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16. Abstract

This report presents the analysis of a questionnaire survey administrated to the responsible governmental agencies which have or had motorist aid systems (MAS) and those manufacturers of recent MAS equipment. The topics covered with each agency include: 1) Indication of present MAS configuration; 2) Reasons for removal and alternatives provided; 3) Recurring costs and systems benefits; 4) Experiences, desired changes, and definite problems; and 5) Trends in MAS. The four manufacturers surveyed covered: 1) Basic statement of primary product; 2) Communications techniques employed; 3) Problems in contracting agencies' expertise; and 4) Future trends in MAS communications.

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STATE-OF-THE-ART OF MOTORIST AID SYSTEMS

by

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Research Report 165-17

Development of Urban Traffic Management
and Control Systems

Research Study Number 2-18-72-165

Sponsored by
The State Department of Highways and Public Transportation
In Cooperation with the
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Texas Transportation Institute
Texas A&M University
College Station, Texas

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ABSTRACT

This report presents the analysis of a questionnaire survey administrated to the responsible governmental agencies which have or had motorist aid systems (MAS) and those manufacturers of recent MAS equipment. The topics covered with each agency include: 1) Indication of present MAS configuration; 2) Reasons for removal and alternatives provided; 3) Recurring costs and systems benefits; 4) Experiences, desired changes, and definite problems; and 5) Trends in MAS. The four manufacturers surveyed covered: 1) Basic statement of primary product; 2) Communications techniques employed; 3) Problems in contracting agencies' expertise; and 4) Future trends in MAS communications.

SUMMARY

There are 13 states which have 40 operational motorist aid systems with a total of approximately 5,200 aid stations. Four of the states have planned expansions or new systems in progress at this time. Only two states have removed systems since 1971 because of operational and maintenance problems. One of these states has implemented a state funded and operated emergency patrol service as a successful alternative to MAS.

The costs and benefits of all motorist aid systems has not been fully determined. Data from some of the agencies were not available and the complete results are not given. Apparently, many agencies are not concerned about quantifying the benefits since motorist aid is considered a public service. However, the costs for providing the system and operating and maintaining the equipment are important, particularly with inflation causing budget problems for all agencies. More research is needed to determine measureable results of current MAS to justify these continually rising costs.

Changes to the present MAS, as indicated by the states, to improve operations included: 1) Providing illumination at aid stations for night-time use; 2) Establishing uniform signing; 3) Redesigning field communications facilities; and 4) Incorporating in the pre-planning stage, all participating agencies (city, county, state, and federal) before systems are designed. Maintenance of motorist aid systems indicated problems caused by: 1) Vandalism at the aid stations; 2) Severance of buried cables, and 3) Maintenance by and from 'other' agencies. These operational and maintenance changes were the results of problems that directly affected MAS.

Trends, as indicated by both the users and suppliers of MAS, are toward voice communications and radio equipment. The concept of in-vehicle communications is anticipated to replace or complement the present motorist aid systems. Some of the new equipment being produced for voice-radio and coded-radio systems has the capabilities for field conversion for in-vehicle communications. Before implementation of the in-vehicle communications, much research and development work, both on the part of the users and suppliers, must be accomplished. In addition clearances, allocations, and regulations from the Federal Communications Commission must be procured.

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INTRODUCTION

Study Description

At the height of the energy crisis, motorists across the United States were faced with limited fuel supplies and the curtailment and uncertainity of service station activities. Motorists had additional problems on urban and remote limited access freeway facilities whenever road services were needed and were not available. City, county, and state agencies responsible for the operations of these freeway facilities generally use patrols to locate the stranded motorists since stalled or parked vehicles adversely affect traffic operations as well as the safety of all motorists. For those traffic facilities where emergency motorist aid systems were operational, the increase in the number of motorists needing aid is taken care of with only minimal increased effort on the part of the operating agencies. For those traffic facilities where motorist aid systems were not present, agencies had to increase service patrols and begin to investigate other ways and means of locating and aiding the stranded motorist. This report surveys the traffic facilities that have operational motorist aid systems.

A questionnaire method was used to gather information on the motorist aid systems (MAS). A literature search of publications, periodicals, and reports which described either equipment and operational systems was used in locating agencies involved in MAS. Fifteen states and four equipment manufacturers were contacted by letter requesting the cooperation of the agency or company in completing a short questionnaire. Appendix A contains samples of each type of questionnaire. All questionnaires were returned, with the exception of one manufacturer, and further correspondence

was used to clarify or confirm some of the answers. The excellent cooperation of the various highway departments and manufacturers has enabled this report to present timely and pertinent information.

The types of MAS investigated in this report were limited to systems where roadside call boxes or telephones were used. Systems such as REACT[1], HELP[2], and FLASH[3] were not studied since their application has been limited to a few research and demonstrative installations. The findings from the questionnaires indicate that various parts of all the above communication systems may be utilized in future MAS.

Objective

The objectives of this report are to present the status of motorist aid systems now in operation in the United States; to examine the developing trends in MAS; and to delineate implementation and operational problems as determined by the responsible agencies.

MOTORIST AID SYSTEMS

The increased use of the automobile and increased utilization of the expanding freeway networks have created a need to provide assistance to stranded motorists. The required assistance takes several forms of road services; such as towing, mechanical repair, police, fire, ambulance, and information. The proper application of MAS provides quick detection and location of stranded motorists, a means of communicating the type of help required, and a timely and appropriate response.

