Analysis of Work Zone MOT

Data Collection and Usage Procedures

Final Report

FM No. 4066331B201

Contract No. BC395

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May 2002

Executive Summary

Several years ago, in the effort to better understand the factors affecting traffic crashes in work zones, Florida Department of Transportation (FDOT) developed the "Engineer's Maintenance of Traffic (MOT) Evaluation at Accident Site" form. The MOT accident report form provides a means to document crashes which occur in a construction work zone, including information such as the type of project, routing of vehicles, safety devices used, etc. Many of the improvements in the existing procedures at the work zone are done based on the feedback received from this MOT form. However, the FDOT wanted to improve the current data collection procedure and make better use of the data collected.

The goal of the research described herein was to identify and correct deficiencies in the collection and use of maintenance of traffic data for construction work zones, including revising the current MOT accident report form. Current FDOT construction office procedures for collecting and utilizing data on maintenance of traffic, vehicular crashes and incidents in work zones were studied. Based on this study and the data collection procedures followed by other states, a new paper form was developed. To overcome limitations in the current procedures, the entire system was computerized and a client-server database and web-based data entry forms were developed.

The computer system will provide a quicker and less error-prone means of collecting data in the event of a work zone crash. It will also help in generating reports and querying the data collected. It is anticipated that this research will improve understanding of factors contributing to work zone crashes, resulting in improved MOT in the work zones, improved driver and worker safety, and fewer traffic incidents. The tool will be of great help to construction zone inspectors, who can see which projects, contractors, and districts have the most crashes and study other crash characteristics, allowing them to better direct the inspection program. The tool will also assist designers of Maintenance of Traffic (MOT) plans, who can study the various implemented MOT's and their effects. This is expected to lead to improvements in the existing designs followed by FDOT that are based only on Manual of Uniform Traffic Control Devices (MUTCD) and Federal Highway Administration (FHWA) standards. It is anticipated that this research will result in an improved understanding of factors contributing to work zone crashes, which will in turn

result in improved MOT in the work zones, improved driver safety, and a reduced number of traffic incidents.

The data from the old MOT accident reports could not be readily used to test the system due to incompatibilities in format and differences in data items requested. To test the system, a pilot study period was implemented for a six-month period in late 2001. Feedback from the pilot study and from FDOT construction engineers and project managers was used to revise the MOT computer system. One user concern was the time it took to load graphics-intensive screens, such as the screens displaying the MUTCD standard forms. However, most of the user feedback was positive, and even novice computer users found the system easy to navigate and utilize.

A major problem noted by the FDOT Construction Office with both the original paper form and the new computer system is the lack of compliance in completing the forms. In fact, it was thought that the ease of use in completing the on-line form might improve the compliance rate and speed of completing the MOT forms. This did not prove to be the case, as a lack of completed forms hampered efforts to evaluate the system's usefulness and to collect sufficient data to draw preliminary conclusions on various MOT plans. Because of these difficulties, the on-line MOT crash reporting system will not presently be implemented by FDOT. Instead, the system will be maintained as a demonstration project at the FAMU-FSU College of Engineering, while the FDOT further considers methods to improve the rate of completion of MOT reports.[1]

Regardless, the present study did reinforce the fact that effective data collection and analysis system can help to improve the safety in the work zone area for both the worker and the people traversing through the work zone. The implementation of this system would avoid delay in reporting the crashes, loss of reports, establish uniformity in reporting procedures and give more power to utilize the collected information for investigating cause-effect relationships. Efforts should be made to continue populating the database developed in this study.

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[1] The necessary files for installing the MOT crash database are provided on the CD-ROM attached to this report. Installation instructions are provided in the README.TXT file.

Acknowledgments

This material is based upon work supported by the Florida Department of Transportation. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the Florida Department of Transportation. The authors also wish to express appreciation to FDOT employees Querido Castillo, David Sumner, Sastry Putcha, Anath Prasad, and John Shriner, who all assisted in the development and review of this project. This report is based upon the thesis project of Bhargav Shah, which was completed in August 2001. His work on this report is greatly appreciated.

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1. Introduction

Work zone safety continues to be a high-priority issue for traffic engineering professionals and highway agencies. Safety of the people driving on the roads as well as the construction workers has been of primary interest to the government. Effective temporary traffic control enhances traffic safety and efficiency, regardless of whether new construction, maintenance or utility work is taking place in the workspace. Effective temporary traffic control must provide for the safety of workers, road users and pedestrians. At the same time, it must provide for the efficient completion of whatever activity suspended normal use of the roadway [MUTCD 1993].

In an effort to better understand the factors affecting traffic crashes in work zones, the State Construction Office of the Florida Department of Transportation (FDOT) developed the "Engineer's Maintenance of Traffic (MOT) Evaluation at Accident Site" form around 1996. This form is currently used by FDOT to report crashes in the construction area and attempt to document the effect of MOT devices and decisions on the traffic crash.

The MOT accident report provides means to document crashes that occur in a construction work zone, including information such as the type of project, safety devices used, speed limit, routing, visibility conditions etc. The form also enables the project engineer to suggest improvements to the site to avoid future occurrences. In the event of an accident, the project engineer is required to complete this report, place it in project files, and send a copy to the District Construction Office, although non-compliance has been noted by the State Construction Office. Some of the major issues to be addressed in this research are improving the MOT form to account for the lack of data needed for analytical processing, estimating the compliance of the MOT form and the procedures followed in filling out and submitting the MOT form. Currently, the MOT accident reports are kept within files of each individual project. This makes it difficult for the District Construction or Safety Office to analyze the data and identify the problem area. The format of the current data collections does not support computerization.

To address the above deficiencies, the following research goals were established. In the first phase the goal is to identify deficiencies in the collection and use of maintenance of traffic (MOT) data for construction work zones. The research team will study the current

procedures followed by FDOT construction office for collecting and utilizing data on MOT and vehicular crashes in work zones. After studying the effectiveness of this report the researcher will suggest appropriate improvements and come up with a new MOT form.

In the second phase, a computerized system for data collection and analysis using reports, will be developed based on the revised MOT form using the prevalent database software to help automate the data collection and analysis procedure. Furthermore, the capability to try various options using computers will relieve the design engineer from the drudgery associated with routine calculations, leaving him time to make other subjective and important decisions.

1.1. Scope And Objectives Of Present Study

The scope of the present study is developing an electronic database, and querying and reporting program for maintaining the centralized data, based on the data collected using the newly developed Maintenance of Traffic Evaluation form for construction work zones. The resulting crash data, plus the data collected using the revised procedures, will be used by FDOT to analyze and determine the trends in construction zone crashes. It is anticipated that the research will result in an improved understanding of factors contributing to the work zone crashes, which will in turn result in improved maintenance of traffic in the work zones, improved driver safety and a reduced number of traffic accidents.

Consistent with the above, the main objectives of the present work are as follows:

- Review MOT forms currently used by Florida and other state DOT's, and to review forms completed by FDOT personnel, i.e. to examine current practice at Florida DOT and in other states.
- Based on the results of Task 1, develop a new Maintenance of Traffic (MOT) Evaluation form.
- Develop a database, querying and reporting program.
- Implement the developed system on a pilot project basis at an ongoing construction project.
- Attempt to analyze crash trends on the pilot project site using the data collected from the construction site.

2. Background and Literature Review

This section contains background information on the subject at hand, and the results of a literature review conducted at the beginning of the project. It is divided into three subsections. The first presents background information on the construction work zones as it relates to safety and maintenance of traffic. The second subsection presents the results survey on MOT practices in the United States as well as a review of general literature in the area of work zone crashes. The third subsection includes a detailed discussion of data modeling and database management as it relates to the work done on this project.

2.1. The Construction Work Zone and Maintenance of Traffic

The Federal Highway Administration (FHWA), a part of United States Department of Transportation, publishes the Manual on Uniform Traffic Control Devices (MUTCD), which contains all national design, application, and placement standards for traffic control devices. The purpose of these devices, which includes signs, signals, and pavement markings, is to promote highway safety, efficiency, and uniformity so that traffic can move efficiently on the streets and highways. The MUTCD provides guidelines on all of the signs used on the streets and highway including their placement, shape, size, color and usage. The manual standardizes the usage of each sign for a specific purpose.

The FDOT publishes design standards, a dated and pre-approved set of drawings, exhibiting standardized practices based on current criteria and policies of the department. These standards are based on MUTCD and FHWA. They carry guidelines and plans to be followed while carrying out construction on a particular type of roadway. These are called Maintenance of Traffic (MOT) plans.

The FHWA also publishes the Standards and Guides for Traffic Controls for Street and Highway Construction, Maintenance, Utility, and Incident Management Operations (Part VI of MUTCD). This part of the manual provides guidelines and standards to be followed while carrying out construction work on a particular type of roadway. According to the MUTCD, any temporary traffic control zone in a construction project on the roadway has five major components - Approach Area, Transition Area, Buffer Space, Work Zone and

Termination Area. Figure 2.1 below shows the major components of a Temporary Traffic Control Zone. These components are described in more detail below.

The Approach area is the region where the drivers are informed of what to expect ahead. The advance warning provided may vary from a single variable message sign or flashing lights on a vehicle to a series of signs in advance of transition area. Table 2.1 (VI-3 in the MUTCD manual) provides guidelines for the spacing of signs, which are to be followed in cooperation with local jurisdictions.

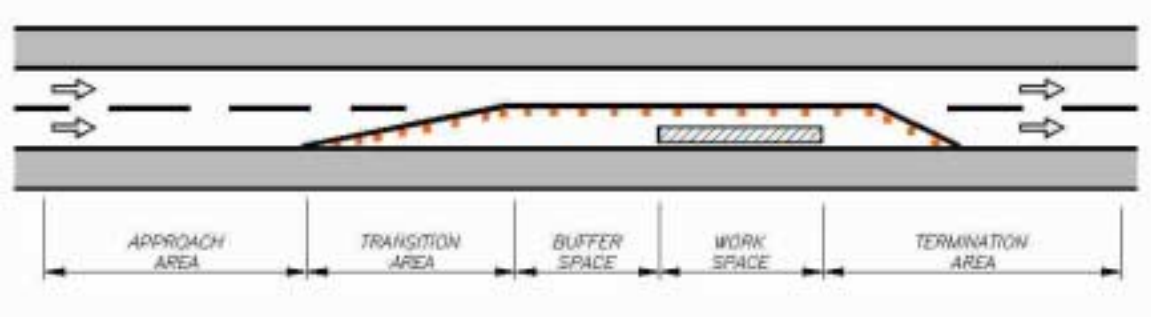


Figure 2.1: Components of a temporary traffic control zone

Table 2.1: Suggested advance warning sign spacing

Road type	**Distance between signs**		
	A (ft)	**B (ft)**	**C (ft)**
Urban (low speed*)	100	100	100
Urban (high speed*)	350	350	350
Rural	500	500	500
Expressway/Freeway	1000	1500	2640

Where,
A = the distance from the transition or point of restriction to first sign.
B = the distance between first and second signs.
C = the distance between second and third signs. (The third sign is the first one in a three-sign series encountered by a driver approaching a temporary traffic control zone.)
*Speed category is to be determined by state highway agency in cooperation with local jurisdictions.

The dimensions are depicted in Figure 2.2 [MUTCD 1993]. The exact configuration of the work zone might change based on roadway geometry and the work being performed and Figure 2.1 is just a generic example.

The Transition area redirects the driver from the normal path to the new path. In mobile operations, the transition area moves with the work space. The Buffer space is an optional feature in the activity area that separates traffic flow from work activity or a hazardous area and provides recovery space for an errant vehicle. Buffer spaces can be longitudinal or lateral depending upon requirements and MUTCD provides guidelines for their length. The work space is that portion of roadway closed to traffic and set aside for workers, equipment and material. The work space may be fixed or may move as work progresses. It is normally guarded with barriers or channelizing devices and at times may be covered with screens to stop passersby from looking at the work being carried out and that way helping to restrict the distraction while driving. The Termination area is used to return the traffic to its normal path from the temporary path. The Termination area extends from the downstream end of work space to the END ROAD WORK sign, if posted. For normal daytime maintenance, the END ROAD WORK sign is optional. The dimensions of all of these zones depend on the offset provided and the posted speed on the roadway. The MUTCD provides guidelines on the dimensions of the various zones based on above two factors [Ref. Table 2.2, Table VI-2 in the MUTCD 1993].

The taper length criteria for various zones is calculated using following equation.

$$L \approx \frac{W * S^2}{60} \qquad \text{For Speed} < 40 \text{ mph} \qquad (2.1)$$

$$L \approx W * S \qquad \text{For Speed} > 45 \text{ mph} \qquad (2.2)$$

Where,

L = Taper length in feet
W = Width of offset in feet
S = Posted speed

The minimum taper lengths recommended by MUTCD [Table VI-2 MUTCD 1993] are repeated in Table 2.2. The taper lengths are shown in the Figure 2.2.

Table 2.2: Taper length criteria for temporary traffic control zones

Type of Taper	**Taper length**
Upstream tapers	
Merging taper	L minimum
Shifting taper	1/2 L minimum
Shoulder taper	1/3 L minimum
Two-way traffic taper	100 feet minimum
Downstream tapers	Use is optional

The MUTCD also recommend use of police for highly vulnerable work situations, particularly of short duration, to increase the awareness of the traffic passing by and to improve safety of the temporary traffic control zone.

2.2. Brief Review of Literature

The literature survey consisted of the study of the currently used MOT report by Florida DOT, the traffic crash report used by Florida Police Department, similar reports used by other states, and their procedures.

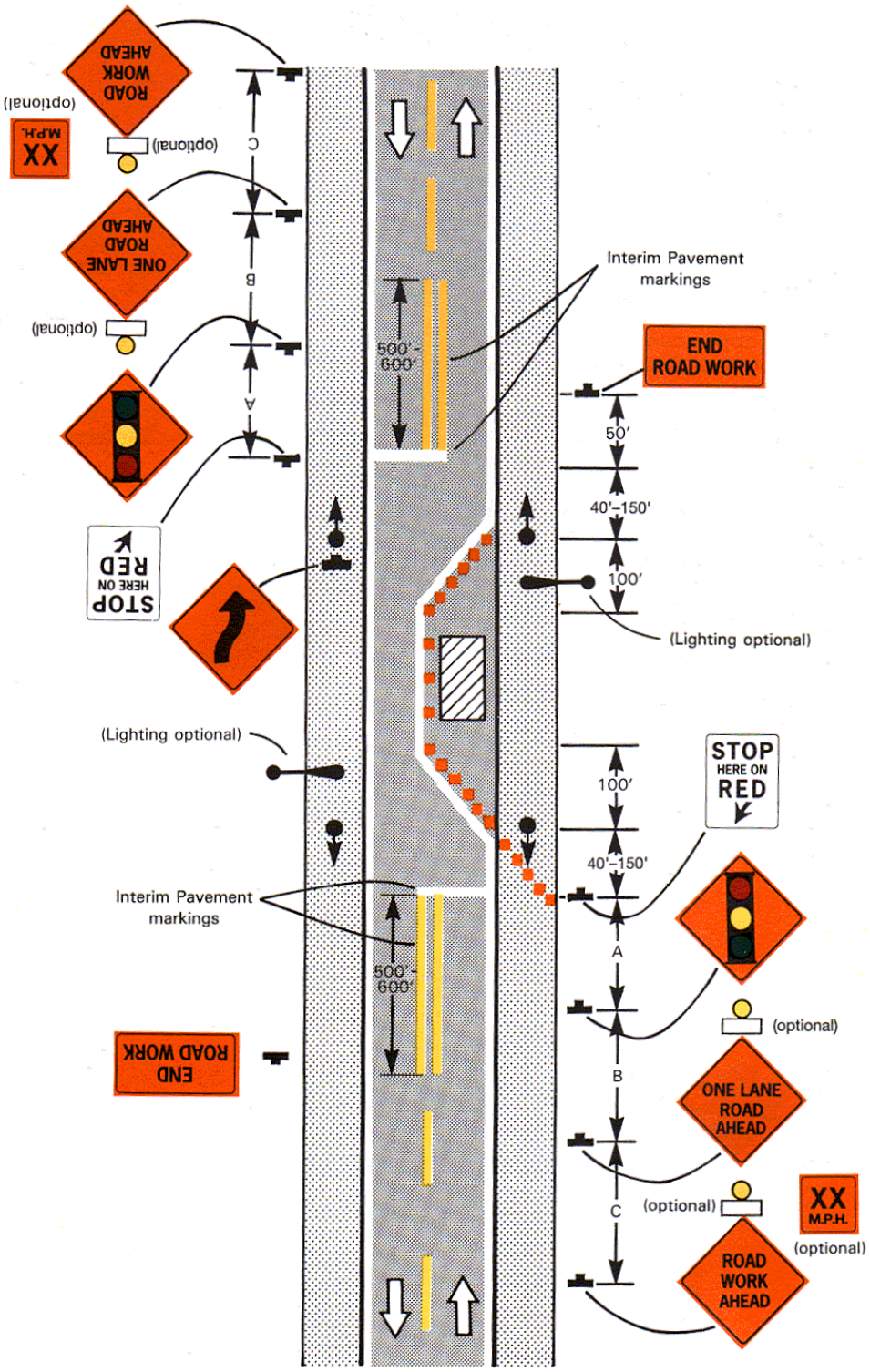


Figure 2.2: Major components in a temporary traffic control zone

2.2.1. MOT Reports Used By Other States

For the first phase of the project, a questionnaire was prepared and sent to the Department of Transportation of remaining 49 states inquiring about the crash report used in the event of a work zone crash, preparation of the reports, personnel involved, and actions taken based on the data collected. Most of the research done so far in this context is published in the Transportation Research Record. Out of the 49 states, 29 states responded the questionnaire, some with the MOT forms, police reports forms, brief details of similar study carried out there and contact information. The questionnaire mailed to the different states is shown in Figure 2.3. Out of the 29 responses received, 17 states used standard forms for reporting accidents in work zone and remaining 12 states didn't specify any alternate procedure used by them. Out of those 17 states, 8 use police report as MOT report and 9 use separate MOT report. Out of the forms supplied, it was observed that Maryland and New York had notable forms in terms of ease in completion and information content, respectively [Appendix A].

According to the survey results, none of the states were using any form of electronic database to store work-zone accident records. With the usage of computers increasing in day-to-day life, they seem to be the most obvious choice. Also, the availability of various software packages in the market to help manage a database with ease has increased the usage of the same. Some of the notable studies carried out in various states are summarized below.

Idaho Study

The Idaho DOT has indicated that they have a special reporting procedure for accidents occurring within the construction zone. They consider the law enforcement officer's traffic crash report as their primary MOT report. They supplement the officer's report with a Final Traffic Report that was completed by the Project Engineer.

Idaho has a Policy and Procedures Manual for controlling the ingress and egress of vehicular traffic in the construction zone. As per the manual a periodic inspection of the construction work zone is done to evaluate the vehicular traffic through the work zone. The contractor is responsible for compliance with regulations and the improvements/corrections suggested are to be made before proceeding with the construction.

CONSTRUCTION WORK ZONE SAFETY QUESTIONNAIRE

Name _____

Address _____

_____

City, State, Zip _____

Phone _____ Fax: _____

E-mail _____

Thank you very much for providing this information to help us in our study. We will provide you with a copy of the final report of this survey. Please answer the following questions and return this page in the enclosed stamped envelope by **January 31, 2000**.

1. Do you have any standard forms for reporting traffic accidents occurring in the Construction Work Zone?
   - ☐ Yes, Can you provide a copy?
   - ☐ No
2. Has your State conducted any study concerning accidents in the construction work zone?
   - ☐ Yes, we have completed a study of this type.
   - ☐ No, this study has never been undertaken in our State.
   - ☐ This study is presently being conducted.

If the answer is No, please skip to **number 5 below**.

3. If this type of study has been conducted, has the result been published in anywhere?
   - ☐ Yes , where _____
     Can you provide a copy?
   - ☐ No
4. If No, are there any internal reports you can share with us?.
   - ☐ Yes, can you provide a copy?
   - ☐ No
5. Please provide any pertinent information on any activities related to Construction Work Zone Safety that you are doing in your State (use the back of this page and/or additional paper if necessary).

Figure 2.3: Work zone safety questionnaire mailed to states

The study, though primarily focused on safety in hot plants, did tackle issues related to work zones. Some of the problems related to work zone safety were incorrect sign spacing or too low placement, short taper lengths in work zones, wrong direction of chevrons on barricades, use of improper flagging card, lack of periodic review of traffic control on construction projects by District Traffic Engineer/Supervisor as recommended in the Traffic Manual (section 602.3) [Johnson, L 1999].

New York Study

The New York DOT also has a special reporting procedure for accidents occurring within the construction zone. They have a Policy and Procedures Manual for evaluating accidents in the work zone. As per their regulations, the Engineer-in-Charge (EIC) is key person in the accident reporting procedure, and is responsible for initiating the process when an accident occurs. All inspection personnel report to the EIC for an accident. The Regional Construction Safety Coordinator (RCSC) ensures that the process is completed in timely manner. The EIC reports to the RCSC in case of an accident. Accidents are categorized in three categories (I, II and III) depending on the severity of the accident criteria listed in the manual. Three standard forms A, B and C are filled out accordingly. The forms used by NY DOT are attached in Appendix A.

The New York State DOT Construction Division produces an annual report that categorizes the accidents in the work zone. Detailed accident statistics were provided in this report [NYDOT 1998 Summary Report].

New Jersey Study

The New Jersey DOT primarily uses the law enforcement officer's traffic crash report to compile the data needed. The State Highway Patrol Officers are trained in the regulations of the Manual on Uniform Traffic Control Devices (MUTCD), Occupational Safety and Health Administration (OSHA), and Traffic Control Planning (TCP). State police are used on all interstate and state route projects to facilitate TCP set-ups and takedowns. The methods and procedures developed by the state are reviewed by OSHA and other states to determine compliance. The Office of Capital Project Safety (OCPS) was dedicated to the

safe movement of traffic through the construction work zone. New Jersey conducts annual TCP reviews in each region [Winther, Anker L.].

Oregon Study

Oregon DOT uses the law enforcement officer's traffic crash report for compiling the needed information. The primary study provided in response to the questionnaire focused on three items, analysis of work zone traffic accidents, the effect of traffic patrols on speed, and a survey of the Oregon DOT and Contractor employees working in the construction zones. It was noted that the traffic patrols helped reduce the speed in the construction zone regardless of the amount of the time they stayed on the construction zone area. About half of the workers believed that there was a way to improve safety in the future on the construction site. The study showed small, but significant reductions in speeds and the survey indicated a perception of increased safety with the police patrols [Jones, B. and Christiansion, L. 1996].

Ohio Study

The objectives of this study were (a) to identify the nature and seriousness of the work zone safety problem in the state of Ohio and (b) to identify major cause and effect relationships of accidents in work zone and make recommendations. In addition, the researchers also studied seven other research projects investigating accident experience during construction, all of which showed an increase in the accident rate during construction [Ha, T. J. and Nemeth, Z. A.].

The study was conducted using the computerized database (1982-1986) of Ohio Department of Highway Safety. Some of the observations of the study were as follows:

- The work zone accidents were generally less severe than other accidents.
- Accidents occurred more frequently in the day compared to night.
- Trucks were involved more frequently in work zone accidents than in other accidents.
- Object and rear-end accidents were over represented.

Nine sites were selected for detailed case study of all relevant accident reports.

The major causes of work zone accidents identified through this research are (i) traffic control problems, for example, inadequate or confusing traffic control especially at exit ramp, lack of warning signs at edge drop or soft shoulder, traffic slowdowns due to work ahead, etc., and (ii) driver's negligence, for example, lack of attention to lane changing or merging, drinking alcohol, etc.

Based on the recommendations of this study, the following changes were made in the policy of the Ohio DOT.

1. Developed maintenance of traffic (MOT) policies for construction work zones (CWZS).
2. Developed M/T standard construction drawings.
3. Analyzed and recommended changes to the existing CWZ MOT procedures, practices and application of traffic devices.

2.2.2. Crash Studies

The literature survey also revealed certain studies addressing crashes in work zones. The studies, which are summarized below, addressed various factors involving the cause and effect relationship in the work zone crashes and representation of crash information.

A good deal of research has been carried out, relating to the factors affecting and/or contributing towards accidents in the construction zone area as well as helping to reduce the same. Some of the studies carried out also examine the accidents in the work zone involving traffic control devices, safety features and construction operations. A research project carried out by the New York DOT in the 1980s showed that certain traffic control devices and safety features can represent a significant hazard when impacted, but that properly designed and installed devices performed well and appeared to present little risk to vehicle occupants and workers [Bryden, J.E. 1990] [Hahn, K.C., and J.E. Bryden 1980].

Work zone safety continues to be high-priority issue for traffic engineering professionals and highway agencies. A study was conducted into the number of fatalities resulting from crashes that were reported in highway work zones between 1984 and 1994. Information from the Fatal Accident Reporting System (FARS) indicates that 833 people were killed in highway work zones during 1994, which was a 29 percent increase over the

number of 1992 fatalities, a 10-year low [Jun Wang, Warren E. Hughes, Forrest M. Council and Jeffrey F. Paniati].

The same article also points out that the emphasis on work zone safety and improving the identification of work zone problems has been increased by legislation. Section 1051 and Section 2002a of the Intermodal Surface Transportation Efficiency Act (ISTEA) specifically requires the Secretary of Transportation to develop and implement a work zone safety program that will improve work zone safety at construction sites. The authors conducted research into work zone safety with five objectives: (i) to determine what is known about the magnitude of highway work zone crashes, (ii) to examine characteristics of highway work zone crashes using the Highway Safety Information System (HSIS), (iii) to investigate how work zone accidents are reported on police report forms and within state accident report system, (iv) to identify critical voids in the knowledge of the relative safety of work zones, and (v) to examine possible ways to address unfulfilled information needs related to work zone safety [Jun Wang, Warren E. Hughes, Forrest M. Council and Jeffrey F. Paniati].

The researchers used different approaches to achieve specific objectives. For objective one, researchers used accident data from 1991-92 for three states Illinois, Maine and Michigan. It was observed that work zone accidents occurred much more frequently than what was reported. The characteristics of the work zone were analyzed using the HSIS, a multi-state database developed and maintained by FHWA. The analysis consisted of accident type and severity, roadway type, work zone type, road surface condition, light and weather condition. The results observed showed that frequency of rear-end collisions in work zone area was much higher than in non-work zone areas. The details from police reports were found to be subject to uncertainties.

Objective three was met by analyzing work zone accident reporting criteria for all 50 states and the District of Columbia using the 1992 State Accident Report Form Catalog. Thirty-five states have a field for identifying a work zone accident on their police accident report. The investigation also indicates that 11 states identified the type of vehicle involved, and 21 states identified the type of construction workers involved (FDOT form lacks this details). The major problem in achieving objectives four and five is found to be the lack of

information and inaccurate data. It was also observed that there was inconsistency in reporting and coding of work zone accidents among different states [Jun Wang, Warren E. Hughes, Forrest M. Council and Jeffrey F. Paniati].

The objective of another research study on crashes in construction and maintenance work zones was to collect data to study the types of traffic control being used. Researchers followed up by collecting of accident data both in the field and through computer records. The data was collected from the Kentucky Accident Reporting System (KARS) for period of 1983-86. A total of 20 locations were selected for additional investigation as case studies. Also, field inspection was done on construction sites during 1986-87. The study only considered accidents with road under construction listed as an environmental (roadway) contributing factor.

The analysis of data from 1983-86 showed that approximately 500 work zone accidents occurred each year. Higher percentages of those accidents were on interstate routes. Work zone accidents were found to be more severe than other accidents. Trucks were involved in more number of accidents. Rear-end of same direction accidents were almost three times statewide percentages.

For the second phase of the project, which involved traffic control evaluation and accident analysis of 20 locations, it was observed that accident rates varied from location to location during construction, but overall accident rates exceeded those before construction. In most accidents, lack of driver's attention, failure to yield right of way, and following closely were observed as contributing factors. Eighteen of twenty locations were in conformance with MUTCD and Kentucky Department of Highways Standard Drawings. Two-way two-lane operations (TWTLO) were used in most of the locations studied. In most locations, concrete barriers, traffic cones and flexible markers were used to separate traffic flow [Pigman, J.G. and Agent, K.R] [Signal 1995].

The National Transportation Safety Board (NTSB) issued a report on June 3, 1992, with two recommendations concerning the reporting of work zone accidents. The recommendations emphasized the need to distinguish between persons driving highway maintenance vehicles within work zones and other drivers who crash in work zones while traversing the work zone site. It was also recommended that, in conjunction with the FHWA,

each state should review its law enforcement accident report form, and that all forms should include data elements to identify work zone accidents. In the past, FHWA has issued a notice and request for comments on National Highway Work Zone Safety Program. The program consists of four components: standardization, compliance, innovation and evaluation. Parts of this program were related to ISTEA Section 2002a and the National Transportation Safety Board (NTSB) recommendations [NHTSB 1992 and Signal 1994].

2.3. The Client-Server and Database Representation

Database programs have been available for personal computers for a long time. Unfortunately, many of these programs have been either simple data storage managers that aren't suitable for building applications or complex application development systems that are difficult to learn and use. Even many computer-literate people have avoided using the more complex database systems unless they had access to a complete, custom-built database application.

2.3.1. Database Development Over The Years

Computers are information-processing machines. The management of that information is one of the most challenging aspects of engineering today. The development of a software includes determining the information content of the application area, developing a model of that information, representing that model with specific computer data structures, and providing the software mechanisms for creating, maintaining, and protecting the information content.

Database systems have evolved over the years as a result of many research and development efforts.

- Before 1960 simplistic punched cards and taped systems or Flat-File Systems were used.
- During the 1960s data structure diagrams and the hierarchical and network data models were developed, and multi-user access became possible with networked computers.

- In the 1970s CODASYL (Conference on Data Systems Languages), the Relational model and SQL (Structured Query Language) were developed.
- In the 1980s came Client/Server databases, including Oracle and DB2, along with PC databases such as Dbase, Paradox etc. SQL, based on the Sequel language, was originally standardized in 1986 by the American National Standards Institute and the International Standards Organization (ISO).
- In the 1990s came the web-based information delivery using expert Databases (DBs), object DBs, distributed DBs, data mining and data warehousing.

Databases are at the center of computing. The use of commercial Database Management System (DBMS) can lead to the creation of systems that are accurate, efficient, reliable, and secure. In today's computer intensive world, database systems and database applications are increasing in importance relative to other developments. Wherever large or small amounts of data are to be dealt with, a database application is a viable means to store information, to maintain its accuracy, and to make it readily available.

For the past several years, the Internet has become more important in business and engineering. Every business today has its own web site through which a person in a remote part of the world with Internet access can look for the products or information of interest. Much of the software development for web sites is concerned with the interaction between web servers and databases. The Oracle database management system dominates the worldwide information systems marketplace [Tom Luers 1997, Ivan Bayross 1998]. Given below is a brief overview of the features and capabilities of a database system.

2.3.2. Information Representation

In the world of software development, there is a distinction between data and information. *Data* means an organized collection of bits. *Information* means data that have a specific interpretation or meaning. A value stored in some specific bytes of a file on a computer is data. Associating information content with the value requires its type (integer, string, float and so on), a name that describes it, and a context in which the name has meaning. Databases are used to represent facts in an organized manner. A DBMS is a combination of software and data:

- **The physical database:** a collection of files that contain the data content
- **The schema:** a specification of the information content of the physical database
- **The database engine:** software that supports access to and modification of the contents of the database
- **The data definition and manipulation languages:** programming languages that support schema definition and database access

A relational database management system (RDBMS) is a DBMS that incorporates the relational model, in which all data are stored in tables. A table is comprised of rows and columns. A row of a table represents a database object, and a column of a table represents the values of a single attribute or characteristic of the objects in the table. The schema of a database system is stored inside the system. That is, a database system is self-describing.

