DEVELOPMENT OF MAINTENANCE METHODS AND COST CODES

in cooperation with the Department of Transportation Federal Highway Administration

RESEARCH REPORT 151-1
STUDY 2-18-71-151
MAINTENANCE
Close cooperation among Texas Highway Department district maintenance operational personnel, central office representatives and the Texas Transportation Institute study team together with a review of the literature provided the necessary information to formulate a list of maintenance activities and to develop maintenance methods and cost codes. The major information presented in the maintenance methods as developed is discussed. A listing of cost codes and the key elements of a maintenance management system are presented.
DEVELOPMENT OF MAINTENANCE METHODS AND COST CODES

by

Jon A. Epps, Irl E. Larrimore, Jr., R. M. Olson and A. H. Meyer

Research Report 151-1
Maintenance Quality, Methods and Ratings
Research Study No. 2-18-71-151

Sponsored by
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TEXAS TRANSPORTATION INSTITUTE
Texas A&M University
College Station, Texas
PREFACE

This is the first report issued under Research Study 2-18-71-151, "Maintenance Quality, Methods and Ratings". This report presents a review of the development of maintenance methods and cost codes suggested for use by the Texas Highway Department. Details of the development of the maintenance rating system and maintenance management programs are contained in separate reports.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the Texas Highway Department personnel in all 25 districts as well as representatives from divisions D-10, D-13, D-18 and D-19 for their time and efforts expended in defining current maintenance methods and activities, review of these methods and guidance in preparing the type of information necessary for effective management of the Texas Highway Department maintenance operations.
ABSTRACT

Close cooperation among Texas Highway Department district maintenance operational personnel, central office representatives and the Texas Transportation Institute study team together with a review of the literature provided the necessary information to formulate a list of maintenance activities and to develop maintenance methods and cost codes. The major information presented in the maintenance methods as developed is discussed. A listing of cost codes and the key elements of a maintenance management system are presented.

KEY WORDS: Maintenance methods, cost codes, management, equipment, materials.
SUMMARY

The basic elements of a maintenance management system have been recognized and defined. These elements include the establishment of maintenance methods, quality standards, evaluation methods, cost codes, maintenance strategy, training, data feedback and trial implementation. This report delineates the development of maintenance methods and cost codes by establishing panels consisting of Texas Highway Department district maintenance personnel, central office personnel, and members of the Texas Transportation Institute.

The establishment of maintenance methods and cost codes form the basis for the further development of the maintenance management system. The establishment of permanent panels to review, revise, and develop new methods should be considered together with the establishment of a management and training section within the maintenance operations division. This appears appropriate to implement the results of the study.

IMPLEMENTATION STATEMENT

The maintenance methods and cost codes developed as part of this study and reported herein are either scheduled for implementation or are being implemented.

Implementation of the maintenance method is widespread, as the methods developed are employed in on-going activities. Implementation of these methods and cost codes are expected to improve efficiency and provide for more uniform maintenance activities throughout the state.

The establishment of training activities based in part on the maintenance methods and cost codes should be organized to provide maximum
benefit to the operational personnel.

The establishment of permanent review panels composed of district maintenance operational personnel and the establishment of a section within the maintenance operations division may be necessary to successfully carry out the task of continued review of the methods and codes.
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INTRODUCTION

Funding for highway maintenance operations in Texas comprises a significant part of the total highway budget. The proportion of the budget is expected to increase as the amount of new construction is reduced and as the highways now in existence become older. This together with public demands for higher and higher levels of service are certain to increase maintenance expenditures. This trend is evident from data presented in Table 1, and in Figure 1 (1).

The Texas Highway Department has a system of maintenance which is managed in each district, the maintenance operations division in Austin provides guidelines and support in the form of manuals and consulting services. That the present system is functioning well is attested to by the excellent condition in which the highways are maintained. Periodic review of maintenance operations in the state are provided when maintenance personnel from the districts meet annually in 3 to 4 groups to discuss mutual problems and successes. These discussions often lead to ways and means to meet current or recurring problems. Areas identified from the meetings include training of maintenance personnel and the necessity of improved maintenance management information. Training needs are based on the desire to improve quality and quantity of work as well as developing the necessary skills in new maintenance employees. The need for improved management information is based on anticipated increased work load, as well as monitoring existing operations and providing information for future work scheduling.

In an attempt to respond to these needs, the Texas Highway Department initiated a cooperative research study with the Texas Transportation
Institute in September of 1970 with the following objectives:

1. Develop a system by which all highway maintenance operations can be coded and placed into functional groups.

2. Develop maintenance quality standards and maintenance methods for the various highway classes.

3. Develop a maintenance rating system that can be used as a basis to schedule highway maintenance operations.

4. Implement on a trial basis the maintenance rating system and assess the established quality standards and maintenance methods.
STUDY APPROACH

To provide for close cooperation between the Texas Highway Department and the Texas Transportation Institute, considered necessary for successful completion of the study, three means of formal contact were established:

1. A study contact man representing the maintenance operations division of the Texas Highway Department was appointed to devote approximately one-half time to the study. This individual has remained the same for the duration of the project and maintained contact with both the study supervisors at the Texas Transportation Institute and Texas Highway Department district personnel.

2. Study panels were established to identify maintenance activities, develop maintenance methods, and to define the type of information that would be useful for maintenance management purposes. These panels were comprised of district supervisory maintenance personnel from each of the districts.

3. An advisory group was formed consisting of representatives of the Texas Highway Department concerned with design, materials and tests, research and maintenance, representatives of the Federal Highway Administration and representatives of the Texas Transportation Institute. The purpose of this group was to furnish overall guidance to the project.
Formal meetings, together with informal contacts made while traveling and after meetings established lines of personal communication between the study supervisors, maintenance operations division contact representative, and the district maintenance personnel. Understanding and acceptance of the information developed in the project was thus greatly enhanced.

Study panels, as will be discussed below, formed the working element of this study. These panels were responsible for identifying the types of maintenance activities currently performed by the Texas Highway Department, for preparing the maintenance methods and for guidance in selecting the appropriate approach to the maintenance evaluation portion of the project.

