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ABSTRACT

Volume 13 of the 19-volume Highway Safety Program Manual (which provides guidance to State and local governments on preferred highway safety practices) focuses on traffic engineering services. The introduction outlines the purposes and objectives of Highway Safety Program Standard 13 and the Highway Safety Program Manual. Program development and operation (the scope of the engineering program, needs determination, priorities, manpower development, and traffic control devices) are presented. The need for a program implementation schedule (which establishes step-by-step work tasks to complete various facets of particular improvements) is specified in relation to improvements during maintenance, operational surveillance, high-accident location correction, hazardous location analysis, needs identification, effectiveness evaluation, and traffic regulations. Criteria and procedures for program evaluation and different types of reports (local, State, and Federal) are explained. Local government participation is outlined. Appendixes contain the Highway Safety Program Standard 13, Traffic Engineering Services; a glossary of definitions; a list of representative projects; a management guide for a Statewide inventory; guidelines for traffic control device maintenance inspections; guides for traffic sign, pavement marking, and traffic signal inventories; a list of resource organizations; and references. (NH)

Highway Safety NO. 13 Program Manual

Traffic Engineering Services

FEBRUARY 1974

U.S. DEPARTMENT
OF TRANSPORTATION

FEDERAL HIGHWAY
ADMINISTRATION

HIGHWAY SAFETY PROGRAM MANUAL

VOLUME 13

TRAFFIC ENGINEERING SERVICES

This manual is designed as a guide for States and their political subdivisions to use in developing highway safety program policies and procedures. It does not supersede the requirements of Highway Safety Program Standard No. 13.

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FOREWORD

As part of the Highway Safety Program Manual, this volume is designed to provide guidance to State and local governments on preferred highway safety practices. Volumes comprising the Manual are:

0. Planning and Administration
1. Periodic Motor Vehicle Inspection
2. Motor Vehicle Registration
3. Motorcycle Safety
4. Driver Education
5. Driver Licensing
6. Codes and Laws
7. Traffic Courts
8. Alcohol in Relation to Highway Safety
9. Identification and Surveillance of Accident Locations
10. Traffic Records
11. Emergency Medical Services
12. Highway Design, Construction, and Maintenance
13. Traffic Engineering Services (Traffic Control Devices)
14. Pedestrian Safety
15. Police Traffic Services
16. Debris Hazard Control and Cleanup
17. Pupil Transportation Safety
18. Accident Reporting and Investigation

The volumes of the Manual supplement the Highway Safety Program Standards and present additional information to assist State and local agencies in implementing their highway safety programs.

The content of the volumes is based on the best knowledge currently available. As research and operating experience provide new insights and information, the Manual will be updated.

The volumes of the Highway Safety Program Manual deal with preferred highway safety practice and in no way commit the Department of Transportation to funding any particular program or project.

Many organizations and individuals at all levels of government and in the private sector contributed to the preparation of the volumes of the Manual. The Department greatly appreciates this help in furthering the national program for improving highway safety for all Americans.

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

HIGHWAY SAFETY PROGRAM MANUAL

VOLUME 13 - TRAFFIC ENGINEERING SERVICES	TRANSMITTAL 43
CHAPTER CONTENTS	February 1974

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

HIGHWAY SAFETY PROGRAM MANUAL

VOLUME	13 - TRAFFIC ENGINEERING SERVICES	TRANSMITTAL 43
CHAPTER	I. INTRODUCTION	February 1974

I. GENERAL

Traffic engineering measures and traffic control devices, when applied in accordance with accepted standards, help motorists and pedestrians to use highways more safely.

The importance of traffic engineering services and uniformity of traffic control devices was recognized by Congress in the committee reports on the Highway Safety Act of 1966. (H. Rept. No. 1700, 89th Cong., 2d Sess. (1966), pp. 18, 19, 23; S. Rept. No. 1302, 89th Cong., 2d Sess. (1966), pp. 5, 11.)

II. HIGHWAY SAFETY PROGRAM STANDARD 13

A. Purpose.

The purpose of the Traffic Engineering Services Standard is to ensure the full and proper application of modern traffic engineering principles and uniform standards for traffic control in order to reduce the likelihood and severity of traffic accidents.

B. Specific Objectives.

Standard 13 (Appendix A) covers items which are essential for effective traffic engineering services, including the design, installation, and maintenance of traffic control devices. Specific objectives are

1. To provide the needed traffic engineering expertise to develop traffic control plans and programs in all jurisdictions.

2. To identify both the short-term and long-range need for traffic control devices.

3. To apply warrants for the application of traffic control devices.

4. To periodically upgrade existing traffic control devices on all streets and highways to conform with standards issued or endorsed by the Federal Highway Administrator.

5. To ensure that the need for new traffic control devices has been determined by adequate traffic engineering studies.

6. To periodically inspect and maintain all traffic control devices.

7. To devise methods for correcting hazardous roadway deficiencies and for installing improved features when modifications to the roadway are made.

8. To provide the necessary authority, personnel, equipment, and facilities for carrying out these efforts.

9. To evaluate the safety adequacy of the roadway, including its capacity and efficiency.

C. Legislative Authority.

Highway Safety Program Standard 13, Traffic Engineering Services, is authorized by 23 U.S.C. 402(a) which provides in pertinent parts as follows:

> "Each State shall have a highway safety program approved by the Secretary, designed to reduce traffic accidents and deaths, injuries, and property damage resulting therefrom. Such programs shall be in accordance with uniform standards promulgated by the Secretary . . . to improve driver. . . and. . . pedestrian performance. In addition, such uniform standards shall include, but

not be limited to, provisions for. . . highway design and maintenance (including. . . markings. . .) (and) traffic control. . . Such standards as are applicable to State highway safety programs shall, to the extent determined appropriate by the Secretary, be applicable to federally administered areas where a Federal department or agency controls the highways or supervises traffic operations."

D. Standard revision.

Standard 13, entitled "Traffic Control Devices" was issued June 27, 1967. It was revised and retitled "Traffic Engineering Services" and reissued on November 19, 1971 (See Appendix A).

E. Applicability to Federal agencies.

On November 24, 1970, Standard 13 was declared to be applicable to highways open to public travel in federally administered areas where a Federal department or agency controls the highways or supervises traffic operations (35 FR 18009).

III. HIGHWAY SAFETY PROGRAM MANUAL

A. Purpose.

This volume of the Highway Safety Program Manual is a guidebook for explaining Federal policy on program activities. It is intended to clarify and supplement Standard 13 and to provide information useful to those responsible for its implementation. References cited in the following paragraph to specific policies are included to call attention to their existence.

B. The Manual on Uniform Traffic Control Devices.

1. The Manual on Uniform Traffic Control Devices (MUTCD) is the standard for all devices used on roads open to public travel. This was established as policy on November 13, 1970, by the Federal Highway Administrator in accordance with 23 U.S.C. 109(b), 109(d), and 402(a).

2. Target dates for compliance with the MUTCD were established in Federal Highway Administration Policy and Procedure Memorandum (PPM) 21-15, dated February 8, 1973 (paragraph 7). These dates are:

   a. Pavement Markings - December 31, 1972.

   b. Signs - December 31, 1974.

   c. Traffic Signals - December 31, 1976.

3. A schedule for compliance with the MUTCD pertaining to traffic control on street and highway construction and maintenance operations (Part VI) also was established by PPM 21-15. Compliance is mandatory on Federal-aid construction projects authorized after January 1, 1973. The same date was established as the target date for compliance on roads and streets off the Federal-aid system which are open to public travel.

I. INTRODUCTION

A. Scope of the Program.

The application of traffic engineering measures and traffic control devices based on proven principles and practices provides for safe and expeditious movement of traffic and effectively reduces highway accidents. The traffic engineering services element of the highway safety Annual Work Program (AWP) is intended to establish an appropriate level of technical capability in all governmental agencies with a highway responsibility. To accomplish this, a Subelement Plan (SEP) or Plans should be developed which provide for:

1. Adequate traffic engineering manpower (see Chapter VI, Paragraph 2 for organizational guidelines).

2. Use of traffic engineering principles during roadway planning, design, and construction.

3. Proper application of traffic control devices.

4. Systematic implementation of traffic engineering recommendations.

B. Relationship to Traffic Control Devices.

Traffic Engineering is that phase of engineering which deals with the planning, geometric design, and traffic operations of roads, streets, and highways, their networks, terminals, abutting lands, and relationships with other modes of transportation for the achievement of safe, efficient, and convenient movement of persons and goods.

Needed traffic controls should be based upon engineering studies that take into consideration traffic volumes, vehicular speeds, sight distances, accident patterns, physical characteristics of the roadway, and the roadway environment. They should be established in accordance with accepted standards. Traffic control devices when hastily installed as a reaction to a single event generally are not in the best interest of the public. Failure to apply traffic engineering principles and techniques to a section of roadway can result in inadequate or too much signing, unmarked hazards, and improper intersection controls, all of which could contribute to a significant number of traffic crashes.

C. Applicability.

In the Highway Safety Act of 1966, Congress made clear that, when appropriate, the highway safety standards are to be applicable to all roads open to public travel. State Governors are made responsible for highway safety on all roads administered by the State highway departments and on the road and street systems in local jurisdictions. Federal agencies are responsible for implementing Standard 13 in those federally administered areas where they control the highways or supervise traffic operations. They have an added responsibility to coordinate their traffic control measures with those of the State program.

II. NEEDS DETERMINATION

A. On-the-Road Improvements.

The need for on-the-road improvements is generally determined as the result of a traffic engineering study. These studies are often begun as a result of noting potentially hazardous conditions, observing traffic operational problems, or by investigating citizens' complaints. Studies may include, among other activities:

1. Accident analyses to determine a particular roadway feature frequently involved in accidents.

2. Specific accident location studies to isolate particular deficiencies.

3. Roadway inventories to compare highway features with established safe design standards.

B. Technical and Administrative Capability.

The need for and level of technical and administrative capability required to operate an effective safety program depends on

1. The roadway mileage controlled by the particular political subdivision.

2. The volume of traffic on the roadway system.

3. The number of operational problems or accidents.

4. The extent of urban development within the jurisdiction.

Typical organization needs for urbanized communities are shown in Chapter VI. The organizational requirements for rural jurisdictions can be adapted from those suggested for urban areas and modified to suit the individual situation.

III. PRIORITIES

A. Determination of Priorities.

In determining priorities, the following two aspects should be considered: 1) ranking of deficient locations on the basis of the severity of the hazard which exists, and 2) ranking of locations on the basis of estimated potential accident reduction due to proposed improvements. For the determination of the first listing, a simple numerical tabulation of accidents is often adequate. More refinement can be obtained, however, by assigning a dollar value to the fatal, injury, and property damage accidents and by establishing priority on the basis of total dollars in accident losses. The second priority listing is a bit more complicated and involves the calculation of benefit-cost ratios, present worth, or rates of return for ranking improvements.

B. Accident Costs.

The direct costs of traffic operations (and conversely he benefits gained by preventing traffic accidents) are estimated on a national basi National Highway Traffic Safety Administration a ows:

Fatality	- $200,700
Nonfatal injury	- $7,300
Property damage accident	- $300

If the State has better data, presumably more accurate for the State, such State data should be used rather than national figures. Because the occurrence of fatalities is a matter of chance and figures are often small, the State may prefer to combine fatality and injury totals to play down the possibility of selecting an improvement project on the basis of chance. The calculation of benefits derived from accident reduction following a safety improvement on this basis is as follows:

$$B = \frac{ADTa}{ADTb}\left[Q(A_{FI})P_{FI} \quad 300\,(A_{PD})P_{PD}\right],$$

where B = Benefits derived as a result of a change from condition "b" to condition "a,"

A_{FI} = Annual average number of fatalities and injuries combined at the location,

P_{FI} = Percentage reduction in fatalities and injuries expected,

A_{PD} & P_{PD} = Number and percentage reduction expected, respectively, of annual property damage accidents at the location.

$$Q = \frac{\$200,700 + (I/F)\ \$7,300,}{1 + (I/F)}$$

where I/F = Ratio of injuries to fatalities in the State for the class of highway (rural two-lane, etc.).

