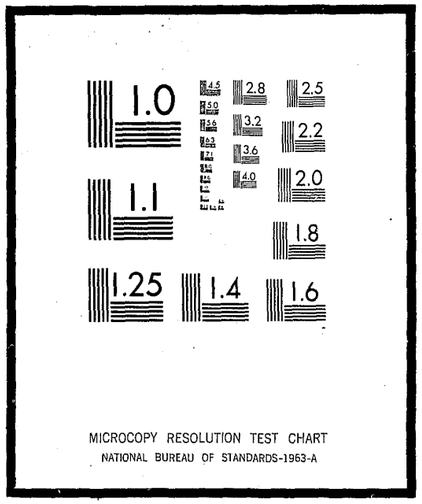

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ANNOTATION:
THE RELATION OF THE PATROL VEHICLE TO THE DEPARTMENT, PROCUREMENT OF BETTER VEHICLES AND POLICIES FOR USE, OPERATION, AND REPLACEMENT.

ABSTRACT:
THE GOAL OF THE RESEARCH WAS AN UNDERSTANDING OF THE VEHICLE IN RELATION TO THE POLICE DEPARTMENTS, TO AID DEPARTMENTS IN PROCURING A BETTER VEHICLE FOR POLICE PURPOSES, IN DEVELOPING A BETTER SET OF POLICIES FOR ITS USE, AND IN GENERATING A BETTER PROGRAM FOR ITS OPERATION AND REPLACEMENT. THE PURPOSE OF THE REPORT IS TO AID POLICE DEPARTMENT ADMINISTRATORS IN ACHIEVING BETTER POLICE OPERATIONS WITHIN THE BEST COST FRAMEWORK. THE SCOPE OF THE REPORT INCLUDES THE ROLE OF THE VEHICLE, HUMAN FACTORS, THE DESIGN OF A FRONT SEAT CONSOLE, SPECIFICATION RECOMMENDATIONS AND MAINTENANCE ASPECTS. RECOMMENDATIONS CONCERNING THE SPECIFICATIONS FOR THE PROCUREMENT OF THE VEHICLE ALONG WITH ITS MAINTENANCE AND REPLACEMENT ASPECTS ARE GIVEN. (AUTHOR ABSTRACT MODIFIED)

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STUDY OF THE POLICE PATROL VEHICLE

Submitted to:

Law Enforcement Assistance and Administration
National Institute of Law Enforcement and
Criminal Justice
by
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Industrial Engineering and
Operations Research
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PREFACE

In a 1967 report to The President's Commission on Law Enforcement and Administration of Justice, entitled, Task Force Report: The Police, it was stated:

> Despite other possibilities, the conventional patrol car will continue to dominate the police scene. For the patrol officer, it serves as his office, means of locomotion and pursuit, observation post and van for transporting prisoners.

Despite the fact that the police vehicle has dominated, is dominating and will, as the above excerpt states, "continue to dominate the police scene," preliminary surveys have revealed that very little has been reported on the design of the patrol vehicle and practically nothing has been accomplished in forming a team from the police departments, the suppliers of vehicles and equipment, and human factors engineers to give the police departments a vehicle designed to meet police needs.

Most of the research findings to date have placed great emphasis on the handling and performance of the police vehicle with little or no consideration as to the functions of the vehicle other than pursuit and visibility. This emphasis has been a natural outgrowth of the traditional policing concepts which

ascribe to visibility and the threat of apprehension as the primary means of controlling and deterring crime.

Only recently has there been a wide recognition that "crime" constitutes but a portion of police work. Accompanying this realization has been a growing interest in, first, the variety and frequency of incidents encountered by the police officer and, second, the courses of action available to him in "handling" these incidents. This development has permitted a break with the traditional view of policing and places the vehicle and the police officer in proper perspective. If is for these reasons that the STUDY OF THE POLICE VEHICLE was undertaken.

The goal of the research was to gain an understanding of the vehicle in relation to the police departments, and from this understanding, to aid the departments in procuring a better vehicle for police purposes, in developing a better set of policies for its use and in generating a better program for its operation and replacement.

Thus, the purpose of the report, stated in the broadest terms, is to aid police department administrators in achieving better police operations within the best cost framework.

The scope of the report includes the role of the vehicle, human factors, the design of a front seat console, specification recommendations and maintenance aspects. It approaches the vehicle as providing functions which satisfy the personal and work needs of the police officer, discusses the human factors

involved in the "man-machine" relationship and then discusses a unique front seat console as a solution to the human factors problem of placing necessary equipment in a centralized area of the police vehicle within the optimal reach of the officers. Based on conclusions drawn from the above, recommendations concerning the specifications for the procurement of the vehicle along with its maintenance and replacement aspects are given.

For anyone interested in the chapters concerning specifications, maintenance, replacement and shop operations, it should be stated here that these chapters "stand on their own" independently of each other and do not require any prerequisite reading in this report with the possible exception of Chapter IV--"Systems Description of Vehicle Ownership"--which serves as a good introductory discussion to the topics that follow it.

However, before commencing with the reading of the body of this report, the reader should be aware of three basic assumptions which underlie the report's conclusions and recommendations:

First, it is assumed that most of the police vehicles in any one major metropolitan police department fleet are regular precinct patrol cars. Therefore, consideration is given only to that type of vehicle and excludes other police department vehicles such as station wagons, ambulances, freeway patrol vehicles, vehicles used for rugged terrain such as Jeeps, etc.

Secondly, it is assumed that a vehicle designed and manufactured exclusively for police purposes is impractical from the standpoints of low costs, ready availability, ease of maintenance

and ease of resale. Thus, this study will concern itself with the production model vehicle and the necessary modification for police use.

Thirdly, it is assumed that the City of Detroit and the Detroit Police Department (DPD) are typical of most metropolitan cities and police departments and, therefore, were sufficiently representative for testing purposes. This assumption was verified by comparing DPD data with data from other major metropolitan police departments. It can be further assumed that three metropolitan police departments are not typical of most metropolitan police departments because of the very high population density area in which they serve. These police departments are located in the cities of New York, Chicago and Philadelphia.

The reader is directed to the "Bibliography" at the end of the report, for in it he will find what is considered to be an excellent list of further readings. To facilitate the reader, these additional readings have been listed according to topics corresponding to the chapter topics in this report and then alphabetized as to authors' names.

The authors wish to acknowledge: At Wayne State University:

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A comprehensive list of the people who were contacted during the work on this project is presented at the end of the bibliography.

I. ROLE OF THE VEHICLE

The purpose of this chapter is to define the role that the police patrol vehicle plays in the metropolitan police function. The basic premise of this research is that this role is primarily determined by activities in which the patrol officer is involved and the courses of action which he has open to him in "handling" these activities. Thus, the primary task of this chapter is to place the patrol (man and machine) within a model of a metropolitan police organization.

A. Metropolitan Police Departments - A Model

The traditional model thought of as being representative of a metropolitan police department is that of a command-control post. As defined by the President's Commission on Law Enforcement, the designation "command-control" is "military terminology in the planning, direction, and control of operations. It involves the mobilization of personnel and facilities to perform the functions of planning, situation intelligence, force status monitoring, decicion making, and exectuion."[1]

[1]The following commentary limits itself to defining the role played by the "standard patrol vehicle" in the operation of a metropolitan police department. "Standard patrol vehicle" is used for purposes of this research to apply to those vehicles utilized to respond to citizen calls for assistance. It does not include those vehicles specially designed for highway patrol, surveillance, traffic control, and the like.

As a command-control post, the police department requires:

(1) a command system to allocate the resources;

(2) an information system which provides the command system with the information required for the effective allocation of the resources;

(3) a supply of resources to allocate, in military terms, commonly called the "weapons" system;

(4) a system which provides for the maintenance, service and supply of the other three systems.

Within this structure, the patrol performs major roles in both the "weapons" system in that it handles the problems found in the environment. Second, it is an "information" system in that it feeds data into the department through its written and verbal reports on the state of the environment.

Operationally speaking, the patrol belongs to the organizational level of the department through which the policies, plans and decisions of the department are translated into action. It is also through this level that the department receives a major portion of the data it requires for its intermediate and long range planning and decision making functions.

Keeping within the limitations of the theme of this chapter, discussion will be limited to the sub-section of this operational level. This sub-system will hereafter be referred to as the "field operations system" and will be defined as consisting of the communications center, the precincts, and the patrols. (See Figure 1.1)

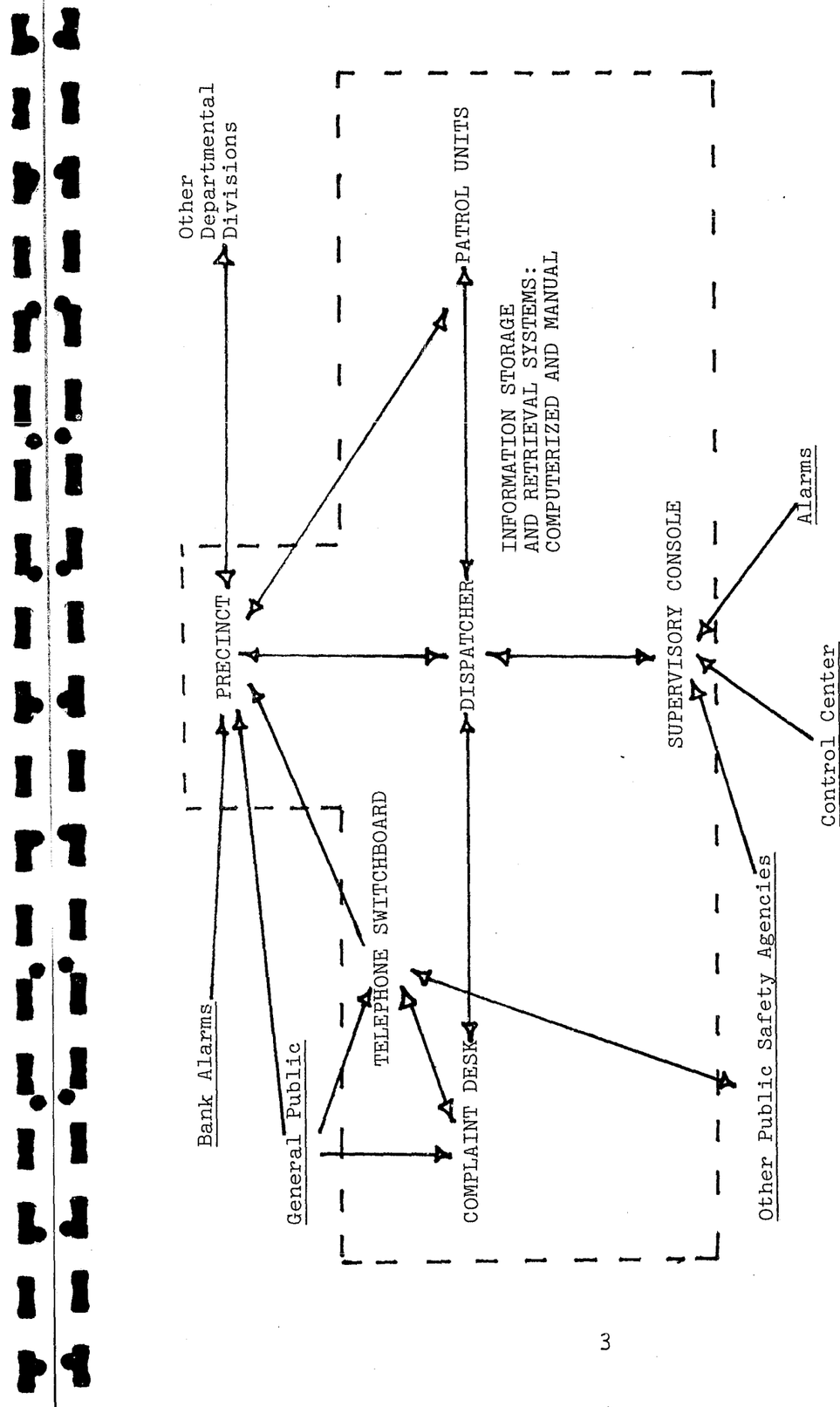


Figure 1.1 The Tactical Operations System.

B. Field Operations System

As indicated in Figure 1.1, the field operations system provides the means for the majority of contacts between the environment and the police, first, through calls for assistance received at the complaints desk and, secondly, through citizen contact at the precincts and through the patrols. The field operations system also is charged with the responsibility of "handling" the majority of these contacts.

Within this system and within the department as a whole, the patrol initiates the majority of face-to-face contacts between the police and the environment. These contacts are made either through a patrol's response to a call for assistance received by the police complaint operators or through self-initiated action on the part of the patrol.

C. Present Role of Patrol Force

A basic assumption of this report is that the patrol possesses two basic responsibilities no matter in what metropolitan police department it functions. Specifically, these are:

(1) to react to calls for assistance assigned by the dispatcher and/or precinct, and

(2) to patrol a specific area, reacting to incongruencies within the environment either through self-initiated action or by request of a citizen.

These responsibilities are a natural outcome of the following policing concepts which are best described by the President's Commission:

First, there is the proposition that "the continued scrutiny of the community by visible and mobile policemen is. . . the best method of controlling crime that is available to the police."

Second, basic to the existence of the patrol force is the assumption that its presence provides a primary source for the deterrence of crime:

> Basic to deterrence is the assumption that to increase the threat of apprehension raises the risk in committing the crime, and so reduces the likelihood of the crime being committed. Projecting that threat of apprehension is the primary objective of police field operations. Improving the apprehension capability itself is raising the threat thereof.[2]

Within the framework of the preceding assumptions--the need for speed, visibility and the resulting illusion of omnipresence--the police patrol vehicle is thought of as being first and foremost in providing mobility combined with visibility. However, it should not be assumed that the patrol is primarily confronted with "crime."

Metropolitan police departments should be viewed as service agencies which are involved in dispensing a diversity of services, both to the individual and to society. This is presented in opposition to the traditional view that police departments should be studied as quasi-military organizations which "enforce the law."

[2]The President's Commission on Law Enforcement and Administration of Justice. Task Force Report: The Police, (Washington, 1962)p. 58.

This service orientation concept was reinforced by an analysis of request for assistance received by the Detroit Police Department which indicated:

(1) the wide range of requests made upon the police by the community;

(2) that these calls constitute a measurement of "consumer (community) demands for governmental service;"

(3) that only 16 per cent of these calls were "crime" related.

As such, these calls contribute to the description, measurement and understanding of urban life. For instance, it is many times overlooked that the patrol officer administers first aid as required during his shift. Such service-related data taken from the officer's daily log assists researchers in analyzing a certain section of a city so that future planning can reflect the area's environmental needs such as more hospitals, more surveillance by police, improved traffic control, better community relations, etc.

Therefore, a framework which allows each activity of the police to be looked upon as contributing to the realization of one or more objectives formulated in non-crime related terms will induce a more rational restructuring of the responsibilities of the department. Specifically, these objectives are:

(1) the minimization of loss or injury to life through "unnatural and/or unavoidable" causes;

(2) the minimization of damage to or loss of property;

(3) the minimization of confusion by the provision of the required authority, information and/or aid for a given situation;

(4) the maintenance of the status quo and/or the dampening of the consequences of change.[3]

The service orientation allows us to break with the traditional concepts of police action that equate calls for assistance with the appearance of a patrol and with the notion that it is responding to "crime." As Table 1 in Appendix I indicates, of the 1,027,000 calls received by the Detroit Police Department in 1969 via their police emergency telephone number, 370,000 (36 per cent) were terminated in ways other than the dispatch of a patrol. In addition the research indicates that only 166,000 (16 per cent) of all calls were "crime" related. Therefore, to study the police in the context of a paramilitary organization primarily concerned with the control and prevention of crimes focuses attention on but a small portion of police work. Such an orientation has encouraged police to make major policy decisions on the weight of crime statistics and to overlook, and thereby fail to take sufficiently in account, the vast majority of its activities. Thus, emphasis on the "crime problem" and " social unrest" have hidden the majority of police work from the public eye. (Refer to Appendix I for further information on the request for service in the cities of Detroit and St. Louis, Missouri.)

D. Functions of the Patrol Vehicle

The order in which the following functions are presented is in no way intended to reflect judgments of value and/or priority.

[3]Bercal, Thomas E. "Calls for Police Assistance: Consumer Demands for Govermental Service." American Behavioral Scientist, Vol. 13, No.'s 5 & 6, Special Edition on Police and Society, Ed. Harlan Han, (May, June, July, August, 1970) p. 686

1. Transportation

The police vehicle, first and foremost, provides the speed and mobility on which present police operations are premised. Operationally, the patrol vehicle is utilized to:

(1) Provide a means of conveying the responding officers to the location of the call for assistance.

(2) Provide a means for the patrol officer to cover large areas quickly and frequently, thereby projecting the image of police presence as a means of deterring crime.

(3) Provide the means to handle matters which call for the movement of a person or object from place to place. A partial list of such situations, in addition to those mentioned above are:

(a) Medical (ambulance service)

(b) Transfer of Prisoners

(c) Recovery of Property

(d) Transfer of Witnesses

(4) Place the patrol officer in an advantageous position or at least on par with those with whom he must deal. Such situations include:

(a) Traffic control

(b) Pursuit of a suspect

(c) Response time in answering calls for assistance

2. Equipment carrier

In addition to providing a transport function for personnel and citizens as described above the vehicle also serves to carry

the equipment required by the patrol officers in the performance of their duties. Radios, weapons, first aid equipment, spot lights, flashlights, information displays and the like are but a partial list.

Of special consideration here is whether the equipment is to be treated as being standard or specialized. This, to a large extent, will be based on the frequency of use, necessity and immediacy of need.

Present operations generally call for the provision of:

(1) Radios - mobile and portable

(2) Weapons - sidearms, shotguns, clubs, MACE, teargas, etc.

(3) Medical - first aid equipment, stretchers, oxygen, etc.

(4) Reports - forms, writing surfaces, dictating equipment, etc.

(5) Information collection devices - cameras, recorders, etc.

(6) Other emergency equipment - flares, safety blankets, fire extinguishers, etc.

In the future specialized considerations may include:

(1) Aids for hearing and observing while on patrol.

(2) Sophisticated communications systems such as teleprinters or direct computer access.

(3) Surveillance equipment such as night vision devices, video equipment, etc.

(4) Devices designed to increase officer safety - seat restraints for prisoners, interior partitions and magnetometers for detecting concealed weapons.

3. Communications center

Part of the equipment carried by the vehicle is the radio system which is utilized to:

(1) Keep the officers in contact with the dispatcher and commanding officers for purposes of direction and/or coordination, and control;

(2) Provide a means of obtaining information to assist in carrying out a task and disseminating information.

The radio is perhaps the most frequently utilized piece of equipment in the patrol vehicle. An indication of this is given by the following statistics for the Detroit Police Department for the month of January, 1970:

Runs:	54,475
Queries:	15,261
Total:	69,736

For each run and each quiry, the officer must reach for the radio at least twice - once to initiate a quiry or answer a dispatch and once to receive an answer to his quiry or put himself back in service. At a minimum radios were used 139,472 times during this month.

4. Office

The role played by the vehicle is indicated by the following statistics from the 1968 Detroit Police Department Annual Report:

PCR's[4] submitted:	201,034
Fire Reports:	501
Motor Vehicle Accident Reports:	39,936
Crime and/or Missing Reports:	1,818
	243,289
Street Interviews	1,799,905

Such a volume of reports and the projected necessity for the continuation for written record-keeping suggests a redesign of vehicle interiors to facilitate this function.

5. Protection (shelter)

Vehicle provides shelter for officers and equipment from elements while on patrol or at times as a shelter from citizens.

6. Command post

(1) Command system

(2) Weapon system

(3) Information system

(4) Support system

7. Visibility and presence

In one respect this function derives from the policing premise that the known presence of an officer is a primary deterrent to "crime." In another it derives from the citizens need to know 1) who he is dealing with when he is pulled over and 2) what vehicle to hail (approval) when in need of help. In yet another sense, visibility and presence are required to clear the way in emergency situations and to identify danger as when marking the location of an accident or other obstruction.

[4]PCR: Preliminary Complaint Report

No figures are available as to the frequency of utilization of equipment designed for this function. However, the consideration here is the necessity of such equipment, not the frequency of use.

8. Detention facility

Its role as a detention facility is shown by the following Detroit Police Department figures for 1968:

Felony Arrests	47,558
Misdemeanor Arrests	48,100
Prisoners Transferred	62,732
	158,390

Little if anything need be said to indicate the need for making provisions for this function especially in situations where more than one prisoner at a time is involved. These provisions are especially critical where circumstances do not allow time for another patrol vehicle or patrol wagon to reach the scene.

E. New Uses and/or Considerations

Concepts, police changes and trends that bear watching are:

(1) the concept of equipping the man rather than the vehicle in the area of radio communications;

(2) the increased use of computer based inquiry systems with attendant trends toward direct access from vehicles and computer displays within the vehicle;

(3) increased utilization of patrol information on a real-time basis for tactical and strategic purposes;

(4) policy changes which place officers in the role of information and/or community service officer to the community - i.e., mobile information centers.

In the immediate future, then, consideration, should be taken in integrating new systems for the collection, manipulation, processing and retrieval of information.

F. Summary

In analyzing police activity emphasis must be placed in four areas:

First, the continuous utilization of the radio for assignments, control, coordination, assistance and information. Virtually no patrol action takes place without the involvement of radio communications at some point in the proceedings.

Second, the frequent necessity for written record-keeping. Provisions must be made for writing surfaces as well as a means of form organization and storage.

Third, the transferring and/or detention of citizens for whatever reason other than medical in which officer safety is involved.

Fourth, the fact that the officer spends eight hours in or around his vehicle suggests a need for the improvement in officer comfort.

II. HUMAN FACTORS ANALYSIS

The primary purpose of the human factors research was to analyze equipment configurations as they are utilized in present police vehicles and to provide recommendations for changes in these configurations to yield a more efficient man-machine system.

In Phase A, efforts were devoted to the analysis of the primary and special vehicular controls in the two major types of vehicles utilized by the Detroit Police Department (DPD). Objective human factors data was gathered in relation to the two vehicles (1969 Ford and 1969 Plymouth) and compared with recommended configurations from the existing literature. Where possible, recommendations for ideal placement of controls is given.

Phase B of the research was assigned to provide additional human factors information in reference to the frequency with which the various special police devices are utilized within the vehicle, the importance that police officers attach to each piece of equipment, and the frequencies of actual and potential critical incidents in which certain items were or may be used. A special questionnaire was designed and administered to a sample

of police officers who varied in age, length of service, precinct area, and types of duty. The ultimate purpose of such information is to provide the foundation for the efficient design of display-control relationships in future equipment placement.

Phase C was designed primarily as a study of the state of scientific investigations related to comfort factors in vehicular systems. The general purpose of this phase is to provide additional guidelines regarding the inclusion or exclusion of certain comfort related equipment in the police vehicle.

Thus, the overall analysis provides quantitative as well as attitudinal human factors data to be considered in the overall evaluation of the police vehicle.

Additional information relating to each phase can be found in the Appendices.

A. Phase A

Phase A provides human factors evaluations in the areas of steering, foot controls, seating and secondary patrol vehicle controls, referring only to the 1969 Ford and 1969 Plymouth police patrol vehicles as equipped and utilized by the Detroit Police Department. However, the recommendations are not restricted to that specific police department but are applicable to police patrol vehicles in general.

1. Steering

Steering wheel angles (measured from vertical) in both the 1969 Ford and Plymouth police patrol vehicles are nearly vertical

at 30 degrees and 22 degrees respectively. Black (1966) and McFarland (1957) recommend a more nearly horizontal wheel (like those in buses and trucks) so that there is an increase in comfort by supporting part of the weight of the driver's arms. However, a vertical wheel is preferred for speed in turning. Both DPD models are equipped with power steering, and the combination of vertical wheel and power steering seems to be optimal both for speed and ease of turning.

Since both Ford and Plymouth have low steering ratios (4.0 and 3.5 respectively, from lock to lock), these vehicles would not be practical without power steering from a police patrol's point of view since the steering forces for these vehicles would be far too heavy without it. There are, therefore, two strong arguments for the installation of power steering in police vehicles:

(1) The nearly vertical steering wheels used in current vehicles do not allow efficient application of large steering forces. In a full-sized car with a heavy V-8 engine, the lack of power steering could be a severe control limitation at low vehicle speeds.

(2) Lower overall steering ratios are practical with power steering resulting in a more responsive vehicle.

A recent survey conducted by the Prince George County Police Department indicated a large utilization of power steering among police departments. Of the 32 responding departments, 72 per cent specified power steering.[1]

[1] Prince George County Police Department, (John W. Rhoads, Commanding Officer). Police Vehicle Specifications (Maryland, 1970)

Thus, it is the conclusion of this study that power steering is mandatory.

2. Foot controls

The throttle and brake pedals in both vehicles have the standard American arrangement which is subject to some criticism. It is not likely, however, that auto manufacturers will redesign the relationship between the brake pedal and the accelerator pedal in standard production vehicles. However, police vehicle suppliers should be made aware of alternative control arrangements which more closely approximate an optimal human factors design so that future standard production models may be improved. The reader is referred to an alternative design found in Appendix 2.

3. Seating

The chief criticism of seats in the current police vehicle stems from their lack of adjustability. The bench seat arrangement is definitely unacceptable when the driver and his partner are of widely different body sizes. The fore-aft adjustment which suits a 5'7" driver severely cramps his 6'4" partner.

> Because police department standards in some instances allow smaller men, body size variability is increasing and incorporation of individually adjustable seats will be a mandatory human factors requirement.

However, standard bucket seats have disadvantages, too. They are often designed, for appearance reasons, to have a concave shape. This centering effect does not allow for variations in the seating position necessary in long periods of driving. Automobile manufacturers are aware of this problem and have made some improvements.

Another difficulty is that the back support is close to the shoulders, whereas a long sitting period requires the support in the lumbar region of the back. To relieve this situation, it is suggested that a seat cushion be used under the driver and up the back of the seat approximately 12 inches.

Another difficulty ith bucket-type seats is the folding design required for two-door vehicles. It is possible for a prisoner to trip the safety latch and push the seat forward from the rear, thereby causing the driver to lose control of the car.

> Because police cars are almost exclusively the four-door models (93 per cent), it is suggested that the folding latch be made inoperative if not previously done so.

Automobile manufacturers are now offering a "split bench" seat with the individual adjustment and bench seat comfort advantages. Several truck seat manufacturers offer individual seats which are designed for long hours of sitting. The support of these seats and the vibration characterisitcs are much superior to automotive bucket seats. They are, however, quite expensive and usually offer no whiplash protection. Therefore, these seats were not studied. It is suggested that these two options be examined in the future and reference be made to the Simons, Radke and Oswald (1956) paper.

The current seats also lack vertical and angular adjustemnts which are very desirable for maximization of comfort and visibility. Vertical adjustment is very important in light of the problem of attaining the best vision from the vehicle for police officers of varying heights.

> Accordingly, it is strongly recommended that adjustable seats in the vertical and angular dimensions be incorporated to accomodate various body sizes.

Seating dimensions in the present cars are quite generous and adequate according to the human factors criteria established by McFarland and Black. There are several exceptions to this generalization. (See Appendix 2.) Vertically adjustable seats would aid these situations.

Generally, the evaluation of comfort variables of present bench seating is that the police vehicle is quite favorable. The seat contour is nearly flat, allowing changes in seating posture which are essential for comfort. The seats provide a fair amount of lumbar support. However, this factor could be improved by increasing the seat spring rate in the lumbar region. The seat surfaces are quite soft (2-3 inches compression) but not so soft as to cause excessive pressure on the thighs. Another potential disadvantage of the present bench seat is the heavy-duty vinyl covering which does not allow proper ventilation around the body, interfering with evaporation of perspiration in high ambient temperatures.

Again, the reader is referred to Appendix 2 for related information on the above.

There are other important considerations related to seat design, one of which is the use of seat belts in the police vehicle. Unequivocally, a multitude of evidence suggests seat belts, along with shoulder harnesses, when properly manufactured and installed, are valuable safety devices.

The major objection to the use of seat belts in the police vehicle comes from the fact that it restricts the officer somewhat and may prevent a quick exit from the vehicle. However, the automotive industry currently is developing an air cushion restraint which is activated on impact. If is felt that the air cushion will provide the desired margins of safety while relieving the restrictions associated with seat belts. However, while awaiting the introduction of the air cushion, it is recommended that the seat be redesigned with an increased height to prevent backlash, or that police agencies specify a headrest with minimum design and dimension standards. (Federal Motor Vehicle Safety Standards now require all domestic car manufacturers to install headrests on the back of the front seats. However, the manufacturers are free to install a headrest with no minimum requirement as to design or dimension.)

Seats should also be designed to absorb low frequency vibrations (1.5 - 5.5 CPS) which may have deleterious effects on performances such as reading printed numbers, compensatory tracking, choice reaction time, foot pressure constancy, peripheral vision and visual acuity as pointed out by Dennis (1965A) (1965B).

4. Secondary patrol vehicle controls

Research performed on the 1969 Ford and Plymouth has revealed that many of the equipment items used by the police officers, such as roof beacon, siren horn, brake light cancel, handspot jack, deck lights, radio mike, etc., are not within the normal reach of the officer. This applies to both the horizontal-vertical and

fore-aft control distances. Appendix 2 points out specifically pieces of equipment which are both within and not within the normal reach of the officer.

> It is concluded that placing as many controls as possible on a specially-designed console positioned between the two officers and mounted on the bench seat or between the bucket seats will effectively bring the controls into the normal reach area.

Green and Muckler (1959) offer evidence that indicates that the placement of a control in the recommended position is optimum in regards to the speed and accuracy of control activation, thus, justifying the consideration of a special police equipment console.

B. Phase B

It is evident from Phase A that the utilization of standard production model vehicles, coupled with the non-systematic placement of special controls has resulted in a man-machine system which inevitably will perform at less than the optimal level in critical situations. It is the purpose of this portion of the chapter to present information which will enable the designers of future police vehicles to systematically place equipment and controls according to human factors recommendations based on frequency of utilization and the importance of individual equipment items. The major effort in this section was directed toward the special police equipment and controls.

1. Method of data collection

It was decided that a survey questionnaire was the most economical as well as expeditious method of collecting the desired

information. Since no instrument of standard design was available, the questionnaire was constructed for the special purpose at hand.

One hundred eighty four questionnaires were distributed to members of the Detroit Police Department and 145 were returned. Seven questionnaires were eliminated from analysis. (See Appendix 2 for further information concerning the questionnaire and its distribution, and a reproduction of the questionnaire itself.)

Note: Any mention of the "Appendix" or various "Figures" in Phase B will be referring to Appendix No. 2.

The following information summarizes data relating to the frequency of utilization and the importance attached to certain special equipment items used by the police officer. In addition, information concerning critical incidents (actual events which were either detrimental or beneficial in the performance of duties) as they relate to each piece of equipment have been recorded in the following tables and summarized herein.

2. Results and conclusions

A close examination of Table 2.18 reveals that there are distinct differences in the frequency with which the various special controls and equipment items are utilized. The controls and items with reference to the amount of use are as follows:

Very high utilization: portable spotlight, flashlight, hot sheets (lists of stolen cars), PREP radio;

Frequent utilization: daily log, radio mike;

Table 2.1

Critical Incidents Related to the Horn Siren

Incident	Frequency of Report
Actual Helpful	
1. Clearing traffic in emergency runs	2
Actual Detrimental	
1. Accidental misuse of item	1
Potential Helpful	
1. Second officer in car performing other duties	3
2. Getting people's attention	1
3. Pulling over cars	1
4. Identify police to traffic and pedestrian	1
5. Getting through traffic	4
6. Clearing traffic in emergency runs	22
7. When in hurry	1
8. Permits driver to keep both hands on wheel	2
9. Officer in trouble	5
10. Helps cut accidents	1
11. In a chase	1
12. Only one man in car	2
13. In emergencies	1
14. Limited use of siren required	1
15. Enables driver to control use of siren	1
16. Patrolman alone	1
17. Auto accidents	1
18. Driver cannot control equipment at high speeds	1
Potential Detrimental	
1. Attracting crowd curiosity seekers	2
2. Confusing in rush hour traffic	1
3. Not audible when car windows closed	1

Table 2.2

Critical Incidents Related to Prep Radio

Incidents	Frequency of Report
Actual Helpful	
1. Used to call for help, cancel	4
2. Answering radio runs	1
3. Communicate with dispatcher (location, situation)	1
4. Keeping track of data	1
Actual Detrimental	
1. Keeping contact while chasing on foot	1
2. When involved in false arrest	1
3. Air crowded, can't use	1
Potential Helpful	
1. Call for help	16
2. Crew chasing more than one subject	1
3. Checking buildings etc. for B & E	4
4. Answering radio runs	1
5. Officers separated from car	14
6. Keeping in contact whlle chasing on foot	8
7. When out of car	2
8. Talking to dispatcher	1
9. Having coffee and remaining in service	1
10. On foot in dark places	1
11. Officer separated from partner	5
12. On detail involving crowd	1
13. One man investigating occupied vehicle	1
14. In event of mobile radio breakdown	4
15. Relaying observation data	1
16. In unmarked car without mobile radio	1
17. At accident, disaster scenes	1
18. Getting aid inside large buildings	1
19. Broadcast description of hold-up men	1
20. Directing help from place other than scene	1
21. On foot patrol alone	1
Potential Detrimental	
1. When officer in trouble	1
2. Hinders mobility of officer	1
3. Item inadequate for intended purpose	1
4. Item awkard to use	1
5. If item was malfunctioning	1

Table 2.3

Critical Incidents Related to Portable Spotlight

Incidents	Frequency of Reports
Actual Helpful	
1. Checking buildings etc. for B & E	2
Actual Detrimental	
none reported	
Potential Helpful	
1. Checking buildings etc. for B & E	42
2. Pulling over cars	1
3. Identify vehicle to traffic and pedestrians	1
4. At night	1
5. When involved in false arrest	1
6. Temporarily blind subject	1
7. Going through alleys	1
8. Searching large lots	1
Potential Detrimental	
1. Hinders mobility of officer	1
2. Hands not free for other duties	1
3. Item has inadequate storage	1

Table 2.4

Critical Incidents Related to Radio Control (Squelch)

Incidents	Frequency of Report
Actual Helpful	
1. Checking if radio volume operating	2
2. Turn down volume while conversing, etc.	1
3. Adjusting radio volume	1
Actual Detrimental	
none reported	
Potential Helpful	
1. Call for help, cancel	1
2. Checking if radio operating properly	11
3. Turn down volume while conversing, etc.	5
4. Adjusting radio volume	4
5. Clearing traffic for emergency runs	1
6. Letting officers approach unnoticed	2
7. Recover wanted cars	1
8. Turn up volume while siren is on	8
9. Clarify broadcasts, remove static	1
10. In event of radio breakdown	1
11. Reduce background noise	1
12. Obtaining clearer radio reception	2
Potential Detrimental	
1. Adjusting audio volume	1

Table 2.5

Critical Incidents Related to Ticket Books

Incidents	Frequency of Reports
Actual Helpful	
none reported	
Actual Detrimental	
none reported	
Potential Helpful	
1. Traffic inforcement	20
2. Keeping permanent records	1
3. Keeping records together	9
4. Helps cut accidents	1
5. Raise money for general city fund	1
6. Decreasing accidents	1
7. Saving lives	2
8. People more observant if they pay a fine	1
9. Enforce traffic regulations	1
Potential Detrimental	
1. Time taken from more important duties	1

Table 2.6

Critical Incidents Related to Shotgun

Incident	Frequency of report
Actual Helpful	
1. Psychological weapon	2
2. If equipment malfunctioned	1
3. A deterrent	1
4. Barricaded gunman	2
5. Self-protection	1
6. Margin of personal safety	1
7. More effective than pistol	1
8. Put many felons in custody	1
Actual Detrimental	
1. Attracted hostile crowd	1
Potential Helpful	
1. Crowd control	3
2. Psychological weapon	9
3. Clearing traffic	1
4. A deterrent	2
5. Farricaded gunman	3
6. Self-protection	2
7. Margin of safety	2
8. Dispersing crowds	1
9. Providing cover for partner	1
10. More effective than pistol	1
11. Family trouble	1
12. Fun runs, armed subjects	5
13. Riot duty	5
14. Raids	1
15. Firepower needed	1
16. Close work indoors	1
17. Controlling large group	3
Potential Detrimental	
1. Poorly located, difficult to use	1
2. Inadequate for intended purpose	1
3. Hold-up in progress	1

Table 2.7

Critical Incidents Related to Flashlight

Incident	Frequency of Report
Actual Helpful	
1. Checking buildings, etc.	1
2. Searching dark obscure places	1
Actual Detrimental	
none reported	
Potential Helpful	
1. Checking buildings, etc.	23
2. Reading forms, hot sheets, etc.	6
3. At night	11
4. Searching dark obscure places	6
5. On foot in dark places	1
6. Going through alleys	1
7. Used when spotlight cannot be used	1
Potential Detrimental	
none reported	

Table 2.8

Critical Incidents Related to Brakelight Suppression Control

Incident	Frequency of Report
Actual Helpful	
1. Letting officers approach unnoticed	1
Actual Detrimental	
none reported	
Potential Helpful	
1. Checking buildings, etc.	2
2. Answering radio runs	2
3. Observing while making U turns, etc.	3
4. Letting officers approach unnoticed	15
5. Going through alleys	5
6. Riot duty	1
7. In alleys, dark streets	2
Potential Detrimental	
1. Item unimportant, rarely used	2
2. Item poorly located, difficult to use	2
3. Item inadequate for intended purpose	2

Table 2.9

Critical Incidents Related to Daily Log

Incident	Frequency of Report
Actual Helpful	
1. Keeping permanent records for later referral	1
2. Keeps track of days, activities, statistics	2
Actual Detrimental	
1. Item unimportant	1
Potential Helpful	
1. Keeping permanent records for later referral	17
2. Keeping permanent records	4
3. Keep track of time, activities, statistics	7
4. Inform supervisors of work	1
5. Check on where and when individuals investigated	2
6. Reference has put felons in custody	1
7. Getting information not in other reports	1
8. Verification of activities	1
Potential Detrimental	
1. Item unimportant	1
2. Time taken from more important duties	1

Table 2.10

Critical Incidents Related to Fire Extinguisher

Incidents	Frequency of Report
Actual Helpful	
1. Extinguish small auto fires	13
2. Fire department not at scene	3
Actual Detrimental	
1. Equipment malfunctioned	1
2. Item inadequate for purpose	1
3. Item poorly located	1
Potential Helpful	
1. Extinguish small or auto fire	14
2. Protects against molotov cocktails, firebombs	2
3. Auto accidents	1
4. Fire department not at scene	1
Potential Detrimental	
1. Item unimportant, seldom used	7
2. Item inadequate for intended purpose	1

Table 2.11

Critical Incidents Related to Radio Mike

Incidents	
Actual Helpful	
1. Item used to call for help, cancel	3
Actual Detrimental	
none reported	
Potential Helpful	
1. Item used to call for help, cancel	7
2. Answering radio runs	3
3. Communication with dispatcher	11
4. Margin of safety for officer	1
5. General Communications	4
6. Getting checks on people	1
7. Relay important information	1
8. Protection of lives	1
9. Communication with hospital	1
10. In chase	2
11. Acknowledging information	1
12. Relaying observation information	1
13. Hold-up in progress	1
14. Other means of communication unavailable	1
15. Warrant and larceny checks	1
16. On mobile patrol	2
Potential Detrimental	
none reported	

Table 2.12

Critical Incidents Related to Roof Light Control (Beacon)

Incidents	Frequency of Reports
Actual Helpful	
1. Identifies vehicle as police vehicle	1
2. Used to seal off street	1
Actual Detrimental	
1. Light ignored, traffic did not yield	1
2. Item poorly located, difficult to use	1
3. Car too easily identified as a police vehicle	2
Potential Helpful	
1. Answering radio runs	1
2. Pulling over cars	1
3. Enable traffic and pedestrians to yield in emergency	7
4. Checking cars for wanted and stolen	1
5. Getting through heavy traffic	6
6. Clearing traffic in emergencies	10
7. At night	2
8. In a hurry	1
9. Prevent problems at scene of accident	1
10. In chase	1
11. At scene of accident	1
12. Stopping vehicle in heavy or fast traffic	1
13. Drawing people's attention to danger or emergencies	1
14. At accident or disaster scenes	1
15. Clearing or stopping traffic	1
16. Answering runs	1
17. Auto accidents	2
18. Avoiding accidents	1
19. Controlling traffic at accidents	1
20. Answer serious runs	1
Potential Detrimental	
1. Color in error	1
2. Confusing in rush hour traffic	1
3. May become dependent on it	1
4. Item also used on non-police vehicles	1

Table 2.13

Critical Incidents Related to Miscellaneous Forms

Incident	Frequency of Report
Actual Helpful	
none reported	
Actual Detrimental	
none reported	
Potential Helpful	
1. Referring back for dates, occurances, etc.	2
2. Officer can familiarize himself with crime suspects	1
3. Keep permanent records	1
4. Keep track of dates, activities, statistics	1
5. Making reports without going to station	2
6. Simiplifies making reports, transferring information	4
7. Recording incidents of crime	1
8. Used for special runs	1
9. Cover sundry things officers required to do	1
10. Establish grounds to work from	1
Potential Detrimental	
1. Item unimportant - seldom used	4
2. Time taken from more important duties	1

Table 2.14

Critical Incidents Related to Electronic Siren

Incident	Frequency of Report
Actual Helpful	
1. In a chase	1
Actual Detrimental	
none reported	
Potential Helpful	
1. Getting people's attention	1
2. Identify vehicles for traffic and pedestrians	4
3. Noticed quickly, attracts attention	2
4. Getting through traffic	3
5. Generally superior performance	1
6. Clearing traffic in emergency runs	6
7. In a hurry	1
8. Officer in trouble	1
9. Broken tones more easily heard in traffic	5
10. In a chase	1
11. Drawing attention to danger, emergency	1
12. Clearing a stopping traffic	1
Potential Detrimental	
1. Item needed but not available	1
2. Confusing in rush hour traffic	1
3. May become too dependent on it	1

Table 2.15

Critical Incidents Related to Public Address Microphone

Incidents	Frequency of Report
Actual Helpful	
none reported	
Actual Detrimental	
none reported	
Potential Helpful	
1. Crowd control	9
2. Pulling over cars	2
3. Clearing park	1
4. Directing traffic	2
5. Looking for missing children	2
6. Dispersing crowds	3
7. Two men can do job of many	1
8. On detail involving crowds	3
9. Letting people in building know what to do	1
10. Directing police officers	1
11. Controlling large group of people	2
12. In locating lost persons	1
Potential Detrimental	
1. Item unimportant, seldom used	2
2. Item needed but not available	1
3. Attracting crowd, curiosity seekers	1

Table 2.16

Critical Incidents Related to Hot Sheet

Incidents	Frequency of Report
Actual Helpful	
1. Checking cars for wanted, stolen	1
2. Checking occupied cars before stopping	1
3. Recover wanted cars	1
Actual Detrimental	
none reported	
Potential Helpful	
1. Quick checking	1
2. Checking cars for wanted, stolen	22
3. Checking occupied cars before stopping	8
4. Recover wanted cars	7
5. Warning in case of possible danger	1
Potential Detrimental	
1. Item not up-dated	1

Moderate utilization: horn siren control, ticket books, electronic siren, roof light control (beacon), radio control (squelch);

Low frequency: public address mike, miscellaneous forms, brake light control;

Infrequent: shotgun, fire extinguisher.

Such results have obvious applications in the design of a console. With the data, it is possible to plan a control configuration based on objective results rather than speculation.

However, caution should be exercised in applying the data to a practical situation in light of Table 2.19 which reveals that although there is a significant difference in the importance attached to the various items, the range of the difference is much more restricted than in the frequency data.

The entire complement of equipment is described by the respondents as being in the upper range of importance. Breaking down the equipment into levels of importance is as follows:

First: flashlight, radio mike, roof light control (beacon), electronic siren, hot sheets;

Second: radio control (squelch), brake light control, public address mike;

Third: daily log, miscellaneous forms;

Fourth: portable spotlight, ticket books;

Fifth: horn siren control, shotgun, fire extinguisher.

Table 2.17

Percentage of Responses in Each Frequency of Use Category
for Special Police Controls

Rank	Equipment Item	Mean Category	Frequency Categories							
			1 0-5	2 6-10	3 11-15	4 16-20	5 21-25	6 26-30	7 31-35	8 35-Over
1	Hot Sheet	5.000	.036	.116	.123	.152	.138	.065	.283	.087
2	Flashlight	4.5036	.051	.131	.161	.175	.153	.080	.226	.022
3	Radio Microphone	4.1824	.051	.124	.234	.234	.102	.066	.175	.015
4	Daily Log	4.1544	.125	.066	.169	.235	.162	.074	.154	.015
5	Portable Spotlight	3.4558	.184	.199	.162	.176	.125	.044	.088	.022
6	Prep Radio	2.7664	.182	.409	.182	.095	.029	.036	.051	.015
7	Roof Light Control (Beacon)	1.5597	.694	.209	.037	.015	.007	.022	.015	.000
8	Electronic Siren	1.5289	.769	.157	.008	.000	.017	.025	.017	.008
9	Miscellaneous Forms	1.4682	.714	.206	.048	.008	.008	.000	.008	.008
10	Radio Controls (Squelch Volume)	1.4485	.787	.125	.022	.029	.015	.007	.007	.007
11	Ticket Book	1.4057	.797	.109	.043	.022	.007	.014	.007	.000
12	Shotgun	1.3359	.820	.117	.031	.008	.000	.008	.016	.000
13	Brake Light Suppression Control	1.2542	.864	.093	.025	.000	.000	.000	.008	.008
14	Horn Siren	1.1897	.883	.088	.000	.015	.015	.000	.000	.000
15	Public Address Mike	1.1351	.955	.018	.009	.009	.000	.000	.000	.009
16	Fire Extinguisher	1.0300	.985	.008	.000	.008	.000	.000	.000	.000

Table 2.18

Percentage of Responses in Each Importance of Item Category for Special Police Controls

Rank	Equipment Item	Mean Category	Importance Category				
			Very Unimportant	Unimportant	No Opinion	Important	Very Important
1	Prep Radio	4.7591	.015	.000	.015	.153	.818
2	Shotgun	4.6771	.016	.008	.039	.157	.780
3	Portable Spotlight	4.4888	.000	.000	.037	.437	.526
4	Horn Siren	4.4160	.007	.007	.022	.489	.474
5	Ticket Book	4.2391	.000	.029	.065	.543	.362
6	Daily Log	3.9555	.044	.059	.126	.437	.333
7	Electronic Siren	3.6721	.254	.000	.016	.279	.451
8	Miscellaneous Forms	3.6461	.015	.110	.285	.423	.177
9	Fire Extinguisher	3.6343	.037	.149	.134	.500	.179
10	Hot Sheet	3.6176	.243	.015	.015	.338	.390
11	Public Address Mike	3.4149	.106	.097	.195	.478	.124
12	Radio Microphone	3.3868	.358	.022	.007	.102	.511
13	Radio Control (Squelch Volume)	3.3576	.168	.051	.190	.438	.153
14	Roof Light Control (Beacon)	3.2230	.341	.031	.008	.341	.279
15	Brake Light Suppression Control	3.1111	.111	.214	.214	.376	.085
16	Flashlight	2.8740	.481	.030	.007	.096	.385

Thus, the rank orders in the frequency data and in the importance data are not perfectly correlated, i.e., the most frequently used itmes are not necessarily those which are considered to be most important, and in some cases, low frequency items are considered to be extremely important.

