Development of Hazardous Materials (HM) Shipper Prioritization Program

Technical Brief

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INTRODUCTION

The Hazardous Materials (HM) Shipper Prioritization Program has been under development at the Federal Motor Carrier Safety Administration (FMCSA) since the early 1990s. Traditionally, FMCSA's shipper program has been driven by complaints. In the mid 1990s, an attempt was made to develop a performance-based prioritization for HM shippers, similar to a program by the name of SafeStat that was developed for carriers. During this attempt it became apparent that there was insufficient performance data to develop such a system. In response, FMCSA developed the HM Package Inspection Program (HMPIP) to focus on inspecting individual shipments of HM at the roadside or on carriers' docks. HMPIP is a browser-based application used during dock and vehicle inspections to record compliance problems with HM packages. This software program can operate as a field system or via a central site. In the stand-alone mode, the data collected while offline is moved to the central site once a network connection is re-established. Data collected using HMPIP can be used as a helpful tool to establish shipper prioritization lists. FMCSA's annual National Shipper Check strike force activity focuses on using HMPIP to conduct inspections of many packages and reviews on shippers of HM. The program grew from less than 1,000 package inspections in 2001 to over 6,000 inspections in 2006. Due to the improvements made over the years to the data collected during HMPIP inspections, HM incident data, and improved departmental data identifying companies involved in shipping HM, FMCSA has begun a second effort to develop a performance-based prioritization of HM shippers.

In 2003, this second effort was initiated and was able to advance the project to the beta testing phase; however, contractual and financial issues arose and the project was abandoned. The purpose of the current project was to review, document, and recommend improvements to FMCSA's HM Shipper Prioritization Program. From this point forward this report will refer to the HM Shipper Prioritization Program as the title of the project and will refer to the actual prioritization application as the HM Shipper Prioritization Application (HMSPA). The purpose of this technical brief is to provide documentation on the development process and the final HMSPA design that was performed by the Virginia Tech Transportation Institute (VTTI). Close communication was maintained by VTTI developers and FMCSA during the development process in order to increase the quality of the work as well as reduce the integration time for FMCSA. It is important to note that a final report for this project was written and delivered to FMCSA which includes this technical brief in its appendices (Schaudt, Bowman, Marinik, Baker, Trimble, and Hanowski, 2009).

HMSPA DESIGN

The final HMSPA contained four main web pages and are as follows:

1) Home Page (figure 1)
2) Prioritization Selection Page (figure 2)
3) Prioritization Results Page (figure 3)
4) About Algorithm Page (figure 4)

