TWO-WIRE EMERGENCY CALL SYSTEM

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The results of the installation and usage tests of the 2-wire emergency call system do not indicate any significant advantages of that system over other types of call systems. Before-installation and after-installation field surveys were conducted to determine the number of motorists needing aid along the roadway and the type of problems they had. Details of servicing times for the stopped motorists also were collected. Records were maintained for system installation and maintenance costs. The summaries of the field survey and system costs are included in the report. Costs for 2 other types of systems (telephone and call box) used in other states are included for comparison.

•MOST INTERSTATE HIGHWAYS have no means for motorists to summon aid in the event of a breakdown or emergency; Interstate highways are noted for their isolation from service facilities, even in urban and suburban areas, due to access control. The demand for improved communications between the motoring public and the highway system is steadily increasing. Several states have implemented emergency aid call systems, including voice (telephone), coded call box, and microwave systems.

The New Jersey Department of Transportation, in cooperation with the Federal Highway Administration, undertook the development of an emergency call system with the following primary objectives:

1. Closely spaced emergency call stations,
2. Low installation costs,
3. Low maintenance costs, and
4. Simplicity of system operation.

It was felt that an emergency call system utilizing a buried two-conductor cable with simple, momentary contact switches for signaling calls would best fulfill the objectives.

The system was designed to have call stations at 200-ft intervals, thus providing access to the system much more frequently than do other systems. The system design concept is basically of a resistance-measuring type. An emergency call is made when a switch is depressed (closed), which shorts the buried cable and decreases its resistance in an amount proportional to the distance from the resistance-measuring unit. This resistance can be converted to a specific location along the highway.

Because the system utilized common principles (shorting a wire and measuring its resistance) for which simple equipment already existed, it was felt that the objectives of the system would be met.

After installation of a test system, the system was operated and a field survey was conducted to determine whether the system would fulfill the objectives as planned.

SYSTEM DESCRIPTION

The section of I-287 chosen for the test site was 8.2 miles long, extending from Main Street, Metuchen, to River Road, Piscataway Township. A cable comprised of two 14-gauge copper wires insulated suitably for direct underground burial was trenched

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along the shoulder of the highway, approximately 6 in. below the surface. Wherever bridges and ramps were encountered, the cable was run through conduits. At each of the 425 delineator posts located on the north and south lanes of the 8.2-mile section, loops were brought up to a height of 3 to 4 ft.

The call stations, which were reflective push-button switches in weatherproof protective enclosures, were connected to the cable and attached to each delineator post replacing the usual reflector (Fig. 1). Instructional signs were also attached to each delineator post to instruct motorists in the use of the system.

The 8.2-mile section of I-287, 16.4 miles in both directions, was divided into four separate segments consisting of approximately 4 miles per segment. With this arrangement, the cables from the four segments, two from the north lanes and two from the south lanes, were terminated at a central location. The central location contained the monitoring equipment as well as the required electrical and telephone utilities. The monitoring equipment consisted of four identical test panels, one for each segment of cable, housed in an equipment rack. Each panel had a meter for indicating an emergency call location, a table for converting the meter reading to the actual milepost value, two push buttons, and two indicator lamps mounted in the front and the associated electrical circuitry in the back. One indicator lamp would light when an emergency call had been made and was turned off by one of the push buttons after the necessary information was recorded. The other indicator lamp warned that a break in the two-wire cable had occurred, making the system inoperative. By use of a known terminating resistance at the end of each segment, a continuous low current flowed through the segment. Any break in the conductor would interrupt the current flow, causing the warning lamp to be actuated. The remaining push button was used for testing the electrical monitoring circuitry.

The electrical source for the system consisted of two 12-V automobile storage batteries under constant charge from a 110-V ac main. In the event of loss of ac power, the storage batteries were capable of supplying the necessary power to operate the system for up to 14 days.

Pressing one of the switches along the highway effected a change of potential in the current-carrying cable and caused a sensor to activate an audio and visual alarm. Simultaneously, a peak voltage memory voltmeter indicated the level of the change, corresponding to the location of the switch. After recording the reading, the attendant restored the line and checked the location chart for the exact location of the alarm.

Once the location of the emergency call was determined, it was necessary to dispatch a vehicle to the location to determine the type of assistance required (police action, fire, mechanical, and the like). State police were notified by telephone of each call and dispatched a patrol car if one was available. If a state police patrol car could not respond, a radio-equipped Department of Transportation vehicle was sent out. Upon determination of the type of assistance required, the information was radioed to the central monitoring station and relayed by telephone to the state police who made arrangements for the aid.

