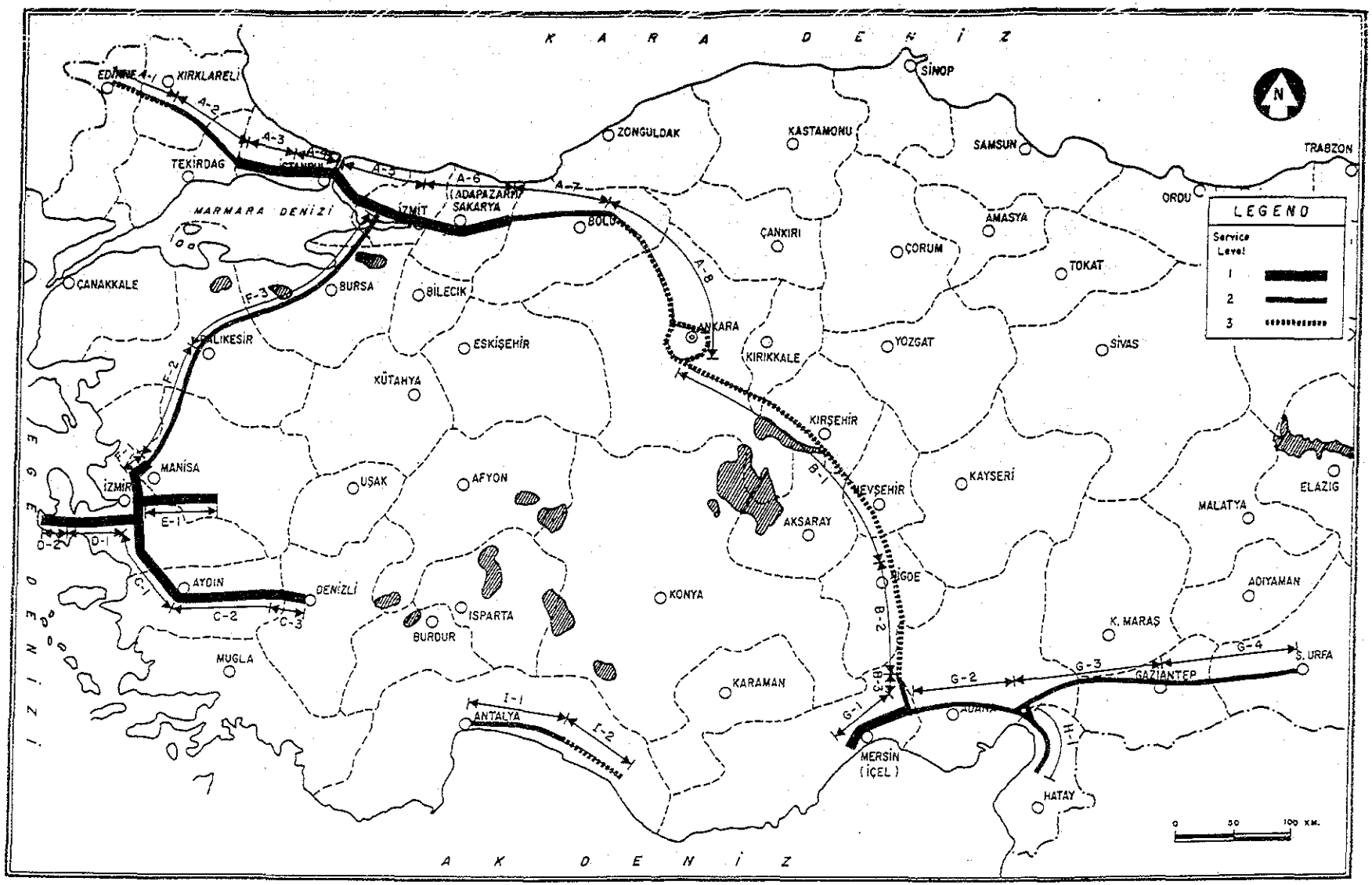


Figure 5.5.10 Application of Service Level (Long-term)

5.5.3 Traffic Management and Operation System Information Flows

1) Outline of Information Flows

Traffic related information is gathered through traffic patrol vehicles, toll collections offices, and other traffic data gathering facilities implemented on the motorway (according to service level) and is processed at the traffic control room (at the main maintenance center) and at the traffic operations room (at the maintenance office). Appropriate messages would then be presented to the motorway users. Figure 5.5.11 illustrates this information flow network.

The traffic control room is responsible for traffic control and the traffic monitoring and measuring equipment in its jurisdiction through the use of traffic operations room. The traffic control room then processes the information that has been gathered and decides which specific information is required to present to motorists, and how that information is to be presented, such as by variable message signs, radio broadcasts, etc. Moreover, during emergency situations, traffic control room will command the dispatch of traffic patrol and traffic police units, first-aid units, etc., as required.

Each traffic control room should have a jurisdictions of approximately 200 - 500 km. Traffic control room jurisdictions on the future motorway network are proposed as shown in Figure 5.5.12. This figure indicates the proposed location of each traffic control room for the jurisdictions of Istanbul, Izmit, Ankara, Nevsehir, Bursa, Izmir, Adana and Antalya, respectively. These recommended locations, however, could be revised according to conditions caused by administrative organizational requirements.

The maintenance offices having traffic operations room are intended for carrying out field related activities such as the provision of traffic patrols, first-aid assistance, law enforcement (together with the traffic police stationed at the maintenance office) and traffic accident investigation. The traffic operations rooms are equipped with a system capable of monitoring and control of traffic as a backup to the traffic control room in the case of communications interruption between the traffic operation room and the traffic control room. The traffic operations rooms are located in maintenance offices and are typically spaced at about every 50 - 70 km.

