/80 HOS violations (Alaska-Passenger)	Hours	7
395.1(h)(3)	Adverse driving conditions violations (Alaska)	Hours	7
395.1(o)	16 hour rule violation (Property)	Hours	7
395.3(a)(1)	Requiring or permitting driver to drive more than 11 hours	Hours	7
395.3A1R	11 hour rule violation (Property)	Hours	7
395.3(a)(2)	Requiring or permitting driver to drive after 14 hours on duty	Hours	7
395.3A2R	14 hour rule violation (Property)	Hours	7
395.3(b)	60/70- hour rule violation	Hours	7
395.3BR	60/70 hour rule violation (Property)	Hours	7
395.3(c)	34- hour restart violation (Property)	Hours	7
395.5(a)(1)	10- hour rule violation (Passenger)	Hours	7
395.5(a)(2)	15- hour rule violation (Passenger)	Hours	7
395.5(b)	60/70- hour rule violation (Passenger)	Hours	7
395.8	Log violation (general/form and manner)	Other Log/Form & Manner	2
395.8(a)	No drivers record of duty status	Incomplete/Wrong Log	5
395.8(e)	False report of drivers record of duty status	False Log	7
395.8(f)(1)	Drivers record of duty status not current	Incomplete/Wrong Log	5
395.8(k)(2)	Driver failing to retain previous 7 days' logs	Incomplete/Wrong Log	5
395.13(d)	Driving after being declared out-of-service	Jumping OOS/Driving Fatigued	10
395.15(b)	Onboard recording device information requirements not met	EOBR Related	1
395.15(c)	Onboard recording device improper form and manner	EOBR Related	1
395.15(f)	Onboard recording device failure and driver failure to reconstruct duty status	EOBR Related	1
395.15(g)	On-board recording device information not available	EOBR Related	1
395.15(i)(5)	Onboard recording device does not display required information.	EOBR Related	1
398.6	Violation of hours of service regulations—migrant workers	Hours	7

Table 5 Driver Fitness Violations

Section	Violation Description Shown on Driver/Vehicle Examination Report Given to CMV Driver after Roadside Inspection	Violation Group Description	Violation Severity Weight
177.816	Driver training requirements	General Driver Qualification	4
383.21	Operating a CMV with more than one driver's license	License-related	8
383.21(a)	Operating a CMV with more than one driver's license†	License-related	8
383.23(a)(2)	Operating a CMV without a CDL	License-related	8
383.23(c)	Operating on learner's permit without CDL holder	License-related	8
383.23(c)(1)	Operating on learner's permit without CDL holder	License-related	8
383.23(c)(2)	Operating on learner's permit without valid driver's license	License-related	8
383.51(a)	Driving a CMV (CDL) while disqualified	License-related	8
383.91(a)	Operating a CMV with improper CDL group	License-related	8
383.93(b)(1)	No double/triple trailer endorsement on CDL	License-related	8
383.93(b)(2)	No passenger vehicle endorsement on CDL	License-related	8
383.93(b)(3)	No tank vehicle endorsement on CDL	License-related	8
383.93(b)(4)	No hazardous materials endorsement on CDL	License-related	8
383.93(b)(5)	No school bus endorsement on CDL	License-related	8
383.93B5LCDL	License (CDL) - Operating a school bus without a school bus endorsement as described in 383.93(b)(5)	License-related	8
383.95(a)	Violating airbrake restriction	License-related	8
386.72(b)	Failing to comply with Imminent Hazard OOS Order	Fitness/ Jumping OOS	10
391.11	Unqualified driver	License-related	8
391.11(b)(1)	Interstate driver under 21 years of age	General Driver Qualification	4
391.11(b)(2)	Non-English speaking driver	General Driver Qualification	4
391.11B2S	Driver must be able to understand highway traffic signs and signals in the English language	General Driver Qualification	4
391.11(b)(4)	Driver lacking physical qualification(s)	Physical	2
391.11(b)(5)	Driver lacking valid license for type vehicle being operated	License-related	8
391.11(b)(7)	Driver disqualified from operating CMV	License-related	8
391.15(a)	Driving a CMV while disqualified	License-related	8
391.41(a)	Driver not in possession of medical certificate	Medical Certificate	1
391.43(h)	Improper medical examiners certificate form	Medical Certificate	1
391.45(b)	Expired medical examiner's certificate	Medical Certificate	1
391.49(j)	No valid medical waiver in driver's possession	Medical Certificate	1
398.3(b)	Driver not physically qualified	Physical	2
398.3(b)(8)	No doctor's certificate in possession	Medical Certificate	1

Table 6 Controlled Substances/Alcohol Violations

Section	Violation Description	Violation Group Description	Violation Severity Weight
392.5(c)(2)	Violating OOS order pursuant to 392.5(a)/(b)	Alcohol Jumping OOS	10
392.4(a)	Driver uses or is in possession of drugs	Drugs	10
392.5(a)	Possession/use/under influence alcohol-4hrs prior to duty	Alcohol	5

Table 7 Vehicle Maintenance Violations

Section	Violation Description Shown on Driver/Vehicle Examination Report Given to CMV Driver after Roadside Inspection	Violation Group Description	Violation Severity Weight[2]
365.511	Fail to display current CVSA Decal: Permanent Authority	Inspection Reports	4
374.313(a)	Failure to maintain a reasonable temperature	Cab, Body, Frame	2
374.313(b)	Bus - Failure to maintain restroom	Cab, Body, Frame	2
374.313(c)	Bus - Not maintained in clean working order	Cab, Body, Frame	2
385.103(c)	Fail to display current CVSA decal- Provisional Authority	Inspection Reports	4
392.2WC	Wheel (Mud) Flaps missing or defective	Windshield /Glass /Markings	1
392.7	No pre-trip inspection	Inspection Reports	4
392.7(a)	Driver failing to conduct pre-trip inspection	Inspection Reports	4
392.7(b)	Driver failing to conduct a pre-trip inspection of Intermodal Equipment	Inspection Reports	4
392.8	Failing to inspect/use emergency equipment	Emergency Equipment	2
392.22(b)	Failing/improper placement of warning devices	Cab, Body, Frame	2
392.33	Operating CMV with lamps/reflectors obscured	Lighting	6
393.9(a)	Inoperative required lamps	Clearance Identification Lamps/Other	2
393.9H	Inoperative head lamps	Lighting	6
393.9T	Inoperative tail lamp	Lighting	6
393.9TS	Inoperative turn signal	Lighting	6
393.11	No/defective lighting devices/reflective devices/projected	Reflective Sheeting	3
393.11LR	Lower retro reflective sheeting/reflex reflectors manufactured on or after 12/1/1993	Reflective Sheeting	3
393.11N	No retro reflective sheeting/reflex reflectors manufactured on or after 12/1/1993	Reflective Sheeting	3
393.11RT	Retro reflective not affixed as required Trailer manufactured on or after 12/1/1993	Reflective Sheeting	3
393.11S	Side retro reflective sheeting/reflex reflectors manufactured on or after 12/1/1993	Reflective Sheeting	3
393.11TL	Truck Tractor manufactured on or after 7/1/1997 with no retro reflective sheeting or reflex reflectors on mud flaps	Reflective Sheeting	3
393.11TT	Truck Tractor no retro reflective sheeting/reflex reflectors manufactured on or after 7/1/1997	Reflective Sheeting	3
393.11TU	Truck Tractor upper body corners retro reflective sheeting/reflex manufactured on or after 7/1/1997	Reflective Sheeting	3
393.11UR	Upper reflex reflectors retro reflective sheeting/reflex reflectors manufactured on or after 12/1/1993	Reflective Sheeting	3

