

had accurate data for the particular county traffic for all those periods in between, but the minute one would try to apply Mercer County data to the District of Columbia or any other place, it would not amount to anything at all

MR. JAMES: That is the very reason why we are attempting to formulate these skeleton surveys. We recognize that a pattern for one community cannot be transferred to another community.

REPORT OF SUBCOMMITTEE ON TRAFFIC REGULATION IN MUNICIPALITIES

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SYNOPSIS

A study of traffic problems and their solution without large expenditure of funds for municipalities under 100,000 population. Among the subjects discussed are: Best methods of adapting obsolete or inadequate signal equipment to modern conditions, principles of sign and signal installation, outline of parking regulations, their need and method of analysing. References are given which can be used for a study in detail of the subjects discussed.

The large cities of the country have many advantages over the smaller communities in handling traffic flow by reason of their extensive technical bureaus, which embrace traffic engineers, police officials giving full time to traffic problems, or nationally known traffic consultants resident in the community. The smaller municipalities are in no such fortunate position. Frequently the superintendent of police, the city engineer or chairman of the street committee is confronted with the solution of a difficult traffic problem and is without the means to study the situation adequately or to obtain competent consulting service.

Ofttimes local officials charged with the problem find it difficult to obtain information or literature applying to the particular phase of the situation as it confronts them. No general review of traffic literature or publications may come before them. They may not be in regular attendance at the meetings of national organizations where such problems are discussed. They must provide some means of protection for school children, pedestrians, vehicle operators and residents on busy streets. Some means must be offered them to a solution of the problem with the minimum of effort and expense and the maximum of efficiency consistent with the local conditions.

Almost every day those who are in contact with the motoring public hear a lament regarding the lack of uniformity of signs or of traffic signals throughout the country. Meanings differ and an interpretation is often a matter of guess work.

To correct this condition the four National Conferences on Street and Highway Safety brought forth a series of model laws, both state and municipal, and recommended certain standards for highway and municipal traffic signs, signals and markings. These several codes and recommendations have been modified and brought up to date in the latter Conferences, and are now in the last stages of publication in their final form.

It is the purpose of this paper to assemble and present approved solutions to a few of the more serious problems. No effort has been made to place the items considered in the order of their importance, but an effort has been made to elaborate upon such items as the Committee in its experience has found to be most important, leaving other subjects for future consideration by this or some other committee.

Recommendations for traffic rules, signs or signals must be based upon some form of study of as many of the facts surrounding the conditions as can be learned.

Definite responsibility for analyzing traffic conditions and preparing recommendations must be placed upon some city official who can and will carry out the program, be he the city engineer, the supt. of police, the chairman of the street committee or someone else.

The Committee wishes to emphasize that the following report is but a mere outline of the broader principles of the subjects covered, not all of them by any means as fully as their importance deserves. It is earnestly recommended that before these principles are applied, interested parties should make a more thorough study of the specific item under consideration and obtain as many as possible of the papers and publications suggested by the references.

I REGULATIONS

Parking

The word "parking" is variously defined. Stripped of non-essentials, the definition most widely approved is "The standing of a vehicle, whether occupied or not, upon the roadway, otherwise than temporarily for the purpose and while actually engaged in loading or unloading or in obedience to traffic regulations or traffic signs or signals" (1) ¹

The problem confronting the officials of any municipality, particularly the capital of a state or a county seat, with reference to parking, is difficult. No subject brings up so much argument with so many opinions. It is essential to the welfare of the city, its merchants and citizens and to the good reputation which it must bear, that visitors be treated with every courtesy and consideration. Nothing is so full of trouble for local officials as discourteous or inconsiderate treatment of parking violators, particularly non-residents.

¹ Numbers in parentheses refer to lists of references.

Every inch of parking space on the streets must be made available with the least possible restrictions. At the same time there must be free movement for heavy volumes of through traffic with the least congestion and inconvenience to everyone concerned. Emergencies may call for the swift passing of fire apparatus or ambulances through crowded sections of the city. The safety of pedestrians and vehicle traffic alike demands orderly and considerate parking regulations and adequate observance of them.

Principles Certain principles regarding the use of the streets have come to be recognized, both in law and through necessity.

Practically and theoretically, a street is primarily for the use of moving vehicles. The law confers upon the vehicle the right of movement upon the street, and with that right the privilege of stopping to load or unload.

The right to move through a street is superior to the right to store or park vehicles thereon.

The stopped vehicle is using street space during the time the operator or passenger thereof is transacting business in some nearby store, or as storage for a relatively long time.

The right of authorities to restrict the use of streets in the interest of the greatest number of users thereof as well as in the interest of the safety of the public is well recognized in law (2).

Restrictions to parking may take one of two forms, i. e. limitation or prohibition.

Limitation Limitation of parking is generally based upon the business needs of a congested area to permit a greater number of motorists to enter the business area, stop at the curb, transact business and get away, or to stop all day or all night parking.

Prohibition Prohibition of parking is generally based upon the need of the full street width to provide lanes for the free movement of vehicles.

