NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE **7**

# MOTORIST AID SYSTEMS



HIGHWAY RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

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# MOTORIST AID SYSTEMS

RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION
OF STATE HIGHWAY OFFICIALS IN COOPERATION
WITH THE FEDERAL HIGHWAY ADMINISTRATION

AREAS OF INTEREST:
- TRANSPORTATION ADMINISTRATION
- MAINTENANCE, GENERAL
- HIGHWAY SAFETY
- TRAFFIC CONTROL AND OPERATIONS
- TRAFFIC MEASUREMENTS

**HIGHWAY RESEARCH BOARD**
**DIVISION OF ENGINEERING NATIONAL RESEARCH COUNCIL**
**NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING** 1971

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Highway Research Board of the National Academy of Sciences-National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectvity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway departments and by committees of AASHO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Highway Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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## PREFACE

There exists a vast storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it resulted from research and much from successful application of the engineering ideas of men faced with problems in their day-to-day work. Because there has been a lack of systematic means for bring such useful information together and making it available to the entire highway fraternity, the American Association of State Highway Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Highway Research Board to undertake a continuing project to search out and synthesize the useful knowledge from all possible sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series attempts to report on the various practices without in fact making specific recommendations as would be found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available concerning those measures found to be the most successful in resolving specific problems. The extent to which they are utilized in this fashion will quite logically be tempered by the breadth of the user's knowledge in the particular problem area.

# FOREWORD

*By Staff*

*Highway Research Board*

This report should be of special interest to administrators responsible for highway needs, traffic and operations personnel in charge of user services, and maintenance personnel responsible for communications and motorist aid patrols. The report offers information on determination of need factors, planning and design factors, maintenance procedures and costs, and other aspects of motorist aid systems as part of the total communications and management system necessary for an efficient highway system.

Administrators, engineers and researchers are faced continually with many highway problems on which much information already exists either in documented form or in terms of undocumented experience and practice. Unfortunately, this information is often fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem is frequently not assembled in seeking a solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem. In an effort to resolve this situation, a continuing NCHRP project, carried out by the Highway Research Board as the research agency, has the objective of synthesizing and reporting on common highway problems—a synthesis being defined as a composition or combination of separate parts or elements so as to form a whole greater than the sum of the separate parts. Reports from this endeavor constitute a new NCHRP Report series that collects and assembles the various forms of information into single concise documents pertaining to specific highway problems or sets of closely related problems. This is the seventh report in the series.

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More than 50 years ago public acceptance and use of the automobile brought with it a need to provide assistance to stranded motorists. The dramatic increase in the number of automobiles, greatly improved road network, and more demanding attitude on the part of the average motorist has since resulted in significantly increased needs for assistance. These needs include changing flat tires, correcting mechanical and electrical failures, providing fuel, oil or water, and providing towing services. The needs also include assistance in the forms of police, ambulances, fire equipment, and information. The challenge to highway agencies is first to learn exactly what the motorists' needs are and how best to provide for those needs. Then, agencies can provide aid systems that quickly detect stranded motorists, offer a means by which specific needs are communicated, and provide a timely and appropriate aid response.

The Highway Research Board in this report provides information on the motorists' needs, reviews existing and proposed aid systems that offer insight as to how best to furnish the required aid, presents factors to be considered in planning and design, and places motorist aid in the context of the total communications and management systems necessary to provide an efficient highway system.

To develop this synthesis in a comprehensive manner and to insure inclusion of significant knowledge, the Board analyzed available information (e.g., current practices, manuals, and research recommendations) assembled from many highway departments and agencies responsible for highway planning, design, construction, operations, and maintenance. A topic advisory panel of experts in the subject area was established to guide the researchers in organizing and evaluating the collected data, and for reviewing the final synthesis report.

As a follow up, the Board will attempt to evaluate the effectiveness of this synthesis after it has been in the hands of its users for a period of time. Meanwhile, the search for better methods is a continuing activity and should not be diminished. An updating of this document is ultimately intended so as to reflect improvements that may be discovered through research or practice.

## CONTENTS

## ACKNOWLEDGMENTS

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Information on current practice, ongoing research, and plans for future motorist aid systems was provided by the AASHO Committee on Communications and Electronic Applications. Their cooperation and assistance were most helpful.

# MOTORIST AID SYSTEMS


## SUMMARY

A motorist aid system assists in the detection of a stranded motorist, offers a means by which his needs are communicated, and provides the appropriate aid response. Existing systems include roadside telephones or radio units, courtesy patrols by highway agencies or private organizations, citizens' band two-way car radios, television and other electronic surveillance methods, cooperative motorist reporting schemes, and police patrols.

Motorist aid systems, however, will never solve the problems of all stranded motorists. These systems are as effective as the design, equipment reliability, response, publicity, and resulting motorist confidence will allow. They are subject to chance and human error, although these will be minimized if an objective, thorough analysis precedes the decision to install a system. The first prerequisite, therefore, is an investigation of motorist needs to determine whether an aid system is justified. This can be followed by a system design tailored to the particular roadway, a commitment of resources, and a detailed operating plan that is agreeable to all participating organizations.

Returning the motorist to the road in an expeditious manner should be a major system goal. The objective of a motorist aid system should be to provide an immediate response to all requests and, if necessary, have someone at the road site at the earliest reasonable time.

The use of motorist aid systems increases safety on high-speed expressways by minimizing the number of motorists crossing operating lanes, hitchhiking, climbing fences, abandoning vehicles, and otherwise creating hazards for themselves and fellow motorists.

Most stranded motorists are unable to repair mechanical failures and thus require service assistance. Women, with few exceptions, are not able to make mechanical repairs or change tires. Men will attempt repairs during daylight hours and will generally change flat tires at any time.

Medical assistance can be expedited where a motorist aid system is available. Experience with existing urban freeway systems indicates a reduction in medical response time. Providing rapid medical assistance increases the likelihood of saving lives and minimizes the effects of injuries.

Fast removal of accident debris from the highway is a major safety consideration. Limited experience gained from operating urban aid systems shows an average reduction of 5 min. in clearing accidents.

A survey of all the states revealed that there are currently 19 operating radio and telephone systems in 12 states and more than a dozen systems of these types now in the planning stages. Other types of systems are also in use throughout the country. Some states are operating courtesy patrols on a 24-hour basis on selected routes; others offer this service only at certain times, such as holiday weekends. Some private organizations also are operating courtesy patrols. A limited-coverage

citizens' band (CB) radio system is used nationwide and an extensive test is being conducted in one state. Details of these and other systems are given in Chapter Two.

It is not reasonable to expect a reduction in the need for police patrols once a motorist aid system is installed. Nor are service requests apt to decline. These needs have little or no relation to the presence of a motorist aid system.

Participating organizations—highway, police, fire departments; ambulance services; service stations; local, state and Federal government—should plan and work together in an atmosphere of cooperation. This should start with the planning phase and carry through the day-to-day operation of the system. All parties should be in general agreement that rapid response action is required and that the desired assistance be provided directly whenever possible. One question remaining is the coordination of all operational needs and responses. Is the answer a single system manager to handle these functions?

Human factors considerations weigh heavily in the design of a motorist aid system and its potential use by the individual motorist. These criteria play an important role in the system design, the location of units, the type of instructions, signing, and a host of other safety and system efficiency considerations.

Effective public information should accompany each installation not only as a forerunner of system operation but also as a continuing program designed to build and maintain motorist confidence. Local advertising via radio, television, newspapers, and even handouts could include a general description of the system, how to operate individual units, and general conclusions about what to expect in terms of emergency vehicle response. Perhaps a set of uniform guidelines could be established to cover this area, thereby removing the confusion and variance that presently exist.

There are numerous types of systems in use that address the motorist aid problem. Each system has its advantages and disadvantages. It is impossible to generalize that any single system type stands head and shoulders above the others. Perhaps a mix involving portions of existing systems may be the best choice, or perhaps an entirely new approach is necessary.

There are other unanswered questions. Is it necessary for the police to respond to all calls for assistance from stranded motorists? After all, less than one-half of these responses have any relationship to law enforcement functions. What role can be assumed by service organizations, petroleum companies, CB radio clubs, etc., in providing motorist aid? It is recommended that there be increased research emphasis to answer these questions and to define measures of effectiveness and costs of motorist aid systems.

Some conclusions can be drawn from information currently available, as follows:

- Aid to motorists on the highways is an existing need.
- Motorist aid and emergency communication systems should be coordinated with other statewide communications needs.
- Highway agencies should establish a function covering highway communication management.

There is a definite need for a coordinated effort to provide direction and to establish guidelines for planning, designing, and operating a motorist aid system.

CHAPTER ONE

# INTRODUCTION

## BACKGROUND AND DEFINITION

The need to provide assistance to stranded motorists arrived with the invention of the automobile. The dramatic increase in the number of automobiles and the growth of the national highway system have significantly increased the needs for motorist assistance. These needs include:

- Service:
  - Flat tires.
  - Mechanical and electrical repair.
  - Fuel, oil, water.
  - Towing.
- Police
- Ambulance
- Fire
- Information:
  - General information.
  - Emergency traffic routing.

*A motorist aid system assists in the detection of a stranded motorist, offers a means by which his needs are communicated, and provides the appropriate aid response.*

Motorist aid systems have been in existence across the United States for more than 50 years. They have varied from the simplest form of routine police patrol to the more complex technological equipment developments characterized by the use of electronic communications systems. Highway agencies are just beginning to learn exactly what motorists' needs are and how best to provide the required services.

## DETERMINING THE NEED FOR MOTORIST AID SYSTEMS

An extensive study has shown that the number of emergency stops to be expected for each 10 miles of any highway system will vary up to 160 per day, depending on ADT and trip length (Fig. 1). Therefore, it would be simple (and prohibitively expensive) to conclude that any given classification of road automatically required a motorist aid system. It should be remembered that nearly all roads have a system in the form of routine or periodic police patrol. However, the decision to add roadside communications systems must be made in consideration of system utility, cost trade-offs, safety, courtesy and police patrol, and available service assistance. There must be an economic advantage, a safety value, or a combination of both that makes an investment in such equipment worthwhile. Table 1 provides a checklist for measuring the relative need for a motorist aid system. Reasonable values should be assigned to each parameter in carrying out the analysis of the proposed system.

Measuring motorist needs is a most difficult task because so many of the parameters are of a qualitative nature. How does one measure the motorist's awareness that the system exists? How does one measure the motorist's ability to use the system? How does one determine whether or not the motorist will walk to a roadside unit? Or how far he will walk? How long will he wait? It is difficult to assign a value to these and other related questions and thus reduce them to a mathematical equation. On the other hand, there are data of a quantitative nature from surveys and analyses. For example, it can be estimated how far a car will continue forward if the engine suddenly quits while traveling at 60 mph, realizing that this distance will vary according to road grade and weather conditions. Thus, some need factors may be quantified whereas others must be estimated or assumed to have zero effect. Most assuredly, additional research must be completed in order to measure all of the necessary parameters available.

## COMPONENTS OF MOTORIST AID AND EMERGENCY COMMUNICATION SYSTEMS

There are five general categories of functions that comprise any given motorist aid system and its administration—detection, communication, assistance, documentation, and evaluation. The following explores briefly the components of each of the five categories.

*Detection* consists of that portion of the system that identifies a need for assistance or for information. It can be as simple as a passing motorist or as complex as a

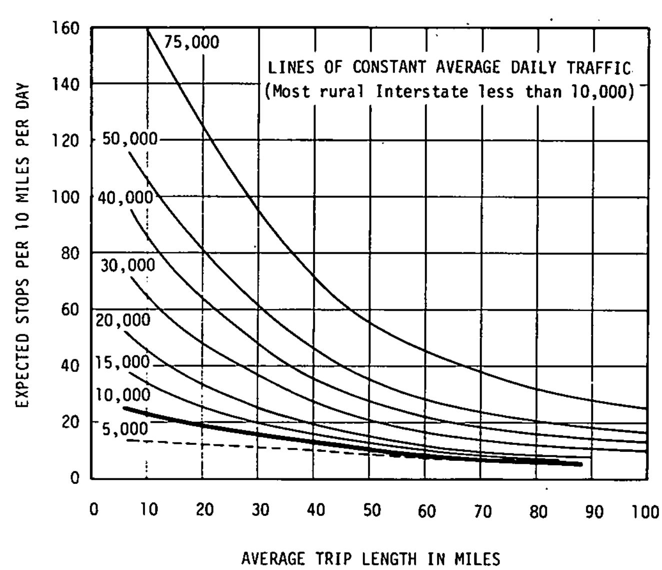



*Figure 1. Expected emergency stops vs average trip length (from* NCHRP Report 64).