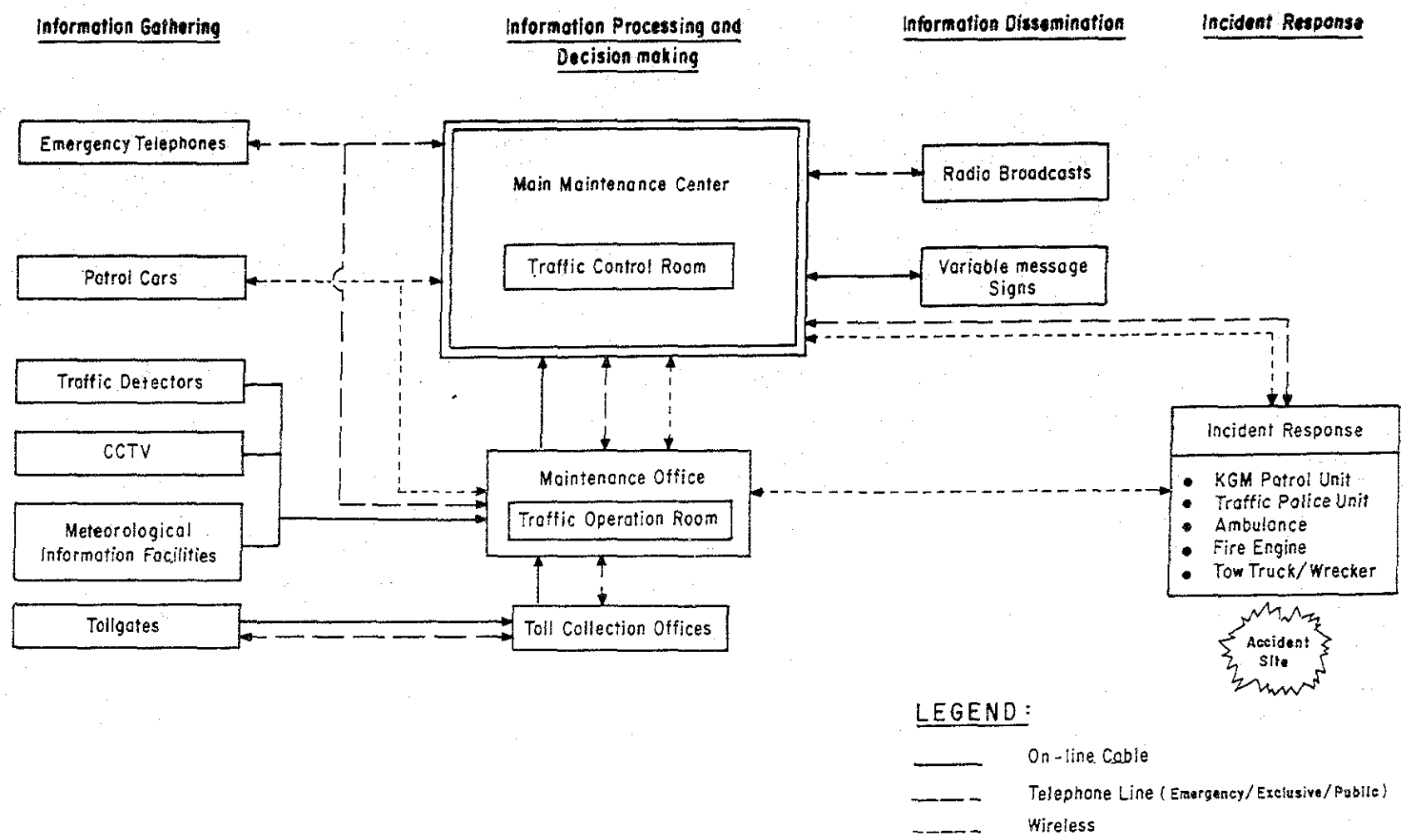


Figure 5.5.11 Outline of Information Flows

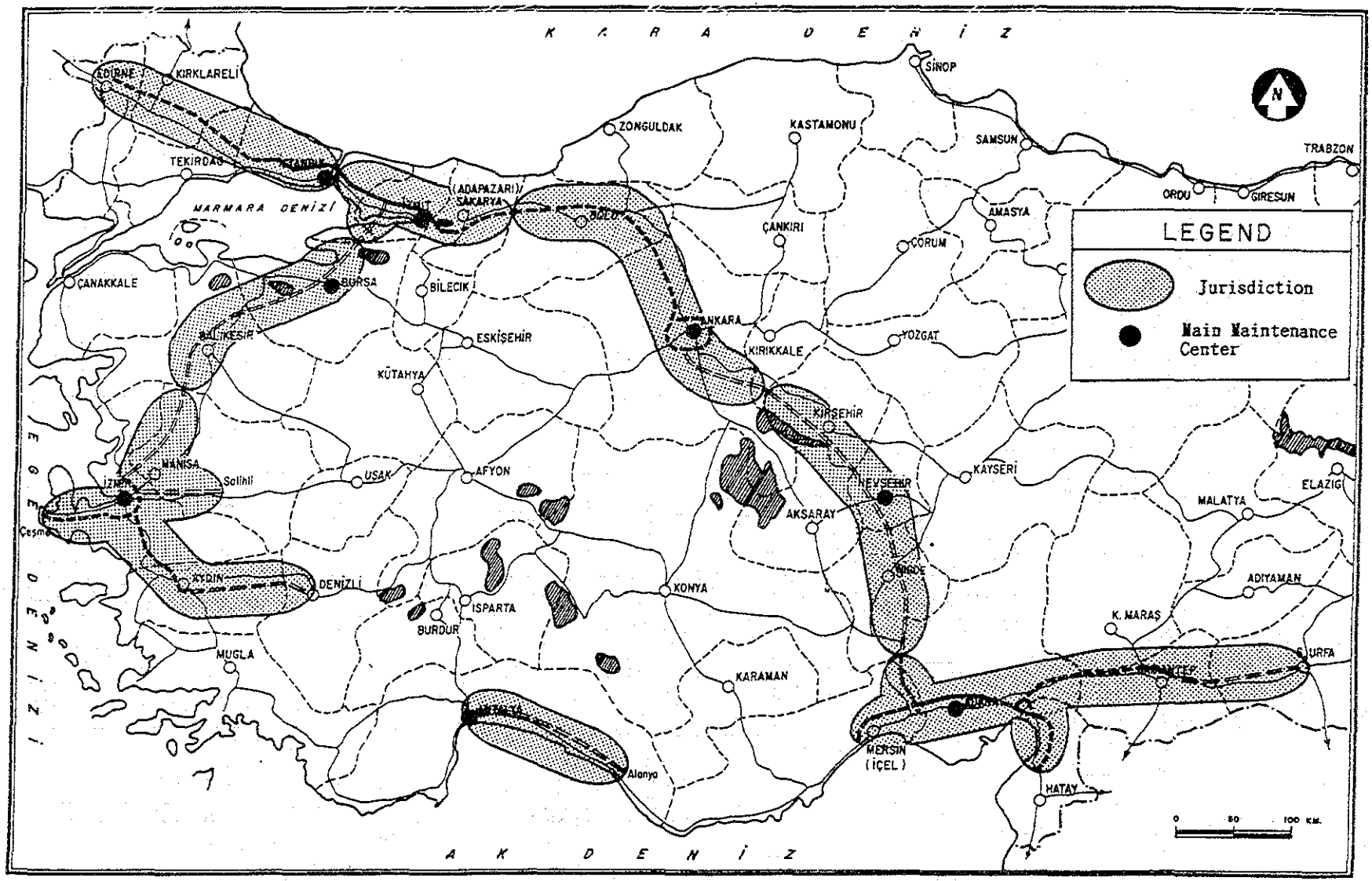


Figure 5.5.12 Jurisdictions of Main Maintenance Center with Traffic Control Room

2) Roles of Traffic Control Room (TCR)

(a) Responsibilities and functions

The traffic control room is equipped with various terminals for the surveillance of traffic and motorway conditions, conveyance of information to drivers, incident response and traffic management on the motorways. TCR is the "nucleus" to which patrolling personnel will report actual motorway or incident conditions, and from which instructions are given to patrolling personnel for actions to take during an emergency or incident. TCR is also the base from which requests for assistance from hospitals, fire department or traffic police are sought. And the TCR is operated on a 24-hour basis.

The proposed specific tasks and responsibilities in the TCR are listed below.

- Contact with patrol cars on duty
- Reception of emergency telephones
- Consultation and contact with other agencies
- Operation of graphic display panel and CRT displays
- Operation of terminal equipment
- Monitor traffic management during an emergency or incident
- Dispatch request to patrol units

(b) Information/communication flow at the TCR

Each traffic control room is to be managed by a chief of TCR and a deputy who will be on duty on a 24-hours basis with three shifts. Both the chief and deputy will control a team of traffic control officers who will be on active duty at the control panel or console. The team of traffic control officers are to report to the chief or deputy and to receive instructions from them. For major incidents or an emergency, consultation with the manager of traffic and maintenance, and neighboring TCR are sometimes necessary (Figure 5.5.13). For minor incidents, the traffic control officers may directly summon help from hospitals, fire departments or the towing companies.

(c) Relationship with various agencies

For effective and prompt response to be taken by traffic control officers at TCR, the traffic management body (KGM) including the TCR has to maintain good rapport with various agencies and private companies such as traffic police,

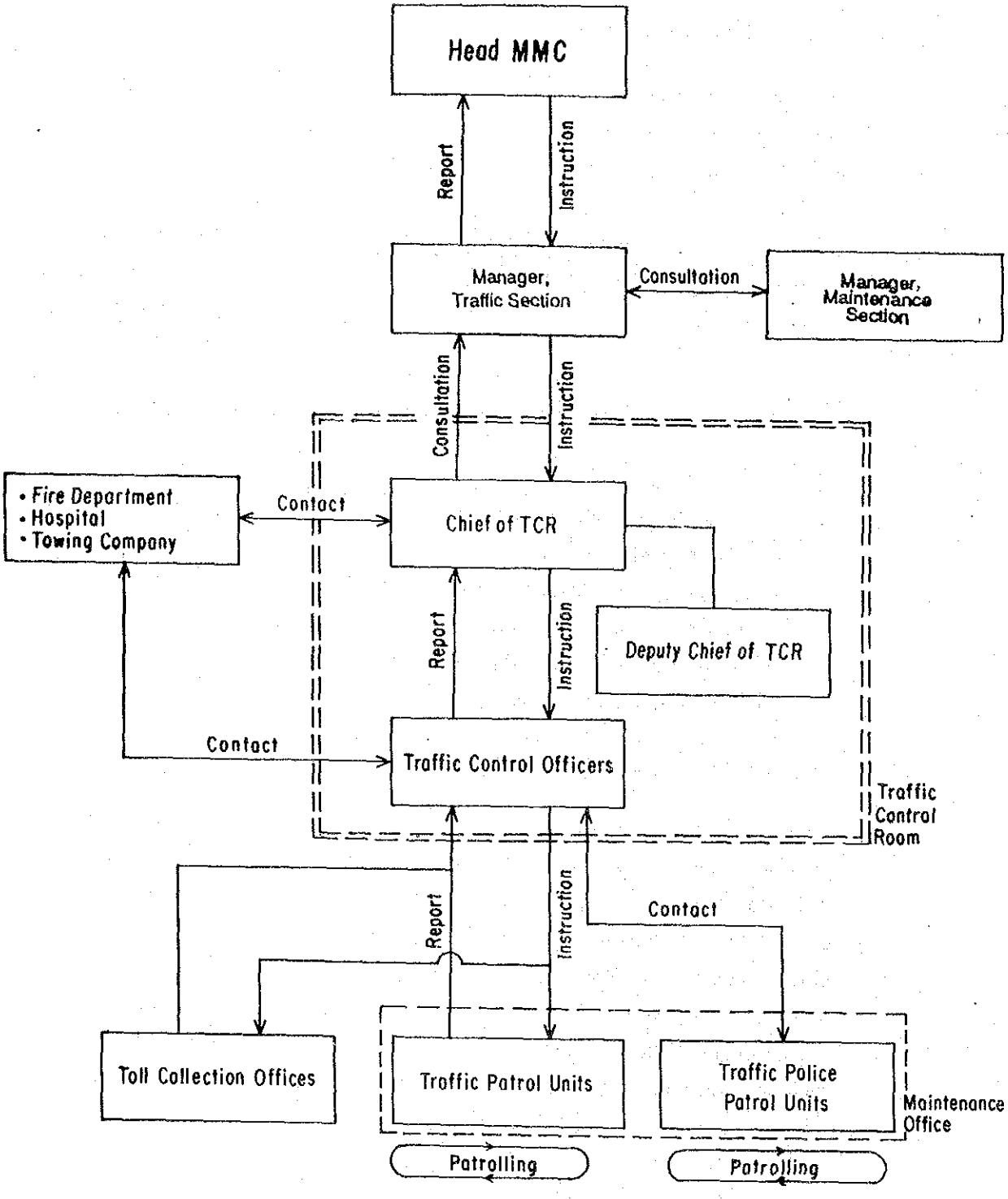


Figure 5.5.13 Information/Communication Flow at TCR

(c) Relationship with various agencies

For effective and prompt response to be taken by traffic control officers at TCR, the traffic management body (KGM) including the TCR has to maintain good rapport with various agencies and private companies such as traffic police, emergency medical services, fire department, towing companies, etc. Particularly, close cooperation with the traffic police on the following items is important for effective traffic management and operations.

- Consult and inform the police regarding the installation, location, and type of regulatory signs used such as speed limit signs, "No Overtaking" signs, etc. for effective law enforcement.
- The police are to be informed regarding the location of major roadwork, schedule and name of the contractor by the maintenance office. Also, a request for assistance form the police for traffic control (if necessary) should be given at the same time.
- The police are to be informed regarding major disasters/accidents/incidents/ fire/explosions/spilled hazardous loads by the traffic control room. Requests for assistance from the police for traffic control should be given at the same time.
- Assist police in accident investigations on site by patrol personnel.
- Obtain a copy of accident records from the police for filing and analysis.

5.6 Service Level of Motorway Maintenance and Operation

5.6.1 Service Level

As defined in paragraph 1) of section 5.2.3, the objective of motorway maintenance and operations is to maintain the road structures and relevant facilities as originally designed, constructed and subsequently improved in a acceptable range, so that traffic safety, smooth traffic flow and riding comfort may be achieved within an efficient and economic system. The service level or the level of service is a scale or target to indicate how satisfactorily the above objective is achieved by the proposed maintenance and operations for the motorway users.

On the other hand, maintenance and repairs of road structures requires considerable cost. In the case of the motorway system in Turkey the budget for maintenance and operations, except that required for the initial investment for equipment and facilities for motorway maintenance, will start from a smaller base, because almost all the motorway structures and facilities are new and should be free from costly maintenance and repairs for the time being. However, road structures and facilities have their own inherent life span. When they approach this life limit, the cost for maintenance and repairs increases accordingly. But, the actual maintenance and operations must be carried out within a certain limitation of budget. There is also a limitation in the manpower to be mobilized for work. Therefore, it is practical to set up some different degrees in the service level when actual maintenance and operations are planned.