The interaction between programs and the database system is specified through a use of variety of languages. Amongst them the data definition language (DDL) is used to specify the conceptual schema of a database. This language supports the specification of database objects and their types and constraints. The data manipulation language (DML) is used for querying and modifying the information stored in database servers. The view definition language (VDL) is used to define the views in a database.

2.3.3. Data Models

Databases are used to represent facts about a system in an organized manner. Thus, the contents of any database represent facts about real objects that are of interest to someone. The first step in building a system to represent information involves determining the meaning and organization of the information that is part of the project. The importance of data modeling cannot be overstated. Limitations on the ability to represent facts are often revealed in this phase. These limitations can cause serious problems in the later development stage, and fixing these errors at that stage is both costly and time-consuming.

For an information system to be successful, it has to record and manipulate information in a way that is important for the usage of the system. The information has to be accurate and complete. Before the database development is started, the information content (data model) must be specified. A structured methodology has evolved over the years,

approved by ANSI, that may be followed to design database schema. A database also has a variety of constraints including cardinality constraints and relational constraints. A cardinality constraint puts restriction on the number of entities or items involved in a relationship. Typical cardinality constraints are one-to-one, one-to-many, many-to-one and many-to-many. Meanwhile, a participation constraint places a restriction that an entity must be related to at least one entity of the related class.

Databases are organized in such a way as to represent the information in the required amount to a specified user. The views presented by a database are generally classified into three levels as the external level, the logical level and the internal level. The database user interacts with the database at the external level, and the logical level controls the views that are displayed at the external level. The internal level is the stage where the collection of tables and files is stored. The following figure, Fig. 2.4, shows the three levels of database schemas.

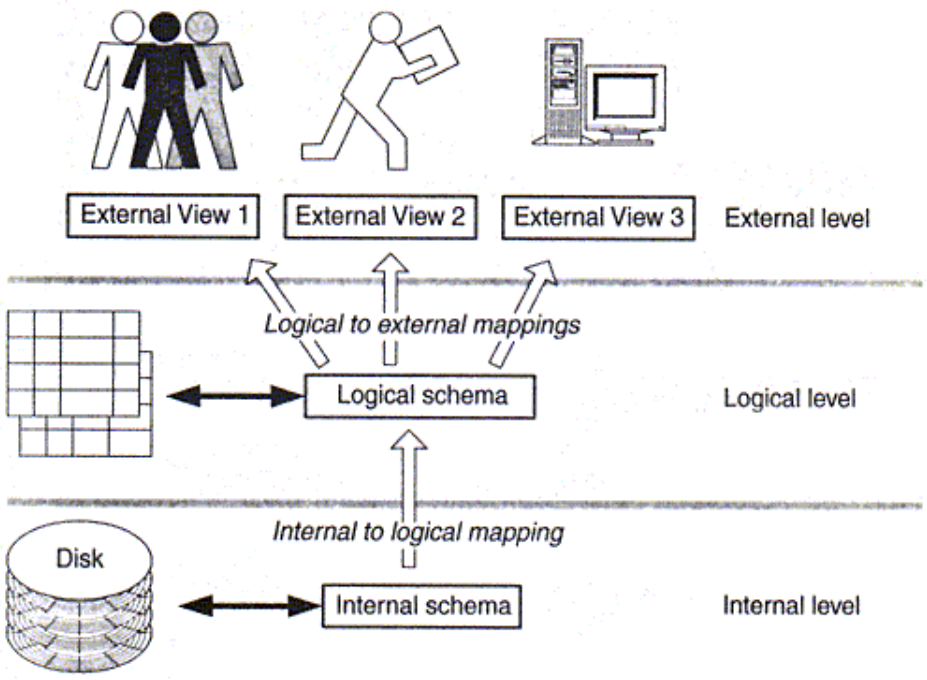


Figure 2.4: Three levels of database schemas

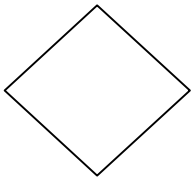
In the database schema the key components are the attributes, entities, and the relationships between them. A database system provides for the representation of the characteristics of objects. These objects are called *entities* and their characteristics are called *attributes*. The entities in a class share common attributes. The possibility of an entity of one class having a relationship with entity of another class is called *relationship type*.

The database schema follows certain symbols in drawing the Entity Relationship (ER) diagram. The symbols help to represent the logical and physical schema diagrammatically. Figure 2.5 shows some of the symbols used in drawing the ER diagram. The table shows the symbols used to state the cardinality constraints [Greg Riccardi 1999].

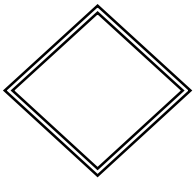
As an example of entities, attributes and relationships, consider "Project" as one entity which has attributes like Contract Number, Project Type etc. and consider "MOT" as another entity having attributes like TCP Type, MOT completion date, MOT report completed by the engineer etc. Both of these entities are related to each other by one-to-many relationship, i.e. each project can have many MOT plans but each MOT plan is related to one project. This relationship is represented in Figure 2.6. The terms are explained later. The names in the oval are the column (Attribute) names. The column names with a dotted underline indicates that it is a foreign key. The column names with a solid underline indicates that it is a primary key.

Entity class

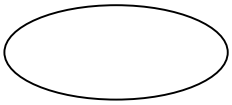
Weak entity class



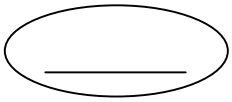
Relationship type



Identifying relationship type



Attribute



Key attribute

Derived attribute

Cardinality Marks

1 — No more than one related entity

M — Many (zero or more) related entities

Must participate in the relationship

May participate in the relationship

Figure 2.5: Symbols used in ER diagram

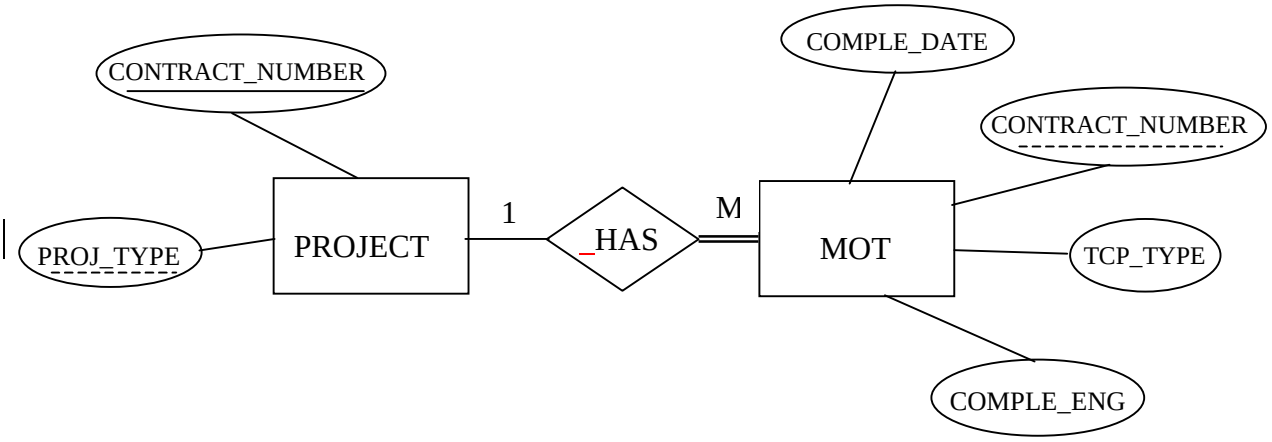


Figure 2.6: Example of Attributes, Entities and Relationships

2.3.3.1. Data Types

The database structure is laid out based on the characteristics of various entities as discussed above. The relational tables for an entity are created with the attributes of that entity, and with appropriate data-types and constraints. The data types that Oracle allows are listed in Table 2.3.

The terms "crash" and "accident" are used interchangeably in this report. Each relation (table) has a *primary key*, which is a unique attribute in the table. The primary key column cannot be left blank and the data held across the column must be unique. These special constraints on the primary key column are taken care by the database software used. Any table can have only one primary key and it can be composed of single column or multi-column. For example, the attribute Contract_Number is the primary key in the project entity in Figure 2.6. A *foreign key* is a column (or group of columns) whose values are derived from the primary key of some other table. For example, the attribute Contract_Number is the foreign key in the MOT entity in Figure 2.6. The foreign key represents relationships between tables. The existence of a foreign key implies that the table with the foreign key is related to the table of which the foreign key is the primary key. The entities that did not have any primary key are related to their master table through the identifying relationship type. These entities are called weak entity type and they carry the primary key of their master table as a foreign key for identifying the records. For an example of a weak entity type, the Buffer entity is shown in Figure 2.7.

Table 2.3: Data types defined in Oracle

Data Type	Description
VARCHAR2	Variable length character strings
CHAR	Fixed length character strings
NUMBER	Fixed or floating-point numbers
BINARY_INTEGER	Integer Values
PLS_INTEGER	Used for fast integer computation
DATE	Dates
BOOLEAN	True/false values

2.3.4. World Wide Web

Normally, the World Wide Web and the Internet are interpreted to be the same. The Internet is nothing but a physical network of computer hosts working to provide links between texts, images, movie files and audio information. The World Wide Web consists of a collection of protocols and standards used to access the information across the Internet. The web brings the information to the host machine with the help of the Internet.

Network applications work on the client/server model, which distributes the work of one application across two programs, a client and a server. The client-server architecture is explained in brief in Section 2.3.4.1. Both the client-side and the server use the same protocol interface. Normally, servers run all the time and are ready to accept the request from any client and give back the required information. Normal protocols used by computers to communicate with each other are: network, transport, and application. Network protocols coordinate the transmission of information, transport protocols manage the integrity of the data, and application protocols format the data for transmission. The Internet normally uses the Transmission Control Protocol (TCP) for coordinating the network transmissions.

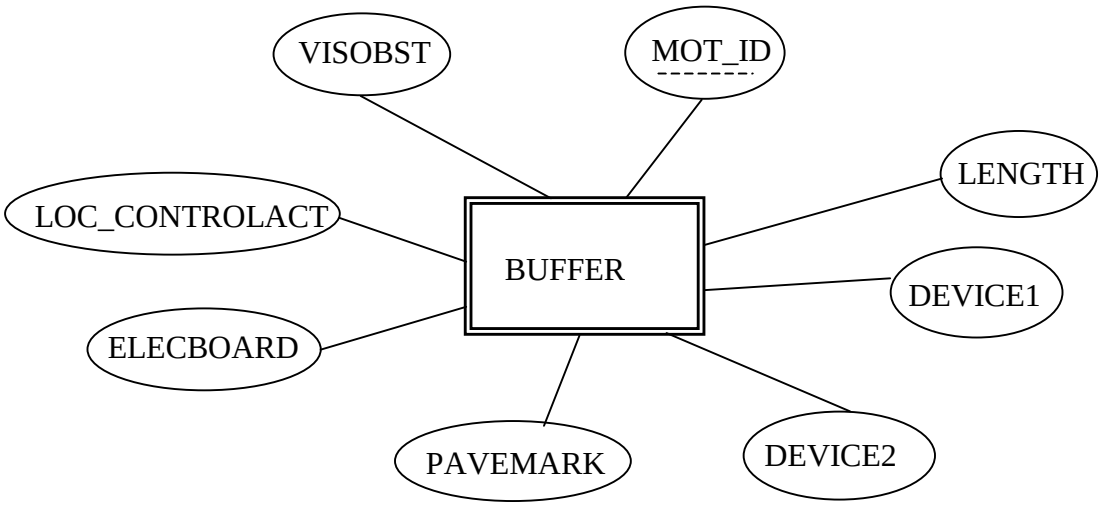


Figure 2.7: Example of weak entity type

Primarily, the web comprises of the following components: Uniform Resource Locators (URLs), Hypertext Transfer Protocol (HTTP), and Hypertext Markup Language (HTML). All the three components are discussed in brief below.

URLs are the Internet addresses, such as http://www.eng.fsu.edu. URLs help to locate data on the Internet by addressing resources across multiple protocols. A URL basically consists of three components - a protocol, the server name, and the path of the file to be reached. Normally, the format of a URL is:

protocol://servername:port/path

Usually the ":port " section is omitted, and the URL uses a default port for that protocol. The "servername" can be in upper or lower case and can be represented by the IP address or hostname. The hostname is same as domain name. For example, consider http://safety.eng.fsu.edu: the URL is read from left to right, where "http" represents the protocol to be used, "safety" is the name of a machine with Oracle server located on the "eng.fsu.edu" server.

HTTP is designed as a protocol that increases data transfer rates without requiring any information about the connection from one request to another. It can have only on

request per connection. Thus, it is a "stateless" and "connectionless" protocol. The client-to-server connection is removed after each request is completed. Every time the server is accessed, a new connection is required.

HTML is the language used predominantly to generate the web pages. HTML was drawn based on the Standard Generalized Markup Language (SGML). The markup languages define areas of text by "tagging" them with labels specifying a specific format. Hypertext links can be created between documents with HTML to provide the transport mechanism. The example shown below depicts the HTML syntax for a web page with the title "FAMU-FSU College of Engineering" in bold letters. The HTML syntax requires both closing and opening tags for allowing the browser to know where to start and stop reading the file. "<B>" is the short for bold. "BODY" represents the area where the content of the web page is written.

```
<HTML>
<HEAD>
   <TITLE><B> FAMU-FSU College of Engineering </B></TITLE>
<HEAD>
<BODY>
</BODY>
</HTML>
```

2.3.4.1. Client-Server Architecture

In a client-server architecture, an application program typically interacts with a database system through an interface as shown in Figure 2.8. In a client-server system the application runs on a computer known as a client and stores information in its memory as objects. Another computer acts as a server and stores information in its memory and its disks as relational database tables.

The client application issues requests for access to information in the database, which resides on the server. The requests are made based on the database schema. In response to the requests, the database server extracts the requested information from its tables and sends it to the client in a standard format. The client knows what information to expect, although it may not know the exact format.

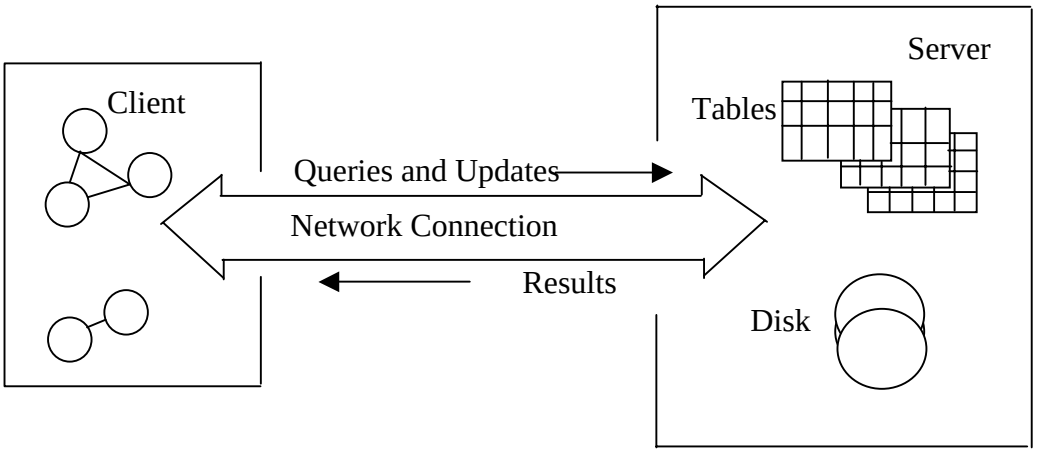


Figure 2.8: Client-server interaction

In its role as database client, the application can submit requests to modify the database contents and the database schema. The database server processes these requests only if they are consistent with that user's access privileges, as assigned by the database administrator.

2.3.5. Databases And The World Wide Web

The advent of the Internet and its growing use has provided a platform for new developments in databases. Nowadays, all the major sectors like industrial, consumer, information technology product groups etc. prefer doing their business through the Internet. This new e-commerce market has helped the database community to explore new avenues and ways to meet the current demand in terms of both efficiency and processing time. As the Oracle software was selected as the database platform its capabilities are described in detail in following sections. However, much of the discussion is generic to databases.

Oracle has been one of the leading providers of database technology for the past several years, and since the Internet is functioning as a massive network for exchanging data, new technology and products have come into the market to help retrieve and disseminate the data over the Internet and through Internet based applications. The Oracle Web Server is the

basis for Oracle's use of the Internet. It allows the user to create Web-based interactive applications that work closely with the Oracle database. This allows the user to access the data stored in the database at any remote location on a server and at the same time add data to the database which can be later on reviewed. The basics of the Web Server architecture are explained below in brief:

In its most basic form, the Web Server acts as a simple request dispatcher, which takes a request in form of URL and returns an HTML document to the requester. The request can be for a static HTML page stored on the server or some information from the database stored on the server. With this capability, Oracle Web Server helps to create customized responses to users requests. It also offers a facility to use the widely used platforms for data transmittal and programming on the Internet, such as cgi, java, HTML etc.

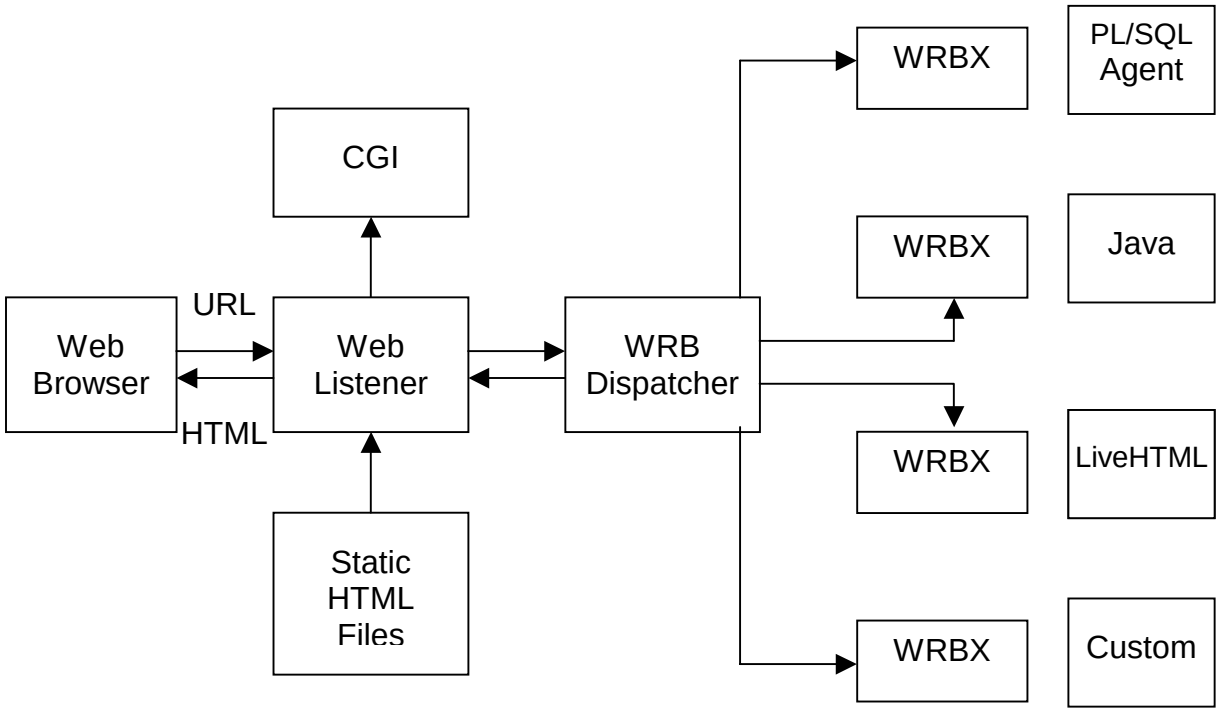


Figure 2.9: Oracle Web Server 2 Architecture

Oracle’s Web Server is composed of many components that work together to provide an environment for a complete web based application. The type of installation one performs

determines the components of the web server. The basic components of the web server are as follows:

- Web Listener
- Common Gateway Interface (CGI)
- Web Request Broker (WRB)
- PL/SQL Agent and Web Toolkit
- Java Cartridge
- LiveHTML Cartridge

As Figure 2.9 shows, the web server takes the request in form of an URL and returns an HTML document to the requester. As described previously, the URL is passed through the web browser to the web listener. If the request is for a static HTML document, then the document will be retrieved and sent back to the browser. If the request is for a dynamic HTML document, then with the help of the module specified in the request by the user, the Web Request Broker (WRB) user will pass the request to that module. The Web Request Broker provides several options for generating dynamic documents, including the PL/SQL Agent (Oracle Web Agent), Java, LiveHTML, and custom-build modules. It is also possible to execute the request through CGI. Depending upon the module that is executed, the generated HTML document will be returned to the browser via the web listener. In web terminology, the term *Cartridge* refers usually to a procedural language module that can be plugged into the Web Server architecture. If the URL specifies to use WRB as the dynamic interface, then the WRB dispatcher within the WRB will execute the WRBX process to direct the request to the proper cartridge. The dynamic content requested by the user is retrieved from the database and sent back to the web browser through the web listener.

The Web Listener is an HTTP engine on the Oracle server managing the incoming requests for services in form of URL's. It submits the request to Web Request Broker for further processing. After the generation of the requested HTML document, it receives the document and sends it back to the requester. Depending upon the configuration and requirements there can be one or many Web Listeners running simultaneously.

The Common Gateway Interface (CGI) helps execute external applications linked to clickable image maps and forms for interfacing with the server. It works with Oracle Web Server, Explorer, and Netscape's Communications server.

The Web Request Broker handles the web requests made to Oracle database. It consists of a dispatcher that maintains communications with a pool of process called WRB executable engines. These engines interface with various WRB cartridges. The combination of the WRB application program interface (API) and a cartridge is called a WRB executable engine (WRBX), which handles HTTP requests sent from the WRB dispatcher. Depending upon the cartridge specified in the URL, the request is executed. The WRB executes the specified number of requests allowed in the configuration at a given time.

The PL/SQL agent is a cartridge allowing the Oracle Web Server to execute store PL/SQL procedures and packages. It also helps to execute standard PL/SQL calls to web server utilities and HTML functions. It helps execute the stored procedure and send the generated HTML documents back to the web listener.

Oracle Web Server 2 is used to develop the software using PL/SQL Web Agent and Web Server's hypertext procedure (htp) and hypertext functions (htf). Oracle has built-in library of standard HTML tags, which are represented by the htp and htf. There is a one-to-one correspondence between the htp and htf libraries.

Oracle's Web Server interprets the htp and htf calls and generates the standard HTML tags, which are interpreted by any web browser. The following example shows the relationship between the standard HTML tags and Oracle Web Server's htf and htp procedures. The example shows the title of a web page:

```
htp.headOpen;
htp.title('This is test line');
htp.headClose;
```

This code would be interpreted in Standard HTML syntax as:

```
<HEAD>
<TITLE>This is test line</TITLE>
</HEAD>
```

2.4. The Platform Selection

There are many database platforms and software to choose from, including Oracle, Microsoft Access, FoxPro, Dbase, Paradox etc. With the advent of Internet and its widespread use, all of the software developers have developed capabilities to work on this backbone of global transportation of data. All of the software's have advantages and drawbacks.

Looking to the current trend in the industry, there were two major software packages to choose from. The first was Microsoft Access from Microsoft Corporation, and the second was Oracle from Oracle Corporation.

The first possibility was using the Microsoft Access package developed by Microsoft Corporation. This is a package that is used widely in the personal computer sector. Microsoft Access provides significant ease of use, as with all Microsoft products, many people are drawn to it to create both simple databases and sophisticated database applications. Still, the industry believes that the product is useful mainly for the personal computer.

The second and obvious choice was Oracle software. Oracle is widely used in the industry for relational database management. Recently, the American Association of State Highway and Transportation Officials (AASHTO) has developed a software program called Site Manager based on the Oracle database platform. Oracle, unlike Microsoft Access, is used widely on the Internet. Most of the database services on the Internet are managed through Oracle. The idea of developing an electronic MOT form will help the project engineer to fill in the data correctly and with relative ease. It would also help to maintain uniformity in the report submitted with all the necessary data as compared to the earlier situation where the State Construction Office has to depend on the Florida Traffic Crash Report to understand the cause and characteristics of accidents.

3. Development of New MOT Form and Database

The purpose of this project was to examine the existing MOT form, develop a new form, and develop a computer database for data collection. For this process, the old MOT form was studied along with the MOT forms of other states and a new form was developed. Taking into account this new form, the database system was developed. As such the whole process was broken down into several stages by applying the principles of database development and modeling the data necessary to monitor the performance of the work zone area of any project at any given time. The process is concentrated on collection of data and generation of reports that will be of importance to the Florida DOT. The reports generated by the resulting computer system will be an effective tool to monitor the performance of a given temporary control plan in the work zone area.

3.1. Study of Existing MOT Form

The form used by Florida DOT prior to this study consisted of information related to the project, like Federal Project Number, Contract Number etc. The form also asked crash related questions, like visibility condition, pavement type etc. The old form provided space for a sketch showing the crash site along with the construction equipment and MOT devices in position at the time of crash. However, few forms had a high quality sketch showing the placement of MOT devices. Most of the forms referenced the police report in place of the sketch; yet, the police report rarely provides any detail about the construction zone and MOT. Researchers thought that project engineers might find it tedious or time consuming to draw the sketch in the provided space with the given symbols [Ref. Appendix B].

Further, the use of fill-in-the blank questions left the user with too much flexibility in giving an answer. In the question regarding the zone where the crash occurred, most reports carried the station number instead of the work zone division approach, transition, etc. The form also asked for recommendations on improving the work site, but most of the reports didn't make any recommendations. The form consisted of narrative description for important questions. All of these deficiencies made it very difficult to form cause-effect relationship, as well as to determine trends of the crashes in the construction area. Because it relied on the sketch, the earlier form failed to ask the questions regarding the type of devices used in the

construction area, as well as other factors like pavement markings, usage of electronic sign boards, length of various zones in Traffic Control Plan (TCP), other traffic control activities etc. Finally, the form did not ask whether an injury or fatality had occurred. The use of sketches and fill-in-the blank answers also made it difficult to computerize. The old MOT form used by FDOT is shown in Figure 3.1 and 3.2 for reference.

To examine the completeness and correctness with which the forms were filled out, completed MOT forms were requested from all eight FDOT districts. In all, 250 MOT report forms were obtained from 6 districts. Four of the districts - two urban and two rural, were selected for analysis, and MOT forms from those districts were observed for their completeness, sketches, time between accident date and report date. Out of the four selected districts, District 1 was rural having accidents distributed evenly among the projects, District 5 was urban having 56% of accidents on a single project, District 7 was urban having 102 accidents in a single project and District 6 was rural having accidents distributed evenly among the projects.

Figure 3.3 shows the time elapsed between the accident date and report date for District C. The report shows that out of 110 crash reports, more than 58 percent of the crashes were reported after two weeks of the actual crash. This highlights the benefit of the new system of real time reporting. Also a high rate of non-compliance in District 5 was noted, where almost 25 percent of MOT reports did not have an accident report attached. The observations are summarized in Table 3.1.

An item from the attached Florida Traffic Crash Report (FTCR) that was reviewed was the "Contributing Factor, Roadway" field. By definition, the accidents under consideration are the ones where the road was under construction. The FTCR contains no field to indicate whether the accident occurred in a work zone; however, a note of "road under construction" is supposed to be indicated when the police officer has determined that the construction activity contributed to the crash. By reviewing the accident reports in the selected districts, it was observed that approximately 40 to 50 percent of work zone accidents were coded with contributing cause roadway of "road under construction". This high percentage of accidents might show that improvements were needed in the MOT and work zone safety, in general.

K. DUGE

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
ENGINEER'S MAINTENANCE OF TRAFFIC EVALUATION AT CRASH SITE

FORM 700-010-64
CONSTRUCTION - 05/99
Page 1 of 3

Date/Time of Occurrence: 01-25-00 10:30PM Report Date: 01-26-00

FIN Project No.: 197604-1-52-01 State Road No.: 546 District: 01

Federal Project No.: ZIZZ-023P County: POLK

Contract No.: 20496 WPI No.: 1118496

MOT Evaluation at Crash Site:

Has there been other crashes in the same vicinity of the work zone?

○ YES ☒ NO

If yes, give dates. _____

Police Investigated? ☒ YES ○ NO CASE NO P.C.S.O. 00-14858

If available, attach police report. CITATION GIVEN FOR VIOLATION OF TRAFFIC CONTROL DEVICES

Work Zone Location of crash:
(Approach, transition, work area) WORK AREA LINCOLN AV. ± WEST BD U.S-92

Is the immediate area at the crash site in accordance with State Standards, MUTCD and TCP? ☒ YES ○ NO

Are there any recommended enhancements to the MOT at the crash site?

☒ YES ○ NO

List enhancements to be made to the work site. DECREASED SPACING OF TRAFFIC CONTROL DEVICES (CONES) TO 2-4 METERS AROUND AREAS OF REMOVED CONC PAVEMENT.