TABLE 1

MAJOR FACTORS AFFECTING THE NEED FOR A MOTORIST AID SYSTEM AND ITS SUBSEQUENT CONFIGURATION

| |
|---|
| Geographical location |
| Road classification |
| Road geometrics |
| Type of travel |
| Speed limit and speed patterns |
| Weather patterns |
| Type and frequency of patrol |
| Number of spacing of interchanges |
| Visually available assistance |
| Average daily traffic (ADT) |
| Available shoulder width |

television camera monitoring system. Some of the existing detection methods include:

1. Passing motorists.
2. Motorist (self reporting).
3. Patrols (police, state courtesy, petroleum companies, road service organizations).
4. Helicopters and fixed-wing aircraft.
5. TV monitors.
6. Presence detectors.
7. Permanently stationed observers.
8. Residents adjacent to right-of-way.

A comparison of the costs of these detection methods shows a wide variance, ranging from zero for self-reporting and passing motorists to $60,000 annually for a single patrol vehicle operated 24 hours a day. TV surveillance systems also represent expensive solutions to the detection problem, particularly because they are limited in their coverage to relatively small ground segments.

Unfortunately, passing motorists and adjacent residents cannot be depended upon for expeditious reporting of motorist needs. Nor is motorist self-reporting dependable unless he has a means of communicating his need or is in close proximity to outside assistance. The widespread use of in-vehicle communication equipment could make self-reporting an effective approach.

Patrols, even though expensive, are presently the most reliable means of detecting the need for assistance and therefore constitute the backbone of the detection network on most highways across the nation.

The *communications* link provides the means of determining where, why, and what, and provides appropriate acknowledgment and assurance that help is on the way. This link may involve the motorist, passing motorists, police patrol officers, courtesy and service patrol operators, emergency vehicle operators, and radio dispatchers. Communication may originate in the vehicle (e.g., citizens' band broadcast), at the roadside (motorist aid telephones and radios), by a passing patrol vehicle, by an overhead helicopter, or by monitors of electronic surveillance equipment.

The method of communicating a need can be selected from a lengthy list of communications modes. These generally are classified into radio, telephone, and hybrid combinations of these.

Two basic types of radio systems—coded signal and voice—are discussed. The coded signal system consists of button-actuated roadside units that transmit a coded signal to the control point. The motorist is able to select one service need out of two to four assistance categories that may be listed on the unit—police, service (road), fire, ambulance—by depressing a button clearly visible to the motorist once the unit door is opened (Fig. 2). All current systems have the police and service categories and many also include the fire and ambulance needs.

Radio voice systems refer to wireless two-way units that enable the motorist to verbally relate his need to a control point. These systems may contain encoders that convert the voice to a coded signal that is decoded at the base station back into a voice transmission.

*Assistance* is often taken for granted by planners and highway officials; however, the waiting time can seem like an eternity to a motorist in need of help, particularly if a bona fide emergency situation exists.

Assistance consists of two major performance factors—the speed with which aid is furnished and the availability of the proper form of assistance. Failure to provide both of these factors can render the entire system useless and increase the hazard for stranded vehicles and their passengers.

Components that comprise the assistance category include:

1. Motorists (passing and self-help).
2. Residents adjacent to right-of-way.
3. Police patrol.
4. Courtesy patrols (state, automobile club, oil company).
5. Ambulance.
6. Fire department vehicles.
7. Contracted motorist aid service.
8. Helicopter.

The many circumstances that affect the ability to provide rapid and efficient assistance should be taken into account when planning a motorist aid system. Police patrols may be diverted to other emergency calls (on or off the highway), ambulances and fire engines may be too distant, passing motorists may be hesitant to stop, and motorists may be unable to perform self-help repairs required. Specific needs often will require a particular type of assistance. A tow truck will be of little value to an accident victim. Similarly, a jeep-type service vehicle may not be equipped to fight a raging gasoline fire.

All forms of motorist aid should include a *documentation* phase to collect and retain those data that can be utilized in the evaluation of performance, the design of new or expanded systems, and the improvement of practices and procedures. Records should be maintained on all of those items to be covered under the evaluation phase.

The fifth category covers *evaluation* of the detection,

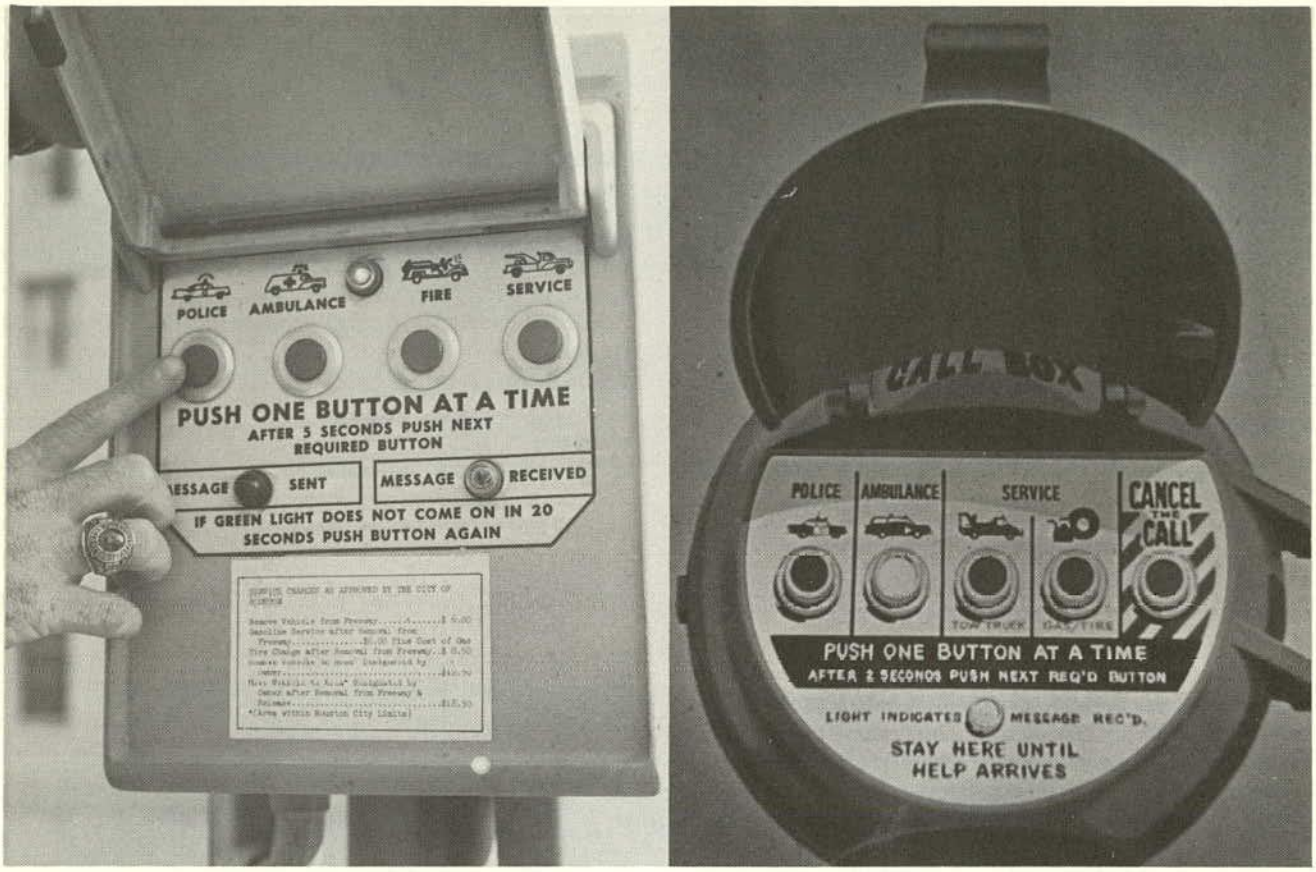



*Figure 2. Typical coded radio call boxes.*

communication, and assistance inputs plus the follow-up review to improve the service. This evaluation should address data inputs relating to highway characteristics and patrol assists made with and without motorist aid equipment, including the following:

1. Traffic and patrol patterns.
2. Types of assists.
3. Motorist use and return-to-the-road times.
4. Testing and maintenance of all hardware.
5. Costs as related to each area of performance (detection, communication, assistance).
6. Highway engineering data (shoulder width, shoulder material, light poles, overhead structures, guardrails, bridges, tunnels, etc.).
7. Accident data before and after installation.

Many of the operational motorist aid systems have neglected the data gathering and evaluation phases. This can be a costly omission because these inputs should be used at the outset to determine whether or not a system is required. Where a system is needed, these data can be of significant value in the design of the system. Current data should be maintained once the system goes into operation in order to evaluate the operation. These operational data can be useful in the design of other systems.

## INTERRELATIONSHIP OF THE COMPONENTS

The three major segments of the system—detection, communication, and assistance—are closely related to each other. Because the system is not automatic, an extremely important component is the human element. Someone must take action upon detecting the situation, whether first-hand or through instrumentation. Even the more complex electronic sensors require an operator to request and coordinate the response actions. And someone may need to go to the road site to provide assistance.

The motorist aid system thus calls for a team approach. Participants might include motorists, police, fire departments, rescue squads, ambulance operators, service stations, etc. It has been noted that a large percentage (ranging from 55 to 85 percent) of assists relate to needs outside the law enforcement, safety, and accident realm normally associated with police assignments. These assists (mechanical repair and general information) can be more effectively performed by service-oriented organizations and thereby free police patrols to handle the growing demand for bona fide police assignments. There appears to be a popular misconception that police should respond to every highway operational emergency; however, there are sufficient data to show that other aid is more often required.

## OPERATIONAL RESPONSIBILITY AND PARTICIPATION

The successful operation of any electronic motorist aid system must include a classic teamwork approach. State, county, and city police departments are generally assigned patrol and base station contact functions, depending on the category of road and the location of stations and barracks. These are the people who must live with the system hour by hour, day by day. Police patrols are frequently called on to respond to emergency requests to attest to the physical presence of a stranded vehicle and the specific action required.

Highway agencies (including turnpike authorities) most often are assigned the role of defining the system (including the selection of hardware), supervising or assisting in the installation, and performing periodic maintenance service. They must ensure that the system complements the entire highway network, taking advantage of traffic patterns and addressing potentially hazardous circumstances.

Fire departments, ambulance services, service stations, highway maintenance forces, and automotive dealers are among the list of participants who respond to calls for emergency assistance. These organizations generally respond *after* formal notification from a base station operator or a police cruiser. Two-way voice systems often provide sufficient data to ensure the validity of the request and emergency service operators will normally respond directly to the request of the base station operator. Non-voice systems frequently fail to clearly identify the service desired and police patrols are thus required to visit the calling location.

Specific contracts with ambulance services, wreckers, etc., may result in all calls for a given category of assistance being channeled to the designated contractor. Maintenance of roadside units is often contracted out to the equipment manufacturer, who provides routine checks on all equipment and overhauls faulty or damaged units as required.

Public information is required to properly identify the system and its method of operation. Radio and TV stations, newspapers, and other local media can effectively perform this role. Private business community participation can measurably improve the use of the system and the effectiveness of the response.

It is desirable to tie together all of these operations; however, it is difficult to categorically award total systems management to any single organization except where the highway is operated by a toll authority. Each participant has a role and all are important to the optimum functioning of the system. On the other hand, the nomination of a single operational system manager goes a long way toward achieving the over-all coordination that is necessary to realize optimal performance. This should result in continuous and adequate patrols; availability of emergency vehicles; knowledge of traffic, road, and weather conditions; and coordination of other variables that determine how best to detect, communicate with, and assist the stranded motorist. Each state should review its own particular circumstances in order to determine the best approach; generalizations would be unfair to different forms of highway and police management.

## MOTORIST, HIGHWAY OFFICIAL, AND POLICE REQUIREMENTS

Each of the four main participants in a motorist aid system—user, designer, operator, responder—has a set of identifiable requirements that must be met. The successful system generally is represented by an optimum mix of these requirements with the user (motorist) being given first consideration. Failure to heed these requirements may result in the motorist bypassing the system, the disrepair of equipment, and a confused or delayed emergency vehicle response.