In order to further assess the relationship between the importance and frequency of use for each equipment item and control, a series of Kendall Rank Order Correlation Coefficients (tau) was performed. Table 2.19 reports the results of these correlations. Only six of these correlations reached significance, i.e., six items placed on either extreme side of a sliding scale measuring frequency of use and relative importance. Included were the portable spotlight (moderate frequence in use and moderately important), ticket books (fairly frequent use and important), the flashlight (fairly frequent use and fairly important or not important by an equal number of respondents) and brake light suppression control (infrequent in use and relatively unimportant). In the case of the flashlight, there is reason to suppose that the bimodal response may reflect different watch periods, moderating the importance effect. Also recorded as being significant was the daily log, reflecting a range of ranks widely distributed in both frequency and importance resulting in average importance and frequency scores, and miscellaneous forms, reflecting a fairly average importance value with low frequency values.

The remaining "insignificant" correlations are important to this study because they reflect discrepencies between the frequency

Table 2.19

Kendall Rank Order Correlation Between

Frequency of Use and Importance of Equipment[1]

Equipment Item	Kendall Tau[2]	One-tailed Probability
1. Horn Siren	.0037	.4761
2. Prep Radio	.0100	.4325
3. Portable Spotlight	.3190	.00003[3]
4. Radio Control (Squelch)	.0379	.2546
5. Shotgun	.0552	.1788
6. Ticket Books	.1291	.0122
7. Flashlight	.2231	.00007
8. Brakelight Control (Suppression)	.0990	.0594
9. Daily Log	.2759	.00003[3]
10. Fire Extinguisher	.0056	.4641
11. Radio Mike	-.0271	.3192
12. Roof Light Control	-.0242	.3409
13. Miscellaneous Forms	.1998	.0005
14. Electronic Siren	.0097	.4404
15. Public Address Mike	.0177	.3936
16. Hot Sheet	.0516	.1867

[1]Kendall Tau - a statistic measuring the extent to which persons or objects are ordered alike on two variables: in this specific case, the rank order of frequencies and importance of equipment items.
One-tailed probability - the liklihood of achieving a value of a given magnitude by chance alone.

[2]N = 138 for all correlations.

[3]Significance exceeds .00003.

with which equipment is used and its importance to the police officer. In the majority of these relationships, it was found that a relatively high degree of importance was attached to items which are infrequently used.

> The overall analysis of data clearly suggests that multiple criteria must be applied in any decisions related to the configuration of equipment especially those items which will relate to the personal safety of the officer and the individual citizen.

In addition to the basic information reported above, each of the respondents was asked to suggest additional equipment items which should be added to or deleted from the police vehicle. A complete presentation of this data is given in Appendix 2.

It should be clear from even a casual observation of Table 2.20 that the great majority of suggested add items could be accommodated in a specially-designed police equipment console. For the most part, the deletes are so infrequent as to be uninterpretable with respect to human factors considerations.

Table 2.21 summarized the total frequencies of actual and potential critical incidents reported by the respondents. The frequencies reported in this table reflect the total number of frequencies and do not represent individual types of incidents. A complete breakdown on frequencies for specific types of incidents is given in Appendix 2. It is quite interesting to note, however, that the large number of potentially helpful incidents may help to explain the high degrees of importance attached to all the equipment items even though a great many of them are not frequently used.

Table 2.20

Frequency of Suggested Equipment Items to be Added To or Deleted From Vehicle

Equipment	Frequencies
ADDS	
1. Shotgun in car. (It is presently in trunk)	47
2. Electronic Siren.	10
3. Bucket or Individual Seats.	28
4. Portable Desk.	6
5. Rack or Bar to Handcuff Prisoners.	5
6. Holder for Hot Sheet.	6
7. Tinted Glass.	8
8. Electronic Door Locks.	6
9. High Performance Vehicle Equipment.	18
10. Air Conditioning.	9
11. Additional Spots or 180° Beacon.	10
12. Wire Mesh Screen between Front and Rear.	9
13. Smaller and Lighter Prep Radios.	5
14. Electronic Locks for Shotguns in Front Seat.	12
15. Console between Officers for Equipment and Writing.	10
DELETES	
1. Police Beacon and other Markings.	1
2. Wire Mesh between Front and Rear.	2
3. Extraneous Radio Transmissions.	2
4. Station Wagons.	1
5. Safety Door Locks.	1

Table 2.21

Summary of Frequencies of Actual and Potential Critical Incidents for Special Police Equipment

Equipment	Frequencies			
	Actual		Potential	
	Helpful	Detrimental	Helpful	Detrimental
1. Horn Siren	3	0	50	4
2. Prep Radio	7	3	67	5
3. Portable Spotlight	2	0	49	2
4. Radio Control (Squelch)	4	0	38	1
5. Shotgun	9	1	42	5
6. Ticket Books	0	0	29	1
7. Flashlight	2	0	49	0
8. Brakelight Stop	1	0	30	6
9. Daily Log	3	1	34	2
10. Fire Extinguisher	16	3	21	8
11. Radio Mike	3	0	45	0
12. Roof Light Control	2	3	43	3
13. Miscellaneous Forms	0	0	15	5
14. Electronic Siren	1	0	30	3
15. Public Address Mike	0	0	29	4
16. Hot Sheet	3	0	39	1

In addition to the foregoing data, the subjects were also asked to provide information regarding their preferences for air-conditioned vehicles and to provide answers as to what types of information external to the vehicle are utilized in the regular performance of their duties.

One hundred four of the individuals who responded to the former question stated their preference for air conditioning while only 25 responded negatively. This seems to be sufficient evidence to conclude that the majority of police officers would be favorably disposed toward equipping their vehicles with air conditioning. Air conditioning will be referred to again in a following section where additional information on the subject is presented.

In the last set of data for this questionnaire, the subjects were asked to indicate what sources of information external to the police vehicle they use in the performance of their patrol duties. The purpose of requesting such data was to assess the need for an externally-mounted microphone which would enable the officer to continue to monitor information sources in the event that the vehicle windows were closed because of air conditioning. Thirty-four information sources were identified by the officer and these are presented in Appendix 2. It will suffice here to suggest that in the event the decision is reached to air-condition the police vehicle, there is reasonable evidence to justify the installation of external sound pick-up devices as well.

C. Phase C

The purpose of Phase C is to provide data relevant to the evaluation of comfort conditions within the police vehicle. In particular, information was sought which provides a basis for recommendations concerning the effects of temperature and ventilation, visibility, and noise.

1. Temperature and ventilation

The effects of temperature on performance have been widely investigated but with somewhat mixed results. However, there are trends in physiological literature which clearly suggest that increased ambient temperatures are associated with a deterioration in performance. Increases in temperature have been known to cause such physiological effects as increase in body temperature, increase in pulse rate, heat palpitating sensations, feelings of weakness, headaches, rushing noises in the ears, loss of hearing, flickering before the eyes, heart ailments, dehydration and hypathermia.

The effects of high temperatures are not restricted to physiology, for in numerous cognitive performance studies, as the temperature increased so did tendency to miss critical signals, though the increases in missing the signals were not significant.

It seems reasonable to conclude from these investigations that high ambient temperatures at best produce little effect on performance and at worst produce significant decrements in performance.

Several investigators have suggested optimum temperature conditions for several varieties of work. Woudsen and Conner (1966) suggest that 65°F is the optimal temperature condition with fatigue beginning about 75°F and mental activities beginning to slow at 85°F. Obviously it would also be desirous to control humidity as this variable contributes significantly to comfort at temperatures above 75°F.

In order to assess the need for additional temperature control in the police vehicle, specifically air conditioning, a survey of the climatic conditions of the Detroit area for a five-year period was conducted. Table 2.22 summarizes the mean dry bulb temperature and humidity conditions for several daily time periods for the six months which are typically the warmest of the year. An examination of the data in this table indicates that the months of June, July and August have average temperatures in the afternoon which might justify the decision to air-condition the police vehicle. In order to provide a full picture of this data, Table 2.23 summarizes the number of days in each of these time periods when the temperature exceeds 65°F. It is clear from this table that there are a number of days each year in which the temperature is of sufficient magnitude to cause possible decrements of performance.

It is concluded that police vehicles in Detroit should definitely be air-conditioned. It is recommended that other police departments develop similar tables so as to be able to make quantitative judgments concerning the utilization of air conditioning in their vehicles.

Table 2.22
Mean Dry Bulb Temperature and Humidity for Several Selected Months From 1965 to 1969[1].

Daily Time	Months											
	April		May		June		July		Aug.		Sept.	
	DB[2]	HUM[3]	DB	HUM	DB	HUM	DB	HUM	DB	HUM	DB	HUM
1:00 A.M.	42.8	75.3	50.1	73.0	61.2	78.5	65.4	78.1	64.2	81.6	58.2	82.2
4:00 A.M.	41.2	77.3	48.3	76.5	59.0	81.5	63.4	81.5	61.7	84.8	56.2	84.9
7:00 A.M.	40.9	78.2	50.3	75.1	62.4	77.8	65.3	80.0	62.5	84.7	55.8	86.0
10:00 A.M.	49.1	63.4	59.1	59.2	71.5	61.5	74.7	62.1	72.6	66.6	66.2	68.3
1:00 P.M.	53.8	56.0	63.6	52.6	75.7	54.2	78.9	54.1	77.7	56.1	71.3	56.9
4:00 P.M.	55.1	54.1	64.7	50.2	76.8	51.4	79.4	53.3	78.6	54.4	71.7	54.7
7:00 P.M.	50.7	60.7	60.6	55.1	72.5	59.0	76.2	58.3	73.8	63.5	65.3	67.4
10:00 P.M.	45.5	70.3	53.0	68.5	64.1	272.8	68.6	73.1	67.0	77.6	60.1	78.1

Note: 1. Based on local climatogical data for Detroit, Michigan obtained from U.S. Department of Commerce.
2. DB refers to dry bulb temperature.
3. HUM refers to humidity.

Table 2.23

Frequency of Days in Which Temperature Exceeded 65°F for the Years 1965 - 1969[1].

Daily Time	Months											
	April		May		June		July		Aug.		Sept.	
	65-74[2]	75+[3]	65-74	75+	65-74	75+	65-74	75+	65-74	75+	65-74	75+
1:00 A.M.	1	0	11	0	45	7	75	12	69	8	38	1
4:00 A.M.	0	0	5	0	43	1	59	6	53	7	32	0
7:00 A.M.	0	0	10	0	51	6	74	9	61	6	32	0
10:00 A.M.	8	0	33	11	8	55	61	86	93	51	63	27
1:00 P.M.	21	0	52	24	46	88	31	122	50	99	58	61
4:00 P.M.	20	6	54	26	49	89	26	125	41	110	61	62
7:00 P.M.	11	1	43	11	65	63	37	101	71	76	69	19
10:00 P.M.	2	0	14	0	59	15	90	20	84	19	47	1

Note: 1. Based on local climatogical data for Detroit, Michigan and obtained from the U.S. Department of Commerce.
2. Frequency of days on which temperature ranged between 65°F and 74°F.
3. Frequency of days on which temperature exceeded 75°F.

2. Driving visibility

Another problem which has received a considerable amount of attention in literature is that of driving visibility. Three major areas seem to have been investigated most frequently, those being (1) reduction of visibility as cars are redesigned, (2) problem of glare in driving and (3) problem of night driving.

First, as cars are redesigned, special attention should be given to such factors as eye levels and lowering roof lines, forward obscuration of the windscreen by the windscreen pillars and bonnet, the vertical and horizontal angles of rearward vision and the positioning of internal mirrors in relation to rearward visibility.

Secondly, the problem of glare cannot be controlled from its source. However, the methods most utilized in achieving some control of glare are the use of sunglasses by the driver or the installation of tinted windshields.

Thirdly, night driving has always been a problem, even to the most experienced driver. It is for this reason that extreme caution be exercised with respect to any decision relating to tinted windshields. It has been shown that even clear glass has a ten per cent reduction in transmission. During periods of limited visibility, losses of visibility when looking through some tinted windshields could go as high as 45 per cent.

> It is the conclusion of this report that tinted windshields do have a detrimental effect on driving visibility at night or other periods of low illumination. Therefore, it is recommended that police departments refrain from the use of tinted windshields and utilize sunglasses to decrease the glare factor during the day.

3. Noise control

The control of ambient noise or unwanted sound in the environment is usually suggested as a desired goal in any man-machine system. Acceptable levels of such sound, as well as methods of control, have been outlined by several authors (McCormick, [1970]; Woodson and Conner, [1966]; Morgan, et.al., [1963]). Specifically, the concern here is the effects of noise on human performance in order to estimate the need for additional noise control in the police vehicle. Like excessive heat, excessive noise has been known to cause body malfunctions, such as impairment of sense organs, immediate functional disability and auditory fatigue, plus arousal of general annoyance, arousal of apprehension or fear, initiation of complex antagonistic activities, decision-making ability and reaction time. However, several studies suggest that attention levels are not very susceptible to the effects of noise (Jerisin, [1959]; Techner, [1963]; Samuel, [1964]; Brown, [1965]; Woodhead, [1966]; and McCann, [1969]). It may be concluded that noise either produces little effect or a deleterious effect. Rarely does it produce an enhancing effect. The following methods of controlling noise within the vehicle have been suggested by Woodson and Conner (1966):

(1) An acoustic blanket under the hood to absorb engine noise and dampen structure;

(2) Interior upholstery material which absorbs noise effectively;

(3) Damping material cemented to the roof and headliner material to dampen and absorb noise;

(4) Damping material placed on all large metal surfaces;

(5) Heavy undercoating on inner surfaces of fenders;

(6) Rubber insulating door seals;

(7) Shock mounting of mechanical parts;

(8) Tight windows;

(9) Undercoating applied to the inside of door panels before assembly.[2]

The utilization of air conditioning may also provide relief from a great deal of noise since the car windows would be shut and the blower would be providing a masking noise.

> If such a decision were made, an externally mounted monitor device should be given serious consideration as an aid to monitoring critical sources of information from outside the vehicle.

Attaching a mike to the exterior of the vehicle and feeding it into the electronic siren system as indicated in Figure A2.2 of Appendix 2 would serve the purpose. This option has the additional possibility of sound amplification which could be used in certain surveillance situations.

[2]Note: Most American cars are presently using the listed recommendations to control noise.

III. CONSOLE AND FRONT SEAT PACKAGE

A 1967 report to the President's Commission on Law Enforcement and Administration of Justice, entitled Task Force, concluded that the operations of police officers in patrol cars would be "appreciably improved" if the monetary investment for one patrol car was allowed to exceed the current $3,000 figure.

In following its recommendation of developing experimental police cars with innovative equipment, many agencies already have made available some of this new equipment, and more is in the testing stages. Unfortunately research projects too often have developed new equipment with little or no consideration as to its convenient and efficient placement in the patrol car.

Past research has suggested an equipment console as a promising answer to the consolidation of the officers' equipment and controls placed so that it may be used in a convenient and efficient manner.[1]

The console is a unit placed within the police vehicle, located between the driver and passenger either on the transmission hump or on the bench-type seat, and containing space for many of the stationary and moveable pieces of equipment used by the police officer.

The console presented in this study--placed on the transmission hump between two bucket-type seats--is the result of a scientific

[1]Clark, G.E. and Ludwig, H.G. Police Patrol Vehicle Study, Wayne State University, (October, 1968)

approach to the problem of placement of the police officer in his vehicle and the packaging of his equipment, aware of the functions he performs and the human factor requirements of his environment.

A functional and human factors analysis of current police cars indicates the insufficiencies of equipment locations. Based on the physical constraints of the officer in the patrol car, the present location of equipment is inadequate. Officers must make extreme reaches to use some of their controls, often requiring a lapse in their attention to the road. Also, the problem of variations in the interior of vehicles results in a lack of uniformity of control location from car to car and year to year. It is obvious that standard production line interiors must be modified for the addition of so much extra equipment.

More space and better utilization of prime control areas is necessary. Therefore, any redesign of the front seat area should:

(1) increase the space available for equipment without diminishing the space needed for the officers;

(2) locate critical and high use controls in convenient locations;

(3) maintain the versatility needed for variations in the equipment desired by different departments;

(4) hold the long and short term costs of the console to a minimum;

(5) hold any alteration to the standard interior to a minimum.

The console developed as part of this study meets these design criteria. The relatively simple installation of the console does convert the standard interior into a versatile control center for patrol functions.

Discussion of the aspects of the equipment console will include:

(1) the conclusions of the study including suggested areas of future research;

(2) the human factors conclusions of the study;

(3) the design aspects of the console;

(4) the cost analysis of the console;

(5) operation advantages of the console;

(6) console manufacturing;

(7) console installation;

(8) cost of the console.

A. Conclusions

Confronted with the task of redesigning the police patrol car to be a more effective mode in which the officer could perform his function, it was decided to confine the study to the five requirements of the design of the front seat area previously mentioned, and it was found that:

(1) the equipment console is the only way of improving the operational effectiveness of the vehicle;

(2) controls within the console would be easily accessible while the capacity for additional equipment would be increased;

(3) costs of the consoles are reasonable and the installation is simple;

(4) results of tests show a significant level of acceptance by the police officers;

(5) police equipment consoles are an inexpensive way to help convert the standard production vehicle into an effective police vehicle.

1. Control locations

From a human factors point of view, the practice of mounting controls under the dash or close to the transmission hump is not acceptable in light of reach limitations. The console, on the other hand, puts the controls into the optimal reach area. A test of the consoles showed a marked improvement in the ease of operating switches because of their closeness and ease of identification. Several police officers remarked that with a console they could acutate controls without taking their eyes off the road. Consequently utility value and safety are improved with its use.

2. Cost of installation

The cost of installing a console is small compared to the $3,000 vehicle cost. The purchase price of the tested consoles were approximately $50 for a bench seat version and $150 for the larger bucket seat version. Over the anticipated three-year life span of the console, its purchase cost, installation and maintenance would be about $300 ($100 per year) in excess of the present under-the-dash methods.

3. Test results

Consoles were tested to gain a measure of their acceptability by the police officer and their operational value in the patrol function. Of the respondents (see Appendix 3 for the questionnaire and complete test results) 92 per cent found the console concept better than present methods and 97 per cent found the arrangement of controls better. It required less than two hours for 85 per cent of the officers to master the controls and 85 per cent said they found them easier to learn than present methods. In 95 per cent of the responses the officer found the controls easier to use in operating situations. These responses found the console to be an improvement because of the placement of controls, the ease with which they may be used and the consolidation of the many special switches and knobs necessary to the patrol vehicle.

B. Human Factors Aspects of the Console Design

An effort was made to apply a human factors analysis to the design of the front seat console. The body of knowledge on controls placement has been well advanced by Air Force studies into cockpit design. Based on this and other literature (see bibliography), the existing patrol car interior was analyzed. Analysis of existing bench seat type consoles was made and the design of the bucket seat type console was developed. Interrelated aspects of the interior also were studied.

1. Reach area

The human constraints in vehicle design are discussed in Black (1966), McFarland (1963) and others. However, the most relevant inputs to the analysis of control locations in a police vehicle come from the more general studies for the military as reported in Morgan (1963), McCormick (1964) and others. Based on these efforts an optimal front seat controls area was examined. Three "good" location areas were selected. Referring to Figure 3.1 these locations are:

(a) the present dash board area;

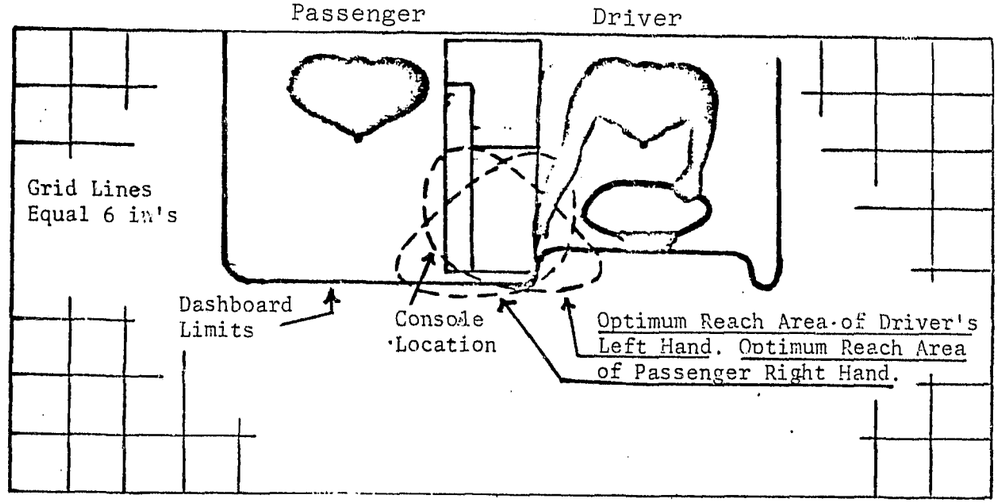
(b) the overhead area from the rear view mirror back;

(c) the seat level area between the driver and the passenger, and from the dash back.

The first and second possibilities proved less advantageous for this design effort than the third. The dashboard already had many controls; any work here would require costly substitution panels or would require longer reaches by the police officer. Many departments presently use the dash area with poor results. The overhead area would require costly wiring for each new car and would cause some loss of visibility during control actuation. Some departments are using the mirror area for switch plates and writing lights. However, feelings are mixed about its efficiency and convenience. For these reasons, it was decided to confine design efforts to the mid-vehicle floor-mounted console.

2. Analysis of a typical vehicle

Before going ahead with preliminary designs of the console, an analysis was made of typical 1969 model Detroit precinct



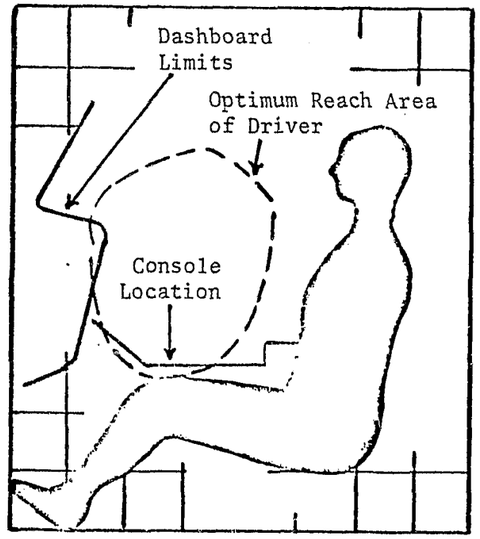


Figure 3.1
Showing Location of Research Console

Strophosphere of optimum police control locations in typical automobile. The inclosed area depicts the region common to all hand motions. Reference: McCormick, E.J., Human Factors Engineering, McGraw-Hill, New York, 2nd ed. 1957, pp. 365.

vehicles. The measurements were compared to objective design criteria from various publications. The analysis was concentrated on the location of special police controls such as siren head, radio head, and beacon switch. Additional analysis was made of standard options such as power steering and seating. It was not intended to preclude the human factors work already done by the automobile companies, but rather to view standard options under the functional constraints of a police vehicle. Detailed results of the analysis of the interior are included in the human factors section of the report. Conclusions presented here are confined to the location of controls.

Because of the changes in dash boards between model years and between vehicles, there is little standardization of control placement. It is not uncommon to find cars in simultaneous service with switches, such as light switch and wiper switch, located on either side of the steering wheel, the result being that an officer could not habitually reach for a given switch with the same hand. The automobile companies have gone a long way in standardizing the location of specific controls. However, the design of the dash panels often necessitates a haphazard location of additional police controls.

3. Location of the radio and siren controls

Radio and siren manufacturers have designed their control boxes to mount under the dash. Because of the present dash panel designs, these controls would be located at extreme distances

from the driver. When the vehicle is moving, he could not make use of these controls without leaning forward and to his right, thereby causing some loss of control over his steering and braking abilities, and restricting his visibility.

Many departments recently have utilized a sheet metal or angle iron bracket located over the transmission hump for mounting their radio and siren control boxes. Although this eliminates the variation between cars and modularized the control packages, it is no better from a location point of view. The controls are outside acceptable reach limits and become virtually useless to the driver in moving situations.

> The conclusion is that the control heads must be located within reasonable reach of the driver.

C. Console Design

The concept of a modularized equipment console for the officer has been justified in earlier research efforts by Ludwig and Clark (1968). The following is an explanation of the assumptions and constraints established for the design, a history of the effort, drawings of the final prototype and suggested design improvements based on the test of the prototype. Photographs of the console are included in Appendix 4, Figures A4.3, A4.4 and A4.5 and A4.6 of the report.

The basic idea was the development of a system that would completely and conveniently package the officer's equipment and fulfill the following conditions:

(1) the design should serve the officer in his routine and extreme needs while minimizing the effort of the officer using his equipment;

(2) the design should fit any standard production vehicle used by police;

(3) the installation costs should be minimal.

1. Preliminary design

Initially, a cardboard mock-up of the basic concept was developed. The mock-up and functional and human factors criteria were given to a local industrial design firm who, in turn, supplied its "polished" version of the console based on information and materials supplied to them. The result, which is shown in a photograph in Appendix 4, was a console that was positioned between and parallel to the seat backs. The forward part of the package was a removable forms case, the center of the console was an aluminum plate holding the siren, radio and switch controls illuminated by a night light just to its rear, and the rear portion of the console was designed as storage area for the PREP radio, flashlights, and spot light. Room was available on either side of the console for gun mounts. An addition to this package was an overhead console that would house additional controls and a writing light.

Many interviews were conducted with people in various police departments and equipment companies. The purpose was to gain insight into their needs and experiences. It would not be practical

to relate all of these conversations here: the reader is referred to the acknowledgement list at the end of the report.

Some modification to the original design was made, including the decision to eliminate completely the overhead portion of the package because of excessive conversion costs. In addition, some thought was given at the outset of the design research to mount a shield with a slideaway center panel which would serve as a partition between officers in the front seat and passengers in the back seat. Since it was determined that such screens would violate Federal Motor Vehicle Safety Standards, the idea was not pursued any further.

2. Final design

A final design was worked out in conjunction with a company specializing in prototype development. This prototype was developed by constructing a wood and clay mock-up in a police car provided by the Detroit Police Department. Modifications resulted in a console that was molded into a fiberglas prototype for testing. Several copies of the console were made to test different control arrangements. Technical drawings of the prototype are included in Appendix 4, Figures A4.1 and A4.2.

A suggestion to improve the console is to incorporate a partition between the seat backs. The reasoning behind such a partition is the prevention of a passenger in the rear seat from reaching for any console equipment, such as flashlights or spotlights. Since the partition would extend no higher than the seat

back, it would not violate Federal Motor Vehicle Safety Standards. This partition could be made part of the console, but care should be taken so that it is not an elbow obstruction to the use of the control switches.

Quick disconnecting wiring panels would greatly reduce the cost of maintenance and replacement of electronic components. Since the wiring would be done by the individual departments or their contracted vendors, this recommendation is intended for those people.

D. Operation Advantages of the Console

The operational advantages of the equipment console are as follows: (1) the safety of the interior under operating conditions is improved; (2) police equipment controls are placed in more convenient and efficient locations; (3) space is made available for the location and storing of other equipment.

1. Safety

As they are currently equipped, most police cars could not pass the Federal Motor Vehicle Safety Standards because of such things as poorly located switches, vertically-placed shotguns and improper use of screening for detention purposes. The two obvious dangers that are alleviated by the console are interior obstructions and control placement. The practice of placing shotguns in a vertical position could cause severe head injury in the case of an accident. The console offers a safe place where the shotgun can

be located horizontally. If it is desired, it can also be hidden from view by the addition of a fabric flap. Controls are placed within reasonable reach of the driver so that he can give undivided attention to his driving while, at the same time, manipulate one of the controls.

2. Placement of controls

Besides the safety advantage for the driver, the console allows for more efficient actuation of controls for both the driver and his partner. As demonstrated in the officer response to test questionnaires, see Appendix 3, the console location increases both speed and improves accuracy of control acutation which is especially necessary in critical situations.

3. Availability of additional space

The console was designed to accomodate those commonly used articles which the majority of police departments require their officers to carry, such as flashlight, night stick, PREP radio, clipboard, report forms and ticket books. However, there is additional capacity available for other equipment items which some police agencies feel is also necessary.

As suggested earlier, the equipment requirements of police departments will increase in the future. The console was designed with that in mind. There are two areas for equipment that have not been used. The space just above the microphones is available within the area of reasonable reach. Any additional controls such as teleprinter, computer console or radio telephone can be located in this space. The space between the seat backs is available for

non-critical equipment storage such as fire extinguisher or breath analyzer.

E. Console Manufacturing

The advantage of the use of fiberglas in the production of the console is the ease with which pockets and holes can be made, allowing for more complicated designs. One exception would be the difficulty of producing "long draws", such as the vertical partition between the seat backs discussed earlier.

If the quantity of production is high enough, the material could be changed from fiberglas to sheet metal. Slight modifications in design could allow for sheet metal construction with a minimum of assembly operations. This material should reduce the cost of manufacturing and consequently the cost to the police department.

F. Console Installation

Installation methods for the tested console were studied during the testing of the prototype. The resulting installation method follows:

(1) Locate the console on the transmission hump. Set the console in a position so that an officer could just touch the front slanted portion of the unit with his fingertips without lifting his back away from the seat.

(2) Unbolt the mounting bracket and lift the fiberglas console off. Make sure that the braket does not move.

(3) Adjust the legs of the bracket to the transmission hump. Locate and drill four holes into the floor pan. Bolt the bracket down with four 1/4 - 12 bolts.

(4) Remove the aluminum face plate from the fiberglas. (Equipping the console should be done before it is permanently mounted in the car.)

(5) Remove the radio and siren heads from their cases.

(6) Locate radio head, siren head, and miscellaneous switches on the face plate as indicated on mounting diagram.

(7) Lengthen wires to mike jacks and relocate on the face plate as indicated on the mounting diagram.

(8) Drill all necessary holes in the face plate to accommodate the switches, knobs, and jacks.

(9) Clean aluminum plate, letter switches and knobs. Use press of letters.

(10) Attach all control heads, switches, and jacks to the aluminum plate.

(11) Attach the gun lock and radio speaker to the fiberglas console.

(12) Run the wires from the trunk, power source, brakes, flasher, P.A., etc. to the console area.

(13) Mount the console on the bracket.

(14) Wire all heads and switches.

(15) Mount the face plate onto the console.

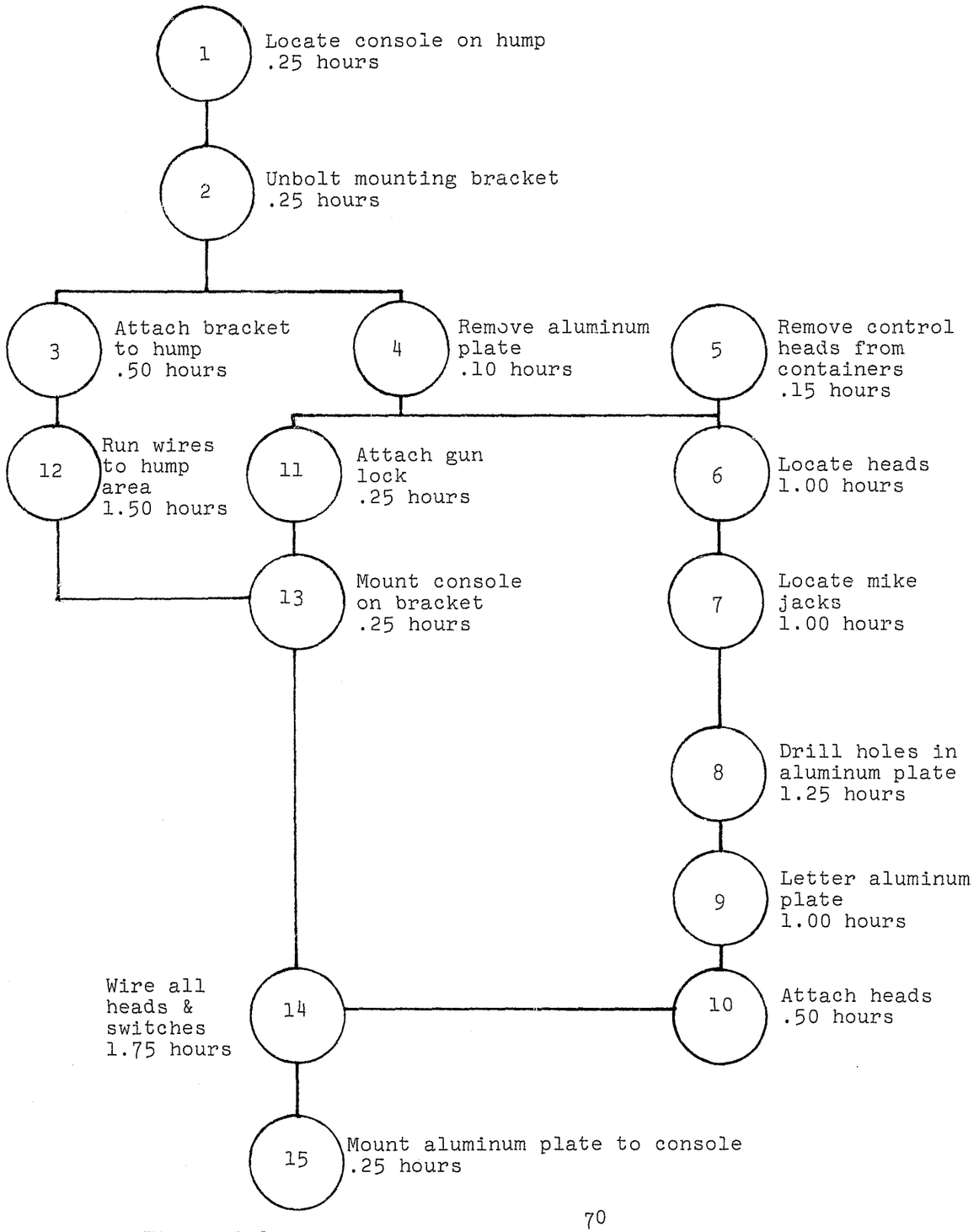


Figure 3.2 Console Installation

G. Cost of the Console

A cost study must necessarily be only approximate. Because of variations in vehicle trade-in policies, conversion policies and equipment policies, the cost of a console would vary between departments. The figures represent the expected cost of the console designed under this project and equipped for use in the Detroit Police Department. Figures do not include costs of control heads or switches in that these items are equipment separate from the console itself. The cost figures are approximated as follows:

Unit purchase price as quoted in quantities of 10-50	$150.00
Initial mounting and wiring of the unit in a vehicle 11 hours @ $10/hr	110.00
Removing and remounting in second vehicle 4 hours @ $10/hr	40.00
TOTAL	$300.00

Note: See installing instruction for cost breakdown.

IV. SYSTEMS DESCRIPTION OF VEHICLE OWNERSHIP

The objective of this chapter is to provide the police community with a management-oriented systems analysis of the procurement-maintenance-replacement cycle of a police vehicle. This analysis requires an examination of each step in the cycle and a determination of the policies, information flow and decisions required to support this cycle. Problems have been defined and whenever modern management practices and engineering analysis may prove to be valuable, they are discussed.

As it is impossible to design a system to meet the specific requirements of any agency, the most desirable or ideal system was developed. This target system is available that can be altered to meet the particular situation at hand. This approach also has been used in the design of the police maintenance information system.

The recommended practices given herein may be augmented by further studies of this type, by review of fleet literature or by the mutual exchange of information by administrators themselves.

The system is described in general with reference to the flow chart on the following page. The discussion indicates the scope of the system under consideration and defines the major steps or activities that take place. These major steps are used to classify the problems and the discussion in Chapters V, VI, VII and VIII.

A. New Vehicle Requirements

The first step in the vehicle life cycle is the request for new vehicles. Demand for new vehicles originates from two sources:

(1) the continual replacement of vehicles and

(2) additional vehicles which increase the size of the fleet.

The latter requests are the result of expanded or intensified police operations. In some police departments they are referred to as capital requests. These new vehicles, when added to the fleet, become indistinguishable from other vehicles already a part of the fleet.

The major tasks of the replacement request are to determine the number of vehicles to be replaced and generate specifications for the new vehicles. There is considerable difference in the development and determination of specifications from one police department to another. A major contribution of the research effort is the recommendation of vehicle specifications that may provide a more uniform practice in this area and a better,

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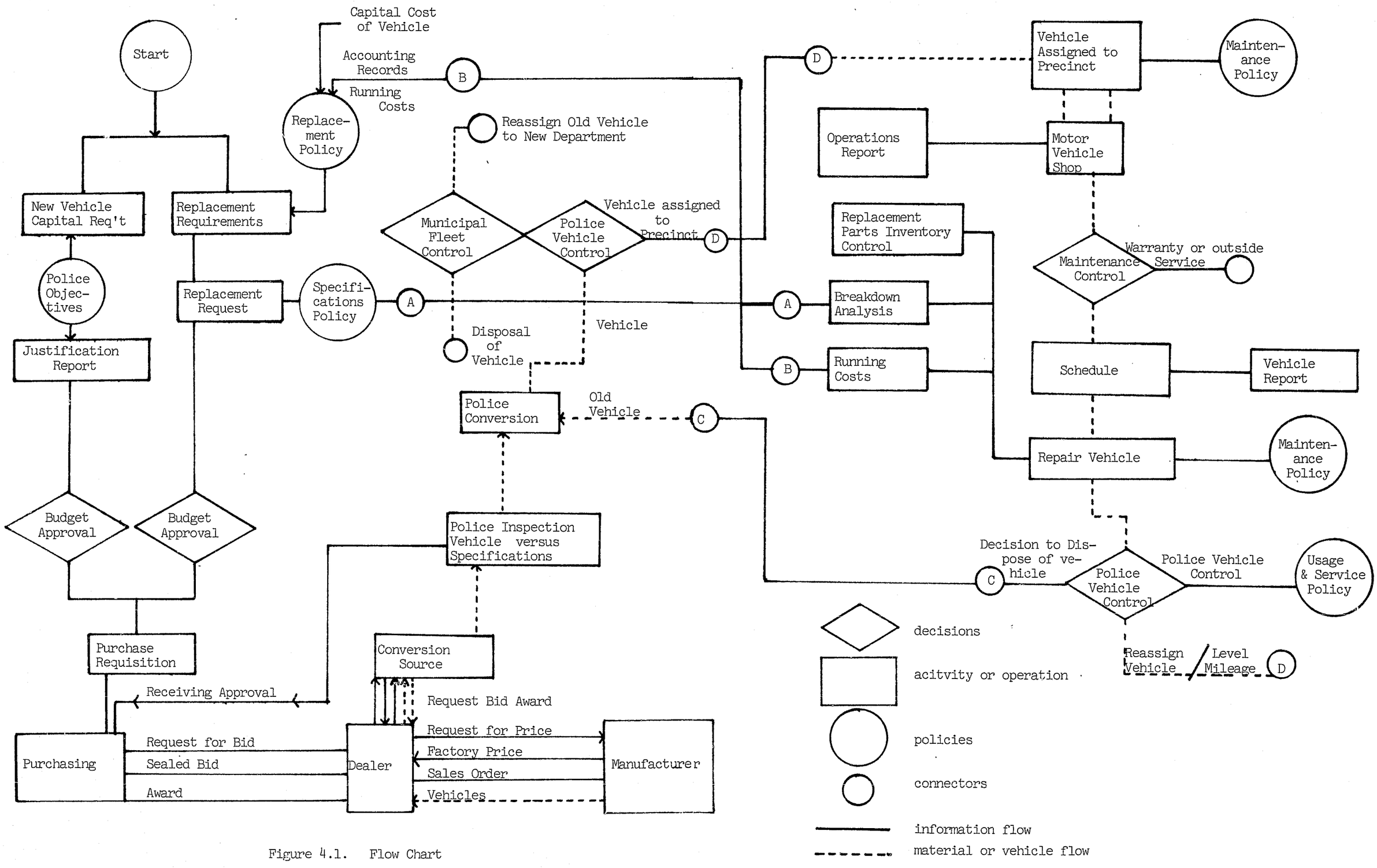


Figure 4.1. Flow Chart

more useful vehicle. This is mandatory if economies of scale are to be passed on to the police departments in more effective equipment.

The number of vehicles to be replaced is determined by the composition of the fleet and by a replacement policy. Such policies state the type of vehicle and amount of time the vehicle should be kept in service. Any effective replacement policy must consider the total cost of operating the vehicle including the cost of maintenance and depreciation. The cost of maintenance is accounted for separately by a maintenance or operations budget. As long as requests for replacements are within the budgeted amount, such requests are routine and normally approved by budget authorities. Replacement parts also are handled on an annual basis for a total budgeted amount. Parts are then purchased for those items with a predictable demand or blanket orders are issued to local suppliers to release parts to the police shop as needs arise.

B. Purchasing of Vehicles

Once the number of vehicles to be replaced and/or purchased is determined and approved by police administration, cost estimates are added to the annual police budget for approval by city government. If approved, a purchase requisition is then developed along with detailed vehicle specifications followed by the release of bid request forms to the dealers. All purchases

must be made through a dealer rather than directly from an automotive manufacturer.

The automotive dealer consults with the manufacturer for a wholesale price for the vehicles, supplying a price for the basic production cars and for the accessories he installs. The items that are not installed by the manufacturer are installed either by the dealer or by a conversion source--a concern which alters production vehicles into specialty vehicle, e.g., the alteration of station wagons to accommodate ambulance cots. In the event a conversion source is required to com lete the specifications, a request for bid and price is required between the dealer and the conversion source. The dealer, upon receipt of all price information, adds his mark-up and submits this price in a sealed bid along with his vehicle specifications (if different from the bid specifications) to the police department.

Bids from all dealers are opened by the purchasing agent for the city, state or municipality. Representatives from the police department review the bids for concordance with the specifications and decide on the acceptability for any deviations or substitutions. Awards are based on price and specifications submitted.

C. Manufacturers

The manufacturer develops a police package through product planning research and contacts with police associations and

the larger fleet managers. Manufacturers provide dealers with prices on specifications. Ford Motor Company, for example, lists police vehicle options as "regular production", "limited production","domestic special order" and "dealer installed accessories." Vehicles are shipped either from the factory to dealers or, in some cases, directly to a conversion source. They are then shipped to police garages.

Police fleet administrators usually inspect any conversion work after it is completed on one vehicle. If such work is approved on the first vehicle, the remaining vehicles are then completed and delivery is then made to the dealer and/or the police department. On receipt of vehicles by the police department, the vehicles are given a final inspection for workmanship and specifications. Notification of final inspection is given to the purchasing agent to enable payment of the vehicles and the notation of record and files.

D. Conversion Work Done by the Police Garage

Prior to assignment of the vehicle to a precinct, the vehicle is processed by the police garage and equipment usually "carried over" from one vehicle to another is installed. Such equipment may include a two-way radio, sirens, lighting, decals and license plates. The radio is installed in the trunk and controls such as the radio head and microphone are assembled to the instrument panel. Lights, siren and public address

microphones and siren controls are installed inside the vehicle. Decals and special markings are also placed on the vehicle.

In addition to installation of equipment, administrative duties concerning the vehicle are performed. License plates and a vehicle identification number are assigned. The serial number, vehicle code number, tire serial numbers and ignition key number are recorded. The vehicle is now ready to be assigned by Police Vehicle Management. This may be a full- or part-time responsibility of one or more officers depending on fleet size and the amount of liaison that is required between police and other municipal activities. Police Vehicle Management must decide which precinct should receive the new vehicle, which vehicle should be exchanged for the new one and whether or not the replaced vehicle should be reassigned or taken out of commission. In the City of Detroit, for example, the Department of Public Works, Motor Transportation Division, performs vehicle maintenance, writes specifications with police concurrence and makes final disposition of vehicles. The Motor Transportation Division may assign a police vehicle to some other non-police assignment if it feels the vehicle has additional economic service life.

The opposite operations are performed on a vehicle that is being taken out of commission, including administrative tasks of removing it from asset accounts and updating operational records. The police equipment that is reusable in other vehicles

is removed and returned to storage. The vehicle is usually available for public sealed bid auction.

E. Precinct Usage

In Detroit, each precinct has a number of different type vehicles assigned to it. Vehicle types could include scout passenger vehicles, station wagons with cots, general assigned vehicles, surveillance vehicles, cruisers and freeway patrol vehicles.

The assignment of vehicles at the precinct includes enough vehicles to satisfy precinct operations plus additional units to be used as standby or spares to cover breakdowns and scheduled maintenance. Vehicles are operated and maintained according to prescribed regulations and maintenance policies. Driver responsibilities include refueling the vehicle, and checking the radiator coolant level, engine oil level, operation of safety equipment and tire pressure on a daily basis. Drivers may also have the vehicle washed when it is needed. They also are required to observe maintenance policies and deliver the vehicle to maintenance or service facilities at the prescribed time or mileage, or when problems arise. In some departments, police officers are relieved of these tasks and the responsibility is given to an officer, who is restricted to light duty, or a civilian employee.

The maintenance policy that is followed by police fleet administrators prescribes the time or mileage that vehicles are

serviced and what services and inspections are to be performed. Policies vary from one police department to another, the extremes being full preventive maintenance covering tune-ups, electrical and mechanical inspections and replacements at prescribed intervals to repair "as needed" only.

If the fleet size does not warrant a police department having its own service facilities, the work is usually done by an outside concern.

F. Vehicle Shop

A determination has to be made whether or not certain services are to be performed by the police department service shop or subcontracted out to a dealer or commercial shop. The latter alternative is exercised when the police department service shop load is extremely heavy or when the police shop does not have the facilities or capability to perform certain repairs. Warranty work is most often performed by the dealers at no expense to the police department.

