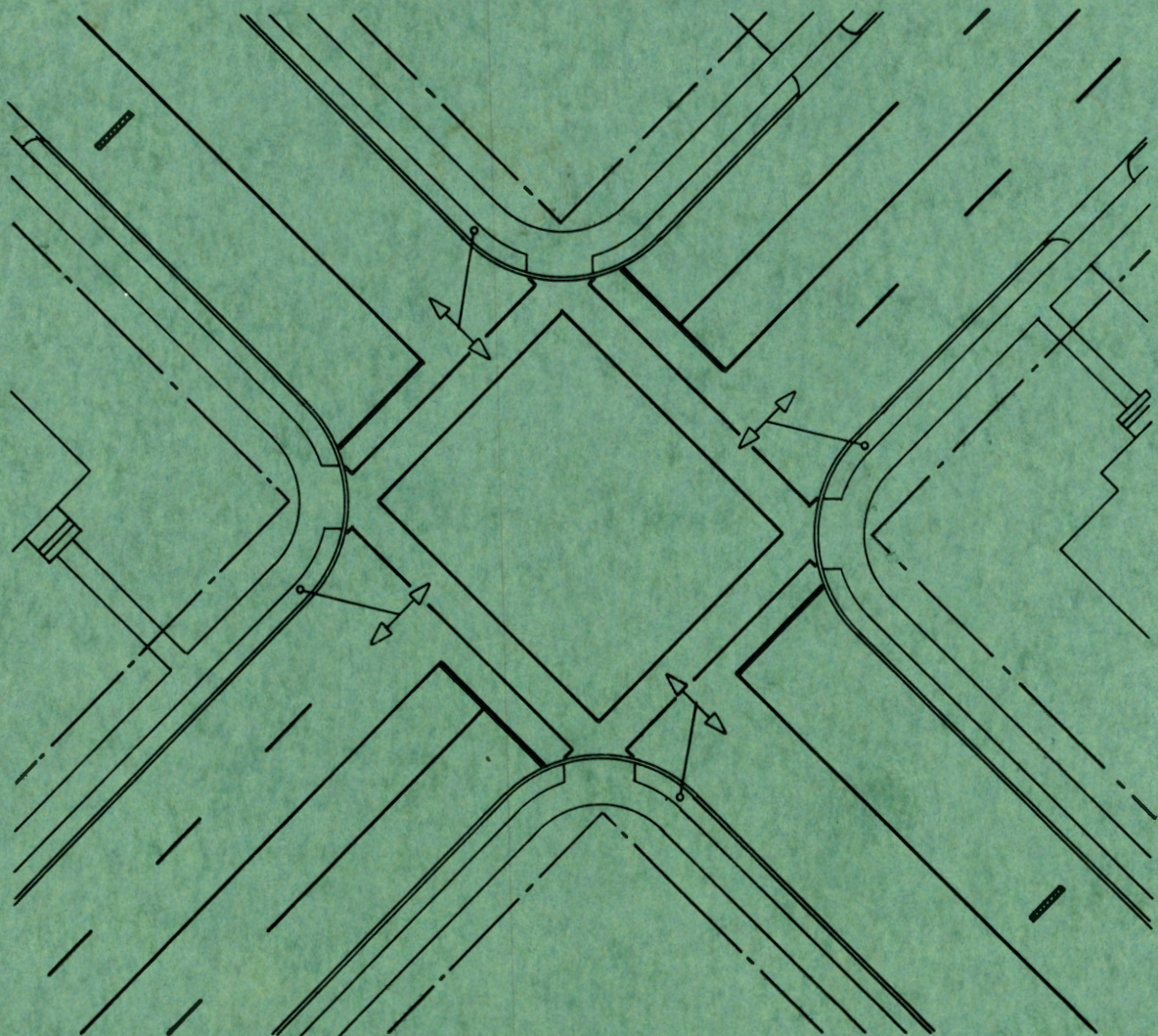




New Jersey
Manual on
Traffic Signal
Application Procedures
for Local Officials



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N.J. DEPARTMENT OF LAW AND PUBLIC SAFETY
DIVISION OF MOTOR VEHICLES
TRAFFIC SAFETY SERVICE

Trenton, N.J.

August 1964

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FOREWORD

This Manual has been adopted as the official State publication specifying the procedures to be followed by local officials in the preparation and submission of applications and related data pertaining to traffic control signals in this State.

As a procedure manual, its content is non-technical. Therefore the use of Traffic Specialists, working in cooperation with the Professional Engineer of the political jurisdiction concerned, is recommended in the preparation of technical data prescribed herein.

The "Manual on Uniform Traffic Control Devices for Streets and Highways", published by the Bureau of Public Roads, is the official State Manual adopted for the purpose of specifying a uniform system and specifications of signs, signals, markings, and all traffic control devices. The design of all traffic control signals must be consistent with the standards and principles found therein.

Ned J. Parsekian
Director

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PART I

STATUTORY REQUIREMENTS AND RESPONSIBILITIES

A — INTRODUCTION

The selection and installation of Traffic Signal equipment places great responsibility upon those officials who must undertake the safe control of vehicles and pedestrians at intersections.

A traffic signal is probably the most influential control device applied to present day traffic. Unfortunately, its influence can easily become detrimental to public safety if the signal is poorly designed, ineffectively placed, improperly operated or poorly maintained.

To ensure that the traffic signals of this state will contribute to the traffic safety of our citizens, various statutes have been legislated to designate specific responsibilities for State and Local Officials. The intent is to coordinate official action regarding this device in a manner that will ensure an engineering analysis of the need for a signal, its proper design and its safe and efficient operation.

The legal status of each traffic signal is dependent upon approval by the Director of Motor Vehicles. To qualify for such approval, each signal must comply with Title 39 of the Revised Statutes and conform with the "Manual on Uniform Traffic Control Devices for Streets and Highways", Bureau of Public Roads, Washington, D. C.

The following sections indicate that local officials may by Ordinance, subject to the approval of the Director of Motor Vehicles, designate the installation of a Traffic Signal at a given location. Details concerning action required of Local Officials prior to submission of such an Ordinance are presented in Part II B of this Manual.

B — APPLICABLE STATUTES

Section 1—Placing Official Traffic Signals:

Pursuant to R.S. 39:4-120.1, Traffic control signals shall be placed only by authority of a public body or official having jurisdiction as authorized by law.

Section 2—Powers of Municipalities:

Pursuant to R.S. 39:4-197 (e), municipalities may, by ordinance, regulate the passage or stopping of traffic at certain congested street corners or other designated points.

Where a county road is involved, it is necessary that a municipality must obtain a Resolution of Consent from the Board of Chosen Freeholders, pursuant to R.S. 39:4-197.2, before the Municipal Ordinance may be enacted.

Section 3—Approval of Ordinances, Resolutions by the Director of Motor Vehicles

Pursuant to R.S. 39:4-8 and R.S. 39:4-202, no ordinance or resolution concerning regulations or governing traffic or traffic conditions, shall be of any force or effect unless the same is approved by the Director of Motor Vehicles.

Section 4—Investigation of Ordinances, Resolutions by the Director of Motor Vehicles

Pursuant to R.S. 39:4-8, the Director shall not approve any ordinance or resolution unless, after an investigation, the same shall appear to be in the interest of safety and the expedition of traffic. Pursuant to R.S. 39:4-120, he may determine the character, type, location, placing and operation of all traffic control devices on the highways of this state.

Section 5—Traffic Signal Installation and Operation Statutes

Article 13, Title 39 of the Revised Statutes, states that all traffic signals shall conform strictly with the provisions therein. These provisions consist principally of regulations concerning the signal installation and actual operation of the signal equipment as follows:

Installation Statutes

	<i>Title</i>
R.S. 39: 4-105	Color System (See Figures I, II, IV)
4-109	Position of Lenses (See Figures I, II, IV)
4-110	Height of Signals (See Figure V)
4-112	Visibility of Signals to Traffic at Intersections (See Figure VI)
4-114	Traffic Signal in Paved Roadway or Poles in Crosswalk Lanes Prohibited (See Figure VII)
4-118	Beacons or Flashing Signals

Operation Statutes

	<i>Title</i>
R.S. 39: 4-106	Sequence of Lights
4-107	Period of Cycle
4-111	Power of Lights
4-116	Special Right or Left Turns
4-117	Special Pedestrian Interval
4-119	Operation of Beacons and Flashes Red; Amber.

