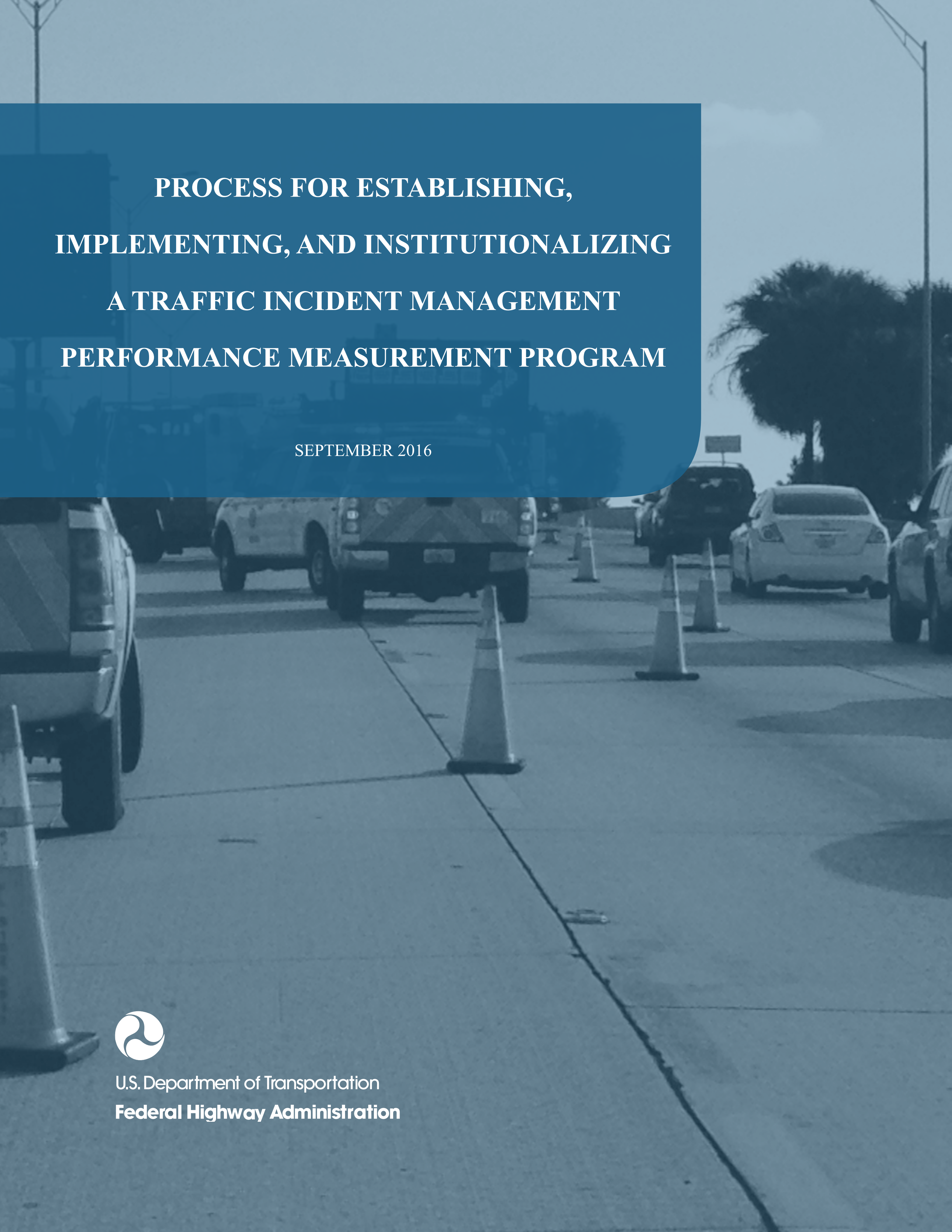

PROCESS FOR ESTABLISHING, IMPLEMENTING, AND INSTITUTIONALIZING A TRAFFIC INCIDENT MANAGEMENT PERFORMANCE MEASUREMENT PROGRAM

SEPTEMBER 2016

U.S. Department of Transportation
Federal Highway Administration

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16. Abstract:

Traffic incident management (TIM) programs have consistently been faced with significant funding challenges. To help justify TIM programs, the benefits of these programs can be shown using the concept of performance measurement. Performance measurement for TIM programs can demonstrate program accountability, process efficiency, and improvements over time; improve communications amongst partners; and support future planning. In addition, Moving Ahead for Progress in the 21st Century Act (MAP-21) requires the establishment of a performance- and outcome-based program in which States invest resources in projects that collectively make progress toward the achievement of national performance goals.

The purpose of this document is to provide a user friendly, easy-to-apply process for establishing, implementing, and institutionalizing a local, regional, or State TIM performance measurement program. The process presented here is based on approaches, practices, techniques, and technologies that have been or can be applied to support a successful TIM performance measures program.

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List of Abbreviations

- Advanced transportation management systems **(ATMS)**
- After Action Review **(AAR)**
- Arizona Department of Public Safety **(AZDPS)**
- Arizona Department of Transportation **(ADOT)**
- Closed-circuit television **(CCTV)**
- Computer aided dispatch **(CAD)**
- Department of transportation **(DOT)**
- Emergency Medical Services **(EMS)**
- Extended duration incident **(EDI)**
- Extract, transform, and load **(ETL)**
- Federal Highway Administration **(FHWA)**
- Florida Department of Transportation **(FDOT)**
- Florida Highway Patrol **(FHP)**
- Freeway and Arterial System of Transportation **(FAST)**
- Freeway service patrol **(FSP)**
- Incident clearance time **(ICT)**
- Incident detection time **(IDT)**
- Incident response **(IR)**
- Incident response time **(IRT)**
- Incident verification time **(IVT)**
- Intelligent transportation systems **(ITS)**
- Memorandum of understanding **(MOU)**
- Metropolitan planning organization **(MPO)**
- Michigan Department of Transportation **(MDOT)**
- Minnesota Department of Transportation **(MnDOT)**
- Minnesota State Patrol **(MSP)**
- Mobility, Accountability, Preservation, Safety and Service **(MAPSS)**

List of Abbreviations (continued)

- Moving Ahead for Progress in the 21st Century Act **(MAP-21)**
- National Cooperative Highway Research Program **(NCHRP)**
- New Jersey Department of Transportation **(NJDOT)**
- Time to return to normal flow of traffic **(NFT)**
- Niagara International Transportation Technology Coalition **(NITTEC)**
- Public-Safety Answering Point **(PSAP)**
- Roadway clearance time **(RCT)**
- Strategic Highway Safety Plan **(SHSP)**
- Tennessee Department of Transportation **(TDOT)**
- Tennessee Highway Patrol **(THP)**
- Traffic and Criminal Software **(TraCS)**
- Traffic Incident Management **(TIM)**
- Traffic Incident Management Enhancement **(TIME)**
- Traffic management center **(TMC)**
- Traffic operations center **(TOC)**
- Traffic Records Coordinating Committee **(TRCC)**
- University of Maryland Center for Advanced Transportation Technology **(UMD-CATT)**
- Virginia Department of Transportation **(VDOT)**
- Virginia State Police **(VSP)**
- Washington State Department of Transportation **(WSDOT)**
- Wisconsin Department of Transportation **(WisDOT)**
- Wisconsin State Patrol **(WSP)**
- Washington State Department of Transportation's Statewide Incident Tracking System **(WITS)**

Introduction

Traffic incident management (TIM) programs have consistently been faced with significant funding challenges. To help justify TIM programs, the benefits of these programs can be shown using the concept of performance measurement. Performance measurement for TIM programs can demonstrate program accountability, process efficiency, and improvements over time; improve communications amongst partners; and support future planning. In addition, Moving Ahead for Progress in the 21st Century Act (MAP-21) requires the establishment of a performance- and outcome-based program in which states invest resources in projects that collectively make progress toward the achievement of national performance goals.

The purpose of this document is to provide a user friendly, easy-to-apply process for establishing, implementing, and institutionalizing a local, regional, or State program for TIM performance measurement. The process presented here is based on approaches, practices, techniques, and technologies that have been or can be applied to support a successful TIM performance measures program.

Intended Audiences

This document is intended for the following audiences:

- Local, regional, and State transportation agencies.
- Local, regional, and State law enforcement agencies.
- Local and regional fire departments.
- Towing companies.
- Emergency Medical Services (EMS).
- Other incident response (IR) organizations.

Organization

The process presented in this document includes the following six steps:

Step 1:

Review traffic incident management performance measures, definitions, and data requirements.

Step 1 presents, defines, and identifies the data elements necessary to calculate the three key traffic incident management (TIM) performance measures, as well as a number of other TIM performance measures.

Step 2:

Determine what data are available.

Step 2 discusses the most common sources of data for TIM performance measurement, the advantages and disadvantages of each type of data source, and other potential data sources. This step also includes a Checklist of Data Elements for use in determining what data are available for TIM performance measurement.

Step 3:

Collect and manage data.

In Step 3, the collection and management of TIM performance data are discussed in terms of example practices used by various agencies. The data elements being collected by these agencies are linked to the Checklist of Data Elements discussed in Step 2. Data collection via traffic management/operations centers, freeway service patrols (FSP), incident response (IR) teams, police computer-aided dispatch (CAD) systems, and statewide crash reports is discussed and illustrated. In addition, practices for overcoming challenges associated with collecting data on secondary crashes are provided. Finally, the management of TIM data, including high-level information on developing a TIM performance measurement database, transferring data between databases, and integrating data, is discussed.

Step 4:

Analyze data and report performance.

In Step 4, the analysis and reporting of TIM performance data are discussed, including both aggregate and disaggregate analyses, as well as the benefits of conduction disaggregate analyses. Examples of the analysis of TIM performance trends; advanced analysis/visualization of TIM data; performance reports, dashboards, and scorecards; and internal use and reporting of TIM performance are provided.

Step 5:

Engage partners in discussions about traffic incident management performance.

Step 5 discusses the importance of looking for and capitalizing on opportunities to discuss TIM performance measurement with TIM partners, sharing and discussing TIM performance goals and objectives, discussing agency roles and coordination, and seeking to fill data gaps through data sharing and integration.

Step 6:

Formalize and/or institutionalize traffic incident management performance measurement.

Step 6 outlines various approaches for formalizing and/or institutionalizing TIM performance measurement at the local, regional, and/or State levels.

Supporting Documentation

National Cooperative Highway Research Program (NCHRP) Project 07-20: ***Guidance on the Implementation of TIM Performance Measurement*** (1)

This project culminated in a guidance document, which provides the background to the development of the three national TIM performance measures, definitions, data sources, and example analyses. In addition, the guidance provides a database schema, data dictionary, and database scripts for creating a TIM performance measurement database.

Corresponding online traffic incident management performance measurement (TIMPM) tool

In addition to this written guidance document on TIM performance measurement, there is a corresponding online guidance tool—TIMPM—which is available via the TIM Network http://nchrptimpm.timnetwork.org/.

STEP 1: Review Traffic Incident Management Performance Measures, Definitions, and Data Requirements

The timeline for a typical incident is depicted in Figure 1.[(2)] Traffic incident management (TIM) performance can be measured in terms of the various time-based components of the incident timeline, as indicated by the colored arrows. To maintain consistency at a national level, the Federal Highway Administration (FHWA) recommends that agencies collect and report three national TIM performance measures: roadway clearance time (RCT), incident clearance time (ICT), and secondary crashes. RCT and ICT are time-based measures and are shown in Figure 1. The definitions, required data elements, and equations for all three national TIM performance measures are listed in Table 1.

The premise of having three national TIM performance measures is to create a defined, sustainable, and comparable basis for TIM program assessment across the boundaries of any given region, allowing for the analysis of national incident response (IR) trends. Consistent and comparable performance reporting is an essential tool in promoting TIM and funding for TIM resources.

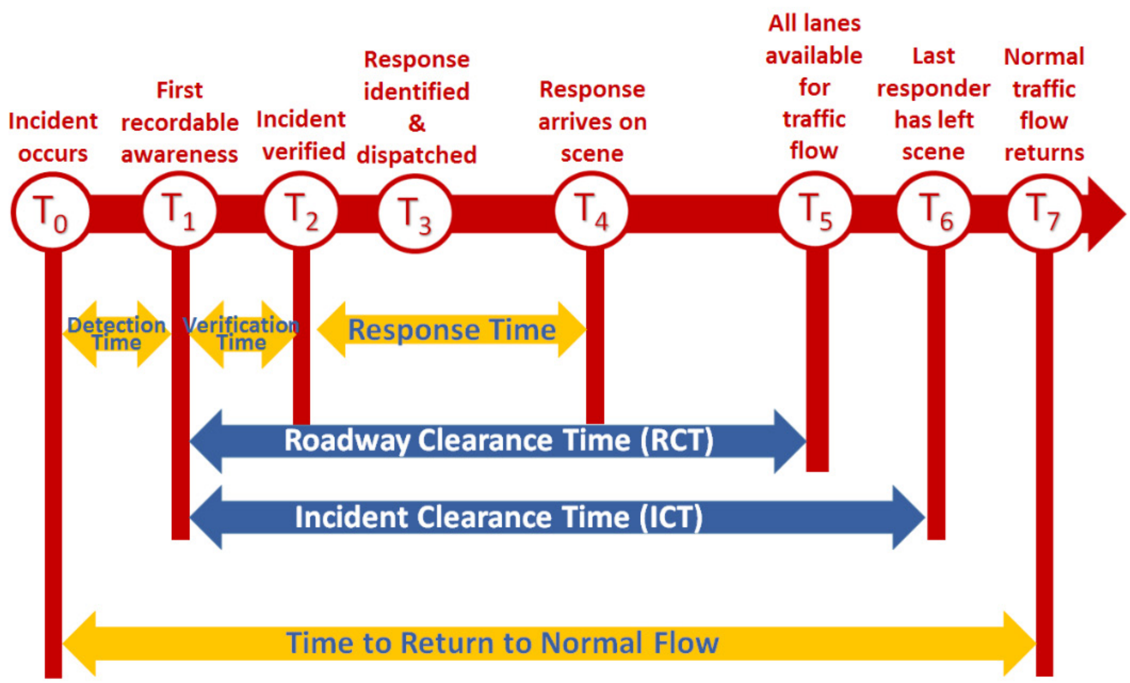


Figure 1. Chart. Incident timeline.

(Source: Federal Highway Administration.)

Table 1. Federal Highway Administration key traffic incident management performance measures.