Let's take a look at these requirements and how they may be met. First, the user (motorist). What are his needs and desires based on research and survey studies? In order of priority they are as follows:

- Knowledge that the system exists (signs (Fig. 3) and effective local media PR).
- System working at all times (with the motorist particularly concerned during hours of darkness).
- System working in any type of environmental condition (cold, hot, wet, dry, with emphasis during inclement weather).
- Detailed instructions for roadside units.
- Rapid acknowledgment from base station (for electronic systems).
- Simple acknowledgment procedure (no lengthy questionnaire process).
- Cancel feature (all systems).
- Roadside units in view during daylight hours and in view within 10 min of walking time after departing vehicle at night (suggests spacing no more than ½ mile).
- Safe roadside unit location (far enough from operating lanes, facing traffic, breakaway post).
- Prompt response (requires availability of emergency vehicles—police, fire, ambulance, wrecker).
- Proper emergency vehicle response.
- Properly equipped emergency vehicle (fuel, oil, water, battery, towing, etc., with trained operator).
- Timely return to the road.
- Choice of service (motorist able to specify road service organization—AAA, Shell, Esso, Texaco, Gulf, etc.)
- Reasonable repair charges (preferably published, for media announcement and for handout to motorist at the scene).
- Provision for information assistance.
- Illumination of roadside unit or area where unit is located (desirable).

The second and third participants (designer and operator) may be grouped together, as each is dependent on the other and often characterized by a single agency (state highway agency or toll authority). Their needs generally relate to safety, costs, and the clearing of the roadway and may be summarized as follows:

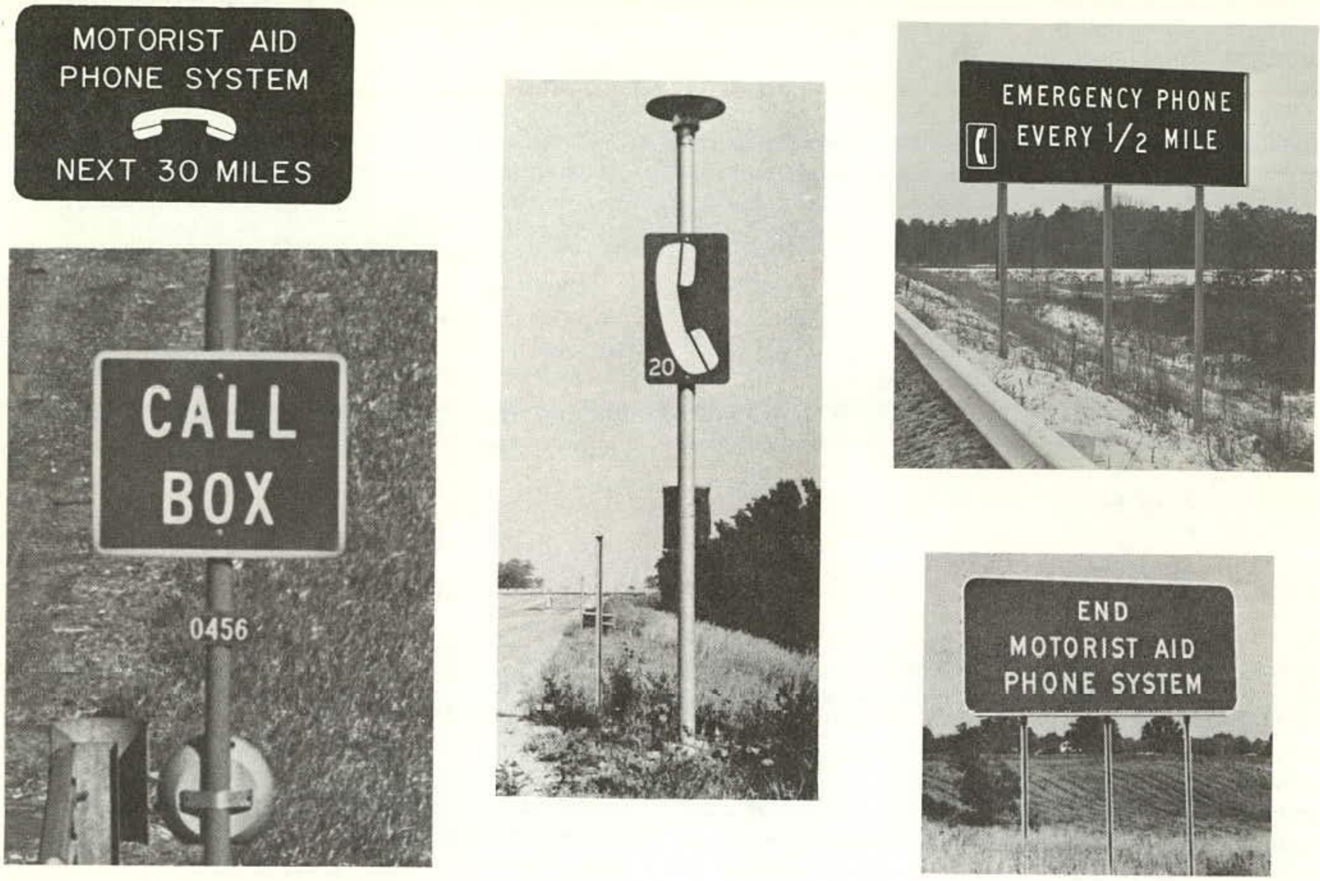



*Figure 3. Signs used for motorist aid systems.*

- Must be affordable (within available budget).
- Readily adaptable to the roadway (minimum construction, takes advantage or adjusts for bridges, ramps, guardrails, etc.)
- Can be used safely (wide shoulder, available pull-off area, etc.)
- Minimum down time of operating lanes during installation.
- Requires minimum of preventive maintenance.
- Low failure rate for units.

The fourth participant is the responder (police, courtesy patrol, service station operators). His requirements are equally important:

- Increased manpower.
- Additional vehicles.
- Additional life-saving and motorist service equipment.
- Minimum of false calls (pranksters, equipment malfunctions).
- Base station receipt of specific assistance need.
- Direct dispatch of requested emergency service.
- Base station cancel feature (cut off pranksters).
- Automatic test feature (direct from base station, direct from roadside unit, passing police cruiser—in motion).
- Minimum time demands on the base station dispatcher.
- Transfer of general information requests (to highway agency, automobile club, etc.)
- Selective use of the system for private police traffic.

The handling of information requests poses a particularly time-consuming activity for police base station operators and patrol officers. Nonvoice coded radio systems are not suitable for handling such requests. Some authorities have suggested that special information telephones connected directly to a separate office (highway agency, automobile club, etc.) be located at major off-ramps, rest areas, service areas, etc. This would reduce the number of requests that police would have to handle. This further suggests that an integrated highway communications system (see Chapter Five) should be designed around cable trunks along the roadway if one is to provide information assistance other than by police patrol or through police dispatcher calls.

A brief discussion on motorist aid system test procedures may explain the automatic test feature mentioned earlier. Roadside units are generally tested at least once each week as part of an over-all system check. Procedures vary; however, typically a police cruiser pulls up to each unit (between 2:00 and 6:00 AM), removes the handset and speaks (two-way voice) or pushes the button (coded radio), and confirms the operation of the unit with the base station dispatcher by voice over the unit or through his two-way vehicular radio. This is a tedious, time-consuming, and expensive procedure, particularly if his zone of coverage includes 100 or more individual roadside units.

Schemes now in the design and testing phase will offer automatic testing by the dispatcher or by a passing police or maintenance vehicle equipped with a portable transmitter. In the first instance, the dispatcher could interrogate the individual roadside units and determine performance. This feature has also been built into the roadside unit wherein a preset test pattern is transmitted at a preset time (roadside units have clocks). The second test procedure is more of a semi-automatic approach in that a passing vehicle must be used to activate the roadside unit.

The foregoing discussion pertains to radio units. Telephone systems would be difficult to adapt to an automatic test feature and therefore are tested on a person-to-person call basis (police are not overly fond of this procedure and prefer it to be handled by maintenance crews).

### DATA REQUIREMENTS

Highway and police agencies require complete data on traffic patterns not only on a given highway but also on a regional basis. These data should include average daily traffic (ADT); number and spacing of patrols; frequency, location and type of accidents; and the number, location, time expended and type of roadside aid by police, emergency, or service organization. The data should be tabulated prior to the design and installation of a motorist aid system and should be continued as a follow-up in the analysis of operating systems.

The data are important in determining the need for a system, and in the location and spacing of roadside units or in helping patrol and service organizations to determine the type of service they should offer.

### RETURN-TO-THE-ROAD DELAYS

Getting the motorist back on the road in an expeditious manner should be a prime goal of any motorist aid system. Stranded motorist studies performed in Michigan, Texas, New York, California and other states suggest that, without any form of roadside assistance, a typical stop consumes an average of 54 min. This means that the motorist is subject to fear, danger, and other hazards for nearly an hour.

The presence of a motorist aid system has clearly demonstrated a significant reduction in the time to complete vehicle repairs or to administer other assistance and put the driver back on the road. Generally, two-thirds of all disabled motorists (urban and rural systems combined) are back on the road in less than 30 min. In the Texas I-45 post-installation study it was shown that 11 min were saved for typical tire changes, 34 min for mechanical repairs, and 25 min for accidents. Equally important in the last instance was a reduction of 5 min in accident-clearing by the police and/or service organizations.

An over-all system goal of getting the motorist back on the road in 30 min is achievable, with the exception of those vehicles that are badly damaged by accident or require a tow to a garage facility for mechanical repair.

### SAFETY PROBLEMS

Problems associated with the absence of a motorist aid system have been alluded to in earlier discussions. These may be synopsized as follows:

1. Motorists crossing operating lanes.
2. Motorists wandering on highway shoulders.
3. Hitchhiking to seek help.
4. Leaving abandoned vehicles in or partially in operating lanes.
5. Climbing roadway protection fences.
6. Inexperienced motorist self-help (improper use of jack, touching hot engine components, etc.)

These safety hazards cannot be totally eliminated by the installation of a motorist aid system; however, they can be significantly reduced by the presence of some form of aid system. For example, the crossing of operating traffic lanes is minimized by having roadside units that are mounted in pairs (units opposite one another in the different traffic directions). Wandering on shoulders and hitchhiking can be reduced by 50 percent or more by making roadside units available at sufficient intervals. Abandoned vehicles can be significantly reduced if confirmation that help is on the way is received. Departing the right-of-way by scaling fences to contact nearby residences or setting out for a service station may be practically eliminated if roadside call boxes are visible or if the motorist is convinced that a short walk will bring him to one.

Installation of a motorist aid system involves a few safety hazards that must be fully analyzed in the system design. These hazards include the following:

1. Insufficient shoulder width or pull-off area.
2. Inadequate shoulders in most tunnels and on bridges.
3. Roadside mounting poles, unless of breakaway design.
4. Stopped motorist who uses the system may cause a traffic tie-up created by curious passers-by.

Some of these problems are extremely difficult to solve, particularly when the roadway space is limited. In such instances patrol must be sufficient to remove or alleviate hazards rapidly.

### MOTORIST FEARS

Motorists generally develop immediate concern when confronted by an unexpected vehicle stop. This concern turns to fear with the passage of time, the presence of darkness, or the remoteness of rural settings. The presence of fear is normally followed by actions previously discussed under "Safety Problems." People will embark on irrational trips seeking assistance or, perhaps even worse, will do nothing to solve their problems.

Does a motorist aid system alleviate such fears? It does if people know that it is there and in working order. A study on I-87 (New York) shows that use of the system increases during darkness. Typical daylight conditions result in approximately 3.5 calls per 1,000 vehicles, whereas night conditions have been known to result in a frequency of as high as 10.7 calls per 1,000 vehicles.

To reduce or eliminate fear, the system must be properly publicized, it must be accessible (acceptable spacing), it must be in view (signs), and motorists must have the confidence that it works. In this latter regard, some systems have gotten off on the wrong foot via equipment failures that have raised the ire of the disabled motorist. His typical reaction might be to protest by vowing not to use the system again and by relating his experience to others.