This report discusses the development of the first two objectives, namely the development of a system by which all highway maintenance operations can be coded and placed into functional groups, and, secondly, the development of maintenance methods. The coding of the maintenance activities, hereafter referred to as cost codes, was developed concurrently with the maintenance methods. After a list of maintenance activities was developed, a systematic code was developed together with a definition of the method to perform this activity. Maintenance methods are commonly referred to as work standards in studies conducted in other states.

A review of literature pertinent to maintenance management has been accomplished in this study. Basic ideas developed for management, and current state practices relative to maintenance management are discussed, as are the procedures utilized to develop the maintenance methods and cost accounting codes suggested for use by the Texas Highway Department.
Importance of Maintenance Management

Francis C. Turner, formerly Director of Public Roads (FHWA), discussed "Maintenance Requirements for the '70's" at a Maintenance Management Workshop held at the Ohio State University in July 1968. He quoted estimates of cost of maintaining the completed Interstate System at $6,400 per year per centerline mile and noted that the report conceded the figure is "probably conservative" and "... it is likely that $10,000 per centerline mile will be a more realistic estimate for the overall mileage".

We have 3,025 miles of Interstate Highways in Texas, at $10,000 per mile per year this represents an annual predicted expenditure of $30,250,000 for maintaining the system. Add to this the annual cost for maintaining the other primary and secondary highways in Texas, and the importance of maintenance management becomes clear as follows:

P. J. F. Wingate, of the Road Research Laboratory (England) concluded his report to the Maintenance Management Workshop.

"To sum up, in Great Britain we must start logically by getting the maintenance task right, i.e., by setting our standards correctly. Then we must get our administration and organization right so that we know what is going on and so that planning and controlling are done correctly. Finally, we must insure that what is to be done on site is done in the most efficient manner. All three of these aims can and are being pursued simultaneously of course, but the emphasis we feel should be placed in the order given - it is false economy to carry out efficiently work that should not be done at all!"

The last phrase bears further consideration. It appears to be a truism, but it also suggests that tasks assigned by managers should be
responsive to the objectives of the organization, and not merely busy work.

Goals of Maintenance Management

Maintenance funds are obtained from the public and accountability for the expenditure of these funds is a primary concern of highway administrators at all levels. Thus, while the maintenance foreman is fully aware of the work he accomplishes on a day-to-day basis, his superiors must evaluate the performance of the maintenance team as a whole and keep records on the expenditure of funds. A management system is required and its importance grows in proportion to the amount of money involved in the operation.

The importance of maintenance management has been established in the preceding paragraphs. The goals of the management system can now be listed:

1. The mission of the highway department must be achieved.
2. Maintenance work accomplished must be necessary to achieve the mission.
3. The amount and quality of work is adequate to meet the needs of the user.
4. Accountability for expenditure of funds must be established and maintained.

These goals although common to all agencies in a general nature are implemented in a variety of ways. A review of state practices will indicate some of the differences.
SURVEY OF SEVERAL STATE HIGHWAY DEPARTMENTS

In December 1971, letters were sent to eleven states requesting information concerning maintenance methods programs. Replies were received from each state, and each state, except North Carolina, sent copies of its standards. The results are summarized in Table 2, and a synopsis of responses from the several highway departments is presented in the following paragraphs, as is additional information which has been obtained from published reports and by other correspondence with highway departments.

Arizona Highway Maintenance Management System

A 24-month research study began in June 1970 and a report (3) was submitted to the highway department in June 1972. The project staff was composed of state and consulting personnel. Review of maintenance standards and procedures was undertaken by a committee. An advisory committee reviewed project progress and provided guidance. Upon completion of the study, the state personnel continued in the maintenance planning functions and the reviewing process. A maintenance management system was developed and results of the system observation were evaluated during a 12-month test period. The report indicates that operating costs were reduced and service level was increased.

Principal system elements included: roadway inventory, quantity and performance standards, work programs and authorization, scheduling, reporting budgeting and evaluation of performance of field units. The report contains examples of forms and techniques developed during the study.
ARKANSAS

A maintenance management research project was begun in 1968, and became operational on January 1, 1972. A manual on maintenance scheduling and reporting aids the maintenance man in the field with work scheduling, management tools, crew schedules, and reporting cards. Thirty-two activity codes are employed and work performance standards define each activity. Information describing a condition needing maintenance, procedure for work to be accomplished, men and equipment required and estimates of daily production are contained in each standard.

California Maintenance Management System

Nineteen maintenance work programs have been established and coded with further classifications for sub-program, activity, standard method, and support activity. An example code includes:

01 - Program: Flexible Roadbed
    -2 - Sub-Program: Surfacing and Patching
    -1 - Activity: Hand Placed
    -1 - Standard Method: Pothole
    -21 - Support Activity: Travel Time

Work standards have been developed for 196 of 361 defined work methods. Scheduling values have been prepared for the remaining work methods; these values are based on historical estimates, performance reporting, work studies, or a combination of these sources. Scheduling values are replaced by work standards as the latter become available.

Illinois Maintenance Management System

The primary objective of this management system is to produce reliable cost and accomplishment data which are to be used in reports to produce a flow of information to the several supervisory and administrative levels. The field reporting was initiated July 1, 1967 when collection and recording
of cost data became a computerized process. Several months of preparation were required before the change was made. New forms and procedures were prepared, and personnel training was required to change from a manual operation in the 10 districts to the central computerized operation. Changes in field operations were also established in January 1970; foremen are expected to participate in the work.

An essential feature of the system is a roadway inventory, which includes lane miles of roadway pavement, acres of mowing, lengths of bridges, miles of ditches, and other items of work. The inventory compares potential work load, and in conjunction with costs will become the basis for performance budgeting. Several reports are generated by the system, but simplicity in field reports is an important consideration. Each district has a remote terminal tied into the central computer.

Development of performance standards is a function of maintenance personnel from the various geographical areas of the state and several supervisory levels. Fifteen standards are in use, and others are being developed.