393.13(a)	Retro reflective tape not affixed; Trailer manufactured before 12//1/1993	Reflective Sheeting	3
393.13(b)	No retro reflective sheeting/reflex reflectors manufactured on or after 12/1/1993	Reflective Sheeting	3
393.13(c)(1)	Side retro reflective sheeting/reflex reflectors manufactured on or before 12/1/1993	Reflective Sheeting	3
393.13(c)(2)	Lower retro reflective sheeting/reflex reflectors manufactured on or before 12/1/1993	Reflective Sheeting	3
393.13(c)(3)	Upper retro reflective sheeting/reflex reflectors manufactured on or before 12/1/1993	Reflective Sheeting	3
393.13(d)(1)	Side retro reflective sheeting/reflex reflectors manufactured on or after 12/1/1993	Reflective Sheeting	3
393.13(d)(2)	Lower rear retro reflective sheeting/reflex reflectors manufactured on or after 12/1/1993	Reflective Sheeting	3
393.13(d)(3)	Upper rear retro reflective sheeting/reflex reflectors manufactured on or after 12/1/1993	Reflective Sheeting	3
393.17	No/defective lamp/reflector-tow-away operation	Lighting	6
393.17(a)	No/defective lamps-towing unit-tow-away operation	Lighting	6
393.17(b)	No/defective tow-away lamps on rear unit	Lighting	6
393.19	Inoperative/defective hazard warning lamp	Lighting	6
393.23	Required lamp not powered by vehicle electricity	Clearance Identification Lamps/Other	2
393.24(a)	Non-compliance with headlamp requirements	Lighting	6
393.24(b)	Non-compliant fog/driving lamps	Lighting	6
393.24BR	Non-compliant fog or driving lamps	Lighting	6
393.24(c)	Improper headlamp mounting	Lighting	6
393.24(d)	Improper head / auxiliary / fog lamp aiming	Lighting	6
393.25(a)	Improper lamp mounting	Lighting	6
393.25(b)	Lamps are not visible as required	Lighting	6
393.25(e)	Lamp not steady burning	Lighting	6
393.25(f)	Stop lamp violations	Lighting	6
393.26	Requirements for reflectors	Reflective Sheeting	3
393.28	Improper or no wiring protection as required	Other Vehicle Defect	3
393.30	Improper battery installation	Other Vehicle Defect	3
393.40	Inadequate brake system on a CMV	Brakes, All Others	4
393.41	No or defective parking brake system on CMV	Brakes, All Others	4
393.42	No brakes as required	Brakes, All Others	4
393.43	No/improper breakaway or emergency braking	Brakes, All Others	4
393.43(a)	No/improper tractor protection valve	Brakes, All Others	4
393.43(d)	No or defective automatic trailer brake	Brakes, All Others	4
393.44	No/defective bus front brake line protection	Brakes, All Others	4
393.45	Brake tubing and hose adequacy	Brakes, All Others	4
393.45(a)(4)	Failing to secure brake hose/tubing against mechanical damage	Brakes, All Others	4
393.45(b)(2)	Failing to secure brake hose/tubing against mechanical damage	Brakes, All Others	4
393.45(b)(3)	Failing to secure brake hose/tubing against high temperatures	Brakes, All Others	4
393.45(d)	Brake connections with leaks/constrictions	Brakes, All Others	4
393.47	Inadequate/contaminated brake linings	Brakes, All Others	4
393.47(a)	Inadequate brakes for safe stopping	Brakes, All Others	4
393.47(b)	Mismatched brake chambers on same axle	Brakes, All Others	4
393.47(c)	Mismatched slack adjuster effective length	Brakes, All Others	4
393.47(d)	Insufficient brake linings	Brakes, All Others	4

393.47(e)	Clamp/Roto-Chamber type brake(s) out of adjustment	Brakes Out of Adjustment	4
393.47(f)	Wedge type brake(s) out of adjustment	Brakes Out of Adjustment	4
393.47(g)	Insufficient drum/rotor thickness	Brakes, All Others	4
393.48(a)	Inoperative/defective brakes	Brakes, All Others	4
393.48(b)(1)	Defective brake limiting device	Brakes, All Others	4
393.50	Inadequate reservoir for air/vacuum brakes	Brakes, All Others	4
393.50(a)	Failing to have sufficient air/vacuum reserve	Brakes, All Others	4
393.50(b)	Failing to equip vehicle-prevent reservoir air/vacuum leak	Brakes, All Others	4
393.50(c)	No means to ensure operable check valve	Brakes, All Others	4
393.50(d)	No or defective air reservoir drain valve	Brakes, All Others	4
393.51	No or defective brake warning device	Brakes, All Others	4
393.52(a)(1)	Insufficient braking force as percent of GVW or GCW	Brakes, All Others	4
393.53(a)	Automatic brake adjuster CMV manufactured on or after 10/20/1993- hydraulic brake	Brakes, All Others	4
393.53(b)	Automatic brake adjuster CMV manufactured on or after 10/20/1994- air brake	Brakes, All Others	4
393.53(c)	Brake adjustment indicator CMV manufactured on or after 10/20/1994- external automatic adjustment	Brakes, All Others	4
393.55(a)	ABS- all CMVs manufactured on or after 3/1/1999 with hydraulic brakes	Brakes, All Others	4
393.55(b)	ABS- malfunction indicators for hydraulic brake system	Brakes, All Others	4
393.55(c)(1)	ABS- all tractors manufactured on or after 3/1/1997 air brake system	Brakes, All Others	4
393.55(c)(2)	ABS- all other CMVs manufactured on or after 3/1/1998 air brake system	Brakes, All Others	4
393.55(d)(1)	ABS- malfunctioning circuit/signal manufactured on or after 3/1/1997, single-unit CMV manufactured on or after 3/1/1998	Brakes, All Others	4
393.55(d)(2)	ABS- malfunctioning indicator to cab of towing CMV manufactured on or after 3/1/2001	Brakes, All Others	4
393.55(d)(3)	ABS- malfunctioning indicator connection from towed CMV manufactured on or after 3/1/2001	Brakes, All Others	4
393.55(e)	ABS- malfunctioning lamps towed CMV manufactured on or after 3/1/1998, manufactured before 3/1/2009	Brakes, All Others	4
393.60(b)	Windshields required	Windshield/ Glass/ Markings	1
393.60(c)	Damaged or discolored windshield	Windshield/ Glass/ Markings	1
393.60(d)	Glazing permits less than 70 percent of light	Windshield/ Glass/ Markings	1
393.60EWS	Windshield - Obstructed	Windshield/ Glass/ Markings	1
393.61	Inadequate or missing truck side windows	Windshield/ Glass/ Markings	1
393.61(a)	Inadequate or missing truck side windows	Windshield/ Glass/ Markings	1
393.61(b)(2)	Emergency exit window handle broken †	Windshield/ Glass/ Markings	1
393.62(a)	No or defective bus emergency exits, manufactured on or after 9/1/1994	Windshield/ Glass/ Markings	1
393.62(b)	No or defective bus emergency exits, manufactured on or after 9/1/1973 but before 9/1/1994	Windshield/ Glass/ Markings	1
393.62(c)	No or defective bus emergency exit windows, manufactured before 9/1/1973	Windshield/ Glass/ Markings	1
393.62(d)	No / defective Safety glass/push-out window	Windshield/ Glass/	1