Key Traffic Incident Management Performance Measures	Definition	Required Data Elements	Equation
Roadway clearance time (RCT)	**Time between** the first recordable awareness of the incident by a responsible agency and the first confirmation that all lanes are available for traffic flow.	T_1 = **Time** of first recordable awareness of an incident by a responsible agency. T_5 = **Time** of first confirmation that all lanes are available for traffic flow.	$RCT = T_5 - T_1$
Incident clearance time (ICT)	**Time between** the first recordable awareness of the incident by a responsible agency and the time at which the last responder has left the scene.	T_1 = **Time** of first recordable awareness of an incident by a responsible agency. T_6 = **Time** at which the last responder has left the scene.	$ICT = T_6 - T_1$
Secondary crashes	The **number** or **percentage** of unplanned crashes beginning with the time of detection of the primary incident, where a crash occurs as a result of the original incident, either within the incident scene or within the queue in either direction.	**Identification** of whether a crash is secondary to a primary crash/incident (e.g., yes/no).	**% secondary crashes =** $\left(\frac{\text{\# secondary crashes}}{\text{Total \# crashes/incidents}}\right) = 100$

These three measures are not the only ones that are used for TIM performance measurement. The incident timeline shown in Figure 1 illustrates a number of other time-based TIM performance measures, including incident detection time (IDT), incident verification time (IVT), incident response time (IRT), and time to return to normal traffic flow (NFT). The definitions, required data elements, and equations for these additional time-based performance measures are listed in Table 2.

Table 2. Other time-based traffic incident management performance measures.

Other Traffic Incident Management Performance Measures	Definition	Required Data Elements	Equation
Incident detection time (IDT)	**Time between** the first recordable awareness of the incident by a responsible agency and when the incident actually occurs.	T_0 = **Time** at which incident actually occurs. T_1 = **Time** of first recordable awareness of incident by a responsible agency.	**IDT = T_1 - T_0**
Incident verification time (IVT)	**Time between** when the incident is verified and the first recordable awareness of the incident by a responsible agency.	T_1 = **Time** of first recordable awareness of incident by a responsible agency. T_2 = **Time** at which incident is verified.	**IVT = T_2 - T_1**
Incident response time (IRT)	**Time between** when the incident is verified and when response arrives on scene.	T_2 = **Time** at which incident is verified. T_4 = **Time** at which response arrives on scene.	**IRT = T_2 - T_4**
Time to return to normal flow of traffic (NFT)	**Time between** when the incident actually occurs (or the first recordable awareness) and when normal traffic flow returns.	$T_{0,1}$ = **Time** at which incident actually occurs. T_7 = **Time** of first recordable awareness of incident by a responsible agency.	**NFT = T_7 - T_0** or **NFT = T_7 - T_1**

In addition, there are different ways of characterizing secondary crashes, including:

Crash secondary to a primary incident

An incident-to-crash relationship where the primary event is a crash or some other type of incident, such as a disabled vehicle.

Crash secondary to a primary crash

A crash-to-crash relationship where the primary event is a crash only (this category is a subset of the previous category).

Secondary crash involving a first responder

(e.g., struck-by)

Beyond the data elements required to calculate the TIM performance measures, there are a number of data elements that, while not required, are useful for putting TIM performance into context. For example, TIM performance at a minor fender-bender can look very different than TIM performance at a catastrophic incident that involves closing an urban freeway for several hours. Therefore, performance can be better understood when expressed in terms of different incident, locational, or environmental characteristics. In order to do this, however, these characteristics also need to be captured and associated with incidents.

Notes on secondary crashes

The original FHWA definition has recently been modified from secondary incidents to secondary crashes. Ideally, crashes as a result of a primary incident would be identified; however, if it simplifies the process, agencies can focus on identifying those crashes that are secondary to a primary crash (crash-to-crash relationship).

(Photo Source: Virginia Department of Transportation.)

Examples of data elements for characterizing Traffic Incident Management performance include:

Type of incident
(e.g., crash, stalled vehicle, debris on roadway)

Incident severity, duration, or impact
(e.g., minor, intermediate, major)

Injury severity
(e.g., property damage only, minor injury, major injury, fatality)

Incident location
(e.g., roadway type/classification, roadway name)

Number of lanes blocked
(e.g., none/shoulder-only, one-lane, full roadway closure)

Arrival and departure times of different responders
(e.g., law enforcement, fire/Emergency Medical Services (EMS), towing)

Virginia Department of Transportation— Statewide Performance Measures Approach

Within the State of Virginia, the regional operations director and district administrators meet to determine performance targets, look at historical data, and work on definitions. The Virginia Department of Transportation (VDOT) central office went through a process with regional and district stakeholders to determine the best measures to "tell the story" of the incident management process at the regional/district level for the Chief Engineer's Report. While the performance measures are the same across the State, the performance targets vary between regions to reflect the needs and challenges of each region. In addition to RCT, ICT, and others, VDOT is introducing reliability (vehicle hours of delay) as a performance measure.

Wisconsin Department of Transportation Performance Measures—Thinking Outside the Box

The Wisconsin Department of Transportation (WisDOT) currently is collecting and reporting RCT and ICT, amongst other TIM performance measures. In addition, WisDOT is examining the potential use of TIM performance measures related to the following:

- ***Duration***—More qualitative than RCT and ICT, WisDOT would like to examine work flows or processes to determine if there is any lag during the response to incidents, and if so, where.
- ***Safety***—In addition to secondary crashes, WisDOT is considering the use of after-action reports to identify safety performance issues, such as the incorrect use of traffic control devices or not wearing high visibility apparel.
- ***Incident impact***—The same incident can have a different impact depending on when and where it occurs. For example, an incident with a long clearance time may have little impact at night, but the same incident could cause major delays during the day. Being able to quantify the impact of incidents is something that needs further investigation.
- ***Communications/coordination***—WisDOT is considering scoring incidents based on intra- and interagency coordination and communications, such as qualitative analyses of work flows/processes to identify "choke points."

STEP 2: Determine What Data are Available

When determining what data are available, consider the most common sources for traffic incident management (TIM) data. Data in support of TIM performance measures generally fall into four broad categories:

- **Transportation data.**
- **Law enforcement data.**
- **Combination of transportation and law enforcement data.**
- **Other data sources.**

Each of these categories is discussed below, along with the advantages and disadvantages associated with each data source.

(Photo Source: Cambridge Systematics, Inc.)

Transportation Data

In this case, a transportation agency, usually the State department of transportation (DOT) or a regional metropolitan planning organization (MPO), has the lead role in collecting/reporting TIM performance. The data flow typically begins when the transportation agency becomes aware of an incident through its network of intelligent transportation systems (ITS) devices or via a call and begins tracking and monitoring the incident. The traffic management/operations center (TMC/TOC) will typically use either advanced transportation management systems (ATMS) software or another electronic incident tracking system to log the incident data. In some cases, the transportation agency will supplement the information gathered by TMC/TOC operators with information provided by transportation personnel in the field, such as freeway service patrol (FSP), via radio communications (and at which point the information is logged into the system by a TMC operator) or via mobile data entry.

Advantages

Global view of crash/incident

When incidents occur within view of a closed-circuit television (CCTV) camera, TMC/TOC operators have a bird's-eye vantage point of the activities associated with the incident (e.g., times lanes closed/opened, number of vehicles involved, type of responders and times on/off scene, secondary crashes). In addition, as TMCs/TOCs are hubs for traffic management, they are generally informed by various sources, including field personnel, law enforcement, and the media.

Focused attention on crashes/incidents within coverage area

TMCs/TOCs are able to capture almost every crash/incident within their coverage area during their hours of operation.

Logging/tracking tool

The operator's interface and ATMS software provide a mechanism for directly entering incident information into a database system.

Data ownership

The DOT is generally the agency responsible for reporting on TIM performance; therefore, it makes sense that the DOT is the "owner" of the data and has full understanding as to how the data are collected.

Disadvantages

Limited coverage area/times result in missed crashes/incidents

Incidents and crashes that occur beyond the ITS coverage area, or outside of TMC/TOC operational hours, are generally missed unless the TMC/TOC is notified of these incidents by other sources. In these cases, some DOTs noted that they are only notified of major incidents, such as fatalities and full road closures. One DOT noted that it is not contacted if the incident can be "handled" in under 30 minutes. In some cases, if the DOT does not manage an incident, the information does not get entered into their system. The result is incidents/crashes in which there is no information on TIM performance.

Law Enforcement Data

In this case, a law enforcement agency, usually the State police or highway patrol, has the lead role in collecting TIM performance data. Incident data are collected by law enforcement officers at incident scenes using the statewide crash report, electronic crash reporting system, and/or computer-aided dispatch (CAD) system. The law enforcement agency may have ownership of the data and may be responsible for the reporting, or it may send the data to the State transportation agency for analysis/reporting.

Advantages

Increased coverage of crashes and incidents

There is almost always a law enforcement officer present at crash/incident scenes, which allows for more ubiquitous coverage of incidents (not limited to TMC/TOC coverage area and times).

Law enforcement officers already collect information at crash/incident scenes

Law enforcement officers complete crash/incident reports, a process that allows for a direct and standard mechanism for gathering data needed for TIM performance.

Disadvantages

Not necessarily focused on data/information collection

While completing forms is part of a law enforcement officer's duties at a crash/incident scene, officers have other duties to perform, such as maintaining the safety of first responders and victims, accident investigation, and coordination with other first responders. These activities could limit the amount/timeliness/accuracy of the information collected.

Data ownership

The law enforcement agency may not have (or want) ownership of the data and would need to determine how to migrate the data to the DOT for analysis and reporting.

Combination of Transportation and Law Enforcement Data

In this case, a transportation agency, usually the State DOT, has the lead role in collecting/reporting TIM performance measures; however, the information being collected by the DOT is supplemented through integration with one or more law enforcement CAD systems. This integration is generally achieved through a direct feed from the CAD system into the TMC/TOC, at which point the information is either manually input into the system by TMC/TOC operators or the data are automatically entered into the system. This model will likely be the most successful in areas with pre-established TIM groups or coalitions that are already working cooperatively to improve incident management in their area.

Advantages

Robust database
This approach may offer the best of both worlds in terms of the quantity and quality of data, combining both sources into one.

Shared understanding of the importance of traffic incident management performance
This approach usually involves a memorandum of understanding (MOU) between transportation and law enforcement regarding the shared use of data, which can start the conversation about TIM performance, getting agencies on the same page with respect to the importance of quick and safe incident clearance.

Disadvantages

Potential institutional challenges/barriers
Institutional silos may be an impediment to reaching agreements about what data are to be shared.

Potential technology challenges/barriers
Integrating diverse technology systems can be a complicated and expensive endeavor that some agencies may not be willing or able to undertake.

Other Data Sources

Beyond transportation and law enforcement data, it is worth exploring what data are available through other sources that could be used to support TIM performance measurement. Sources to consider include:

Fire and Emergency Medical Services Computer-Aided Dispatch Systems

Information from fire/Emergency Medical Services (EMS) CAD systems could be used to supplement the information available from transportation and/or law enforcement. This information might include the arrival and departure times of fire/EMS responders, the number of fire/EMS responders and response vehicles at the scene, and the number and type of injuries.

Towing Services

Towing companies are yet another type of responder that may record incident information, such as arrival and departure times, clearance time (when they are the only responder), and other potential useful incident-related information.

511 Systems

Incident information put into 511 systems (by law enforcement, media, etc.) is another potential source of data for measuring/assessing TIM performance. Tennessee Department of Transportation (TDOT) currently is developing a new centralized ATMS that will integrate the current statewide incident database with the 511 system. TDOT captures most of the incidents in the urban areas within its coverage areas; however, it currently has very little knowledge and information of incidents outside of these areas. As the Tennessee Highway Patrol (THP) enters all incidents over 30 minutes into 511, the integration of the ATMS with the 511 system will allow TDOT to capture data on additional incidents.

Public-Safety Answering Points

A Public-Safety Answering Point (PSAP) is a call center responsible for answering calls to an emergency telephone number (e.g., 911) and for dispatching emergency services. A county or large city usually handles this responsibility, and the information entered into the PSAP system can provide information on incidents not captured by the State DOT or law enforcement agency, as well as supplemental information on incidents managed by the State.

Social Media/ Crowd-Sourcing Apps

Social media and crowd-sourcing applications are a new way of getting incident information. Both the Virginia Department of Transportation (VDOT) and the Florida Department of Transportation (FDOT) are exploring the use of WAZE as a source of incident information. WAZE is a community-based traffic and navigation application that encourages users to input information about the activities happening along their routes. This information can help to identify incidents outside of TMC/TOC coverage areas, as well as provide information on incident details and impacts (delays, queue lengths). FDOT notes that, while the TMCs are quicker to identify incidents within their coverage areas than via WAZE, the use of WAZE has allowed them to more quickly identify incidents outside of their coverage areas than they would without the data.

Virginia Department of Transportation—Public-Safety Answering Points Integration

VDOT has put a concerted effort into integrating PSAP information into its process of capturing incident information and data. While VDOT's focus is reporting TIM performance on interstate highways, VDOT has conducted more than 15 local/regional PSAP integrations across the State and is working to add more. With the addition of this information, VDOT is able to capture data for about one-quarter of the incidents on primary and arterial routes statewide, which has increased its awareness and knowledge of TIM performance outside of its primary TOC coverage areas. VDOT's approach has been not to impact the operations of the PSAP or to improve the system; instead, VDOT takes what it can get and find ways to use it. Filtering components on both ends of the connection remove personal information and ensure that only relevant traffic information gets shared. The information is very granular and varies from one PSAP to another. As much of the information is in free-form text, VDOT relies on the TOC operators to comb through the information and use their knowledge to extract what is relevant. As a result, VDOT ultimately manages about one-quarter of the incidents from the PSAPs.

Checklist of Data Elements

As part of National Cooperative Highway Research Program (NCHRP) 07-20, a common database schema and data dictionary were developed to help guide agencies in collecting the required and desired data elements for consistent reporting of TIM performance. These documents are available for view and download on the TIM PM Web site at: http://nchrptimpm.timnetwork.org/.

To assist agencies in determining what data elements are available to them and from what sources, a comprehensive Checklist of Data Elements by data source is provided in the appendix of this document. This checklist is consistent with the NCHRP 07-20 database schema and data dictionary.

STEP 3: Collect and Manage Data

In this step, examples of data collection and management practices used by various agencies are presented. Figures 2 through 6 show examples of agency data entry screens and highlight the specific data elements within these screens that are either required for the national traffic incident management (TIM) performance measures or are desirable for conducting a disaggregate, more refined analysis of TIM performance. (See the Checklist of Data Elements in Appendix A for a comprehensive list of data elements that are required for the national TIM performance measures or are desirable for other TIM performance analyses, along with potential sources for these data elements.)

(Photo Source: iStockphoto LP.)

Collect Data

Data for traffic incident management (TIM) performance measurement can be collected in numerous ways, including:

- Traffic management centers (TMC)/ traffic operations centers (TOC).
- Transportation personnel at the incident scene.
- Crash report.
- Using or integrating multiple sources.

Data Collected via the Traffic Management/ Operations Center

TIM performance data can come from the information that TMC/TOC operators enter into the system, such as time stamps, secondary crashes occurrence, and other data elements associated with an incident. An example from the Freeway and Arterial System of Transportation (FAST) TMC in Las Vegas, Nevada is shown in Figure 2.