*Louisiana Maintenance Standards*

Louisiana originally developed 115 functions, and trimmed these to 92 in 1971, further trimming to 85 functions is under consideration. Quality standards have been established for 30 functions, and accomplishment reporting is required on several other functions. Quality standards have been developed, and in conjunction with unit costs an annual work plan is prepared which is the basis for the budget.

An interesting feature of some of the standards is the use of photographs for illustrating conditions requiring maintenance. A description of what causes the condition, the need for repair and how to make repair is contained in the standard; as are helpful hints to the field man.
Minnesota Maintenance Standards Field Manual

The purpose of the manual is to assist management in work scheduling, planning and budgeting. Minnesota law requires all state departments to budget by activity and the manual is designed to assist in the budgeting procedure. The manual is not a rigid management policy, but is a guide to indicate the best rate of production based on crew production studies, audits or work reported and the consensus of the Field Productivity Standards Committee.

Forty-three maintenance operations are coded in five classes: routine, special, extraordinary, betterment and non-roadway. Operations in the field are supervised by a working member of the crew. Emphasis is placed on standard crew size, because studies indicate that productive crew size is one of the most important factors in efficient operations.

New Jersey Maintenance Work Standards

The work standards contain 133 function codes and descriptions, each of which contains the payment unit (hour, square yard, etc.), the basic crew, work factors hours per unit, and units per hour. Equipment, material and tools required for each function is listed on each standard. New Jersey has a Safety Manual, and each standard contains a note which states that safety practices must conform with the Safety Manual.

Oregon Maintenance Management System

Mr. Tom Edwards, Deputy State Highway Engineer, reported to an HRB meeting at Austin, Texas in August 1971 that:

"Oregon's Maintenance Management System is based upon a numerical recording of data which adapts itself admirably to computerized control."
Maintenance and minor betterments are coded into twenty-one activities, or items of work. These code numbers are tied into the county and control numbers, which provides for charging of labor and materials to the proper section of the highway. Equipment is given a fleet code number and daily rental rates are charged to the appropriate highway section. Reports are submitted to the central staff and budget control is established.

South Dakota Maintenance Functions, Quality Standards, and Productivity Standards

A maintenance study began in July 1968 and was implemented in July 1, 1971. The manual contains 77 function codes, 17 productivity standards, and 21 performance standards. Equipment, manpower, daily production and average unit costs are provided; as are descriptions, purpose, quality of work, scheduling and procedures for performance. Productivity and performance standards are to be developed for all function codes.

Tennessee Maintenance Management Improvement Program

A management research study (4) was completed in January 1970. Review of costs records and distribution of expenditures for twenty function codes was conducted. Work performance by crews and organizational structure was examined. Examples of maintenance activities in a program, performance standards, costs budgets and comparisons of illustrative budgets with actual 1969 expenditures are presented in the report.

Utah Maintenance Management System

A twenty-eight-month research study was completed in September 1969, and the final report (5) contained the results of the study which was prepared by the project staff consisting of highway and management consulting personnel. An advisory committee and a maintenance standards panel worked actively
during the course of the research effort. The management system elements consist of: standards and planning values, work program and performance budget, procedures for planning, scheduling, and performing work, work reporting system, and performance evaluation.

A Foreman's Handbook is used as a guide for performance of maintenance work. Approximately forty activities are defined, and standards have been developed for each activity. Reports on progress are made on a Period Activity Record Form, on which daily entries are made by the foreman.

Virginia Maintenance Program

Fourteen ordinary maintenance activities are coded for purpose of preserving each facility as near as possible in its condition as constructed. Eight maintenance replacement activities are coded for the purpose of restoring of facilities where such restoration becomes necessary.

Maintenance training material is available for some activities and is being prepared for other activities; methods and crew size are included in these training guides.

Washington Maintenance Work Control System

A Time Standards Manual was developed for daily use by field supervisors. Each standard defines the amount of time required to complete a unit of work, personnel and equipment requirements, purpose, procedures and special considerations. Planning of work and consistency in activity evaluation are provided by the standards. The manual contains ninety coded operations which were developed from extensive studies in the field and revised when necessary from historical data maintained by computer.
Interim standards are employed in the field, but are subject to revision.

Another type of manual is used to disseminate information not covered by time standards. These manuals are concerned with new processes, or a field of related operations; and are intended for use in the field as guidelines for training as well as performing work.

A third manual on Quality Standards provides criteria for the maintenance work control system. Description of maintenance activities is employed rather than a measured value. The quality standards provide guidance to a supervisor for evaluating work accomplishments.

**SUMMARY OF LITERATURE**

Based on the above literature review it appears that several basic elements are necessary for a successful maintenance management program.

1. Methods for performing individual maintenance activities should be established. These methods provide the manager with a clear, concise statement of the method by which his forces are to proceed to accomplish a selected activity. These methods should be under constant review and provision should be made to perform this continuing task.

2. Standards of quality should be established. The maintenance methods described in the guidelines discussed in item (1) may require a variety of quality control. For example, the standard for an Interstate Highway will require higher quality than that for a lightly traveled farm or ranch road. The proper amount of work and quality of that work can be determined by the standard established for the task.

3. An inventory control should be established. In whatever form
it might take, it is clear that the manager at whatever level should have an inventory of the traveled way and its appurtenances.

4. Evaluation of the maintenance operation described by its method and controlled by the standard of quality should be a function of the management system. Such continuing evaluation will provide the manager with a clear indication of how well the funds are being expended. It will also permit re-evaluation of the standards, and will determine how effectively the task is being done on the job. Where productivity is lagging, newer methods and techniques may need to be established to reduce expenditures.

5. Priorities for scheduling improvement should be developed. This element of a management system will require firm control by the manager, lest he and his operation find themselves carrying out "...efficiently work that should not be done at all."