The scheduling activity consists of determining the type of services or inspections that are required for each vehicle and determining the order or sequence that the jobs are to be performed for each available mechanic. (This is sometimes referred to as determining the routing for each job.) The objective of the scheduling function is to service as many vehicles as possible to reduce the number of vehicles that are out of service. Reports indicating the number of vehicles out

of service and the duration of time spent in the shop are distributed to police officials as a means of control. Maintenance dispatchers may work closely with Police Vehicle Management or precincts to expedite those vehicles that are urgently needed.

Vehicles are inspected and repaired in accordance with the maintenance policy and the instructions given by the shop foreman. Mechanics may perform specialized or general services depending upon the size of the facility and its organization. A facility that has a policy of preventive maintenance may perform the same inspection maintenance operations for every vehicle. If some additional work is required as a result of these inspections, the same mechanic may make the repairs or another may be assigned the more general type repairs. In the case of repair "as needed", the type of work performed is more varied and more difficult to control. As the work is performed and parts are replaced on the vehicle, the parts used, operations performed and time expended are recorded on various documents by the mechanic or shop foreman. Then documents are used to describe the service history of the vehicle, control part inventories, pay the mechanic and provide the input for operating and maintenance costs and other management control reports.

The events that take place in the maintenance and repair of the vehicle provide the information that is used as an input to the control system of the cycle. The number of vehicles serviced

and the duration of time spent in the shop are indicators of how well the maintenance system is working. The operations performed in the shops indicate the type of breakdowns that are occurring. The schedule of operations can be used to (1) evaluate the service the vehicle is receiving, (2) determine the manner which the vehicle is being operated, (3) determine the durability of the vehicle's components and (4) evaluate the vehicle's specifications in light of service problems and maintenance required. A schedule of operations performed can also be used to evaluate the efficiency of maintenance manpower and extract parts usage information used for inventory control. The labor and material costs, together with fuel and oil costs, are used as control reports on the costs of vehicle operations and the determination of when vehicles should be replaced. The maintenance costs are added to administrative costs for budgeting and control of the maintenance function.

In addition to the above operating costs, reports on mileage per week or month and vehicle inspections permit police fleet or Vehicle Management officers to reassign vehicles so as to distribute them more evenly between high usage and low usage areas. The experience gained by the operation of a vehicle is then used as feedback to revise the maintenance, replacement and specifications policies for the next new vehicle.

V. POLICE VEHICLE SPECIFICATIONS

The specification of a police vehicle must take into consideration a number of factors which generally can be categorized into (1) departmental usage policy, (2) replacement policy, (3) maintenance policy, (4) compatibility factors and (5) economic considerations.

In this chapter, each of these five factors as they relate to police vehicle specifications will be considered. In addition, an attempt will be made to establish and justify a philosophy used to generate specifications which fulfill departmental requirements. Police vehicle optional equipment will be discussed and, finally, the minimum requirements for the vehicle will be recommended in a model specification.

As discussed previously, the police vehicle in some departments may be used to perform some or all of the following functions: (1) patrol car, (2) freeway traffic car, (3) ambulance, (4) prisoner transport, (5) interim road service vehicle. Each of these functions requires specialized equipment and the police vehicle should be properly equipped to perform the functions dictated by its departmental usage policy.

In some instances, departmental policy calls for the transporting of detained persons in a special vehicle, necessitating

the need for at least two types of vehicles. In other cases, departments recognize three basic objectives (general patrol, freeway traffic work and prisoner transport), necessitating a different type of vehicle for each objective. In the latter case, the patrol car would handle normal police activity, the freeway vehicle might handle interim road service and emergency ambulance service besides expressway traffic, and the prisoner transport vehicle would be used solely on that basis. If the list of functions were expanded to include all types of police activities rather than those associated with the "marked" police vehicle, further usage could be justified, but since the scope of this report is limited to the marked police patrol vehicle, no attempt will be made to expand usage.

A. Considerations for Selecting a Vehicle for Police Service

Several questions arise as to the approach which should be used to provide a vehicle which meets departmental usage standards. Police associations in various parts of North America feel that the present practice of modifying current passenger production vehicles does not provide an adequate vehicle for police work.[1] They say a special type of vehicle is needed. These claims are based on incidents in which the police vehicle was attacked by

[1]See Police Association of Ontario, Minimum Standards-Police Vehicles (Ontario, 1970) p.2-3.

gunfire, objects thrown through the windows, etc. The result of talks with policemen and their representatives intimates a need for special or armored vehicles.

Several factors would have to be considered before adopting this type of vehicle, one of which is a determination of whether such a vehicle would really provide the sought-after protection. In all probability, those elements in society which intend to attack a police vehicle will carry out their intention regardless of the degree of protection afforded the occupants of the vehicle. The mode of attack on a specialized vehicle would require a more sophisticated weapon than being used currently. Any type of armored vehicle that could be reasonably used for police work would have insufficient protection against the simplest homemade bombs, firebombs, etc. The only effective means of solving the safety problem is to eliminate the attacks by changing the social attitudes which exist regarding the police.

Secondly, the frequency with which a patrolman is attacked while in his vehicle is minimal. A preliminary survey indicates that the largest number of injuries and fatalities are inflicted upon the police while they are outside their vehicles. As a result, a vastly increased amount of money could be spent on armored vehicles without drastically improving the safety of the patrolman.

A third argument against the use of a specialized vehicle is based on the economic factors of building such a vehicle. The cost of production of a specialized vehicle would triple or

quadruple because of the low volume of production. As a result of the increased cost, various government agencies would be required to increase their capital investments in the police fleets. As a direct result of the fiscal problem, it would be expected that the interim between unit replacement would be prolonged. Patrolmen would be faced with the prospect of driving older equipment which would lack the latest improvements in automotive design, such as disk brakes. (Disk brakes are just one example of a recent development that would not have been on a fleet that was purchased, say, three years ago.) Since many departments have replacement policies based on a two-year cycle and have limited funding, the specialized vehicle usage would have to be extended over a much longer period of time. It is estimated that these vehicles would have no resale value and would be depreciated over a five- to eight-year period.

> In order to provide a vehicle which will satisfy the vehicle usage profile within the economic constraints, it must be concluded that a police department must purchase a modified standard production automobile.

B. Types of Police Vehicles in Use

In examining the vehicles used by various police departments, one becomes aware of a wide variation in the types of vehicles used in patrol work. To a certain degree the variations may be due to different usage policies established by the department. However, economic limitations frequently become dominant in the purchase of a police fleet. When this occurs, a vehicle may be

placed in a severe operating climate for which it was not designed. A comparison of the normal passenger vehicle of American manufacture with the same make equipped with a "police package" indicates a vast difference in the design, handling performance and safety of the vehicles. On the surface, the normal passenger vehicle, when painted in police colors and equipped with the appropriate lights and siren, will look the same as a vehicle which was assembled in the factory from certain components specifically designed and selected for police service. In all probability, the normal passenger car used in police duty will be somewhat cheaper than one equipped with a "police package." The question arises whether anything is wrong with such a practice.

It should be clarified here what the advantages are in purchasing a vehicle equipped with a "police package" rather than a standard passenger car. All domestic auto compaiies build into the police vehicle at the time of production certain components collectively referred to as a "police package." These components exceed the standard requirements of the normal passenger car. Such components include special engine parts (highlift camshaft, high performance valve springs with internal dampers, special hydraulic lifters and other high-speed and longer life features), special clutches and transmissions, heavy-duty axle, heavy-duty battery, heavy-suspension (coil springs, shock absorbers, front stabilizer bar, lower front suspension arms), heavy-duty brakes, etc.

It can be assumed that the police officer driving a vehicle not equipped with a police package does not have the proper equipment for police service. There is always the probability that the police vehicle will be placed in a situation which calls for superior handling and performance. Without a doubt, anytime a police officer is on a high speed emergency run or in a high speed chase, there is present an element of risk to the patrolmen in the vehicle and the public. The risk of a traffic accident exists regardless of the type of vehicle being driven. However, it is held to a minimum when the vehicle being driven is one equipped with a police package.

At least two other factors weigh against the cheaper initial cost of a standard passenger car used for police functions.

(1) If an injury accident should occur due to the lack of proper police equipment and components, possible compensatory and pension costs plus other damage costs could more than offset the initial savings.

(2) Another factor which may result from using a standard vehicle would be an increased maintenance cost.

> Since all American manufacturers provide a police package with a variety of options which represent vital design changes from the normal production vehicle, it is recommended that the minimum technical specification which a department should consider would be one with the standard police package as offered by the manufacturer.

In regard to the body style used for police patrol work, the manufacturers have stopped production of two-door sedans in most

car lines. Usually the four-door models, both hard-top and door post styles are produced. Structurally, the four-door sedan equipped with a door post is considerably stronger than the hard-top lines.

Certain usage policies may call for the use of a station wagon for patrol work. The station wagon has one disadvantage in general patrol work: the weight distribution of the station wagon results in a vehicle which has poorer response and performance characteristics.

The station wagon handling performance is not equal to that of the sedan because of the additional weight. Even when equipped with a police package suspension, the station wagon will not handle as well as a sedan equipped with a corresponding package. For a given engine size and drivetrain the acceleration performance of the station wagon will be less than that of the sedan due to its increased weight.

C. Philosophy for Generating Vehicle Specifications

The problems which arise in the purchase of a police vehicle from a manufacturer are concerned with the formation of technical specifications by which the vehicle requirements are established. The results of this study indicate that a large variation exists in the length and detail of specifications produced by the police departments. (See Appendix 5 for examples.) Some department specifications cover two pages while others cover ten to fifteen

pages. Present techniques of formulating technical specifications are also widely varied. In specifying the requirements for the subsystem of the vehicle, one department may indicate the criteria which the subsystem must meet, another will specify a particular brand and model which must be installed, while a third department will attempt to engineer the subsystem with design specifications. Many specifications contain unnecessary requirements or requests for illegal vehicle modifications under the Federal Motor Vehicle Safety Standards.

This study indicates that only a few police departments are staffed with technical personnel qualified to engineer the vehicles and that frequently the specifications are generated on the basis of practical experience. By these remarks, that practice is not condemmed, for indeed, in many cases it has resulted in an excellent set of specifications. However, in moderate or small size departments insufficient experience may lead to a poor technique in formulating specifications, or they may be unaware of the options which are available for police equipment.

It would seem that a reasonable philosophy for formulating technical specifications should be established. Since most police departments are in a position to define what they expect from the vehicle under specific operating conditions, it is suggested that a vehicle or subsystem performance requirement be established. An example of the performance specification concept is given in regard to the specifications for the cooling system of a police vehicle:

> The cooling system of the vehicle should provide sufficient cooling to maintain an ethylene glycol mixture having a freezing point of (x)°F at a temperature below (x)°F maximum during all driving conditions occuring at an ambient temperature of (x)°F. In addition, the vehicle cooling system must provide sufficient cooling to meet the above requirement for a period of (x) minutes with the vehicle motionless and the engine at an idle speed of (x)rpm. These requirements must be met with all equipment operating.

The concept involved here is that the cooling system will operate satisfactorily providing there is sufficient heat removal to prevent damage or service outages for all reasonable operating conditions. The above performance specification might be compared with a design specification approach which might represent an example of present practice. This design form might state: "The cooling system must have a heavy-duty radiator, an 18" six-bladed fan with two belt drive."

In the hope of gaining desired performance from the vehicle, many police departments write specifications with regards to description only (heavy-duty radiator, 18 inch six-bladed fan, with two-belt drive; or a 428 cubic inch engine). However, this procedure is no guarantee the vehicle will perform within the police department's desires. Though this type of specification is more the rule than the exception, it should not be used.

Further, the definition of a "heavy-duty" radiator may not have any real meaning. For example, in some models of vehicles with certain combinations of optional equipment, such as engines, air conditioning, power steering, etc., the manufacturer has only

our radiator which will fit the vehicle, and the standard radiator for that model, therefore, becomes heavy-duty in name only. The specification of fan size and number of blades will not insure proper cooling. In an engineering sense, the various components of the cooling system, fan, radiator, water pump, engine and transmission must be matched to provide satisfactory service using a systems concept of design.

> Since the manufacturer is best qualified to perform this matching using his engineering talent and test facilities, it is recommended that the police department use a philosophy in which the performance requirements become the specification.

This concept of a performance specification cannot be over-emphasized. It will provide the user with equipment which will perform satisfactorily and allow the manufacturer to perform the system engineering function for which he is much better qualified and equipped than most police departments.

Since the modified passenger vehicle must be integrated into the user's system, a second concept, that of compatibility, should be introduced into the formation of vehicle specification. Many departments have investments in specialized equipment, such as lights, sirens and radios, which is added to the vehicle. This capital equipment may represent up to fifty per cent of the vehicle cost and usually has a replacement cycle two to three times as long as that of the vehicle. The technical specification, when properly written, insures compatibility between the vehicle and this capital equipment.

In conclusion, there are two premises which should be used in writing the technical specifications:

> (1) the specification should define the operating limits which are expected of the vehicle;
>
> (2) the specification should insure compatibility between the vehicle and other departmental equipment.

D. Problems Associated with Technical Specifications

In examining the practicality of the performance approach to the specification, certain problems are foreseeable:

First, at the present time, manufacturers assemble the vehicle from specifications requesting particular types of equipment. The performance specification does not specify the components but only asks that the vehicle perform in a particular manner. This method will require that someone select the components which should be put into the vehicle. Since this is an engineering function, this translation should be performed by the manufacturer. Another approach the manufacturer might use to overcome this problem of selecting the components is to present the performance of the vehicle and its subsystems in a form which defines how the vehicle will act with different combinations of equipment. A certain advantage exists with the system in that the information would provide the buyer with a basis to evaluate the vehicle and become familiar with the characteristics of certain selections.

Secondly, it is exceedingly difficult to limit the bidders to a particular make of vehicle. There may be valid reasons for making such a limitation. For example, the low initial cost of a vehicle combined with a relatively high cost of repair parts might provide a valid reason for rejecting a bid. On the other hand, the selection of a minimum engine piston displacement might eliminate certain bidders from competing on an equivalent model basis. For instance, the following chart gives the cubic inch displacement for recommended V-8 engines of four makes of 1970 police vehicles as listed in the manufacturer's bulletins:

V-8 Engines--Cubic Inch Displacemert

Ford	Chevrolet	Dodge	Plymouth
351	350	318	318
390	454	383	383
428		440	440
429			

If a specification were to require a V-8 engine with no more than a 325-cubic-inch displacement, one can see from the chart that only Dodge or Plymouth could bid on the request and Ford and Chevrolet would be eliminated because their lowest recommended displacement for V-8 engines in police vehicles is 351 and 350-cubic-inches respectively. Frequently, this practice of procuring bids is done to support a subjective evaluation of a particular make.

However, it is difficult to support the descriptive component type of specification when used in this manner. In all probability it results in a higher cost to the police department because of the lack of competition.

Before entering into a discussion of the individual subsystems, one fallacy of terminology should be mentioned. The term "heavy-duty" has been discussed previously with respect to the cooling system of the vehicle. The term is frequently found in connection with the suspension system, seating, etc. Unfortunately, the term has little significance as to performance of a system. For example, a specification of a heavy-duty suspension by a police department is intended to provide a superior handling vehicle. However, the manufacturer may offer a standard suspension, a heavy-duty suspension and a police handling package. The specification for a heavy-duty suspension may be interpreted by the manufacturer as the heavy-duty trailer package (greater load capacity) rather than the desired "police handling package." (Parenthetically, it should be clarified that there are no set testing procedures for a police handling package. The decision of whether a manufacturer's police handling package is acceptable under department conditions is a subjective one usually made by the test drivers of the individual department.) A second problem is that frequently no heavy-duty equipment exists. If heavy-duty items are requested, manufacturers will only provide components used in their standard production models.

It is recommended that clarification of heavy-duty be made whenever the term is used in the specifications.

E. Discussion of Particular Vehicle Specifications

The following discussion breaks down the police vehicle into eight general divisions of vehicle characteristics and recommends particular specifications within each division.

1. Vehicle size

The first question which arises in the purchase of a police vehicle is the size of chassis or wheel base of the vehicle. Several theories have been presented to justify the larger (more than 118-inch wheel base) vehicle. Hereafter, these vehicles will be referred to as custom or full-sized vehicles, while the 112-inch to 118-inch wheel base vehicles will be termed intermediate lines. These theories are related to occupant comfort and safety. There is little question that the full-sized line vehicle is potentially safer than the intermediate line vehicle in certain accident situations. The full-sized vehicle provides increased mass which, in turn, lowers the rates of deceleration for a given crash force. The lower deceleration rates reduce the injury potential to the vehicle occupants. Therefore, greater safety is provided. A subjective comparison of the full-sized and intermediate vehicles indicate that the human factors aspects favor the full-sized vehicle.

These human factors deal largely with the packaging of the vehicle occupants and the comfort provided the individuals.

Many production vehicles are designed to accommodate the 50th percentile[2] male torso with adjustment ranges which will allow the smallest woman (5th percentile) or largest man (95th percentile) to drive the vehicle. Unfortunately, the police officer is frequently a member of the 95th percentile and is not provided the same degree of comfort which is available to the average driver. Therefore, the full-sized vehicle with its larger passenger compartment is usually able to meet the larger police officer requirement. The basic variation in packaging the occupants in the full-sized vehicle and the intermediate vehicle exists in the headroom and hiproom areas in the front seat and legroom area in the rear. The front seat variation is usually less than 1.5 inches in headroom while hiproom may show a larger variation. The rear seat legroom and door opening size must be evaluated in light of using the vehicle for transporting prisoners. The smaller intermediate vehicle may complicate placing an unruly prisoner in the rear seat of the vehicle. Yearly model variations make it difficult to provide an exact door size. However, the minimum door size should be approximately 29 inches high by 32 inches wide with a ground to upper body opening of 47 inches. All dimensions are measured according to the Automobile Manufacturer's Association (AMA) standards.

[2]The size dimensions of the body have been studied for the American population. The results of these studies have led to a classification by the frequency of occurance, termed the percentile. For example, the 50th percentile represents one-half the total population and may be termed the average size.

The second area of human factors which seems superior in the full-sized vehicle is ride comfort and noise control. The present state of the art in full-sized vehicles is superior to that of the smaller vehicle in this respect. This may be in part due to the differences in construction techniques which are employed. Frequently, the intermediate vehicle is equipped with a unit body[3] while the full-sized vehicle has a body and frame construction. It is difficult to correlate the different size vehicles with the type of body construction because of variations between manufacturers and the yearly model changes.

The depreciation on the intermediate-sized vehicles is approximately $330 less than the depreciation on the custom line vehicles at the end of the first year and approximately $?60 less at the end of the second year. (Determined by subtracting average wholesale from delivery price for several low-priced full-sized 1969 model vehicles based on Red Book (1970) price.) Exact values of these figures are dependent on the manufacturer with certain models holding their value quite well. Economically, the intermediate-sized vehicle has the advantage of smaller capital investment and less depreciation.

Furthermore, the study indicates that the economic consideration of vehicle depreciation based on manufacturer's suggested retail price to used car wholesale price does not favor any type of engine significantly. For example, the additional cost of a V-8 engine is approximately $100 at the time of purchase and that same price

[3]Unit body construction is that type which the body provides the structural support for the running gear and suspension components of the vehicle.

differential exists at the time the vehicles are traded in (when it is one to two years old.)

A great deal has been said about the advantages of the full-sized vehicle. However, it is not the intention of this report to favor the full-sized vehicle to the exclusion of the intermediate-sized vehicle for police patrol. Indeed, the usage requirement of narrow streets and superior handling may favor the use of an intermediate-sized vehicle. This type of unit has been successfully used by the Los Angelos Police Department for several years. The factors involved in the ultimate decision are largely subjective.

The selection of a police vehicle for general patrol work from the compact or subcompact ranks would be deemed unsuitable on the basis of human factors analysis. Again, such a recommendation must be modified if usage factors warrant a vehicle having less than a 112-inch wheel base, e.g., certain patrols might require jeep-like vehicles for off-road or unimproved road applications.

2. Power plant size and drive ratio

An examination of various vehicle specifications submitted to the manufacturer from the dealer (the manufacturer submits his price to the dealer who adds his markup cost and submits the bid to the police department) contain requirements for engine displacement, rear axle ratio and transmission. The reason for such a practice is to give the police vehicle acceleration and performance characteristics which are compatible with departmental policy. There are

several different philosophies being used presently which affect vehicle performance requirements. Some departments attempt to eliminate the pursuit function of the patrol car. These departments may rely on helicopter support for identifying and trailing a fugitive vehicle, or a communication system with road blocks to apprehend a vehicle. The theory of such an approach to pursuit is that the public is not exposed to the hazards of high speed chase. The second theory of apprehending a vehicle calls for minimizing the duration of the chase by providing the police officer with a high performance vehicle. The combination of good handling characteristics and excellent performance may quickly terminate a chase.

a. Performance

It is not the intention of this report to establish departmenal usage policies. This decision should be left to the police policy-making bodies. It is felt, however, that the specifications of the power plant, transmission and rear axle should be covered by vehicle performance requirements. These requirements are most easily established on a "time-to-reach-a-given-speed" basis. For example, the specification might read:

> The vehicle must be capable of the following performance:
>
> 0 - 45 mph in (xx) sec.
> 0 - 60 mph in (xx) sec.
> 0 - 100 mph in (xx) sec.

In addition, it might be desirable to specify a top speed requirement for the vehicle.

b. Piston speed limitation

The performance requirements established by the above performance table might be met by a small engine and high rear axle ratio. This combination might prove to be unfavorable from a maintenance standpoint. The engine may be operating at high piston speeds during normal cruise operations. The high piston speeds are usually related to rate of engine component wear and, thus, to maintenance problems. In order to avoid maintenance problems, a ratio of piston speed in feet per second to a vehicle speed in mph can be established:

$$\text{Piston Speed/Vehicle Speed Ratio} = .47\ \frac{GS}{R}$$

where G = rear axle gear ratio
S = engine stroke in inches
R = tire rolling radius in inches

An example of this ratio for a Mercury Montego with an engine having a 429-cubic-inch displacement, 3.5 to 1 rear axle ratio and tires having approximately a 13-inch rolling radius would be:

$$\text{Piston Speed/Vehicle Speed Ratio} = .47 \times \frac{3.5 \times 3.6}{13}$$

$$= .47 \times .969$$

$$= .455\ \frac{\text{ft./sec.}}{\text{mph}}$$

It might be noted that this ratio is controlled by the term:

$$\frac{G \times S}{R}$$

The present state of the art in automotive design indicates that this term (GS/R) will range between 0.5 to 1. Vehicles having the

larger values usually are capable of high acceleration rates and potentially higher maintenance problems.

> It is recommended that the engine size specification and rear axle specification be accomplished by specifying a time-speed schedule, and also a limit of piston speed to vehicle speed, not to exceed 0.5 fps/mph.

The performance specification of a time-speed schedule has established the engine displacement, transmission gear ratios and rear axle ratio for the vehicle. The only problem which exists is a determination of the values which should be used for the time-speed schedule and top speed of the vehicle. One method of determining these values is to take an existing vehicle and measure its performance. If the performance is acceptable, those values obtained may be used in the time-speed schedule. If more performance is desired, the times must be adjusted.

To establish some feeling for the performance of various types of vehicles, the following chart is presented:

Range of Vehicle Performance

Max. Performance Sports or Muscle Cars		Moderate Pursuit Police V-8		Minimum Pursuit Police 6 Cyl.	
0-30 mph	2.2 sec.	0-30 mph	3 sec.	0-30 mph	3-5 sec.
0-60 mph	6.0 sec.	0-60 mph	9 sec.	0-60 mph	12 sec.
0-90 mph	14.3 sec.	0-90 mph	32 sec.	0-90 mph	---
Top Speed	120+ mph	Top Speed	110+ mph	Top Speed	90 mph

The maximum performance represents the approximate limit of performance which can be placed in a vehicle.

c. Fuel

The final consideration on power plant specifications is the vehicle fuel requirement compatibility with the department storage capability. For instance, if a police department is equipped with a "regular" gasoline pump only, it might be uneconomical to purchase a V-8 engine with a large cubic inch displacement which runs efficiently only on "hi-test" gasoline.

d. Transmission type

An automatic transmission is recommended on the basis of fleet owners' experience in maintaining the driveline of their vehicles. The reduction in maintenance requirements of universal joints, clutches, gearing and axles of a vehicle equipped with an automatic transmission over that of the standard transmission more than offset the increased capital investment. Although the performance requirements of the vehicle may be met by some two-speed automatic transmissions and certain engines, such combinations usually are exposed to more severe conditions. A subjective evaluation is that they require major maintenance more frequently than three-speed units. Since the police vehicle is frequently subject to severe conditions, it is recommended that the automatic transmission be liquid cooled. The typical transmission cooling system has a heat exchanger located in the lower tank of the radiator of the engine cooling system. This type of unit seems to provide satisfactory cooling in most areas. Additional transmission cooling may be required in some areas which have extremely hot weather conditions. The only

performance indicator which could be used to define satisfactory transmission cooling performance would be the oil temperature in the transmission hump after the vehicle has performed a specified service cycle. It is felt that most equipment produced by American manufacturers will operate satisfactorily. In summary:

> It is recommended that the police vehicle be equipped with an automatic transmission having liquid cooling and a minimum of three forward speeds.

e. Rear axle selection

The rear axle gear ratio is determined by the performance specification. The only variation which exists in rear axles is the limited slip differential. Basically, the limited slip differential increases the amount of torque which can be transmitted to the ground. In those areas in which the patrol vehicle is subject to prolonged periods of poor traction due to ice, snow, sand, etc., a limited slip differential will improve the vehicle mobility. In the selection of the limited slip differential, one might expect additional maintenance requirements. However, it should be mentioned that adequate and reliable research results on the limited slip differential installed in the police vehicle is lacking. Therefore, it is stressed that only those police departments which experience very severe weather conditions as mentioned above for prolonged periods should consider this component. If a department does not need it, limited slip differential should not be specified.

> The limited slip differential is recommended only in areas which require vehicle mobility during poor traction driving conditions.

3. Ride and handling specifications (steering)

The importance of the technical specification for the ride and handling of a police vehicle cannot be overemphasized. A police officer involved in any situation requiring vehicle maneuverability should expect performance which is superior to the average production vehicle. Failure to provide such performance may lead to injury or death of the police officers or to the innocent public who might be involved. The subsequent legal liabilities which might result in pensions, compensation, etc. would be more expensive than the cost of the additional suspension equipment.

As mentioned previously, most manufacturers provide a multitude of suspension systems. These systems are referred to as heavy-duty, taxi, sports, trailering and police or police interceptor packages. Unfortunately, the names may change between manufacturers and thus compound the problem of vehicle specification. Most of the manufacturers provide a police handling package for their vehicles. Some confusion exists if the specification for a police vehicle merely states "heavy-duty suspension." The intention of the police department ordering the package is to receive the police handling package. However, if the specification is phrased in such a general way as "heavy-duty suspension", it permits the manufacturer to substitute any other heavy-duty suspension he manufactures, such as heavy-duty overweight suspension, which is designed to permit heavier loads rather than superior handling.

Basically, the handling characteristics of a vehicle may be categorized as understeer, neutral steer, or oversteer. An understeer vehicle can be defined as a vehicle which has the natural tendency to reduce any lateral disturbing force acting on it. For example, if a wind gust strikes the side of an understeer vehicle, the interaction of the body, suspension and tires will cause the vehicle to steer in a direction away from the gust providing the vehicle driver makes no corrective action. This is a stable condition of operation and represents the design thinking in current American passenger production vehicles. However, the standard production vehicle provides too much of an understeering tendency for police work. The oversteering vehicle has the reverse tendency. As the wind strikes the side of the oversteering vehicle, it would tend to turn into the wind and thus increase the distrubing force by generating centrifugal forces which act in the same direction as the force created by the wind gust. The vehicle is considered to be unstable because it would continue to turn into the direction of the original disturbing force--the wind--even though that force no longer exists, but has been replaced by the centrifugal force. The vehicle has self-exited itself into a steering condition rather than straight ahead. The neutral steering vehicle would not respond to the lateral forces and cause steering of the vehicle. A vehicle which approaches a neutral steering condition or slightly understeering condition is most desirable from a handling standpoint.

The understeer or oversteer of a vehicle may be related to the change in position of the body and chassis with respect to the suspension components. This change in position is termed "roll" as the vehicle leans to the outside during a turn. The present technique for controlling the amount of roll is to provide heavy-duty sway bars on the front suspension and in some cases the rear axle. Shock absorbers and springs also contribute to the total ride and handling characteristics and must be selected with the total system concept in mind.

In examining the methods used to develop these ride and handling characteristics of a vehicle in the automotive industry, it is found that the final design is established by subjective evaluation of combinations of the various suspension components carried out by experienced personnel of the manufacturers. Such a technique of design complicates the job of establishing the technical specification for the suspension system. This job is further complicated by the complexity of the inter-relationship between the body, suspension, and tires. A complete discussion of these relationships is beyond the scope of this report.

A quantitative measure of the understeering, neutral, or oversteering characteristics is Bundorf's Coefficient, "K". This coefficient is defined as:

$$K = \frac{(W.A.) - (T.A.)}{(L.A.)}$$

where W.A. = Wheel angle measured as the amount that the front wheel is turned from a straight forward position - degrees.

T.A. = Track angle measured as the amount of angle which the path of the wheel makes on the ground with respect to a straight forward position - degrees.

L.A. = Lateral acceleration - the radial acceleration produced by turning the front wheels through a given wheel angle - in g's.

In order to understand the coefficient, a further explanation of the angle involved is necessary. When the driver of a vehicle turns the steering wheel, the front wheels take on an angle, the wheel angle, with respect to the straight ahead position. The path of the front wheel over the road surface may not fall along the plane of rotation of the wheel. The actual path forms the track angle with respect to the straight ahead direction as shown in the following figure.

Understeer Condition - Front Wheel Geometry

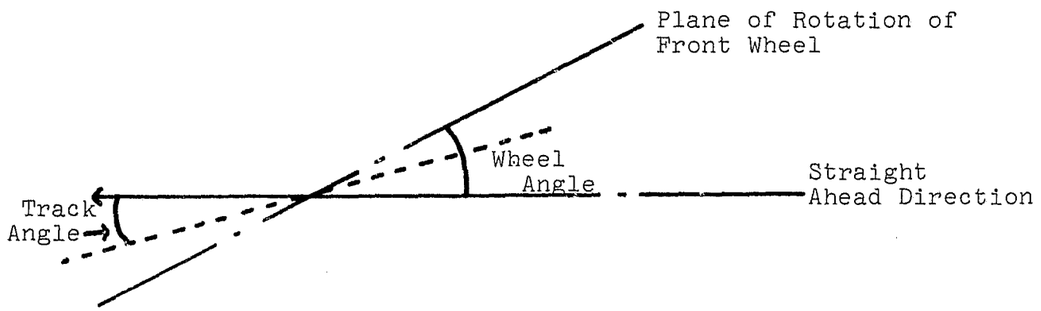


Figure 5.1

If the wheel angle is larger than the track angle, as shown in the preceding figure, the vehicle is understeering and Bundorf's Coefficient will have a positive value. When the track angle coincides with the wheel angle, the vehicle has neutral steering tendencies and Bundorf's Coefficient is zero. Should the track angle exceed the wheel angle the vehicle has oversteering tendencies and Bundorf's Coefficient takes on a negative value. In order to have good handling characteristics in the vehicle, Bundorf's Coefficient should be of small positive values. The coefficient should not change value rapidly over the entire operating range and load conditions. Finally, the coefficient should never become negative in value.

The technical specification for the suspension system should state:

> The vehicle will be so equipped by the manufacturer in regard to suspension components, that when equipped with the tires contained in this specification and all other equipment, it will have a Bundorf's Coefficient within the range of 0-1.0 degrees/g at 0.1g, and 0-2 degrees/g at 0.5 lateral acceleration for all combinations of load. No value should exceed the upper limit established by a straight line passing through the upper limit points.

In addition some qualifying statement may be included in the specification to permit a subjective evaluation of the ride and handling characteristics for those departments having personnel qualified to make such a judgment.

It should be pointed out that the vehicle having only slight understeer characteristics will not react the same as a normal automobile. It will give the patrolman less of a feeling than he is accustomed to when driving his own vehicle.

> It is recommended that the patrolman be given sufficient driver's training to become accustomed to the vehicle and its limitations.

The full size American production vehicle when equipped with a large V-8 engine requires power steering for ease of low speed maneuvering. If the vehicle were not equipped with power steering, a larger gear reduction would be necessary in the manual steering system. The manual steering would be less responsive than a power steering system. The only drawback to the power steering system on a police vehicle is the loss in feedback to the driver during turns. Feedback is the feel which a driver senses as he causes a vehicle to change course. As the cornering of the vehicle becomes more severe, the driver feels or senses that he must exert a greater force on the steering wheel. The magnitude of the feedback is greatly reduced by the damping characteristics of the power steering unit. The disadvantage of less feedback would only be noticeable in high speed pursuit or handling maneuvers. The frequency of this type of police work is small in comparison with normal patrol work. In addition to the handling factors involved, several human factor considerations must be made. A complete discussion of these human factors is presented on pages 14 through 54 of this report.

> The recommendation is that a police patrol vehicle should be equipped with power steering.

4. Brake selection

In order to specify the brake system of a police vehicle, the performance criteria for the stopping of the vehicle must be established. The three problem areas which most frequently occur in vehicle braking are brake fade, vehicle directional stability and total stopping distance. Brake fade is the result of a change in the frictional characteristics of the brake linings due to heat generated during braking. It is typified by requiring greater pedal force to produce the same braking effort and in its worst stages may prevent the driver from locking the wheels during a stop. Fade can be controlled by various brake lining materials or type of brake system used on the vehicle.

Organic and metallic are the two most commonly found lining materials. The study indicated that the metallic linings have the characteristic of improving as the operating temperatures of the brakes increase. The complaint registered is that in order to stop the vehicle the first time (when the brake temperatures are relatively cold), it requires a greatly increased pedal pressure by the operator when compared to the normal or warm operating condition. This characteristic has been deemed unsafe in that it tends to surprise the driver and may contribute to an accident.

Organic materials may be compounded in different ways to give different frictional characteristics and wearing qualities. Those

materials which provide a satisfactory balance are subject to fade under severe usage in drum and shoe type of brake designs.

An alternative method of controlling brake fade is to lower the operating temperature of the friction surfaces. In order to achieve the lower temperature, disc-type brakes are used instead of the drum and shoe-type of system. When ordering disc brakes, power assist is compulsory on all American-made vehicles (unless specially ordered without it) for without power assist, disc brakes would require higher pedal forces than drum and shoe brakes to produce the same braking effort. The power assist requirement is offset by the lower operating temperature characteristic of disc brakes and their inherent fade resistance.

The second problem area associated with braking is the lack of the directional stability. It is desirable that the vehicle remain in its original direction during all phases of braking, including high speed locked wheel stops. The vehicle should not require excessive steering correction by the driver during any braking maneuvers of the vehicle.

The performance of the braking system is covered under the Federal Motor Vehicle Safety Standards. However, these standards do not specify a total vehicle stopping distance. Such a distance is not only a function of the brake system but of the tires and suspension system. In order to evaluate the total vehicle during braking, it is necessary to extend the testing beyond the SAE

(Society of Automotive Engineers) J937 and J843a recommended practices and specify a maximum acceptable stopping distance.

The recommendation for the brake system of the police vehicle should read:

> It is preferred that the vehicle be equipped with power assisted disc brakes on all four wheels. In lieu of the availability of the aforementioned system, a power assisted system having disk front brakes and drum and shoe rear brakes will be considered. If the system is equipped with automatic adjusters, the units must pass part of the performance specification. Either system must meet the following performance specification. After the vehicle has been prepared for brake testing according to methods outlined in SAE J843b and J937a recommended practice, the vehicle will stand the following test with temperatures at the 300° level:
>
> 1. The vehicle must make four stops from 90 mph at a deceleration rate of 20 ft./sec. at two minute intervals. The vehicle must then make a "panic" or locked wheel stop from 60 mph without deviating from a 12 foot wide straight line or yawling more than 15° from its original direction. The vehicle stopping position should not exceed 172 feet. The test is to be conducted on a clean concrete roadway. The vehicle will then be driven in reverse at approximately 5 mph and the brakes applied to lock the wheels.
>
> 2. The above performance should be repeated within five minutes.
>
> 3. After completion of the test, the vehicle will be allowed to stand until the brake drums have cooled to ambient temperature. The vehicle will then be lifted and the wheels checked for proper adjustment.

At the present time, American production vehicles do not have disc brakes on the rear axle because of the difficulty in providing parking brakes with this type of design. Some European vehicles

have solved the problem and hopefully it will be introduced on American produced vehicles.

5. Tires and wheels

The police vehicle requires tires which are superior to the normal production tire. It is difficult to define a performance specification for tires. The tire size and rim width for a police vehicle must have as a minimum, the load carrying capacity and rim size which satisfies the Federal Motor Vehicle Safety Standard 109.[4]

a. Tires

It is difficult to specify a particular tire size and style because yearly models change and different manufacturers may require different styles of tires. These styles or series of tires differ in cross-sectional shape. Since the tire plays an important part in the handling characteristic, it is recommended that the manufacturer of the vehicle be permitted to select the tire which will meet the handling specifications. This would permit the manufacturer to use a systems approach on the tire rims, and suspension components of the vehicle.

Tire specifications must establish certain minimum standards. In studying the different types of tire construction and tire cord materials, it is concluded that the normal two-ply/four-ply rating type of construction is unsatisfactory for police service. In general, these tires do not provide the handling characteristic required during high speed chases. The vehicle handling characteristics improve with full four-ply construction or belted tires.

[4] Code of Federal Regulations. Title 49 - Chapter III

As the tire tread width and rim width increases, the handling characteristics improve. Tires which are constructed of nylon cord and fiberglas belts are recommended for police service. The users of steel belted tires indicate that they have experienced loss of handling on wet pavement.

In those areas which are subject to snow and ice conditions, snow tires are recommended for average patrol work. One problem encountered with snow tires is their inability to handle sustained high speed driving conditions. Studded snow tires have been used in several areas with mixed subjective evaluations. One report indicates that studded snow tires do not have satisfactory traction and handling characteristics when operating on dry pavement.

The recommendation for the tire specification is as follows:

> The police vehicle will be equipped with tires mounted on rims having the maximum width available for police service. The tire will be sized by the manufacturer to meet the vehicle handling requirements specified under the suspension specifications and satisfy all Federal Safety Regulations.

It should be pointed out that the major tire manufacturers have developed tires for police work.

b. Wheels and rims

The wheels on a police vehicle are subject to a much higher loading than the normal passenger vehicle. In order to prevent failure of the wheel in the area of the mounting holes or hub, the manufacturers provide a heavy-duty wheel, in this case, a heavy-duty wheel having additional strength. The rim design on the wheel

must conform to the Federal Motor Vehicle Safety Standard 110. This standard controls both the width and tire bead holding requirements. The recommendation for the wheel specification is as follows:

> The vehicle must be equipped with heavy-duty wheels. In this case heavy-duty is intended to mean wheels having additional strength over normal production wheels by either design and/ or material used in their manufacture.

6. Electrical systems

A study of the police vehicle electrical system indicates that the charging capacity, battery requirements and need for wiring harnesses modification are primarily a function of the accessory equipment, such as type of radio, siren, lights, etc. which is added to the vehicle either by the department, during manufacturing, or at a modification center. The study indicates that the combination of a 42-amp alternator, having a 15-amp idle speed capacity and a 70-amp hour battery is sufficient to handle a police vehicle equipped with electronic siren and solid state type radios.

For those departments using the motor-driven sirens and vacuum tube radios, an alternator having increased charging capacity may be required. One problem which exists with increased alternator size is that a special two pulley drive may be required. This problem is further complicated in that some models of vehicles cannot accommodate the additional drive requirements when equipped with air conditioning and power steering. The study indicates

that some departments are using the smaller alternators with the high load accessory equipment with satisfactory performance. It is suggested that before selecting an alternator larger than the normal police duty alternator offered by the manufacturer a test of existing equipment be carried out to determine whether such a system is actually required. That test would be to determine the average discharge rate for existing equipment.

a. Electrical system performance

The performance specification for the electrical system should consider three areas: the charging rates, the storage capacity and the radio interference characteristics. A police vehicle's maximum charging rate should be approximately one and one third times its average discharge rate. The average discharge rate for the American production vehicle is approximately 25 to 30 amps. If this load is increased by tube-type two-way radio (4-5 amps), siren and public address system (5 amps), and additional lights (2 amps), the total police vehicle average discharge rate with all systems operating would be from 36 amps to 42 amps. This estimated load may increase due to additional equipment, such as air conditioning (2-4 amps) and rear window defoggers (1-2 amps). If a solid state radio is used, amperage would be lowered somewhat. Operation of a vehicle in warm climates may permit a reduction of this ratio between maximum charging rate and average discharge rate to approximately 1.2 times average discharge rate. The energy storage system-the battery-should have sufficient reserve energy

to permit the engine to be started after the vehicle has been standing for one-half hour with all electrical equipment, including police modification equipment, operating and the engine not running. The vehicle should be capable of reliable starts when this test is conducted at the lowest expected ambient temperature. Finally, the electrical system should be compatible with the communication system. Therefore, the performance specification should indicate that the vehicle's electrical system should not produce radio frequency interference with the type of communications to be used in the vehicle. Unfortunately, the wide variety in communication equipment and causes of interference make it impossible for the auto manufacturers to give completely satisfactory assistance in this area. The manufacturer will provide suppression equipment as an option upon request. The using department must indicate the steps to be taken to provide interference suppression. However, it is concluded that the communication equipment manufacturer might be the best source of suppression information and equipment for these reasons:

First, because there are annual variations in body design, a suppression device which helped reduce interference previously might not be necessary in the following model year. Instead, a problem might originate elsewhere. Consequently, if a department for successive years accumulated locations of previous interference problems and specified that all these locations bear

suppression devices in the latest model year vehicle, the auto manufacturer would have to charge for the installation of all the suppression devices.

Secondly, the type of radio utilized in a police vehicle will have a significant bearing on possible origins of interference, especially if the terrain is such that it contributes to poor reception.

Thus, two police departments in the same state driving the same year, make and model vehicle but having two different brands of radios will have two different sets of suppression problems.

It is concluded that when police departments ask for bids on new vehicles, specifications for suppression devices should not be cumulative "carry-overs" from previous years' specifications. It is further concluded that when departments purchase new radios, information should be sought from the radic manufacturer about possible suppression problems. If suppression equipment is needed, the radio manufacturer should be the source.

b. Wiring modifications

In addition to the performance specification, the electrical system of the production vehicle must be modified for police work and to insure compatibility of equipment to be installed by the department. One modification to the production lighting system required for police work is de-activation of the courtesy lights when a vehicle door is opened. This modification should be carried out in a manner which will permit easy re-activation when the vehicle is traded in.

The second modification of the lighting system would be the installation of an interior lighting system which will illuminate the front seat area with sufficient light to permit the writing of reports, approximately 20 to 30 foot candles at the driver and passenger positions. The light should be positioned in a manner which will not cast shadows on the laps of the front seat occupants while writing. The aforementioned console is equipped with a goose-neck lamp which is one solution to the problem. Thought should also be given to the possibility of installing a red light into the dashboard for the purpose of report writing. A red light reduces the interference with night vision.

The vehicle may be equipped with a roof or bar-mounted flasher light and additional identification lights or signs. The light bar may carry the siren and public address horn. The wiring installation for this type of bar is usually run along the drip rail of the body and down the windshield post. There is usually sufficient space to permit the wire to enter the engine compartment without drilling access holes in the exterior body shell. No additional specifications need be made for this type of installation unless the purchaser is requesting that the bid include the cost of the installation of the bar.

If the vehicle is to be equipped with a roof-mounted flasher, the vehicle wiring harness should be modified at the time of manufacture. The manufacturers will provide such a wire terminating between the head liner and roof of the vehicle. In addition, the

the manufacturers will provide a reinforcement plate for mounting the lights. If a roof siren is to be used, additional roof reinforcement and wiring will be required. Again, this reinforcement and wiring should be installed at the time the vehicle is assembled.

Since the installation of the roof-mounted equipment is frequently carried out at a modification center after the vehicle is assembled, the manufacturer usually provides, upon request, a zippered head liner which opens to provide access to the wires and mounting plates which have been installed.

c. Roof-mounted versus bar-mounted lights and siren

Several questions about the feasibility of roof-mounted siren and lights versus bar-mounted units exist. The roof-mounted units require additional wiring and structural supports. They require access holes to be drilled in the exterior sheet metal of the roof and thus reduce the resale value of the vehicle. From an appearance standpoint, the single light mounted on the roof is better than a single light mounted on the roof bar. The roof bar provides an installation which is simplier than the roof mounting accessories and does not effect the resale value of the vehicle. One disadvantage attributed to the light bar and reported during our study from several large departments was that the unit could be stolen easily from the vehicle. It is felt that this problem could be cured by a better type of mounting having a security lock rather than the simple bolt-on units.

The overall economic cost of a roof installation compared with a light bar is shown below.

	2-light bar with siren speaker	Roof-mounted light
Capital cost[5]	$150.00	$96.50
Vehicle modification[6]	00	18.00-31.00
Repair of modification at resale	9.00	35.00
Installation cost	9.00	18.00
Total Cost	$168.00	$157.50- 174.50

For electrical system recommendations, see model specification.

7. Interior of vehicle

Research indicates that the interior of the standard production vehicle does not satisfy the functional requirements of police usage. Placement of controls and equipment are not carried out with due regard to human factor considerations when the vehicle is modified for police work. A complete discussion of the human factors element may be found on pages 14 through 54 of this report. In order to eliminate many of the problems associated with interior modifications a portion of this research was devoted to the design of a front seat package which would meet the functional requirements of police work. The results of this design effort may be found on pages 55 through 71 of this report.

a. Violation of safety standards

An area of concern about the current police vehicle interior which has developed from this study is related to violations of Federal Motor Vehicle Safety Standards. In modifying the vehicle

for police work, the front seat area is frequently cluttered with shotguns, radio equipment, lights, fire extinguishers, etc. The placement of these items violates the philosophy upon which the Federal Safety Standards were predicated in that they are frequently placed in positions which will increase the extent of bodily injury resulting from an accident. It is predictable that modifications of this nature which fail to consider occupant safety will result in indefensible lawsuits and the corresponding fiscal liabilities. The occupants being transported in the rear seat of police vehicles equipped with barriers and modified door locks are subject to a similar type of hazard and may, therefore, bring suit for injuries sustained in an accident. The changing mood of the general public, police officer associations, legal profession, and courts with regard to auto safety must be considered when changing the interior design of a police vehicle.