Distribution: Original to Project Engineer
Copies to: District Safety Engineer, Contractor

Figure 3.1: Old MOT form Page 1

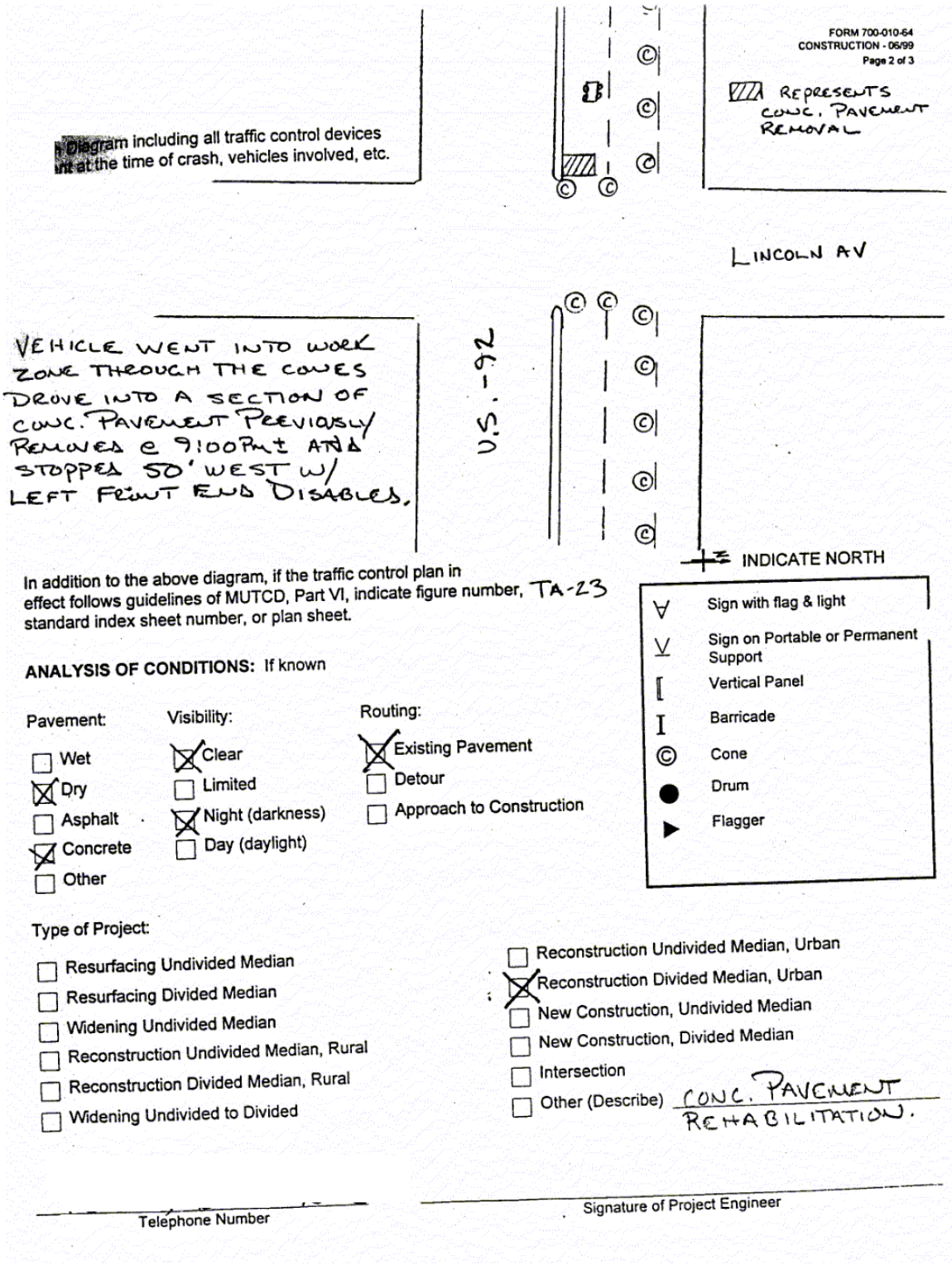


Figure 3.2: Old MOT form Page 2

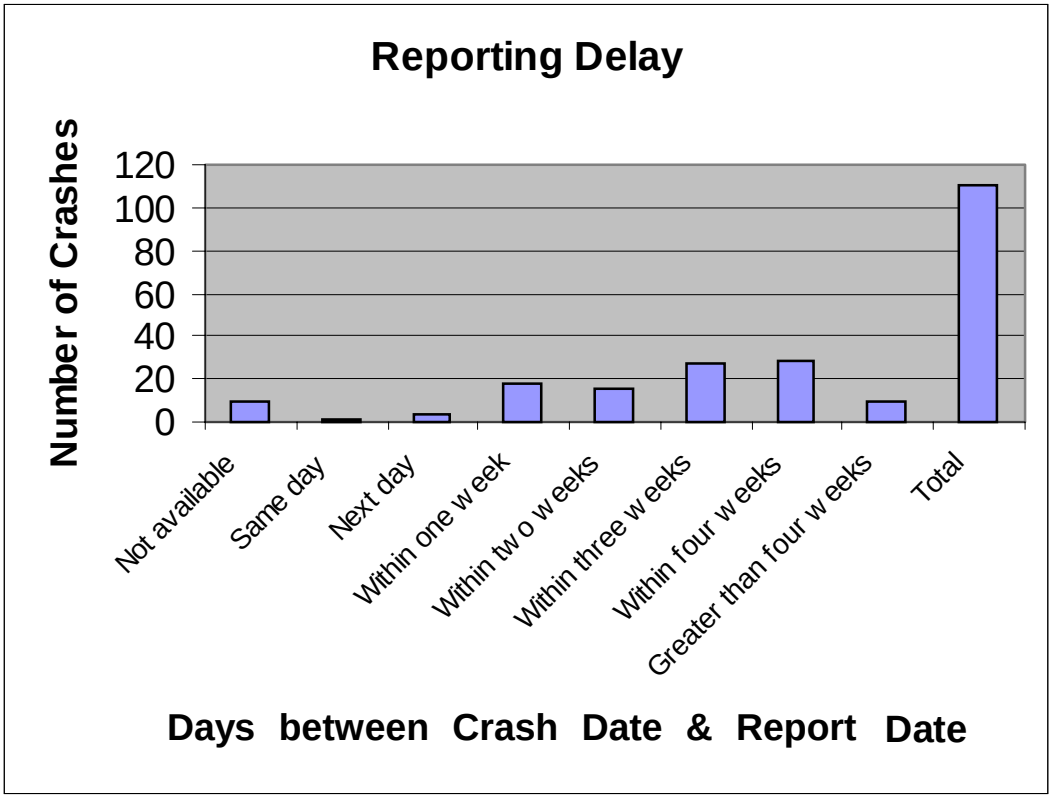


Figure 3.3: Chart representing delays in reporting the accident

Table 3.1: Work Zone accidents by Contributing Factor on FTCR

Contributing Cause Roadway	District 1	District 5	District 6	District 7
No Defects	14	36	14	56
Road under Repair/Construction	15	41	9	39
FTCR Not Attached	0	26	3	1
Total Accidents where FTCR available	29	79	23	101
Percent Construction Related	52	52	39	39

3.2. Development Of New MOT Form

After studying the MOT forms of other states and the current MOT form used by Florida DOT, additional information needs and deficiencies were identified. The identified information was added to the existing MOT form in consultation with the research committee of Florida DOT comprising of project managers and district construction engineers. The information added improved the usefulness and usability of the MOT form. The newly developed MOT form is attached in the Figures 3.4 and 3.5 for reference.

The new form was developed taking into account the amount of information needed and the ease in filling the form. The new MOT form now gives a picture of a standard construction zone and asks for information about the MOT in regarding the individual divisions, including their lengths, MOT devices used, pavement markings, electronic board usage, location of other traffic control activities and other MOT issues like total number of advance warning signs, approximate sign spacing etc. The new MOT form also asks questions about the crash, including the number of vehicles involved, speed limits, vehicle movement at the time of crash etc. The new information is asked with the intent that, it will help to analyze the performance of a particular traffic control plan better and suggest the improvements accordingly to avoid future crashes.

Although the new form asks for additional information, it is easy to use and will take less time to complete than the previous form as most of the questions are answered either using check boxes or numbers. The web-based form also makes use of either pull down menus or check boxes to speed data entry.

3.3. Database Development Based On Revised MOT Form

Based on this new revised MOT form the database a web-based form and associated database were developed. Standard data modeling practices were followed in developing the database: as a first step, entities were identified and grouped. It was seen that the form primarily addressed three entities:

1. Project Information,
2. MOT Information, and
3. Crash Information.

Report No_____

FLORIDA DEPARTMENT of TRANSPORTATION
Engineer's Maintenance of Traffic Report

Project Information

Report Date: _____ Crash Date:_____ State Road No:_____

District:_____ County _____ Traffic Crash Report No._____

FIN Project No:_____ Federal Project No._____

Contact No:_____ WPI No:_____

MOT Evaluation at Crash Site

Traffic Control Plan
01 Original
02 Revised

Speed Limit
Posted Limit
Construction Zone

Construction Ongoing at time of Crash
01 Yes
02 No

Type of Project
01 Resurfacing
02 Widening
03 Reconstruction
04 New Construction Undivided Median
05 Intersection
06 Other_____

Radar Sign
01 Yes
02 No

Visibility
01 Clear
02 Limited

01 Night (Darkness)
02 Night (Lighted)
03 Day

Pavement
01 Wet
02 Dry

01 Asphalt
02 Concrete
03 Other

Routing Where Crash Occurred
01 Existing Pavement
02 Detour (Temporary)
03 Milled Pavement
04 New Pavement

Lane Closure
01 Temporary Lane Closure at Start of Day
02 24-Hour Lane Closure
03 Temporary Lane Shift
04 24-Hour Lane Shift
05 Temporary Detour
06 24-Hour Detour
07 Shoulder Closure
08 No Lane Closure

Vehicle Movement
Vehicle 1 | Vehicle 2 | Vehicle 3

01 Straight Ahead
02 Slowing/Stopped/Stalled
03 Making Left Turn
04 Backing
05 Making Right Turn
06 Changing Lanes
07 Entering/Leaving Parking Space
08 Properly Parked
09 Improperly Parked
10 Making U-Trun
11 Passing
12 Driverless/Runaway Vehicle
13 All Other

Geographical Location
01 Urban
02 Rural

Roadway Under Construction
01 2-Lane
02 2-Lane with Center Turn Lane
03 4-Lane Divided Median
04 4-Lane Undivided
05 4-Lane with Center Turn Lane
06 6-Lane Divided Median
07 6-Lane Undivided
08 6-Lane with Center Turn Lane
09 Intersection 2-Lane
10 Intersection 4-Lane
11 Intersection 6-Lane
12 Exit Ramp
13 Entrance Ramp
14 Other

Harmful Event/Traffic Crash
HE 1 | HE 2 | HE 3

01 Collision Rear-end
02 Collision Head-on
03 Collision Angle
04 Collision Sideswipe
05 Collision Construction Worker
06 Collision Other Pedestrian
07 Collision Fixed Barrier
08 Collision Moveable Barrier
09 Collision Guardrail
10 Collision Crash Attenuator
11 Collision Other Fixed Object—Permanent
12 Collision Other Fixed Object—Construction Related
13 MV Ran into Ditch/Culvert
14 MV Overturned
15 Tractor/Trailer Jackknife
16 Other Collision
17 Construction Vehicle
18 Law Enforcement Vehicle

Report Completed by:_____ Date:_____

Report Reviewed by:_____ Date:_____

Figure 3.4: New MOT form Page 1

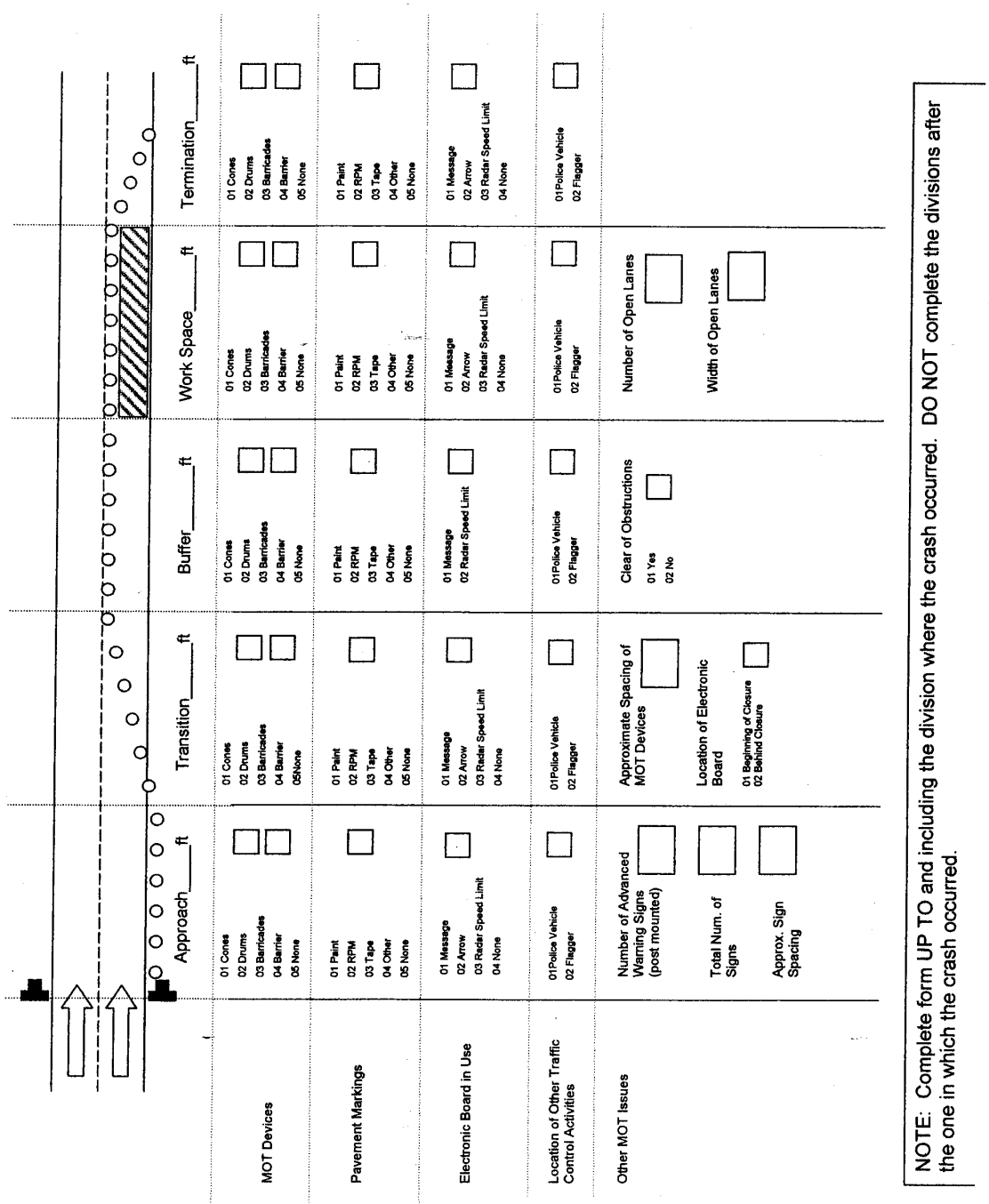


Figure 3.5: New MOT form Page 2

The above entities were identified based on the information that the MOT form collected. The information like Contract Number, Project FIN (financial) Number, Federal Project Number, Project Type, District, County etc. are related to the project, and do not change for a given project. The information about the various divisions within the work zone (i.e. Approach Area, Transition Area, Buffer Space, Work Space, Termination Zone), pavement markings, usage of traffic control devices and their spacing, use of advance warning signs etc. are related to the MOT or temporary traffic control plan. These items can vary when the MOT on the project is changed. The information like crash report date, police crash report number, visibility conditions, pavement conditions, speed restrictions etc. are related to a specific crash, and thus are categorized as crash information.

The revised MOT form was designed to help establish the cause and effect relationship between MOT and traffic crashes to the possible extent. For this reason, many of the questions on the form describe the conditions in which the crash took place.

Using the basic principles of database management, the relationships among the various entities were established for the data, resulting in an entity relationship diagram of the database schema, as shown in Figure 3.6 below. As described in section 2.3.3, a relationship describes the way in which one entity interacts with another. The Project is the key entity. The project entity then links together with both the MOT and Accident entities (referred to as "crash" on the data entry forms). Each is a One-to-Many relationship because many different MOT plans and accidents can occur on the same project. The MOT plan can change whether or not an accident has occurred; therefore, they are stored in separate entities. The Accident entity is then further related to the vehicular characteristics like movement and type of vehicle; these data items are in the Vehicle entity. The Accident entity is also related to the harmful events as the outcome of the accident.

3.3.1. Entity-Relationship Diagram And Database Structure

The entity relationship (ER) diagram was prepared after studying the relationships between various entities distinguished as individual and related entities from the MOT form. In simple words, the relationships can be stated as follows: Every project has one or more MOT plans. Every MOT has various zones like Approach, Transition, Buffer, Work Space and Termination to guide the vehicles on the road safely through the construction area (Only Approach is shown in Figure 3.6 due to space reasons). A project can have one or more accidents (or crashes). If there is an accident, then vehicles will be involved; The ER diagram relating the various entities discussed above is shown in Figure 3.6. Figure 3.6 shows the attributes that act as primary and foreign keys and serve to link the tables/entities together. Other attributes are described in subsequent figures and tables.

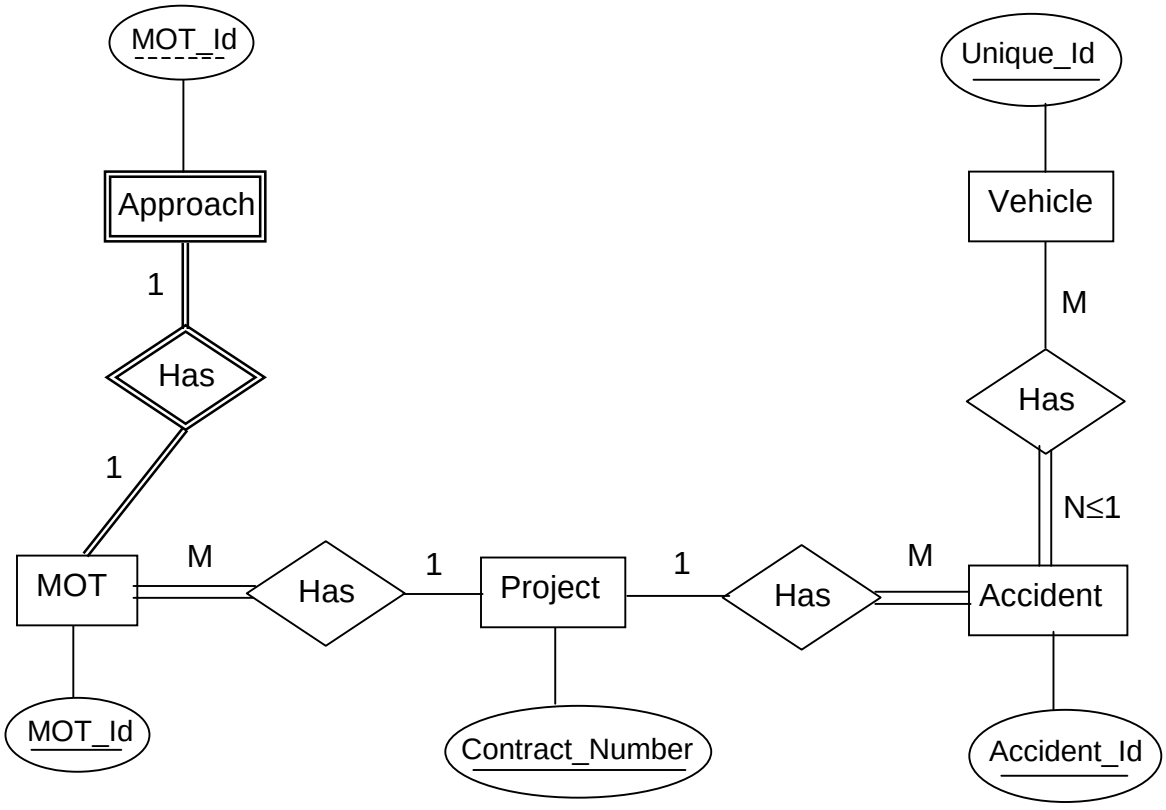


Figure 3.6: Entity-Relationship Diagram of Work Zone MOT and Crash (Accident) Database

The database structure is laid out based on the characteristics of various entities. The Project entity consists of the attributes Contract_Number, which is the primary key, County Name, State Road Number, District Name, Project type, Road type and Geography. The entity diagram for project is shown in Figure 3.7. The names, constraints, data types and descriptions of the attributes of the Project entity are shown in Table 3.2.

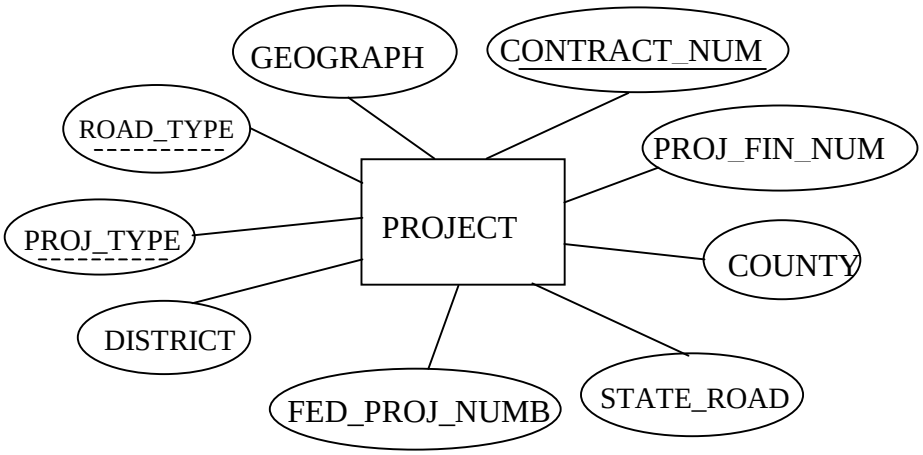


Figure 3.7: Project Entity and its attributes

Table 3.2: Name and descriptions of attributes of Project Entity

Project

Variable	Constraint	Type & Size	Comment
CONTRACT_NUMBER	Primary key	NUMBER(10)	Contract number of the project
PROJ_FIN_NUMBER		NUMBER(10)	Project finance number
STATE_ROAD		VARCHAR2(5)	State road number of the project
FED_PROJ_NUMBER		VARCHAR2(11)	Federal project number
DISTRICT		VARCHAR2(2)	District number of the project
COUNTY		VARCHAR2(25)	County name of the project
PROJ_TYPE	Foreign key	NUMBER(1)	Type of project
ROAD_TYPE	Foreign key	NUMBER(2)	Type of roadway for project

GEOGRAPHY		VARCHAR2(7)	Geographical location of project

Project type and Road type are foreign keys because they are actually ID codes referring to tables, which list all of the legal values of these two fields. These values are taken from the earlier paper form (Ref. Figure 3.2). These type of tables are called the lookup tables [Ref. Appendix C].

The MOT entity consists of the attributes MOT identification number as primary key, Name of Engineers completing the MOT report and Reviewing the MOT report, MOT report completion date, MOT reviewed on date, Traffic control plan type, and Contract Number as foreign key, relating back to the project entity. The entity diagram for MOT is shown in Figure 3.8. The names, constraints, data types and descriptions of the attributes in the MOT entity are shown in Table 3.3.

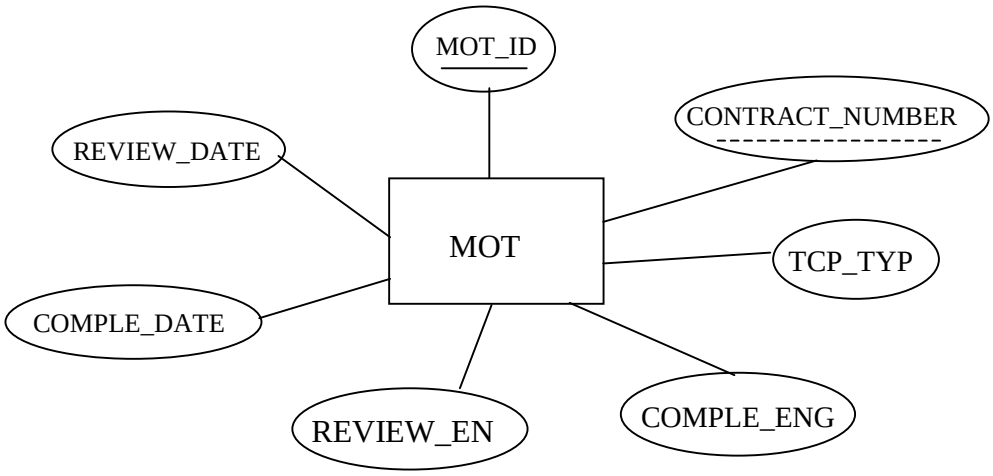


Figure 3.8: MOT Entity and its attributes

Table 3.3: Name and descriptions of attributes of MOT Entity

MOT

Variable	Constraint	Type & Size	Comment
MOT_ID	Primary key	NUMBER(6)	Unique MOT identification number
CONTRACT_NUMBER		NUMBER(10)	Contract number of the project
TCP_TYPE		NUMBER	Indicates if TCP is original or revised
COMPLE_ENGR		VARCHAR2(30)	Name of Engineer completing the report
REVIEW_ENGR		VARCHAR2(30)	Name of Engineer reviewing the report
COMPLE_DATE		VARCHAR2(10)	Date of report completion
REVIEW_DATE		VARCHAR2(10)	Date of reviewing report

The Accident (Crash) entity consists of the attributes Accident identification number as primary key, Routing type, Accident date, Accident report date, Accident time, Police report number, Whether construction was ongoing at time of crash, Type of lane closure, Number of vehicles, Pavement type, Pavement condition, Visibility type at time of accident, Posted speed in construction zone, Posted speed on roadway and Contract Number as foreign key. An additional field to enter other information pertaining to the crash is also provided. The entity diagram for Accident is shown in Figure 3.9. The names, constraints, data types and description of the attributes of the Accident entity are shown in Table 3.4.

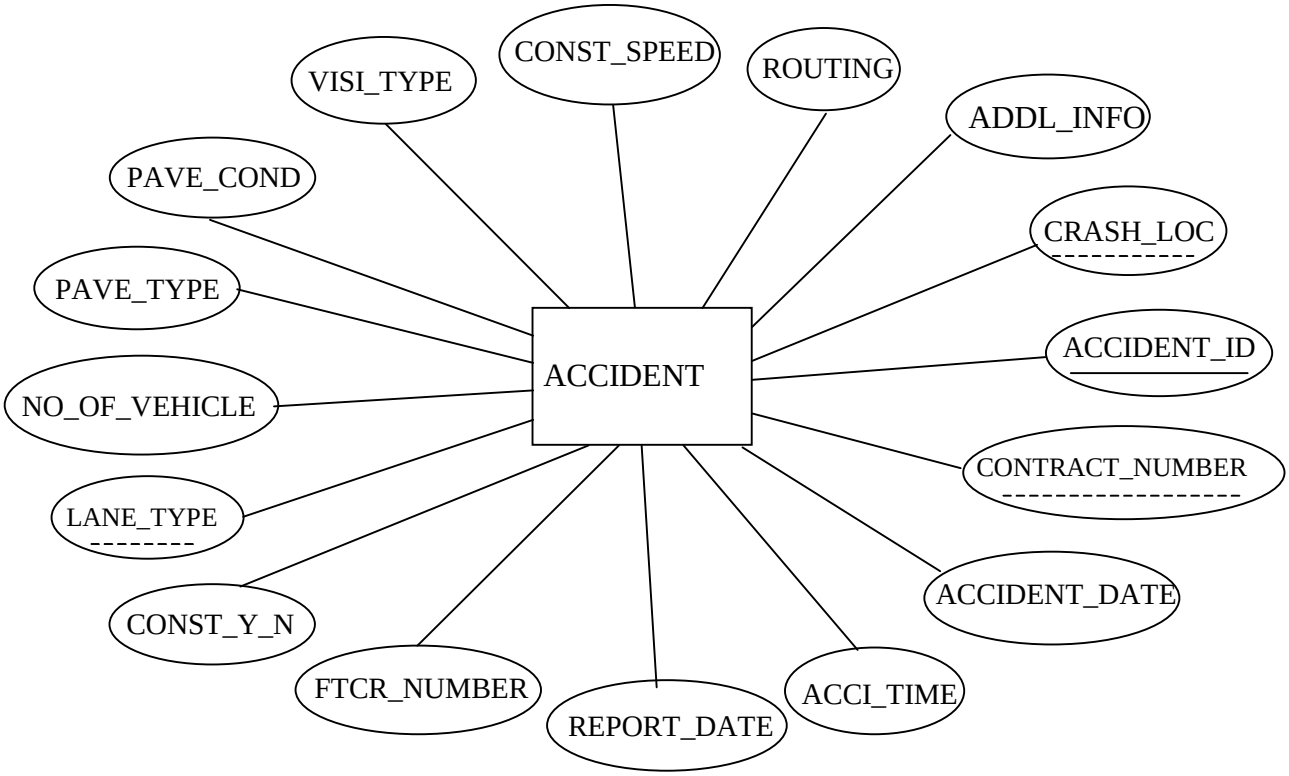


Figure 3.9: Accident Entity and its attributes

Table 3.4: Name and descriptions of attributes of Accident Entity

Accident

Variable	Constraint	Type & Size	Comment
ACCIDENT_ID	Primary key	NUMBER(10)	Unique accident identification number
CONTRACT_NUMBER	Foreign key	NUMBER(10)	Contract number of the project where accident occurred
ACCIDENT_DATE		DATE	Date of accident
ACCI_TIME		VARCHAR2(7)	Time of accident
REPORT_DATE		DATE	Date of report of accident
FTCR_NUMBER		NUMBER(10)	Police report number
CONST_Y_N		VARCHAR2(3)	Whether construction was ongoing at the time of accident
LANE_TYPE	Foreign key	NUMBER(1)	Type of lane in the project details

NO_OF_VEHICLES		NUMBER(2)	Number of vehicles involved in the accident
PAVE_TYPE		VARCHAR2(8)	Type of pavement where accident occurred
PAVE_COND		VARCHAR2(3)	Pavement condition where accident occurred
VISI_TYPE		VARCHAR2(18)	Visibility type where accident occurred e.g. Clear or limited
CONST_SPEED		NUMBER(2)	Posted speed in the construction area
ROUTING		VARCHAR2(18)	whether routing was provided at site e.g. Detour, New Pavement, Existing Pavement, etc.
CRASH_LOC		VARCHAR2(8)	Location where crash occurred e.g. Approach, Transition etc.
ADDL_INFO		VARCHAR2(1)	Additional Information if provided for crash.

The Vehicle entity consists of the attributes Unique identification number as the primary key, vehicle identification number, which states the sequence of vehicles involved in the accident, accident identification number as foreign key, vehicle movement number as foreign key, and vehicle type as foreign key. The entity diagram for Vehicle is shown in Figure 3.10. The names, constraints, data types and description of the attribute of the Vehicle entity are shown in Table 3.5.

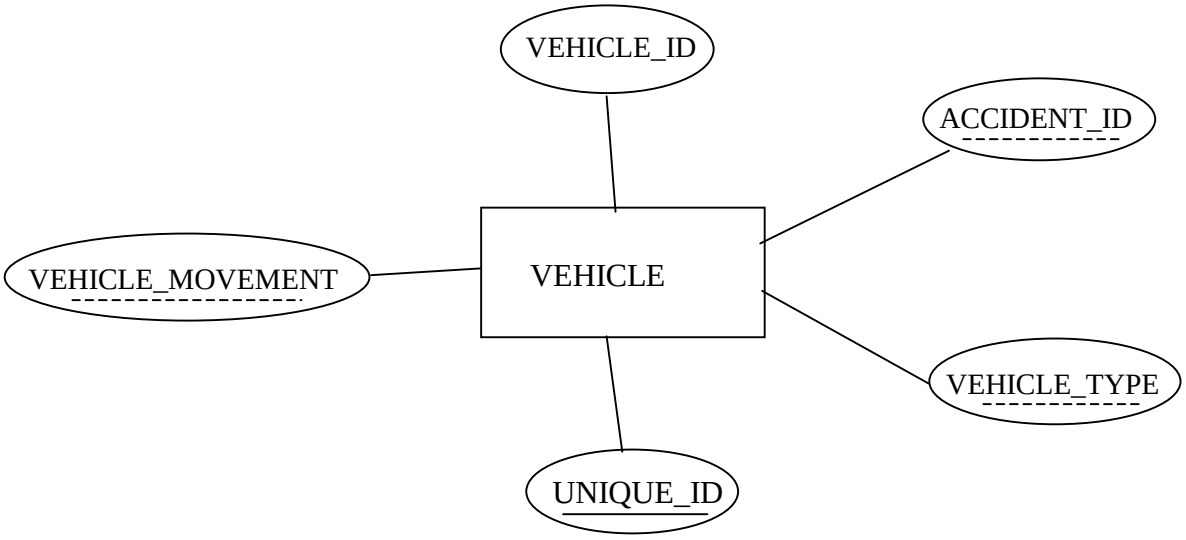


Figure 3.10: Vehicle Entity and its attributes

Table 3.5: Name and descriptions of attributes of Vehicle Entity

Vehicle

Variable	Constraint	Type & Size	Comment
VEHICLE_ID		NUMBER(5)	Number of vehicle in the accident e.g. 1st, 2nd
ACCIDENT_ID	Foreign key	NUMBER(5)	Accident identification number from accident table
VEHICLE_TYPE	Foreign key	NUMBER(1)	Number identifying the type of vehicle
UNIQUE_ID	Primary key	NUMBER(12)	Unique identification number
VEHICLE_MOVEMENT	Foreign key	NUMBER(2)	Number identifying vehicle movement type

The Approach entity is a weak entity type, which means it does not have any primary key of its own. The Approach entity consists of the attributes like MOT identification number as foreign key, which relates Approach with the entity MOT, length of approach zone, MOT devices used in the approach zone, pavement marking type used, type of electronic message board used, location of other traffic control activities and number of advance warning signs. The entity diagram for Approach is shown in Figure 3.11. The names, constraints, data types and description of the attributes of the Approach entity are shown in Table 3.6.

