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16. Abstract

The effective management of incidents is necessary in order to maintain efficient freeway operations. Within the Virginia Department of Transportation (VDOT), there are a number of units responsible for supporting incident management. These groups collect data describing the incidents they manage in order to facilitate real-time coordination and to allow for post-event analysis to improve incident management practices. However, the units generally collect different data elements and describe incident characteristics in different ways. This significantly reduces the value of these data. The purpose of this research project was to develop statewide incident data collection standards for use in VDOT freeway operations.

The standard developed in this research includes the following 15 data elements:
1. Unique ID
2. Incident Type
3. Incident Severity
4. General Description
5. Agencies Responding
6. Reversible High-Occupancy Vehicle Facility State
7. Lanes Closed
8. Route
9. Nearest Mile Marker
10. City or County
11. Direction
12. Start Time
13. End Time
14. Video Coverage
15. Detection Source

This standard is beneficial in that it supports regional and statewide coordination of incident management and fully supports the incident management performance measures recently adopted by VDOT's Statewide Incident Management Committee. Furthermore, the VDOT standard is shown to comply with national intelligent transportation systems standards related to incident management. Risks of implementing the standard include a possible increase in data entry requirements and the potential need to modify software and databases slightly at some of VDOT's transportation management systems.

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FINAL CONTRACT REPORT

**DEVELOPMENT OF INCIDENT DATA COLLECTION STANDARDS
FOR VIRGINIA DEPARTMENT OF TRANSPORTATION FREEWAY OPERATIONS**

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INTRODUCTION

In order to provide a high level of mobility to travelers, the Virginia Department of Transportation (VDOT) has taken action to operate the extensive freeway system as efficiently as possible. One of the most critical requirements to efficient freeway operation is the effective management of incidents. VDOT's safety service patrols (also referred to as freeway incident response teams), Smart Traffic Centers (STCs), Transportation Emergency Operations Center (TEOC), and other district-level entities all have significant responsibilities in incident management. In addition, each of these entities collects and stores data describing incidents that they manage. These data are used (1) to support regional and statewide coordination of incident management, and (2) to plan for improved response to future incidents.

While each VDOT entity does collectcollects incident-related data, there is no statewide standard. This lack of a standard has reducedreduces the effectiveness of VDOT incident management efforts and hampers improvements in operations. In short, existing incident data sets are often unreliable and not relatable as follows:

- They are unreliable in the sense thatbecause STC operators, safety service patrollers, and TEOC managers frequently use variations in nomenclature in describing incident characteristics, and in the interest of time, operators/patrollers often do not enter complete data. In terms of analysis, this means that while there may be two nearly identically managed incidents, in data terms, they may appear very different and thus will be either analyzed differently or discounted altogether.

- They are not relatable in the sense that the STCs, safety service patrols, and the TEOC use different formats when capturing information on incidents to which they respond.

For VDOT to improve its incident management efforts, it must develop a better way of capturing incident data for center-to-center sharing and operational analysis. In its session on October 30, 2003, the Virginia Transportation Research Council's Intelligent Transportation Systems (ITS) Research Advisory Committee acknowledged these issues and requested that a solution, i.e., incident data collection standards, be developed. In a separate vein of activity, the VDOT Statewide Incident Management (SIM) Committee has met on a bi-monthly basis in the winter and spring of 2005 to address the need for a common set of performance measures across VDOT's STC operations. Given that the set of measures are underpinned by available data, the research team worked closely with the SIM Committee in establishing a freeway incident data standard.

The benefits of the development and application of a common incident data collection standard for VDOT will be realized in more effective incident management via improvements in data analysis and center-to-center coordination.

- *Improvements in data analysis*. Currently, VDOT operational entities are unable to compare or relate their incident data to other organizations effectively or efficiently, thereby limiting improvements in their operations relative to incidents and inter-organization coordination. However, the existence of an incident data standard will enable transportation professionals to improve incident management by better understanding what has happened in the past. For example, a comparison of incidents from STC to STC would be feasible.

- *Improvements in center-to-center sharing*. A common incident data collection standard would make immediate sharing of incident data within Virginia a reality, improving regional situational awareness. Further, the TEOC could develop an active visualization of all on-going incidents within STC regions without being required to re-enter incident information.

- *Improvement in mobility*. The importance of incident management to the mobility of Virginia travelers is clear. A recent analysis by the Smart Travel Laboratory revealed that between 25% and 40% of congestion on Hampton Roads freeways is due to incidents. This congestion, which results in lost time, hurts the local economy and Virginia's economy (through hurting the competitiveness of the ports) and national security (due to the heavy military presence in the region). Of course, this does not take into account the stress and inconvenience congestion causes to the citizens of the Commonwealth. In short, any activity of VDOT that can reduce congestion caused by incidents results in significant benefits.

PURPOSE AND SCOPE

The purpose of this research was to develop a practical, meaningful, and relatable incident data collection standard for VDOT to implement statewide. The scope was limited to freeway incidents.

METHODOLOGY

To meet the objectives of this research, the following tasks were completed.

1. *Review of Current VDOT Practice*. A review of existing VDOT transportation management systems' incident data elements was conducted. The systems' incident-related data sets were collected and a high-level analysis was performed. Features similar in name, definition, or data content were grouped so that basic usage trends could be identified. Commonly used, high-level, incident information were was reviewed from the following systems:

- VDOT Systems:
    - Smart Traffic Centers (Hampton Roads, Northern Virginia, Richmond, Staunton)
    - Safety Service Patrol in Northern Virginia
    - Virginia Operational Information System (VOIS)
    - Virginia Archived Data Management System

- Maryland State Highway Administration's Statewide Freeway Management System (CHART)

- Virginia State Police Computer Aided Dispatch System

- The Capital Wireless Integrated Network.