		Markings	
393.62(e)	No or inadequate bus emergency exit marking	Windshield/ Glass/ Markings	1
393.65	Fuel system requirements	Fuel Systems	1
393.65(b)	Improper location of fuel system	Fuel Systems	1
393.65(c)	Improper securement of fuel tank	Fuel Systems	1
393.65(f)	Improper fuel line protection	Fuel Systems	1
393.67	Fuel tank requirement violations	Fuel Systems	1
393.67(c)(7)	Fuel tank fill pipe cap missing	Fuel Systems	1
393.67(c)(8)	Improper fuel tank safety vent	Fuel Systems	1
393.68	Compressed Natural Gas (CNG) Fuel Container does not conform to regulations	Other Vehicle Defect	3
393.70	Fifth wheel	Coupling Devices	3
393.70(a)	Defective coupling device-improper tracking	Coupling Devices	3
393.70(b)	Defective/improper fifth wheel assemblies	Coupling Devices	3
393.70(b)(2)	Defective fifth wheel locking mechanism	Coupling Devices	3
393.70(c)	Defective coupling devices for full trailer	Coupling Devices	3
393.70(d)	No/improper safety chains/cables for full trailer	Coupling Devices	3
393.70(d)(8)	Improper safety chain attachment	Coupling Devices	3
393.71	Improper coupling driveaway/tow-away operation	Coupling Devices	3
393.71(g)	Prohibited towing connection / device	Coupling Devices	3
393.71(h)	Towbar requirement violations	Coupling Devices	3
393.71(h)(10)	No/improper safety chains/cables for towbar	Coupling Devices	3
393.75	Tires/tubes (general)	Tires	8
393.75(a)	Flat tire or fabric exposed	Tires	8
393.75(a)(1)	Tire-ply or belt material exposed	Tires	8
393.75(a)(2)	Tire-tread and/or sidewall separation	Tires	8
393.75(a)(3)	Tire-flat and/or audible air leak	Tires	8
393.75(a)(4)	Tire-cut exposing ply and/or belt material	Tires	8
393.75(b)	Tire-front tread depth less than 4/32 of inch	Tires	8
393.75(c)	Tire-other tread depth less than 2/32 of inch	Tires	8
393.75(d)	Tire-bus regrooved/recap on front wheel	Tires	8
393.75(e)	Tire-regrooved on front of truck/truck-tractor	Tire vs. Load	3
393.75(f)	Tire-load weight rating/under inflated	Tire vs. Load	3
393.75(f)(1)	Weight carried exceeds tire load limit †	Tire vs. Load	3
393.75(f)(2)	Tire under-inflated †	Tire vs. Load	3
393.75(h)	Tire under-inflated	Tire vs. Load	3
393.76	Sleeper berth requirement violations	Other Vehicle Defect	3
393.77	Defective and/or prohibited heaters	Other Vehicle Defect	3
393.77(b)(5)	Protection of operating controls from tampering	Other Vehicle Defect	3
393.77(b)(11)	Bus heater fuel tank location	Other Vehicle Defect	3
393.78	Windshield wipers inoperative/defective	Windshield/ Glass/ Markings	1
393.79	Defroster / Defogger inoperative	Windshield/ Glass/ Markings	1
393.80	Failing to equip vehicle with two rear vision mirrors	Other Vehicle Defect	3
393.81	Horn inoperative	Other Vehicle Defect	3
393.82	Speedometer inoperative / inadequate	Other Vehicle Defect	3
393.83(a)	Exhaust system location	Exhaust Discharge	1