Limitation most frequently provides for one hour parking. Sometimes two hour parking is allowed, and on special streets for short distances 30 minute or 15 minute parking may be found necessary. Probably the easiest limit to enforce is one hour. A single officer may then patrol three or four blocks and by observing license numbers or marking tires with chalk can readily enforce the one hour limit. A 30 minute or 15 minute limit multiplies the effort required for enforcement, and many cities may find it hard to secure observance of the shorter limit. If a shorter limit than one hour is found necessary, the section should be as short as possible and always under the eye of an officer, perhaps one guarding a corner. If that cannot be done, then perhaps the best step is to prohibit parking entirely, permitting vehicles to stop only for loading or unloading.

Frequently there is complaint that 30 minute or one hour parking limits are too short, but careful study will probably reveal the fact that the average vehicle stands at a parking space in a limited parking zone,

ie on a business street, for rather short periods of time A survey of a number of smaller cities reveals that 80 to 85 per cent of the vehicles were parked for less than 30 minutes, that an additional 10 or 12 per cent parked between 30 minutes and one hour, and around 5 per cent were parked for one hour or more (3) (4)

It is easy to learn the parking habits of any business area by having someone walk the length of one or two blocks on each side of the street every 15 minutes, making note of the license numbers of vehicles parked at the curb in the order in which they are parked Such a study may be made in the morning or in the middle of the afternoon when business conditions are at their peak At the same time the observer may note any other parking habits that have a bad effect upon the free movement of traffic, ie double parking, angle parking where not permitted, parking too far from curb, etc

TABLE I
COMPARATIVE DATA FOR DIFFERENT PARKING ANGLES (5)

Parking Arrangement	Par- allel	25°	30°	35°	40°	45°	50°	70°	90°
Distance Between Vehicles (Prac- tical Minimum as Found by Ex- perience)	3 ft	6 in	8 in	10 in	1 ft	1 ft	1 ft	1 ft	1 ft
Length of Curb Required in Feet	18	15 4	13 3	11 9	10 9	9 9	9 1	7 4	7 0
Vehicles Parked Per 100 Feet	5 6	6 4	7 5	8 4	9 1	10 1	11	13 5	14 3
Street Width Con- sumed in Feet	7 0	11 8	12 7	13 5	14 3	14 9	15 4	16 2	15 0
Vehicles Per 100 Feet Per Foot of Street Width Consumed	800	542	590	622	636	678	714	833	953

Parallel Parking On the average street vehicles should be parked parallel to the curb with the wheels on the side nearest the sidewalk not more than six inches from the curb If placed in that manner, the average vehicle will occupy a space about 7 ft. wide and 18 ft in length Therefore, parking limit lines, if painted on the pavement, should be not more than $6\frac{1}{2}$ ft from the curb line

Angle Parking Angle parking requires greater width of street than parallel parking, and also requires additional width to permit vehicles to enter and leave the parking spaces It has the advantage of provid-
ing space for more vehicles in a given block If a street is of such width that at least two free lanes of not less than 10 ft are available for moving vehicles and the needs for moving vehicles do not demand a third or fourth lane, then angle parking may be permitted

Head In or Back In The question as to whether or not vehicles parked at an angle should head in or back in practically answers itself in favor of head in parking. Few drivers are sufficiently skilful at backing to get their cars into a narrow space without more than one attempt. Delay to moving vehicles and the danger of damaging fenders of several cars may be done away with if vehicles are headed in to the curb. In backing out, the operator may select a time when the stream of traffic is broken by traffic signals or officers and there is then no danger of collision. Further, a vehicle must pull up beyond the space before beginning to back in. Quite frequently it will be found that following vehicles will drive so close to the vehicle attempting to park that access to the parking space will be completely cut off. The result will be confusion, delay and congestion if one, two or more vehicles following are compelled to back away or turn out in order that the vehicle attempting to park may have clear access to the stall.

Abuses Abuses of parking privilege through negligence or carelessness of the operator consist of parking at slight angle to the curb where parallel parking is required, facing in the wrong direction, double parking, parking too close to an intersection or in front of a fire plug, theater, etc. Most of these abuses are indications of the need for additional parking space for the customers of business houses. Double parking by delivery trucks may be carelessness of the drivers or it may be lack of understanding on their part or that of their employers of the necessity for keeping the street clear. Loading zones may be needed. Double parking by passenger cars in a business section usually means that the parking limit on the street is too long or the existing limit is not enforced. There is no excuse other than careless habits for parking at an angle to the curb, parking too far from the curb, or parking facing in the wrong direction. Many of these abuses may be stopped by the police officers calling the matter to the attention of the vehicle operators, by soliciting the cooperation of the merchants and through some newspaper publicity.

No street upon which parking is limited or prohibited should be without at least two signs on each side of the street, preferably not less than 200 feet apart, in every block, briefly stating the parking regulations. These signs should be placed along the curb at a height of eight feet so that they will clear the tops of the cars, and should be facing in the direction from which vehicles approach.