The accident figures to be inserted in the formula may not all be available, particularly the number of property damage accidents. It is not recommended that assumptions be made for unreported accidents, and only available data should be used in calculating benefits.

C. Application of Formulas.

If more than one improvement is required at a single location, the calculation of benefits must be adjusted to reflect the fact that the values of P (reduction in accidents) must be applied successively rather than simultaneously. Thus, if the first improvement will produce a reduction of P_1 percent and the second improvement will produce a reduction of P_2 percent, the second reduction does not apply to the total number of accidents, but rather to $(1-P_1)$ times the original accident total. A third improvement, with an expected reduction of P_3 percent likewise will affect $(1-P_1)$, $(1-P_2)$ times the total number of accidents. It is essential to the success of this benefit-cost concept that a reasonable method for estimating the values of P, or the expected percentage reduction in accidents be available. If, as the result of previous work, the State has available supporting values for P, these may be used. These values may also be obtained from published literature, including Evaluation of Criteria for Safety Improvements on the Highway.*

D. Use of Priority Listings.

Each analysis must be weighed separately to select the most hazardous locations and to select those locations where funds can be applied to produce the greatest return. A balanced improvement program should select locations from both priority listings.

*Evaluation of Criteria for Safety Improvements on the Highway, Roy Jorgensen and Associates, Westat Research Analysts, Inc., 1966.

E. Documentation of Corrective Measures.

To permit evaluation of their safety effectiveness, traffic engineering improvements need documentation both before and after implementation. As a minimum, the documentation should include

1. Use of accident records to determine priorities for improvement.

2. Development of cost records for improvements.

3. Effect of improvements on traffic movements.

4. Collection of accident records after improvements.

5. Determination of improvement cost-effectiveness.

IV. MANPOWER DEVELOPMENT

The proper use of traffic control devices and other traffic engineering measures has become a highly specialized field of engineering. Thus, to ensure the success of a highway safety program, it must be administered by trained traffic engineers. While much of the work can be accomplished by trained technicians, their activity should be under the direct supervision of persons with professional experience and training in the field of traffic engineering.

A. Comprehensive Plan.

A requirement of the Standard is the development, both by the State and Federal agencies, of a comprehensive plan for supplying traffic engineering manpower and for the utilization of that manpower by all jurisdictions with a highway responsibility. This may include

1. The establishment of a plan for utilizing consultants when no other expertise is feasible, and

2. The development of a State capability for offering traffic engineering assistance to local units of government.

B. Training.

Because of the rapid growth of communities and urban automotive travel, the demand by State and local governments for trained traffic engineers and technicians far exceeds the supply in most jurisdictions. To achieve the goal of providing adequate supplies of manpower, States are encouraged to establish traffic engineering training programs.

1. Training programs should be designed to serve the following personnel:

   a. Graduate engineers with training and experience in traffic engineering.

   b. Graduate engineers without prior traffic engineering training or experience.

   c. Technical and support personnel.

2. Types of training courses offered may include

   a. Postgraduate training in traffic engineering.

   b. Short courses at a college or university.

   c. Workshops conducted by professional organizations or others having expertise in traffic engineering.

   d. Technical training ranging from vocational schools to on-the-job training.

For more information on training activities which may be eligible for Federal funding, see the joint NHTSA-FHWA Order 7-8 entitled, "Use of Section 402 Funds for Training." Funding eligibility is also discussed in the FHWA Highway Safety Program Management Guide.

C. Utilization of Traffic Engineering Expertise.

Traffic engineering principles should be applied in the planning, design, construction, and maintenance of roadways.

1. The traffic engineering function should be placed in an organizational position which gives the traffic engineer the stature and authority to carry out his responsibilities. This will require an organizational level equal to the maintenance, construction, design, and similar highway functions.

2. During the planning phase, traffic engineering capability is needed to furnish data on studies of high accident locations, to advise others on quality of service to be provided, and to make recommendations on priorities for scheduling improvements.

3. Roadway design considerations such as intersection and interchange layouts, horizontal and vertical curvature, cross-sectional elements, and sight distances should be evaluated by traffic engineers to determine their effect on traffic operations and pedestrian movements.

4. Operational reviews are needed during construction to analyze and correct previously unnoticed potentially hazardous design features which appear as work progresses, and to develop operational safeguards for vehicles and pedestrians traveling through construction work zones.

5. Operational reviews are also needed on completed roadway sections as soon as they are opened to traffic. This will permit any needed adjustment of control devices and the verification of earlier design decisions.

6. Traffic engineers should participate in the development of maintenance procedures which provide for safe travel of vehicles and pedestrians through work sites. This should include making provision for replacement of damaged or ineffective control devices.

V. TRAFFIC CONTROL DEVICES

A. Comprehensive Plan.

Four basic conditions must be satisfied before traffic control devices used in regulating and controlling traffic can be effective. The device must 1) conform to recognized standards, 2) be based on legal authority, 3) be easily understood by motorists and pedestrians, and 4) its observance effectively enforced. Because of the many considerations involved in utilizing traffic control devices, a comprehensive plan is needed to effectively coordinate these various conditions. Taking inventory, upgrading, maintaining, and improving control devices, as well as applying public information measures, are basic to the Traffic Engineering Services Standard.

B. Inventories.

A continuing inventory can supply information on the condition, life span, and cost of control devices, and give an indication of replacement needs. This information is often collected informally without its being recorded and is usable only by the person who has collected it. Recorded inventory data, although more time consuming and costly to develop, is available to many persons within an organization and is a necessary part of a traffic control devices plan. The specific characteristics of different types of devices make it desirable to prepare separate records of signs, signals, or markings, and not to combine these into one form. The inventory system should be utilized whenever data on control devices are collected, even if it is only on a particular roadway section or intersection. Haphazard gathering of data is a wasteful practice and should be avoided. Types of inventories are

1. Manual inventory.

   Data are recorded on standard forms (See Appendix F) and filed. Specific summary information can then be selected at will. This is usually suitable only for smaller jurisdictions or for specific site application.

2. ADP inventory.

   Data are collected and processed using ADP equipment and procedures. The records should be updated either at regular intervals from maintenance records or by periodic inventories. The usefulness of the ADP data depends on the frequency of control device field changes and the rate at which updated material is entered in the files. The inventory can be kept current by regular inspection and work order reports being fed into the computer files. Printouts giving the current status of needed maintenance work, sign replacement, or expenditures are then available at any time.

C. Periodic Upgrading.

Traffic control devices frequently become unusable or ineffective because of changes in traffic patterns, vehicle impacts, vandalism, or normal deterioration. This means that each control device needs a periodic check to see if it is still effective or if changes are needed. As part of their routine activities, field employees should note visible deficiencies and report them for correction. To make sure all control devices receive attention, however, the traffic engineering agency should develop a plan for systematic coverage of all routes or streets and compare the application of control devices with that recommended by the Manual on Uniform Traffic Control Devices.

1. Guidelines and warrants for the use of warning and regulatory devices are included in the MUTCD. Engineering studies of existing traffic conditions and accident patterns should be compared with these guidelines (or warrants) to determine the appropriate traffic control. Use of these warrants will generally produce a traffic control system which is responsive to traffic needs. Justification for deviations from these criteria should be determined on the basis of a thorough engineering study.

2. The design of guide or information signs should conform to the provisions of the MUTCD with consideration given to the following principles:

   a. Letter size, number of lines of copy, number of destinations, and sign placement should be adequate to allow a motorist sufficient time to understand and react to the message.

   b. Advance guide signs for major street crossings should be used where practical.

   c. Information signs should be installed for the specific guidance of the motorist and not to satisfy requests from special interest groups.

d. The effect of different environmental conditions (darkness, bad weather, etc.) should be considered in determining the design, proper placement, and lighting or reflective requirements of guide signs.

3. The maintenance of adequate pavement markings on all roadways is recommended for safe vehicle operation and pedestrian movement. In relation to this, use of the following items should be considered:

   a. Supplemental warning and regulatory signs with no-passing barrier markings.

   b. Long life materials such as thermoplastics.

   c. Special markings, such as raised pavement markers, for bad weather conditions.

   d. Special fast drying paints or quick application methods.

D. Control Device Maintenance.

It is not enough to merely use modern traffic control devices, they must also be maintained. Poorly maintained traffic control devices soon lose their effectiveness and can impair highway safety. Maintenance should include a program of preventive maintenance as well as a system to detect needs and effect repairs in the shortest time possible.

1. Determination of maintenance needs.

   a. The most important source of maintenance information is an agency's own personnel. All employees of the responsible agency should promptly report any malfunction or other hazardous condition to the traffic engineering or maintenance staff. Police and other outside agencies also can be utilized to provide this information.

   b. To provide adequate surveillance, an inspection schedule should be established. The various inspections should consider the adequacy of operation during all time periods and under all weather conditions; the general condition of the device, including the need for straightening, cleaning, repainting, or refurbishing; and whether the sign or signal is obscured by shrubbery, weeds, tree limbs, construction materials, or another sign or device. Detailed recommendations for conducting control device inspections may be found in Appendix E.

2. Assignment of maintenance forces.

   Depending on local conditions, the maintenance function can be performed in two ways:

   a. Where there are reliable maintenance personnel in sufficient numbers within the governmental unit, they can perform the unit's maintenance.

   b. Maintenance work can be contracted to an outside agency. Supervisory responsibility, however, should always be retained by the governmental agency.

3. Maintenance techniques.

   It is important to consider both emergency repairs and preventive maintenance in developing a control device maintenance plan. Details related to various maintenance techniques are found in Appendix E.

4. Keeping adequate maintenance records.

   Maintenance records should be kept to analyze the adequacy of traffic control devices. By utilizing well kept records, a governmental agency can anticipate future need for new devices, project needed maintenance funds, and determine necessary manpower requirements. In addition, an adequate records system can provide information for the public when required in civil actions and for use in defense against governmental liability in lawsuits claiming improper maintenance of traffic control devices. Recommended criteria for maintenance records are shown in Appendix E.

E. Use of New Control Device Concepts on an Experimental or Demonstration Basis.

The standards established by the MUTCD, as with all standards, are subject to periodic review. Modifications of these standards, many having a direct relationship to highway safety, will occur periodically. Existing devices made obsolete by new techniques or new traffic control devices should be changed within a reasonable time following adoption of a new standard.

1. Controlled experimentation through the installation of roadway "test sections" is often the means of developing and of proving the worth of new devices. Widespread application of untested devices must not be attempted until they are shown to be of value in controlling traffic. Tests of this type should be thoroughly planned before they begin, so that a maximum amount of useful data can be collected. Federal Highway Administration issued or endorsed procedures should be followed in planning the tests. Before experimental devices can be given wide application, they must be evaluated by the National Advisory Committee on Uniform Traffic Control Devices and approved by the Federal Highway Administration.

2. Before experimenting with devices that involve a conflict with existing codes and laws, it will be necessary to receive legislative authority. In the event that such an experimental device proves successful, the experimenter should bring his findings to the attention of the National Committee on Uniform Traffic Laws and Ordinances and the appropriate legislative body, with the proposal that the law be amended to permit the use of the proven device.

HIGHWAY SAFETY PROGRAM MANUAL

VOLUME	13 - TRAFFIC ENGINEERING SERVICES	TRANSMITTAL 43
CHAPTER	III - PROGRAM IMPLEMENTATION SCHEDULE	February 1974

I. INTRODUCTION

A. Scope.

An implementation schedule establishes, step by step, work tasks to complete various facets of a particular improvement and their estimated costs and times of completion. It is recommended that such a schedule be prepared for every traffic engineering services project to aid in the systematic development of preliminary activities and to predict possible accident reduction. The Annual Work Program (AWP) requires the use of an implementation schedule for each Subelement Plan.

B. Schedule Contents.

The implementation schedule should describe the complete development of an activity, through all the preliminary steps, up to and including the development of final operational measures. As a minimum, it should contain the following information:

1. A statement of what the project is to accomplish and how it is to be evaluated.

2. A step-by-step listing of task items which must be carried out to reach the final objective, including

   a. Any necessary approvals.

   b. Any necessary legislative action.

   c. Development of operating plans.

   d. Purchase of equipment.

   e. Training of personnel.

   f. Preparation of guidelines or manuals.

   g. Conducting of studies.

   h. Formulation of recommendations.

   i. Implementation of corrective measures.