Finally, once the common data elements were grouped and identified, their usage in each of the systems listed was tallied. This provided the research team with a measure of the importance of each element in statewide operations. In tandem, the research team also interviewed key VDOT personnel in both operations and incident data analysis. This allowed the research team to assess how well each potential implementation of incident data elements supported will support both operations (i.e., real-time coordination of incident management), and analysis (i.e., post event review of incident data to identify ways to improve incident management). Task 1 culminated with a first set of incident data elements that served as candidate components of the incident data standard.

2. *Refinement of Standard with VDOT's SIM Committee*. As VDOT's SIM Committee worked in the winter and spring of 2005 to establish statewide incident management

performance measures, the research team participated actively with the committee to ensure that the incident data standard effectively supported the adopted measures. The research team's activities in this task included:

- Participating in statewide committee meetings

- Contributing draft incident data standards to facilitate committee discussion and feedback

- Conducting one-on-one discussions with key committee members to solicit more detailed feedback

- Refining the draft incident data standard to ensure it effectively supported the measures adopted by the committee.

3. *Analysis of ITS Standards*. An important consideration in developing the VDOT incident data standard was to ensure that it is compliant with appropriate national standards. The national intelligent transportation systems (ITS) program has developed a number of standards related to incident management. In this task, these standards were analyzed from two perspectives:

- Are elements of VDOT's incident data standard defined in a compatible manner with ITS standards?

- How should VDOT's incident data standard elements be named and recorded to ensure compatibility with ITS standards?

ITS standards analyzed in this effort include:

- IEEE Std 1489-1999 – IEEE Standard for Data Dictionaries for Intelligent Transportation Systems

- IEEE Std 1512-2000 – IEEE Standard for Common Incident Management Message Sets for Use by Emergency Management Centers

- ITE/AASHTO Message Sets for External Traffic Management Center Communications (MS/ETMC2)

- ITE TCIP-IM – Transit Communications Interface Profiles

- ITE TMDD – Standard for Functional Level Traffic Management Data Dictionary (TMDD)

- SAE J2353 – Data Dictionary For Advanced Traveler Information Systems (ATIS)

- SAE J2354 – Message Sets for Advanced Traveler Information System (ATIS)

- SAE J2374 – Location Referencing Message Specification (LRMS)

- SAE J2540-2 – ITIS Phrase Lists (International Traveler Information Systems)

A more descriptive listing of the standards used in this effort is presented in Appendix A.

4. *Definition of Final Incident Data Standard.* All of the information and knowledge gained by the research team in Tasks 1-3 was synthesized to define VDOT's freeway incident data standard. Each element of the standard was chosen in order to meet the following objectives:

- minimize data entry

- support incident performance measurement

- support regional and statewide incident management coordination.

Finally, for each data element of the standard, the following information was developed to support its implementation. This essentially provides a roadmap for VDOT to use in implementing the standard.

- Name – a text description of the data element

- Keyword – describes the role of the data element in the standard

- Element – proposed database field name of the data element that meets VDOT's information technology database naming conventions

- Type – defines the data type used to store data for the element

- Description – a paragraph description of the element of the standard

- Example – a brief example showing how the standard may be applied to a VDOT system.

- Standards Compliance – a statement describing how the element meets ITS standards requirements.

RESULTS

Task 1 – Review of Current VDOT Practice

Once incident data elements currently collected by the VDOT transportation management centers (listed in the methodology) were in hand, it was necessary to synthesize this information to support further analysis in developing the statewide incident data standard. To do so, a question was posited: given the review of the data elements (these will also be referred to as "fields" in this report – the common database term used to refer to individual data elements) of these systems, what characterizes an incident, generally? The answer allowed for a grouping of similar elements. The results of this effort was captured in the form of a sentence, the first part of which, "*An incident is characterized by . . .*" was later followed by the response and resulting category. This assisted in grouping common elements – for example, (as seen in Table 1) a response to the second half of this statement includes "a description of its spatial characteristics." Thus a grouping could be pursued, across all systems, of that type and kind of data. In this instance, spatial characteristics could encompass such elements as latitude and longitude, or road name, or direction. By examining both a category (seemingly related fields), and a preference (a count across systems within a specific field), it was then possible to identify trends of common expression and need; an initial set of possible fields for a common incident data standard. Table 1 presents the initial results of this activity.

As is evident in Table 1, the results of this task serve asprovide an initial set of high-level incident characteristics that serve as the underpinnings of an incident data standard. In the next step, the research team examined the usage of each of the elements in current VDOT systems (i.e., those listed in Task 1's methodology). For each category, the team considered how the category was "implemented" by each system. For example, in the category of spatial characteristics, the team counted how many systems used latitude and longitude, mileposts, etc. Note that the team considered the practice of a center or system, not simply its published database structure. For example, if a system has fields to collect latitude/longitude location information, yet rarely does so in practice, this is not "counted" in this task. Finally, the team interviewed VDOT experts to ascertain how well each implementation supported incident management operations, and incident data analysis. The results of this effort are displayed in Tables 2 through 6, where each table focuses on a particular set of incident characteristics. The assessment of the ability to support analysis and operations is presented in the final two rows of each table.