FAST notes that its success lies in having good camera coverage, as well as its internal database, which was developed in-house due to the desire to have more data that are automatically processed and ready to use. This database has allowed FAST to take a big step forward in understanding the impact of incidents and TIM performance.

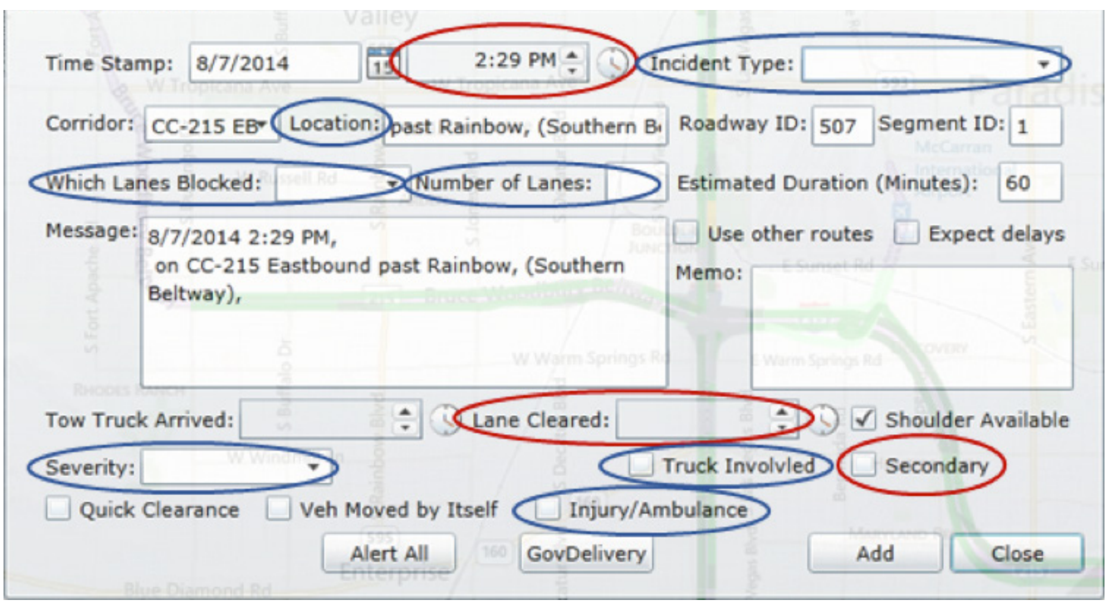


Figure 2. Form. Traffic incident management performance data elements on the Freeway and Arterial System of Transportation incident entry screen.

(Source: Freeway Arterial System of Transportation.)
Note: Data elements required for the national TIM performance measures are circled in red, data elements desirable for conducting a more refined analysis are circled in blue.

Data Collected via Transportation Personnel at the Incident Scene

TIM performance data can be collected by transportation personnel at the incident scene:

Department of Transportation Maintenance Staff

Department of Transportation (DOT) maintenance staff deployed to the incident scene usually communicate incident information to the TMC/TOC via radio, which then can be entered into the advanced transportation management systems (ATMS) or incident database.

Freeway Service Patrols

Data elements for TIM performance measurement can come from freeway service patrol (FSP) personnel at the scene of an incident. In most cases, this information is communicated via the radio to the TMC/TOC, at which point the information is entered manually into the system. In some cases, the field personnel have laptop computers and/or hand-held devices with automatic touch points that interface remotely with the ATMS and/or incident database. This allows field personnel to enter data directly into a database from a remote location.

Incident Response Teams

The Washington State Department of Transportation (WSDOT) has incident response (IR) teams that are trained to support first responders at traffic incidents that occur within WSDOT's coverage areas. The IR teams enter data remotely in the field by completing an electronic incident report using a laptop computer. A WSDOT incident report is shown in Figure 3. When entered, the data are automatically populated into WSDOT's statewide Incident Tracking System (WITS) database.

WSDOT Incident Response

- ☐ Roving IR Unit
- ☐ IR Tow Unit
- ☐ IR Unit Called-out (During Non-Roving Hours)
- ☐ Maintenance Assist

Other Agency/Company

- ☐ RTTO Service Patrol
- ☐ WSP Service Patrol
- ☐ Motorist Assistance Van (MAV)

Incident Information

Date of Incident	Start of Incident	Time Notified	Time Arrived	Time All Lanes Open	Time Cleared

State Route (3 Digits)	MP	County	Maint. Area	Notified by	☐ Unable to Locate

Landmark | Number of Vehicles Involved | ☐ Work Zone

Closure Information

Direction: ☐ W/B ☐ N/B ☐ E/B ☐ S/B | ☐ Single Lane ☐ Multiple Lanes | ☐ All Lanes ☐ Total Closure | ☐ Shoulder/Median ☐ HOV Lane | ☐ Ramp ☐ Other

Direction: ☐ W/B ☐ N/B ☐ E/B ☐ S/B | ☐ Single Lane ☐ Multiple Lanes | ☐ All Lanes ☐ Total Closure | ☐ Shoulder/Median ☐ HOV Lane | ☐ Ramp ☐ Other

Reason For Response (Check Only One)

- ☐ Fatality Collision
- ☐ Injury Collision
- ☐ Non-Injury Collision
- ☐ Blocking Disabled
- ☐ Disabled Vehicle
- ☐ Abandoned Vehicle
- ☐ Debris Blocking Traffic

Supplemental Reasons (Check any that apply)

- ☐ WSDOT Property Damage
- ☐ Fire
- ☐ Haz-Mat
- ☐ Other Contact

Action Taken

- ☐ Traffic Control
- ☐ Provided Fuel
- ☐ Changed Flat Tire
- ☐ Minor Repair
- ☐ Push
- ☐ Tow
- ☐ Cleared Debris
- ☐ Advised WSP
- ☐ Other

Tow Information

- ☐ Rotational
- ☐ Owner's Request
- ☐ Auto Club

Description of the Incident and/or Action Taken ☐ Comment Card Provided

Additional Agencies / Units Involved

- ☐ WSDOT Radio #'s ____________
- ☐ WSP Badge #'s ____________
- ☐ DOE
- ☐ Fire Department
- ☐ EMS
- ☐ RTTO Service Patrol Radio # ____________
- ☐ WSP Service Patrol Radio # ____________
- ☐ Motorist Assistance Van (MAV) Radio # ____________

Vehicle Information

Vehicle License # ____________ State/Province ________ Make ____________ Color ____________

Comments

Figure 3. Form. Traffic incident management performance data elements on Washington State Department of Transportation incident report.

(Source: Washington State Department of Transportation.)
Note: Data elements required for the national TIM performance measures are circled in red, data elements desirable for conducting a more refined analysis are circled in blue.

Data Collected by Law Enforcement Officers via the Crash Report

TIM performance data can be collected by law enforcement officers at the incident scene via the crash form:

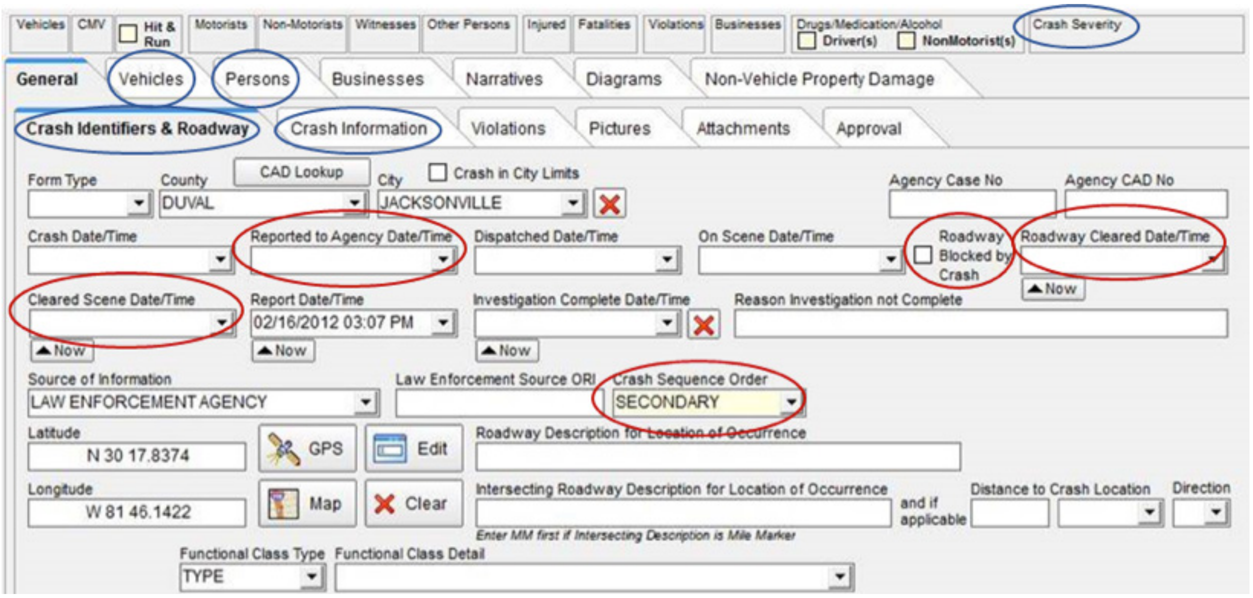


Figure 4. Form. Traffic incident management performance data elements on Florida Highway Patrol electronic crash form.

(Source: Florida Highway Patrol (FHP).)
Note: Data elements required for the national TIM performance measures are circled in red, data elements desirable for conducting a more refined analysis are circled in blue.

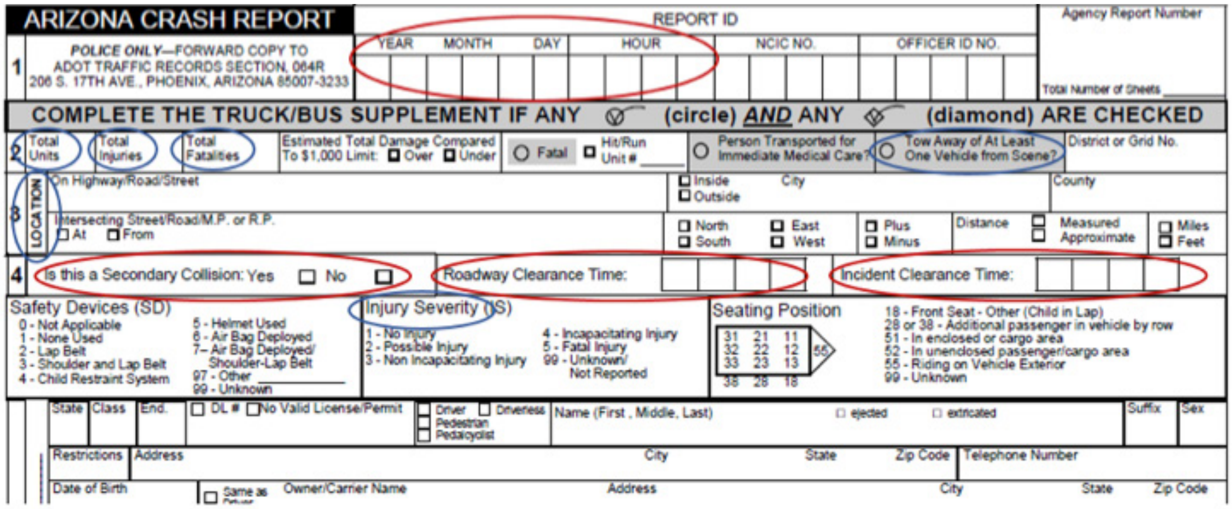
Florida Highway Patrol

The State of Florida is dedicated to supporting the collection of TIM performance measures. As such, time stamps for calculating roadway clearance time (RCT) and incident clearance time (ICT) have been part of the Florida State crash report since 2011. Like most law enforcement agencies in Florida, the Florida Highway Patrol (FHP) uses a mobile crash reporting application to capture incident information electronically. In addition to the time stamps needed to calculate RCT and ICT, FHP added the ability to identify a crash as "secondary" (see Figure 4).

Arizona Department of Public Safety

The Arizona Department of Public Safety (AZDPS) has led the charge for collecting TIM performance measures in the State of Arizona. The primary motivating factor for doing so was to have more data to determine if TIM strategies were improving officer safety. In 2010, the AZDPS incorporated the three national TIM performance measures into their crash reporting system, Traffic and Criminal Software (TraCS). In July 2014, the Arizona Department of

Transportation (ADOT) adopted the fields associated with these performance measures through the Traffic Records Coordinating Committee (TRCC) and the statewide crash form (Figure 5).



ARIZONA CRASH REPORT
POLICE ONLY—FORWARD COPY TO ADOT TRAFFIC RECORDS SECTION, 064R 206 S. 17TH AVE., PHOENIX, ARIZONA 85007-3233
REPORT ID: YEAR | MONTH | DAY | HOUR | NCIC NO. | OFFICER ID NO.
Agency Report Number
Total Number of Sheets
COMPLETE THE TRUCK/BUS SUPPLEMENT IF ANY (circle) AND ANY (diamond) ARE CHECKED
Total Units | Total Injuries | Total Fatalities | Estimated Total Damage Compared To $1,000 Limit: Over Under | Fatal | Hit/Run Unit # | Person Transported for Immediate Medical Care? | Tow Away of At Least One Vehicle from Scene? | District or Grid No.
LOCATION: On Highway/Road/Street | Inside Outside | City | County
Intersecting Street/Road/M.P. or R.P. At From | North South | East West | Plus Minus | Distance | Measured Approximate | Miles Feet
Is this a Secondary Collision: Yes No | Roadway Clearance Time: | Incident Clearance Time:
Safety Devices (SD): 0 - Not Applicable; 1 - None Used; 2 - Lap Belt; 3 - Shoulder and Lap Belt; 4 - Child Restraint System; 5 - Helmet Used; 6 - Air Bag Deployed; 7 - Air Bag Deployed/ Shoulder-Lap Belt; 97 - Other; 99 - Unknown
Injury Severity (IS): 1 - No Injury; 2 - Possible Injury; 3 - Non Incapacitating Injury; 4 - Incapacitating Injury; 5 - Fatal Injury; 99 - Unknown/ Not Reported
Seating Position: 31 21 11; 32 22 12; 33 23 13; 38 28 18; 55
18 - Front Seat - Other (Child in Lap); 28 or 38 - Additional passenger in vehicle by row; 51 - In enclosed or cargo area; 52 - In unenclosed passenger/cargo area; 55 - Riding on Vehicle Exterior; 99 - Unknown
State | Class | End. | DL # | No Valid License/Permit | Driver | Driverless | Pedestrian | Pedalcyclist | Name (First, Middle, Last) | ejected | extricated | Suffix | Sex
Restrictions | Address | City | State | Zip Code | Telephone Number
Date of Birth | Same as | Owner/Carrier Name | Address | City | State | Zip Code

Figure 5. Form. Traffic incident management performance data elements on Arizona crash report.