PART II

SIGNAL WARRANTS AND APPLICATION PROCEDURE

A — WARRANTS FOR THE INSTALLATION OF TRAFFIC SIGNALS

Section 6—Introduction

The applicability of a Traffic Control Signal for any given location cannot be determined by guesswork. Maximum traffic safety can be obtained only where valid evaluations of traffic behavior, traffic flow, accidents, speeds, and physical conditions will show the exact nature of the difficulty. With this information, the proper type of control device can be determined and its operation correctly applied for public convenience and safety.

The following sections indicate the data that must be obtained to permit a factual determination of warrants upon which the need, type and operation of a traffic signal is based.

Adherence to these warrants will eliminate haphazard experimentation and contribute immeasurably toward the installation of signal devices for the improvement of traffic flow. The traveling public is quick to recognize good traffic control intelligently applied. Authentic traffic signals, as well as other appropriate regulatory devices, receive greater cooperation and obedience from the traveling public with a corresponding reduction of hazardous acts.

Section 7—Advance Engineering Data Required:

A thorough study of traffic, roadway and accident conditions must precede the installation of traffic control signals. Among the facts that should be obtained are the following:

1. Complete vehicle volume counts including all traffic movements.
2. Pedestrian volume counts on each crosswalk during the same periods as the vehicle counts.
3. A summary of accidents covering at least three years or more of accident experience.
4. Details of the physical layout of the site.

Section 16 on page 7 contains details of the above data.

Section 8—Signal Warrants

With such information as will be provided by the data referred to in Section 15, it is possible to appraise the need for signalization in terms of the warrants given below:

1. Minimum vehicular volume.
2. Interruption of continuous traffic.
3. Relationship of continuous traffic.
4. Minimum pedestrian volume.
5. Accident hazard.
6. Combination of warrants 1 through 5.

The need for signal control is determined from several prevailing traffic elements and all should be considered in reaching the decision. No one element can be considered independently, but rather each must be evaluated in conjunction with all others.

In the Sections which follow, the above warrants are defined.

Section 9—Minimum Vehicular Volume

This is a major consideration where the number of vehicles is the primary reason for intersection conflicts. The vehicular volume data should be representative of an average day and should be subdivided by hours and include turning as well as through movements for each approach.

When evaluating vehicular volumes, consideration must be given to the number of lanes available on an approach, since an intersection is capable of passing more vehicles with multiple lanes than with a single lane during a given period of time.

Minimum vehicular volume warrants are as follows:

1. Total vehicular volume entering the intersection from all approaches for each of eight hours of an average day should exceed 750 vehicles, and
2. Total vehicular volume entering the intersection from minor street or streets for each of the same eight hours should exceed 150 vehicles.

Section 10—Interruption of Continuous Traffic

This is a consideration where traffic crossing or entering an artery is subject to abnormal delay due to nearly continuous vehicular traffic movement on the artery.

Minimum warrants for interruption of continuous traffic are as follows:

1. Vehicular volume entering the intersection from the arterial roadway for each of eight hours of an average day must exceed 750 vehicles per hour, and

2. Total vehicular volume entering the intersection from the minor roadway, plus pedestrians crossing the artery for each of the same eight hours must exceed 75 vehicles and pedestrians, and
3. The signal installation must not adversely affect coordinated traffic flow.

Section 11—Relationship to Adjacent Signals:

This is a consideration where adjacent signals along the major street are so located that the new signal would disrupt the orderly and safe flow of traffic. In such cases, the installation of a signal should be avoided. It should be realized that a signal proposed for installation at a location which will not permit reasonable progression of artery traffic in both directions may increase accidents and congestion on the main street which will be far out of proportion to its usefulness.

Section 12—Minimum Pedestrian Volume:

This is a major consideration where the predominating conflict is between pedestrians and frequent vehicular traffic. The vehicular and pedestrian volume data should be representative of an average day.

1. Pedestrian volume crossing the major street for each of eight hours of an average day should exceed 150 pedestrians and,
2. Vehicular traffic entering the intersection from the major street for each of the same eight hours should exceed 600 vehicles.

Section 13—Accident Hazard

The accident record of the location should be carefully considered before any installations are made under this warrant. If none of the previous warrants except the accident hazard warrant described below is fulfilled, the signal installation may not contribute to safe operation. Therefore the inclination should be against signalization.

Accident hazard warrants are as follows:

1. An adequate trial of less restrictive measures, with satisfactory observance and enforcement, has failed to reduce the accident frequency, and
2. Five or more reported accidents of types susceptible of correction by a traffic control signal have occurred within a 12-month period, each accident involving personal injury or property damage to an apparent extent of \$100 or more.

It is important to realize that the types of accidents have a very important bearing on the appropriateness of signalization. A warranted traffic control signal, when

obeyed by drivers and pedestrians, can be expected to eliminate or reduce the number and seriousness of the following types of accidents:

1. Those involving right angle collisions or conflicts which occur between vehicles on intersecting streets.
2. Those involving conflicts between straight moving vehicles and crossing pedestrians.

Traffic control signals cannot be expected to reduce the following types of accidents:

1. Rear-end collisions, which often increase after signalization.
2. Collisions between vehicles proceeding in the same directions, one of which makes a turn across the path of the other.
3. Accidents involving pedestrians and turning vehicles, when both move on the same go indication.
4. Other types of pedestrian accidents, if pedestrians do not utilize crosswalks and obey the signals.

Section 14—Combination of Warrants

The installation of a traffic signal should be decided on the basis of a thorough analysis of facts and never on the basis of petitions, or complaints alone. Due to the wide variation of circumstances at proposed signal locations, it is impractical to attempt the construction of a specific warrants-formula to be applied in a stereo-typed manner. There will often be situations where no one warrant is completely satisfied, but where a combination of warrants are sufficiently fulfilled to justify a signal installation. For this reason, responsible officials should insure that each existing warrant is evaluated in conjunction with all others.

In view of the inherent flexibility of traffic-actuated equipment, the preceding warrants may, under certain circumstances, be modified somewhat if a traffic-actuated signal is to be utilized instead of fixed-time equipment.

B — SIGNAL APPLICATION PROCEDURE

Section 15—Introduction

It is the responsibility of State and Local Officials to ensure that every Traffic Signal Installation shall benefit the general public.

To ensure this result, it is necessary that Local Officials base signal applications upon sound, factual data which will satisfy the warrants that justify the installation

of a traffic signal. To accomplish this end all measurements, traffic counts, compilation and analysis of data, designs, drawings, plans and general work in connection with the application of traffic control devices to the public thoroughfares of this state should be under the direction of a competent engineer.

To be acceptable for consideration by the Director of Motor Vehicles, all required data and designs submitted to him for review and approval shall bear the endorsement of the duly constituted Registered Professional Engineer of the concerned political jurisdiction.

From these data, and from additional studies he may require, the Director of Motor Vehicles must confirm the need of the Traffic Signal.

Following receipt of such confirmation by the Director, Local Officials may proceed with the selection of type equipment, the design of the installation and details regarding signal timing and hours of operation. Approval of the Director must be obtained for the results of this work before proceeding with any actual installation. Therefore it is essential that those engaged in the design and method of operation of the traffic signal maintain liaison with the State Representative assigned to cooperate with Local Officials on that specific project. Such liaison will ensure that the proposed traffic signal will warrant the approval of the Director of Motor Vehicles at the completion of this work.

To achieve legal status for the signal after its installation, and to authorize its operation, Local Officials must submit a Signal Ordinance or the Directors approval. Such approval will be issued following a field inspection of the signal installation provided it complies with the details of the improved proposal.

Sections 16 through 21 explain this procedure in detail.

Section 16—Compilation of Advance Engineering Data

The submission, by local officials, of an application for the installation, modification, or revamping of a traffic signal must include the following advance engineering data:

1. Complete vehicle volume counts including the various traffic movements. These counts should include the periods in an average day when the signal is to operate Stop-and-Go, and in all cases should be for a period of at least eight of the busiest traffic hours, preferably 16. Vehicular Count Field Sheets and Summary Sheets are available upon request from the Traffic Safety Service of the N. J. Division of Motor Vehicles.
2. Pedestrian volume counts on each crosswalk during the same periods of the vehicle counts. Pedestrian Count Sheets are available upon request from the Traffic Safety Service of the N. J. Division of Motor Vehicles.