Basic System Description

Motorist aid systems can be divided into two general categories; voice and non-voice communications. In voice systems, a common handset or telephone

receiver is used by the motorist for two-way voice communications with a communications center. In non-voice systems, the motorist activates one of several possible requests by pushing a button. Confirmation at the aid station is observable by the motorist by means of an illuminated lamp or audible tone. The communication media for either the voice or non-voice system may be public telephone circuits (wireline), state owned cables (wireline), assigned radio frequencies, or submultiplexed over a microwave carrier. Each control or communications center, which is usually operated by police or highway patrol personnel, has common equipment, a message receiving and confirmation unit; a printing or recording unit for automatic message documentation; and an automatic call station checkout unit. The control center operator has communications to local agencies for police, ambulance, fire, and road service requests.

The complexity of the systems will depend upon: 1) Number of call stations; 2) Total distance covered by aid systems; and 3) Type of communications media utilized. This report does not investigate in depth each motorist aid system surveyed, but the collective data on all systems does provide trends in design, operational and maintenance costs, and benefits.

Questionnaire Survey

Information was collected by two questionnaire surveys; one directed to the governmental agencies and the other to equipment manufacturers responsible for MAS. The information requested from the governmental agencies was concerned with: 1) System size; 2) Design alterations; 3) Economics of systems; 4) Operational problems; and 5) Changes in maintenance and operations. The basic facts requested from the manufacturers were: 1) Their activity in MAS; 2) New products or techniques being developed; and 3) Critique of the expertise of the contacting agencies. Detail summaries

for each questionnaire are presented in the following sections.

QUESTIONNAIRE SUMMARY - STATES

Present Operational Systems

Table 1 delineates the present configuration of MAS in the United States. In 1971 (4), 12 states had 19 operating systems and at least a dozen additional small-scale systems (25 or less roadside units each). Fifteen states had systems in various stages of planning or implementation. Since 1971, two of the 12 states (Michigan and Texas) have entirely removed the MAS. Five states (California, Connecticut, Illinois, New Jersey, and Washington, have expanded the number of call stations. Of the 15 states planning systems in 1971, only 3 have actually installed systems. Presently, 13 states have or will have 40 systems in operation. Other states have indicated an interest in MAS and are presently studying their needs and the available system configurations.

The largest system is operated by the State of California. Agreements between Los Angeles County and the California Department of Transportation provide for a total of 3,264 telephones. At the present time, there are over 2,100 telephones in operation along 290 miles of Los Angeles freeways. The County paid approximately $1,000,000 to the telephone companies for the initial installation charges, and the State of California spend $200,000 for signing and paved areas adjacent to the telephones. Los Angeles County manages the system, the California Highway Patrol answers all calls and dispatches the appropriate services, and two telephone companies provide the communications and maintenance. The California system represents the largest single system in quantity of units and costs of initial installations

TABLE 1. Operational Motorist Aid Systems (A)

LOCATION	# UNITS	SPACING (MILES)	TYPE	SYSTEM MANAGER	ORIGINAL SYSTEM COST ($1,000)	PATROLLED	FUNDED BY	NOTES
CALIFORNIA								
Harbor Fwy.	182	1/4	Telephone			California Highway Patrol	County of Los Angeles	MAS entirely telephones
San Diego Fwy.	394	"	"	County of Los Angeles	1,150			
Hollywood Fwy.	123	"	"					
Ventura Fwy.	250	"	"					
Santa Monica Fwy.	130	"	"					
Santa Ana Fwy.	148	"	"			Southern California Auto Club (Limited)		
Golden State Fwy.	230	"	"	California Highway Patrol answers calls				
Pomona Fwy.	184	"	"					
San Gabriel Fwy.	162	"	"					
Long Beach Fwy.	176	"	"					
*Terminal Island Fwy.	28	"	"					*Not yet installed
*Marina Fwy.	28	"	"					
Foothill Fwy.	61	"	"					
Pasadena Fwy.	46	"	"					
San Bernardino Fwy.	106	"	"					
CONNECTICUT								
Waterbury Viaduct (I-84 & Conn. Rte 8)	18	Varied	Telephone	State DOT	Conduit by DOT	State Police	DOT	Calls answered by Waterbury Police Department
Gold Star Bridges (I-95, Thames River) New London	27	2/10	Telephone	State DOT	Conduit by DOT	State Police	DOT	All calls to State Police at Montville Barracks

TABLE 1. Operational Motorist Aid Systems (Cont.) (B)

LOCATION	# UNITS	SPACING (MILES)	TYPE	SYSTEM MANAGER	ORIGINAL SYSTEM COST ($1,000)	PATROLLED	FUNDED BY	NOTES
Charter Oak Bridge (Routes US 5 & Conn. 15)	11	1/10	Telephone	State DOT	R e m o v e d		DOT	Spring 74 Non-use
Old Saybrook Bridge, I-95	10	1/10	"	"	12 Conduit & Posts by DOT	State Police	DOT	Maintained by Telephone Co.
I-84 (22 Mi.) & I-91 (20 Mi.)	178	1/2	Radio-Voice Duplex + Micro-wave Stations	"	600	"	90/10	All calls to State Police at Westbrook Barracks Under construc-tion-Microwave to be used by other State agencies-DOT maintenance, expandable
FLORIDA								
I-95 & I-95	180	1/2-3/4	Radio-Voice	Florida DOT	329	Florida Highway Patrol	DOT (90/10)	
I-75	164	1/2	Coded Radio	"	273	"	"	

TABLE 1. Operational Motorist Aid Systems (Cont.) (C)