393.83(b)	Exhaust discharge fuel tank/filler tube	Exhaust Discharge	1
393.83(c)	Improper exhaust-bus (gasoline)	Exhaust Discharge	1
393.83(d)	Improper exhaust-bus (diesel)	Exhaust Discharge	1
393.83(e)	Improper exhaust discharge (not rear of cab)	Exhaust Discharge	1
393.83(f)	Improper exhaust system repair (patch/wrap)	Exhaust Discharge	1
393.83(g)	Exhaust leak under truck cab and/or sleeper	Exhaust Discharge	1
393.83(h)	Exhaust system not securely fastened	Exhaust Discharge	1
393.84	Inadequate floor condition	Cab, Body, Frame	2
393.86	No or improper rearend protection	Cab, Body, Frame	2
393.86(a)(1)	Rear impact guards-all trailers/semitrailers manufactured on or after 1/26/98	Cab, Body, Frame	2
393.86(a)(2)	Impact guard width- all trailers/semitrailers manufactured on or after 1/26/98	Cab, Body, Frame	2
393.86(a)(3)	Impact guard height- all trailers/semitrailers manufactured on or after 1/26/98	Cab, Body, Frame	2
393.86(a)(4)	Impact guard rear- all trailers/semitrailers manufactured on or after 1/26/98	Cab, Body, Frame	2
393.86(a)(5)	Cross-sectional vertical height- all trailers/semitrailers manufactured on or after 1/26/98	Cab, Body, Frame	2
393.86(b)(1)	Rear Impact Guards- motor vehicle manufactured on or after 12/31/52, see exceptions	Cab, Body, Frame	2
393.88	Improperly located television receiver	Cab, Body, Frame	2
393.89	Bus driveshaft not properly protected	Cab, Body, Frame	2
393.90	Bus-no or obscure standee line	Cab, Body, Frame	2
393.91	Bus-improper aisle seats	Cab, Body, Frame	2
393.93(a)	Bus-not equipped with seat belt	Cab, Body, Frame	2
393.93(a)(3)	Seats not secured in conformance with FMVSS	Cab, Body, Frame	2
393.93(b)	Truck not equipped with seat belt	Cab, Body, Frame	2
393.95(a)	No/discharged/unsecured fire extinguisher	Emergency Equipment	2
393.95(a)(1)(i)	No/discharged/unsecured fire extinguisher	Emergency Equipment	2
393.95(b)	No spare fuses as required	Emergency Equipment	2
393.95(c)	No spare fuses as required	Emergency Equipment	2
393.95(f)	No / insufficient warning devices	Emergency Equipment	2
393.95(g)	HM-restricted emergency warning device	Emergency Equipment	2
393.201(a)	Frame cracked / loose / sagging / broken	Cab, Body, Frame	2
393.201(b)	Bolts securing cab broken/loose/missing	Cab, Body, Frame	2
393.201(c)	Frame rail flange improperly bent/cut/notched	Cab, Body, Frame	2
393.201(d)	Frame accessories improperly attached	Cab, Body, Frame	2
393.201(e)	Prohibited holes drilled in frame rail flange	Cab, Body, Frame	2
393.203	Cab/body parts requirements violations	Cab, Body, Frame	2
393.203(a)	Cab door missing/broken	Cab, Body, Frame	2
393.203(b)	Cab/body improperly secured to frame	Cab, Body, Frame	2
393.203(c)	Hood not securely fastened	Cab, Body, Frame	2
393.203(d)	Cab seats not securely mounted	Cab, Body, Frame	2
393.203(e)	Cab front bumper missing/ unsecured/ protrude	Cab, Body, Frame	2
393.205(a)	Wheel/rim cracked or broken	Wheels, Studs, Clamps, Etc.	2
393.205(b)	Stud/bolt holes elongated on wheels	Wheels, Studs, Clamps, Etc.	2
393.205(c)	Wheel fasteners loose and/or missing	Wheels, Studs, Clamps, Etc.	2

393.207(a)	Axle positioning parts defective/missing	Suspension	7
393.207(b)	Adjustable axle locking pin missing/disengaged	Suspension	7
393.207(c)	Leaf spring assembly defective/missing	Suspension	7
393.207(d)	Coil spring cracked and/or broken	Suspension	7
393.207(e)	Torsion bar cracked and/or broken	Suspension	7
393.207(f)	Air suspension pressure loss	Suspension	7
393.207(g)	No/defective air suspension exhaust control	Suspension	7
393.209(a)	Steering wheel not secured/broken	Steering Mechanism	6
393.209(b)	Excessive steering wheel lash	Steering Mechanism	6
393.209(c)	Loose steering column	Steering Mechanism	6
393.209(d)	Steering system components worn/welded/missing	Steering Mechanism	6
393.209(e)	Power steering violations	Steering Mechanism	6
396.1	Must have knowledge of and comply with regulations	Inspection Reports	4
396.3(a)(1)	Inspection/repair and maintenance parts and accessories	Wheels, Studs, Clamps, Etc.	2
396.3A1B	Brakes (general)	Brakes, All Others	4
396.3A1BA	Brake out of adjustment	Brakes Out of Adjustment	4
396.3A1BC	Brake-air compressor violation	Brakes, All Others	4
396.3A1BD	Brake-defective brake drum	Brakes, All Others	4
396.3A1BL	Brake-reserve system pressure loss	Brakes, All Others	4
396.3A1T	Tires (general)	Tires	8
396.5	Excessive oil leaks†	Other Vehicle Defect	3
396.5(a)	Failing to ensure that vehicle is properly lubricated	Other Vehicle Defect	3
396.5(b)	Oil and/or grease leak	Other Vehicle Defect	3
396.7	Unsafe operations forbidden	Other Vehicle Defect	3
396.9(c)(2)	Operating an OOS vehicle	Vehicle Jumping OOS	10
396.9(d)(2)	Failure to correct defects noted on inspection report	Inspection Reports	4
396.11	No or inadequate driver vehicle inspection report	Inspection Reports	4
396.13(c)	No reviewing driver's signature on Driver Vehicle Inspection Report (DVIR)	Inspection Reports	4
396.17(c)	Operating a CMV without periodic inspection	Inspection Reports	4
398.5	Parts/access-migrant workers	Other Vehicle Defect	3
398.7	Inspect/maintain motor vehicle-migrant workers	Inspection Reports	4
399.207	Vehicle access requirements violations	Cab, Body, Frame	2
399.211	Inadequate maintenance of driver access	Cab, Body, Frame	2

Table 8 Cargo-Related Violations

Section	Violation Description Shown on Driver/Vehicle Examination Report Given to CMV Driver after Roadside Inspection	Violation Group Description	Violation Severity Weight
171.2(a)	Failure to comply with HM regulations	HM Other	2
171.2(b)	Failure to comply with the requirements for HM transportation (including labeling and handling)	HM Other	2
171.2(c)	Representing a package./container for HM not meeting specs	Markings - HM	5
171.2(d)	Accepting HM without registering with PHMSA	Documentation - HM	3
171.2(f)	Transporting HM not in accordance with this part	Fraudulent Behavior - HM	5
171.2(g)	Cargo tank does not comply with HM Regulations	Fraudulent Behavior - HM	5
171.2(k)	Representing vehicle with HM, none present	Fraudulent Behavior - HM	5
172.301(a)	No ID number on side/ends of non-bulk package - large quantity of single HM	Markings - HM	5
172.301(a)(1)	No proper shipping name and/or ID# marking on non-bulk	Markings - HM	5
172.301(b)	No technical name on non-bulk	Documentation - HM	3
172.301(c)	No special permit number on non-bulk package	Documentation - HM	3
172.301(d)	No consignee/consignor on non-bulk	Documentation - HM	3
172.302(a)	No ID number (portable and cargo tank)	Markings - HM	5
172.302(b)	Bulk package marking incorrect size	Markings - HM	5
172.302(c)	No special permit number on bulk package	Documentation - HM	3
172.303(a)	Prohibited HM marking on package	Markings - HM	5
172.304(a)(1)	Package marking not durable, English, or print	Markings - HM	5
172.304(a)(2)	Marking not on sharply contrasting color	Markings - HM	5
172.304(a)(3)	Marking obscured by label or attachments	Markings - HM	5
172.304(a)(4)	Marking not away from other marking	Markings - HM	5
172.310(a)	No gross weight on radioactive materials package greater than 50 KG	Markings - HM	5
172.310(b)	Radioactive materials package not marked "Type A or B"	Markings - HM	5
172.312(a)	No package orientation arrows	Cargo Protection - HM	4
172.312(a)(2)	No package orientation arrows	Cargo Protection - HM	4
172.312(b)	Prohibited use of orientation arrows	Cargo Protection - HM	4
172.313(a)	No "inhalation hazard" on package	Markings - HM	5
172.313(b)	No "poison" on non-bulk plastic package	Markings - HM	5
172.316(a)	Other regulated material non-bulk package not marked	Markings - HM	5
172.320(a)	Class 1 package not marked with ex-number	Markings - HM	5
172.322(b)	No marine pollutant marking on bulk packaging	Markings - HM	5
172.324	Non-bulk hazardous substance not marked	Markings - HM	5
172.325(a)	Elevated temperature not marked "Hot"	Markings - HM	5