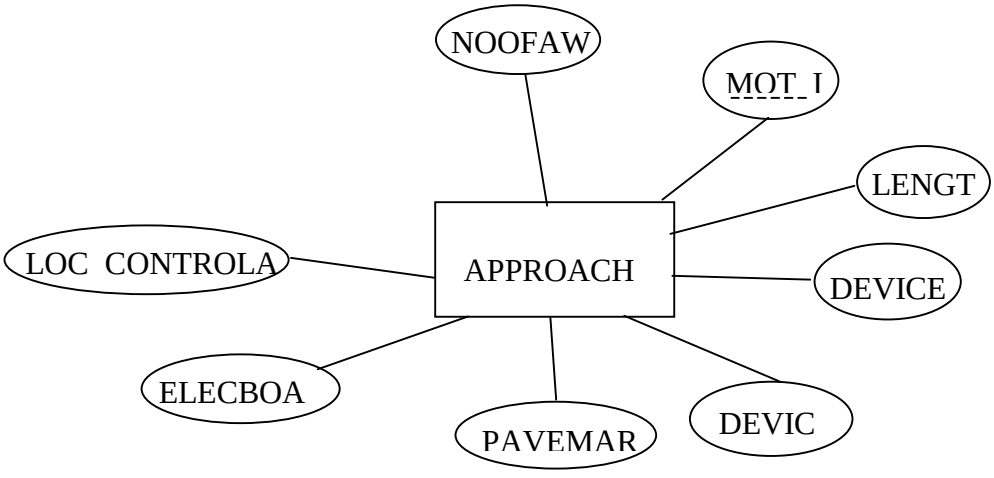


Figure 3.11: Approach Entity and its attributes

Table 3.6: Name and descriptions of attributes of Approach Entity

Approach

Variable	Constraint	Type & Size	Comment
MOT_ID	Foreign key	NUMBER(6)	Refers to MOT_ID from table MOT
LENGTH		NUMBER(4)	Length of Approach zone
DEVICE1		VARCHAR2(10)	MOT device used - number 1
DEVICE2		VARCHAR2(10)	MOT device used - number 2
PAVEMARK		VARCHAR2(5)	Type of pavement marking used
ELECBOARD		VARCHAR2(17)	Type of electronic board in use
LOC_CONTROLACT		VARCHAR2(15)	Location of other traffic control activities
NOOFAWS		NUMBER(3)	Number of Advance Warning Signs

The entities Transition, Buffer, Work Zone and Termination are described in Appendix C. The entity Harmful Event data stores the details of harmful events in the crash. The program uses a number of look-up tables like Type of lane, Type of harmful events, Type of project etc. These look-up tables are linked to the main entity like accident or project to enforce the referential integrity and display the options through a pull down menu on the computer screen. The look-up tables are also described in Appendix C.

4. System Description and User Manual

This chapter is designed to highlight the features and capabilities of the Workzone/MOT Report System. It also serves as a user manual to help the first time user navigate the system. Previously, data was collected using a paper form; with the new system, it will now be stored electronically and thus give a powerful tool to extract and examine the important information. The new system will collect the information on Projects, MOT's, and Crashes through data-entry on web-based forms, and allow the user to generate a variety of summary, detail, and custom reports.

The goal of the project is to have a central server running the database at the State Construction Office. With the capability of Oracle ported through the Internet, the project engineer could access the central database from anywhere in the state, as long as they have access to Internet. The MOT reports and accident information could be submitted to the State Construction Office on the day of the incident. By monitoring the projects, the project engineer has the opportunity to redesign individual work zones to improve MOT.

4.1. Accessing the System

During the database development and pilot study phases, the database resided on a server at the FAMU-FSU College of Engineering. Users accessed the system through a remote terminal/computer via World Wide Web. The web address "http://safety.eng.fsu.edu" leads the user to the systems web page[2]. This address would change based on the final installation location of the system. At present, the first page provides a link to the Workzone/MOT Report System, along with a general description of the system, as shown in Figure 4.1. By clicking on the link the user is taken to the password entry page.

[2] The necessary files for installing the MOT crash database are provided on the CD-ROM attached to this report. Installation instructions are provided in the README.TXT file.

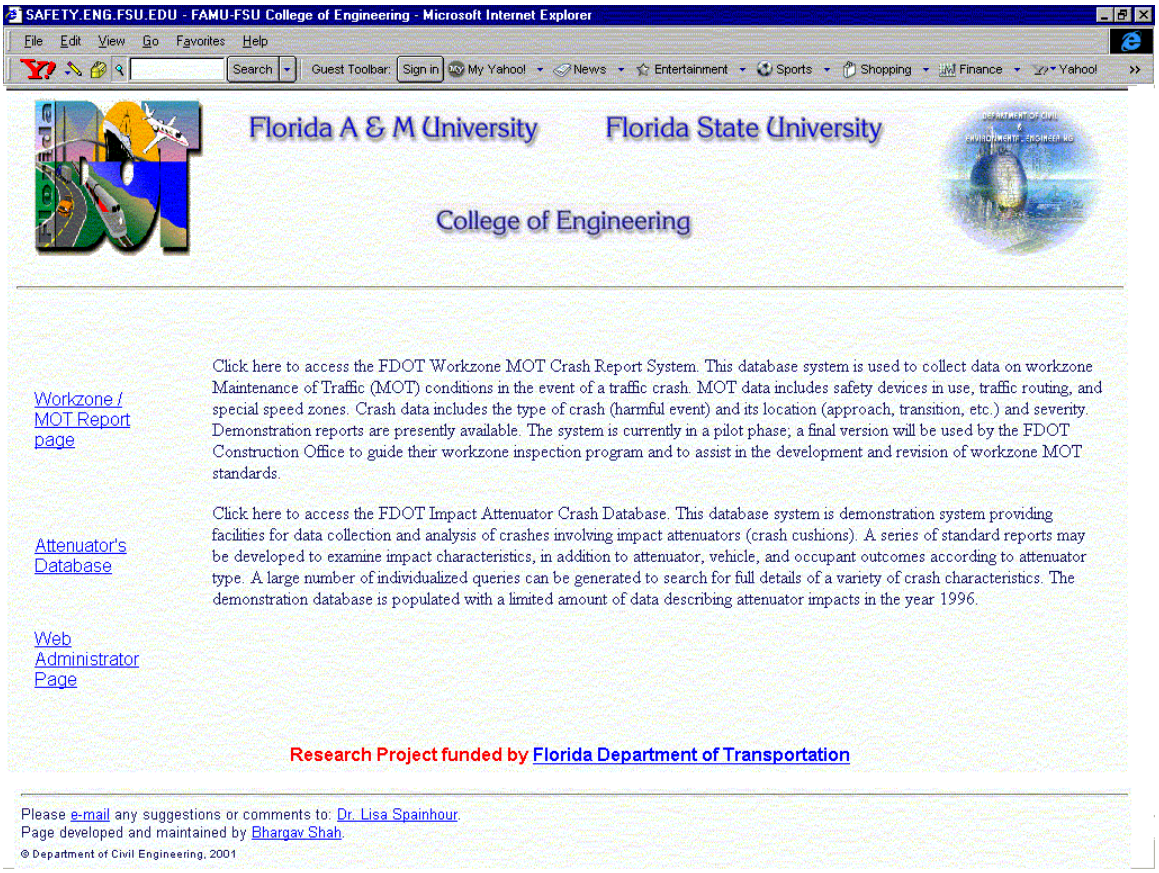


Figure 4.1: Web page for Workzone/MOT System

By entering the authorized password and clicking on 'Enter' the user is permitted to enter the system. Presently, the password is the word "Construction." Figure 4.2 shows the password entry page.

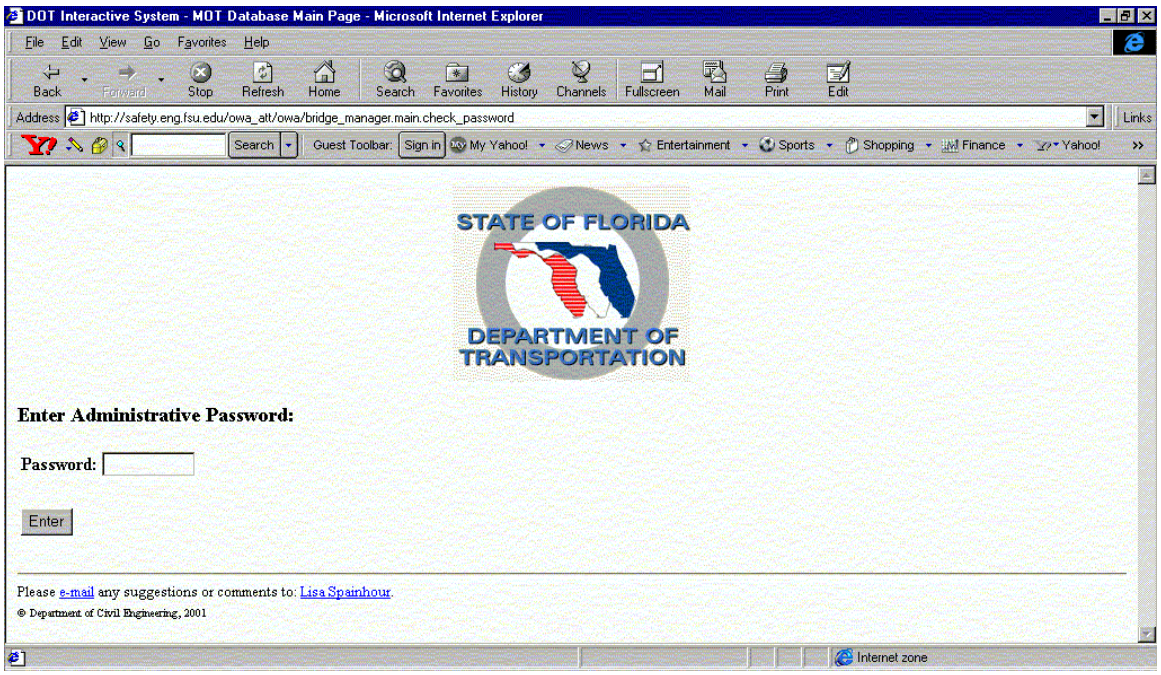


Figure 4.2: Password Entry for Workzone/MOT System

If the user enters a wrong password and clicks 'Enter', the user will be logged off the system. The user has to go through the whole process again. This is done to discourage unauthorized users from accessing the system.

Once the user enters the correct password, the user is taken to the first page of the system, which shows the various options. From this page, the user can choose the option by clicking on the image. The user can choose from the following:

- Enter Data: This will allow the user to enter data for New Project/MOT/Crash Report.
- View Demo Reports: This will allow the user to view Summary/Detailed reports based on the existing data in the database.
- Provide Feedback: This will allow the user to provide feedback on the system.

Figure 4.3 shows the page with options of entering data, viewing demo reports based on existing data and providing feedback.

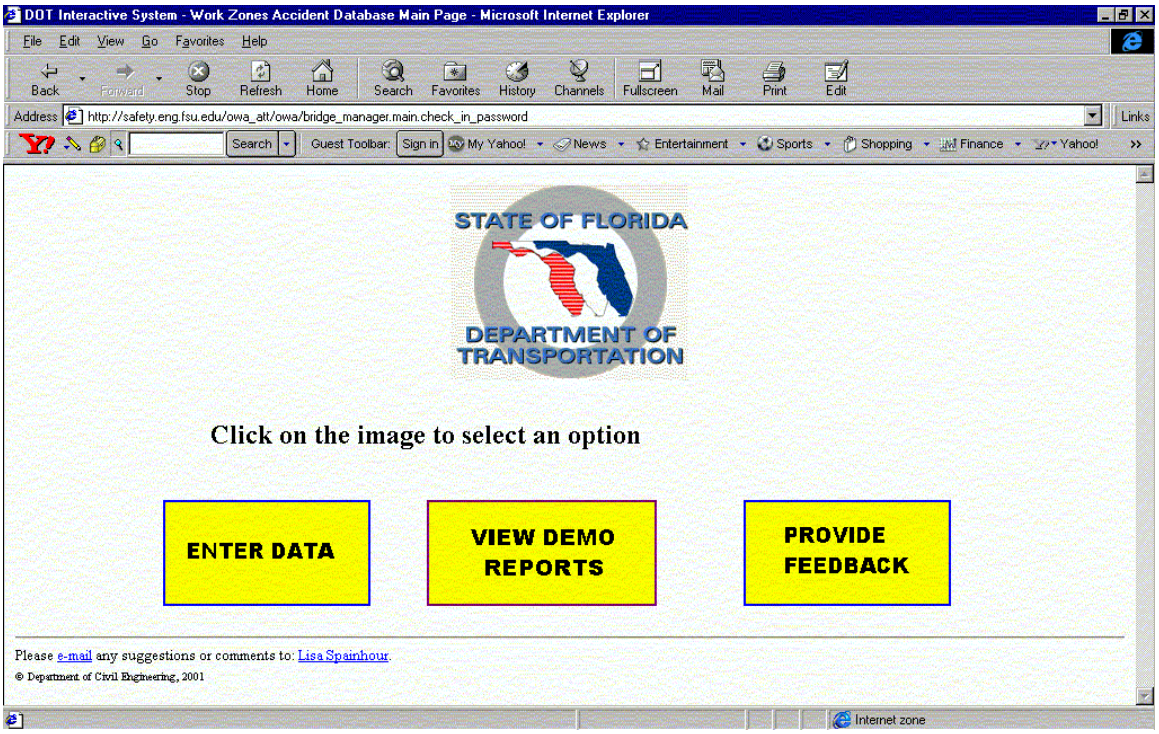


Figure 4.3: Options for Workzone/MOT System

4.2. Entering Project, MOT, and Crash Data

Once the user clicks on the 'Enter Data' image, the user is asked to enter the project contract number. Figure 4.4 shows the contract number entry page. The user may access the Help file by clicking on the 'Help' image, if using the system first time. The user should also read the specific guidelines for data entry at the bottom marked with asterisk (**).

On entering the project contract number, the system checks for the specified number in its database. If the number exists in the database, the system pulls up the information related to the project and displays it.

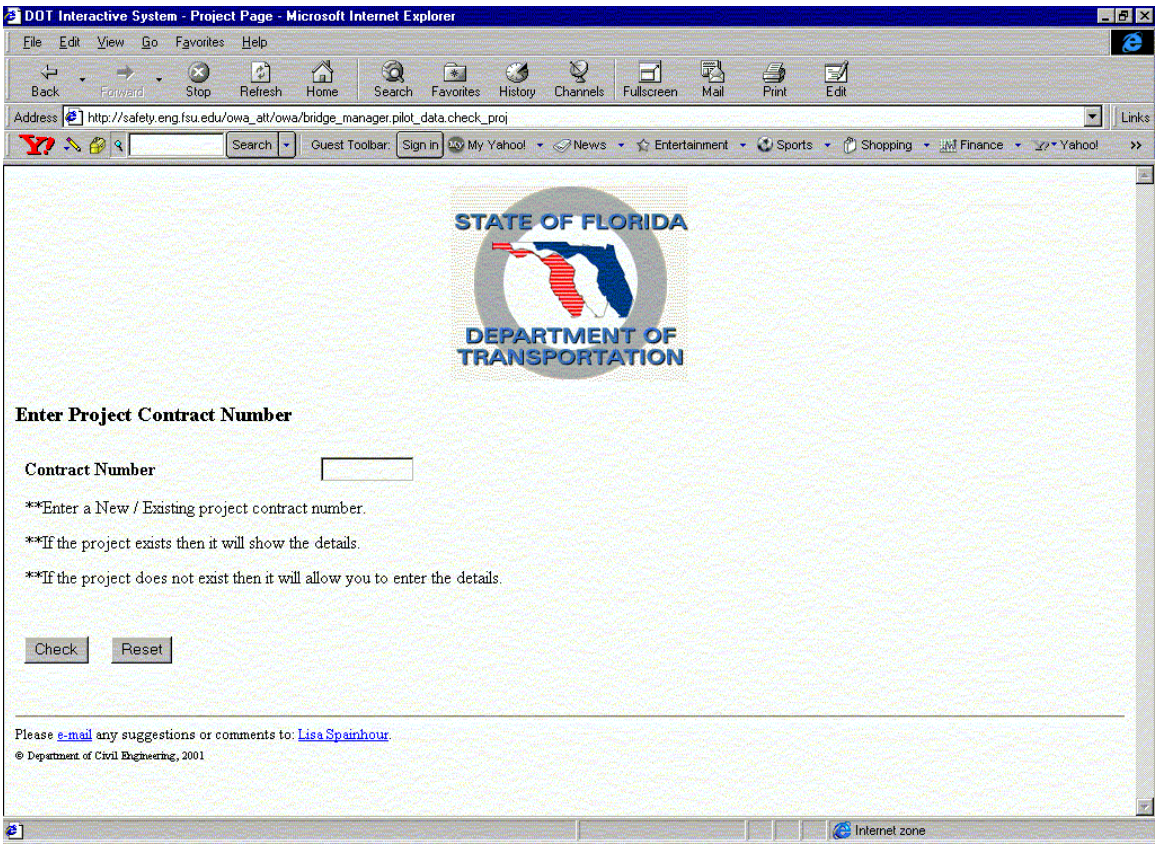


Figure 4.4: Project Contract Number Entry

If the project contract number doesn't exist in the database, the system pulls up a blank data entry form to enable the user to complete the information related to the project, which includes Contract Number, State Road Number, District Name, County Name, FIN Project Number, Federal Project Number, Type of Project, Road Type, and Geographical Location. The Contract Number is already filled out from previous screen. Figure 4.5 shows the project entry page. The names, data types and descriptions of the Project data entry are shown in Table 4.1.

Table 4.1: Name and Descriptions of Items for Project Data Entry

Project

Variable	Comment
CONTRACT NUMBER	Contract number of the project, numeric value.
PROJECT FIN NUMBER	Project finance number, numeric value.
STATE ROAD NUMBER	State road number of the project, alphanumeric value.
FEDERAL PROJECT NUMBER	Federal project number, alphanumeric value.
DISTRICT	District number of the project, alphanumeric value.
COUNTY	County name of the project, alphanumeric value.
TYPE OF PROJECT	Select any one from the drop-down list.
ROADWAY UNDER CONSTRUCTION	Select any one from the drop-down list.
GEOGRAPHICAL LOCATION	Select any one from the drop-down list.

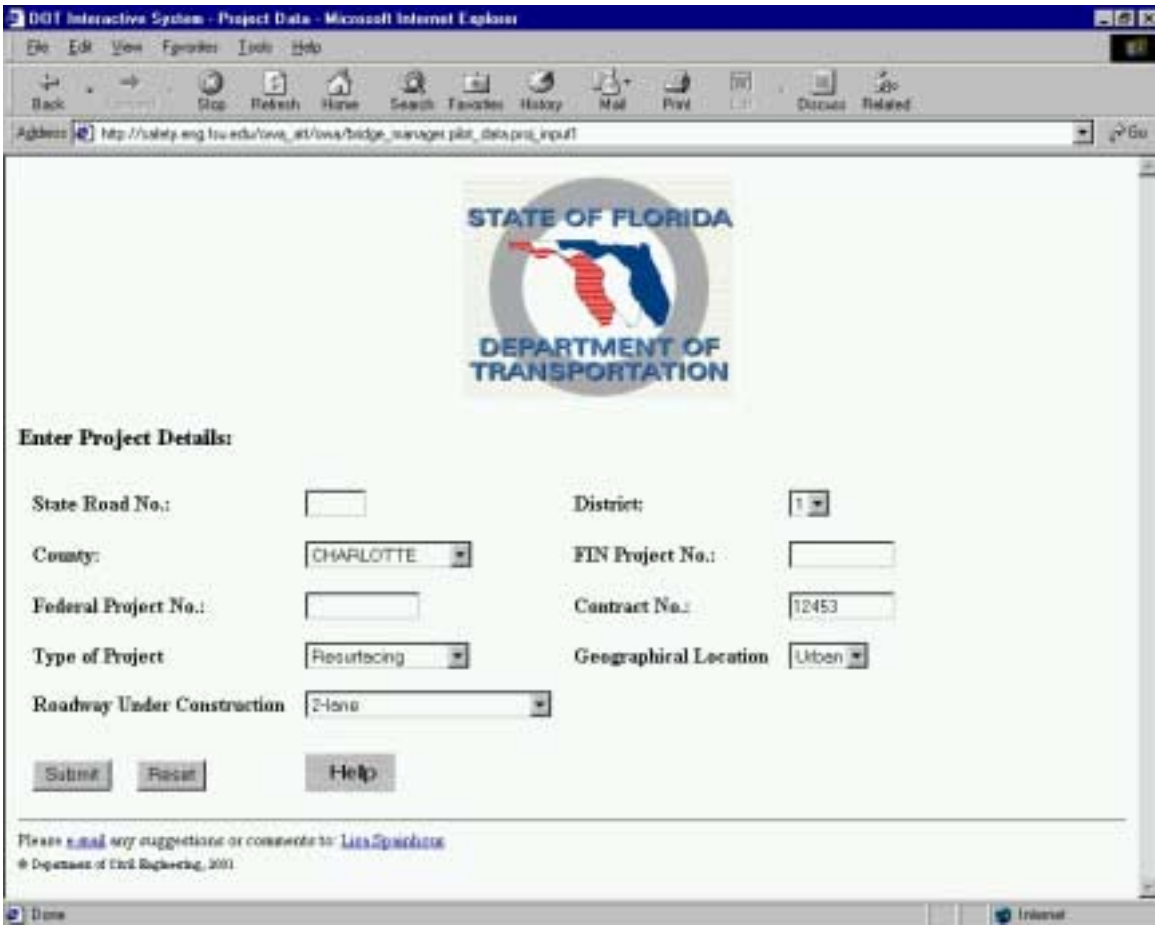


Figure 4.5: Project Data Entry

To clear the information on the project form, the user can click on ‘Reset’ button. Clicking the ‘Reset’ button just clears the new information entered on the form; it will not remove the information of existing project in the database. After filling out all the information correctly on the project form, the user can click the ‘Submit’ button to enter the information in the database and proceed to the next stage. If the contract number exists in the database, the user is presented with the project related information and a ‘Proceed’ button. User has to click onto ‘Proceed’ button to advance to the next stage.

The next screen will vary depending on whether any MOT information exists in the database. If so, the user is presented with an option to either Review/Change the existing MOT information or enter the related crash data, as shown in Figure 4.6.

If the project does not exist in database, the user is presented with an option to either Enter new MOT data or Exit the system. If the user elects to enter the MOT data, the user is presented with all 46 standard MOT configurations from the MUTCD. After the user selects the applicable MOT configuration, the MOT data form comes up.

Figure 4.6: MOT Review/Crash Data Entry Option

The new MOT form asks for information on the Approach, Transition, Buffer, Work and Termination zones. The information asked is regarding MOT devices used, Pavement markings, Electronic Board usage and Location of other traffic control activities for all five zones. The form also asks information regarding the Number of advance warning signs (post mounted), approximate spacing of MOT devices, Number of open lanes and width of open lanes. The form also allows the user to recommend changes to the MOT. The form asks for name of person completing/reviewing the report and date the report is completed/reviewed. Figure 4.7 shows the new MOT data entry page with all of the aforementioned options.

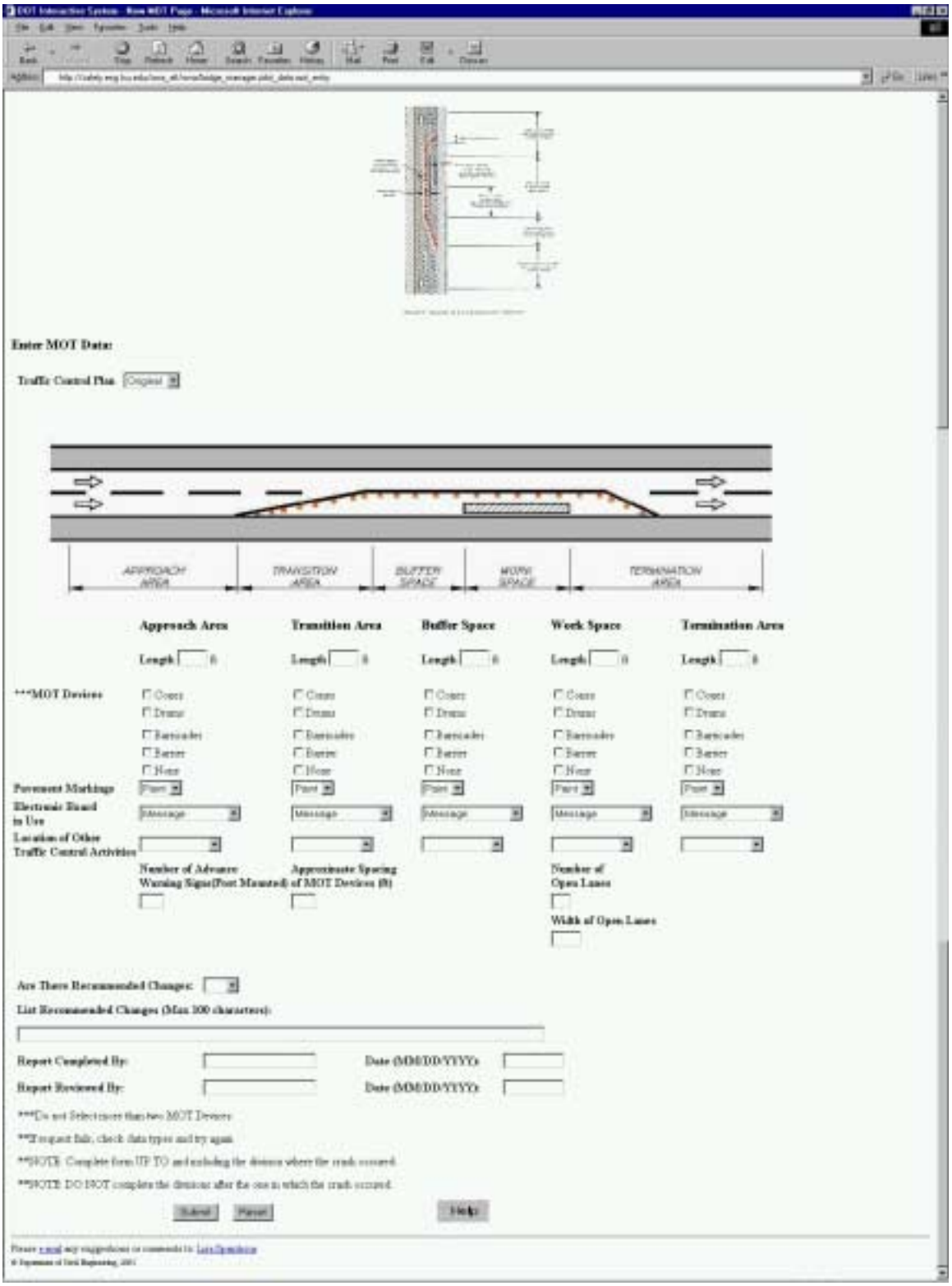


Figure 4.7: New MOT Data Entry Page

After filling out all of the details the user can click on the ‘Submit’ button to proceed further. On clicking the ‘Submit’ button, the user is given the option to either Enter Crash Data related to the MOT or Exit the system.

Choosing the option ‘Enter Crash Data’ and clicking the ‘Enter’ button will take the user to the New Crash Report form. The form will allow the user to enter information related to the crash, such as crash report date, crash date, crash time, police report number, type of lane closure in effect, construction ongoing at time to crash, type of pavement, condition of pavement, visibility/time of day, construction zone speed limit, routing where crash occurred, crash location and additional crash relevant information as shown in Figure 4.8. The names, data types and descriptions of the Crash data entry are shown in Table 4.2.

Table 4.2: Name and Descriptions for Crash Data Entry

Accident

Variable	Comment
CRASH DATE	Date of accident - Select from pull down menus.
CRASH TIME	Time of accident (Hour-Minute) - AlphaNumeric Entry.
REPORT DATE	Date of report of crash - Select from pull down menus.
POLICE REPORT NUMBER	Police report number - Numeric Entry.
CONSTRUCTION ONGOING AT TIME OF CRASH	whether construction was ongoing at the time of crash.
LANE CLOSURE	Type of lane in the project details - Select from pull down menu.
NUMBER OF VEHICLES IN CRASH	Number of vehicles involved in the crash - Numeric Entry.
PAVEMENT TYPE	Type of pavement where crash occurred - Select from pull down menu.
PAVEMENT CONDITION	Pavement condition where crash occurred - Select from pull down menu.
VISIBILITY/TIME OF DAY	Visibility type where crash occurred e.g. Clear or limited
CONSTRUCTION ZONE SPEED LIMIT	Posted speed in the construction area
ROUTING WHERE CRASH OCCURED	whether routing was provided at site e.g. Detour, New Pavement, Existing Pavement, etc.

CRASH LOCATION	Zone where crash occurred e.g. Approach, Transition, etc.
ADDITIONAL RELEVANT INFORMATION	For additional information related to crash - limit up to 500 characters.

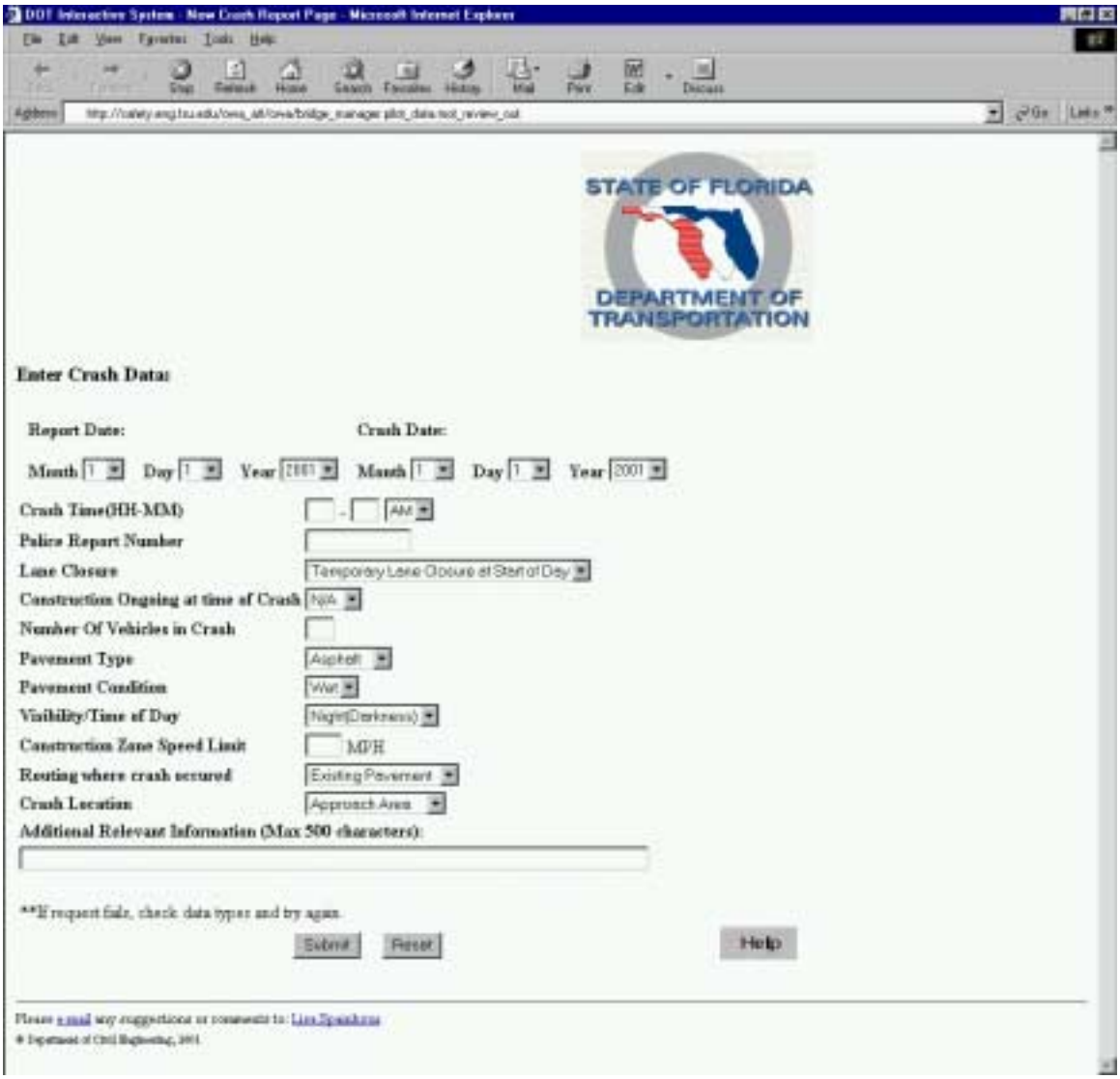


Figure 4.8: New Crash Data Entry Page

After filling out the information, the user has to click on the 'Submit' button to add the data to the database. On clicking the 'Submit' button, the software loads another screen to allow the user to fill out information regarding the vehicles involved in the crash and their movement, as shown in Figure 4.9. Depending on the number of vehicles involved in crash,

as specified on the crash report page, this page allows the user to enter information related to those vehicles. The user has to select the type of vehicle and the movement vehicle was making while getting into the crash.