STUDY PROCEDURES

The base for developing an effective two-wire emergency call system rests on the ability to

1. Keep installation costs low;
2. Have a system where malfunctioning is a minor problem and damage caused by vehicles or vandals is minimized, easily detected, and quickly taken care of; and
3. Service the motorist in need of aid in a shorter time than if there were no emergency call system.

Measurement of these items is possible, but, unless another system is used for comparison, the cost and maintenance factors can only be subjectively evaluated. To avoid the possibility of misinterpreting the installation and maintenance costs of other emergency call systems we simply itemized these items (given in a later section of this report). The effectiveness of the system, using these costs, can then be weighed with other factors of policy, availability of funds, motorists' needs, and so forth.

Definite comparative measures are provided for the third item between summer of 1970 (when no emergency call system was in operation) and summer of 1971 (when the two-wire emergency call system was in operation). It is also possible to compare the service times for the drivers who chose to use the two-wire call system and those drivers who chose to service their own needs (either by themselves, through other drivers, or by walking off the road for service).

The field studies that provided this information, in the summers of 1970 and 1971, consisted of observers stationed along the roadside during the daylight hours and patrolling the road in vehicles during the nighttime hours.

Information about drivers who used the call system during the 1971 survey was determined by matching results of the field survey with records of calls kept in the central monitoring station and the state police barracks. From the 1970 and 1971 surveys, information about the time stopped, time from stop to first contact, time until aid arrived, type of assistance required, and other vehicles contacting the disabled motorist was obtained. Results of the surveys are presented later in this report.

Definition of Terms

1. Need aid—those motorists during the field survey who, in the observer's opinion, needed aid from another party in order to be on their way;
2. First contact—those motorists who stopped during the survey period because they needed aid and who were observed having contact with another motorist, state police, or Department personnel;
3. Serviced by system—motorists who pushed the emergency call switch during the period of operation, were contacted by state police or Department personnel, and obtained assistance through the contact made by means of the system; and
4. Gone on arrival—those calls that were responded to by the state police or Department personnel but that resulted in no contact, or, if contact was made, the motorist had left before the service vehicle arrived.

Daytime Studies (Stationary Observers)

When all survey positions were covered, 5.7 miles of the 8.2-mile system were observed with the aid of binoculars. For 14 days the observers were stationed from 5:30 a.m. to 1:00 p.m. and for 14 days from 12:30 p.m. to 8:30 p.m. They used the form shown in Figure 2. (The column for "time switch was pushed" was only used during operation of the emergency call system during the summer of 1971.)

Nighttime Studies (Patrolling Vehicles)

An observer and driver in each of four vehicles patrolled the entire route of the emergency call system for 7 successive nights from 8:00 p.m. through 5:30 a.m. The use of four patrolling vehicles resulted in an average spacing between vehicles of 7.5 min. To maintain this headway, each vehicle, in the course of a round trip, passed a specified point on the road at a specific time. A fifth vehicle was used to allow ½-hour breaks every 2½ hours for each of the four patrolling vehicles.

Volume Data

A permanent count station (with loop detectors) was located within the 8.2-mile study roadway. Counting at the station was continuous and was tabulated (by hour and day) for 3 weeks in the primary direction and 1 week in the other direction.

Central Monitoring Station

The monitoring station was located near an interchange in the center of the study section. The interchange afforded convenient access to the road for Department of Transportation personnel when they were required to answer an alarm. This was only necessary when the state police indicated they were unable to respond. It also permitted the call system to be easily divided into four segments, two to the north and two

Figure 1. Reflective push-button switch: call station.

Figure 2. Emergency call system reporting form.

Shift Time_____to_____ Date_____

Study Form

Position_____

NOTE: Record location of stopped vehicle to nearest .1 mile using the Milepost system.

A - Relief,rest,reading,change drivers, etc.
B - Police action,checking car,adjusting load.
C - Fix vehicle,vehicle or medical problem.