172.325(b)	Improperly marked molten aluminum/sulphur	Markings - HM	5
172.326(b)	No portable tank owner or lessee marking	Markings - HM	5
172.326(c)(1)	No ID number marking on vehicle carrying portable tank	Markings - HM	5
172.326(c)(2)	Shipper failed to provide ID number to carrier	Markings - HM	5
172.328(a)	Shipper failed to provide or affix ID number for cargo tank	Markings - HM	5
172.328(b)	Cargo tank not marked for class 2	Markings - HM	5
172.328(c)	No quenched and tempered steel (QT)/other than quenched and tempered steel (NQT) marked on cargo tank (MC 330/331)	Markings - HM	5
172.328(d)	Fail to mark manual remote shutoff device	Markings - HM	5
172.330(a)(2)	Tank car tank (non cylinder) not marked as required	Markings - HM	5
172.330(b)	Motor vehicle with tank not marked	Markings - HM	5
172.332	Required ID markings displayed	Markings - HM	5
172.334	Prohibited ID number marking	Markings - HM	5
172.334(a)	ID # displayed on Class 7/Class 1/Dangerous or Subsidiary placard	Markings - HM	5
172.336(b)	ID numbers not properly displayed	Markings - HM	5
172.336(c)(1)	Failing to display ID numbers on compartment cargo tank in sequence	Markings - HM	5
172.338	Carrier failed to replace missing ID number	Markings - HM	5
172.400(a)	Package/containment not labeled as required	Markings - HM	5
172.401	Prohibited labeling	Markings - HM	5
172.402(a)	No label for subsidiary hazard	Markings - HM	5
172.402(b)	Display of class number on label	Markings - HM	5
172.402(d)	Subsidiary labeling for radioactive materials	Markings - HM	5
172.402(e)	Subsidiary labeling for class 1(explosive) materials	Markings - HM	5
172.403(a)	Radioactive material label requirement	Markings - HM	5
172.403(f)	Radioactive material package-2 labels on opposite sides	Markings - HM	5
172.403(g)	Failed to label radioactive material properly	Markings - HM	5
172.403(g)(2)	Class 7 label - no activity/activity not in SI units	Markings - HM	5
172.404(a)	Mixed package not properly labeled	Markings - HM	5
172.404(b)	Failed to properly label consolidated package	Markings - HM	5
172.406(a)(1)	Label placement not as required	Markings - HM	5
172.406(c)	Multiple label placement not as required	Markings - HM	5
172.406(d)	Label not on contrasting background or no border	Markings - HM	5
172.406(e)	Failed to display duplicate label as required	Markings - HM	5
172.406(f)	Label obscured by marking or attachment	Markings - HM	5
172.504(a)	Vehicle not placarded as required	Markings - HM	5
172.506(a)(1)	Placards not affixed to vehicle	Markings - HM	5
172.516(a)	Placard not visible from direction it faces	Markings - HM	5
172.516(c)(1)	Placard not securely affixed or attached	Markings - HM	5
172.516(c)(2)	Placard not clear of appurtenance	Markings - HM	5
172.516(c)(4)	Placard improper location	Markings - HM	5
172.516(c)(5)	Placard not reading horizontally	Markings - HM	5
172.516(c)(6)	Placard damaged, deteriorated, or obscured	Markings - HM	5
172.516(c)(7)	Placard not on contrasting background or border	Markings - HM	5
172.600(c)	Emergency Response (ER) information not available	Documentation - HM	3
172.602(a)	Emergency response information missing	Documentation -	3

		HM	
172.602(b)	Form and manner of emergency response information	Documentation - HM	3
172.602(c)(1)	Maintenance/accessibility of emergency response information	Documentation - HM	3
173.24(b)(1)	Release of HM from package	Load Securement	10
173.25(c)	Failure to label and package poison properly, when transported with edible material	Markings - HM	5
173.29(a)	Empty package improper transportation	Cargo Protection - HM	4
173.30	Loading/ unloading transport vehicles	Cargo Protection - HM	4
173.33(a)	Cargo tank general requirements	Cargo Protection - HM	4
173.33(b)	HM in cargo tank which had dangerous reaction with cargo tank	Cargo Protection - HM	4
173.33(c)(2)	Cargo tank not marked with design or maximum allowable working pressure (MAWP)	Cargo Protection - HM	4
173.35(a)	Intermediate bulk container requirements	Package Integrity - HM	8
173.35(f)(2)	Intermediate bulk container (IBC) not secured to or within vehicle	Load Securement	10
173.54	Forbidden explosives, offering or transporting	Fire Hazard - HM	6
173.315(j)(3)	Residential gas tank not secure in transport	Fire Hazard - HM	6
173.315(j)(4)	Liquefied Petroleum Gas (LPG) storage tank overfilled for transport	Fire Hazard - HM	6
173.421(a)	Transporting limited quantity-radioactive material exceeds 0.5 millirem/hour	Cargo Protection - HM	4
173.427(a)(iv)	No instructions for exclusive use packaging-low specific activity	Cargo Protection - HM	4
173.427(a)(vi)	Exclusive use low specific activity (LSA) radioactive material not marked "Radioactive-LSA"	Markings - HM	5
173.427(a)(6)(iv)	No instructions for exclusive use packaging-low specific activity	Cargo Protection - HM	4
173.427(a)(6)(vi)	Exclusive use low specific activity (LSA) radioactive material not marked "Radioactive-LSA"	Markings - HM	5
173.427(d)	Not packaged in accordance with 10 CFR, part 71	Cargo Protection - HM	4
173.441(a)	Exceeding radiation level limitations allowed for transport	Cargo Protection - HM	4
177.801	Accepting/transporting HM not prepared properly	HM Other	2
177.817(a)	No shipping papers (carrier)	Documentation - HM	3
177.817(b)	Shipper certification missing (when required)	Documentation - HM	3
177.817(e)	Shipping paper accessibility	Documentation - HM	3
177.823(a)	No placards/markings when required	Markings - HM	5
177.834(a)	Package not secure in vehicle	Load Securement	10
177.834(c)	Smoking while loading or unloading	Fire Hazard - HM	6