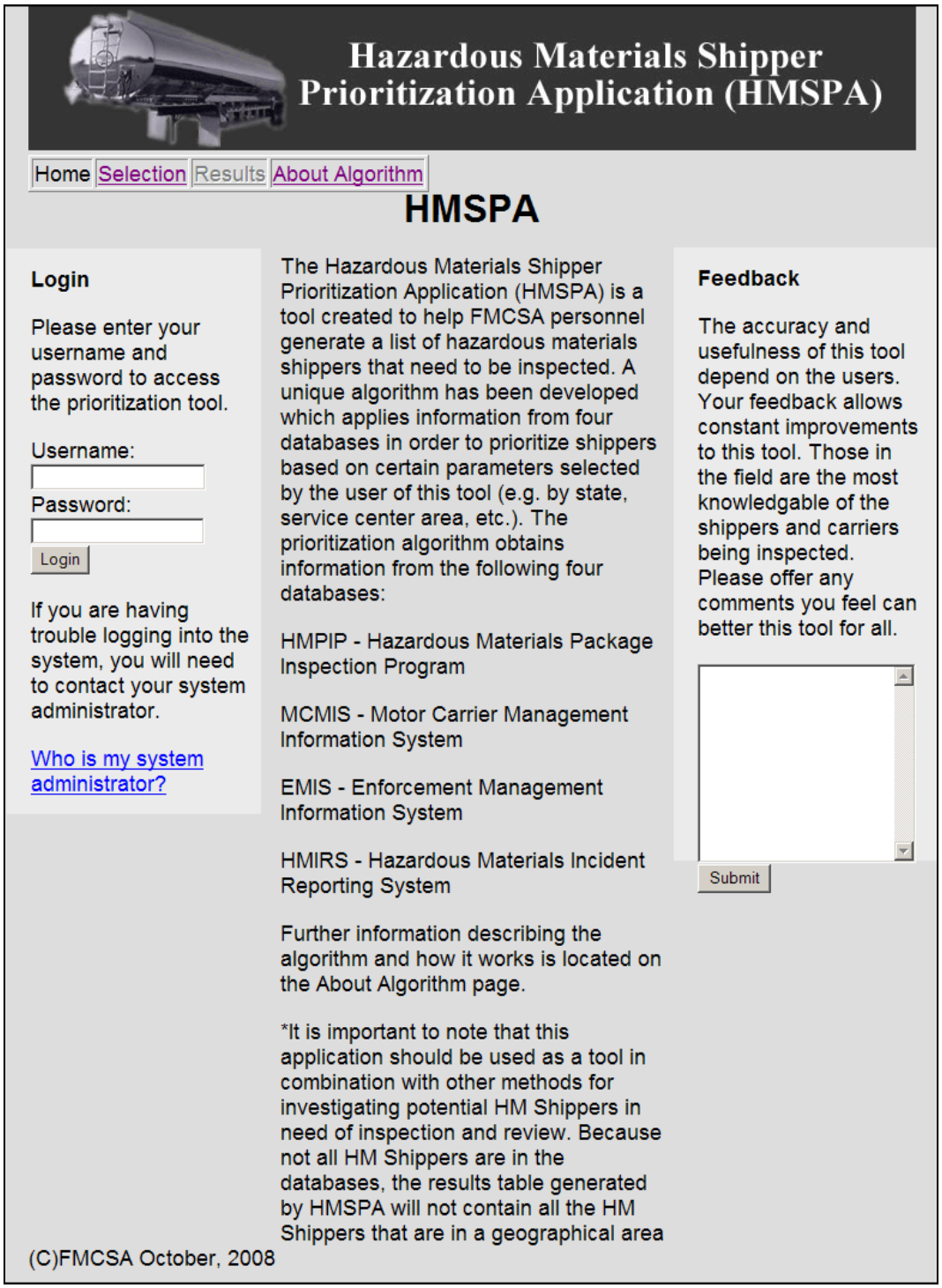


Figure 1. Final HMSPA Home Page

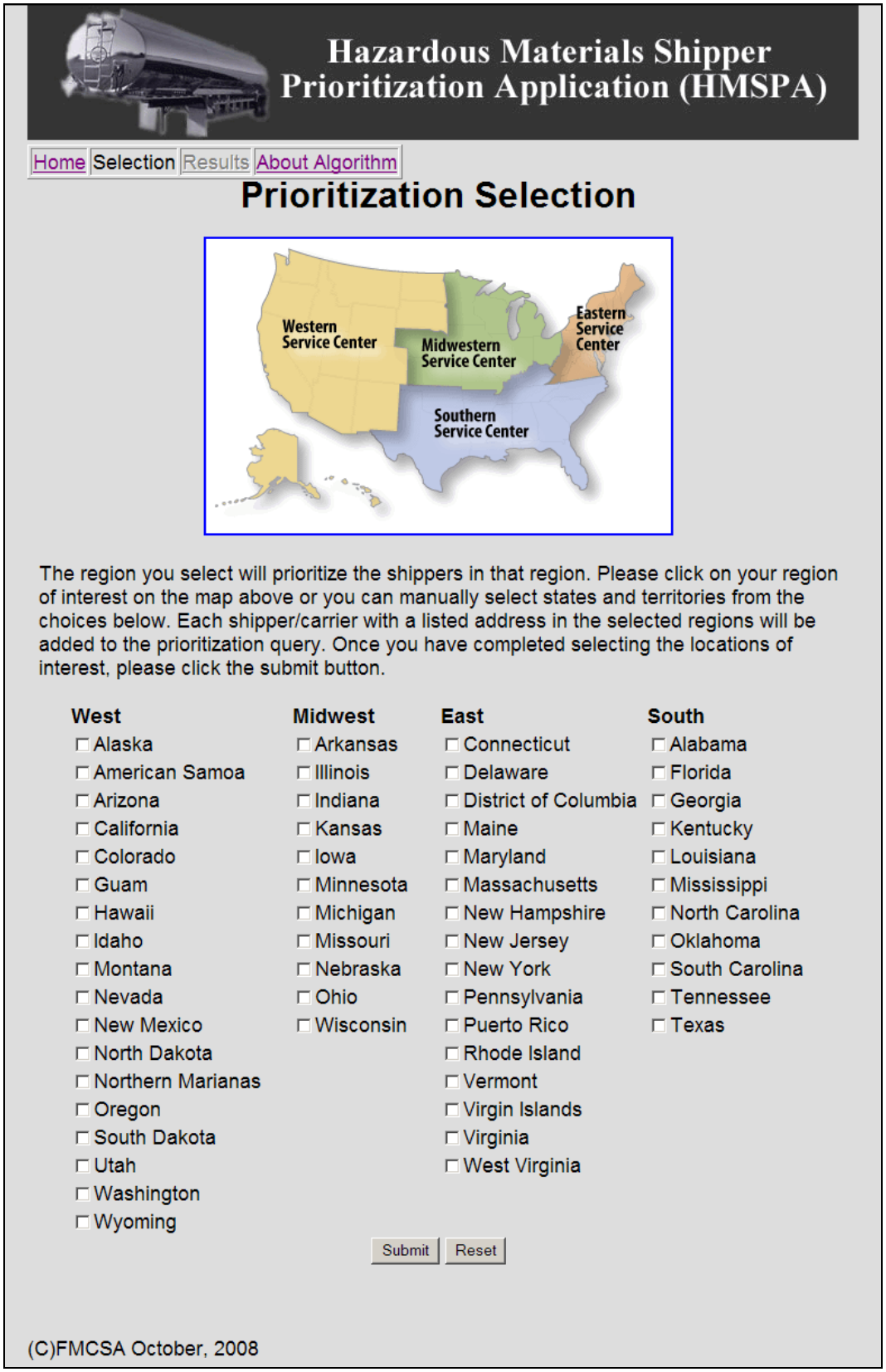