Table 1. Common Data Elements in VDOT Transportation Management Systems

An incident is characterized by . . .	Description
a unique identifier.	Elements that provide the incident with a unique name or number to assure its differentiation from other incidents identified within the data repository.
a description associating this incident with another.	Fields that link this incident with others that have occurred as a result of the first event.
a description of its spatial characteristics.	Elements that define the incident's spatial location.
a description of its temporal characteristics.	Elements that define the incident's time elements.
an identification of the data input source.	Elements that define the individual or organization who input the data.
an identification of the detection source.	Fields that typically identify the source of the detection. For example: CCTV visual, VSP CAD, Motorist call-in, VDOT SSP, VDOT employee, VDOT maintenance, etc.
a characterization of its state or status.	Fields typically describing whether or not the incident is active.
its capacity impact.	Fields detailing impact, such as blocked lanes or shoulders or congestion extent characterized in terms of time or space.
an identification of type.	This grouping is a classification of the type of incident. For example: crash, disabled vehicle, debris, etc.
a categorization of severity.	This grouping is a classification of the severity of the incident. In practice, this varies greatly, but examples would include: major, minor, etc.
a description of the transport entities involved in the incident.	The characteristics of the entities involved within the incident – pedestrians, cars, trucks, etc.
a recommendation for response and resolution.	This grouping conveys information about the characteristics of incident – what is needed to resolve the incident from vehicles provided, to agencies involved.
a description of the local weather conditions.	Information about the local weather conditions at the time of the incident.
a description of the local infrastructure.	Information about the physical characteristics of the infrastructure neighboring the incident – for example, a pothole, or a guardrail failure, etc.
being able to coordinate with others.	An indicator that other systems, or agencies, have been notified by the system or via other means.
a description of the human factors, reasons, and safety characteristics of the event.	This grouping provides information about the injuries or fatalities at the scene, who they are (in terms of civilian or agency – non-name specific), and the initial anticipated reasons for the crash.

Table 2. Spatial Characteristics

An incident is characterized by…	Lat-long segments	Lat-long points	Text description	Mile markers	Road name	City/County	Mile from/Mile to	Pre-defined corridores or special locations	Direction (N/S/E/W)	Duty post	Link/Node/Off-set	State
SYSTEMS												
VDOT HR STC	X			X	X		X		X			
VDOT NOVA STC (current paper form)								X				
VDOT NOVA STC (old data form)								X				
VDOT NOVA SSP		X			X	X			X			X
VDOT Staunton STC		X	X	X	X		X		X			
VDOT Richmond STC		X	X	X	X		X		X			
VDOT VOIS*			X			X						
VDOT/VSP/DMV CAPS/HTRIS				X		X					X	
MDSHA CHART			X									
VSP CAD			X							X		
CapWIN			X			X						X
Analytical need*	X	X	X	X	X	X	X	X	X	X	X	X
Operational need*		X	X	X	X	X	X		X			
Count	2	5	8	6	6	6	5	3	6	2	2	3

Table 3. Temporal Characteristics

An incident is characterized by…	Start date	Start time	End date	End time	Duration	Duration est.	Active/inactive	Time asst. on scene (time response)	Est. back-up (time impact)	Day of week	Arrival/departure time of all responders	Notify date & time (response/communications)
SYSTEMS												
VDOT HR STC	X	X			X		X	X				
VDOT NOVA STC (current paper f	X	X	X	X				X	X			
VDOT NOVA STC (old data form)	X	X	X	X	X	X						
VDOT NOVA SSP	X	X			X			X				X
VDOT Staunton STC	X	X			X							
VDOT Richmond STC	X	X			X							
VDOT VOIS*	X	X										
VDOT/VSP/DMV CAPS/HTRIS	X	X								X		
MDSHA CHART	X	X	X	X								
VSP CAD	X	X	X	X								
CapWIN	X	X										
Analytical need*	X	X	X	X								
Operational need*	X	X	X	X	X			X	X		X	X
Count	13	13	6	6	6	1	1	4	2	1	1	2

Table 4. Incident Response Characteristics

An incident is characterized by…	…an identification of type:	…a categorization of severity:	…a description of the units involved:				…a description of transport entities involved in the incident:				…a recommendation for response and resolution:			
			VDOT	Police	Fire/EMS	Other	Vehicle	Pedestrians	Number of entities involved	Transport entity characteristics	Type of assist	Status	Watched/monitored	Juris/agencies involved
SYSTEMS														
VDOT HR STC							X				X			X
VDOT NOVA STC (current paper form)	X						X							
VDOT NOVA STC (old data form)		X					X					X		
VDOT NOVA SSP	X						X			X	X			
VDOT Staunton STC	X												X	
VDOT Richmond STC	X												X	
VDOT VOIS*	X	X					X							
VDOT/VSP/DMV CAPS/HTRIS		X					X	X	X	X				
MDSHA CHART	X						X							
VSP CAD	X													
CapWIN														
Analytical need*														
Operational need*	X	X	X	X	X	X	X	X	X	X	X			X
Count	8	4	1	1	1	1	8	2	2	3	3	1	2	2

Table 5. Incident Detection and Impact

An incident is characterized by…	...a unique identifier:		…a description associating this incident with another:	…an identification of the data input source:		…an identification of the detection source:	…a characterization of its state or status:	…being able to categorize its capacity impact:		
SYSTEMS	Unique ID number	Unique ID name	Associative link (secondary incident)	User name	Update date/time	Sensory network/communications		Lanes impacted	Estimated back-up (space/time)	Shoulders
VDOT HR STC	X					X		X		
VDOT NOVA STC (current paper form)				X		X		X		
VDOT NOVA STC (old data form)	X			X	X			X	X	X
VDOT NOVA SSP						X		X		
VDOT Staunton STC	X			X	X	X	X	X		
VDOT Richmond STC	X			X	X	X	X	X		
VDOT VOIS*										
VDOT/VSP/DMV CAPS/HTRIS	X									
MDSHA CHART		X						X		
VSP CAD	X									
CapWIN										
Analytical need*	X									
Operational need*			X				X	X	X	X
Count	7	1	1	4	3	5	3	8	2	2