3. A summary of accidents by type, location, vehicle and pedestrian direction, time of occurrence and injuries or fatalities for a recent three year period.
4. In the event that a sepia plan of the signal site is already available, it may be submitted with the above data with the initial signal application. The plan of the location should show details of the physical layout including all approaches, roadway widths, channelization, bus stop locations, existing curbs, shoulders, driveways, catch basins, pavement markings, existing controls, sidewalks, corner sight distance restrictions, and parking regulations.

(Note: Application for a new traffic signal does not require the submission of a sepia until the Director of Motor Vehicles has reviewed the other required data and investigated the justification for the requested signal. (See Section 17.)

Section 17—Submission of Signal Application and Advance Engineering Data to Director.

Local Officials should ensure that the the following material is included with the signal application submitted to the Director of Motor Vehicles.

1. An explanation of the special traffic condition existent in the municipality which has prompted the signal application.
2. Vehicle volume counts per Section 16.
3. Pedestrian volume counts per Section 16.
4. Accident summary per Section 16.
5. A plan and sepia of the physical layout of the intersection per Section 16, if available at the time of initial request.

From such information as will be provided by the advance engineering data and an investigation of the subject intersection, the Director of Motor Vehicles will determine the justification for the proposed traffic signal, or modification or revamp of an existing signal.

Section 18—Preliminary Approval by Director

- a. Where a review of the advance engineering data, and an investigation of the subject intersection indicates sufficient warrants to justify the installation, modification or revamping of a traffic signal, the Director of Motor Vehicles will issue a *Preliminary Approval* to local officials. The Director's Preliminary Approval constitutes authorization for local officials to proceed as described in Section 19.

- b. Where a review of the advance engineering data and an investigation of the intersection indicates that the traffic signal is lacking in warrants, and would not be in the interest of safety and expedition of traffic pursuant to R.S. 39:4-8, local officials shall be so notified by the Director of Motor Vehicles.

Section 19—Design of Signal and Operation.

Upon receipt of a Preliminary Approval by the Director of Motor Vehicles regarding the requested traffic signal, local officials may, through use of the local engineer or retention of traffic specialists, proceed with the engineering design of the traffic control signal to include the following:

1. Type of signal equipment to be installed.
2. Coordination requirements by the adjacent signals.
3. Hours of operation.
4. Signal timing schedule.
5. Signal layout plan. (sepia).

The Director of Motor Vehicles, upon issuing his Preliminary Approval, will assign a State Representative to initiate and maintain such liaison as may be needed to guide local officials in the engineering design of the traffic signal. The municipal engineer or consultant should maintain close coordination with the assigned State Representative to ensure familiarity and conformance with statutory requirements and appropriate design features.

Section 20—Authorization for Signal Installation

Local Officials shall:

1. Submit the completed signal design, prepared in accordance with Section 19 and bearing the endorsement of the local engineer, to the Director of Motor Vehicles for his review pursuant to R.S. 39:4-120.
2. Authorization to proceed with the installation, modification, or revamping of the traffic signal will be issued by the Director for designs which are in accord with statutory requirements and appropriate techniques of operation.
3. Authorization to proceed with the installation, modification, or revamping of the traffic signal will be withheld if deficiencies in the design are evident. In such cases, the Director of Motor Vehicles will inform local officials of the deficient features. Local Officials should utilize the assigned State Representative to obtain the features necessary for approval by the Director of Motor Vehicles.

Section 21—Installation of Signal and Submission of Signal Ordinance

Having obtained the Director's Authorization through the procedure described in Section 20, local officials may proceed with the installation, modification or revamping of the traffic signal.

Upon completion of the authorized signal work, local officials should prepare a traffic signal ordinance similar to the model shown in the appendices of this Manual. If the signalized intersection involves a county roadway, it is necessary that the municipality must also obtain a resolution of consent from the Board of Chosen Freeholders, pursuant to R.S. 39:4-197.2. The proposed municipal ordinance, and county resolution of consent from the Board of Chosen Freeholders if applicable, must be submitted to the Director of Motor Vehicles for his approval pursuant to R.S. 39:4-8 and R.S. 39:4-202.

Section 22—Director's Approval of Signal Ordinance and Installation

The Director's approval of the municipal traffic signal ordinance, and county resolution of consent if applicable, will be based upon the results of a field inspection of the signal installation and operation. This inspection will determine the conformance or lack of conformance with the requirements upon which the Director's Authorization for the signal installation and operation was based.

PART III

TRAFFIC SIGNALS, BASIC INFORMATION

A — INTRODUCTION

Section 23—Definition

Highway traffic signals include all power-operated traffic control devices, except signs, by which traffic is warned or is directed to take some specific action.

Section 24—Value of Signals

In most cases, a signal installation will operate quite definitely either to the advantage or disadvantage of the vehicles and persons controlled. Consequently, it is of the utmost importance that the selection and use of this important control device be preceded by a thorough study of roadway traffic conditions by an experienced engineer.

Traffic signals, properly operated, usually have one or more of the following advantages:

1. They provide for orderly movement of traffic.
2. They reduce the frequency of certain types of accidents.
3. They can be coordinated to provide for continuous or nearly continuous movement of traffic along a given route.
4. They can be used to interrupt heavy traffic at intervals to permit other traffic, pedestrian or vehicular, to cross.
5. They represent a considerable economy, as compared with manual control, at intersections where some definite means of assigning right-of-way first to one movement and then to another is warranted by the volumes of vehicular and pedestrian traffic, or by accident conditions.

There is a belief among some persons that traffic signals are the answer to all traffic problems at intersections. This has led to their installation at numerous locations where no legitimate, factual warrants exist. This must be avoided.

Many signal installations, even though warranted by traffic and roadway conditions, have been ill-designed, ineffectively placed, improperly operated, or poorly maintained. The consequences have often been excessive delay, disobedience of signal indications, use of alternate routes, and, often, increased accident frequency.

Section 25—Standardization

In view of constantly increasing traffic, it is of primary importance that there be

national standardization of those features of traffic signals that affect motorists and pedestrians in traffic movement. Design, application, location and operation all lend themselves to a certain degree of standardization and standards for such features are detailed in the "Manual on Uniform Traffic Control Devices for Streets and Highways", Bureau of Public Roads, Washington, D. C.

Section 26—Legal Authority

Traffic control signals should be installed and operated on public highways only in accordance with appropriate N. J. Motor Vehicle Statutes. Sections 1 through 7 of Part 1, Statutory requirements, provides reference to the appropriate statutes.

B—FEATURES COMMON TO VARIOUS TYPES OF TRAFFIC CONTROL SIGNALS

Section 27—Classification of Signals

In the following classification of traffic signals, the distinction is made on the basis of operating function and not the traffic signal unit itself. It is common practice to use the term "signal" to describe the complete installation, and that practice is followed in this manual.

- (a) Fixed-time signals
- (b) Traffic-actuated signals
 - (1) Full-traffic-actuated signals
 - (2) Semi-traffic-actuated signals

Section 28—General Aspects of Signals

The features of traffic control signals in which vehicle operators and pedestrians are interested, namely, the location, design, indications, and legal significance of the signals themselves, are identical in fixed-time and traffic-actuated signals, the difference between the two types being in the mechanisms that operate them. Standardization in those design factors that affect the traffic to be controlled is especially important. The sections of this subdivision briefly explain standards and requirements of this nature that are equally applicable to the two types of signals named.

Section 29—Design for Future Needs

Traffic control equipment should be purchased with the future in mind. Flexibility which may not immediately be considered necessary will often be found desirable within the life of the equipment. Equipment that will give long effective life

will almost always prove an economy even if the first cost is moderately higher than that of equipment of inferior quality.

Section 30—Number and Position of lenses per signal face

The face of a signal head shall have at least three lenses — Red, Amber and Green. Additional lenses such as Turn Arrows are permissible and will be used at intersections where individual turning movements are provided. (See Figures I, II, III, IV).

The lenses may be arranged in either a vertical or horizontal position to form the signal face. When arranged vertically, the lenses shall be placed in the following relative positions with position number one at the top of the signal head: (See Figure IV).

<i>Positions</i>	<i>Lens</i>
1	Red
2	Amber
3	Green
4	Straight through Green Arrow
5	Left Turn Green Arrow
6	Right Turn Green Arrow

When arranged horizontally, the lenses shall be placed in the following relative positions from left to right with position number one at the left of the signal head: (See Figure IV).