However, from its nature a motorway is required to have a superior function compared with other categories of roads, especially with respect to speed, comfort and safety. Although there is a large difference in traffic volume and required characteristics amongst the motorway sections, the same functions is equally required overall the motorway.

Consequently it would be practical for the motorway maintenance to set up two or three different service levels for the various motorway sections throughout the fully developed 3,000 km motorway system corresponding to the traffic volume, importance of the routes in the road network and other governing factors for particular maintenance items.

Once such service levels are reasonably established, they would become a useful tool for planning of the maintenance organization and activities.

An effort is made to set up such service levels for typical maintenance tasks of inspections and snow and ice control to utilize them for the Basic Plan and the Short-term Implementation Program presented in Chapter 6 of this study report as follows.

5.6.2 Service Levels for Particular Work Items

1) Inspections

The service level for the inspection is reflected to the density and frequency of inspections by routine, periodic and special inspections hereinafter defined. Any defects of road structures and facilities can not be repaired before such defects are identified by the inspections. Therefore, it could be said that the density or frequency of inspections should generally be proportional to the service level for the given motorway section. On the other hand, in the case of maintenance of pavement for a typical example, the necessity of maintenance and repair work or probability of defects occurring will increase as the traffic becomes larger in volume and heavier in loadings where other conditions are the same. The same would also increase as the aging of the pavement after construction or its renewal. It is also influenced by the types of road structures of whether the section mainly consists of cut and fill, tunnels or bridges.

2) Snow and Ice Control

The service levels for snow and ice control is reflected to the requirement for snow and ice control operations, for example.

(1) How many lanes should be open to traffic in a specified time after the snow deposit begins to hinder normal car traveling?

(2) If cars can travel without anti-slippery tires or tire chains after the above operations?

However, these requirements must be determined by the more dominant factors, such as frequency of snowfall, thickness of snow deposit and the prevailing temperature in winter. In determination of snow and ice control capacity of the motorway, it should be empathized that the task given to the motorway is speedier transport by road compared with other categories of road systems.

As seen in the above discussions on the major work items of maintenance and operations, the matter is not simple to be determined by a single factor. Therefore, it has been decided to determine the capacity of maintenance and operations in each motorway section considering various factors particular to each work item of maintenance in addition to the service levels set up for the traffic management and operations in 5.4 of this chapter, where the service levels have been classified mainly in accordance with the traffic volume forecasted for the section.

However, it is important to set up two or three classes of service levels for the maintenance and operations based on actual experience and requirement from the motorway users.

KGM are recommended to establish their own service levels for the maintenance and operations in the course of their own accumulation of actual operations from now on.

5.7 Basic Plan for Motorway Maintenance and Operations

The basic plan for Motorway Maintenance and Operations on the 3,000 km motorway network in Turkey is discussed and recommended in the following paragraphs based on the previous discussion for Motorway Maintenance and Operations. The jurisdictional segmentation of the 3,000 km Motorway network is indicated in Figure 5.5.12 together with locations of main maintenance centers for each division.

5.7.1 Flow of Motorway Maintenance and Operations

In order to keep the motorway maintenance and operations within acceptable service level, its components have to be carried out in a regular and systematic manner. This manner must be consistent with the requirements of its organization and in accordance with the established procedures. These procedures have to be consistent with any operation. Whilst the details may vary slightly between various tasks, the overall procedural routine must be followed. This routine must be free form unnecessary interference. The work flow is portrayed in Figure 5.7.1.

5.7.2 System to Operate Motorway Maintenance

1) Organization

The following levels of KGM organization have been studied for motorway maintenance considering the present Motorway Department and the organization for highway and provincial roads:

- Headquarters
- Regional Division Offices
- Main Maintenance Centers (MMC)
- Maintenance Offices (MO)

Reference is made to Section 5.3, Organization.

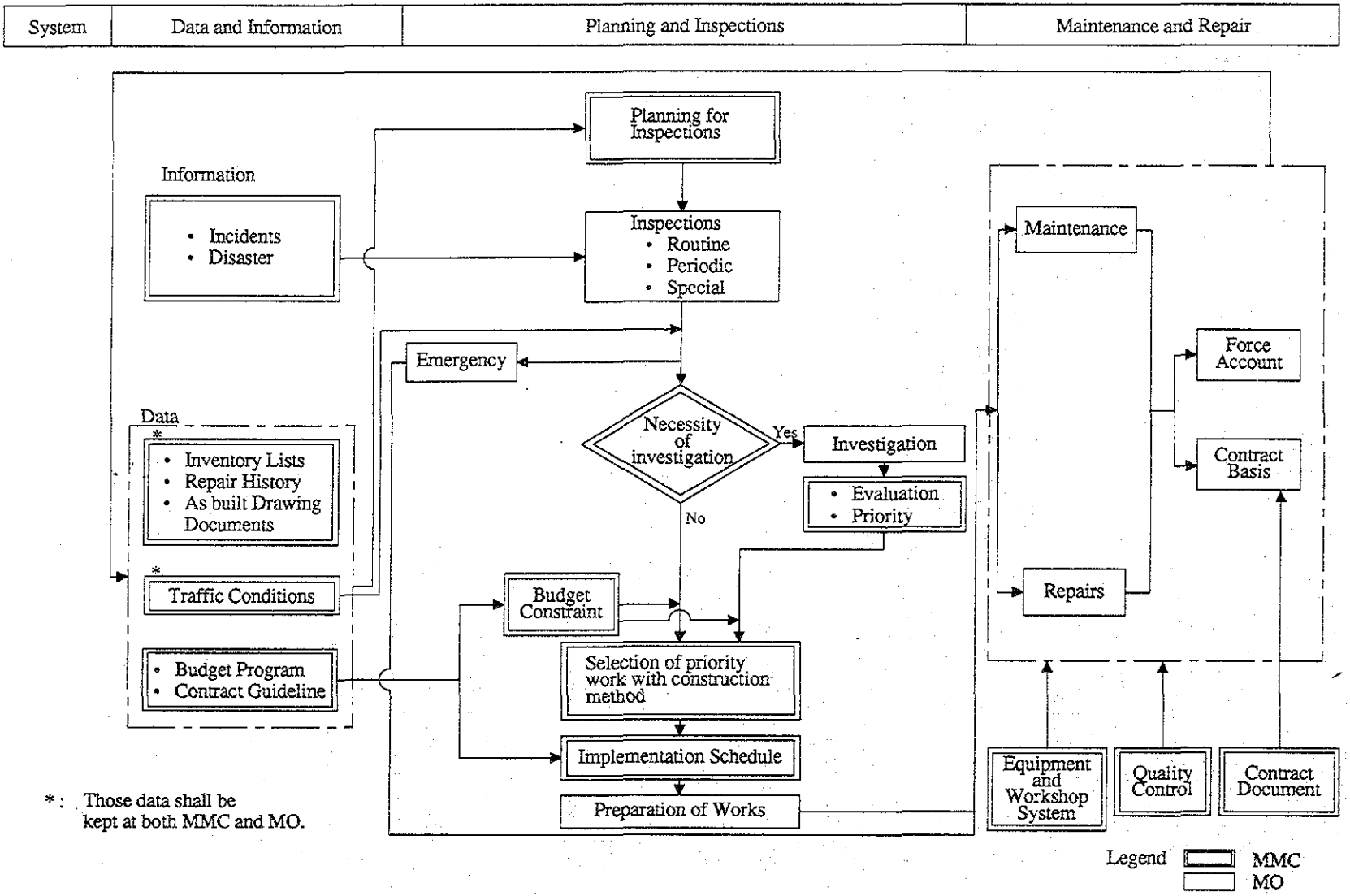


Figure 5.7.1 Flow Chart of Motorway Maintenance and Operations

2) Maintenance Operating System

Motorway maintenance covers various activities related to inspections, maintenance and repairs, which require quick response and appropriate treatments to keep the motorway always open to traffic.

KGM should be responsible for the following activities of motorway maintenance by force account or on contract basis, depending on the nature of the work;

- Inspections by maintenance patrol unit
- Road cleaning of road surface, tunnel walls, etc.
- Vegetation control
- Snow and ice control
- Repairs of traffic safety and management facilities
- Pavement maintenance and repairs
- Maintenance and Repair of bridges
- Maintenance Repair of tunnels and other structures
- Disaster prevention and restoration
- Others

The following matters shall be materialized to implement the above for the objective of motorway maintenance and operations;

- Communications (instruction, response, duty, decision and coordination) system among headquarters, regional division office, main maintenance center and maintenance office
- Extent of activity and responsibility of each office

Maintenance on a contract basis should be gradually increased to cope with an increase of maintenance work volume and due to budget constraint for KGM staff and workers, and to promote technical advances of contractors or concession companies. The following should be considered to encourage the use of contractors to carry out motorway maintenance activities:

- Maintenance activities based on a monthly and annual program
- Clarification of working criteria of maintenance and repairs
- Formulation of contracts, supervision and acceptance system for motorway maintenance work

- Establishment of a contract system for private firms to rent KGM's equipment (equipment which is specialized and costly)
- Provide guidance to the contractors as to the significance of motorway maintenance.

Inspection by Maintenance Patrol Unit

Inspections by maintenance patrol unit should be established and performed by KGM in order to determine the appropriate actions to take for necessary maintenance and repairs. The maintenance patrol system should be linked to the traffic patrol system and each patrol system should have its assigned duties for coordination.

3) Equipment and Workshops

(1) Equipment

The number and types of maintenance equipment required at each main maintenance center and maintenance office are closely related to maintaining intended service levels for the motorway section, the weather conditions, the types of major road structures (tunnel, bridge, pavement type, etc.) and the traffic volume. A consideration whether the work will be done by force account or on a contract basis is also necessary for such determination.

The maintenance equipment will be mostly used on a motorway open to public traffic, so that the equipment used should have the following capabilities:

- high degree of safety and workability
- compact size and substantial maneuverability so as not to affect traffic flow
- high degree of mobility
- Less hazardous to public with respect to noise, vibrations and smell during operations
- capability of performing night work

(2) Workshops and Depots

Workshops and depots will be located at each main maintenance center. However, they might be of a small scale since main maintenance centers will be supported by each regional division's workshop and depot except Regional Division 17.