Figure 2. Final HMSPA Prioritization Selection Page

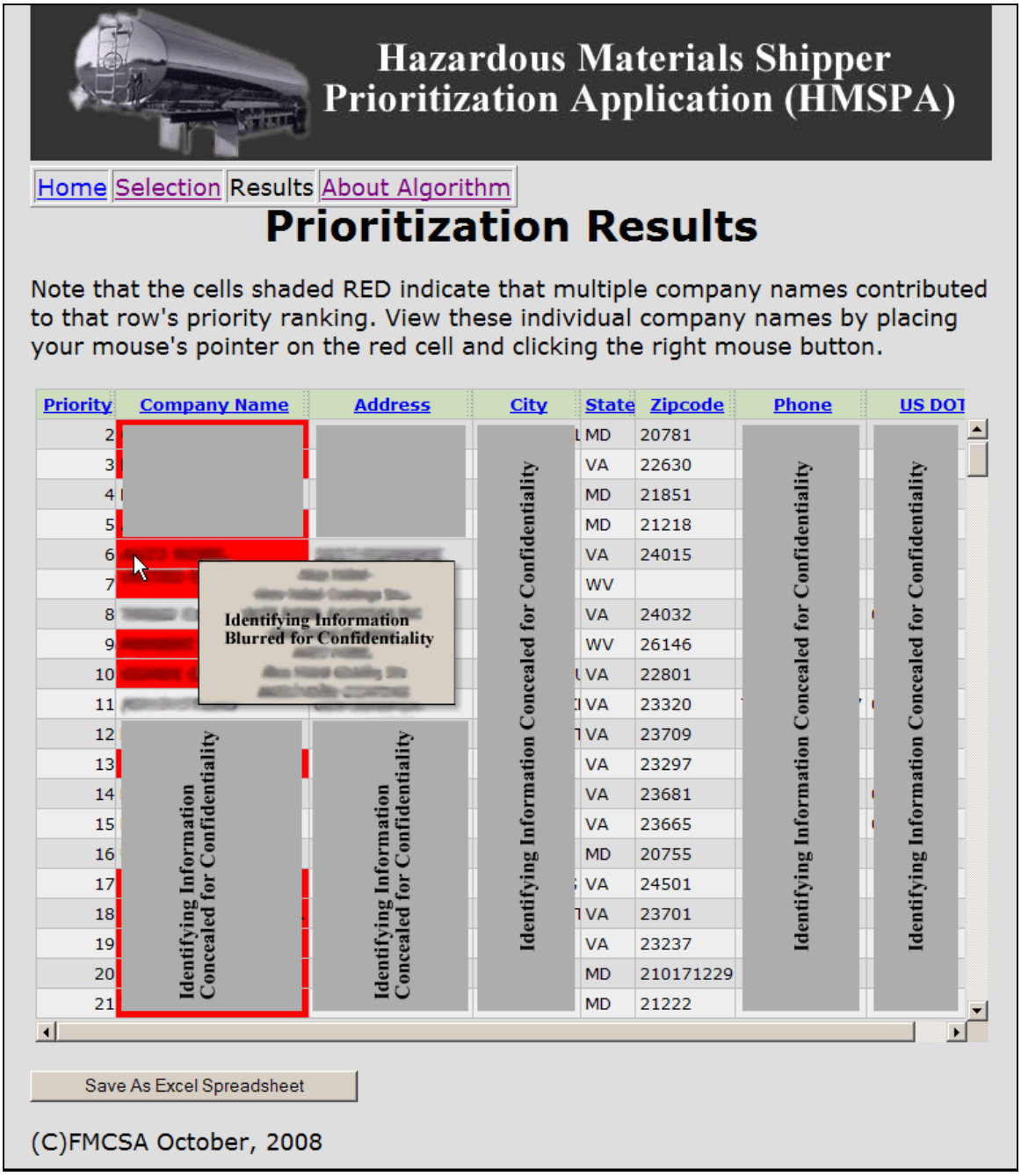
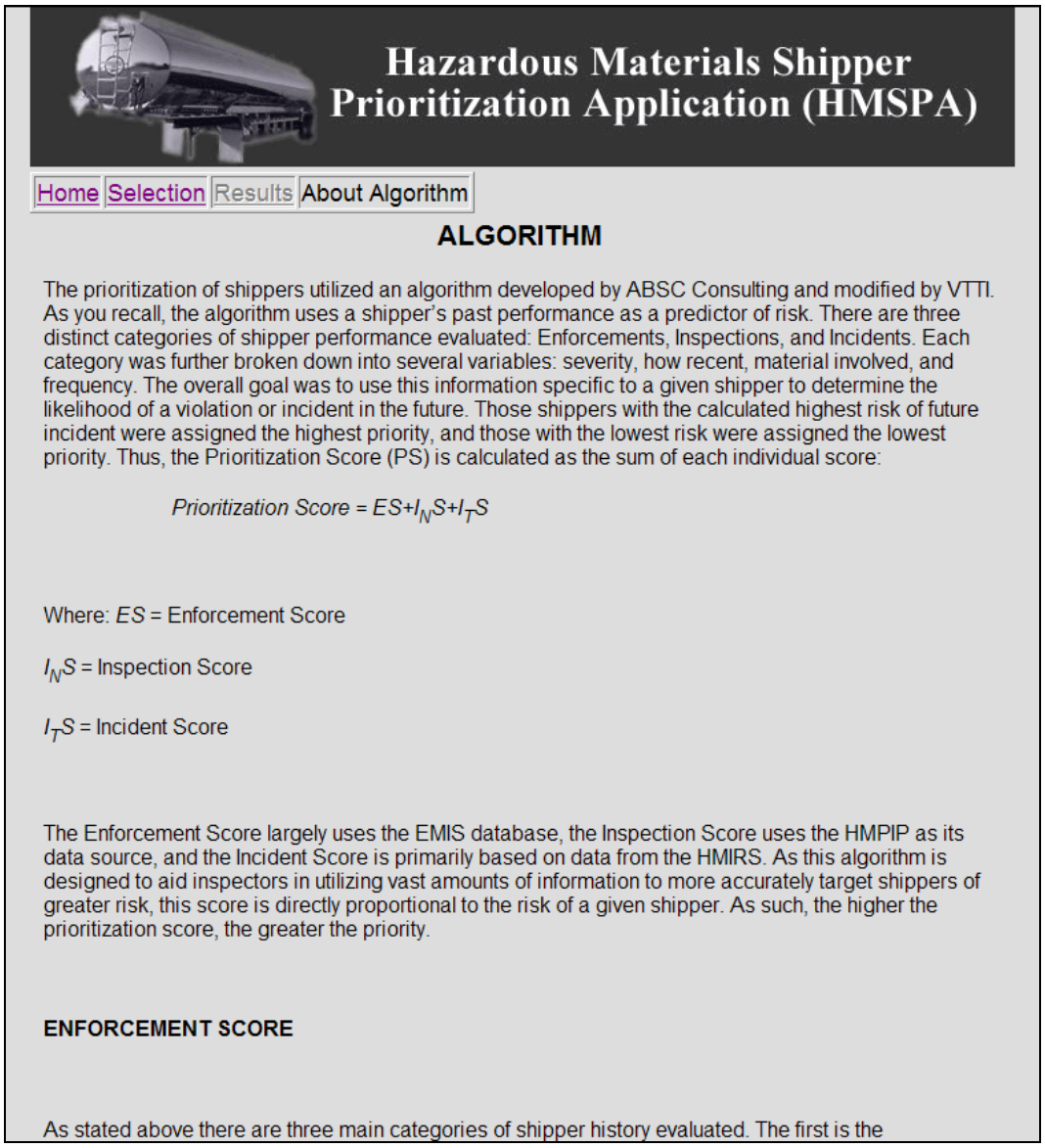