<i>Positions</i>	<i>Lens</i>
1	Red
2	Amber
3	Left Turn Arrow
4	Green
5	Straight through Arrow
6	Right Turn Arrow

Section 31—Meaning of Color and Arrow Indications

Color and Arrow indications in traffic control signals have the meanings ascribed to them in this section and no other meanings. The simultaneous illumination or overlapping of different color indications except where Green Arrows are shown together with the circular Red indications, is not permitted.

GREEN (alone)

Vehicular traffic facing the signal may proceed straight through or turn right or left unless a sign at such place prohibits either turn.

STEADY AMBER (alone, preceding Red)

Vehicular traffic facing the signal is thereby warned that the Red or Stop signal will be exhibited immediately thereafter and such vehicular traffic shall not enter or be crossing the intersection when the Red or Stop signal is exhibited.

STEADY RED (alone)

Vehicular traffic facing the signal shall stop before entering the crosswalk on the near side of the intersection or, if none, then before entering the intersection, and shall remain standing until a Green signal is shown.

STEADY RED WITH GREEN ARROW

Vehicular traffic facing such signal may cautiously enter the intersection only to make the movement indicated by such arrow.

NOTE: Whenever it is intended to permit traffic on a certain thoroughfare to make certain movements and prohibit it from proceeding straight through, the regular circular red lens facing that traffic shall be illuminated together with a separate green arrow for each permitted movement.

FLASHING RED

When a Red lens is illuminated by rapid intermittent flashes, drivers of vehicles shall stop in advance of the nearest crosswalk at an intersection or a stop line when marked and the right to proceed shall be subject to the rules applicable after making a stop at a STOP sign.

FLASHING AMBER

When an Amber lens is illuminated with rapid intermittent flashes, drivers of vehicles may proceed through the intersection or past such signal exercising due caution.

Section 32—Shapes and Dimensions of Lenses

Two types of lenses for normal signal indications may be used. Both are circular in shape.

For Red, Amber and Green, the standard lens, which is approximately 8" in diameter, is in most cases adequately visible to vehicular traffic. An oversized lens, which is approximately 12" in diameter, may be used where increased visual impact is needed.

Although 8" Green Arrow lenses have been used, experience has shown that their visibility, in many instances, is unsatisfactory. It is, therefore, recommended that 12" Green Arrow lenses be used. It should be noted that only one arrow indicating a single direction is permitted on any signal lens.

Section 33—Illumination of Lens

Each lens in a signal face shall be adequately illuminated independently of any other lens by a clear lamp, designed especially for traffic signals.

Section 34—Visibility and Shielding of Lens

Each lens, reflector and visor shall be of such design that the indications will be clearly visible to approaching traffic at distances up to 1000'.

It is desirable that each signal face shall, to the extent practicable, be so shielded by visors that an approaching driver can see only the indications which control his movement. Special visors or ray directors may be required where the angle between opposing signal indications is comparatively small.

Section 35—Number of Signal Heads and Faces

Two or more signal heads or faces must be visible to traffic on each approach to the intersection. The actual number of signal heads to be installed is dependent upon the geometric layout of the intersection, the widths of the highways involved and the variation of the movements to be controlled. All heads must be adjustable to facilitate aiming the signal indications at approaching traffic.

Where signals are installed on the basis of the pedestrian volume warrants, or where the pedestrian volume warrant is equaled or exceeded, a vehicle or pedestrian signal face should be installed at the far end of each crosswalk. (See Figure V)

Section 36—Location and Height of Signal Heads

Signal heads should preferably be suspended over the roadway or lanes which they control. At least one signal face shall give an unmistakable indication to traffic approaching the intersection. At least one signal face shall give an unmistakable indication to traffic which is passing through the intersection.

Overhead signal heads shall be suspended with a minimum clearance above the pavement of 14'6". Pedestal or bracket mounted signal heads within the curb line shall be erected with the bottom of the housing not less than 8', nor more than 10' above the highway pavement. (See Figure VI)

NOTE: The use of signals suspended directly over the roadway from mast arms is increasing. This location is especially effective where maximum prominence for signal indications to drivers is needed. Another factor contributing to the desirability of over-the-roadway signals is the growth in brilliance and color of illuminated advertising signs in shopping areas. Over-the-road signals are less affected by such background lighting than are signal indications mounted within the curb line.

Section 37—Limit of Signal Control Area

A signal shall control traffic only at the intersection where the signal is located. Depending on a signal to control traffic at adjacent, non-signalized intersections is an uncertain and hazardous practice and is not authorized in New Jersey.

Section 38—Efficiency and Continuity of Operation

The full utility of traffic signals can be obtained only when they are operated in accordance with actual traffic requirements. Inaccurate operation usually results in inconvenience, disobedience and increased hazard. The operation standards contained herein provide for a reasonable efficiency in the operation of signals at warranted locations.

Section 39—Basic Operational Standards

It is important that a person approaching a traffic signal should be able to presume that it is functioning. If the indication facing him is not illuminated, he must

be able to presume that the reason is a lamp burnout or failure of equipment. This should cause him to enter the intersection with caution.

For this reason, all traffic control signals shall be "live" or continuously in operation. When Stop-and-Go operation is not justified, because of low traffic volumes during the late night or early morning hours, the signal should be operated as a flashing device. During flashing operation, intermittent Amber indications should be provided to the major roadway and intermittent Red indications to the minor.

During seasonal shutdowns when it is not desirable to operate traffic signals, the signal heads shall be covered or removed, to give positive indication that the signals are not in operation.

Section 40—Length of Cycle

Much of the dissatisfaction with traffic signals may be attributed to improper timing and/or poor selection of cycle length. It is essential that the cycle length and its division be as accurately related to traffic requirements as possible.

Section 41—Number of Traffic Phases

A traffic phase is that part of the time cycle that has been allocated to a specific traffic movement receiving the right-of-way. The number of phases required at an intersection varies with the composition and direction of the traffic flows, as well as with the number of entering streets and the general intersection layout.

The greatest efficiency is normally obtained with a traffic signal operating on a two-phase cycle in which the right-of-way is alternately assigned to each of the two cross movements.

The use of more than two traffic phases should be avoided if at all possible because each additional phase induces unavoidable delays before the Green interval is given to the other phases. At intersections having more than four approaches, consideration should be given to designating the additional approaches as one-way streets leading away from the intersection, or to the prohibition of turning movements so as to eliminate the need of more than two traffic phases.

It should be noted that traffic-actuated controllers are more adaptable than fixed-time controllers to more than two-phase operation because phases for which there is no traffic demand will be skipped.

Section 42—Proportioning Traffic Movement Intervals to Traffic Requirements

Cycles must be divided into intervals proportionate to the time required by the traffic which will enter the intersection during the cycle intervals. Where such time requirements vary widely during different hours of the day, provision can be made in expansible-type, fixed-time controllers to permit the programming of signal timing to more precisely meet the demands of traffic during the peak and off peak hours. Traffic-actuated controllers achieve a considerable measure of flexibility in the signal timing intervals due to the nature of their mechanism and some of the time and capacity losses inherent in fixed time control are automatically avoided. Even so, the selection of a proper cycle length and minimum-maximum intervals is equally important with this equipment.

Section 43—Determining Length of Cycle Intervals

Factors to be considered in the determination of interval lengths are:

1. The flow of traffic for each movement including peak hour volumes.
2. The number of lanes available for each movement.
3. The presence and effect of slow moving vehicles such as trucks or buses in the traffic streams.
4. The volume of pedestrian traffic.
5. Turning movements.
6. The geometric layout of the intersection area.

C — SELECTION OF FIXED-TIME OR TRAFFIC-ACTUATED SIGNALS

Section 44—Consideration of Future Needs

Traffic control equipment should always be purchased with the future in mind. Flexibility which may not be considered necessary to meet existing conditions may become a vital factor in the safe and efficient control of traffic at a later date.

In many instances, changes occur in the traffic pattern as a result of the construction of such traffic generators as shopping centers, industrial establishments, schools, churches, etc. Equipment capable of providing additional control features that may be required will prove to be the more economical in the long run, even though the initial cost may be somewhat higher.

The following sections present some of the considerations involved in selecting appropriate signal equipment.

Section 45—Fixed-time Signals

Fixed-time signals are adaptable at locations where movements are well balanced by direction, where volumes are fairly consistent, and where a fixed cycle length and split will not result in undue delay, inconvenience, or reduction in intersection capacity. They are also used effectively at intersections where a fixed-time program is desirable for pedestrians.