3. A time schedule for completion of the above tasks, indicating approximate periods for starting and ending.

4. Costs for the various task items, with an indication of fund sources for each.

C. Performance Requirements.

The requirements listed in paragraph D of the Standard are the basis for project activity which will have a direct or indirect safety benefit. In the discussion which follows, important aspects of each item and appropriate considerations which should go into preparation of the implementation schedule are covered.

II. REVIEW OF ROAD PROJECTS

The involvement of traffic engineering personnel early in the development stage of roadways can provide an objective review for such considerations as traffic operations, control device usage, and highway safety.

A. Procedure.

An official procedure needs to be established for involvement of traffic engineering personnel. This might be through participation with representatives from other disciplines (design, maintenance, police, etc.) on a joint design review panel. In the operation of a design review panel, it is important that persons be designated to perform specific reviews and that one member be designated as having the final approval authority.

B. Consultants.

Traffic engineering consultants may participate in reviews when in-house staff personnel are not available. When this is the case, reviews have to be scheduled more precisely to fit into road project timetables and defined more accurately than when staff personnel are utilized.

C. Evaluation.

The evaluation of improvements accepted and installed should be a part of the review activity to determine the effectiveness of the improvements and the suitability of the recommendations.

III. IMPROVEMENTS DURING MAINTENANCE

A. Transition.

The transition to an improved piece of roadway hardware can be made during routine maintenance activities whenever an existing device has been damaged or otherwise rendered ineffective. Maintenance personnel need to be trained and equipped to be able to implement the necessary changeover measures.

B. Items Involved.

The conversion to improved devices may involve sign, signal, and lighting supports, motorist protection at bridge piers and parapets, and similar roadwide objects. In addition, the conversion might involve

1. Relocation of the obstacle away from the travel lane.

2. Use of yielding supports in locations where a falling support would not create a hazard to other vehicles or pedestrians.

3. Installation of attenuation devices or protective barriers which will absorb the impact of an out-of-control vehicle.

4. Application of guardrail or redirecting barriers.

IV. OPERATIONAL SURVEILLANCE

The correction of accident causing deficiencies on the roadway is, of course, dependent on the detection of such deficiencies. Sources of such information need to be developed and promoted into an efficient detection system.

A. Detection of Deficiencies.

1. Arrangements should be made with governmental agencies to have personnel who use the roadway system frequently report any damaged or obscured control device or other hazardous condition. Police normally are instructed to note such deficiencies, but unless proper procedures for passing on this information are established, reports may not reach the traffic engineering agency.

2. Another valuable source of information as to maintenance needs comes from complaints received from the general public. These complaints should be reviewed and, if valid, the appropriate corrective action taken. A program to educate the public on the proper way to register complaints deserves consideration. Such a program should be directed toward opening better lines of communication between the public and the governmental agency responsible for highway operations, including such measures as

   a. Prominent display of the appropriate maintenance telephone numbers in the white and yellow pages of the telephone directory.

   b. Development of public information programs which emphasize the need for and the means to report defective traffic control devices. Radio, TV, newspapers, community groups, etc., can be used in this effort (see Program Management Guide for funding guidelines).

B. Analysis Methods.

An on-site investigation of a reported deficiency is usually the first step in analyzing the severity of the situation and determining needed corrective action. A skilled investigator can often create a true picture of the problem which may be inaccurately described during the initial reporting. Some of the clues available are

1. Accident records.

   These should be utilized to determine the degree of severity, with care being given to using only those accidents related to a particular deficiency. Recognition also needs to be given to evidence that accidents have occurred and had not been reported.

2. Skid marks.

   These can show precise locations where problems are occurring, but should not be used to quantitatively establish severity of the problem.

3. Tangible evidence of accidents.

   Such things as bent guardrails, broken car parts, damaged signs, and fractured poles are also useful in establishing the problem location.

4. Speed analysis.

   Speed data recorded in the vicinity of a deficiency with a comparative evaluation of vehicle travel patterns can provide typical approach conditions and are useful in judging the severity of a particular deficiency.

5. Trial runs.

   Where operational difficulties are the cause of the problem, trial vehicle runs by the investigator can give him a "feel" for the problem and can aid him in formulating effective corrective measures.

6. Other useful data.

Information such as traffic volumes, including those of peak hours; turning movements; pedestrian volumes; classification by type of vehicle; nighttime conditions and special seasonal conditions may also be required from time to time to permit determination of the need for improvements or to permit proper improvement plans to be developed.

C. Corrective Measures.

1. Structures, sharp curves, steep hills, and railroad grade crossings are among the common hazards found along streets and highways. Roadway hazards which are impractical to correct by reconstruction should be carefully reviewed to determine the need for and/or adequacy of warning devices. Particular attention should be given to such refinements as

   a. Oversized warning signs.

   b. "Blank out" signs, which warn of hazards occurring only during certain conditions, e.g., "ice on bridge" signs.

   c. Flashing beacons.

   d. Special railroad crossing protection.

   e. Delineators and hazard markers to outline the roadway or hazards, or both.

2. Intersection improvements might involve geometric improvements, lighting, clearing for improved sight distance, separate turn lanes, and delineation. High-volume intersections and high-accident locations may require channelization to reduce the frequency and severity of collisions. Channelization can be provided by pavement markings or raised dividers, and should conform with the standards established in the MUTCD or the AASHO design policies (See Appendix J).

V. HIGH-ACCIDENT LOCATION CORRECTION

Procedures to detect and evaluate locations with a high accident rate are described in Volume 9. The following are suggested steps to follow in developing corrective measures for such locations and for completing the improvements.

A. Site Visit.

Visit the location for a field review and prepare an inventory of existing control devices.

B. Recommendations.

Use accident data on and prevailing traffic conditions at a given site to prepare recommendations for correcting operational problems.

C. Implementation.

Secure necessary approvals and have responsibility for implementation assigned appropriate persons.

D. Evaluation.

Evaluate implemented recommendations to verify correction of problem.

VI. HAZARDOUS LOCATION ANALYSIS

A. Locations to be Checked.

All locations noted as being potentially hazardous should be investigated by a traffic engineer to establish the accident potential.

B. Priorities.

A priority listing should be developed for implementation of improvements. It should be based on

1. The expected benefit from the proposed modification at all similar locations.

2. The benefit-cost of the improvement.

C. Implementation.

The priority listing, which ranks improvements on a benefit-cost basis, should be used for scheduling implementation.

VII. NEEDS IDENTIFICATION

A. Basic Data.

Obtain the basic data for future needs from inventory records, recorded present traffic volumes, and comprehensive street and highway plans.

B. Develop needs.

Expand these data into major or long range improvement program needs.

C. Form projects.

From the long range needs, develop short range projects which will be compatible with the time and funding available during regular programming and planning periods (approximately 1 year).

VIII. EFFECTIVENESS EVALUATION

The posting of regulations, the marking of traffic hazards, and the furnishing of other information to the driver are accomplished through the proper use of traffic control devices. It is important, therefore, that these devices portray the meaning intended, both day and night.

A. Requirements.

A traffic control device should meet six basic requirements to be effective.

1. Fulfill an important need.

2. Command attention whenever applicable, day or night.

3. Convey a clear, simple meaning.

4. Command respect of road users.

5. Be located to give adequate time for response.

6. Be designed and placed so as not to create a hazard by its presence.

B. Application.

Traffic control devices need to be applied in a consistent manner to convey the desired message to motorists. The recommendations for application of traffic control devices contained in the MUTCD should be used as the standard for determining the acceptability of existing devices. In addition, it is important that all devices be adequately maintained.

C. Analysis.

Using cost-effectiveness procedures,* studies should be made of the effect of each type of improvement, e.g., geometric modification, signal improvement, or lighting, on accident rates and traffic capacity and delay. In each instance, the study should be for a comparable period before and after the improvement.

1. Accident studies.

Collisions which have occurred during the before and after periods are analyzed to determine if an actual reduction in costs was achieved during the after period. The average annual savings in accident costs can then be determined. Hopefully, the results of this analysis will show that the total accident costs are less during the after period.

2. Capacity analysis.

This can be used to quantitatively determine whether the safety improvement has affected the flow of traffic. The

*See Appendix B for definition.

553-869 O - 74 - 3

capacity of the intersection is calculated and compared for the before and after time periods. When an analysis of this type indicates that the traffic capacity has been significantly increased, it is often found that the improvement has had a positive effect on traffic safety.

3. Time-delay studies.

The elapsed time of runs using a test vehicle are averaged and changes between before and after periods are noted. When safety measures have been implemented, delay may be increased depending on the particular measures. A check should be made to determine that where delays have increased, there is a compensating decrease in accidents. For example, a slight amount of traffic delay may be acceptable if the installation of a "STOP" sign has substantially increased safety.

4. Combining study results.

The results of the three studies should then be reviewed in order to make a final judgment about the effectiveness of the improvement. If all three indicate the same result, the conclusion is apparent. If, however, the findings do not agree, an evaluation of the relative importance of each is required.

5. Additional analyses.

Additional analyses may be needed under certain traffic and roadway conditions. For example, more detailed pedestrian studies may be required in the vicinity of schools and churches. Studies near school bus stops, mail boxes, or telephone booths may be necessary to consider use of turnouts. The principles and techniques outlined in the Traffic Engineering Handbook and other references identified in Appendix J should be used as a basis for conducting these additional studies. For the application of some devices, precise specifications need to be prepared. Such items as provisions for fail-safe circuitry in solid state traffic signal controllers, for example, often need to be specified.

IX. TRAFFIC REGULATIONS

A. Speed Regulations.

To be reasonable and safe, speed regulations should be established on the basis of traffic engineering studies and investigations. The following should be considered when determining the appropriate limits:

1. Existing speed patterns.
2. Character of roadway.
3. Roadside development.
4. Composition of traffic.
5. Sight distance restrictions.
6. Accident experience.
7. Accident severity.
8. Consistent speed regulations for similar conditions.
9. Need for establishing minimum speeds to reduce speed differential.
10. Conditions requiring special speed regulations, e.g., inclement weather, construction zones, and school areas.

B. Parking Regulations.

Curb parking regulations should be considered as a means of reducing accident frequency as well as a means of improving street capacity. Parking prohibitions on approaches to intersections, as well as traffic needs during various times of the day, should be studied as part of this analysis. Some factors to consider are:

1. Pedestrian activity.
2. Street width.

3. Accident pattern.

4. Abutting land use.

5. Availability of off-street parking.

6. Current level of traffic congestion.

7. Parking and traffic demand.

8. Sight distance.

9. Turning movements.

C. One-Way Traffic Operations.

One-way street operation should be considered as a means of improving traffic safety by reducing traffic conflicts and congestion. This measure may be especially suitable for streets having substantial congestion or a pattern of crashes indicating numerous conflicts between opposing vehicles. Signs, signals, and pavement markings which conform to the MUTCD should be used to establish necessary traffic control. Items which need to be considered in establishing one-way streets are

1. Availability of parallel streets with sufficient capacity to handle the reverse flow.

2. Means for providing transition roadways at the extremities of the one-way system.

3. Effect on abutting land use.

4. Effect on the transit system.

D. Pedestrian Regulations.

1. General pedestrian considerations.

Safe movement of pedestrians in the highway environment is dependent on the availability of adequate pedestrian walkways, the physical separation of pedestrian areas by fences or grade separation structures, and adequate visual control devices such as pedestrian signals and signs. Where pedestrians are forced to use at-grade crossings, a check should be made to see that there are adequate gaps in traffic to permit safe crossings. If not, devices such as pedestrian signs or signals should be used.

2. Special considerations for school children.

   Because school children frequently become impatient to cross when delay (between the occurrence of adequate gaps) becomes excessive, they may endanager themselves by crossing during an inadequate gap (see Section 7A-3, MUTCD). Because of this, special consideration needs to be given to

   a. Special signing for motorists.

   b. Supervisory personnel to assist the very young at crossings.

   c. Changes in control during periods when there is no school activity.