(Source: Arizona Department of Public Safety.)

Note: Data elements required for the national TIM performance measures are circled in red, data elements desirable for conducting a more refined analysis are circled in blue.

Using or Integrating Multiple Sources

According to leading transportation agencies, one of the keys to increasing the situational awareness of TMC/TOC staff is through information from law enforcement. TMC/TOC operators need tools that provide insight into what law enforcement is doing. Tools range from inexpensive radios to being full partners with integrated computer-aided dispatch (CAD).

Use of computer-aided dispatch information (not integrated)

Many TMCs/TOCs monitor live radios and/or Web sites with law enforcement/incident information. The New York State Department of Transportation Region 8 TMC has a live CAD

Training to Support Improved Data Collection

As the new electronic TraCS forms were released, AZDPS developed and distributed a training presentation on how to complete them. The data are monitored, and if they see something in the data that does not look right, they will put out information to the officers. The forms allow for quick entry. In addition, definitions are provided via the HELP menu/ screen, which can be pulled up and viewed immediately.

screen on the operations floor. The Southeast Michigan TOC is colocated with the Michigan State Police, and they share a (nonintegrated) CAD feed. These sources can lead to incident awareness and provide accurate data on incidents, which can be manually entered into the ATMS for TMC/TOC operators.

Use of integrated computer-aided dispatch

Nearly a decade ago, the Minnesota Department of Transportation (MnDOT) provided money to the Minnesota State Patrol (MSP) to upgrade its CAD. As a result, MnDOT and MSP have been on the same statewide CAD system since 2008. MnDOT is able to get accurate start times from law enforcement information (as it is entered into 911). MnDOT does experience some challenges with incident clearance times when law enforcement leaves an incident before it is completely cleared (see Challenge box below).

Wisconsin Department of Transportation (WisDOT) has a direct link to the CAD system of the Milwaukee County Sheriff's Office. Incident details populate the statewide TOC (STOC) database and are displayed on a congestion map. This direct link facilitates sharing of information, reduces operator workload, and improves the STOC's response time to traffic incidents. Outside of Milwaukee, there is ongoing integration of WisDOT and Wisconsin State Patrol (WSP) CAD on a statewide basis. WSP is a division within WisDOT, and having that centralized agency oversight has been beneficial for Wisconsin.

CHALLENGE: Using Incident Cleared Times from Law Enforcement

Challenge: Several State DOTs have noted concern about obtaining incident cleared times from law enforcement, as officers do not always stay at incidents until they are completely cleared. There is a perception that using ICTs from law enforcement for TIM performance measurement will result in inaccurate results.

Practice: AZDPS, the agency that leads incident data collection in Arizona, provided some general statistics to address this concern. On average, AZDPS investigates over 30,000 crashes per year; 500,000-600,000 incidents lasting 5-20 minutes; and 70,000 motorist assists. While an AZDPS officer might complete his/her investigation at a major incident prior to the towers removing the vehicles, the number of incidents where an officer leaves before the incident is cleared is very low.

In addition, the Arizona Department of Transportation (ADOT) opens a call for every incident that comes in one of its roadways, and all of the information that comes in from various sources gets recorded at the TMC. For major incidents, ADOT can later communicate to AZDPS the time of incident clearance. As an example, a truck recently lost its load on I-17. While AZDPS and ADOT were involved early on, everyone left the scene before the towing company was able to clear the debris. More than 5 hours later, the towing company notified ADOT that it was going to remove the debris, at which point AZDPS was notified, and the information was entered into the CAD system.

Use of integrated traffic management center and freeway service patrol data

Another example of integrating multiple data sources comes from the Niagara International Transportation Technology Coalition (NITTEC) in Buffalo, New York. From the TOC, NITTEC operators see both their incident entry screen and the HELP activity log (FSP) (Figure 6). The TOC data entry screen contains data elements for the entire incident timeline, as well as a checkbox for secondary crashes. This screen also allows operators to note the roadway, number of lanes blocked, and the incident severity level.

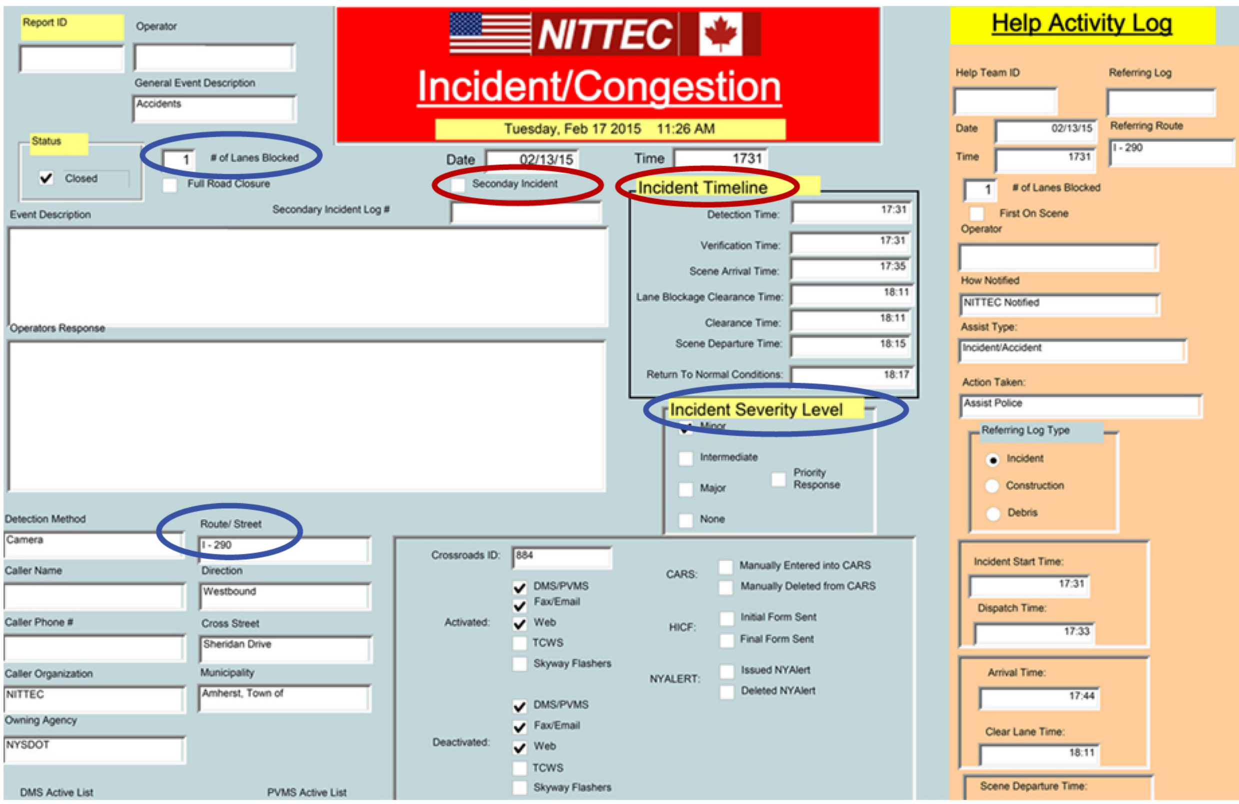


Figure 6. Form. Traffic incident management performance data elements on Niagara International Transportation Technology Coalition traffic operations center incident entry screen.

(Source: Niagara International Transportation Technology Coalition.)
Note: Data elements required for the national TIM performance measures are circled in red, data elements desirable for conducting a more refined analysis are circled in blue.

Data Collection Specific to Secondary Crashes

A number of challenges have been reported with the definition and collection of secondary crashes.

Challenges include:

The definition of secondary crashes is not clear/specific enough.

There are many different variables that come into play when determining if a crash is secondary.

If there are multiple crashes around the same time during the peak period, there is too much going on to determine if/which ones are secondary.

Whose responsibility is it? Some agencies do not believe that good data on secondary crashes can be collected at the incident scene, while others do not believe that TMC operators are going to be able to make a determination.

Some examples of how organizations have approached the issue of secondary crashes include:

Using the closed-circuit television (CCTV) cameras at a TMC/TOC, secondary crashes can be identified by operators when a crash occurs in the queue on either side of the road resulting from an upstream incident. As one agency stated, if a crash correlates to a queue, and the queue is not typically there, then the crash is most likely a secondary crash. There is a learning curve associated with making this call, and there is a need to have a supervisor verify that the operators are following a process that is credible and accurate.

According to the AZDPS, as law enforcement officers are investigating the facts and conditions associated with an incident, they are in the best position to determine if a crash is secondary—especially officers that patrol in certain areas, as they are familiar with the roadways.

As has been shown in previous examples of crash reports secondary crashes can be identified or "tagged" using check boxes by TMC/TOC operators or law enforcement officers. Tagging the incidents in this way either flags the incident as a secondary crash and/or ties the crash to the primary incident for analysis purposes. Without the proper training and support, however, these check boxes generally are not well-utilized. Therefore, simply adding the check box as a way of getting the data is not going to necessarily result in good, reliable data; training and support are needed.

Florida Highway Patrol:

Between 2011 and 2012, FHP officers began collecting secondary crashes via a check box on the crash report, and management provided training and direction for its use. In 2013, a directive was sent out to verify that the check box was being used. This addition was contemporaneous with the new statewide crash report, which contained over 100 data elements. As such, there was no push-back from law enforcement on collecting the data. In addition, FHP had a champion within the agency who was able to gain buy-in, which helped support the effort.

Arizona Department of Public Safety:

During the first few months of adding the three national TIM performance measures onto the crash report in TraCS, there was a lot of feedback from officers. When the officers heard the term "secondary" crash, they were looking for two crashes. It took further explanation of the definition and some training/examples to get over this initial hurdle.

The State of Michigan will have a new crash report in 2016 on which officers will be able to note two different types of secondary crashes under "contributing circumstances." The options will be back-up due to regular congestion; prior crash; and back-up due to other incidents (e.g., glare, missing shoulder). There will be online training on the new crash report, as there are many new areas on the report, and Michigan Department of Transportation (MDOT) is working with the State police on the training. Now that secondary crashes will be a data point, MDOT will be able to filter the total number of secondary crashes, those resulting from a previous crash, and those resulting from a previous incident; run reports; and watch for trends. If the officers are not utilizing this selection, MDOT and the State police will do more education and/or distribute an announcement bulletin to promote and encourage its use.

Manage Data

As with data collection, the flow and management of incident data, once it has been collected, varies depending on how the data are being collected and who is collecting the data. While it is outside the scope of this document to provide detailed guidance on the flow and management of incident data, this section presents a high-level guide related to database development and data management, and provides some examples of how various organizations have approached the management of incident data.

High-Level Guide

Developing a traffic incident management performance measures database

As part of National Cooperative Highway Research Program (NCHRP) 07-20, a beta database schema and data dictionary were developed to help guide agencies towards collecting the required and desired data elements for reporting TIM performance in a consistent manner. In addition to the schema and data dictionary, two Structured Query Language (SQL) scripts were created. When executed, the first script creates an empty TIM performance measurement database. The second script can then be executed to populate the database look-up tables with static information according to the data dictionary (please visit: http://nchrptimpm.timnetwork.org/?page_id=954 to view and download these files). This database schema was a first attempt at a national "standard" for reporting TIM performance. Using the schema and the data dictionary, agencies can begin to map/integrate existing datasets and databases in a consistent fashion. Agencies can use the schema and the Checklist of Data Elements in the appendix of this document (which is consistent with the schema) to determine what data are available, what data are missing, what data need to be transformed, etc. Once this step is complete, the next step is getting data into the database.

Getting data into the database

Getting data into a database is accomplished through a process known as extract, transform, and load (ETL). In the case of a local, regional, or State TIM performance measurement database, the ETL process will not be one-size-fits-all; rather, the process must be customized depending on the types of systems and data being used. In other words, the goal is the same—to get clean data formatted as specified by the database schema so that everything can be consistently reported and compared nationally—but the approach necessary to achieve this goal will vary between agencies.

Extract data from the source

Source data can be stored in many different ways, including relational databases; folders containing Excel/Extensible Markup Language (XML) files; Access databases; and flat files (e.g., text, comma-separated values (CSV)), to name a few. Depending on the way in which the data are stored, the data may be organized/formatted differently. Before the data can be imported into the database, the relevant data fields need to be located and extracted from these databases/folders/files.

Transforming data

Once the data fields are extracted from the source, each field in the files needs to be transformed into its corresponding value in the database schema. For example, if time in the source database is expressed in terms of the 12-hour clock, and the schema requires that time be expressed in terms of the 24-hour clock, the times will be need to be transformed. Likewise, the categorical components of the data (e.g., incident types, incident severity) in the source database will need to be mapped to those in the schema. This mapping should be done using best judgment and capabilities and does not have to be "perfect." In some cases, data in the source files may have more detail or be at a lower level than what is required by the database schema. For example, data in a law enforcement database generated from information entered on the crash report may identify every person involved in an incident. The database schema, however, only needs a count of the number of people involved. In this case, the law enforcement data would need to be aggregated to match the schema.

Loading data into the database

Once the data fields are extracted and transformed, they need to be loaded into the database. At this point, the data fields are cleaned and formatted in a way that is acceptable by the schema; however, the data needs to be distributed across the various database tables according to the schema so that the data can be operationalized for querying and providing insights.

Integrating data from different sources

Comprehensive and complete incident information more than likely will not come from one single source of information; rather, data from transportation, law enforcement, fire, and towing may be required to ensure a complete set of data to fulfill the requirements of the schema. In order to use data from different sources, these data feeds need to be integrated. Data integration is basically a multisource ETL process. As the data come from different sources with different perspectives, the ETL process becomes more complicated; a more complex ETL process needs to be developed to clean (i.e., remove redundancies in the combined set of data) and merge each source data into a single database. In these composite ETL processes, data integration can be complex because it can introduce redundant data (or closely redundant data), and extra processing is required as part of the ETL process to compare these values and determine which values will be selected. The selected values may differs for each incident record.

Agencies can look for data integration specialists and/or ETL developers within or outside the organization to assist in developing a database; extracting, transforming, and loading data into the database; and integrating data from various sources in support of consistent TIM performance measurement and reporting. Most agencies are already using such specialists to build and maintain their advanced traffic management systems.

Agency Examples

States with common, centralized ATMS software and/or a statewide incident databases generally have less difficulty reporting TIM performance and doing so consistently as compared to those with a more decentralized approach. Examples include:

Tennessee Department of Transportation Locate/IM

Tennessee Department of Transportation's (TDOT) statewide TMCs are in their fourth year utilizing a Web-based traffic incident locator, along with activity and reporting capabilities. This system provides real-time location information and reporting of traffic incidents and HELP Truck activity. The program system, Locate/IM, was integrated with the statewide TMCs for TIM control and roadway monitoring, which allows for regional and statewide reporting of incident management activities and performance.[(3)]

Virginia Department of Transportation VaTraffic

While each Virginia Department of Transportation (VDOT) TOC/region has its own ATMS from which data can be pulled and analyzed, much of these data also go to a central database known as VaTraffic. This approach has worked well and has allowed VDOT to develop a comprehensive TIM performance measures program. VDOT currently is in the process of transitioning to one platform statewide, which will further improve consistency in incident data collection and reporting.