The approach to solving some of these safety problems was a front seat package composed of two bucket-type seats separated by a console containing the radio, siren, and other auxillary equipment. This unit packages the equipment in a housing which reduces the likelihood of injury in an accident. In regard to the technical specification for the interior fabrics and vinyl materials, the selection of the interior trim is largely dependent on departmental usage policy. For example, a department which does not transport unruly prisoners may deem that carpeted floor and a combination cloth and vinyl seat are adequate for their needs.

On the other hand, a department which transports prisoners may expect that the interior will become soiled and select floor mats and seating materials which can be washed easily. The technical specification should cover the type of interior to be used.

b. Seats

On the basis of the human factors study previously mentioned it is recommended that the front seat of the vehicle have individually adjustable seats. The individual seat should be of the six-way adjustable type. The seats will be equipped with seat belts at all positions and upper torso restraint for the front seat passenger.

c. Seat belts

The Federal Motor Vehicle Safety Standards will be modified for 1972 model year vehicles. In all probability, cars produced beyond that date will not require seat belts and will rely on inflatable bags for occupant protection. The manufacturers will still be required to place seat belt anchors in the vehicle and many experts concede that both belts and bags should be used.

d. Headrest

The headrest must be locked in such a manner that an occupant of the rear seat cannot release the adjustment lock and pull the headrest from the seat. The object of this specification is to eliminate the possibility of a prisoner using the headrest as a weapon.

8. Vehicle markings

The police vehicle in performing its crime prevention function is most effective if it has a distinctive and easily recognizable

color scheme. Research findings indicate there are at least two advantages to the standardization of color schemes:

First, because of psychological principles of concept formation and stimulus discrimination, every individual forms expectations related to objects in his environment and behaves in accordance with those expectations. Thus, if an individual expects a patrol vehicle to be of a certain color because it was in his home environment, he may be confused or fail to respond appropriately when police vehicles are painted differently in other places. Such confusion could easily result in failure to yield to police vehicles in emergencies, in traffic situations and other problems related to a lack of recognition. If a uniform national color scheme were adopted for the police vehicle, then expectations regarding the identification of a police vehicle would be appropriate in every part of the country, a benefit for both the police and the citizen.

Secondly, there is greater apparent coverage when all police vehicles have the same color scheme regardless of whether they are state, county, township or municipally owned. Greater apparent coverage could deter some criminal activity. For instance, within some states, a highway patrol still exists. The primary function of this agency is to patrol the state highways, with little or, in some cases, no jurisdiction over any other area. However, if a would-be criminal or violator within a city or municipality could

not easily recognize the highway patrol car through external markings or paint color, the mere presence of the patrol car in this area might deter him from his premeditated wrong-doing.

The Province of Ontario in Canada is now considering the adoption of a standard color scheme for all marked police cars. It is recommended that such a procedure be undertaken in the United States.

The criteria for choosing colors for police vehicles should be that it be clearly distinctive from all privately-owned vehicles and yet not be ominous. In order to implement these recommendations, it may be necessary to restrict the uses of certain color combinations to police vehicles by ordinance or law. One such set of color combinations which is both distinctive and meaningful is the blue and white color combination currently being employed by some metropolitan police departments.

Furthermore, it is recommended that rotating beacons have a standardized color. At the present time many Midwestern police departments are utilizing a rotating blue beacon. This color seems to be more distinctive against backgrounds of neon lights. Flashing red beacons may be confused with fire fighting and other emergency vehicles.

> It is recommended that the police vehicle be painted white above the belt line and blue below the belt line.

> It is further recommended that police organizations adopt the blue beacon as the standard signal for marked police vehicles. In states having laws which prevent such a system, work should be undertaken to gain new legislation which will enable the use of blue lights for police service only.

F. Model Specification

Basically, the major modifications required of a vehicle have been discussed. In order to summarize the recommendations of this study a model of the technical specifications is presented. The model will not represent a complete request for bid since the portions governing the method of bid, delivery terms, and other legal aspects will not be present. Along with the specifications, a column of comments will be presented explaining the options which might occur.

TECHNICAL SPECIFICATIONS FOR A POLICE PATROL VEHICLE

COMMENTS

I. General Conditions Upon Which the Bid is to be Based

The vehicles upon which the bid is to be made will be new cars of model year_ _ _ _, constructed for police service and will contain all equipment and features listed for the standard police vehicle by the manufacturer, except as modified in these specifications.

The car is intended for use in the *(0a) area and will operate in ambient temperatures ranging from *(0b) to *(0c).

*0a. State area.
*0b. Lowest temperature.
*0c. Highest temperature.

Any component or subsystem placed on the vehicle must be of the design and construction intended for police service even though those components and subsystems are not specifically named herein.

The vehicle will meet all Federal and State regulations and laws in effect at the time of purchase.

II. Vehicle Description

The vehicle required is a *(1) having a wheel base of not less than *(2) inches.

*1. State body style desired.
*2. 118 inches for a full-sized vehicle or 116 inches for an intermediate-sized vehicle.

III. Vehicle Performance

The vehicle engine, transmission, rear axle ratio, wheel and tires will be selected in a manner which will permit the vehicle to have a minimum top speed of *(3a)mph and an engine piston speed to vehicle velocity ratio which does not exceed 0.5 fps/mph when in cruising gear. The vehicle must be capable of acceleration which will equal or better the times stated in the following schedule.

0 to 30 mph in *(3b) sec.

0 to 60 mph in *(3c) sec.

0 to 90 mph in *(3d) sec.

The power plant will operate on *(3e) fuel.

*3a. 6 cyl-90 mph maximum. V-8 depends on usage requirements.

*3b. 3.5 sec. average
3.0 sec. moderate
2.5 sec. max. pursuit

*3c. 12 sec. average
10 sec. moderate
7 sec. maximum pursuit

*3d. 35-40 sec. average
25-30 sec. moderate
14.3 sec. max. pursuit

*3e. Regular, ehtyl, unleaded, etc.

Transmission

The transmission will be a liquid cooled automatic transmission having a minimum of three forward speeds.

Rear Axle Type

The rear axle will be *(4) type.

*4. Either specify normal differential or limited slip.

Cooling System

The cooling system of the vehicle should provide sufficient cooling to maintain an ethylene glycol coolant mixture having a freezing point of *(5a) °F at a temperature below *(5b) °F maximum during all driving conditions occuring at an ambient temperature of *(5c) °F. In addition, the vehicle cooling must provide sufficient cooling to meet the above requirement for a period of *(6) minutes.

*5a. 15° below lowest ambient temperature, or use a 50-50 mixture if it meets requirements.
*5b. Max. coolant temp. without loss of coolant is approx. 250°F.
*5c. Highest ambient temp.
*6. 30 Minutes.

IV. Ride and Handling Performance

The manufacturer will equip the vehicle with all springs, shock absorbers, sway bars, tires, wheels and other suspension components to provide a vehicle with flat cornering characteristics and a positive Bundorf Coefficient which will fall between zero and a limit established by a line passing thru +*(7a) degree/g at 0.1g lateral acceleration and *(7b) degree/g at 0.5 lateral acceleration for all load conditions of the vehicle. The vehicle must be free of wheel hop, shake, or any other characteristic detrimental to superior handling performance.*

*7a. 1 degree/g**
*7b. 2 degrees/g
The average production vehicle values are approximately 3 and 6 degrees/g respectively.

Steering System

The vehicle must be equipped with *(8) steering.

*8. Recommend power steering for all vehicles and feel that it is absolutely essential with full V-8 vehicles.

* Does not apply to station wagon vehicle.
** g is a measure of acceleration.
1g is equal to 32.174 feet/sec./sec.

V. Brake System

It is preferred that the vehicle be equipped with power assisted disk brakes on all four wheels. In lieu of the availability of the aforementioned system, a power assisted system having disk front brakes and drum and shoe rear brakes will be considered. If the system is equipped with automatic adjusters, the units must pass part 3 of the brake performance specification below. Either system must meet the following performance specification. After the vehicle has been prepared for brake test according to methods outlined in SAE J843b and J937a recommended practice. The vehicle will stand the following test with temperatures at the 300° level.

Brake Performance Test

1. The vehicle must make four stops from 90 mph at a deceleration rate of 20 ft./sec. at two minute intervals. The vehicle must then make a "panic" or locked wheel stop from 60 mph without deviating from a 12-foot wide straight lane or yawling more than 15° from its original direction. The vehicle stopping distance from point of brake application to final stopping position should not exceed 172 ft. The test is to be conducted on a clean, dry concrete roadway. The vehicle will then be driven in reverse to approximately 5 mph and the brakes applied to lock the wheels.

2. The above performance should be repeated within five minutes.

3. After completion of the test, the vehicle will be allowed to stand until the brake drums have cooled to ambient temperature. The vehicle will then be lifted and the wheels checked for proper adjustment.

VI. Tires and Rims

The vehicle must be equipped with *(9) tires mounted on heavy-duty rims having the maximum width available for police service. The tire will be sized by the manufacturers to conform with the handling requirements contained in specification VI. Heavy-duty rim is intended to mean a wheel which has additional strength to withstand severe police service.

*9. Recommend bias cord tires having four plys on tread and sidewall with 2 glass belts for patrol or a police special for sustained high speed driving.

VII. Electrical System

Alternator

The alternator will have a maximum charging rate which is approximately *(10) times the average discharge rate of the vehicle. The average discharge rate will include the normal equipment supplied with the vehicle and the following items:

1.	radio	*(11) amps
2.	siren and public address	_____ amps
3.	flasher lights	_____ amps
4.	other	_____ amps
5.	normal, average discharge of vehicle as ordered	_____ amps

Total average discharge rate _____
(Sum of 1-4)

The alternator must be capable of supplying approximately one third of its maximum charging rate at engine idle.

*10. 1.3 times is recommended, however, 1.2 may be used in mild climates.

*11. The discharge rate of equipment to be added to the vehicle after delivery should be supplied to the manufacturer by the department ordering the vehicle. The manufacturer can supply item 5 and size the alternator.

Battery

The energy storage system should have sufficient reserve energy to permit reliable engine starts after the vehicle has been standing with the total average discharge rate occuring for a period of *(12) minutes in an ambient temperature condition of *(13) °F without the engine running.

*12. A thirty-minute period is recommended.

*13. The lowest ambient temperature which can reasonably be expected.

Radio Interference Suppression

The vehicle will be equipped with the following suppression devices so as to limit radio interference to an acceptable level.

1. *(14)
2. _____
3. _____

*14. List devices and positions. For further information on suppression devices, it is recommended that the police department consult with the manufacturer of communications equipment. See page 117.

Wiring Modification

1. All courtesy light circuits should be modified so that they will not function automatically when doors are opened. These lights must be equipped with manual switch operated from the driver's position.

2. Interior lighting must be modified to produce 20 to 30 foot candle illumination at the driver and front passenger position. The light will be placed in a manner so as not to cast a shadow on the laps of the front seat occupants.

3. Other - *(15)

*15. At this point any additional wiring modifications for sirens, PA systems, spot and flashlights, ets. should be made.

VIII. Equipment Mountings

1. Radio Mounting Platform shall be located *(16) and consist of *(17).

2. Other - see *(18).

*16. The location in the truck of the vehicle should be specified.

*17. Individual radios require different mountings which must be described. If a metal or plastic conduit is desired for passing wires from the trunk and radio location to the front seat, it should be specified here.

*18. If roof mountings of lights or siren are desired, the roof reinforcement should be requested at this point. The make and model of equipment to be mounted and its location should be specified.

IX. Interior of Vehicle

Police Model Trim *(19).

*19. Modification of standard upholstery and floor mats may be made to fit users requirements.

Seating

The front seats must be individually adjustable for each occupant of the front seat, and be of heavy-duty quality. Heavy-duty is intended to mean that the coverings, cushion material, springs and frame are adequate for police cervice. All seating positions must be equipped with seat belts and the front seat occupants must be provided with upper torso restraints. The headrests on the seat backs must be provided with stops which prevent their removal from the seat back. *(20)

*20. Recommend six-way adjustable if available.

X. Vehicle Exterior Color Scheme

The vehicle will be painted white above the belt line and blue below the belt line. A white panel approximately 18 inches in height will extend horizontally from the leading edge of the front fender the full length of the vehicle. The panel should permit a blue strip to exist between the panel and the belt line.

Xi. Additional Features

See *(21)

*21. Various manufacturer's options may be specified at this point, such as air conditioning, limiter for the trunk lid, etc.

Optional Radio Speaker Suggestions:
Mount <u>two</u> permanent magnet speakers between headlining and the roof of vehicle, in roof rail area, approximately 10" back from "A" post. Two lead wires to be connected to the speaker terminals of each speaker (neither terminal grounded) and routed to the back of the dash board. Speakers must have a voice coil impedance of 8 ohms and be capable of accepting a maximum of 2.5 watts of audio power in the frequency range of 500 to 3,000 H_z without distortion.

G. Optional Equipment

The manufacturers offer a variety of equipment which can be added to the vehicle. Among this optional equipment is air conditioning. A discussion of the human factors involved in the selection of air conditioning is found on pages 28 through 32 of this report. Other options which might be considered are enumerated below.

1. Optional equipment available from the manufacturer

a. Deck lid remote release: Depending on the manufacturer, this device may be a vacuum or electrically-operated lock which permits the truck to be opened from the driver's position. This unit permits the driver quick access to equipment carried in the vehicle's trunk and eliminates the fumbling for keys in an emergency situation.

In discussing the operation of the trunk lid, it should be noted here that whether the police officer uses the remote switch to open the trunk or whether he does it manually, depending on the model of police vehicle, the possibility exists of the open trunk lid visually blocking off the roof beacon from anyone to the rear of the vehicle. If this occurs, some type of limiter should be installed to prevent the lid from blocking the beacon. This additional component should be included in the specification.

b. Fast idle control: Some manufacturers offer a manually-operated control to permit an increase in the idle charge rate of the alternator. This accessory would be good for a vehicle having large average discharge rates in that the fast idle could be used to reduce the rate of discharge when the vehicle is stationary.

c. Hood locks and warning systems: An additional security measure is a tamper-proof latch operated from inside the vehicle. Another security feature is a device which would sound the horn if the hood is raised. This unit could be de-activated for normal maintenance activity.

d. Keys: It is possible to obtain a single key for all the locks on a vehicle, or to order a fleet which uses the same key. The latter has the disadvantage of officers consciously or unconsciously using the wrong car. However, master keys could be made for appropriate members of the department with the officer maintaining one key which fits only one car.

e. Spot lights: Windshield post-mounted lights are available as well as the hand held style. The hand-held model has limited usage on one-man patrols because of the lack of adequate mount while, on the other hand, vehicle-mounted spots are less flexible than their counterpart. Evaluation of the two types of units is largely subjective.

f. Rear window defogger: Recommended where climatic conditions require it.

g. Oil pressure gauge: The oil pressure gauge is probably of more interest to the maintenance personnel than it is to the police officer operating the vehicle.

h. Ammeter (see g).

i. Calibrated speedometer: It is usually part of the recommended police package.

2. Optional equipment not available from the manufacturer

Many police departments have adopted a policy which permits the pushing of another vehicle via a "push bumper." The practice is done to clear traffic, reducing the likelihood of an accident. Road service performed by the police officer also improves the image of the police department in the public eye. Departments operating with the simplest form of push bumpers (two upright guards extending four inches in front of the regular bumper) report a reduction in the incidence of damage to the front sheet metal and grille. Expressway traffic cars have a much more elaborate push bumper. Most of these units are designed within the department using them or by a conversion center.

3. Modifications requested but violating the Federal Motor Vehicle Safety Standards

a. Disconnect the latches so that the doors cannot be locked from the interior.

b. Disconnect the interior door handles on the rear doors of the four-door sedans.

c. Temporarily disconnect switch for the stoplights.

d. Separate front and rear compartments with wire or plastic screening.

A complete list of options which can be used to modify the police vehicle are shown in Appendix 5.

VI. POLICE VEHICLE MAINTENANCE

The policies associated with the maintenance of police vehicles are generally one of organization, fleet size and depth of services to be performed. Interviews indicate that maintenance takes place under varying situations. In defining the responsibility of performing vehicle service and maintenance, it is found that some cities organize around a single Department of Public Works garage serving all city departments. Other cities are organized around a police garage, while still others depend on both the police personnel and the DPW to maintain and service the vehicles. The range of work performed is dependent upon the fleet size, fleet age and manufacturers' warranties. The range of work performed may be limited to light repair work and services, or it may extend to major repairs being performed by contract vendors or under warranties as in Chicago. It may even extend to complete repair facilities and services as performed by Detroit's DPW garages.

From an organizational standpoint, there does not seem to be any great advantage of one system over another. The only organizational problem which seems to exist is the lack of feedback from the maintenance group to the using departments having DPW

garages. It is impossible to evaluate the seriousness of this problem due to the variability of structuring and budgeting of these units.

The organization of any repair facility and the depth of maintenance is dependent upon fleet size and fleet management policies. For example, a fleet maintenance operation dealing with light repair work and preventive maintenance (such as brakes, exhausts, tune-ups, lubrications, etc.) requires a vehicle-mechanic ratio of between 15:1 and 30:1.[1] A vehicle brought in on a preventive maintenance schedule will require approximately two to three hours of work for each servicing. Approximately three vehicles can be serviced per man per day. If vehicles are scheduled in at least once per month, the mechanic will be performing preventive maintenance 5-10 days per month, and his time may increase if the work is performed on mileage intervals. For example, if a vehicle is scheduled at a 3,000-mile interval, or a once-per-month interval which ever occurs first, it will come into the garage for preventive maintenance more frequently than once per month if it averages more than 100 miles per day. Such mileage can be expected if the vehicle is used two or three shifts per day.

If the departmental vehicles are relatively new and warranties cover the major portion of the vehicle, the light repair service and preventive maintenance will be the only functions which the garage usually must perform, exclusive of accident repair, of course.

[1]These values based on Flat Rate Manual and the experience of the authors.

An estimate of garage personnel can be achieved based on total departmental mileage. Thus:

$$\text{mechanics hours devoted to preventive maintenance per year} = \frac{\text{total departmental mileage per year} \times 2.5}{\text{preventive maintenance mileage interval}}$$

(The figure 2.5 represents the estimated average hours spent for preventive maintenance per vehicle per servicing.)

If the vehicles are serviced on a time interval rather than a mileage interval, mechanics hours devoted to preventive maintenance per year can be approximated as:

$$30 \times \text{fleet size} = \text{hours/year}$$

(The figure 30 represents the average 2.5 hours spent for preventive maintenance servicing per vehicle multiplied by 12 months.)

The number of men required to perform preventive maintenance can be derived from the following formula:

$$\frac{\text{mechanic hours devoted to preventive maintenance}}{2{,}000}$$

(The average hours available for work per year is approximately 2,000 hours per man.)

In addition to the preventive maintenance function the vehicle must be fueled, cleaned, have its tires changed and be repaired. It is estimated that the total garage personnel is approximately three times the personnel involved in the preventive maintenance function. Thus, total garage staff can be approximated on the basis of:

$$\frac{\text{mechanic hours devoted to preventive maintenance}}{667}$$

A second approach which can be used to estimate the garage facility involves the departmental size. A department which patrols on a 24-hour basis has 8-10 officers per vehicle when using two-man cars. Therefore, if the officer strength of the

department is known, the approximate number of cars can be estimated. It is approximated that the average police vehicle in an urban setting accumulates 30,000 miles per year.

The cumulative mileage given can be estimated as:

yearly mileage = 3,000 x number of patrolmen

This value of yearly mileage may then be used in the first equation given on the preceding page to determine the mechanic hours devoted to preventive maintenance per year and the total garage size.

The question of whether a department should do its own maintenance is not determined strictly by the size of the fleet. However, it would be difficult to justify a maintenance facility for a fleet under 25 vehicles. Fleets under 25 should consider maintenance contracts with garages in the area because insufficient work exists for one man. Maintenance of fleets between 25 vehicles and 200 vehicles may be accomplished on either a maintenance contract basis or in a municipal garage. The garage size would vary from a one-man operation to a 10-man operation in this fleet size range. A careful study of the availability of qualified personnel, capital investment in buildings and equipment, plus other overhead costs such as administration, benefits, and services would be required to justify such a municipal operation. If the fleet size is greater than 200 vehicles there is little question that a garage facility can be economically operated. These fleet size break points are based on fleets consisting of

passenger cars having an average age of one year. If trucks, garbage packers and other pieces of heavy equipment are in the fleet, manpower requirements will increase. A second way of looking at such a mixed fleet is that the breakpoints of 25 and 200 would be reduced. No attempt will be made to adjust these breakpoints for the variables involved are too numerous.

In judging the extent of repair work which should be undertaken in any garage, the investment in manpower, equipment, and capital should be justified on a usage basis. If the volume of work is large enough, good management practices should permit a savings in the cost of repairs which equals the profit of the outside contractor.

Before discussing the different levels of maintenance which must be performed, the question of performance of daily vehicle maintenance must be considered. Interviews indicate that many departments require their officers to perform daily service on their own vehicles, and thereby save the expense of having an attendent. Such practice may prove to be a false economy measure. Because the officer runs the risk of getting dirty performing such chores as filling tires, checking radiators, checking crankcases, etc, essential maintenance is frequently neglected and results in costly repairs or added operational expenses. For example, excessive tire wear due to underinflation of tires is frequently evident in departments following the practive of having its officers perform their own daily maintenance.

It is recommended that the daily maintenance be performed by personnel trained and responsible for that function.

The design of automotive components in the past decade has reduced the amount of maintenance required and lenghtened the interval between servicing. A police vehicle is subjected to more severe service conditions than are imposed upon the average passenger vehicle. Therefore, preventive maintenance must be carried out with greater frequency than is indicated by the manufacturer's recommendation for normal service. There is no way to pick an optimum mileage at which the police vehicle should be serviced. In discussing the problem with various people having responsibility for maintaining police vehicles, it is concluded that intervals of 2,000-3,000 miles are most frequently used by departments having good maintenance.

The recommendation based on this practical experience is that a vehicle be given a daily inspection of gas station items, a monthly or 3,000-mile interval depending on which occurs first, for lubrication, and major inspection at 9,000-mile intervals, with additional items at 27,000-mile intervals. The items of service to be performed are listed in the following tables.

Table 6.1

Daily Maintenance

I. Underhood Items

1. Check engine oil level.
2. Check coolant level in the radiator.
3. Check transmission oil level (automatic transmission).
4. Check battery water level.
5. Check windshield washer reservoir level.

II. Exterior Items

1. Inspect all driving lights, turn signal, etc.
2. Inspect horn and siren operation.
3. Inspect for body condition and whether vehicle requires washing.
4. Check tire inflation pressure.

III. Interior Items

1. Check brake pedal.
2. Check clutch pedal (standard transmission).
3. Check parking brake.
4. Check windshield wiper and washers.
5. Check interior lights.
6. Check interior condition and cleanliness.

III. Interior of Vehicle

1. Check brake pedal-adjust if necessary.
2. Check clutch pedal-adjust if necessary.
3. Check parking brake-adjust if necessary.
4. Check windshield wiper and washer.
5. Check all vehicle lights.
6. Lubricate door hinges and locks as needed.
7. Interior condition and cleanliness.

IV. General Operations

1. Wash vehicle (if required).

Table 6.3

9,000-Mile or 3 Months Service

9,000-mile inspection consists of the 3,000-mile inspection plus the following operations:

1. Replace spark plugs, distributor points, condenser and rotor (tune-up).
2. Adjust carburetor (as needed).
3. Remove brake drums and inspect lining (replace as needed).
4. Check disk brake pads for wear (replace as needed).
5. Adjust valves.
6. Check headlight alignment.

Table 6.2

3,000-Mile Interval

I. Under-the-Hood Operations

1. Change engine oil and oil filter.
2. Check radiator level and quality of coolant for freezing point (in cold weather only).
3. Check automatic transmission oil level.
4. Check power steer reservoir level.
5. Check battery water level and clean battery connections.
6. Check windshield washer reservoir.
7. Check brake fluid level in master cylinder.
8. Inspect brake lines for leakage at fittings.
9. Inspect all hoses for coolant leaks.
10. Check for oil leaks at valve cover, filter and oil pan with engine running.
11. Lubricate heat riser valve (if so equipped).
12. Check belt drives for tension and belt condition.
13. Check PCV valve and anti-pollution controls.
14. Check carburetor air cleaner.
15. Lubricate hood latch and other points as needed.

II. Under the Vehicle Operations

1. Lubricate chassis.
2. Check transmission level(standard transmission).
3. Check rear axle lubrication.
4. Inspect front and rear suspension components for damage or wear, and shocks for leakage.
5. Inspect exhaust system.
6. Inspect brakes for proper adjustment, condition of all brake hoses and lines. Adjust if necessary.
7. Inspect tires, including spare for proper inflation, abnormal wear patterns and tire damage on tread and side walls. Remove any foreign objects from tires.
8. Lubricate parking brake cables.
9. Check front wheel bearing adjustment.

Table 6.4

27,000-Mile Service

These additional operations should be performed at 27,000 miles.

1. Extended lubrication of vehicle.
2. Change carburetor air cleaner.
3. Change automatic transmission fluid and filter.
4. Change fuel filter.
5. Change rear axle lubricant if vehicle is equipped with limited slip type differential.
6. Replace shocks.
7. Inspect radiator and heater hoses for hardening.
8. Run compression check on engine.
9. Check battery cell specific gravity.
10. Check alternator and regulator for proper operation.

VII. REPLACEMENT OF VEHICLES

Vehicles must be replaced as they get old, wear out, or become obsolete. The goal of a replacement policy is to have the desired type of vehicle, from both a functional and a safety point of view, for the least overall cost, year in and year out.

After discussing replacement policies with a number of police departments and studying the literature on this subject, it is concluded that subjective judgments must still be used in formulating replacement policies. It will be the purpose of this report to present guide-lines for making the replacement decisions.

The approach to be used in presenting the material on this subject will be:

(1) Discuss the general costs involved;

(2) Present the cost figures upon which the replacement decision is to be made;

(3) Present the costs not included in the replacement decision;

(4) Present some current replacement policies;

(5) Discuss why mathematical models are not feasible at the present time.

In this discussion on replacement a "typical police department" will be considered which has the following features.

(1) Usage is approximately 30,000 miles/year for each vehicle.

(2) Vehicles are purchased only once, or at the most twice, a year. In other words, replacement of vehicles occur in fleet or volume purchases once or twice a year. The reason for this is to reduce the expense involved in the bidding and purchasing procedures. The bidding and purchasing procedures cost almost as much for one vehicle as for several hundred and can easily cost several hundred dollars.

(3) Vehicles have had good care and are in presentable condition when they are traded.

(4) A preventive maintenance program exists for the fleet. How the facts as to the effectiveness of this program effect the replacement decision will be discussed later.

A. Vehicle Costs - In General

There are many costs associated with the ownership of vehicles. These costs can conveniently be divided into five categories.

Fixed costs are those that do not vary with the mileage or age of the vehicle. For example, overhead costs for the repair and service are fixed costs.

Mileage costs are those costs that increase as the number of miles driven per month increases, such as gas, oil, tires and preventive maintenance.

Depreciation and wear-out costs are those costs that change as the vehicle gets older either in terms of years or in terms of

total mileage. Depreciation per year decreases as the vehicle gets older, but parts repair, due to wear out, increases as the vehicle gets older in terms of mileage.

Modification costs are those costs incured in the commissioning and decommissioning of the vehicle. These costs would cover such items as installing radio equipment in a new vehicle, removing radio equipment from a vehicle before disposal, application and removal of decals, and installation of other specialized police equipment.

Non-scheduled repair costs are those costs related to random failures of vehicle components. These failure costs may be high on a new vehicle due to manufacturing defects. These costs are relatively low during the usable life of the car; however, they tend to increase as the car wears out with increased mileage.

B. Costs Important to the Replacement Decision

The three types of costs that are important to the replacement decisions are depreciation, repair (not preventive maintenance but repair due to wear out) and modification.

1. Depreciation

This cost is the difference between the price that is paid for a vehicle and the price for which it is sold. The depreciation cost is affected by several factors:

(a) Make of vehicle

Certain makes of vehicles seem to depreciate less than other makes in a particular time period. For example, in comparing first

year depreciation of four-door models of Chevrolet, Ford, and Plymouth, the depreciation was $1175.00, $1225.00 and $1310.00, respectively.[1]

(b) Model line of vehicle

Certain model lines depreciate at a faster rate than other models; for example, the difference in first year depreciation between a Plymouth Fury III and a Fury I was $115.00; between a Ford Custom and Galaxie, $130.00; between a Chevrolet Biscayne and Impala, $125.00.[2] The more deluxe models seemed to depreciate less than the standard or basic models.

(c) Amount of fleet discount

In past practice, the automotive manufacturers have offered fleet discounts on large volume sales. These discounts have reduced the original unit price of the vehicle. Such practice would permit small departments to enter a joint purchase agreement with their neighboring departments to achieve a reduction in original cost. Recently, Ford and General Motors announced that they were discountinuing fleet discounts to local governments. Insufficient time has elapsed since the announcement to accurately determine the effect or duration of the policy.

(d) Used car market

The used car market affects the price that the dealer will pay for retired police vehicles. If the market is good, the price will be high and if the market is low the price the dealer will pay will be low. The used car market also varies considerably with the geographical location and by makes and models.

[1]National Market Reports, Inc. Red Book. (Illinois, 1969) Vol. 59, No. 1

[2]Ibid.

(e) Effectiveness of maintenance program

A used car that appears to have been well-maintained always brings a higher price on the used car market than a vehicle that doesn't appear well-maintained.

(f) The age of the vehicle

As a vehicle gets older, its depreciation per year decreases. The depreciation in the first year is considerably higher than in the second year and so on. This goes on for about six or seven years after which the depreciation remains constant or else goes to zero. For example, a $3000 vehicle that depreciates $1000 the first year will only depreciate $500 the second year. Therefore, from a depreciation point of view the longer you keep the vehicle, the less the depreciation cost per year.

2. Repair cost

The repair costs referred to are the costs of repairing and replacing parts that wear out through use as distinguished from costs involved in a preventive maintenance program. The preventive maintenance repair replacements are scheduled and predictable. The wear out repairs are usually unpredictable and unscheduled. These repairs increase as the accumulative mileage on the vehicle increases. For example, a very low incident of unscheduled repairs would be expected between 20,000 and 30,000 miles, but between 80,000 and 90,000 miles the probability of unscheduled maintenance increases. The cost of unscheduled repairs is very hard to predict because of the variations in vehicle designs, the service which

they have experienced, and the maintenance care they received. An additional cost is incured when the failure occurs during service due to time lost by personnel using the vehicle. Should the failure result in an accident, additional costs are incured. For a police fleet, a maintenance program is not a matter of costs but one of safety. In almost all cases a preventive maintenance program gives a department lower overall costs. It is difficult to prove this because of the intangible costs of not losing personnel time and not having accidents are not accountable. Thus, a preventive maintenance program may have a higher apparent cost because dollar values are accernable. A department should have a preventive maintenance program even if it doesn't give them lower costs because good preventive maintenance is the best way to insure that the vehicles are in as good a condition as possible from a safety point of view.

From general observation and discussions with repair people, the author makes the subjective judgment that most well-maintained vehicles should go about 60,000 to 70,000 miles without major repair costs.

In contrast to depreciation costs which indicate that you should keep the vehicle as long as possible, repair costs indicate you shouldn't keep the vehicle too long because repair costs increase with mileage.

3. Modification costs

These are the costs of the final conversion of the delivered vehicle into a finished police vehicle and the stripping of a used vehicle that is about to be sold. They include such costs as

installing radio equipment (and removing it later), roof lights, switches, consoles, and markings. It usually costs a minimum of $150 to $200 to commission and decommission a vehicle as described above. These costs are non-recoverable so that the fewer times you change vehicles the lower your modification costs will be. These costs indicate the same direction as depreciation costs; namely, keep the vehicle as long as possible.

C. Costs Not Included in Replacement Decisions

It is the opinion of the author that the following costs are more or less independent of the replacement policy or the age and accumulative mileage of the vehicles.

1. Direct operating costs

These costs are for such items as fuel, oil, tire, windshield washer fluid, antifreeze, etc. These costs change very little over the life of a vehicle and for all practical purposes can be considered independent of the age or accumulative mileage.

2. Accident costs

Accident repair costs are self-explanatory and are obviously independent of age or accumulative mileage, providing the vehicle is reasonably maintained.

3. Preventive maintenance cost

These costs include oil changes, inspection, brakes, filters, etc. They are scheduled and are very predictable on a mileage basis. For the most part these are independent of the age and accumulative mileage of the vehicle. In other words, the preventative maintenance

on a vehicle with 20,000 to 30,000 miles on it is about the same as a vehicle with 50,000 to 60,000 miles on it.

Therefore, the above three costs do not affect our replacement decision because they are independent of how old the vehicle is and how many miles it has been driven.

D. Present Replacement Policies

As a result of many discussions with police departments concerning their replacement policies, it can be concluded that they vary considerably. For example, Kansas City is trying out a program which they seem to do very well with whereby they buy a model that sells well on the used car market and keep it for only one year. They purchase a top-of-the-line model because this model sells better on the used car market. They also have instituted a program of vehicle preservation among their officers and this, with the better grade of vehicle, appears to have improved the officers' attitudes toward vehicle care. The vehicles are painted standard production colors and equipped with removable decals for police identification.

In order to make this policy work one must buy readily re-salable vehicles, get a good fleet discount, maintain the vehicles mechanically and appearance-wise, keep the modification costs at a minimum. With this type of replacement policy the repair costs (other than preventive maintenance) should be very low. The fact that fleet discounts will be discountinued may seriously affect

this replacement policy. Also, more time is needed to ascertain the effectiveness of this replacement policy. Of course, these vehicles should meet the performance specifications as outlined in Chapter 5.

Some other departments buy standard models which have lower resale as well as lower first cost and keep them for longer periods, such as three, four, or even five years. In these cases resale value is low and repair costs are high, but depreciation per year is quite low.

The majority of the departments interviewed use a policy somewhere in between the two extremes just mentioned. They replace either on a two year basis or on a mileage basis ranging from 60,000 to 80,000 miles or higher.

Detroit pulls a vehicle out of police duty at two years and then either transfers the vehicle to non-police duty or trades it, depending on its condition.

These policies are very subjective and depend to a great extent on such things as:

(1) Police image that the community desires.

(2) Quality of maintenance work.

(3) Type of police duties vehicle is used for, such as chase vehicle, push car, prisoner transport, etc.

(4) Budget limitations. Even though a more expensive vehicle would depreciate less, many city councils won't okay the large initial cost.

E. Mathematical Models of Economic Replacement Policies

A review of the literature concerning economic replacement models (see Appendix 7) has led to the conclusion that these models are not feasible for use by most police departments at this time. The reasons for this conclusion are as follows:

(1) The models are too complex and require rather sophisticated data systems.

(2) Most of the models are concerned with replacing individual vehicles rather than fleets. For example, the model's output may indicate vehicle A should be retired this week and possibly vehicle B next week, rather than indicating an overall replacement policy for the fleet.

(3) Many of the models use historical data in their decision processes. This data may not be valid to be used for present replacement decisions.

(4) All of the models require accurate up-to-date data which most police departments don't have available.

Therefore, it is concluded that these classic economic replacement models are not applicable at this time to the majority of police departments. This is not to say that these models may not be useful where they can be properly applied.

F. Summary

The replacement decision is a very important one for all police departments because of their objectives of having a functional

police vehicle that performs safely, and of having the lowest overall costs.

It has been pointed out that the three most important costs in the replacement decision model are:

Depreciation

Repairs

Modifications

If good cost data is available and if the police department buyers are knowledgable of all of the factors involved, it is recommended that a simple model using the sum of the above three costs be used for the replacement decision. If the cost data is not readily available, it is recommended that a subjective judgment be used and vehicles be replaced every two years or every 60,000 to 70,000 miles, whichever occurs first.

VIII. FACILITIES PLANNING FOR POLICE FLEET MAINTENANCE

A. Introduction

The purpose of this part of the chapter is to present a program to determine the equipment and facilities needed to accomplish fleet maintenance as an in-house operation; and to ascertain the point at which an in-house operation becomes preferable to contracting the service to an independent garage or service center. Maintenance as used in this chapter means primarily preventive maintenance and does not include accident work or extensive heavy repair work.

This part of the chapter is divided into four main sections. The first section is the Introduction. Section B itemizes the equipment and facilities required to perform the maintenance operations and derives the equations for the quantity of equipment needed, based on manpower and fleet miles. Section C presents the costs of manpower, equipment and material for an in-house operation and the cost of contracting the maintenance to an independent service center. This section also derives the break-

even calculations for determining which method should be used. The conclusions drawn from the break-even analysis are presented in Section D. The tables at the end of this chapter contain tabulated information relative to the derivations and analysis which is referenced in the text itself.

1. Maintenance requirements

The maintenance requirements prescribed in this section represent a composite of vehicle manufacturers' specifications and the recommendations of manufacturers' service managers, and are given in greater detail in Chapter VI of this report. While geographic location and severity of usage may necessitate the addition or deletion of items, the listing presented is comprehensive and, in the great majority of cases, may be used with only minor alterations.

This recommended maintenance schedule consists of replacements, adjustments and inspections to be performed daily, and at intervals of 3,000 miles, 9,000 miles and 27,000 miles.

a. Daily inspection

The daily maintenance schedule (Table 6.1, page 146) prescribes the necessary inspections that should be performed between each servicing of the vehicle. A conscientious daily inspection will preclude any gradual impairment of the mechanical system due to an out-of-adjustment condition or a lack of lubrication or coolant and assure the correct operation of those devices related to the safety of the operator and passengers.

Since the time for performing these daily checks is about five minutes, it would be more effective to have the daily inspection the responsibility of regular gas station servicemen rather than police officers. (This concept is discussed more fully in Chapter VI, page 144.)

b. Regular maintenance

The 3,000-mile maintenance (Table 6.2, page 147) is fundamentally an oil change, chassis lubrication and a detailed inspection of the chassis components and safety items. The time required for this maintenance is four hours (1/2 day).[1]

At 9,000 miles (Table 6.3, page 148) a tune-up and an alignment are prescribed in addition to the oil change, chassis lubrication and inspection. An additional four hours are required for the 9,000-mile maintenance for a total of eight hours (1 day).[1]

The requirements of the 27,000-mile maintenance schedule (Table 6.4, page 149) are basically an extension of the 9,000-mile maintenance with a recommended replacement of a number of items. The time for the 27,000-mile maintenance is sixteen hours (2 days).[1]

B. Equipment Requirements

Table 8.1 lists the equipment that will be necessary in performing the required preventive maintenance service and the price that is listed is an estimate of the competitive price for this equipment.

[1]These times are very liberal and would allow for most repair work required as a result of the inspections such as brake replacements, wheel alignments, etc. A shop with well-maintained vehicles should be able to beat these times by as much as 20%, but shops starting a preventive maintenance program will find these times about right.

Table 8.1

Equipment	Cost
1. Single post frame contact lift	730.00
2. Packages air compressor	890.00
3. Alignment rack	3760.00
4. Alignment accessory package	226.00
5. Tire changer	450.00
6. Mechanical wheel balancer	692.00
7. Total performance scope analyzer	2480.00
8. Hi-compression tester	48.00
9. Exhaust emission analyzer	660.00
10. Automatic transmission tester	140.00
11. Alternator-regulator tester	150.00
12. Battery cell analyzer	36.00
13. Battery charger	129.00
14. Battery tester	58.00
15. Brake pedal adjustment gage	37.00
16. Brake shoe adjustment guide	10.00
17. Diaphram brake bleeder	84.00
18. Headlight aiming kit	109.00
19. Oil drain tank	94.00
20. Ceiling reel lube set	1766.00
21. Roll-about oil tank	130.00
22. Hydraulic floor jack	180.00

Table 8.1, cont'd

Equipment	Cost
23. Gasoline tanker	265.00
24. Basic tool kit	237.00
25. Impact wrench	139.00
26. Mechanic's vise	52.00
27. Tool stand	37.00
28. Work bench	40.00
29. Storage cabinets	67.00
30. Drum racks	19.00
31. Roll-about vacuum cleaner	115.00
32. Belt tension gage	17.00
33. Cement block building - 16 ft. ceiling	13./sq. ft.

Table 8.2 gives the quantity of each piece of equipment that is required, based on the manpower. As a justification for the number of hoists, there are two reasons; first, the obvious reason is that if a hoist is down for repair, a spare is needed, but the second reason is a realistic approach to shop operations. Often, during an inspection, a vehicle is found to require maintenance other than the routine maintenance that was prescribed. Should this occur and replacement parts have to be ordered from a parts wholesaler, the vehicle can be left on the hoist while the mechanic uses an auxiliary hoist to start his next job. Therefore there should be an excess in the number of hoists, not just one per mechanic.

Certain equipment items depend on usage rather than manpower. These items are designated as graphs in the equipment table.

1. G-I Tire and wheel equipment

This analysis for the tire changing equipment assumes:

(1) that tires need to be changed on the average every 9,000 miles;

(2) that the time required to change four tires and balance them is equal to approximately 1.5 hours.

The above calculations also apply to the alignment equipment.

2. G-II Total performance scope analyzer

The scope analyzer and related equipment are used for the tune-ups every 9,000 miles. The time for the tune-ups is two to three hours, or about three vehicles per day, and even though

Table 8.2

QUANTITY OF EQUIPMENT TABLE

SERVICE-MEN

Equipment No.	1	2	3	4	5	6	7	8	9	10	11	12
1	2	3	5	6	8	9	11	12	14	15	17	18
2	1	1	1	1	1	1	1	1	1	1	2	2
3					- G-I -							
4					- G-I -							
5					- G-I -							
6					- G-I -							
7					- G-II -							
8					- G-II -							
9	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	2	2	2	2	2	2
11	1	1	1	1	1	1	2	2	2	2	2	2
12	1	1	1	1	1	1	1	1	1	1	1	2
13	1	1	1	1	1	1	1	1	1	1	1	2
14	1	1	1	1	1	1	1	1	1	1	1	2
15	1	1	1	1	1	1	2	2	2	2	2	2
16					- G-III-							
17					- G-III-							
18	1	1	1	1	1	1	2	2	2	2	2	2
19					- G-IV							
20	1	2	3	3	4	5	6	6	8	8	9	10
21	2	2	2	2	2	2	2	2	2	2	2	2
22	1	1	1	1	1	1	2	2	2	2	2	2
23	1	1	1	1	1	1	1	1	1	1	1	1
24	1	2	3	4	5	6	7	8	9	10	11	12
25	1	1	1	2	2	2	3	3	3	4	4	4
26	1	2	3	4	5	6	7	8	9	10	11	12
27	1	2	3	4	5	6	7	8	9	10	11	12
28	1	2	3	4	5	6	7	8	9	10	11	12
29	1	1	1	1	1	1	2	2	2	2	2	2
30	4	4	4	4	4	4	4	4	4	4	4	4
31	1	1	1	1	1	1	2	2	2	2	2	2
32	1	1	1	2	2	2	3	3	3	4	4	4
33					- Calculation -							

the scope is not used continuously throughout this period it should be available for use any time within the period.

Therefore: $\frac{\text{Total Mileage/Yr.}}{9{,}000}$ = no. of Tune-ups/Yr.

3 Tune-ups/Day x 240 Days = 720 Tune-ups /Yr. Scope

No. of Scopes = $\frac{\text{Mileage/Yr.}}{9{,}000} \times \frac{1}{720}$

No. of Scopes = $\frac{\text{Mileage/Yr.}}{6{,}480{,}000}$

3. G-III Brake equipment

It is assumed that the brakes will have to be relined every 27,000 miles and that it takes approximately 1/2 day for the job. This is a big assumption, and the frequency with which the brakes need relining is quite a variable thing. Many fleets may have to reline more often than indicated and therefore should have more equipment than indicated.

4. G-IV Oil drain tank

With similar reasoning here, as in the case of scope and brake analysis, even though the drain tank is not used continuously throughout the two hour oil change and lubrication, it should be available for the entire time.

C. Building Requirements

Related to both manpower and equipment is the size of the building that will be required to contain the equipment. The

factors that have to be considered are the number of service areas, the number of alignment racks and the size of the storage area.

The number of service areas can be determined after the manpower has been calculated. For an even number of servicemen the number of service areas is equal to 1.5M (where M = the Manpower). For an odd number of servicemen the number of service areas is equal to 1.5M + .5. The number of service areas for from 1 to 12 men are listed in Table 8.2.

The number of alignment racks can be determined from the graph G-I. For simplicity, the storage area is a semi-constant, one bay (12' x 30') for a building with two to seven service bays and two bays (12' x 60') for a building with more than seven service bays.

While it is true that a building one bay in width is more economical than one that is two bays wide, the space factor can become a problem. For this reason, buildings that are to contain from two to seven service bays are calculated as being one bay wide (Illustration 1), and buildings containing more than seven service bays are calculated as being two bays in width with entries on each side (Illustration 2).

