

# REPORT OF COMMITTEE ON HIGHWAY TRAFFIC

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## TRAFFIC CONTROL MECHANISMS

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Traffic control mechanisms at present in use in American practice are varied in character. For the purpose of this report attention is limited exclusively to traffic control signals, that is, devices designed for the purpose of alternating the flow of various streams of traffic at street intersections.

The introduction of traffic control signals in the United States has been very rapid. Ten years ago there were scarcely any examples of such devices. Today hundreds of jurisdictions have installed traffic control signals at thousands of intersections. Not only are such signals accepted as a regular and effective part of traffic control systems, but it must be recognized that their use in the future will expand with great rapidity and that of necessity there will be many refinements in design and methods of operation. It is not improbable that with such refinements the greater part of traffic regulation, especially in the larger cities, will become automatic in character.

It is highly desirable, therefore, that this process of application and expansion development be based upon sound technical information both in order that refinements may be expedited and that individual communities may avoid costly mistakes.

Substantial progress has already been made toward the establishment of standards with respect to many of the elements involved in traffic control signal use. The most outstanding of these standards is to be found in the code on "Traffic Signs, Signals, and Markings" prepared by a special committee of the American Engineering Council and approved by the National Conference on Street and Highway Safety. Several local jurisdictions have expanded these standards for local administrative use. Most notable among these expanded codes is that promulgated by the Department of Public Works of the Commonwealth of Massachusetts.

No small part of the past development in traffic control signal technique has been on the basis of trial and error. This applies less to the actual design and manufacture of such apparatus than it does to in-

stallation and operation by public authorities. Several of the manufacturers of signal apparatus have contributed greatly to the art by research working toward a perfection in design. Much less can be said for the bases upon which typical jurisdictions have installed and operated signal apparatus.

It would seem practicable and highly desirable at the present time to encourage thorough-going research in connection with various aspects of traffic control signalling in order that some of the hypothetical conclusions adopted may be definitely established, modified, or overthrown. The economic implications of traffic signalling are such as to warrant substantial expenditures for such purposes. Millions of dollars will be spent for such apparatus in the next decade. Additional millions will be involved in public convenience.

In this report an attempt has been made to set forth some of the existing problems which have never been answered in a definitive manner and which must be answered before traffic signalling can assume a position of stable technique. For this purpose a series of problems, each suitable for an independent research are discussed as follows.

**PROBLEM 1 WHAT ARE THE ESSENTIAL MINIMUM SPECIFICATIONS NECESSARY TO ASSURE ADEQUATE UNIFORMITY IN TRAFFIC CONTROL SIGNAL DESIGN?**

*Present status* There is a definite tendency toward national uniformity with respect to the outward appearance and functional operation of traffic control signals. This movement has been crystallized in the recommendations on "Traffic Signs, Signals, and Markings" of the National Conference on Street and Highway Safety. Thus it may be said with assurance that the standard recognized signal is one giving directions by optical-electrical means, and that there is a reasonable standardization with respect to the use and meanings of the colors, red, yellow, and green. Furthermore, a substantial majority of the progressive manufacturers of signal devices are in agreement as to the general specifications of the devices. Thus for example, visible lense diameter is commonly eight inches.

Public officials at the present time are handicapped in their attempts to obtain competitive bids, which are often required by law, with assurance that they will obtain for their communities apparatus recognized as conforming to uniform standards. Quite naturally independent manufacturers have prepared specifications which accurately describe their own apparatus and which, if used, would generally preclude a bid by competitors. Thus, where real competitive bids are required, public officials must attempt to generalize upon the specifications of individual manufacturers. This task is at best difficult and frequently results in inadequate and inaccurate descriptions.

