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Project 20-24(37)D
Recommendations for Improving the use of Traffic Incident Management Performance Measures when Comparing Operations Performance Between State DOTs

FINAL REPORT

Prepared for
National Cooperative Highway Research Program
Transportation Research Board
Of
The National Academies

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January 2011

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## DISCLAIMER

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## ACKNOWLEDGMENTS

The research reported herein was performed under NCHRP Project 20–24(37)D by the Center for Advanced Transportation Technology (CATT) in the Department of Civil and Environmental Engineering at the University of Maryland. Thomas H. Jacobs, CATT Director, was the Principal Investigator. Nikola Ivanov, Senior Data Architect, and Michael L. Pack, CATT Lab Director, were instrumental in the supporting the data acquisition, compilation, and analysis for this effort.

The research team would like to thank the following agencies for their participation in this project and, in particular, providing incident response data: Maryland State Highway Administration, Missouri Department of Transportation, New York State Department of Transportation, New York State Thruway Authority, Oregon Department of Transportation, Tennessee Department of Transportation, Texas Department of Transportation, Utah Department of Transportation, Virginia Department of Transportation, and Washington State Department of Transportation. This research was positively influenced by the cumulative experience of the review panel, chaired by Daniela Bremmer of the Washington State Department of Transportation.

**ABSTRACT**

The initial premise behind the project was to use available state Departments of Transportation (DOT) data on traffic incident response performance to provide a time series / cross section-sectional analysis of incident response performance, which could be measured based on average, median, or maximum incident response time, total incident duration or incident clearance time. The idea was that a cross-state comparison and examination of changes in performance over time might identify best practices that could be instrumental in reducing incident duration with associated benefits to travelers.

For reasons explained in this research report, the primary emphasis of this project shifted to one of developing specific recommendations that could improve Traffic Incident Management (TIM) performance measurement. While this research did result in a cross-state comparison for some of the participating agencies, the lack of standardization in collection and use of nationally adopted TIM performance measures made it difficult to draw definitive conclusions as to how the agencies are performing with respect to one another. What the research did yield is a set of recommendations that will be useful in enhancing existing agency TIM data collection and reporting efforts and the possible development of a standard approach to TIM performance data collection that will allow future efforts at cross-comparison to yield results that are consistent and more readily comparable.

## EXECUTIVE SUMMARY

The Departments of Transportation (DOT) participating in this research are each collecting and archiving widely varying amounts of traffic incident response and event data for performance monitoring of their respective incident management programs. Using this data for comparative analysis purposes is premature in that, only recently, have agencies begun adopting nationally defined Traffic Incident Management (TIM) program objectives and performance measures. In fact, the agencies participating in this research have not been using their Traffic Management Center (TMC) incident response data sets to calculate and report on the adopted Traffic Incident Management Performance Measures (TIM PM's) "roadway clearance" time (RCT) and "incident clearance" time (ICT). *That is not to say the agencies are not concerned with these clearance times, only that they have not yet adopted these "standard" TIM PM's and their definitions*. Lack of "standards" in the area of TIM is not a new issue, and efforts to address the issue have been (and continue to be) underway as noted in this report. This presented the research team with the following challenges in trying to conduct a comparative analysis effort:

- Understanding definitions of unique database variables in each agency's data sets and how these variables relate to those required to determine RCT and ICT.
- Using a common definition of "traffic incident" across agency data sets. Currently, there are at least three definitions of "traffic incident". The definition used in this research is that published by the Institute of Transportation Engineers (ITE) and the American Association of State Highway and Transportation Officials (AASHTO) in the Traffic Management Data Dictionary (TMDD).
- Using agency data sets to derive RCT, ICT, and other potential TIM PMs and examining them in as close to an "apples-to-apples" comparison as possible.
- Conducting a finer level of comparison of RCT and ICT based on non-standard incident types.
- Attempting to draw meaningful results and conclusions from the comparative analysis that was achieved.

Regarding this last point, a relatively small number (10) of agency data sets were used in conducting a comparative analysis and in a majority of instances, only a subset of the data sets could be used depending on the TIM PM analyzed. However, the volume of data provided by each agency and used in the analysis is considerable. Using an approach that involved collecting all data in the participating agency TMC databases, the resultant comparative analyses was based on over 600,000 incident records representing a combined 22 years of data. While the comparative analysis presented in this report must be viewed with extreme caution, the participating agencies can use the information to examine what appears to be going well with agency TIM operations and where improvements might be targeted. Further, and perhaps more importantly, this research did lead to a number of recommendations that will be useful in advancing adoption and use of TIM PMs and conducting future comparative analyses. A summary of these recommendations follows (for a full description of each recommendation, please refer to Chapter 4 of the full report).

***Recommendation 1***- The Federal Highway Administration, working together with the National Traffic Incident Management Coalition, the National Transportation Operations Coalition, and the TMC Pooled Fund Study States, must continue to "Market" the importance of collecting and reporting TIM PM data. The marketing campaign should be on the same level as that which is being used to request the States to adopt the TIM National Unified Goal (NUG).

***Recommendation 2*** – Build on existing TMC collection capabilities and practices and have transportation agencies take on the lead responsibility for TIM PM adoption, data collection, and reporting. Asking DOT's to adopt this lead role should be part of the marketing campaign recommended above. Key to the TIM PM definitions is the concept of "first recordable awareness". Efforts to capture "first recordable awareness" outside of the TMC should continue; however, implementation of the TIM PMs should allow for *best available* "first recordable awareness" including the time the TMC (or other transportation system) first records the incident.

***Recommendation 3*** – Provide transportation agencies with guidelines and resources needed to take on lead responsibility for TIM PM data collection and reporting that would include:

- The definitive source of TIM PM related definitions and standards for TIM PM data elements as well as an adopted definition of a "traffic incident". The definition used for "traffic incident" in this report is based on the TMDD: *An unplanned randomly occurring traffic event that adversely effects normal traffic operations.*

- Coordination of TIM PM related definitions and standards with the TMDD to ensure that TIM PM time stamp variables are properly reflected in both documents.

- Definitions and standard data elements for *incident types* that can be used in analyzing TIM PM data (see recommendation 4).

- Provide a reference implementation (including database schema) that conforms to standard definitions and data elements.

***Recommendation 4*** - Develop definitions and standard data elements for *incident types* that can be used in analyzing TIM PM data. The work to develop national TIM PMs is an excellent start. This effort should be expanded to include some common incident type definitions and data elements perhaps starting with the common types used in this research.

***Recommendation 5*** - Adopt "Arrival Time" as a national level TIM PM. Arrival Time is *the time between first recordable awareness by transportation and the time when transportation assets first arrive on scene* [note: if necessary it could be referred to as Transportation Arrival Time to distinguish it specifically from other response agencies].

***Recommendation 6*** - Incorporate collection and reporting of TIM PMs into an annual National TIM PM Assessment Program using TIM PM's as comparative measures. This would build on FHWA's National TIM Self Assessment program and is a concept advocated by the National Traffic Incident Management Coalition. A central repository would be created for archiving TIM PM data which would be provided annually by the DOTs, alleviating one of the most time

consuming aspects of comparative analysis work (acquisition of DOT TMC incident response data). Standard web-accessible reports would be developed for each TIM PM and would continue to remain anonymous.

# **CHAPTER 1** Background

This work builds on a series of highly successful comparative performance measurement initiatives sponsored by the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Quality (SCOQ) in the areas of Project Delivery, Smooth Pavements, and Safety. Each of these projects has involved compilation of detailed performance data for multiple Departments of Transportation (DOT), calculation of performance measures for each agency, composition of peer groups for comparative analysis, identification of top tier agencies with respect to the selected measures, and interviews to determine practices that may be related to exemplary performance.

## Problem Statement and Research Objective

The premise of comparative performance measurement among DOTs is that independent agencies in different states often share similar strategic goals with their peers, such as smoother pavement or improved mobility, but that in any grouping of peers, one or two agencies are likely to devise unique yet transferable business processes that enable better performance in these areas[1]. In each of the completed comparative performance initiatives noted above, the research focused on answering two fundamental questions: (1) What if a DOT could compare performance both in the near term and over and extended period relative to its peers?; and (2) Do variations in performance among states suggest opportunities for practitioners to find new and improved ways to do business?[2].

This operations related performance comparative research endeavored to answer these fundamental questions in the area of traffic incident response. The initial premise behind the project was to use available state DOT data on incident response performance to provide a time series / cross section-sectional analysis of incident response performance, which could be measured based on average, median, or maximum incident response time, total incident duration or incident clearance time. The idea was that a cross-state comparison and examination of changes in performance over time might identify best practices that could be instrumental in reducing incident duration with associated benefits to travelers.

For reasons explained in this research report, the primary emphasis of this project shifted to one of developing recommendations and in the area of Traffic Incident Management performance measurement (TIM PM) that could improve future TIM PM data collection and analysis. While this research did result in a cross-state comparison of agency incident response datasets, the lack of standardization in collection and use of TIM performance measures made it difficult to draw definitive conclusions as to how the agencies are performing with respect to one another. What the research did yield is a set of recommendations that will be useful in enhancing existing agency TIM data collection and reporting efforts and the possible development of a standard approach to TIM performance data collection that will allow future efforts at cross-comparison to yield results that are consistent and more readily comparable.

This project adhered to the basic principles for comparative performance measurement as identified in AASHTO's March 2006 document "Measuring Performance Among State DOTs":

- Make participation voluntary,

- Focus on knowledge sharing not "number crunching,"
- Ensure comparisons are between peers,
- Consider creating peer groupings by topic,
- Ensure methodologies for measurement are rigorous,
- Minimize added burdens on data collection, and
- Protect DOTs from unfair scrutiny.

With regard to the last bullet, as in the previous comparison studies, the purpose of this effort was NOT to rank the participants, but to learn from existing TIM data collection practices so that existing practices can be enhanced and future efforts at cross-comparison can be improved. While agencies participating in the study are identified, anonymity has been maintained in reporting all cross-comparative research results.

Challenges associated with collecting comparative incident management time stamp data across DOTs have long been identified. Consider the example of Response Time as collected by the Florida Department of Transportation (FDOT) and Maryland State Highway Administration (SHA) as illustrated in Figures 1 and 2 respectively. As shown in Figure 1[i], FDOT calculates Response Time from the time an incident is verified by the TMC to when a service patrol arrives on scene. The FDOT actually captures a value called Verification Time which is the time from when the TMC is first notified to when the incident is verified. While Maryland SHA also verifies incidents, a Verification Time value is not collected. As shown in Figure 2[ii], Response Time is calculated from the time the Traffic Management Center (TMC) is first notified to when the first service patrol arrives on scene. Therefore, in order to do a comparative analysis, the solution is to add FDOT's Verification Time and Response Time together and compare against SHA's Response Time.

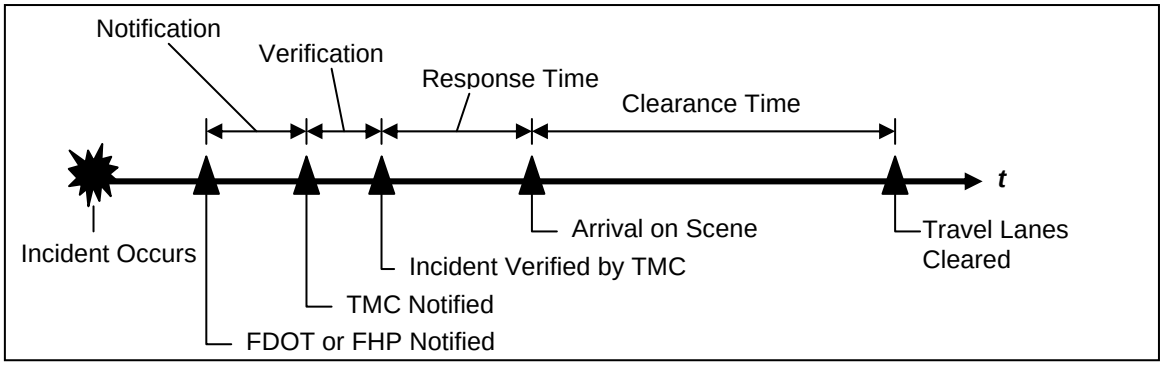


FIGURE 1 - FLORIDA DOT INCIDENT TIMELINE EXAMPLE

This lack of standardization in capturing Response Time data exists for other potential comparative performance measures that were examined such as Clearance Time and Incident Duration as well. For example, one DOT (e.g., FDOT) may measure Clearance Time as the time between arrival of a service patrol and when *travel lanes* are cleared (but shoulders may continue

to be blocked) whereas another (e.g., Maryland SHA) may measure the same the time as the time between arrival of a service patrol and when the incident is *completely cleared* (all travel lanes and shoulders). This problem is also depicted in Figures 1 and 2.

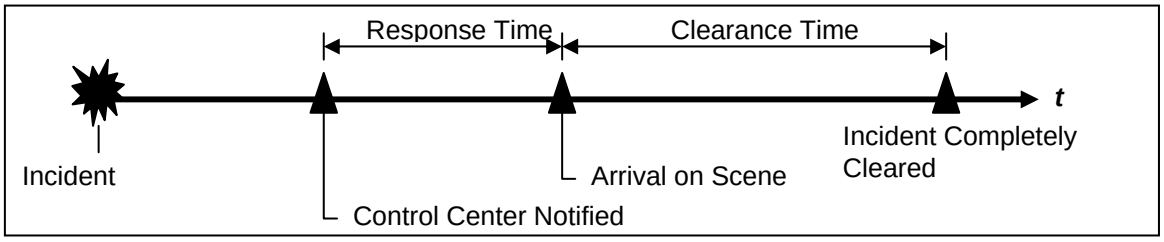


FIGURE 2 - MARYLAND SHA INCIDENT TIMELINE EXAMPLE

As depicted by this example, careful attention to the incident time stamp values captured by the DOT's participating in this study, as well as the various definitions used by their incident management programs, was a key component of this research.

# CHAPTER 2 Research Approach

Reviewing traffic incident management programs using a formal comparative approach has been, to an extent, underway since 2003. Since that time, the Federal Highway Administration (FHWA) has facilitated the assessments of Traffic Incident Management (TIM) programs in the largest 75 urban areas of the United States. Representatives of key transportation and public safety agencies and private sector partners in each area conduct the assessments.

While progress has been made since 2003, the establishment and collection of TIM performance data as part of a formal program continues to be a significant challenge. As noted in the most recent (2009) TIM Self-Assessment (TIM SA) National Analysis Report[3], despite progress in the Strategic area, the five questions receiving the lowest mean score in the TIM SA are in this section, with four of the five coming from the subsection on TIM Performance Measurement (TIM PM). The TIM National Analysis report goes on to suggest that low scoring questions and those with the least improvement over baseline indicate specific program areas where additional guidance from FHWA is warranted and this includes TIM PM. Performance measurement is key to targeting limited resources and measuring TIM program performance is the means for documenting program value, identifying areas for improvement and justifying program continuation and expansion. However, measuring program performance is challenging; the program is the result of the efforts of many agencies and the data necessary to evaluate program performance resides with those multiple agencies.

Perhaps the biggest obstacle to creating a comparative performance analysis across states is the fact that standard definitions do not exist for traffic incident response programs. In 2002, the FHWA sponsored a report by the Texas Transportation Institute (TTI) that examined the topic of incident management performance measures in detail[4]. Under this research, performance measurement practices of transportation and public safety agencies (primarily law enforcement and fire/rescue) across the United States were examined. The goal was to provide a better understanding of how transportation and public safety agencies measure performance in traffic incident management and to identify the differences in the definitions and data sources of the measures of used.

The study found that while many agencies measure performance related to traffic incident management, the definition of the measures are inconsistent across transportation and public safety disciplines. Agencies tended to measure what is important to them with little coordination on measurement with other agencies in the same region.

Under National Cooperative Highway Research Program (NCHRP) 20-7 *Guide to Benchmarking Operations*[iii], a research initiative conducted by the University of Maryland Center for Advanced Transportation Technology, problems with consistency of incident start and end times were noted when trying to pilot *incident duration* as a TIM PM. These problems were due to lack of standard definitions of incident start and end time.

To address these challenges, FHWA convened 11 states through its Focus States Initiative (FSI) to develop, implement and test TIM performance measures. This two-year effort, completed in January 2009, resulted in three national-level TIM program objectives and supporting performance measures defined as follows:

- **Reduce "roadway clearance" time**: the time between the first recordable awareness of an incident (detection, notification or verification) by a responding agency and first confirmation that all lanes are available for traffic flow.

- **Reduce "incident clearance" time**: the time between the first recordable awareness of the incident and the time at which the last responder has left the scene.

- **Reduce the number of secondary incidents**: the number of unplanned incidents beginning with the time of detection of the primary incident where a collision occurs either a) within the incident scene or b) within the queue, including the opposite direction, resulting from the original incident.

The results of the initial FSI effort indicated that TIM performance measures could be structured so that all states use the same performance measure to analyze their respective programs. Further, it showed that states are able to collect and analyze the data needed to support TIM performance measurement using a common performance metric, although methods of data collection varies significantly.

In late 2009, the FHWA funded a follow on project led by the TTI that builds on the work of the TIM Focus State Initiative. The purposes of this two-year study are to (1) investigate and identify issues of definition, data collection and analysis that inhibit successful measurement of frequency, severity, types and causes of secondary crashes; (2) determine what incident specific performance measurements are being collected by the top 40 metropolitan jurisdictions and their corresponding States and how they differ from the definitions and criteria set forth by the TIM Focus States; (3) establish a National baseline built upon the top 40 metropolitan areas to assess progress in TIM operations; and (4) establish a system that enables FHWA to build upon the baseline and integrate other areas for a National TIM operational snapshot of TIM programs. This NCHRP comparative performance research effort has been coordinated with the initial work activities associated with this TTI study and provides results and recommendations that will support many of the above identified purposes.

The research approach for this project made maximum use of past and ongoing work in the area of TIM performance measures in an effort to avoid duplication and leverage previous work. To this end, the research was coordinated closely with the FSI participating states, and to the extent possible, used incident data contacts that were involved in this effort.

Following is a summary of the research tasks conducted for this project followed by a description of the research approach used for each.

1. Indentify candidate TIM comparative performance measures and data requirements to support these measures;

2. Identify potential candidate agencies and invite them to participate;

3. Confirm TIM data availability and collect data;

4. Compile and analyze comparative performance measures based on collected data; and

5. Based on compilation and comparative analysis effort, develop a set of recommendations that could be useful in enhancing existing agency TIM data collection and reporting efforts.

**Task 1 – Identify candidate TIM comparative performance measures and data requirements to support these measures**

At the outset of this project, the expert oversight panel recommended the use of the TIM FSI performance measures for comparison purposes to the maximum extent possible. The TIM FSI was described in the previous chapter. Table 1 shows the three consensus program level TIM objectives and related performance measures[iv] .

TABLE 1 - TIM PROGRAM OBJECTIVES AND PERFORMANCE MEASURES

| TIM Program Objective | Related Performance Measure |
|---|---|
| **1. Reduce "roadway clearance" time** defined as the time between awareness of an incident and restoration of lanes to full operational status. | Time between first recordable awareness of incident by a responsible agency and first confirmation that all lanes are available for traffic flow. |
| **2. Reduce "incident clearance" time** defined as the time between awareness of an incident and removal of all evidence of the incident, including debris or remaining assets, from shoulders. | Time between first recordable awareness of incident by a responsible agency and time at which the last responder has left the scene. |
| **3. Reduce the number of secondary incidents**—specifically unplanned incidents for which a response or intervention is taken, where a collision occurs either a) within the incident scene or b) within the queue (which could include opposite direction) resulting from the original incident. | Number of unplanned incidents beginning with the time of detection of the primary incident where a collision occurs either a) within the incident scene or b) within the queue, including the opposite direction, resulting from the original incident. |

The two *primary* TIM performance measures used in this comparative performance research project were those related to "roadway clearance" time and "incident clearance" time. TIM Program Objective three – Reduce the number of secondary incidents – and its related

performance measure was not used as a comparative measure in this research. The primary reason it was not included is because there are many issues surrounding the collection of data related to "secondary crashes" that are a major focus of the follow-on TTI TIM Incident Performance Metric Adoption Campaign which would not be resolved during the course of this research effort.