The area of building required is then:

For service bays from 2 to 7;

$$\text{Area} = (B + 1 + A)(12)(30) = (B + A + 1)(360)$$

ILLUSTRATION 8.1

Building For 2 to 7 Service Bays

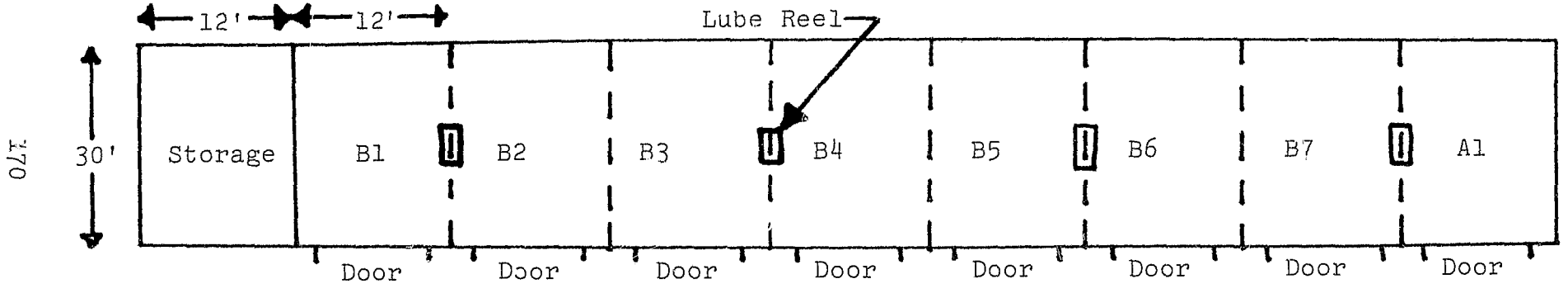
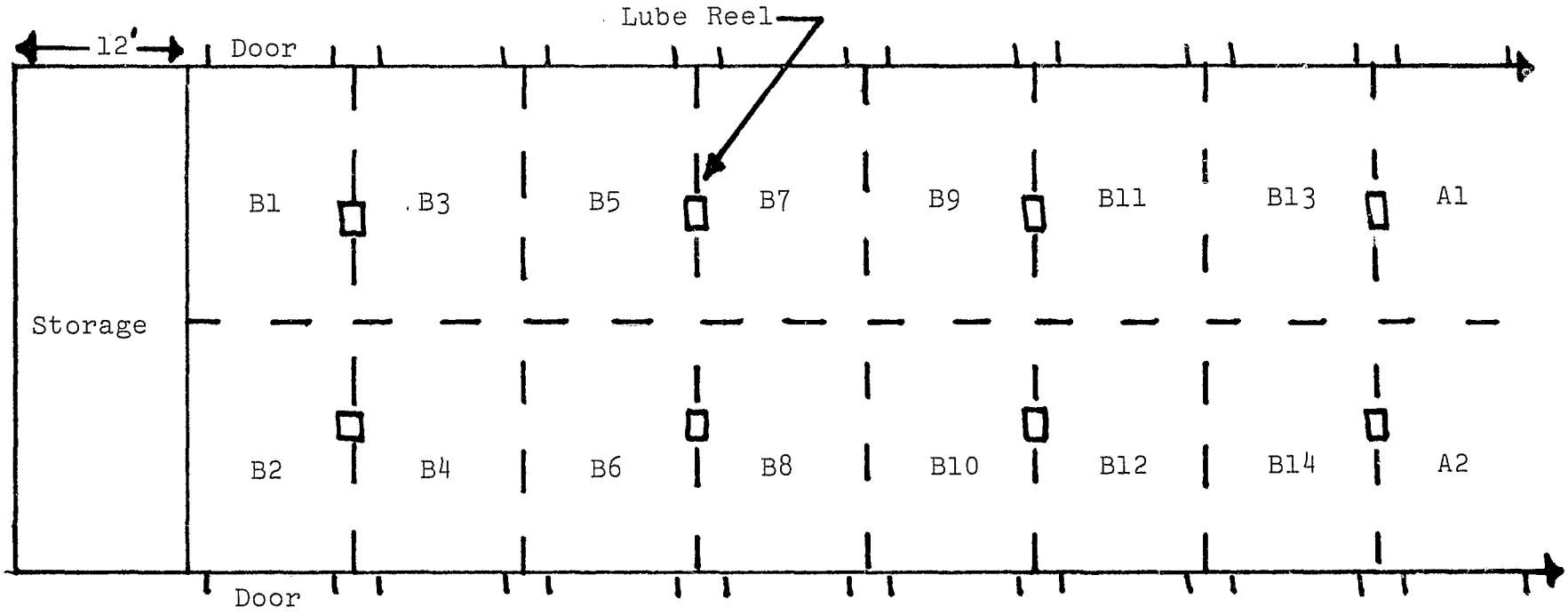


ILLUSTRATION 8.2

Building For More Than 7 Service Bays



where B is the number of service bays
A is the number of alignment racks
1 is the storage area
12 is the bay width
30 is the building width

For service bays over 7;

$$\text{Area} = \left(\frac{E + 2}{2}\right) \quad (12)(60) = \left(\frac{E + 2}{2}\right)(720)$$

where E = A + B to the highest even number

Example:

For a fleet of 100 vehicles with an expected annual mileage of 3,000,000.

$$\text{Manpower}^2 = \frac{3{,}000{,}000 \times 2.5}{3{,}000 \times 667} = 4 \text{ men}$$

From Table 8.2 the number of pieces of equipment can be determined. From the graphs the following equipment can be determined:

G-I	- Alignment Equipment	1
G-II	- Tire and Wheel Equipment	1
G-III	- Scope Analyzer and Compression Tester	1
G-IV	- Brake Equipment	1
G-V	- Oil Drain Tank	2

The size of the building required is calculated from;

Area = (B + A + 1) (360)

B = 6 = Service Bays
A = 1 = Alignment Rack

Area = (6 + 1 + 1) (360) = 2880 sq.

D. Break-Even Analysis

The cost of having an in-house service operation can be segregated into six cost categories:

[2]From page 142, Chapter VI.

Class A. Fixed Cost - Manpower Dependent (Direct)
Class B. Fixed Cost - Manpower Dependent (Indirect)
Class C. Fixed Cost - Dependent on Mileage
Class D. Fixed Cost - Manpower and Dependent on Mileage
Class E. Variable Cost - Dependent on Mileage
Class F. Variable Cost - Manpower and Dependent on Mileage

1. Fixed costs

Table 8.2 represents all the fixed costs that will be incurred with an in-house service operation. The items on this list can be classified as to whether they are Class A, B, C or D items as in Table 8.3.

The Class A costs are those which are directly related to manpower and can be further separated into subclasses of 1 unit per man (Z), 1 unit per 3 men (Y), 1 unit per 6 men (X) and 1 unit per 12 men (W).

Class B costs are those which, while dependent on manpower, are either not as readily definable or are more related to an item of equipment that is directly related to manpower than to the manpower itself.

The number of service areas, item 1, was previously explained as 1.5M (M = manpower) for even values of M and 1.5M + .5 for odd values of M.

Items 2 and 20 are related to the number of service areas and have to be calculated separately for each service area layout.

Class C costs are those associated with fleet size and usage rather than manpower and are obtainable from the graphs G-I through G-IV.

Class D, item 33, the building cost, is dependent on both the number of service areas and the number of alignment racks and has to be calculated separately for each condition.

Table 8.3

EQUIPMENT CLASSIFICATION

Equipment Class	Item	Calculate From	W 1/12M	X 1/6M	Y 1/3M	Z 1/M
B	1	*				
B	2	*				
C	3	G-I				
C	4	G-I				
C	5	G-I				
C	6	G-I				
C	7	G-II				
C	8	G-II				
A	9		660			
A	10			140		
A	11			150		
A	12		36			
A	13		58			
A	14		129			
A	15			37		
C	16	G-III				
C	17	G-III				
A	18			109		
C	19	G-IV				
B	20	*				
A	(2) 21		260			
A	22			180		
A	23		265			
A	24					237
A	25				139	
A	26					52
A	27					37
A	28					40
A	29			67	52	
A	(4) 30		96			
A	31			115		
A	32				17	
D	33	B				
Total			$1504	$798	$208	$366

*From Table 7.2.

Table 8.4 shows the direct and indirect manpower dependent costs tabulated for from 1 to 10 servicemen.

Table 8.5 shows the total fixed cost for selected mileage values. For example; mileage - 5,500,000.

$$M = \frac{5{,}500{,}000 \times 2.5}{3{,}000 \times 667} = 7 \text{ men}$$

Manpower dependent cost for 7 men (from Table 8.4) = $26,532.

Mileage dependent costs for mileage = 5,500,000 (from graphs).

1 G-I	@	3986	=	3986
1 G-I	@	1142	=	1142
1 G-II	@	2528	=	2528
1 G-III	@	94	=	94
2 G-IV	@	94	=	188
				$ 7,938

B = Service Areas ((1.5)(7) + .5) = 11
A = Alignment Racks (G-I) = 1

$$E = 12$$

$$\text{Building Area} = \left(\frac{E + 2}{2}\right)(720)$$

$$= \left(\frac{14}{2}\right)\left(720\right) = 5040 \text{ sq. ft. @ } \$13/\text{sq. ft.} = \$65{,}520$$

TOTAL FIXED COST $100,020

2. Variable costs

The cost of labor depends on both the number of servicemen for the base wage and the value of mileage.

The annual straight time labor cost, calculated on the basis of a 240 day work year for various hourly rates, is as follows:

	Hourly Rate				
	$4.00	$4.50	$5.00	$5.50	$6.00
Annual Cost	$7680	$8640	$9600	$10560	$11520

Table 8.4

FIXED COST - MANPOWER DEPENDENT

	MANPOWER									
	1	2	3	4	5	6	7	8	9	10
F	1460	2190	3650	4380	5840	6570	8030	8760	10220	10950
W	1504	1504	1504	1504	1504	1504	1504	1504	1504	1504
X	798	798	798	798	798	798	1596	1596	1596	1596
Y	208	208	208	416	416	416	624	624	624	832
Z	366	732	1098	1464	1830	2196	2562	2928	3294	3660
S1	890	890	890	890	1420	1420	1620	1620	1620	1620
S2	1766	3532	5298	5298	7064	8830	10596	10596	14128	14128
TOTAL	6992	9854	13446	14750	18872	21734	26532	27628	32986	34290

Table 8.5

TOTAL FIXED COST FOR SELECTED MILEAGES

Mileage x 1000	Manpower	F,W,X Y,Z,S1 S2	+ G-I G-III	G-II G-IV G-V	+ Building	= Fixed
463,000	1	6992	7844		18720	33556
1600	2	9854	7844		23400	41098
2462	3	13446	7844		32760	54250
3388	4	14750	7938		37440	60128
4314	5	18872	7938		56160	82970
5240	6	21734	7938		56160	85832
6165	7	26532	8032		65520	100084
6480	8	27628	10560		74880	113068
7200	9	32968	10560		84240	127768
8140	10	34290	10656		84240	129186

The material cost for service, determined from the wholesale price to jobbers in the Detroit area for parts, oils and greases is as follows:

3,000-Mile Service	9,000-Mile Service	27,000-Mile Service
$4.00	$15.00	$116.00

Using the formulas from Section II for the average number of servicings per year and applying these costs, average cost for

$$\text{27,000-mile service per year} = \frac{(\text{mileage})(116)(1)}{27{,}000} = \frac{116(\text{mileage})}{27{,}000}$$

$$\text{9,000-mile service per year} = \frac{(\text{mileage})(15.5)(2)}{27{,}000} = \frac{31(\text{mileage})}{27{,}000}$$

$$\text{3,000-mile service per year} = \frac{(\text{mileage})(4)(6)}{27{,}000} = \frac{24(\text{mileage})}{27{,}000}$$

$$\text{TOTAL AVERAGE COST FOR PREVENTIVE MAINTENANCE MATERIAL PER YEAR} = \frac{171(\text{mileage})}{27{,}000}$$

$$\frac{(171)(\text{mileage})}{27{,}000} = \$.0063 \times \text{mileage}$$

3. Contract cost

Five sources were surveyed and asked to quote a price for the 3,000, 9,000 and 27,000-mile service.

3,000-Mile Service	9,000-Mile Service	27,000-Mile Service
$18.00	$70.00	$240.00

Using the same method as was used to calculate the material cost, the average contract cost is:

$$\text{27,000-mile service per year} = \frac{(\text{mileage})(240)(1)}{27} = \frac{240(\text{mileage})}{27}$$

$$\text{9,000-mile service per year} = \frac{(\text{mileage})(70)(2)}{27} = \frac{140(\text{mileage})}{27}$$

$$\text{3,000-mile service per year} = \frac{(\text{mileage})(18)(6)}{27} = \frac{108(\text{mileage})}{27}$$

$$\text{TOTAL PER YEAR} = \frac{488(\text{mileage})}{27}$$

Total material and labor cost for preventive maintenance on contract=

$$\frac{(488)(\text{mileage})}{27{,}000} = 0.0181 \times \text{mileage}$$

4. Break-even point

The following discussion on break-even analysis assumes that a contract source exists in any particular location that is able and willing to do quality maintenance work.

The break-even point, X (in mileage per year), is that point at which both the contract costs and the in-house costs are the same for the same set of conditions.

$$(X)(\text{In-House Cost}) = (X)(\text{Contract Cost})$$

Since the in-house cost consists of the fixed cost plus the annual variable cost,

$$(X)(\text{In-House}) = (\text{Fixed}) + (X)(\text{Variable})$$

$$(\text{Fixed}) + (X)(\text{Variable}) = (X)\ (\text{Contract})$$

$$X = \frac{(\text{Fixed})}{(\text{Contract} - \text{Variable})}$$

and since the variable cost consists of material plus labor,

$$X = \frac{(\text{Fixed})}{(\text{Contract} - \text{Material} - \text{Labor})}$$

$$X = \frac{(\text{Fixed})}{(0.0181\ \text{Mileage} - 0.0063\ \text{Mileage} - \text{Labor})} =$$

$$\frac{(\text{Fixed})}{(0.0118\ \text{Mileage} - \text{Labor})}$$

Table 8.6 shows the fixed costs, the material costs, the labor costs and the contract costs for selected values of mileage.

Table 8.6

COSTS FOR SELECTED VALUES OF MILEAGE

Mileage x 1000	Fixed Cost	Annual Material Cost	Annual Labor Cost @ $4.00/HR	Annual Labor Cost $4.50/HR	Annual Labor Cost $5.00/HR	Annual Labor Cost $5.50/HR	Annual Contract Cost
463	33556	2932	7680	8640	9600	10560	8368
1600	41098	10130	15360	17280	19200	21120	28800
2462	54050	15592	23040	25920	28800	31680	44498
3388	60128	21456	30720	34560	38400	42240	61235
4314	82970	27321	38400	43200	48000	52800	77971
5240	85832	33185	46080	51840	57600	63360	94708
6165	100084	39043	53760	60480	67200	73920	111426
6490	113068	41100	61440	69120	76800	84480	117000
7200	127768	45598	69120	77760	86400	95040	130133
8140	129186	51500	76800	86400	96000	105600	146300

Table 8.7 lists the break-even points in years for the data in Table 8.6.

From these break-even points, it is quite apparent that as the going rate for labor increases, the larger the fleet must be to justify an in-house service operation.

Selecting 15 years as the maximum desirable time to pay off the building and the equipment, the list that follows specifies the combination of mileage and number of vehicles required to make an in-house service operation feasible.

Labor Rate	4.00/hr	4.50/hr	5.00/hr
Vehicles	Mileage per Vehicle	Mileage per Vehicle	Mileage per Vehicle
10	42,600	71,000	
20	21,300	35,500	
30		23,600	92,500
40			69,500
50			55,500
60			46,200
70			39,600
80			34,800
90			31,000
100			27,800

D. Conclusion

The preceeding sections have prescribed the maintenance schedule, the equipment, facilities and manpower necessary for an in-house maintenance operation, and the cost that would be incurred by contracting the maintenance to an independent garage.

The cost figures used in this report are factual 1970 costs for the Detroit area. Geographic location and time will cause

Table 8.7

BREAK-EVEN POINTS IN YEARS FOR SELECTED MILEAGE VALUES AND VARIOUS LABOR RATES

Mileage x 1000	B.E.P @ $4.00/HR	B.E.P. @ $4.50/HR	B.E.P. @ $5.00/HR	B.E.P. @ $5.50/HR
463	-			
1600	11.6	25.4	-	
2462	7.5	12.6	38.6	-
3388	6.6	11.5	43.0	-
4314	7.2	10.7	28.5	-
5240	5.5	8.7	21.0	-
6165	5.2	8.2	18.0	-
7200	8.1	13.5	-	-
8140	6.7	13.5	-	-

these figures to change; however, the relative relationship between them should remain approximately the same.

The break-even analysis in Section IV showed that, given a constant average mileage per vehicle, as the labor rate for servicemen is increased, the number of vehicles required to justify an in-house service operation increases exponentially.

As an example, for an average annual mileage per vehicle of 20,000 miles, at a labor rate of $4.00/hour only 20 vehicles are required to justify the in-house operation. As the labor rate is increased to $4.50 and $5.00/hour, the required fleet size is increased to 35 and 140 vehicles respectively.

For a large metropolitan police force, the labor rate restriction would not be as crucial as for a small suburban force since the fleet would have the sufficient size and mileage to permit an in-house operation even with the higher labor rate.

The suburban forces operating independently have virtually no alternative than to contract the maintenance service to a garage or service center and lose two of the most important aspects of an in-house operation, control and scheduling convenience.

To circumvent this alternative and make it possible for suburban forces to have a pseudo in-house maintenance operation, two, three, four or more of the suburban forces could undertake a joint venture. With this method, the mileage value for the combined forces would be of sufficient size to warrant the facility, and the control and convenience advantages would be retained.

In addition to the retention of these advantages, under the pseudo in-house maintenance concept, the cost for any one of the forces would be less than the contract maintenance cost for that particular fleet.

E. Management Information System

In this section of the chapter a management information system for shop operation and some guidelines on facilities planning are presented. Both of these subjects are very broad in scope and much has been written in this area.

1. Purpose

To describe the information system needed to provide the information required for the efficient operation, planning, and control of a police fleet.

2. Scope

The system presented must be adapted to the organization structures, facilities, and operation policies of the municipality that would wish to implement it.

3. Miscellaneous

The management information system presented here can apply equally well to small fleets or large fleets. In the larger fleets a computer facility would be used for data handling.

F. Objectives of the Control System

The following general criterial were considered in order to maximize the effectiveness of this control system:

(1) System must be understood by the users.

(2) System must prevent serious problems.

(3) System must be flexible.

(4) System must be economical.

Specific objectives of the control system are to provide quantitative information from which decisions can be made concerning the following:

(1) How long vehicles should be kept.

(2) What repairs and maintenance should be done in the Central Police Garage and which should be done by contracts with local service stations and garages.

(3) Mileage limits for routine maintenance procedures.

(4) Vehicle operation costs.

(5) Human factors in type and placement of supplemental equipment.

(6) Other miscellaneous pertinent vehicle data.

G. Basic Assumptions

In an effort to focus on the key factors of the control system, several basic assumptions have been made. These include the following:

(1) This control system begins after vehicles have been procured and ends with calling cars in for final disposal.

(2) Parts contracts, local service station contracts (gas and minor repairs), and other vehicle-related service contracts have already been negotiated and are in effect.

(3) Gas and oil, windshield washer fluid, minor adjustments and repairs such as changing flat tires, will generally be done at a precinct service unit or on a contract basis with a local service station. Credit cards identified by vehicle number will be assigned to each vehicle to record services. These cards will also be used to record work done in the police shop facility. Maintenance work which is to be done by the police shop and that which will be done at local contract shops will be periodically adjusted on the basis of the analysis of incoming control information.

(4) It is recognized that large police department vehicle fleets include patrol cars, motorcycles, patrol wagons, tow trucks, and even riot-control equipment such as armored trucks; however, for the purpose of this discussion, only patrol cars are considered. Furthermore, it is assumed that the majority of the patrol cars are pool vehicles which may be driven by different drivers routinely. There is only limited use of permanently-assigned vehicles such as those assigned to detectives and high-echelon personnel.

(5) For the following example it is assumed that the patrol is fairly large, say several hundred vehicles, which are distributed among a number of precincts and one central headquarters. A small fleet will have a similar organization and information system except on a smaller scale.

H. Basic Organization of Automotive and Equipment Division (A & E)

A basic structure for the A & E Division has been devised and is shown in Chart 1. In this organization the Division Head of A & E has overall responsibility for all matters that relate to the Division. All directives and policies relating to vehicle use and care are issued by the Division Head, who reports directly to the Police Commissioner. Under The Division Head are two Section Heads - one is responsible for Operations and one is responsible for Records.

The Records Section is responsible for maintaining records on all vehicle operations which include the assignment of vehicles, description of vehicle including all supplemental equipment which has been installed on the vehicle, mileage logs on all vehicles, individual motor vehicle service and repair records, and motor vehicle accident reports. It is also the responsibility of the Records Section to keep records on all parts purchased by the Parts Unit of A & E and the disposition of these parts. Records will also be kept of itemized costs of parts and labor for all work done under outside contracts. In addition, this Section has responsibility for preparing summaries of vehicle data in such a form as to allow the Policy Committee to make policy determinations. The Records Section will process requests for vehicles and distribute and analyze any questionnaires to vehicle

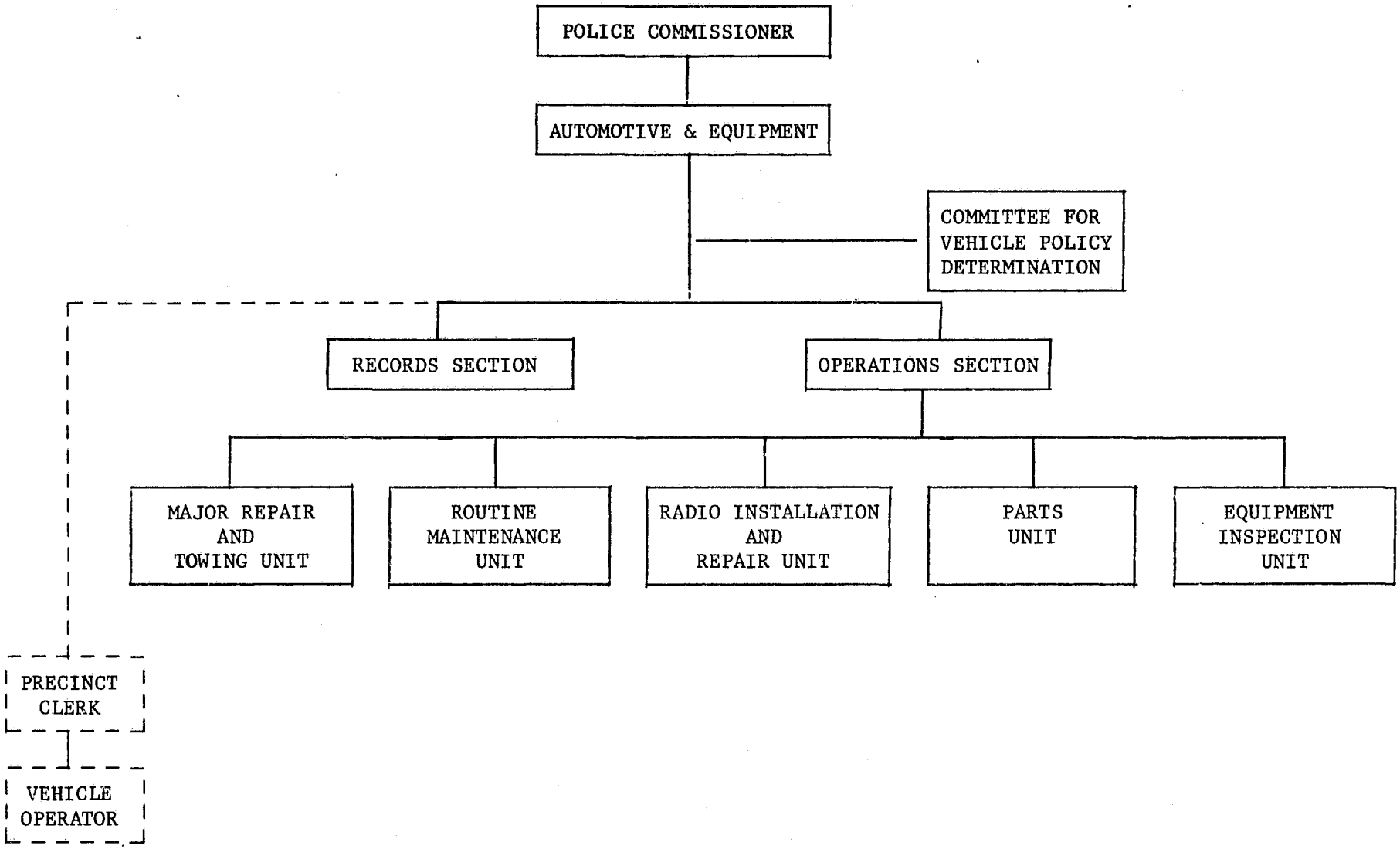


CHART 8.1 BASIC ORGANIZATION OF AUTOMOTIVE & EQUIPMENT DIVISION (A & E)

operators deemed necessary by the Policy Committee to evaluate human factors in placement of supplemental equipment or other related vehicle behavior areas.

The Operations Section is responsible for all operations of the A & E Central Garage and is divided into five units - Major Repair and Towing Unit, and Routine Maintenance Unit, Radio Installation and Repair Unit, Parts Unit, and Equipment Inspection Unit.

The Major Repair and Towing Unit is responsible for all major repair work such as collision, painting, transmission, and other non-routine repairs. This unit would also be responsible for towing disabled police vehicles.

The Routine Maintenance Unit is responsible for all routine repair and maintenance work including tune-ups. It is also this unit's responsibility to install all supplemental equipment on new vehicles and remove this equipment prior to vehicle disposal. This equipment would include sirens, police decals, rotating lights, etc., but not mobile radio equipment.

The Police Equipment Installation and Repair Unit is responsible for the installation and repair of all mobile radio equipment. This includes periodic checkups of each radio.

The main responsibility of the Parts Unit is to purchase and maintain an inventory on all parts that are needed for vehicles. All other units obtain parts from this unit.

The Equipment Inspection Unit has the responsibility for making periodic inspection of all fleet vehicles to assure that

they are receiving proper maintenance and repair service. In a small fleet this unit may consist of only one man or even a part time duty of one man whereas in a larger fleet it would consist of several people. Their responsibility also includes inspecting outside contract service agencies to assure that their standards are sufficiently high to warrant continued use. The Equipment Inspection Unit assists the Precinct Clerk in determining whether vehicles should be called off the road so that minor repairs can be made or can wait until the vehicle is due for its regular and routine maintenance work. The Equipment Inspectors spend nearly all of their time traveling around the precincts.

Chart 8.1 also shows a Committee on Policy Determination . This committee includes the A & E Division Head, the two Section Heads, and the Unit Heads from the Routine Maintenance Unit and the Equipment Inspection Unit. It is the responsibility of this Committee to formulate policies covering the care of police vehicles.

There is a precinct Clerk in every precinct and one at Central Headquarters. His responsibilities are to keep mileage logs on all cars in his precinct, to assign pool vehicles, and schedule routine maintenance appointments. Again, this may be only a part time assignment in a smaller police fleet. It is also his responsibility to submit to the Records Unit of A & E the following information on a bi-weekly basis: Bi-weekly Mileage Log Summaries (Form 5), copies of Vehicle Service and Repair Record (Form 2), and copies of all receipts for work including gas, oil, and wash jobs

done by local service stations and garages under contract. (Typical policy directives on this subject appear in Appendix 6).

It is the vehicle operator's responsibility to contact the Precinct Clerk whenever non-routine work is needed on the vehicle he is driving. The vehicle operator of a pool vehicle must record the mileage at the end of his shift on the Daily Mileage Log (From 3) kept by the Precinct Clerk. This form provides space for the vehicle operator to make any pertinent remarks about the performance of the vehicle on his shift. The vehicle operator of a permanently-assigned vehicle will keep the same information on a Daily Mileage Log (Form 4) but will be required to post with the Precinct Clerk only on a bi-weekly basis. Each vehicle operator is responsible for submitting all receipts for work including gas, oil, and wash jobs by local contract service stations and garages, which he has signed. These are to be given to the Precinct Clerk on a daily basis for pool vehicles and on a bi-weekly basis for permanently-assigned vehicles. Other responsibilities of the vehicle operator will be sent to him from A & E as policies are formulated. (Typical policy directives appear in Appendix 6.)

I. Basic Forms

In order that the necessary data be recorded and transmitted to the proper control units, a series of forms have been made. These include the following: Assignment of Automotive Equipment, Motor Vehicle Service and Repair Record, Daily Mileage Log, Daily

Mileage Log for Permanently-Assigned Vehicles, and the Bi-Weekly Mileage Log Summary. The specific function of these forms, where they originate, and who gets copies is shown in Chart 8.2, Flow of Paperwork in Informational Control System. Samples of these forms are shown in Appendix 6.

J. Police Fleet Management Information System Summaries: Description of Functions

Monthly Summary of Equipment Expense - Prepared by Records Unit based on all feeder reports eminating from this system. This is a detailed expense log which is maintained on each vehicle.

Car Life Summary - This report continues for the life of each car. It is annotated monthly based on Monthly Summary of Equipment Cost.

Quarterly Report - A formal presentation of contents is given to the Police Commissioner. It summarizes all data into cost, availability, and reliability factors. It compares current performance of other comparable cities. It is also possible to compare Brand X against Brand Y if two different makes of cars are in the fleet or if previous years' car was of a different make.

Review and Analysis - As a result of analyzing quarterly report, decisions are made relating to required changes regarding procurement, operating or maintenance policies.

K. Policy Directives

A series of policy directives have been established which detail the police, procedure, and operational aspects of the A & E

Division. Directives on the following subjects have been prepared: Policy on Assignment and Utilization of Police Vehicles, Utilization of Authorized Garages and Service Stations, Schedule for Servicing Vehicles, Procedure for Repairing and Servicing Automotive Vehicles, Vehicle Service and Repair Record, Procurement of Tires and Batteries for Vehicles, and the Use of Jumper Cables. These directives are shown in Appendix 6 and the flow of this paperwork is shown in Chart 8.2. It is recognized that the policies of the A & E Division will be continuously supplemented to reflect the various operational problems that are sure to arise as the vehicle operational data becomes available. Therefore, no attempt has been made to cover all possible contingencies, but rather several typical directives, such as the use of jumper cables and the scheduling of service, have been included in this report.

L. Conclusions

This management information system provides a general procedure for efficiently operating a city police department vehicle maintenance facility.

A set of directives has been presented which establish a flexible, economical system which will ensure that vehicles are given the proper repair and routine maintenance necessary to keep them in top running condition. This system recognizes the need to minimize down-time of vehicles when undergoing service and has therefore provided a flexible system by which vehicles can be serviced at local service stations in the precinct.

PAPER	FUNCTION	ORIGINATES	ORIGINAL COPY TO:	ADDITIONAL COPIES TO:		
Assignment of Automotive Equipment (Form 1)	Record of vehicle assignment and supplemental vehicle equipment.	Records Section (keeps copy)	Vehicle Assignee (Precinct Clerk in case of pool vehicles)	Precinct Clerk (for permanently-assigned vehicles)		
Motor Vehicle Service and Repair Record (Form 2)	Record vehicle service repairs.	At the time of service (form is kept in glove compartment of vehicle)	Remains in glove compartment of vehicle	Precinct Clerk (receives two copies from vehicle operator bi-weekly)	Records Section (receives one copy from Precinct Clerk bi-weekly)	
Daily Mileage Log (Form 3)	Record daily mileage and remarks concerning vehicle behavior.	Precinct Clerk's Office (filled out by vehicle operators)	Kept by Precinct Clerk			
Daily Mileage Log for Permanently-Assigned Vehicles (Form 4)	Record daily mileage and remarks concerning vehicle behavior.	Operator of permanently-assigned vehicle (keeps copy)	Precinct Clerk (bi-weekly)			
Bi-Weekly Mileage Log Summary (Form 5)	Summarizes mileage and remarks concerning vehicle behavior bi-weekly.	Precinct Clerk (keeps copy)	Records Section (bi-weekly)			
Credit Card Receipts	Acknowledges purchases of gas, motor oil, lubes, car washes, and tire repairs.	Contract garage and service stations	Main Accounting Division of Police Department through Precinct Clerk	Vehicle Operator of pool vehicle submits daily; permanently-assigned, bi-weekly ——>	Precinct Clerk (transmits bi-weekly to:) ——>	Records Section
Receipts from Contract Garages and Service Stations for Repair Work	Acknowledges repair work done by contract garages and service stations.	Contract garage and service stations	Main Accounting Division of Police Department through Precinct Clerk	Vehicle Operator of pool vehicle submits daily; permanently-assigned, bi-weekly ——>	Precinct Clerk (transmits bi-weekly to:) ——>	Records Section
Automotive & Equipment Directives (See Appendix A for specific directives)	Policy interpretations.	Automotive & Equipment Division Director	Addressee	General distribution: Central Headquarters, Equipment Inspectors, Operations Section, Precinct Clerks, Precinct Supervisors, Records Section, Vehicle Operators		

NOTE:———>denotes movement of same piece of paper.

CHART 8.2 FLOW OF PAPERWORK IN INFORMATIONAL CONTROL SYSTEM.

Provisions have been made through the use of the Equipment Inspection Unit to lend expertise in determining whether a vehicle in need of minor repair should be left in service until it is due for its routine maintenance or pulled off the road for immediate repair. The Equipment Inspection Unit also provides the necessary control to assure that the vehicles are being maintained as directed.

Another feature of this system is a strong Records Section which keeps complete records on all vehicle cost and performance data. With this information, decisions on how long vehicles should be kept, mileage limits for routine maintenance, and other vehicle operational cost areas can be intelligently made.

This system does not go into all the many details of operation but provides a general framework which, if followed, will provide an economical, flexible control system which will prevent serious problems.

IX. SUMMARY

The objective of this research is to present recommendations and guidelines to police administrators so that they may procure a better vehicle for patrol purposes and operate it at an overall lower cost. The first six chapters are concerned with the design parameters of the vehicle and how to procure it and replace it. The last two chapters offer recommendations on maintenance of the vehicle and guidelines for the maintenance facility operation. The summary is best presented under the following headings.

(1) Human Factors

(2) Front Seat Package

(3) Specifications

(4) Maintenance

(5) Replacement

(6) Shop Operations

A. Human Factors

The primary purpose of the human factors research is to analyze equipment configurations as they are utilized in present police vehicles and to provide recommendations for changes so as to yield a more effective man-machine system. The following areas were studied and corresponding improvements recommended.

(1) Steering. Power steering is recommended for all full-sized vehicles.

(2) Foot Controls. Okay as they are.

(3) Seating. Because of the variability in the size of police officers, it is recommended that police vehicles be equipped with individually adjustable seats and that these seats be adjustable vertically and angularly as well as horizontally.

(4) Controls of Police Related Equipment. It is recommended placing as many of these controls as possible on a specially-designed console positioned between the two officers and mounted on the bench seat or between the two bucket-type seats. Doing this will bring the controls into normal reach areas.

(5) Importance and Location of Equipment. The frequency of utilization and the importance an officer attaches to his equipment is a complex relationship. An analysis of this relationship leads to a recommendation that a multiple criteria must be applied in any decisions related to the configuration of equipment, especially those items which will relate to the personal safety of the officer.

(6) Temperature Control. A method of analysis is presented that can be used in any individual local to determine whether or not air conditioning is needed for the patrol vehicle.

(7) Visibility. After an analysis of tinted glass, it is concluded that tinted windshields have a detrimental effect on driving visibility at night. Therefore, it is recommended that police vehicles do not use tinted glass, but utilize sunglasses to decrease the glare factor during the day.

(8) Noise Control. Production vehicles at present do a reasonably good job of noise damping. The recommendation is made that an externally-mounted monitor device be given serious consideration as an aid to monitoring critical sources of information from outside the vehicle.

B. Front Seat Package

A front seat package design was developed which included the desired equipment console between the two front seats. This design was installed in a Detroit Police Department patrol car and test results showed that it was well accepted by the officers who used it. The design and details are presented in Chapter III.

C. Police Patrol Vehicle Specifications

The vehicle itself is discussed in detail and a model specification is presented along with many recommendations concerning the vehicle. A few of these are:

(1) Since all American manufacturers provide a police package with a variety of options which represent vital design changes from the normal production vehicle, it is recommended that the minimum technical specification which a department should consider would be one with the standard police package as offered by the manufacturer.

(2) Since the manufacturer is best qualified to perform this matching using his engineering talent and test facilities, it is recommended that the police department use a philosophy in which the performance requirements become the specification.

(3) It is recommended that the police vehicle be equipped with an automatic transmission having liquid cooling and a minimum of three forward speeds.

(4) The limited slip differential is recommended only in areas which require vehicle mobility during poor traction driving conditions.

A comprehensive recommendation on braking and on vehicle handling is presented.

A recommended color scheme of blue and white is recommended as well as the adoption of the blue beacon as a standard signal for marked vehicles.

Optional equipment is discussed, as are modifications which violate Federal Motor Vehicle Safety Standards, such as the disconnecting of door handles and the installation of wire prisoner screens.

D. Maintenance

Preventive maintenance is discussed in detail and a recommended program of periodic replacements and inspections is given. The recommendation based on practical experience is that a vehicle be given a daily inspection of gas station items, a

monthly or 3,000-mile lubrication and safety check, a 9,000-mile major inspection and tune up, with additional items at 27,000-mile intervals.

E. Replacement of Vehicles

The costs related to the vehicle operation and ownership are discussed in detail and the following recommendation is made.

(1) The three most important costs related to vehicle replacement policy are depreciation, repairs, and modifications. If good cost data is available and if the police department buyers are knowledgable of all of the factors involved, it is recommended that a simple model using the sum of the above three costs be used for the replacement decision. If the cost data is not readily available, it is recommended that a subjective judgment be used and vehicles be replaced every two years or every 60,000 to 70,000 miles, whichever occurs first.

F. Shop Facilities and Operations

The recommendations in this area are less definitive than those in other areas. Rather, a set of guidelines are given as to the facilities required for fleet maintenance and a thorough discussion on deciding whether to do your own maintenance or contract it out. Also, an information system for controlling the shop operations is discussed and guidelines are given.

This research project has studied the police patrol vehicle in all its aspects outside of the operational policies of the

particular Police Departments. This research has encompassed the vehicle's design (including the human factors and the front seat equipment console), procurement, specifications, replacement, maintenance and the requirements of the maintenacne facilities and the operation of the maintenance facility.

APPENDIX 1

Table A1.1

RESPONSE OF POLICE COMPLAINT OPERATORS TO CITIZEN CALLS FOR ASSISTANCE*

CITY	Number of Telephone Calls for Assistance Received Via Police Emergency Number in 1968[1]	Disposition of Calls (Service Provided) by Police Complaint Operator[2]		1968 Population Figures[3]	Requests for Service INDEX (Calls/Person)
		SERVICE I Call Handled Without Dispatch of Patrol[4]	SERVICE II Dispatch of Patrol to Scene[5]		
DETROIT	1,027,000[a]	370,000 (36%)	657,000 (64%)	1,570,000	.65
NEW YORK	5,200,000[b]	2,080,000 (40%)	3,120,000 (60%)	7,964.200	.65
ST. LOUIS	461,000[c]	98,000 (21%)	363,000[c] (79%)	671,700	.67

1. Figures on calls for assistance received and their respective breakdowns were obtained from:
   (a) Detroit Police Department, Communications Department
   (b) New York Police Department, Communications Department
   (c) St. Louis Police Department, R & D Division

2. Upon receipt of a call to police complaint operator must make the following decisions:
   Whether or not to dispatch a car in response to the call.
   How to respond to those calls in which a patrol car is not dispatched.

3. Estimated from Bureau of the Census provisional figures July 1, 1968.

4. See Table A1.2 for breakdown of complaint operators' responses to calls handled without the dispatch of a patrol.

5. See Table A1.4 for breakdown of types of runs responded to by patrol.

*As opposed to the response by the officer at the scene of the incident.

Table A1.2

POLICE COMPLAINT OPERATORS' RESPONSES TO CALLS
IN WHICH A PATROL CAR WAS NOT DISPATCHED

CITY	Total Calls Handled Without Dispatch in 1968	Police Report Taken Via Telephone[1]	Call Referred to Another Government Agency	Call Referred and/or Transferred to Another Police Bureau	Call Referred To Private Agency	Call Resolved Without Referral
DETROIT[2]	370,000		35,600 (9.6%)	131,000 (35.5%)	8,400 (2.2%)	195,000 (52.6%)
NEW YORK	2,080,000	NO BREAKDOWN AVAILABLE				
ST. LOUIS[3]	98,000	6,225 (6.3%)	8,325 (8.5%)	9,700 (9.9%)	2,250 (2.3%)	71,500 (73.%)

[1]No phone reports currently taken in Detroit.

[2]Breakdown estimated from one month study taken during June of 1969.

[3]Breakdown estimated from figures of calls handled during first 8 month of 1969.

Table A1.3

METROPOLITAN POLICE DEPARTMENT REQUESTS FOR POLICE SERVICE RESOLVED WITHOUT DISPATCH UNDER COMPLAINT EVALUATION PROGRAM (BY CATEGORY)

CATEGORY	DETROIT[1]		ST. LOUIS[2]	
	% of All Calls Rec'd	% of Calls Handled Without Dispatch[3]	% of All Calls Rec'd	% of Calls Handled Without Dispatch[3]
REFERRAL TO OUTSIDE GOVERNMENTAL AGENCIES Recorder's Court, Board of Health, Fire Dept., Dog Pound, Dept. of Public Works, City Physician Ambulance Dispatcher[4], Building Commissioner, Citizen Service Bureau, Street Lighting Section,, City Traffic Division, Water Division	?.4%	9.1%	1.7%	8.5%
REFERRALS TO PRIVATE AGENCIES Alcoholics Anonymous, Legal Aid Society, Family Service Association of America, Attorney, Michigan Humane Society, Anti-Cruelty Association, Service (gas, light, etc.)	0.8%	2.2%	0.5%	2.3%
REFERRALS TO POLICE DEPARTMENT UNITS[5] Precinct Detective, Uniform Division Precinct, Youth Burear, Women's Division	12.2%	33.8%	2.1%	9.9%
RESOLVED WITHOUT REFERRAL Caller Discontinued Conversation, Natural Phenomenon, Miscellaneous Information, Ordinary Sick Case (Complaint Consented to Secure Own Transportation to Hospital), Resolved Through Advice by Phone	18.0%	50.0%	15.5%	73.0%
POLICE REPORT PREPARED VIA PHONE[6] MPD, Minor Larceny	1.6%	4.8%	1.2%	6.3%

[1]Breakdown estimated from 1 month study, June 1969. Sample size 35,192 calls handled without dispatch.

[2]Breakdown estimated from calls received during first eight month of 1969. Sample size 72,557 calls.

[3]Percentages different from Table II due to the inclusion of an estimate of reports that could have been

[4]Applicable only to St. Louis Police Department. Detroit Police provide ambulance sercice.

[5]The large difference between the departments is due to the dispatching of runs in St. Louis for incidents in which Detroit requests that the caller make a report in person at his local precinct station.

[6]Estimated for Detroit. No phone reports currently taken.

Table A1.4

BREAKDOWN OF TYPES OF RUNS RESPONDED TO BY THE DISPATCH OF A PATROL

CATEGORY	% OF CALLS DISPATCHED	
PREDITORY & ILLEGAL SERVICE CRIMES		
Crime, Prowler, Alarms, Recovery of Property	38.7%	51.0%
PUBLIC DISORDER		
Boys[3], Family Trouble, Parking Complaint, Disturbance, Missing Person, Neighbor Trouble, Tenant Trouble, Rubbish Complaint Strike	34.8%	27.2%
CRIMES OF NEGLIGENCE	12.0%	9.6%
Accidents--Vehicles		
SERVICE		
Health Sick Person, Injury or Misc. Accident, City Physician, Animal Bites, Death, Attempted Suicide, Suicide, Ambulance Call	10.0%	11.7%
Safety Crossing Detail, Direct Traffic, Fire, Street Defect, Tree-Pole-Wire, Animal Injured, Misc. Hazards	4.5%	.5%
Total Service	14.5%	12.2%

[1]Breakdown estimated from 1 month study of runs dispatched in Precincts 15 and 16. Sample size 16,531 runs.

[2]Breakdown estimated from runs dispatched during first nine months of 1969. Sample size 200,496 runs.

[3]This is a general description used to indicate such incidents as "the boys are making noise," "the boys are throwing rocks," etc.

APPENDIX 2

ALTERNATIVE DESIGNS FOR PEDAL POSITIONS

According to Black's (1966) recommendations the throttle should be angled 30° left so that the driver's foot can assume a number of good driving positions. The brake pedal should be .5" below the accelerator at 2/3 throttle, and the left edge of the brake should be 7" to the right of the driver center line. In this way application of the brakes simply requires a rotational movement of the foot and application of downward pressure. Black (1966) cites evidence that this arrangement yielded a 20 per cent reduction in braking reaction time. This arrangement generally conforms to human factors design principles. Specifically, control layout should allow the greatest possible margin of safety for the most adverse emergency conditions. This is particularly important in police vehicles where emergency conditions are likely to occur.

SEATING AREA--STEERING WHEEL ROOM AND SEAT POSITIONS

The seat-steering wheel distance and the backrest-steering wheel distance in the 1969 Plymouth are somewhat below the recommended dimensions. The somewhat cramped steering wheel position on the Plymouth may therefore interfere with the entry and exit of larger officers. In addition, headroom in both the 1969 Ford and Plymouth are below recommended criteria. Some taller officers may be forced to assume a slumped seating position, particularly if they are wearing hats. Vertically adjustable seats would aid this situation.

Table A2.1

HUMAN FACTORS EVALUATION OF PRIMARY CONTROLS
IN DETROIT POLICE VEHICLES

Primary Controls	Vehicle Data		Recommendations		
	1969 Ford	1969 Plymouth	Black (1966)	Morgan et. al. (1963)	Damon et. al. (1966)
A. Steering Wheel					
1. Wheel Angel	30° From Vert.	22° From Vert.	50°-60°*	---	---
2. Rim Thickness	3/4"	3/4"	1 1/2"	3/4 - 2"	3/4 - 1 1/2"
3. Rim Texture	Plastic Ridges	Plastic Ridges	Absorbant	Ridged	---
4. Turns - Lock to Lock	4	3.5	3-3.5	---	---
5. Wheel Diameter	15 1/2"	16"	---	7" - 21"	7" - 21"
B. Throttle					
1. Angle - Before Activation	67°	65°	60°	60°	---
2. Angle - Toward Brake	-10°	-12°	+30°	---	---
3. Effective Pedal Length	10"	10"	9"	---	---
4. Clearance with Brake	4"	5"	3"	4"	---
5. Pedal Type	Suspension	Suspension	Organ	---	---
6. Stroke Distance	3 1/4"	3 1/2"	3"	2 1/2"	2 - 4"
7. Max. Force Required	NA	NA	12lbs.	6 1/2-9lbs.	6 1/2 - 9lbs.
C. Brake Pedal					
1. Length	7"	7 1/2"	12"	3 1/2"	3 1/3"
2. Width	2 1/2"	2 1/2"	2 1/2"	3 1/2"	3"
3. Dist. Left End From Center	4"	0"	7"	0-3"	0-3"

*McFarland (1963) also recommends a steering angle of 45.3°.