LOCATION	# UNITS	SPACING (MILES)	TYPE	SYSTEM MANAGER	ORIGINAL SYSTEM COST ($1,000)	PATROLLED	FUNDED BY	NOTES
ILLINOIS								
I-80	302	1	Two-way Voice-Land Line	Illinois State DOT	1,047	State Police	90/10	System owned by Illinois DOT-Div. of Highways. State dispatches services. Operational - March 1973.
I-55/70 & I-270	165	1/2	Coded Radio	Illinois DOT-Division of Highways	428	Illinois DOT Emergency Patrol	90/10	Operational - August 1973 Services: Mechanical, Medical, Police, and Cancel.
KENTUCKY								
Louisville Fwys.	110	1/2	Telephone	Louisville Police Dept.	---	Louisville Police Dept.	---	Some units installed on street system.
MARYLAND								
Jones Falls Expwy.	12	1	Telephone	City of Baltimore	No installation charge made	Baltimore Police Dept.	City of Baltimore	Installed by Telephone Co. $2,000 per year covers cost.

TABLE 1. Operational Motorist Aid Systems (Cont.) (D)

LOCATION	# UNITS	SPACING (MILES)	TYPE	SYSTEM MANAGER	ORIGINAL SYSTEM COST ($1,000)	PATROLLED	FUNDED BY	NOTES
Harbor Tunnel Thruway	12	1/2	Telephone	Maryland State Admin.	1.85	Maryland State Police	Maryland State Admin.	Toll Road
I-495 (Capital Beltway)	265	1/8-1/2	Coded Radio	"	379	"	And FHWA	Federal Aid
MASSACHUSETTS								
I-495	250	1/2	Coded Radio	Mass. Dept. of Public Works	900	Mass. State Police	FHWA (90/10)	
MINNESOTA								
I-94 (Lowry Hill Tunnel)	18	3/50	Telephone	Minn. Highway Dept.	---	Minnesota Highway Patrol	Minnesota Highway Dept.- FHWA	
NEW JERSEY								
Atlantic City Expressway	100	1	Coded Radio	Expressway Authority	175	State Police Commission Patrol	Expressway Authority	Toll Road

TABLE 1. Operational Motorist Aid Systems (Cont.) (E)

LOCATION	# UNITS	SPACING (MILES)	TYPE	SYSTEM MANAGER	ORIGINAL SYSTEM COST ($1,000)	PATROLLED	FUNDED BY	NOTES
I-80	50	1/2	Telephone	N.J. DOT	250	State Police	DOT (90/10)	Operation - State Police; Maintenance - New Jersey DOT
NEW YORK								
I-87	712	1/2	Telephone	State DOT	676	N. Y. State Division of State Police	State DOT	Five area state police stations receive calls
PENNSYLVANIA								
I-80	370	1/2	Telephone	State DOT	382	Penn. State	State DOT	Contractor - Bell Telephone Co. Fifty percent cash - Remainder amortized at $6,350/month, includes maintenance
VIRGINIA								
Chesapeake Bay Bridge - Tunnel	118	1/18-1/2	Telephone	Operations-Police; Maint. - Maint.Div.	70 (Exclusive of cable trays)	District Police	District	

TABLE 1. Operational Motorist Aid Systems (Cont.) (F)

LOCATION	# UNITS	SPACING (MILES)	TYPE	SYSTEM MANAGER	ORIGINAL SYSTEM COST ($1,000)	PATROLLED	FUNDED BY	NOTES
WASHINGTON								
Alaska Viaduct	35	1/18-1/4	Telephone	City of Seattle				
Tacoma Narrows Bridge	22	1/10	Telephone	WSDH				106 calls in 1 year
Evergreen Pt. Floating Bridge SR 520	36	1/3 (Both Directions)	Telephone	WSDH	4.5		Wash. State police & Tacoma Bridge Auth.	11.4 calls/MVM $250/month
SR 18 @ SIR	1		Telephone	WSDH			WSDH	$45/month
Proposed Systems								
I-90 @ Bulge of 1st Lake Float Br.	4		Party Line Telephone	WSDH			WSDH	To supplement Wrecker Patrol now in use
I-5 Thruout downtown Seattle		1/4	Private Line Telephone	WSDH			WSDH	Will incorporate high sound volume & noise shielding

TABLE 1. Operational Motorist Aid Systems (Cont.) (G)

LOCATION	# UNITS	SPACING (MILES)	TYPE	SYSTEM MANAGER	ORIGINAL SYSTEM COST ($1,000)	PATROLLED	FUNDED BY	NOTES
District of Columbia								
Various Points	7	-	Telephone	Dept. of Hwys.	-(1)	Metropolitan Police Dept.	Dept. of Hwys.	(1) Installed with operating funds
I-95	41	(Covers 1.5 mi.)	Telephone	"	-(2)	"	"	(2) Included in construction
I-295	26	(Covers 5.25 miles)	Telephone	"	-(2)	"	"	
Puerto Rico								
P.R. 52	67	1	Coded Push-Button	Highway Authority	318	Police	Highway Authority	35 Miles Open 20 Miles Planned
P.R. 22	7	1	Coded Push-Button	"	Included Above	Police	"	4 Miles Open 50 Miles Under Construction

and operations. The costs are apparently justified based on the number of persons served (see section on Economics). The average number of aid stations in all reported systems is approximately 125 units.

Unit spacing in urban areas range from 1/5 to 1/2 mile. In rural areas, such as the 138-mile section of I/80 in Illinois, unit spacings of one mile are used. The exact effect of unit spacing is not known, but the above spacings have been used in operational systems for some time and no unique problems have been observed or reported by the operating agencies.