### SELF-HELP CAPABILITIES

Research studies have dealt with the ability (or inability) of the motorist to solve his own needs without soliciting outside assistance. It has been found that motorists are generally ill-equipped to perform even minor repairs to their vehicles. However, there are perhaps five types of action that many motorists could undertake if they had the proper equipment, supplies, and know-how. These areas are:

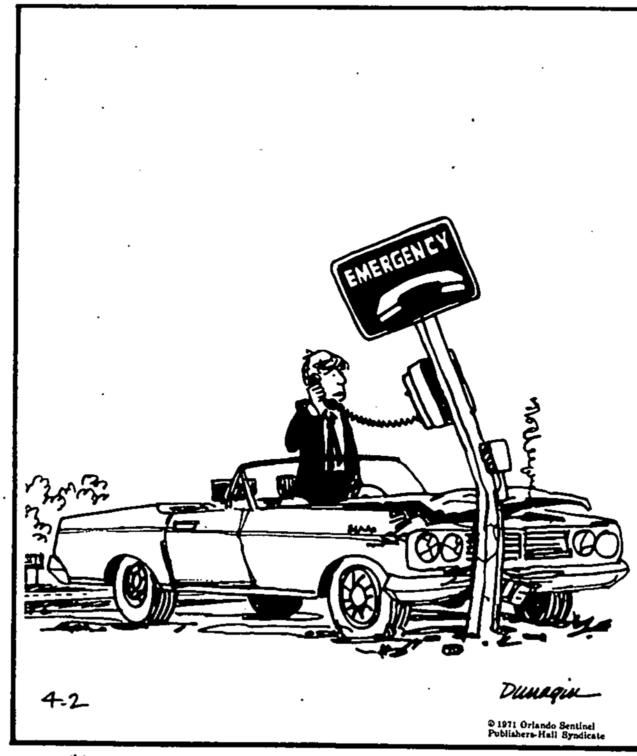
1. Change flat tires.
2. Replenish gas, oil, and water.
3. Extinguish minor fires.
4. Make minor checks and adjustments.
5. Check all electrical connections.

The fact is that of these five areas, only the first seems to fall under the "can do" classification. The average motorist could accomplish items 2 and 3 as well; however, very few carry spare gasoline and oil or a fire extinguisher. Most males will make a spot check of carburetor and electrical system components, although it is doubtful that they really know what to look for or how to make the repair.

Such areas as major engine repair, transmission, chassis, and suspension problems will not be identifiable or repairable by the motorist. In these instances, he needs help (and probably a tow).

Women are generally incapable of mechanical repair, with the possible exception of tire changing. Even in this area, only a few will try to jack up the car and change a tire.

**DUNAGIN'S PEOPLE** **by Dunagin**




"COULD YOU SEND A WRECKER TO..."

*(Courtesy of Publishers-Hall Syndicate)*

In summary of self-help capabilities, therefore, it can be easily seen how incompetent most motorists really are in time of need. Motorists clearly need help!

CHAPTER TWO

# EXISTING AND PROPOSED SYSTEMS

### ROADSIDE TELEPHONE AND RADIO SYSTEMS

A recent survey indicates that there are at least 19 operating motorist aid systems each with more than 25 units that provide for direct communication with a control center. Stranded motorists may contact these centers via a roadside unit by lifting a handset from its cradle or pushing a button.

The 19 operating systems are found in 12 states (Table 2). There are at least a dozen additional small-scale systems (25 or less roadside units each) presently in operation.

Table 2 presents a compendium of known operational systems (more than 25 units), including such data as number of units, unit spacing, system manager, system cost (excluding maintenance), type of equipment, and the agency responsible for funding the installation and continued operation of the system. Note the variance in all of these parameters (further discussion appears later).

TABLE 2

OPERATIONAL RADIO AND TELEPHONE MOTORIST AID SYSTEMS WITH MORE THAN 25 ROADSIDE UNITS
(June 1971)

| FACILITY | NO. LOCATIONS | SPACING (MI) | TYPE | SYSTEM MANAGER | ORIGINAL SYSTEM COST ($1,000) | COST PER ASSIST | FUNDED BY |
|---|---|---|---|---|---|---|---|
| CALIFORNIA | | | | | | | Los Angeles County (81%) |
| Southern California (L.A.) | 2103 | 1/4 | Telephone | Calif. Div. of Hwys. | 965 | | Cal. Div. of Hwys. (19%) |
| San Francisco-Oakland Bay Bridge [a] | 250 | —[b] | Coded radio | | | | |
| Richmond-San Rafael Bridge [a] | 100 | —[c] | Coded radio | | | | |
| San Mateo Bridge [a] | 134 | —[d] | Coded radio | | | | |
| CONNECTICUT | | | | | | | |
| Waterbury Viaduct | 36 | 1/10 | Telephone | Conn. DOT | | Insufficient data presently available to determine effective cost comparisons. Additional research needed. | |
| ILLINOIS | | | | | | | |
| I-80 | 302 | 1 | Telephone | | | | |
| KENTUCKY | | | | | | | |
| Louisville freeways | 110 | 1/2 | Telephone. | | | | |
| MARYLAND | | | | | | | |
| Harbor Tunnel Thruway [a] | 44 | 1/2 | Telephone | Md. State Roads Comm. | 18.5 | | Md. SRC |
| I-495 (Capital Beltway) | 324 | 1/8-1/2 | Coded radio | Md. State Roads Comm. | 379 | | Md. SRC and FHWA |
| MICHIGAN | | | | | | | |
| I-94 (Jackson-Battle Creek) | 62 | 3/5-1 | Telephone | Dept. of State Hwys. | | | Dept. of State Hwys. |
| NEW JERSEY | | | | | | | |
| Atlantic City Expressway [a] | 100 | 1 | Coded radio | Expressway Auth. | 175 | | Expwy. Authority |
| I-287 | 425 | —[e] | Pushbutton wire | New Jersey DOT | | | |
| NEW YORK | | | | | | | |
| I-87 Northway | 712 | 1/2 | Telephone | New York DOT | 676 | | New York DOT |
| PENNSYLVANIA | | | | | | | |
| I-80 | 370 | 1/2 | Telephone | Pennsylvania DOT | | | Pennsylvania DOT |
| I-95 | 56 | Varies | Telephone | | | | |
| TEXAS | | | | | | | |
| I-45 (Houston) | 145 | 1/4 | Coded radio | Texas Highway Dept. | 161 | | Texas Hwy. Dept.[f] |
| VIRGINIA | | | | | | | |
| Chesapeake Bay Bridge-Tunnel [a] | 118 | 1/2[g] | Telephone | | | | |
| WASHINGTON | | | | | | | |
| Alaska Viaduct (Seattle) | 35 | 1/8-1/4 | Telephone | | | | |
| Evergreen Point Bridge [a] | 36 | —[c] | Telephone | | | | |

[a] Toll facility. [b] 600 ft. [c] 1000 ft. [d] 500 ft. [e] 200 ft. [f] Maintained by City of Houston. [g] 300 ft in tunnel.

Fifteen agencies contemplate installation during the next three years of motorist aid systems utilizing roadside communications. These plans include additional installations in Maryland and Pennsylvania, plus Connecticut/Massachusetts/Rhode Island (joint system), Delaware, District of Columbia, Florida, Hawaii, Iowa, Nevada, New Mexico, Ohio, Utah, and Vermont. This brings to 25 the number of states (including the District of Columbia) in which there will be operational systems by 1974.

Other states have indicated an interest in motorist aid systems of this type and are presently studying their needs and available system configurations.

The Federal Highway Administration has actively supported research and development in this field and has funded a dozen or more Highway Planning and Research (HPR) studies over the past three fiscal years. FHWA also has communications staff engineers who work with motorist aid systems from functional and design standpoints on a daily basis.

#### Systems Now in Planning Phase

The 15 new systems previously noted as being in the planing stage have evolved as a result of considerable research, including survey teams who have conducted extensive surveillance of the particular roadway under review. This research has crossed functional lines, ranging from human factors analysis to complex communications propagation tests. State and local authorities have realized that motorist needs will vary due to types of traffic, volume of traffic, road types, road width, median strip construction (divided highways), weather conditions, patrol procedures (including frequency), availability of roadside service (in view), surrounding residential area and a number of other related factors. Each road has its own peculiar characteristics and thus must be studied in detail before any decisions regarding motorist aid can be concluded.

The 15 states that plan such systems have been through a preliminary fact-finding and system definition phase. They have compared their findings with the published results of the 19 operational systems to verify some specific facts. In the end, the decision must in part relate to the economics of providing the needed service through different combinations of detection, communication, assistance, analysis, and record keeping. These calculations require a statistical base that is often difficult to construct due to the lack of sufficient quantitative means of measuring needs, fears, and delays. Each factor is estimated, extrapolated, or assumed in order that some means of system comparison is possible.

Financing of these planned systems will be handled by the respective highway organizations with Federal government participation possible in some instances. State police will provide the basic patrol, with contract road service as a supplement in three or four instances. All are believed to be two-way voice systems, with at least one radio voice system included in present plans.

**Analysis of Existing Systems**

Most of the existing systems have been in use long enough to generate some meaningful data; however, more data are still desirable. Police personnel have some understanding of patrol needs and procedures. Service station and emergency vehicle operators know when and how to respond. Maintenance requirements are known and somewhat predictable. In total, there is sufficient operating experience to refine the existing systems and provide at least some insight into planning future installations. This is not to say that all has been flawless. There have been a number of relatively minor shortcomings in each system and some surprises. A discussion of five of the larger installations follows to show the different characteristics and performance results to date.

*I-87 New York Northway (Rural Telephone System)*

The New York Northway (I-87) is a 178-mile north-south section of highway that runs from Albany, N.Y., to the Canadian border (south of Montreal). Passenger cars account for 78 percent of the total traffic; a large proportion of these consist of tourist traffic. Road use is seasonal, although in constant heavy use. Tourist traffic is heaviest in the June-August period; traffic during the remaining nine months is evenly distributed. Daily traffic peaks follow the traditional morning and evening urban rush-hour peaks, even though this road is primarily rural.

A telephone system consisting of 712 roadside units (Fig. 4) spaced ½-mile apart and three state-police-operated base stations was installed over a two-year period beginning in January 1966. Each unit is mounted on a 50-in. pole 12 ft from the outside edge of the pavement. A unit is activated by removing the handset from its cradle. The base station police operator is alerted by flashing light and warning sound. Amplifiers are mounted every 6,000 ft in the underground plastic-sheathed cable to ensure constant volume. The installation of this rather large system followed a period of extensive studies and analysis conducted by the state highway department. A total of $48,900 was expended over seven different areas involved in the preliminary review. Installation of the complete system cost approximately $700,000 based on $950 per telephone and $8,000 per base station. Monthly phone rental is $15 per unit, including maintenance.

Use of the system has averaged 4.48 calls per 1,000 vehicles using the Northway during weekdays and 5.46 calls per 1,000 vehicles on weekends. The highest rate of use is in the 4:00-6:00 AM period, when more than 10 calls per 1,000 vehicles are received. Forty-five percent of all accidents are reported over the system. Service time (time elapsed from call to completed service and back on the road) data have been collected as follows:

| | |
|---|---|
| Fuel, oil water | 24 min |
| Tire repair | 32 min |
| Electrical repair | 39 min |
| Mechanical repair | 30 min |
| Other | 34 min |

Payment for these services is handled directly between the motorist and the service operator. Police service is limited to extremely minor repairs and generally related to accident or law enforcement functions.

The use of the system over a three-year period yields the following breakdown of repair and service needs:

| | |
|---|---|
| Fuel, oil, water | 21.3% |
| Tire repair | 18.6% |
| Mechanical | 31.9% |
| Other vehicle service | 11.2% |
| Information | 1.0% |
| Miscellaneous | 3.5% |
| False alarm | 0.4% |
| Police action | 12.1% |

Contract tow operators are assigned 12-mile segments for their routine coverage, enabling them to reach a stranded motorist in less than 25 min. Ambulance operators are selected so as to reach any point on the roadway in 15 min.

The I-87 Northway facility is a good example of a motorist aid system on a rural limited-access highway. The system is financed by the New York State Department of Transportation with Federal participation in the construction costs.

*Southern California System (Urban Telephone System)*

The Southern California system consists of 2,103 telephones installed on 12 major freeways in the greater Los Angeles area. All units are spaced at ¼-mile intervals. These 275 miles of freeways handle more than a million tourists and commuter traffic vehicles each day. Traffic patterns result in huge peaks in traffic during the 6:00-8:00 AM and 4:00-6:00 PM rush-hour periods, although traffic remains heavy during other daylight hours as well. Weekday traffic accounts for the heaviest use. All 2,103 roadside units are connected to a single control center operated by the California Highway Patrol.