Table A2.1

HUMAN FACTORS EVALUATION OF PRIMARY CONTROLS
IN DETROIT POLICE VEHICLES

	1969 Ford	1969 Plymouth	Black (1966)	Morgan et. al. (1963)	Damon et. al. (1966)
C. Brake Pedal					
4. Maximum Stroke	2"	1.4"	1.5"	2" - 4"	2" - 6"
5. Vertical Dist. From Throttle	2/3 + 4"	+5"	-.5"	---	---
6. Clearance From Steering Column	2"	Clear	No Foul	---	---

Table A2.2

HUMAN FACTORS EVALUATION OF SECONDARY POLICE VEHICLE CONTROLS:
HORIZONTAL AND VERTICAL PLACEMENT

Secondary Control	Vehicle Data		
	1969 Ford		
	Frontal Plane Distance From Driver Center	Horizontal Distance From S.R.P.	Vertical Distance From S.R.P.
I. Special Switch			
1. Roof Beacon	19" right	35"	+7"
2. Siren-Horn	19" right	35"	+4"
3. Brake Light Cancel	18" right	35"	+7"
4. Gun Lock	18" right	35"	+4"
5. Hand Spot Jack	20" right	35"	+4"
6. Deck Lights	---	---	---
II. Siren Controls			
A. Electronic Type			
7. Function Switch			
8. Siren Button			
9. Gain			
10. Mike Position			
B. Mechanical Type			
11. Siren Button	21" right	33"	+7"
12. Brake Button	21" right	33"	+4"
III. Radio			
13. Gain	13" right	29"	+1"
14. Squelch	17" right	29"	+1"
15. Mike Position	21" right	29"	+2"
IV. Spot Light			
16. Position	28" right	40"	---

NOTE: SRP refers to seat reference point, the intersection of the vertical and horizontal seat cushion.

Table A2.2, continued

HUMAN FACTORS EVALUATION OF SECONDARY POLICE VEHICLE CONTROLS:
HORIZONTAL AND VERTICAL PLACEMENT

Secondary Control	Vehicle Data 1969 Ford		
	Frontal Plane Distance From Driver Center	Horizontal Distance From S.R.P.	Vertical Distance From S.R.P.
I. Special Switch			
1. Roof Beacon	8" right	26"	18"
2. Siren-Horn	8" right	26"	16"
3. Brake Light Cancel	6" right	26"	18"
4. Gun Lock	---	---	---
5. Hand Spot Jack	9" right	26"	16"
6. Deck Lights	7" right	26"	17"
II. Siren Controls			
A. Electronic Type			
7. Function Switch	18" right	24"	0"
8. Siren Button	16" right	24"	0"
9. Gain	20" right	24"	0"
10. Mike Position	18" right	24"	0"
B. Mechanical Type			
11. Siren Button			
12. Brake Button			
III. Radio			
13. Gain	17" right	33"	0"
14. Squelch	12" right	33"	0"
15. Mike Position	16" right	25"	+10"
IV. Spot Light			
16. Position	---		

Table A2.3

HUMAN FACTORS EVALUATION OF SECONDARY CONTROLS
IN DETROIT POLICE VEHICLES - FRONTAL PLANE

	1969 Ford		1969 Plymouth	
	Frontal Distance	Comparison with Recommendation*	Frontal Distance	Comparison with Recommendation
I. Special Switches				
1. Roof Beacon	19"	A	8"	A
2. Siren Horn	19"	A	8"	A
3. Brake Light Cancel	18"	A	6"	A
4. Gun Lock	18"	A	---	---
5. Hand Spot Jack	20"	A	9"	A
6. Deck Lights				
II. Siren Controls				
A. Electronic Type			18"	A
7. Function Switch			16"	A
8. Siren Button			20"	A
9. Gain			18"	A
10. Mike Position				
B. Mechanical Type				
11. Siren Button	21"	A		
12. Brake Button	21"	A		
III. Radio				
13. Gain	13"	A	17"	A
14. Squelch	17"	A	12"	A
15. Mike Position	21"	A	16"	A
IV. Spot Light				
16. Position	28"	NA		

NOTE: Based on a recommendation by Morgan et. al. (1963) finger operated controls are best located at fore-aft distances no greater than 22 1/2". All distances in the above table were measured in the horizontal plane from the seat reference point. NA refers to nonacceptable while A refers to acceptable.

Table A2.4

HUMAN FACTORS EVALUATION OF SEATING DIMENSIONS
IN DETROIT POLICE VEHICLES

	Seating Dimension	Relevant Body Measure	Vehicle Data	
			1969 Ford	1969 Plymouth
1.	Seat Height	Popliteal Height	9"	11"
2.	Seat Length	Buttock-Popliteal Height	20"	19"
3.	Seat Breadth	Hip Breadth Seated	55"	58"
4.	Backrest Height	Seat to Top of Shoulder	21"	20"
5.	Backrest Breadth	Shoulder Breadth	55"BT	58"
6.	Seat-Roof Distance	Sitting Height	37 1/2"	37"
7.	Seat-Steering Distance	Thigh Thickness	7 3/4"	6"
8.	Backrest-Steering Distance[1]	Abdomen Length	14"	13"
9.	Backrest-Steering Distance[2]	Buttock-Knee Length	29"	29"
10.	Brake-Steering Distance	Knee Height (top)	26"	26"
11.	Vertical-Seat Adjustment	Seated Eye Height	None	None
12.	Fore-Aft Seat Adjustment	Functional Leg Reach	5"	4 1/2"
13.	Seat-Pan Angle	Weight Seated Distribution	10°	10°
14.	Backrest Angle	Seated Weight Distribution	115° Fixed	112° Fixed
15.	Steering Wheel Angle ---	Measured Vertical	30°	22°

Note: 1. Seat at mid fore-aft adjustment.
2. Seat full back adjustment.

Table A2.4, continued

HUMAN FACTORS EVALUATION OF SEATING DIMENSIONS
IN DETROIT POLICE VEHICLES

Seating Dimension	Relevant Body Measure	Recommendations				
		McFarland 1963	Black 1966	Morgan et.al. 1963	Damon et.al. 1966	Jones 1969
1. Seat Height	Popliteal Height	10-14"	16"	15-16"	15-16"	12"
2. Seat Length	Buttock-Popliteal Height	18"	17 1/2"	17"	16-17"	17"
2. Seat Breadth	Hip Breadth Seated	58"	---	18"/pass	18"/pass	---
4. Backrest Height	Seat to top of Shoulder	18-21"	20"	18-20"	18-20"	---
5. Backrest Breadth	Shoulder Breadth	20"/Pass	---	20"/pass	20"	---
6. Seat-Foor Dist.	Sitting Height	40"	---	40"	39-41"	38.5"
7. Seat-Steering dist.	Thigh Thickness	7"t	8"	7"t	---	8.5"
8. Backrest-Steering Dist.[1]	Abdomen Length	14"	15"	14"	---	---
9. Backrest-Steering Dist.[2]	Buttock-Knee Length	27 1/2"	29"	27"	---	---
10. Brake-Steering Dist.	Knee Height (Top)	24"	26"	25"	---	---
11. Vertical-Seat Adj.	Seated Eye Height	4 1/2",1/2inc	ADJ	4"	4"	---
12. Fore-Aft Seat Adj.	Functional Leg Reach	8",1/2inc	ADJ	6"	6",1"inc	---
13. Seat-Pan Angle	Weight Seated Distribution	7°	6°	6-7°	6-7°	7°
14. Backrest Angle	Seated Weight Distribution	112°ADJ±.5°	105°	103°-115°	103°-115°	108°
15. Steering Wheel Angle--Measured Vertical		45.3°	50°-60°	---	---	30°

Note: 1. Seat at Mid fore-aft adjustment.
2. Seat full back adjustment.

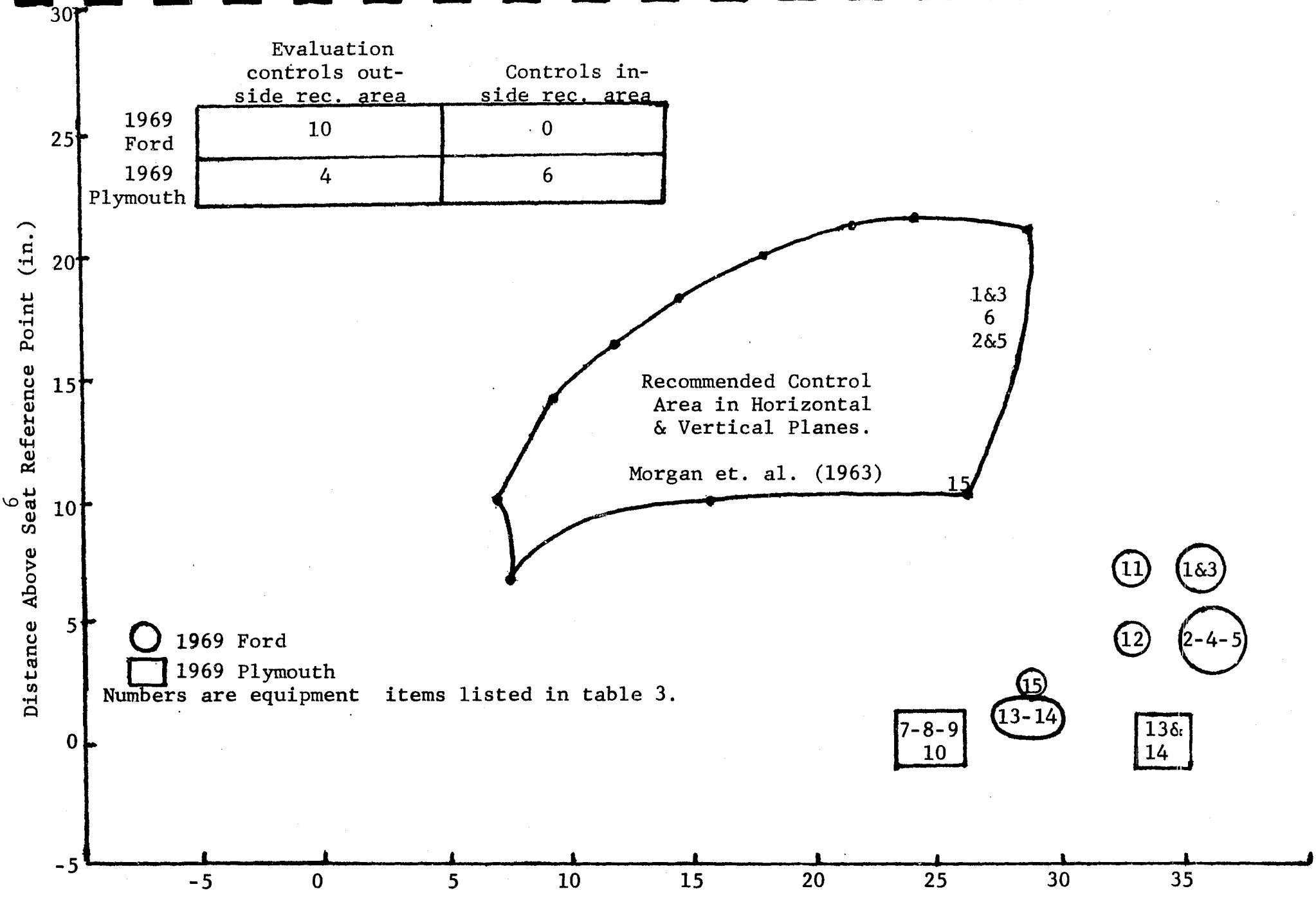


FIG. A2.1A comparison of actual control locations in the 1969 Ford and Plymouth Police vehicles with recommended areas for control.

Table A2.5

A Complete List of Frequencies of Suggested External Information Sources Utilized by the Police Officer

	Information Source	Frequency of Report
1.	Erratic driving	1
2.	Suspicious persons	17
3.	Tips from citizens	15
4.	Human voices	19
5.	Suspicious noises (glass)	42
6.	Smoke	3
7.	Unusual or no lights in building	12
8.	Mobile radio	1
9.	Hand signals	24
10.	Whistles	8
11.	Claims	17
12.	Suspicious changes, sights	15
13.	Horns blowing	14
14.	Headlights blinking	5
15.	Illegally parked or suspicious	11
16.	Gunshots	17
17.	Squealing tires, high speed take-offs	12
18.	Barking dogs	17
19.	Crowd gathered	6
20.	Broken windows	1
21.	Traffic jams	1
22.	Car crashes	1
23.	Senses, observation of officer	8
24.	Teletype statistics	2
25.	Car engines	5
26.	Pounding, hammering	4
27.	Explosions	4
28.	Silence	1
29.	Odors	1
30.	Reflections in glass, mirror	3
31.	Tracks in snow	1
32.	Visual inspections	3
33.	Tire irons	1
34.	Unused entrances	1

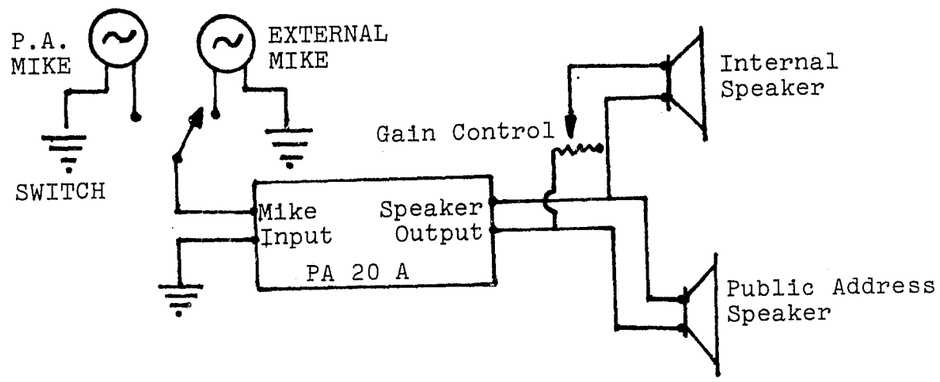


Figure A2.2. External sound monitoring system.

POLICE VEHICLE EQUIPMENT

QUESTIONNAIRE

Wayne State University, in cooperation with the Department of Justice, is presently involved in an intensive analysis of the police vehicle. In particular, this study focuses on the equipment normally contained within the police vehicle for utilization by the officer.

In the following pages you are asked to answer a number of questions concerning the equipment contained within your vehicle and your use of this equipment. In asking for this information, we are attempting not only to evaluate the utilization of the present equipment, but to obtain information that might enable us to take the policeman's individual requirements and needs into account in suggesting equipment modifications or additions.

Please answer the questions as accurately and fully as you can, since the outcome of this study will influence future police car design, not only in Detroit, but across the country.

1. Equipment utilization

Below you will find a list of the equipment items usually contained within your vehicle.

We would like you to rank this equipment according to how frequently you use a particular item during an average duty shift. For example, if you feel you use your radio microphone more frequently than any other piece of equipment, give this item the rank of 1. The next most frequently used item give the rank of 2.

Use the space provided to the right of the list of equipment items to indicate your ranking of the items.

If your vehicle does not contain a particular item, do not rank the item, merely write in the abbreviation N.A. (not applicable). If your vehicle contains an additional item that you feel ought to appear in the ranking, add this item to the list and rank it appropriately.

A. Horn-siren _____
B. 'Prep'radio _____
C. Portable spotlight _____
D. Radio _____
E. Shot-gun _____
F. Ticket Books _____
G. Flashlight _____
H. Brake light control _____
I. Daily log _____
J. Fire extinguisher _____
K. Radio microphone _____
L. Roof light control _____
M. Miscellaneous forms _____
N. Auxillary radio _____
O. Electronic siren _____
P. Public address system _____
Q. 'Hot sheet' _____
_____ _____
_____ _____

II. Time distribution

For an average duty shift indicate the percentage of time you spend in the activities of

A. Law enforcement _____%
B. Medical emergency _____%
C. Removing disabled vehicles _____%
D. Other (specify) _____%
Total 100%

III. Equipment item utilization

In item one of this section we would like you to rate the actual frequency with which you use each piece of equipment. Simply circle on the scale the frequency with which you use each of the pieces of equipment during an average duty shift.

In item two of this section we would like you to rate the importance of each of the pieces of equipment in the performance of your duties. Once again simply circle the response which most closely approximates your answer.

A. Horn-siren

1. frequency of use

*	*	*	*	*	*	*
0-5 times	6-10 times	11-15 times	16-20 times	21-25 times	26-30 times	31-35 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very important	important	no opinion	unimportant	very unimportant

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

B. 'Prep' radio

1. frequency of use

*	*	*	*	*	*	*
31-35 times	26-30 times	21-25 times	16-20 times	11-15 times	6-10 times	0-5 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very important	important	no opinion	unimportant	very unimportant

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

C. Portable spotlight

1. frequency of use

*	*	*	*	*	*	*
31-35 times	26-30 times	21-25 times	16-20 times	11-15 times	6-10 times	0-5 times

if more than 35, specify

2. importance

*	*	*	*	*
very important	important	no opinion	unimportant	very unimportant

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

D. Radio

1. frequency of use

*	*	*	*	*	*	*
31-35 times	26-30 times	21-25 times	16-20 times	11-15 times	6-10 times	0-5 times

if more than 35, specify

2. importance

*	*	*	*	*
very unimportant	unimportant	no opinion	important	very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

E. Shotgun

1. frequency of use

*	*	*	*	*	*	*
31-35 times	26-30 times	21-25 times	16-20 times	11-15 times	6-10 times	0-5 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very unimportant	unimportant	no opinion	important	very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

F. Ticket Books

1. frequency of use

*	*	*	*	*	*	*
0-5 times	6-10 times	11-15 times	16-20 times	21-25 times	26-30 times	31-35 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very important	important	no opinion	unimportant	very unimportant

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

G. Flashlight

1. frequency of use

*	*	*	*	*	*	*
31-35 times	26-30 times	21-25 times	16-20 times	11-15 times	6-10 times	0-5 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very unimportant	unimportant	no opinion	important	very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

H. Brake light control

1. frequency of use

*	*	*	*	*	*	*
0-5 times	6-10 times	11-15 times	16-20 times	21-25 times	26-30 times	31-35 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very unimportant	unimportant	no opinion	important	very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

I. Daily log

1. frequency of use

*	*	*	*	*	*	*
0-5 times	6-10 times	11-15 times	16-20 times	21-25 times	26-30 times	31-25 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very important	important	no opinion	unimportant	very unimportant

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

J. Fire extinguisher

1. frequency of use

*	*	*	*	*	*	*
0-5 times	6-10 times	11-15 times	16-20 times	21-25 times	26-30 times	31-35 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very important	important	no opinion	unimportant	very unimportant

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

K. Radio microphone

1. frequency of use

*	*	*	*	*	*	*
0-5 times	6-10 times	11-15 times	16-20 times	21-25 times	26-30 times	31-35 times

if more than 35, specify _____

2. importance

*	*	*	*	*
very important	important	no opinion	unimportant	very unimportant

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties. _____

_____

L. Roof light control

1. frequency of use

*	*	*	*	*	*	*
0-5 times	6-10 times	11-15 times	16-20 times	21-25 times	26-30 times	31-35 times

if more than 35, specify _____

2. importance * very unimportant * unimportant * no opinion * important * very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties._____

M. Miscellaneous forms

1. frequency of use * 0-5 times * 6-10 times * 11-15 times * 16-20 times * 21-25 times * 26-30 times * 31-35 times

if more than 35, specify_____

2. importance * very important * important * no opinion * unimportant * very unimportant

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties._____

N. Auxiliary radio

1. frequency of use * 0-5 times * 6-10 times * 11-15 times * 16-20 times * 21-25 times * 26-30 times * 31-35 times

if more than 35, specify_____

2. importance * very unimportant * unimportant * no opinion * important * very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties._____

O. Electronic siren

1. frequency of use * 0-5 times * 6-10 times * 11-15 times * 16-20 times * 21-25 times * 26-30 times * 31-35 times

if more than 35, specify_____

2. importance * very unimportant * unimportant * no opinion * important * very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties._____

P. Public address system

1. frequency of use * 0-5 times * 6-10 times * 11-15 times * 16-20 times * 21-25 times * 26-30 times * 31-35 times

if more than 35, specify_____

2. importance * very unimportant * unimportant * no opinion * important * very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties._____

Q. 'Hot sheet'

1. frequency of use

*	*	*	*	*	*	*
0-5 times	6-10 times	11-15 times	16-20 times	21-25 times	26-30 times	31-35 times

if more than 35, specify_____

2. importance

*	*	*	*	*
very unimportant	unimportant	no opinion	important	very important

3. Please indicate in the space below any actual incidents where some feature of this piece of equipment was particularly helpful and/or particularly detrimental to the performance of your duties._____

_____

IV. Suggestions

Can you make suggestions as to any additional equipment items that your vehicle might contain, or the deletion of any present equipment items, that would contribute to the ease or efficiency of performance of your police duties?

_____

_____

_____

Do you think an air-conditioned vehicle would be beneficial to you in the performance of your duties? if so, how?

_____

_____

_____

Could you give us an abbreviated list of the external sources of information that you utilize during patrol as cries for services, for example, human voices, or glass breaking?

_____

_____

_____

IV. Biographical information

1. What is your age?_____
2. What rank do you presently hold?_____
3. How many years have you served as a police officer?_____
4. List your specific job assignments (patrolman,etc.) during these years, and estimate the time spent in each.

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

APPENDIX 3

POLICE VEHICLE CONSOLE QUESTIONNAIRE

1. How would you rate the console as compared to cars equipped in the usual fashion? ( ) Much superior ( ) Better in some respects ( ) About the same ( ) Worse than other cars ( ) Much worse. Explain your feeling._____

2. How long did it take to get used to the new location of switches and mikes? ( ) 1 - 2 hrs. ( ) 2 - 4 hrs. ( ) One shift ( ) Two or more shifts.

3. Does it take any longer to learn these new locations than it takes to learn the locations on a new car? ( ) Longer ( ) Less time. Explain your answer._____

4. How do you rate the arrangement of equipment on the console? ( ) Very good ( ) Satisfactory in most cases ( ) Generally poor. What changes would you recommend?_____

5. Did you find it generally easier or harder to use the switches on the console as compared to other cars? ( ) Easier ( ) Harder. Comments._____

6. What changes would you recommend for future designs of police car equipment consoles?_____

7. What types of devices or equipment would you like to see installed in police cars?_____

8. Any additional remarks on the console idea would be greatly appreciated._____

_____

_____

Signature_____

Date_____

Precinct number_____

FEEDBACK FROM OFFICERS WHO TESTED CONSOLES

One of the major measures of effectiveness for the console concept was the acceptance of the idea by the police officer. A second measure of effectiveness was the utility value of the console in the patrol function. Another piece of information desired was concerned with the design and with gaining information for future modifications. The testing phase of the study was, therefore, designed to:

(1) Measure the acceptance of the console by police officers.

(2) Study the value of the console in the police function.

(3) Gain input for design modifications.

This portion of the report will describe the testing of the equipment console, the results of the test, and the conclusions that can be drawn.

Bench Seat Console

Tests were made on a commercially available console that rests on the bench type seat between the driver and the passenger. Tests were also made on a console of Wayne State University design that sits on the drive train hump between individually adjusted bucket-type seats. Photographs of the two consoles appear in Appendix 4.

The bench seat console was tested in a full size 1970 model police car in the Southfield, Michigan Police Department and in an intermediate size 1969 model police car in the Wayne State University Department of Public Safety. Bench seat consoles were also installed in the Allen Park, Michigan Police Department and Pontiac, Michigan Police Department, but feedback is not yet available from these departments. In both cases for which we have feedback, the operating officers objected to the large size of the console and the lack of positive securing of the unit. Discussions were carried out with the Cleveland Police Department but no installation was made. The Cleveland vehicles are equipped with a shotgun mounted on the floor just in front of the seat and the console would have made that weapon inaccessable.

Bucket Type Seat Console

The bucket seat version was tested in a full size 1970 model police vehicle in the Detroit Police Department First, Second, and Thirteenth precincts. Discussions were carried out with the Oak Park, Michigan Department of Public Safety but no installation was made. The experience with Oak Park was that consoles must be rebuilt from year to year when new model vehicles are purchased and that the width of our design would have to be narrower to insure the ease of fit into future vehicles.

In the departments where tests were completed a questionnaire was distributed to the officers who used the vehicle. A sample questionnaire was presented at the beginning of this appendix.

The questions were designed to gain input on the three desired measures of the test. A measure of officer acceptance was solicited through the following questions:

1. How would you rate the console as compared to cars equipped in the usual fashion? Explain your feelings.

4. How do you rate the arrangement of equipment on the console?

A measure of the operational value of the console was solicited through the questions:

2. How long did it take to get used to the new location of switches and mikes?

3. Does it take any longer to learn these new locations than it takes to learn the locations on a new car?

5. Did you find it generally easier or harder to use the switches on the console as compared to other cars? Comments?

A measure of the suggested design improvements was gained through the questions:

6. What changes would you recommended for future designs of police car equipment consoles?

7. What types of devices or equipment would you like to see installed in police cars?

8. Any additional remarks on the console idea would be greatly appreciated.

It was desired to test the bench seat type console for comparison purposes. One such console was installed in the city of Southfield, Michigan. The test vehicle and patrol function has the following characteristics:

- Vehicle type - 1970 Full size four-door, sedan
- Console used - bench seat
- Equipment used
- Officers/car - one and two
- Types of runs - traffic control
  - radio dispatches
  - high speed runs

This test resulted in 13 responses. The following pages are the results of these responses. The results are presented in three parts.

(1) The distribution of the multiple choice answers and the qualitative reasons for questions evaluating acceptance.

(2) The distribution of the multiple choice answers and the qualitative reasons for questions evaluating operational value.

(3) Qualitative answers regarding suggested improvements.

The evaluation of those results appears later in this section of the report.

Southfield Test

1. How would you rate the console as compared to cars equipped in the usual fashion?

	no. of responses
(A) Much superior	7
(B) Better in some respects	5
(C) About the same	0
(D) Worse than other cars	1
(E) Much worse	0

Responses to question #1:

no. of responses	
7	It is easier to get at controls and equipment.
1	It takes up too much seat room.

4. How do you rate the arrangement of equipment on the console?

	no. of responses
(A) Very good	7
(B) Satisfactory in most cases	6
(C) Generally poor	0

Responses to question #4.

no. of responses	
2	It should be closer to the dash.
1	Move it to the right - out of the driver's way.
1	It has sharp edges.
1	We need a light to indicate when the beacon is on.

2. How long did it take to get used to the new location of switches and mikes?

	no. of responses
(A) 1 - 2 hours	13
(B) 2 - 4 hours	0
(C) One shift	0
(D) Two or more shifts	0

3. Does it take any longer to learn these new locations than it takes to learn the locations on a new car?

	no. of responses
(A) Less time	11
(B) Same	2
(C) Longer	0

Responses to question #3.

no. of responses	
4	The switches are closer to the driver.
1	You can't miss or confuse switches.
1	It is very convenient to use without diverting one's attention.
1	Much less movement to get at controls.

5. Did you find it generally easier or harder to use the switches on the console as compared to other cars?

	no. of responses
(A) Easier	13
(B) Same	0
(C) Harder	0

Responses to question #5.

no. of responses	
3	It is easier to reach.
1	You don't have to reach down for the controls.

Responses to question #6:

What changes would you recommend for future designs of police car equipment consoles?

1. Make it narrower.
2. It should be padded.
3. It should be farther forward.
4. The storage area was hard to use.
5. It makes the seat too cramped for two officers.
6. It should be used with bucket seats.

Responses to question #7:

What types of devices or equipment would you like to see installed in police cars?

1. Tinted glass.
2. Bucket seats.
3. Buzzer to indicate when beacon is on.
4. Armor plate.
5. Writing light that doesn't glare in driver's eyes.
6. Detention screens.

Responses to question #8:

Any additional remarks on the console idea would be greatly appreciated.

1. Console should be used with bucket seats.
2. Should have a clip board for hot sheets.
3. Storage area was not usable.
4. It doesn't leave enough sitting room.

Another test of the bench seat console was made in the Wayne State University Department of Public Safety. The Wayne test area has the following characteristics:

- Population - Commuting students
- Police Department Size - 36
- Community Description - Campus

The test vehicle and patrol function has the following characteristics:

Vehicle - 1969 Intermediate, two-door Sedan
Console used - Bench
Equipment - Federal siren head
Portable beacon
Motorola radio head
Brake switch
Horn/siren switch
Dome light switch
Headlight flasher switch
Officers/car - one and two
Type of runs - Traffic control
High speed runs
Prisoner transport
Radio dispatch
Surveilance

This test resulted in 10 responses. The following pages are the results of these responses. The results appear in the same order as before.

Wayne State University

1. How would you rate the console as compared to cars equipped in the usual fashion?

	no. of responses
(A) Much superior	0
(B) Better in some respects	1
(C) About the same	1
(D) Worse than other cars	5
(E) Much worse.	3

Responses to question #1.

1. It gets in the way, takes up too much space
2. The switches are immediately available.
3. The switches can be accidentally actuated.

4. How do you rate the arrangement of equipment on the console?

	no. of responses
(A) Very good	0
(B) Satisfactory in most cases	2
(C) Generally poor	8

Responses to question #4.

1. The switches are too close together.

2. How long did it take to get used to the new location of switches and mikes?

	no. of responses
(A) 1 - 2 hours	2
(B) 2 - 4 hours	2
(C) One shift	2
(D) Two or more shifts	3

3. Does it take any longer to learn these new locations than it takes to learn the locations on a new car?

	no. of responses
(A) Less time	0
(B) Same	2
(C) Longer	8

Responses to question #3:

1. Switches should be segregated.
2. Switches are hard to see.
3. It's not like other cars.

5. Did you find it generally easier or harder to use the switches on the console as compared to other cars?

	no. of responses
(A) Easier	0
(B) Same	0
(C) Harder	9

Responses to question #5:

1. It gets in the way.
2. The switches are confusing.
3. It's too close to the driver.

Responses to question #6:

What changes would you recommend for future designs of police car equipment consoles?

1. Mount it on the dash rather than on the seat.
2. The switches should be overhead.

Responses to question #7:

1. It should have a folding writing surface.
2. The space on the dash board should be used.

Responses to question #8:

1. We need more storage area.
2. It should have a foot operated mike.
3. Switches should be identifiable by touch.
4. We need bucket seats.

The test of the bucket seat console was limited to the Detroit Police Department. Three different precincts were given an opportunity to evaluate the design. They were the First, Second and Thirteenth precincts. For the purpose of evaluation, the area description and the quantitative statistics are broken down by precinct. But the vehicle description, type of run, and qualitative responses are identical and are presented together. The First precinct (1st) has the following characteristics:

- Land Area - 2.89 sq. miles
- Precinct Size - 194 Officers
- Community Description: The central business district of the water front.
- Responses - 33

The Second (2nd) precinct has the following characteristics:

- Land Area - 6.47 sq. miles
- Precinct size - 178 Officers
- Community Description - Low income, older neighborhood
- Responses - 31

The Thirteenth (13th) precinct has the following characterisitcs:

- Land Area - 5.68 sq. miles
- Precinct Size - 156 Officers
- Community Description - Low income, older neighborhood
- Responses - 30

The test vehicle and patrol function in all precincts were:

- Vehicle - 1970 full size, four-door Sedan
  Console - Bucket Seat
  Equipment - Federal siren head
  Shotgun
  Two flashlights
  Spotlight
  Beacon switch
  Horn/siren switch
  Gun lock button
  Trunk release button
  Console night light switch
  Writing light - visor mounted
  Officers/car - two
  Type of runs - Traffic control
  High speed runs
  Prisoner transport
  Surveillance
  Radio dispatch
  Investigation

The following pages are the statistical results to questions regarding acceptance from the 1st, 2nd and 13th precincts.

1st Precinct

1. How would you rate the console as compared to cars equipped in the usual fashion?

	no. of responses
(A) Much superior	16
(B) Better in some respects	12
(C) About the same	2
(D) Worse than other cars	3
(E) Much worse	0

2nd Precinct

1. How would you rate the console as compared to cars equipped in the usual fashion?

	no. of responses
(A) Much superior	18
(B) Better in some respects	12
(C) About the same	1
(D) Worse than other cars	0
(E) Much worse	0

13th Precinct

1. How would you rate the console as compared to cars equipped in the usual fashion?

	no. of responses
(A) Much superior	22
(B) Better in some respects	7
(C) About the same	0
(D) Worse than other cars	0
(E) Much worse	1

Responses to question #1:

no. of responses	
32	Everything is easily accessable to both officers.
10	The controls are consolidated in one convenient location.
8	It's much easier to use, especially in the dark or when the driver is alone.
6	The individual seats are more comfortable.
5	The storage capability is very useful.
5	The mike and spot light cords get in the way. (This was improved in later versions.)
3	Seating is uncomfortable.
2	Gun is hard to get at.
2	Like the gun location.
1	Should have a detention screen.
1	Seats obstruct the view to the rear.
1	The console is too large.

1st Precinct

4. How do you rate the arrangement of equipment on the console?

	no. of responses
(A) Very good	15
(B) Satisfactory in most cases	17
(C) Generally poor	1

2nd Precinct

4. How do you rate the arrangement of equipment on the console?

	no. of responses
(A) Very good	11
(B) Satisfactory in most cases	20
(C) Generally poor	0

13th Precinct

4. How do you rate the arrangement of equipment on the console?

	no. of responses
(A) Very good	18
(B) Satisfactory in most cases	10
(C) Generally poor	2

Responses to question #4.

no. of responses	type of responses
7	Move the spot light and mike cords out of the way. (This was improved in later versions.)
7	The gun is hard to get at.
5	I like it, especially the switch locations.
5	The mikes should be moved closer.
3	Reverse the PA mike and radio mike.
3	Protect switches for accidental actuation.
2	Make it smaller if possible.
2	Don't use storage areas.
2	Don't need shotgun rack.
2	Don't label "shotgun" and "truck lock" buttons.
1	We need even more storage.
1	I like the location of the mikes.
1	Console light should go off with ignition.
1	Easier identification of switches.
1	Need a place for a hot sheet board.
1	Conceal the switches.
1	Move the horn/siren switch nearer driver.

The following pages are the statistical results to questions regarding the operational value of the console. The order is again, 1st, 2nd and 13th precincts.

1st Precinct

2. How long did it take to get used to the new location of switches and mikes?

	no. of responses
(A) 1 - 2 hrs	27
(B) 2 - 4 hrs	3
(C) One shift	2
(D) Two or more shifts	1

2nd Precinct

2. How long did it take to get used to the new location of switches and mikes?

	no. of responses
(A) 1 - 2 hrs	23
(B) 2 - 4 hrs	6
(C) One shift	2
(D) Two or more shifts	0

13th Precinct

2. How long did it take to get used to the new location of switches and mikes?

	no. of responses
(A) 1 - 2 hrs	29
(B) 2 - 4 hrs	1
(C) One shift	0
(D) Two or more shifts	0

1st Precinct

3. Does it take any longer to learn these new locations than it takes to learn the locations on a new car?

	no. of responses
(A) Less time	25
(B) Same	7
(C) Longer	1

2nd Precinct

3. Does it take any longer to learn these new locations than it takes to learn the locations on a new car?

	no. of responses
(A) Less time	28
(B) Same	2
(C) Longer	1

13th Precinct

3. Does it take any longer to learn these new locations than it takes to learn the locations on a new car?

	no. of responses
(A) Less time	27
(B) Same	3
(C) Longer	0

Responses to question #3.

no. of responses	type of response
21	Everything is at your fingertips, you don't have to look for things.
18	Everything is easier to identify, you can learn the controls immediately.
12	Everything is in one place rather than all over the car.
4	Both officers can use the controls.
1	One is more apt to use these convenient controls.
1	You don't have to bend over and search.

1st Precinct

5. Did you find it generally easier or harder to use the switches on the console as compared to other cars?

	no. of responses
(A) Easier	31
(B) Same	1
(C) Harder	1

2nd Precinct

5. Did you find it generally easier or harder to use the switches on the console as compared to other cars?

	no. of responses
(A) Easier	31
(B) Same	0
(C) Harder	0

13th Precinct

5. Did you find it generally easier or harder to use the switches on the console as compared to other cars?

	no. of responses
(A) Easier	27
(B) Same	1
(C) Harder	2

Responses to question #5.

no. of responses	type of response
10	It is much easier to get at the controls.
2	The cords cometimes got in the way.
2	You don't have to take your eyes off the road.
2	Everything is together.
1	It is difficult to read the labels on the switches.
1	Either officer can use the controls.

Responses to questions on potential improvements to the console are as follows.

Question #6: What changes would you recommend for future designs of police car equipment consoles?

no. of responses	type of response
11	Better access to the long gun.
7	Storage place for hot sheet.
5	Move mike cords.
3	More storage.
3	Smaller console.
2	Bigger seats.
2	Install power rear door locks.
2	Place to store flashlights. (This was added in later versions.)
2	Omit storage area.
2	Omit storage area.
2	Two guns.
2	Recommend installation in all cars.
2	Brake switch that does not have to be held to bypass rear lights.
2	A writing light that doesn't glare.
2	Dentetion screen.
2	A handy writing area.
2	Computer I/O device.
1	Have everything go off with ignition.

Responses to question #6:

no. of responses	type of response
1	Cover switches so that they are not accidentally actuated.
1	Put mike cords on springs to pull them away.
1	Higher in rear between seat backs.

Responses to question #7: What types of devices would you like to see installed in police cars?

no. of responses	type of response
10	Air conditioning.
5	Non-glare writing light.
4	Prisoner dentntion screen.
3	Computer I/O
2	Tinted glass.
2	Bullet proofing.
2	Bucket seats.
1	Storage for night stick in doors.
1	A litter container.
1	Mike that doesn't have to be held.
1	Faster defogger.
1	Larger rear view mirror.
1	Tilt steering wheel.
1	Hand cuff bar in rear.
1	Standardized controls.
1	Heat and cold insulation.

Responses to question # 8: Any additional remarks on the console would be greatly appreciated.

Comments not previously mentioned.

1. My elbow hit the clip board.
2. Space between seats would allow access from the rear.
3. Should be padded.
4. A writing light that doesn't illuminate interior at night.
5. Hood lock to prevent tampering with the engine.
6. Console is ideal for police work.
7. Writing light in rear seat area.

The results of the tests were very encouraging. To examine them, the per cent of responses to the questions are summarized below:

Bench Seat Console

Acceptance	Southfield Test					Wayne State Test				
% Response	A	B	C	D	E	A	B	C	D	E
Question #1	54	38	0	8	0	0	10	10	50	30
Question #4	54	46	0	---	---	0	20	80	---	---
Utility										
% Response	A	B	C	D	E	A	B	C	D	E
Question #2	100	0	0	0	---	20	20	20	30	---
Question #3	84	16	0	---	---	0	20	80	---	---
Question #5	100	0	0	---	---	0	0	100	---	---

W.S.U. Designed Console

Acceptance	1st Prec. Test					2nd Prec. Test					13th Prec. Test				
% Response	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Question #1	48	36	6	10	0	58	38	4	0	--	73	23	0	0	4
Question #4	45	52	3	--	--	35	65	0	--	--	60	37	3	--	--
Utility															
% Response	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Question #2	82	9	6	3	--	74	19	7	0	--	97	3	0	0	--
Question #3	76	21	3	--	--	90	7	3	--	--	90	10	0	--	--
Question #5	94	3	3	--	--	100	0	0	--	--	90	3	7	--	--

From the summary table the most striking difference is in the acceptance and utility responses of the bench seat console between the Southfield and W.S.U. tests. The only significant difference in the two tests was the size of the vehicle; Southfield has full-sized models and the W.S.U. car was an intermediate. The difference in vehicle size would make the sitting room of the officers more restricted in the W.S.U. model. The qualitative response to question #1 was identical with one W.S.U. remark on accidental actuation of switches. In the response to question #3, Southfield

were completely positive about the switch location and convenience, whereas W.S.U. police were equally negative. Switch location and convenience should not be effected by the size of the vehicle. In the response to question #4, Southfield officers mention the amount of room the console takes up on the front seat area while the W.S.U. officers had nothing to say about room. In question #5, the Southfield police praise the convenience and ease of operation and the W.S.U. officers found the console confusing and in the way. Two other installations of this console resulted in immediate rejection because of the restriction of space on the front seat.

Based on this, it is concluded that the bench seat test console was restrictive in terms of driver and passenger seating room. This restriction is very unsatisfactory in an intermediate vehicle. The utility improvement of the bench seat console is positive but the space problem can prejudice the acceptance in a negative fashion. To be acceptable the bench seat type console must be either narrower than the 11 inches of the tested model or mounted toward the dash and away form the occupants. Additional observations by the researcher regarding the bench seat console are that it does bring the controls into a better location than the W.S.U. design, cognizant of human factor literature. The bench seat console, wide as it is, has very little room for mounting controls. It is quite difficult to attach the tested console securely to the seat. A better mounting method would be on legs fastened to the transmission hump.

A comparison between the bench type console and the W.S.U. design is made difficult by the two opposite receptions given the bench seat model. Because of the prejudiced response from the intermediate vehicle test, any comparison will be restricted to the full-sized vehicles of Southfield and Detroit. The bucket seat console was rated much superior to existing methods 60% of the time, while the bench seat console was rated superior 54% of the time. The arrangement of controls on the bucket seat console was rated very much better 46% of the time, while the bench seat version arrangement was much superior 54% of the time. The time to learn the new console was within two hours in 84% of the responses to the bucket seat console and 100% in the responses to the bench seat console. Compared to non-console arrangements, 85% of the Detroit officers found the W.S.U. console easier to master and 84% of the Southfield officers found the bench seat console easier. Compared to non-console arrangements, 95% of the Detroit police found the W.S.U. console easier to use and 100% of the Southfield police found the bench seat console easier to use.

In comparing the two types of consoles it is concluded that the W.S.U. design is slightly superior, but the arrangement of controls and the ease of utilization is slightly superior in the bench seat version. The superiority of the W.S.U. design is attributed to the seating room benefits over the bench version. The difference in arrangement and utility is attributed to the higher positioning of controls as suggested by McCormick. In the opinion of the researcher, the differences in these statistics

are insignificant for these sample sizes. The increased versatility and capacity of the W.S.U. design offers an advantage. In conclusion, given a bench seat console modified as already discussed it appears that the choice of console would well be dictated by the choice of seats.

The most significant results of the tests are the acceptability and utility of the packaging concept. By combining the statistical and qualitative response of Detroit and Southfield together, we can observe the degree of improvement over existing methods. In the responses to question #1 on the console, 59% found the console much superior and 33% found it better than non-console methods. The most frequent reasons were that it was easier to use (39 responses) and that the controls were all together (10 responses). In the responses to question #4 on the arrangement of controls, 48% found them very good and 49% found them satisfactory. The most frequent remarks on equipment were that the cords got in the way (7 responses) and that the gun was hard to get at (7 responses). In the response to question #2 on the time to master the console, 85% were able to learn to use the console in less than two hours. In the responses to question #3 on the relative ease of mastering the console compared to the usual arrangement, 85% found it easier to learn. The most frequent remarks being the closeness of the controls (25 responses), the ease of identification (19 responses), and the consolidation (12 responses).

In response to question #5 on the operational value of the console, 95% found it easier to use than the conventional arrangement. The most frequent reason being the handiness of the locations (14 responses). These statistics speak well for the acceptance and operational value of the console packaging concept.

In conclusion, the console concept appears to be a valuable improvement of the police vehicle. Suggested improvements to the bench seat version are that it be mounted close to the dash and make as narrow as possible. The installation of consoles would be well received by the majority of the police officers and it would significantly improve the ease with which they operate their controls.