Communications Media

The type of communications used by each facility is indicated in Table 1. Telephone type communication is two-way voice and occurs over regular telephone company lines except where noted, such as I-80 in Illinois where state owned cables are used. Coded-radio, voice-radio, and radio-voice duplex occur by FCC assigned radio frequency communications. Short distances separating the communications center and transceiving towers, such as the Illinois and Connecticut facilities, may be connected by wireline, even though the majority of the communication is RF. More communications information is covered in following sections.

Management Organization

The majority of system managers are the state highway departments or departments of transportation. California, Kentucky, Maryland, and Washington have MAS where the system managers are the city, county, or some other authorized agency. The state police or highway patrol operate the MAS and dispatch services in all but four systems. Of these four systems, three city police departments and one expressway authority operate and dispatch requested services.

Patrolling agencies are the operating agencies and indicated as being

the state police or highway patrol.

Removal/Alternatives

One question was designed to determine the reasons for systems to be removed or altered. Two states have completely removed systems while others have replaced one hardware type with another. The State of Michigan removed from service 62 telephones from I-94 (Jackson-Battle Creek). The problems that caused the removal of the system were both operational and environmental. Several independent telephone companies were interconnected to tie voice communications together. This design caused interruption in the quality and operations of the system. Other disruptions were caused by lightning and traffic accidents.

The 145 coded-radio call boxes on I-45 in Houston were removed after two years of operations by the State of Texas. In the opinion of the motorists surveyed, the prices posted on each call box for road service, such as wrecker towing, fixing flat tires, and gasoline were too high. The wrecker association, fire department, and ambulance service became reluctant to answer requests unless the calls were confirmed by the police at the site because of the large nunber of 'gone on arrivals.' Therefore, the City of Houston Police Department answered and responded to all calls and consequently the time of response for services other than police was greater than desired. Overworked staff and crowded space conditions within the police dispatcher's office where calls were received were problems. Also, the police department preferred voice communications.

The State of California replaced 114 coded-radio call boxes with 123 telephones several years ago. The only reason stated was that the coded-radio system proved unreliable. Connecticut removed 11 telephones due to vandalism damage and malfunctions. Also, the state of Washington removed

TABLE 2. Summary of Removal/Alternatives

STATE	QUESTION 1	QUESTION 2
California	Coded radio replaced with telephones on Hollywood Fwy. Unreliable operations.	Normal patrols
Connecticut	I-84 at Route 8 - 18 telephones removed due to location and traffic conditions. Charter Oak Bridge at Hartford - 11 telephones removed due to vandalism and malfunctions.	No alternatives until evaluation of new radio system.
Michigan (Telephones)	Removed because of excessive operational problems. System design included interconnection with independent companies. Problems with voice grade lines and environmental conditions caused removal.	No organized supplemental aid has been provided. Area is patrolled by police as priorities permit.
Texas (Coded-Radio)	Removed after 2 years. Many motorists did not use call boxes because they felt prices of services (posted on boxes) were too high. Long delays or reluctance to answer calls by wreckers and ambulances because of 'gone on arrivals.' Calls received by police department dispatcher's office, whose personnel were already overworked.	After system was removed, a 24-hour freeway emergency patrol was provided by Texas Highway Department.
Washington	1 pair of telephones removed after service station opened at same location. One hundred percent non-use.	None

one pair of telephones after a service station opened at the same location. The motorist preferred to use the public telephone instead of the emergency phones.

"If a system was removed, what alternatives to the MAS were provided?" This question was answered by the two states which had removed systems in the following manner. Michigan had no organized activity other than the regular police patrols system of the area that was based on a priority basis. Texas implemented a 24-hour freeway emergency patrol service on the I-45 freeway section as well as other freeway facilities in the immediate Houston area. The other states indicated no special activities in this area.

A report in 1971 (4) listed an 8.2-mile section of I-287 in New Jersey as an operational motorist aid system. This system was an experimental continuous two-wire buried cable with push-button switches mounted on delineator posts every 200 feet. The response to the questionnaire by New Jersey indicated that this system was not considered operational at anytime and was removed after a two-month research test was completed. Therefore, this system was not included in the Removal/Alternatives analysis with the Michigan and Texas installations.

Cost/Benefit

The most difficult question to answer in the questionnaire was that of the economics of the motorist aid systems. Some agencies responding to this question either did not have complete figures available or were still evaluating their systems. Most agencies accept the fact that the total benefits associated with the MAS are unmeasureable. Stranded motorist present a hazard to themselves as well as to passing motorists. Safety factors and an increased feeling of security offered by MAS cannot always be represented in monetary terms. The most common item used by the agencies

to represent the benefits offered by the MAS was the number of annual calls.

California led in the number of calls received annually with over 288,300. Not all states were able to provide the annual number of calls or the maintenance and operations costs as indicated in Table 3. Those MAS which utilize police agencies to answer all calls, such as in California and New York, have operating costs which are not included in the annual costs. The cost to the police agencies is difficult to assess as personnel that answer MAS requests share duty responsibility with other dispatch activities. Therefore, complete annual costs per unit, as contained in Table 3, would be slightly increased to compensate for the police activities.

The experiences gained in the operation and maintenance of motorist aid systems by the states is presented in recommendation form in Table 4. Each communications group indicated that maintenance should be conducted by either a single agency or state agency. Several states reported the need for good illumination for the nighttime users of the aid station. System designs for aid stations to minimize vandalism were recommended more than once. Other recommendations were aimed at solving definite system weaknesses which have caused significant problems to operation or maintenance.