E. No-Passing Regulations.

In addition to determining highway sections with sight distance below the distances specified in the MUTCD, the following should be considered when establishing passing restrictions:

1. Length of continuous passing restriction.

   Long ontinuous stretches of a no-passing barrier on two-lane roads will invite violations. Consideration should be given to supplemental warning and regulatory no-passing zone signs at these locations to control unsafe passing.

2. Regulatory signs.

   Use of the standard "DO NOT PASS" regulatory sign to accompany the no-passing barrier is recommended as a standard practice.

3. Warning signs.

Where a supplemental warning is needed to emphasize the "DO NOT PASS" sign and where improved visibility of the no-passing pavement marking is needed, the pennant "NO PASSING ZONE" sign may be used.

F. Turning Restrictions.

Heavy turning volumes, either to the right or left, may cause sudden congestion at intersections with resulting accidents. Where turn control by separate signal faces is impractical, or where the volume of traffic is too great to be accommodated, consideration should be given to the establishment of turn restrictions. Alternate locations, where turns can be made safely, need to be available for such restrictions to be practical. Signs should be erected where they are easily visible to inform motorists where turns cannot be made. Since a possible safety hazard is introduced by increased speed of curb lane vehicles, precautions should be taken to provide good pedestrian control measures where the turn restrictions are used.

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

HIGHWAY SAFETY PROGRAM MANUAL

VOLUME 13 - TRAFFIC ENGINEERING SERVICES	TRANSMITTAL 43
CHAPTER IV. PROGRAM EVALUATION	February 1974

I. INTRODUCTION

The Traffic Engineering Services Standard requires that each State evaluate its program for that standard periodically and that a summary of that evaluation be provided to the Federal Highway Administration. The results of this periodic evaluation are to be used in the preparation of the State's Comprehensive Plan and its Annual Work Programs. While the precise content and form of such an evaluation will be determined by each State according to its ongoing activities, this chapter suggests approaches a State can use in carrying out this evaluation.

II. EVALUATION MEASURES

Meaningful measures need to be established for measuring the progress and effectiveness of individual projects. These measures may or may not relate directly to the reduction of accidents, but should, as a minimum, provide a measure of the achievement resulting from the project. The selection of these measures is very important because their usefulness depends on how well they reflect the overall progress of the project activity. As examples of these types of measures, the Annual Work Program procedures call for the use of effectiveness, coverage, and volume measures to evaluate the results of individual Subelement Plans.

A. Effectiveness Measures.

Desirably, this value relates the program activity to its effect on accident reduction. From a practical viewpoint, however, it may not always be possible to develop effectiveness measures with a direct relationship between a particular program activity and its effect on accident reduction. Proxy measures should then be used in defining intermediate Subelement Plan goals. All effectiveness measures should be

1. Defined in measureable terms.

2. Related to information which can be reasonably expected to be available.

3. Traceable to an activity directly related to accident reduction.

B. Coverage Measures.

This measure defines the scope of project activity. It should reflect a true picture of the portion of a roadway, total problem, or jurisdiction being affected by program task achievement. Care should be taken to see that statistics needed for the measure selected are readily available or are easily collected. The coverage measure should be expressed as a percentage of the total coverage desired when the SEP or project is completed.

C. Volume Measures.

This measure relates to the quantity of work done. It also should be linked closely to the ultimate goal of the Subelement Plan so that a true measure of work accomplished will be available at each periodic reporting period.

III. PLANNING EVALUATIONS

A. Initial Consideration.

Evaluation should be considered at the earliest conception of an SEP or project activity. Such questions as "What do we want to accomplish?" and "How can we measure progress?" need to be asked. The definition of project goals in clear, understandable terms can often make the establishment of a meaningful evaluation procedure much easier and tends to aid in detecting activities whose ultimate objective is other than accident and fatality reduction.

B. Intermediate Objectives.

The establishment of objectives short of accident reduction (Proxy Measures) is often necessary in a good evaluation system to be able to measure the true effect of a particular program effort. Accident reduction is generally the result of many measures working together, and the contributing effects of any one measure may be hard to distinguish. An intermediate objective or series of objectives therefore should be established to link program activity to the ultimate objective of accident reduction. These objectives should be defined and recorded for every SEP or comparable project unit proposed.

C. Activity Justification.

An evaluation must be done initially to determine whether or not a project can be expected to be worth the fund required (see Chap. II, Par. 3). This involves making an estimate of the final results of the project activity. A final evaluation of the project then involves simply a verification or rejection of the estimates made originally.

D. Data Collection.

Each program manager should regularly collect data which could show progress on the program, such as costs incurred, changes in related accident occurrences, or capability established. The collection of such data should be anticipated during the initial stages of program planning and provision made for their collection. Consideration should be given to

1. Use of sampling techniques to reduce amount of data to be collected.

2. Establishing efficient cost accounting techniques for maintaining good fiscal records.

3. Coordination with agencies involved with collecting and maintaining accident records to secure appropriate accident data.

E. Monitoring.

Monitoring is the routine charting of progress toward and achievement of intermediate objectives. This activity is greatly aided by the use of milestones at frequent stages within the planned activity. The milestones may be, but need not be, considered as intermediate objectives. They are check points by which program goals can be compared to work actually completed.

F. Levels of Evaluation.

Projects which involve an innovative or untried approach need to be evaluated both for a conceptual as well as an operational value. Other projects which are adaptions of the established safety improvement measure can be evaluated with attention primarily toward operational results and by noting minor departures or differences from other similar improvements.

IV. METHODS OF EVALUATION

A rigid method for evaluating all project activity is not recommended because each type of undertaking has different characteristics, some of which are easily evaluated and others which are not. Three methods are suggested which may be used separately or in combination.

A. Comparison to Standard.

The standard of achievement selected can be a nationally recognized standard or it can be one prepared especially for a particular project. The standard may be defined as a desired system performance level or it may be defined as a level of training deemed to be satisfactory. Care should be taken to ensure that the standard used describes the desired results in a manner which will permit easy recognition of when compliance is reached. In the use of Standard 13 as a basis for evaluation, the following related questions should be answered in relation to individual jurisdictions to determine compliance.

1. To what extent are traffic engineering improvements not being made because of a lack of capable personnel?

2. Are the measures employed by a jurisdiction for correcting traffic problems in keeping with currently recognized standards for design, construction, or maintenance?

3. Is there complete knowledge of the condition of traffic control devices in a jurisdiction including figures on devices needing replacement due to damage, change in standard, or improper application?

4. Are traffic control devices being maintained in a manner which generally leaves them effective for motorists? (See Chapter III, Par. 8A.)

5. Are needed traffic studies made promptly after roadway deficiences are detected?

6. Are implementation schedules prepared following the completion of studies to ensure the prompt installation of improvements?

B. Before and After Comparison.

This method is frequently used where a change in accident experience is involved (see Chap. III, Par. 8). Conditions are recorded at a particular location before an improvement is made and after to show the change due to the improvement. Care must be taken to make sure other conditions from those being evaluated remain constant so that any change detected can be attributable to the program activity. The use of collision diagrams is recommended to show the before and after conditions at improvement locations.

C. Use of Control Locations.

Where before conditions cannot be obtained or where there are several variable conditions involved, a control location can be used. Such a location should be, as closely as possible, a duplication of the location for which the improvement is planned. This will permit the control location to represent the condition which would have existed at the improved location if the improvement had not been made. Any difference noted can then be attributed to the improvement.

V. ANNUAL PROGRAM EVALUATION

The evaluation summary required by paragraph II of Standard 13 may be provided every 4 years as a part of the State's Comprehensive Plan. It should be included in Part II (Evaluation of Current Situation) along with similar evaluations from other standards. The evaluations should indicate the State's overall needs to comply with Standard 13 and show, through a condensation of evaluation reports on individual SEPs or similar projects, those changes in needs or emphasis which have occurred as a result of the previous activities. The following aspects should be considered in relation to each completed SEP or project:

A. Cost-Effectiveness.

All program costs should be considered, including direct costs (installation, operation, and maintenance) and indirect costs (design and administration). Reduced costs from the prevention or reduction of accidents (lives or property saved) are considered direct benefits and should be identified separately in the analysis before being combined with other benefits (reduced travel time, increased capacity, etc.).

B. Accident Reduction.

Where improvements relate to correction of a specific type of accident, these should be separated out for analysis. Care must be taken to avoid determining results on data which are not statistically significant, i.e., there are not enough accidents to be sure the change in accidents is due to the improvement. The collection, processing, and interpretation of these data are established in Volumes 9 and 10 of the Highway Safety Program Manual (Identification and Surveillance of Accident Locations, and Traffic Records).

HIGHWAY SAFETY PROGRAM MANUAL

VOLUME 13 - TRAFFIC ENGINEERING SERVICES	TRANSMITTAL 43
CHAPTER V. REPORTS	February 1974

I. INFORMATIONAL REQUIREMENTS

At each of the three governmental levels, local, State, and Federal, certain information is required to effectively operate, evaluate, and manage the traffic engineering services program. The degree of information required in the form of "Operations Reports," "Evaluation Reports," and "Management Reports" varies according to the needs of the jurisdiction involved.

II. LOCAL LEVEL REPORTING

A. Operations Reports.

These reports should contain all pertinent information on implementation and continued operation of local and State agency programs. This includes such information as inventory data, work accomplishments, work schedules, material and equipment requirements, intersection drawings, and traffic control data. The information reported should provide an adequate basis for management decisions pertaining to program direction, scope, and funding.

B. Management Reports.

Management reports should include summary type information based on both operational reports and independent program monitoring. Management reports must be decision oriented. The information given should be adequate to highlight operational problems in accomplishing program objectives. These problems may relate to costs, manpower, legislation, scheduling, and quality of work performed. The local jurisdictions should make timely use of this type of reporting since it enables problems to be detected early and corrective measures to be taken.

C. Evaluation Reports.

The purpose of evaluation reporting is to measure program effectiveness and it is often difficult to separate it from management reporting. One distinction is that management reporting is more general than evaluation reporting. An evaluation report should involve a single element of a standard or a single project activity and relate how effective its implementation has been, as determined by before and after studies. If it is necessary to provide a meaningful evaluation from available data, the scope of the report may be broadened to encompass the entire traffic engineering services program and gross before and after accident or cost-effectiveness data used in the analysis.

III. STATE LEVEL REPORTING

Management reports and their use are a responsibility of State governments. State agencies should view all management reporting by jurisdictions in concert so that statewide programs can be responsive to local needs. State management reporting must be adequate to show program status and accomplishments and warrants for new or expanded emphasis at State and national levels. The Standard provides for a periodic evaluation of the State program by the State and FHWA.

IV. FEDERAL LEVEL REPORTING

Progress reports to the Federal agencies (FHWA and NHTSA) are required on each Subelement Plan of a State's AWP (HSPM Volume 103, Chap. VII, par. 4). Management and evaluation reports which will aid the State in meeting the Federal reporting requirements are described in Volume 0 (Chap. VI, par. 2 & 3). These reports also serve as the basis for parts of the Annual Work Program and the multi-year Comprehensive Plan. Intermittent directives may be issued by the FHWA requesting additional information which is considered useful by other States in managing their safety programs and by the FHWA in developing and revising national emphasis programs. Because of the value project data has at all governmental levels, it is important that the records kept be selected to serve local, State, and Federal needs as well as to comply with program requirements.

HIGHWAY SAFETY PROGRAM MANUAL

VOLUME	13 - TRAFFIC ENGINEERING SERVICES	TRANSMITTAL 43
CHAPTER	VI. - LOCAL GOVERNMENT PARTICIPATION	February 1974

I. INTRODUCTION

Experience has shown that the effectiveness of traffic programs increases as the extent of participation of local jurisdictions* and other local agencies increases. Each local government, therefore, should carefully evaluate its capabilities and make arrangements to work with other communities within the State to accomplish a complete traffic control program. For a statement of DOT policy with respect to local government participation, see paragraph 5B, Chapter I, Volume 102.

II. ORGANIZATIONAL GUIDELINES

Because each State, in cooperation with its local jurisdictions, should organize its highway safety program according to its own needs, a national consensus concerning requirements for traffic engineering organizations does not exist. General organizational guidelines, however, are provided.