D - Involved with other driver or vehicle,directions,aid,ride.
E - Unknown

EMERGENCY CALL SYSTEM EVALUATION

Obs. No.	TIME				VEHICLE				LOCATION		EXPLAIN ALL ENTRIES				
	Vehicle Stopped	Pushed Switch	Occupant Leaves Area	Vehicle Departed	Type C T M	Color	Identification: Garage Transportation Police Company Name, Etc.	State & License No.	Travel Dir.	M.P. No.	Type of Aid or Motorist Problem (Flat,gas,engine, medical, etc.)	Aid Needed	No Aid Needed	Aid to Vehicle	Observer's Initials

to the south of the station. Two Department of Transportation personnel were monitoring the system at all times for the 57 days of operation.

When the central monitoring station records were matched with the state police log (described in the following section), information was obtained on total calls received, time and date of calls, nature of motorist's need, extent of misuse of system (gone on arrival), and response time to alarm.

State Police Log

Each alarm received at the central monitoring station was immediately relayed by telephone to the Somerville State Police barracks (located 12 miles west of the monitoring station). The desk sergeant on duty at the time made the appropriate entries into a log and advised Department of Transportation personnel at the monitoring station on whether a police patrol could respond to the alarm. If a state trooper responded, he then supplied the desk sergeant with vehicle description, type of service required, and time of arrival at the site. The desk sergeant then completed the log by entering the time and name of the service agency called to respond to the site.

If a state trooper did not respond but Department personnel did, the Department personnel then supplied the appropriate information to the sergeant at the Somerville barracks for entry into the log.

Motorist Information Signing

Motorists on I-287 were informed of the presence of the emergency call system by eleven 5- x 12-ft informational signs. The signs were placed prior to and throughout the system.

Smaller instructional signs (Fig. 1) were placed below each delineator switch. No reference was made on these signs regarding the type of aid that would arrive. The operation of the system necessitated the determination of the type of aid required prior to sending aid. Hence, the initial contact with the motorist was made through either the state police or Department of Transportation personnel.

RESULTS

1970 and 1971 Field Surveys

The following results reflect only those vehicles that were observed by field survey personnel and determined by them to need aid. The field surveys were conducted for 285 hours each summer during the 1970 and 1971 studies. The emergency call system was in operation for 1,368 consecutive hours during the summer of 1971.

The 1970 field survey results indicate that 62 motorists were observed to need aid for the 2.48 million vehicle-miles (MVM) traveled, yielding a rate of 25.0 motorists needing aid per MVM. During the 1970 survey period, approximately 3,250 motorists were seen to stop along the survey section for a stopping rate of 1,310 per MVM.

The 1971 field survey results indicate that 101 motorists were observed to need aid for the 3.77 MVM traveled, yielding a rate of 26.8 motorists needing aid per MVM. During the 1971 survey period, approximately 5,500 vehicles were seen to stop along the survey section for a rate of stopping of 1,460 per MVM. These rates include all motorists who stopped during the survey period, whether or not they left prior to the end of the survey period, because they were included in the vehicle-miles of travel given.

A summary of the types of aid needed and the average times required for first contact to be made and for aid to arrive (as well as the average total stopped time) is given in Tables 1 and 2. The data are for both the 1970 and 1971 field surveys and include only those vehicles that stopped within the time limits of the surveys. Figure 3 shows total stopped time for all vehicles needing aid during the surveys, and Figure 4 shows times until first contact and aid arrived and total stopped time for vehicles that needed aid and that were serviced by the system during the 1971 survey.

Table 1. Details of vehicles needing aid during survey periods.