Experiences/Changes

Each state or agency was asked, based on experiences with operating MAS, to report on changes that would be made for the installation of new systems and the operation and maintenance of all systems. In summarizing the responses, the recommendations were divided into three groups based on the type of communication medium used: 1) Telephone leased line facilities, 2) Telephone and radio systems, and 3) Radio systems only.

Telephone Lease Line Facilities

Six states reported the exclusive use of telephone systems which used

TABLE 3. Economics

STATES / SYSTEMS	NUMBER OF UNITS	BENEFITS: TOTAL CALLS	BENEFITS: CALLS PER UNIT	MAINTENANCE	OPERATIONS	CAPITAL COST: PER SYSTEM	CAPITAL COST: PER UNIT	ANNUAL COSTS PER UNIT: AMORTIZED COST(1)	ANNUAL COSTS PER UNIT: MAINT.	ANNUAL COSTS PER UNIT: OPR.	ANNUAL COSTS PER UNIT: TOTAL	COST PER CALL	NOTES
California													
Total	2,248	288,300	128	226,800(a)	18,000(a)	1,150,000	511	76	100	8	184	1.43	(1) All capital and installation costs amortized over 10 years at an 8% interest rate.
Connecticut													
Waterbury	18	160-200 (Used 200)	11	100	2,400	----	---	---	5	133	---	----	(a) 1973 Data for Los Angeles County. Does not include Calif. DOT site costs or Highway Patrol costs for switchboard and toll charges.
Gold Star	27	150	5	200	3,800	----	---	---	7	140	---	----	
I-84/I-91	178	2,500 (Estimated)	14	17,460	2,540	600,000 (b)	3,370	502	98	14	614	43	
Florida													(b) Includes microwave 'backbone' carrier.
I-95/I-195	180	11,590 (d)	64	N/A	N/A	329,000 (c)	1,827	272	---	---	272	4.25	
I-75	164	7,100 (d)	43	N/A	N/A	273,000 (c)	1,664	248	---	---	248	5.76	(c) Installation includes 2-year maintenance.
Illinois													(d) 6 months projection.
I-80	302	13,600	45	N/A	N/A	1,100,000 (c)	3,642	542	---	---	542	12	Maintenance quote $85,000
I-55/I-270	165	5,200 (e)	31	N/A	N/A	428,000 (c)	2,593	386	---	---	386	9	Maintenance quote $35,000
													(e) Projected
Kentucky	110	100	1	40,000		N/A	---	---	363		363	363	Removal suggested by Louisville Police Dept.
Maryland													
Jones Falls	12	1,023	85	2,000		No Cost	---	---	166		166	----	
Harbor Tunnel	42	N/A	N/A	6,972		1,850	44	6	166		172	----	
I-495	165	18,250	110	35,000		379,000	342		212		554	----	
Massachusetts													
I-495	250	N/A	N/A	5,000		900,000	3,600	536	20		556	----	
Minnesota	18	1,000	55	3,363		N/A	---	---	214		---	----	
New Jersey													
A.C. Expy.	100	1,500	15	4,000		175,000	1,750	260	40		280	18	
I-80	50	N/A	---	N/A	N/A	250,000	5,000	745	---	---		----	Under construction
New York													
I-87	712	9,200	12	172,098		676,000	949	141	241		382	31	
Pennsylvania													
I-80	370	4,052	10	86,200		382,000	1,032	153	232		385	38	
Virginia													
Chesapeake Bay	118	N/A	---	Slight		70,000	593	88	---	---		----	
Washington													
Evergreen Point	36	N/A	---	3,000		4,500	125	18	83		101	----	Washington figures - $/.25/call 0.024 cents/vehicle 0.0082 cents/veh-mile.

private telephone companies. Three states indicated adequate or satisfactory operations with their present system and recommended no changes. None of the responses of other types of systems expressed this level of satisfaction with existing systems. One of the six states indicated that new installation would switch from leased-line telephone to radio-voice facilities, but none of the states recommended the use of coded-radio. Other changes to design, operations, and maintenance are shown in Table 4.

Telephone and Radio Systems

Four states reported on both telephone and radio systems. Three states used coded-radio and one used radio-voice system. Their recommended changes indicated a switch to voice communications, with only one state recommending the use of the coded-radio.

Radio Systems

Three states, reporting on only radio systems, used coded-radio, with one of the states also having a two-way voice-radio system. That state was the only one recommending voice communications would be used in future systems. The other two states have just recently installed coded-radio systems and have little experience on which to recommend a change in design.

Trends

The states and agencies were asked to respond to whether any noticeable trends were developing for motorist aid systems. The two most commonly mentioned were: 1) Two-way voice communications and 2) Utilization of radio equipment (Table 5). Six agencies specifically mentioned two-way voice as being a trend, and radio communications, in some form, was mentioned by five responses. The combination of two-way voice with radio was mentioned as a

TABLE 4. Operations and Maintenance Changes

	TELEPHONE SYSTEMS	TELEPHONE & RADIO SYSTEMS	RADIO SYSTEMS
OPERATIONS	Aid Station		
	-Night illumination	-User illumination	-Operations Aspects to be planned before system design
	-Eliminate 'party lines'	-Capability to include changeable matrix signs and ice sensors and control	-Use of system whether emergency or non-emergency
	-Employ high gain sound	-Change button assignment	-Uniformity of highway signing
	-Noise Shield		
MAINTENANCE	-Breakaway pedestals at aid station	-Eliminate buried cable	-One agency to install, operate, and maintain
	-Cabled handsets (reduce vandalism	-Automatic system checkout	
	-Single maintenance agency	-Design to minimize vandalism	
		-Maintenance by state agency	