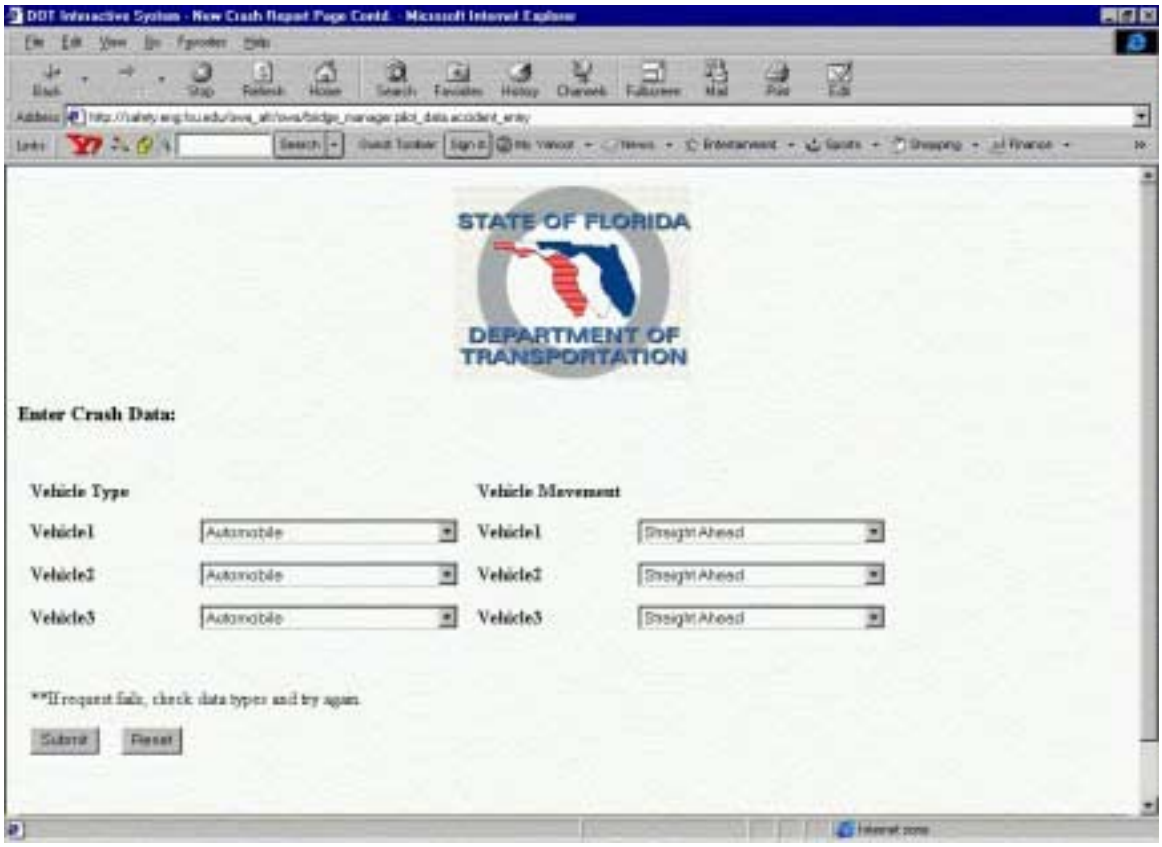


Figure 4.9: Vehicle Data Entry Page

After filling out the information, the user has to click on the 'Submit' button to add the data to the database. On clicking the 'Submit' button, the software loads another screen to allow the user to fill out information for another crash or exit the system.

4.3. Viewing Demo Reports

Once the user clicks on the 'View Demo Reports' image, the system loads a form asking the user to select the type of report or return to the main menu, as shown in Figure 4.10.

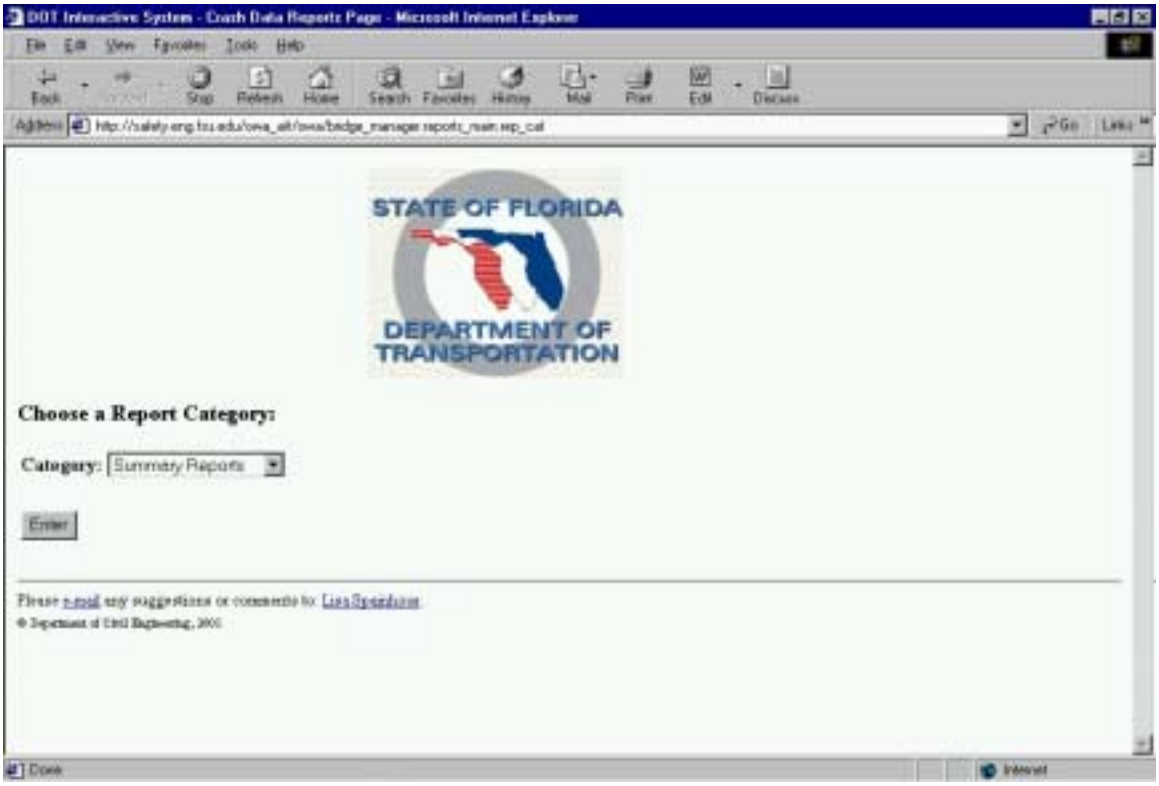


Figure 4.10: View Demo Reports Option Page

4.3.1. Viewing Summary Reports

On selecting Summary Reports from the pull-down menu, clicking 'Submit' will take user to the form with various summary reports that the user can view, as shown in Figure 4.11. The summary report offers the following options:

1. Number of Crashes Per Project
2. Crashes Vs. Police Presence
3. Crashes Vs. Approach Zone Lengths
4. Crashes Vs. Transition Zone Lengths
5. Number of Crashes Per District
6. Number of Crashes Per County
7. Summary of Crash Report Numbers
8. Return to options menu

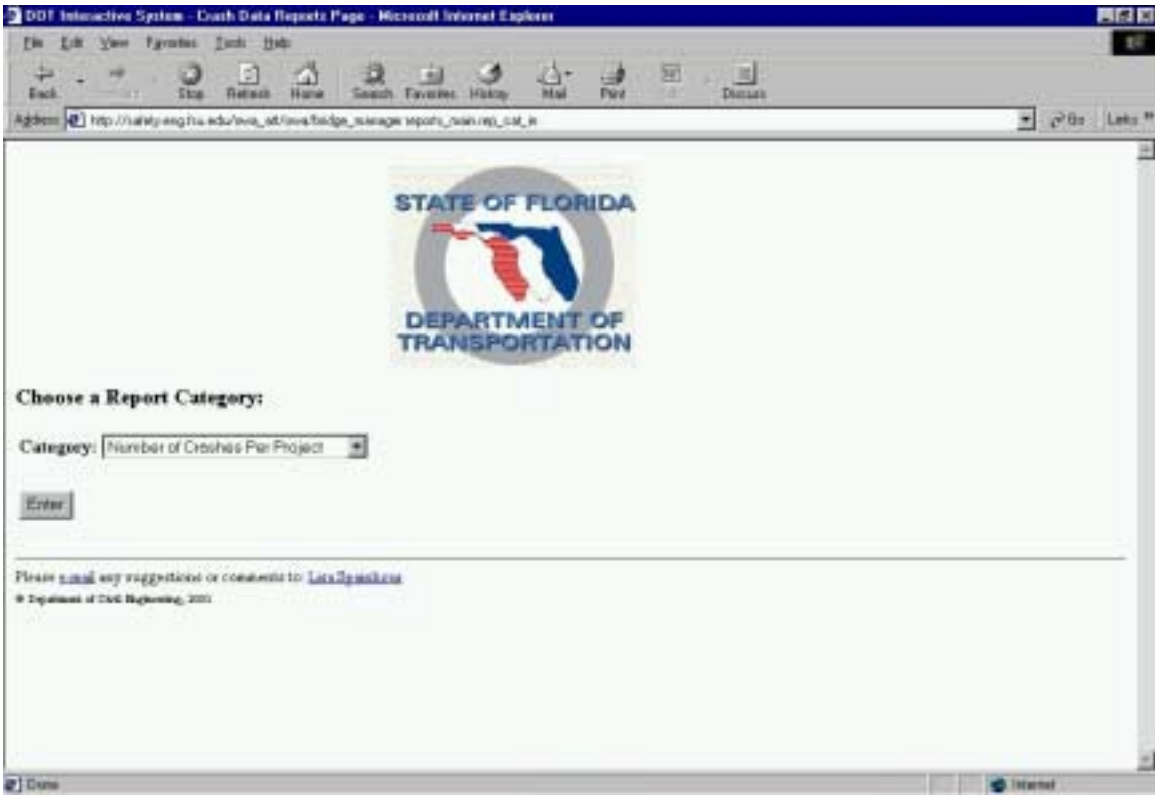


Figure 4.11: Summary Reports Option Page

For example, if the user selects the ‘Number of Crashes Per Project’ Option and clicks on ‘Enter‘ button as shown in Figure 4.12, the program shows the user the data as shown in Figure 4.13. The program displays all the project numbers in the database along with the total number of crashes reported to date on those projects.

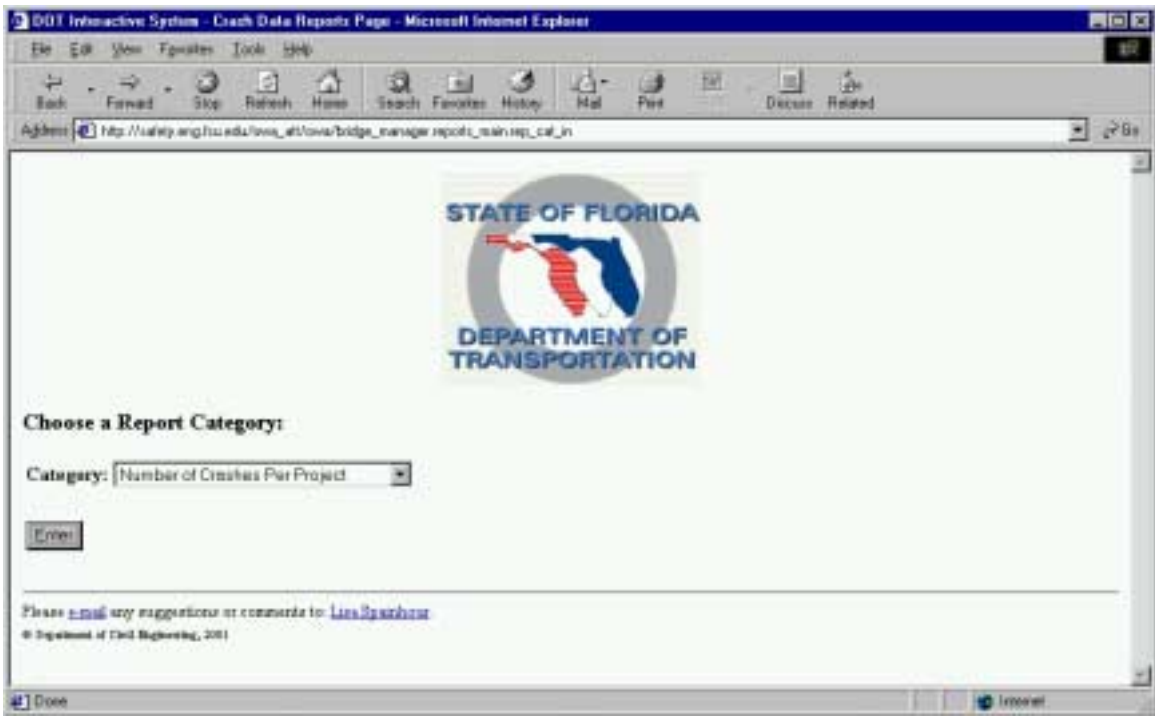


Figure 4.12: Number of Crashes Per Project Option from Summary Reports

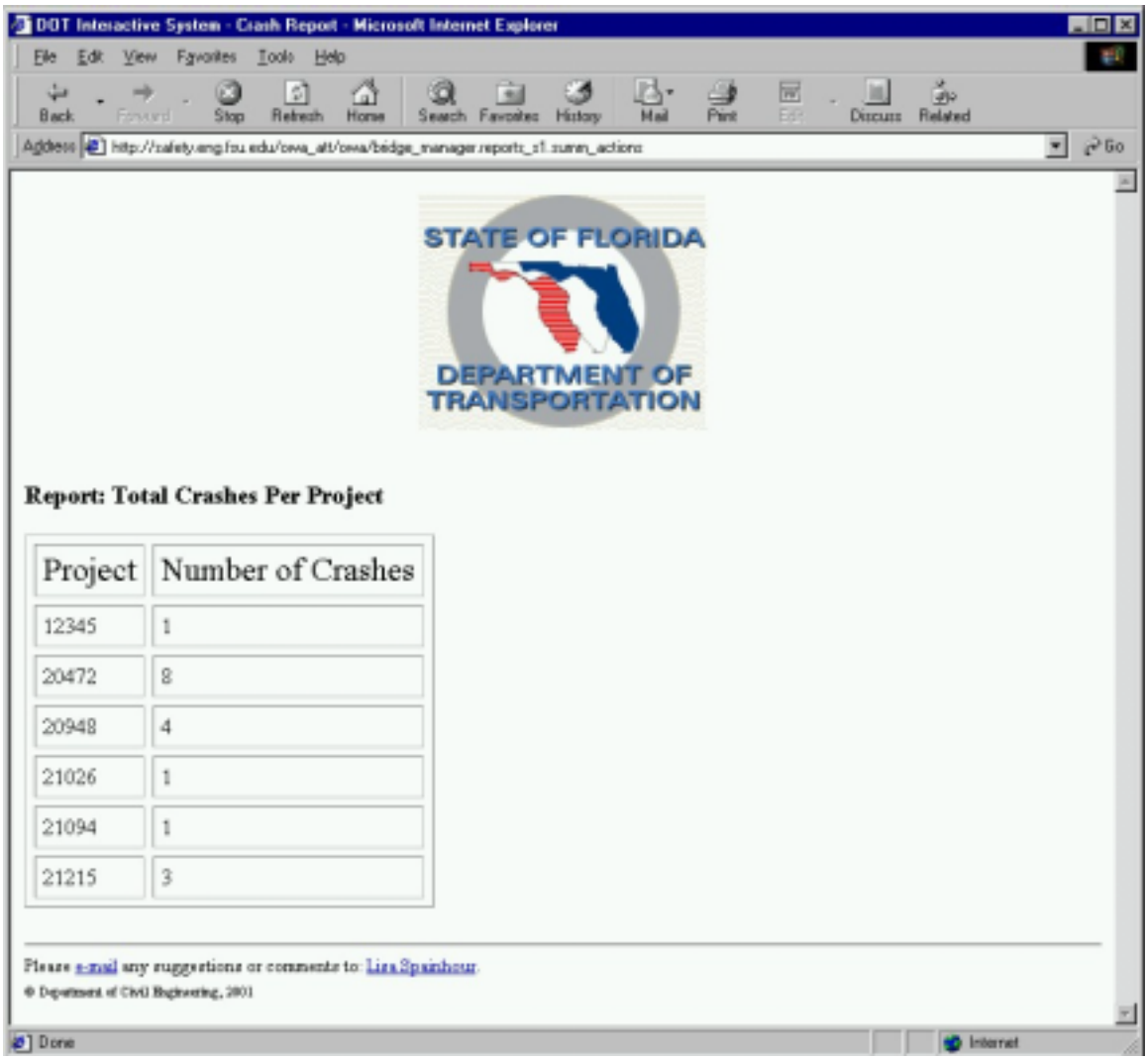


Figure 4.13: Summary Report of Crashes Per Project

On selecting ‘Return to options menu’ the user will be taken to the screen to select between ‘Summary Reports,’ ‘Detail Reports,’ ‘ Custom Reports,’ or ‘Return to main menu.’ On selecting ‘Return to main menu’ and clicking ‘Enter,’ the user will be taken to the screen to select either ‘Enter Data,’ ‘View Demo Reports,’ or ‘Provide Feedback.’

4.3.2. Generating Detail Reports

On selecting Detail Reports from the pull-down menu, clicking ‘Submit’ will take the user to the form listing the detail reports that the user can view, as shown in Figure 4.14. The detail report offers the following options:

1. Detail Crash Report
2. Detail Project Report
3. Return to options menu

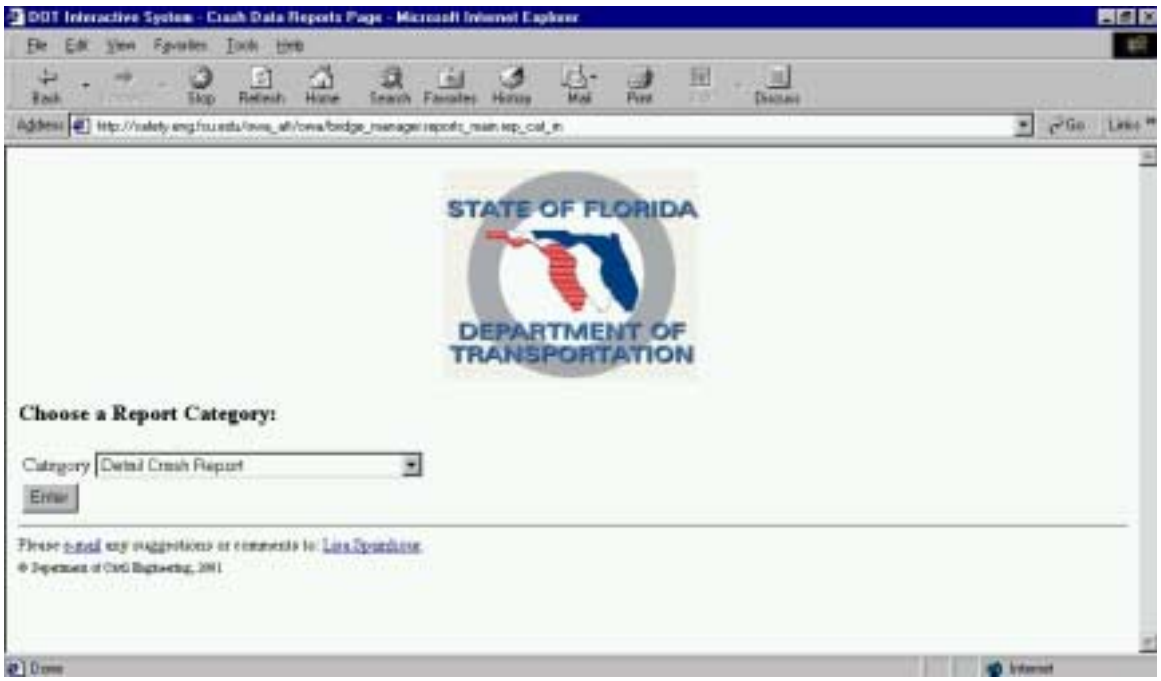


Figure 4.14: Detail Reports Option Page

For example, if the user selects the ‘Detail Crash Report’ Option and clicks the ‘Enter‘ button, the program asks the user to enter a valid Police report number for which the user is interested in viewing the data, as shown in Figure 4.15. (A list of valid crash report numbers is available as a summary report.) On entering the police report number and clicking the ‘Get Report’ button, the program checks in the database for the given police report number and retrieves all of the information related to that particular crash.

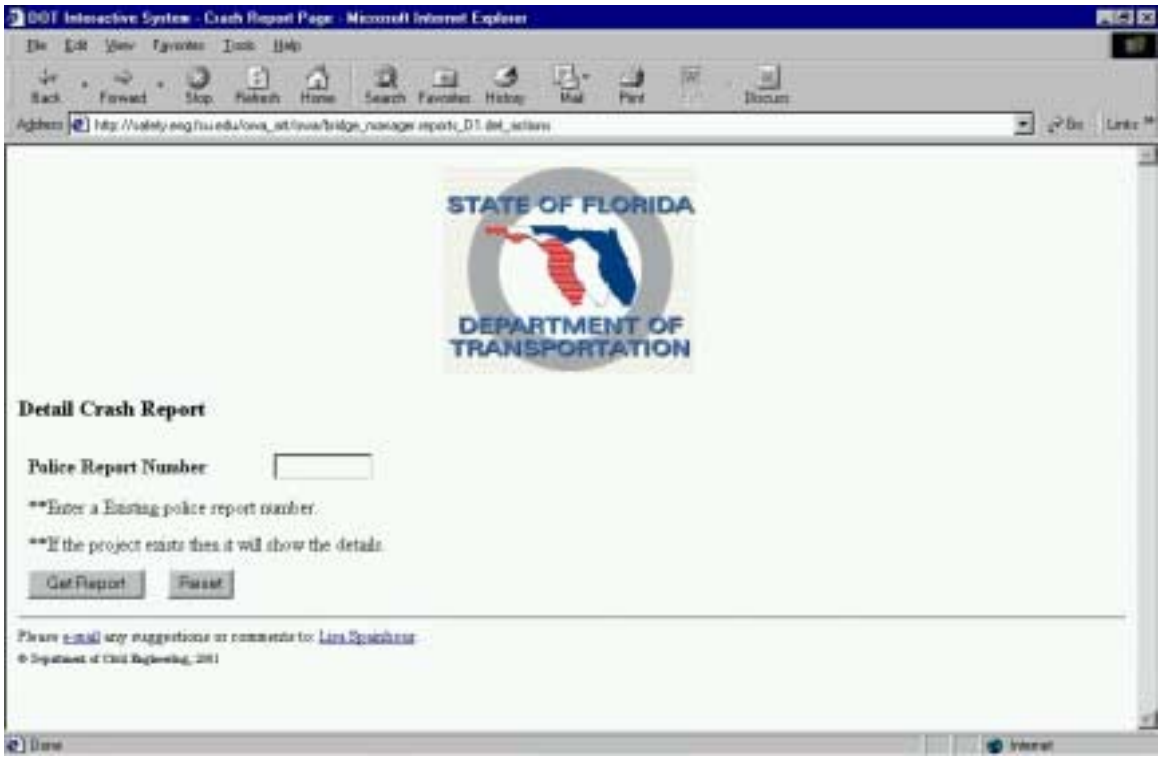


Figure 4.15: Detail Crash Report Page

Figure 4.16 is an example of the type of data that the program will display on requesting a particular detail crash report. The program displays information regarding the project, the details of MOT zone (particular zone in which crash occurred), crash details and details of vehicle(s) involved in crash.

On selecting ‘Return to options menu’ the user will be taken to the screen to select between the ‘Summary Reports’ or ‘Detail Reports’ or ‘Custom Reports’ or ‘Return to main menu’.

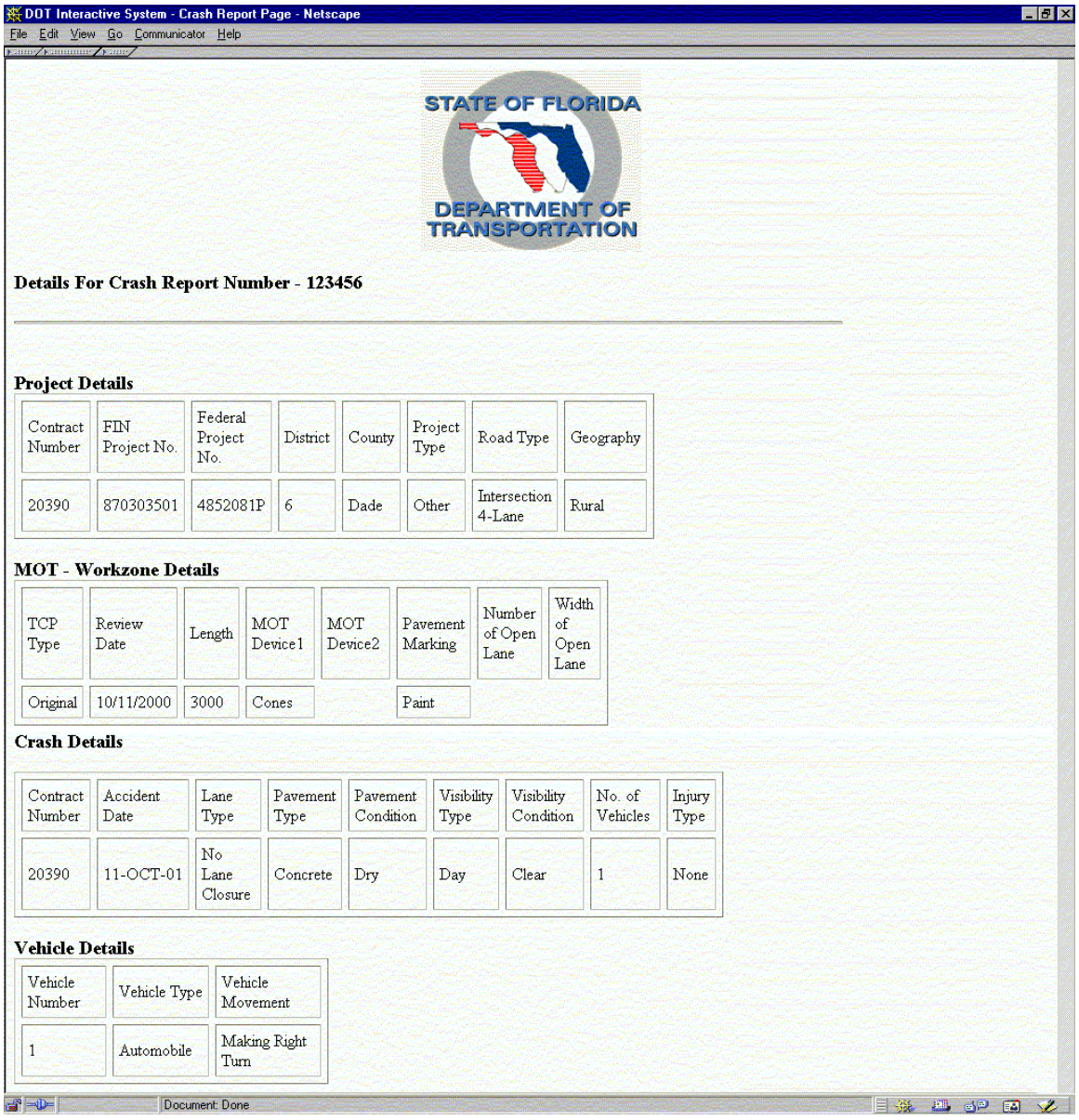


Figure 4.16: Detail Crash Report

4.3.3. Viewing Custom Reports

Selecting Custom Reports from the pull-down menu and clicking 'Submit' will take the user to the form listing the available custom reports, as shown in Figure 4.17. The custom report offers the option to see reports on particular MOT characteristics for all crashes associated with a particular project, or to see information on all projects and crashes in the database. A specific project is selected by checking the checkbox and selecting a

specific project number, or one can view all projects by keeping the checkbox empty. The user can select from the following crash characteristic:

1. No Lane Closure Vs. 24 Hour Lane Closure
2. Night (Darkness) Vs. Day
3. Concrete Vs. Asphalt Pavement
4. Wet Vs. Dry Pavement
5. Ongoing Vs. No Construction

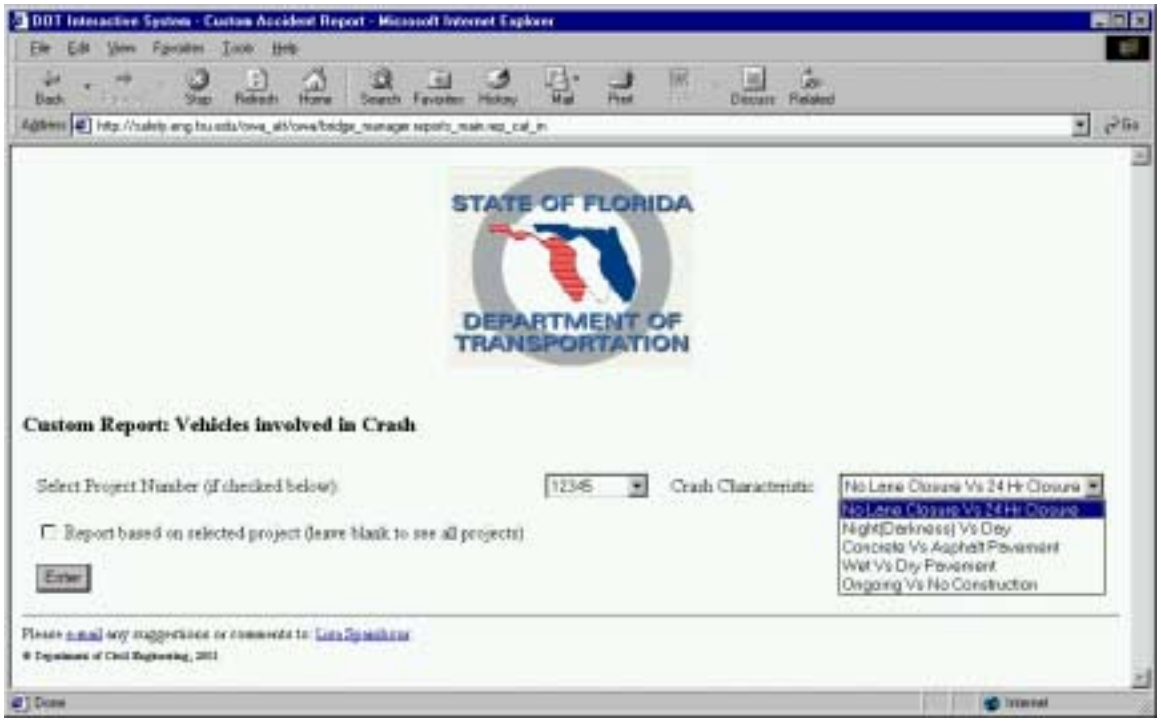


Figure 4.17: Custom Crash Report Page

For example, assume the user wants to see how many crashes occurred on projects with and without lane closures. The user selects the crash characteristic as ‘No Lane Closure Vs. 24 Hr. Closure’, keeps the checkbox empty and clicks on the ‘submit’ button. The program searches through the database and computes the total number of crashes occurred when there was no lane closure, temporary lane closure, and 24-hour lane closure. The program than displays this information on screen as shown in Figure 4.18.