While Roadway Clearance Time and Incident Clearance Time were selected as the primary TIM performance measures for comparative analysis, other candidate performance measures were identified as well. Figure 1, which shows a generic TIM timeline response, was developed to identify time stamp data that would be required to support the calculation of Roadway Clearance Time and Incident Clearance Time. It also provides an indication of TIM disciplines that might be associated with the collection and archiving of the time stamp data.

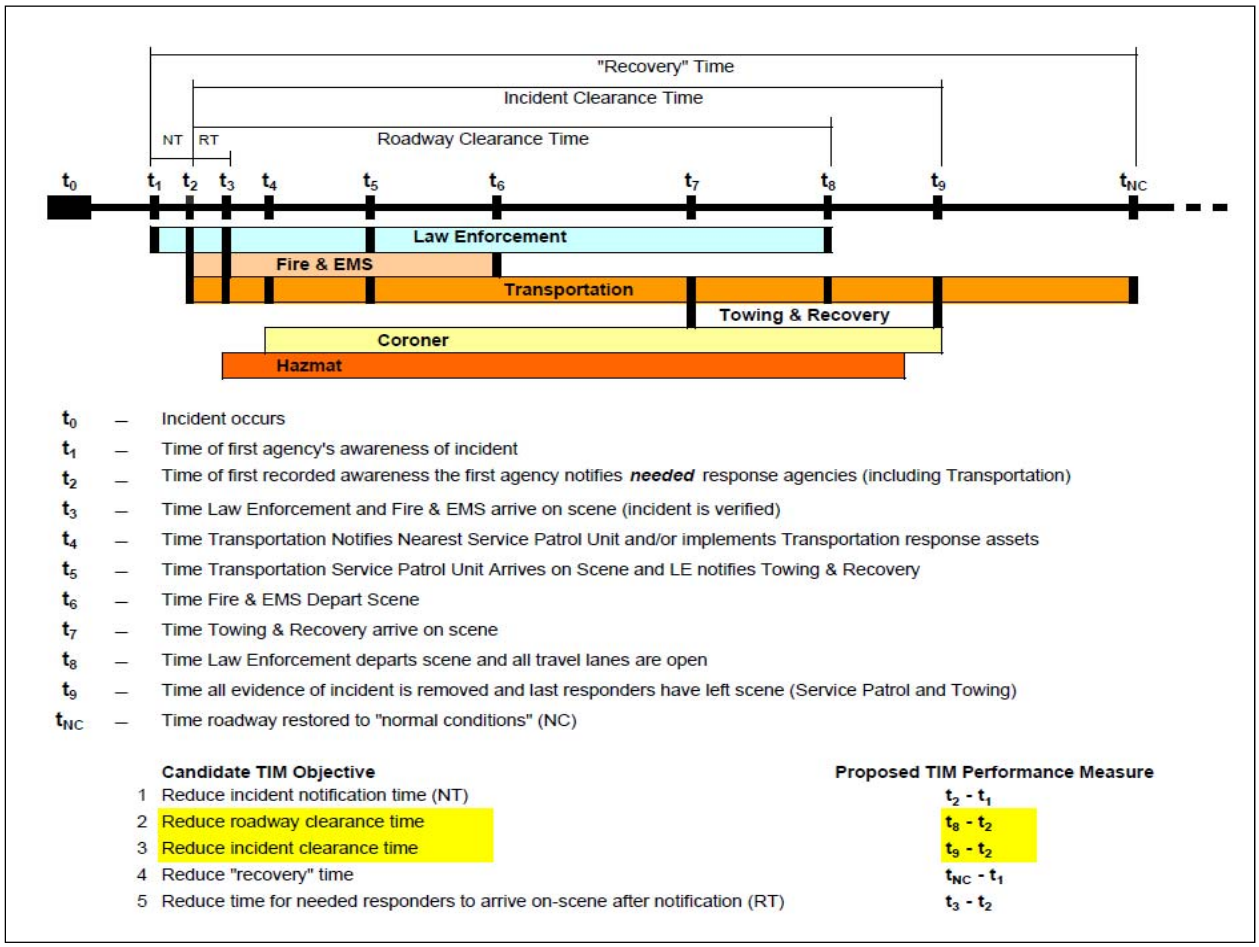


FIGURE 3 - TIM TIME STAMPS & PERFORMANCE MEASURES

Note that the transportation discipline is associated with the majority of time stamp data as they typically have the most interest in tracking a traffic incident from as close to the time it occurs to the time when the scene has been entirely cleared and/or the roadway has been restored to "normal conditions".

An on-going dilemma with TIM performance measures is the difficulty, for transportation agencies, in capturing data related to "the time of first recordable awareness of an incident." As law enforcement and fire/emergency medical services (EMS) are typically (although certainly not always) first to the scene, this data is routinely captured within law enforcement and fire computer-aided dispatch (CAD) systems. However, the extraction of this data can be anything but routine, especially for non-law enforcement or fire/EMS agencies. While progress continues to be made around the country in integrating CAD and transportation management systems, facilitating the capture of "first recordable awareness" by transportation agencies via CAD data, these integrated systems are far from the norm. Because of the challenges associated with collecting CAD data, and in keeping with the principle of "minimizing the burden" on DOT volunteers providing data, this research focused specifically on data captured and reported by TMC and other transportation agency systems. It should be noted, however, that for the transportation agencies participating in this research, the time recorded when an incident is opened in the TMC's system may not be the time of *first recorded awareness* of the incident.

Other candidate TIM objectives and related performance measures that were identified as potential candidates for comparative performance are as depicted at the bottom of Figure 1 [note that the primary TIM objectives and performance measures are highlighted]. The secondary candidates, which were also identified under the TIM FSI, are as depicted in Table 2.

TABLE 2- OTHER CANDIDATE TIM FSI OBJECTIVES AND PERFORMANCE MEASURES

| Candidate Objective | Proposed Performance Measures |
|---|---|
| **Reduce incident Notification time** (defined as the time between the first agency's awareness of an incident, and the time to notify needed response agencies). | The time between the first agency's awareness of an incident, and the time to notify needed response agencies. |
| **Reduce "recovery" time** (defined as between awareness of an incident and restoration of impacted roadway/ roadways to "normal" conditions). | Time between awareness of an incident and restoration of impacted roadway/roadways to "normal" conditions. (NOTE: Participants noted that "normal" conditions could be difficult to define.) |
| **Reduce time for needed responders to arrive on-** | Time between notification and arrival of first qualified response person to |

| | |
|---|---|
| **scene after notification.** | arrive on incident scene. |

The decision as to which of these secondary candidate performance measures to use in this comparative research effort was made only after collecting incident response data from the project participants. Ultimately, as will be shown later in this report, "recovery time" and "arrival time" were used as comparative performance measures. However, arrival time as used and defined in this research report is not the same as defined in Table 2 which emphasizes arrival of the "first qualified response person to incident scene" regardless of discipline. The "arrival time" performance measure as used in this report is defined as the *time between first recordable awareness by transportation to arrival of first transportation assets (e.g., service patrols, maintenance vehicles, etc.) at the scene*.

This task resulted in the identification of two primary TIM performance measures for comparison; two secondary candidate TIM performance measures for comparison; and identification of the time stamp data needed from transportation TMC databases to calculate and compare these performance measures.

**Task 2 – Identify potential candidate agencies and invite them to participate**

At the time this task was conducted in December 2009, a national *up-to-date* TMC contact list was not readily available so the research team had to first compile potential candidate TMC agency contacts that would be willing to participate and contribute incident response data. A list of potential TMC contracts was compiled using:

- contact information for the TMC pooled fund study participants included on the project web site[v];
- a list of contacts that participated in the TIM PM FSI provided by FHWA;
- USDOT's Intelligent Transportation Systems (ITS) deployment tracking database; and
- the expert panel that participated in the oversight of this research project.

The contact list included 30 states representing 62 TMCs. A personal e-mail was sent to each of the contacts inviting participation in this incident response performance measure comparative research effort along with a request for ALL incident response data collected by their TMC(s) for a period of 1-3 years. This invitation and data request letter is included in Appendix A.

It is worth noting that one of the initiatives associated with the TMC pooled fund study is the development and support of a web-based TMC Clearinghouse[vi] which includes a searchable database of TMC's including state, metropolitan area, city, and owner. This is an excellent resource; however, as with all databases that rely on its user base for maintaining contact information, currency of the data can be an issue.

**Task 3 – Confirm TIM Data Availability and Collect Data**

Initially, twelve (12) agencies responded to the invitation indicating a desire to participate and provide incident response data. When it appeared that further responses to the e-mail invitation would not be received, the Expert Panel was asked for their help in personally contacting those states that did not respond to the e-mail invitation. With the Panel's assistance, additional agencies agreed to participate. Each contact who replied with an affirmative response to participate was contacted by phone for a follow up discussion about the project and the next steps required to acquire their respective TMC's incident response data set. In all cases, follow up contact was made with the specific person who could help provide access to the requested data which, in some cases, required multiple follow up e-mails and phone calls between CATT staff and the agency data contacts. Ultimately, incident response datasets were obtained from 10 agencies with a geographic distribution as depicted in the U.S. map below.

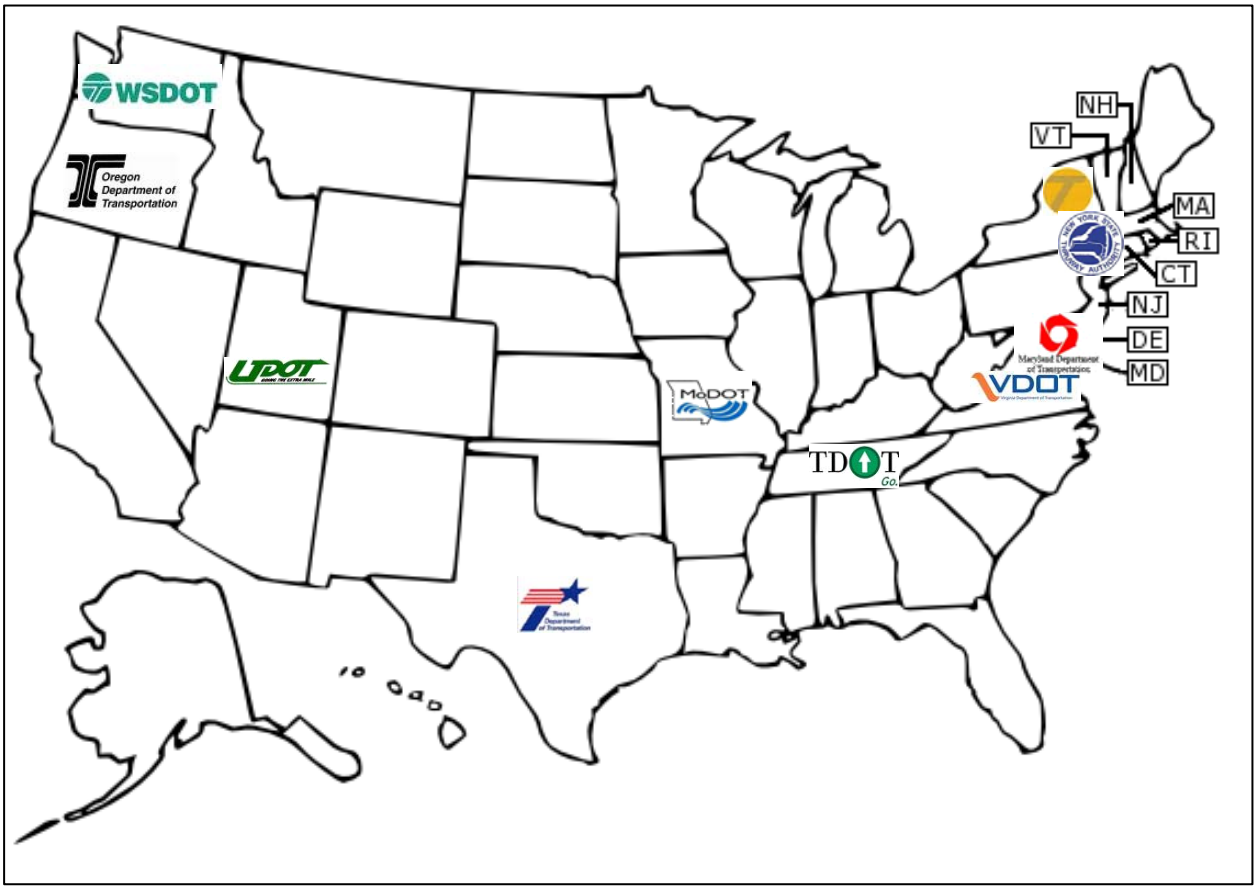


FIGURE 4 - GEOGRAPHIC DISTRIBUTION OF AGENCY DATA PROVIDERS

The agencies contributing incident response data for this research included:

- Maryland Department of Transportation (Maryland State Highway Administration)
- Missouri Department of Transportation

- New York State Department of Transportation
- New York State Thruway Authority
- Oregon Department of Transportation
- Tennessee Department of Transportation
- Texas Department of Transportation
- Utah Department of Transportation
- Virginia Department of Transportation
- Washington State Department of Transportation

*Note that while the agencies participating and providing data for this study are acknowledged above, they are not specifically indentified in the Findings and Recommendations of this report so as to adhere to the principle of anonymity used in all AASHTO sponsored comparative performance research efforts in an effort to protect the participant agencies from unfair scrutiny.*

As indicated previously, agencies were requested to provide all incident response data in their databases (as opposed to requesting specific incident response performance data). The rationale for requesting all the data in the respective agency databases include:

- *Desire to minimize impact to agency participants* – it was determined that it would be easier on the agencies to use their raw data to calculate desired TIM PMs as opposed to asking them to run specific scripts/queries and calculate the PMs themselves;
- *Opportunity to examine how all data is collected and stored* – this was an opportunity to examine at ALL data being collected and stored including format and naming of data elements; and
- *Opportunity to identify additional TIM PMs* – having access to all database elements provided an opportunity to identify additional potential TIM PM's beyond the focus on Roadway Clearance Time and Incident Clearance Time.

**Task 4 – Compile and analyze comparative performance measures based on collected data**

The approach of collecting all data in the TMC databases resulted in the acquisition and compilation of over 600,000 incident records representing a combined 22 years of data. The time span for data provided went from a minimum of ten months to a maximum of over five years.

The analysis approach for identifying, compiling, and comparing TIM performance measures based on the data collected involved the following steps:

1. Analyze each agency database for the existence of primary and secondary TIM PM variables (in some cases, variables had to be derived).

2. Obtained clarification of variable definitions in each agencies database.

   This was a critical step in the analysis approach. The purpose was to make sure the variable definitions used within the respective agency databases were clearly understood both on their own and with respect to the TIM PM's used in this research. Rather than ask each agency to provide definitions of every variable in their database, an attempt was made by the researchers to identify the applicable variables based on their names alone and then inquire if our identification was correct [An example set of questions is provided in Appendix B]. In most cases, the initial attempt at identifying the correct variables was accurate and the agencies responses to the questions provided confirmation. In some cases; however, it was found that the same variable name had different definitions depending on the agency using it. For example, one agency's definition of the variable "clear-time" was "when all travel lanes are clear" while another's definition of the same variable was "when the incident has been cleared and all responders have left the scene." Clearly, knowledge of differences in variable definitions such as this is critical when trying to compare Roadway Clearance Time and Incident Clearance Time performance measures across agencies.

3. Analyze each agency database for existence of other potential TIM PM variables.

   Each agency database was examined for what appeared to be common temporal variables that could be used to calculate additional TIM related performance measures.

4. Filter erroneous / unusual variables.

   Incident records that had erroneous or missing variables and values were excluded from any TIM PM calculations. This included incidents that were marked clear prior to having a start time entered, default computer values for dates (such as 01/01/1970), and instances where a key variable needed to perform a calculation (such as start time) was missing.

5. Calculated TIM PMs

   Using the available temporal variables in each agency database, TIM PMs were calculated including average Roadway Clearance Time, average Incident Clearance Time, average Arrival Time, and average Recovery Time.

6. Compared TIM PMs to extent possible

   The results of the comparison effort are presented in Chapter 3.

   One key assumption used in the analysis relates to the definition of a "traffic incident". Currently, there is no "standard" definition. The definition used in the analysis is significant. For example, Roadwork is an incident type included in some agency databases which meets two of the three following "traffic incident" definitions:

- "any non-recurring event that causes a reduction of roadway capacity or an abnormal increase in demand" – *Traffic Incident Management Handbook*

- "an occurrence on a roadway that impedes normal traffic flow" – *Highway Capacity Manual*

- "An unplanned randomly occurring traffic event that adversely effects normal traffic operations" – *Traffic Management Data Dictionary*

Inclusion of Roadwork "traffic incidents" in this analysis greatly skewed agency average Roadway and Incident Clearance times as did other non-random incident types. The Traffic Management Data Dictionary definition of "traffic incident" was used in the analysis so that incident types not considered an unplanned randomly occurring event where filtered from the data.

7. Associated related incident types

   To compare TIM PM's by type, an effort was made to group the unique incident types using what appear to be comparable data type elements in the agency databases. This is discussed further in Chapter 3.

8. Repeated steps 5 and 6 for each "common" incident type

   The TIM PMs calculated in step 5 were recalculated and compared for each "common" incident type.

# **CHAPTER 3** Findings

## Incident "Start" time and "First Recordable" Awareness

In this project, the incident "start" time variable was based on "first recorded awareness" by participant transportation agency Traffic Management Center's (TMC's). As noted previously, because of the challenges associated with collecting computer-aided dispatch (CAD) data, and in keeping with the principle of "minimizing the burden" on departments of transportation (DOT) volunteers providing data, this research focused specifically on data captured and reported by TMC systems. It should be noted, however, that for the transportation agencies participating in this research, the time recorded when an incident is opened in the TMC's system may or may not be the time of *first recorded awareness* of a particular incident as this may exist in another agency system (e.g., public safety agency).

Table 3 below provides a summary of "first recorded awareness" by agency TMC's participating in this project. The majority of agencies rely on their TMC operations staff to enter incident information into their TMC systems hence serving as the primary input for "first recorded awareness" and the origin of incident "start" time.

TABLE 3 - SOURCE OF "FIRST RECORDED AWARENESS"

| | Agency | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J |
| **TMC Operator** | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Transportation Field Unit** | | | | | ✓ | | | | | |
| **External System Feed** | | | | ✓ | | ✓ | | ✓ | ✓ | |
| **Other** (e.g., incident detection system) | | | | | | ✓ | | | | |

At least one agency's incident response database relied primarily on patrolling Transportation Field Unit's as the primary source of first recorded awareness. In addition to the TMC operator, one agency recorded first awareness using an external CAD feed as well as an automated incident detection system. In two instances, the External System Feed was not a CAD system, but a regional incident information sharing system that provides for automated incident sharing between TMC's in different jurisdictions but in geographically close proximity.

## Time Stamp Availability for Primary and Secondary TIM PMs

Figure 5 depicts the number of agencies that are collecting (or have the data that allow for deriving) the temporal values required to calculate the primary and secondary Traffic Incident Management (TIM) performance measure's (PM's) used in this project. Recall that the primary TIM PM's are Roadway Clearance Time and Incident Clearance Time and the secondary TIM PM's are Arrival Time and Recovery time as defined earlier.