TABLE 5. Developing Trend by States

TREND	NUMBER OF RESPONSES
Voice Communications	4
-By RF	2
RF Equipment - General	1
-Coded-Radio	1
-In-Vehicle Communications	3
Total Communications (Coaxial and Wide-Band)	1
Multi-Uses of MAS Communications	1
Privately Owned Systems	1
Observed No Trends	1
No Comments	3

part of a total in-vehicle communications for future motorist aid systems. The in-vehicle communications would be conducted between vehicles via low powered radio to roadside transceiving units relaying communications to area control centers. Also recognized for future utilization was coaxial cable and wide-band RF equipment with motorist aid systems being only a small part of the total communications picture. Motorist aid systems could also be used as the common carrier for other motorist communications systems such as changeable matrix signs, ice sensors, and sign control.

The trend toward voice communication is substantiated by the types of systems these states are using in expanding their MAS. Although this question was not specifically asked in the questionnaire, three states indicated expansion; one state with public telephones, one with private telephones, and the third with voice-radio communications.

Problems

The states and agencies were asked to respond to problems that adversely affected the maintenance and operations of the motorist aid systems. Table 6 includes a summary of the responses based on four groupings; field installation damages, failures in call box equipment, failure within communications systems, and miscellaneous problems. Many responders listed more than one problem area with only two states specifically stating no existing problems.

Freeway improvements and excavation activities were mentioned as being the greatest problem area for MAS which utilized buried cables. Also, vandalism at the call box units was a problem with two of the states. Those states which utilized the telephone type call box units with

TABLE 6. Problems Affecting Operation/Maintenance

AREA	NUMBER OF RESPONSES
Damage to Field Installations By:	
-Freeway Improvements	1
-Others	2
-Vandalism	2
-Knockdowns	1
Failures in Call Box Equipment:	
-Battery Charging Circuits	1
-Coded-Radio Circuits	2
-Time Clocks for Monitoring	1
-Corrosion	2
System Failures Due To:	
-System Monitor	2
-Cable Damage by Lightning	2
-Telephone Line Interconnection	2
-False Signals Received	1
-Circuit Interference	3
Miscellaneous:	
-Giving 'Non-Emergency' Aid	2
-Hiring Bilingual Operators	1
-Telephone Company Maintenance	1
No Stated Problems	2

underground cabling experienced most of the above problems.

Failures within coded-radio units included only two reported malfunctions of the electronic circuits. Two support devices within the unit, a battery changing circuit and a time-clock mechanism, did cause disruption in two separate installations. Corrosion was reportedly caused by salt water spray in one case and inadequate environmental protection in the other.

System failure occurred both in voice and non-voice systems. Monitor problems were limited to failures of a monitoring device to detect malfunctioning field units. In two separate installations, damage to buried cable was done by lightning. Telephone companies' communications were responsible for interferences, false signals, and interconnection problems.

The remaining problems were of a general nature and closely tied to operations of the motorist aid systems. The problem of whether the giving of non-emergency information over the voice type system was stated by two responders as being a problem. The ability to employ and retain qualified bilingual operators in a voice type MAS was also listed. The final problem listed was that the "telephones are maintained by the local telephone companies."

QUESTIONNAIRE ANALYSIS - MANUFACTURERS

communication as applied to MAS, and 3) The competence of contracting agencies in understanding the technical and practical problems encountered in MAS. Five companies were contacted and four responded with one company, a local telephone company, responding to the questions as applicable on a regional basis. The other three companies represent experiences and opinions based on a nation-wide coverage.

The telephone companies have historically avoided furnishing motorist aid communications since they are generally expected to do so 'at cost' as a public service inherent to monoply operations. Federal restrictions and other limitations prohibit the establishment of a system of coin telephones on most highway right-of-way. The telephone companies have cooperated with the states and agencies in those areas which desired to use the communication facilities to implement motorist aid systems. The best example of such cooperation has been the great Los Angeles MAS. Without doubt, the telephone companies have: 1) An extensive network of direct wirelines; 2) The ability to provide complete communications maintenance; 3) The facilities to link together far-reaching areas; and 4) The means of implementing MAS with lower original equipment purchase costs.

The questionnaire responses by the telephone company that was contacted were not included in the manufacturers' analysis. The fact that as a local company with restricted regional business interests, the opinions expressed in the questionnaire may not be the attitudes of other telephone companies. Also, no national organization within the telephone companies exists from which data can be secured.

Products

In the past, the market for motorist aid systems has been sparse with

few installations being implemented from time-to-time. In 1971, only one (California) of 19 systems in operation had been expanded with equipment designed as 'add-ons' to original equipment. This limited demand for MAS equipment and components has not made it profitable for many companies to undertake major research and develop programs. Therefore, in conducting a study of the existing suppliers for motorist aid systems, it was found that only six companies nationally market equipment. Four companies, whose products were bid or used in recent installations, were sent questionnaires and three of the companies responded.

Each company relies on other applications for use of their equipment. As shown in Figure 7, the basic products are directed towards: 1) Security systems, 2) Municipal fire departments, 3) Traffic control components (signal heads and controllers), and 4) Two-way mobile radio systems. One company entered the motorist aid equipment field through the simularities of requirements that applies to security systems and motorist aid systems. Another company has entered as supplier of MAS by the re-direction of mobile two-way radio systems. The other companies have traditionally supplied system equipment and components for traffic control. All the companies have been in business for more than five years and have had products under development for use in motorist aid systems for an average of four years.