Parking Lots Merchants and business men on a congested street may make additional curb space available for their customers by requiring that their employees' cars be placed in parking lots or on some streets not so crowded. In some communities chambers of commerce, business men's associations, service clubs or others have provided free parking lots in order that additional curb space may be made available. While not all of the customers will use the parking lots, most of those who expect to be in the neighborhood for a long time will do so. In

any event, the employees should be required to use them. It is easy to see that one car of an employee parked at the curb on a business street for as long as four or five hours occupies a space that may be used by eight or ten customers of some business house. The use of parking space on a business street by business men or their employees as a terminal storage for their cars, while convenient to them, is inconvenient to their customers and may have the effect of bringing about a more stringent parking regulation or of driving away from the area possible customers who are dissatisfied with parking conditions.

Prohibition of parking is seldom a necessity in the average small community. Only at a few locations where narrow streets create a "bottle-neck" and the flow of traffic is exceptionally heavy, perhaps only at certain hours of the day, may absolute prohibition of parking be necessary. Such a condition should receive careful study before prohibited parking is tried, as the difficulty of enforcement is so great as to present serious difficulties to a small police department. If the necessity for prohibiting parking on short sections, or on one side of a street, is found to exist and can be proved, the authorities should not hesitate to do so.

Pedestrians

In decisions in accident cases, the courts have long since established the rights of the pedestrian in the street, now incorporated in the statute law of many states and in the National Codes.

Pedestrians crossing the street at an intersection where there are traffic lights or officers on duty have the right of way over vehicles when the "Go" signal is in their favor, from the second they step off the curb. If the signal changes while the pedestrian is in the middle of the street, he still has the right of way. If the signal is against the pedestrian before he leaves the curb, the vehicle has the right of way.

At intersections where there are no signals or officers, the pedestrian has the right of way if he uses reasonable care in crossing the street (6).

In crossing between intersections, the pedestrian must yield the right of way to vehicles (7).

It is the duty of the pedestrian in all cases to realize that the crossing of a street, either at an intersection, protected or not, or between intersections, is a hazard, and in doing so he must at all times use the ordinary care that any reasonable man would use under like circumstances, otherwise the pedestrian may be guilty of "contributory negligence."

Some states and many cities provide by statute or ordinance that pedestrians shall observe all traffic lights and officers' signals (8). Other cities object to this plan. In many cities pedestrians simply will not submit to organized control, and regulation is difficult. Probably the safest and best way to establish some form of regulation is to paint cross walks on the pavement at busy crossings and urge their use. The use

of a separate pedestrian period in the cycle of a traffic signal is not to be recommended as few pedestrians are willing to wait their turn. Not only is the pedestrian period ignored, but it creates an unnecessary delay to vehicular traffic. It is, in fact, a confusing waste of a period.

One Way Streets

If we think of a one way street as just half of a two way street, the picture seems to be clearer. The reverse flow of traffic must be provided for, if not on this street, then on some other nearby street. It then follows that if a street is made one way, the next street parallel to it on one side or the other must be made one way in the opposite direction, unless the nearby streets are wide enough and not so crowded with traffic that they can carry the added load of reverse traffic forced off the one way street. In many cases, however, it will be found possible to prohibit parking on one or both sides and still have two way movement (9).

Through Streets and Stop Intersections

The use of "Stop" signs or blinker lights flashing red on the side street and amber on the main street very often may provide a substitute for a traffic light at places where some form of protection is necessary but where the volume of cross traffic is low. "Stop" signs may be used on cross streets between traffic signals where the vehicles move in a "wave" or by the "progressive" system. There is no hazard to the vehicles on the cross street, as they may move out between the waves as though a traffic light were there (10) (11).

Taxi Stands and Cruising

Taxi stands, if established, should be so located as to be out of the way of "through" traffic and off a street or the side of a street where parking is prohibited. There is no object in prohibiting parking if taxicabs are permitted to stand on that street and obstruct one lane of traffic. Such stands may always be located on a side street where the full street width is not so necessary for moving vehicles.

The "cruising" of taxicabs, or drifting around the streets in search of passengers, by all means should be prohibited and taxicabs required to go immediately to their designated stands upon returning from a call (12) (13).

Bus Stops, Terminals and Routes

Bus stops on busy streets should be designated by proper signs, other vehicles prohibited from occupying the space, and buses in every case should be required to pull up to the curb before stopping to load or unload. Wherever it is possible, off-street terminals for buses should be provided whenever they are required to stand for a considerable length of time between trips (14). If no off-street terminal is available,

then the waiting bus should be allotted terminal space on some cross street where the traffic volume is not heavy

Police officials or the local governing body are usually vested with the authority to designate the bus routes into and through a municipality. In choosing the route, consideration must be given to the patrons of the bus and of the business houses in the community, as well as to the volume of traffic on the route over which the bus must travel. Wherever possible to do so, a bus route should follow some street other than that already crowded with vehicular traffic, entering the congested area by the route which will take it most quickly to its terminal or the essential areas which it must serve, and depart from those areas as quickly