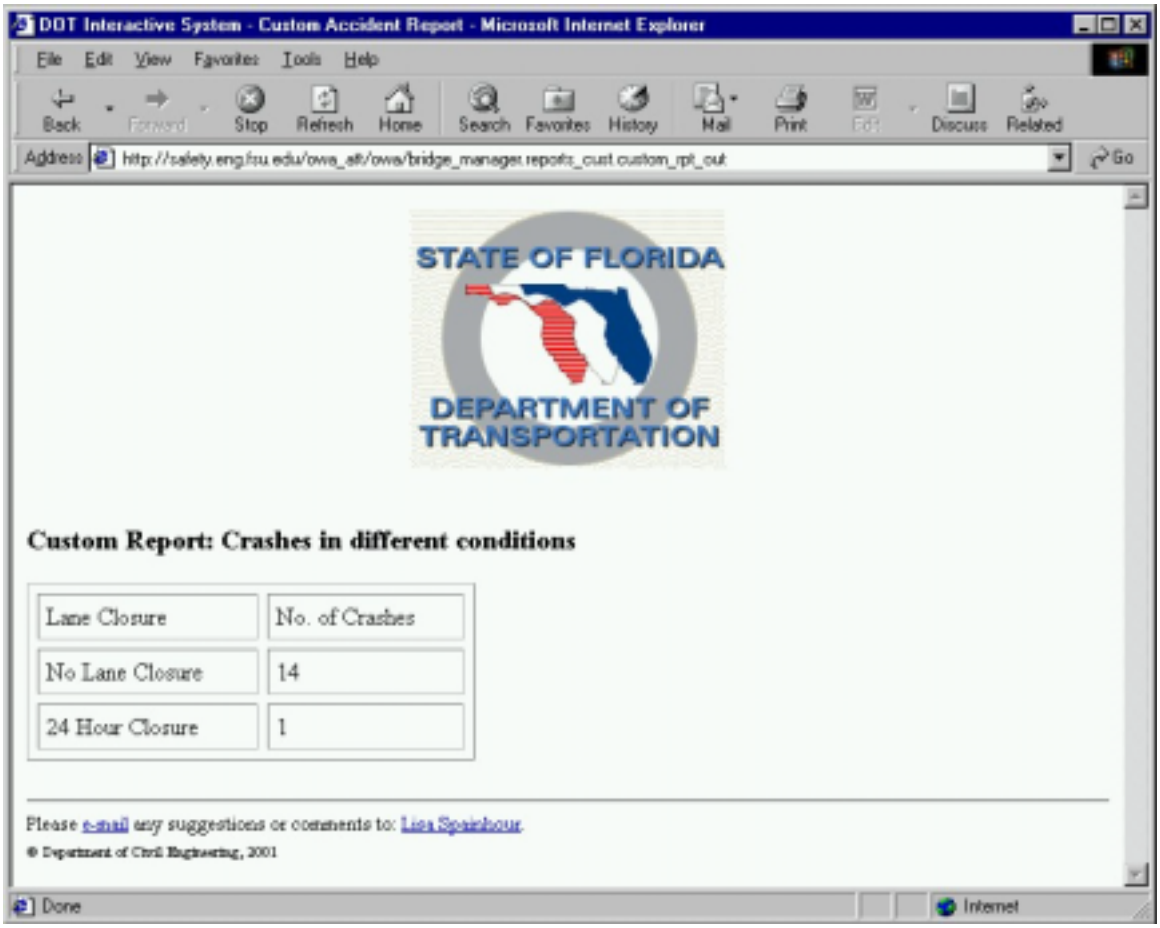


Figure 4.18: No Lane Closure Vs. 24 Hour Lane Closure Report

4.4. Provide Feedback Option

Once the user clicks on the ‘Provide Feedback’ image, the system loads the feedback form, as shown in Figure 4.19. The form allows the user to specify brief details of the problems he or she encountered while using the program. It also asks for the user’s contact information to provide him with solutions/update of the program. On clicking the ‘Submit’ button, the details of the form are submitted into the database and the person maintaining the system can respond back to the user after reviewing the details.

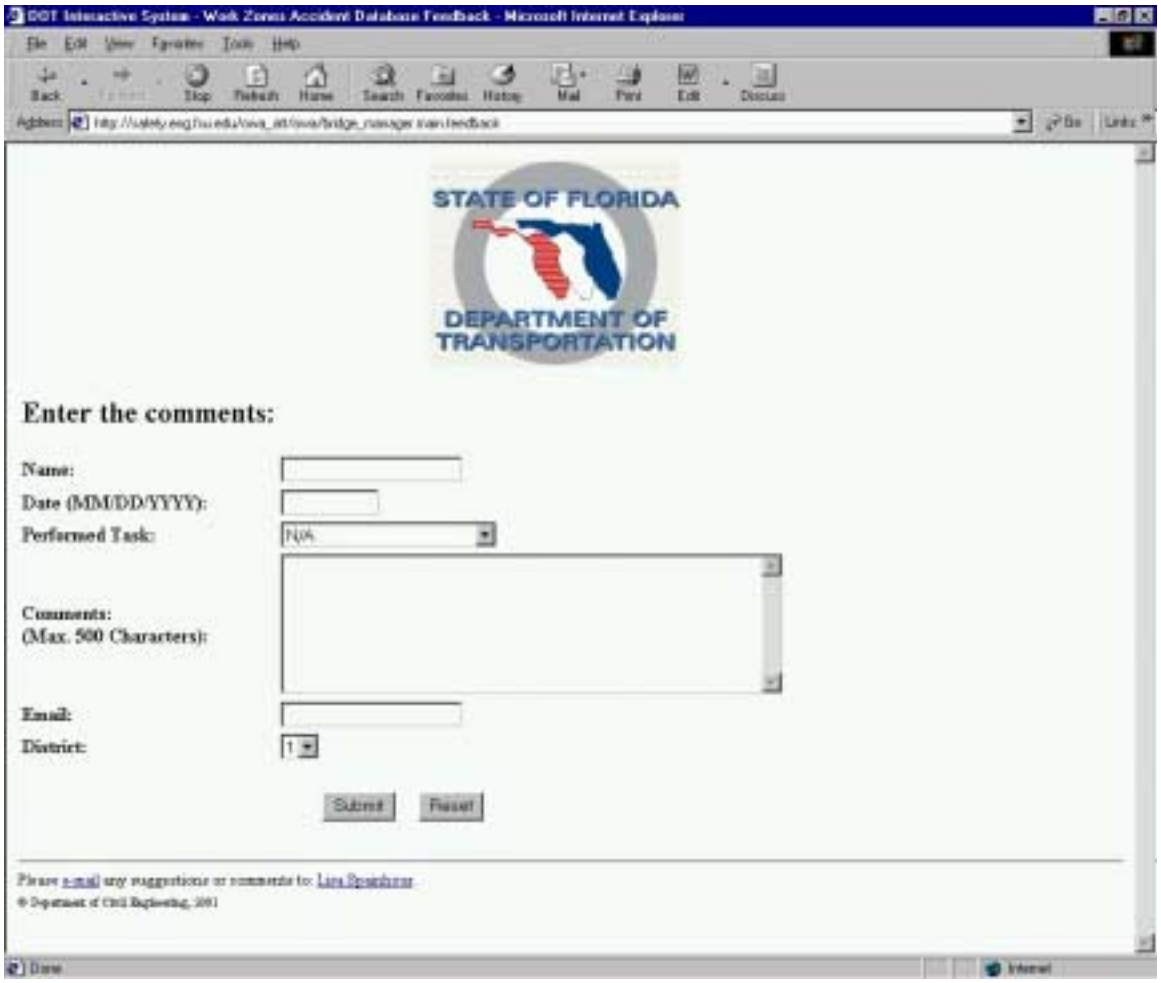


Figure 4.19: Provide Feedback Page

5. Conclusions Based on Pilot Study and Present Status

This study helped to develop a new MOT crash report form for the Florida Department of Transportation. Use of this form will help the FDOT to establish the cause and effect relationship to the extent possible in the case of crashes in the work zone. Previously, data was collected using a paper form; with the new system, it will now be stored electronically and thus give a powerful tool to extract and examine the important information. The study demonstrated the ways the stored information could be utilized to generate effective reports, which will help to improve the temporary traffic control planning. The new system will collect the information on Project, MOT, and Crash through data-entry on the web-based MOT review form developed after review of FDOT and other states MOT forms.

With the idea of having a central database at the State Construction Office, Oracle was the obvious choice for software development. With the capability of Oracle ported through Internet, the project engineer can access the central database from anywhere as long as they have access to Internet. The MOT reports and accident information can be submitted to the State Construction Office on the day of the incident. By monitoring the projects, the project engineer has the opportunity to redesign individual work zones to improve MOT.

The newly developed system will help all of the people linked with the construction and maintenance of temporary traffic control zone. For example, the construction engineer can identify and eliminate problem areas in individual work zones, and better utilize the work zone inspection program by monitoring the reports generated. The roadway designer, who is responsible for developing the traffic control plan to ensure maintenance of traffic flow during the construction phase, can identify crash trends and make the necessary changes in the MOT standard plans.

5.1. Limitations Of Present Study

This section discusses some limitations of the system as developed. The present computer system reflects the MOT for a construction project involving lane closure on a roadway with two-lanes in same direction. This approach is typical of MOT forms used in other states, e.g. the state of Maryland (see Appendix A). However, the data collected by the

system is not well suited to more complex geometries, including intersections, ramps, and changes in geometry. To be more useful and flexible, the system could grow more complex and require more data to be collected for different types of roadways. For instance, MOT for a roadway closed with diversion provided or roads closed with off-site detour will require a different set of information than the current information.

The database, as presently structured, can show correlations between MOT factors and the occurrence of traffic crashes, but relies on the users' knowledge of typical practice to determine whether an event is over or under represented. For instance, the hypothetical case in Figure 5.1 shows the number of crashes that occur when the police are present versus the number that occur when they are not. If, as with this hypothetical project (or district or MOT plan) 70% of the crashes occurred when a police vehicle was present and 30% occurred when the police were not present, one might conclude that police presence actually had a negative effect on work zone safety. However, one would need to know how frequently the police were actually present at the project (or in that district or for that MOT plan) to know whether police presence had a true negative impact on crash frequency, as shown in Table 5.1.

To address this problem, ideally, the system would require information about exposure length, including the number of days for which each MOT plan was in place. Presently, this shortcoming requires users to be knowledgeable about standard practices in construction zones across the state.

Table 5.1: Summary Report - Total number of crashes with/without police

	Crashes	Days	Crashes/Day	Days	Crashes/Day
Total	100	100	1.00	100	1.00
With Police	70	50	1.4	90	0.77
No Police	30	50	0.6	10	3
	Same number of crashes with police present	Over 2 times as many crashes/day with police present		Over 3.5 times as many crashes/day with no police present	

5.2. Conclusions Based on Pilot Study and Current Project Status

Data from the original MOT forms could not readily be used to test the system due to incompatibilities in format and differences in data items requested. To test the system, a pilot study period was implemented for a six-month period in late 2001. Feedback from the pilot study and from FDOT construction engineers and project managers was used to revise the MOT computer system. User feedback suggested that construction engineers were more comfortable with a system that reflected the original paper form: information on crash severity was removed and the text block to recommend changes to the MOT was added based on their feedback. Another user concern was the time it took to load graphics-intensive screens, such as the screens displaying the MUTCD standard forms. However, most of the user feedback was positive, and even novice computer users found the system easy to navigate and utilize.

A major problem noted by the FDOT Construction Office with both the original paper form and the new computer system is the lack of compliance in completing the forms. In fact, it was thought that the ease of use in completing the on-line form might improve the compliance rate and speed of completing the MOT forms. This did not prove to be the case, as a lack of completed forms hampered efforts to evaluate the system's usefulness and to collect sufficient data to draw preliminary conclusions on various MOT plans. Because of these difficulties, the on-line MOT crash reporting system will not presently be implemented by FDOT. Instead, the system will be maintained as a demonstration project at the FAMU-FSU College of Engineering, while the FDOT further considers methods to improve the rate of completion of MOT reports.[3]

Regardless, the present study did reinforce the fact that effective data collection and analysis system can help to improve the safety in the work zone area for both the worker and the people traversing through the work zone. The implementation of this system would avoid delay in reporting the crashes, loss of reports, establish uniformity in reporting procedures and give more power to utilize the collected information for investigating cause-effect

[3] The necessary files for installing the MOT crash database are provided on the CD-ROM attached to this report. Installation instructions are provided in the README.TXT file.

relationships. Efforts should be made to continue populating the database developed in this study.

References

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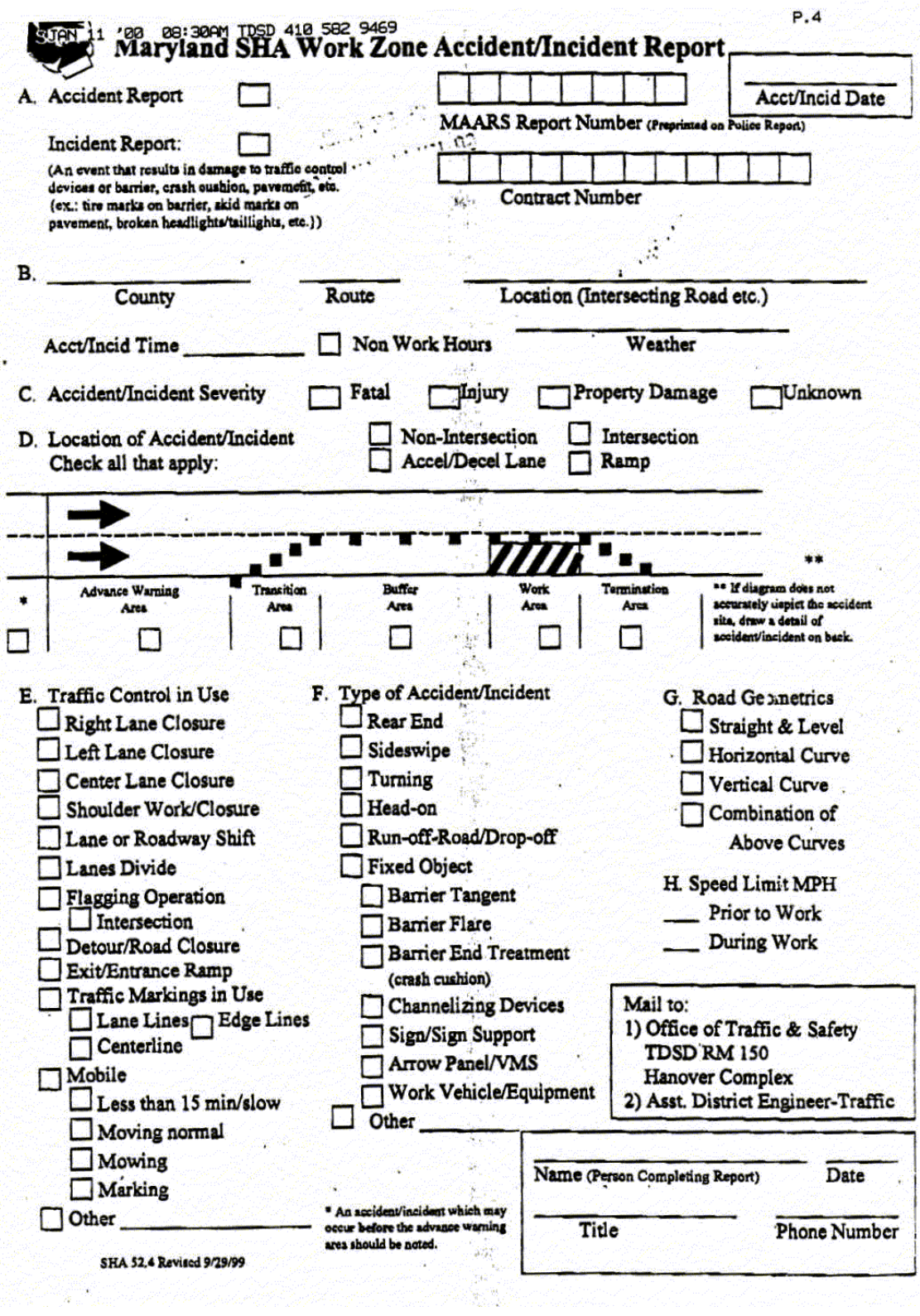
Appendix A: MOT Forms from Other States

Appendix A-1: Maryland

In response to the questionnaire mailed to them, the Maryland DOT provided the following MOT form. The form appears to be easy to complete, as most of the questions have check boxes. The accidents or incidents in the work zone are reported to the central Office of Traffic & Safety (OOTS). The state had conducted a similar study of accidents in work zones and found that 41% of all accidents were occurring within the taper area, although these results were yet to be confirmed. The state has also formed a committee to look into the issues of maintenance of traffic, constructability, intelligent transportation systems, use of State Police, FHWA's practice, etc.



JAN 11 '00 08:30AM TDSD 410 582 9469 P.4

Maryland SHA Work Zone Accident/Incident Report

A. Accident Report ☐ — Acct/Incid Date

MAARS Report Number (Preprinted on Police Report)

Incident Report: ☐

(An event that results in damage to traffic control devices or barrier, crash cushion, pavement, etc. (ex.: tire marks on barrier, skid marks on pavement, broken headlights/taillights, etc.))

Contract Number

B. County — Route — Location (Intersecting Road etc.)

Acct/Incid Time _____ ☐ Non Work Hours — Weather

C. Accident/Incident Severity ☐ Fatal ☐ Injury ☐ Property Damage ☐ Unknown

D. Location of Accident/Incident Check all that apply: ☐ Non-Intersection ☐ Intersection ☐ Accel/Decel Lane ☐ Ramp

E. Traffic Control in Use
- ☐ Right Lane Closure
- ☐ Left Lane Closure
- ☐ Center Lane Closure
- ☐ Shoulder Work/Closure
- ☐ Lane or Roadway Shift
- ☐ Lanes Divide
- ☐ Flagging Operation
  - ☐ Intersection
- ☐ Detour/Road Closure
- ☐ Exit/Entrance Ramp
- ☐ Traffic Markings in Use
  - ☐ Lane Lines ☐ Edge Lines
  - ☐ Centerline
- ☐ Mobile
  - ☐ Less than 15 min/slow
  - ☐ Moving normal
  - ☐ Mowing
  - ☐ Marking
- ☐ Other _____

F. Type of Accident/Incident
- ☐ Rear End
- ☐ Sideswipe
- ☐ Turning
- ☐ Head-on
- ☐ Run-off-Road/Drop-off
- ☐ Fixed Object
  - ☐ Barrier Tangent
  - ☐ Barrier Flare
  - ☐ Barrier End Treatment (crash cushion)
  - ☐ Channelizing Devices
  - ☐ Sign/Sign Support
  - ☐ Arrow Panel/VMS
  - ☐ Work Vehicle/Equipment
- ☐ Other _____

G. Road Geometrics
- ☐ Straight & Level
- ☐ Horizontal Curve
- ☐ Vertical Curve
- ☐ Combination of Above Curves

H. Speed Limit MPH
- ___ Prior to Work
- ___ During Work

Mail to:
1) Office of Traffic & Safety
TDSD RM 150
Hanover Complex
2) Asst. District Engineer-Traffic

* An accident/incident which may occur before the advance warning area should be noted.

Name (Person Completing Report) — Date

Title — Phone Number

SHA 52.4 Revised 9/29/99

Figure A.1: MOT form used by Maryland

Appendix A-2: New York

In response to the questionnaire mailed to them, the New York DOT provided the following MOT form, along with summary reports from years 1989-94 and 1996-98. The reports showed a summary of statewide construction accidents and factors involved in the accidents. The report gave statistics based on various factors involved in the accident, along with other programs that the DOT had implemented to improve the safety measures. The New York DOT has three different MOT forms -

- Form A - Initial Notification of Work Zone Accident
- Form B - Construction Work Zone Traffic Accident Report
- Form C - Construction Employee Accident Report and an Incident Report having witness statement.

The forms carry all the necessary instructions for completion along with the notification requirements. The forms appeared to be very thorough, with a detail description of the required procedures. However, the length of the form and the number of fill-in-the-blank responses might make it time-consuming to complete.

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
CONSTRUCTION DIVISION

Initial Notification of Work Zone Accident - Form A

Report No. _ _ - _ _ - _ _ _ _ - A

Date _____ Time _____ AM __ PM __

Contract D _____ Contractor _____

Region _____ County _____ Route _____

EIC: Name _____ Title _____ Phone _____

MM (traffic acc. only) _ _ _ _ - _ _ _ _ - _ _ _ _

Accident Category I _____ II _____ III _____

Traffic		Non - Traffic	
Motorist or Pedestrian-on project	_____	Contractor Employee	____
Employee (Cont. Cons. DOT) on proj.	_____	Consultant Employee	____
DOT Employee - off project	_____	DOT Employee	____
		Private Citizen	____

Description of Injuries (attach additional sheets if needed)

Name (if known)	DOT Empl.	Contr. Empl.	Consult. Empl.	Trav. Pub.	Title	Injury-Severity

Provide brief description of accident, including how it related to Construction activity and M&PT:

Police, emergency squads involved _____

Briefly list construction activity or traffic controls involved in, related to, or associated with this accident _____

Report Prepared by:

Name _____ Title _____ Date _____

Phone _____

Figure A.2: MOT form Part-A used by New York

FORM A INSTRUCTIONS

Notification Requirements:

Category I - immediate - by phone (MO Construction or Duty Officer) FAX form no later than next working day.

Category II - FAX Form no later than the next work day

Category III - Transmit Form within 5 work days

Distribution:

By Regional Construction Safety Coordinator

- Regional Director (Categories I & II only)
- Regional Construction Engineer
- Regional Safety & Health Representative
- Regional Traffic Engineer (Traffic Accidents only)
- Regional Claims Engineer
- MO Construction Division

By MO Construction Division

- Director, Employee Safety and Health (All Category I and II, and Category III if DOT employee involved)
- Assistant Commissioner - Engineering (Category I)
- Executive Deputy Commissioner (Category I)
- Assistant Commissioner - Legal Affairs

MO Construction Division: Telephone - 518-485-1834
FAX - 518-485-1833

MO Duty Officer: Telephone - 518-485-7002

Figure A.3: MOT form Part-A Instructions used by New York

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
CONSTRUCTION DIVISION

Construction Work Zone Traffic Accident Report - Form B

Report No. _ _ - _ _ - _ _ _ _ - B

Date _____ Time _____ AM ___ PM ___

Contract D _____ Contractor _____

Region _____ County _____ Route _____

EIC: Name _____ Title _____ Phone _____

Const. Supr.: Name _____ Phone _____

Subcontractor (if responsible for M&PT) _____

Brief accident description: Provided by: Name _____ Title ____

_____

_____

_____

_____

_____

Accident Parameters

Weather _____ Pvt. Surface Condition _____

Light Conditions _____ Roadway Lighting _____

Investigating Police Agency _____ Officer _____

Contributory Factors _____

Witnesses (add additional sheets if necessary)

Name	Address	Phone

Report Prepared By: Name _____ Title _____ Date ____

Phone _____

Figure A.4: MOT form Part-B used by New York

FORM B CONTINUED

Indicate inclusion of the items listed by inserting the appropriate code in the space provided:

A - attached to this report
B - to be provided later
NA - not applicable to this report.

__ 1. NYS DMV Police Accident Report
__ NYS DMV Motorist Accident Report

__ 2. Traffic Control Plans from contract plans (if M&PT was involved).

__ 3. Detailed sketch of accident site, (including M&PT if involved)
Prepared by: Name_____Title_____Date_____

__ 4. Narrative description of accident, including description of vehicle, victims names, addresses, ages, and injuries, extent of property damage, witnesses statements, and other relevant information.
Prepared by: Name_____Title_____Date_____

__ 5. Written assessment by construction supervisor of how this accident related to construction activity, and any needed corrective actions.
Prepared by: Name_____Title_____Date_____

__ 6. All available photographs and newspaper accounts. List photographer, date, newspaper, etc.

_____

_____

_____

7. Supplemental Forms

____ SAF-1 Prepared by: Name_____Title_____Date____

____ SAF-2 Prepared by: Name_____Title_____Date____

____ C-2 Prepared by: Name_____Title_____Date____

Figure A.5: MOT form Part-B Continued

Appendix B: Completed MOT Forms

As part of the study of compliance rates in completing MOT forms, sample reports from four FDOT districts were reviewed. This appendix contains various reports completed using the existing MOT form. The reports provide illustrative examples of well-completed, poorly-completed, and average forms. Names of project engineers and others completing these reports are removed to preserve anonymity.

Appendix B-1: Well-Completed Report

Figures B.1 and B.2 show an example of a well-completed MOT report. The report not only cites the zone in which the accident occurred, but also states the changes required for existing MOT to avoid future occurrences of the incident. The report also gives a sketch of the MOT using given symbols along with a description of the accident.

K. DUGE

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
ENGINEER'S MAINTENANCE OF TRAFFIC EVALUATION AT CRASH SITE

FORM 700-010-64
CONSTRUCTION - 05/99
Page 1 of 3

Date/Time of Occurrence: 01-25-00 10:30PM Report Date: 01-26-00

FIN Project No.: 197604-1-52-01 State Road No.: 546 District: 01

Federal Project No.: Z122-023P County: POLK

Contract No.: 20496 WPI No.: 1118496

MOT Evaluation at Crash Site:

Has there been other crashes in the same vicinity of the work zone?

○ YES ☒ NO

If yes, give dates. _____

Police Investigated? ☒ YES ○ NO CASE NO P.C.S.O. 00-14858

If available, attach police report. CITATION GIVEN FOR VIOLATION OF TRAFFIC CONTROL DEVICES

Work Zone Location of crash:
(Approach, transition, work area) WORK AREA LINCOLN AV. ± WEST BD U.S-92

Is the immediate area at the crash site in accordance with State Standards, MUTCD and TCP? ☒ YES ○ NO

Are there any recommended enhancements to the MOT at the crash site?

☒ YES ○ NO

List enhancements to be made to the work site. DECREASED SPACING OF TRAFFIC CONTROL DEVICES (CONES) TO 2-4 METERS AROUND AREAS OF REMOVED CONC PAVEMENT.

Distribution: Original to Project Engineer
Copies to: District Safety Engineer, Contractor

Figure B.1: Good MOT Report - Page 1

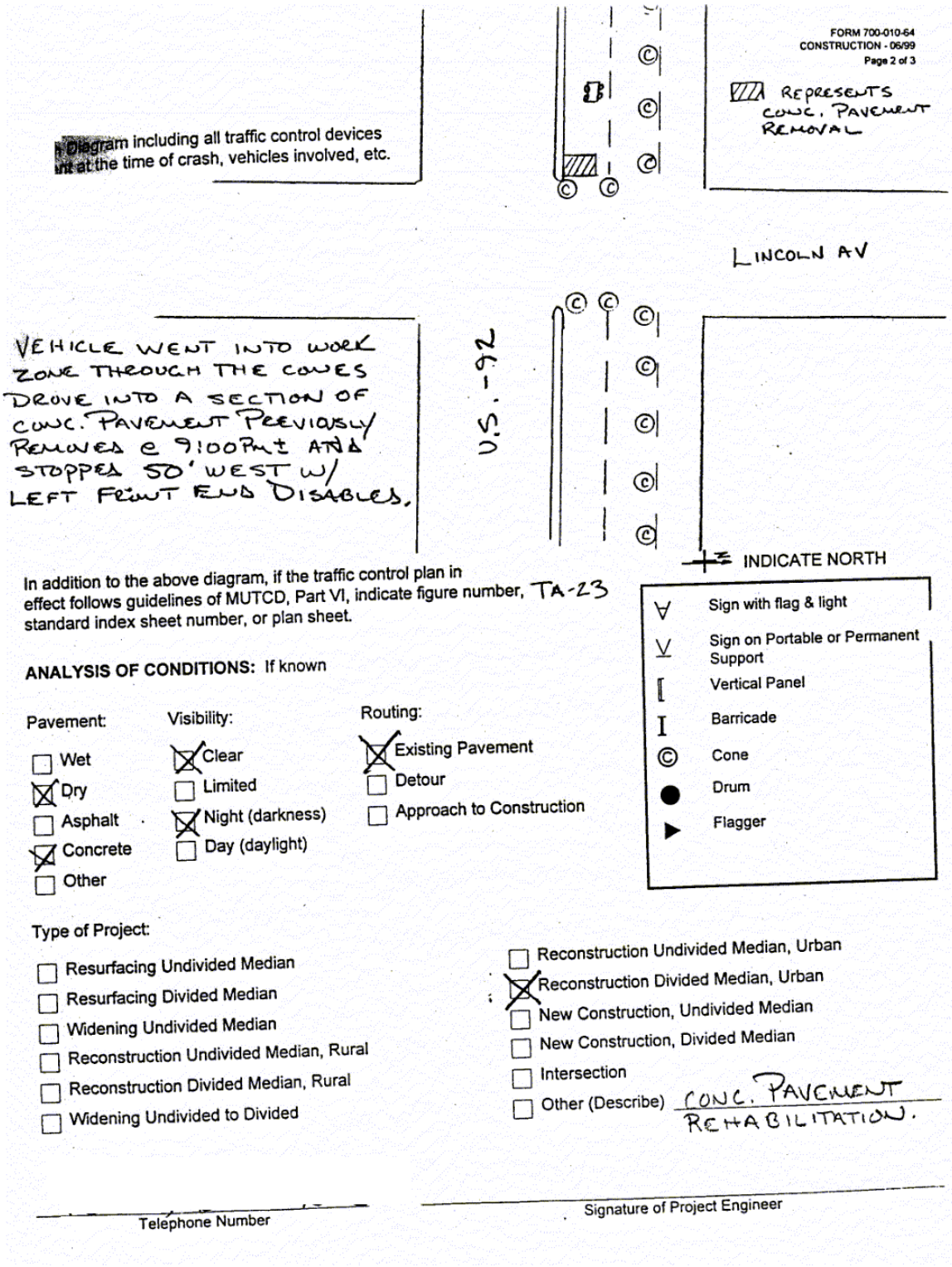


Figure B.2: Good MOT Report - Page 2

Appendix B-2: Poorly-Completed Report

Figures B.3 to B.8 show an example of a poorly completed MOT report. The corresponding Florida Traffic Crash Report form is attached for illustrative purposes. The time elapsed between the accident date and reporting date is about 10 months in the first report. The report did not answer several questions and instead of giving the zone in which accident occurred, it references the station number. This information is not useful without a great deal of additional information about the progress of the construction at the time of the accident. It does not give sketch of the MOT and references the traffic crash report, which also does not carry the sketch. The report does not answer the important questions like pavement and visibility conditions at the time of accident.