Installation of the system commenced in November 1962 and is still being expanded to the remaining freeways in Los Angeles County. Coded radio call boxes were the first to be installed, but after subsequent testing and comparison with telephones it was determined that the system would consist of telephone units. This decision was based on commonality, reliability, and the need for two-way voice communication. The original coded radio units were in-


*Figure 4. Telephone system on I-87 (New York Northway).*

stalled at a cost of $967 per unit plus $14,243 for base station equipment. Maintenance added $38 per unit annually to the cost of the system.

The first telephones were installed on the Harbor Freeway in July 1965. The initial 80 units have since been expanded to 182 total units on this facility. Installation of the first 80 units averaged $84 per unit with a monthly equipment rental of about $26, including maintenance.

The total 2,103-unit system cost approximately $965,000 ($785,000 paid by Los Angeles County; $180,000 by the state) for installation plus $225,000 per year rental and maintenance charges. Two telephone companies are involved in providing and servicing this vast network.

The California Highway Patrol has total patrol responsibility for the freeway network and answers all calls. Ambulance and fire equipment are dispatched by the Patrol. Calls from AAA members are automatically referred to the Southern California Auto Club for roadside assistance, whereas calls from non-members are referred to an approved list of automotive service stations and garages.

Use of the Southern California motorist aid system averages more than 25,000 calls per month. Police personnel also use the system for selected private traffic (in lieu of overloaded, public listening-post police frequency bands). Male callers account for 80 percent of all calls.

The following breakdown of calls on the Harbor Freeway is typical of the over-all system:

| | |
|---|---|
| Mechanical | 23% |
| Tire repair | 17% |
| Gas, oil, water | 13% |
| Stalled vehicle | 4% |
| Report on accident | 8% |
| False alarms | 1% |
| Private police use | 6% |
| Miscellaneous categories | 28% |

Thirty-nine percent of all calls required vehicle tows.

In summary, the Southern California system represents the largest single system presently in existence. It is a relatively expensive system; however, its cost is apparently justified based on the number of persons served.

### *I-495 Capital Beltway (Urban Coded Radio System)*

The system consists of 324 call boxes located over Maryland's 42-mile stretch of the Capital Beltway encircling Washington, D.C. The system was installed by contract in 1966 for the Maryland State Roads Commission. The contractor also provided the first year of maintenance. Purchase and installation of the equipment totalled $379,300, including three base stations. The cost was shared by the state and the Federal Highway Administration as a demonstration project.

The system operates at 72.46 MHz and requires only 1 watt of power. A digitally coded signal is transmitted to the base station, where the signal is decoded and information covering calling location and assistance required is printed on a tape along with the time of day. It is an inexpensive means of communication; however, the one-way communication capability does result in less information and, therefore, added costs and delays in providing service.

The system is monitored at Maryland State Police Barracks (base stations) and all calls for assistance are responded to by the State Police, regardless of need. Some roadside units have four buttons (police, fire, ambulance, service); however, most of the units have only police and service buttons. Service stations, fire departments, and ambulance services do not respond as a direct result of a keyed button requesting their services. Fire departments and ambulance services insist on field verification of each call by police. As a matter of practice, service calls are handled by the police in a similar fashion. This is attributed to the large number (20 percent) of "gone-on-arrivals" (GOA) experienced on the system to date. Officials explain that certain equipment deficiencies (false triggering due to power fluctuations) are being investigated, including the type of battery and solar cell. They hope to reduce the high incidence of false triggering of the equipment, which has a direct bearing on the number of GOA's.

Unit spacing varies from ⅛ to ½ mile. Each unit is mounted on an aluminum breakaway pole with its transmitting antenna vertically mounted on top of the pole (Fig. 5).

Experience shows that 72.5 percent of all calling motorists had pulled off the road within 100 ft of a roadside unit. Police believe that approximately 50 percent of all stopped vehicles were assisted by the motorist aid system.

Peak traffic periods are the 7:00-9:00 AM and 4:00-6:00 PM commuter rush hours during weekdays. Traffic declines approximately 15 to 20 percent on weekends during non-vacation periods, but remains about the same during summer vacation months. The number of calls for assistance


*Figure 5. Coded radio call box on I-495 (Capital Beltway).*

remains relatively stable regardless of weather conditions.

Annually, some 17,000 to 18,000 calls (including GOA's) are received over this system. The average time between request and arrival of a police cruiser is reported to be 15 min. Motorists are assisted by State Police where possible (no fuel or mechanical repair) or police radio for other assistance. The following gives the breakdown of service calls:

| | |
|---|---|
| Fuel, oil, water | 11% |
| Tire repair | 26% |
| Mechanical, no tow | 10% |
| Mechanical, tow | 8% |
| Accident | 3% |
| Fire | 1% |
| Information | 3% |
| Gone-on-arrival | 20% |
| Other | 18% |

It should be noted that this system consists of equipment designed circa 1961-62. Numerous improvements made in recent years have reduced GOA's and maintenance problems to negligible levels (see "Atlantic City Expressway" below).

*Atlantic City Expressway (Rural Coded Radio System)*

This system is installed on a 44-mile stretch of rural expressway connecting Philadelphia with Atlantic City, N.J. It is a toll road operated and maintained by the Expressway Authority.

A total of 100 coded radio roadside units has been installed at 1-mile intervals. Maintenance is performed by contract at an annual cost of less than $50 per unit. A single centrally located base station controls the system. The manufacturer is the same one that provided the I-495 Capital Beltway system; however, this system is a new generation design that uses improved circuitry, battery, and solar cell. "Gone-on-arrivals" (GOA) are negligible. Emergency services are dispatched directly by the police upon receipt of a call.

This road has relatively light traffic during winter months and extremely heavy traffic during the summer beach resort season. It does not have the normal rush-hour peaks; however, it does have decided peaks in the Friday 5:00-9:00 PM and Sunday 2:00-8:00 PM periods when weekend sunbathers head for the beach and return home again.

Motorists use the system approximately 50 percent of the time. Assistance is usually on the scene in less than 10 min as a result of the police patrol schedule employed. Patrol vehicles are assigned 11-mile segments and remain on this assignment alone.

Motorists are given a pamphlet when the patrol vehicle or service truck arrives. This pamphlet describes the system and provides a listing of all charges to preclude any misrepresentation or subsequent repair price disagreement. A $5 minimum service charge is made.

The Atlantic City Expressway combines a relatively simple radio system with a rather extensive police patrol schedule. High frequency of patrols is definitely one means of solving the stranded motorist problem; however, many police departments generally have other responsibilities and limited funds.

*I-94 Michigan (Combination Rural-Urban Telephone System)*

The I-94 motorist aid system was installed in 1968 on the 30-mile segment between Jackson and Battle Creek, Mich. A 6-month study preceded the installation. I-94 traffic is relatively light (14,000 ADT); however, a rather high percentage (20 percent) of the total traffic consists of commercial vehicles.

The system consists of 62 telephones spaced at ⅗-mile and 1-mile intervals. It is owned by the Michigan Department of State Highways, with the exception of the leased telephone lines connecting the roadway with the base stations. Units are mounted on 12-ft aluminum poles that are 13.5 ft from the edge of pavement. Two State Police base stations control the two 15-mile segments. The dispatcher is notified of an incoming call for assistance by a bell ring and a light appearing on a route display on his console.

A number of early problems associated with this system have since been eliminated. These included moisture conditions in the encoders, false ringing caused by faulty encoders and decoders, and equipment damage occasioned by vandalism and lightning strikes.

People residing in surrounding residential neighborhoods were often asked to provide aid to stranded motorists before the telephone system was installed. Some residents reported up to five assists on a given day; however, this has totally disappeared since the aid system became operational. Recent surveillance shows that approximately 50 percent of all stalled motorists use the system, with the balance completing their own repairs or abandoning their vehicles to seek outside aid via hiking or hitchhiking. These surveillance studies also show the following breakdown of system use (exclusive of informational requests):

| | |
|---|---|
| Fuel | 21% |
| Water | 4% |
| Oil | 2% |
| Tire repair | 22% |
| Mechanical, tow | 19% |
| Mechanical, no tow | 17% |
| Accident, medical and tow | 1% |
| Accident, tow only | 1% |
| Accident, no tow or medical | 5% |
| Stuck off the road | 3% |
| Fire | 1% |
| Police use | 2% |
| Miscellaneous | 2% |

About 25 percent of all I-94 traffic consists of tourist trips. When combined with the 20 percent commercial vehicles, it can be concluded that local commuter traffic is not a dominant factor, although approximately 35 percent of all traffic is related to business.

*Commentary*

A few general comments are in order concerning the over-all evaluation of radio and telephone systems presently in use. These comments may be categorized into three classifications—system use, communication effectiveness, and cost comparisons.

In analysis of the *use* of the systems, the following facts and observations have been noted:

1. Approximately 50 percent of all stopped motorists requiring aid will use the system.
2. Use depends on system availability (the more units, the greater the use).
3. If instruments of procedures are difficult to use (confusing instructions) the motorist may elect another option.
4. It has been observed that, if a motorist used the system in the past with unsatisfactory results, he may not try it again; conversely, success breeds confidence and continued use (and the word does have a way of getting around).
5. The type of communication mode does not markedly affect the use of the system (from the motorist standpoint).

It is unknown whether or not system use can be increased much above the 50-percent factor. Personal motivations, including the fear of high service charges plus man's desire to help himself, will probably constrain any marked improvement, although highway and police authorities are continuously seeking new means to encourage system use.

The exact effect of unit spacing on system use is not known; however, a maximum of ½-mile spacing is generally accepted for urban highways, with some systems designed around ⅛- to ¼-mile spacing. Rural systems, on the other hand, seem to do well with 1-mile spacing because they rely so heavily on patrol and passing motorist aid.

*Communication effectiveness* covers the clarity of the voice (voice systems) and, more significantly, the "works the first time" result. Systems with some form of acknowledgment (voice, light, etc.) generally give the motorist the confidence he demands, whereas one-way (send only) systems leave him uncertain as to whether or not his message was received. Existing one-way systems experience a high rate of repeat calls (motorist calls back at 5-min intervals, or less).

The mode of communication affects the aid response. Two-way voice systems are preferred by police, as they believe that a verbal interrogation can lead to a prompt response by the right kind of service or emergency vehicle. They are less likely to respond to calls where nonvoice one-way systems are in use. In fact, according to police officials, fire departments and ambulance services will not respond on the Capital Beltway system unless a police cruiser has gone to the roadside and confirmed the need.

*Cost comparisons* are difficult to make because each roadway has its own peculiarities and needs. Moreover, the size and location of the system have a bearing on the final cost. Telephone systems have a much lower original equipment purchase cost; however, they are characterized by high installation costs (drilling, cable placement, pipe pushing, etc.). In addition, the system user usually pays monthly rental for leased lines. Maintenance is generally included in the monthly lease fee.

Radio systems (signal or voice) have relatively low roadside unit purchase prices and relatively high base station costs; however, rental is not required. Maintenance costs are comparable between either signal or voice type.

Total systems cost comparisons should be made over a reasonable period because the design life of equipment runs a minimum of 10 years and as high as 25 years with some component replacement.

## COURTESY PATROLS

### State Courtesy Patrols

At least 13 states have initiated courtesy patrols in recent years to provide free assistance to those motorists in need of routine aid such as fuel, oil, water, tire change, and minor mechanical repairs. A few states provide this service on a round-the-clock basis throughout the year on selected routes; however, most offer this assistance only during high traffic periods (holiday weekends, etc.—see Appendix B). Some states use specially equipped police or highway maintenance vehicles (Fig. 6). Others award a contract to a private service organization to provide this service.

Courtesy patrols generally provide a rapid response to motorist needs; however, they may become prohibitively expensive unless high utilization of the service is experienced. This explains why most states that use any form of courtesy patrol generally limit its use to selected routes and peak periods.

One state reports an annual cost of about $400,000 for a 12-vehicle patrol. This covers 750 miles of largely rural Interstate on a 24-hr basis.

Courtesy patrols usually service only those minor malfunctions which may be corrected at the road site without the need for replacement parts. Towing and major repairs are referred to private service stations.

Although they may not be an economic approach to the over-all motorist aid needs, state courtesy patrols are an effective service during high traffic periods and in remote areas, particularly during hours of darkness.