4) Data Base and Management System

Data base and management system is indispensable for the motorway maintenance. One of the most important activities is to collect reliable data, in particular, to collect and keep as-built drawings and documents including design reports and documents, construction record, and historical records. These records must include inspector's observation of an extraordinary incident, the work carried out, and the inference to traffic, particularly in relation to vehicular accident and the causes for them to occur. This function is to determine any previous incident that may relate to the present condition. Various inventories for road structures and facilities shall be developed to maintain the motorway properly.

5.7.3 Planning to Operate Motorway Maintenance

Motorway maintenance consists of many types of works for which the scope and scale are profound and vague. Therefore, it is important to prepare a detailed work plan for each category of work in advance so that the implementation of the similar works will be carried out effectively. Since inspections, maintenance and repairs are performed on the motorway open to public traffic, it is necessary that the coordination should be effectively done between the MO and MMC, among the engineers and chief in the MO, and the manager and head in the MMC. It is also necessary that a notice should be forwarded to the police office in advance and that public announcement activities are made to motorway users and residents along the motorway.

5.7.4 Activities and Tasks of Motorway Maintenance

The activities and tasks of the motorway maintenance are shown in Figure 5.7.2.

A brief description of each activity of motorway maintenance is given on three (3) components; inspection, maintenance and repairs as follows:

1) Inspections

Inspections are performed to identify the needs of maintenance and repair works so that maintenance and repairs could timely be made and motorways be free from hindrance to traffic.

2) Maintenance

Maintenance consists of the following activities:

(1) Road Cleaning

Road cleaning involves removing dirt and trash from the road and adjacent facilities to eliminate traffic obstructions.

(2) Vegetation Control

Vegetation control consists of planting new growth, maintaining established vegetation, and removing old vegetation so that grass, plants and trees may well be maintained so that a pleasing ambiance can be provided for drivers.

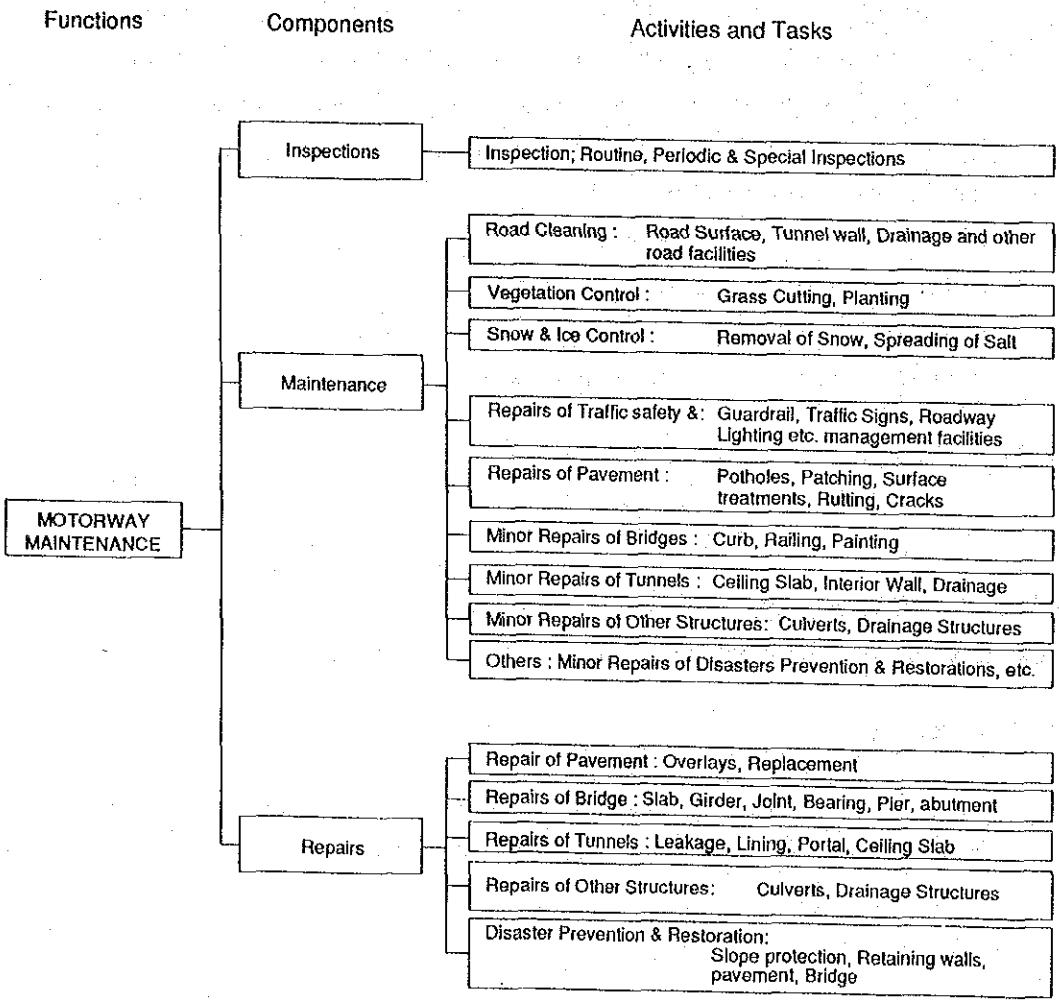


Figure 5.7.2 Activities and Tasks of Motorway Maintenance

(3) Snow and Ice Control

Snow and ice control is comprised of snow-removal and road surface de-icing.

Snow removal includes the removal of fresh snow by snow-plows, wider clearance of snow from the lanes by snow-plows and disposal by a combination of loaders and dump trucks.

Road surface de-icing is a preventative operation done at locations where freezing is expected. It involves the scattering of de-icing agents on the road by specially equipped vehicles.

(4) Repairs of Traffic Safety and Management Facilities

Traffic safety and management facilities are directly related to traffic safety and management. The following are the facilities to be maintained and repaired:

- Guardrail and guard pipe
- Anti-dazzle plate
- Traffic signs
- Roadway Lighting
- Traffic markings
- Delineator
- Kilometer post

(5) Minor Repairs of Pavement

Pavement maintenance consists of pothole repair, crack sealing and patching of small area of damaged pavement and adjustments of gaps on roadway surface.

(6) Minor Repairs of Bridges & Tunnels

Minor repairs to bridges include curbs, railings, and necessary repainting. Minor repairs to tunnels include interior wall, ceiling and drainage.

(7) Others (Maintenance)

- Maintenance of buildings, machinery, and electrical equipment as well as communication facilities is required to operate the motorway maintenance activities in a proper manner.
- Small scale repairs of disaster prevention and restoration work.

3) Repairs

(1) Repairs of Pavement

Asphalt overlay or replacement is required due to cracking and rutting caused by heavy traffic and asphalt deterioration overlay and replacement may include the areas of existing patching and pothole repairs. An evaluation method shall be established to determine the thickness of overlay required, based on a survey and analysis of the existing pavement roughness, cracking ratio and depth of rutting.

(2) Repairs of Bridges

Repair of superstructures and substructures is needed due to the damage caused by heavy traffic, accidents, weathering, scouring, etc.

Replacement and strengthening of bridge slabs, expansion joints and bearings based on the identification and evaluation of causes and defects are also required due to the damage caused by heavy traffic, accidents, etc.

(3) Repairs of Tunnels

Repair of tunnel walls, leakage prevention and ventilation repair are required to restore the condition of tunnels caused by damages by earth pressure, water penetration, heavy traffic, accidents, etc.

(4) Repairs of Other Structures

Repair of drainaged structures and drainage facilities are needed to protect the road structures.

The repairs and restoration of slope failures in cut and fill sections are accomplished by employing slope protection methods such as retaining walls, concrete cribs, mortar spraying, anchorages, vegetation, etc.

(5) Disaster Prevention & Restoration of Damages Caused by Unforeseen Natural Disasters

Slope failures, and pavement and structure damages can be caused by heavy rainfall and earthquakes. Slope failures are normally related to heavy rainfall or inadequate drainage of the surface and seepage water. The work include both preventive and restoration works.

5.8 Operation System during Unusual Conditions

5.8.1 General

Incidents to disrupt the smooth flow of traffic on the motorway can be distinguished into "man-made" and "natural".

Man-made incidents include those caused by road users such as traffic accidents, vehicle breakdowns, fallen objects, spilled loads, fires on the roadside/slope caused by cigarettes. Other types of man-made incidents are due to road maintenance activities like overlays, pavement repairs, cleaning activities, equipment repairs and so on. Still others may be caused by external factors such as fires close to the motorway corridors, damages to access road facilities or illegal access by pedestrians.

Natural incidents include those caused by natural causes like unusual weather (heavy snow, fog, strong winds, heavy rain, earthquake) and incidents related to slope erosion, fallen rocks, and landslides.

These incidents pose threats to the safety of road users and are potential causes for traffic accidents. Appropriate and prompt measures for handling such incidents are therefore important in order to avoid loss of life and property damage.