177.834(f)	Using a tool likely to cause damage to the closure of any package or container	Load Securement	10
177.834(i)	Attendance of cargo tank- (load or unload)	Cargo Protection - HM	4
177.834(j)	Manholes and valves not closed or leak free	Cargo Protection - HM	4
177.834(m)(1)	Securing specification 106a or 110a tanks	Cargo Protection - HM	4
177.834(n)	Improper loading-specification 56, 57, IM101 and IM102	Fire Hazard - HM	6
177.835(a)	Loading/Unloading Class 1 with engine running	Fire Hazard - HM	6
177.835(c)	Transporting Class 1 in combination vehicles	Fire Hazard - HM	6
177.835(j)	Transfer of Class 1 materials en route	Fire Hazard - HM	6
177.837(c)	Cargo tanks not properly bonded/grounded	Cargo Protection - HM	4
177.837(d)	Improper unloading of combustible liquids	Cargo Protection - HM	4
177.838	Improper transport of class 4, 5 or division 4.2	Fire Hazard - HM	6
177.840	Improper transport of class 2	Fire Hazard - HM	6
177.840(g)	Discharge valve not closed in transit class 2	Cargo Protection - HM	4
177.840(o)	Fail to test off-truck remote shutoff device	Cargo Protection - HM	4
177.840(s)	Fail to possess remote shutoff when unloading	Cargo Protection - HM	4
177.841(e)	Poison label loaded with foodstuffs	HM Other	2
177.842(a)	Total transport index exceeds 50- non-exclusive use	HM Other	2
177.842(b)	Distance from package to person-radioactive material	HM Other	2
177.842(d)	Blocking and bracing of radioactive material packages	HM Other	2
177.848(d)	Prohibited load/transport/storage combination	Fire Hazard - HM	6
177.848(f)	Class 1 load separation or segregation	HM Other	2
178.245-4	DOT51 integrity and securement	Package Integrity - HM	8
178.245-5	DOT51 valve protection	Package Integrity - HM	8
178.245-6(a)	DOT51 name plate Markings - HM	Package Integrity - HM	8
178.245-6(b)	Tank outlets not marked	Package Integrity - HM	8
178.251-4	DOT 56/57 integrity and securement	Package Integrity - HM	8
178.251-7(b)	DOT 56/57 spec Markings - HM	Package Integrity - HM	8
178.255-4	DOT 60 manhole	Package Integrity - HM	8
178.255-7	DOT 60 valve protection	Package Integrity - HM	8
178.255-14	DOT 60 ID plate	Package Integrity - HM	8

178.270-1	IM101/102 general design	Package Integrity - HM	8
178.270-11(d)(1)	IM101/102 pressure relief	Package Integrity - HM	8
178.270-4	Structural integrity	Package Integrity - HM	8
178.270-6	IM 101/102 frames	Package Integrity - HM	8
178.270-8	IM101/102 valve protection	Package Integrity - HM	8
178.270-9	IM101/102 manholes	Package Integrity - HM	8
178.270-14	IM101/102 spec plate	Package Integrity - HM	8
178.336-9(a)	Safety relief devices MC330	Package Integrity - HM	8
178.336-9(c)	Marking of inlets/outlets MC330	Package Integrity - HM	8
178.336-10	Protecting of fittings MC330	Package Integrity - HM	8
178.336-13	Anchoring of tank MC330	Package Integrity - HM	8
178.336-17	Metal ID plate marking MC330	Package Integrity - HM	8
178.336-17(a)	Certification plate MC330	Package Integrity - HM	8
178.337-8(a)	Outlets general requirements MC331	Package Integrity - HM	8
178.337-8(a)(2)	Outlets MC331	Package Integrity - HM	8
178.337-8(a)(3)	Internal or back flow valve MC331	Package Integrity - HM	8
178.337-8(a)(4)(i)	Remote closure device greater than 3500 gallons MC331	Package Integrity - HM	8
178.337-8(a)(4)(ii)	Remote closure device less than 3500 gallons MC331	Package Integrity - HM	8
178.337-9(c)	Marking inlets/outlets MC331	Package Integrity - HM	8
178.337-10(a)	Protection of fittings MC331	Package Integrity - HM	8
178.337-10(d)	Rear end protection MC331	Package Integrity - HM	8
178.337-11(b)	Shut off valves MC331	Package Integrity - HM	8
178.337-13	MC331 supports and anchoring	Package Integrity - HM	8
178.337-17(a)	Metal ID plate missing MC331	Package Integrity - HM	8
178.338-6	Manhole MC338	Package Integrity - HM	8
178.338-8	Pressure relief devices MC338	Package Integrity - HM	8
178.338-10(a)	Protection of fittings MC338	Package Integrity - HM	8
178.338-10(c)	Rear end protection MC338	Package Integrity - HM	8
178.338-11(b)	Manual shutoff valve MC338	Package Integrity - HM	8

178.338-12	Shear section MC338	Package Integrity - HM	8
178.338-13	Supports and anchoring MC338	Package Integrity - HM	8
178.338-18(a)	Name plate/Specification plate missing MC338	Package Integrity - HM	8
178.338-18(b)	Specification plate missing MC338	Package Integrity - HM	8
178.340-6	MC306/307/312 supports and anchoring	Package Integrity - HM	8
178.340-7(a)	MC306/307/312 ring stiffeners	Package Integrity - HM	8
178.340-7(c)	MC306/307/312 double bulkhead drain	Package Integrity - HM	8
178.340-7(d)(2)	MC306/307/312 ring stiffener drain hole	Package Integrity - HM	8
178.340-8(a)	MC306/307/312 appurtenances attachment	Package Integrity - HM	8
178.340-8(b)	MC306/307/312 rearend protection	Package Integrity - HM	8
178.340-8(c)	MC306/307/312 overturn protection	Package Integrity - HM	8
178.340-8(d)	MC306/307/312 piping protection	Package Integrity - HM	8
178.340-8(d)(1)	MC306/307/312 piping protection	Package Integrity - HM	8
178.340-8(d)(2)	MC306/307/312 minimum road clearance	Package Integrity - HM	8
178.340-10(b)	MC306/307/312 metal certification plate missing	Package Integrity - HM	8
178.341-3(a)	MC306 no manhole closure	Package Integrity - HM	8
178.341-4	MC306 venting	Package Integrity - HM	8
178.341-4(d)(1)	MC306 inadequate emergency venting	Package Integrity - HM	8
178.341-4(d)(2)	MC306 pressure activated vents	Package Integrity - HM	8
178.341-4(d)(3)	MC306 no fusible venting	Package Integrity - HM	8
178.341-5(a)	MC306 internal valves	Package Integrity - HM	8
178.341-5(a)(1)	MC306 heat actuated safety	Package Integrity - HM	8
178.341-5(a)(2)	MC306 remote control shutoff	Package Integrity - HM	8
178.342-3	MC307 manhole closure	Package Integrity - HM	8
178.342-4	MC307 venting	Package Integrity - HM	8
178.342-4(b)	Inadequate venting capacity	Package Integrity - HM	8
178.342-5(a)	MC307 internal valve	Package Integrity - HM	8
178.342-5(a)(1)	MC307 heat actuated safety	Package Integrity - HM	8
178.342-5(a)(2)	MC307 remote control shutoff	Package Integrity - HM	8