### American Freeway Patrol; San Diego, Calif.

The American Freeway Patrol system was initiated in November 1968 by the American Oil Company as a means of identifying itself with the motoring public and as a response to a growing community need for traffic monitoring, motorist advisory information, and motorist aid. A total of five trucks (Fig. 7) and a helicopter cover approximately 110 miles on two Interstate and three state highways in the metropolitan San Diego area. The helicopter is used primarily for traffic advisory broadcasts over local radio stations, although it has performed a few emergency aid missions involving serious accidents and personal injury. The trucks operate on a detailed schedule, with all five vehicles deployed during the 6:30-8:30 AM and 3:00-6:00 PM rush-hour periods and either two or three vehicles assigned during the balance of the day. All patrols terminate at 11:30 PM and resume at 6:30 AM.

American Oil provides this service free of charge.


*Figure 6. State courtesy patrols.*


*Figure 7. American Freeway Patrol (San Diego, Calif.)*

Service trucks on patrol carry gasoline, water, oil, tire-changing equipment, basic tools, maps, flares, first aid and emergency oxygen supplies. Each truck is equipped with a mobile two-way radio that is used to communicate with the American Freeway Patrol control center or with local police authorities.

Motorist assists have nearly doubled since the inception of this program, with an average of 50 to 60 per day during current weekday operations. With an average of less than four vehicles in use during a typical day, this means that each vehicle is responding to 14 to 15 motorists each 17-hr service day.

American Oil has maintained detailed records on this service and reports a $10 cost per assist, including driver costs, vehicle depreciation, vehicle and control center equipment, analysis, and management investment.

Actual assists have been tabulated over a two-year operating period, as follows:

| | |
|---|---|
| Fuel | 65% |
| Water | 2% |
| Tire changes | 10% |
| Battery | 10% |
| Information and special request | 10% |
| Miscellaneous (including first aid) | 3% |

Trucks are able to reach a motorist in need of aid in 5 to 10 min after he pulls off the road and complete their assistance in 10 to 15 min for a total return-to-the-road average of 20 min.

The five trucks have averaged 100,000 miles per year per truck and will be replaced at the end of 2½ years.

The system has been publicized extensively via radio and pamphlet handouts to motorists at local American service stations. Included with the pamphlet is a yellow-and-black "HELP" sign that motorists are instructed to display to assist patrol trucks in locating vehicles in need of assistance.

Project officials are presently trying to improve on the communications and coordination among trucks, with the helicopter, and with state and local police organizations.

More than 35,000 motorists have been assisted by the American Freeway Patrol in its first 2½ years of operation. This has been a significant contribution to motorist needs in the metropolitan San Diego area and has no doubt enabled American Oil to establish a favorable community image and increased fuel and service patronage of its dealers' facilities.

## CITIZENS' BAND RADIO

### REACT (Radio Emergency Associated Citizens Teams)

REACT is a national association of local volunteer teams who provide two-way citizens' band (CB) radio communications in local emergencies. CB transceivers broadcasting on channel 9 are mounted in passenger cars (Fig. 8), trucks, buses, other commercial vehicles, etc. The stranded motorist reports his need for aid directly from his vehicle. If he does not possess such equipment, his fellow motorists equipped with CB radio give him a helping hand.

The Federal Communications Commission has set aside channel 9 of the citizens' band for emergency communications and for assistance to disabled motorists. Channel 9 broadcasts are monitored on a volunteer 24-hr basis by REACT teams and also by police departments, rescue services, road service stations, automobile dealers, and other interested private or commercial listeners. A call for help may be effectively transmitted up to 20 miles (depending on terrain, interference patterns, etc.), whereupon it will generally be answered in rapid fashion.

This concept was proposed in 1962 because of the widespread availability of CB equipment and its relatively low cost. It is currently being sponsored by the General Motors Research Laboratories. Approximately 1,500 teams (40,000 members) have been assigned listening posts to ensure that calls for assistance are quickly heard by someone knowing what type of aid to request. A test program, in which the State Highway Patrol is cooperating, covers 75 percent of primary roads in Ohio. This program is specifically geared to obtain statistical data that may be used throughout the country.

A long-range goal of the REACT system is to incorporate the vehicle-mounted transceiver in an ordinary AM car radio with a button on the radio keyed to operation of the CB channel. This goal is secondary to the announced intention of encouraging more people to participate in REACT, motorists and listeners alike.

A similar program to REACT was HELP (Highway Emergency Locating Plan), sponsored by the Automobile Manufacturers Association. This program involved a more sophisticated driver aid network requiring the assignment of special radio frequencies. However, due to difficulties in obtaining these frequencies, all HELP activity is now being referred to REACT.

REACT is a low-cost approach to motorist aid that can be effective if enough people participate in the program. This is the only nationwide project currently active that addresses the stranded motorist problem. Critics of the REACT system contend that the motorist is at the mercy of either fellow motorists to report his need or the

*Figure 8. Motorist requesting assistance via CB radio.*

volunteer to hear his request and summon appropriate aid. There are also arguments that a call for help may be monitored by troublemakers as well as good samaritans, but there are no available facts to support the claim.

### CB Radio Driver Aid Network (Detroit, Mich.)

A CB radio driver aid program, sponsored by the City of Detroit and General Motors Research Laboratories, was started in 1966. Initially, 12 miles of one freeway were covered by one fixed transceiver and about 100 mobile units installed in the cars of GM and City of Detroit employees. To improve reception, three additional receivers were later added.

Participation has been excellent: in fact, early in the program more than one-third of the calls were made by other than the 100 original participants, and this has since risen to more than 90 percent.

Because of this favorable response, the system was expanded to cover the entire City of Detroit. The receivers and five transmitters are now connected by telephone lines to a master control site.

Recent statistics show that about 900 calls per month are being received. A reduction in detection time of 17 min has been reported.

The entire system was donated to the City in July 1969 and is now an ongoing program of the City of Detroit, Department of Streets and Traffic.

## SURVEILLANCE SYSTEMS

### John C. Lodge Freeway TV Surveillance Project (Detroit)

The Lodge Freeway surveillance system consisted of a 3.2-mile section of freeway monitored by 14 closed-circuit TV cameras. These cameras provided a control center dispatcher with a composite view of this section of roadway and enabled him to remotely control displays, indicating lane closings, change speed signs, etc. Although the system was not designed as a motorist aid system, a side benefit was its ability to spot disabled motorists and summon police or other needed emergency service.

The system is limited by the amount of roadway a camera can cover. In addition, it requires a highly trained operator to detect a problem while monotonously viewing routine patterns during a watch period. Installation is quite expensive, although it may be justified in specific instances for heavy urban traffic intersections or short problem roadway sections.

### Project Scout (Sky Control of Urban Traffic) (Buffalo, N.Y.)

Buffalo's "Sky Control" system made use of a helicopter to report motorists in need. In addition, a small fixed-wing aircraft was deployed, covering more ground in a less detailed fashion. The fixed-wing craft was used for most routine patrol (80 percent of total project flying time at a cost of $10 per hour) and the helicopter was used for specific tasks and rush-hour loiter patrol (20 percent of total project flying time at a cost of $60 per hour). Both aircraft carried two-way VHF and/or FM communications equipment and reported into a single control center that provided necessary ground emergency vehicular service.

## COOPERATIVE MOTORIST REPORTING

### FLASH (Flash Lights and Send Help); I-4, Florida

An experimental system being tested on a rural expressway between Tampa and Orlando, Fla., has been in use for nearly two years. It utilizes a scheme whereby a helping motorist flashes his lights in a designated flash zone if he has seen a disabled motorist.

The system uses extensive signing to explain the procedure for flashing and to identify the flash zone (Fig. 9). A roadside detector picks up the flashing lights (three times on high beam) and relays a signal to a roadside signal processor. The processor counts the number of flashes and the number of vehicles that emit a flash. To eliminate pranksters, the system can be adjusted to count a certain number of vehicles reporting in a given time (e.g., three vehicles in 5 min) before an actual alarm is sounded at the base station. Police respond to a request for assistance upon notification by the dispatcher.

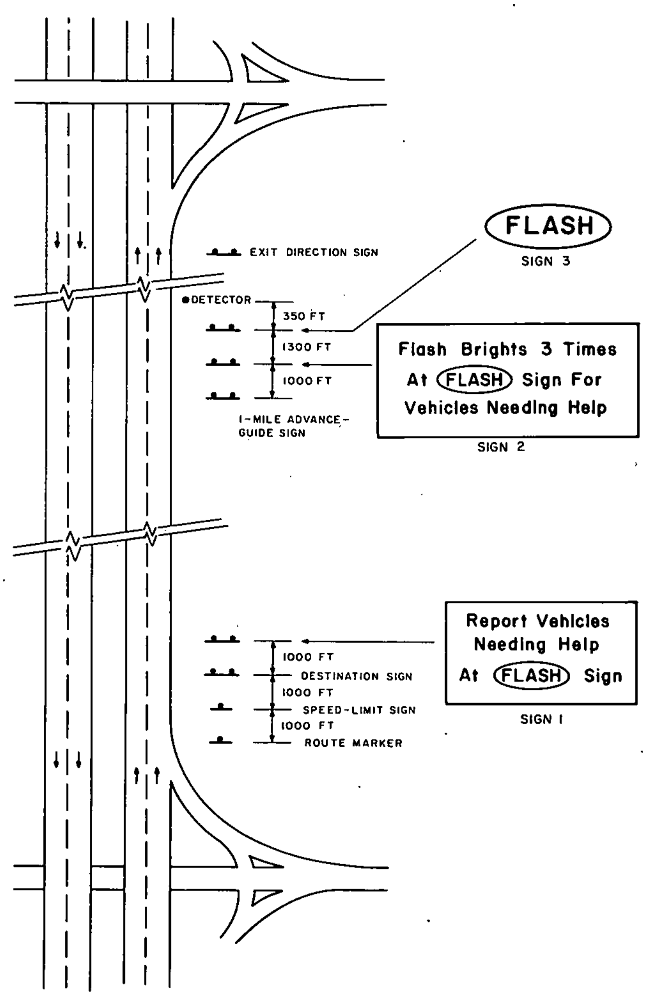



*Figure 9. FLASH system layout and signing.*

This is a relatively inexpensive approach to motorist aid; however, it requires a motorist educational program. It relies on moderate traffic in order that a stalled motorist does not wait too long before his need is answered. Moreover, there is no provision for acknowledgment to the stranded motorist that anyone has noticed his plight.

#### Off-Ramp Telephone; Eisenhower Expressway, Chicago

A telephone unit (same as roadside units described earlier) was located at a major off-ramp of Chicago's Eisenhower Expressway. An important goal was to determine the level of passing motorist assistance in reporting stranded vehicles. The unit was preceded by elaborate signing to encourage its use and was in operation 24 hours a day. Forty percent of all reported vehicular breakdowns were reported by passing motorists. Data showed that disabled motorists would walk up to ½ mile to reach the off-ramp unit; however, helping motorists often drove up to 6 miles to pass on a need for assistance.

A second system goal was to determine the extent of information requests. Thirty-one percent of all calls were for driver informational needs. During part of the experiment a roadway map was mounted near the phone to see what effect this might have on reducing calls. However, there was no effect: the number of informational requests continued at the previous rate.

CHAPTER THREE

# FACTORS TO BE CONSIDERED IN PLANNING AND DESIGN

Effective planning is a part of any and all motorist aid systems. Far too many systems have failed in providing both detection and assistance response to a given need. It is important that the over-all system ensure that a bona fide need is identified and transmitted, and that appropriate response action is completed in the least amount of time. It is imperative that motorists know that assistance is readily available in order for them to use any of the systems previously discussed. This relates to motorist confidence not only that the system is there and that communication can be established, but also that it produces assistance on an expeditious basis. Such aid is all the more important in instances involving vehicular accident, fire, and personal injury.

After the need for a motorist aid system has been evaluated and a decision has been made to provide such a system, the following planning and design factors are among those to be considered.

## COORDINATION WITH POLICE

Highway organizations have found that police participation in the design of a system is an important precursor to successful patrol and assist. In short, police officials are becoming involved during the planning phase in order to effect proper equipment selection and operating procedures before the system goes into service.

Police participation is integral to the over-all success of any motorist aid system. However, there are certain functions that law enforcement officers should not have to perform in deference to their criminal and traffic responsibilities. An effective police force cannot take time out to change tires and perform various and sundry other mechanical repairs. Moreover, it is less costly to have service organizations performing these tasks. Police cannot afford to spend base station operator time trying to relay travel information to motorists or to send a police cruiser out to the road site to dispense such advice. There must be maximum utilization of state and local police organizations as law enforcement bodies first, and other functions second.