Figure 3. Final HMSPA Prioritization Results Page



Hazardous Materials Shipper Prioritization Application (HMSPA)

Home Selection Results About Algorithm

ALGORITHM

The prioritization of shippers utilized an algorithm developed by ABSC Consulting and modified by VTTI. As you recall, the algorithm uses a shipper's past performance as a predictor of risk. There are three distinct categories of shipper performance evaluated: Enforcements, Inspections, and Incidents. Each category was further broken down into several variables: severity, how recent, material involved, and frequency. The overall goal was to use this information specific to a given shipper to determine the likelihood of a violation or incident in the future. Those shippers with the calculated highest risk of future incident were assigned the highest priority, and those with the lowest risk were assigned the lowest priority. Thus, the Prioritization Score (PS) is calculated as the sum of each individual score:

$$\textit{Prioritization Score} = ES + I_N S + I_T S$$

Where: ES = Enforcement Score

$I_N S$ = Inspection Score

$I_T S$ = Incident Score

The Enforcement Score largely uses the EMIS database, the Inspection Score uses the HMPIP as its data source, and the Incident Score is primarily based on data from the HMIRS. As this algorithm is designed to aid inspectors in utilizing vast amounts of information to more accurately target shippers of greater risk, this score is directly proportional to the risk of a given shipper. As such, the higher the prioritization score, the greater the priority.

ENFORCEMENT SCORE

As stated above there are three main categories of shipper history evaluated. The first is the

Figure 4. Final HMSPA About Algorithm Page (only portion of page shown)

The home page contained a login area to the left and a feedback box to the right for users to supply comments and recommendations. The main content of the home page consisted of a brief description of the site and the databases used for calculating priority scores for shippers. The purpose of the prioritization selection page was for a user to choose the geographic area to prioritize shippers by using a map to click service center areas, or by selecting each individual state of interest near the bottom. Finally, an interactive prioritization results page was created to display the prioritized list of shippers generated from the prioritization selection page. This results table contained 8 different columns of information all of which a user could use to sort the list. These columns were as follows: Priority Score, Company Name, Address, City, Zip, Phone, and DOT No. The About Algorithm page contained a detailed discussion on the algorithm. For further information detailing all project tasks leading to the final design of HMSPA, please refer to the final report, "Development of Hazardous Materials (HM) Shipper Prioritization Program" (Schaudt et al., 2009).

DATA SOURCES

The source of prioritization for HMSPA is an algorithm designed to evaluate the potential risk for an HM shipper. The algorithm used a shipper's historical information to extrapolate future risk characteristics. The algorithm required the combination of various data extracted from several databases for the same shipper, and thus, required a way to uniquely identify each shipper across databases. VTTI developed a method to filter shipper nomenclature within the source databases to ensure accurate score calculations. The algorithm utilized several data sources to calculate the necessary scores. In order for HMSPA to have successfully used this algorithm, VTTI had to organize the data in one central location for access. The original developers of the algorithm specified potential data sources of use. After further discussion with FMCSA personnel, the following databases were selected:

- Hazardous Materials Package Inspection Program (HMPIP)
- Motor Carrier Management Information System (MCMIS)
- Enforcement Management Information System (EMIS)
- Hazardous Materials Incident Reporting System (HMIRS)

The first three are databases controlled by FMCSA. The last database is controlled by the Pipeline and Hazardous Materials Safety Administration (PHMSA). For the purposes of creating the HMSPA, VTTI requested access to these databases. VTTI was provided a static export of both the HMPIP and the MCMIS databases. VTTI was denied access to the databases themselves. VTTI was also provided a Microsoft Excel spreadsheet containing the results of a query against the EMIS database. Data from HMIRS was retrieved from at the PHMSA Incident Reports Database Search web page on August 1, 2008 in CSV files which can be accessed at https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/.

The algorithm required the use of varying severity levels to calculate individual scores for a given shipper these severity levels were based on Citations of Federal Regulations (CFR) section numbers. Although most of the databases contained the CFR section numbers cited for a violation or enforcement action, they did not provide a level of severity. Therefore, VTTI requested clarification as to the level of severity for the various citations. This was provided by FMCSA in hardcopy form (Appendix A). After collecting all of the necessary data sources, VTTI began the process of creating locally housed databases for use in the creation of the beta version of HMSPA.

After collecting all of the necessary data sources, VTTI began the process of creating locally housed SQL databases. The HMPIP data export and MCMIS data export were directly imported as local databases. However, due to the formats delivered by FMCSA of the HMIRS data, EMIS data, and Severity Level data, VTTI imported each set as a single table. The HMIRS and EMIS data became single table databases. The severity level data was imported into the HMPIP database as an additional table.