Arizona Department of Public Safety TraCS

Using TraCS software, AZDPS officers submit their reports electronically to the database at the end of each shift. Then, these data are migrated from AZDPS to ADOT's database using an XML Web service. Prior to this electronic approach, there was an eight-month lag in getting the crash report data into ADOT's system. With TraCS, AZDPS crash reports are in the system within eight days.

Washington State Department of Transportation Incident Tracking System

The Washington State Department of Transportation Incident Tracking System (WITS) is a statewide database, developed in-house for storing incident data. Using laptop computers in their trucks and an electronic incident form via the WITS application, WSDOT's IR teams enter data remotely following each incident. The incident data are stored on the laptops in the trucks during the work shifts. After each shift, the stored data are uploaded to a secured WSDOT server via WSDOT (internal and external) networks. Data are collected to a central (HQ) server (WITS Database).

Freeway and Arterial System of Transportation Database and Dashboard System

To improve access to and ease of use of incident-related data, FAST developed an internal database and dashboard program. This system provides FAST with data that are ready to use. Prior to having this system, the data were in a raw format (CSV file), which made for a "convoluted" process of getting access to the data for analysis. The database has allowed FAST to take a big step forward in understanding the impact of incidents and performance. It is a process that has evolved over time.

Minnesota Department of Transportation Computer-aided Dispatch Integration

Before the MnDOT-CAD integration, MnDOT used an Access database to manage its incident data. TMC operators would monitor the radio, identify incidents, and manually enter the information into the system. While this approach worked well and generated a lot of data, it also resulted in redundant data. The CAD integration removed a few steps of data entry. The only State patrol data that are shared are incident start time, arrival time, and ICT and the data are output in real-time in XML from the CAD vendor. In addition, workstations allow operators to see the remarks as they are entered into the CAD system; and while it is not automatically captured, operators can add it.

STEP 4: Analyze Data and Report Performance

In this step, traffic incident management (TIM) performance analysis and reporting are discussed. Information on and examples of aggregate and disaggregate analyses; the analysis of TIM performance trends; advanced analysis/visualization of TIM data; performance reports, dashboards, and scorecards; and internal use and reporting of TIM performance are provided here.

Traffic Incident Management Performance Analysis

Aggregate Analysis

An agency can use the TIM data collected in Step 3 to calculate the TIM performance measures for all incidents during a specified time period, which is a good starting point for understanding regional TIM performance at the highest level. Table 3 is a TIM performance measures summary for Florida Department of Transportation (FDOT) District 4 for the week of September 8, 2013.

Table 3. One-week performance measures summary for Florida Department of Transportation District 4.

	52-Week Average	Current Week	Previous Week
Events included in Performance Measures	86	114	89
A. Notification Duration (min.)[1]	—	—	—
B. Verification Duration (min.)	1.1	1.2	1.4
C. Response Duration (min.)	3.8	4.0	4.2
D. Open Roads Duration (min.)	31.4	28.1	35.5
E. Departure Duration (min.)	18.6	17.0	21.4
Roadway Clearance Duration (min.)	**36.2**	**33.2**	**41.1**
Incident Clearance Duration (min.)	**54.8**	**50.2**	**62.5**

(Source: Florida Highway Patrol.)

[1] *Florida Highway Patrol Data is not available for Notification Duration.*

Disaggregate Analysis

Considering the range of incident types and incident characteristics, aggregate measures of performance may not always be informative enough. Minor incidents confined to the shoulder can generally be cleared relatively quickly as compared to major incidents that block multiple roadway lanes and/or involve injuries/ fatalities. Combining these wide-ranging clearance times into one overall average value results in a loss of understanding as to how the incident characteristics impact incident response and clearance. Instead, calculating the average clearance times for minor and major incidents separately can provide more useful and revealing information about performance that can help TIM programs identify ways to improve. Furthermore, using more refined information on TIM performance can help an agency better demonstrate accountability, process efficiency, and/or program effectiveness.

While Step 1 noted data elements for characterizing TIM performance, the most commonly used include incident type (e.g., crash, noncrash); incident severity/ duration/impact; injury severity (e.g., property damage only, fatality); and roadway information (e.g., name). Figure 7 is a table extracted from the November 2014 Southeast Michigan Transportation Operations Center (SEMTOC) Performance Measures Report. This table shows the total incidents, incidents per mile, and average incident clearance time (ICT) reported by freeway. The measures are compared to those from the previous month, as well as those from the same month during the previous year.

This table shows how the average ICT for each roadway can differ greatly from the overall regional average, illustrating the importance of conducting a more refined analysis of performance.

Figure 8 shows the results from an analysis of TIM performance developed from data from the Washington State Department of Transportation (WSDOT). This figure shows the number of responses and the average ICTs by incident type and injury severity for 2002 and 2004. Incident types include collisions, noncollision blocking incidents, and noncollision/ nonblocking incidents. Injury severity includes fatality, injury, and noninjury incidents. While the overall average ICTs for 2002 and 2004 are not shown, it is clear from the range of disaggregate ICTs (5 to 271 minutes), as well as the range of responses per incident type (30 to 7,172), that the overall average ICT values would not provide as useful information as presented in these graphs, once again illustrating the importance and value of breaking down TIM performance measures.

Freeway	Miles	Nov. 2014 Total Incidents	Nov. 2014 Incidents per Mile	Nov. 2014 Average Duration	Oct. 2014 Total Incidents	Oct. 2014 Incidents per Mile	Oct. 2014 Average Duration	Nov. 2013 Total Incidents	Nov. 2013 Incidents per Mile	Nov. 2013 Average Duration
I-275	37.5	52	1.39	43.6 min	49	1.31	51.6 min	45	1.20	46.7 min
I-375	1.2	2	1.67	37.5 min	1	0.83	28.0 min	2	1.67	57.0 min
I-96 (Jeffries)	34	101	2.97	41.9 min	65	1.91	40.7 min	92	2.71	43.9 min
I-696 (Ruether)	28.7	127	4.43	47.3 min	84	2.93	43.2 min	91	**3.17**	42.8 min
I-75 (Chrysler/Fisher)	87.6	**181**	2.07	47.2 min	189	2.16	44.9 min	**179**	2.04	44.4 min
I-94 (Ford)	60.7	175	2.88	46.8 min	**197**	3.25	38.3 min	143	2.36	63.9 min
M-10 (Lodge)	17.9	57	3.18	50.4 min	49	2.74	37.3 min	52	2.91	37.4 min
M-14	6.4	12	1.88	**82.2 min**	2	0.31	**277.0 min**	9	1.41	56.6 min
M-39 (Southfield)	14.2	50	3.52	43.1 min	52	**3.66**	41.8 min	41	2.89	38.6 min
M-59	24	3	0.13	31.7 min	5	0.21	45.0 min	1	0.04	41.0 min
M-8 (Davison)	2.2	13	**5.91**	56.5 min	7	3.18	40.2 min	5	2.27	**173.4 min**
Regional Average Duration				46.4 min			44.4 min			49.0 min

Figure 7. Table. Extracted from the November 2014 Michigan Department of Transportation Southeast Michigan Transportation Operations Center performance measures report—incident clearance time by freeway.[4]

(Source: Michigan Department of Transportation.)

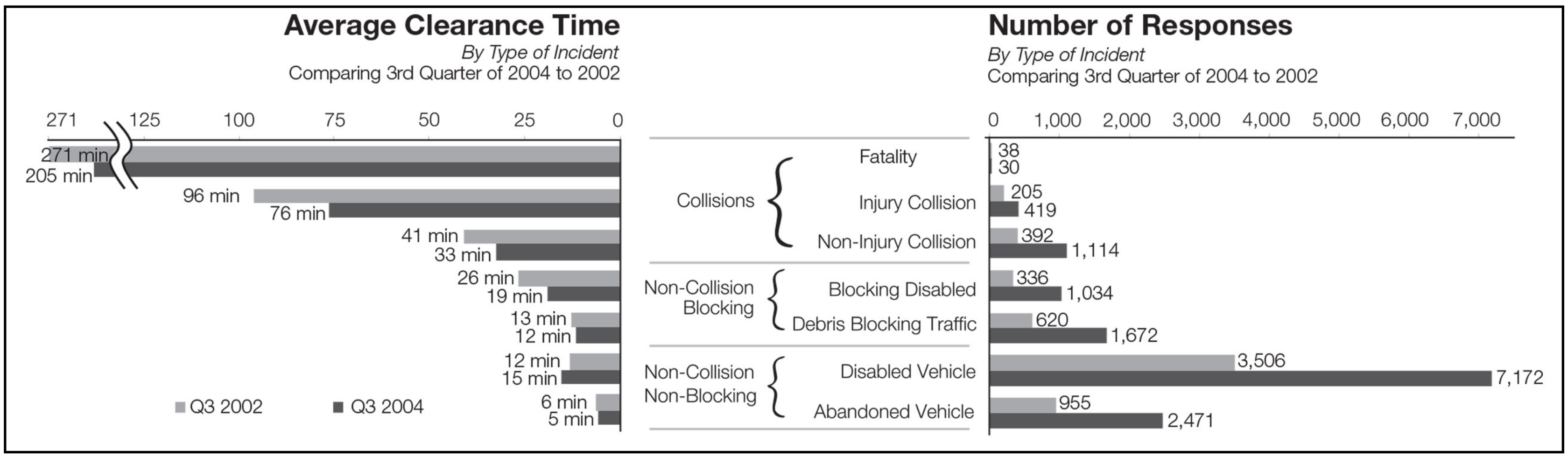


Figure 8. Graph. Washington State Department of Transportation traffic incident management performance by incident type and injury severity.[5]

(Source: Washington State Department of Transportation.)

Analyzing Trends in Traffic Incident Management Performance

Incident information from New Jersey Department of Transportation's (NJDOT) traffic operations center (TOC) is used to produce monthly reports on the incident management program. The reports provide a range of aggregate performance measures, including monthly and yearly trends in average ICT (as shown in Figure 9). The reports also provide more disaggregate trend analysis by presenting average ICT by major highway (Table 4).

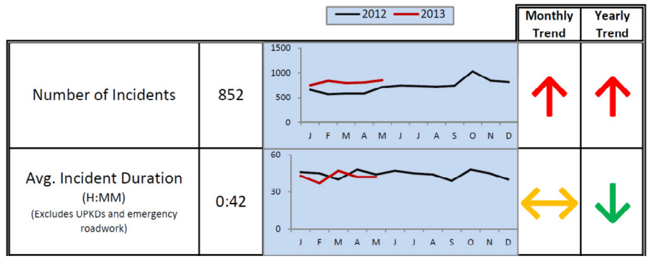


Figure 9. Graph. Trends in aggregate average incident clearance times, May 2013.

(Source: New Jersey Department of Transportation.)

Table 4. Trends in average incident clearance times by roadway.

Interstate	Number of Incidents	Average Duration (H:MM)	Year to Date Average Duration (H:MM)	Duration Monthly Trend	Duration Yearly Trend
I-195	11	0:30	0:46	↓	↓
I-280	31	0:25	0:31	↑	↓
I-287	54	0:53	0:46	↑	↑
I-295	97	0:42	0:42	↓	↓
I-676	9	0:31	0:23	↑	↑
I-76	11	0:24	0:27	↔	↓
I-78	41	0:39	0:45	↓	↓
I-80	78	0:34	0:34	↑	↓
I-95	10	0:32	0:38	↓	↑
NJ 24	5	0:28	0:42	↑	↓
NJ 42	36	0:27	0:26	↑	↓
NJ 55	6	0:32	0:41	↑	↑

(Source: New Jersey Department of Transportation.)

NJDOT shares its performance measures with the State police and the transportation commissioner and staff, as well as the public via presentations, the Governor's dashboard, and the Federal Highway Administration (FHWA).

WSDOT uses the WSDOT Incident Tracking System (WITS) data archive to conducted short-term trend analyses to monitor overall program performance. WSDOT uses the WITS data archive to conducted short-term trend analyses to monitor overall program performance. WSDOT's Gray Notebook is a quarterly performance report on transportation systems, programs, and department management. The Goals, Performance, and Trends provides an overview of the key performance indicators for five of six policy goals; one of which is mobility. These trends shows the current and previous performance mark for each measure, including average ICT for all incident response (IR) program responses, and indicates which way the program is trending. Figure 10 is an extract from the December 31, 2014 report.[(6)] Figure 11 shows a three-year trend analysis comparing total IR team responses to average ICT before and after expansion of the IR program.[(5)] The trends show a significant drop in average ICT after expansion of the program, as well as a continued downward trend and leveling off of ICT despite a steady and significant increase in the number of responses.

Policy goal/Performance measure	Previous period	Current period	Goal	Goal met	Five-year trend *(unless noted)*	Desired trend
Mobility (Congestion Relief)						
Highways: Annual (weekday) vehicle **hours of delay** statewide at **maximum throughput speeds**[1] (Annual measure: calendar years 2012 & 2013)	30.9 million	32.4 million	N/A	N/A		
Highways: Average **incident clearance times** for all Incident Response program responses (Calendar quarterly measure: Q3 2014 & Q4 2014)	12.2 minutes	13.2 minutes	N/A	N/A	(Five-quarter trend)	

Figure 10. Graph. Extract from Washington State Department of Transportation's Gray Notebook—Goals, performance and trends, December 31, 2014.

(Source: Washington State Department of Transportation.)

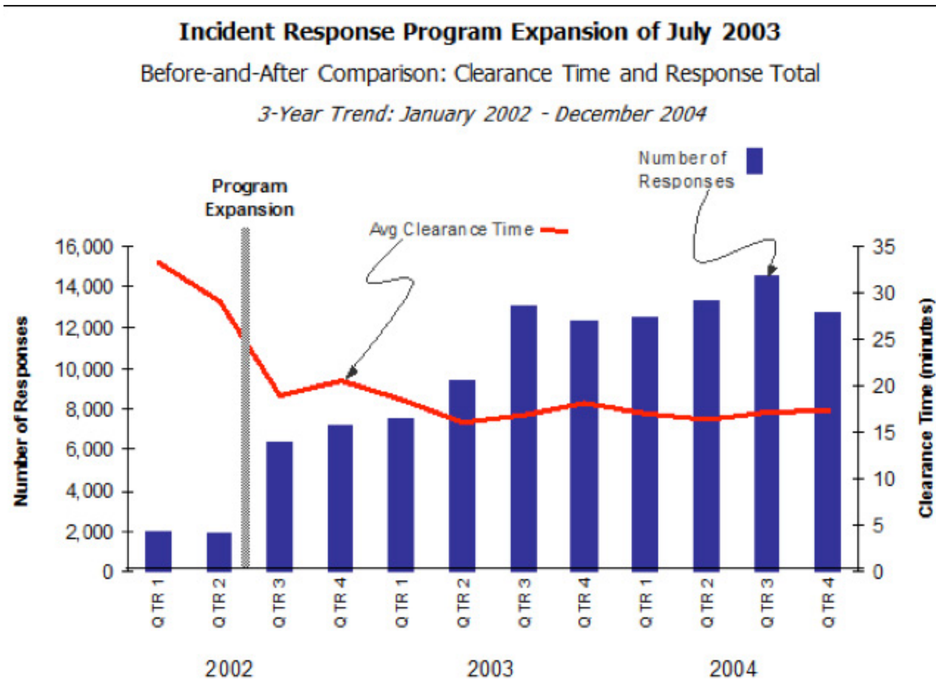


Figure 11. Graph. Analysis of incident response trends using Washington State Department of Transportation's statewide incident tracking system data.