Table 6. Miscellaneous Incident Characteristics

An incident is characterized by…	…a description of weather conditions:	…a description of the local infrastructure:	…being able to coordinate with others:			…a description of the human factors, reasons, and safety characteristics of the event:				
SYSTEMS	Conditions	Description	Incident/event POC	External entity notification verification	Internal entity/system notification	VDOT personnel - injury/fatality	Non-VDOT personnel - injury/fatality	Police on scene performing reconstruction	Police complete with reconstruction	Crash reason
VDOT HR STC	X									
VDOT NOVA STC (current paper form)				X	X					
VDOT NOVA STC (old data form)	X									
VDOT NOVA SSP	X				X					
VDOT Staunton STC			X		X					
VDOT Richmond STC			X		X					
VDOT VOIS*	X		X	X	X					
VDOT/VSP/DMV CAPS/HTRIS	X	X	X							
MDSHA CHART										
VSP CAD										
CapWIN										
Analytical need*										
Operational need*						X	X	X	X	X
Count	5	2	4	2	5	1	1	1	1	1

The research team next examined the field counts for each table. Large field counts indicate that the data element has a level of importance, given the fact that many systems have made the effort to capture the element. In order to reduce the number of data elements to consider in depth, the research team assumed that in cases where the counts are greater than 6, preference was indicated. These cases are described here:

- " . . . a unique identifier," in Table 1.3, a **unique ID number** is dominant.

- ". . . a description of its spatial characteristics (location)," in Table 1.1 there are several widely used fields:
  - Text description
  - Mile markers

- Road name
- City/County
- Direction

- ". . . a description of its temporal characteristics (time)," in Table 1.2, the following were frequently used fields:
  - Start date
  - Start time
  - End date
  - End time

- ". . . being able to categorize its capacity impact," in Table 1.3, **Lanes impacted** was dominant.

- "…an identification of type," in Table 1.4, identified that **type** was dominant.

- "…a description of transport entities involved in the incident," in Table 1.4, demonstrating that a description of **vehicles** involved was dominant.

Thus, at the conclusion of Task 1, the first set of potential elements of an incident data standard was isolated. These elements included: a unique ID number; a text description; identification of mile markers, road name, the city or county, and direction; the start date/time and the end date/time; the lanes impacted; the type of the incident; the vehicles involved in the incident.

Task 2 – Refinement of Standard with VDOT SIM Committee

With an initial set of potential elements of an incident data standard identified in Task 1, the research team was well prepared to participate actively in VDOT's winter/spring 2005 effort to establish incident performance measures. This effort was led by the incident management performance measure committee as part of the SIM Committee. The objectives of this committee included:

- Establishing a common definition of an incident

- Establishing the first of a series of common performance measures for incident management relative to transportation services in Virginia

- Identifying data and information necessary to provide for the calculation of the measures.

Thus, tThe research effort described in this report directly addresses the third objective: providing the necessary data to calculate the adopted performance measures. The remainders of the results presented in this section includes those developed jointly with the SIM Committee, and results those that coordinate effectively with the measures the SIM Committee developed.

First, the committee established a common, statewide definition of an incident. This definition, finalized in April 2005, is as follows: *"an incident is an unexpected event that adversely impacts traffic flow."* For the sake of consistency, this definition of an incident shall be included in the final incident data standard.

The second result of the committee was the establishment of the first in a series of common performance measures for incident management. This measure is *the percent of incidents cleared within X minutes.* Obviously, time is the key factor of interest with this measure. Therefore, over several of the committee sessions, it was necessary to define the beginning and the end of an incident. The start of the incident was defined to be when Virginia public services (Virginia State Police, VDOT, localities) become aware of the incident. The end of an incident was to be when all travel lanes are cleared. These important definitions, of course, must be supported in the temporal elements of the final incident data standard.

Finally, the research team worked with the SIM Committee to identify data necessary to provide for the calculation of the initial performance measure, as well as subsequent ones adopted. In terms of need relative to the calculation of performance measures, as well as data the committee considered essential to the general improvement in coordinated operations, the members prioritized data by two levels. Level I data are defined as data needed immediately to support performance measures. Level II data are defined either as less important data, or data not currently consistently collected. The data, by level, are as follows:

- *Level I*
  - First Notification – the time the Virginia State Police, VDOT, or the localities are notified of an incident.
  - All Lanes Cleared – the time all travel lanes have been cleared.
  - Incident Identification # - a unique number to separate this incident from others identified in the system
  - Location – the location of the incident (County, route, mile marker or nearest interchange/intersection, direction of travel impacted, number of lanes affected, shoulder affected).
  - Incident Type – a classification of the type of incident, for example, vehicle crash, truck crash, debris in roadway, etc.
  - Incident Duration – calculated from the start and end times.
  - Visible by CCTV – is the incident visible to a VDOT controlled camera? (Yes or No).

- *Level II*
  - Comment Box – a field where additional incident details may be added.
  - Impact Severity – a classification of incident severity, based on the current one used in VOIS (Virginia Operational Information System).
  - Detection Source – a field allowing VDOT to answer, how did we get the information and from what source?
  - On scene incident responders – for example; Fairfax Co. Police, Alexandria Fire & Rescue, Willow Springs Towing, VDOT SSP.