A. Communities of 25,000 to 50,000 Population.

1. The department of public works or its equivalent should be given primary responsibility for the traffic function.

*This includes, among others, municipalities, townships, counties, park districts, port authorities, and special districts.

559-860 O - 74 - 1

2. A minimum of one technician should be trained in traffic control techniques related to operation, maintenance, and evaluation.

3. In addition to performing regular traffic engineering functions as described in Chap. II, the department should

   a. Set up procedures for utilizing traffic engineering services available through consulting or governmental agencies.

   b. Provide specialized training for technicians through short courses or their equivalent.

   c. Work with the police department to obtain police traffic support, including school crossing protection and emergency traffic control.

   d. Utilize the new media and service organizations in disseminating information of public interest.

   e. Jointly develop with the school district, school bus routes, safe routes to school, and safety education programs.

B. Communities of 50,000 to 100,000 Population.

1. The department of public works or its equivalent should be given primary responsibility for the traffic engineering function.

2. Traffic engineering should be a separate division within the department.

3. The division head should be a qualified engineer, preferably with training and experience in traffic engineering.

4. The division should have a minimum of two technicians with some degree of technical training.

5. In addition to performing regular traffic engineering functions as described in Chap. II, the division should

a. Provide initial and refresher training for traffic engineers and technicians through university short courses or their equivalent.

b. Set up procedures for utilizing traffic engineering services when needed through consulting or government agencies.

c. Work with the police department to obtain police traffic support, including school crossing protection and emergency traffic control.

d. Utilize the news media and service organizations in disseminating information of public interest.

e. Jointly develop with the school districts, school bus routes, safe routes to school, and educational programs.

f. When appropriate, participate in traffic advisory groups (e. g., traffic commission) to furnish advice and support for new traffic control programs.

g. Participate in the city planning effort and utilize data on land use projections, zoning, etc., in determining future traffic safety and capacity needs.

C. Communities With Over 100,000 Population.

1. A traffic engineering department should be established at the same level as the public works department.

2. The department head should be a professional traffic engineer with extensive experience.

3. The engineering operation should have approximately one traffic engineer for each 50,000 population and ample technicians, maintenance men, and facilities.

4. The department should provide for regular training for traffic engineers and technicians through university short courses or their equivalent.

5. In addition to the program elements described in Chap. II, the following activities should be undertaken:

   a. Work with the police department to obtain police traffic support, including school crossing protection and emergency traffic control.

   b. Utilize the newspaper media and service organizations in disseminating information of public interest.

   c. Jointly develop with the school districts, school bus routes, safe routes to school, and educational programs.

   d. Contribute to the city planning effort and utilize data on land use projections, zoning, etc.

   e. Assist the department of public works through advice and coordination on roadway projects and other primary improvements.

III. METHODS FOR ENCOURAGING LOCAL PARTICIPATION

A. To provide the tools for more effective local participation, it is recommended that each State make available to local jurisdictions copies of the Manual on Uniform Traffic Control Devices and any supplemental manual sections adopted to provide for specific State needs. Because regular issuances of additional information pertaining to the MUTCD can be expected, a means of providing this material to the local jurisdictions also needs to be developed.

B. Each State Governor's Representative should inform local jurisdictions of new developments in the traffic control area. In this regard, he should establish a communications method whereby such information can be disseminated readily. Such things as data on new devices and techniques, new literature in the field, results of other States' activities, and State statistics are examples of items which would be of value to local jurisdictions.

In addition, other activities which may be considered are

1. Sponsoring a series of State-local government meetings where the effect of the safety program on the local community would be discussed. Such meetings could be conducted by a traffic engineer.

2. Encouraging cooperation between the smaller community without traffic engineering expertise and the larger community with traffic engineers. This could be particularly beneficial in metropolitan areas composed of many local governments.

3. The establishment of a traffic engineer to provide advice and guidance to the local community, either by employment of the engineer in the State highway department or by funding his salary while he is locally employed.

4. The use of an area traffic engineer employed jointly by several local communities, or a consultant to provide advice and guidance to the local community.

5. Publishing an annual report indicating the progress of the safety program, with particular emphasis on local communities having successful traffic control programs.

6. Inviting local communities to participate in State sponsored training programs.

APPENDIX A

HIGHWAY SAFETY PROGRAM STANDARD 13

TRAFFIC ENGINEERING SERVICES

PURPOSE

To assure the full and proper application of modern traffic engineering principles and uniform standards for traffic control to reduce the likelihood and severity of traffic accidents.

STANDARD

Each State, in cooperation with its political subdivisions, and each Federal department or agency that controls highways open to public travel or supervises traffic operations shall have a program for applying traffic engineering measures and techniques, including the use of traffic control devices, to reduce the number and severity of traffic accidents.

I. The program as a minimum shall consist of

A. A comprehensive manpower development plan to provide the necessary traffic engineering capability, including

1. Provisions for supplying traffic engineering assistance to those jurisdictions unable to justify a full-time traffic engineering staff.

2. Provisions for upgrading the skills of practicing traffic engineers and providing basic instruction in traffic engineering techniques to subprofessionals and technicians.

B. Utilization of traffic engineering principles and expertise in the planning, design, construction, and maintenance of the public roadways, and in the application of traffic control devices.

C. A traffic control devices plan including

1. An inventory of all traffic control devices.

2. Periodic review of existing traffic control devices, including a systematic upgrading of substandard devices to conform with standards issued or endorsed by the Federal Highway Administrator.

3. A maintenance schedule adequate to ensure proper operation and timely repair of control devices, including daytime and nighttime inspections.

4. Where appropriate, the application and evaluation of new ideas and concepts in applying control devices and in modifying existing devices to improve their effectiveness through controlled experimentation.

D. An implementation schedule to utilize traffic engineering manpower to

1. Review road projects during the planning, design, and construction stages to detect and correct features that may lead to operational safety difficulties.

2. Install safety-related improvements as a part of routine maintenance and/or repair activities.

3. Correct conditions noted during routine operational surveillance of the roadway system to rapidly adjust for the changes in traffic and road characteristics as a means of reducing accident frequency or severity.

4. Conduct traffic engineering analyses of all high-accident locations and develop corrective measures.

5. Analyze potentially hazardous locations, such as sharp curves, steep grades, and railroad grade crossings and develop appropriate countermeasures.

6. Identify traffic control needs and determine short and long range requirements.

7. Evaluate the effectiveness of specific traffic control measures in reducing the frequency and severity of traffic accidents.

8. Conduct traffic engineering studies to establish traffic regulations such as fixed or variable speed limits.

II. This program shall be periodically evaluated by the State or appropriate Federal department or agency where applicable, and the Federal Highway Administration shall be provided with an evaluation summary.

APPENDIX B

GLOSSARY OF DEFINITIONS

The following is a glossary of terms used in this volume which are not defined elsewhere* and whose meanings may be unclear or misinterpreted by the reader. These terms are defined with respect to this volume only.

Traffic Control Device - A sign, signal, marking, or other device placed on or adjacent to a street or highway by authority of a public body or official having jurisdiction to regulate, warn, or guide traffic.

Traffic Engineering Measures - Engineering procedures for controlling or regulating the movement, direction, speed, right-of-way, and parking of vehicular traffic and, where applicable, pedestrian traffic on streets and highways. This includes such elements as one-way streets, turn controls, reversible lanes, crosswalks, etc.

Warrants - The minimum conditions which would justify the establishment of a particular traffic control regulation or device, usually including such items as traffic volumes, geometrics, traffic characteristics, accident experience, etc.

Program - A major undertaking by a State, generally with statewide application. It may consist of a series of projects which are contributing in different ways to the desired result. "The Program" refers to the Annual Highway Safety Work Program (AWP).

Traffic Engineering Capability - Provision of the necessary traffic engineering resources (trained personnel and adequate funding) for the planning, geometric design, and traffic operations of roads, streets, and highways.

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*Other definitions applicable to traffic engineering and traffic control devices may be found in the Manual on Uniform Traffic Control Devices for Streets and Highways (1971), the Uniform Vehicle Code and Model Traffic Ordinance (1968), and the AASHO Highway Definitions.

Subelement Plan (SEP) - A standardized administrative format used for reporting data on a particular project area. It includes information on project goals, work tasks, time schedules, and costs; it serves to chart progress related to completion of necessary work and project effectiveness.

Project - An organized work task, generally small enough to be clearly defined, well organized, and tightly controlled. It can be related to a small scale SEP or to an individual task of a large scale SEP.

Implementation Schedule - A listing of the events needed to complete a particular project activity. The listing is arranged in a chronological sequence according to the time for initiating each event and with an estimated time of completion.

Cost-Effective Analysis - A comparison study between the cost of a traffic control device (initial plus upkeep) and the benefits it provides. The latter may be derived from accidents reduced, travel time reduced, or increased volume of usage, and translated into equivalent dollars saved.

APPENDIX C

REPRESENTATIVE PROJECTS

The following is a list of typical traffic engineering projects which are eligible for Highway Safety Grant funds and which contribute to improving highway safety.

1. Inventory of traffic control devices and establishment of a records system.

2. Automation of a State's record keeping and retrieval procedures for traffic control devices inventory data.

3. Preparation of supplemental provisions to the Manual on Traffic Control Devices or preparation of a State Manual on Uniform Traffic Control Devices.

4. Upgrading of warning and regulatory signs of the Federal-aid systems to conform with approved standards.

5. Establishment of a sign maintenance program, including the application of preventive maintenance, a system for making prompt damage repair, and regular inspections for appearance and reflectivity.

6. Preparation of a maintenance manual for traffic signs, signals, and markings.

7. Utilization of innovations in control devices and traffic engineering techniques on a demonstration basis.

8. Graduate traffic engineering training of up to 9 months for practicing engineers.

9. Establishment of a State highway department staff which would supply traffic engineering expertise to local communities.

10. Studies of selected roadway locations to determine where such measures as one-way streets, turn restrictions, parking restrictions, reversible lanes, designated turning lanes, and signal coordination can contribute to highway safety.

11. Special evaluation studies, including evaluation of accident records before and after an improvement, as well as cost-effectiveness determinations.

12. Measurement of prevailing speeds and establishment of speed zones and recommended limits on that basis.

13. Studies of selected intersections in a city to determine where signal installations might contribute to increased safety.

14. Training of traffic engineers and traffic engineering technicians through short courses and seminars in safety related curriculums.

15. Study of the pedestrian-vehicle conflicts at selected intersections with recommendations for increased control.

16. Survey of traffic engineering manpower needs and comparison with available capabilities.

17. Employment of traffic engineers and technicians to make studies and implement recommendations.

APPENDIX D

MANAGEMENT GUIDE FOR A STATEWIDE INVENTORY

A. The program plan.

For large scale inventories, it is recommended that the full study be preceded by a pilot study:

1. Pilot study.

The purpose of the pilot study is to obtain a general picture of overall system needs and an estimate of time and resources required for the full inventory, using a minimum of time and manpower.

a. In planning the pilot study, highways of each type or classification should be included. For example, a study of an urban street system should include an adequate sample of arterial, secondary, industrial, business, and residential streets, as well as streets in downtown, intermediate, and outlying areas. It is suggested that the sample contain approximately 10 percent of the mileage within an urban jurisdiction.

b. The pilot study should include a traffic engineering analysis of the selected roadway sections, as well as a determination of the deficiencies of existing traffic control devices. The information obtained from the pilot study should then be expanded to provide a reasonable estimate of the magnitude of the improvement program for the entire jurisdiction.

c. Typical survey forms for recording information concerning existing traffic control devices are shown in Appendices F, G, and H. These forms should be used as guides in the development of appropriate forms for the full inventory. It should be emphasized that simply filling out these forms is not a substitute for the required traffic engineering studies.