5.8.2 Communications during Unusual Conditions

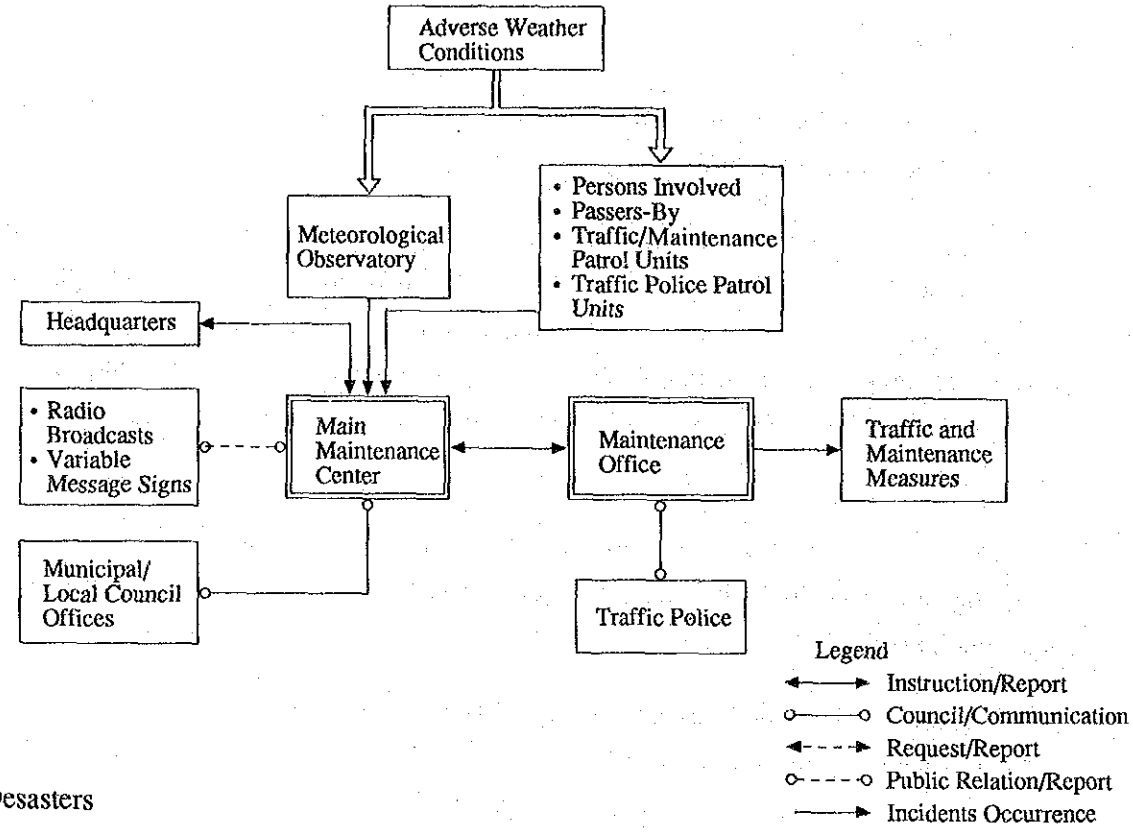
The flow of communications during an incident, which occurs under unusual conditions, is illustrated in Figure 5.8.1.

5.8.3 Standards for Determining the Level of Traffic Control Measure

The initial disaster countermeasure is to prevent as far as possible the occurrence of traffic accident, or slope slips, for example in the case of concentrated rainfall. Next, if disaster has occurred, measures are to be taken to prevent the spread of damages and prevention of secondary incidents. This can be achieved by activating the communication system and passing on the information quickly to the traffic control room and users, assessing the nature and seriousness of the incident and deciding the appropriate countermeasure to take.

In principle, disaster prevention system defines three levels of warning as 'Alert', 'Warning' and, 'Emergency' in accordance with the seriousness of the disasters. The three levels are shown as follows.

- Adverse Weather Conditions



- Desasters

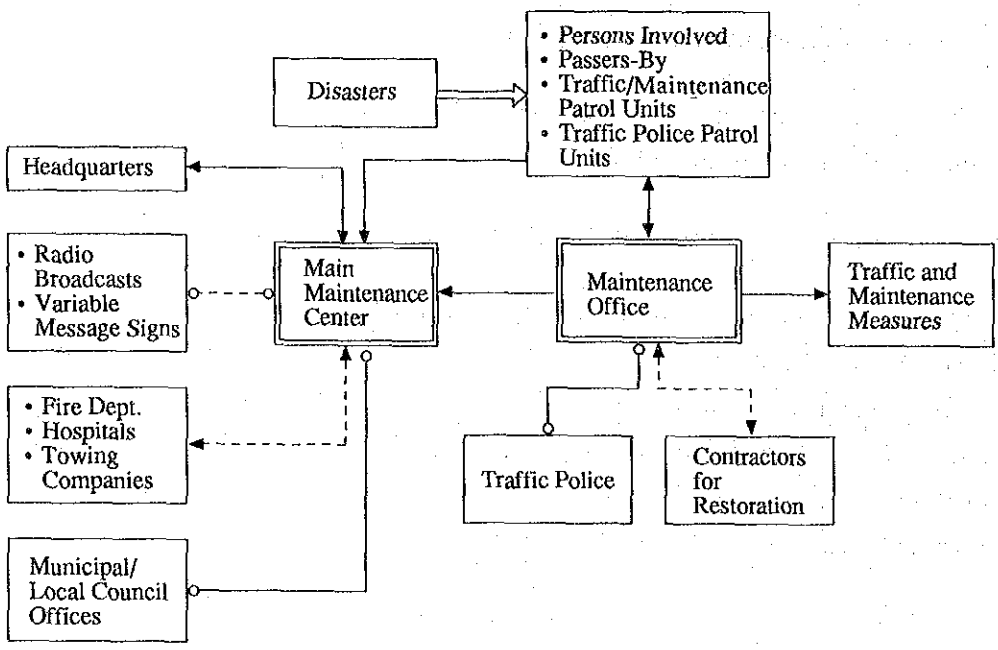


Figure 5.8.1 Communication during Unusual Conditions

1) Alert and warning stage:

These stages are set up when a certain disaster is expected for example, because of adverse weather and some standard measurements (target values) are considered to be taken.

The organized personnel are required to be positioned in the main maintenance center and maintenance office. If necessary, staff with work force, materials and equipment are positioned in the site to be ready for immediate response to any change in the circumstance.

2) Emergency stage:

This stage is set up when a major disaster has occurred. The entire resource of the organization is mobilized to cope with the disaster. A person to direct and supervise the organization is stationed in the main maintenance center and maintenance office and, if necessary, the request may be made for assistance to other authorities concerned.

5.8.4 Organization and Main Tasks

A disaster prevention task force will be positioned in the main maintenance center and maintenance office. The organization of main maintenance center should consist of a chief, coordinating group, information collection group and administration group. And the organization of maintenance office should consist of a chief, coordinating group, traffic management group, maintenance group and administration group.

Principal tasks of the disaster prevention task force are described below.

1) Collection of information on weather, road and traffic conditions

2) Analysis and dissemination of information on road and traffic conditions

3) Calling of the staff and work force

4) Preparation of materials and equipment

5) Planning and execution of the measures to deal with traffic control and maintenance work to recover from disaster

6) Others

5.8.5 Traffic and Maintenance Measures for Disaster Prevention

Some standard measurement (target values) by three levels of warning stages are set. Disaster prevention task force (maintenance office) may prohibit or regulate the road traffic when the traffic is judged hazardous because of damage or collapse of the road structure, and emergency restoration from damage is carried out. Such traffic regulation and restoration are as follows:

1) Traffic regulation - Road closure, Lane control, Speed control,
2) Emergency rescue
3) Emergency restoration - Execution of emergency restoration, Detour planning

5.9 Traffic Safety Plan

5.9.1 Scope of Traffic Safety

The traffic safety plan mainly covers two basic functions of accident prevention and minimization of damages to road users and property. The three principal factors affecting the occurrence of traffic accidents are;

a. Traffic and road conditions
b. Drivers
c. Vehicles

The components of traffic safety are shown in Figure 5.9.1. Countermeasures considered for traffic accidents must take into account both prevention of the accident and minimization of injuries to road users. Accident analysis is not necessarily directly related to these two facts, but they should be closely related to proposals for future traffic safety plans and measures.

The promotion of traffic safety can be conducted through the 3E method which includes Engineering, Enforcement and Education. Another E, Environments, has been added to traffic safety promotion due to the recent increase in the awareness of the role of environment on human behavior. Engineering is responsible for road design, road construction, etc. as well as the design of vehicle from the safety viewpoint. Enforcement is vital to ensuring smooth traffic flow and complying with traffic regulations. Education is important in instilling the appropriate safety attitudes, skills and knowledge required for driver's traffic safety.

Introduction of such a comprehensive approach to traffic safety can be expected to reduce accidents and enhance overall traffic safety.

5.9.2 Level of Traffic Safety

To enhance traffic safety on the motorways, steps should be taken to introduce the components as depicted in Figure 5.9.1, both individually and collectively.

Social and economic factors may make it unreasonable to expect application of every traffic safety measure simultaneously. Because of this, the identification of safety plans and their priorities are very important for road safety planners. Generally, the selection of important plans and their priorities are determined by several steps based on the adopted definition of the traffic safety level. In the early stages, basic and fundamental levels of traffic safety measures can be introduced as the minimum level of action to be taken.

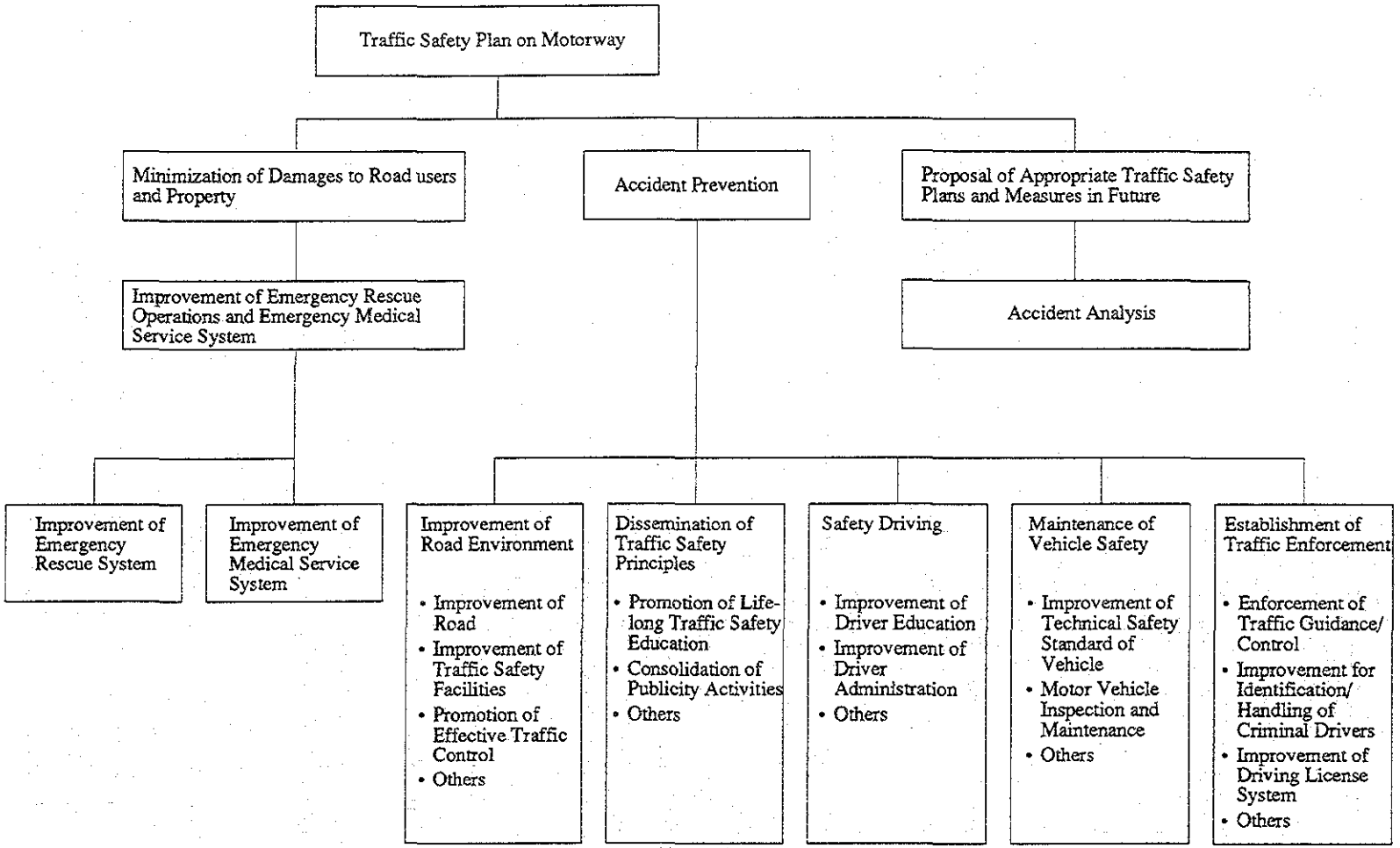


Fig. 5.9.1 Components of Traffic Safety

In determining the minimum level of action to be taken, the relationship of human activities and road environment is very helpful in establishing priorities. Three levels of traffic safety measures are established as follows:

1st Level : Safety measures are considered from the driver's viewpoint, such as psychological and physiological factors.