6. A cost accounting method should be established. This element, like inventory control, is a bookkeeping method. Here, however, it is the dollars and cents history of what has been accomplished, and the basis for making estimates for future maintenance. Inventory control and cost accounting can become the be-all and end-all of any management process; unless the manager recognizes that these two functions are the servants not the dictators of the management system. The manager must be ever cognizant of the goals of the system, of which accountability is one quarter of the overall goal. The other three-quarters being the mission of the highway department in making necessary maintenance repairs and improvements to meet the needs of the user.
through appropriate standards of quality.

7. A maintenance strategy should be established. This element is needed to coalesce the other elements into meaningful, cost-effective, user oriented effort. The success or failure of a strategy is dependent upon the tactics employed to achieve the goals of the planned tactical efforts. In the history of warfare, many great tactical victories have been won, but strategical failures have led to losing the war. Conversely, great strategies without adequate tactics can produce defeat. Thus, the manager must have both strategy and tactics at his command.

In small operations the several elements (or tactics) make up the strategy. In large operations the manager must employ a strategy which is consistent with the other elements of the management system. Decision making can be at the upper echelons of a system, it can be centralized; or it can be delegated to the level appropriate to the task function. Probably the most onerous chore for the manager is selecting the strategy which will best fit the goals of the organization.

8. Maintenance training should be a part of the system. The training must be a continuing effort and centered not only on the engineering aspects as defined by the maintenance methods and evaluation techniques but also it must be concerned with management principles and utilization of information provided by the management system.

9. The establishment of a data bank capable of providing needed information for management purposes as well as accounting
purposes is necessary. This data bank must be easily accessible and have the capability of providing information in a time frame compatible with the need for the information at several levels in the decision making process.

10. A period of trial implementation is desirable during the development of new methods. New evaluation techniques and the utilization of management feedback information can be appraised during this trial period.

DEVELOPMENT OF COST CODE AND MAINTENANCE METHODS

Initial work on the study concerned development of methods to classify maintenance activities. A review of the literature previously cited produced data shown in Table 3. Based on the table and discussions with Texas Highway Department Maintenance Operations Division personnel five major areas were identified for the purpose of establishing study panels. These panels were formed during the first 6 months of the project and were composed of district personnel, representatives of the maintenance division and the Texas Transportation Institute. The panels and their respective areas of responsibility were:

- PANEL A - Base and Subgrade
- PANEL B - Bituminous Surfaces and Shoulders and Approaches
- PANEL C - Portland Cement Concrete Surfaces
- PANEL D - Roadside Maintenance
- PANEL E - Structures

The original members of the panels are shown in Table 4. These panels have remained active during the project although the composition of the panels have changed due to retirements and promotions. The existing composition of the panels is shown in Table 5.
As noted in Tables 4 and 5 each district was represented with a meeting held as required at the various district offices located throughout the state. The first round of panel meetings was held to describe the objectives of the study, to identify existing maintenance operations and to assign responsibility for development of the maintenance methods. Subsequent meetings were held to review the developed methods, assign responsibility for developing additional methods, and to initiate action on the development of the maintenance evaluation techniques. A total of 5 rounds of panel meetings have been held to develop in excess of 200 maintenance activities currently performed by Texas Highway Department maintenance forces.

**Maintenance Method**

A typical example of a maintenance method developed by the panel is shown in Plate 1. The major information provided in the method is described below.

**Identification.** This top portion of the method gives the title and the cost code number.

**Definition.** This section defines the activity that is described below. The conditions favoring use are stated to provide guidance in terms of traffic, size, extent, or other conditions that would favor the use of this method over some other method. The procedure defines a step by step method for accomplishing the maintenance activity together with the necessary men, equipment, materials, and small tools necessary for proper performance of the activity.

**Performance Data, Quantitative.** This section of the method is intended to give the reader an indication of the cost and production that can be expected by use of the method under average conditions. The cost data were
obtained from one or more districts by use of a form shown in Plate 2.

Performance Quality Standard and Method of Rating. This item indicates in a very general way the level to which the maintenance activity should be performed and the method to make this evaluation.

Scheduling. This section provides a delineation of the time of year or under what conditions the activity should be performed.

Comments. Alternative types of materials, new equipment and potential problems are often included in the section.

Cross References. The reader is provided with code numbers of other methods that pertain to use of the method being described.

Cost Codes

Parallel to the development of maintenance methods, coding of the methods for cost accounting purposes was studied. Results of this study are shown in Appendix A. Seven maintenance categories were established as shown below:

100 Base and Subgrade
200 Surfaces
400 Shoulders and Approaches
500 Roadside Maintenance
600 Structures over 20 Feet
700 Traffic Surfaces
800 Extraordinary Maintenance
Subgroups were defined in each of the seven categories, and the subgroups were further subdivided, as required. For example item 521 identifies a roadside maintenance activity - "litter pick-up by hand". The first digit indicates a 500 series activity which is reserved for roadside maintenance. The 520 series represents litter pick-up and the particular item 521 indicates that litter is removed by hand. Items 522 and 523 refer to litter pick-up by a "tow type" of machine and by a "self-propelled machine with shredder" respectively.

As noted from the above example these function codes can be utilized to compare alternative methods of performing the same basic activity such as litter pick-up. It is anticipated that this type of information will be helpful in establishing the type of action that is required under a given set of conditions. This three digit system will be implemented in September of 1975.

DISCUSSION

The formation of cost codes and maintenance methods form the background necessary for the development of an improved maintenance management system. Continued revisions of the methods established, deletion of certain methods and the addition of methods will be necessary in the future. The establishment of permanent panels composed of district operational personnel and the establishment of a section within the maintenance operation division may be necessary to successfully carry out the task.

Performance quality standards which comprise part of the maintenance method need to be improved and quantified where possible. Development of the maintenance rating system should provide a valuable input to the need.

A continuous collection of performance data with feedback to the
working panels is necessary. The rapid rate of inflation together with the need to evaluate existing standards makes this an important item.

The establishment of training activities based on the maintenance methods, cost codes and evaluation techniques, and management principles should be organized to provide maximum benefit to the operational personnel. These training activities should lead to rapid implementation of all phases of the study.