(Source: Washington State Department of Transportation.)

Figure 12 and Figure 13 are graphs generated from annual TIM performance measures provided by the Minnesota Department of Transportation (MnDOT). Figure 12 shows the six-year trend (2008 to 2013) for average roadway clearance time (RCT), and Figure 13 shows the same six-year trend for average ICT. In addition, the performance trends are shown separately by incident type, including crashes, injury crashes, rollovers, spinouts, blocking stalls, and blocking unoccupied stalls, as well as the overall annual performance averages (indicated by the dashed trend lines). Not only do these graphs indicate how overall TIM performance is trending, the graphs provide information on where performance is and how it is trending for different types of incidents in relation to the overall average and other incident types. This type of information can be useful in identifying if there is a specific type of incident that needs special attention. For example, while the average RCTs for most incident types have been decreasing or generally holding steady, the average RCTs for spinouts gradually increased over the six-year period. Armed with this information, the TIM partners could looking for ways to improve RCT for these types of incidents.

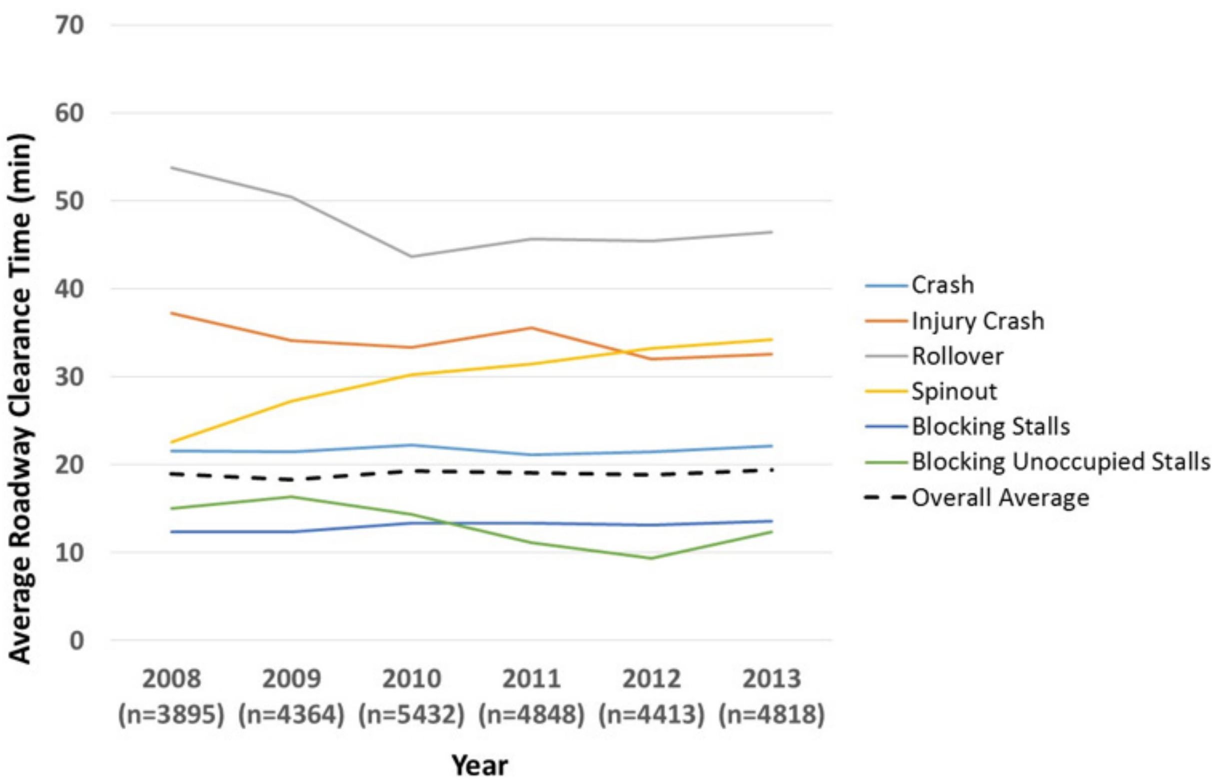


Figure 12. Graph. Minnesota Department of Transportation traffic incident management performance six-year trend—average roadway clearance time by incident type.
(Source: Minnesota Department of Transportation.)

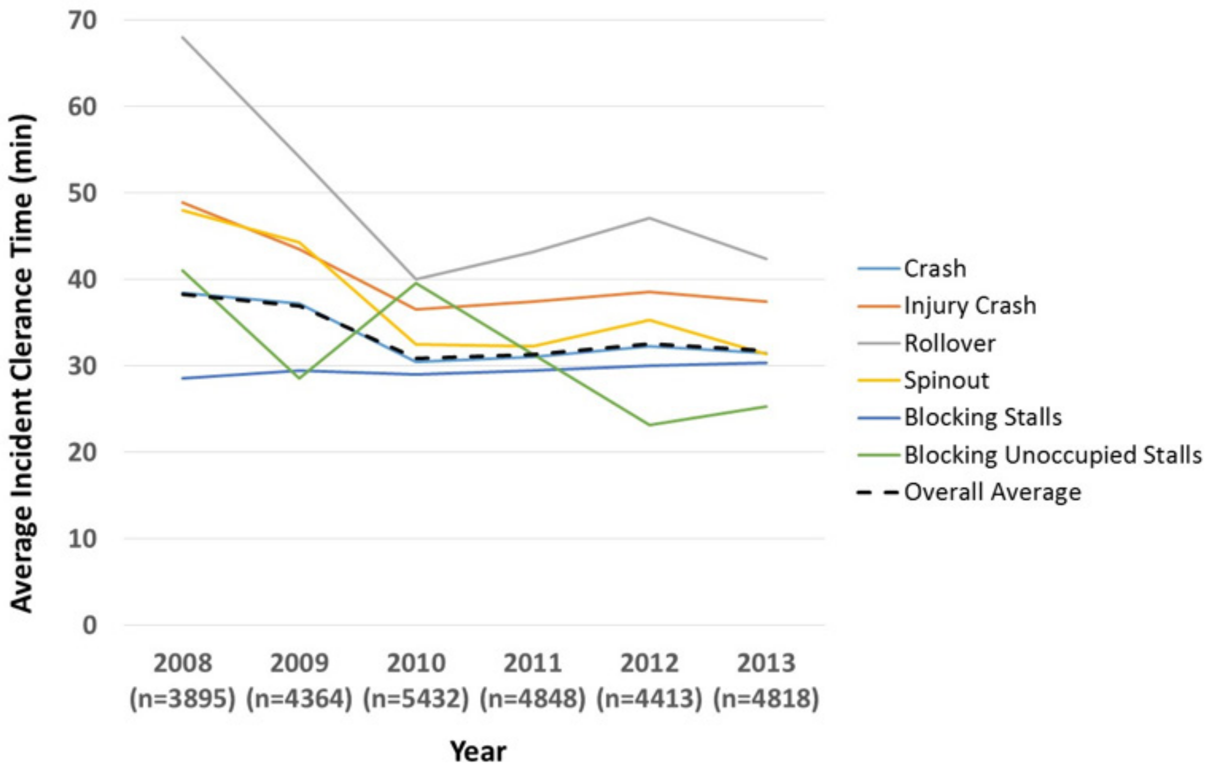


Figure 13. Graph. Minnesota Department of Transportation traffic incident management performance six-year trend—average incident clearance time by incident type.

(Source: Minnesota Department of Transportation.)

Advanced Analysis/Visualization of Traffic Incident Management Data

Real-time analysis

In addition to weekly and quarterly performance reports on regional TIM, the Virginia Department of Transportation (VDOT) is developing real-time analysis tools and reporting capabilities for the TIM program. Real-time analysis tools and reporting capabilities include showing current impacts of an incident, consequences of extended lane closures, congestion impacts, detour options, etc. VDOT hopes that, once developed, these real-time reporting tools and capabilities will aid in the decision-making process.

Mining of archived snapshots

The Freeway and Arterial System of Transportation (FAST) recently generates a "30-60-90" RCT calculation for the Nevada Department of Transportation (NDOT) using the following categorization of incidents:

- An incident meets the **30-minute roadway clearance** criterion if it involves no injuries and it is removed from the travel lanes in 30 minutes or less.

- An incident meets the **60-minute roadway clearance** criterion if injuries are involved and it is removed from the travel lanes in 60 minutes or less.

- An incident meets the **90-minute roadway clearance** criterion if it involves a fatality and it is cleared in less than 90 minutes.

To aid with these calculations, FAST added a check box on the traffic management center (TMC) incident screen for operators to indicate when an injury/ambulance is involved. In addition, FAST archives closed-circuit television (CCTV) snapshot images taken during the incident timeframe at the incident location, as well as of adjacent roadway segments, such as ramps or arterial streets) (Figure 14). By reviewing these snapshots (animation plays at 15-second intervals), analysts can examine the impacts of the incidents on the roadways (which lanes are blocked/cleared and when) to obtain additional details. FAST makes use of these snapshot archives to help generate reports to the NDOT.

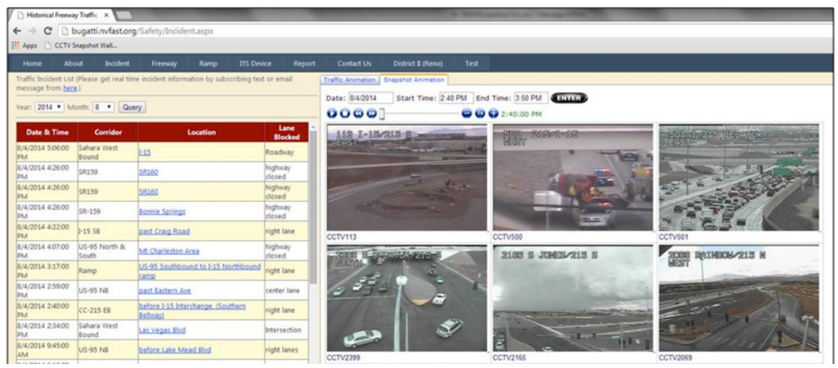


Figure 14. Screenshot. Snapshot archiving.

(Source: Freeway and Arterial System of Transportation.)

Heat Maps

A heat map is a graphical representation of data where the individual values contained in a matrix are represented as colors. Heat maps can be used to show the impact of an incident (and the associated response and clearance times) on congestion (e.g., speeds, density, delay). An example heat map from FAST is shown in Figure 15. In this heat map the colors represent the average speed along one corridor over a 24-hour period. It can be seen in the plot how using heat maps could aid in determining if a crash is a secondary crash, an approach that is favored by FAST over the TMC operators making the determination at the time of the crash. Another example of a heat map representing the effects of an incident is provided in Figure 16 This heat map is part of the Incident Timeline Tool developed by the University of Maryland Center for Advanced Transportation Technology (UMD-CATT).

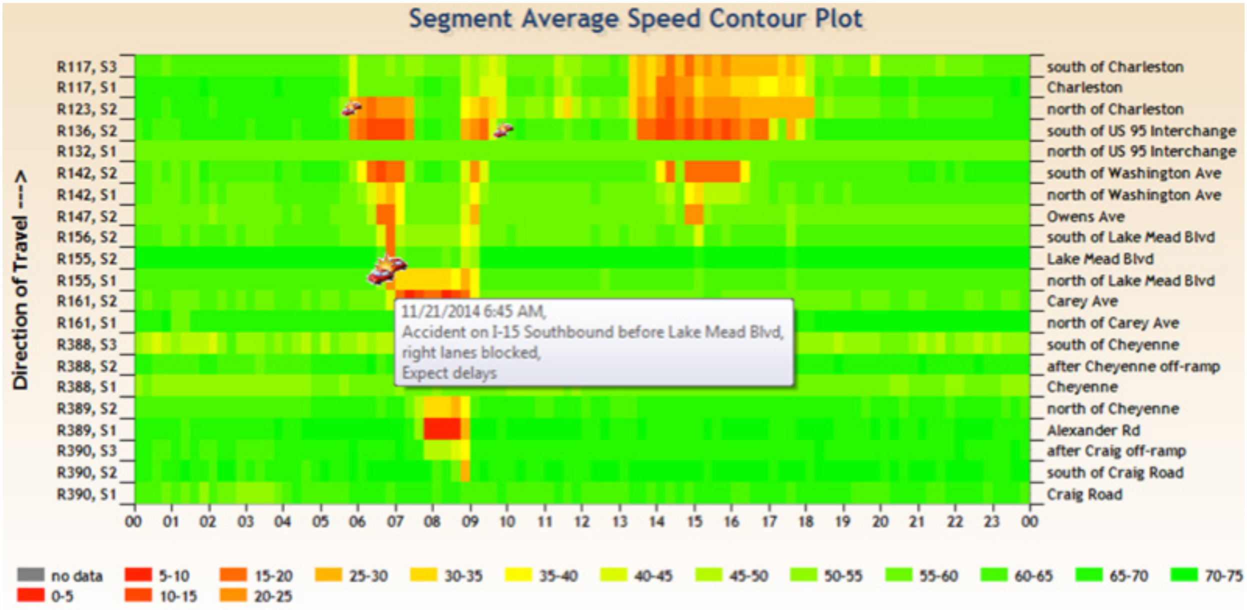


Figure 15. Heat Map. Heat map of average speed.

(Source: Freeway and Arterial System of Traffic.)