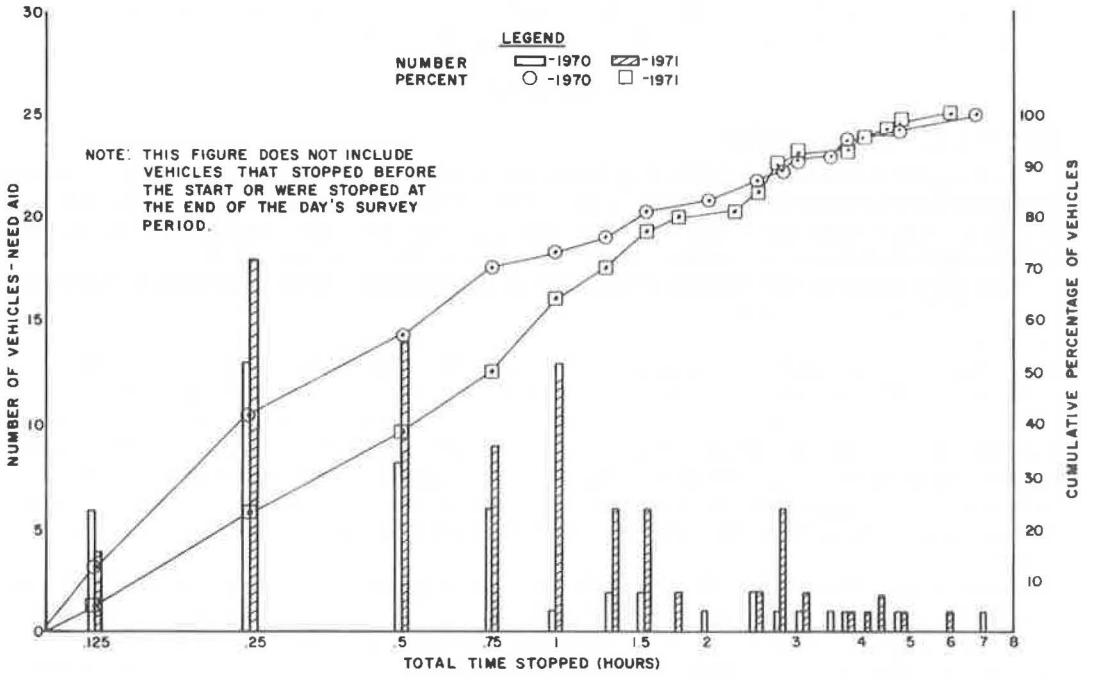
Reason for Stop	1970 Field Survey		1971 Field Survey					
	All Vehicles		All Vehicles		Vehicles Not Serviced by System		Vehicles Serviced by System	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Mechanical	28	45	50	50	35	47	15	58
Tire	13	21	25	24	20	27	5	19
Gas	9	14	5	5	4	5	1	4
Other[a]	12	20	21	21	16	21	5	19

[a]Includes motorists whose needs could not be determined by the field observers; also includes cases in which operating personnel failed to properly fill out the data log and one motorist who required water for his vehicle.

Table 2. Average time (in minutes) spent by vehicles needing aid during survey periods.

Item	1970 Field Survey	1971 Field Survey		
		All Vehicles	Vehicles Not Serviced by System	Vehicles Serviced by System
To first contact	42	30	28	38
Until aid arrived	44	48	44	60
Total time stopped	65	74	69	90

Figure 3. Total time stopped on test section.



Emergency Call System Use

During the 57 days of operation, 539 calls were received at the central monitoring station, of which 170 or 32 percent were classified as serviced by system. The remaining 369 calls, or 68 percent, were classified as gone on arrival. The 369 gone on arrivals can be divided into two groups. The first group includes those calls where the motorist had left before state police or Department personnel arrived, including the true false alarm calls and the ones where service was obtained from another source (e.g., passing motorist). This group includes 311, or 84 percent, of the 369 gone on arrival calls. The second group includes those motorists with whom contact was made by state police or Department personnel but who left prior to the arrival of the service vehicle. Because initial contact was made with state personnel, it is doubtful that many of these calls were true false alarms; instead, assistance was received from another source before the service vehicle arrived. These calls make up 58 or 16 percent of the gone on arrivals calls. Of the 539 calls received, the state police responded to 224 or 42 percent and Department of Transportation personnel responded to 315 or 58 percent.

The rate of vehicles serviced by the system for the 57 days of system operation (170 vehicles serviced by the system with 21.6 MVM of travel) was 7.9/MVM. During the field survey, 26 vehicles were serviced by the system per 3.77 MVM of travel, which yields a rate of 7.0 vehicles serviced by the system per MVM.

A summary of the types of aid needed by motorists who were serviced by the system is given in Table 3.

MAINTENANCE OF SYSTEM

A log of all maintenance required by the system was kept for a period of 7 months. The last 2 months were during operation of the system. A total of 45 maintenance calls were handled. Two major problems were encountered: failure of system due to electrical shorts to ground and destruction of posts and switches by vehicles and lawn mowers.

During the 2 months of operation, the system or part of the system was down for a total of 35 hours due to a variety of electrical and test equipment malfunctions.

The most serious problem was shorts to ground, traced to excessive moisture in the underground splices and cable or moisture and corrosion in the splices aboveground. This problem was the most difficult to trace and repair. Repair time averaged 5 hours for the major down periods.