These elements, combined with those identified in Task 1, served as the basis for defining a draft incident data standard. Next, ITS standards were analyzed to support the finalization of the freeway incident data standard.

Task 3 – Analysis of ITS Standards

The analysis of ITS standards revealed that two classes of standards exist. The first is composed of data dictionary standards. These standards define how common data elements are defined and recorded within ITS databases. Thus, it is important for VDOT's incident data standard to use data definitions consistent with these standards. The second class of standard relative to incident management can be classified as exchange standards. These standards define what and how incident data should be communicated between coordinating systems. Thus, since an objective of this research is to create a VDOT standard that allows for improved incident management coordination, these standards are important. The standards analysis revealed that the key standards in each category are as follows:

Data dictionary standards:

- IEEE Std 1489-1999 Standard for Data Dictionaries for Intelligent Transportation Systems

- ITE TMDD Standard for Functional Level Traffic Management Data Dictionary (TMDD)

Exchange standards:

- IEEE Std 1512 series IEEE Standard for Common Incident Management Message Sets for Use by Emergency Management Centers

- ITE/AASHTO Message Sets for External Traffic Management Center Communications (MS/ETMC2)

Based on an analysis of these ITS standards, the research team worked to formalize incident data elements identified in Tasks 1 and 2. Thus, for each identified element, each standard was examined to determine whether or not the standard offered a field or field description that matched those identified by the committee. If the standard did offer a field that related well, it was used in defining data type and range of responses. FinallyHowever, if, in the exchange standards there could not be found a field that related a related field could not be found in the exchange standards, then the data dictionary standards were examined. The initial review of fields sought by the SIM Committee vs. the ITS standards yielded the identification of select data elements that were compatible. The results of this analysis are summarized in Table 7.

Table 7. Mapping of VDOT Incident Data Elements to ITS Standards

Proposed Data Element	Relationships with National Standards - Data Elements Identified for Possible Definition Linkage
Unique ID	TMDD 3215 - EVENT_Identifier_identifier
Incident Type	IEEE 1512.1-2003 EXT_Incident-Type and the IEEE 1489/TMDD/MS/ETMCC TMDD-DE 3212 EVENT_DescriptionTypeIncident_code
Incident Severity	IEEE 1512.1-2003 EXT_Event-IncidentSeverity and TMDD 3312 EVENT_IncidentSeverity_code
General Description	TMDD 3210 EVENT_DescriptionNotesAndComments_text
Agencies Responding	TMDD 3337 EVENT_OrganizationResponding_identifier and IEEE 1512.1-2000 EXT_IM_ResponseAgencyID_text
RHOV State	IEEE 1512.1-2003 DF_LaneDescriptions or TMDD 3219 EVENT_LanesBlockedOrClosed_code
Lanes Closed	TMDD 3219 EVENT_LanesBlockedOrClosed_code or IEEE 1512.1-2003 EXT_Event-LanesBlockedOrClosedCount
Route	IEEE and TMDD accept LRMS standardization for location. LRMS accepts geocoordinates.
Nearest Mile Marker	IEEE and TMDD accept LRMS standardization for location. LRMS accepts geocoordinates.
City or County	IEEE and TMDD accept LRMS standardization for location. LRMS accepts geocoordinates.
Direction	TMDD 3220 EVENT_LanesDirectionOfTravel_code or IEEE 1512 LINK_Direction_code
Start Time	TMDD 3290 EVENT_TimelineStart_date and TMDD 3291 EVENT_TimelineStart_date and ATIS DateTimePair
End Time	TMDD 3277 EVENT_TimelineEnd_date and TMDD 3278 EVENT_TimelineEnd_date and ATIS DateTimePair
Incident Visible Via STC's CCTV?	TMDD 3706 Device-Organization Operator Identifier and TMDD 3701 Device-Device Identifier
Detection Source	TMDD 3302 EVENT_EventDetectionMethod_code

The result of this analysis served as the basis for the final incident data standard, which included the data element name, its data type, and a brief description of its meaning and responses. This was submitted via email to the members of the SIM Incident Management Performance Measure Committee. Their responses refined and expanded on the proposed fields. The result was the final incident data standard detailed in Task 4.

Task 4 – Definition of Final Incident Data Standard

Based on the results of Tasks 1 through 3, and considering the goals established for the standard as defined in the methodology for Task 4, the research team developed the final incident data standard. This complete standard is presented in Appendix B.

CONCLUSIONS

The freeway incident data standard presented in this report represents an important tool for VDOT to use in improving regional and statewide coordinated incident management, as well as targeted analysis to support improvements in incident management practice.

The following observations resulted from the research team's efforts in developing the freeway incident data standard:

- It is critically important that VDOT use common definitions of incidents and incident characteristics in order to create data that are compatible on a statewide level. These definitions are provided in the proposed standard.

- VDOT does not currently have a single statewide repository for freeway incident data. This would be useful in supporting performance measurement.

- The value of the standard is completely dependent on the diligence that VDOT personnel place on accurate, complete data entry.

RECOMMENDATIONS

1. *VDOT's Operations Management Division should adopt the proposed standard for freeway incident data collection.* The standard developed in this effort should be adopted and used on a statewide basis by all centers and systems collecting freeway incident data. VDOT should collect data describing each of the 15 elements for all freeway incidents that occur in Virginia.

2. *VDOT's Smart Traffic Centers should train its operators on the proper use of the standard.* A policy statement alone will likely be ineffective in making the promise of the incident data standard realized. Those who enter incident data will need training to ensure that they fully understand each data element.