Communications

The continued miniaturization of solid state electric components has enabled compact aid station equipment to be constructed. These advancements have particularly benefitted radio communications equipment; both voice and non-voice systems. This is evidenced by the fact that all

of the MAS suppliers have aid station equipment that mounts in less than 1.5 cubic feet of cabinet space and weights less than 50 pounds with the battery or power supply included.

Although several suppliers indicated more than one type of motorist aid unit that operated by different communications techniques, such as coded-radio versus voice-radio, only one type of unit was evaluated for each supplier in this report. All units must be FCC approved and assigned to operate in the following VHF or UHF bands. The coded-radio units operate in the 72-76 megahertz VHF band, while the voice-radio unit is assigned to operate in the 450-470 megahertz UHF band. All units are rated at one watt RF power. The coded-radio units send indentification information as well as service requested in each message. One coded-radio unit uses amplitude modulation (AM) encoding for a 10-bit message that is repeated three times powered from a battery. The other coded-radio unit employees frequency modulation (FM) encoding for a 9-bit message. This unit utilizes mechanical energy (stored by pulling down a handle) to run a small generator that supplies power for the message output operations. Twenty bits of indentification, unit status, and switching information via frequency shift keying (FSK) precede the FM voice communications for the voice-radio system. A rechargeable battery supplies power for the unit.

Only one of the aid systems (mechanical energy operations) cannot be 'checked out' from the communications center since no on-site stored energy exists. All other units can be remotely interrogated because of resident batteries. The specifications for all units indicate line-of-site transmission up to 25 miles. For transmission distances further than 25 miles or other conditions that affect the RF signal, repeater stations must be

used and are available from each supplier.

At the communications center, all suppliers provide basically the same equipment. The incoming signal from an aid station is received and decoded. An audible alarm is activated, a visual display of the box number is set, and for the coded-radio systems, the type of service requested is produced. The operator, in the voice-system, uses the telephone-type handset to converse with the caller for service requests. Permanent logs are provided by tape-printer devices that indicate date, time of day, location of call station, and service requested (if coded-radio). The communications center equipment is designed to operate from emergency power if primary power fails.

Trends

As indicated in Table 7, the responses from the manufacturers of MAS concerning trends in communications are somewhat general statements. The statements of trends in reliability, speed, and economics appear to be objective type statements of what that particular manufacturer is tyring to achieve. Certainly all manufacturers should strive to include these objectives in their designs and equipment. The theme of the remaining responses was voice communications in future systems. Radio-voice was mentioned by one manufacturer of coded-radio. The radio-voice manufacturer indicated future 'in-car' voice communications. This trend towards voice communications was also expressed by the states and agencies responsible for MAS as being desirable.

Communications and Technical Problems

The manufacturers were asked to answer the following questions based on the MAS proposals and specifications issued in the last two years,

TABLE 7. Manufacturers Data

Basic Product Direction	Development Time (Yrs)	Communications Techniques	Trends
Security Alarms Municipal Fire Departments MAS	5 1/2	Coded-Radio (Batteryless) Coded-Radio (Battery operated) Radio-Voice Wire-Voice	Reliability Speed Economical
Traffic Control Components (Signal Heads & Controllers) Municipal Fire Departments MAS	50 + 3	Coded-Radio (Battery operated) Radio-Voice	Radio-Voice
Communications 2-Way Radio (Mobile) MAS	15 + 4	Radio-Voice (Automatic identification)	'In-Car' Voice

"Has it been apparent that the contracting agencies understand and have made adequate allowances for the technical problems unique to the communications systems required by MAS?" Only one manufacturer indicated a brief and unexplained,, "Yes." The remaining MAS suppliers indicated the following responses:

> "It has become more apparent that states are more concerned with constant budget problems such as maintenance, logistics, personnel, etc."
>
> "Recent proposals indicate strong emphasis on maintenance free, reliable systems."
>
> "Little understanding of technical problems, thus making it necessary for assistance from other agencies, consultants, and manufacturers."
>
> "System performance is being specified."
>
> "In early systems, consideration was not given to frequencies available, bilingual operators, logistics, time consumption, re-charging batteries, failure characteristics of two-way mobile radio on the highway for 15 years, initial cost, etc."

As can be seen, these comments are opinionated to an extent, but there is a certain degree of truth that can be associated with each response. For instance, maintenance was listed by the states as a problem regardless of the type of communications media used for the MAS. To solve problems of earlier systems or experience, the states issued proposals to, hopefully, correct system weaknesses. Also, these responses from the manufacturers do indicate a need for more expertise on the part of the states in developing system designs and specifications.

SUMMARY

There are 13 states which have 40 operational motorist aid systems with a total of approximately 5,200 aid stations. Four of the states have planned expansions or new systems in progress at this time. Only two states have removed systems since 1971 because of operational and maintenance problems. One of these states has implemented and operated a successful emergency patrol service as an alternative to MAS.

The costs and benefits of all motorist aid systems have not been fully determined. Data from some of the agencies were not available and the complete results are not given. Apparently, many agencies are not as concerned about quantifying the benefits since motorist aid is considered a public service. However, the costs for providing the system and operating and maintaining the equipment are important, particulary with inflation causing budget problems for all agencies. More research is needed to determine measureable results of current MAS to justify these continual rising costs.