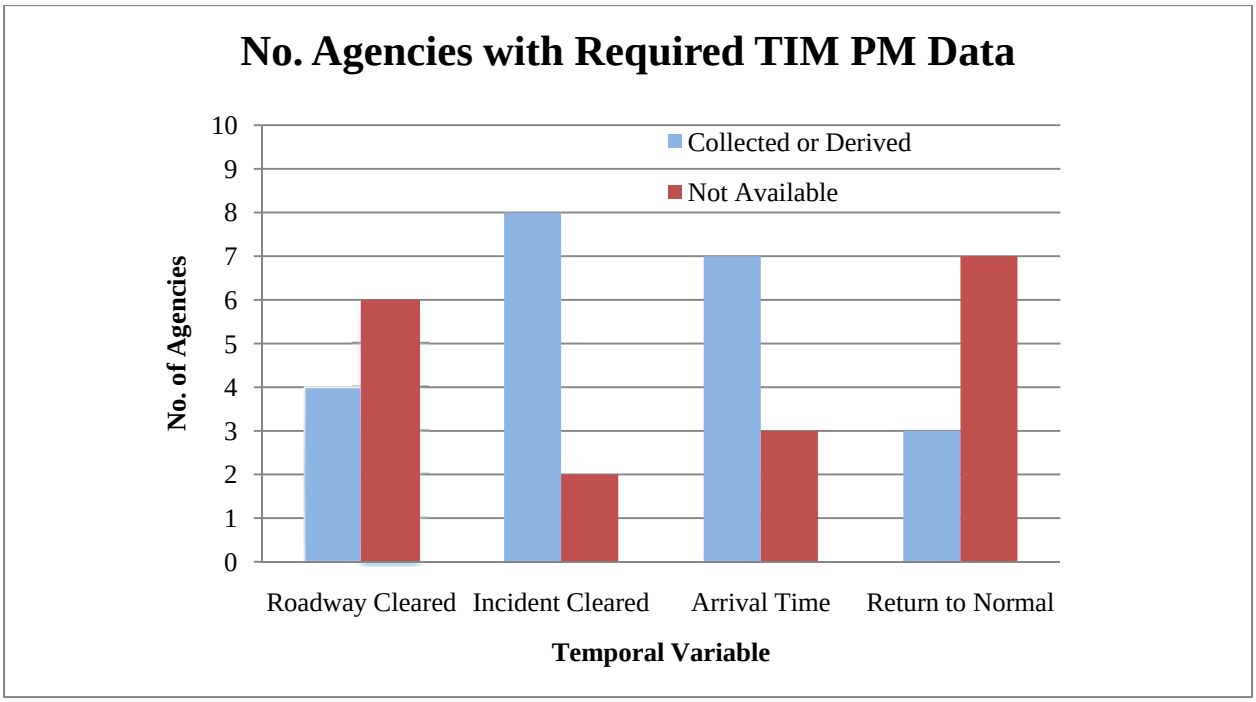


FIGURE 5 – NUMBER OF AGENCIES COLLECTING TIM PM TIME STAMPS

## Comparing TIM PMs

For agencies where TIM PMs could be compared, the comparisons were performed in two ways. The first was to compare all incident response data regardless of incident type with some notable exceptions. Recall that the TMDD definition of "traffic incident" -- *An unplanned randomly occurring traffic event that adversely effects normal traffic operations* – was used in this research. This is significant when trying to compare data for all TIM PM types because planned roadwork was included in many agency databases which significantly skewed average clearance time duration (and was, therefore, filtered out). Another example of a type collected by an agency that was filtered for not meeting the traffic incident definition was abandoned vehicle (as distinct from disabled vehicle). Typical agency policies allow for 24 hours or more to clear abandoned vehicles, which again, skews the duration of average clearance times.

The second was to compare TIM PMs for incidents of similar type. The rationale is that comparisons of agencies by TIM PMs for all incident types (even with roadwork filtered out) will be impacted by the differences in types and the number of incident types. However, the difficulty with comparing TIM PMs by incident type is the fact that there are no standard type definitions and associated standard type data collection. Figure 6 depicts the number of unique incident types collected by each agency. To compare TIM PM's by type, an effort was made to group the unique incident types using what appear to be comparable data type elements in the agency databases.

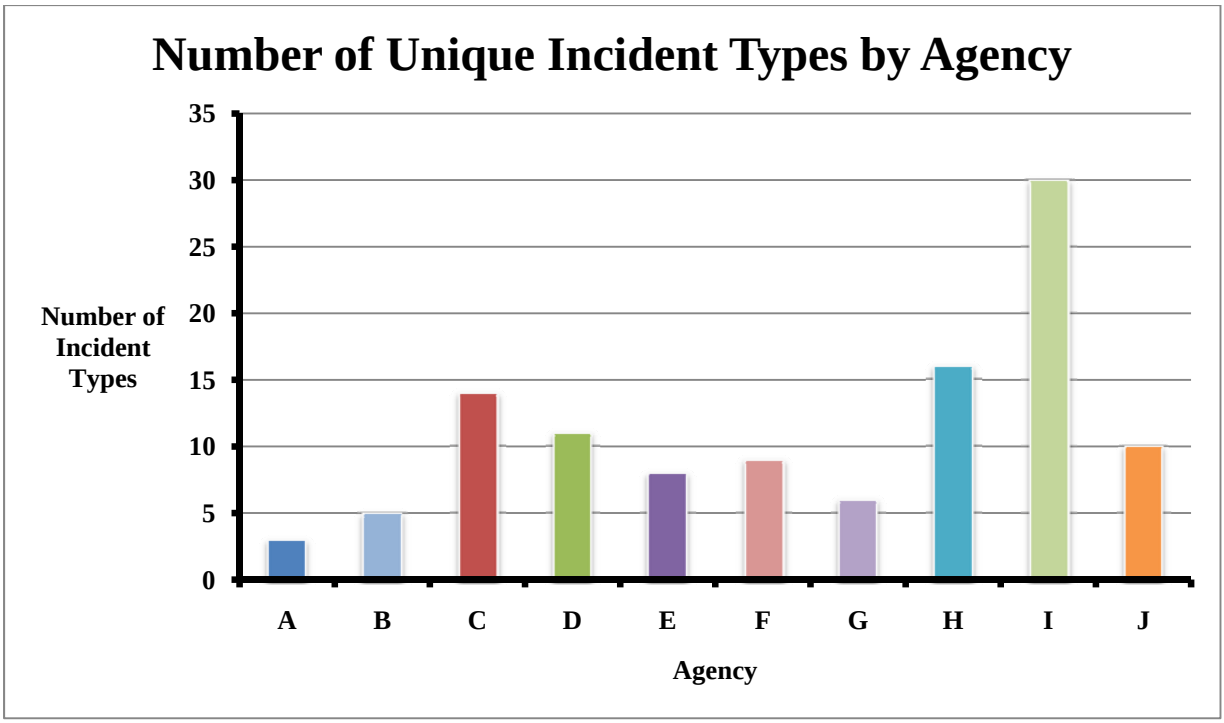


FIGURE 6 - NUMBER OF INCIDENT TYPES PER AGENCY

At the end of this section, some general observations are provided relative to the use of TIM PMs for comparative analysis between agencies. Because of difficulties in generating TIM PM and common incident types due to lack of standardization, no conclusions are provided or specific inferences drawn from the comparison data (this is left to the reader). The graphs are provided, however, to show examples of comparative TIM PM data and how agencies might use this data to ask questions of their own agency operations. In the future, once TIM PMs become more widely adopted and data becomes increasingly standardized, researchers will have the ability to make clear inferences and conclusions with confidence.

### TIM PM Comparison – Roadway Clearance Time for all Traffic Incidents

For those agencies where the average Roadway Clearance Time PM could be calculated, Figure 7 depicts a comparison of average Roadway Clearance times for all traffic incidents. Agency's C, E, and A have, respectively, 94%, 67%, and 64% of all traffic incidents cleared from the roadway within 15 minutes. For each of these agencies, there is an overall downward trend in the percent of all traffic incidents as average Roadway Clearance Time's increase. Agency D, by comparison, clears 19% of all traffic incidents within 15 minutes with a relatively flat trend in average Roadway Clearance Time through the 60-90 minute time interval followed by a decrease back down to just under the 10% level for 90 minutes and up.

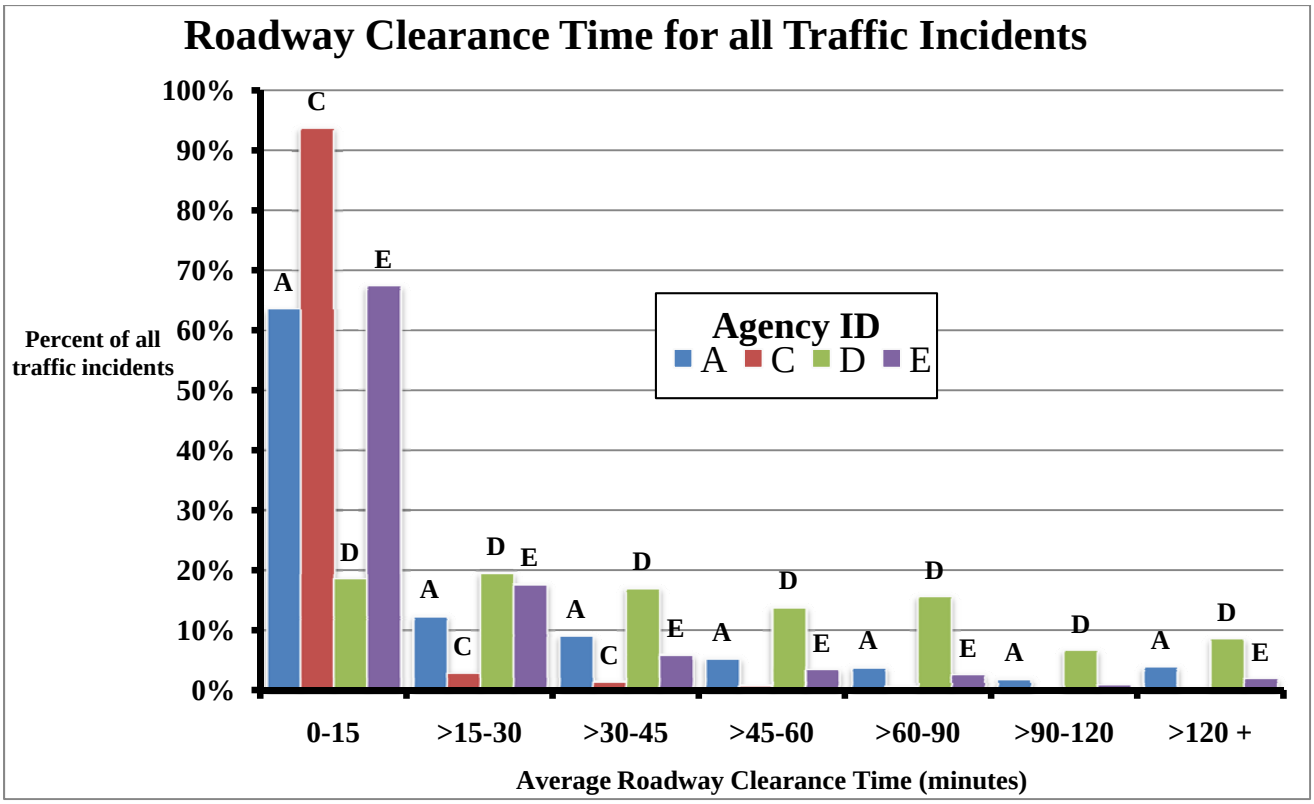


FIGURE 7 – COMPARISON OF AVERAGE ROADWAY CLEARANCE TIME FOR ALL TRAFFIC INCIDENTS

**TIM PM Comparison – Incident Clearance Time for all Traffic Incidents**

Figure's 8 and 9 show a comparison of Incident Clearance Time for all traffic incidents. Figure 9 highlights agencies with an overall downward trend in the percent of total traffic incidents as Incident Clearance Time's increase. Agency's A, E, G, and H have, respectively, 42%, 74%, 26%, and 56% of all traffic incidents entirely cleared from the incident scene within 15 minutes. In Figure 10, the trends for Agencies B, D, F, and J are relatively steady with slight increases in traffic incidents lasting 90 minutes or more for some agencies.

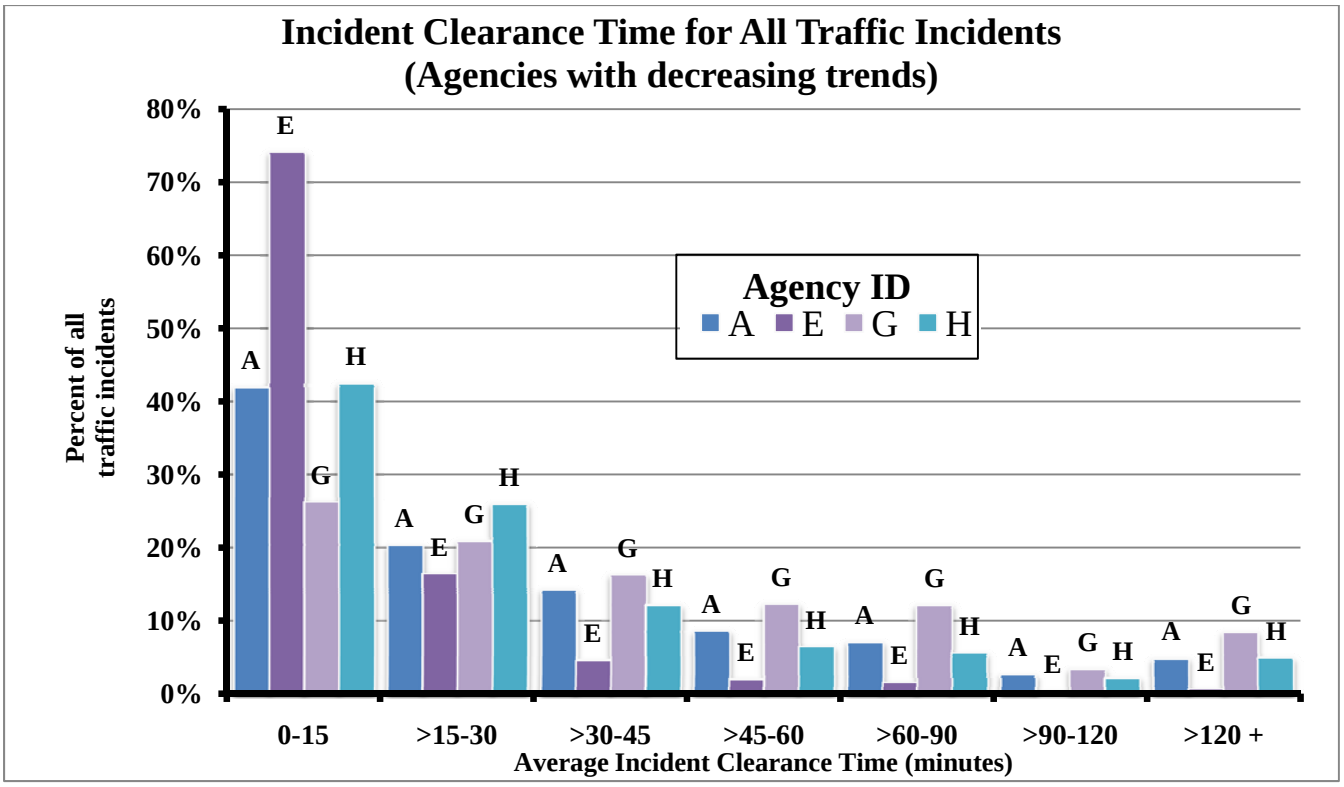


FIGURE 8 - COMPARISON OF AVERAGE INCIDENT CLEARANCE TIMES FOR ALL TRAFFIC INCIDENTS SHOWING AGENCIES WITH DECREASING TRENDS

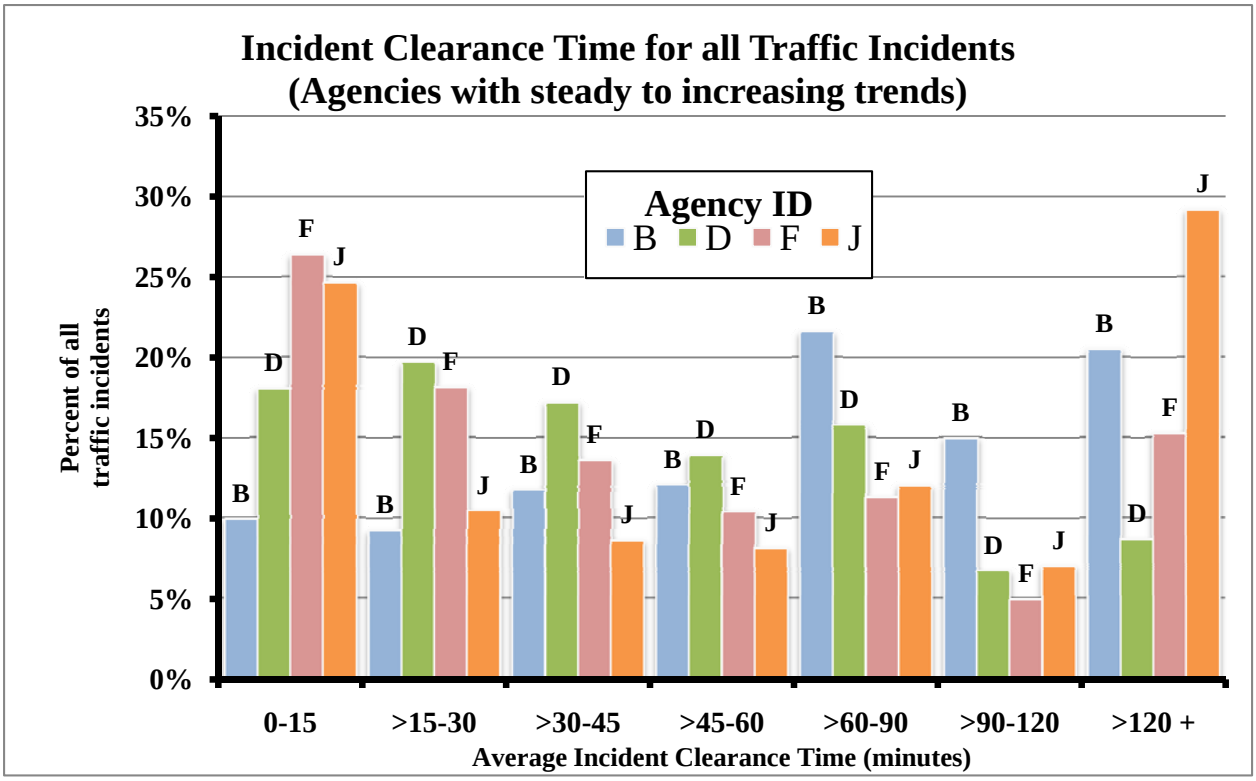


FIGURE 9 - COMPARISON OF AVERAGE INCIDENT CLEARANCE TIME FOR ALL TRAFFIC INCIDENTS SHOWING AGENCIES WITH STEADY TO INCREASING TRENDS

**TIM PM Comparison – Arrival Time for all Traffic Incidents**

Figure 10 shows a comparison of average Arrival Time for all traffic incidents. Agencies A, C, D, E, and H arrive on scene with transportation assets within 15 minutes for, respectively, 95%, 88%, 76%, 93%, and 87% of all traffic incidents. For agencies B, and J, these percentages are 55% and 61% respectively. For all agencies there is an overall downward trend in the percent of total traffic incidents as average Arrival Time's increase.