*Scope of the problem* There should be prepared a detailed set of specifications for uniform traffic control devices capable of being fulfilled by all manufacturers of devices coming within the standard range. These specifications should include an adequate description of the functional services demanded, with optional clauses covering the various types of functional operation. In addition, the specifications should include certain basic descriptions of the mechanical devices, as for example, the size of the lense and the minimum standards for materials to be used. It is believed that such uniform signal specifications can be drafted without in any manner impairing the development of special refinements or improvements by individual manufacturers, and that their utilization by public officials throughout the country will tend to stimulate materially the adoption of standard apparatus, discourage the purchase of improper devices, and insure greater public confidence in signal installation.

*Suggested method of procedure* Such research would be suitable for preliminary work by a neutral technical agency. Under any conditions, however, the tentative conclusions should be subject to conference and approval by all standard manufacturers of traffic control signal apparatus.

**PROBLEM 2    WHAT CONDITIONS WARRANT THE INSTALLATION OF TRAFFIC CONTROL SIGNALS?**

*Present status* Traffic control signals are now generally recognized as an important part of control technique and as of the greatest value where intelligently installed and operated. They are equally recognized as being of little or no value and frequently of great harm where installed under conditions not warranting their use. Under such conditions the capital investment is wasted, and in addition there is a constant loss through public inconvenience.

With few exceptions, signals have been installed in the United States as the result of a demand for protection by laymen or through action by public officials based on casual observation. Many such installations have been notably successful as a need for such service was obviously apparent. On the other hand, many installations have been of a questionable character and many have been obviously unwarranted. This situation is serious, not only because of economic considerations but because in most communities the placing of a control signal at an unnecessary point means that no control signal will be placed at some point which seriously needs such protection. It is now generally recognized that the function of a traffic control signal is primarily the regulation of traffic flow under conditions where the volume or character of movement otherwise results in inconvenience, hazard, or delay. It is further recognized that one of the most direct measures of the need for alternate

control by signal apparatus is to be found in the volume and character of the traffic passing through the intersection. Thus, various jurisdictions in a desire to place signal installation upon an intelligent basis have established intersection volume standards which will warrant consideration for signal installation. These standards range from five hundred vehicles per hour through the intersection to fifteen hundred vehicles per hour. It is probable that somewhere between these two extremes, for typical intersections, the correct volume is to be found. It is highly desirable, however, that the conclusions be based upon much more definitive research than has been made in the past, and, furthermore, that the standards ultimately adopted give due consideration to existing special conditions.

*Scope of the problem.* The proposed research to determine conditions warranting traffic control signal installations should include primarily an accurate analysis of the traffic capacity and delay factors involved in intersections of varying design with and without signal operation. With varying volumes of traffic and with an analysis of the delay factors with and without control, it should be possible under stated conditions to erect an accurate formula indicating the volumes warranting installation. Emphasis is placed upon capacity and delay because it is believed that they are the important factors in traffic signal operation. By no means, however, should the question of safety be neglected, and the research suggested should incorporate an accurate investigation of all types of accidents at the test location.

*Suggested method of procedure.* This research is suitable for action by any competent agency. It is believed that a capable research any place in the United States, under described conditions, would give a reasonably accurate cross-section of general practice. It would be highly desirable, however, to have an investigation conducted in numerous jurisdictions throughout the country and it is therefore recommended that any agency undertaking to organize the research, conduct special investigations of its own, and in addition, prepare standard forms and research instructions to be used by public officials in various jurisdictions throughout the country.

### PROBLEM 3 WHAT IS THE RELATIVE EFFICIENCY OF MECHANICAL AND NON-MECHANICAL CONTROL?

*Present status.* This problem logically follows the one discussed immediately above. It is now generally recognized that uncontrolled action by vehicle operators and pedestrians at intersections possessing a volume of conflicting movements above a certain number is inefficient and that some action must be taken if capacity is not to drop below a point of toleration. The traffic control signal alternates movements and substitutes its directions for the normal right of way rule generally

applicable by law. The traffic control signal, however, is not the only type of control which may be used. There are likewise certain non-mechanical methods which possess utility. The relative efficiency of these non-mechanical and mechanical methods is a question which has never been definitely decided.