References to Section I

- (1) Model Municipal Traffic Ordinance, Section 1, Definitions
- (2) "Formulation of Curb Parking Regulations," Matson, Institute of Traffic Engineers *Proceedings*, 1931, pp 9-27
- (3) Annapolis Survey, Canning, 1934, Keystone Automobile Club
- (4) Report, Traffic Problem, Boston, McClintock, 1928, p 164
- (5) Mass Code for Traffic Signs & Signals, p 46
- (6) "The Legal Rights of Pedestrians," Blanchard, *Proceedings* Institute of Traffic Engineers, 1932, p 101
- (7) "The Legal Rights of Pedestrians," Blanchard, *Proceedings* Institute of Traffic Engineers, 1932, p 102
- (8) Model Ordinance (1930), alternate Section 16
- (9) Report of Committee on Measures for Relief of Traffic Congestion (1930), National Conference on Street and Highway Safety, p 44
- (10) Report of Committee on Measures for Relief of Traffic Congestion (1930), National Conference on Street and Highway Safety, p 43
- (11) "Through Streets," *Public Safety*, Series No 23, National Safety Council
- (12) "The Taxicab—Its Service & Regulation," Schnader, *The Annals*, American Academy of Political and Social Science, November, 1924
- (13) "Taxicab Regulation," Simpson, *American City*, August 1932, p 71
- (14) "Camden Municipal Bus Terminal," North, *American City*, May 1930, p 155

II EQUIPMENT

Signs

Traffic signs are intended to give information, direction, warning or command to the vehicle operator by means of words or symbols. To serve their purpose they must be understandable, the notice given must be positive, and they must be so made as to be quickly read. The standards adopted by the American Association of State Highway Officials and the National Conference on Street and Highway Safety fix definite shapes, colors and all other details for each type of sign (1)

Shapes In serving the purpose for which signs are intended, square signs have been adopted for the purpose of caution, diamond shape for warning of a more serious hazard, octagonal for Stop signs, round for railroad crossings and rectangular for directional signs

Color Combinations The United States Bureau of Public Roads and

the National Bureau of Standards (2) have proven by careful tests that under all conditions black letters or symbols on yellow background are superior to all other color combinations for visibility, and this combination has been adopted for warning signs. For direction signs and route markers, the combination of black letters on white background is used.

Symbols Symbols are generally to be preferred to words or letters as they are more readily understood at a single glance by all drivers. Words, if used, should be as short as possible and as few on the sign as will tell the story.

Lettering Advertising companies have learned that signs to be readable must have not more than 70 per cent of the vertical background occupied by the text. The letters should be of such a size as to be perfectly readable to a person with normal vision at the distance at which the driver must see and prepare to act upon the notice given. With normal vision the following letter heights can be read at the distances stated (3)

1 in	20 ft	4 in 150 ft
2 in	45 ft	5 in	200 ft
3 in	70 ft		

The principals set up by the Manual on Signs, etc. of the National Conference should always be followed.

Route Markings and Detour Signs Route markings and detour signs probably present the most difficult problem for officials of a municipality. It is well to bear in mind that any departure from a straight road or the usual route of travel should be so well marked that even the most unobserving driver cannot fail to see one or more signs giving notice of the turn. Even after the turn is made, "assurance" signs should be erected to satisfy the driver that he is on the right road and has made the proper turn. Numerous signs at every turn may be necessary to carry out this plan. Depending upon the speed likely on the street or highway, the signs should be far enough back so that no driver can fail to see them, and following that, they should be numerous enough and sufficiently definite to leave him no doubt as to what he should do when he reaches the turn. It is well to remember in erecting signs that the person most likely to be lost or to stray from the proper route is the stranger in town, and it is from the stranger that impressions of the city are carried throughout the country.

Mounting All signs, to be effective, should be mounted at such a height as to be visible over the tops of parked cars if parking is permitted or is likely on the street. If parking is not likely, then the signs may be mounted at a height of about three feet above the crown of the road, always on the right and facing in the direction from which they are to be read.

Lighting Night driving requires that some form of lighting be pro-

vided If the sign is not in a position to be lighted by street lights or in direct line of the headlights of the vehicle, by all means it should be provided with reflector devices, preferably buttons, that will call attention to the sign

Material The best of material and workmanship is the greatest economy Signs are forced to withstand the most severe weather conditions and are subject to accidental damage or deliberate abuse, yet they must always tell their story. If a sign is considered necessary at all, it must convey its message at all times The use of rust-resisting steel and the best grade of paint will cost but a few cents more per sign than cheaper material The cost of erection of the sign is the largest single item Therefore, it would seem that it is much cheaper to spend a few cents more for high-class material and workmanship in the first place than to have to replace the sign at frequent intervals A rusty, discolored sign is no good to the driver and a definite discredit to the municipality

Signals

Traffic signals, usually electrically operated, are placed at street intersections to direct traffic in an orderly manner, reduce accidents or regulate continuous movement at reasonable speeds, by the successive lighting of the colored lenses in their faces The modern traffic signal approved as standard for use throughout the country (4) has three lenses in each face, the red lens at the top, the amber in the center and the green at the bottom A fourth lens with green arrow for right or left turns may be placed below the green lens

A traffic signal is expensive to install and is a continued expense for its operation and maintenance Unless properly installed, operated and maintained, traffic signals may become a nuisance or even a definite hazard to vehicles and pedestrians alike No signal should be installed unless it can be justified by traffic volume, pedestrian movement or accident rate, or some combination of these factors, with or without physical conditions