2nd Level : Establishment of relief measures for traffic accidents such as changes to the driver's license system, vehicle maintenance system and insurance system.

Final Level : Establishment of total safety improvements based on rectifying both human error and mechanical problems.

Based on these three levels of traffic safety measures, the first level is recommended as the first step for traffic safety measures for the motorway in Turkey. Accordingly, the recommended traffic safety measures are as follows:

a. Improvement plans for safe road environment
b. Public dissemination of information on traffic safety and safe driving procedures
c. Establishment of an accident analysis and reporting system

Item c., should be carried out even though it is not directly related to human behavior on the motorway. Establishment of an accident analysis and reporting system is critical to the identification of higher than average accident locations and the systematic implementation of procedures to reduce those accidents.

5.9.3 Improvement Plans for Traffic Safety

1) Improvement Plans for Safe Road Environment

An improvement plan for a safe road environment is based on the study team's rough site survey, by which the following countermeasures are proposed:

a. To eliminate intrusion by animals and pedestrians
b. To install warning signs for sections with sharp curves or steep vertical grades
c. To install warning signs for sections with severe weather conditions.

2) Dissemination of Information on Traffic Safety and Safe Driving Habits

To promote safe driving habits on the motorway, a traffic safety campaign and the promotion for safe driving are recommended as follows:

a. Traffic Safety Campaign

For the traffic safety campaign, the following are proposed:

- Preparation of a motorway map,
- Traffic safety campaign on proper motorway driving,
- Others

b. Promotion of Safe Driving

To promote safe driving, the following are recommended:

- Preparation of a guide book on safe driving,
- Introduction of safety training,
- Holding on traffic safety symposiums,
- Others.

3) Accident Analysis and Reporting System

An accident analysis and reporting system is recommended as a part of the safety proposals, as it is essential to conduct research into the causes of accidents, which in turn enables proposals for appropriate actions or safety plans to be established. The recommended improvement items are as follows:

a. Preparation of a motorway accident investigation form,
b. Establishment of an accident reporting system,
c. Creation of an accident analysis team.

5.10 Outline of Architectural Facilities

5.10.1 General

The architectural facilities consist of buildings required for the management and maintenance of motorways, and for traffic control and service facilities for motorway users. The following are the types of architectural facilities, each of which may be composed of more than one building:

Types of Architectural Facilities

1. Main Maintenance Center
2. Maintenance Office
3. Maintenance Substation (for snow and ice control)
4. Toll Collection Office
5. Barrier
6. Parking Area
7. Service Area
8. Rest Area
9. Training Center

5.10.2 Purpose and Function

(1) Main Maintenance Center

A main maintenance center will be established in each region to act as a main maintenance center in the region. The service area will be some 200 - 500 km in motorway length and each main maintenance center will have the following facilities:

1) Administration Building
2) Traffic Control Building
3) Police Station
4) Workshop (for special vehicles)
5) Workshop (for ordinary vehicles)
6) Rest House with Catering Facilities
7) Storage Building (salt)
8) Storage Building (spare parts)
9) Power Building (substation and emergency power generation unit)
10) Workers' Rest House
11) Filling Station
12) Sports Facilities (tennis courts and volleyball courts, etc.)

13) Garage
14) Construction Machinery Yard
15) Car Park
16) Staff Accommodation (for families and single people)
17) Kindergarten

(2) Maintenance Office

Within the jurisdiction of a main maintenance center covering a section of 200 - 500 km in length, several maintenance offices will be located to be responsible for road maintenance and traffic control. Each maintenance office will be responsible for a section of 50 - 70 km in order to achieve smooth and efficient motorway management, maintenance and efficient traffic control. Each maintenance office will have the following facilities:

1) Administration Building
2) Traffic Control Building
3) Police Station
4) Workshop (for ordinary vehicles)
5) Rest House with Catering Facilities
6) Storage Building (salt)
7) Power Building (substation and emergency power generation unit)
8) Filling Station
9) Garage
10) Staff Accommodation (for families and single people)
11) Car Park

(3) Maintenance Substation

A maintenance substation to remove snow and ice from the road will be provided at 25 km intervals in mountain areas with heavy snowfall spot in winter. These units will only be operational in winter during which time each unit will have full-time staff. Each maintenance unit will have a substation with the following facilities:

1) Staff Accommodation (including office)
2) Storage Building (salt)
3) Garage
4) Car Park
5) Power Building
6) Warehouse (gasoline and others)

(4) Toll Collection Office

A toll collection office will be established at each access point to the motorway from ordinary trunk roads to collect the toll from motorway users. Each toll collection office will have the following facilities:

1) Toll Booth(s)
2) A Combined Monitoring Station and Office
3) Police Branch Office
4) Power Building (substation and emergency power generation unit)

(5) Barrier

For full access control of the toll road, a barrier will be introduced at both the starting and ending points of the motorways and also near metropolitan cities. Each barrier will have the following facilities:

1) Toll Booth(s)
2) A Combined Monitoring Station and Office

(6) Parking Area

Parking areas will be installed along the motorway at 10 - 20 km intervals so that travelers can have a short rest. Each parking area will have the following facilities:

1) Car Park
2) Public Toilets

(7) Service Area

Service Areas will be installed along motorways at intervals of approximately 100 km to provide travelers with rest, meals and fuel services. The construction of service area is not included in the motorway construction projects currently in progress. The BOT method will be employed for the construction and management of these service area. It is expected that the construction of services area will commence after the completion of the 1,500 km motorway network in Turkey at the end of 1994. Each service area will have the following facilities:

1) Restaurant and Cafe
2) Kiosk
3) Filling Station

4) Power Building (substation and emergency power generation unit)
5) Staff Accommodations
6) Car Park
7) Public Toilets

(8) Rest Area

Rest Area with overnight accommodation facilities will be provided on motorways at 200 - 300 km intervals, selecting scenic sites to provide travelers with sightseeing and leisure services. Together with rest facilities, the construction of hotels or motels in mountainous regions by a lake or along the coast is desirable so that travelers can enjoy beautiful surroundings. Each rest area will have the following facilities:

1) Hotel/Motel
2) Restaurant and Cafe
3) Kiosk
4) Filling Station
5) Power Building (substation and emergency power generation unit)
6) Staff Accommodations
7) Car Park
8) Public Toilets

(9) Training Center

One or two training centers will be established in Turkey to provide both managerial and technical education/training for new recruits and middle ranking staff members of the KGM. The following facilities will be introduced for each training center.

1) Education/Training Building
2) Trainee Accommodations (for 30 people, including instructors)
3) Canteen Building
4) Staff Accommodations
5) Car Park

Short Term Implementation Program

6. Short Term Implementation Program

6.1 Introduction

The Short Term Implementation Program will establish the requirements for implementing a complete motorway maintenance, operations and traffic management system for the motorway segments, already open or soon to be open, in regional divisions 1, 2, 4, 5 & 17.

The following points are considered important relative to the 1,500 km Implementation Program:

1) As a new system of motorway OMM is being established in the Republic of Turkey, significant knowledge and experience would be furnished from this "Implementation Program"

2) The existing features of the maintenance, operations and traffic management system have been considered, such as the existing road maintenance facilities and equipment, and traffic management equipment such as emergency telephones, fixed guide signs, variable message signs, CCTV systems, etc.

3) The service areas will be operated under the BOT (build, operate, transfer) system, in which private contractors will provide all the services necessary for those areas to function in a manner satisfactory to KGM. The requirements for those areas were already discussed in Chapter 5, as an integral part of the 3,000 km motorway OMM system.

The following sections of the motorway with their cumulative lengths are involved in this Short Term Implementation Program:

• Division 1 :	from Camlica to Duzce,	L = 190.8 km
• Division 2 :	from Izmir Ring Road to Aydin,	L = 126.0 km
	from Izmir Ring Road to Cesme,	L = 91.1 km
• Division 4 :	from Duzce to Ankara Ring Road,	L = 332.4 km
• Division 5 :	from Pozanti to Tarsus,	L = 59.7 km
	from Mersin to Gaziantep,	L = 313.9 km
	from Iskenderun Bati I.C to Arsus,	L = 90.4 km
• Division 17 :	from Edirne to Kozyatagi,	L = 314.0 km
	(including 2nd Peripheral Road	
	from Topkapi to Sogutlucesme,	L = 24.0 km
	(1st Peripheral Road)	
	Total Length :	1542.3 km

6.2 Planning and Engineering

6.2.1 Traffic Management and Operations

1) System Configuration

The traffic management and operations system for the motorway has four major functions. They are information collection, information processing and decision making, information dissemination, and execution and enforcement of the decision.

The structure of the system configuration is shown in Figure 6.2.1.