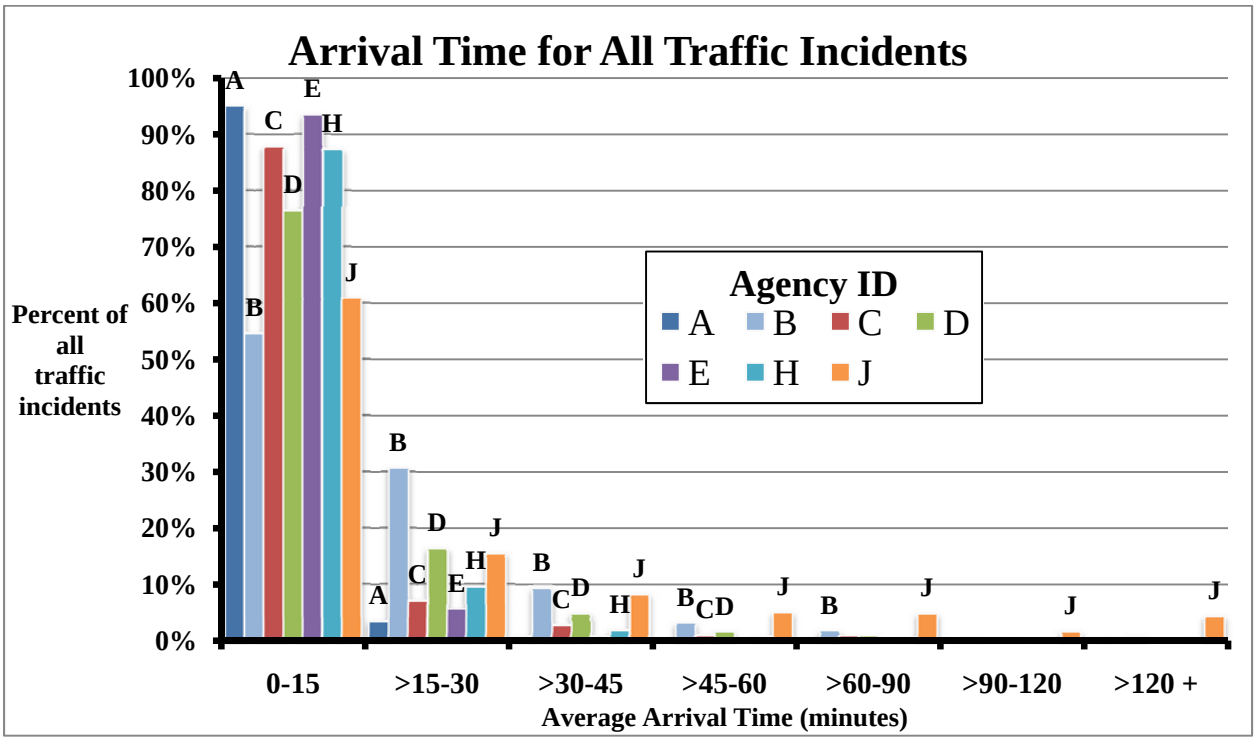


FIGURE 10 - COMPARISON OF AVERAGE ARRIVAL TIME FOR ALL TRAFFIC INCIDENTS

**TIM PM Comparison – Recovery Time for all Traffic Incidents**

Figure 11 shows a comparison of average Recovery Time for all traffic incidents. For Agency C, 92% of all traffic incidents return to normal conditions within 15 minutes. For Agencies A and J, these percentages are 44% and 11% respectively. There is an overall downward trend for Agencies C and A in the percent of total traffic incidents as average Recovery Time's increase. For agency J, this trend is increasing as average Recovery Time's increase.

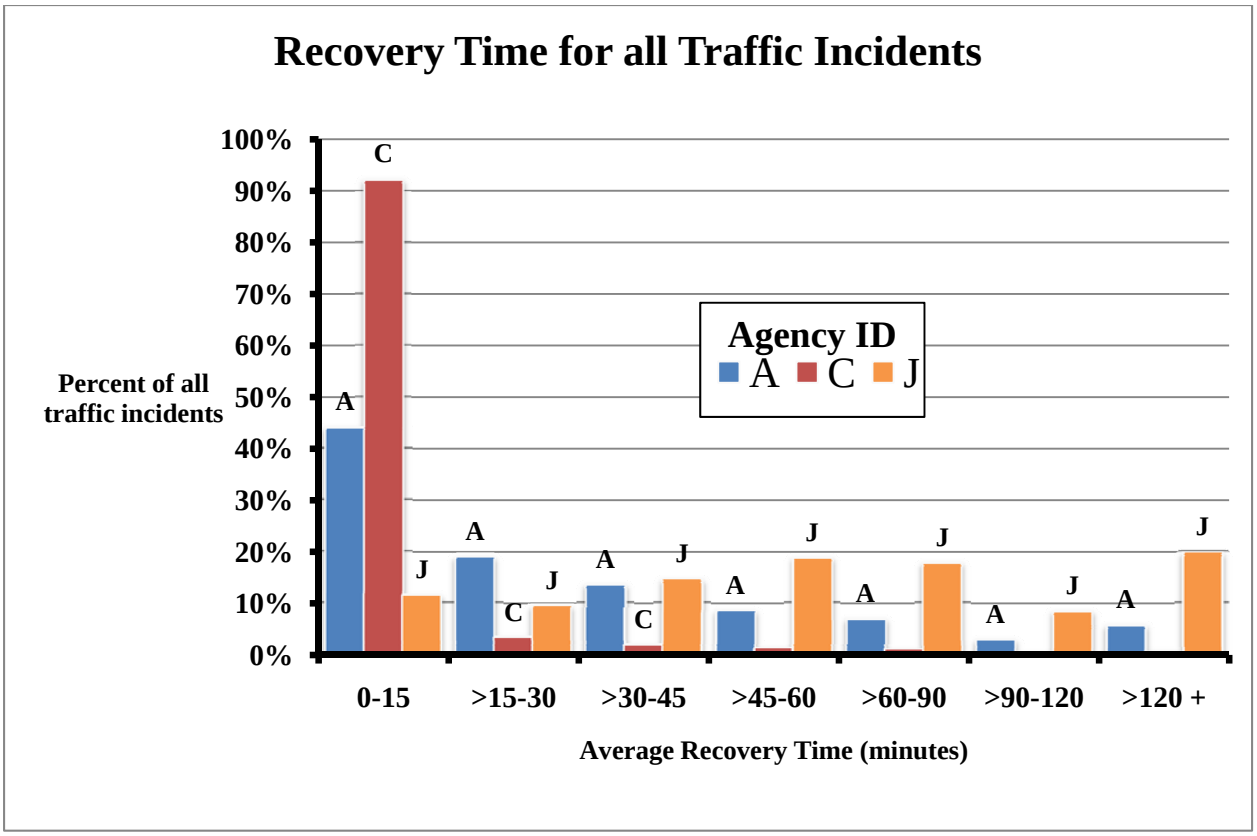


FIGURE 11 - COMPARISON OF AVERAGE RECOVERY TIME FOR ALL TRAFFIC INCIDENTS

### Comparing TIM PMs by Incident Type

As noted previously, comparing agencies using TIM Performance Measures by incident type is very difficult as there are no standard types. However, an effort was made to review each agency's incident types to find exact type matches or types that were very similar. The result was the following set of five generally common incident types:

- Accident
- Fatal Accident
- Vehicle Fire
- Disabled Vehicle
- Debris

The variables in agency databases for incident types Fatal Accident, Vehicle Fire, and Debris were close to exact. The same could be said for the Disabled Vehicle incident type with the exception of one agency that used "Stalled Vehicle" (which was included with Disabled Vehicle). The incident type Accident was not as straightforward in matching agency's use of

this type. In this report, the type Accident includes the following agency database variables: Accident, Single Vehicle Accident, Collision, non-Injury Collision, Collision Property Damage, and Crash. Because of the variety of Accident variables the graphs depicting comparisons based on this incident type should be viewed with considerable caution.

TABLE 4 - AGENCY'S COMPARED USING TIM PMS AND INCIDENT TYPE

| | | Common Incident Types | | | | |
|---|---|---|---|---|---|---|
| | | **Accident** | **Fatal Accident** | **Vehicle Fire** | **Disabled Vehicle** | **Debris** |
| **TIM PMs** | **Roadway Clearance Time** | A, C, D, E | E | C,D | A,C,D,E | C,E |
| | **Incident Clearance Time** | A,B,D,E,F,H | B,E,H | B,D,F,H | A,D,E,F,H | E,F,H,J |
| | **Arrival Time** | A,B,C,D,E,J | B,E,H,J | B,C,D,J | A,C,D,E,J | C,E,H,J |
| | **Recovery Time** | A,C | | C,J | A,C,J | C,J |

Table 4 is a matrix showing which agencies were compared to each other using TIM PMs and the five "common" incident types. Graphs are provided below for each cell in the matrix with the exception of the shaded cells as there was only one (or no) agency with that particular combination of TIM PM and incident type. For each graph, only a general description of how the agencies compare is provided based on the data depicted.

**TIM PM Comparison By Type – Roadway Clearance Time and Accidents**

Figure 12 shows a comparison of average Roadway Clearance Time based on the incident type Accident. Agency's C, E, and A have, respectively, 62%, 54%, and 42% of all Accidents cleared from the roadway within 15 minutes. For each of these agencies, there is an overall downward trend in the percent of total Accident incidents as average Roadway Clearance Time's increase. Agency D, by comparison, clears 11% of Accident incidents within 15 minutes with a slight upward trend in average Roadway Clearance time through the 60-90 minute time interval followed by a decrease back down to the 10% level for 90 minutes and up.

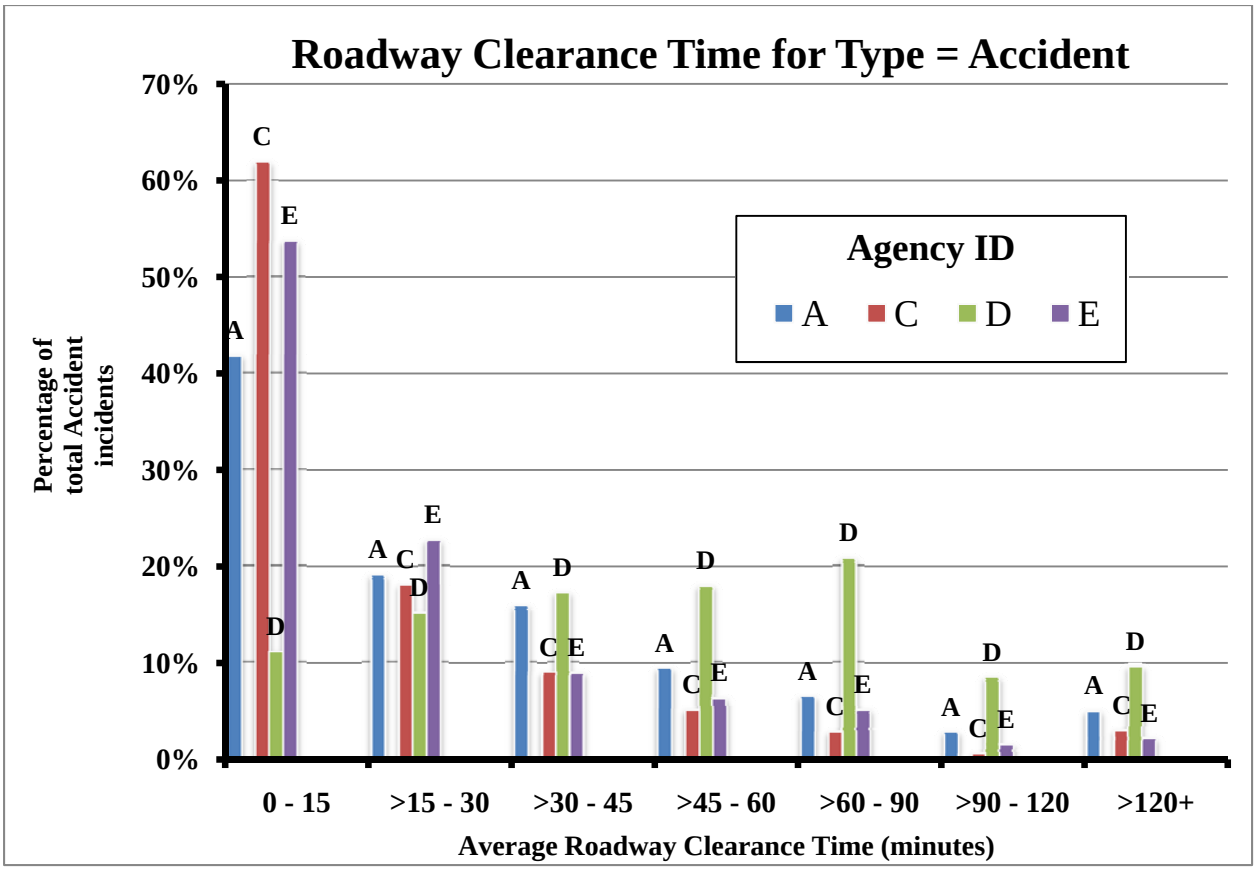


FIGURE 12 - COMPARISON OF AVERAGE ROADWAY CLEARANCE TIME FOR INCIDENT TYPE ACCIDENT

**TIM PM Comparison By Type – Incident Clearance Time and Accidents**

Figure 13 shows a comparison of Incident Clearance Time based on the incident type Accident. Agency's B, H, and E have, respectively, 57%, 40%, and 34% of all Accidents entirely cleared from the incident scene within 15 minutes. For agencies A, F, D, and J, these percentages are 17%, 17%, 11%, and 6% respectively. For agencies B, H, and E, there is an overall downward trend in the percent of total Accident incidents as average Incident Clearance Time's increase. The trend for Agencies A, D, and F is fairly constant up through and average Incident Clearance Time of 90 minutes and decreases thereafter. Agency J shows an overall increasing trend in the percent of total Accident incidents as Incident Clearance Time's increase.

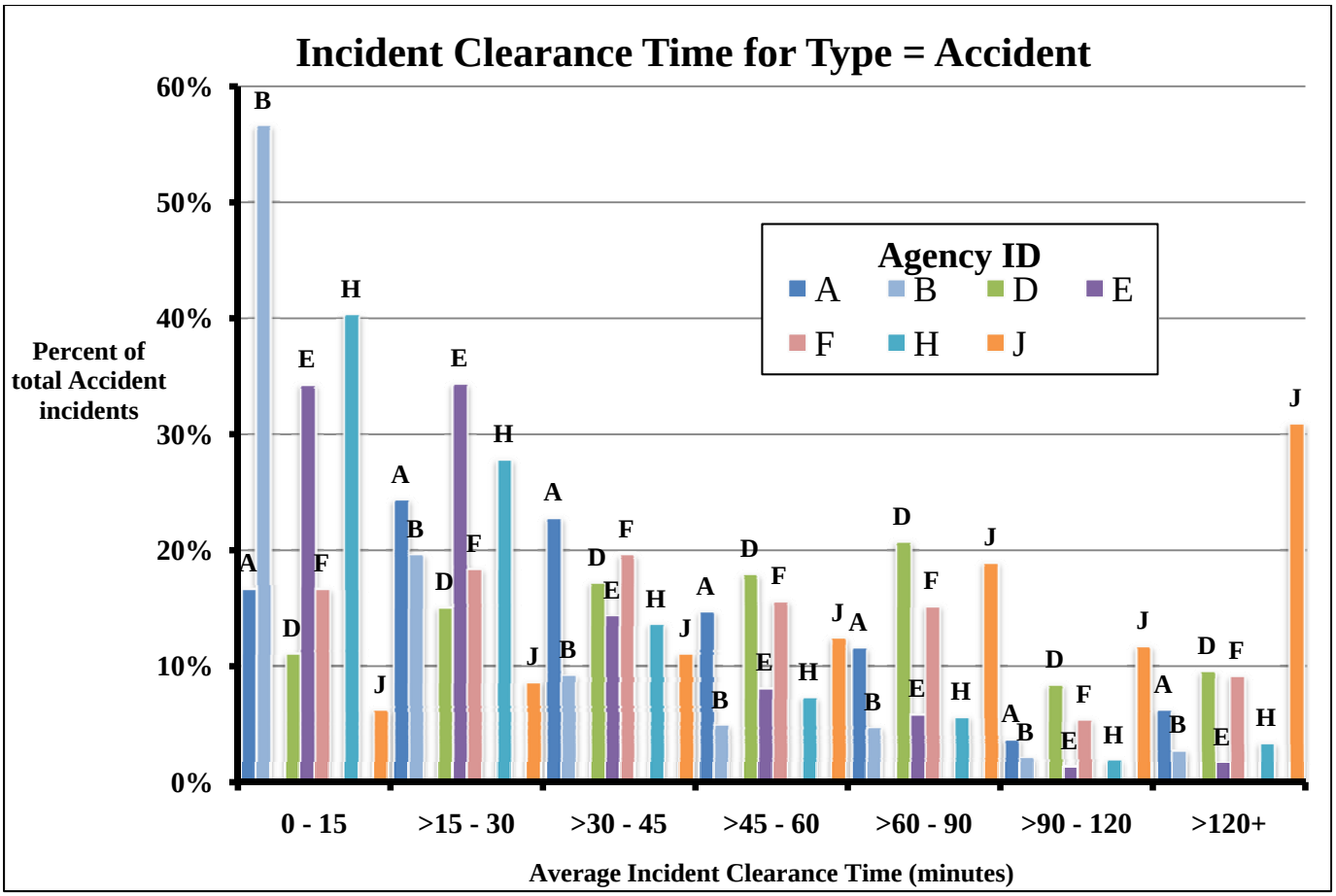


FIGURE 13 - COMPARISON OF AVERAGE INCIDENT CLEARANCE TIME FOR INCIDENT TYPE ACCIDENT

### TIM PM Comparison By Type – Arrival Time and Accidents

Figure 14 shows a comparison of Average Arrival Time based on the incident type Accident. Agency's A, C, H, and E arrive on scene with transportation assets within 15 minutes for, respectively, 97%, 91%, 91%, and 87% of all Accident incidents. For agencies D, B, and J, these percentages are 73%, 59%, 38% respectively. For all agencies there is an overall downward trend in the percent of total Accident incidents as average Arrival Time's increase.

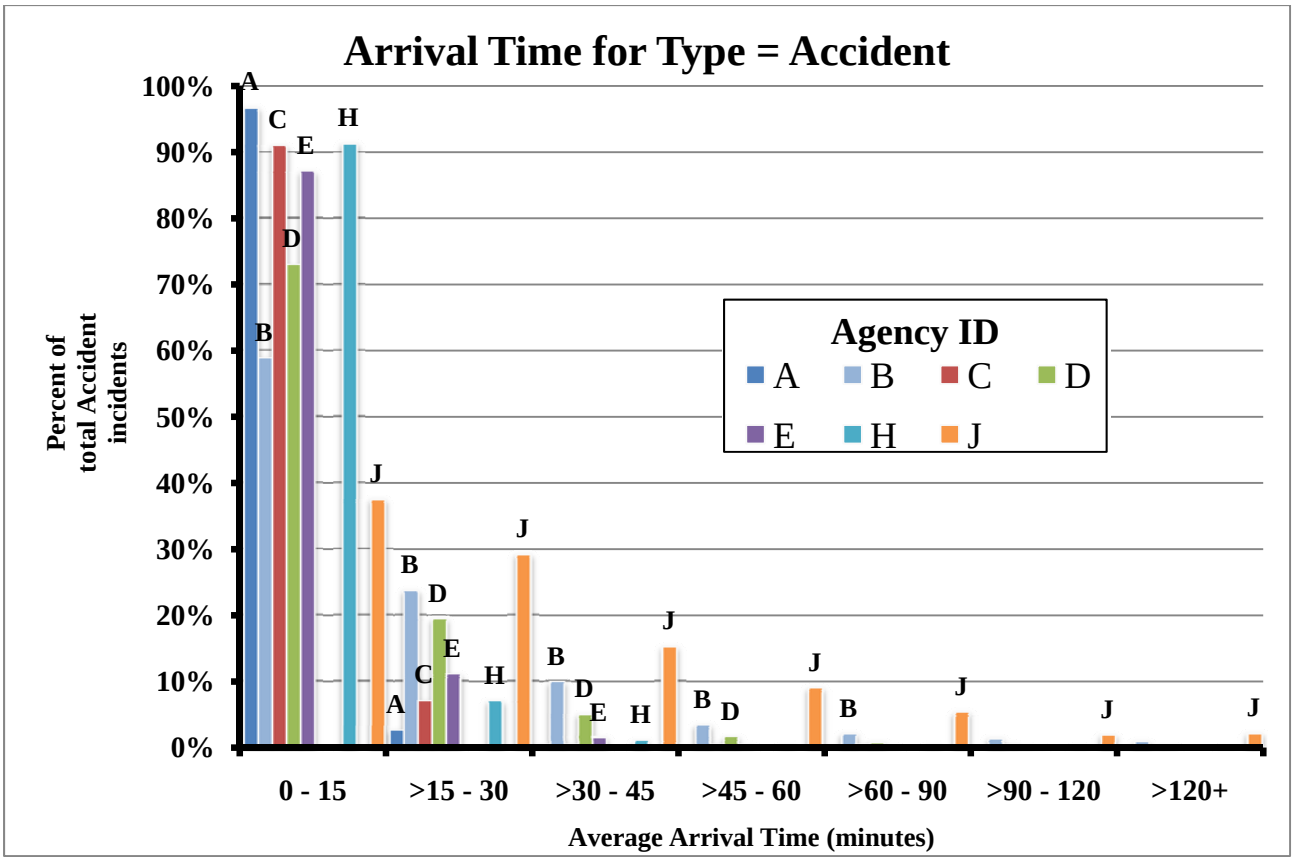


FIGURE 14 - COMPARISON OF AVERAGE ARRIVAL TIME FOR INCIDENT TYPE ACCIDENT

**TIM PM Comparison By Type – Recovery Time and Accidents**

Figure 15 shows a comparison of average Recovery Time based on the incident type Accident. For Agency C, 59% of all Accident incidents return to normal conditions within 15 minutes. For Agencies A and J, these percentages are 19% and 13% respectively. There is an overall downward trend for Agencies C and A in the percent of total Accident incidents as average Recovery time's increase. For agency J, the average Recovery Time remains relatively steady between 12% and 20% from 0 to 90 minutes dropping to 10% and under after 90 minutes.