Traffic Volume The minimum volume of traffic which may warrant a signal is 1,000 vehicles per hour for at least eight hours of the day Of this 1,000 vehicles, at least 250 should enter the intersection from the cross street (5) (6) (7) When the volume of traffic entering the intersection from all directions falls below one-half of this minimum, the signal should be changed to operate as a flashing amber light on the "through" street and flashing red light on the side street

Pedestrian Movement When pedestrians numbering about 300 per hour must cross the main street in the face of vehicles numbering 750 or more per hour and traveling at speeds in excess of 15 miles per hour, traffic signals may be warranted

Accidents When accidents number five or more per year, a traffic signal may be warranted

Physical Conditions Other things to be considered in the installation of a traffic signal are heavy left turning movement, grades, lack of sight distance, the necessity for controlling speed

In all of these cases, the use of the lesser remedies should be tried first, i e the stop sign or the flashing light

Effect of Signals on Accidents Traffic signals cannot be expected to prevent accidents All they may do is reduce the number of certain types of serious accidents Three separate studies (8) in different parts of the country covering 599 intersections, before and after signals were installed, showed that 36 per cent had an increase, 59 per cent a decrease and 5 per cent showed no change The same study showed that the installation of signals had no effect on the accident rate if less than five accidents per year were recorded The effect of signals on the types of accidents showed that while right-angle crashes were reduced about 56 per cent, rear-end and side-swipe collisions increased about 37 per cent and pedestrian accidents showed little change

The conclusions to be drawn from the study referred to indicate that unless the accident rate is high, traffic signals are no help, that the more serious collisions, i e right-angle crashes, may be reduced, but that rear-end collisions may increase and that pedestrian accidents have not been reduced by the installation of signals

Simplicity The best signal system is the one which does its work in the simplest manner If after analyzing the conditions, signals are found to be necessary and are decided upon, the simplest form of signal operation is that which will stop the traffic on one street and allow it to go on the other for a time, and then reverse the movement A third period for any purpose, turning movement, pedestrians or other reason, is seldom needed

Cycle Length The cycle length should be kept as short as possible Studies by the U S Bureau of Public Roads at a heavily traveled intersection in Washington, showed that short periods were the best, (9) and that there is no advantage in favoring heavily traveled streets with extremely long periods It was found that with periods of about 15 seconds on each street, approximately 1,000 vehicles per hour could pass through the intersection of two simple two-way streets Since intersections carrying greater volumes of traffic than this are seldom found in the ordinary small community, the short period of 15 to 20 seconds on each street will provide ample time to pass all of the vehicles approaching most intersections, except under rare or unusual conditions

A long cycle has no advantage in passing a greater number of vehicles at a light traveled intersection, although there may be some advantage when vehicles are closely spaced on the main street and the cross traffic is not heavy Such conditions are not usually of long duration and the final delay to all vehicles approaching the intersection may be less if the short cycle be maintained throughout.

Objections to Long Cycle The long cycle has many objections. Probably the most serious is that it creates the desire on the part of drivers who are familiar with the signal to 'beat the light,' and they, speeding up may dash through the intersection just as vehicles on the cross street have started, with the result that a serious crash may occur. The long cycle creates a feeling of impatience and disgust in the minds of the operators who are forced to wait on the cross street for the light to change, perhaps while few vehicles are using the main street. Pedestrians are more likely to disregard the light entirely and cross whenever they get a chance, increasing the hazard to themselves and the possible accident toll of the intersection.

The Amber Light The amber light is used following the green and before the red, to give warning of the change of signal. It is intended as a clearance light to permit vehicles that are already within the intersection to clear. It means "Stop" to all vehicles except those which are so close that a stop cannot be made in safety. The length of time the amber light is shown should be great enough to warn drivers that the signal is about to change while they are far enough from the crossing to stop. An amber light of from three to four seconds in length is sufficient in nearly all cases. If shorter, the driver does not have sufficient warning. If longer, he is likely to disregard the warning, with serious consequences. It is essential that the amber light be so screened as to be invisible to traffic on the cross street.

No Amber After Red There is no place for an amber light following the red. Signals in which an amber light must now follow the red light or in which a change cannot be made to eliminate this showing entirely, are obsolete and should be discarded, as they are accident breeders of the worst kind. Drivers approaching a signal which shows a red light should know that they must wait until the green light appears. If an amber light follows the red light, the driver is likely to "step on the gas" and enter the intersection at the same time as does a driver on the cross street who may be speeding up to take advantage of the last few seconds of the green, or who may be perhaps in the center of the crossing when the light changed from green to amber. Such right-angle collisions are frequently of serious consequence. It is false economy and tampering with the lives and property of the public for city officials to maintain a signal showing an amber light following the red.