2. Full study.

Once the magnitude of the full inventory has been determined, an operational plan and manpower assignments can be determined. Some of the necessary details are

a. A scheduling of inventory operations for maximum utilization of employees and equipment. It is preferable to have the full study performed during a 1-year period to take into consideration any changes in traffic characteristics.

b. Proper staffing to provide adequate supervision and a balance of technical personnel. This might be accomplished with agency personnel or traffic engineering consultants.

c. A data processing plan for systematic processing of collected information and for use in achieving highway safety goals.

d. A continuation plan which would permit regular or intermittent updating of the initial data and its routine use in day to day operations.

e. An improvement plan, based on the study findings. Initially such a plan should be in general terms only, with as many alternate improvement ideas incorporated as possible. Cost-beneficial relationships should be employed as a means of selecting the preferable improvement method.

f. An improvement implementation schedule. This may be planned for a 1- to 5-year period and should be, as closely as possible, patterned to take care of the most critical needs first. It should also take into consideration changes in traffic conditions after the study is completed.

B. Implementation of the plan.

Before actual implementation of a safety activity can begin, a detailed activity plan and specification and a work schedule need to be developed.

1. Detailed plans and specifications.

The development of improvement details should be postponed until the specific activity is ready to be implemented, thus avoiding inclusion of outdated methodology as well as erroneous data on traffic conditions as a basis for the improvement. If the continuation plan (Par. A(2)(d)) is functioning properly, current inventory information will be readily available as a basis for detailed plan preparation.

2. Work plans.

This may involve either work done by a governmental agency's own personnel or by contractors. The first is preferable if routine projects can be postponed, because it permits a greater familiarity with new or modernized traffic control equipment and allows more effective performance of the maintenance function. The use of a contract agreement requires careful attention to the work specifications and to the on-site inspection. The contracting arrangement has an advantage over governmental supervision in that the latter does not have to enlarge its work force to handle the additional projects.

APPENDIX E

TRAFFIC CONTROL DEVICE MAINTENANCE INSPECTIONS

A. Frequency and type of inspections.

All signs should be inspected at least twice a year with a nighttime inspection at least once a year. During the day, signs may be entirely adequate, but may be ineffective at night due to little or no reflective qualities. Illuminated signs should be inspected on a more frequent basis for failure of lighting elements. Traffic signals should be checked at night to ensure a sharp and clear signal indication. The reflective qualities of markings also should be inspected under nighttime conditions. Periodic inspections during special conditions (twilight, inclement weather, dew conditions, etc.) should be made of specific problem locations.

B. Type of maintenance work needed.

For emergency repairs, it is important that arrangements be made to ensure that repair personnel are on call at all times. For a preventive maintenance program, the following items need to be considered:

1. All signs, delineators, and hazard markers should be periodically scheduled for cleaning and refurbishing. In addition, a periodic check is desirable to determine the need for interim cleaning, the presence of loose nuts, crooked posts, etc. For example, the following conditions may be noted:

    a. Signs often need cleaning after a snow removal operation has deposited salt and abrasives on the sign face.

    b. Signs may need washing after a major rain due to mud splashed by automobiles.

    c. Signs located in heavy industrial or high-volume traffic areas need cleaning more often than those in other locations.

2. Pavement markings must be replaced when significant wear occurs. In some urban areas, this may be as often as four or more times a year. Restriping should be done often enough to ensure clear, effective markings at all times, both day and night.

3. All traffic signals should be scheduled periodically for cleaning, repainting, and/or renovating. Where area and weather conditions introduce special problems, it is desirable to develop a flexible time schedule to ensure that the signal indications are bright and clear at all times.

   a. Signal lamps should be replaced on a regular basis. It is generally safer and may be more economical to group-replace signal lamps rather than to dispatch signal crews to replace individual lamp burnouts. Group-lamp replacement can often be scheduled concurrently with controller preventive maintenance. Cleaning of lenses and reflectors should also be performed at the same time.

   b. Signal controllers should be cleaned and serviced at least as frequently as specified by the manufacturer and more frequently if experience proves necessary. It is recommended that at least once a year all electro-mechanical controllers be lubricated, and all timing motors and dial settings be checked for accuracy. This maintenance may be performed in the field without removing the controller. However, it is recommended that every 2 to 5 years (depending on field maintenance) the controller be taken to the shop for inspection and refurbishing. Availability of a spare unit for each type of controller is of prime importance, both for routine servicing and emergency repair. Special maintenance procedures should be developed for the newer "solid state" controllers.

C. Types of maintenance records needed.

1. Records for signs should show the frequency of cleaning, the type of repairs performed, etc. This information will be helpful in determining whether the signs are properly positioned (to avoid splashing or being struck), are

of adequate construction (both the sign blank and the mounting device), and have sufficient durability.

2. Pavement marking records showing the condition of the markings at the time of replacement should also be kept. With these records, it will be possible to determine whether it is necessary to replace markings more frequently.

3. Records for traffic signals should indicate the frequency of cleaning, lubricating, repairing, retiming, overhauling, lamp replacement, painting, and similar activities for each installation. From these records, for example, it may be determined that

   a. Group-lamp replacement should be performed more often due to a large number of burnouts prior to the regularly scheduled replacement time.

   b. A controller should be replaced or overhauled whenever it has required an unusually large number of repairs.

   c. A specific item of equipment has a history of a particular type of malfunction.

   d. A particular type of controller lacks reliability.

APPENDIX F

GUIDE FOR A TRAFFIC SIGN INVENTORY

I. INTRODUCTION

The following is a description of a sign inventory technique which is not only adaptable for automatic data processing (ADP) methods, but can be used by traffic engineering organizations operating on a manual basis. Where necessary, the coding information can be modified to suit individual needs.

Exhibit I provides a sample inventory form for signs, Any corrections brought about by the field inspections would be recorded in the master file and periodically incorporated into the inventory to keep it current.

II. CODING INSTRUCTIONS

Coding should be made as meaningful as possible by incorporating route numbers, direction abbreviations, etc., into the coding system. This will reduce the time required to scan coding lists to find correct designations. Codes can consist of numbers, letters, or combinations and be directly usable on ADP input cards. If desired, direct punching of ADP cards can be done in the field; however, this may make verification of the data more difficult than the use of a larger form.

Suggested codes for use with the sign inventory form are listed in Exhibit II.

EXHIBIT I

SIGN INVENTORY DATA SHEET

SIGN INVENTORY DATA SHEET

CONTROL SECTION (1-4)__________ DATE__________

PR NO. (5-7)_____ DIRECTION(8)__________ PARTY__________

MAINT. AREA (9-10)_____ RURAL OR URBAN (11)__________ UNIT NO.__________

SUBSECTION DESC. (12-46)__________ SHEET_____OF_____SHEETS

A	B	C	D	E	F		G	H	I	J	K	L	M	N	O	P	Q	R	S	T
ODOMETER READING (FIELD)	SIGN SERIAL NUMBER	DISTANCE (OFFICE)	TYPE OF SIGN	SIGN CODE NUMBER	SIZE HOR. (IN.)	SIZE VERT. (IN.)	GEOMETRIC SHAPE	SIGN FACE	MATERIAL	COLORS	SIGN CONDITION	VISIBILITY	NO. OF THIS SIGN IN ASSEMBLY	PLACEMENT	SIDE OF ROADWAY	ADEQUACY	TYPE OF POST	CONDITION OF POST	LOCATION (SAFETY)	REMARKS
	47 50	51 54	55	56 58	59 61	62 64	65	66	67	68	69	70	71-72	73	74	75	76	77	78	

EXHIBIT II

ADP CODING INSTRUCTIONS
(Sign Inventory)

Column	Item	Code
1 - 4	Control section	Number assigned
5 - 7	Project number	Number assigned
8	Direction traveling while recording data	N, S, E, W
9 - 10	Maintenance area	Number assigned
11	Rural or urban	R or U
12 - 46	Subsection description	Describe beginning and ending points as well as route being inventoried. Select easily identified points and abbreviate. Example: W. Co. Line to N. L. St. Cloud for west county line to north limit, St. Cloud. (Note: all column spaces may not be needed)
	Odometer reading	Actual mileage recorded - coded as distance from reference point (column C)
47 - 50	Sign serial number	Begin at 0000 for each subsection and number successive signs consecutively
51 - 54	Distance	Computed in office using odometer readings from a reference point noted in the subsection description

EXHIBIT II

(continued)

Column	Item	Code
55	Type of sign	0 - warning signs 1 - regulatory signs 2 - route markers, including assemblies 3 - destination, distance, and information signs 4 - fixed advertising signs 5 - moveable advertising signs 6 - church signs 7 - service signs 8 - signs not on inventory list, note details in remarks column
56 - 58	Sign code number	Use predetermined code listing, example: 010 - Turn symbol (left) 070 - Cross road symbol
59 - 61	Horizontal dimension	Code actual dimension in inches
62 - 64	Vertical dimension	Code actual dimension in inches
65	Geometric shape	0 - rectangular 1 - square 2 - diamond 3 - octagon 4 - triangle 5 - circular 6 - shield (specify) 7 - others (specify)

EXHIBIT II

(continued)

Column	Item	Code
66	Sign face	0 or A* - reflective sheeting 1 or B* - enamel 2 or C* - refl. buttons, nonrefl. background 3 or D* - refl. buttons, refl. background 4 or E* - refl. letters, nonrefl. background 5 or F* - refl. letters, refl. background 6 - internally illuminated * Use when external illumination is provided
67	Material	0 - steel (flat) 1 - steel (embossed) 2 - aluminum 3 - wood 4 - other (fiberglass, plastic, etc.)
68	Colors	0 - black on white 1 - white on black 2 - white on red 3 - red on white 4 - white on green 5 - green on white 6 - black on yellow 7 - black on orange 8 - white on blue 9 - red, white, and blue A - other (specify)
69	Sign condition	G - good condition B - rusty, bent, or damaged

EXHIBIT II

(continued)

Column	Item	Code
69	Sign condition (cont.)	S - needs repair or straightening F - faded R - poor reflectivity L - not legible
70	Visibility	0 - easily seen 1 - hidden by official sign 2 - hidden by advertising sign 3 - hidden by parked vehicles 4 - hidden because of curve 5 - hidden because of hill 6 - hidden by other objects (trees, brush, light poles, etc.) 7 - other (specify)
71 - 72	Number of signs in assembly	01 - first sign 02 - second sign 03 - third sign, etc.
73	Placement of sign	0 - overhead G - ground mount
74	Side of roadway	R - right side L - left side
75	Adequacy	0 - standard as per MUTCD 1 - nonuniform - replace with uniform sign 2 - nonstandard - remove, do not replace

EXHIBIT II

(continued)

Column	Item	Code
75	Adequacy (cont.)	3 - add this sign 4 - other (specify)
76	Type of post	0 or A* - steel channel or U 1 or B* - steel round 2 or C* - steel H-beam 3 or D* - steel rectangular 4 or E* - wood 4 x 4 5 or F* - wood 4 x 6 6 or G* - wood 6 x 6 7 or H* - wood round 8 - light or power pole 9 - other (specify) * Use where post is considered breakaway or frangible
77	Condition of post	0 - satisfactory 1 - replace 2 - straighten 3 - paint 4 - straighten and paint 5 - sign too low 6 - sign too high
78	Location (safety)	0 - satisfactory 1 - relocate behind existing guardrail 2 - relocate on lighting or power pole 3 - place on support with another sign 4 - relocate on overcrossing structure 5 - move farther away from roadway

EXHIBIT II

(continued)

Column	Item	Code
78	Location (safety) (cont.)	6 - move to better location up or down roadway 7 - needs guardrail protection
	Remarks	Use where special information about sign is to be inserted.

APPENDIX G

GUIDE FOR A PAVEMENT MARKING INVENTORY

1. INTRODUCTION

The following technique is recommended for making an inventory of streets and highways. The form for conducting such an inventory, provided in Exhibit I, is designed for automatic data processing (ADP) application. A graphic representation of markings related to a specific section of highway is shown in Exhibit II.

2. CODING INSTRUCTIONS

Coding should be made as meaningful as possible by incorporating route numbers, direction abbreviations, etc., into the coding system. This will reduce the time required to scan coding lists to find correct designations. Codes can consist of numbers, letters, or combinations and be directly usable on ADP input cards. If desired, direct punching of ADP cards can be done in the field; however, this may make verification of the data more difficult than the use of a larger size form.