UNIQUE IDENTIFICATION PROCESS

Attributing the correct scores to a proper shipper was essential in creating an accurate prioritization score. Based on data filtering and evaluation, VTTI found an absence of a unique identification number or alphanumeric code for linking shipping entities from various data sources. The shipping entity name alone was insufficient to create a unique identity to link shippers across databases. The issue with greatest frequency was misspellings of a shipper name. This would allow the score associated with the misspelled shipper to be counted separate from the rest of the shipper's score. To prevent this from happening, VTTI employed a novel method to define a unique identification for each shipper. VTTI created a unique identifier that allowed cross database querying for a given shipper. To accomplish this goal VTTI used the Soundex technique. Developed by Robert C. Russell, Soundex is a phonetic index created to match misspelled surnames. The Soundex technique uses a phonetic algorithm to allow similar names to be matched up with one another, even if placed far apart in a large listing. This technique was improved upon with the development of the American Soundex System. VTTI used the American Soundex System to abbreviate the shipper name and the shipper city. The abbreviations were then concatenated and the two-digit state code was added to create a unique identifier.

For example, a fictional shipper by the name of VTTI in Blacksburg, Virginia would have the unique identifier of:

VTTI = V300
Blacksburg = B421
Therefore, V300+B421+VA = V300B421VA.

A reliability test was performed by running the unique identifier creation query on all shippers in the locally housed HMIRS database. After creating the unique identifier, a random selection of 15 percent was chosen for manual verification. Manual verification consisted of checking both the shipper name for consistency and the unique identifier for accuracy. VTTI found that the unique identifier technique proved successful 98.84 percent of the time with a 95 percent Wald confidence interval of [98.35 percent, 99.33 percent](Agresti, 2002). The confidence interval was calculated by:

$$\hat{\pi} \pm Z_{\alpha/2}\sqrt{\frac{\hat{\pi}(1-\hat{\pi})}{n}} \qquad \textit{Eq. 1}$$

Where: $\hat{\pi}$ = Sample Proportion
$Z_{\alpha/2}$ = z-value with an area of $\alpha/2$ to its right and left (obtained from a table).
n = Sample Size

Based on these results, VTTI used this technique to create unique identifiers for each shipper in all three databases (HMIRS, HMPIP, and EMIS) to accurately combine individual scores.

ALGORITHM

The prioritization of shippers utilized an algorithm developed by ABSC Consulting and modified by VTTI. As you recall, the algorithm uses a shipper's past performance as a predictor of risk. There are three distinct categories of shipper performance evaluated: Enforcements, Inspections, and Incidents. Each category was further broken down into several variables: severity, how recent, material involved, and frequency. The overall goal was to use this information specific to a given shipper to determine the likelihood of a violation or incident in the future. Those shippers with the calculated highest risk of future incident were assigned the highest priority, and those with the lowest risk were assigned the lowest priority. Thus, the Prioritization Score (PS) is calculated as the sum of each individual score:

$$\textit{Prioritization Score} = ES + I_N S + I_T S \qquad \textit{Eq. 2}$$

Where: ES = Enforcement Score
$I_N S$ = Inspection Score
$I_T S$ = Incident Score

The Enforcement Score largely uses the EMIS database, the Inspection Score uses the HMPIP as its data source, and the Incident Score is primarily based on data from the HMIRS. The algorithm is designed to aid inspectors in utilizing vast amounts of information to more accurately target shippers of greater risk. The prioritization score is converted to a priority number to be presented in the priority column. Therefore, higher risk is associated with a higher priority and a lower priority number. It is important to note that this application should be used as a tool in combination with other methods for investigating potential HM Shippers in need of inspection. Because HM shippers are not required to register, some HM shippers will not be accounted for in the databases, thus the results table generated by HMSPA will not contain all the HM shippers for a given geographical area.

ENFORCEMENT SCORE

As stated above there are three main categories of shipper history evaluated. The first is the enforcement history. The Enforcement Score for a given shipper is calculated by multiplying the weighted variables accordingly for a single enforcement action, then summing the scores for all enforcement actions for a given shipper over the same period of time. For a single enforcement action, four weighted variables are taken into account. The four variables are Severity, Time, Multiple Enforcements, and Material.

$$\textit{Enforcement Score (ES)} = \sum S_E * W_T * W_{ME} * W_{Ma} \qquad \textit{Eq. 3}$$

Where: S_E = Severity
W_T = Time Weight
W_{ME} = Multiple Enforcement Weight
W_{Ma} = Material Weight

For a more severe enforcement action a higher weight is applied to the severity variable. Similarly, a more recent enforcement action earns a higher numerical weight for the time variable. This variable increases the overall score for shippers who have recently had an infraction, but allows scores to decrease over time if no further infractions occur. The Multiple Enforcements variable accounts for the frequency of infractions for a given shipper. To calculate the Multiple Enforcement variable, each enforcement action is examined individually and then assigned a value equal to the number of enforcements occurring within the six months prior to that action, and the six months after that action. Thus shippers are penalized more for consistently having infractions than shippers that occasionally have an infraction. The final variable, Material, is calculated by a chart assigning weights to each type of HM by class and division. However, VTTI was supplied a spreadsheet containing results of a query against EMIS, rather than an EMIS database export. As such, the material information was not provided and could not be used in the development of this application. Thus, the variable for material weighting was replaced with a constant of 1 for this initial application. It is recommended that the material values specified by ABSC during algorithm development (shown in Appendix B) are utilized when available to increase accuracy of the algorithm. After each variable is defined, the product of all four weights becomes the single enforcement action. After calculating this value for each enforcement for a given shipper, the total is summed. That sum is applied to the shipper's Prioritization Score as the final Enforcement Score.

Table 1 contains the Enforcement Score variables and the associated locations within the locally housed databases created by VTTI for calculating the algorithm. This table should aid in the integration process by identifying the specific data capture locations.