The remaining down periods were due to component failure in the test station monitoring equipment. These down times were relatively short compared to the periods described above. After 1 month of operation, all audio and visual alarm sensor cards developed a malfunction and were removed from the test set and not replaced. However, this did not in any way inhibit operation of the system. One memory voltmeter card, three relays, two capacitors, and indicator lamps were also replaced during this period.

Although the moisture problems were corrected during the down times, this problem recurred every time there was a rainstorm or excessive humidity; the short would be relieved as the ground, cable, or switches dried.

All maintenance calls were the responsibility of the Bureau of Instrumentation Services of the Department.

SYSTEM COST

Table 4 gives the costs incurred in the installation and operation of the two-wire emergency call system. The cost of installing this system reflects the expense of the materials and equipment used, along with the salaries of the personnel who installed and inspected the system. The cost also includes all operational and maintenance costs incurred for 57 days or 1.9 months of operation.

Operational costs include utilities, vehicle usage, and salaries for two men per shift for three 8-hour shifts per day who maintained the central monitoring station. All personnel used in the monitoring station were employed by the New Jersey Department of

Figure 4. Time expended by motorists using system.

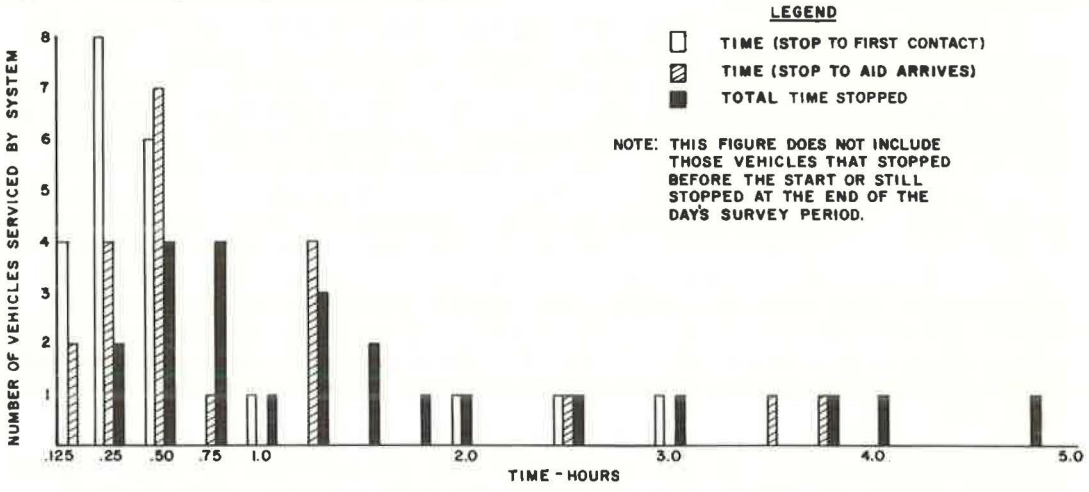


Table 3. Types of aid needed by motorists serviced by system.

Type of Need	Vehicles	
	Number	Percent
Mechanical	100	59
Tires	30	18
Gas	25	15
Other	15	8

Table 4. Breakdown of expenses for the two-wire call system.

Expense Item	Breakdown	Cost (dollars)
Installation		
Materials and equipment	Electrical installation contract	52,479
	Electrical equipment	3,500
	Vehicle expense	1,073
	Approximate cost of wire	9,000
	425 switches at $15.54/switch	6,605
	Housing for equipment	1,000
	Informational signs	1,500
Salaries[a]	Equipment installation (1 man-month)	1,000
	Delineator sign and switch installation (5 man-months)	5,000
	Inspection and testing of system (2½ man-months)	2,500
Subtotal		83,657
Maintenance	Delineator post and switch replacement	800
	Electrical equipment and cable	200
Subtotal		1,000
Operation	16 man-months[a]	16,000
	1 vehicle at $100/month	200
	Utilities	250
Subtotal		16,450
Total		101,107

[a]Salaries are based on $1,000 per man-month.

Transportation, and their salaries were computed at an average rate of $1,000 per man-month. However, it is important to note that the system may be intended to be operated by the state police. Thus, the operating costs of the system, if run as intended, would be quite negligible because of the use of normal police patrols to respond to the calls and the desk sergeant to monitor the operation in addition to his other duties.