Changes to the present MAS, as indicated by the states, to improve operations included: 1) Providing illumination at aid stations for nighttime use; 2) Establishing uniform signing; 3) Redesigning field communications facilities; and 4) Incorporating in the pre-planning state, all participating agencies (city, county, state, and federal) before systems are designed. Maintenance of motorist aid systems indicated problems caused by: 1) Vandalism at the aid stations; 2) Severence of buried cables, and 3) Maintenance by and from 'other' agencies. The operational and maintenance changes were the results of problems that directly affected MAS.

Trends, as indicated by both the users and suppliers of MAS, are toward voice communications and radio equipment. The concept of in-vehicle communications is anticipated to replace or complement the present motorist aid systems. Some of the new equipment being produced for voice-radio and coded-radio systems has the capabilities for field conversion for in-vehicle communications. Before implementation of the in-vehicle communications, much research and development work, both on the part of the users and suppliers, must be accomplished. In addition clearances, allocations, and regulations from the Federal Communications Commission must be procured.

RECOMMENDATIONS

Based on the responses from users and suppliers of motorist aid systems in the United States, there exists the need for: 1) Utilization of more technical expertise and resources on the part of the agencies specifying and operating MAS; 2) More national uniformity and standardization of the functions of the electronics and communications equipment; and 3) More definite leadership from communications, state highways, state police, and federal transportation agencies in designing, operating, and maintaining motorist aid.

CLOSURE

To design, implement, operate, and maintain a successful MAS is time consuming, complex, and expensive. These facts are evident if the data in this report are studied. Many systems have been in operation for some years and all continue to require significant funding and manpower. Newer systems rely more on multi-year maintenance contracts and consequently installation costs go up to support this service. Many early systems have relied on conventional methods of voice communications via telephone companies. Maintenance is provided as a part of the telephone service, thus the complex equipment and system operations were not the responsibility of the MAS agencies. Recent installations, using voice-radio or coded-radio equipment, will require more competent technical resources on the part of the MAS agencies if useful long term operations are to be expected.

The survey results indicated that several states which had planned MAS in 1971 did not implement the systems. Although unreported by these agencies, the recurring costs and long range commitments had to play a dominant role in the non-implementation decision. The economic outlook in the near future in the United States will not be conducive to increasing involvement and support of MAS. Responsible agencies, with already overburdened budgets, will be forced to carefully evaluate all areas of traffic operations. The degree to which MAS will be affected will depend upon the effectiveness of present systems, the attitudes held by the responsible officials within the agencies, and the availability of installation and operational funds. Unless better methods can be established for which more real and reliable benefits can be found to evaluate the effectiveness of MAS, expansion and

support may be reduced. Although the general public may accept and use MAS, the total benefits will not be easy to quantify.

If the primary attitude of the responsible officials and agencies is to build and maintain traffic facilities, then redirection of priorities has to be established. At some point in time, responsible agencies must exercise responsibilities of operations. MAS may be only a part of a total traffic operations and management program.

In heavily traveled interconnected urban freeway systems, several traffic management systems must be included in a priority list of operations. The operations may include entrance ramp, freeway lane, and frontage road control systems; motorist information and aid systems; and incident detection and traffic diversion systems. Rural areas, such as the western part of the United States where long isolated stretches of the interstate system are may have only MAS as the primary traffic management program. In both cases, MAS has a role in the operations of traffic facilities and must be recognized by and planned for in the responsible agencies' programs.

Funding has been and will continue to be difficult to secure for operations. Participating federal funds will be available for the installation of MAS, but have not been available for operations. Agencies should thoroughly investigate the availability of local funds (city or county) during the preplanning stages.

Many more problems exist in establishing MAS than have been reported herein. Unreported were problems such as determining members and agencies of design teams, establishing objectives and goals for each MAS, affirming operational and maintenance responsibilities to mention a few. Operational agencies (mostly state or local police) often find more overhead in manpower

and equipment than originally envisioned. This may cause concern about the real purposes to be served by the police agency when the primary responsibility of the agency is law enforcement. Also, problems have been and will continue to be found in the response mechanism of supporting MAS. Service agencies must be totally aware of responsibilities to respond to MAS requests. Confidence placed in the MAS by the motorist and the overall effectiveness of the MAS will depend directly upon the cooperation of the operating and response agencies.

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APPENDIX A

Questionnaire - States

1. If systems were removed or altered, please explain why.
2. If systems were removed, what alternatives to the Motorist Aid Systems are being provided? (For example, increased freeway patrols.)
3. What are the economics of the MAS within the State?

   Benefits per year

   Operating cost per year

   Maintenance cost per year

   Cost per service call

4. Based on experiences with MAS, what changes would be made for the installation of new systems and the operation and maintenance of all systems?
5. What are the trends in communications equipment for MAS?
6. After the initial impact of the energy crisis, is there renewed interest in greater utilization of MAS within the State?
7. Please list the problems that have caused definite disruption to maintenance and/or operation of the MAS?

APPENDIX B

Questionnaire - Manufacturers

1. Is the basic product of the Company (or Division) Motorist Aid Systems? If not, briefly describe the basic product.
2. How many years has the Company been actively pursuing development of MAS?
3. List and describe the different MAS developed by the Company which operate from basically different communications techniques.
4. List and describe the number of MAS that the Company has installed in the last two years.
5. Describe (without divulging proprietary information) any new communications equipment, components, or techniques that are scheduled to be marketed by the Company in the immediate future.
6. List the regional and national competitors with which the Compamy must compete for MAS contracts.
7. Describe the trend in MAS communications based on the experiences or projections by the Company.
8. Based on the MAS proposals and specifications issued in the last two years, has it been apparent that the contracting agencies understand and have made adequate allowances for the technical problems unique to the communications systems required by MAS? If not, please explain why.