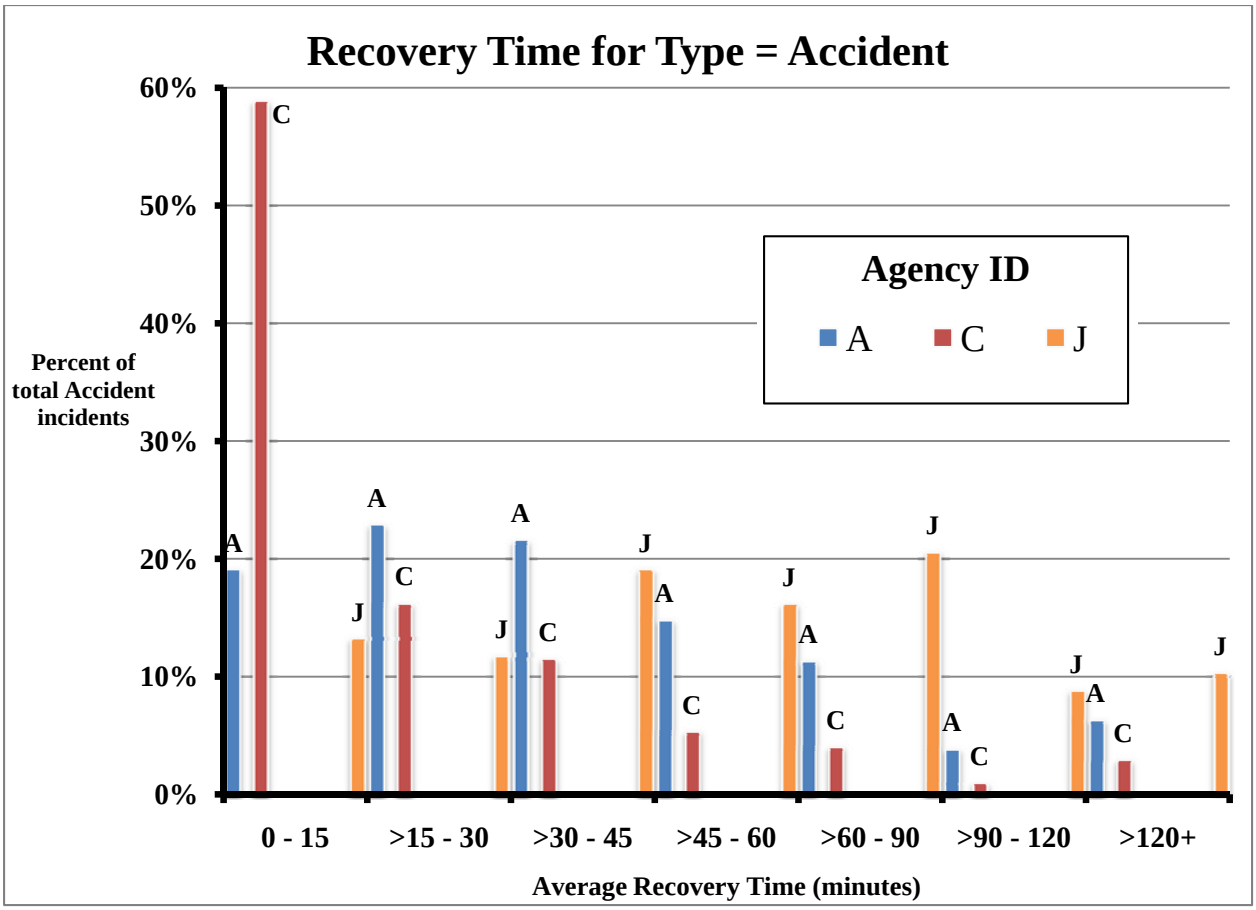


FIGURE 15 - COMPARISON OF AVERAGE RECOVERY TIME FOR TYPE ACCIDENT

**TIM PM Comparison By Type – Incident Clearance Time and Fatal Accidents**

Figure 16 shows a comparison of Incident Clearance Time based on the incident type Fatal Accident. A large majority of Fatal Accident incidents for agencies B, E, H, and J require 120 minutes or more to entirely clear the incident scene. The percent of total Fatal Accident incidents with an average Incident Clearance Time of 120 minutes or more agencies B, E, H, and J is, respectively, 99%, 74%, 77%, and 94%.

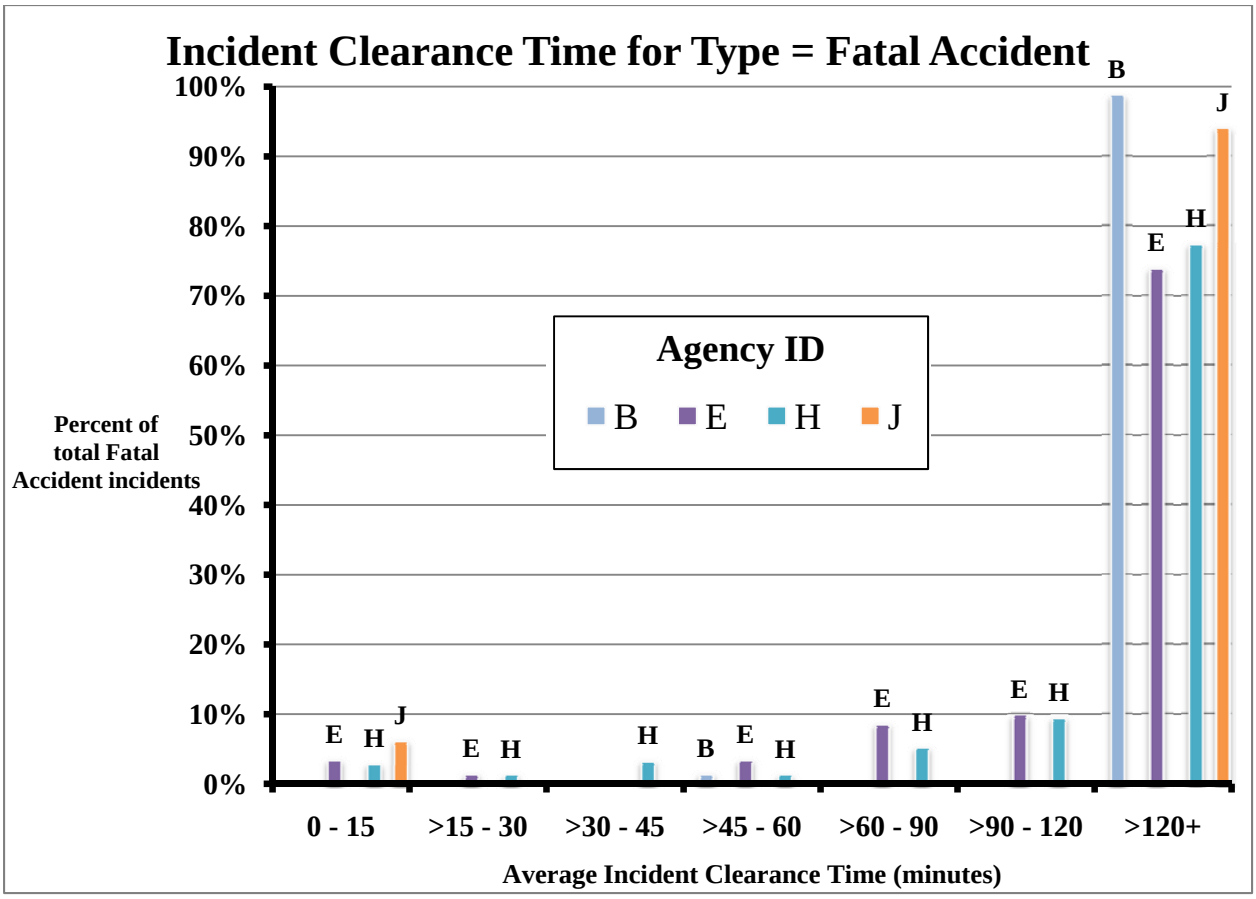


FIGURE 16 - COMPARISON OF AVERAGE INCIDENT CLEARANCE TIME FOR INCIDENT TYPE FATAL ACCIDENT

**TIM PM Comparison By Type – Arrival Time and Fatal Accidents**

Figure 17 shows a comparison of average Arrival Time based on the incident type Fatal Accident. The percent of total Fatal Accident incidents with an average Arrival Time of 15 minutes or less for agencies B and H, respectively, is 80% and 92%. For agencies E and J, the percent is, respectively, 20% and 14%. For agencies B and H there is an overall downward trend in the percent of Fatal Accident incidents as Arrival Time's increase. The trend is downward as well for agencies E and J staring with the 15-30 minute time interval.

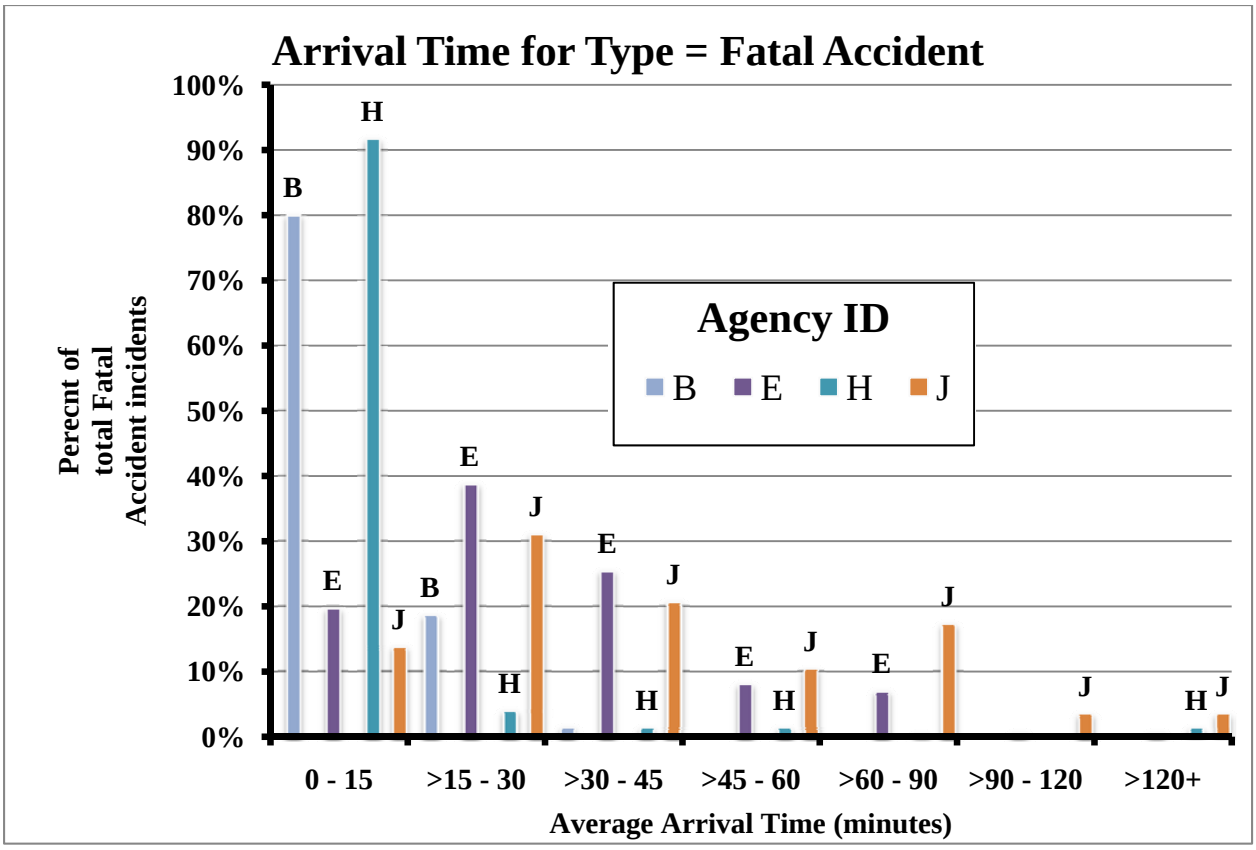


FIGURE 17 - COMPARISON OF AVERAGE ARRIVAL TIME FOR INCIDENT TYPE FATAL ACCIDENT

**TIM PM Comparison By Type – Roadway Clearance Time and Vehicle Fire**

Figure 18 shows a comparison of Average Roadway Clearance Time based on the incident type Vehicle Fire. For agency C, all lanes are open to traffic in 15 minutes or less for 40% of the total Vehicle Fire incidents. The trend for agency C is for this percentage to decrease as average Roadway Clearance Time increases. For agency D, all lanes are open to traffic in 15 minutes or less for 19% of the total Vehicle Fire incidents. This percentage remains relatively steady through the 45-60 minute average Roadway Clearance Time interval after which it decreases.

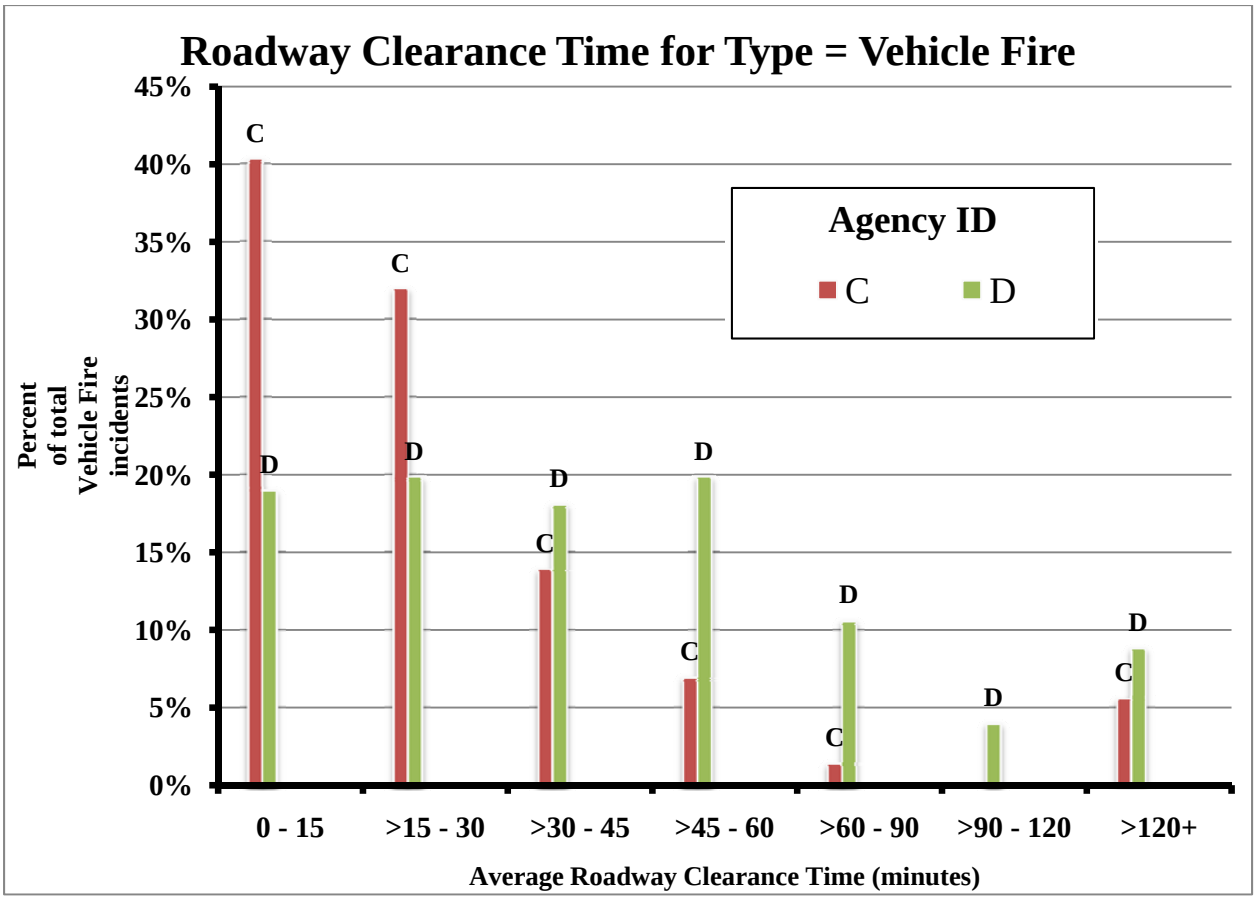


FIGURE 18 - COMPARISON OF AVERAGE ROADWAY CLEARANCE TIME FOR INCIDENT TYPE VEHICLE FIRE

**TIM PM Comparison By Type – Incident Clearance Time and Vehicle Fire**

Figure 19 shows a comparison of Incident Clearance Time based on the incident type Vehicle Fire. Agency H has 35% all Vehicle Fire incidents entirely cleared from the incident scene within 15 minutes and an overall downward trend in the percent of total Vehicle Fire incidents as average Incident Clearance Time's increase. For agencies B, D, F, and J, the percent of total Vehicle Fire incidents is relatively evenly distributed through each of the time intervals with the exception of the last (Vehicle Fire incidents lasting 120 minutes or more). For agencies B and F, the percent of total Vehicle Fire incidents requiring 120 or more minutes to clear the scene is 33% and 50% respectively.

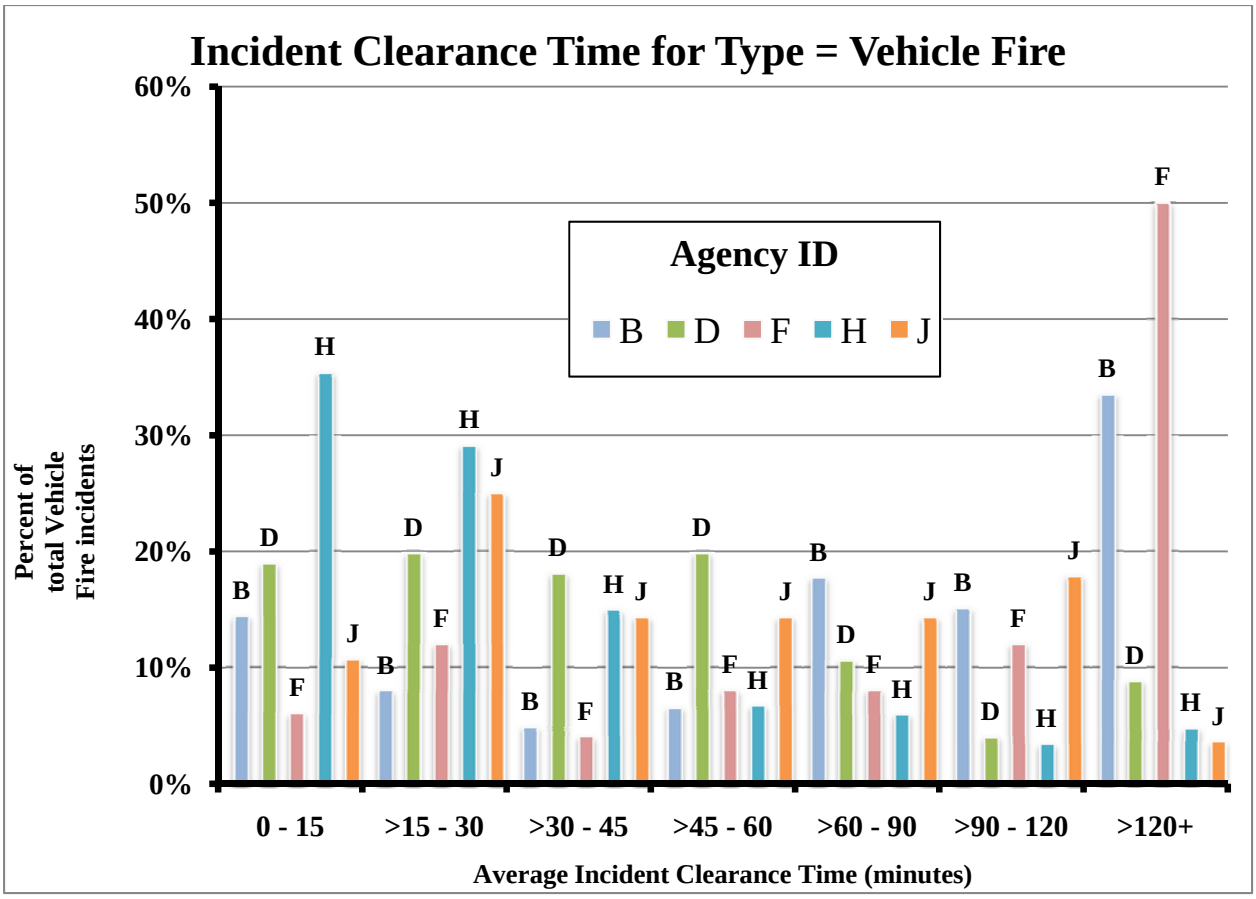


FIGURE 19 – COMPARISON OF AVERAGE INCIDENT CLEARANCE TIME FOR INCIDENT TYPE VEHICLE FIRE

**TIM PM Comparison By Type – Arrival Time and Vehicle Fire**

Figure 20 shows a comparison of average Arrival Time based on the incident type Vehicle Fire. Agencies C, D, and H arrive on scene with transportation assets within 15 minutes for, respectively, 91%, 86%, and 93% of all Vehicle Fire incidents. For agencies B, and J, these percentages are 80% and 69% respectively. For all agencies there is an overall downward trend in the percent of total Vehicle Fire incidents as average Arrival time's increase.