Unusual Signals Long amber lights for turning or for pedestrian movement or perhaps the red light shown all around or the flashing red or amber light for movement of fire apparatus are unusual, are not generally accepted as standard and are objectionable, again giving rise to the complaint of lack of standardization of traffic signals throughout the country. There is seldom any real need for such unusual signal indications, and they should be avoided wherever possible. Standard showings of signal lights, fully understood by every driver, will go fur-

ther toward reducing the accident toll than will signal lights, the meanings of which may be unknown to any but local people

Location (10) A signal should control only the intersection at which it is located. Wherever possible a signal should be placed to give an indication from the far right corner of the intersection. This normally requires four pedestals at each intersection, but finances sometimes prevent such an elaborate installation. When four pedestals cannot be afforded, two may be made to serve by installing two or preferably three faces on each pedestal, placed on the far right corners of the principal street, with the lights on the same pedestal being on the near right corners of the cross street. This diagonal corner installation may serve for a time until additional funds are available, when the complete installation may be provided.

The generally accepted height for traffic signals above the pavement is between 8 and 10 feet. Signals placed at this height give the best opportunity to the driver to observe and obey them.

Signals on pedestals in the center of the intersection are unsatisfactory and dangerous unless on a traffic island amply protected from danger of collision. Overhead signals, i.e. those suspended from mast arms or from cables over the center of the intersection at a height of about 14 feet above the pavement, always nuisances, are now obsolete and should be replaced as soon as funds are available or when changes are made in the signal system.

Signal Systems Not infrequently a number of intersections on a main street may be supplied with traffic signals. Sometimes they are operated together, constituting a signal system, or, if some distance apart, may be operated independently as isolated signals. If two or more signals are within 1,000 feet or less of each other, they should be wired together to operate as a signal system. If the distance between signals approaches 1,200 to 1,500 feet, they may not be economically operated as a connected system (11) but may be satisfactorily operated as a non-connected system by use of synchronous motors at distances as high as 2500 feet.

A system of traffic signals should be so arranged as to pass a considerable volume of traffic regularly spaced in an orderly manner, at a reasonable speed, at the same time giving opportunity for vehicular traffic on the cross streets to enter or cross the main street, and sufficient time for pedestrians to cross either the main or side streets. This may be done by proper signal installations under what is known as the "flexible progressive system" (12). Most frequently, the signal system in the average small community operates at present on what is called a "simultaneous system," i.e. all of the signals facing the main street are green at the one time and all change to red at the one time. This system has serious objections in that traffic moves by a series of starts and stops, and when moving the driver has every inducement to make as much

speed as possible in order that he may travel as many blocks as he can before again being stopped. Such speed results in a serious hazard to pedestrians and other vehicles in congested sections, and may result in collisions with serious consequences at side streets that are not protected by signals.

Changes Easy Many small communities are unable financially to replace their present systems with the flexible progressive. Most simultaneous systems may be easily changed to what is known as the "alternate system," simply by changing the wiring on the lights. Such a system will probably be satisfactory for the majority of small cities. When such a change is made, every other signal will then show red or green alternately. When the length of the block is known, definite

TABLE II

PERIOD OF "GO" TIME IN SECONDS, FOR VARIOUS SPEEDS AND DISTANCES BETWEEN SIGNALS

(The "Go" time is just half the cycle length)

Speed Miles per hr	Distance between signals—feet						
	400	500	600	700	800	900	1000
12	<i>sec</i> 23	<i>sec</i> 28	<i>sec</i> 34	(2)	(2)	(2)	(2)
				<i>sec</i>	<i>sec</i>	(2)	(2)
15	18	23	27	32	36	<i>sec</i>	(2)
18	15	19	23	27	30	34	<i>sec</i>
20	14	17	20	24	27	31	34
22	(1)	16	19	22	25	28	31
25	(1)	14	16	19	22	25	27
28	(1)	(1)	15	17	19	22	24
30	(1)	(1)	14	16	18	20	23

(1) Time too short to pass more than 3 or 4 vehicles

(2) Time too long to control average running speed

speeds at which vehicles should pass through the street may be fixed and the length of red or green periods so figured as to permit that speed only and no greater throughout the length of the system. Drivers will soon learn the speed at which they can make the run through the signal system without stops, particularly if signs are attached to the signals or to the pedestals showing the speed for which the signals are timed.

Progressive movement may be provided on both of two principal streets crossing each other at right angles if the signal at the intersection of the two streets is used as the basis for alternating the light indications of the signals one block away in each of the four directions. Progressive movement may be provided in a system that embraces one square block, if signals are installed at each of four intersections by connecting all of

the lights and setting the two signals at the diagonal corner to show the same light colors at the same time

Objections to Alternate System The principal objection to the use of the alternate system of signal installation is that the length of the red and the green period must be exactly the same in all lights. However, this cannot be a serious problem to the average community since it has been shown before that the short cycle is most efficient and satisfactory in the majority of cases. The length of period in an alternate system must depend upon the volume of traffic at the principal intersection covered by the system. If the principal intersection is properly served with the minimum of delays and the cycle is kept as short as possible, no undue or annoying delay or unfair condition will likely be created at any of the other intersections.

Traffic Actuated Signals For some years there has been an increasingly worth-while development of a new type of signal control. This type of control discards the idea that traffic flow must conform to "Stop" and "Go" intervals of fixed length, operated by a sort of "clock-work." In place of it, these new controllers respond to demands for the "Go" signal by traffic. At an isolated intersection "Traffic Actuated Control" as it is called will cause less delays than fixed time control. Actuated control is especially valuable at complicated intersections, but its use warrants consideration at all isolated intersections. This type of signal control is also effective for enabling residents of a small community to cross a main highway safely without unnecessarily holding up the through traffic.