Vehicular and pedestrian volumes are, in many instances, drastically reduced during certain periods, particularly in the late night and early morning hours. During such periods, fixed-time signals should be operated as flashing signals to reduce delays and inconvenience.

Section 46—Traffic Actuated Signals

Traffic-actuated signal controllers adjust to actual traffic requirements and reduce unnecessary stops. Because of the inherent flexibility of this equipment, it will provide more desirable traffic control than fixed-time signal equipment under circumstances such as the following:

1. **Cross Traffic:** When artery volumes are so great as to restrict and unduly jeopardize the movement of traffic from the side road, semi-traffic-actuated signals will provide for assignment of the right-of-way without seriously delaying artery traffic.
2. **Peak Hour Volume:** When signal control is required during only part of the day, such as during peak hours, traffic-actuated signals will not unduly delay traffic.
3. **Traffic Fluctuations:** When the traffic requirements vary considerably, traffic-actuated signals will provide more efficient control.
4. **Pedestrians:** When the principal need for a signal is to accommodate pedestrian traffic, actuated signals have good application since they will delay vehicular movement only when pedestrians are crossing the highway.
5. **Complicated Intersections:** When traffic signals are warranted at complicated intersections requiring multiple traffic phases, use of traffic-actuated signals should be given consideration because, in addition to the usual advantages of traffic actuation, a phase can be skipped when there is no traffic to use it.

Upon reaching a decision to install a traffic-actuated signal, the following types are available:

1. Semi Traffic-Actuated Signal.
2. Full Traffic-Actuated Signal.
3. Full Traffic-Actuated and Traffic-Adjusted Signal.

The more commonly used type of traffic-actuated signal in New Jersey is the semi-traffic actuated controller employing the use of either vehicle detectors or pedestrian push buttons or both, for actuation. (See Figure VIII)

In view of the widespread use of this equipment and its particular applicability to traffic requirements on the roadways in this State, the following section presents a general explanation of its functions:

Section 47—Semi-Traffic-Actuated Signals

This equipment normally gives the Green indication to the artery unless a pedestrian or side road vehicle actuation is received, at which time the right-of-way is temporarily given to side road or pedestrian traffic. The Green indication is automatically returned to the artery after expiration of the side road interval and remains there for at least a predetermined minimum. At the expiration of this minimum artery interval, the controller is again free to respond to side road or pedestrian actuation.

The length of the side road interval will vary from a predetermined minimum for one actuation to a predetermined maximum for additional actuations. The important feature is that the side road interval operates only on demand and is retained only as long as the demand is maintained. In this way, artery movement is facilitated and hazards due to potential rear-end accidents on the artery are minimized.

This type of signal equipment is particularly adaptable to locations where artery traffic is heavy, relatively uniform, and the traffic from the side road fluctuates in volume.

Actuation of this equipment can be by vehicle detectors situated on the minor street, pedestrian push buttons, or both. The following section discusses the use of, and operation of pedestrian push buttons.

Section 48—Pedestrian Push Button Actuation:

This type of detector is used to register pedestrian demand for the right-of-way. Upon actuation it provides a Green interval in the same manner as a vehicle detector

which is installed in the roadway. It also will call for a separate pedestrian phase at a signal which has such a phase provided for in its cycle. Pedestrian push buttons should normally be located from 3½' to 4' above the sidewalk and in view of the persons using the crosswalks. It is desirable to maintain permanent type signs just above the push buttons explaining their purpose and use. (See Figure IX)

E—FLASHING BEACONS

Section 49—Justification

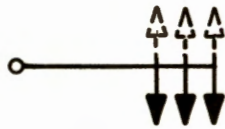
A flashing beacon may be justified at an intersection which does not meet the warrants for a traffic control signal, but where emphasis of the stop requirement on the minor highway by flashing Red indications and advance warning of the intersection to artery motorists by flashing Amber indications is desirable. Such beacons should be installed only at points of special hazard. Unwarranted use of this device tends to reduce its effectiveness.

Section 50—Operation

The proper operation of a flashing beacon requires the display of flashing Amber indications facing the two opposite approaches of the artery and flashing Red indications facing the side road approaches. At Tee end type intersections, flashing amber indications should be displayed to the approaches forming the top of the Tee and flashing red indications should be displayed to the approach forming the stem of the Tee.

All flashing beacons shall be "live" or continuously in operation.