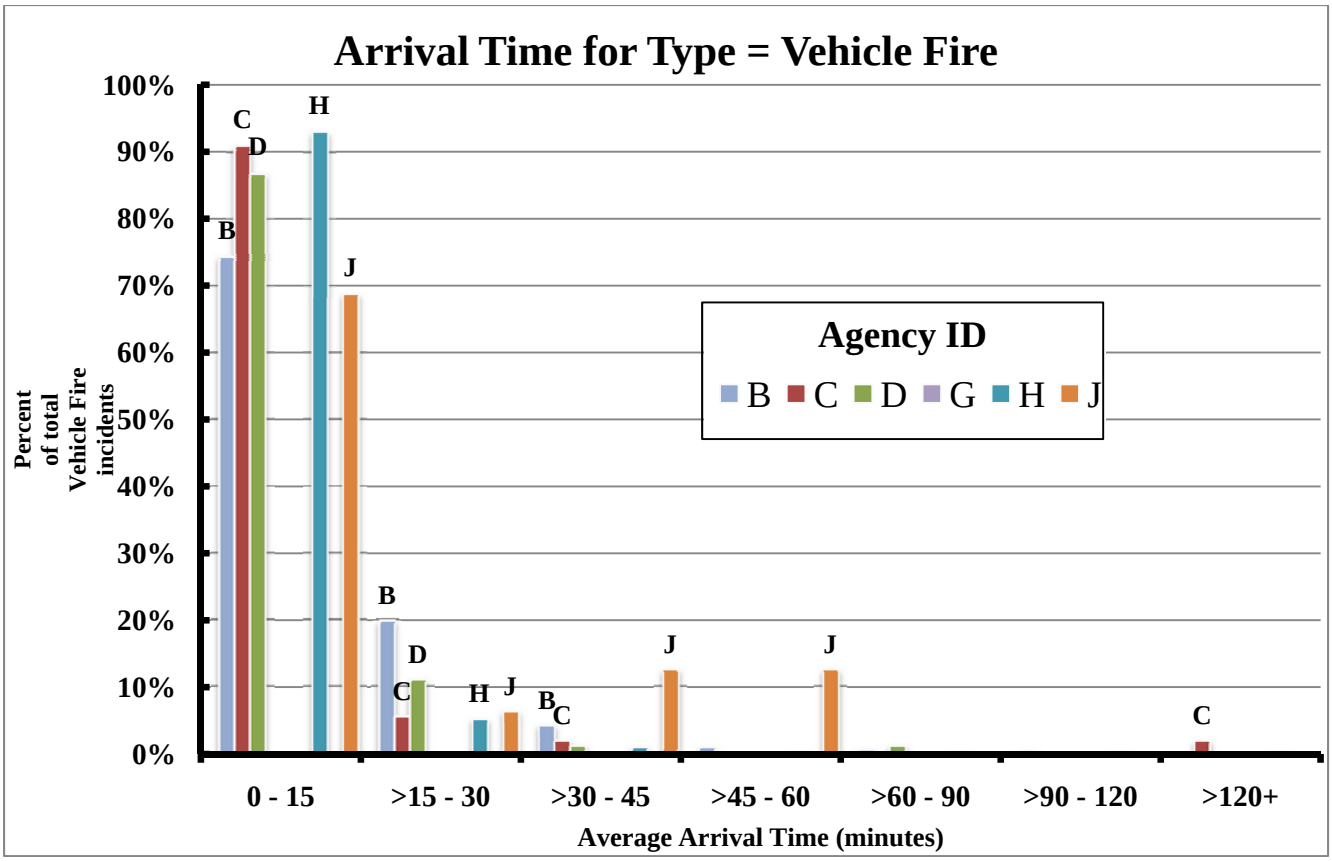


FIGURE 20 - COMPARISON OF AVERAGE ARRIVAL TIME FOR INCIDENT TYPE VEHICLE FIRE

**TIM PM Comparison By Type – Recovery Time and Vehicle Fire**

Figure 21 shows a comparison of average Recovery Time based on the incident type Vehicle Fire. For agency C, the roadway is restored to normal conditions in 15 minutes or less for 36% of the total Vehicle Fire incidents. The trend for agency C is for this percentage to decrease as average Recovery Time increases. For agency J, it is highly likely that a default Return to Normal Time is entered by an operator anytime a Vehicle Fire incident occurs.

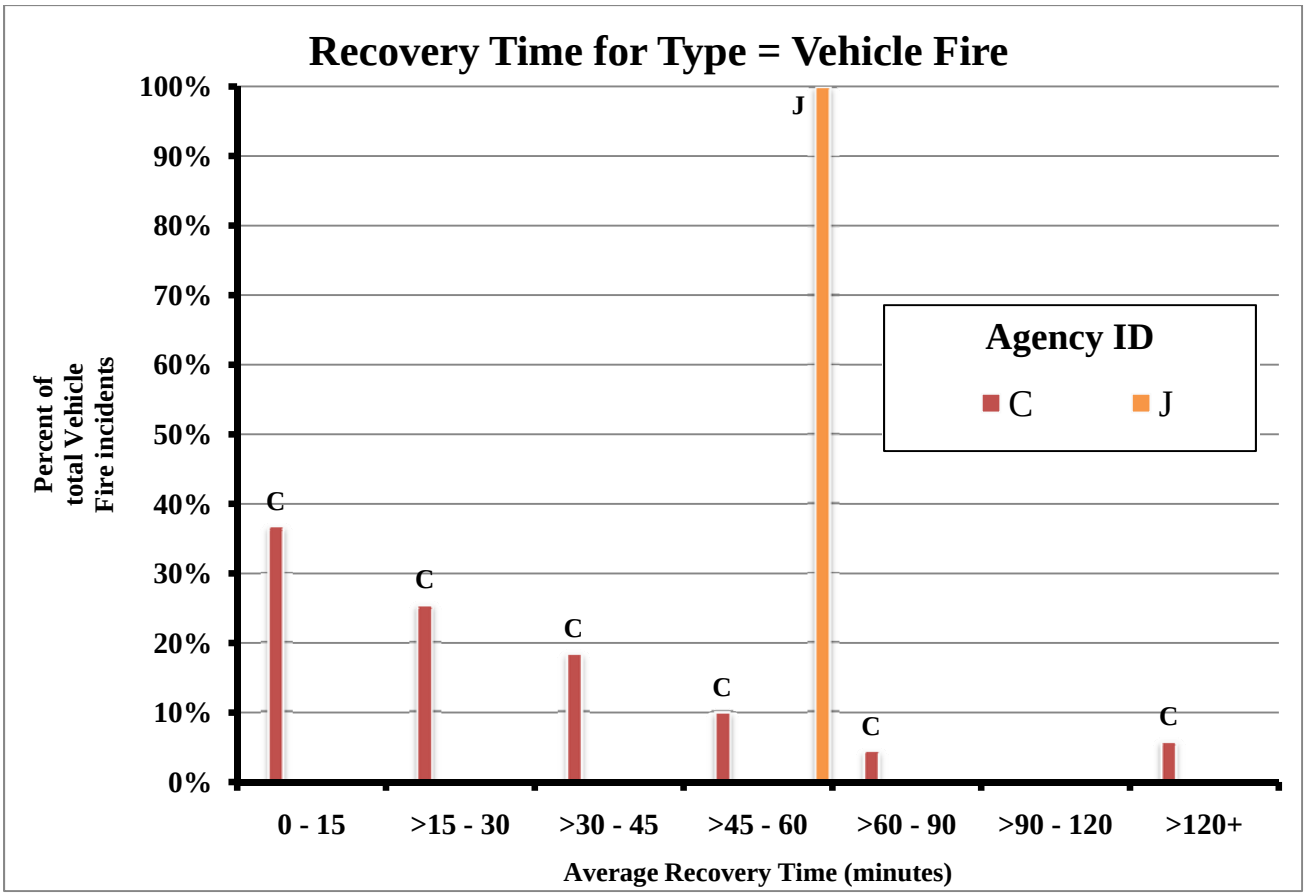


FIGURE 21 - COMPARISON OF AVERAGE RECOVERY TIME FOR INCIDENT TYPE VEHICLE FIRE

**TIM PM Comparison By Type – Roadway Clearance Time and Disabled Vehicle**

Figure 22 shows a comparison of average Roadway Clearance Time based on the incident type Disabled Vehicle. Agency's A, C, and E have, respectively, 86%, 98%, and 75% of all Disabled Vehicles cleared from the roadway within 15 minutes. For each of these agencies, there is a steep downward trend in the percent of total Disabled Vehicle incidents as average Roadway Clearance Time's increase. Agency D, by comparison, clears 24% of Disabled Vehicle incidents within 15 minutes with a slight downward trend in average Roadway Clearance Time through the remaining time intervals.

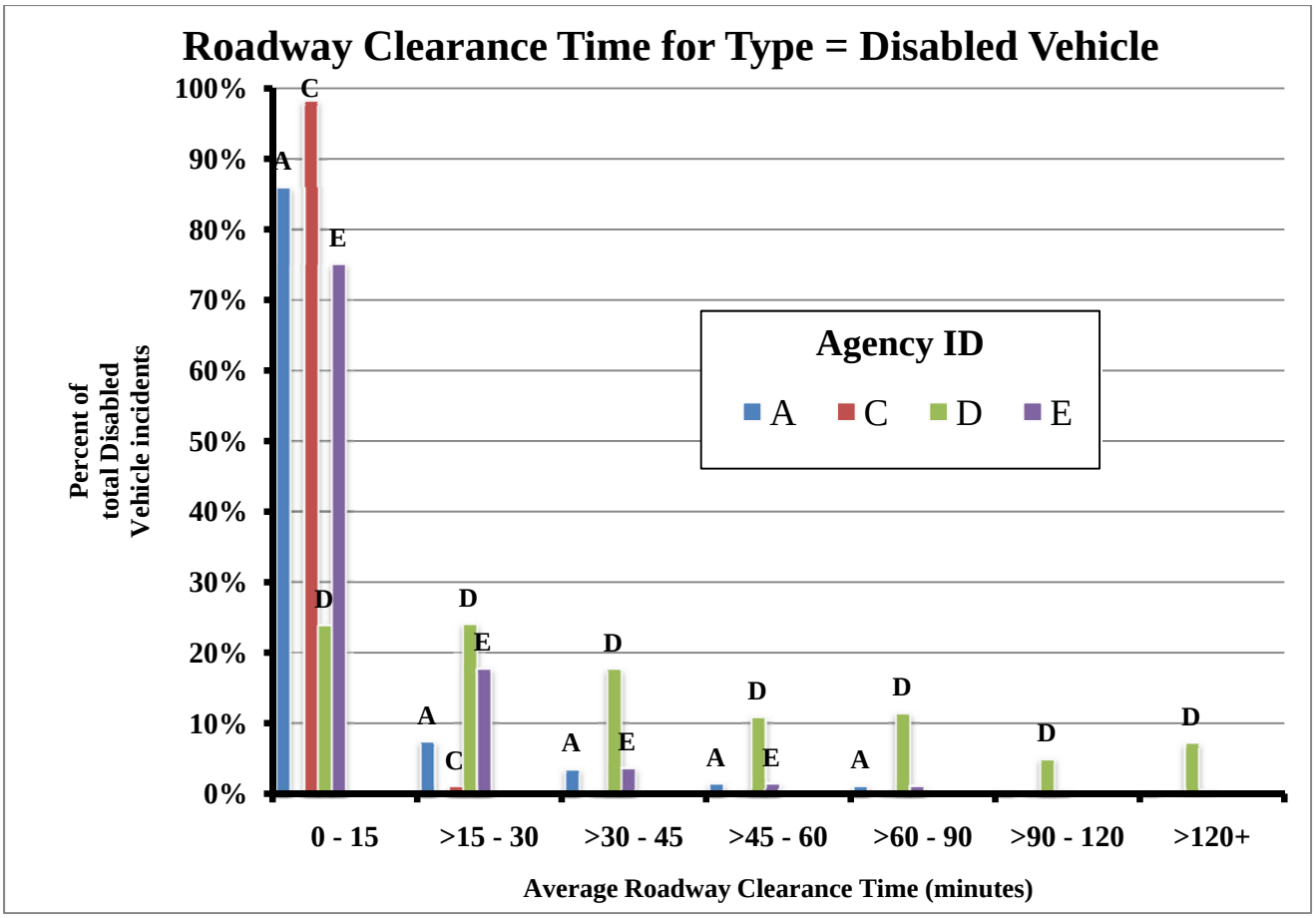


FIGURE 22 - COMPARISON OF ROADWAY CLEARANCE TIME FOR INCIDENT TYPE DISABLED VEHICLE

**TIM PM Comparison By Type – Incident Clearance Time and Disabled Vehicle**

Figure 23 shows a comparison of average Incident Clearance Time based on the incident type Disabled Vehicle. Agency's A, E, and H have, respectively, 65%, 78%, and 56% of all Disabled Vehicles entirely cleared from the incident scene within 15 minutes. For agencies D, F, and J, these percentages are 24%, 34%, and 38% respectively. For agencies A, E, and H, there is an overall downward trend in the percent of total Disabled Vehicle incidents as average Incident Clearance Time's increase. The trend for Agencies D, F, and J is also decreasing; however, with an up-tick for agencies F and J in the percent of total Disabled Vehicle incidents lasting 120 minutes or more.

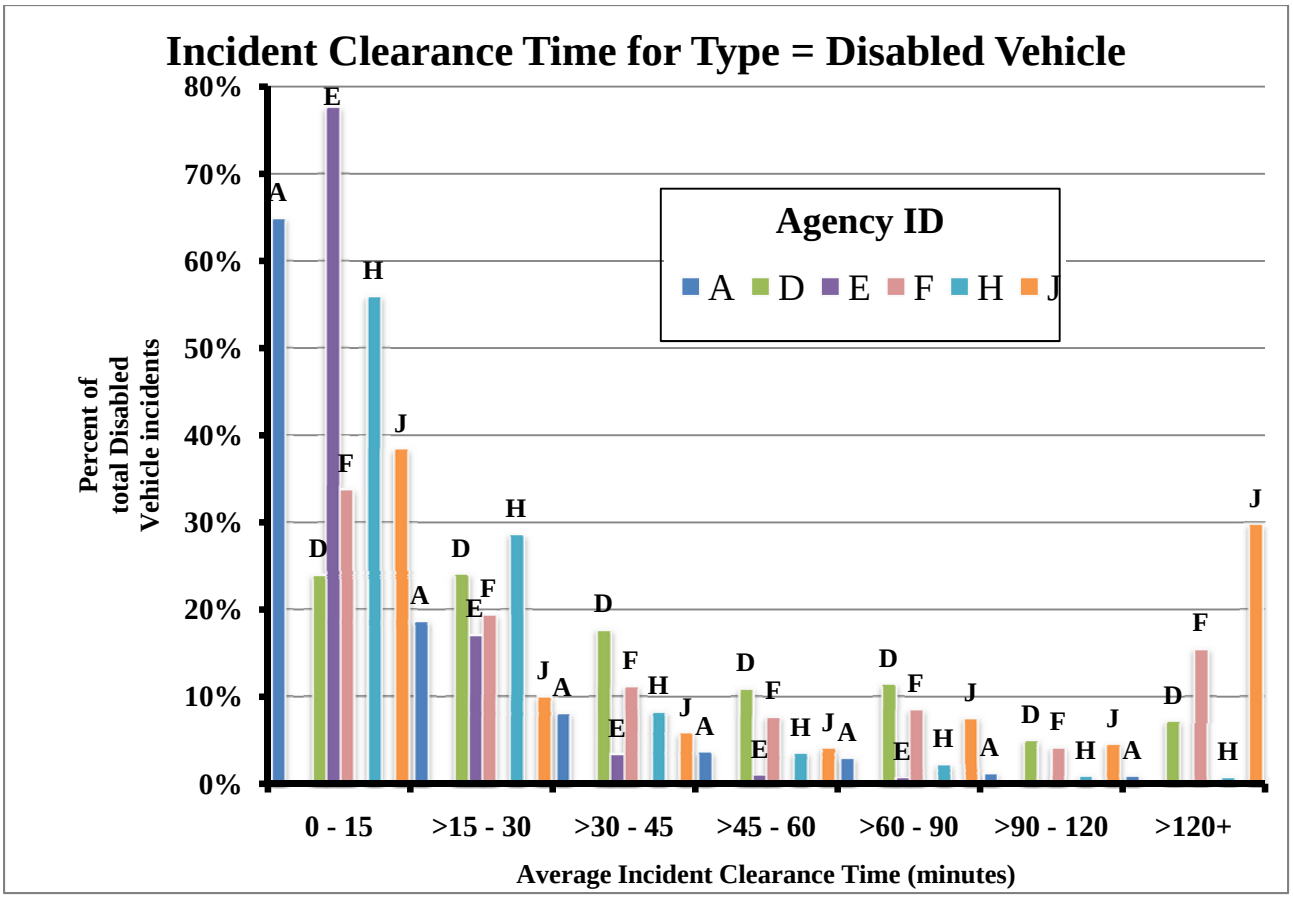


FIGURE 23 - COMPARISON OF AVERAGE INCIDENT CLEARANCE TIME FOR INCIDENT TYPE DISABLED VEHICLE

**TIM PM Comparison By Type – Arrival Time and Disabled Vehicle**

Figure 24 shows a comparison of average Arrival Time based on the incident type Disabled Vehicle. A large majority of Disabled Vehicle incidents for agencies A, C, D, H, and J require less than 15 minutes to arrive at the incident scene with transportation assets with a rapidly decreasing trend in the percent of total Disabled Vehicle incidents as average Arrival Time increases.