Maintenance of the system was also performed by Department personnel. Maintenance costs involved materials and equipment needed to repair breakdowns in the system and personnel salaries for time involved in making the repairs. If the system, as intended, had been run by the state police, it might have been necessary to contract personnel for handling the maintenance of the system.

Table 5 gives a comparison of the expenditures of two other emergency call systems and the two-wire call box system. Both of these other systems provide the motorists with a means of summoning aid, as the two-wire emergency call system does, but differ in the mechanics of actual use. The two systems are the Michigan telephone system and the Texas call box system. The costs of the systems are broken down by installation, maintenance, and operation.

DISCUSSION OF TWO-WIRE SYSTEM

The results of the study indicate that not all of the primary objectives were acheived. The system, as designed, did provide the motorist with call switches spaced very close to each other and was simple to operate. However, the 2-month operating period did not indicate a low maintenance cost. Installation costs on a per-mile basis were high, but, because there were 50 switches per mile, the cost per unit switch was low. The largest portion of the installation cost was the contract to bury the wire. The cost of burying the wire may have been much less had it been performed by state forces instead of an outside contractor. This reduction in cost may have made the installation cost less than those of either of the other systems given in Table 4.

1970-1971 Field Study Comparison

When the 1970 and 1971 field results are compared, consideration must be given to the types of aid required. The comparisons given in Table 1 show that a slight increase in the percentage of the mechanical and tire needs was evidenced during 1971. However, the 1971 results indicate a much higher percentage of mechanical difficulties for those motorists using the system than for those motorists who chose not to use the system.

It may be assumed that many motorists who felt they had a serious problem (mechanical) were inclined toward using the emergency call system. The needs of the 1970 motorists and the 1971 motorists that were not serviced by the system were very similar.

Also, when the average total time stopped, average time to first contact, and average time until aid arrived between 1970 and 1971 are compared (Table 2), some interesting observations can be made. The average total time stopped and the average time until aid arrived for those who were serviced by the system were significantly higher than the corresponding times in 1970 and in 1971 of those who did not use the emergency call systems. Although no conclusive evidence is available, we may assume that many of those motorists who felt they had a serious problem utilized the system. Also, when a motorist used the system, he frequently refused aid from passing motorists, indicating that he had aid coming, but there were times when the aid was delayed. For those motorists who did not use the system (in 1970 and 1971), the first contact was frequently the source of aid, probably because the type of aid required was of a minor nature.

Emergency Call System Use

The fact that the system experienced a false alarm (gone on arrival) rate of 68 percent is difficult to explain. Although we have no absolute evidence except during the survey, not all of the gone on arrivals should be classified as no aid needed. It is shown that a number of them did need aid but serviced themselves or received aid from

passing motorists prior to initial contact by the state police or Department personnel or, in some cases (16 percent), after initial contact but before the service vehicle arrived. Table 6 gives the reasons for gone on arrivals during the 1971 field survey period.

The operation of the emergency call system for 57 days showed that the majority of calls received and serviced were from those motorists having some form of mechanical problem (59 percent). The next largest group (18 percent) had a tire problem. The large variance between these two groups may be explained in that only those motorists that had potentially serious problems tended to use the system to summon aid.

A comparison of the field survey data for those who used the system (Table 1) and the log of the central monitoring station for system usage (Table 3) indicates a difference in percentages of two of the reasons for motorists' summoning aid: gas and other. The reasons for these differences can be attributed to the small time sample for the 1971 field survey, a lack of accurate identification on the part of field survey personnel, and failure to properly complete both the central monitoring station and the state police logs.

Without an emergency call system, it may be expected that some motorists will have to wait excessively long periods of time before first contact is made (another motorist stopping). In fact, this waiting period will add substantially to their total time stopped on the road. However, the operation of an emergency call system should show a reduction in the distribution of time until first contact (at least with the two-wire system). The explanation of why this was not true (Table 2) follows.

The distribution of times for motorists awaiting aid (utilizing the call system) is shown in Figure 4. If it is assumed that ½ hour is a reasonable time for operating personnel to respond to a call and if the failuure of the operating personnel to respond to all calls within that time could be overcome, the average time to first contact could be reduced by 18 min. Similarly, if the aid that is requested by the motorist can arrive within 1 hour after being notified (a maximum of 1½ hours after the time the motorist stopped), the average time stopped until aid arrives could be reduced by 15 min. It follows that a reduction of 15 min in the average time from stop until aid arrives would result in a similar reduction in the average total stopped time (Table 2 and Fig. 4). The increased number of serious problems (mechanical) in 1971 over 1970 (50 versus 28) at least partially explains the longer average stopped time for 1971.