Table 1. Enforcement Score Variables and Associated Database Locations

Variable	Database	Table	Columns	Description
U_ID	EMIS	SHIPPERS	NAME, PHY_CITY, PHY_ST	Universal Identification derived as a function of the SoundEx method as described in the Technical Brief.
Severity	EMIS	SEVERITIES_VTTI	EnforcementScore	Severity can be Acute, Critical or Other.
Time Weight	EMIS	ENFORCEMENTS	SHIPPING_DATE	Date associated with violation.
Multiple Enforcement Weight	EMIS	ENFORCEMENTS	SHIPPING_DATE	Date associated with violation.
Material Weight	No data was available	No data was available	No data was available	Hazardous material weight should be based on tabular data from document by ABSC company.

INSPECTION SCORE

The Inspection Score also consists of four weighted variables: Severity, Time, Multiple Violations, and Material.

$$\textit{Inspection Score } (I_N S) = \sum S_I * W_T * W_{MV} * W_{Ma} \qquad \textit{Eq. 4}$$

Where:

S_E = Severity
W_T = Time Weight
W_{MV} = Multiple Violation Weight
W_{Ma} = Material Weight

Each citation section in the code is assigned a severity level (provided to VTTI by FMCSA). The weights are directly proportional to the severity, and again a greater severity is assigned a greater weight. The Time variable is calculated in the same manner as it was for the Enforcement Score. A greater value is assigned for a more recent violation, but decreases over time. Again, the multiple violations variable accounts for the frequency of violations. Last, the material weight is defined by the same table used for the Enforcement Score (shown in Appendix B). The product of all four variables becomes the individual violation score. Again, all individual violations scores are summed to provide the Inspection Score for a given shipper.

Table 2 contains the Inspection Score variables and the associated locations within the locally housed databases created by VTTI for calculating the algorithm. This table should aid in the integration process by identifying the specific data capture locations.

Table 2. Inspection Score Variables and Associated Database Locations

Variable	Database	Table	Columns	Description
U_ID	HMPIP	SHIPPERS	SHIPPERS_NAME, SHIPPERS_CITY, SHIPPERS_STATE	Universal Identification derived as a function of the SoundEx method as described in the Technical Brief.
Severity	HMPIP	SEVERITIES_VTTI	InspectionScore	Determined as Level I or Level II based on provided document in report Appendix A.
Time Weight	HMPIP	SHIPMENTS	SHPPING_DATE	Date associated with Inspection.
Multiple Violation Weight	HMPIP	SHIPMENTS	SHPPING_DATE	Date associated with Inspection.
Material Weight	HMPIP	SHIPMENTS	HMCLASS	Hazardous material weight based on tabular data from ABSC document.

INCIDENT SCORE

The incident score is comprised of four weighted variables: Severity, Time, Multiple Incidents, and a variable accounting for Undeclared Shipments.

$$\textit{Incident Score } (I_T S) = \sum (S_I + US) * W_T * W_{MV} \qquad \textit{Eq. 5}$$

Where:
S_I = Severity
US = Undeclared Shipment
W_T = Time Weight
W_{MV} = Multiple Violation Weight

The Severity, Time, and Multiple Incident variables are all calculated in the same fashion as previously explained. The severity of an incident can be defined as serious, significant, or minor. The associated weights are 5, 3, and 1 respectively. Due to a lack of citation and severity information, VTTI used a constant severity of 3 for the Incident Score calculations. When citation and severity information from the HMIRS database is available, that information should be used to increase the accuracy of the algorithm scores. Furthermore, the Incident Score accounts for undeclared shipments. This is done by adding a weighted value to the severity variable for an undeclared shipment. There are two types of undeclared shipments, undeclared-no-release or cargo-tank-no-release. As of 2005 this information is noted on Hazardous Materials Incident Report Form 5800.1. Each individual incident score is calculated by summing the

severity-variable value with the Undeclared Shipment variable if necessary, and then multiplying that value by the Time variable and Multiple Incident variable. The Incident Score is the sum of all individual incident scores for a given shipper.

Table 3 contains the Incident Score variables and the associated locations within the locally housed databases created by VTTI for calculating the algorithm. This table should aid in the integration process by identifying the specific data capture locations.

Table 3. Incident Score Variables and Associated Database Locations

Variable	Database	Table	Columns	Description
U_ID	HMIRS	SHIPPER	S_NAME, S_CITY, S_STATE	Universal Identification derived as a function of the SoundEx method as described in the Technical Brief.
Severity	No data was available	No data was available	No data was available	Severity should be based on values from ABSC document.
Undeclared Shipment	HMIRS	MATERIAL	UNDECLAR	Box marked on form 5800.1. Also noted in the HMIRS.
Time Weight	HMIRS	IncidentReports	Date of Incident	Date associated with Incident.
Multiple Incident Weight	HMIRS	IncidentReports	Date of Incident	Date associated with Incident.

DATA LIMITATIONS

This report has identified many data limitations that affect the results generated by HMSPA. The first limitation was the lack of Material weights received in the EMIS query. Therefore, all Material weight values were set to a constant of 1 to remove the effect of Material from the algorithm's calculation. During FMCSA's implementation of HMSPA, it is recommended that FMCSA use the Material codes from EMIS to determine the Material weight values as specified by ABSC (shown in Appendix B) to increase the algorithm's accuracy.

The second limitation was the lack of Severity data in the HMIRS database necessary for determining an Incident score; therefore, a constant severity value of 3 was used for all I_TS calculations. It is recommended that this information be populated within HMIRS to increase the algorithm's accuracy.

FMCSA provided a key that translated each CFR section number to the appropriate severity level which allowed VTTI to develop a data table to be used HMSPA to determine final severity

values. The third limitation involved inconsistent severity levels associated with a particular CFR section number. For instance, CFR section number 172.205(a) is associated with both Severe Level 1 and Severe Level 2 (see Appendix A). The CFR section numbers where discrepancies are present should be addressed so algorithm accuracy is maintained.