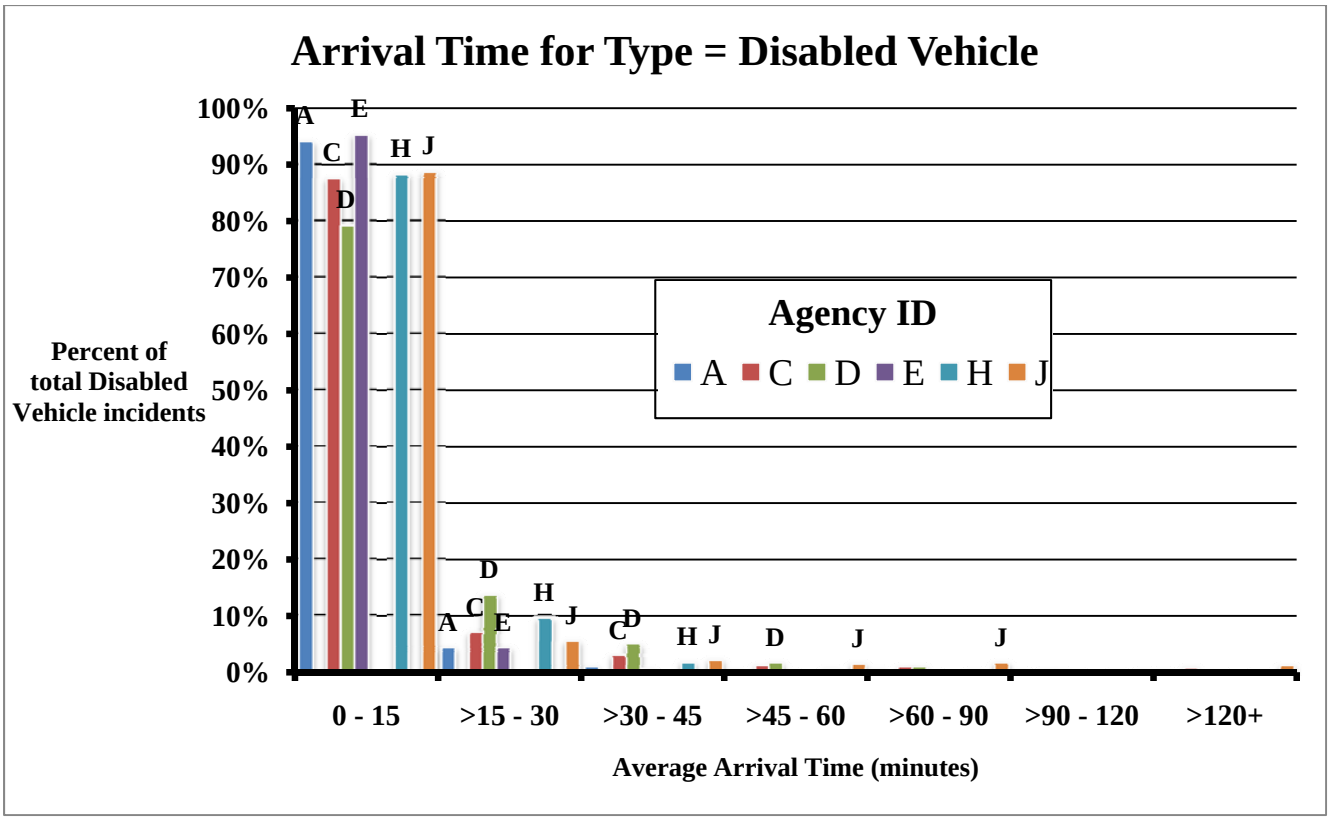


FIGURE 24 - COMPARISON OF AVERAGE ARRIVAL TIME FOR INCIDENT TYPE DISABLED VEHICLE

**TIM PM Comparison By Type – Recovery Time and Disabled Vehicle**

Figure 25 shows a comparison of average Recovery Time based on the incident type Disabled Vehicle. For Agency C, 97% of all Disabled Vehicle incidents return to normal conditions within 15 minutes. For Agencies A and J, these percentages are 66% and 7% respectively. There is an overall downward trend for Agencies C and A in the percent of total Disabled Vehicle incidents as average Recovery Time's increase. For agency J, this trend is increasing as average Recovery Time's increase.

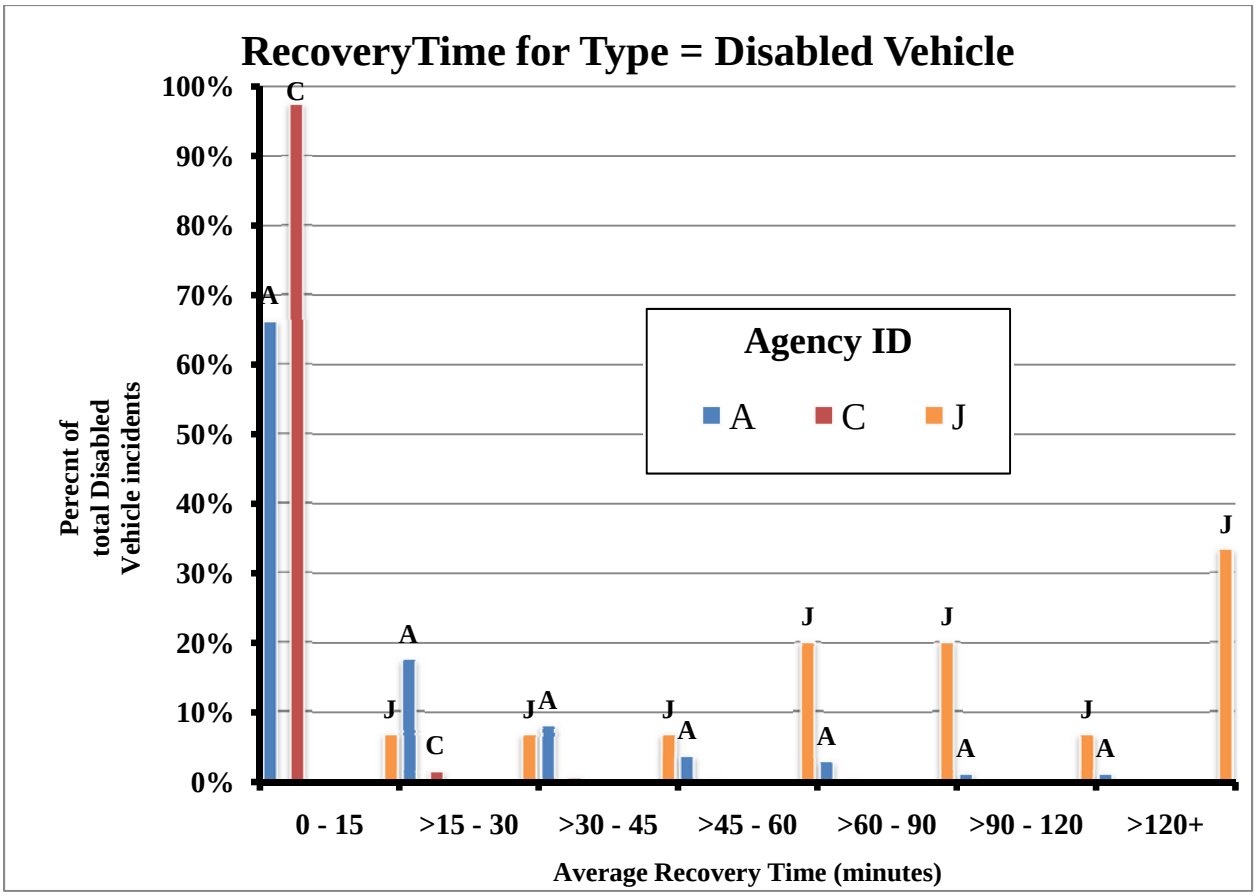


FIGURE 25 - COMPARISON OF AVERAGE RECOVERY TIME FOR INCIDENT TYPE DISABLED VEHICLE

**TIM PM Comparison By Type – Roadway Clearance Time and Debris**

Figure 26 shows a comparison of average Roadway Clearance Time based on the incident type Debris. Agency's C and E have, respectively, 76% and 83% of all Traffic Incidents cleared from the roadway within 15 minutes. For each of these agencies, there is a steep downward trend in the percent of total Debris type incidents as average Roadway Clearance Time's increase.

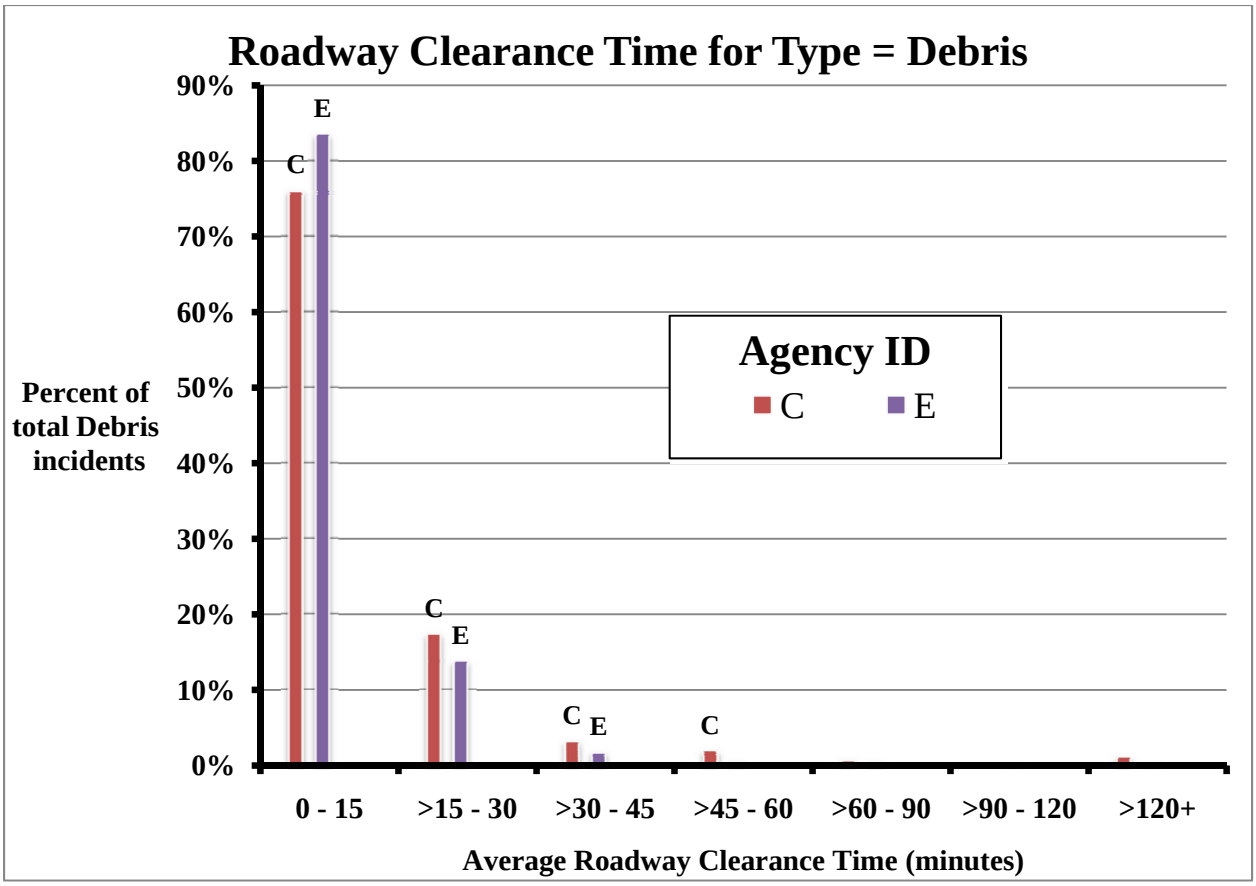


FIGURE 26 - COMPARISON OF AVERAGE ROADWAY CLEARANCE TIME FOR INCIDENT TYPE DEBRIS

**TIM PM Comparison By Type – Incident Clearance Time and Debris**

Figure 27 shows a comparison of average Incident Clearance Time based on the incident type Debris. Agency's E, F, H and J have, respectively, 80%, 39%, 56%, and 31% of all Debris type incidents entirely cleared from the incident scene within 15 minutes. For agencies E, F, and H, there is an overall downward trend in the percent of total Debris type incidents as average Incident Clearance Time's increase. The trend for Agency J is also decreasing; however, with an up-tick in the percent of total Disabled Vehicle incidents lasting 120 minutes or more.

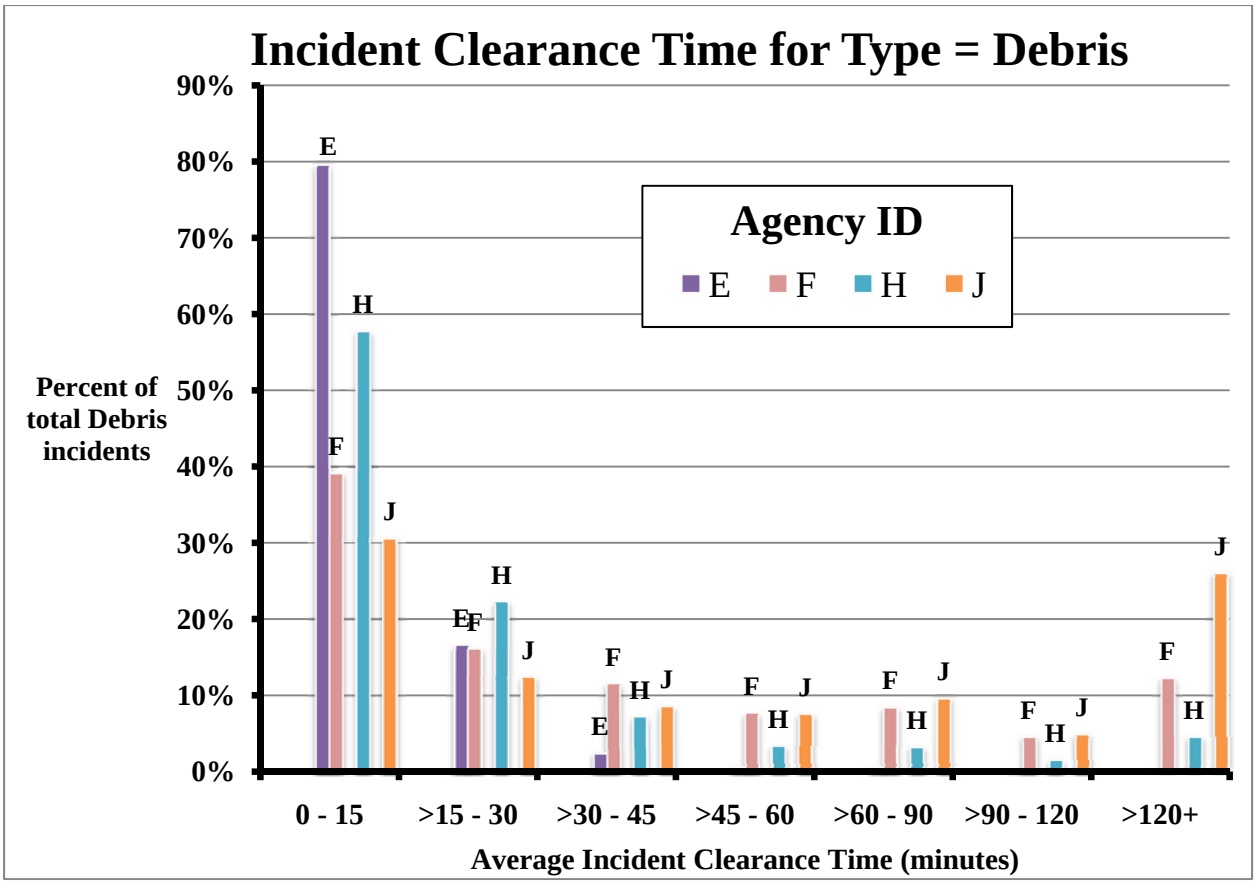


FIGURE 27 - COMPARISON OF AVERAGE INCIDENT CLEARANCE TIME FOR INCIDENT TYPE DEBRIS

**TIM PM Comparison By Type – Arrival Time and Debris**

Figure 28 shows a comparison of average Arrival Time based on the incident type Debris. A majority of Debris type incidents for agencies C, E, H, and J require less than 15 minutes to arrive at the incident scene with transportation assets with an overall decreasing trend in the percent of total Debris type incidents as average Arrival Time increases.

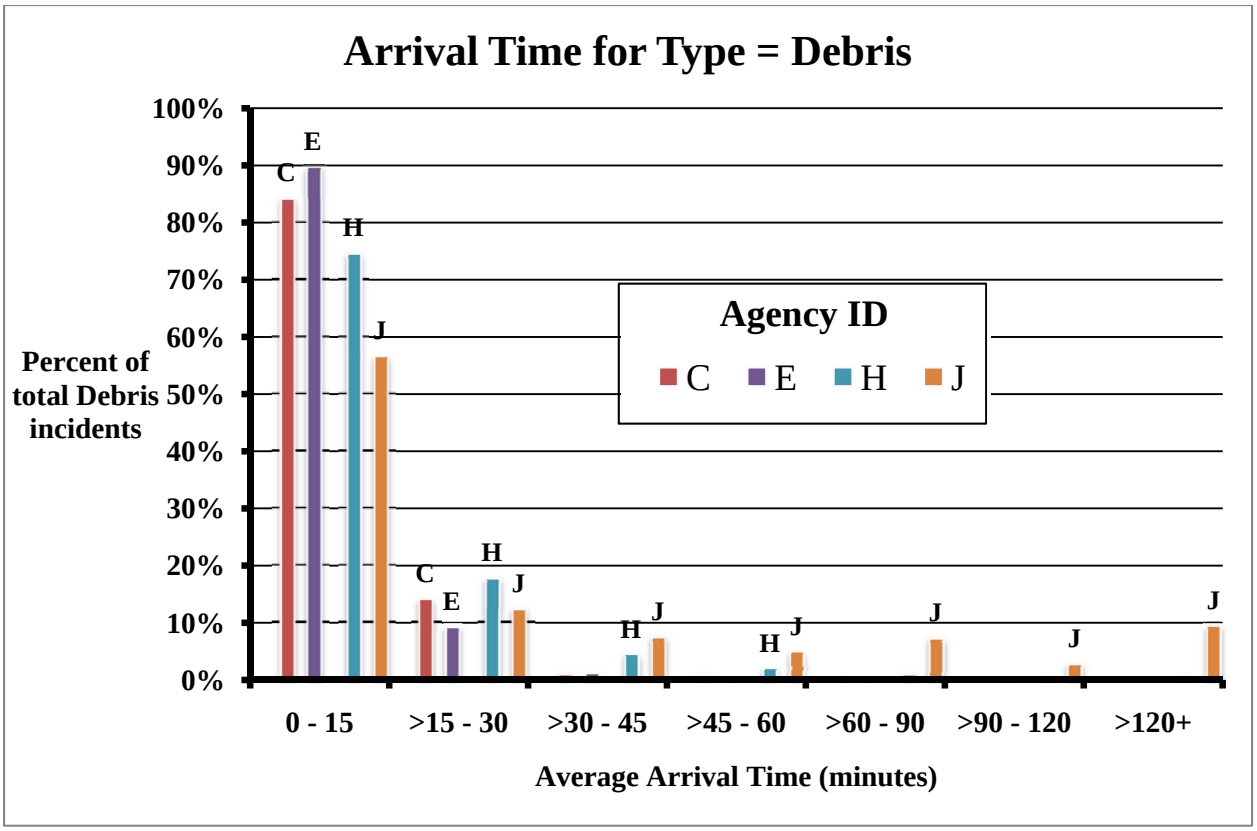


FIGURE 28 - COMPARISON OF ARRIVAL TIME FOR INCIDENT TYPE DEBRIS

**TIM PM Comparison By Type – Recovery Time and Debris**

Figure 29 shows a comparison of average Recovery Time based on the incident type Debris. For Agency's C and J, 74% and 8%, respectively, of all Debris type incidents return to normal conditions within 15 minutes. There is an overall downward trend for Agency C in the percent of total Debris type incidents as average Recovery Time's increase. For agency J, this trend is increasing as average Recovery Time's increase.