APPENDIX 4

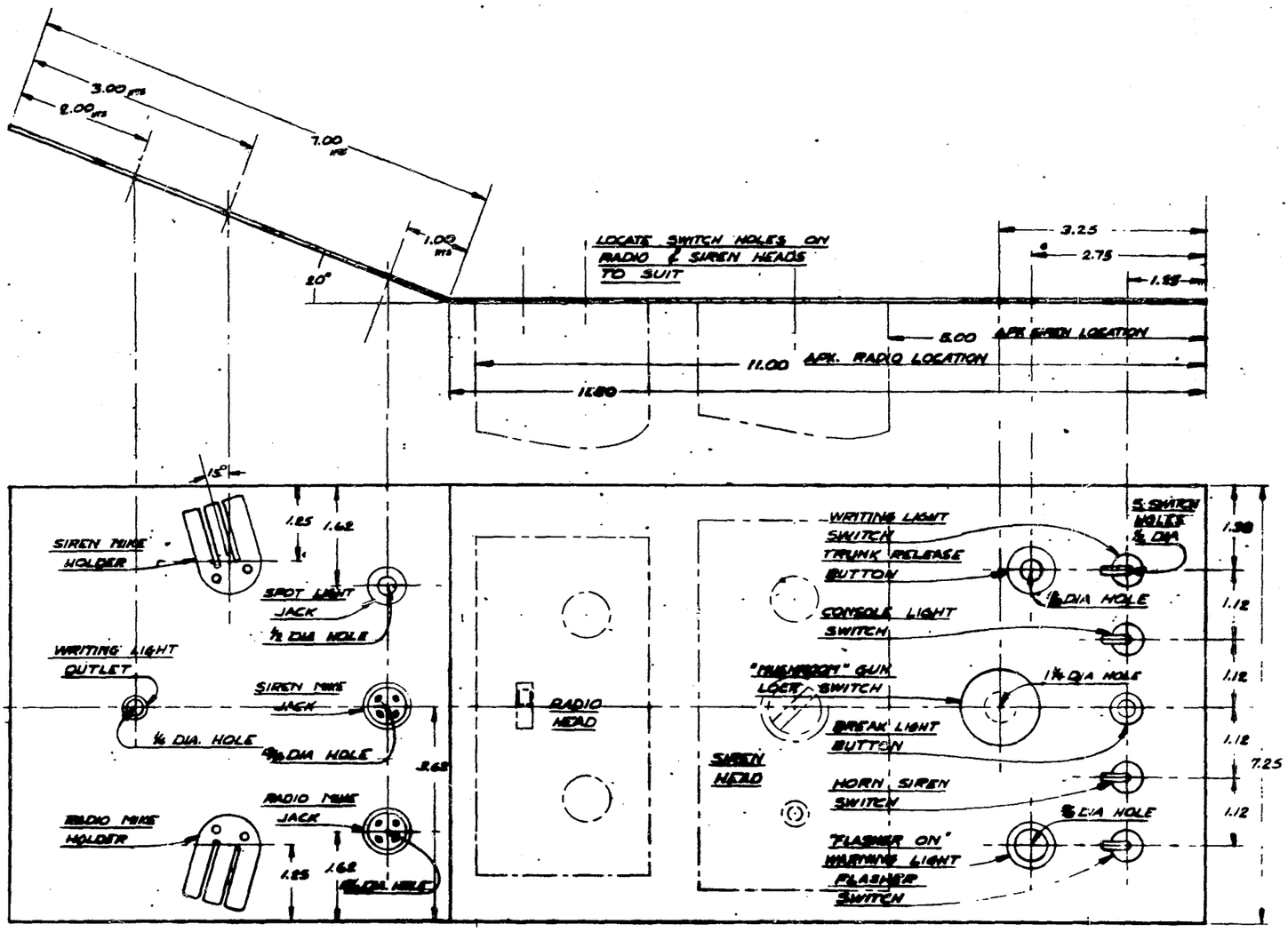
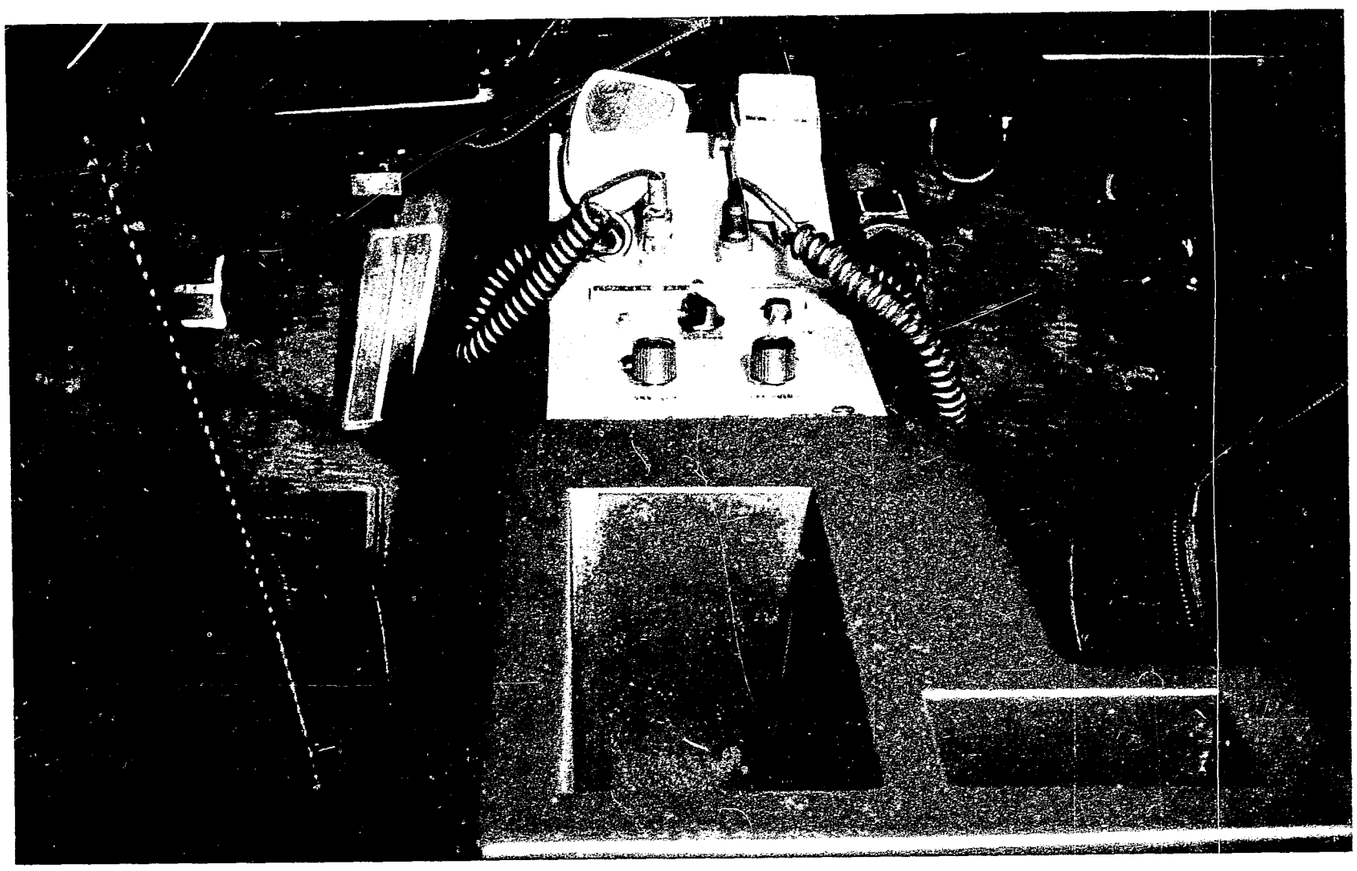
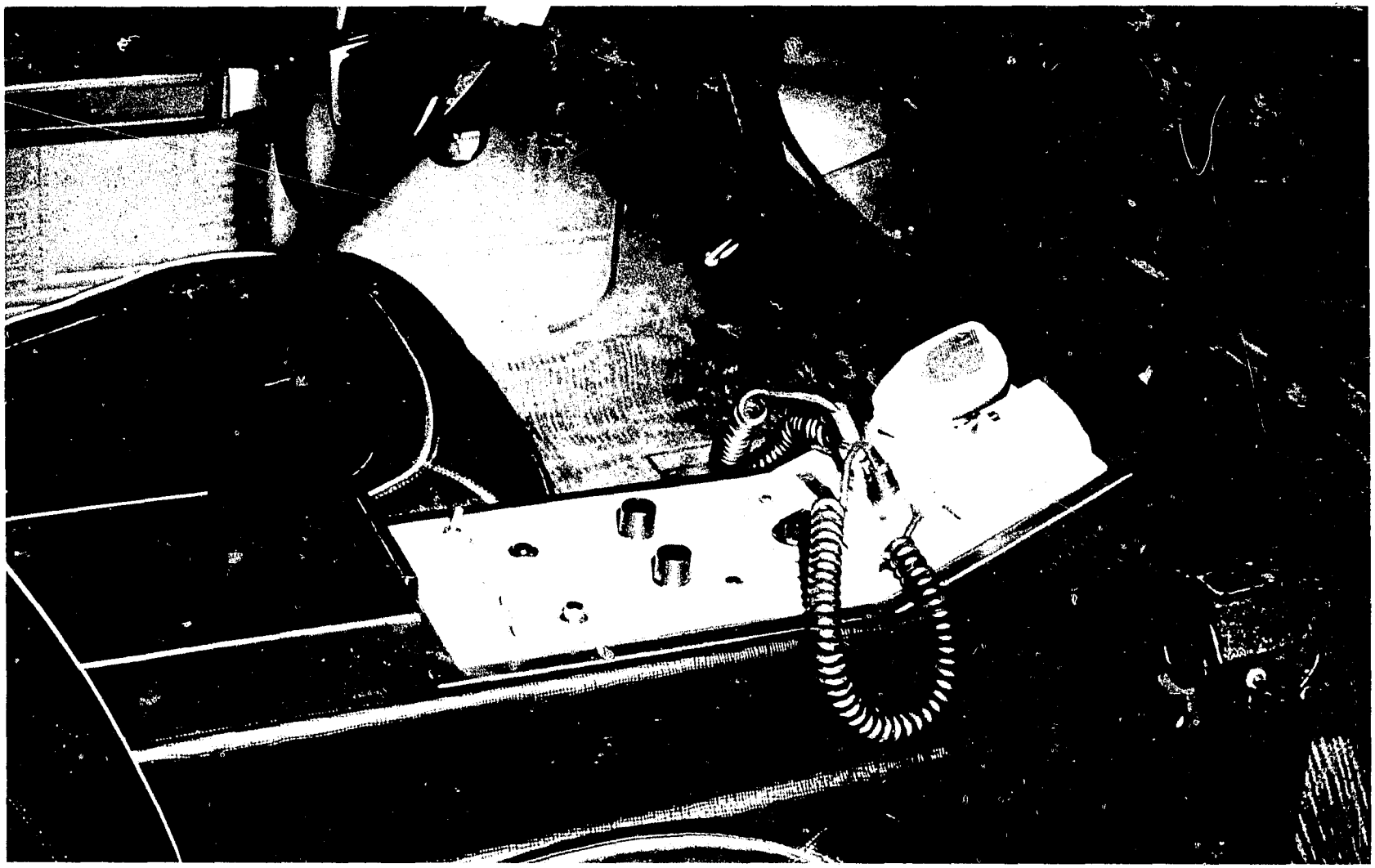
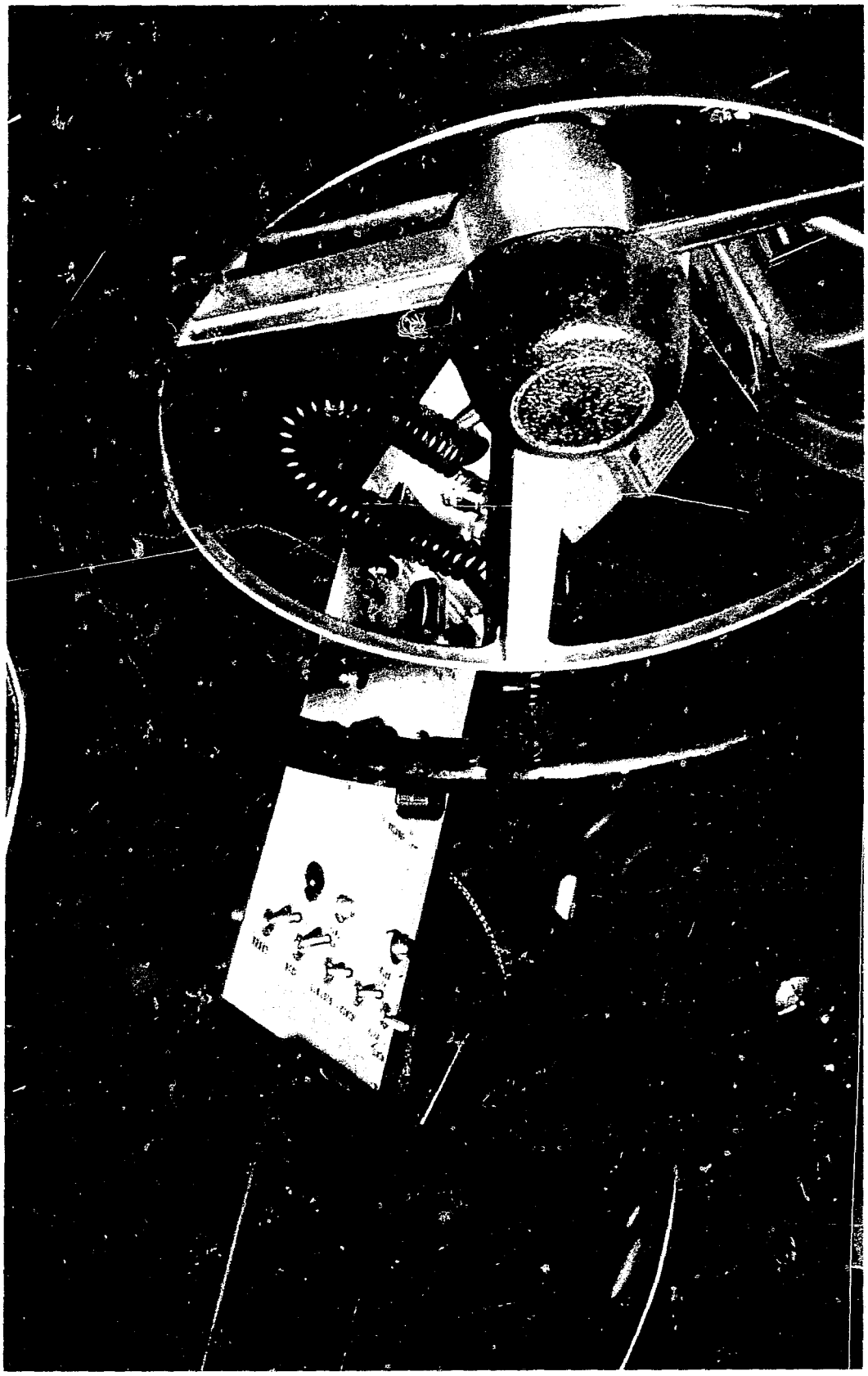


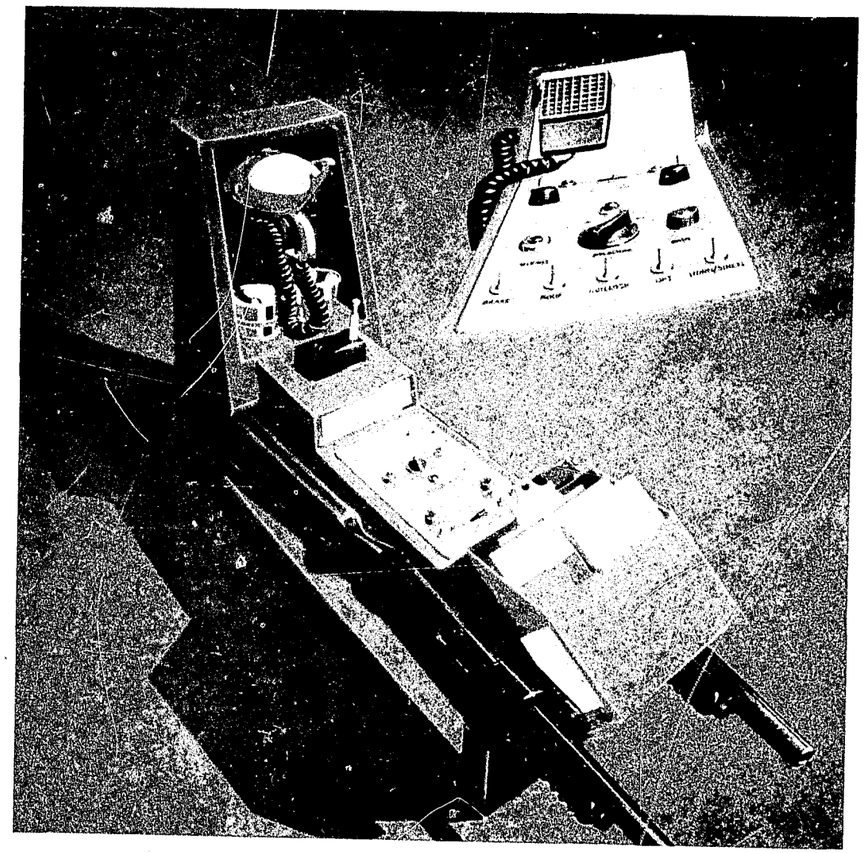
Fig. A4.1

POLICE CAR CONSOLE-CONTROL PANEL LAYOUT	wayne state university INDUSTRIAL ENG'G & OPER. RES.	7-28-70 J. Bailey









APPENDIX 5

MINIMUM STANDARDS
POLICE VEHICLES

By The

POLICE ASSOCIATION OF ONTARIO

PART I

Minimum Standards
Police Vehicles

1. In this regulation,

(a). "heavy duty" shall mean that the item to which the term is applied shall exceed the usual quantity, quality, or capacity supplied with standard production vehicles; and it shall be able to withstand unusual strain, exposure, temperature, wear and use;

(b). "motor vehicle" shall mean a vehicle as defined in The Highway Traffic Act;

(c). "patrol vehicle" shall mean a police vehicle used mainly for general police patrol duties;

(d). "police vehicle" shall mean any motor vehicle, other than a motorcycle, operated by a police force or member thereof on duty;

(e). "unmarked vehicle" shall mean a police vehicle used by members of a force who are not required to wear a uniform.

2. No police vehicle shall be used, operated, maintained by any police force or member thereof while on duty, including the Ontario Provincial Police Force, unless it conforms to, or exceeds the standards herein;

(a). Appearance

(i). Patrol vehicles shall be marked with the work "POLICE" in clearly visible letters of at least eight inches in height at a central position on each side and on the rear of the vehicle, and where practical shall include the name of the force;

(b). Size and Chassis

Police vehicles shall,

(i). have a minimum wheelbase of one hundred and eighteen inches (118"),

(ii). have a bumper to ground clearance, front and rear, of at least ten inches (10") as measured by the Automobile Manufacturers Association,

(iii). be equipped with heavy duty front and rear suspension inclusive of heavy duty front and rear springs and including heavy duty maximum control shock absorbers suitable for police work;

(iv). be equipped with a heavy duty front stabilizer bar,

(v). be equipped with full-time power assisted steering,

(vi). have a minimum of thirty-eight inches (38") head room and a minimum of forty-one point eight inches (41.8") leg room as measured by the Automobile Manufacturers Association;

(c). Seats and Upholstery

Police vehicles shall,

(i). be equipped with the front seat and seat back of heavy duty construction containing foam rubber cushions or padding of at least two inches (2") in thickness and heavy duty springs,

(ii). be equipped with the vehicle manufacturer's recommended head restraint,

(iii). be equipped with a heavy duty high grade nylon or vinyl material upholstery of a light color;

(d). Engine Power

(i). Police vehicles shall have a manufacturer's rating of not less than two-hundred and twenty-five brake horsepower (225bhp) and displacement of not less than three-hundred cubic inches (300CID) for eight cylinder engines or not less than two-hundred and twenty-five cubic inches of displacement (225CID) for six cylinder engines;

(e). Brakes

Police vehicles shall,

(i). be equipped with power assisted brakes with heavy duty linings,

(ii). be equipped with heavy duty disc type brakes on the front wheels;

(f). Tires and Rims

Police vehicles shall,

(i). be equipped with fifteen inch (15") diameter wheels with a six inch (6") minimum rim width and shall have a safety ridge rolled into the rim or otherwise designed to prevent the tire from separating from the wheel in the event of a flat or blowout,

(ii). be equipped with first line heavy duty "belted" tires of not less than four (4) full plies and such tires shall not be used when the tread wears to six thirty-seconds of an inch (6/32") or under in thickness, and shall be kept in proper balance,

(iii). be equipped, subject to The Highway Traffic Act and regulations thereto, during those months of the year when show and/or ice is liable to affect driving conditions, with snow tires containing studs,

(iv). not be equipped at any time with retread or remanufactured tires;

(g). Mechanical Fitness

Police vehicles shall,

(i). not be used by a police force after the accumulation of sixty thousand (60,000) miles or two (2) years of service, whichever occurs first,

(ii). be inspected by the holder of a subsisting certificate of qualification as a motor mechanic under The Apprenticeship and Tradesmen's Qualification Act, 1964, and certified approved according to such safety inspection every ten thousand (10,000) miles or three (3) month, whichever occurs first;

(h). Safety and General Equipment

(i). Police vehicles shall,

(1) be equipped with a heavy duty steering wheel of a light color or other heat-reflecting color of material and shall include a full horn ring,

(2). be equipped with automatic seat belt retractors on the outside front seat belts,

(3). be equipped with outside rear view mirrors, one on each side, capable of being adjusted to the convenience of the driver,

(4). be equipped with a rear window defogger,

(5). be equipped with an air expelled two and three-quarter pound (2 3/4 lb) capacity dry chemical fire extinguisher which shall be as approved by the Underwriters Laboratories of Canada (U.L.C.) for gasolene and electrical fires,

(6). be equipped with a two-way radio of at least twenty-five (25) watts power output for the transmitter portion and no higher than point five (.5) microvolts sensitivity for the receiver portion, and capable of clearly communicating with a base or central station from any point within or adjacent to the area of jurisdiction,

(7). be equipped with a speedometer calibrated in two (2) mile increments over the entire scale with such speedometer accurate within two (2) miles per hour at all speeds up to one hundred (100) miles per hour;

(ii). Patrol vehicles shall,

(1). be equipped with at least one rotating red beacon or warning light on the roof containing four (4) sealed beam lamps of which there shall be two (2) red lamps at opposite directions, and two (2) white lamps in the other two directions,

(2). be equipped with an electrically operated siren, or as an alternate an electronic siren of the public address system type,

(3). be equipped with a heavy duty roof carrier bar which shall be securely attached to the outer side edges of the roof and upon which shall be mounted the rotating warning light and may also accommodate the siren,

(4). be equipped with a fender stop light on the top of the right front fender, with the lense to contain the word "STOP" or "POLICE", and shall be of at least six inches (6") in diameter and positioned in such a direction, when illuminated,

will assist the operator of the patrol vehicle to attract the attention of the operator of another desired vehicle,

(5). be equipped with a hand spot light containing a sealed beam lamp and attached with a ten foot (10') length of coiled expansion type wire,

(6). be equipped with a wire mesh screen or barrier of at least eight (8) gaage wire or equivalent, securely positioned between the front and back seats of the vehicle so as to adequately protect the driver and occupants of the front seat, provided those forces and detachments that provide special truck-type vehicles for the transportation of prisoners shall not be subject to this sub-paragraph;

(iii). Unmarked vehicles shall not be subject to paragraph (ii) of this subsection, except where the conditions of service or application of service dictates the use of such equipment.

3.(a). A certificate of mechanical fitness for a police vehicle shall not be issued unless a police vehicle has been,

(i). inspected in accordance with the inspection procedures in the Schedule, and

(ii). found to comply with the performance standards prescribed in the Schedule and the Regulation;

(b). A certificate of mechanical fitness is valid for a period of three (3) months or when the inspected vehicle has accumulated a further the thousand (10,000) miles, whichever occurs first, from the date of inspection shown on the certificate.

4. No motor vehicle registered in Ontario in accordance with The Highway Traffic Act shall bear the word "POLICE" or facsimile, except when used by a police force established under the Act, or the Royal Canadian Mounted Police Force.

5. Police vehicles shall conform to the standards as prescribed by the Motor Vehicle Safety Act (Canada) and regulations thereto.

6. Vehicles and equipment presently in use shall be permitted until January 1, 1971, provided that all vehicles and equipment in use after such date shall conform to this regulation.

SCHEDULE

INSPECTION PROCEDURES AND PERFORMANCE STANDARDS

Body Work

1.(1) The body, sheet metal and equipment of a police vehicle shall be inspected and tested for conditions hazardous to occupants, pedestrians or to other vehicles and,

(a). each bumper shall be securely mounted;

(b). no bumper, fender, molding or other sheet metal shall have a broken, bent or sharp edge that protrudes in such a way as to be a hazard to vehicles or pedestrians;

(c). no fender shall have been removed, and each truck mud flat where applicable shall be in position;

(d). each door shall close securely;

(e). the hood latch shall hold the hood securely and no safety catch in the case of a front opening hood shall be missing or inoperative; and

(f). each seat shall be securely mounted and shall maintain its position and adjustment.

(2). the frame shall be inspected for cracks and loose rivets and the underbody sheet metal shall be inspected for rust or other damage and,

(a). no chassis frame member shall be cracked or have loose chassis frame rivets;

(b). the floor pan shall not be perforated by rust or other damage; and

(c). no seat belt anchorage shall be insecure.

(3). The condition and security of mounting of each rear view mirror shall be inspected, and,

(a). no inside rear view mirror shall have been removed except on police vehicles having no rear window or a rear window that is permanently obstructed by the body of the vehicle;

(b). each mirror shall be securely mounted;

(c). no mirror shall be cracked or broken or have any reduction in reflecting surface owing to deterioration of silvering; and

(d). no outside rear view mirror shall be missing.

(4). An inspection of the windshield and of all windows shall be made for material damage, discoloration and clarity of the glazing and,

(a). opaque material shall not be fitted in place of glazing in the windshield or in place of any other window;

(b). no glazing material shall be crazed or discolored or have exposed sharp edges or have any part missing; and

(c). the windshield shall not have any star, or crack running from edge to edge, in the area swept by the windshield wipers.

(5). The fuel tank, filler pipe and cap and the fuel lines shall be inspected and,

(a). no mounting or attachment of the fuel tank or fuel line shall be insecure;

(b). the filler cap shall not be insecure or missing; and

(c). no leakage shall be present at any point in the fuel system.

(6). The exhaust pipe, muffler and tailpipe shall be inspected and,

(a). no component of the system shall be missing, perforated, patched or insecurely mounted;

(b). no joint or seam shall leak; and

(c). no component shall cause charring or other heat damage to any wiring, fuel line or combustible material of the vehicle.

Brakes

2.(1). All wheels shall be removed for brake inspection, and the condition of the friction surface of each brake disc and drum shall be inspected and,

(a). no drum or disc shall have any external crack, or cracks on the friction surface other than the normal heat-check cracks, that reach an edge of the drum bore or periphery of the disc; and

(b). no drum or disc shall have any mechanical damage to the friction surface.

(2). All brake drums shall be removed for the brake lining inspection on police vehicles having brake drums and the thickness of bonded linings and of pads shall be measured at their thinnest point and riveted or bolted linings shall be measured at the minimum thickness at a rivet or bolt head and an inspection shall be made for loose or missing rivets or bolts and for damaged linings and contamination and,

(a). a bonded lining shall not be thinner than five thirty-seconds of an inch (5/32") when measured at the thinnest point;

(b). a riveted or bolted lining surface shall not be closer than five sixty-fourths of an inch (5/64") to any rivet or bolt head;

(c). no wire backing shall be visible in a friction surface;

(d). no disc pad shall be less than five thirty-seconds of an inch (5/32") in thickness when measured at its thinnest point;

(e). no rivet or bolt shall be loose or missing;

(f). no brake lining shall be broken, cracked or loose on the shoe or pad or so worn as to indicate an out-of-round drum or warped shoe; and

(g). no lining or pad friction surface shall be contaminated or glazed.

(3). All hydraulic components, fluid reservoirs, wheel cylinder connections, hoses and tubes, master cylinder and rod and supports shall be inspected and the entire length of all brake lines other than those portions that are within a structure and are not visible by any means shall be inspected and all vacuum components, hoses, tubes, supports, hose clamps and air cleaners shall be inspected and,

(a). no master cylinder or wheel cylinder shall show evidence of leakage;

(b). no wheel cylinder piston shall be incorrectly connected to the brake shoes;

(c). no hydraulic hose and tube shall be abraded or leak or be restricted, crimped, cracked or broken or rub against structure or have damaged or missing clamps or supports;

(f). the master cylinder rod shall not be improperly adjusted;

(g). the brake line shall not be fouled by an extra shock absorber;

(h). no vacuum hose, tube or connection shall leak or be restricted, abraded, crimped, cracked or broken or rub against structure or have damaged or missing clamps or supports;

(i). the vacuum pump air cleaner shall be clean; and

(j). the vacuum piston packings, valves or diaphrams or other component parts, shall not leak.

(4). All mechanical components, cables, pins, cotter pins, spring rods, clevises, coupl ngs, spring clips, grease retainers and brake camshafts shall be inspected and,

(a). no mechanical part shall be misaligned, badly worn, broken or missing;

(b). no pull cable shall be badly worn, stretched or frayed or not operating freely; and

(c). no parking brake disc or facing shall be broken or badly worn.

(5). The anti-skid surface on the service brake pedal pad shall be inspected, the pedal position shall be inspected by the pedal being depressed and released, the pedal travel of the power assisted hydraulic service brake shall be inspected with the engine running, the vacuum system shall be tested by applying the brakes several times while the engine is stopped to exhaust the vacuum and by then applying normal foot pressure on the service brake pedal while the engine is restarted, and the brake failure warning light shall be tested in dual braking systems, and,

(a). the service brake pedal pad shall not have been removed or be badly worn or be insecure;

(b). no pedal or any other component shall bind or have high friction;

(c). no pedal lever shall be misaligned or improperly positioned;

(d). no hard pedal condition shall be present and the pedal free travel shall not be less than on inch (1");

(e). in the case of,

(i). a police vehicle at least one-fifth (1/5) of the total available pedal travel remains, or

(ii). in the case of a commercial police vehicle, the pedal is at least two inches (2") above the floorboards,

when the pedal is depressed under moderate foot force;

(f). where firm foot pressure is maintained on the service brake pedal for one minute, the service brake pedal shall not move slowly toward the applied position;

(g). the brake pedal shall fall away from the foot as the engine is restarted while foot force is maintained on the pedal in the vacuum system test;

(h). the brake failure warning light shall not be inoperative on a police vehicle with dual braking;

(i). the brake failure warning light shall not turn on when manual-brake pedal force between forty and sixty pounds, or when power-brake pedal force between fifteen and twenty pounds, is applied while the ignition switch is on;

(j). in the case of a commercial police vehicle, the rod stroke or chamber travel at each wheel of an air or vacuum mechanical or hydraulic power cluster from fully released to fully applied shall not exceed 75 per cent (75%) of the maximum allowable; and

(k). in the case of a commercial police vehicle, and axle fitted with brake drum and shoes shall not be set up so as to render the brakes inoperative.

(6). The control of the parking brake shall be inspected by fully applying the control and then releasing it, and,

(a). the mechanism while set, but not held by hand, in the fully applied position shall hold the police vehicle against the engine while the vehicle is stationary and the engine is at a light throttle setting for a few seconds only; and

(b). the mechanism in the off position shall not fail to release the brakes fully.

(7). The performance of the service brake system shall be inspected on a substantially level surface by stopping, with the wheels locked, and with a maximum brake pressure from a speed of not less than four (4) miles per hour and not more than eight (8) miles per hour to test for potential failure in a full emergency stop, and the performance of the service brake system shall be tested, where road and traffic conditions permit, by stopping the police vehicle, while travelling at a speed of twenty (20) miles per hour, in the shortest possible distance, without locking the wheels, to test for brake pull, or the service brake system may be inspected for pull by using a brake dynamometer, and,

(a). the wheels shall lock when the police vehicle is stopped from travelling at a speed of not less than four (4) miles per hour and not more than eight (8) miles per hour;

(b). no component shall fail;

(c). the police vehicle shall not pull to the right or to the left; and

(d). the brakes shall release immediately.

Electrical

3.(1). The horn shall be inspected for security and functioning, and,

(a). the horn shall not be loose on its mounting; and

(b). the operating mechanism shall be functioning properly.

(2). The siren, if fitted,shall be inspected for security and functioning, and,

(a). the siren shall not be loose on its mounting;

(b). the operating mechanism shall be functioning properly; and

(c). the siren shall sound loud enough so as to be easily deemed to be able to adequately warn other drivers and pedestrians of the approach of the police vehicle.

(3). The windshield wiper system shall be inspected for functioning and deterioration and the functioning of the defroster system shall be inspected, and,

(a). no windshield wiper shall have been removed;

(b). every wiper arm shall move over the full range of travel;

(c). no wiper blade shall be missing, badly worn or deteriorated so as to impair its effectiveness; and

(d). the defroster system shall deliver air to the windshield.

Lighting

4.(1). All prescribed lamps and prescribed reflectors shall be inspected and tested, and,

(a). every filament in every bulb or unit shall produce normal light output when switched to the appropriate "ON" position;

(b). no lens shall be missing in whole or in part or be incorrectly installed;

(c). every lamp shall be securely mounted on the vehicle;

(d). no headlamp shall be coated with a colored lacquer;

(e). no lamp shall be modified by the attachment to the lamp or to the vehicle of any device that reduces the effective area of the lens of the brightness of the light;

(f). the turn signal flasher unit shall operate properly and the indicator lamp shall flash;

(g). no reflector shall be broken or missing, defective or be incorrectly or insecurely installed;

(h). the beam of every dipping headlight shall switch correctly;

(i). the upper beam indicator lamp shall light and shall indicate properly; and

(j). every headlamp shutter or retracting headlamp shall operate over the full range of movement.

(2). A headlamp alignment inspection shall be carried out after the police vehicle has been inspected for faulty wheel alignment and improper tracking of the rear axle and been passed as satisfactory, and the alignment inspection shall be carried out on one beam, and,

(a). in the case of a mechanically aimed headlamp, the graduation of the mechanical aimer shall be,

(i). not higher than one-half down,

(ii). not lower than three and one-half down,

(iii). not left of straight ahead, and

(iv). not more than four to the right;

(b). in the case of a headlamp inspected on the low or dipped beam, the top edge of the low beam high-intensity zone shall not be more than two inches (2") above or below the horizontal centre-line of the lamp and the left edge of the low beam high-intensity zone shall not be to the left or more than six inches (6") to the right of the vertical centre-line of the lamp, as measured on a screen placed twenty-five feet (25') in front of the lamp; and,

(c). in the case of a headlamp inspected on the high or upper beam, the centre of the high beam high-intensity zone shall not be above or more than four inches (4") below the horizontal centre-line of the lamp and not more than six inches (6") to the left or right of the vertical centre-line of the lamp, as measured on a screen placed twenty-five feet (25') in front of the lamp.

Steering and Controls

5.(1). In the case of the engine controls, the complete accelerator linkage system and carburetor or injection pump controls and linkage shall be

inspected while the engine is running and the police vehicle is stationary, and the power steering and the power-steering drive belt shall be inspected, and,

(a). no return spring shall be damaged or missing;

(b). no component shall be missing, damaged or worn or out of adjustment so as to prevent the engine speed dropping to idle with the transmission in neutral, when the accelerator pedal is released; and,

(c). the power-steering drive belt shall not be worn, cut, glazed, frayed or slack.

(2). The steering column shall be inspected for security of positioning and steering shaft coupling or spline shall be inspected, and,

(a). the steering column or steering box shall not show looseness in its mounting to the body or frame;

(b). the steering-shaft coupling or spline shall be secure;

(c). no bolt or nut shall be missing from the mounting; and

(d). the steering column energy absorbing section shall not be damaged.

(3). The steering mechanism shall be inspected for loosnness, wear and jamming while the front wheels are on the ground and in the case of large commercial police vehicles the inspection shall be carried out while the wheels are off the ground and shall be carried out with the engine running and the power steering unit in operation, and,

(a). free movement of the steering wheel with no movement of the front wheels shall not exceed two inches (2"), and in the case of commercial police vehicles four inches (4"), measured at the steering-wheel rim when the front wheels are in the straight ahead position, and

(b). the front wheels shall turn from full right to full left and back again without jamming, fouling or roughness of the mechanism.

Front Suspension Misalignment and Wear

6.(1). The front suspension shall be inspected for alignment and for wear and damage while the front wheels of the police vehicle are off the ground in such a way that the front suspension joints are not under load, and,

(a). the front wheels shall not be visibly out of alignment;

(b). any non-load carrying ball joint shall not show any perceptible movement;

(c). in the case of ball joints, no front wheel shall have excessive rocking play about a horizontal axis;

(d). in the case of king pins, no front wheel shall have a rocking play about a horizontal axis in excess of,

(i). one-quarter of an inch (1/4") for a wheel of sixteen inches (16") or less,

(ii). three-eighths of an inch (3/8") for a wheel that is larger than sixteen inches (16") but not larger than eighteen inches (18"), or

(iii). one-half of an inch (1/2") for a wheel that is larger than eighteen inches (18"),

as measured at the tire sidewall;

(e). no front wheel shall have excessive vertical play between the lower control arm and the spindle;

(f). no wheel bearings shall be worn or damaged sufficiently to show play between brake drum and back plate or between brake disc and caliper; and

(g). no springs, shackles, U-bolts, centre bolts, shock-absorbers or stabilizer links shall be loose, bent, broken, disconnected or missing and no air bag suspension shall be leaking, flat or inoperative.

(2). The steering mechanism shall be inspected for wear, damage and maladjustment by manipulating from full left to full right the front wheels of the police vehicle while they are off the ground, and,

(a). no front wheel shall have a play about a vertical axis in excess of,

(i). one-quarter of an inch (1/4") for a wheel of sixteen inches (16") or less,

(ii). three-eighths of an inch (3/8") for a wheel that is larger than sixteen inches (16") but not larger than eighteen inches (18"), or

(iii). one-half of an inch (1/2") for a wheel that is larger than eighteen inches (18"),

as measured at the tire sidewall;

(b). the steering mechanism links shall not show damage or repaired damage and the steering mechanism shall not have been modified so as to affect the proper steering of the police vehicle;

(c). no nut, bolt or cotter pin shall be loose, worn or missing;

(d). there shall not be excessive fluid leakage from the power steering system;

(e). no steering linkage joint shall show excessive wear when the pitman arm is manipulated; and

(f). the front wheels shall turn smoothly from full left to full right, and the steering high spot shall be in the straight ahead position.

(3). The drive shaft and the universal joints shall be inspected, and,

(a). the drive shaft and universal joints shall not be damaged; and

(b). the drive shaft and universal joints shall not have any loose, missing or damaged bolts.

(4). The rear suspension shall be inspected for alignment, wear and damage, and,

(a). the rear axle shall not be tracking improperly so as to affect control of the police vehicle; ans

(b). springs, shackles, U-bolts, centre-bolts, shock absorbers, radius rods or stabiiizer links shall not be loose, bent, broken, disconnected or missing.

Tires and Wheels

7.(1). All tires installed on axles shall be inspected for depth of tread, tread defects, sidewall defects, undersizing, regrooving, missing studs, and mixed radial and bias ply, and,

(a). no tire shall be worn sufficiently,

(i). for the tread wear indicators to contact the road, or

(ii). that less than six thirty-seconds (6/32) of that tread remains,

in any two adjacent major tread-molded grooves;

(b). no tire shall have exposed cord at worn spots;

(c). no tires shall have cuts or snags deep enough to expose the cord;

(d). no tire shall have any abnormal visible bump, bulge or knot apparently related to tread or sidewall separation or to failure or partial failure of the tire structure, including bead areas;

(e). no tire shall have been regrooved or recut;

(f). no tire shall be of a smaller size than the size marked on the vehicle placard if fitted or be sufficiently oversize as to contact body structure;

(g). no studded shall have less than one-half (1/2) of the number of studs on the corresponding tire on the same axle;

(h). no mixture of radial-ply and bias-ply tires shall be fitted;

(i). no tire shall be under-inflated or fail to maintain the correct air pressure;

(j). in the case of a commercial police vehicle, no front tire shall be worn sufficiently for less than eight thirty-seconds (8/32) of the tread to remain in any two (2) adjacent major tread-molded grooves;

(k). in the case of a commercial police vehicle, dual tires shall not be in contact with each other or differ from each other in overall diameter by more than one-half inch (1/2"); and

(l). in the case of a commercial police vehicle, the total load capacity of the tires shall not be less than the licensed load limit of the vehicle.

(2). All wheels installed on axles shall be inspected for defects and damage, and,

(a). no bolt, lug, stud, spacer, lock ring or nut shall be defective, loose or missing;

(b). no wheel shall be so bent, cracked or otherwise damaged as to affect the safe operation of the police vehicle; and

(c). every tire valve shall be in good condition.

8. A certificate of mechanical fitness required by section____ of the Act shall be in the following form:

CERTIFICATE OF MECHANICAL FITNESS

Issued pursuant to Section ___ of The Police Act

Date of inspection .....

Vehicle mileage.....

Particulars of Police Vehicle

Make..... Year.....

Type..... Registration Plate No.....

Year of Registration..... Serial No.....

Department No.....

I HEREBY CERTIFY that the above described police vehicle has been examined in accordance with the provisions of Section __ of The Police Act and that the items inspected meet the prescribed requirements and performance standards on the date of inspection as specified in Ontario Regulation____/__.

Name of Police Department.....

Address.....

Signature of Motor Mechanic.....

Address.....

holding a subsisting certificate of qualification as a motor mechanic under The Apprenticeship and Tradesmen's Qualification Act, 1964

Number of Certificate.....

Every person who makes a false statement in a Certificate of Mechanical Fitness is guilty of an offence and on summary conviction is liable to a fine of not more than $300.

VALID FOR 3 MONTHS OR 10,000 MILES WHICHEVER OCCURS FIRST AFTER THE DATE OF INSPECTION

LIST OF OPTIONS

DESCRIPTION AND MODEL APPLICATION

AIR CONDITIONING - SELECTAIRE CONDITIONER
- For use with 240 CID Engine
  (Tinted Glass Recommended with this Option.)
  (Extra Cooling Standard with this Installation.)

ALTERNATOR -
65-Ampere Autolite Alternator for use with Selectaire Cond.
(Selectaire Conditioner Not included in Price)

NOTE: Alternator is Single Belt Drive when Power Steering Installed
Non Police Package -
390 C.I.D. Engine - Manual Steering
390 C.I.D. Engine - Power Steering
Police Package -
390 C.I.D. Engine - Manual Steering
390 C.I.D. Engine - Power Steering
428 Police Interceptor Engine - Manual Steering
428 Police Interceptor Engine - Power Steering

ALTERNATOR -
65-Amp. Autolite Alternator
- For use on 429 Engine with Selectaire Conditioner

ALTERNATOR -
65-Amp. Autolite (Dual Belt) Alternator
- For use on 240 C.I.D. Engine
  (Not Available with Air/Cond.)

ALTERNATOR -
65-Amp. Autolite Alternator
- For use on - 302 C.I.D. Engine
  - 351 C.I.D. Engine

ALTERNATOR WITH TRANSISTORIZED REGULATOR -
55-Ampere Autolite Alternator with Transistorized Regulator
(Not Available with Heated Backlite or Air Conditioning)

ALTERNATOR WITH TRANSISTORIZED REGULATOR -
- For use on All Models
42-Amp. Std. Autolite Alt. with Transistorized Regulator
65-Amp. RPO Autolite Alt. with Transistorized Regulator
65-Amp. DSO Autolite Alt. with Transistorized Regulator

ALTERNATOR - LEECE-NEVILLE 65 AMP. (7000 SERIES) INCLUDING AMMETER GAUGE
65-Amp. L-N Alternator For Use With Selectaire Conditioner
- For Use With 390 C.I.D. Engines
  Manual Steering - (Except Police Package)
  - (Police Package Only)
  Power Steering - (Except Police Package)
  - (Police Package Only)
  Normal L-N Regulator Number 3737 Used With Alternator

DESCRIPTION AND MODEL APPLICATION

ALTERNATOR - LEECE-NEVILLE - 65 AMP. (7000 SERIES) INCLUDING AMMETER GAUGE
For Use with 428 C.I.D. Interceptor Engine, Automatic Transmission and Selectaire Conditioning.
For Manual Steering
For Power Steering
Normal L-N Regulator Number 3737 Used with Alternator

ALTERNATOR - LEECE-NEVILLE - 65 AMP. (7000 SERIES) INCLUDING AMMETER GAUGE
- 65-Amp. Alternator with L/N Regulator #3737
- For use with 429-2V-4V Engine with Selectaire Cond.

ALTERNATOR - LEECE-NEVILLE
65-Amp. L/N Alt. with L/N Regulator #3737
(Ammeter Not Included)
60-0-60 Ammeter in RPO Location
60-0-60 Ammeter Located in Instrument Panel
- For use on 302 and 351 C.I.D. Engine
NOTE: If Ammeter desired add Selection to Alternator Price.

ALTERNATOR - LEECE-NEVILLE 85 AMP.
Including Ammeter Gauge.
(Not Available on XL or LTD Models)
- For use on 351 C.I.D. Engine
Normal L/N Regulator #3737 used with Alternator
NOTE: Regulator Mounted on L.H. Radiator Support.

ALTERNATOR - LEECE-NEVILLE - 100 AMP. (2000-AB Series)
- For use on 390 or 428 Engine - Except LTD or XL Models
(Not Available with Air/Cond. or Special Regulator)

ALTERNATOR - MOTOROLA 55-AMP. DUAL BELT
(With Standard Charge Indicator)
- For use with 240, 302 or 351 C.I.D. Engines

ALTERNATOR - MOTOROLA
55-Amp. Motorola Alternator with Std. Charge Indicator
- For All 390 C.I.D. Engines & Police Interceptor 428 C.I.D. Engine
(Not for Use With Super Extra Cooling)

AMMETER - 60-0-60
60-0-60 Ammeter Located in R.P.O. Location
60-0-60 Ammeter Located in Instrument Cluster
(Not Available with R.P.O. Leece-Neville Alternator)
- For use with Autolite Alternator
- For use with Motorola Alternator
- For use with DSO Leece-Neville Alternator

AMMETER - RELOCATED
Ammeter Relocated to Clock Opening
(Required 65-Amp. Leece-Neville Alt. or 60-0-60 Ammeter Not Included in Price.)

AMMETER - RELOCATED
R.P.O. Ammeter Located in Instrument Cluster
(Located in Air/Conditioning Opening)
(Not Available with Air/Conditioning)
- For use with 65-Amp. Leece-Neville Alternator

AXLE - REAR - LOCKING
Optional Axle Ratio for Locking Axle
(For use with Police Package with Power Disc Brakes)
2.75:1 Axle Ratio - (Includes Locking Axle)
- Required Speedometer Gear 0252000
- Required R. P. O. Power Disc Brakes at Published Price
(For 240, 351 & 390 Engines & Automatic Transmission)

AXLE - REAR - LOCKING
Optional Ratio for Locking Axle
3.00:1 Axle Ratio (Includes Locking Axle)
- For use with 240, 302, 351 & 390 Engines, Auto Trans, and Drum Brakes
(Not Avail. w/Police Pkg., Trailer Towing Pkg., or Fleet A/C Vehicles with 240, 302 Engine or Model 71)
- Required Speedometer Gear's 0252000

BATTERY - 60-AMP. BATTERY INSTALLATION
In Lieu of 45 Amp. Battery Installation
In Lieu of 55 Amp. Battery Installation
In Lieu of 70 Amp. Battery Installation

BUMPER GUARDS
- Front Bumper Guards
- For Custom & Custom 500 4-Door and All Wagons
- Rear Bumper Guards
- For Custom & Custom 500 4-Door and All Wagons

CARPETS - FRONT & REAR - FOR POLICE & TAXI PACKAGES
- In Lieu of H.D. Black Floor Mats
For Custom & Custom 500 - 4-Door Sedans - Blue
- Ivy Green
- Black
- Nugget
For Ranch Wagon & Custom Ranch Wagons - Blue
- Ivy Green
- Black
- Nugget
- Ginger

CONSOLE AND BUCKET SEAT COMBINATION - 4-Door
The following Options and Prices "MUST" be combined for Subject Installation.
"XL" TYPE CONSOLE
- For use with "XL" HI-BACK BUCKET SEATS ONLY
(Not available with Stereo Tape System)
(Available with Steering Column mounted Shift Control)
(Or Available with Console Mounted Shift Control)

"XL" HI-BACK BUCKET SEATS - Driver & Passenger - Front
(Manual Type Bucket Seats)
NOTE: Bucket Seat Trim Does Not Match Trim Style of Rear Seat

AUTOMATIC TRANSMISSION WITH CONSOLE MTD. SHIFT CONTROL
- For use with Hi-Back Seats and "XL" Console Options
- When used with 302, 351 or 390 C. I. D. Engine
- When used with 429 C. I. D. Engine
(Not available with Police or Taxi Package.)

DECK LID RELEASE - ELECTRIC
- Switch Located Left of Steering Column
- Switch Located Right of Steering Column

DECK LID RELEASE - MANUAL
- Remote Control Release for Luggage Compartment
Normal Control Cable (162.25") (Normal Installation)
Special Control Cable (170.25") (Special Cable Size Installation)
(All Models - Except Wagons)

EXHAUST SYSTEM - DUAL EXHAUST FOR 390-2V & 429-2V ENGINES (EXCEPT WAGONS)
- For 390-2V Engine (Except Wagons)

FAN
5-Blade Flex Fan
For Use on 302 C. I. D. Engine Less Air Conditioning

FAN
7-Blade Flex Fan for 390 C. I. D. Engine
(Not Available on Police Package.)
(Used with 55 or 65-Amp. Alt. or Trailer Towing Pkg.)