178.343-3	Manhole closure MC312	Package Integrity - HM	8
178.343-4	Venting MC312 (show calculations)	Package Integrity - HM	8
178.343-5(a)	MC312 top outlet and valve	Package Integrity - HM	8
178.343-5(b)(1)	MC312 bottom valve/piping protection	Package Integrity - HM	8
178.345-1(i)(2)	DOT 406, 407, 412 Obstructed double bulkhead drain/vent	Package Integrity - HM	8
178.345-5(d)	DOT406/407/412 manhole securement	Package Integrity - HM	8
178.345-5(e)	DOT406/407/412 manhole marking	Package Integrity - HM	8
178.345-6	DOT406/407/412 supports and anchoring	Package Integrity - HM	8
178.345-7(d)(4)	DOT406/407/412 ring stiffener drain	Package Integrity - HM	8
178.345-8(a)	DOT406/407/412 accident protection	Package Integrity - HM	8
178.345-8(a)(5)	DOT406/407/412 minimum road clearance	Package Integrity - HM	8
178.345-8(b)	DOT406/407/412 bottom damage protection	Package Integrity - HM	8
178.345-8(c)	DOT406/407/412 rollover damage protection	Package Integrity - HM	8
178.345-8(d)	DOT406/407/412 rear end protection	Package Integrity - HM	8
178.345-10	DOT406/407/412 pressure relief	Package Integrity - HM	8
178.345-11(b)	DOT406/407/412 tank valves	Package Integrity - HM	8
178.345-11(b)(1)	DOT406/407/412 remote control	Package Integrity - HM	8
178.345-11(b)(1)(i)	DOT406/407/412 remote control	Package Integrity - HM	8
178.345-14(b)	DOT406/407/412 name plate	Package Integrity - HM	8
178.345-14(c)	DOT406/407/412 specification plate	Package Integrity - HM	8
178.703(a)	Intermediate bulk container (IBC) manufacturer Markings - HM	Package Integrity - HM	8
178.703(b)	Intermediate bulk container additional Markings - HM	Package Integrity - HM	8
178.704(e)	Intermediate bulk container bottom discharge valve protection	Package Integrity - HM	8
180.205(c)	Periodic re-qualification of cylinders	Package Testing - HM	7
180.213(d)	Re-qualification Markings - HM	Package Testing - HM	7
180.352(b)	Intermediate bulk container retest or inspection	Package Testing - HM	7
180.405(b)	Cargo tank specifications	Package Testing - HM	7
180.405(j)	Certification withdrawal (failed to remove/cover/obliterate spec plate)	Package Testing - HM	7
180.407(a)(1)	Cargo tank periodic test and inspection	Package Testing - HM	7

180.407(c)	Failing to periodically test and inspect cargo tank	Package Testing - HM	7
180.415(b)	Cargo tank test or inspection Markings - HM	Package Testing - HM	7
180.605(k)	Test date marking	Package Testing - HM	7
385.403	No HM Safety Permit	Documentation - HM	3
392.9	Failing to secure load	Load Securement	10
392.9(a)	Failing to secure load	Load Securement	10
392.9(a)(1)	Failing to secure cargo/§§ 393.100-393.136	Load Securement	10
392.9(a)(2)	Failing to secure vehicle equipment	Load Securement	10
392.9(a)(3)	Driver's view/movement is obstructed	Load Securement	10
392.62(c)(1)	Bus - baggage/freight restricts driver operation	Load Securement	10
392.62(c)(2)	Bus - Exit(s) obstructed by baggage/freight	Load Securement	10
392.62(c)(3)	Passengers not protected from falling baggage	Load Securement	10
392.63	Pushing/towing a loaded bus	Load Securement	10
393.87	Warning flag required on projecting load	Warning Flags	4
393.87(a)	Warning flag required on projecting load	Warning Flags	4
393.87(b)	Improper warning flag placement	Warning Flags	4
393.100	Failure to prevent cargo shifting	Load Securement	10
393.100(a)	Failure to prevent cargo shifting	Load Securement	10
393.100(b)	Leaking/spilling/blowing/falling cargo	Load Securement	10
393.100(c)	Failure to prevent cargo shifting	Load Securement	10
393.102(a)	Improper securement system (tiedown assemblies)	Load Securement	10
393.102(a)(1)	Insufficient means to prevent forward movement	Load Securement	10
393.102(a)(1)(i)	Insufficient means to prevent forward movement	Load Securement	10
393.102(a)(1)(ii)	Insufficient means to prevent rearward movement	Load Securement	10
393.102(a)(1)(iii)	Insufficient means to prevent lateral movement	Load Securement	10
393.102(a)(2)	Tiedown assembly with inadequate working load limit	Load Securement	10
393.102(a)(3)	Insufficient means to prevent lateral movement	Load Securement	10
393.102(b)	Insufficient means to prevent vertical movement	Load Securement	10
393.102(c)	No equivalent means of securement	Load Securement	10
393.104(a)	Inadequate/damaged securement device/system	Load Securement	10
393.104(b)	Damaged securement system/tiedowns	Load	10