3. *VDOT's Operations Management Division should take the lead in an effort to automate the collection of as many of the elements of the proposed incident data standard as possible.* Manual data entry is an undesirable means to implement the standard. VDOT should seek

opportunities in field technology and system upgrades to automate data entry for each incident.

COSTS AND BENEFITS ASSESSMENT

The expected benefits of implementing the recommendations are as follows:

- Regional and statewide coordination of incident management will improve. By sharing consistent data with agreed-upon meanings, each unit involved in incident management will have a clear, unambiguous sense of the characteristics of the incident. This will allow for quicker, better-informed decisions.

- VDOT will have consistent statewide data for use in performance measurement. This will allow activities such as the operations dashboard to function properly on a statewide basis.

- VDOT will have consistent data to support the post-hoc analysis of incidents. This will support operational planning – identifying what actions did (or did not) work well for particular incidents.

- VDOT's incident data collection practices will comply with national ITS standards, ensuring that incident management activities remain eligible for federal ITS funding.

The expected risks of implementing the recommendations are as follows:

- Operators in VDOT management systems (such as Smart Traffic Centers) may feel an increased burden in data entry. Because of this, VDOT must educate those involved about the benefits of adhering to the standard.

- To help automate the process, VDOT may need to slightly modify software and databases at some of their transportation management systems.

APPENDIX A

INCIDENT DATA-RELATED STANDARDS

IEEE Std 1489™-1999, IEEE Standard for Data Dictionaries for Intelligent Transportation Systems.

IEEE Std 1512-2000, IEEE Standard for Common Incident Management Message Sets for Use by Emergency Management Centers.

ITE/AASHTO Message Sets for External Traffic Management Center Communications (MS/ETMC2).

ITE TCIP-IM, Transit Communications Interface Profiles

NTCIP 1402v01.02, December 2000.

ITE TMDD, Standard for Functional Level Traffic Management Data Dictionary (TMDD), Standard No.

SAE J2353, Data Dictionary For Advanced Traveler Information Systems (ATIS), October 1999.

SAE J2354, Message Sets for Advanced Traveler Information System (ATIS), November 1999.

SAE J2369, Standards for ATIS Message Sets Delivered Over Reduced Bandwidth Media, March 2000.

SAE J2540, Messages for Handling Strings and Look-Up Tables in ATIS Standards, July 2002.

SAE J2540-2, ITIS Phrase Lists (International Traveler Information Systems), February 2002.

SAE J2630, Converting ATIS Message Standards From ASN.1 To XML, Draft of July 2002.

Virginia Department of Transportation – Virginia Route Index, Designated Interstate and Primary Route Numbers, Named Highways, Named Bridges and Designated Virginia Byways, July 1, 2001.

Virginia Department of Transportation – VDOT Standard Codes: County and City/Town, Accepted as a VDOT standard by the Data Administration Steering Committee on 11/5/03.

APPENDIX B

PROPOSED VDOT FREEWAY INCIDENT DATA STANDARD

For every incident, defined as an unexpected event that adversely impacts traffic flow, occurring on a freeway in Virginia, the following data will be collected:

Data Name: **Unique ID**

Keywords: Internal Information

Data Element: UNQ_ID

Data Type: VARCHAR2 (26)

Data Description: A unique identifier that is composed of 5 segments: This element is created by aggregating other elements of the standard. The first segment, excluding the seconds, is 'STRT' YYYYMMDDHHMM (12 characters); the second segment is 'CNTY'; (3 characters); the third segment is 'RTE' (3 characters); the fourth segment is 'DIR' (2 characters); and the fifth is a unique index count for multiple occurrences (2 digits).

Example: For the first incident in this space-time slot, for an incident starting on April 21st, 2005 at 4:34 am in the county of Frederick, affecting the north east traffic flow on Interstate I-81: 200504210434-034-081-16-01

Standards Compliance: The MS/ETMC2-TMDD identifies TMDD 3215 - EVENT_Identifier_identifier as a unique ID field that may be up to 32 characters in length. This standard complies with their requirement.

Data Name: **Incident Type**

Keywords: Incident Characterization

Data Element: TYPE

Data Type: NUMBER (2)

Data Description: A response identifying the type of an incident. 0=Stalled Vehicle; 1=Vehicle Fire; 2= Roadway Debris; 3= HAZMAT Spill; 4=Vehicular Accident; 5=Weather Related Incident; 6=Other; 7 through 15 reserved for standard; 16, 32, 48, 64,..,240 in increments of 16 reserved for local use (i.e. in the future, VDOT could define new incident types, as needed, and code in the >16 range)

Example: A debris in the roadway incident would be coded as: 2.

Standards Compliance: This data element is referred to as the field "EVENT_DescriptionTypeIncident_code" in IEEE 1489/TMDD/MS/ETMCC . Therefore, it is compliant with national ITS standards.

Data Name: **Incident Severity**

Keywords: Incident Characterization

Data Element: SVR

Data Type: CHAR (1)

Data Description: A level of severity of the incident. 0=Routine, 1=Minor, 2=Major, 3=High Profile.

Example: For a stopped vehicle effecting traffic flow in the travel lanes – minor severity: 1

Standards Compliance: This is the current VOIS standard, which was unanimously accepted by the VDOT SIM. It is consistent with both the IEEE 1512.1-2003's "EXT_Event-IncidentSeverity" and the TMDD 3312 "EVENT_IncidentSeverity_code. Per the 1512 document, "...external data element taken from TMDD. A code, which describes the severity of an incident. Each region must define the meaning of the values defined." The values include: noAdditionalInformation (0), otherAdditionalInformation (1), none (2), minor (3), major (4), naturalDisaster (5)." Obviously, 1512 is consistent with the other national standards in this case. VDOT VOIS documentation provides for the determination of severity, including more extensive definitions of the following: Routine – this level is for routine events or maintenance that are of little or no impact; Minor – this level is for minimal notifications; Major – this level requires additional notifications to include the District Office, STC (where applicable), and TEOC Emergency Coordinator; reporting, and possible response; High Profile – this level requires the highest procedures notifications to include the District Office, STC (where applicable), and TEOC Emergency Coordinator; and interagency cooperation and coordination.