Implementation of the results discussed in this report is widespread, as the methods developed in the study are used in on-going activities. Exchange of ideas through these methods is evident. The cost codes will be implemented in September of 1975.
REFERENCES

1. Texas State Highway Department Biennial Report, Austin, Texas.


7. Larrimore, Irl, Senior Field Engineer, Texas Highway Department, Personal Correspondence.


Figure 1. Maintenance Expenditures in Texas 1960 Through 1970. [After Reference (1).]
## Plate 1: Typical Maintenance Method

<table>
<thead>
<tr>
<th>REPAIR OF POT HOLES</th>
<th>Cost Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary</td>
<td>262</td>
</tr>
</tbody>
</table>

### Definition
The temporary repair of bowl-shaped holes of various sizes in an asphalt pavement.

### Method

#### Conditions Favoring Use
The temporary method of repair should be used anytime that the permanent method cannot be, such as adverse weather conditions, traffic too heavy, etc.

#### Procedure
1. Provide adequate traffic control.
2. Remove water and loose material from the hole.
3. Backfill the hole with one of the following types of material:
   a. Base material or crushed gravel.
   b. Base material and an asphaltic concrete material.
   c. Asphaltic concrete material.
   d. In case of a submerged hole, asphaltic concrete material in burlap bag.
4. Compact the patch as well as possible by hand operated equipment or truck wheel.

#### Men
3 Crewmen with capability of operating truck and placing asphaltic concrete material. Flagmen as needed.

#### Equipment
- Truck
- Signs and Barricades as required

#### Small Tools
- Asphalt rake
- Broom
- Hand Tamp

#### Materials
- Base material
- Asphaltic concrete material
PLATE 1: Typical Maintenance Method (Continued)

<table>
<thead>
<tr>
<th>PERFORMANCE DATA, QUANTITATIVE</th>
<th>Unit of Measure -- Cubic Yard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Cost Labor</td>
<td>Unit Cost Traffic Control</td>
</tr>
<tr>
<td>Unit Cost Preparation</td>
<td>Total Unit Cost</td>
</tr>
<tr>
<td>Unit Cost Travel</td>
<td>Labor Required Hours/Unit (Net)</td>
</tr>
<tr>
<td>Unit Cost Equipment</td>
<td>Labor Required Hours/Unit (Cross)</td>
</tr>
<tr>
<td>Unit Cost Materials</td>
<td>Approximate Accomplishment Per day</td>
</tr>
</tbody>
</table>

PERFORMANCE QUALITY STANDARD

Provide a reasonably smooth and safe riding surface until permanent repairs can be completed.

METHOD OF RATING

1. Test ride the repaired surface at designated speed limit to insure smoothness.
2. Make a visual inspection to insure that a neat appearing surface which adequately prevents surface water from passing into the base or subgrade is produced.

SCHEDULING

Temporary repairs may be performed at any time as needed.

COMMENTS

1. During wet weather cement may be added to the asphalt patching material and around the exposed surfaces of pot holes to add stability to the patch.
2. An infrared heater, butane burner, or other system may be used for drying the hole and patch.
3. An "Ejecto" truck may be useful in this operation.

CROSS REFERENCES
PLATE 2: Performance Data Gathering Form

Activity Code No. ___________ Date ___________
Method ___________ Unit of Measure ___________
District ____ Foreman No. ____ County ____
Highway No. ________ Location ______________________ (Milepost, distance from intersection, etc.)

PERSONNEL DATA

<table>
<thead>
<tr>
<th>Title</th>
<th>Comp Rate</th>
<th>Hours in Preparation</th>
<th>Hours on Travel</th>
<th>Hours Traffic Control</th>
<th>Hours Performing Activity</th>
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EQUIPMENT DATA

<table>
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<th>Equip. Number</th>
<th>Rate</th>
<th>Hours or Miles in Preparation</th>
<th>Hours or Miles on Travel</th>
<th>Hours, Miles Traffic Control</th>
<th>Hours, Miles Performing Activity</th>
<th>Description of Equipment</th>
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Quantity of Material Charged __________________________
Unit Cost of Material Charged _________________________
Total Cost of Material Charged ________________________
Quantity of Work Performed ______ Work Performed per Day ______
Labor Required _______ (Hrs/Unit) Unit Cost ___________
### Table 1: Highway Expenditures in Texas

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Total Disbursements</th>
<th>Construction</th>
<th>Maintenance</th>
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<td>562,358,008.43</td>
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<td>407,545,010.17</td>
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<td>447,685,578.01</td>
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<td>69-70</td>
<td>682,469,094.86</td>
<td>514,782,405.36</td>
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<td>70-71</td>
<td>708,897,968</td>
<td>525,843,854</td>
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<td>103,613,168.84</td>
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<td>72-73</td>
<td>640,754,258</td>
<td>431,670,158</td>
<td>116,341,062</td>
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</tbody>
</table>

* a) Regular Maintenance, Betterment, Traffic Services and Structural maintenance.

* b) Special and regular maintenance betterments and traffic services.

(after reference 1)
TABLE 2: SUMMARY OF RESPONSES TO LETTER REQUESTS

<table>
<thead>
<tr>
<th>STATE</th>
<th>RESPONDER</th>
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<tbody>
<tr>
<td>Arkansas</td>
<td>Bert Rownd</td>
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<tr>
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<td>Maintenance Engineer</td>
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<tr>
<td>California</td>
<td>C. E. Forbes</td>
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<tr>
<td></td>
<td>Maintenance Engineer</td>
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<tr>
<td>Illinois</td>
<td>E. J. Keel</td>
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<tr>
<td></td>
<td>Engineer of Maintenance</td>
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<tr>
<td>Louisiana</td>
<td>F. E. Crawford</td>
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<tr>
<td></td>
<td>Assistant Road Maintenance Engineer</td>
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<tr>
<td>Minnesota</td>
<td>J. S. Katz</td>
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<tr>
<td></td>
<td>Maintenance Methods Engineer</td>
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<tr>
<td>New Jersey</td>
<td>John C. Gibson</td>
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<tr>
<td></td>
<td>Chief Engineer</td>
</tr>
<tr>
<td></td>
<td>Construction and Maintenance</td>
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<tr>
<td>North Carolina</td>
<td>Paul J. DuPre</td>
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<td></td>
<td>State Maintenance Engineer</td>
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<tr>
<td>South Dakota</td>
<td>Eugene Rowen</td>
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<td></td>
<td>Project Coordinator</td>
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<td>Highway Maintenance Study</td>
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<tr>
<td>Utah</td>
<td>Henry C. Helland</td>
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<tr>
<td></td>
<td>Director of Highways</td>
</tr>
<tr>
<td>Virginia</td>
<td>C. O. Leigh</td>
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<tr>
<td></td>
<td>Assistant Maintenance Engineer</td>
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<tr>
<td>Washington</td>
<td>Donald R. Anderson</td>
</tr>
<tr>
<td></td>
<td>Roadway Maintenance Engineer</td>
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<tr>
<td>Province</td>
<td>Province</td>
</tr>
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<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>Alberta</td>
<td>British Columbia</td>
</tr>
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</table>