HORIZONTAL SIGNAL HEAD



SYMBOL

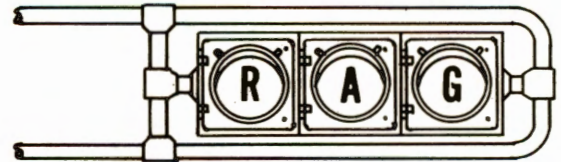


FIG. I

VERTICAL SIGNAL HEAD



SYMBOL

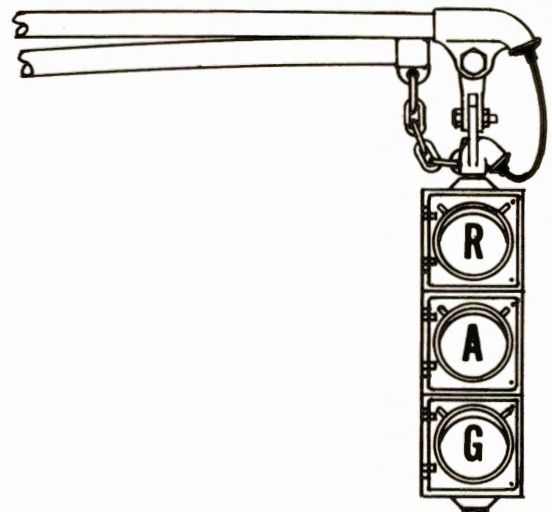


FIG. II

POST-OR PEDESTAL-MOUNTED SIGNAL HEAD



CLAMP MOUNTED SIGNAL HEAD

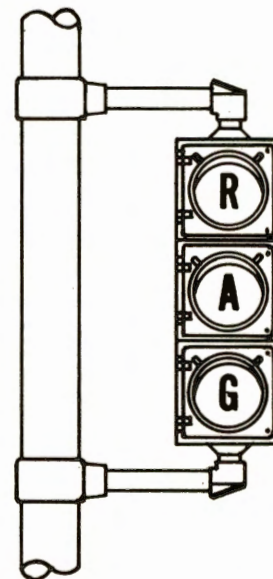


FIG. III

SEQUENCE OF LENSES

DISPLAYED VERTICALLY



DISPLAYED HORIZONTALLY

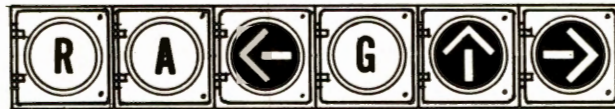


FIG. IV

VEHICULAR AND PEDESTRIAN SIGNAL HEADS

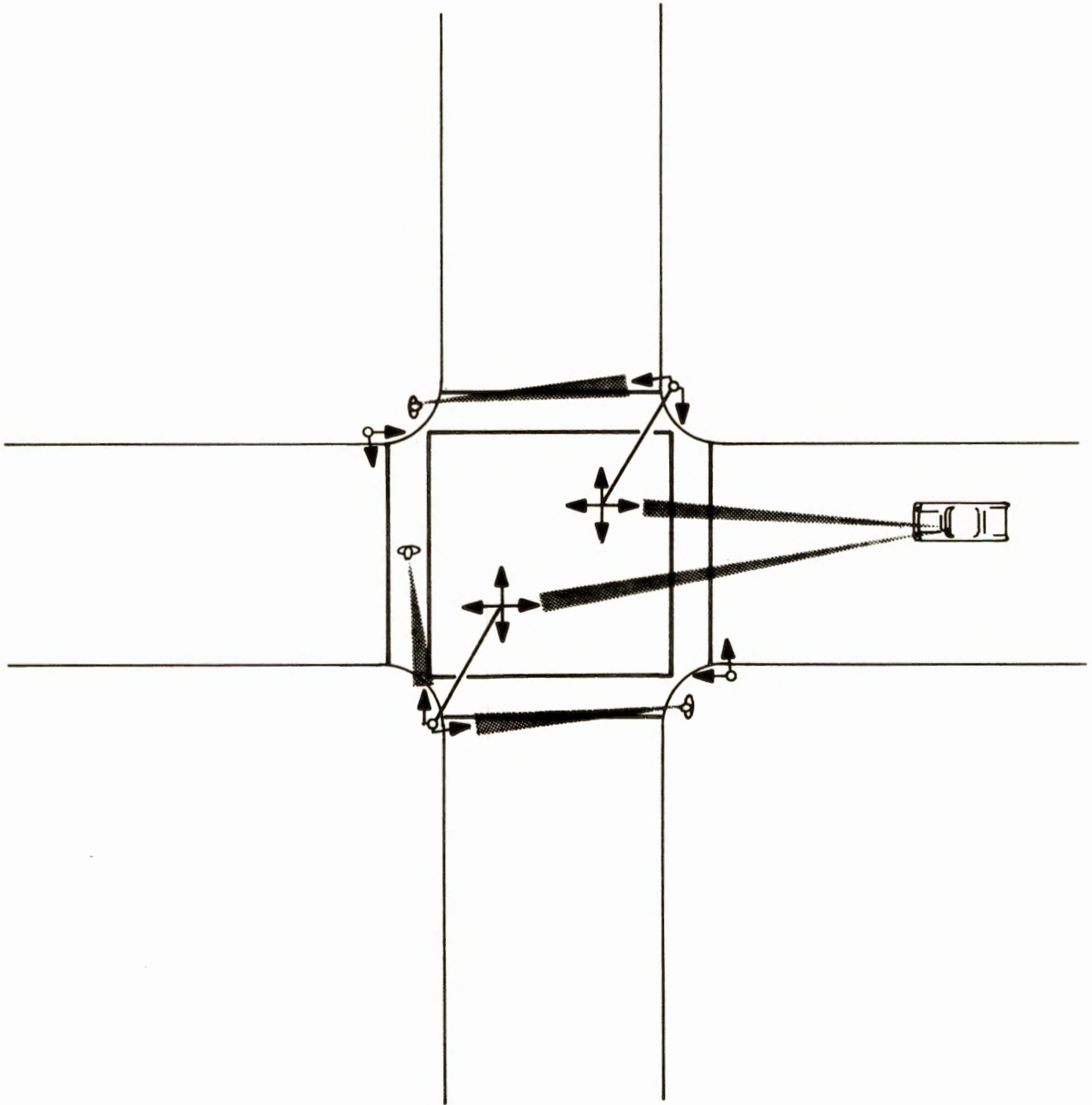


FIG. V

HEIGHT OF SIGNAL HEADS

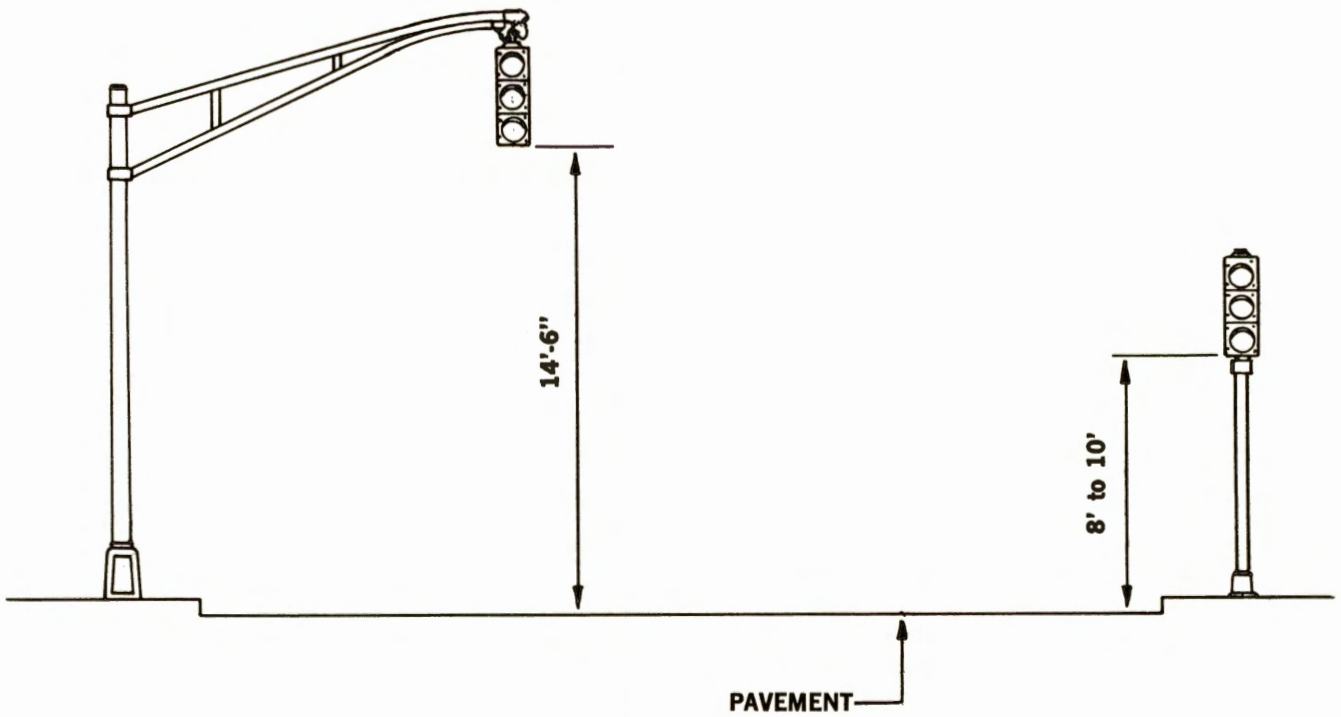