Data Name: **General Description**

Keywords: Incident Characterization

Data Element: GNRL_DCCDSC

Data Type: VARCHAR2 (1024)

Data Description: This element allows VDOT personnel to add any additional information concerning the incident that is not required by the other components of the standard. For

example, this may be the Point of Contact - the name, agency, or department, and contact means for a primary responding figure at a given incident.

Example: Truck stalled in right lane and was unable to start engine; repair service has already been requested by the driver. VSP officer providing traffic control. VSP Officer Smith, 555-555-1234.

Standards Compliance: Free text was considered necessary by the VDOT SIM to capture those features, or highlights, of the event that needed to be conveyed but the system (at large) had not captured. This element is not required by national standards – but they do not preclude its use.

Data Name: **Agencies Responding**

Keywords: Incident Characterization

Data Element: AGCY_RSPD

Data Type: VARCHAR2 (1024)

Data Description: A comma separated list of the agencies responding to the scene: 00 = Not used, escape; 01 = Transit Agency ID; 02 = NCIC; 03 = NFIRS; 04 = FARS; 05 - 49 = reserved; 50 - 89 = Local Use (for this standard: 50 = VDOT; 51 = VDOT SSP; 52 = VSP; 53 = Local Police; 54 = Fire; 56 = EMS; 57 = Towing Company; 58 = HAZMAT specialists); 90 = Null (data is null); 91 = Intentionally left blank (not used); 92 = Deleted by device (reset to null); 93 = Data unavailable; 94 = Illegal calculation (e.g. divide by zero); 95 = value out of range; 96 = device malfunction (no value returned); 97 = data expired (data deleted, no longer available); 98 = data suppressed for security or privacy; 99 = unspecified. Where a sequence of agencies may be selected.

Example: For the VSP patrol car responding and performing traffic control for the disabled truck, and for a VDOT SSP who arrived on scene later during the incident: 52,51

Standards Compliance: TMDD and IEEE both offer responding agencies fields, though both are a bit different. For the purposes of this standard, the IEEE 1512.1 field EXT_IM_ResponseAgencyID_text works well. The fields described above correspond to that standard's fields.

Data Name: **RHOV State**

Keywords: Incident Characterization (scene)

Data Element: RHOV_ST

Data Type: CHAR (1)

Data Description: The state of a reversible high occupancy vehicle (RHOV) facility (if needed): 0=open to HOV traffic; 1=open to all traffic (HOV restrictions lifted); 2=closed; 3=non-existent.

Example: For the location in question along I-81 (there are no RHOV facilities on I-81): 3
 For an incident occurring on I-64 in Hampton Roads during a period in which the HOV facility points in the direction in which the incident is occurring: 0

Standards Compliance: IEEE 1512 and TMDD have (TMDD 3219 EVENT_LanesBlockedOrClosed_code) a series of optional fields based on the lane type, which includes HOV, which is included as a descriptor - it is capable of conveying the type of facility, and its state (open/closed/blocked). The field presented here differs, as it is dedicated to RHOV, thus, its format is different, but it still conveys the same type of information.

Data Name: **Lanes closed**

Keywords: Incident Characterization (scene)

Data Element: LANES_CLSD

Data Type: CHAR (16)

Data Description: The number and location of closed lanes at the time in the incident in which the maximum number of lanes were closed (i.e. when the incident most impacted available capcity). One bit per lane; Lanes are numbered from the median out beginning with 1; 0 and 15 represent left shoulder and right shoulder, respectively. 0 indicates an open lane, 1 represents a closed lane.

Example: Along this segment of I-81, near where the truck has been disabled, there are two travel lanes heading northeast. The truck is blocking the right travel lane. Thus, the response would be: 0010000000000000.

Standards Compliance: The present fits 1512.1-2003's "EXT_Event-LanesBlockedOrClosedCount." Also, per the 1512.1, "Number to identify lane. Numbered in each direction, with 1 at the median or the leftmost lane if one-way in this standard. Note that this definition matches Traffic Management Data Dictionary (TMDD) usage.

Data Name: **Route**

Keywords: Incident Location (region and scene)

Data Element: RTE

Data Type: VARCHAR2 (3)

Data Description: A response identifying the VDOT primary or interstate route number as defined by the VDOT Route Index. The range of responses will be from 001 to 895.

Example: For the stalled truck incident, it stalled on Interstate 81, and is therefore represented as: 081.

Standards Compliance: The VDOT route number as required by the VDOT SIM to assure ease of input across all districts relative to incident location. IEEE 1512 and TMDD accept LRMS standardization for location. LRMS calls for the use of latitude and longitude to define location. However, through VDOT GIS data and applications, it is trivial to convert route number and mile marker to latitude and longitude. In such a manner, this data standard, with respect to incident location, may serve both VDOT's legacy, and national standard requirements.

Data Name: **Nearest Mile Marker**

Keywords: Incident Location (regional and scene)

Data Element: MILE_MRKR

Data Type: NUMBER (5,1)

Data Description: A response indicating where the incident occurred to the nearest mile marker; tenths permissible.