FAN
Viscous Drive Fan & Clutch
For Use on 302 C. I. D. Engine Less Air Conditioner
(Required R. P. O. Extra Cooling or Police Package Not Included in Price)

FAN - VISCOUS DRIVE FAN & FAN SHROUD
Viscous Drive Fan For Use With 390 and 428 Engines
- For Use With 390 Engine (Non Police)
(Required RPO Extra Cooling Pkg. Not Included in Price)
(Extra Cooling Package Not Required With 3.25:1 Axle Ratio)

For Use With 390 and 428 C. I. D. Engine (Police Pkg.)

GAUGES - TRIPLE GAUGE INSTALLATION - OIL PRESSURE, AMMETER & TEMPERATURE INDICATORS
(Mounted in Single Bracket under Center of Instrument Panel.)
- When installed with Autolite Alternator
- When installed with Motorola Alternator
- When installed with R. P. O. Leece-Neville Alternator
(Required Alternators Not Included in Price.)

Triple Gauges installed with D. S. O. Leece-Neville Alt.
(Required Ammeter Gauge Not Included in Price.)
Ammeter Gauge Option 0244000 Required (Add to DSO Gauge Option)
(Required L/N DSO Alternator Not Included in Price.)

FLOOR MATS - H.D. BLACK RUBBER - FRONT & REAR
- In Lieu of the Following Colored Carpets -
4-Door Sedan - Black
- Blue
- Red
- Ivy Green
- Aqua
- Nugget
- Ginger
Station Wagon - Black
- Blue
- Red
- Ivy Green
- Aqua
- Nugget
- Ginger

FLOOR MATS - COLOR KEYED
- In Lieu of Carpets - Front & Rear
- For Custom, Custom 500 4-Door Sedans & Wagons
- For Galaxie 500 Country Sedans

HEADLINING - ZIPPERED
For 4-Door Sedan
(2) 9" V-Shaped Zippers (1 in Second Panel & 1 in Fourth Panel)
When Used with - Beige Interior Trim
- Black Interior Trim
- Nugget Gold Interior Trim
- Blue Interior Trim
(1) Single 14" Zipper (Opening Laterally in Fourth Panel)
When Used with - Beige Interior Trim
- Nugget Gold Interior Trim
(1) Single 9" V-Shaped Zipper (In Second Panel)
When Used with - Beige Interior Trim

For Station Wagon
(2) 9" V-Shaped Zippers (1 in Second Panel & 1 in Fourth Panel)
When Used with - Black Interior Trim
- Blue Interior Trim

HANDLE - REAR DOOR METAL PULL HANDLE
- For All 4-Door Models
- Right Hand/or/Left Hand Pull Handle (1)
- Right Hand and Left Hand Pull Handles (2)

HOOD SOUND ABSORBER PAD
- For Custom & Custom 500 4-Door Sedans & Wagons

LAMP
Glove Box Lamp
- For Custom, Custom 500 4-Dr. Sedans & Ranch Wagons

LAMP - LUGGAGE COMPARTMENT LAMP
For Custom & Custom 500 4-Door Sedan

LAMP - MAP LAMP WITH INTEGRAL SWITCH LOCATED AT WINDSHIELD HEADER
- Located at Centerline of Windshield Header -
For Sedan & Hardtop Models
For Station Wagon

DESCRIPTION AND MODEL APPLICATION

LAMP - DOME LAMP (STD. TYPE) RELOCATED TO CENTERLINE OF WINDSHIELD
- Standard Type Dome Lamp Relocated to Centerline of Windshield Header -
  For All 2-Door & 4-Door Sedans
  For Station Wagons

LAMP - DOME LAMP IN ADDITION TO STD. DOME LAMP
In Addition to Standard Dome Lamp the 2-nd. Dome Lamp is Mounted on Centerline of Windshield Header
- For All 2-Door & 4-Door Sedans
- For Station Wagons

LAMP - ROTATING ROOF LAMP - 4 DOOR SEDANS & WAGONS
- Federal Rotating Roof Lamp
  (Required Roof Reinforcement - Option 0272020)
  Available In Following Models & Color
- #17 Federal - Red Dome
- #173 Federal - Red Dome
- #17 - Federal - Blue Dome
- #173 Federal - Blue Dome

NOTES: (1) NORMAL ROOF LAMP LOCATION IS 18" FROM WINDSHIELD MOULDING

(2) CUSTOMER MAY REQUEST THE FOLLOWING ROOF LAMP LOCATIONS IF DESIRED

SEDANS: 12 INCHES EXACTLY BETWEEN 14 AND 18 INCHES (1.00 IN. INCREMENTS)
22 INCHES EXACTLY BETWEEN 24 AND 28 INCHES (1.00 IN. INCREMENTS)

WAGONS: BETWEEN 12.50 AND 19.50 INCHES (1.00 INCREMENTS) 23.50 INCHES EXACTLY

(3) WHEN THE CUSTOMER SPECIFIES THE ROOF LAMP LOCATION, MEASURE DISTANCE ON SURFACE OF ROOF SHEET METAL FROM REAR EDGE OF WINDSHIELD MOULDING TO CENTER OF DESIRED ROOF LAMP POSITION. MEASUREMENT MUST BE TAKEN ON VEHICLE CENTER LINE.

(4) LOCATIONS SPECIFIED ABOVE ARE LIMITED BY THE LOCATION OF HEADLINING SUPPORTS AND ROOF REINFORCEMENTS.

LAMP - ROTATING ROOF LAMP - 4 DOOR SEDANS
- Dietz #211 Rotating Roof Lamp & Single Switch
  (Required Roof Reinforcement - Option 0272020)
- 4 Bulb Type Available with - Clear Dome - Red Bulb
  - Amber Dome - Clear Bulb

NOTES: (1) NORMAL ROOF LAMP LOCATION IS 18" FROM WINDSHIELD MOULDING

(2) CUSTOMER MAY REQUEST THE FOLLOWING ROOF LAMP LOCATIONS IF DESIRED:

SEDANS: 12 INCHES EXACTLY BETWEEN 14 AND 18 INCHES (1.00 IN. INCREMENTS)
22 INCHES EXACTLY BETWEEN 24 AND 28 INCHES (1.00 IN. INCREMENTS)

(3) WHEN THE CUSTOMER SPECIFIES THE ROOF LAMP LOCATION, MEASURE DISTANCE ON SURFACE OF ROOF SHEET METAL FROM REAR EDGE OF WINDSHIELD MOULDING TO CENTER OF DESIRED ROOF LAMP POSITION. MEASUREMENT MUST BE TAKEN ON VEHICLE CENTER LINE.

(4) LOCATIONS SPECIFIED ABOVE ARE LIMITED BY THE LOCATION OF HEADLINING SUPPORTS AND ROOF REINFORCEMENTS.

DESCRIPTION AND MODEL APPLICATION

LIGHT - CARGO LIGHT (REAR)
(All Wagons) (Not Avail. with Visibility Grp.)

LIGHT - COURTESY LIGHT
4-Door Operated Courtesy Light with Open Door Warning Light - For Sedans & Wagons
(Not Avail. with Visibility Group or Luxury Trim)

LIGHT - COURTESY LIGHT
4-Door Operated Courtesy Light
(Not Avail. with Visibility Group or Luxury Trim)

LOCKS - POWER DOOR LOCKS
- Power Door Locks for Rear Doors Only

LOCKING SYSTEM - SINGLE KEY CODE ON MULTIPLE UNIT ORDERS
- Same Key Code on Multiple Unit Orders -
  For All Models Except Station Wagons
  For Station Wagons
  For Special Key Code

LUBRICATION FITTINGS
Lubrication Fittings in Lieu of Plugs for Ball Joints & Steering Linkage
All Models

LUBRICATION FITTINGS
Driveshaft Lubricator Fitted
- For All Transmissions

LUBRICATION FITTINGS
H.D. Front Suspension Upper Arm with Lube Fittings (Police Type)
All Models

MIRROR - OUTSIDE REAR VIEW MIRROR R.H. MOUNTED
Remote Control Style - For All Models
Manual Control Style - For All Models

MOULDINGS - EXTERIOR
- Custom 500 Type Exterior Side Moulding
- For Custom 4-Door Sedan
- For Custom Ranch Wagon

OIL PRESSURE GAUGE - ELECTRICAL
(Not Available with Stereo Tape System)
Mounted in Single or Dual Mounting Panel Located Under Instrument Panel to Right of Steering Column.
- Oil Pressure Gauge - Single Mounting
- Oil Pressure Gauge For Use with DSO Ammeter
- Oil Pressure Gauge For Use with RPO Ammeter
- Oil Pressure Gauge For Use with DSO Water Temp. Gauge
- For Use with - 240 CID Engine
  - 302 & 351 CID Engines
  - 390, 428 & 429 CID Engines

DESCRIPTION AND MODEL APPLICATION

OIL PRESSURE GAUGE - ELECTRICAL - MOUNTED IN INSTRUMENT CLUSTER CLOCK OPENING
(Not Available with Stereo Tape System)
- Oil Pressure Gauge For Use with DSO Ammeter
- Oil Pressure Gauge For Use with RPO Ammeter
- Oil Pressure Gauge For Use with DSO Water Temp. Gauge
- For Use with - 240 CID Engine
  - 302 & 351 CID Engines
  - 390, 428 & 429 CID Engines

NOTE: Refer To Option 0244080 For Water Temp. Gauge.

PARKING BRAKE WARNING LIGHT
All Models

RADIATOR - EXTRA COOLING FOR 302 C.I.D. ENGINE (EXCEPT POLICE, TAXI & A/COND.)
- For Use with Manual Transmission
- For Use with Automatic Transmission

RADIATOR - EXTRA COOLING FOR 390 C.I.D. ENGINE
(Except Police Package, Trailer Towing Package or A/C)
- For Use with Manual Transmission
- For Use with Automatic Transmission

RADIO ANTENNA CABLE WITH OR WITHOUT HOLE IN ROOF
- Routed From Roof Panel to L.H. Side of Cargo Area
  For Antenna Cable RG-58 A/U (Stranded) No Hole in Roof
  For Antenna Cable RG-58 U (Solid) No Hole in Roof
  When Used on 4-Door Sedans
  When Used on Station Wagons
  When Used With 3/8" Dia. Hole in Roof
  When Used With 3/4" Dia. Hole in Roof

Customer Supplied Antenna Cable (No Hole in Roof)
- When Used on 4-Door Sedans
- When Used on Station Wagon

Customer Supplied Antenna Cable
- With 3/8" Dia. Hole in Roof
- With 3/4" Dia. Hole in Roof

NOTE: When Hole in Roof Panel Requested it is Located Behind Existing Front Roof Reinforcement on Center Approx. 38.5" (Sedans) or 33.0" (Sta. Wagons) From Top Edge of W/Shield Moulding

RADIO INTERFERENCE SUPPRESSION
(Same as State of Indiana Specification)
For All Models With 8 Cylinder Engine
For Use With Single Exhaust System
For Use With Dual Exhaust System

RADIO NOISE SUPPRESSION - (POLICE TYPE)
Highway Suppression For All Engines (Except Police Pkg.)
For Use With Radio
For Use With Autolite Regulator Without Radio
For Use With Leece-Neville Regulator Without Radio
For Use With All Transistorized Regulator W/out Radio

RADIO NOISE SUPPRESSION - (BONDING STRAPS)
(Meets or Exceeds State of Connecticut Specification)
For Use With 302, 351, 390 & 428 Interceptor C.I.D. Engine

RADIO NOISE SUPPRESSION
- Bonding Straps Conforming to Kansas Turnpike Auth. Spec.
- Single Exhaust System
- Dual Exhaust System

RADIO SPEAKER - MOUNTED IN INSTRUMENT PANEL FOR CUSTOMER INSTALLED RADIO
Speaker with Standard Coil & Standard Leads (36")
- 36" Leads & 1/8" Tip Plugs
- 48" Leads
Speaker with 3.2 OHM Impedance Coil & Std. Leads (36")
- 36" Leads - 2.5 Oz. Magnet

RADIO SPEAKER MOUNTED OVER LEFT DOOR
- For Use with All Models

RADIO WIRING CONDUIT (1 1/2" I.D. FLEXIBLE SEALTITE) (ROUTED BENEATH CAR)
All Models Except Station Wagons
- Routed from Front Passenger Compartment thru Dash Panel Beneath Vehicle to Rear Seat Compartment

- Routed from Engine Compartment Beneath Vehicle to Rear Passenger Seat Area

RADIO WIRING CONDUIT - (3/8" I.D. x 1/2" O.D.)
- For Use In 2-Door & 4-Door Sedans
(For Routing of RG-58-U or RG-58-A/U Antenna Cable Only From Dome Lamp to L.H. Side of Luggage Compartment)

- For Conduit Only
- For Conduit Plus Hole In Roof for Wire
(Hole In Roof Would be .75 Dia. Located Center of Roof Approx. 38.5" from Top of Windshield Moulding.
- For Pull Cord - (Routed Inside Conduit) (Approx. 14 ft.)

RADIO WIRING CONDUIT - (1-1/2" I.D. FLEXIBLE PLASTIC)
- For Custom and Custom 500 - 4 Door Sedans with Std. Rear Seat. Conduit Routed Inside Vehicle-Dash to Trunk.

REGULATOR - TRANSISTORIZED - REFER TO ALTERNATOR SECTION.

REGULATORS - FOR LEECE-NEVILLE ALTERNATORS
L-N #5003 Transistorized Regulator
- R.H. Mounted - For Use with L-N 65 Amp. Alternator
- L.H. Mounted - For Use with L-N 65 Amp. Alternator
(For Use on R.P.O. or D.S.O. L-N Alternators)

REGULATOR - FOR LEECE-NEVILLE ALTERNATORS
L-N #5016RA Adjustable Transistorized Regulator
- R.H. Mounted - For Use with L-N 65 Amp. Alternator
- L.H. Mounted - For Use with L-N 65 Amp. Alternator
(For Use on R.P.O. or D.S.O. L-N Alternators)

REGULATOR - FOR LEECE-NEVILLE ALTERNATORS
L-N #5022 Adjustable Transistorized Regulator
- R.H. Mounted - For Use with L-N 65 Amp. Alternators
(For Use On R.P.O. or D.S.O. L-N Alternators)

ROOF LAMP WIRING - NO HOLE IN ROOF
(Price Shown is for Each Wire)

NOTE: Wire Termination Distance from Front Edge of Roof Panel on Center is 16.50". When More Than One Wire of the Same Size is Requested the Appropriate Item must be Specified an Equal Number of Times.

For All Models Except Station Wagons:
(1) #6 Gage Black Wire
(1) #8 Gage Black Wire
(1) #10 Gage Black Wire
(1) #12 Gage Red Wire
(1) #12 Gage Black Wire
(1) #12 Gage White Wire
(1) #14 Gage Red Wire
(1) #14 Gage Black Wire
(1) #14 Gage White Wire
(1) #16 Gage Red Wire
(1) #16 Gage Black Wire
(1) #16 Gage White Wire
(1) #18 Gage Black Wire

For Station Wagon Models:
(1) #6 Gage Black Wire
(1) #8 Gage Black Wire
(1) #10 Gage Black Wire
(1) #12 Gage Red Wire
(1) #12 Gage Black Wire
(1) #12 Gage White Wire
(1) #14 Gage Red Wire
(1) #14 Gage Black Wire
(1) #14 Gage White Wire
(1) #16 Gage Red Wire
(1) #16 Gage Black Wire
(1) #16 Gage White Wire
(1) #18 Gage Black Wire

NOTE: The Above Price Must be Used for Each Selection or Multiplied by the Number of Times any One Selection is Used.

ROOF LAMP WIRING (HOLE IN ROOF PANEL)
NOTE: The Roof Hole Locations are to be Measured from Top Edge of Windshield Moulding, on Centerline. The Following Locations are Available and are Compatible with Added Roof Reinforcement Option.

Sedans:
10.50" Exactly
Between 12.50" & 16.50" (1.00" Increments)
20.50" Exactly
Between 22.50" & 26.50" (1.00" Increments)
Wagons:
Between 11.00" & 18.00" (1.00" Increments)
22.00" Exactly

10 - GAUGE WIRING
For Wagons
(2) Wires

12 - GAUGE WIRING
For 4-Door Sedan
(1) Wire
(2) Wires
(3) Wires
(4) Wires

For Wagons
(1) Wire
(2) Wires

14 - GAUGE WIRING
For 4-Door Sedan
(1) Wire
(2) Wires
(3) Wires
(4) Wires

For Wagons
(1) Wire
(2) Wires
(3) Wires
(4) Wires

16 - GAUGE WIRING
For 4-Door Sedans
(2) Wires
(4) Wires
For Wagons
(2) Wires

COMBINATION GAUGE WIRING
For 4-Door Sedan
(1) #10 Gauge Wire & (1) #12 Gauge Wire (2-Wires)
(4) #18 Gauge Wire & (1) #14 Gauge Wire (5-Wires)

For Wagon
(1) #10 Gauge Wire & (1) 12# Gauge Wire (2 Wires)

ROOF LAMP WIRING - (WITHOUT HOLE IN ROOF)
L.P.O. Roof Lamp Wiring without Hole In Roof
- For Police & Taxi Packages
(Wire Ends Insulated & Excess Wire Looped at Location where Hole Would Normally be)

ROOF LAMP WIRING
To North & South Carolina Vehicle Specifications
(1) #10 Gauge Wire & (1) #16 Gauge Wire
(Required Roof Reinforcement - Option 0272010)
(Wiring & Reinforcements Required For Siren Mounting Base)

ROOF REINFORCEMENT (NORTH & SOUTH CAROLINA HWY. PATROL TYPE)
(2) Added Lateral Reinforcements & (4) Cage Nuts For Siren Mounting
- For 4-Door Sedans
- For Station Wagons

ROOF REINFORCEMENT
(1) Additional Standard Production Roof Reinforcement
(Recommended for use with D.S.O. Wiring Options 0250000 & 0250030)
For 4-Door Sedans
For Station Wagons

NOTE: Customer may request one of the following Reinforcement Locations, measured along Roof Surface from rear edge of Windshield Moulding to Reinforcement Centerline:

SEDANS
13.50" Exactly
Between 15.50" and 19.50" (1.00 Inch Increments)
23.50" Exactly
Between 25.50" and 29.50" (1.00 Inch Increments)

STATION WAGONS
Between 14.00" and 21.00" (1.00 Inch Increments)
25.00 Exactly

If no location is specified, install at 19.50 from w/shield

When RPO Roof Light Wiring Desired The Following Locations Must be Used:
Sedans – 26.50"
Station Wagon – 21.00"

ROOF REINFORCEMENTS
(2) Added Lateral Roof Reinforcements with 1/8" Thick and 6" Wide C/L Plate Extending to Windshield Header
For 4-Door Sedans
For Station Wagons

NOTE: Reinforcement Located From Rear Edge of Windshield Mldg. to C/L of Lateral Reinforcement 18.50" 1st Reinforcement - 25.00" 2nd Reinforcement

ROOF REINFORCEMENTS
(2) Added Lateral Roof Reinforcements with 1/8" Thick and 9" Wide C/L Plate Extending to Windshield Header
- For 4-Door Sedans
- For Station Wagons

SEATS - FRONT
H.D. Front Seat & Back Assy. with H.D. Pads - (Police & Taxi Type Seat)
- For Use on 4-Door Sedans & Station Wagons

SEATS - BUCKET FRONT
XL-Type Hi-Back Manual Bucket Seats - Driver & Passenger (For Use with Standing Column Shift Lever)
- Available for 4-Door & Wagons

NOTE: Customers to be advised that Bucket Seat Trim Pattern DOES NOT MATCH Trim Style of Rear Seat.

XL-Bucket Seats Available in Following Color & Material
Black-Code 8A Clarion Knit Vinyl
Blue-Code 8B Clarion Knit Vinyl
Red-Code 8D Clarion Knit Vinyl
Ivy Green - Code 8G Clarion Knit Vinyl
White-Code 8W Clarion Knit Vinyl
Ginger-Code 8F Clarion Knit Vinyl

SEAT - ELECTRIC BUCKET SEAT
6-Way Electric Bucket Seat (Driver Only)
(For Use on "XL" and D.S.O. Bucket Seat Models)

SEAT - JUMP TYPE
- Auxiliary Jump Seat for Station Wagons (Except LTD.) (The Split Rear Seat which Folds Flat with the Floor, Makes it Possible to Carry a Stretcher in Back of a Station Wagon and Still Have a Seat for an Attendant)

NOTE: This Option Exempt from Compliance with Federal Motor Safety Standard #207 Per Sec. 83-1.

SEATS - REAR
Heavy Duty Rear Seat - (Taxi Type)
- For All Galaxie & LTD 4-Doors
- For Custom & Custom 500 - 4-Doors

SHOCK ABSORBERS - REAR - AUTOLITE SUPERFLEX REAR SHOCK ABSORBERS
- For Use With H.D. Suspension - Non Police Package
- All Sedan Models
- Station Wagons
(Required H.D. Suspension Not Included in Price)

SHOCK ABSORBERS - REAR - AUTOLITE SUPERFLEX REAR SHOCK ABSORBERS
- Police Type Autolite Superflex Rear Shock Absorbers - (Required H.D. Suspension Not Included in Price)
For All Sedans - With Non-Police Package
For Station Wagons - With Non-Police Package
For All Sedans & Wagons With Police Package (Includes H.D. Suspension)

SHOCK ABSORBERS - H.D. FRONT & REAR
(Except Police Packages)
- For Use With 240, 302 & 351 C.I.D. Engines (All Sedans)
- For Use With 390, & 429 C.I.D. Engines (All Sedans)
- For Use with All Station Wagons

SIREN EQUIPMENT
Wiring & Mounting Brackets For Horn Ring Operated Siren (For Use with Federal 28, P-280 or Sireno J-1-8 Sirens)
- Inboard Facing - Normal Installation of Siren Mounting
- #16 Gauge Wiring - Control Switch to Siren Relay
- Single Switch Mounting Bracket
- Optional Forward Facing of Siren Mounting Installation (Not Avail. on XL, LTD, or any Models with Vac. Door Locks or Level System)

SIREN EQUIPMENT
- Switch Control Panel - Mounting Bracket For Multiple Switch Combinations (Not Available with Stereo Tape System)
Title & Location of Switch Control Panels
- Siren & Roof Lamp - Mtd. to Right of Steering Column
- Siren & Rotating Roof Lamp - Mtd. in Radio Opening

SPARK PLUGS
Suppressor Spark Plugs
- For 240 CID Engine (Except Police & Taxi)
- For 240 CID Engine Police & Taxi
- For 302, 351, 390 & 429 CID Engines
- For 428 CID Police Interceptor Engine

SPARE TIRE & WHEEL - RELOCATION
R.H. Mounting in Luggage Compartment
For Custom & Custom 500 - 4-Door Sedans (Models 54B-E)
For Galaxie "500" 4-Door Sedan (Model 54A)
L.H. Mounting in Luggage Compartment
For Custom & Custom 500 - 4-Door Sedans (Models 54B-E)
For Galaxie "500" 4-Door Sedan (Model 54A)

SPEEDOMETER
Police Type Calibrated Speedometer - All Models

SPOTLAMP - MOUNTED ON "A" PILLAR
Left Hand Installation - All Models Except Convertible - Convertible Only
With 5" Lens - (Unity 250) - Clear Lens - Red Lens
With 6" Lens - (Unity 225) - Clear Lens - Red Lens - Blue Lens
With 6" Lens - (Unity 225) - Clear Lens With Unity Jobber Handle & Shorter Shaft

With 6" Lens - (Unity 225) - Clear Lens - With Aircraft Bulb (GE#4537)

Right Hand Installation - All Models Except Convertible - Convertible Only
With 5" Lens - (Unity 250) - Clear Lens - Red Lens
With 6" Lens - (Unity 225) - Clear Lens - Red Lens - Blue Lens
With 6" Lens - (Unity 225) - Clear Lens - With Unity Jobber Handle & Shorter Shaft

With 6" Lens - (Unity 225) - Clear Lens - With Aircraft Bulb (GE#4537)

SPOTLAMPS - FENDER MOUNTED
5" Clear Lens - L.H.
5" Clear Lens - R.H.
For All 4-Door Sedans & Wagons

SPOTLAMP - TWO FACED RED & CLEAR LENS
5" Two Faced Lens L.H. - "A" Pillar Mtd.
5" Two Faced Lens R.H. - "A" Pillar Mtd.
(All Models Except Convertible)

STABILIZER BAR
Heavy Duty Stabilizer Bar - 4-Door Sedans

SUSPENSION SYSTEM - MANUAL ADJUSTING LOAD LEVELING SYSTEM (AIR)
- For All Models

NOTE: For Maximum Load Carrying Capacity, The Heavy Duty Suspension and the Maximum RPO Tire Size Should be Specified

SWITCHES - DOOR - INOPERATIVE
Inoperative Courtesy Lamp Door Switches
Custom, Custom 500 4-Door Sedans

THERMOSTATS
160° Thermostat for 390 C.I.D. Engine
180° Thermostat for 302 C.I.D. & 351 C.I.D. W Engine

THROTTLE CONTROL - LOCKING TYPE THROTTLE CONTROL
- For All Models

TIRES - ADDITIONAL - TUBELESS TIRES
NOTE: Additional Tire Must be Consistent With the (5) Production Tires on the Vehicle - Refer to Option 0205000 For Extra Wheel

(1) F78 x 15 - 4 Pr. Black R & P
(1) F78 x 15 - 4 Pr. White R & P
(1) 7.75 x 15 - 4 Pr. Black Nylon
(1) 7.75 x 15 - 4 Pr. White Nylon
(1) F78 x 15 - 4 Pr. Black R & P (Snow)
(1) F78 x 15 - 4 Pr. White R & P (Snow)
(1) 7.75 x 15 - 4 Pr. Black Nylon (Snow)
(1) 7.75 x 15 - 4 Pr. White Nylon (Snow)
(1) G78 x 15 - 4 Pr. Black R & P
(1) G78 x 15 - 4 Pr. White R & P
(1) G78 x 15 - 4 Pr. Black R & P (Snow)
(1) G78 x 15 - 4 Pr. White R & P (Snow)
(1) 8.25 x 15 - 4 Pr. Black Nylon
(1) 8.25 x 15 - 4 Pr. White Nylon
(1) 8.25 x 15 - 4 Pr. Black Nylon (Snow)
(1) 8.25 x 15 - 4 Pr. White Nylon (Snow)
(1) H78 x 15 - 4 Pr. Black R & P
(1) H78 x 15 - 4 Pr. White R & P
(1) H78 x 15 - 4 Pr. Black R & P (Snow)
(1) H78 x 15 - 4 Pr. White R & P (Snow)
(1) 8.55 x 15 - 4 Pr. Black Nylon
(1) 8.55 x 15 - 4 Pr. White Nylon
(1) 8.55 x 15 - 4 Pr. Black Nylon (Snow)
(1) 8.55 x 15 - 4 Pr. White Nylon (Snow)
(1) H70 x 15 - 4 Pr. White R & P
(1) 8.25 x 15 - 4 Pr. Black Nylon (High Performance)
(1) 8.25 x 15 - 4 Pr. White Nylon (High Performance)
(1) 8.55 x 15 - 4 Pr. Black Nylon (High Performance)
(1) 8.55 x 15 - 14 Pr. White Nylon (High Performance)

(PR - Indicates Ply Rating) (R & P Indicates Rayon & Polyester)

TRANSMISSION - HEAVY DUTY AUTOMATIC
Heavy Duty Automatic Transmission (C-6) Police Type Column Shift
For Use On All Models (Except Police Package)
For 390-2V C.I.D. Engine
For 429-2V C.I.D. Engine
For 429-4V C.I.D. Engine

NOTE: For Column Shift Only

TRANSMISSION - SELECTOR LOCKOUT
Delete 1st Gear Lockout
For Use on Vehicles With Taxi Package

VOLTMETER
Stewart-Warner Voltmeter
(Required R.P.O. or D.S.O. Ammeter Not Incl'd in Price)
(Voltmeter & Ammeter Mounted in Single Bracket)

DESCRIPTION AND MODEL APPLICATION

WATER TEMPERATURE GAUGE - ELECTRICAL -
Specific Request
(Not Available with Stereo Tape System)
Mounted in Single or Dual Mounting Panel Located Under Instrument Panel To Right of Steering Column
- Water Temp. Gauge
- Water Temp. Gauge For Use with DSO Ammeter
- Water Temp. Gauge For Use with R.P.O. Ammeter
- Water Temp. Gauge For Use with DSO Oil Pressure Gauge

WATER TEMPERATURE GAUGE - ELECTRICAL -
Specific Request
(Not Available with Stereo Tape System)
Mounted in Instrument Cluster Clock Opening
- Water Temp. Gauge For Use with DSO Ammeter
- Water Temp. Gauge For Use with RPO Ammeter
- Water Temp. Gauge For Use with DSO Oil Pressure Gauge

NOTE: Refer to Option 0244020 For DSO Oil Pressure Gauge.

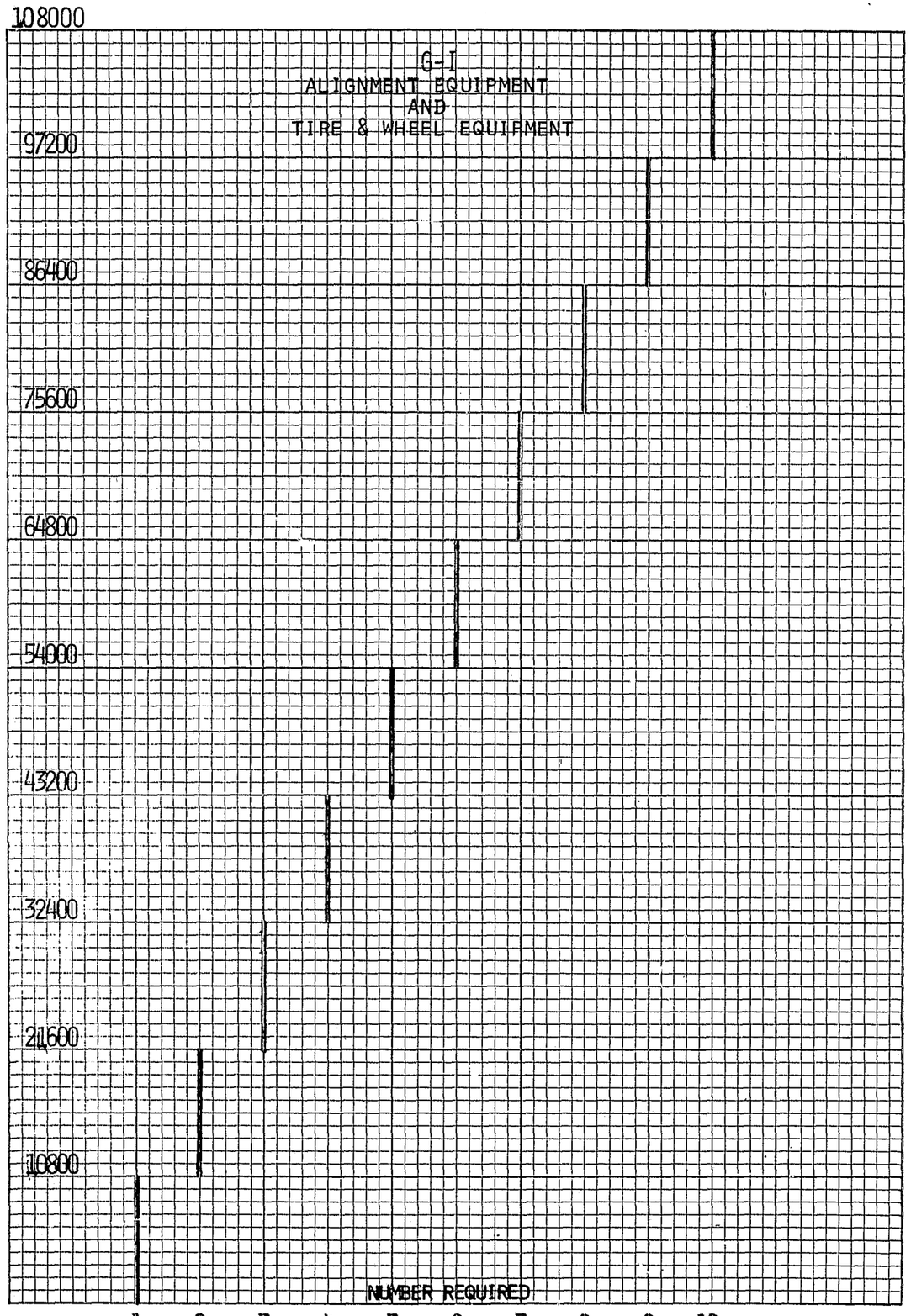
WHEELS
Sets of (5) - Wheels For All Models Except 71
(5) 15 x 5.5 Wheels in Lieu of (5) 15 x 5.0 Wheels (Drum Brakes)
(Not Used With Package)
(For 7.75, 8.25, F78 or G78 Tires)
(5) 15 x 6.0 Wheels in Lieu of (5) 15 x 5.0 Wheels (Drum Brakes)
(Not Used With Police Package)
(For 7.75, 8.25, F78 or G78 Tires)
(5) 15 x 6.5 Wheels in Lieu of (5) 15 x 5.5 Wheels (Disc Brakes)
(Not Used With Police Package)
(For 8.55 x 15 or H78 x 15 Tires)
(5) 15 x 6.0 Wheels in Lieu of (5) 15 x 5.5 Wheels (Disc Brakes)
(Not Used With Police Package)
(For 8.55 x 15 or H78 x 15 Tires)

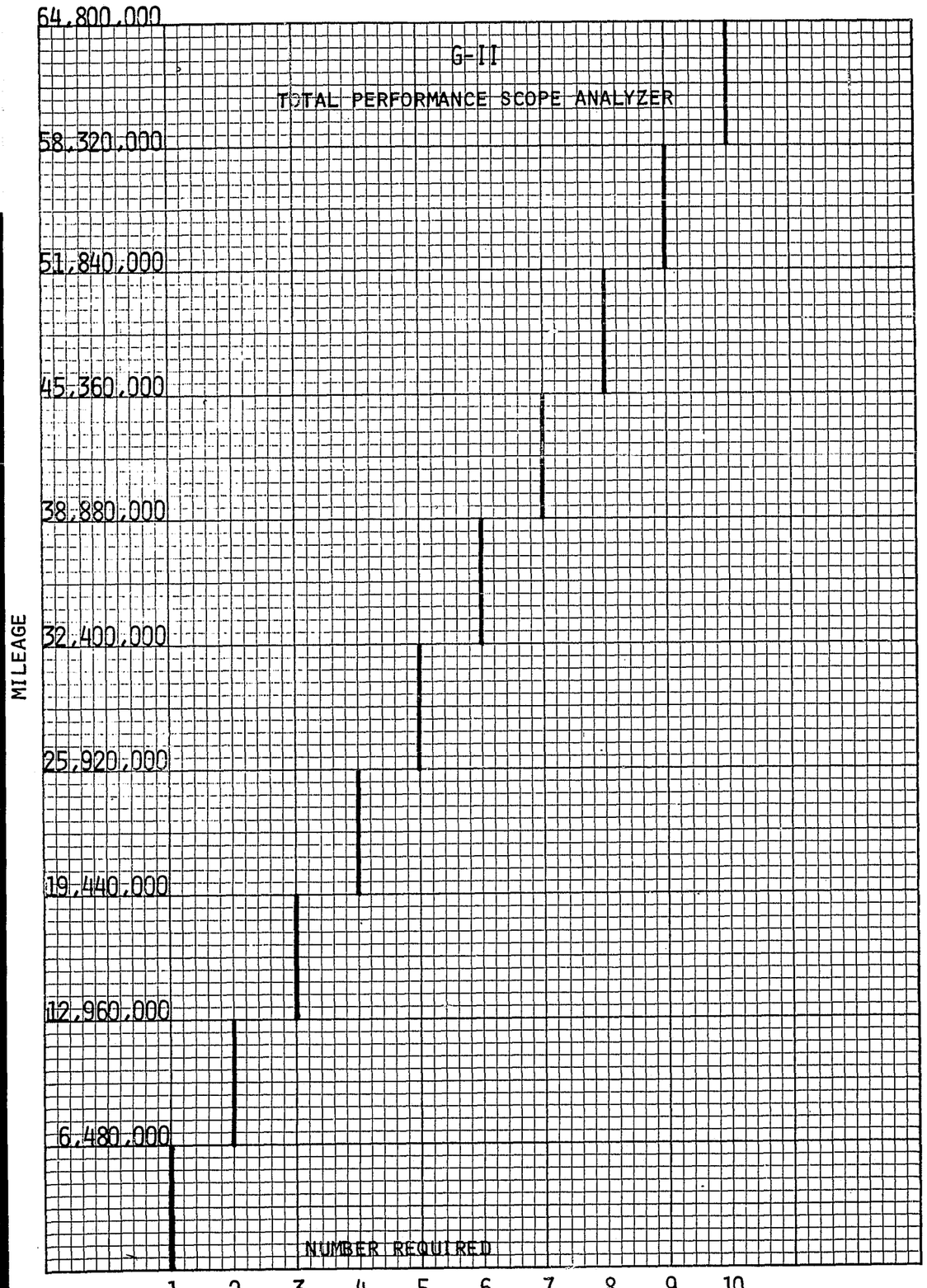
WHEELS - ADDITIONAL
NOTE: Additional Wheels When Ordered Must be Consistent to Those Supplied With Vehicle
(1) 15 x 6.0 Wheel for 8.25 x 15 or G78 x 15 Tires (For Police Packages Only)

(1) 15 x 6.5 Wheel for 8.55 x 15 or H78 x 15 Tires (For Police Packages Only)

WHEELS - ADDITIONAL
(Additional Wheel Must Be Consistent with Wheels Supplied with Vehicle) (Not Used with Interceptor Engine)
(1) 15 x 5.0
(1) 15 x 5.5
(1) 15 x 6.0
(1) 15 x 6.5

WINDOWS - POWER
- For Use On Custom 4-Door Sedans & Wagons
- For Use On Custom 500, 4-Door Sedans & Wagons


G-I
ALIGNMENT EQUIPMENT
AND
TIRE & WHEEL EQUIPMENT
MILEAGE X 1000
108000
97200
86400
75600
64800
54000
43200
32400
21600
10800
NUMBER REQUIRED
1 2 3 4 5 6 7 8 9 10


G-II
TOTAL PERFORMANCE SCOPE ANALYZER
MILEAGE
64,800,000
58,320,000
51,840,000
45,360,000
38,880,000
32,400,000
25,920,000
19,440,000
12,960,000
6,480,000
NUMBER REQUIRED
1 2 3 4 5 6 7 8 9 10

G-III

BRAKE EQUIPMENT

MILEAGE X 1000

129600
116640
103680
90720
77760
64800
51840
38880
25920
12960

NUMBER REQUIRED

1 2 3 4 5 6 7 8 9 10

G-IV

OIL CHANGE EQUIPMENT

MILEAGE X 1000

28800
25920
23040
20160
17280
14400
11520
8640
5760
2880

NUMBER REQUIRED

1 2 3 4 5 6 7 8 9 10

City of XYZ
Police Department
Automotive & Equipment Division

Form 1

ASSIGNMENT OF
AUTOMOTIVE EQUIPMENT

PLEASE RETAIN THIS COPY IN VEHICLE OR ON PERSON

1. The equipment assignee is authorized to be in possession of this city-owned vehicle.
2. The Motor Vehicle Service and Repair Record and credit card should remain in the glove compartment at all times. They are assigned to the vehicle and are not transferable.
3. Contact the Automotive & Equipment Division to make arrangements for picking up the equipment.

EQUIPMENT ASSIGNED TO:

☐ Automotive & Equipment Division

☐ Assignee_____

Precinct_____

EQUIPMENT RECEIVED FROM:

☐ Automotive & Equipment Division

☐ Assignee_____

Precinct_____

NOTE: Duration of the assignment is _____. Equipment on temporary assignment should either be returned on the indicated date or the precinct should request (in writing) an extension of the assignment, giving a justification and the period needed.

Vehicle No.	Year and Make	Type

Remarks_____

APPROVED:_____ Date_____
Director, A & E Division

Extra Equipment:
Radio_____
Rotating Lights_____
Flarestat Lights_____
Seat Belts_____
Siren_____
Other_____
_____

City of XYZ
Police Department
Automotive & Equipment Division

Form 2

MOTOR VEHICLE SERVICE AND REPAIR RECORD

MAKE OF VEHICLE _____ TYPE_____ YEAR _____ VEHICLE NO._____

DATE	SPEEDOMETER	DESCRIPTION OF SERVICE OR REPAIR	GARAGE OR SERVICE STATION	INITIALS

EQUIPMENT INSPECTOR'S COMMENTS

COMMENTS: _____

_____

_____

INSPECTOR'S NAME _____ DATE _____

COMMENTS: _____

_____

_____

INSPECTOR'S NAME _____ DATE _____

COMMENTS: _____

_____

_____

INSPECTOR'S NAME _____ DATE _____

City of XYZ
Police Department
Automotive & Equipment Division

Form 3

DAILY MILEAGE LOG

Date_____ Precinct_____

Vehicle Number	Mileage at End of Shift and Driver's Badge Number						Remarks Concerning Vehicle Behavior
	1st Shift Mileage	Badge Number	2nd Shift Mileage	Badge Number	3rd Shift Mileage	Badge Number	

City of XYZ
Police Department
Automotive and Equipment Division

Form 4

DAILY MILEAGE LOG

FOR PERMANENTLY-ASSIGNED VEHICLES

Vehicle No. _____ Precinct _____

For period starting _____ Ending _____

DATE	MILEAGE AT END OF DAY	REMARKS CONCERNING VEHICLE BEHAVIOR

Submitted by _____
(signature)

City of XYZ
Police Department
Automotive & Equipment Division

Form 5

BI-WEEKLY MILEAGE LOG SUMMARY

For period starting _____ ending _____ Precinct _____

VEHICLE NUMBER	MILEAGE AT END OF PERIOD	REMARKS CONCERNING VEHICLE BEHAVIOR

Submitted by _____
Signature of Precinct Clerk

C I T Y O F X Y Z

P O L I C E D E P A R T M E N T
Automotive & Equipment Division

TO: Vehicle Operators and Precinct Clerks

FROM: Director, A & E Division

SUBJECT: Utilization of Authorized Service Stations

The following information has been prepared in order to familiarize employees on the policy and precedure governing the servicing of city vehicles by authorized privately-owned service stations. All servicing of vehicles should be in accordance with the established policies.

I. POLICY

Precinct Clerks and Equipment Inspectors are authorized by the Automotive & Equipment Division to enter into agreements with privately-owned service stations who will provide discounts to all city police vehicles. Following are approximate charges and discounts approved by A & E.

1. Gasoline: 2 cents per gallon discount
2. Oil: 10 cents per quart discount
3. Lubrication: $1.50
4. Wash Jobs: $1.50

NOTE: Precinct Clerks and Equipment Inspectors who find it necessary to deviate from these prices and discounts should contact the A & E Division prior to approving firms whose prices do not confrom.

II. PROCEDURE

Responsibilities of Precinct Clerk

When a vehicle requires repair, the Precinct Clerk should contact an authorized garage or service station and advise them of the repairs necessary, request a cost estimate, and an estimate of the length of time the vehicle will be out of service.

Responsibilities of Garage or Service Station

The service station must submit two copies of their invoices to the Precinct Clerk bi-weekly. Invoices must include the following items:

1. List cost of services and fuel and discount allowed.
2. Vehicle number and vehicle operator's signature.

Responsibilities of Vehicle Operator

The vehicle operator shall sign the invoice and check to determine that the correct vehicle number is insicated.

C I T Y O F X Y Z

P O L I C E D E P A R T M E N T

Automotive & Equipment Division

TO: Precinct Supervisors and Central Headquarters

FROM: Director, A & E Division

SUBJECT: Policy on Assignment and Utilization of Police Vehicles

The following instructions have been compiled in order to clarify the policies on assignment and utilization of police vehicles.

1. ASSIGNMENT, TRANSFER, AND REPLACEMENT OF VEHICLES

All requests for the assignment, transfer, or replacement of vehicles must be made to the Automotive and Equipment Division in writing, and must be submitted by, or under the approval of, the head of each precinct. Requests from Precinct Supervisors should be forwarded to the Central Headquarters for review. If approved, the request will be forwarded to the A & E Division for action.

2. REQUESTS FOR PERMANENTLY ASSIGNED AND ADDITIONAL VEHICLES

Requests for permanently assigned or additional vehicles should be made prior to their need by submitting a justification in writing to the A & E Division. Central Headquarterssand the precincts will be notified of decisions made regarding these requests.

3. REQUESTS FOR TEMPORARILY-ASSIGNED VEHICLES

Requests for vehicles to be assigned on a temporary basis must be justified in writing. The vehicle must be returned to the Central Garage on the assignment's expiration date. If an extension of the assignment is required, the using precinct must submit an additional justification memo to the A & E Division prior to the expiration date.

C I T Y O F X Y Z

P O L I C E D E P A R T M E N T
Automotive & Equipment Division

TO: Precinct Clerks and Vehicle Operators

FROM: Director, A & E Division

SUBJECT: Schedule for Servicing Vehicles

In order that all vehicle operators may be assured that police vehicles are being properly serviced, the attached chart indicates when vehicles should be serviced. Unless otherwise stated, the standards are given in miles.

Please see that vehicles which you drive or are responsible for are serviced in accordance with these standards.

C I T Y O F X Y Z

P O L I C E D E P A R T M E N T
Automotive & Equipment Division

TO: All Unit Heads and Mechanics of A & E Division

FROM: Director, A & E Division

SUBJECT: Vehicle Service and Repair Record (Form 2)

A brief description of all repair work, including routine maintenance, shall be recorded on the Motor Vehicle Service and Repair Record (Form 2) which is in the glove compartment of the vehicle. Gasoline, additions of crankcase oil, and wash jobs need not be listed.

C I T Y O F X Y Z

P O L I C E D E P A R T M E N T
Automotive & Equipment Division

TO: All Unit Heads and Mechanics of A & E Division

FROM: Director, A & E Division

SUBJECT: Vehicle Service and Repair Record (Form 2)

A brief description of all repair work, including routine maintenance, shall be recorded on the Motor Vehicle Service and Repair Record (Form 2) which is in the glove compartment of the vehicle. Gasoline, additions of crankcase oil, and wash jobs need not be listed.

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