**Table 3: Classification of Maintenance Operations**

- **Facilities**
  - Roads
  - Transportation
  - Public Works
- **Operations**
  - Planning
  - Design
  - Construction
  - Maintenance
- **Services**
  - Traffic
  - Safety
  - Environmental
  - Security
### TABLE 4: ORIGINAL PANEL MEMBERS 1972

<table>
<thead>
<tr>
<th>PANEL</th>
<th>NAME</th>
<th>MEMBERS</th>
</tr>
</thead>
</table>
| A     | BASE AND SUBGRADE | J. M. McDowell, Chairman, Dist. 1  
|       |                  | L. S. Thompson, Dist. 20  
|       |                  | J. N. Dominey, Dist. 22  
|       |                  | J. O'Connell, Dist. 17  
|       |                  | R. P. Hudson, Dist. 19 |
| B     | BITUMINOUS SURFACES AND SHOULDERS AND APPROACHES | S. G. Cox, Jr., Chairman, Dist. 21  
|       |                  | J. L. Wilder, Jr., Dist. 24  
|       |                  | W. B. Collier, Dist. 26  
|       |                  | W. F. Adams, Dist. 22  
|       |                  | R. S. Martin, Jr., Dist. 23 |
| C     | PORTLAND CEMENT CONCRETE SURFACES | V. F. Matusek, Chairman, Dist. 13  
|       |                  | B. E. Davis, Dist. 2  
|       |                  | G. G. Cleveland, Dist. 9  
|       |                  | J. H. Doss, Dist. 12  
|       |                  | C. H. Brown, Dist. 20 |
| D     | ROADSIDE MAINTENANCE | A. L. McKee, Chairman, Dist. 8  
|       |                  | F. L. Ragland, Dist. 3  
|       |                  | R. C. Liles, Dist. 4  
|       |                  | J. W. King, Dist. 6  
|       |                  | J. H. Swaringen, Dist. 25 |
| E     | STRUCTURES | J. R. Evans, Chairman, Dist. 7  
|       |                  | R. S. Neal, Dist. 6  
|       |                  | H. Schneeman, Jr., Dist. 16  
|       |                  | G. Green, Dist. 18  
<p>|       |                  | J. L. Lawrence, Dist. 24 |</p>
<table>
<thead>
<tr>
<th>PANEL</th>
<th>NAME</th>
<th>MEMBERS</th>
</tr>
</thead>
</table>
| A     | BASE AND SUBGRADE | J. M. McDowell, Chairman, Dist. 1  
L. S. Thompson, Dist. 10  
J. N. Dominey, Dist. 11  
W. T. Byford, Dist. 17  
R. P. Hudson, Dist. 19 |
| B     | BITUMINOUS SURFACES AND SHOULDERS AND APPROACHES | S. G. Cox, Jr., Chairman, Dist. 21  
J. L. Wilder, Jr., Dist. 14  
W. B. Collier, Dist. 15  
W. F. Adams, Dist. 22  
R. S. Martin, Jr., Dist. 23 |
| C     | PORTLAND CEMENT CONCRETE SURFACES | V. F. Matusek, Chairman, Dist. 13  
B. E. Davis, Dist. 8  
G. G. Cleveland, Dist. 9  
J. H. Doss, Dist. 12  
C. H. Brown, Dist. 20 |
| D     | ROADSIDE MAINTENANCE | F. L. Ragland, Chairman, Dist. 3  
R. C. Liles, Dist. 4  
W. M. Pope, Dist. 5  
F. M. Shave, Dist. 3  
J. H. Swaringen, Dist. 25 |
| E     | STRUCTURES | J. R. Evans, Chairman, Dist. 7  
R. S. Neal, Dist. 6  
R. G. Welsch, Dist. 16  
G. Green, Dist. 13  
J. L. Lawrence, Dist. 24 |
APPENDICES

APPENDIX A. MAINTENANCE ACTIVITY COST CODES
100 Base and Subgrade

110 Removal of Base and/or Subgrade

120 In Place Repair - No Stabilizer

130 In Place Repair - Stabilizers (Maintainer)

131 In Place Repair Existing Base and/or Subgrade - Add Lime
132 In Place Repair Existing Base and/or Subgrade - Add Cement
133 In Place Repair Existing Base and/or Subgrade - Add Asphalt
134 In Place Repair Existing Base and/or Subgrade - Add Sand
135 In Place Repair Existing Asphalt Stabilized Base - Add Sand

140 In Place Repair - Stabilizers (Maintainer and Mixing Machine)

141 In Place Repair Existing Base and/or Subgrade - Add Lime
142 In Place Repair Existing Base and/or Subgrade - Add Cement
143 In Place Repair Existing Base and/or Subgrade - Add Asphalt
144 In Place Repair Existing Base and/or Subgrade - Add Sand
145 In Place Repair Existing Asphalt Stabilized Base - Add Sand

150 Repair Existing Base and/or Subgrade Other Than In Place

160 Install and/or Maintain Sub-drains - All Types
Surfaces

Seal Coat

- Aggregate Seal Coat
- Strip or Spot Seal Coat - Major
- Strip or Spot Seal Coat - Minor
- Fog or Sheet Sealing