*Scope of the investigation.* Such an investigation of the relative efficiency of non-mechanical and mechanical devices (traffic control signals) should be judged on a basis of capacity, safety, and cost. The types of control which should be investigated with respect to their elements are (1) rotary traffic, (2) manual control by police officer, (3) application of single or double stop rule, (4) pre-timed independent traffic control signals.

*Method of procedure.* This investigation is one of considerable complexity and should be undertaken only by research agencies capable of supplying trained observers. It would be suitable for investigation by such an agency as the United States Bureau of Public Roads, highway departments of the several states, or engineering departments of universities. Care should be taken to see that the intersections selected for comparison are comparable with respect to all the essential factors including area, volume of traffic, character of traffic, turning movements, and type of district.

#### PROBLEM 4 WHAT IS THE PROPER FORMULA FOR CYCLE AND INTERVAL LENGTHS?

*Present status.* *Cycle* is here used to indicate the total sequence of all movements indicated by a traffic control signal at any particular location. The term *interval* indicates a single indication for any particular movement within the cycle. It is recognized that the efficiency of any installation is determined to a considerable extent by the cycle and interval lengths which are used. Thus, they must be of adequate length to accommodate the intersection in each direction, but no interval should be longer than is on an average necessary to accommodate vehicles which may be waiting. Intervals that are too short result in lowered efficiency, and often in a backing up of traffic flow, whereas intervals of too great length are wasteful, in that cross traffic remains standing unnecessarily. Practice with respect to cycle and interval lengths varies materially in various cities (cycle lengths ranging from 35 to 180 seconds and interval lengths from 10 to 90 seconds).

*Scope of the investigation.* This investigation should be conducted under conditions giving complete results in capacity and delay for varying volumes of traffic and for varying intersection designs. The investigation should work toward the establishment of a specific formula capable of being applied on the basis of specific counts which may be conducted by public officials.

*Method of procedure* This investigation is suitable for research by a technically qualified agency and it is suggested as an especially appropriate study for engineering departments in universities

PROBLEM 5 WHAT IS THE RELATIVE EFFICIENCY OF VARIOUS TYPES OF COORDINATION?

*Present status* Coordinated signal operation describes the operation of two or more signals in accordance with some plan of interrelationship. The forms of coordination commonly recognized are simultaneous, alternate, and flexible progressive. Each of these three types of coordination is used in the United States at the present time and each has its strong partisans. The general tendency in recent installations has been toward the flexible progressive type of coordination, it being apparent that it possesses higher average speed potentials. The question of the capacity of flexible progressive coordination as compared to simultaneous coordination is much less clear. Partisans of flexible progressive control claim that in addition to high speed possibilities for individual operators, it likewise gives a greater per hour capacity to the street served. On the other hand, the partisans of simultaneous control claim that under conditions approximating saturation (not an unusual condition in central districts or on improved trunk routes at peak hours) it will give a much greater per hour capacity than will flexible progressive coordination. While several theoretical computations have been made of this problem no definite factual investigations have yet been completed.

*Suggested scope of the study* The investigations should include a complete consideration of the operating characteristics of the three types of coordination described above with respect to over-all average speed, delay, and capacity per hour. If the street under consideration carries street car traffic, this traffic should be analyzed separately.

*Suggested method of procedure* This subject is suitable for investigation by any qualified technical agency. It is desirable that the investigation be conducted on a single artery and under comparable traffic flow conditions in order that accurate comparisons may be made. It is thus desirable that the investigation be made on a street possessing conditions of traffic varying from very light to saturation and with a signal installation capable of being operated under each of the three forms of coordination described.

PROBLEM 6 WHAT IS THE PROPER FORMULA FOR THE COMPUTATION OF THE ECONOMIC COST OF TRAFFIC DELAY?