Exhibit III shows suggested codes for use with the form in Exhibit I.

EXHIBIT I

INVENTORY FORM

Pavement Markings Inventory

OBSERVERS 1 ☐ 2 ☐ 3 ☐

INITIALS ONLY 4 ☐ 5 ☐ 6 ☐

DIRECTION 7 ☐

DATE 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐

COUNTY 14 ☐ 15 ☐

TWP. 16 ☐ 17 ☐

ROUTE 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐

MILE 23 ☐ 24 ☐ TO MILE 25 ☐ 26 ☐

SHEET 27 ☐ 28 ☐ OF 29 ☐ 30 ☐

CENTER LINES

	Odometer Begin						Odometer End						Log Mileage				Type	Color	Width
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
(A)	0	0	2	5	5	0	0	0	2	7	5	0					2	1	4
(B)	0	0	2	7	5	0	0	0	3	2	5	0					4	3	4
	0	0	3	2	5	0	0	0	3	0	5	0					1	1	4
(C)	0	0	3	0	5	0	0	0	4	6	5	0					3	3	4
	0	0	4	6	5	0	0	0	5	1	5	0					5	2	4
(M)	0	0	0	5	5	0	0	0	0	6	1	0					1	1	4
	0	0	0	5	5	0	0	0	0	6	1	0					1	1	4
(N)	0	0	0	0	1	0	0	0	0	7	5	0					5	1	6
	0	0	0	6	1	0	0	0	0	7	5	0					1	1	4
	0	0	0	6	1	0	0	0	0	7	5	0					1	1	4

EDGE LINES

	Odometer Begin						Odometer End						Log Mileage				Type	Color	Width
	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
(A)	0	0	2	5	5	0	0	0	5	1	5	0					2	1	4

RR. CROSSING / OTHER

	RR. Crossing Marked		RR. Crossing Conform		Horizontal	Vertical	Area	Lane Line
	69	70	71	72	73	74	75	76
(A)								
(B)								
(C)								
(M)								
								1
								3
(N)								
								1
								3
								5

EXHIBIT II

GRAPHIC REPRESENTATION OF MARKINGS

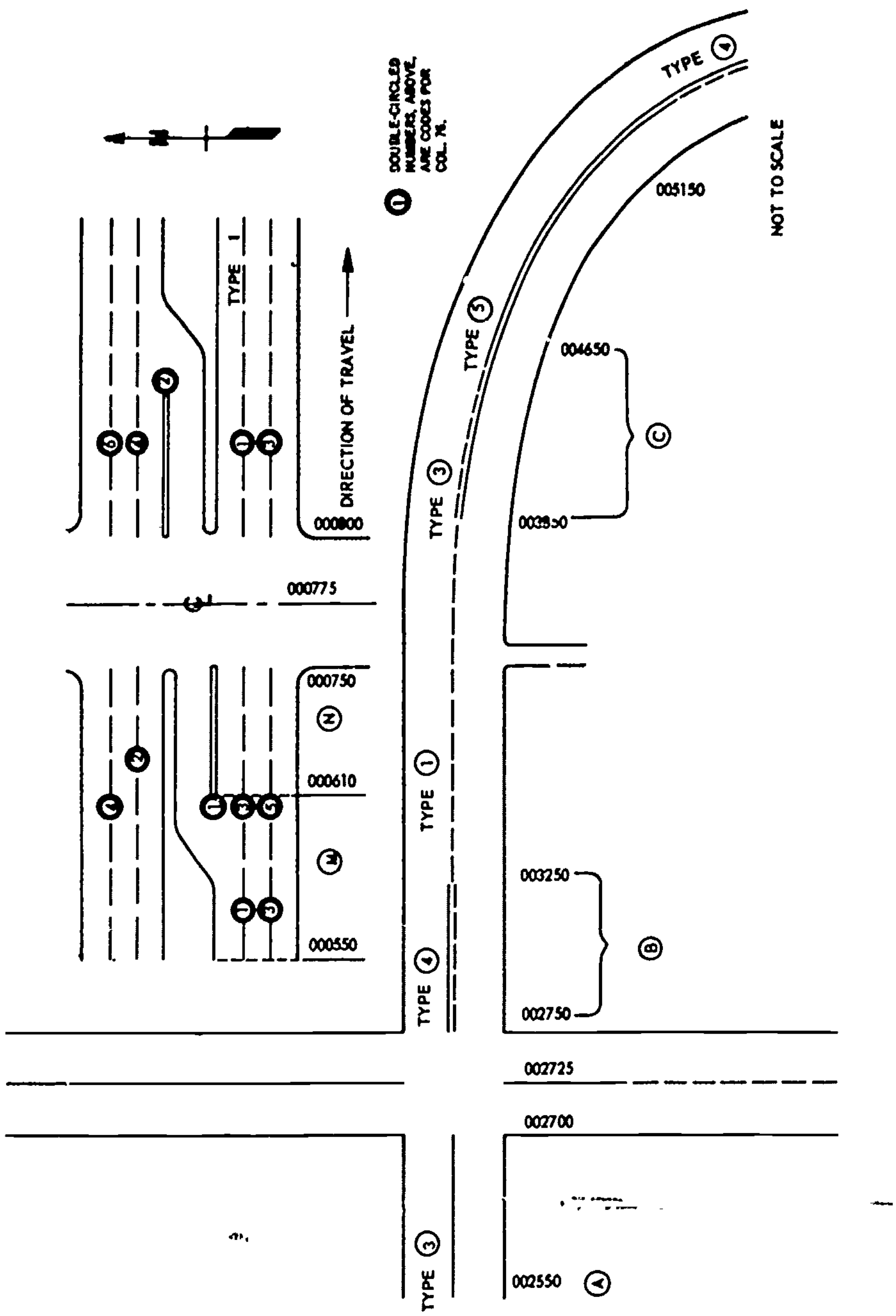

EXHIBIT III

ADP CODING INSTRUCTIONS
(Markings Inventory)

Column	Item	Code
1 - 6	Identification of observers	Enter initials
7	Direction traveling while recording	N, S, E, W
8 - 13	Date	Code in numeric form, e.g., June 25, 1967 06 25 67
14 - 15	County or equivalent	Use number assigned
16 - 17	Township, if appropriate	Use number assigned
18 - 21	Route	Use number assigned or actual route number
22	Route type	A - alternate B - business S - spur
23 - 26	Length of study section	Code actual miles
27 - 30	Sheet identification	Code number of pages
31 - 36	Beginning of a particular type center line	Code actual odometer reading
37 - 42	End of a particular type of center line	Code actual odometer reading
43 - 46	Mileage of a particular marking	Calculate from odometer readings
47	Marking type	1 - dashed 2 - solid 3 - dashed left, solid right

EXHIBIT III

(continued)

Column	Item	Code
47	Marking type (cont.)	4 - solid left, dashed right 5 - solid left, solid right 0 - none
48	Marking color	1 - white, only 2 - yellow, only 3 - white dashed, yellow solid 4 - yellow dashed, white solid
49	Marking width	Code actual width in inches
50 - 55	Beginning of an edge line	Code actual odometer reading
56 - 61	End of an edge line	Code actual odometer reading
62 - 65	Mileage of a section of edge line	Calculate from odometer readings
66	Marking type	As for cenier lines
67	Marking color	As for center lines
68	Marking width	Code actual width in inches
69 - 70	Railroad crossing markings	1 - crossing marked 2 - crossing not marked
71 - 72	Railraod crossing markings type	1 - markings conform to standard 5 - markings are in-complete

EXHIBIT III

(continued)

Column	Item	Code
71 - 72	Railroad crossing markings type (cont.)	9 - markings do not conform
73	Horizontal curve	1 - curve present
74	Vertical curve	1 - curve present
75	Area type	1 - urban 9 - rural
76	Lane line	Record length in center line section Code of lines on right side 1 - first lane from center 3 - second lane from center 5 - third lane from center Code for lines on left side 2 - first lane from center 4 - second lane from center 6 - third lane from center, etc.

APPENDIX H

GUIDE FOR A TRAFFIC SIGNAL INVENTORY

The following are examples of forms which can be used for traffic signal inventory. One of these forms covers automatic data processing (ADP) instructions while the other is a location sketch.

1. ADP CODING INSTRUCTIONS

The ADP coding instructions as described in Exhibit I are designed for automatic data processing application using a single 80-column card for each signalized intersection. Other information may be included and submitted for that shown or additional cards may be used.

2. LOCATION SKETCH

The location sketch as shown in Exhibit II is a scale drawing of the physical characteristics of the signalized intersection. This drawing provides an adequate record for those agencies where data processing is neither available nor necessary. In addition, it can be used to supplement data processing records.

The sketch is an example of a signalized intersection showing signal hardware and traffic phasing, as well as pertinent data on geometrics and operational characteristics of the approaches. The symbols used on this type of location sketch are shown in Exhibit III.

Additional data which could be indicated on the sketch are

A. The distance of the supports and signal heads from the edge of the traveled way.

B. The vertical clearance of the signal heads.

C. The type of protection for the motorist from the supports, such as guardrails and frangible type pedestals.

The signal timing, type of equipment, date placed in operation, and other support information can be shown on a supplemental sheet if necessary.

EXHIBIT I

ADP CODING INSTRUCTIONS
(Signal Inventory)

Column	Item	Code
1 - 5	Intersection Code	Number assigned to each intersection
6 - 9	Date of Coding - Month and Year	01 = Jan., etc. 68 = 1968, etc.
10	Type of Intersection	1 - Four leg or regular 2 - Tee; 3 - Wye; 4 - Irregular; 5 - Jogged 6 - Circle; 7 - 5 legs; 8 - 6 legs; 9 - 7 legs; A - 8 legs; B - other
11	Number of Approaches	Code direct; when number is more than 9; A = 10; B = 11, etc.
12	Approaches with a Single Indication (Nonstandard)	Same as Column 11
13	Approaches - Nonstandard Signal Location or Operation	Same as Column 11
14	Number of Phases	Same as Column 11
15	Leading Protected Left Turn	0 = No; 1 = one approach; 2 = two approaches, etc.
16	Lagging Protected Left Turn	Same as Column 15
17	Leading Protected Right Turn	Same as Column 15
18	Lagging Protected Right Turn	Same as Column 15

EXHIBIT I

(continued)

Column	Item	Code
19	All Red Clearance	1 = yes; 2 = no
20	Part-Time Flashing Operation	1 = yes; 2 = no
21	Pedestrian Phases	1 = No pedestrian signals 2 = All walk phase 3 = Flashing "walk" (or blank out) 4 = Steady "walk" for at least one crosswalk 5 = Flashing "walk" and steady "walk," at least one crosswalk
22	Type of Controller	1 = Pretimed; 2 = pretimed with actuated demand 3 = Semiactuated 4 = Fully actuated 5 = Volume density 6 = Volume density with actuated minor movement units; 7 = Special unit in a computerized system
23	Solid State	1 = yes; 2 = no
24	Controller Manufacturer	Code manufacturers signal number i. e., -1 = Eagle; 2 = Automatic signal, etc.
25	Location of Controller	1 = NW corner; 2 = NE corner; 3 = SE corner; 4 = SW corner; 5 = Center in intersection; 6 = Northerly;

EXHIBIT I

(continued)

Column	Item	Code
25	Location of Controller (cont.)	7 = Easterly; 8 = Southerly; 9 = Westerly
26 - 27	Year Installed	Last two digits of year
28	Number of Intersections Controlled by this Controller	Code direct; when number is more than 9; A = 10; B = 11, etc.
29	Type of Interconnection	1 = telephone wire; 2 = cable; 3 = radio; 4 = cable & decoder; 5 = radio & cable; 6 = coordinated noninter-connected synchronous system; 7 = isolated
30	Number of Dials Installed	Code direct
31	Number of Dials in Use	Code direct
32	Number of Dials Possible	Code direct
33	Number of 1 Section Signal Faces	Code direct
34 - 35	Number of 3 Section Signal Faces	Code direct
36 - 37	Number of 4 Section Signal Faces	Code direct
38	Number of 5 Section Signal Faces	Code direct
39	Number of 6 Section Signal Faces	Code direct

EXHIBIT I

(continued)