FIG. VI

PROHIBITED LOCATIONS FOR SIGNAL POLES

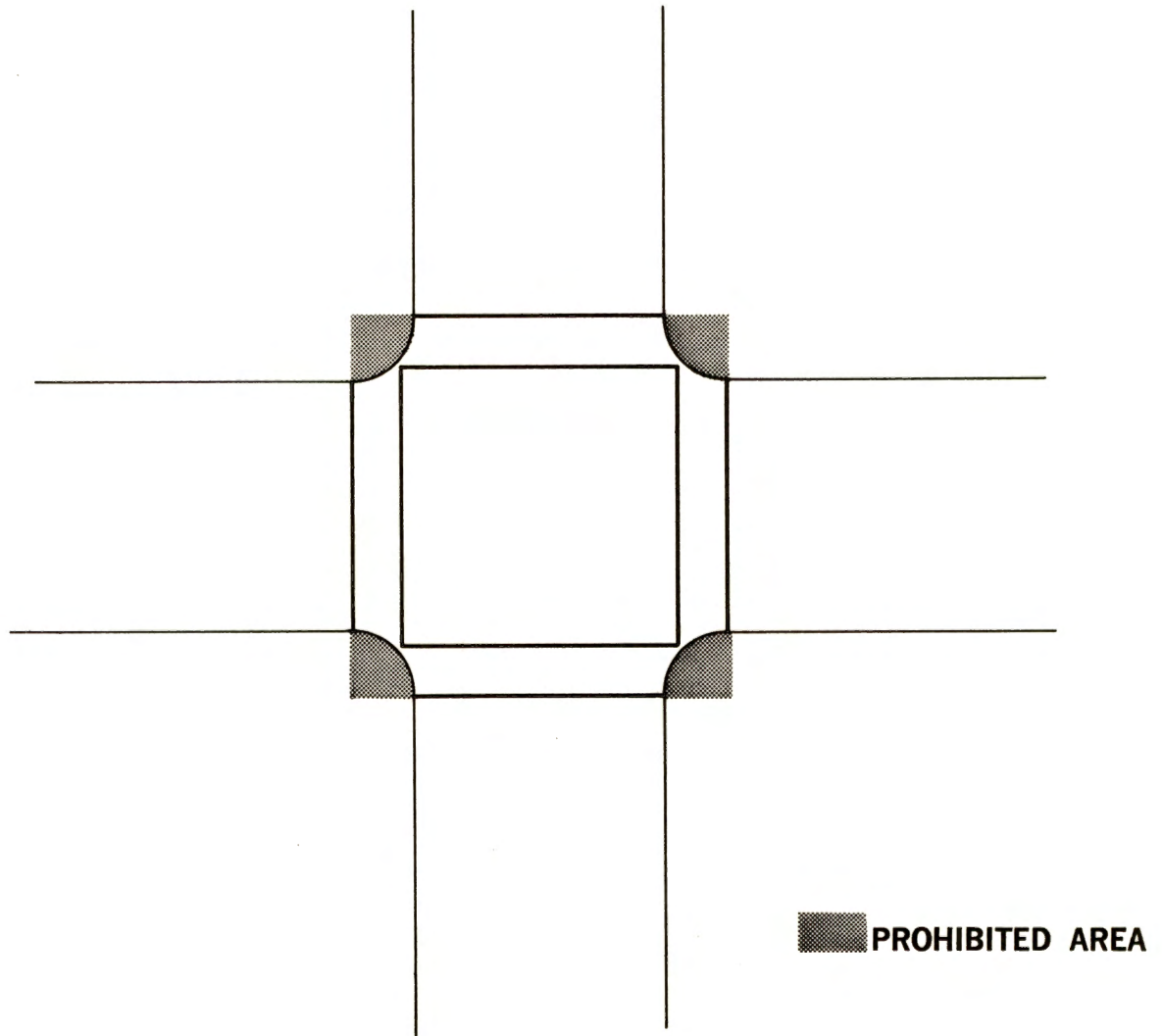
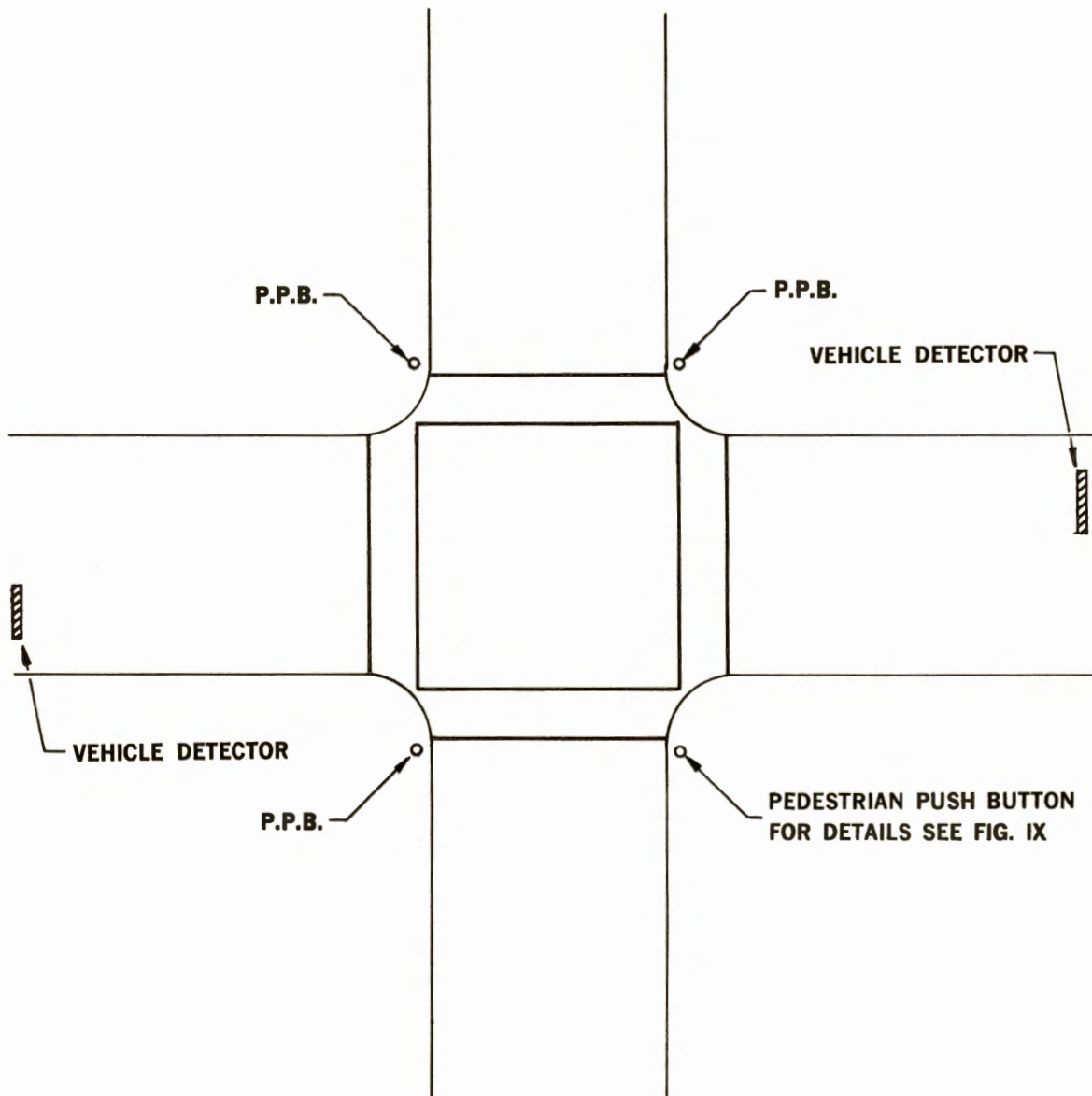


FIG. VII

MANNER OF ACTUATION FOR TRAFFIC ACTUATED SIGNALS



TYPES OF VEHICLE DETECTORS

PRESSURE-SENSITIVE DETECTORS
MAGNETIC DETECTORS
RADAR DETECTORS
ULTRASONIC DETECTORS
OTHER

FIG. VIII

DETAILS OF PEDESTRIAN PUSH BUTTON INSTALLATION ON PIPE AND SIGNAL POLE

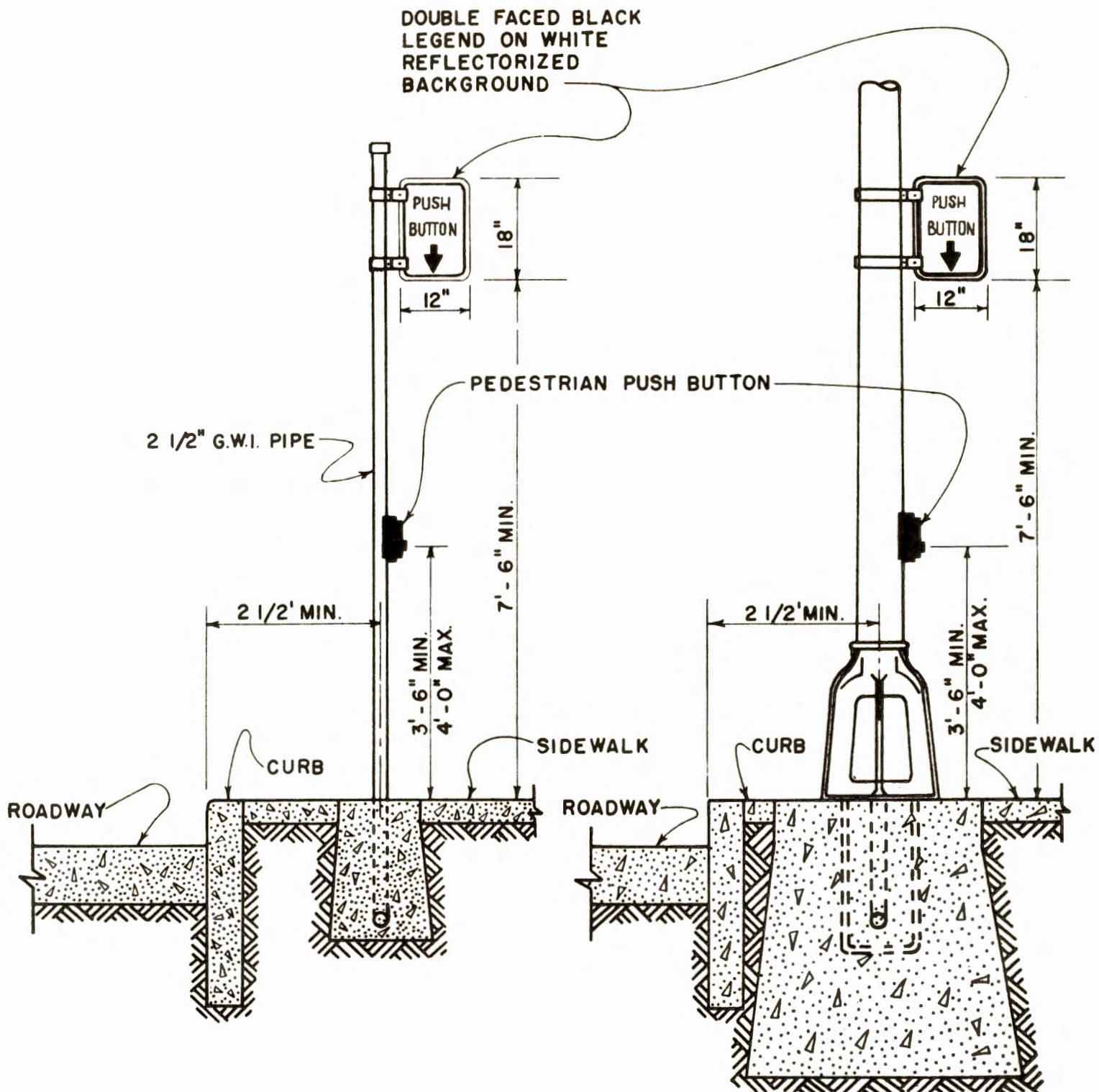


FIG. IX

APPENDICES

The various forms contained herein are available upon request from the:

Division of Motor Vehicles
Traffic Safety Service
25 South Montgomery St.
Trenton, New Jersey 08625

Traffic Signal Application

Field Sheet, Vehicular Count

Summary Sheet, Vehicular Count

Pedestrian Count Sheet

Model Traffic Signal Ordinance

REMARKS

The following conditions are believed to justify the proposed traffic signal installation:

.....
Signed

.....
Title

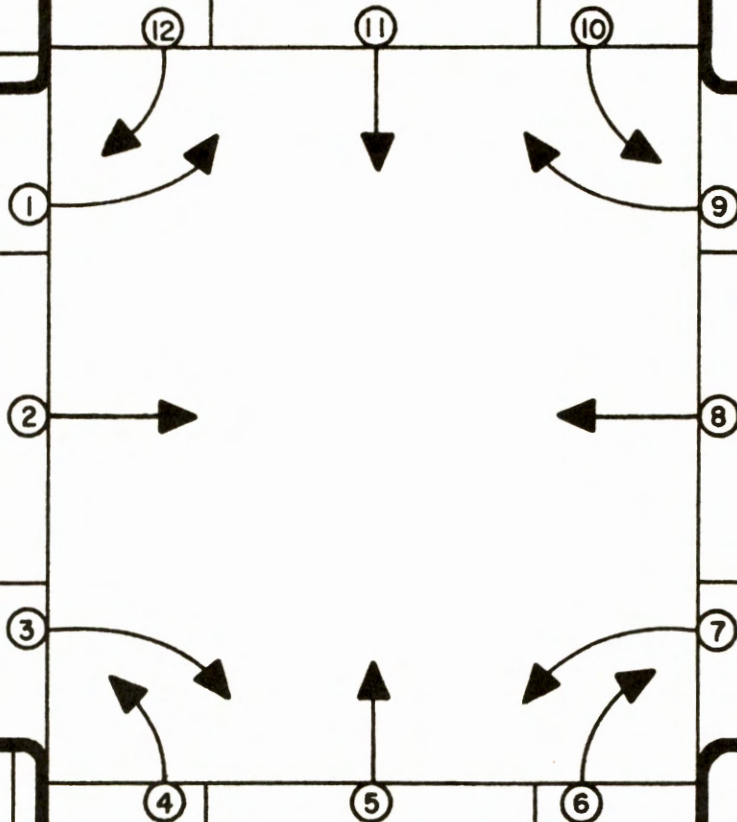
STATE OF NEW JERSEY
DEPARTMENT OF LAW AND PUBLIC SAFETY
DIVISION OF MOTOR VEHICLES
TRAFFIC SAFETY SERVICE
25 SOUTH MONTGOMERY STREET
TRENTON 25, NEW JERSEY

LOCATION _____
MUNICIPALITY _____
COUNTY _____
DATE _____ SMTWTFS
TIME: FROM _____ TO _____ (INDICATE DAY)

FIELD SHEET



STREET NAME

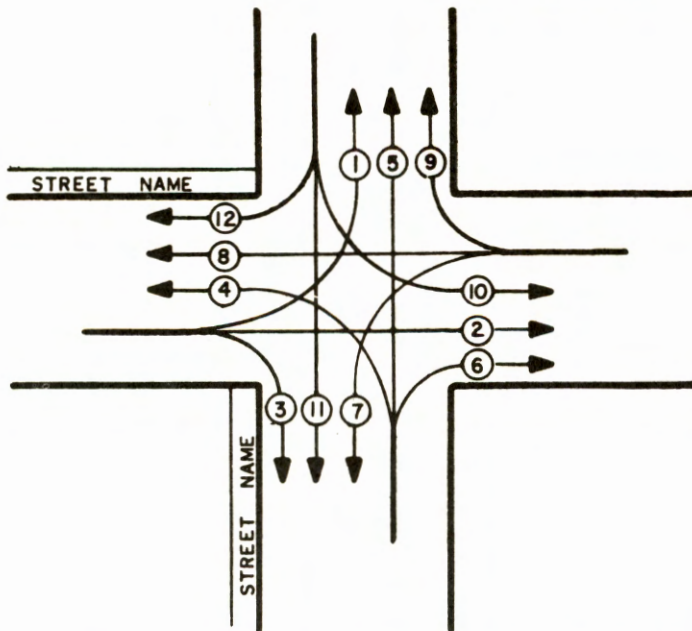
REMARKS

WEATHER _____

RECORDER _____

LOCATION _____

 MUNICIPALITY _____
 COUNTY _____
 DATE _____ SMTWTFs
 TIME: FROM _____ TO _____ (INDICATE DAY)

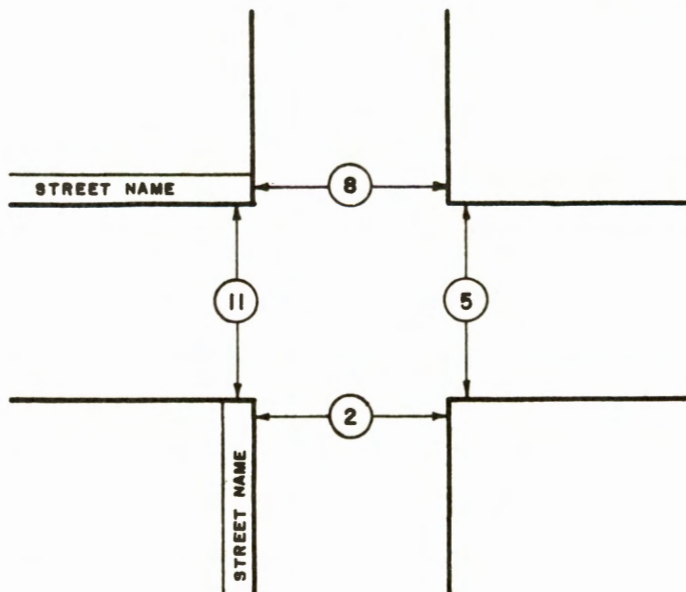
[illegible]

STATE OF NEW JERSEY
DEPARTMENT OF LAW AND PUBLIC SAFETY
DIVISION OF MOTOR VEHICLES
TRAFFIC SAFETY SERVICE
25 SOUTH MONTGOMERY STREET
TRENTON 25, NEW JERSEY

LOCATION _____

 MUNICIPALITY _____
 COUNTY _____
 DATE _____ SMTWTFSS
 TIME: FROM _____ TO _____ (INDICATE DAY)

(USE ONE HOUR COUNTING PERIODS)



WEATHER _____

RECORDED _____

[illegible]

(MODEL TRAFFIC SIGNAL ORDINANCE)

AN ORDINANCE PROVIDING FOR THE INSTALLATION
AND OPERATION OF AN AUTOMATIC TRAFFIC
CONTROL SIGNAL AT THE INTERSECTION OF
..... AND
IN THE OF

BE IT ORDAINED by the
(Governing Body)

of in the County of
(Municipality)

1. That an automatic traffic control signal shall be installed at the intersection
of and
(Street Name) (Street Name)

2. That the traffic signal installation shall be in accordance with the provision
of an act concerning motor vehicles and traffic regulations, Subtitled 1 of Title 39
of the Revised Statutes and as more specifically described in the engineering design
approved by the Director of Motor Vehicles, dated, which
is made a part of this ordinance and on file in the office of the municipal clerk.

3. This ordinance shall take effect upon its passage and publication and its ap-
proval by the Director of Motor Vehicles as provided by law.