The rate of motorists serviced by the system was 7.0/MVM during the survey periods and 7.9/MVM for the 57 days of system operation. The rate of drivers needing aid, 26.8/MVM, determined from the survey periods, is assumed to be constant for the 57 days of system operation. From these figures, it is determined that between one of three and one of four motorists needing aid utilized the emergency call system during the period of system operation.

SUMMARY AND CONCLUSIONS

With the rapidly increasing mileage of limited-access highways being built, the need for a means of summoning aid by stranded motorists is becoming of paramount importance. Emergency call systems are available that use land wires or radio propagation. However, because of the unit station cost, call stations are usually located between ¼ and 1 mile apart. In an attempt to place call stations closer together, a two-wire emergency call system was developed. This system provides call stations along the shoulder of a highway on each delineator post spaced an average of 200 ft apart. Because of the large number of call stations per mile, a low-cost call station was devised. The station only provided a switch that the motorist depresses to indicate a need. No provisions for type of aid needed or verification of a call being received were made. A vehicle is dispatched to the site of the call to collect the required information. Field surveys and system usage records were utilized to determine types of needs and servicing times.

The system was operated for 57 consecutive days during summer 1971. During this period, there were 21.6 MVM of travel in the system operation area. A total of 539 calls were received at the monitoring station: 170 were serviced by the system, and 369 were classified as gone on arrival.

Table 5. Comparison of costs for two-wire call system and two other emergency call systems.

Location	Type of System	Length of System		Call Station Spacing	Installation Expenses (dollars)			Maintenance Expenses (dollars)		Operation Expenses (dollars)	
		Months	Miles		Total	Per Mile	Per Call Station	Total	Per Mile per Month	Total	Per Month
Michigan	Telephone	42	30	1 mile	290,170	9,670	4,835	55,895	56	5,114[a]	426[b]
Texas	Call box	12	11	¼ mile	161,025	14,639	1,830	20,000[c]	151		
New Jersey	Call box	2	8.2	200 ft	83,657	10,202	197	1,000	60	16,450	8,660

[a]Annual. [b]For 12 months. [c]Estimated.

Table 6. Reasons for motorists who were gone on arrival during 1971 field survey period.

Reason	Before First Contact		Before Service		Total	
	Number	Percent	Number	Percent	Number	Percent
False alarm	24	73	0	0	24	55
Fixed self	1	3	2	20	3	7
Called own service	0	0	3	30	3	7
Assisted by other motorist	3	9	5	50	8	19
Unknown	5	15	0	0	5	12
Total	33	100	10	100	43	100

A sample of the stopped motorists, made by a field study, indicated that 37 percent of the total calls received were false alarms, and 31 percent serviced themselves or received aid from other motorists.

The 170 motorists serviced by the system yielded a rate of 7.9 vehicles serviced per MVM for the period of system operation. The rate of motorists needing aid, as determined from the field survey, was 26.8/MVM, showing that almost one in three motorists needing aid were serviced through the call system.

The study did not show the two-wire system to have a low maintenance or installation cost in comparison with other types of call systems on a per-mile basis. However, the two-wire system provided call boxes at 200-ft spacings instead of ¼- to 1-mile spacings, thus reducing the stranded motorist's exposure to traffic while walking to a call station.

For the emergency call system studied to be effective, the time for aid to arrive must be reduced. The long periods of time taken for aid to arrive can be partially explained by the failure in some cases of the operating and servicing personnel to respond in a short period of time. It must be noted that this is true with any type of call system and should not be considered a fault of the two-wire system alone. The total length of time stopped was much longer for motorists who used the call system than for other motorists needing aid. This can be explained by the fact that motorists with serious (mechanical) problems were more likely to use the call system than those with minor problems, thus increasing the time to effect repairs.

At the present stage of development, the two-wire emergency call system has not proved to have any significant advantages over other types of call systems now in use. If further research is conducted, two areas should be included. First, the equipment should be refined, and, second, procedures must be implemented to reduce the time required for servicing agencies to respond to motorists who need aid. One approach is to investigate the advantages of contracting with service agencies for the service.

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