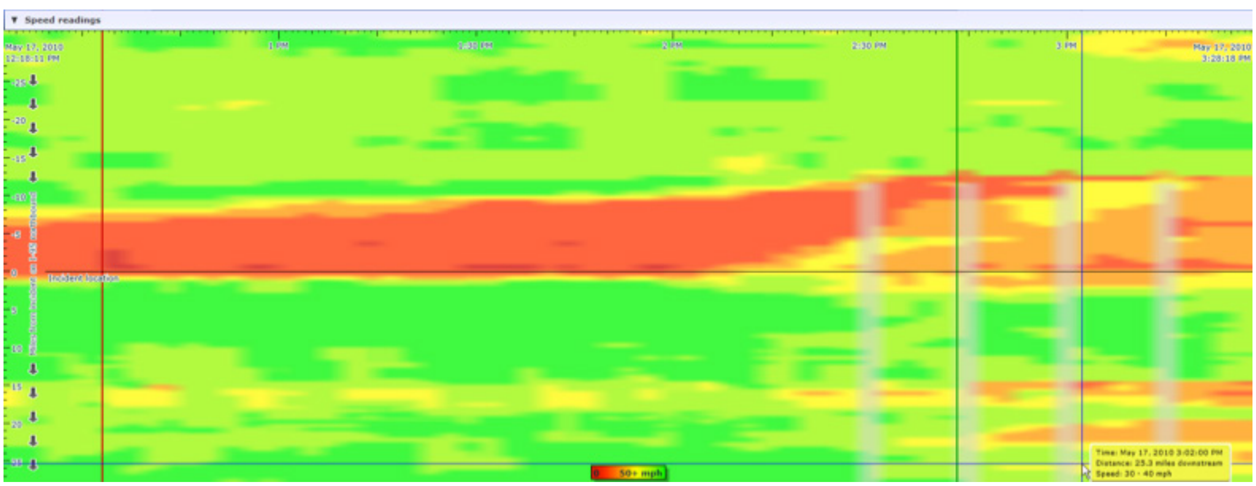


Figure 16. Heat Map. Heat map illustrating the impact of an incident.

(Source: University of Maryland Center for Advanced Transportation Technology.)

Traffic Incident Management Performance Reporting

The systematic, ongoing performance measurement process involves collecting and analyzing data to determine if organizational objectives have been met, and then using the information internally to make strategic and tactical decisions, as well as reporting the findings to stakeholders and customers.

Performance reports

Weekly, monthly, quarterly, and/or annual performance reports, developed and available for various audiences, are a common way of reporting TIM performance. Good examples include: Michigan Department of Transportation's (MDOT) Monthly Performance Measures Reports for the West Michigan TOC and the Southeast Michigan TOC are archived and available to the public via MDOT's Web site. Figure 17 is an extract from West Michigan TOC for October 2014.[7] The graph on the left presents the aggregate analysis (overall averages) of roadway and ICT, the graph on the right breaks down the number of incidents by incident severity/ duration (to give further context to the average clearance times), and the number and percentage of secondary crashes is noted at the bottom. In addition to the

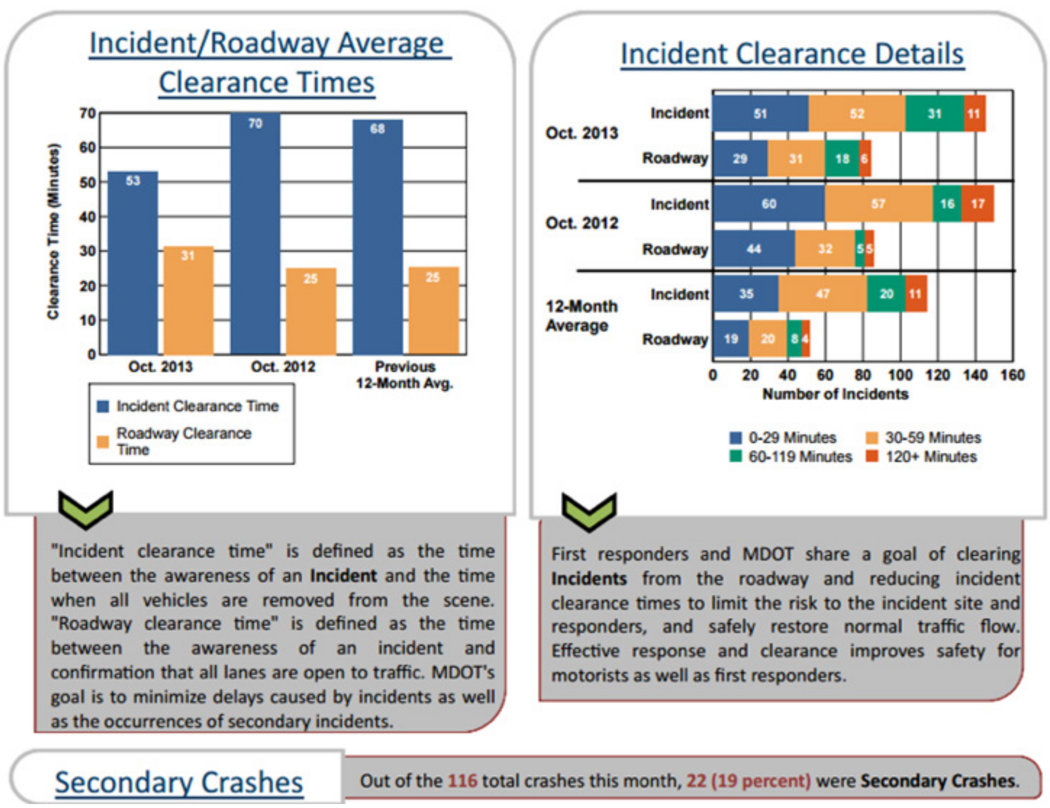


Figure 17. Graph. Extract from West Michigan traffic operations center's October 2014 performance measures report.

(Source: Michigan Department of Transportation.)

monthly reports, MDOT produces an annual Performance Measures Report, which essentially rolls up the monthly reports to cover the entire year's activities and performance.

The Gray Notebook is the WSDOT's quarterly accountability report, providing the latest information on system performance and project delivery.

Through Tennessee Department of Transportation's (TDOT) Locate/IM database, each regional system has the capability to produce a quarterly report on traffic incidents and HELP Truck activity, including total incidents, events affecting traffic, clearance times, and the types of service provided by the HELP patrol in each region. The system also allows for a statewide quarterly report to be generated, combining each region's information.

Dashboards

Dashboards are another way of reporting TIM performance, and are generally geared more towards the public. The VDOT's online dashboard presents a variety of performance data, including incident durations. Figure 18 is a screenshot of the incident duration page of the dashboard.(8) While this page presents the aggregate analysis of incident duration of all incidents statewide over the past three months, the data can be filtered to show a more disaggregate analysis by district, incident severity, incident type, and for various time frames. At the bottom of the page, the user can choose to view the incident details, including individual ICT, or to display trends in average clearance times over the past few months. VDOT currently is in the process of revamping its dashboard.

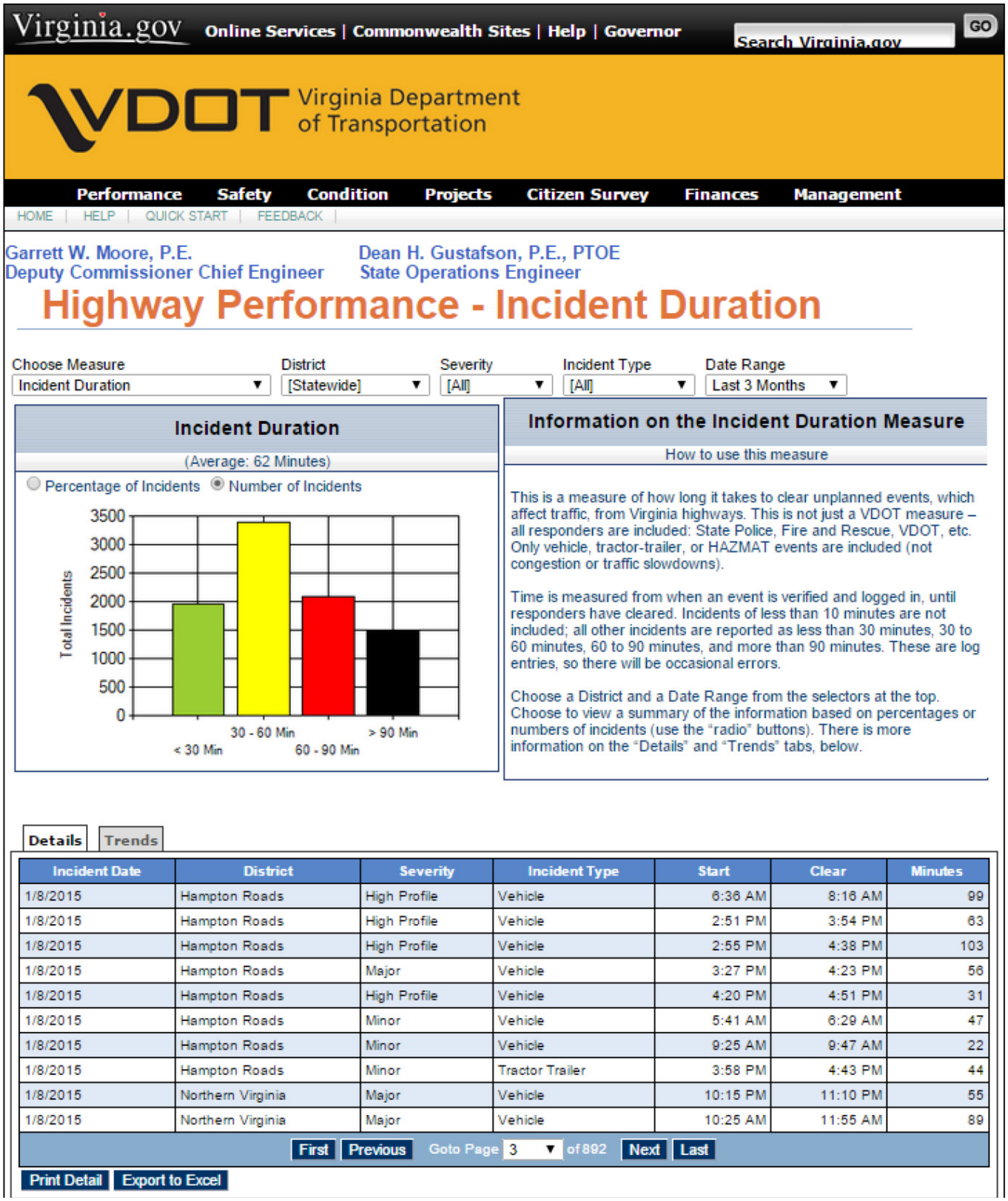


Figure 18. Screenshot. Virginia Department of Transportation incident clearance times (3 months).

(Source: Virginia Department of Transportation.)

Scorecards

The Wisconsin Department of Transportation's (WisDOT) Performance Improvement program focuses on the core goal areas of Mobility, Accountability, Preservation, Safety and Service (MAPSS). A quarterly MAPSS Performance Improvement Report summarizes the progress of selected customers to show the current state of Wisconsin's transportation system. The department also has interactive Web pages within each core goal area for performance measures on a two-page scorecard, and then details the progress of each measure in the body of the report. These scorecard measures have been deemed of highest importance to WisDOT customers who are interested in "drilling down" into the data (Figure 19). One of the scorecard measures is the average incident clearance time for "extended duration incidents" (EDI)—those incidents that close one direction of an interstate for two hours or more, or both directions for 30 minutes or more.[9]

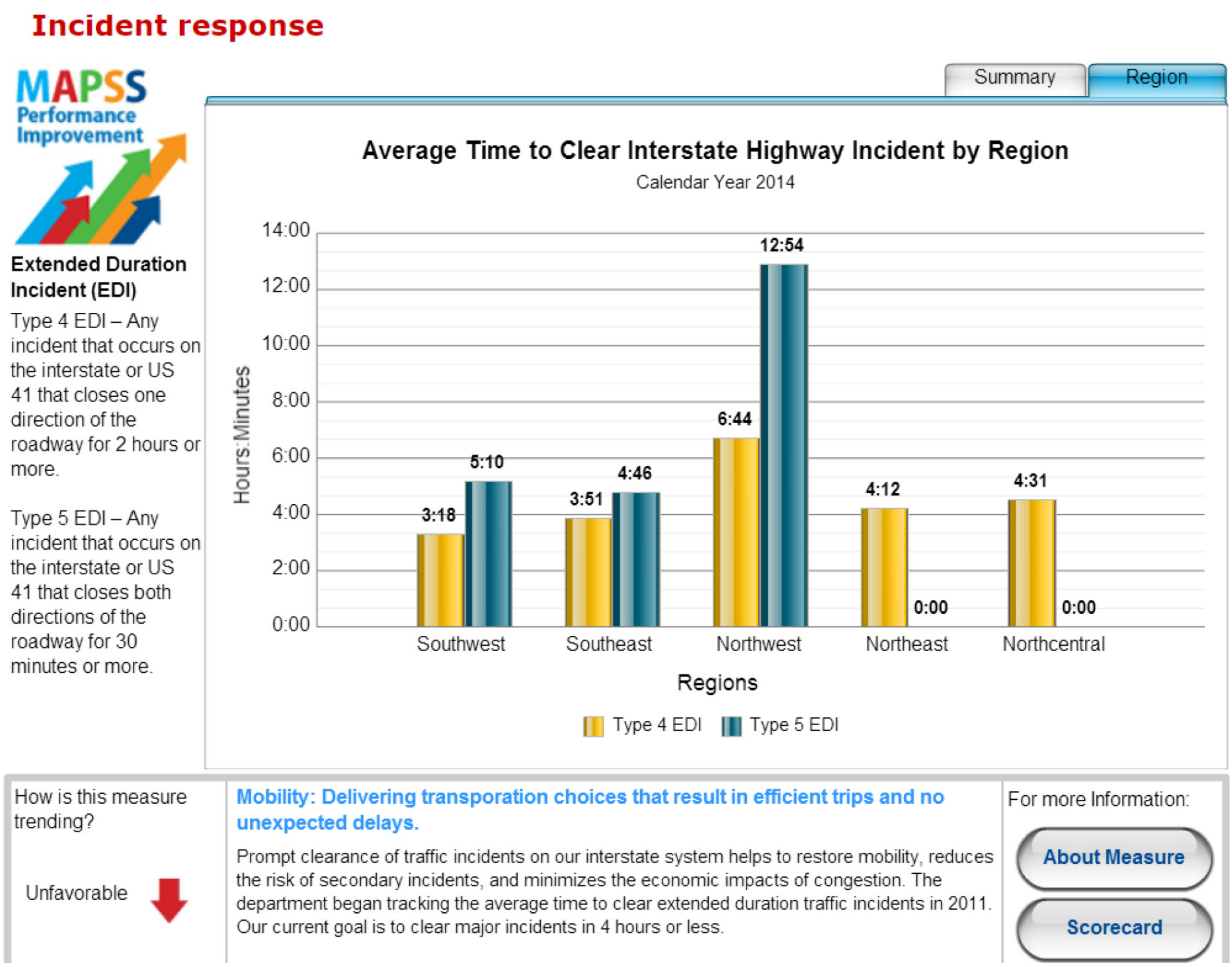


Figure 19. Screenshot. Screenshot of Wisconsin Department of Transportation's interactive Web page for incident response goal area.

(Source: Wisconsin Department of Transportation.)