Leveling or Overlay

- Spot Leveling - Blade Spread
- Spot Leveling - Hand
- Spot Leveling - Hot Box
- Level-up Blade - Sections
- Level-up Blade - Continuous
- Overlay - Major
- Overlay - Minor
- Underseal

Improve Texture

- Treat Bleeding Pavement - Add Aggregate
- Treat Bleeding Pavement - Heating Aggregate
- Treat Bleeding Pavement - Heating Pavement
- Heater Planer Work
- Grooving (ACP)
- Grooving (Concrete Pavement)
- Improve Pavement Texture - Basic (CRCP)
- Improve Pavement Texture - Basic (RCP)

Rutting and Shoving

- Repair Rutting and Shoving - Basic
- Repair Rutting and Shoving - Trim and Overlay

Cracks and Joints

- Seal Cracks and/or Joints - Major
- Seal Cracks and/or Joints - Minor
- Seal Cracks - Squeegee
- Seal Cracks - Major Operation (CRCP)
- Seal Cracks - Minor Operation (CRCP)
- Seal Cracks - Hot Rubber (CRCP)
- Seal Cracks - Major Operation (RCP)
- Seal Cracks - Minor Operation (RCP)
- Seal Cracks - Hot Rubber (RCP)
260 Potholes and Spalling
   261 Repair Potholes - Permanent
   262 Repair Potholes - Temporary
   263 Repair Potholes - Hot Box
   264 Repair Spalling - Basic (Epoxy-CRCP)
   265 Repair Spalling - Asphalitic Concrete (CRCP)
   266 Repair Spalling - Basic (Epoxy-RCP)
   267 Repair Spalling - Asphalitic Concrete (RCP)

270 Edge Repairs
   271 Edge Repairs - Basic
   272 Edge Repairs - Box
   273 Seal Joint Between Pavement and Shoulder - Basic (Cat Blown-CRCP)
   274 Seal Joint Between Pavement and Shoulder - Cutback (CRCP)
   275 Seal Joint Between Pavement and Shoulder - Basic (Cat Blown-RCP)
   276 Seal Joint Between Pavement and Shoulder - Cutback (RCP)

280 Remove and Replace Concrete Pavement
   281 Removing and Replacing - Basic (CRCP)
   282 Removing and Replacing - Fast Set Cement (CRCP)
   283 Removing and Replacing - Stabilized Base (CRCP)
   284 Removing and Replacing - Normal Portland Cement (Minor Repairs-CRCP)
   285 Removing and Replacing - Basic (RCP)
   286 Removing and Replacing - Fast Set Cement (RCP)
   287 Removing and Replacing - Stabilized Base (RCP)
   288 Removing and Replacing - Normal Portland Cement (Minor Repairs-RCP)

290 Blow-ups, Joint and Stress Relief
   291 Repair Blow-up - Permanent (RCP)
   292 Repair Blow-up - Temporary (RCP)
   293 Seal Contraction and Expansion Joints - Basic (RCP)
   294 Seal Contraction and Expansion Joints - Emulsion with Latex (RCP)
   295 Seal Contraction and Expansion Joints - Hot Rubber (RCP)
   296 Stress Relief - CRCP
   297 Stress Relief - RCP
400 Shoulders and Approaches

410 Seal Coat Shoulders

411 Aggregate Seal Coat Shoulders
412 Strip or Spot Seal Coat Shoulders - Major
413 Strip or Spot Seal Coat Shoulders - Minor
414 Fog or Sheet Sealing Shoulders

420 Leveling or Overlay Shoulders

421 Spot Leveling Shoulders - Blade Spread
422 Spot Leveling Shoulders - Hand
423 Spot Leveling Shoulders - Hot Box
424 Level-up Shoulders - Blade, Sections
425 Level-up Shoulders - Blade, Continuous
426 Overlay Shoulders - Major
427 Overlay Shoulders - Minor

430 Treat Bleeding, Rutting and Shoving Shoulders

431 Treat Bleeding Shoulders - Add Aggregate
432 Treat Bleeding Shoulders - Heating Aggregate
433 Treat Bleeding Shoulders - Heating Paved Shoulder
434 Heater Planer Work Shoulders
435 Repair Rutting and Shoving Shoulders - Basic
436 Repair Rutting and Shoving Shoulders - Trim and Overlay

440 Cracks and Joints, Shoulders

441 Seal Cracks and/or Joints, Shoulders - Major
442 Seal Cracks and/or Joints, Shoulders - Minor
443 Seal Cracks, Shoulders - Squeegee

450 Potholes and Edge Repairs, Shoulders

451 Repair Potholes, Shoulders - Permanent
452 Repair Potholes, Shoulders - Temporary
453 Repair Potholes, Shoulders - Hot Box
454 Edge Repairs, Shoulder - Basic
455 Edge Repairs, Shoulder - Box

460 Repair Existing Base and/or Subgrade Other Than In Place, Shoulders

461 Removal of Base and/or Subgrade, Shoulders
462 Replacement of Removed Base and/or Subgrade, Shoulders - Stabilized Material
463 Replacement of Removed Base and/or Subgrade, Shoulders - Non-Stabilized Material
470 In Place Repair Existing Base and/or Subgrade, Shoulders

471 In Place Repair Shoulders - No Stabilizer
472 In Place Repair Shoulders - Add Lime (Maintainer)
473 In Place Repair Shoulders - Add Cement (Maintainer)
474 In Place Repair Shoulders - Add Asphalt
475 In Place Repair Shoulders - Add Sand (Maintainer)
476 In Place Repair Shoulders - Add Lime (Maintainer and Mixing Machine)
477 In Place Repair Shoulders - Add Cement (Maintainer and Mixing Machine)
478 In Place Repair Shoulders - Add Asphalt (Maintainer and Mixing Machine)
479 In Place Repair Shoulders - Add Sand (Maintainer and Mixing Machine)