## INITIAL AND OPERATING COSTS

Officials should be cautioned against arriving at hasty cost conclusions that pit motorist aid systems against a do-nothing alternative. Perhaps a better way of viewing these systems is to compare them with an insurance policy whereby all motorists who use high-speed, limited-access highways (e.g., the Interstate System) are being provided insurance coverage that their travel plans will not be unduly interrupted. Viewed from this perspective, the cost per motorist becomes very modest.

It is important that the responsible agencies conduct a comprehensive cost analysis based on design needs during the planning and design phases. In fact, the planning phase may turn out to be the more critical, as it is at this point that trade-offs are made and selection of equipment types and configurations is finalized.

System planners must be careful to include all costs, direct and indirect, to get a complete picture prior to embarking on the procurement phase. This includes being able to quantify all features on a like basis, assigning dollar values where known, and using sensible estimates where uncertain. Finally, costs must be projected over a long period of time in order to determine crossover points among competing approaches. This is also dictated by the long life expectancy of an average system (10-25 years).

The following major cost elements must be reviewed in detail:

1. Cost per roadside unit.
2. Preparation of unit location.
3. Roadside construction:
   (a) Widening shoulders.
   (b) Emergency pull-off area.
   (c) Trenching and filling (cable systems).
4. Installation, contractor.
5. Installation, system manager.
6. Equipment rental.
7. Phone line lease cost.
8. Patrol vehicle and driver cost.
9. Costs of emergency services provided free.
10. Base station costs.
11. Base station operating costs.
12. Maintenance costs (including component replacement).
13. Testing costs (patrol and base station).
14. Equipment and vehicular insurance.
15. Administrative costs (record keeping, analysis, reports, etc.).

These costs probably will show wide variance, depending on the specific application, highway geometry, geographical locale, and equipment features. It is fallacious to rely solely on the experience of other system operators, although this is a good form of comparison.

In the final analysis, costs must be related to something. One can calculate cost per assist, cost per vehicle-mile, cost per highway-mile, and so forth. Police dispatcher time, patrol time, patrol vehicle operating costs, maintenance of equipment by state highway personnel, etc., all must be factored into the total cost. The importance of thorough cost analysis cannot be overemphasized. However, further study in this area is required in order that complete cost data are available for meaningful comparisons.

### FUNDING

Motorist aid systems are generally funded at the state level by the highway agency, although in some cases private, local, and Federal funding has been used. For example, Los Angeles County provided most of the funds for the Southern California System. A local automobile club provides "free" aid to its members who are stranded on any of the freeways in the system.

An example of Federal support is seen in the I-495 Capital Beltway encircling Washington, D.C. The Maryland State Roads Commission was assisted in the purchase and installation of its system as an experimental project by the Federal Highway Administration. The state pays for operating costs and is presently performing all maintenance on the 324 units.

Toll authorities (bridge, tunnel, and highway) finance their motorist aid systems through normal toll collections. Moreover, this type of installation is characterized by private patrols and/or contract service organizations. These systems pay their own way via fixed minimum charges and added traffic volume resulting from well-planned services. The Atlantic City Expressway is an example of such a system. This system is particularly effective as it combines comprehensive patrol with a call box system.

Research in the design and demonstration of new approaches to motorist aid is funded by the Federal Highway Administration (U.S. Department of Transportation). FHWA has funded at least a dozen separate efforts over the past three fiscal years, including research on the FLASH system concept in Florida previously noted. A planned and designed motorist aid system may be installed as an experimental construction item with Federal participation (*Instructional Memorandum 20-2-70*).

### MAINTENANCE PROCEDURES AND COSTS

Maintenance of motorist aid systems varies in complexity and cost according to type of system, type of equipment, environmental conditions, and test procedures.

The cost of maintenance of the vehicles used for courtesy patrols is frequently considered a part of the system operating cost. The maintenance costs will vary with the mileage covered and the types of vehicles used.

Maintenance on electronic systems can cost as little as $3.50 or as much as $8.50 per unit per month. Most agencies to do not employ preventive maintenance because they feel that there are few components that can fail. They generally wait for a breakdown because impending failure is next to impossible to detect in advance.

How are breakdowns detected? Normally, each unit is tested by the patrol organization (usually the state police) at least once each week. Units that do not function properly are noted and this listing is passed on to the maintenance contractor or the agency maintenance organization.. Testing is conducted during low peak traffic periods, usually between 2:00 AM and 6:00 AM. As previously noted, police officers typically try out each unit and receive a base station confirmation over the unit or through the police cruiser two-way radio that the system is or is not operating at peak performance. In battery-powered systems, it is not uncommon to find power degradation at this time of night (solar panels are not energized) that can cause weak or intermittent signals. The dawning of a new day puts fresh power back into these units and problems disappear. Fortunately, engineers have discovered new solar panel, battery, and circuit techniques that will eliminate this problem. Another category of problem involves environmental protection. This problem is common to all types of motorist aid systems; however, again it is being solved by new fabricating techniques. Most maintenance repairs are completed at the road site and consist of wire and battery replacement. Units that need to be removed for repairs are replaced by spares to maintain coverage.

Equipment malfunction may be detected by two other methods—maintenance crews performing routine checks (infrequent) and motorists unable to relate their need (extremely unfortunate). In each instance this discovery may be too late.

Most systems have lowered maintenance costs to the

$5.00-per-unit-per-month range. Much of this cost consists of labor input because component failures have become insignificant in most installations. Labor costs are not apt to decline; thus we are probably near bottom in the cost of maintaining each unit unless large numbers of installations are completed whereby economics of scale might result in further reductions. The advent of new automatic testing techniques should permit a significant savings in testing costs; however, this will not affect present maintenance financial data because only the actual cost to repair is calculated in the cost—not the patrol testing time. Automatic testing will add to the purchase price. This additional cost is relatively insignificant and could be easily offset by the elimination of the present procedure of manually testing each unit.

Personnel assigned the maintenance task generally have other communications equipment repair responsibilities. Typically, there may be three to ten engineers who are responsible for the entire statewide communications systems —antennas, transmitting site power and amplification, cable and wire (exclusive of telephone), mobile two-way radios (state highway maintenance), and assorted other tasks. This small cadre is often assigned the task of maintaining all state police equipment as well. The net result is that most of these organizations are undermanned to take on motorist aid system maintenance and repair. In addition, they generally have inadequate facilities for performing major repairs; a small workbench in the corner of a garage is not uncommon.

Some states and toll authorities have put all system maintenance under an outside contract on a fixed-price basis (exclusive of any major nonwarranty repairs). The effectiveness of this approach must be determined by the availability of a first-class service company or the original equipment manufacturer and his repair shop facilities. If he is equipped to handle all repairs within 48 hours, this may be a good investment; however, it may increase the maintenance cost. The single most important factor is the service organization's ability to do it right the first time without delay.

Regardless of the form of maintenance adopted for any given system, the method of calculating maintenance costs should be far more comprehensive than that used at present. Testing costs should be combined with actual repair costs to get a true measure of total maintenance expenditure. This includes patrol operator and base station dispatcher time, vehicle operating costs, maintenance vehicle and operator costs, repair parts, and any other cost associated with inspecting, testing, and overhauling any part of the system. The replacement of complete units resulting from theft, vandalism, accidents, lightning, etc. should not be included here, but rather as a capital investment.

## EQUIPMENT RELIABILITY AND AVAILABILITY

*Reliability* of motorist aid systems has been vastly improved over the past ten years. Inadequate batteries and solar panels, leaking encoders, leaking unit cases, and a variety of other early problems have been identified and corrected. Moreover, newer circuit techniques permit additional functions and in some instances circuit redundancy.

Operational motorist aid systems usually require maintenance on an average of one to two times per unit per year. Some units require more frequent service and therefore overshadow those that have a 100-percent reliability. Exact numbers are not available; however, it is estimated that well over 50 percent of the units on a given system do not require any maintenance over a 12-month period. Battery-powered systems require a battery change approximately every two years, although batteries (usually lead-acid) often are capable of lasting beyond this period.

*Equipment availability* is also worthy of brief mention because it is necessary to know how long it will take to implement a given system design.

The vehicles—pickup trucks, vans, station wagons—used in courtesy patrol systems are readily available, as are the equipment and supplies that are normally carried.

Telephones are available within three to six months, with a slight delay possible due to scheduling of production runs. Manufacturing is fairly routine unless new features are being added for the first time. Manufacturing, installation and test normally requires 10 to 12 months from the time of order, although this could be reduced by 2 to 3 months.

The availability of coded radio signal systems is approximately the same as telephones. There may be a slight delay in manufacturing and testing the units because of the lower production capability of this type of manufacturer. The total elapsed time from order to operational deployment could well be 12 to 15 months. Installation is extremely simple and would typically require less than 2 months for a 150-unit system.

The future of radio voice systems is dependent on the use of the recently approved frequencies in the 450-MHz band. These have been reserved for motorist aid communications systems. This would be a radio system that could offer two-way voice conversation. The feasibility of building such a system has been demonstrated and it is claimed that it can be built in a competitive time frame with coded radio signal and telephone systems.

Regardless of the type of system, it is not necessary to maintain a large inventory of spare roadside units or components. A 5-percent inventory of complete roadside units is typical to cover those instances where a unit must be removed for repair. Extra batteries, transistors, handsets and other critical components should be stocked in small supply.

Contractors generally complete the system installation and assign someone to remain on site until the testing phase is completed and the system is declared operational. Beyond this phase, the contractor usually drops out of the active operation of the system except for maintenance support covered by the contract or by the equipment warranty.

## PLANNING THE LOCATION OF ROADSIDE EQUIPMENT

Careful consideration must be given to the location of roadside telephones, radios, signs, detectors, cameras, and other motorist aid hardware. Too often systems are planned on a predetermined unit spacing basis with little or no consideration given to road grade, interchanges, shoulder width, existing poles and overhead structures, bridges, tunnels, available power sources, buried cable, RF interference problems, communications propagation patterns, and other factors. Many road characteristics have a direct bearing on the system design, the selection of individual components, and the communications mode selected. All of the foregoing factors should be analyzed during the planning and design phase, not as a last-minute consideration or a quick-fix modification.

Sometimes it is difficult to determine optimal unit location based on safety, economics, and sufficient coverage. Communications, design, and traffic engineers can work together to determine the proper alternative. Too many operating systems apparently relied on "someone else" to make these decisions, and as a consequence the wrong party may have been involved or perhaps no one at all was aware of the needs until too late.

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CHAPTER FOUR

# FEDERAL INVOLVEMENT

## HIGHWAY SAFETY ACT OF 1966

There are a number of ways in which the Federal government becomes involved in motorist aid deliberations. From a basic safety standpoint there is the 1966 Highway Safety Act, a far-reaching legislative backdrop to the whole highway and motorist safety problem. Under the Act, a grant-in-aid program was established to assist states in developing their highway safety programs. These programs are developed in accordance with uniform Highway Safety Program Standards issued by the Secretary of Transportation. Three of these standards—emergency medical services, police traffic services, and debris hazard control—refer to communications for summoning and dispatching assistance in response to highway emergencies.

The National Highway Traffic Safety Administration also supports research into all aspects of highway safety and conducts a program of Federally funded demonstration projects.

## FREQUENCY MANAGEMENT

A second category of Federal government involvement covers the effective utilization of the airways (frequency spectrum) as monitored and regulated by the Federal Communications Commission (FCC). Motorist aid systems that employ radio, TV, and other communication modes must be licensed by the FCC. Telephone, CB, and closed-circuit television do not require individual licenses unless in combination with radio or other RF-type systems. The FCC has wrestled with the over-all frequency allocation situation for years, and in May 1971 reserved four frequency pairs in the 450-MHz band for radio call boxes. This opens the door for the future expansion of radio motorist aid communication systems. In fact, some states had already filed application for a license in anticipation of this decision.

## LAW ENFORCEMENT ASSISTANCE ADMINISTRATION PROGRAM

The Federal government also becomes indirectly involved in motorist aid systems through the Law Enforcement Assistance Administration (LEAA), an arm of the U.S. Department of Justice. LEAA provides grants to each state based on population and specific law enforcement needs. These funds are, in turn, awarded to state and local police organizations on a need basis. Helicopter surveillance, new communications approaches to law enforcement, and a host of other projects utilizing new equipment and procedures fall under the purview of this legislation. Although motorist aid systems per se are not funded by LEAA, police participation may be significantly affected by the availability of these funds.