Internal Use and Reporting

Reporting requirements and public transparency are only some of the reasons for collecting data and analyzing TIM performance. Another primary reason for collecting and analyzing TIM data is to be able to make strategic and tactical, data-driven decisions to impact TIM program performance.

The TDOT maintains an internal performance goal to open travel lanes within 90 minutes for 94 percent of all incidents. TDOT collects RCT data and tracks performance to ensure that it is meeting that goal. If the goal is not being met, it works to determine what needs to be done to improve performance. Past examples of improvements include training and expanded HELP coverage areas. In addition, secondary crashes are recorded by both TDOT (via the TMCs) and the State police (via the TITAN database's electronic crash reports). Having data on secondary crashes has allowed Tennessee to identify serious secondary crashes that have occurred in the queue of a primary incident. As a result, TDOT developed a "queue protection" program to minimize secondary crashes. The program involves deploying equipment (e.g., trucks, arrow boards) and trained personnel to help protect queues that develop as a result of incidents. This program has been in operators for about two years; and while TDOT does not have historical data with which to compare, preliminary data suggest a 20- to 30-percent reduction in secondary crashes over the past year.

In early 2011, there was a major policy revision in Arizona requiring police officers to move vehicles completely off the roadway (away from view) during incidents. The Arizona Department of Public Safety (AZDPS) used performance measures before and after this policy change to determine if the policy had an impact on TIM performance. Table 5 compares the average RCT and ICT for crashes that occurred between October and December 2010 (prior to the policy change) and four years later between October and December 2014 (after the policy change) by injury severity. For noninjury and injury incidents, average clearance times decreased after implementation of the policy, suggesting that the change was effective at reducing the clearance times of these crashes, particularly the noninjury crashes. For fatal crashes, however, clearance times actually increased, suggesting that the policy change no impact on these severe and highly sensitive crashes.

Table 5. Arizona Department of Public Safety Metropolitan Phoenix traffic incident management performance between October-December 2010 and October-December 2014.

Injury Category	Performance Measure	October-December 2010 Performance	October-December 2014 Performance	Percent Change
Non-injury	RCT	45	9	-80%
	ICT	84	34	-60%
Injury	RCT	54	23	-54%
	ICT	94	54	-43%
Fatal	RCT	212	267	+26%
	ICT	214	282	+32%

(Source: Arizona Department of Public Safety.)
Note: RCT is roadway clearance time, ICT is incident clearance time.

The AZDPS uses secondary crashes in the agency's strategic plan. The Commander tracks the percent of secondary crashes over time; and if the numbers start increasing, it is the Commander's role to determine ways to reduce the numbers. In addition, AZDPS is using the data to better manage its resources on the roads. For example, they were able to reduce/eliminate recurring crashes in one location by strategically placing officers near the site. By knowing where and when incidents tend to occur (as well as the type of incidents), AZDPS staged its resources to reduce/eliminate response times (drive times, time to deploy tow trucks). AZDPS started this program to get the supervisors involved in using the data and understanding how they could influence how their officers are patrolling. The next step is to look at response and clearance times.

The WisDOT has set a departmental goal to reduce the length of time traffic flow is disrupted by EDIs on the interstates—those that close an interstate for more than two hours in one direction or for more than 30 minutes in both directions. The target for Extended Duration Incidents (EDI) clearance is four hours or less. WisDOT monitors and records all major incidents, and then conducts an After Action Review (AAR) to help identify strengths, weaknesses, opportunities, and threats associated with clearance activities. An EDI workgroup has been formed to analyze all facets of the process to identify areas for improvement.

STEP 5: Engage Partners in Discussions about Traffic Incident Management Performance

A comprehensive traffic incident management (TIM) performance measurement program requires buy-in, support, and input from more than just the agency leading the charge. Therefore, it is important to look for and capitalize on opportunities to discuss the importance of TIM performance measurement with TIM partners.

(Photo Source: Virginia Department of Transportation.)

Engage Partners in the Traffic Incident Management Performance Measurement Discussion

Regular, local/regional TIM meetings are an opportune venue for discussions regarding TIM performance measurement. If performance measurement is a new topic, engaging partners in discussions about clearing incidents and the importance of safe, quick clearance can open the doors to more indepth discussions about measuring and tracking the performance of TIM activities.

Share Traffic Incident Management Goals and Objectives

Do not assume that other agencies or TIM partners share the same goals and objectives with respect to TIM performance. While transportation might value roadway and incident clearance time (ICT) as a performance measure, law enforcement might place a higher priority on response time, which is a component of both roadway and ICT. Work to develop a shared understanding of everyone's performance measures and priorities. Then, develop common measures and goals that are equally important to all agencies involved so that everyone is driven by the same goals.

The Tennessee Department of Transportation (TDOT) and Tennessee Highway Patrol (THP) had different approaches with respect to secondary crashes. After TDOT shared its secondary crash definition, the THP modified its definition to match that of TDOT (which is consistent with the Federal Highway Administration's (FHWA) definition). Afterwards, everyone was brought in, and the definition was used in the TIM training. Tennessee's approach to secondary crashes is that, while there is not a total science to it, the importance is making people aware that they matter.

As a way to engage the sheriff and State patrol in discussions about incident clearance, the Wisconsin Department of Transportation (WisDOT) requires an After-Action Review (AAR) for all incidents that exceed an arbitrary clearance threshold (any incident that closes any interstate for two hours in one direction or 30 minutes in both directions).

The Virginia Department of Transportation (VDOT) is in the process of expanding and standardizing its TIM performance measurement program statewide, and this effort has involved networking and collaborating with a wide range of stakeholders, working at the executive level within VDOT, and reestablishing the statewide TIM Executive Leadership Team. This team includes a Virginia State Police (VSP) colonel and the Commissioner of VDOT and meets twice a year to discuss the needs of the various TIM stakeholders and partners.

SAFETY is a shared priority and a starting point for conversation!

Discuss Agency Roles and Coordination

Success comes through a coalition of partners—knowing who is responsible for what, but understanding that there is a shared responsibility. This approach is counter to that of agencies not wanting to take "responsibility" or worrying about being "penalized" for others' actions/ performance. Determine roles and discuss how to work better behind the scene to get everyone working together at incident scenes.

WisDOT hosts regional traffic incident management enhancement (TIME) meetings with responders from local law enforcement, volunteer fire departments, highway departments, towing companies, and more to conduct incident debriefings, build relationships, and promote best practices statewide. In addition, since 2012, over 3,000 first responders have been trained and equipped to instruct their agency personnel in responder safety, safe and quick clearance, and improved communication—all to aid in quick restoration of traffic flow. Through a partnership with the Department of Justice, TIM training will be mandatory for all new police recruits in 2016, and WisDOT is working with technical colleges to incorporate formal TIM training into their fire service programs.[10]

Seek to Fill Data Gaps Through Data Sharing and Integration

Recognize that the various partners collect data and information that can supplement that of others. Sharing data and knowledge can improve awareness and an understanding of TIM performance outside of limited coverage areas/times. Additional data elements available through other agencies can increase the quantity and quality of information available for incidents, which can help to better uncover directions on how to improve. Build on existing frameworks (e.g., TIM Coalitions) and memorandum of understanding (MOU) to support data sharing and integration.

Traffic Incident Management Sharing in Virginia

To improve incident response and tracking, the VSP computer-aided dispatch (CAD) system shares traffic incident data with the advanced transportation management systems (ATMS) software at each of the VDOT regional traffic operations centers (TOC). Data sharing between the VSP CAD system and the VDOT TOCs is a coordinated effort and involves an MOU between VDOT and the VSP about the type of information/data shared. The information from the VSP is filtered to provide to VDOT only data on incidents occurring on roadways (no criminal information). When a VSP officer on the scene of an incident enters information about the incident into a mobile data terminal (e.g., electronic tablet, laptop) and/or calls the information into police dispatch, the information is automatically shared with VDOT's regional TOC, and the information appears on the TOC operator's control screen. The TOC operator then enters the information into the ATMS, thereby, combining TOC and VSP data. This data sharing began as a pilot project in one region to determine if it would improve incident response and coordination efforts between the agencies. After the success of the pilot project, data sharing was expanded to include all regional TOCs and VSP divisions. In addition, incident data from 10 local/county law enforcement CAD systems is shared with VDOT's TOCs via the local/regional Public-Safety Answering Points (PSAP), and 5 additional PSAP data exchanges are in progress.[(1)]

Building on Existing Frameworks/Agreements to Improve Data

In 2010, it was apparent to the Arizona Department of Public Safety (AZDPS) that it needed not only to improve TIM, but there was a need for measures to determine if what they were doing as an agency was working. Further, AZDPS recognized that it needed to be in charge of collecting the data, but in Arizona, the Arizona Department of Transportation (ADOT) is the agency that owns the crash data. While AZDPS and ADOT have a long-standing relationship through planning, AZDPS built a coalition with ADOT on the technical side to collect the data. ADOT promoted electronic crash data; and in 2007, the coalition assessed various platforms and decided on Traffic and Criminal Software (TraCS). Building on a 30-year old agreement and an existing statute to share the crash data, the crash data are now sent electronically from TraCS to ADOT, increasing the availability of the data from about eight months to about eight days.

STEP 6: Formalize or Institutionalize Traffic Incident Management Performance Measurement

Formalization and/or institutionalization of traffic incident management (TIM) performance measurement is an important step for taking a TIM performance measurement program to the next level. While there are a few specific actions that can be taken to help in formalizing/institutionalizing TIM performance measurement, in many cases, any “formalization” has come about through either a bottom-up/grass roots effort, as the result of a top-down directive, of some combination of the two.

(Photo Source: Florida Department of Transportation.)

Bottom-up formalization of TIM performance measurement usually starts with a champion or planned special event:

- The Minnesota Department of Transportation (MnDOT) started TIM performance measurement over a decade ago as a benchmark for the traffic management centers (TMC) within the department. In addition, the Republican National Convention was a good motivator to get it done. Capitalizing on planned special events that require coordination can sometimes spur changes, integration, and funding.

- Freeway and Arterial System of Transportation's (FAST) internal database and dashboard program came about as a combination of a strong champion that provided the vision, the desire at the agency level to get the data, and having available staff with the necessary skill set to develop the program.

- As a way to get the TIM performance measures data and formalize the process, the Arizona Department of Public Safety (AZDPS) went through the Traffic Records Coordinating Committee (TRCC), the committee responsible for developing and approving changes to the statewide crash report. The AZDPS suggested to the TRCC that 15 blank fields be added to the electronic crash report that would be available for each law enforcement agency to configure to its needs. These extra fields provided AZDPS a way of adding the TIM performance data elements into the crash report. Arizona also incorporated TIM performance measurement into its Strategic Highway Safety Plan (SHSP) by making it an awareness/focus area.

Top-down formalization of TIM performance measurement is usually the result of a specific directive or a leadership initiative:

- In Tennessee, the TIM performance measures program was established through a formal stewardship and oversight agreement between Tennessee Department of Transportation (TDOT) and the Federal Highway Administration (FHWA) division office. While TDOT had been tracking the TIM performance measures prior to this agreement, now it is required. Additionally, there is a memorandum of understanding (MOU) between TDOT and the Tennessee Highway Patrol, which outlines the goal to clear incidents within 90 minutes.

- In general the Wisconsin Department of Transportation (WisDOT) is focused on TIM, quick clearance, and emergency operations planning and readiness; and the commitment of the department's leadership to these programs has resulted in increased resources. Incident management, in particular, has risen within the top 10 issues, and WisDOT hired a consultant to develop reports on TIM performance measurement. In addition, WisDOT recently was given a staff position to support TIM performance measurement.

Combination of Bottom-Up and Top-Down

Each Virginia Department of Transportation (VDOT) region has its own personality, which has driven the establishment of local MOUs and relationships with respect to TIM. While many of the same data are captured by the traffic operations centers (TOC) across the State, VDOT is now in the process of statewide expansion and standardization of its TIM performance measurement program, and outreach has been important in achieving a change. VDOT central staff has reached out to the regions to inquire about discrepancies as they work to standardize best practices to operate on the same level. Through this outreach, central staff is making an effort to foster an attitude amongst regions that they are all connected within the State and to promote the idea that the collection and reporting of TIM performance measures goes beyond just the local areas, and that eventually the data need to be rolled up to the statewide level. This effort has involved working at the executive level within VDOT and through the statewide TIM Executive Leadership Team.

Summary

This guide provides an easy-to-apply, step-by-step process for establishing, implementing, and institutionalizing traffic incident management (TIM) performance measurement. The guide is directed at any agency or organization involved in TIM at a local, regional, or State level. The guide helps users understand the data requirements for TIM performance analysis and reporting, where and how to get the data, ways in which to analyze and report the data, and how to move from an ad hoc approach to TIM performance measurement to a more formalized and institutionalized process. The information provided is based on approaches, practices, techniques, and technologies that have been or can be applied to support a successful TIM performance measurement program.

Appendix A–
Checklist of Data Elements by Source

Data Elements	Data Sources							
	Transportation				*Public Safety*			
	from TMC/TOC		from Field Personnel (FSP, IR team)		from Crash Report		from CAD/Other	
	Yes	No	Yes	No	Yes	No	Yes	No
Required for 3 National Traffic Incident Management (TIM) Performance Measures (PM)								
Time of first recordable awareness of an incident by a responsible agency								
Time of first confirmation that all lanes are available for traffic flow								
Time last responder has left scene								
Whether a crash is secondary to a primary crash/incident								
Desirable for other TIM PMs								
Time incident verified								
Time response identified								
Time response dispatched								
Time first response arrives on scene								
Time normal traffic flow returns								
Desirable for TIM Performance Analysis								
Details of Incident								
Date of Incident								
Time incident occurred								
Description of Incident								
Incident type								
Severity of incident (e.g., minor, major)								
Severity of injury (e.g., none, minor, fatality)								
Conditions at Time of Incident								
Weather conditions								
Lighting conditions								
Roadway								
Roadway name								
Roadway type (e.g., freeway, arterial)								
Roadway direction								
Roadway location (e.g., latitude/longitude milepost)								
Surface condition								
Work zone								
Lanes Involved in Incident								
Number of lanes involved								
Total roadway lanes at scene								
Time of closing/opening of each lane involved								

Vehicles Involved in Incident								
Number of vehicles involved								
Hazmat vehicle								
Heavy vehicle involved								
Participants Involved in Incident								
Number of participants involved								
Injury involved								
Number of Injuries								
Injury type								
Participant types								
Emergency Responders and Vehicles								
Number of responders involved								
Response organization								
Responder(s) ID (identification)								
Response vehicle(s) type								
Response vehicle(s) arrival on scene								
Response vehicle(s) departure from scene								

Note on acronyms and abbreviations in Appendix A: TMC is traffic management center; TOC is traffic operations center; FSP is freeway service patrol; IR is incident response; CAD is computer aided dispatch.

Appendix B –
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