The fourth limitation was the lack of consistent shipper identification between databases (i.e., HMPIP, HMIRS, MCMIS, and EMIS). A unique identifier was generated by using a technique called Soundex. Until a primary key for shipper identification can be established across the four databases, the Soundex technique is needed for HMSPA to function. To improve the accuracy of HMSPA, it is recommended that a primary key be established across the four databases.

FINAL IMPLEMENTATION ISSUES

VTTI anticipates certain implementation issues may arise during the transitional process of the web application from VTTI to FMCSA. These issues and potential solutions are detailed here for the purposes of ensuring the best transition possible. The login credentials portion of the web application was created as a placeholder for such a function when implemented. VTTI does not have access to, nor control of login information of FMCSA personnel. The login credentials section on the HMSPA index page will need to be connected to the FMCSA system by FMCSA personnel in order to work. VTTI also included a feedback portion of the web application. This feature includes an input text box and submit button. The destination of the text submission will need to be set by FMCSA personnel to work as designed.

There are several navigation buttons on each page. These buttons are designed to aid the user in navigating throughout the web application. VTTI has concern that the implementation process may change the true locations of each page and the navigation buttons will need to be updated accordingly. At this time, the "Results" navigation button has been left inactive. This was left inactive because after a list of shippers has been generated and a user navigates to another page, returning to the prioritization results page will result in viewing a table with no shippers listed. Some sort of memory logic must be implemented within FMCSA in order to supply a shipper list upon return to the page. After this logic has been implemented, the "Results" navigation button can then be re-activated.

If the event occurs when new territories are required to be updated within HMSPA, certain application development will be required. For example, if a new territory has been identified within the United States, the Prioritization Selection page will need to have this territory added to the appropriate service center column and associated program code amended. In addition, the four databases would need to be populated with new data for this territory in order for results to be generated. In the event of the need to add new territories outside of the United States jurisdiction, such as Mexican and Canadian territories, the Prioritization Selection page will need changes to the map, and an addition of a new column containing territory choices. In addition, the four databases would need to be populated with new data for these territories in order for results to be generated. If a new database has been established for housing new territory data, a large effort will be needed to adjust HMSPA.

HMSPA software files transferred to FMCSA on January 31, 2009 were as follows:

- EMIS.mdf
- EMIS_log.ldf
- HMIRS.mdf
- HMIRS_log.ldf
- HMPIP_log.ldf
- HMSPA.war
- README.txt

REFERENCES

Agresti, A. (2002). *Categorical data analysis* (2nd ed.). New York: Wiley-Interscience.

Pipeline and Hazardous Materials Safety Administration, (2008). Office of hazardous materials safety: incident reports database search. Retrieved August 1, 2008 from: https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/.

Schaudt, W.A., Bowman, D., Marinik, A.R., Baker, S., Trimble, T.E., and Hanowski, R.J., (In Press). *Development of Hazardous Materials (HM) Shipper Prioritization Program Final Report* (Contract No. TMC75-07-H-00008). Washington, DC: Federal Motor Carrier Safety Administration.

APPENDIX A: HM SHIPPER SEVERE VIOLATIONS

HM Shipper Severe Violations

Citation	Type	Description
107.608	Severe Level II*****	Offering a hazardous material for transportation without having registered with the Department of Transportation, under Subpart G of Part 107.

Citation	Type	Description
172.200(a)	Severe Level I	Offering a hazardous material without preparing a shipping paper. (Use for nothing prepared).
172.201(e)	Severe Level II	Offerer fails to maintain a copy of the HM shipping paper as prescribed for 375 days (two years after Jan 9, 2006) after the date accepted by the motor carrier.
172.202(a)	Severe Level II	Failing to enter the proper description of a hazardous material on a shipping paper. (Use for incorrect or incomplete shipping papers or to consolidate multiple shipping paper violations).
172.203(a)	Severe Level II	Failing to enter on a shipping paper the notation "DOT-E" followed by the exemption number.
172.203(c)(1)	Severe Level II	Failing to enter the hazardous substance constituent on a shipping paper when not identified by the proper shipping name.
172.203(d)	Severe Level II	Failing to include on shipping papers for a shipment of radioactive material physical and chemical form, activity, and category of label.
172.203(m)	Severe Level I	Failing to enter the words "Poison Inhalation Hazard" or "Toxic Inhalation Hazard" on the shipping paper when required.
172.203(n)	Severe Level II	Failing to enter the word "HOT" on the shipping paper for elevated temperature materials as required.
172.203(o)	Severe Level I	Failing to include the additional required information for organic peroxides or self reactive materials on shipping paper.
172.205(a)	Severe Level I	Offering a hazardous waste without a hazardous waste manifest.
172.205(a)	Severe Level II	Failing to properly prepare a hazardous waste manifest. (Use for an incorrect or incomplete hazardous waste manifest).
172.205(b)	Severe Level II	Failing to prepare the hazardous waste manifest in accordance with 40 CFR Part 262.
172.313(a)	Severe Level I	Failing to mark a package of hazardous materials with the words "Inhalation Hazard" when required.
172.301(a)(1)	Severe Level II	Failing to properly mark a non-bulk package of hazardous material with the proper shipping name and identification number.
172.320(a)	Severe Level II	Failing to mark a package containing Class 1 material with the appropriate EX-number. (Check for applicable exceptions before citing).
172.326	Severe Level II	Failing to properly mark a portable tank of hazardous materials with the proper shipping name and identification number.