## FEDERAL HIGHWAY ADMINISTRATION GUIDANCE

Although they are not covered by enforcing type of legislation, the states also look to the Federal Highway Administration (FHWA) to establish guidelines for purchase, installation, and operation of motorist aid systems. Some guidelines have been published in *Instructional Memorandum 20-2-70*. The FHWA has a wealth of experience through its contractual program, its own in-house research, and its participation with state and national associations such as the American Association of State Highway Officials (AASHO).

CHAPTER FIVE

# MOTORIST AID IN THE TOTAL COMMUNICATIONS AND MANAGEMENT SYSTEMS

A motorist aid system is only one element of the total communications and management system. Also important is the handling of communications necessary in the coordination and operation of police functions, highway maintenance, traffic control, motorist advisory services, etc. These might include state and local police patrols, highway maintenance units, courtesy patrols, roadside call units, surveillance systems, ramp controls, lane controls, changeable message signs, and in-car advisory instruments. An integrated system becomes even more desirable when one considers the rapid expansion and increasing complexity of each of these activities and also other governmental communication needs.

The integration of motorist aid and emergency highway communications into an over-all communications and management system will not come easy. Vested interests, established procedures, historical legislative precedents, antiquated facilities, and a host of other factors that make change more difficult will require compromise, redirection, enaction, and time.

*Vested interests* cover a wide spectrum of activities. Police, for example, generally feel that all patrol functions should come under their control. Highway agencies often refer to the highway as their child and consider any event that affects motorist use of the roadway as coming under their charter. Service stations are generally profit motivated and therefore susceptible to undue emphasis on potential monetary return. Motorists themselves often exhibit the "I'd-rather-do-it-myself" attitude when confronted with vehicular breakdown. Some will even go out of their way to circumvent the system, accepting their problem as a means of challenging someone else's solution to motorist aid. The list goes on and on.

*Established procedures* often become straitjackets when there is a need for change. A new transportation environment consisting of complex traffic patterns, large urban growth, larger and faster vehicles, and surveillance and control requires procedures attuned to the system it serves. The fact that a given procedure has been followed for 30 years has little or no bearing on today's challenge. Procedures must be continually evaluated to ensure the ability to face current problems and opportunities with current technology and expertise.

*Legislative changes* may have to be enacted to permit the establishment of new services and facilities. Moreover, highway codes and state laws pertaining to the use of highways may require change in order to permit the addition of new devices both at the roadside and in operating vehicles. There needs to be a state coordinating function for all highway communications management. To accomplish this will require careful evaluation in each state government.

*New facilities* will be required to handle an integrated communications system. They will require access to communications transmission and reception antennas and/or cables. Also, it will be necessary to plan, design, and build new communications networks, including strategically located transmitting and receiving equipment.

Integration of all the elements of the communications management system should result in an improved system efficiency, including reduced fixed and operating costs. It will require considerable compromise and certainly maximum coordination at all levels. Moreover, it will require time—perhaps longer than some desire. The magnitude of these changes and the rapidity with which technology has made this change possible is such that this could not be expected to take shape overnight.

The technology on which an integrated communications management system could be based is at hand today. It is possible, with existing knowledge, to satisfy most of the communications needs that can be foreseen in the next 10 to 15 years. There is a need to address the important challenge of how to put this technology to use by integrating it into the over-all communications system. Work is progressing in some states toward this end; however, it will be a number of years before this effort will result in an operating system addressing the multiplicity of needs discussed.

CHAPTER SIX

# CONCLUSIONS AND RESEARCH RECOMMENDATIONS

## CONCLUSIONS

Aid to motorists on the highways is an existing need. Each highway agency should assess this need, estimate its cost and compare alternative solutions and the means of financing each. Cost trade-offs, engineering factors, operational requirements and response capabilities should be thoroughly evaluated at the outset and carried through any subsequent decision to install a motorist aid system. This analysis should cover all available options, including courtesy patrols, REACT teams, telephones, and radio.

Highway design and communication engineers need to work together in the early stages in order to adapt the system to the road characteristics and as a means of designing communications needs into planned highway construction.

Motorist aid and emergency communication systems should be coordinated with all other communication needs within state government. This would encourage the integration of all communications management needs into statewide systems and make future interstate communication easier.

State highway agencies should establish a function covering highway communications management. A qualified communications-oriented employee should be assigned this role and should be provided with the means to coordinate directly with the statewide communications activity at the appropriate staff level.

It is the opinion of many police and highway officials that the response by state and local police to all calls for assistance should be reconsidered. This function is often unrelated to law enforcement. In excess of 50 percent (varies from 55 to 85 percent on present systems) of all motorist assists are for service and information.

Although limited qualitative data are available relating to roadside spacing of call boxes or telephones, it is believed that ½ mile and 1 mile should be the accepted separation for urban and rural highways, respectively. Further, spacing should not be automatically at exact ½- or 1-mile intervals, but should reflect good judgment concerning traffic, safety, or engineering aspects of the road and shoulder area.

## RESEARCH RECOMMENDATIONS

Several agencies are currently engaged in research into motorist aid systems. Some of these are identified in Table 3. It is readily acknowledged that this is not a comprehensive list, especially as regards electronic components where in-house research and development are conducted by manufacturers.

A number of areas have been encountered that are most difficult to address without additional data on factors relating to present and planned systems. The first recommendation, therefore, is to increase the emphasis on data collection and analysis in such areas as the following:

- Quantifying of motorist characteristics relating to abilities, fears, and reactions.
- Request for aid acknowledgement (how long motorists will wait and alternatives they might elect).

TABLE 3

SUMMARY OF KNOWN RESEARCH ACTIVITIES RELATED TO MOTORIST AID SYSTEMS [a]

| RESEARCH PROJECT TITLE | RESEARCH AGENCY | HRIP NO.[b] |
|---|---|---|
| Evaluation of Vehicle Collision with Motorist-Aid Call System Terminal Support | Texas Transportation Institute | 51 213842 |
| Analysis of Citizen Band Radio Communication | Wayne State University | 52 206859 |
| Emergency Call Systems | New Jersey Department of Transportation | 53 019424 |
| Evaluation of Emergency Call Systems | Bureau of Public Roads (US) | 53 081610 |
| Emergency Call Equipment for Rural Freeways | Nevada Department of Highways | 53 082851 |
| Development and Evaluation of Cooperative Motorist System | AIL Division/Cutler-Hammer | 53 085287 |
| Research and Evaluation of Emergency Call Box System | Texas Transportation Institute | 53 201662 |
| Motorist Aid System for Rural Freeways | Illinois Division of Highways, Res. & Dev. Bureau | 53 201684 |
| Emergency Wayside Telephone Systems for Expressways and Freeways | District of Columbia Department of Highways & Traffic | 53 207640 |

[a] As of June 1971. [b] Acquisition number assigned by the Highway Research Information Service of the Highway Research Board; HRIP = publication entitled *Highway Research in Progress* (current issue).

- How long motorists will wait for assistance, both with and without roadside communication units.
- Assist data (police or service organization) prior to motorist aid system installation.
- More cost data and better means of relating costs to system utility.
- Relationship of roadside unit spacing to system use, etc.
- Relationship of response time to gone-on-arrivals.
- Accident data before and after system installation.

There is a need for better methods of evaluating the effectiveness of existing systems, including development of meaningful facts and relationships that will permit comprehensive comparisons. These comparisons might consist of use ratios, average time delays, time to respond, time to repair, cost per assist, cost per vehicle-mile, cost per highway-mile, etc. In this regard, criteria for evaluating systems could be effectively drawn up and issued in the form of uniform guidelines.

Installation criteria should be developed that identify correct procedures and the avoidance of safety hazards.

The functions of electronic equipment used in motorist aid systems should be reviewed with the aim of standardization. This will help to achieve cost effectiveness.

Finally, the National Joint Committee on Uniform Traffic Control Devices should review motorist aid signing needs and develop recommended standards relating to color, shape, size, legend, mounting height, location, and any other factor that bears on the legibility, understanding, or safety of individual signs.

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The foregoing conclusions and research recommendations cover a wide range of interests and responsibilities. Effective action on these points will require a coordinated effort of nationally oriented organizations. The American Association of State Highway Officials, the Federal Highway Administration, and the International Association of Chiefs of Police will obviously be involved, along with others. Each should contribute to the support of the effort, but *there is an obvious need for leadership.*

# APPENDIX A

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# APPENDIX B

## SURVEY OF MOTORIST AID SYSTEMS *

| STATE | MOTORIST AID SYSTEM | | | |
|---|---|---|---|---|
| | POLICE PATROL | STATE COURTESY PATROL | CALL BOX OR TELEPHONE | OTHER |
| ALABAMA | ✓ | | | Limited REACT patrol |
| ALASKA | ✓ | | | |
| ARIZONA | ✓ | | | |
| ARKANSAS | ✓ | | | Limited aircraft patrol |
| CALIFORNIA | ✓ | | ✓ | Auto club and oil company patrol |
| COLORADO | ✓ | ✓ | | |
| CONNECTICUT | ✓ | | ✓&P(1) | |
| DELAWARE | ✓ | | P | |
| FLORIDA | ✓ | | P | Auto club patrol(2); FLASH |
| GEORGIA | ✓ | | | |
| HAWAII | ✓ | | P | |
| IDAHO | ✓ | | | Rest area telephones |
| ILLINOIS | ✓ | | ✓ | |
| INDIANA | ✓ | | | REACT teams |
| IOWA | ✓ | | P | Project delayed - lack of funds |
| KANSAS | ✓ | | | Limited aircraft patrol |
| KENTUCKY | ✓ | | ✓ | |
| LOUISIANA | ✓ | | | |
| MAINE | ✓ | ✓ | | |
| MARYLAND | ✓ | | ✓&P | |
| MASSACHUSETTS | ✓ | ✓(2) | ✓&P(1) | |
| MICHIGAN | ✓ | | ✓ | Detroit CB System |
| MINNESOTA | ✓ | ✓ | | Limited aircraft patrol |
| MISSISSIPPI | ✓ | ✓ | ✓ | |
| MISSOURI | ✓ | | | |
| MONTANA | ✓ | | | Rest area telephones |
| NEBRASKA | ✓ | ✓ | | |
| NEVADA | ✓ | | P | Traffic surveillance counters |
| NEW HAMPSHIRE | ✓ | ✓(3) | | |
| NEW JERSEY | ✓ | | ✓ | Cable with switch at delineator post |
| NEW MEXICO | ✓ | | P | |
| NEW YORK | ✓ | | ✓ | |
| NORTH CAROLINA | ✓ | | | |
| NORTH DAKOTA | ✓ | | | |
| OHIO | ✓ | ✓(2) | P | REACT test program |
| OKLAHOMA | ✓ | | ✓ | |
| OREGON | ✓ | | | |
| PENNSYLVANIA | ✓ | | ✓&P | Auto club patrol |
| RHODE ISLAND | ✓ | ✓ | P(1) | |
| SOUTH CAROLINA | ✓ | | | |
| SOUTH DAKOTA | ✓ | | | |
| TENNESSEE | ✓ | ✓ | | |
| TEXAS | ✓ | | ✓ | |
| UTAH | ✓ | | P | CCTV surveillance being studied |
| VERMONT | ✓ | ✓(3) | P | |
| VIRGINIA | ✓ | ✓(2) | ✓ | |
| WASHINGTON | ✓ | | ✓ | |
| WEST VIRGINIA | ✓ | ✓ | | |
| WISCONSIN | ✓ | | | Aircraft patrol on summer holidays |
| WYOMING | ✓ | | | Limited maintenance patrol |
| DISTRICT OF COLUMBIA | ✓ | | ✓&P | |

✓ = In Operation P = In Planning or Design Phase
(1) Installation of joint system (Conn., Mass., R. I.) planned
(2) Holidays only (3) Winter nights only

* From HRB survey, Jan. 1971.

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**THE HIGHWAY RESEARCH BOARD,** organized November 11, 1920, as an agency of the Division of Engineering, is a cooperative organization of the highway technologists of America operating under the auspices of the National Research Council and with the support of the several highway departments, the Federal Highway Administration, and many other organizations interested in the development of transportation. The purpose of the Board is to advance knowledge concerning the nature and performance of transportation systems, through the stimulation of research and dissemination of information derived therefrom.

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***NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL***

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