Example: For the stalled truck incident, it occurred near Interstate 81 mile marker: 180.2

Standards Compliance: The VDOT nearest mile marker was required by the VDOT SIM to assure ease of input across all districts relative to incident location. IEEE 1512 and TMDD accept LRMS standardization for location. LRMS calls for the use of latitude and longitude to define location. However, through VDOT GIS data and applications, it is trivial to convert route number and mile marker to latitude and longitude. In such a manner, this data standard, with respect to incident location, may serve both VDOT's legacy, and national standard requirements.

Data Name: **City, County, or Town**

Keywords: Incident Location (regional)

Data Element: CNTY

Data Type: VARCHAR2 (3)

Data Description: A response identifying the VDOT City, County, or Town code. For Counties, the range of responses will be from 001 to 099. For Cities and Towns, the range of responses will be from 100 to 399.

Example: For the stalled truck incident, it stalled on Interstate 81 in Frederick County, and is therefore represented as: 034

Standards Compliance: This element simply supplements the LRMS standards. It is not necessary for compliance with ITS standards, yet it is acceptable.

Data Name: **Direction**

Keywords: Incident Location (scene)

Data Element: DIR

Data Type: NUMBER (3)

Data Description: A response indicating the primary direction of traffic flow the incident is impacting. 0=North; 1=East; 2=South; 3=West

Example: For the stalled truck incident, it stalled on Interstate 81 and blocked a lane in the northbound direction, and is therefore represented as: 0

Standards Compliance: The VDOT SIM verified this field as required relative to accurate incident location. MS/ETMCC-TMDD references a field, TMDD 3220 EVENT_LanesDirectionOfTravel_code, which this field's (DIR) responses are consistent.

Data Name: **Incident Start Time**

Keywords: Incident Timeline

Data Element: STRT

Data Type: VARCHAR2 (14)

Data Description: The date and time public agencies are first notified of the incident. Recorded in ATIS DateTimePair format, where the date portion includes: YYYYMMDD; YYYY the year, in common era units; MM the month, range 01 to 12; DD the day, range 01 to 31; and the time portion includes HHMMSS; HH is the hour, range 00 to 24; MM is the minute, range 00 to 59; and SS is the second, range 00 to 59.

Example: For the stalled truck incident starting on April 21st, 2005 at 4:34:24 am: 20040421043424

Standards Compliance: Conforms to ATIS DateTimePair format. TMDD/MS/ETMC2/1489 have multiple fields dedicated to the characterization of an incident in time. However, there exist two fields that are similar to this field in information. The two are separate as one conveys

start date, the other start time. Both relate to the initiation of an event, or incident. The fields are TMDD 3290 EVENT_TimelineStart_date and TMDD 3291 EVENT_TimelineStart_utc. Their format is effectively a split form of the version used by this standard's STRT. The ATIS DateTimePair format is used in 1512 and fits VDOT's needs better as it succinctly captures both date and time.

Data Name: **Incident End Time**

Keywords: Incident Timeline

Data Element: END

Data Type: VARCHAR2 (14)

Data Description: The date and time that all response vehicles have left the scene of an incident and all of the facility's capacity has been restored. Recorded in ATIS DateTimePair format, where the date portion includes: YYYYMMDD; YYYY the year, in common era units; MM the month, range 01 to 12; DD the day, range 01 to 31; and the time portion includes HHMMSS; HH is the hour, range 00 to 24; MM is the minute, range 00 to 59; and SS is the second, range 00 to 59.

Example: For the stalled truck incident ending on April 21st, 2005 at 6:34:24 am: 20040421063424

Standards Compliance: Conforms to ATIS DateTimePair format. TMDD/MS/ETMC2/1489 have multiple fields dedicated to the characterization of an incident in time. However, there exist two fields that are similar to this field in information. The two are separate as one conveys start date, the other start time. Both relate to the initiation of an event, or incident. The fields are TMDD 3277 EVENT_TimelineEnd_date and TMDD 3278 EVENT_TimelineEnd_utc. Their format is effectively a split form of the version used by this standard's END. The ATIS DateTimePair format is used in 1512 and fits VDOT's needs better as it succinctly captures both date and time.

Data Name: **Video Coverage**

Keywords: Internal Information

Data Element: VIS_STC_CCTV

Data Type: CHAR (1)

Data Description: A response identifying whether or not the incident was within a field of view of a VDOT camera. 0=yes; 1=no.

Example: For the stalled truck incident example, along that segment of I-81, there exists no VDOT camera: 1

Standards Compliance: A field unique to this standard.

Data Name: **Incident Detection Source**

Keywords: Internal Information

Data Element: DTCT_SRESRC

Data Type: VARCHAR2 (8)

Data Description: The source of the notification of the incident. From a drop-down list, selectable sub-types include: 0=Aerial Surveillance; 1=Automated Incident Detection; 2=Police; 3=Transit Agency; 4=Traffic Agency; 5=Commercial Traffic Service; 6=Motorist Call-in; 7=Commercial Fleet Operator; 8=DOT; 9 =Other; 10-15 reserved for standard;16-31 for local use - 16=CCTV; 17=police scanner; 18=SSP; 19=VSP CAD; 20=TEOC.

Example: For the stalled truck incident, notification came by way of the VSP: 19.

Standards Compliance: Required per VDOT SIM. The field corresponds to the MS/ETMC2-TMDD field, 3302 EVENT_EventDetectionMethod_code, which simply indicates the detection method for the specified incident. DTCT_SRE SRCmaintains the same primary responses, and, per the TMDD, adds additional 'local' definitions, as identified above in the description. When there is an 'other,' then it may be typed into the General Description.