Pavement Markings

White lines painted on the pavement may safeguard and help the free movement of traffic in numerous ways. Center lines (12) may be painted on the roadway, on curves or at the crest of a hill to divide opposing lanes of traffic (13). Cross walks painted at the intersection show the area in which pedestrians may walk with safety. Lane markings (14) dividing the roadway into two, three, four or more lanes may be painted in each direction 50 to 75 feet from the cross walk. Some of these lanes may be marked for left or right turns by painting words in the proper places (15). If words are painted on the street surface, elongated letters (16) should be used so as to be more readable when viewed from the position of the driver in the car.

"Stop" lines or limit lines (17) may be painted part-way across the street at the point where a vehicle should stop in obedience to a "Stop" sign before entering a "through" highway.

The boundary limits of a safety zone (18), when not a platform above the surrounding street surface, may be indicated by paint lines. Parking lines (19) parallel and not more than 6 feet from the curb line will aid in reducing careless parking habits. Where angle parking is per-

mitted, lines painted at an angle to the curb (20) will mark the stalls in which vehicles should park. Curbs are sometimes painted (21) to show prohibited parking or short parking zones. Where curbs are painted for this purpose, yellow or orange is preferred.

Safety and Loading Zones

Safety or loading zones may sometimes be necessary (22) at points where a number of pedestrians cross or where a considerable number of people must stand in the roadway to board or upon alighting from street cars. This pedestrian traffic, coupled with a heavy volume of vehicular traffic at high speeds, may warrant the use of safety zones or loading islands.

Any fixed object in the paved area of a street is a serious hazard, and there is considerable doubt as to the final effect of safety zones on the accident record.

If safety zones are necessary, they should be of permanent type (23) to give the maximum of protection to pedestrians. They should be fully illuminated both day and night with flood lights and with blinker lights at a height of both 4 feet and 12 feet above the road surface (24). They should be designed with a prow or sloping abutment (25) to turn aside any vehicle that might collide with them or to decrease the speed of a head-on collision with the least possible damage to the vehicle. If safety zones are established, vehicle traffic should by all means be permitted to pass on both sides of the area (26).

References to Section II

- (1) Manual on Uniform Traffic Control Devices, 1934, National Conference on Street and Highway Safety
- (2) *Public Roads*, September 1933, p. 109
- (3) P. M. Peltz, M. D., 1809 Pine Street, Philadelphia, Pa.
- (4) Manual on Uniform Traffic Control Devices, Part 3, Section 326
- (5) Manual, etc., Part 3, Section 302
- (6) Mass. Code for Traffic Signals, p. 13, Section 3
- (7) New Jersey Code for Traffic Control Signal Installation and Operation, p. 7, Section 3-A
- (8) Effect of Signalization on Accidents, Vey, *Proceedings* Institute of Traffic Engineers, 1933, p. 56
- (9) *Public Roads*, February 1934, p. 234
- (10) Manual on Uniform Traffic Control Devices, Part 3, Section 341
- (11) Report of Committee on Highway Traffic Analysis—Hamlin *Proceedings*, Highway Research Board, 1929, p. 92
- (12) Manual on Uniform Traffic Control Devices, Part 2, Markings, Section 203
- (13) Manual, etc., Section 206
- (14) Manual, etc., Section 204
- (15) Manual, etc., Section 214
- (16) "Simplification of Highway Traffic," Wm. Phelps Eno, 1929, p. 50. Also "Pavement Signs," a pamphlet, Eno Foundation for Highway Traffic Regulations, Inc.
- (17) Manual on Uniform Traffic Control Devices, Part 2, Markings, Section 207.

- (18) Manual, etc , Section 209
- (19) Manual, etc , Section 210
- (20) See tabulation of data for parking angles in Section I-A of this report
- (21) Manual on Uniform Traffic Control Devices, Section 231
- (22) Manual, etc , Part 4, Sections 401 and 402
- (23) Manual, etc , Section 409
- (24) Manual, etc , Section 412
- (25) "Modern Practice in Design and Use of Safety Zones," Simpson, a pamphlet reprint, A E R A , p 20
- (26) "A Traffic Control Plan for Kansas City," McClintock, 1930, pp 187 and 188.

III. SPECIAL PROBLEMS

Circles and Rotary Intersections Traffic circles or rotary intersections (1) may be used where there are heavy volumes of traffic on two or more main streets or at locations where there are "Y" or other irregular intersections, to avoid conflict between paths of vehicles driving over wide paved areas (2)

Street Railway Operation The use of street cars in the average small municipalities appears to be on the decline and buses are rapidly being substituted (3) They still have their place in many communities and present problems difficult to solve because they must travel in a fixed path Sharp turns of tracks and the wide swinging ends or overhang of the cars makes necessary special provision for marking the pavement and safeguarding vehicular and pedestrian traffic Street cars sometimes move in reverse direction on one-way streets or to the left around traffic circles One-way streets should never be considered unless cars can be routed, but when such conditions exist, no effort should be spared to place sufficient signs at all dangerous points to warn motor traffic of the unusual movements of the street cars