172.326(c)(2)	Severe Level II	Failing to provide to a motor carrier the required identification numbers for a portable tank.
172.328(a)(1)	Severe Level II	Failing to provide to a motor carrier the required identification numbers for a cargo tank.
172.328(a)(2)	Severe Level II	Offering a cargo tank containing hazardous material that has not been marked with the required identification number.
172.400(a)	Severe Level II	Failing to properly label a package of hazardous materials.
172.403	Severe Level II	Failing to affix the correct label to a package of radioactive material.
172.506(a)	Severe Level II	Failing to provide the required placards to a motor carrier.
172.600(c)(1)	Severe Level II	Failing to provide emergency response information.
172.604(a)	Severe Level II	Failing to provide an emergency response telephone number.
172.604(a)(1)	Severe Level II	Failing to provide an emergency response telephone number that is monitored at all times that a hazardous material is in transit.
172.604(a)(2)	Severe Level II	Failing to provide the 24-hour emergency response telephone number of a person who is knowledgeable of the hazards and characteristics of the hazardous materials being shipped (of a person who does not have comprehensive emergency response and accident mitigation information).
172.704(a)	Severe Level II	Failing to train hazardous material employees as required. (Use when at least 10% of hazardous material employees are not trained as required).

Citation	Type	Description
173.21(a)	Severe Level I	Offering a forbidden material for transportation.
173.21(e)	Severe Level I	Offering for transportation materials, which if combined, would likely cause a dangerous evolution of heat, flammable or poisonous gas or vapor, or a corrosive material.
173.22(a)(2)	Severe Level I	Offering a hazardous material in an unauthorized package.
173.24(b)(1)	Acute	Transporting hazardous materials in a portable tank that has an identifiable release of hazardous materials to the environment.
173.24(b)(1)	Acute	Transporting hazardous materials in a cargo tank that has an identifiable release of hazardous materials to the environment.
173.24(b)(1)	Acute	Transporting hazardous materials in a non-bulk packaging that has an identifiable release of hazardous materials to the environment.
173.24(b)(2)	Severe	Offering for transportation a hazardous material in

	Level I	a package that resulted in the effectiveness of the package being substantially reduced.
173.24b(d)(2)	**Severe Level I**	Loading a cargo tank with a hazardous material that exceeds the maximum weight of lading marked on the specification plate.
173.25(a)(2)	**Severe Level II**	Failing to properly mark an overpack with the proper shipping name and ID number for materials contained within.
173.25(a)(2)	**Severe Level II**	Failing to properly mark an overpack with the proper labels for materials contained within.
173.25(a)(2)	**Severe Level II**	Failing to properly orient packages subject to the marking requirements of 172.312 in an overpack.
173.30/177.848(d)	**Severe Level I**	Loading hazardous materials not in accordance with the segregation table.
173.30/177.834(g)	**Severe Level II**	Failing to brace containers of hazardous materials to prevent relative motion between containers.
173.30/177.835(a)	**Severe Level II**	Loading into or on, or unloading a Class 1 (explosive) material from a motor vehicle with the engine running.
173.33(a)	**Severe Level I**	Offering or accepting for transportation a hazardous material in an unauthorized cargo tank motor vehicle.
173.33(a)(2)	**Severe Level I**	Transporting or loading two or more materials in a cargo tank motor vehicle that resulted in an unsafe condition (fire, explosion, etc.)
173.33(b)(1)	**Severe Level I**	Transporting in a cargo tank motor vehicle a hazardous material that had a dangerous reaction when in contact with the tank.
173.33(c)(5)	**Severe Level I**	Loading a division 6.1 material in a cargo tank having a maximum allowable working pressure of less than 25 psig.
173.33(e)	**Severe Level I**	Transporting (Division 6.1 material, oxidizer liquid, liquid organic peroxide, or corrosive liquid) in cargo tank piping without bottom damage protection devices meeting the requirements of § 178.337-10 or § 178.345-8(b).
173.33(e)	**Severe Level I**	Transporting (Division 6.1 material, oxidizer liquid, liquid organic peroxide, or corrosive liquid) in cargo tank piping while using a sacrificial device to satisfy accident damage protection requirements.
173.40(d)	**Severe Level I**	Offering a cylinder charged/filled with a poisonous material without providing additional protection as required.
173.301(d)	**Severe Level II**	Offering manifolded (interconnected) cylinders except as authorized.
173.301(e)	**Severe**	Offering a charged/filled cylinder that has a

	Level II	removable contamination in excess of 22 dpm/square cm.
173.443(b)	**Severe Level II**	Offering a package of radioactive material with removable contamination in excess of 220 dpm/square cm.
173.447	**Severe Level I**	Storing in one-area packages of radioactive material that exceed a total Transport Index of 50.
173.457(b)(3)	**Severe Level I**	Offering a fissile material, controlled shipment in a conveyance containing other packages of any Class 7 (radioactive) material required to bear one of the labels prescribed in 49 CFR 172.403.

APPENDIX B: TABLE OF MATERIAL WEIGHTING FACTORS

Material Weighting Factors

Class and Division	Weighting Factor
1.1 Explosives - mass detonating	10
1.2 Explosives - projectile hazard	10
1.3 Explosives - fire hazard	10
2.1 Flammable Gases	10
2.3 Toxic Gases	10
6.1 Toxic Substances - Zones A and B	10
7 Radioactive [Highway Route Controlled Quantity(HRCQ)]	10
1.5 Explosives - insensitive mass detonating	5
4.3 Water Reactive Materials	5
5.1 Oxidizing Substances	5
5.2 Organic Peroxides	5
6.1Toxic Substances - except Zones A and B	5
1.4 Explosives - no significant blast hazard	2
2.2 Non-flammable Gases	2
3 Flammable/Combustible Liquids	2
4.1 Flammable Solids	2
4.2 Spontaneously Combustible Materials	2
7 Radioactive (except HRCQ)	2
1.6 Explosives - extremely insensitive	1
6.2 Infectious Substances	1
8 Corrosive substances	1
9 Miscellaneous materials	1