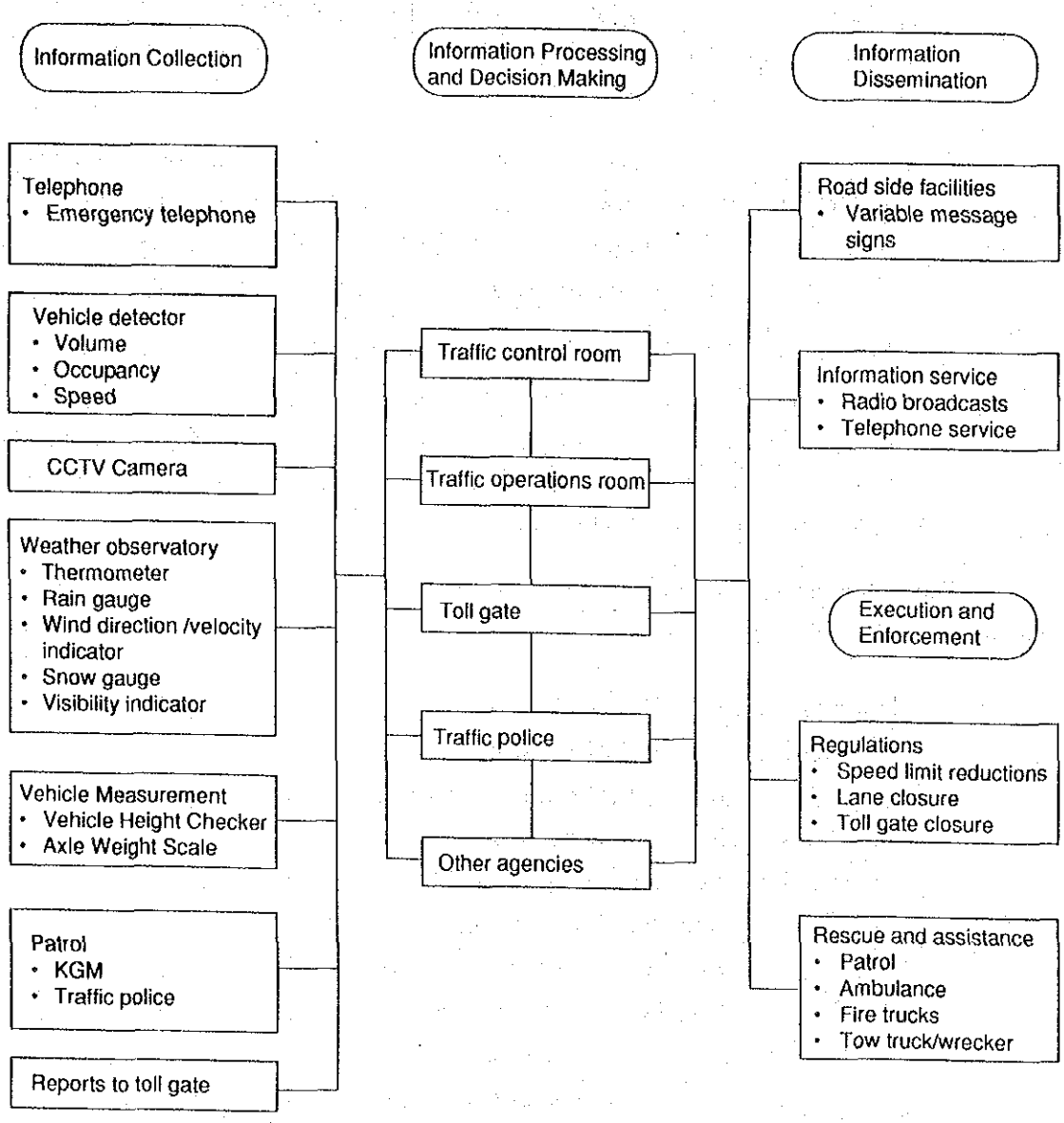


Figure 6.2.1 Traffic Management and Operations System Structure

(1) Information Collection

The information collection system will consist of three different systems, those being an automatic system, a manual system and a visual system. Traffic data and traffic incident information are either automatically gathered through traffic detectors, weather observatory equipment and other devices, or manually reported by emergency telephone or by the radio communications system provided by patrol cars. The CCTV system is also a tool for traffic surveillance as it furnishes the system operator with a visual image of the traffic situation.

(2) Information processing and decision making

Information processing and decision making is accomplished in the traffic control room. The traffic control room is the core of the traffic management and operation system. All information is gathered at the center where traffic management activities such as incident detection, assistance to drivers, detour implementation, special enforcement, etc. are activated in response to monitoring of the traffic situation.

(3) Information dissemination

Roadside information dissemination devices such as variable message signs are controlled from the traffic control room so that road and traffic conditions can be conveyed to road users. Information is provided through a telephone service, in which an inquiry is answered either by an operator or by a prerecorded message.

(4) Execution and enforcement

If an incident occurs on the motorway, countermeasure must be taken swiftly. There are a variety of traffic control measures that can be taken such as a speed limit reduction during an adverse weather condition, closure of a shoulder, closure of a lane, and total closure of a section of motorway. Traffic control measures must be executed in a coordinated manner by both the motorway management body (KGM) and the traffic police. The traffic control room has a major responsibility for overseeing such activities.

2) Traffic Control Room and Traffic Operations Room

(1) Outline of the functions for the traffic control room and the traffic operations room

The traffic control room is located at the main maintenance center and is the core of the traffic management and operations system.
It accommodates a computer system and associated equipment as well as staff to operate the system and to plan for countermeasures to be taken when incidents occur. The computer system is operated by the judgment of staff.
The traffic operations room is located in each maintenance office. Its purpose is to gather and distribute data from/to roadside equipment and to monitor information so as to promptly respond to incidents. Another important function of the traffic operations room is to back up the functions of the traffic control room (to some extent) in the case of communications interruption between the traffic operation room and the traffic control room.

(2) Outline of construction

The traffic control room is a location where staff are stationed and control desks, terminals and a display panel are located. It is also a location where the computer, peripherals and other equipment are installed, a power room where an uninterruptible power supply system is placed, and provides other spaces for offices, a workshop, a storage room, etc.

The traffic operations room is a control room where a monitoring or control desk is installed and a carrier terminal station where peripherals and a data transmission system are located.

(3) Location

The traffic control room should be located at the main maintenance center. The traffic operations room should be located at the maintenance offices in order to monitor certain information required for management activities, such as patrolling, motorway maintenance activities and the provision of first-aid.
As shown in Figure 6.2.2, five (5) traffic control rooms and 27 traffic operation rooms are proposed for the traffic management and operation system.

(4) Connection of roadside equipment

Roadside equipment is installed at various locations along the motorway as described in the following section, and this equipment is controlled either by the maintenance office or by the main maintenance center. The communications network is established between the offices and from the offices to the roadside equipment. Figure 6.2.3 illustrates the location of the roadside equipment and now this equipment is connected and operated.

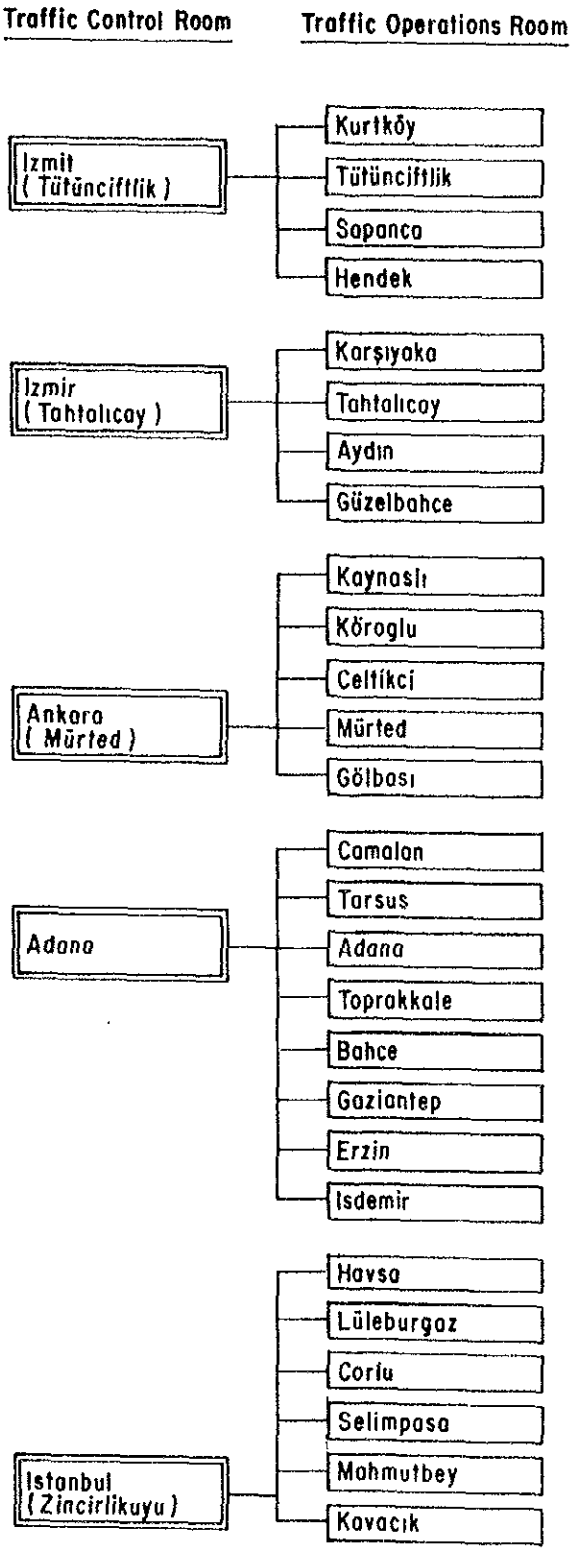


Figure 6.2.2 Locations of the Traffic Control Room and the Traffic Operation Room