References to Section III

- (1) Manual on Uniform Traffic Control Devices, Part 4, Section 426
- (2) "Planning Intersections for Modern Traffic," Marsh, *Municipal Index*, reprint, 1931, p 138
- (3) "The Place of the Street Car in Traffic," Hoover, *Proceedings*, Institute of Traffic Engineers, 1932, p 117

IV ACCIDENT REPORTS

The hazards at any location are measured by the frequency with which accidents happen to motor vehicles and to pedestrians No plan for any improvement can be worked out without having a full and complete record of all accidents happening at the location The seriousness of an accident is not the measure of the hazard at that point, but rather the number of accidents, however, slight, gives an idea of the danger Because an intersection has had one or two fatal accidents in the course of one or two years does not indicate that a traffic signal or some other device should be used The space of time between one collision which

may result only in a bent fender and another which may result in a death is too short for most people to measure. Therefore, all accidents of all types should be considered in figuring the hazard of an intersection.

A collision diagram (1) will show the types of accidents. The types of accidents, whether they be right-angle, rear-end or perhaps side-swipe collisions, should be considered as well as collisions between motor vehicles and pedestrians, and such remedies should be applied as will best reduce the type of accident which occurs most frequently or results most seriously (2).

References to Section IV

- (1) "What Shall We Do About Accident Records," Simpson, *Transactions*, National Safety Council, 1930, p 167. Also "The Use of Accident Records," Marsh, *Proceedings*, Annual Conference on Highway Engineering, University of Michigan, 1932, p 199.
- (2) "Effect of Signalization on Accidents," Vey, *Proceedings*, Institute of Traffic Engineers, 1933, p 56.

DISCUSSION—TRAFFIC REGULATION IN MUNICIPALITIES

MR J ROWLAND BIBBINS. I am glad Mr Canning called up the question of what I term the "skip-signal progressive" applicable in the major cities. There are also plenty of cases in the smaller cities where you go through the city and cross bridges, for instance, Harrisburg, where there is heavy cross traffic at each bridge portal. I have never been convinced why this skip signal is not perfectly feasible and a much simpler method than to wait until you have enough money to install signals at every intersection of the main highways. If you do that you run into great expense and serious difficulty with non-standard block-spacing. I consider that it would be vastly most beneficial to use as few main signals as possible at control points in order to regularize and coordinate to better advantage the most important intersections and produce a much more uniform speed-line and a much wider time-band or capacity for the same traffic than if we use, as our friends in New York demand, a signal at every crossing. In Cleveland they have such a skip signal system, installed some years ago, but only a small proportion of the streets of that system are signaled and the intermediate streets which are not signaled are protected by STOP signs.

Immediately some of you decide that this is not safe enough. Well, I haven't the data to show whether it is safer to put a STOP sign at unimportant streets or to put up signals there, where there may be such a long wait to cross-traffic that more people will disobey the signal than will the STOP sign. There are many of these small towns having a main highway through them but with only certain essential control points. And in large cities I see no reason why 1000 or even 1500 ft skip spacing will not be quite justifiable.

The percentage of main street vehicles stopped by signals really measures their validity to the man on the street. If you can locate STOP signals even every four streets or $\frac{1}{2}$ mile and press 85 per cent of the main traffic through without stopping, it is a great deal better than to wait until you can signal every street which is generally difficult or impossible for maximum efficiency and width of time-band or capacity. In Chicago outside of the Loop only about $\frac{1}{3}$ of the streets are signaled in progressive runs. There is greater flexibility in working out the best speed and time-band and with much better practical results than to force signals at every intersection on an irregular block spacing. The latter will always result in increased stoppage, and stoppage, to me, is the efficiency index of the system.

MR L W MCINTYRE, *Director of Traffic, Pittsburgh, Pa.* The report does not mention the use of "Stop" signs at isolated intersections. I believe that it should include a warning against such use.

Neither does it advise with respect to high mounting. High mounted "Stop" signs at such locations do not reduce the speed for really blind corners, where the critical speed is seven miles per hour or less, the erection of signs, even if mounted low, has no effect on drivers. For isolated corners of medium blindness, or for corners actually blind but apparently open, a low mounted speed sign has just as much effect as a "Stop" sign without as great a burden on the police department for enforcement.

I should strongly advise against taxicab cruising. I believe the report should carry some amplification indicating the most nearly effective methods of enforcing the prohibition of cruising.

With regard to safety zones, the report recommends a prow or sloping abutment to turn aside any vehicle which might collide with the safety zone, or to decrease the speed of a head-on collision. A simple mathematical calculation will show that any such sloping prow yet devised does not have sufficient frictional area in contact with the vehicle axle to materially slow the vehicle. There is need for considerable more experimental research with actual designs and with vehicles colliding with them before such a recommendation may be made.

MR A W WELCH, *American City Magazine*. It has been suggested that the lettering recommendations should include 6 and 8 inch letters, as many signs using these sizes are being manufactured and this information would be welcomed by officials.

Devoting 70 per cent of the vertical background to text is thought to be too much, and 60 per cent is suggested as enough.