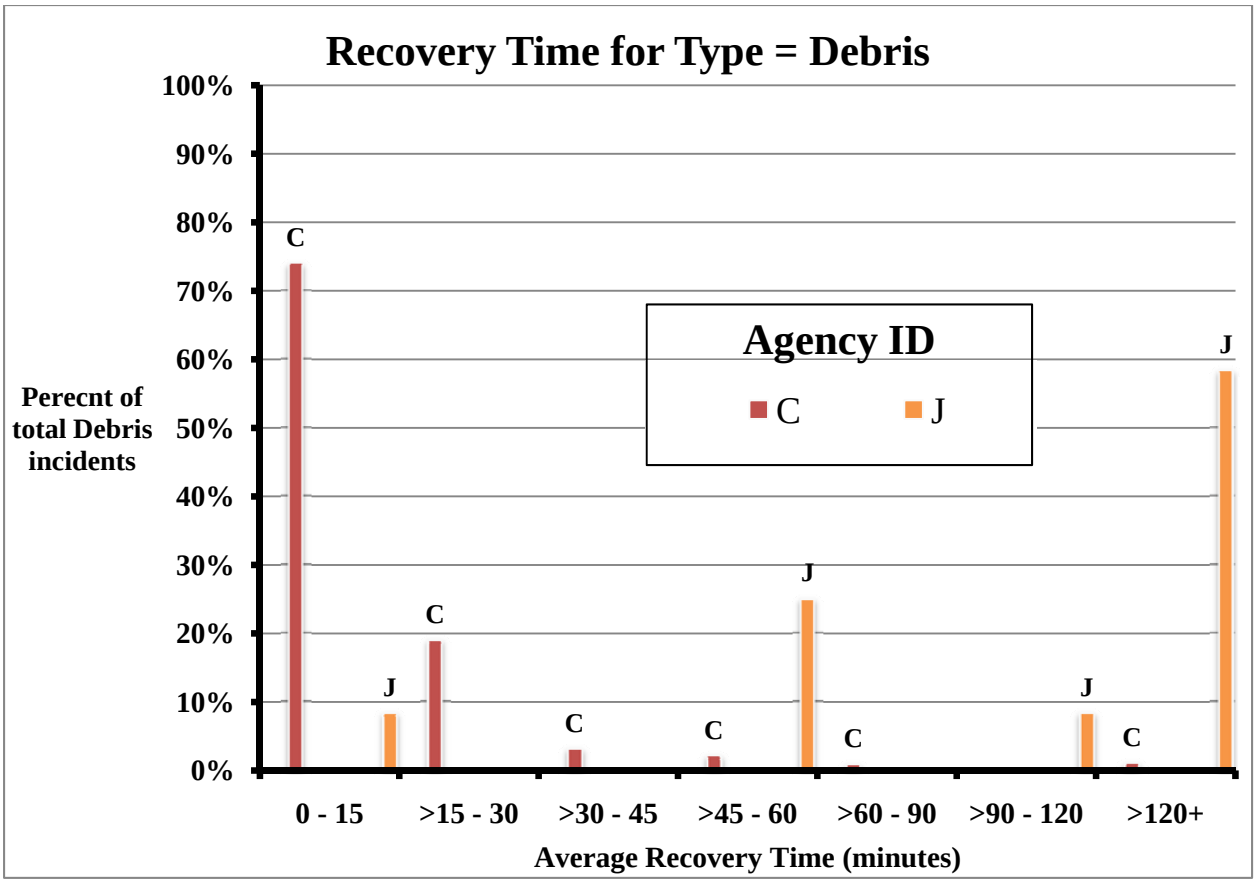


FIGURE 29 - COMPARISON OF AVERAGE RETURN TO NORMAL TIME FOR VEHICLE TYPE DEBRIS

**General Observations on TIM PM Comparative Data and Graphics**

Following are some general observations relative to the use of TIM PMs for comparative analysis between agencies. As noted earlier in this section, because of the difficulties in generating TIM PM and common incident types due to lack of standardization, no conclusions are provided or specific inferences drawn from the comparison data.

- In general, the overall trends depicted in the graphs are relatively positive in terms of TIM PMs with some exceptions. For all TIM PMs, one would hope to see the percent of total incidents of any type decrease as any of the TIM PM times increase and this was the case for a majority of the agencies. Where this is not the case (for example, see agency F in Figure 15 or agency J in Figure 19) there could be multiple possibilities for reverse trends including, but not limited to, local response operations, internal agency response operations, operator data entry, data comparability (again due to lack of standard data definitions between agencies), etc.

- As noted throughout this report, caution must be exercised when interpreting the comparative data provided in this report. However, participating agencies can still use the information to examine what appears to be going well with agency operations and where improvements might be made. Following are a few examples:

- Agency D might examine why the percentage of total Accident incidents within the 0-15 minute Average Roadway Clearance Time interval is low compared to the other agencies (Figure 13).

- Agency J might examine why the percentage of total Accident incidents within the 0-15 minute Arrival Time interval is low compared to the other agencies (Figure 15).

- Agencies B and F might examine why the percentage of total Vehicle Fire incidents within the 120+ minute Average Incident Clearance Time interval is high when compared to the other agencies (Figure 20).

- Fatal Accidents continue to be the most difficult incident type to address from a TIM PM perspective, as depicted by the high percentages of total Fatal Accidents in the 120+ minute Average Incident Clearance Time interval (Figure 17).

- Arrival Time, defined as *the time between notification of transportation to arrival of first transportation assets (e.g., service patrols, maintenance vehicles, etc.) to the scene,* appears to have very good potential as a TIM PM.

- Recovery Time, at this time, is not a good TIM PM from a comparative analysis perspective as recording Return to Normal Conditions is done infrequently and its use by agencies is subjective in terms of how "normal conditions" are interpreted. There is current research underway at the University of Maryland's CATT Lab examining the potential for using vehicle probe data to automatically identify when a roadway facility returns to "normal conditions" after an incident by comparing current roadway link speeds with historical average roadway link speeds. This research holds promise for calculating consistent and accurate Recovery Time's for incidents based on a quantitative approach to determining when normal conditions have been restored.

# CHAPTER 4 Conclusions, Recommendations, and Suggested Research

## Conclusions

While agencies are collecting a variety of incident response data used for carrying out their own internal incident response operational analysis and performance measures, a lack of standardized incident definitions and data elements makes comparative analysis between Departments of Transportation's (DOTs) extremely difficult. Fortunately, a great deal of work has been accomplished to help define National Traffic Incident Management (TIM) Program Performance Measures (PM). It is clear from this research, however, that there is considerable work to be done to ensure that these relatively newly defined TIM PMs are adopted by agencies in a way that will facilitate ongoing accurate comparative analyses. It certainly appears, even with a limited number of participating agencies in this research, that comparative analysis of TIM PMs holds considerable promise as a tool in helping improve agency operations in the traffic incident management arena.

## Recommendations

By implementing the recommendations in this section, agencies may one day have the TIM PM data that would allow for an accurate cross-comparison of agency practices that impact TIM PMs and how best practices might be replicated across agencies.

***Recommendation 1***- The Federal Highway Administration (FHWA), working together with the National Traffic Incident Management Coalition (NTIMC), the National Transportation Operations Coalition, and the TMC Pooled Fund Study States, must continue to "Market" the importance of collecting and reporting TIM PM data. The marketing campaign should be on the same level as the NTIMC's effort to have the State's adopt the TIM National Unified Goal (NUG). Fortunately, there is an existing mechanism to do so by leveraging existing FHWA sponsored Focused State Initiative (FSI) and related follow on work. The Texas Transportation Institute (TTI) is leading a TIM PM adoption campaign which, among other significant tasks, is looking to generate the support of DOT, Law Enforcement, and Fire/Rescue on adopting the TIM PMs (including the TIM PM related to Secondary Incidents not specifically addressed in this research) and their definitions in the top 40 metropolitan areas and their resident States. The TTI effort can make use of this research as the adoption campaign effort proceeds.

***Recommendation 2*** – Build on existing traffic management centers (TMC) collection capabilities and practices and have transportation agencies take the lead responsibility for TIM PM data collection and reporting. TMCs (certainly the ones participating in this research) are currently capturing and archiving a wide array of incident response data. With some effort (see recommendations below) TMC data can serve as the primary source for generating TIM PMs used locally for measuring and improving operations performance and nationally for ongoing comparative analysis and TIM Program assessment.

Key to the TIM PM definitions is the concept of "first recordable awareness". Efforts to capture "first recordable awareness" outside of the TMC should continue (e.g., through Computer Aided Dispatch Systems, Automatic Crash Notification Systems, and other systems external to the TMC); however, implementation of the TIM PMs should allow for *best available* "first recordable awareness" including the time the TMC (or other transportation system) first

recorded the incident. Transportation agencies have an inherent motivation to continually strive for improving capture of incident information as their response and assets have a significant impact on incident duration and, hence, the mobility of the traveling public.

TIM PM continues to receive the lowest self assessment scores in FHWA's annual national analysis report. A significant issue in multidisciplinary coordination efforts such as traffic incident management is identifying who's in charge of what function. As part of the marketing campaign noted in the first recommendation, transportation agencies should be encouraged to take the lead for capturing all TIM PM related incident response data. Include in the campaign to adopt TIM PMs a component for DOTs to embrace a leadership role for collecting, archiving, and reporting TIM PMs.

***Recommendation 3*** – Provide transportation agencies resources needed to help take on lead TIM PM data collection and reporting:

- Guidelines and related resources are needed to assist in helping DOTs standardize TIM PM terminology and data elements. These guidelines would be a concise document that is the definitive source of TIM PM related definitions and standards for TIM PM data elements including, for example:
    - The Institute of Transportation Engineers (ITE) and American Association of State Highway and Transportation Officials (AASHTO) Traffic Management Data Dictionary (TMDD) definition for a traffic incident: "an unplanned randomly occurring traffic event that adversely effects normal traffic operations".
    - The definitions of all adopted National TIM PM's including Roadway Clearance Time, Incident Clearance Time, and Secondary Accidents.
    - The TIM PM data elements and definitions required to capture TIM PMs (note these are for Roadway Clearance Time and Incident Clearance Time only):
        - start_time: start time of incident in TMC system
        - travel_lanes_cleared_time: time when all roadway lanes are cleared and open to traffic
        - incident_cleared_time: time when incident is cleared and last responder has left the scene
    - Instructions on how to upload TIM PM data to a national TIM PM data archive (see recommendation 6).
    - New TIM PM and data elements as they are added (see next recommendation for proposed Arrival Time TIM PM).
    - Ensure that TIM PM time stamp variables are properly reflected in the TMDD – the research team has been in contact the consultants involved in maintaining and updating the TMDD. Suggestions have been made to clarify TMDD data

elements relative to TIM PMs. The guidelines document would be used as input into the TMDD.

- Definitions and standard data elements for *incident types* that can be used in analyzing TIM PM data (see recommendation 4) and allow for more consistent TIM PM comparisons.

- Provide a reference implementation (including database schema) that conforms to standard definitions and data elements. This reference implementation could be used by DOT's to help build/modify their TMC systems to the reference specification.

***Recommendation 4*** **-** Develop definitions and standard data elements for *incident types* that can be used in analyzing TIM PM data. The work to develop national TIM PMs is an excellent start. This effort should be expanded to include some common incident type definitions and data elements perhaps starting with the common types used in this research. Analyzing and reporting TIM PMs in aggregate may not provide sufficient detail for operational purposes. Further, comparisons of agencies by TIM PMs for all incident types will be impacted by the differences in types and the number of incident types. These incident type definitions and data elements should be developed in close coordination with the National Traffic Incident Management Coalition. An initial candidate list of incident types, based on this research, could include:

- *Collision* (including the following sub-types Property Damage Collision, Personal Injury Collision, and Fatal Collision)

- *Vehicle Fire*

- *Disabled Vehicle*

- *Debris*

Getting agreement on common incident types is likely to be a difficult task, but one worth pursuing. It is suggested that a small set of types be developed first (those that are already fairly common) and avoid trying to develop a long laundry list of types that, while useful, are not already in common use.

***Recommendation 5*** **-** Adopt Arrival Time as a national level TIM PM. Arrival Time is *the time between first recordable awareness by transportation and the time when transportation assets first arrive on scene* [note: if necessary it could be referred to as Transportation Arrival Time to distinguish it specifically from other response agencies]. Based on this research, Arrival Time performance data already appears to be somewhat pervasive and, unlike other TIM PMs currently, there is considerable consistency amongst the agencies that use it. Once adopted, the Arrival Time PM definition and suggested data element would be added to the TIM PM Guidelines per Recommendation 3.

Arrival Time can be an important incident response performance measure as shown by previous research. A transportation oriented definition such as Arrival Time and a comparative analysis of data collected in support of this definition could be extremely useful. Consider, for example,

a recent evaluation conducted for Maryland State Highway Administration's (SHA) Coordinated Highways Action Response Team (CHART) program, the average incident duration in 2007 with the involvement of service patrols was 25 minutes whereas the average duration without the assistance of a service patrol was 35 minutes[5]. This led to a corresponding reduction of 36 million veh-hrs of delay due to the response and clearance activities of CHART service patrols. Incident duration, as captured by CHART, is the time between first notification of the TMC and when all responders have left the scene (analogous to TIM PM Incident Clearance Time). For transportation agencies that operate a service patrol program such as Maryland SHA, a key component of Incident Clearance Time is Arrival Time as defined above. Clearly, anything that reduces the Arrival Time of service patrols will help reduce duration and veh-hrs of delay to the traveling public.

***Recommendation 6*** – Incorporate the collection of TIM PMs into an annual National TIM PM Assessment Program using TIM PM's as comparative measures. This would build on FHWA National TIM Self Assessment program and is a concept advocated by the National Traffic Incident Management Coalition. One of the most time consuming aspects of this research was the acquisition of DOT TMC incident response data. A central repository should exist for archiving TIM PM data which would be provided annually by the DOTs. Standard web-accessible report format(s) would be developed for each TIM PM (and each incident type) that would continue to remain anonymous. These reports would be extremely useful in tracking TIM PMs nationally and DOT's could easily conduct anonymous comparative analysis so as to continually self-asses their programs against their peers using quantitative data. The national incident data repository would also be an excellent research tool for analyzing the impacts of incidents on congestion and travel time reliability.

**Suggested Research**

The recommendations above already identify a number of follow-on work activities associated with this research. Rather than repeat those, following are some additional suggested research topics:

- Given that this research migrated away from "Best Practices" due to the challenges of collecting and using TIM PM data for comparative analysis, include in future TIM comparative analysis work, follow on tasks to try and explain differences in agency TIM PMs that can be attributed to operational practices;

- Incorporate results of work on Secondary Crash TIM PMs in a follow-up comparative analyses efforts using TIM PMs;

- Using data collected in this research effort, develop some web-based tools for generating prototype TIM PM reports;

- Design and prototype a real-time system for collecting and reporting TIM PMs including a small set of incident types;

- Develop a model reference implementation that would be vetted among participating agencies, perhaps through the TMC pooled fund study effort; and

- Develop marketing materials and/or guide documents that would help agencies understand the implications and benefits of modifying current TMC systems to one based on the reference implementation mentioned above.

## **APPENDIX A.** Example Invitation and Data Request Letter

Dear [insert name]:

As a participant in the TMC Pooled Fund Study Initiative, you have been identified as a key contact who can help contribute to the success of a very important research initiative being carried out under the National Cooperative Highway Research Program (NCHRP) project 20-24(37)D "Measuring Performance Among State DOTs: Sharing Best Practices – Operations Performance Using Incident Response Time." As a potential volunteer participant in this effort, you would serve a critical role in the successful outcome of the project by facilitating the provision of Incident Response (IR) data from the Transportation Management Center(s) in your State. It is important to note that, while your agency will be identified as a volunteer in this research initiative, *anonymity will be maintained* in terms of linking states/TMCs with any specific IR data provided.

Background

This work, which is being led by an Expert Panel of State and Federal representatives and a research team at the University of Maryland's Center for Advanced Transportation Technology, builds on a series of highly successful comparative performance measurement initiatives sponsored by the AASHTO Standing Committee on Quality in the areas of Project Delivery, Smooth Pavements, and Safety. In each of these comparative performance initiatives, the research focused on two fundamental questions: (1) What if a DOT could compare performance both in the near term and over an extended period relative to its peers?; and (2) Do variations in performance among states suggest opportunities to find new and improved ways to do business?.

This operations related performance comparative effort will endeavor to answer these fundamental questions in the area of traffic incident response and clearance. Through cross-state comparison and an examination of changes in performance over time, the study will identify best practices that can be instrumental in reducing incident duration with associated benefits to travelers. It is important to note that this project will adhere to the basic principles for comparative performance measurement - the idea is NOT to rank the volunteer participants, but to identify and highlight any top performing strategies that are being used by the participating agencies.

Incident Response Data Request

The Panel and research team is interested in collecting 1-3 years of time stamped incident data from Transportation Management Centers specifically related to traffic incident management and response activities. This would include data captured regarding:

- Time of first recordable awareness of incident by a responsible agency;
- Time the TMC was notified of incident;
- Time all travel lanes are cleared and open to traffic; and
- Time all evidence of incident is removed and last responders have left the scene.

We realize that not all organizations collect the same data and you may only have some of the above data points, but we would greatly appreciate any or all of the requested data sets available. In addition, we would also welcome any and all other data collected by the TMC including, but not limited to:

- Time of any and all notifications, actions, and/or arrivals and departures of all incident responders;
- Location of incident;
- Type and/or subtype of incident;
- Severity;
- Lane Status;
- Weather conditions;
- TMC operator notes; and
- Any other data captured pertaining to the incident.

The research team at UMD will work closely with the TMC data contact(s) you provide to make the acquisition of the data as easy as possible. In many cases, simple raw data dumps from your TMC databases would be sufficient. Again, the goal is to minimize disruption to your operations and your staff.

Closing

We ask that you reply as soon as possible with and indication of your willingness to participate as a volunteer in this initiative. A member of the Expert Panel or research team will be in contact with you to follow up on this invitation and to identify the most appropriate TMC data contacts in your state.

Thank you in advance for your consideration of this request and we hope you can support our mutual efforts to enhance traffic incident response across the Nation!

## APPENDIX B. Example of Database Variable Follow Up Questions

1. We are looking to capture the time stamp for when an incident is *first* entered into your TMC's system. It appears that the field "**date, detection_time**" captures this time. Is this correct?

    1.1. If this is not the correct field, can you point us to the one that is correct?

    1.2. Is this field populated based on creation of an incident in your system by your operators or is it populated based on creation of incident in an external system that is interfaced to your TMC system (e.g., automated data feed from CAD system)?

2. We are looking to capture the time stamp for when all *travel* lanes are cleared so that any and all lanes that were blocked due to an incident are open to traffic. It appears that the field "**lan_block_clear_time time without time zone**" captures this time. Is this correct?

    2.1. If this is not the correct field, can you point us to the one that is correct?

3. We are looking to capture the time stamp for when all evidence of an incident are cleared from the scene. It appears that the field "**closed_time**" captures this time. Is this correct?

    3.1. If this is not the correct field, can you point us to the one that is correct?

4. It appears your system captures a time stamp for when the roadway is restored to "normal conditions" after an incident. Can you provide a definition for the field "**ret_norm_time time without time zone**"?

5. We are interested in the time when transportation assets (e.g., service patrol if your agency operates them) arrive on scene. It appears that the field "**arrival_time time without time zone**" captures this time. Is this correct?

    5.1. If this is not the correct field, can you point us to the one that is correct or provide us with a definition of this field?

6. We are interested in the time when transportation assets (e.g., service patrol if your agency operates them) have left the incident scene. It appears that the field "**scene_departure_time time without time zone**" captures this time. Is this correct?

6.1. If this is not the correct field, can you point us to the one that is correct or provide us with a definition of this field?

7. We noticed that your system captures a field related to incident “severity” (e.g., “**inc_severity integer”**). Can you provide your definition of “severity”?

8. Does your system capture an incident or event “type” that is *not* a free text field? If so can you indicate which fields capture this information?

8.1. Are lane closures related to construction projects designated as “incidents” in your system but not captured as a specific “type”?

## APPENDIX C. Select Bibliography


FHWA Traffic Incident Management (TIM) Performance Measurement Knowledgebase:

http://ops.fhwa.dot.gov/eto_tim_pse/preparedness/tim/knowledgebase/index.htm

Performance Measurement Exchange Community of Practice (CoP) Website:

http://knowledge.fhwa.dot.gov/cops/pm.nsf/home

AASHTO Standing Committee on Performance Management:

http://www.transportation.org/?siteid=97&pageid=2955

TRB Performance Measurement Committee (ABC30) Website:

http://www.trb-performancemeasurement.org/

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# APPENDIX D. References

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[iii] Tarnoff, P. and Young, S.E., "Guide to Benchmarking Operations," NCHRP 20-7, 2005

[iv] Focus State Initiative Traffic Incident Management Performance Measures Final Task Report, Federal Highway Administration, January 2009

[v] TMC Pooled Fund Study Website: http://tmcpfs.ops.fhwa.dot.gov/index.cfm

[vi] TMC Clearinghouse Website: http://tmc-clearinghousedev.tamu.edu/