EVALUATION AT ACCIDENT SITE

FORM 300-4 CONSTRUCTION

Date/Time of Occurrence: 10/2/98 4:15PM Report Date: 8/18/99

State Project No.: 77080-3500 State Road No.: 436 District: 5

Federal Project No.: XA-8888-503(A) County: Seminole

Contract No.: 20210 WPI No.: 5117724

MOT Evaluation at Accident Site:

Has there been other accidents in the same vicinity of the work zone?
YES____ NO_

If yes, give dates. _____

Police Investigated? YES_✓_ NO____

If available, attach police report.

Work Zone Location of Accident:
(Approach, transition, work area) Station 127+00 RD SIDE LT.

Is the immediate area at the accident site in accordance with State Standards, MUTCD and TCP? YES_X_ NO_

Are there any recommended enhancements to the MOT at the accident site?
YES____ NO_X

List enhancements to be made to the work site. _____

stribution: Original to Project Engineer
Copies to: District Safety Engineer, Contractor

Figure B.3: Below Average MOT Report 1 - Page 1

DIAGRAM:
Accident Diagram including all traffic control devices present at the time of accident, vehicles involved, etc.

FOR DIAGRAM
SEE CASE # 98-28-04313-17

In addition to the above diagram, if the traffic control plan in effect follows guidelines of MUTCD, Part VI, indicate figure number, standard index sheet number, or plan sheet.

INDICATE NORTH

- Sign with flag & light
- Sign on Portable or Permanent Support
- Vertical Panel
- Barricade
- Cone
- Drum
- Flagger

ANALYSIS OF CONDITIONS: If known

Pavement:
_____ Wet
_____ Dry
_____ Asphalt
_____ Concrete
_____ Other

Visibility:
_____ Clear
_____ Limited
_____ Night (darkness)
_____ Day (daylight)

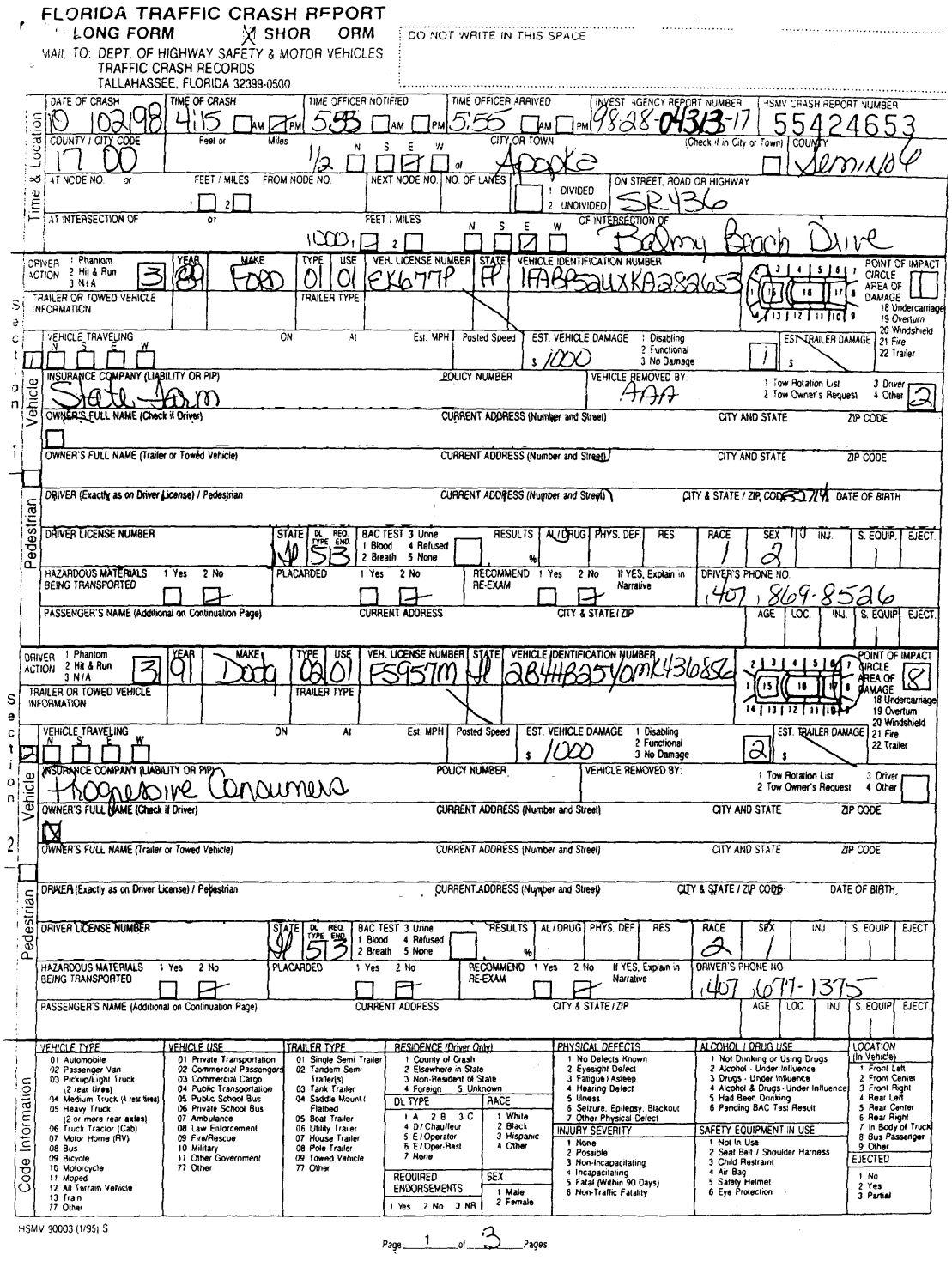
Routing:
_____ Existing Pavement
_____ Detour
_____ Approach to Construction

Type of Project:
_____ Resurfacing Undivided Median
_____ Resurfacing Divided Median
_____ Widening Undivided Median
_____ Reconstruction Undivided Median, Rural
_____ Reconstruction Divided Median, Rural
_____ Widening Undivided to Divided
_____ Reconstruction Undivided Median, Urban
_____ Reconstruction Divided Median, Urban
_____ New Construction, Undivided Median
_____ New Construction, Divided Median
_____ Intersection
_____ Other (Describe) _____

Telephone Number

Signature of Project Engineer

Figure B.4: Below Average MOT Report 1 - Page 2



FLORIDA TRAFFIC CRASH REPORT
LONG FORM X SHORT FORM
DO NOT WRITE IN THIS SPACE
MAIL TO: DEPT. OF HIGHWAY SAFETY & MOTOR VEHICLES
TRAFFIC CRASH RECORDS
TALLAHASSEE, FLORIDA 32399-0500

Time & Location
DATE OF CRASH: 10 10 2198 | TIME OF CRASH: 4:15 AM PM | TIME OFFICER NOTIFIED: 5:55 AM PM | TIME OFFICER ARRIVED: 5:55 AM PM | INVEST. AGENCY REPORT NUMBER: 98280431317 | HSMV CRASH REPORT NUMBER: 55424653
COUNTY / CITY CODE: 17 00 | Feet or Miles: 1/2 N S E W of | CITY OR TOWN: Apopka | (Check if in City or Town) | COUNTY: Seminole
AT NODE NO. or | FEET / MILES FROM NODE NO. | NEXT NODE NO. | NO. OF LANES | 1 DIVIDED 2 UNDIVIDED | ON STREET, ROAD OR HIGHWAY: SR 436
AT INTERSECTION OF or | FEET / MILES 1000 | N S E W OF INTERSECTION OF: Bailey Beach Drive

Section 1 — Vehicle
DRIVER ACTION 1 Phantom 2 Hit & Run 3 N/A: 3 | YEAR: 89 | MAKE: Ford | TYPE: 01 | USE: 01 | VEH. LICENSE NUMBER: EX677P | STATE: FL | VEHICLE IDENTIFICATION NUMBER: 1FABP52AUXKA282653 | POINT OF IMPACT CIRCLE AREA OF DAMAGE: 12
TRAILER OR TOWED VEHICLE INFORMATION | TRAILER TYPE
VEHICLE TRAVELING N S E W | ON | At | Est. MPH | Posted Speed | EST. VEHICLE DAMAGE 1 Disabling 2 Functional 3 No Damage: $1000 | EST. TRAILER DAMAGE: 1 $ | 18 Undercarriage 19 Overturn 20 Windshield 21 Fire 22 Trailer
INSURANCE COMPANY (LIABILITY OR PIP): State Farm | POLICY NUMBER | VEHICLE REMOVED BY: AAA | 1 Tow Rotation List 2 Tow Owner's Request 3 Driver 4 Other: 2
OWNER'S FULL NAME (Check if Driver) | CURRENT ADDRESS (Number and Street) | CITY AND STATE | ZIP CODE
OWNER'S FULL NAME (Trailer or Towed Vehicle) | CURRENT ADDRESS (Number and Street) | CITY AND STATE | ZIP CODE

Section 1 — Pedestrian
DRIVER (Exactly as on Driver License) / Pedestrian | CURRENT ADDRESS (Number and Street) | CITY & STATE / ZIP CODE: 32714 | DATE OF BIRTH
DRIVER LICENSE NUMBER | STATE: FL | DL TYPE: 5 | REQ. END: 3 | BAC TEST 1 Blood 2 Breath 3 Urine 4 Refused 5 None | RESULTS % | AL / DRUG | PHYS. DEF. | RES | RACE: 1 | SEX: 2 | INJ. | S. EQUIP. | EJECT.
HAZARDOUS MATERIALS BEING TRANSPORTED 1 Yes 2 No | PLACARDED 1 Yes 2 No | RECOMMEND RE-EXAM 1 Yes 2 No | If YES, Explain in Narrative | DRIVER'S PHONE NO.: (407) 869-8526
PASSENGER'S NAME (Additional on Continuation Page) | CURRENT ADDRESS | CITY & STATE / ZIP | AGE | LOC. | INJ. | S. EQUIP. | EJECT.

Section 2 — Vehicle
DRIVER ACTION 1 Phantom 2 Hit & Run 3 N/A: 3 | YEAR: 91 | MAKE: Dodg | TYPE: 02 | USE: 01 | VEH. LICENSE NUMBER: FS957M | STATE: FL | VEHICLE IDENTIFICATION NUMBER: 2B4HB25Y0MK436856 | POINT OF IMPACT CIRCLE AREA OF DAMAGE: 8
TRAILER OR TOWED VEHICLE INFORMATION | TRAILER TYPE
VEHICLE TRAVELING N S E W: 2 | ON | At | Est. MPH | Posted Speed | EST. VEHICLE DAMAGE 1 Disabling 2 Functional 3 No Damage: $1000 | EST. TRAILER DAMAGE: 2 $ | 18 Undercarriage 19 Overturn 20 Windshield 21 Fire 22 Trailer
INSURANCE COMPANY (LIABILITY OR PIP): Progressive Consumers | POLICY NUMBER | VEHICLE REMOVED BY: | 1 Tow Rotation List 2 Tow Owner's Request 3 Driver 4 Other
OWNER'S FULL NAME (Check if Driver): X | CURRENT ADDRESS (Number and Street) | CITY AND STATE | ZIP CODE
OWNER'S FULL NAME (Trailer or Towed Vehicle) | CURRENT ADDRESS (Number and Street) | CITY AND STATE | ZIP CODE

Section 2 — Pedestrian
DRIVER (Exactly as on Driver License) / Pedestrian | CURRENT ADDRESS (Number and Street) | CITY & STATE / ZIP CODE | DATE OF BIRTH
DRIVER LICENSE NUMBER | STATE: FL | DL TYPE: 5 | REQ. END: 3 | BAC TEST 1 Blood 2 Breath 3 Urine 4 Refused 5 None | RESULTS % | AL / DRUG | PHYS. DEF. | RES | RACE: 2 | SEX: 1 | INJ. | S. EQUIP. | EJECT.
HAZARDOUS MATERIALS BEING TRANSPORTED 1 Yes 2 No | PLACARDED 1 Yes 2 No | RECOMMEND RE-EXAM 1 Yes 2 No | If YES, Explain in Narrative | DRIVER'S PHONE NO.: (407) 677-1375
PASSENGER'S NAME (Additional on Continuation Page) | CURRENT ADDRESS | CITY & STATE / ZIP | AGE | LOC. | INJ. | S. EQUIP. | EJECT.

Code Information

VEHICLE TYPE: 01 Automobile; 02 Passenger Van; 03 Pickup/Light Truck (2 rear tires); 04 Medium Truck (4 rear tires); 05 Heavy Truck (2 or more rear axles); 06 Truck Tractor (Cab); 07 Motor Home (RV); 08 Bus; 09 Bicycle; 10 Motorcycle; 11 Moped; 12 All Terrain Vehicle; 13 Train; 77 Other
VEHICLE USE: 01 Private Transportation; 02 Commercial Passengers; 03 Commercial Cargo; 04 Public Transportation; 05 Public School Bus; 06 Private School Bus; 07 Ambulance; 08 Law Enforcement; 09 Fire/Rescue; 10 Military; 11 Other Government; 77 Other
TRAILER TYPE: 01 Single Semi Trailer; 02 Tandem Semi Trailer(s); 03 Tank Trailer; 04 Saddle Mount (Flatbed; 05 Boat Trailer; 06 Utility Trailer; 07 House Trailer; 08 Pole Trailer; 09 Towed Vehicle; 77 Other
RESIDENCE (Driver Only): 1 County of Crash; 2 Elsewhere in State; 3 Non-Resident of State; 4 Foreign; 5 Unknown
DL TYPE: 1 A 2 B 3 C; 4 D / Chauffeur; 5 E / Operator; 6 E / Oper-Rest; 7 None
RACE: 1 White; 2 Black; 3 Hispanic; 4 Other
REQUIRED ENDORSEMENTS: 1 Yes 2 No 3 NR
SEX: 1 Male; 2 Female
PHYSICAL DEFECTS: 1 No Defects Known; 2 Eyesight Defect; 3 Fatigue / Asleep; 4 Hearing Defect; 5 Illness; 6 Seizure, Epilepsy, Blackout; 7 Other Physical Defect
INJURY SEVERITY: 1 None; 2 Possible; 3 Non-Incapacitating; 4 Incapacitating; 5 Fatal (Within 90 Days); 6 Non-Traffic Fatality
ALCOHOL / DRUG USE: 1 Not Drinking or Using Drugs; 2 Alcohol - Under Influence; 3 Drugs - Under Influence; 4 Alcohol & Drugs - Under Influence; 5 Had Been Drinking; 6 Pending BAC Test Result
SAFETY EQUIPMENT IN USE: 1 Not In Use; 2 Seat Belt / Shoulder Harness; 3 Child Restraint; 4 Air Bag; 5 Safety Helmet; 6 Eye Protection
LOCATION (In Vehicle): 1 Front Left; 2 Front Center; 3 Front Right; 4 Rear Left; 5 Rear Center; 6 Rear Right; 7 In Body of Truck; 8 Bus Passenger; 9 Other
EJECTED: 1 No; 2 Yes; 3 Partial

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Page 1 of 3 Pages

Figure B.5: Below Average MOT Report 1 - Page 3

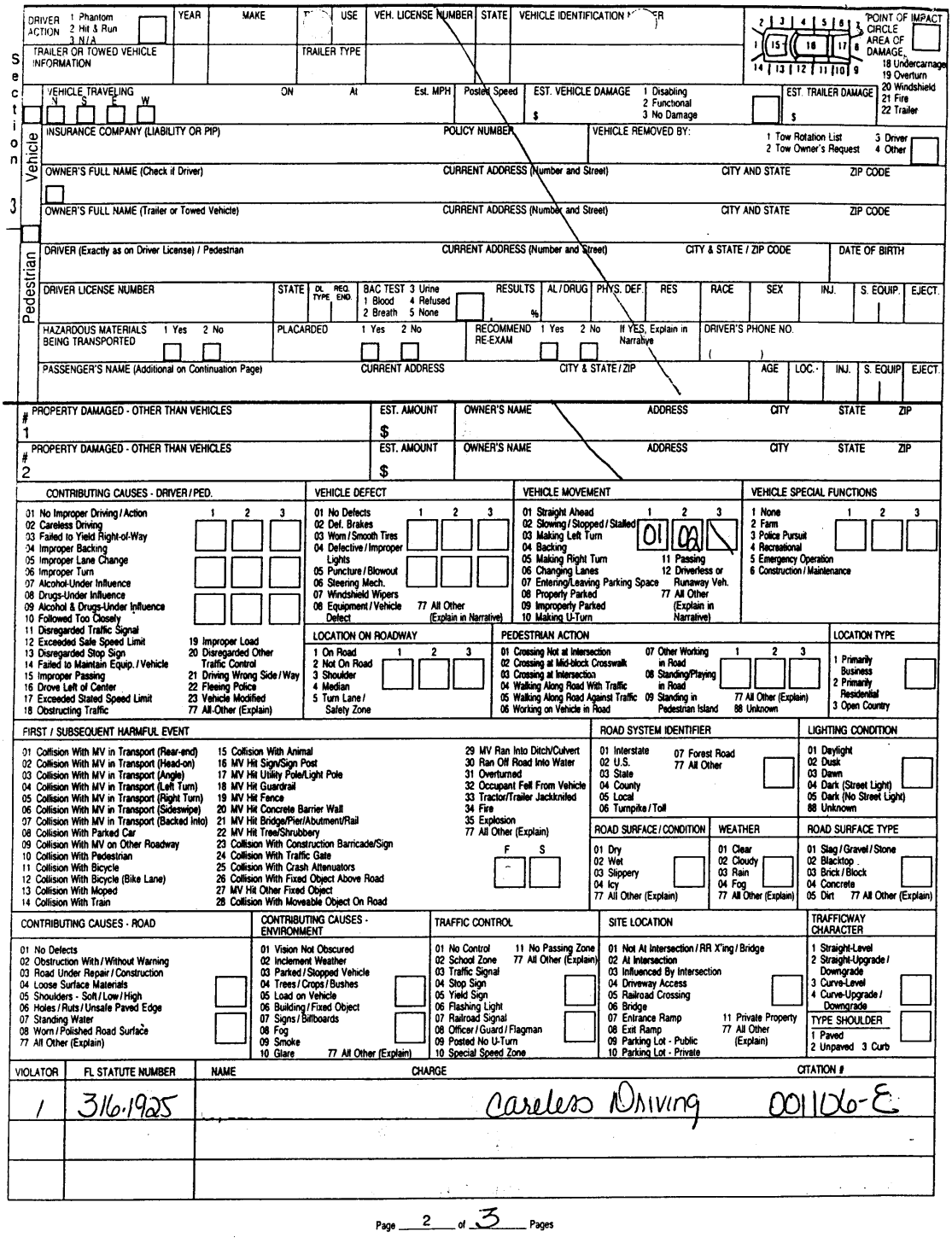
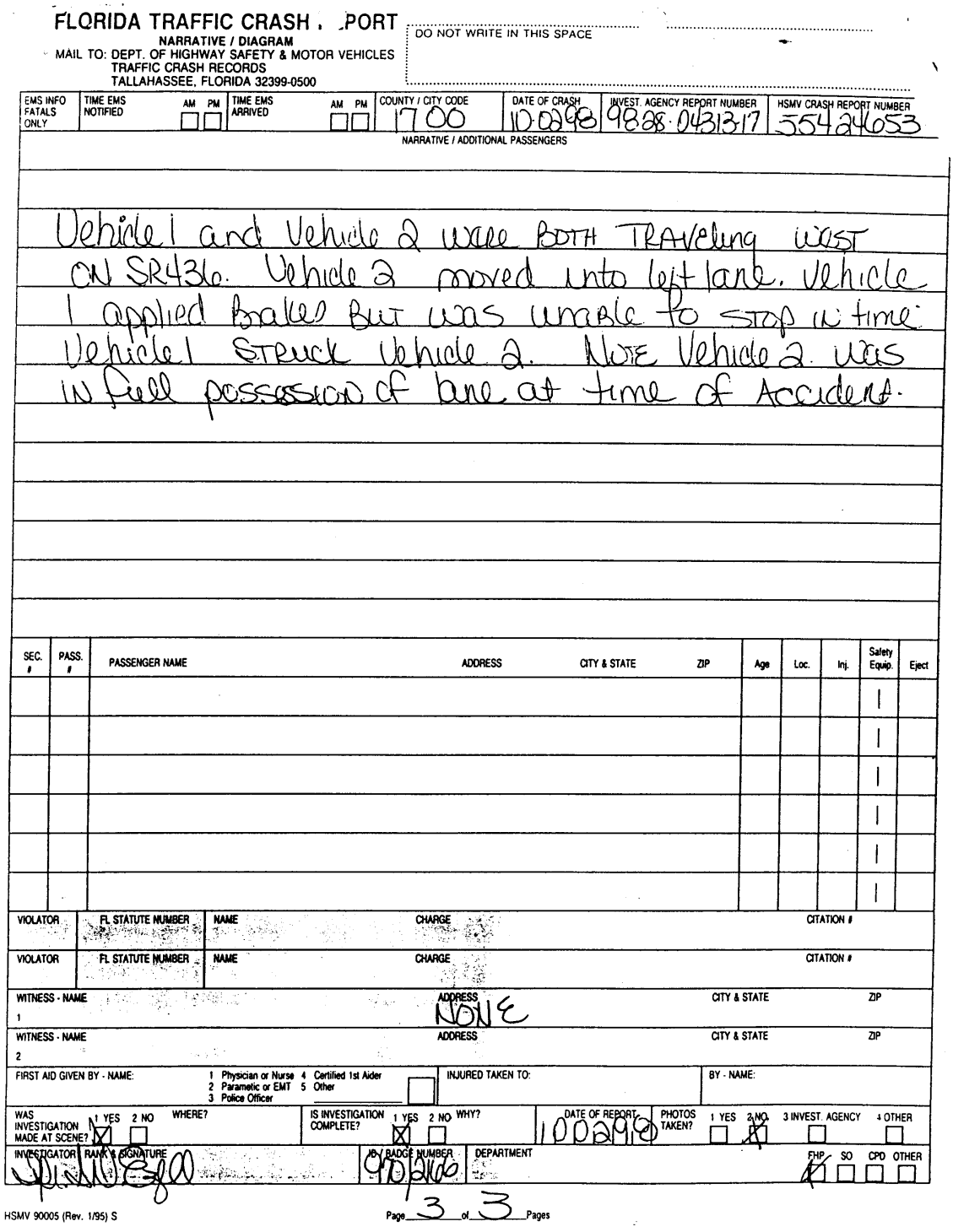


Figure B.6: Below Average MOT Report 1 - Page 4



FLORIDA TRAFFIC CRASH REPORT
NARRATIVE / DIAGRAM
MAIL TO: DEPT. OF HIGHWAY SAFETY & MOTOR VEHICLES
TRAFFIC CRASH RECORDS
TALLAHASSEE, FLORIDA 32399-0500
DO NOT WRITE IN THIS SPACE

EMS INFO FATALS ONLY	TIME EMS NOTIFIED AM PM	TIME EMS ARRIVED AM PM	COUNTY / CITY CODE	DATE OF CRASH	INVEST. AGENCY REPORT NUMBER	HSMV CRASH REPORT NUMBER
			1700	10/02/98	9828-0431317	554246053

NARRATIVE / ADDITIONAL PASSENGERS

Vehicle 1 and Vehicle 2 were BOTH TRAVeling WEST ON SR436. Vehicle 2 moved into left lane. Vehicle 1 applied brakes BUT was unable to STOP in time. Vehicle 1 STRUCK Vehicle 2. NOTE Vehicle 2 was in full possession of lane at time of Accident.

SEC. #	PASS. #	PASSENGER NAME	ADDRESS	CITY & STATE	ZIP	Age	Loc.	Inj.	Safety Equip.	Eject

VIOLATOR	FL STATUTE NUMBER	NAME	CHARGE	CITATION #
VIOLATOR	FL STATUTE NUMBER	NAME	CHARGE	CITATION #

WITNESS - NAME	ADDRESS	CITY & STATE	ZIP
1	NONE		
WITNESS - NAME	ADDRESS	CITY & STATE	ZIP
2			

FIRST AID GIVEN BY - NAME:	1 Physician or Nurse 4 Certified 1st Aider 2 Parametic or EMT 5 Other 3 Police Officer	INJURED TAKEN TO:	BY - NAME:

WAS INVESTIGATION MADE AT SCENE?	WHERE?	IS INVESTIGATION COMPLETE?	WHY?	DATE OF REPORT	PHOTOS TAKEN?	3 INVEST. AGENCY	4 OTHER
1 YES 2 NO		1 YES 2 NO		10/29/98	1 YES 2 NO		

INVESTIGATOR RANK & SIGNATURE	ID / BADGE NUMBER	DEPARTMENT	FHP	SO	CPD	OTHER
	970166					

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Page 3 of 3 Pages

Figure B.7: Below Average MOT Report 1 - Page 5

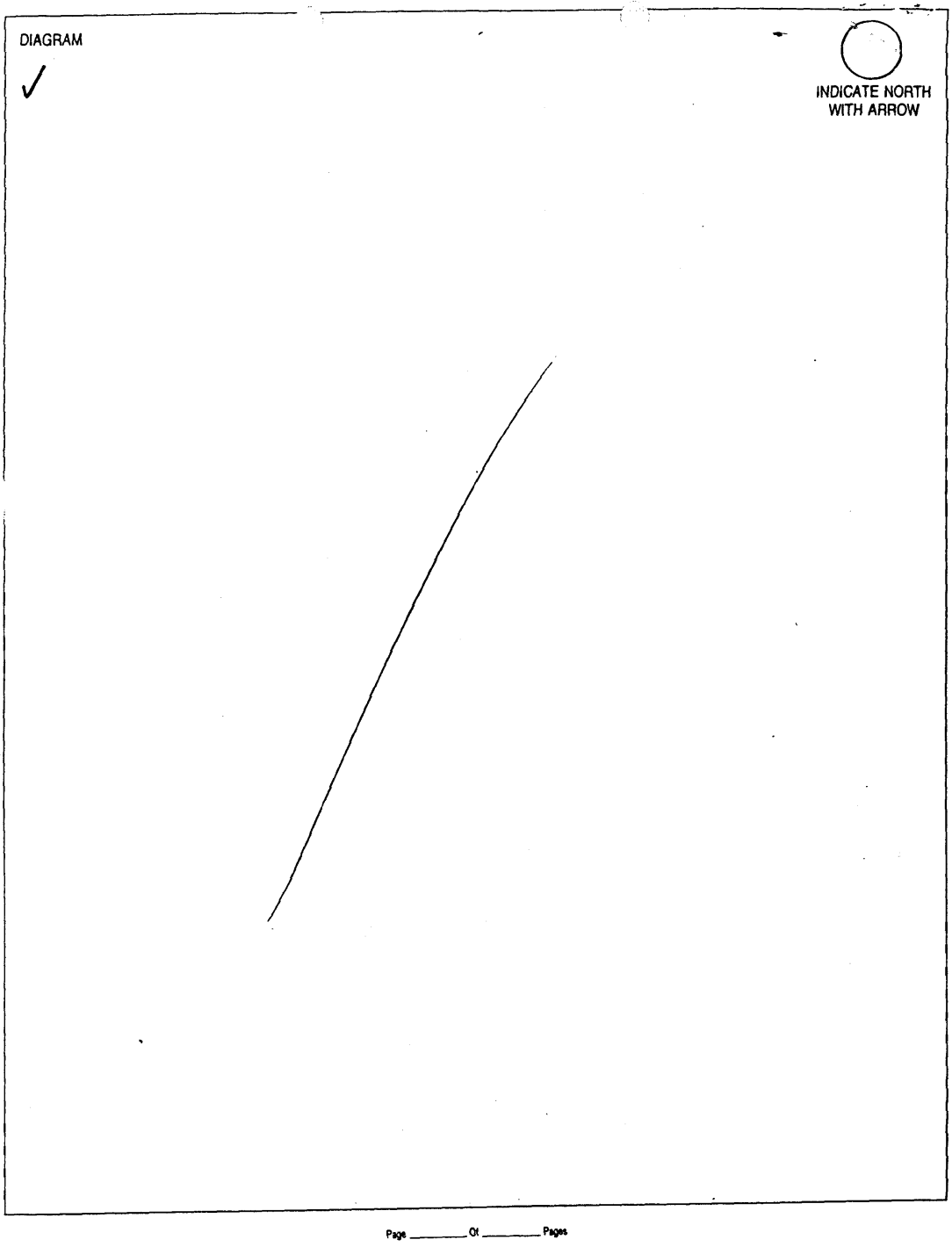


Figure B.8: Below Average MOT Report 1 - Page 6

Appendix B-3: Average to Poorly-Completed Report

Figures B.9 to B.15 show an example of an average to poor MOT report. The corresponding Florida Traffic Crash Report form is again attached for illustrative purposes. This report, though referencing the sketch in the police report, does not answer many questions regarding the MOT in place. Note that the diagram on the police report has no description of the MOT in place at the time of the crash. The project location is provided instead of the work zone location; however, all of the remaining questions are answered adequately.

Attachment 6-5-1

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

ENGINEER'S MAINTENANCE OF TRAFFIC EVALUATION AT CRASH SITE

FORM 700-010-64
CONSTRUCTION - 06/99
Page 1 of 3

Date/Time of Occurrence: 9-13-99 @ 2:48 PM Report Date: 9-23-99

FIN Project No.: 197948-1-52-01 State Road No.: 776 District: 01

Federal Project No.: X4-131-1(25) County: Sarasota

Contract No.: 19805 WPI No.: 1119238

MOT Evaluation at Crash Site:

Has there been other crashes in the same vicinity of the work zone?

○ YES ● NO

If yes, give dates. _____

Police Investigated? ● YES ○ NO

If available, attach police report.

Work Zone Location of crash:
(Approach, transition, work area) SR776 @ Overbrook Road

Is the Immediate area at the crash site in accordance with State Standards, MUTCD and TCP? ● YES ○ NO

Are there any recommended enhancements to the MOT at the crash site?

○ YES ● NO

List enhancements to be made to the work site. _____

Distribution: Original to Project Engineer
Copies to: District Safety Engineer, Contractor

Figure B.9: Average MOT Report 2 - Page 1

Attachment 6-5-1 (continued)

FORM 700-010-64
CONSTRUCTION - 05/99
Page 2 of 3

DIAGRAM:

Crash Diagram including all traffic control devices present at the time of crash, vehicles involved, etc.

See attached Police Report

In addition to the above diagram, if the traffic control plan in effect follows guidelines of MUTCD, Part VI, indicate figure number, standard index sheet number, or plan sheet.