*Present status* Numerous estimates have been made of the cost of traffic delay, and computations have been made on the basis of various

per minute values for delay of individuals and vehicles of various types. At best these values have been very hypothetical. It is not probable that precise values can be established, but it is believed, that reasonably sound values can be. The availability of such a set of values is highly desirable for until they have been established it is impossible in many instances to determine the economic advisability and efficiency of various types of traffic signals and other control mechanisms.

*Scope of the investigation* The investigation should include a consideration of all economic factors involved in individual or vehicle delay including a monetary value for lost personal time, the loss of vehicle time, the wear and tear resulting from stopping and starting, and fuel losses through idling during delay, and additional factors of similar character. The cost factors should be classified separately for simple types of vehicles, as for example, passenger cars, light trucks, heavy trucks, street cars. The classification should be quite simple in order that it may be followed by traffic observers.

*Suggested method of procedure* This investigation is suitable for research by an economic agency capable of determining the approximate monetary values of the factors involved.

**PROBLEM 7    WHAT IS A SUITABLE UNIFORM COST ACCOUNTING METHOD FOR TRAFFIC CONTROL SIGNAL INSTALLATION?**

*Present status* Under present conditions it is practically impossible to make comparisons of the cost of various types of traffic control signal installations or of the relative cost of control signal installations and other types of control such as police officer direction. The thousands of signal installations at present in use involve millions of dollars of investment. It seems entirely suitable, therefore, from the viewpoint of municipal efficiency and economy, that separate cost accounts should be maintained for signal installations and these should be on such a basis as to make possible accurate comparisons with practices in other jurisdictions.

*Scope of the problem* Investigation looking toward the establishment of such uniform accounting methods should include consideration of current operations in typical jurisdictions and should make suitable provision for the following items among others: (1) carrying charges on original capital investment in completed installation, (2) power charges, (3) supervisory and operating charges, (4) maintenance and replacement charges, (5) depreciation.

*Suggested method of procedure* This subject is suitable for research by an agency dealing with public cost accounting or for any public agency dealing with the administration of traffic signal installations.

PROBLEM 8 WHAT ADMINISTRATIVE CONTROL SHOULD BE EXERCISED  
OVER THE SELECTION, INSTALLATION, AND OPERATION OF TRAFFIC  
CONTROL SIGNALS?

*Present status* The administration of traffic control signals is one of great confusion at the present time. In many communities signals are under the jurisdiction of public agencies which are in no manner qualified to administer them. In other communities, several agencies possess powers which are overlapping and conflicting. The situation is such that there is little assurance in any community of uniformity in design and effectiveness even within the city proper. The situation is, of course, much more complicated and confused so far as state-wide operations are concerned. With the exception of one state, Massachusetts, there has been little or no attempt to establish centralized, supervisory authority over the types of signals to be installed on the highway system or in cities and towns.

*Scope of the problem* The investigation should include an analysis of current practice and especially a study of the functional elements involved in traffic signal selection, installation, and operation, working toward the drafting of plans suitable for application under various types of governmental organization.

*Suggested method of procedure* This subject is suitable for research by agencies qualified in the field of public administration and informed on the function problems of traffic signal installation and operation.

## DISCUSSION

ON

### TRAFFIC CONTROL MECHANISMS

MR. A. H. BLANCHARD, *Consulting Engineer*. I conducted sixty hours of investigation on one point, namely, the efficiency of turning right on the red after stopping. This investigation was made on sixty days, from 5 to 6 o'clock. In sixty hours 483 operators turned right on the red at speeds exceeding 5 miles per hour. In the case of 54 per cent, people had to jump out of the way. In the case of 22 per cent, people were hit, and 15 people were taken to their homes or to hospitals. In this report, not one word is found relative to the pedestrian. I would suggest that this subcommittee consider very carefully the pedestrian in its further consideration of cycles and intervals.