Column	Item	Code
40 - 41	Number of Arrow Indications	Code direct
42 - 43	Number of 12-inch lenses	Code direct
44	Number of 12-inch Arrow Indications	Code direct
45 - 46	Number of Tunnel Visors	Code direct
47	Number of Louvers	Code direct
48	Number of Backplates	Code direct
49	Number of Incandescent Pedestrian Signals	Code direct
50	Number of Neon or Blank-Out Pedestrian Signals	Code direct
51	Number of Illuminated "NO LEFT TURN" or "NO RIGHT TURN"	Code direct
52	Number of Vehicle Detectors	Code direct; when number is more than 9; A = 10, B = 11, etc.
53	Number of Radar Detectors	Code direct
54	Number of Inductive Loop Detectors	Code direct
55	Number of Magnetic Loop Detectors	Code direct

EXHIBIT I

(continued)

Column	Item	Code
56	Number of Pressure Pad Detectors	Code direct
57	Number of Ultrasonic Detectors	Code direct
58	Number of Pedestrian Detectors	Code direct
	Post and Poles on Which Signals are Mounted	
59 - 60	Number of Metal Street Light Poles	Code direct
61 - 62	Number of Pedestal Signal Posts	Code direct
63	Number of Mast Arm Mountings	Code direct
64	Number of Span Wire Mountings	Code direct
65	Number of Wood Poles	Code direct
66	Number of Exclusive Left Turn Lanes	Code direct
67	Number of Exclusive Right Turn Lanes	Code direct
68 - 69	Posted Speed Limit - Major Street (if practical to record)	Code direct
70 - 71	Posted Speed Limit - Minor Street (if practical to record)	Code direct

EXHIBIT I

(continued)

Column	Item	Code
72 - 75	Nearest Traffic Signal - Major Street — in feet - (if less than 10,000 feet)	Code direct
76 - 79	Nearest Traffic Signal - Minor Street - in feet - (if less than 10,000 feet)	Code direct
80	Blank	

EXHIBIT II
SIGNAL LOCATION SKETCH

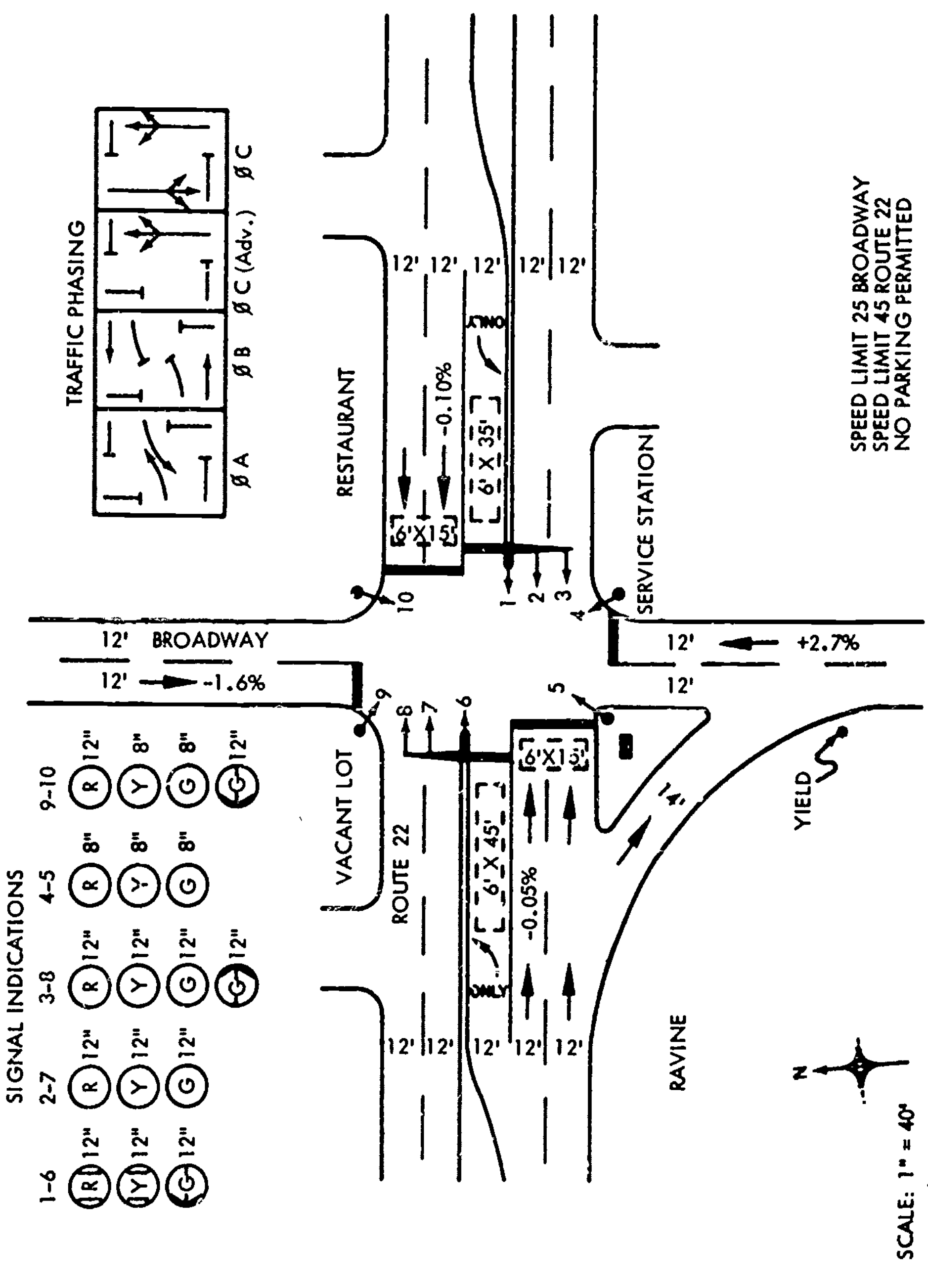

EXHIBIT III

TRAFFIC SIGNAL SYMBOLS

- SIGNAL FACE (VEHICULAR)
- SIGNAL FACE WITH BACKPLATE
- PED — SIGNAL FACE (PED. "DON'T WALK - WALK")
- POST MOUNTED SIGNAL HEAD WITH SIGN
- STOP LINE
- LANE USE
- CONTROLLER
- SPAN WIRE WITH SIGNAL HEAD
- MAST ARM WITH SIGNAL HEAD
- MAST ARM WITH SIGNAL HEADS
- MAST ARM WITH OVER-HEAD SIGN
- R — MAST ARM WITH RADAR DETECTOR
- S — MAST ARM WITH ULTRA-SONIC DETECTOR
- S — SIDE FIRE ULTRA-SONIC DETECTOR
- NON-COMP. MAG. DET.
- COMP. MAG. DETECTOR
- PRES.-SENS. DET. NON-DIR.
- PRES.-SENS. DET. DIR.
- INDUCTION LOOP DETECTOR
- PUSH BUTTON DETECTOR
- SIGNAL POLE
- POWER POLE
- O—L — SIGNAL POLE WITH STREET LIGHT
- TELEPHONE POLE
- R — RED INDICATION
- Y — YELLOW INDICATION
- G — CIRCULAR GREEN INDICATION
- G — GREEN STRAIGHT AHEAD ARROW
- G — GREEN LEFT ARROW
- G — GREEN RIGHT ARROW
- |G| — TUNNEL VISOR
- |Y| — TUNNEL VISOR WITH LOUVERS
- 8 — SIGNAL FACE NUMBER WITH PROGRAMMED OPTICS

NOTE: FOR ADDITIONAL SYMBOLS SEE "TRAFFIC SIGNAL MANUAL", INTERNATIONAL SIGNAL ASSOCIATION, HOUSTON, TEXAS, 1971

APPENDIX I

RESOURCE ORGANIZATIONS

The following is a list of national organizations which can provide information on traffic engineering and traffic control devices. These organizations may provide many valuable suggestions for initiating and carrying out elements of the Highway Safety Program.*

American Association of State Highway and Transportation Officials (AASHTO)
341 National Press Building
Washington, D.C. 20004

American Automobile Association (AAA)
8111 Gatehouse Road
Falls Church, Virginia 22042

American Public Works Association
1313 East Sixtieth Street
Chicago, Illinois 60637

Highway Research Board (HRB)
2101 Constitution Avenue, N.W.
Washington, D.C. 20003

Highway Users Federation for Safety and Mobility (HUFSAM)
1776 Massachusetts Avenue
Washington, D.C. 20036

Institute of Traffic Engineers (ITE)
1815 N. Fort Myer Drive
Arlington, Virginia 22209

*There are also many other organizations, both private and regional, which are involved in traffic safety. The organizations listed above can assist in locating them. In addition, many universities conduct traffic research and have courses in traffic engineering. Information concerning these and related courses can be obtained from the Institute of Traffic Engineers.

Insurance Institute for Highway Safety (IIHS)
2600 Virginia Avenue, N. W.
Washington, D. C. 20037

National Advisory Committee on Uniform Traffic Control Devices
c/o Office of Traffic Operations
Federal Highway Administration
Washington, D. C. 20590

APPENDIX J

REFERENCES

The following is a list of nationally recognized authoritative references which are available and can be used as source material to assist in implementing the Traffic Engineering Services Program. It is not a general bibliography of the field. For that kind of information, the organizations listed in Appendix I should be contacted, particularly the Institute of Traffic Engineers.

When available, local source material should be utilized, such as State highway department traffic control devices manuals and those developed by city and county agencies. It is expected that these local documents would be in substantial conformance with those documents listed below to ensure uniform design and application of all traffic control devices.

Application and Design of Uniform Traffic Control Devices AASHO Highway Definitions (1968). American Association of State Highway and Transportation Officials, 341 National Press Building, Washington, D. C. 20004.

Color Tolerance Charts. Office of Traffic Operations, Federal Highway Administration, Washington, D. C. 20590.

Handbook of Safety Design and Operating Practices (1973). Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

Manual on Uniform Traffic Control Devices for Streets and Highways (1971). Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

Standard Alphabets for Highway Signs (1966). Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

Standard Highway Signs (1972). Office of Traffic Operations. Federal Highway Administration, Washington, D. C. 20590.

Traffic Laws

Uniform Vehicle Code and Model Traffic Ordinance (1968). National Committee on Uniform Traffic Laws and Ordinances, Suite 430, 1776 Massachusetts Avenue, N. W., Washington, D. C. 20036.

Uniform Vehicle Code: Rules of the Road with Statutory Annotations (1967). National Committee on Uniform Traffic Laws and Ordinances, Suite 430, 1776 Massachusetts Avenue, N. W., Washington, D. C. 20036.

Traffic Engineering Principles and Techniques

An Introduction to Highway Transportation Engineering (1968). Institute of Traffic Engineers, 1815 N. Fort Myer Drive, Arlington, Virginia 22209.

Highway Capacity Manual (1965). Special Report No. 87, Highway Research Board, 2101 Constitution Avenue, N. W., Washington, D.C. 20418.

Improved Street Utilization Through Traffic Engineering (1967). Special Report No. 93, Highway Research Board, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

Manual of Traffic Engineering Studies (1964). Institute of Traffic Engineers, 1815 N. Fort Myer Drive, Arlington, Virginia 22209.

Traffic Engineering (1965). Theodore M. Matson, Wilbur S. Smith, Frederick W. Hurd. McGraw-Hill, 330 West 42nd Street, New York, New York 10036.

Traffic Engineering Handbook (1973). Institute of Traffic Engineers, 1815 N. Fort Myer Drive, Arlington, Virginia 22209.

Evaluation Criteria for Safety Improvements on the Highway, Roy Jorgensen and Associates, Westat Research Analysts, Inc., 1966 (distributed by the National Technical Information Service, Springfield, Virginia 22151 - No. PB173822).

Geometric Design of Roadways

A Policy on Geometric Design of Rural Highways (1965). American Association of State Highway and Transportation Officials, 341 National Press Building, Washington, D.C. 20004.

A Policy on Arterial Highways in Urban Areas (1973). American Association of State Highway and Transportation Officials, 341 National Press Building, Washington, D.C. 20004.

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