+ INDICATE NORTH

∀	Sign with flag & light
V	Sign on Portable or Permanent Support
‖	Vertical Panel
I	Barricade
©	Cone
●	Drum
▶	Flagger

ANALYSIS OF CONDITIONS: If known

Pavement:
- ☐ Wet
- ☒ Dry
- ☐ Asphalt
- ☐ Concrete
- ☐ Other

Visibility:
- ☒ Clear
- ☐ Limited
- ☐ Night (darkness)
- ☐ Day (daylight)

Routing:
- ☒ Existing Pavement
- ☐ Detour
- ☐ Approach to Construction

Type of Project:
- ☐ Resurfacing Undivided Median
- ☐ Resurfacing Divided Median
- ☐ Widening Undivided Median
- ☐ Reconstruction Undivided Median, Rural
- ☐ Reconstruction Divided Median, Rural
- ☐ Widening Undivided to Divided
- ☒ Reconstruction Undivided Median, Urban
- ☒ Reconstruction Divided Median, Urban
- ☐ New Construction, Undivided Median
- ☐ New Construction, Divided Median
- ☐ Intersection
- ☐ Other (Describe) _____

_____ Telephone Number

_____ Signature of Project Engineer

Figure B.10: Average MOT Report 2 - Page 2

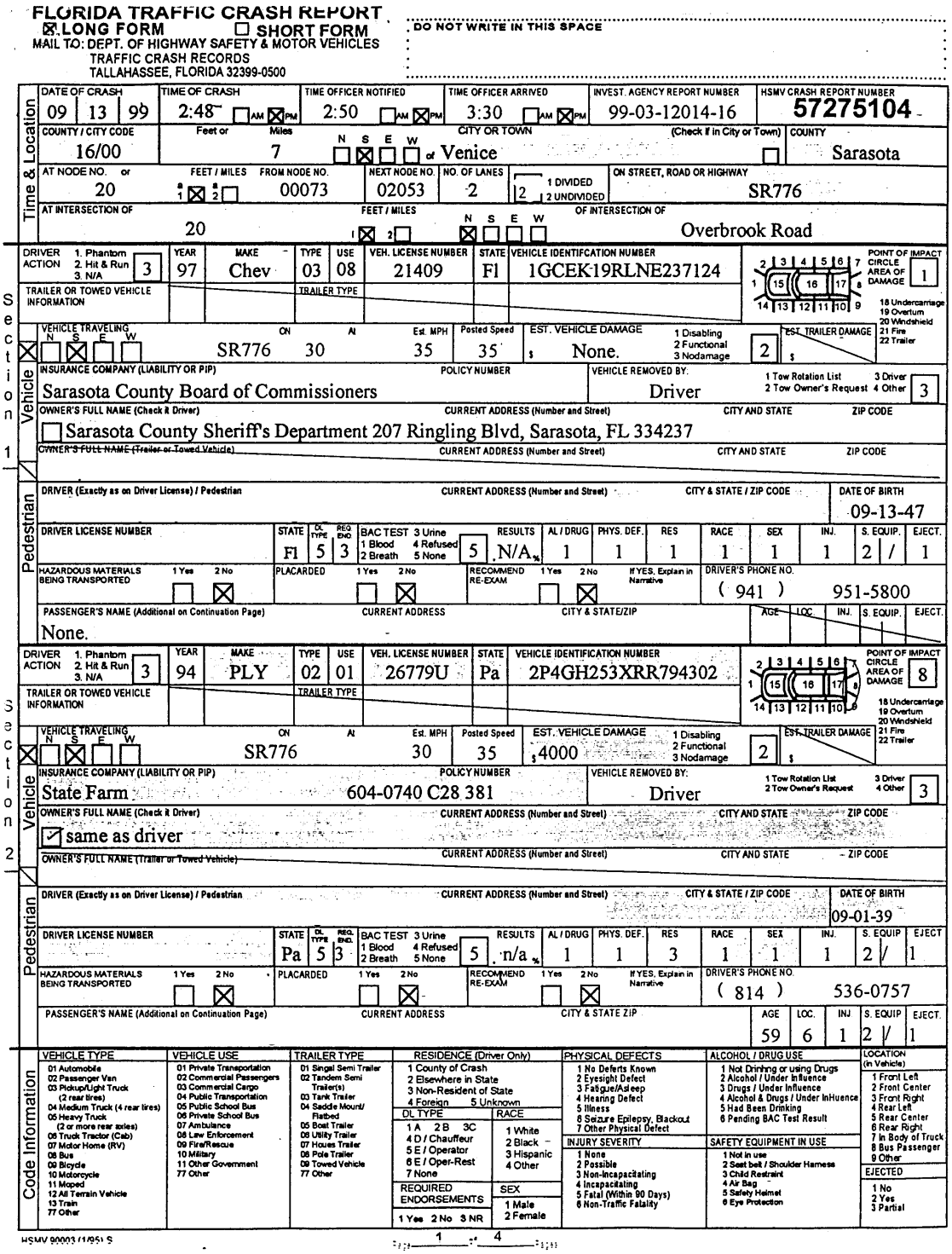
Attachment 6-5-1 (continued)
DIRECTIONS FOR FORM NUMBER 700-010-64
ENGINEERS MOT EVALUATION AT CRASH SITE
(TYPE OR PRINT)

FORM 700-010-64
CONSTRUCTION - 06/99
Page 3 of 3

DATE/TIME OF OCCURRENCE:	the day-month-year and estimated time am/pm of occurrence
REPORT DATE:	the day-month-year the report was written up
PROJECT NO:	state project number federal project number
STATE ROAD NUMBER:	the state road number, i.e., SR-8
COUNTY:	the county where the mishap occurred
DISTRICT:	the district where crash occurred
CONTRACT NO.:	contract number of project(s)
WPI NO.:	work program item number of project(s)
OTHER CRASHES:	List dates of other crashes that have occurred in the same vicinity
POLICE INVESTIGATED:	If yes, attached report if available. Do not hold off submitting Crash/Evaluation report
LOCATION OF CRASH:	List the particular section of the TCP where the crash occurred
IN ACCORDANCE WITH STATE STANDARDS, MUTCD, TCP?:	If the MOT in the immediate area of the crash site is in substantial conformance, check yes. If not, explain thoroughly.
RECOMMEND ENHANCEMENTS:	Check yes only if considered critically necessary.
DIAGRAM:	Show vehicles involved in crash and detailed collision diagram. Show all MOT devices in the crash immediate area (drums, barriers, signa, pavement markings, etc.)
PROJECT ENGINEER:	Sign here and date. Show telephone number (day).

RECYCLED PAPER

Figure B.11: Average MOT Report 2 - Page 3



FLORIDA TRAFFIC CRASH REPORT
☒ LONG FORM ☐ SHORT FORM
MAIL TO: DEPT. OF HIGHWAY SAFETY & MOTOR VEHICLES
TRAFFIC CRASH RECORDS
TALLAHASSEE, FLORIDA 32399-0500

DO NOT WRITE IN THIS SPACE

Time & Location

DATE OF CRASH	TIME OF CRASH	TIME OFFICER NOTIFIED	TIME OFFICER ARRIVED	INVEST. AGENCY REPORT NUMBER	HSMV CRASH REPORT NUMBER
09 / 13 / 99	2:48 ☐AM ☒PM	2:50 ☐AM ☒PM	3:30 ☐AM ☒PM	99-03-12014-16	57275104

COUNTY / CITY CODE	Feet or Miles	N S E W	CITY OR TOWN	(Check if in City or Town)	COUNTY
16/00	7	☐N ☒S ☐E ☐W	of Venice	☐	Sarasota

AT NODE NO. or	FEET / MILES	FROM NODE NO.	NEXT NODE NO.	NO. OF LANES	1 DIVIDED 2 UNDIVIDED	ON STREET, ROAD OR HIGHWAY
20	1 ☒ 2 ☐	00073	02053	2	2	SR776

AT INTERSECTION OF	FEET / MILES	N S E W	OF INTERSECTION OF
20	1 ☒ 2 ☐	☒N ☐S ☐E ☐W	Overbrook Road

Section 1 — Vehicle

DRIVER ACTION (1. Phantom 2. Hit & Run 3. N/A)	YEAR	MAKE	TYPE	USE	VEH. LICENSE NUMBER	STATE	VEHICLE IDENTIFICATION NUMBER	POINT OF IMPACT CIRCLE AREA OF DAMAGE
3	97	Chev	03	08	21409	Fl	1GCEK19RLNE237124	1

TRAILER OR TOWED VEHICLE INFORMATION — TRAILER TYPE

VEHICLE TRAVELING N S E W	ON	AT	Est. MPH	Posted Speed	EST. VEHICLE DAMAGE	1 Disabling 2 Functional 3 Nodamage	EST. TRAILER DAMAGE
☒N ☐S ☐E ☐W	SR776	30	35	35	$ None.	2	$

18 Undercarriage 19 Overturn 20 Windshield 21 Fire 22 Trailer

INSURANCE COMPANY (LIABILITY OR PIP)	POLICY NUMBER	VEHICLE REMOVED BY:	1 Tow Rotation List 2 Tow Owner's Request 3 Driver 4 Other
Sarasota County Board of Commissioners		Driver	3

OWNER'S FULL NAME (Check if Driver)	CURRENT ADDRESS (Number and Street)	CITY AND STATE	ZIP CODE
☐ Sarasota County Sheriff's Department	207 Ringling Blvd, Sarasota, FL	334237	

~~OWNER'S FULL NAME (Trailer or Towed Vehicle)~~	CURRENT ADDRESS (Number and Street)	CITY AND STATE	ZIP CODE

Pedestrian

DRIVER (Exactly as on Driver License) / Pedestrian	CURRENT ADDRESS (Number and Street)	CITY & STATE / ZIP CODE	DATE OF BIRTH
			09-13-47

DRIVER LICENSE NUMBER	STATE	DL TYPE	REQ ENDO	BAC TEST 1 Blood 2 Breath 3 Urine 4 Refused 5 None	RESULTS	AL / DRUG	PHYS. DEF.	RES	RACE	SEX	INJ.	S. EQUIP.	EJECT.
	Fl	5	3	5	N/A %	1	1	1	1	1	1	2 /	1

HAZARDOUS MATERIALS BEING TRANSPORTED	PLACARDED	RECOMMEND RE-EXAM	IF YES, Explain in Narrative	DRIVER'S PHONE NO.
1 Yes ☐ 2 No ☒	1 Yes ☐ 2 No ☒	1 Yes ☐ 2 No ☒		(941) 951-5800

PASSENGER'S NAME (Additional on Continuation Page)	CURRENT ADDRESS	CITY & STATE/ZIP	AGE	LOC.	INJ.	S. EQUIP.	EJECT.
None.							

Section 2 — Vehicle

DRIVER ACTION (1. Phantom 2. Hit & Run 3. N/A)	YEAR	MAKE	TYPE	USE	VEH. LICENSE NUMBER	STATE	VEHICLE IDENTIFICATION NUMBER	POINT OF IMPACT CIRCLE AREA OF DAMAGE
3	94	PLY	02	01	26779U	Pa	2P4GH253XRR794302	8

TRAILER OR TOWED VEHICLE INFORMATION — TRAILER TYPE

VEHICLE TRAVELING N S E W	ON	AT	Est. MPH	Posted Speed	EST. VEHICLE DAMAGE	1 Disabling 2 Functional 3 Nodamage	EST. TRAILER DAMAGE
☒N ☐S ☐E ☐W	SR776		30	35	$ 4000	2	$

18 Undercarriage 19 Overturn 20 Windshield 21 Fire 22 Trailer

INSURANCE COMPANY (LIABILITY OR PIP)	POLICY NUMBER	VEHICLE REMOVED BY:	1 Tow Rotation List 2 Tow Owner's Request 3 Driver 4 Other
State Farm	604-0740 C28 381	Driver	3

OWNER'S FULL NAME (Check if Driver)	CURRENT ADDRESS (Number and Street)	CITY AND STATE	ZIP CODE
☑ same as driver			

~~OWNER'S FULL NAME (Trailer or Towed Vehicle)~~	CURRENT ADDRESS (Number and Street)	CITY AND STATE	ZIP CODE

Pedestrian

DRIVER (Exactly as on Driver License) / Pedestrian	CURRENT ADDRESS (Number and Street)	CITY & STATE / ZIP CODE	DATE OF BIRTH
			09-01-39

DRIVER LICENSE NUMBER	STATE	DL TYPE	REQ ENDO	BAC TEST 1 Blood 2 Breath 3 Urine 4 Refused 5 None	RESULTS	AL / DRUG	PHYS. DEF.	RES	RACE	SEX	INJ.	S. EQUIP	EJECT
	Pa	5	3	5	n/a %	1	1	3	1	1	1	2 /	1

HAZARDOUS MATERIALS BEING TRANSPORTED	PLACARDED	RECOMMEND RE-EXAM	IF YES, Explain in Narrative	DRIVER'S PHONE NO.
1 Yes ☐ 2 No ☒	1 Yes ☐ 2 No ☒	1 Yes ☐ 2 No ☒		(814) 536-0757

PASSENGER'S NAME (Additional on Continuation Page)	CURRENT ADDRESS	CITY & STATE ZIP	AGE	LOC.	INJ	S. EQUIP	EJECT.
			59	6	1	2 /	1

Code Information

VEHICLE TYPE	VEHICLE USE	TRAILER TYPE	RESIDENCE (Driver Only)	PHYSICAL DEFECTS	ALCOHOL / DRUG USE	LOCATION (In Vehicle)
01 Automobile 02 Passenger Van 03 Pickup/Light Truck (2 rear tires) 04 Medium Truck (4 rear tires) 05 Heavy Truck (2 or more rear axles) 06 Truck Tractor (Cab) 07 Motor Home (RV) 08 Bus 09 Bicycle 10 Motorcycle 11 Moped 12 All Terrain Vehicle 13 Train 77 Other	01 Private Transportation 02 Commercial Passengers 03 Commercial Cargo 04 Public Transportation 05 Public School Bus 06 Private School Bus 07 Ambulance 08 Law Enforcement 09 Fire/Rescue 10 Military 11 Other Government 77 Other	01 Singal Semi Trailer 02 Tandem Semi Trailer(s) 03 Tank Trailer 04 Saddle Mount/ Flatbed 05 Boat Trailer 06 Utility Trailer 07 Houes Trailer 08 Pole Trailer 09 Towed Vehicle 77 Other	1 County of Crash 2 Elsewhere in State 3 Non-Resident of State 4 Foreign 5 Unknown DL TYPE: 1 A 2 B 3C 4 D / Chauffeur 5 E / Operator 6 E / Oper-Rest 7 None RACE: 1 White 2 Black 3 Hispanic 4 Other REQUIRED ENDORSEMENTS: 1 Yes 2 No 3 NR SEX: 1 Male 2 Female	1 No Deferts Known 2 Eyesight Defect 3 Fatigue/Asleep 4 Hearing Defect 5 Illness 6 Seizure Epilepsy, Blackout 7 Other Physical Defect INJURY SEVERITY: 1 None 2 Possible 3 Non-Incapacitating 4 Incapacitating 5 Fatal (Within 90 Days) 6 Non-Traffic Fatality	1 Not Drinking or using Drugs 2 Alcohol / Under Influence 3 Drugs / Under Influence 4 Alcohol & Drugs / Under InHuence 5 Had Been Drinking 6 Pending BAC Test Result SAFETY EQUIPMENT IN USE: 1 Not in use 2 Seat belt / Shoulder Harness 3 Child Restraint 4 Air Bag 5 Safety Helmet 6 Eye Protection	1 Front Left 2 Front Center 3 Front Right 4 Rear Left 5 Rear Center 6 Rear Right 7 In Body of Truck 8 Bus Passenger 9 Other EJECTED: 1 No 2 Yes 3 Partial

HSMV 90003 (1/95) S

1 — 4

Figure B.12: Average MOT Report 2 - Page 4

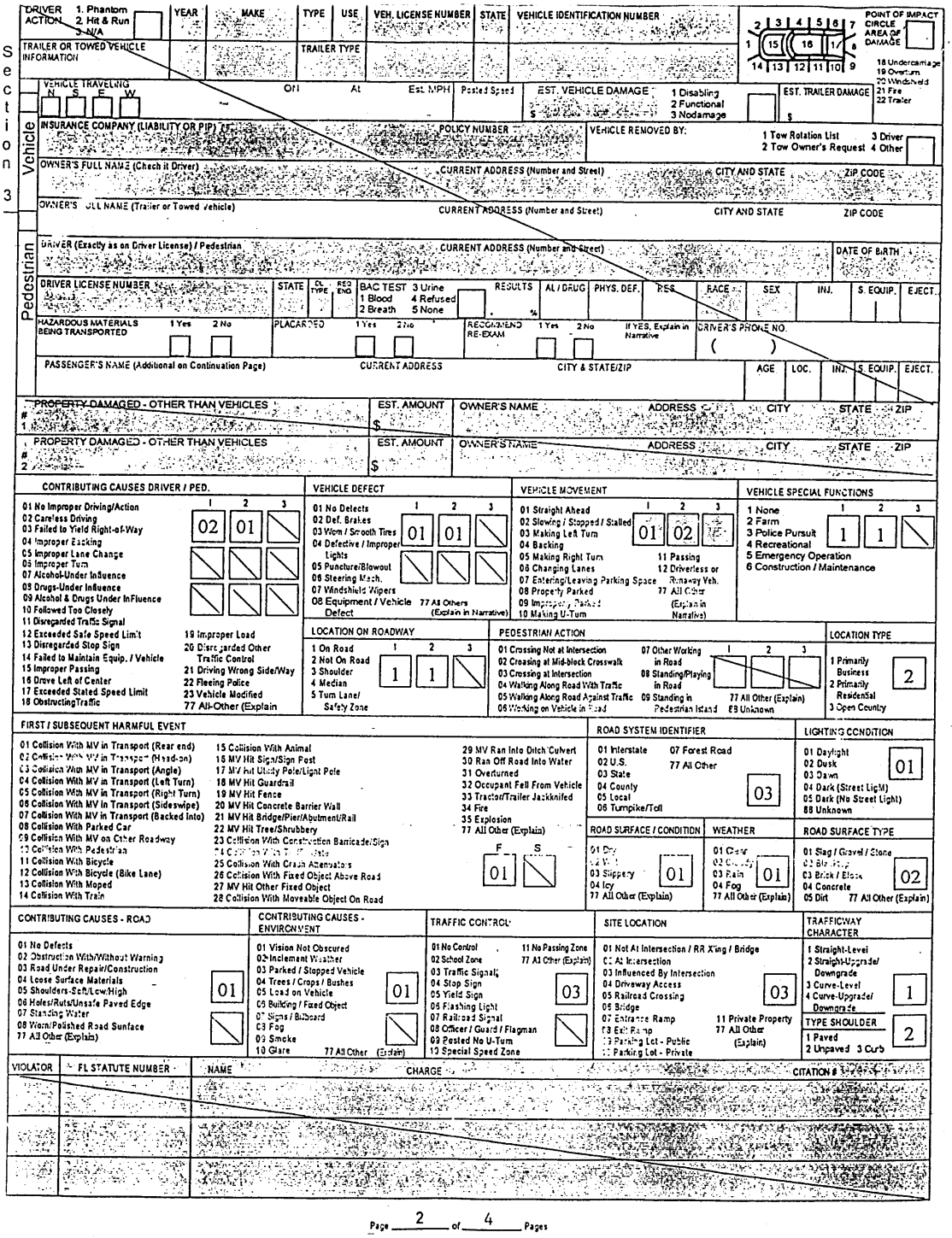


Figure B.13: Average MOT Report 2 - Page 5

FLORIDA TRAFFIC CRASH REPORT
NARRATIVE / DIAGRAM
MAIL TO: DEPT. OF HIGHWAY SAFETY & MOTOR VEHICLES
TRAFFIC CRASH RECORDS
TALLAHASSEE, FLORIDA 32399-0500

DO NOT WRITE IN THIS SPACE

EMS INFO FATALS ONLY	TIME EMS NOTIFIED AM PM	TIME EMS ARRIVED AM PM	COUNTY / CITY CODE	DATE OF CRASH	INVEST. AGENCY REPORT NUMBER	HSMV CRASH REPORT NUMBER
			16 00	09-13-99	99-03-12014-16	57275104

NARRATIVE / ADDITIONAL PASSENGERS

Vehicle 1 was Northbound on State Road 776, approaching the intersection of Overbrook Road.

Vehicle 2 was Southbound on State Road 776 in front of V-1. The traffic signal at State Road 776 and Overbrook Road turned amber and the driver of V-2 applied the brakes to stop.

The driver of V-1 failed to stop and the front of V-1 struck the rear of V-2.

Both vehicles were moved from the roadway prior to my arrival.

SEC. #	PASS. #	PASSENGER NAME	ADDRESS	CITY & STATE	ZIP	Age	Loc.	Inj.	Safety Equip.	Ejecl
2	2					89	3	1	2 1	1

VIOLATOR | FL STATUTE NUMBER | NAME | CHARGE | CITATION #

VIOLATOR | FL STATUTE NUMBER | NAME | CHARGE | CITATION #

WITNESS NAME 1 | ADDRESS | CITY & STATE | ZIP

WITNESS NAME 2 | ADDRESS | CITY & STATE | ZIP

FIRST AID GIVEN BY NAME: 1 Physician or Nurse 2 Paramedic or EMT 3 Police Officer 4 Certified 1st Aider 5 Other | INJURED TAKEN TO: | BY NAME:

WAS INVESTIGATION MADE AT SCENE?	WHERE?	IS INVESTIGATION COMPLETE?	WHY?	DATE OF REPORT	PHOTOS TAKEN?	3 INVEST. AGENCY	4 OTHER
1 Yes ☒ 2 No ☐		1 Yes ☒ 2 No ☐		0 9 1 3 9 9	1 YES ☐ 2 NO ☒	☐	☐

INVESTIGATOR RANK & SIGNATURE	ID / BADGE NUMBER	DEPARTMENT	FHP	SO	CPD	OTHER
Trooper Stan P. Nemitz	1885/1633	Florida Highway Patrol	☒	☐	☐	☐

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Page 3 of 4 Pages

Figure B.14: Average MOT Report 2 - Page 6

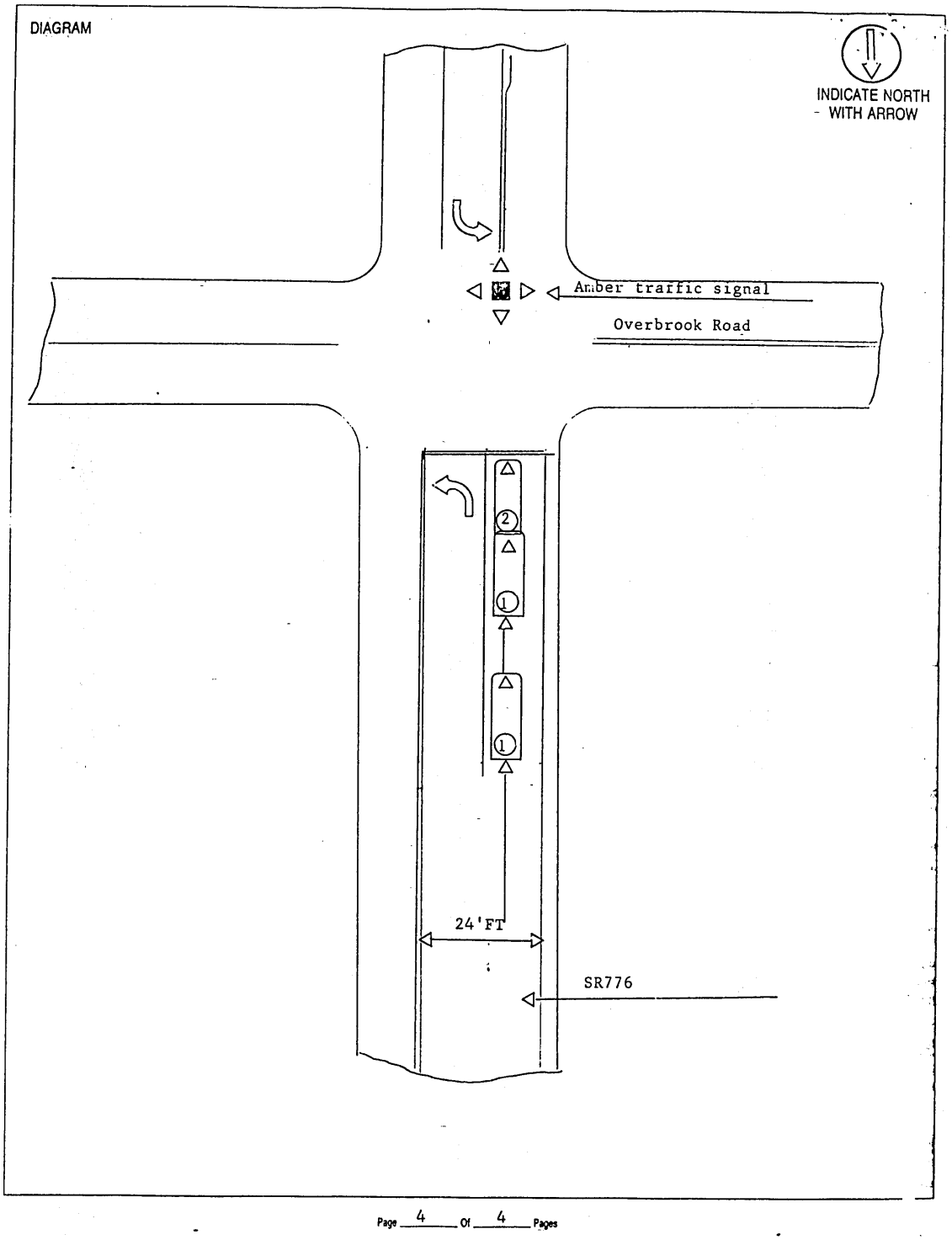

Figure B.15: Average MOT Report 2 - Page 7

Appendix C: Entities and Look-up Tables

Appendix C-1: Entity Creation

Some of the entities (tables) in the MOT database, including Project, MOT, Accident, etc. are described in Chapters 3 and 4 of this report. The remaining entities, such as Transition, Buffer, Work Zone and Termination are described below. The entities are further used to describe the SQL statements for developing and populating a database schema.

SQL syntax for table creation is as follows:

CREATE TABLE <table name> (<column name> <column type> [<attribute constraint>] {,(<column name> <column type> [<attribute constraint>]} [<table constraint> {,<table constraint>}])

SQL Syntax for inserting a value into a table is as follows:

INSERT INTO <table name> [(<column name> {,<column name>})] (VALUES (<constant value>, {<constant value>}){,(<constant value>{,<constant value>})} | <select statement>)

Table Transition:

CREATE TABLE TRANSITION (MOT_ID Number(6), LENGTH Number(4), DEVICE1 Varchar2(10), DEVICE2 Varchar2(10), PAVEMARK Varchar2(5), ELECBOARD Varchar2(17), LOC_CONTROLACT Varchar2(15), MOTD_SPACE Number(4), LOCOF_ELECB Varchar2(20), FOREIGN KEY (MOT_ID) REFERENCES MOT(MOT_ID));

Table Buffer:

CREATE TABLE BUFFER (MOT_ID Number(6), LENGTH Number(4), DEVICE1 Varchar2(10), DEVICE2 Varchar2(10), PAVEMARK Varchar2(5), ELECBOARD Varchar2(17), LOC_CONTROLACT Varchar2(15), VISOBST Varchar2(3), FOREIGN KEY (MOT_ID) REFERENCES MOT(MOT_ID));

Table Work Zone:

CREATE TABLE WORK_ZONE (MOT_ID Number(6), LENGTH Number(4), DEVICE1 Varchar2(10), DEVICE2 Varchar2(10), PAVEMARK Varchar2(5), ELECBOARD Varchar2(17), LOC_CONTROLACT Varchar2(15), NOOF_OPENL Number(2), WIDTH_OPENL Number(4), FOREIGN KEY (MOT_ID) REFERENCES MOT(MOT_ID));

Table Termination:

CREATE TABLE TERMINATION (MOT_ID Number(6), LENGTH Number(4), DEVICE1 Varchar2(10), DEVICE2 Varchar2(10), PAVEMARK Varchar2(5), ELECBOARD Varchar2(17), LOC_CONTROLACT Varchar2(15), FOREIGN KEY (MOT_ID) REFERENCES MOT(MOT_ID));

Appendix C-2: Look-up Table Creation and Values

Look-up table Harmful Event:

CREATE TABLE HARMFUL_EVENT (HARMFUL_EVENT Number(2), DESCRIPTION Varchar2(50), PRIMARY KEY (HARMFUL_EVENT));

Values in look-up table Harmful Event:

```
insert into harmful_event values(01, '');
insert into harmful_event values(02, 'Collision Rear-end');
insert into harmful_event values(03, 'Collision Head-on');
insert into harmful_event values(04, 'Collision Angle');
insert into harmful_event values(05, 'Collision Sideswipe');
insert into harmful_event values(06, 'Collision Construction Worker');
insert into harmful_event values(07, 'Collision Other Pedestrian');
insert into harmful_event values(08, 'Collision Fixed Barrier');
insert into harmful_event values(09, 'Collision Moveable Barrier');
insert into harmful_event values(10, 'Collision Guardrail');
insert into harmful_event values(11, 'Collision Crash Attenuator');
insert into harmful_event values(12, 'Collision Other Fixed Object-
Permanent');
insert into harmful_event values(13, 'Collision Other Fixed Object-
Construction Related');
insert into harmful_event values(14, 'MV Ran into Ditch/Culvert');
insert into harmful_event values(15, 'MV Overturned');
insert into harmful_event values(16, 'Tractor/Trailer Jackknife');
insert into harmful_event values(17, 'Other Collision');
insert into harmful_event values(18, 'Construction Vehicle');
insert into harmful_event values(19, 'Law Enforcement Vehicle');
```

Look-up table Lane Type:

CREATE TABLE LANETYPE (LANE_TYPE Number(1), DESCRIPTION Varchar2(50), PRIMARY KEY (LANE_TYPE));

Values in look-up table Lane Type:

```
insert into lanetype values(01, 'Temporary Lane Closure at Start of Day');
insert into lanetype values(02, '24-Hour Lane Closure');
insert into lanetype values(03, 'Temporary Lane Shift');
insert into lanetype values(04, '24-Hour Lane Shift');
insert into lanetype values(05, 'Temporary Detour');
insert into lanetype values(06, '24-Hour Detour');
insert into lanetype values(07, 'Shoulder Closure');
```

insert into lanetype values(08, 'No Lane Closure');

Look-up table Road Type:

CREATE TABLE ROAD_TYPE (ROAD_TYPE Number(2), DESCRIPTION Varchar2(50), PRIMARY KEY (ROAD_TYPE));

Values in look-up table Road Type:

```
insert into road_type values(01, '2-lane');
insert into road_type values(02, '2-lane with Center Turn Lane');
insert into road_type values(03, '4-Lane Divided Median');
insert into road_type values(04, '4-Lane Undivided');
insert into road_type values(05, '4-lane with Center Turn Lane');
insert into road_type values(06, '6-Lane Divided Median');
insert into road_type values(07, '6-Lane Undivided');
insert into road_type values(08, '6-lane with Center Turn Lane');
insert into road_type values(09, 'Intersection 2-Lane');
insert into road_type values(10, 'Intersection 4-Lane');
insert into road_type values(11, 'Intersection 6-Lane');
insert into road_type values(12, 'Exit Ramp');
insert into road_type values(13, 'Entrance Ramp');
insert into road_type values(14, 'Other');
```

Look-up table Project Type:

CREATE TABLE PROJECT_TYPE (PROJ_TYPE Number(1), DESCRIPTION Varchar2 (50), PRIMARY KEY (PROJ_TYPE));

Values in look-up table Project Type:

```
insert into project_type values(01, 'Resurfacing');
insert into project_type values(02, 'Widening');
insert into project_type values(03, 'Reconstruction');
insert into project_type values(04, 'New Construction');
insert into project_type values(05, 'Other');
```