		Securement	
393.104(c)	Damaged vehicle structures/anchor points	Load Securement	10
393.104(d)	Damaged Dunnage/bars/blocking-bracing	Load Securement	10
393.104(f)(1)	Knotted tiedown	Load Securement	10
393.104(f)(2)	Use of tiedown with improper repair.	Load Securement	10
393.104(f)(3)	Loose/unfastened tiedown.	Load Securement	10
393.104(f)(4)	No edge protection for tiedowns	Load Securement	10
393.104F4R	No edge protection for tiedowns	Load Securement	10
393.104(f)(5)	No edge protection for tiedowns	Load Securement	10
393.106(a)	No/improper front end structure/headerboard	Load Securement	10
393.106(b)	Cargo not immobilized or secured	Load Securement	10
393.106(c)(1)	No means to prevent cargo from rolling	Load Securement	10
393.106(c)(2)	Cargo without direct contact/prevention from shifting	Load Securement	10
393.106(d)	Insufficient aggregate working load limit	Load Securement	10
393.110	Failing to meet minimum tiedown requirements	Load Securement	10
393.110(b)	Insufficient tiedowns; without headerboard/blocking	Load Securement	10
393.110(c)	Insufficient tiedowns; with headerboard/blocking	Load Securement	10
393.110(d)	Large/odd-shaped cargo not adequately secured	Load Securement	10
393.112	Tiedown not adjustable by driver	Load Securement	10
393.114	No/improper front end structure	Load Securement	10
393.114(b)(1)	Insufficient height for front-end structure	Load Securement	10
393.114(b)(2)	Insufficient width for front-end structure	Load Securement	10
393.114(d)	Front-end structure with large opening(s)	Load Securement	10
393.116	No/improper securement of logs	Load Securement	10
393.116(d)(1)	Short; over 1/3 length past structure	Load Securement	10
393.116(d)(2)	Short, insufficient/no tiedowns	Load Securement	10
393.116(d)(3)	Short, tiedowns improperly positioned	Load Securement	10
393.116(d)(4)	Short, no center stakes/high log not secured	Load Securement	10
393.116(e)	Short, length; improper securement	Load Securement	10
393.118	No/improper lumber/building materials.	Load	10

	securement	Securement	
393.118(b)	Improper placement of bundles	Load Securement	10
393.118(d)	Insufficient protection against lateral movement	Load Securement	10
393.118(d)(3)	Insufficient/improper arrangement of tiedowns	Load Securement	10
393.120	No/improper securement of metal coils	Load Securement	10
393.120(b)(1)	Coil/vertical improper securement	Load Securement	10
393.120(b)(2)	Coils, rows, eyes vertical; improper secure.	Load Securement	10
393.120(c)(1)	Coil/eye crosswise improper securement	Load Securement	10
393.120(c)(2)	X-pattern on coil(s) with eyes crosswise	Load Securement	10
393.120(d)(1)	Coil with eye lengthwise-improper securement	Load Securement	10
393.120(d)(4)	Coils, rows, eyes length-improper securement.	Load Securement	10
393.120(e)	No protection against shifting/tipping	Load Securement	10
393.122	No/improper securement of paper rolls	Load Securement	10
393.122(b)	Rolls vertical-improper securement	Load Securement	10
393.122(c)	Rolls vertical /split-improper securement	Load Securement	10
393.122(d)	Rolls vertical /stacked-improper securement	Load Securement	10
393.122(e)	Rolls crosswise-improper securement	Load Securement	10
393.122(f)	Rolls crosswise/stacked load-improperly secured	Load Securement	10
393.122(g)	Rolls length-improper securement	Load Securement	10
393.122(h)	Rolls lengthwise/stacked-improper securement	Load Securement	10
393.122(i)	Improper securement-rolls on flatbed/curb-side	Load Securement	10
393.124	No/improper securement of concrete pipe	Load Securement	10
393.124(b)	Insufficient working load limit-concrete pipes	Load Securement	10
393.124(c)	Improper blocking of concrete pipe	Load Securement	10
393.124(d)	Improper arrangement of concrete pipe	Load Securement	10
393.124(e)	Improper securement, up to 45 in. diameter	Load Securement	10
393.124(f)	Improper securement, greater than 45 inch diameter	Load Securement	10
393.126	Fail to ensure intermodal container secured	Load Securement	10
393.126(b)	Damaged/missing tiedown/securement device	Load Securement	10
393.126(c)(1)	Lower corners not on vehicle/structure	Load	10

		Securement	
393.126(c)(2)	All corners of chassis not secured	Load Securement	10
393.126(c)(3)	Front and rear not secured independently	Load Securement	10
393.126(d)(1)	Empty container not properly positioned	Load Securement	10
393.126(d)(2)	Empty container, more than 5 foot overhang	Load Securement	10
393.126(d)(4)	Empty container-not properly secured	Load Securement	10
393.128	No/improper securement of vehicles	Load Securement	10
393.128(b)(1)	Vehicle not secured-front and rear	Load Securement	10
393.128(b)(2)	Tiedown(s) not affixed to mounting points.	Load Securement	10
393.128(b)(3)	Tiedown(s) not over/around wheels.	Load Securement	10
393.130	No/improper heavy vehicle/machine securement	Load Securement	10
393.130(b)	Item not properly prepared for transport	Load Securement	10
393.130(c)	Improper restraint/securement of item	Load Securement	10
393.132	No/improper securement of crushed vehicles	Load Securement	10
393.132(b)	Prohibited use of synthetic webbing.	Load Securement	10
393.132(c)	Insufficient tiedowns per stack cars	Load Securement	10
393.132(c)(5)	Insufficient means to retain loose parts	Load Securement	10
393.134	No/improper securement of roll/hook container	Load Securement	10
393.134(b)(1)	No blocking against forward movement	Load Securement	10
393.134(b)(2)	Container not secured to front of vehicle	Load Securement	10
393.134(b)(3)	Rear of container not properly secured	Load Securement	10
393.136	No/improper securement of large boulders	Load Securement	10
393.136(b)	Improper placement/positioning for boulder	Load Securement	10
393.136(c)(1)	Boulder not secured with chain	Load Securement	10
393.136(d)	Improper securement-cubic boulder	Load Securement	10
393.136(e)	Improper securement-non cubic boulder with base	Load Securement	10
393.136(f)	Improper securement-non cubic boulder without base	Load Securement	10
397.1(a)	Driver/carrier must obey part 397	HM Other	2
397.1(b)	Failing to require employees to know/obey part 397	HM Other	2
397.2	Must comply with rules in parts 390-397-transporting HM	HM Other	2

397.7(a)	Improperly parked explosives vehicle	Fire Hazard - HM	6
397.7(b)	Improperly parked HM vehicle	Fire Hazard - HM	6
397.11(a)	HM vehicle operated near open fire	Fire Hazard - HM	6
397.11(b)	HM vehicle parked within 300 feet of fire	Fire Hazard - HM	6
397.15	HM vehicle fueling violation	Fire Hazard - HM	6
397.17	No tire examination on HM vehicle	HM Other	2
397.19	No instructions/documents when transporting Division 1.1/1.2/1.3 (explosive) materials	Documentation - HM	3
397.19(c)	Required documents not in possession-explosive materials	Documentation - HM	3
397.67	HM vehicle routing violation (non-radioactive materials)	HM Route	1
397.101(b)	Radioactive materials vehicle not on preferred route	HM Route	1
397.101(d)	No or incomplete route plan-radioactive materials	HM Route	1
397.101(e)(2)	Driver not in possession of training certificate	HM Route	1
397.101(e)(3)	Driver not in possession of written route plan	HM Route	1