480 Unpaved Shoulders

481 Recondition Sod Shoulders
482 Blade Flexible Shoulders - Maintainer and Pneumatic Roller
483 Blade Flexible Shoulders - Two Machines
484 Blade Flexible Shoulders - One Machine Kickoff Blade
485 Blade Flexible Shoulders - Maintainer

490 Approaches, Driveways, Turnouts

491 Public Side Road Approaches
492 Driveways - Valley and Pipe Type
493 Driveways - Safety Island
500 Roadside Maintenance

510 Mowing

511 State Owned Mowers
512 Leased Mowers
513 Full Width Mowing - State Owned Mowers
514 Full Width Mowing - Leased Mowers
515 Specialized Mowers
516 Hand Clean-up

520 Litter

521 Litter Pick-up - Hand
522 Litter Pick-up - Machine (Tow Type)
523 Litter Pick-up - Machine (Self-propelled with Shredder)
524 Street Sweeping
525 Maintain Litter Barrel

530 Rest Area Maintenance

531 Maintain Rest Areas - Comfort Stations
532 Maintain Rest Areas

540 Chemical Vegetation Control

541 Chemical Vegetation Control - Basic
542 Chemical Vegetation Control - Shoulder Edges
543 Chemical Vegetation Control - Spray Mesquite
544 Chemical Vegetation Control - Channels

550 Establish and Maintain Vegetation

551 Establish Vegetation - Basic
552 Establish Vegetation - Mulch Sodding
553 Establish Vegetation - Asphalt Mulch
554 Establish Vegetation - Small Hand Operation
555 Establish Vegetation - Disk or Drill
556 Maintain Sprinkler System Urban Areas

560 Pruning and Planting

561 Pruning and Brush Control - Minor
562 Pruning and Brush Control - Major
563 Pruning and Brush Control - Chipper
564 Planting - Large
565 Planting - Small
570 Silt and Erosion

571 Silt Removal - Basic
572 Silt Removal - Hydraulic Telescopic Boom Type Excavating Machine
573 Reshape Ditch and Slope - Basic
574 Ditch Retards - Grass
575 Ditch Retards - Concrete
576 Ditch Retards - Other
577 Ditch Liners - Jute
578 Ditch Liners - Concrete

580 Remove Silt From Culverts

581 Up to 36"
582 36" to 6' x 6'
583 6' x 6' to Bridge Class
600 Structures Over 20 Feet

601 Inspection Cost

610 Bridge Decks

611 Repair of Bridge Deck Spalling and Delamination - Portland Cement
612 Repair of Bridge Deck Spalling and Delamination - Epoxy
613 Repair of Bridge Deck Spalling and Delamination - Quick Setting Cements
614 Armor Joint Repair
615 Clean Bridge Deck - Mechanical
616 Clean Bridge Deck - Hand

620 Substructure - Concrete

621 Substructure Crack Repair
622 Substructure Crack Repair - Pressure Grouting
623 Repair of Badly Cracked or Spalled Substructure
624 Repair of Badly Cracked or Spalled Substructure - Collar
625 Repair of Badly Cracked or Spalled Substructure - Gunite
626 Repair Bearing Plates - Replace Lead Sheeting (Concrete Beams)
627 Substructure Waterproofing
628 Substructure Waterproofing - Epoxy Coating

630 Substructure Steel

631 Repair of Steel Substructure
632 Repair of Steel Substructure - Asphalt

640 Substructure - Timber

641 Repair of Timber Substructures
642 Removal of Timber Substructures

650 Railing

651 Paint Railing - Spray (Hand Cleaning)
652 Paint Railing - Hand
653 Paint Railing - Spray (Sandblast Cleaning)
654 Paint Railing - Touch-up
655 Metal Bridge Railing Repair
656 Concrete Bridge Railing Repair

660 Paint Bridges

661 Brush-off Blast
662 Near White
663 Touch-up

670 Channels and Riprap

671 Maintain Channels
672 Maintain Channels - Remove Drift
673 Repair and/or Replace Concrete Riprap
674 Remove Silt From Culverts

680 Linseed Oil

681 Linseed Oil Treatment of Bridge Decks
691 Biennial Safety Inspection
692 Damage Inspection

700 Traffic Services

710 Guide Markings

711 Center Stripe
712 Edgelining
713 Painting Traffic Medians and Islands
714 Zone and Pavement Markings
715 Install Traffic Buttons
716 Maintain Traffic Buttons

720 Delineation and Railing

721 Erect and Maintain Guard Fence and Railing
722 Maintain Concrete Median Barrier
723 Erect Delineators
724 Replace Damaged Delineators
725 Clean Delineators

730 Signs

731 Special Sign Studies
732 Install New Signs
733 Replace Signs
734 Repair Signs
735 Replace or Repair Traffic Damaged Signs
736 Replace or Repair Vandalized Signs
737 Wash Signs
738 Wash Vandalized Signs
739 Sign Clear Coating

740 Signals and Illumination

741 Install Signals
742 Install Illumination
743 Maintain Signals
744 Maintain Illumination
745 Replace or Repair Traffic Damaged or Vandalized Signals
746 Replace or Repair Traffic Damaged or Vandalized Illumination
747 Sign Illumination
748 Safety Lighting

750 Reimbursement to Railroad Companies (D-18 Use Only)
800 Extraordinary Maintenance

801 Emergency Repairs Due to Flooding
802 Emergency Repairs Due to Hurricanes
803 Emergency Repairs Due to Tornadoes
804 Emergency Repairs Due to Other Causes

810 Assistance to Traffic Other Than Caused by Snow and Ice

811 Assistance Needed Due to Floods or Flooding
812 Assistance Needed Due to Hurricanes
813 Assistance Needed Due to Tornadoes
814 Assistance Needed Due to Accident
815 Operation of Nail Picker
816 Removal of Sand Drifts

820 Assistance to Traffic - Snow and Ice

821 Assistance Needed Due to Snow and Ice
822 Plow Snow or Ice
823 Sand Bridges
824 Sand Roadway
825 Deicing Agents
826 Remove Sand, etc., - Mechanical
827 Remove Sand, etc., - Hand