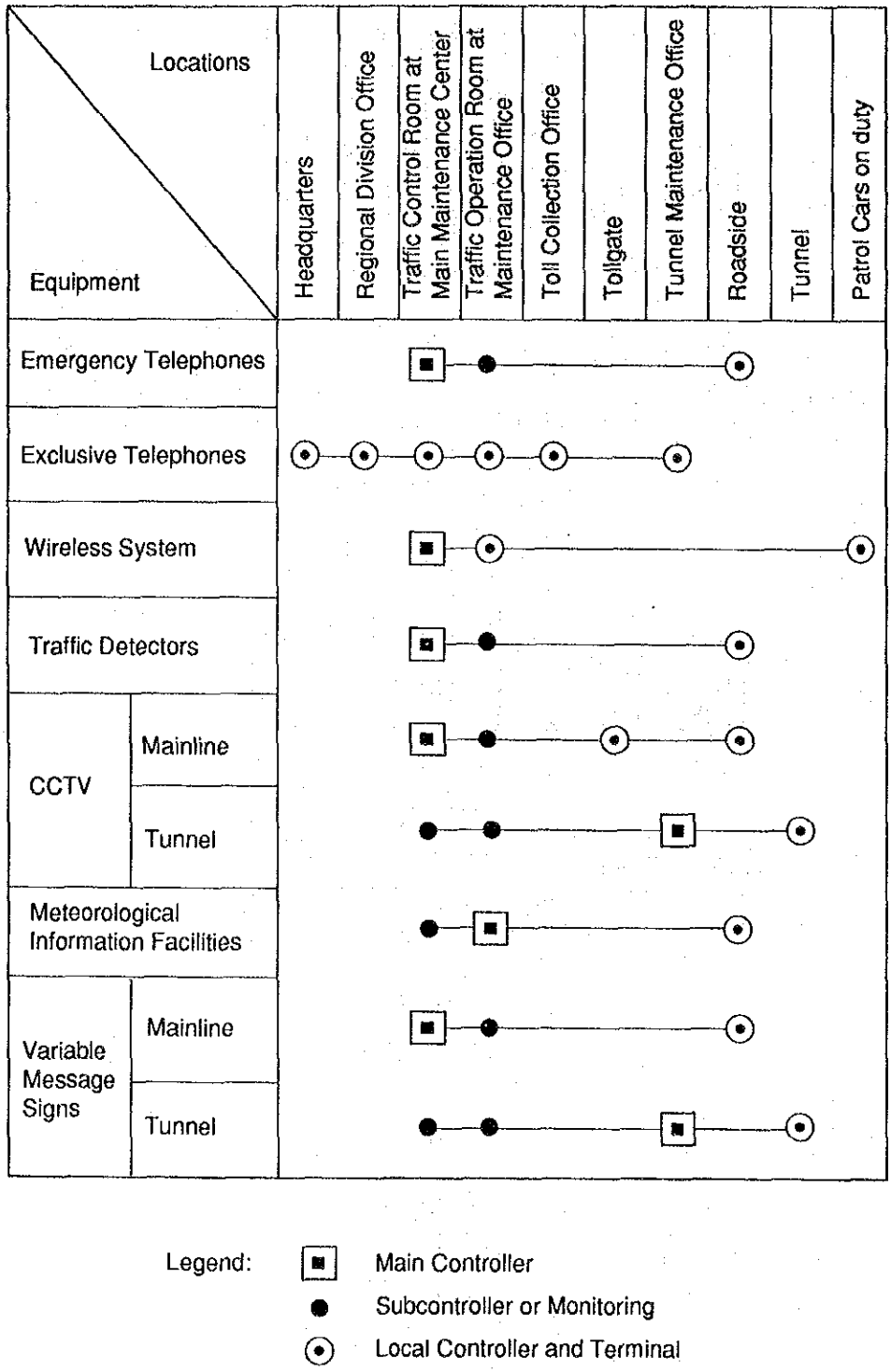


Figure 6.2.3 Connection of Roadside Equipment

3) Installation Standards

As mentioned above, a traffic management and operations system consists of various facilities and equipment on the roadside and at various locations within the motorway management organization as well as a communication network.

These facilities and equipment are installed differently in different segments of the motorway to reflect the appropriately designated traffic management and operation service level. Table 6.2.1 shows the general guidelines for installation standards for various facilities and equipment on the motorway, according to service level.
For Service Level 3, the basic facilities such as installation of emergency telephones and establishment of the communication cable network are implemented. In addition to these, other basic facilities which provide for safety on the motorway are installed. These basic facilities include traffic detectors at representative locations of the jurisdiction of maintenance offices with traffic operation rooms, meteorological information facilities at representative locations subject to severe weather, variable massage signs at each entrance of tollgates and long tunnel entrances. Measurement facilities such as vehicle height checkers and axle weight scales are installed at tollgates for preservation of the motorway itself.

For Service Level 2, the facilities and equipment installed for Service Level 3 are to be enhanced by either increasing the numbers of units installed or adding other devices. The installation of traffic detectors, for example, is increased to provide for locations with large traffic volume variations such as junction and interchanges located in major cities. With these increased numbers of detectors, more traffic data including merging and diverging traffic volumes at junctions and access and egress traffic volumes at major interchanges can be accurately counted. Visual information gathering is made possible by introducing CCTV systems at Service Level 2. CCTV cameras are installed at representative locations having high traffic accidents and severe weather conditions for traffic flow observation. The numbers of variable message signs are also increased in Service Level 2 and installed upstream of off-ramp at major interchanges.

Service Level 1 is established to achieve a more sophisticated management than Service Level 2, where all the necessary data collection devices are installed to gather detailed and accurate traffic data, in particular, traffic congestion data. The information dissemination function is further expanded by installing variable message signs before each interchange off-ramp.

Table 6.2.1 Installation Standards

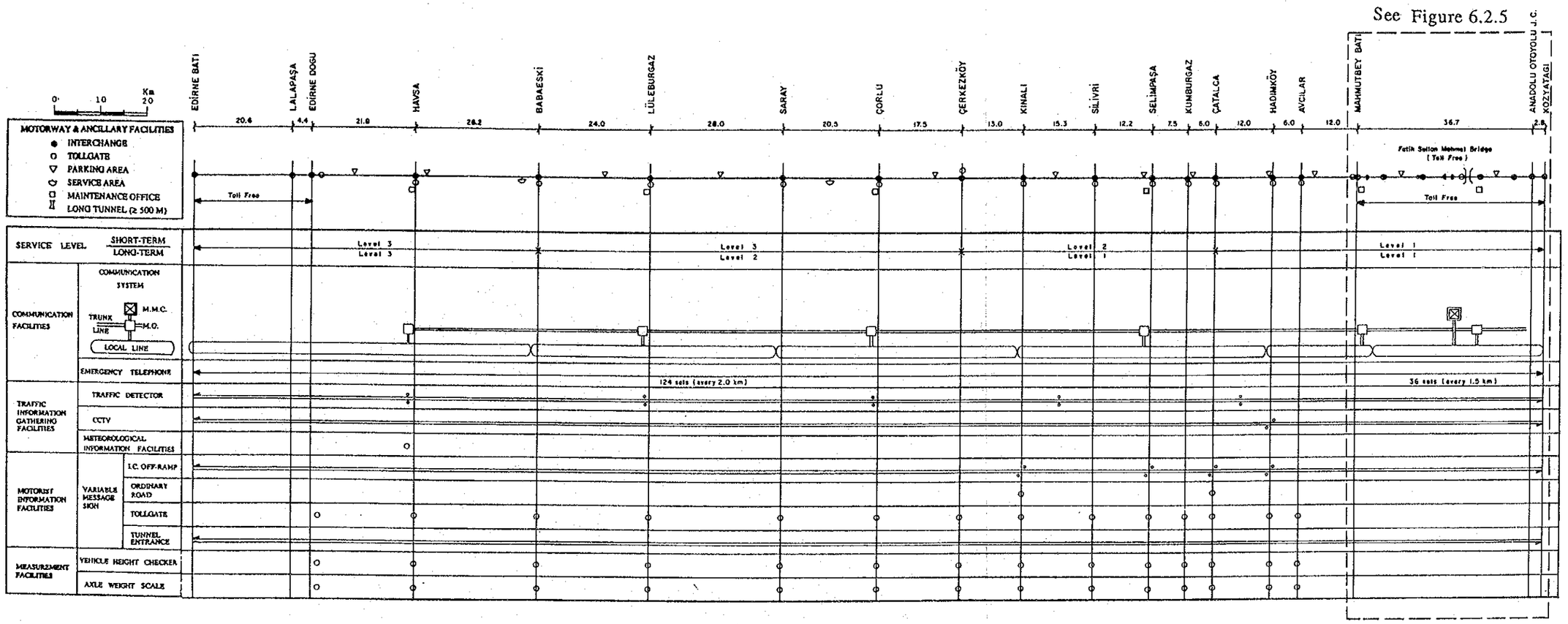
Facilities/Equipment			Service Level		
			Level 1	Level 2	Level 3
Communication Facilities	Emergency Telephones		• 2.0 km intervals on both sides (1.5 km in metropolitan area). • 200 m interval in tunnel (≥1,000 m), or vicinity of the exits (<1,000 m).		
	Exclusive Telephone & Wireless System		• Exclusive telecommunication circuit between Main Maintenance Center, Maintenance Office and Toll Collections Office. • Wireless communication system between Main Maintenance Center, Maintenance Office and patrol cars.		
Measurement Facilities	Vehicle Height Checkers		• In front of each tollgate entrance.		
	Axle Weight Scales		• In front of each tollgate entrance.		
Traffic Information Gathering Facilities	Traffic Detectors		• On both sides of motorway at points of frequent traffic congestion, large variations in traffic volumes and at locations necessary for the collection of traffic volume statistical data for traffic control. • Particularly, they should be installed at intervals of 1.0 km on the 1st peripheral road of Istanbul to detect the extent of traffic congestion.	• Points of large variations in traffic volumes and at locations necessary for the collection of traffic volume statistical data.	• Representative locations of the jurisdiction of maintenance offices with traffic operation rooms for collection of traffic volume statistical data.
	CCTV		• At toll barriers and junctions, locations with merging/diverging of traffic flows and in sections having traffic congestion and high traffic accidents. • Locations of severe weather conditions.	• Representative locations for traffic flow observation having high traffic accidents and severe weather conditions.	-
	Meteorological Information Facilities		• Representative locations with severe weather conditions.		
Motorist Information Facilities	Variable Message Signs	I.C. Off-ramp	• Prior to major I.C. off-ramps		-
		Ordinary Road	• Prior to intersections on principal trunk roads connecting to the motorway.		-
		Tollgate	• At each entrance booth at the tollgates.		
		Tunnel Entrance	• Prior to each long tunnel (≥500 m) entrance.		
	Radio Broadcasts		• To all areas from broadcasting stations with information for respective areas.		

4) Proposed Traffic Management and Operation System

Based on the installation standards of the traffic management and operations system, the traffic management and operations system installation plans on the 1500 km motorway networks are proposed as shown in Figures 6.2.4 to 6.2.13. All of the proposed roadside equipment are shown schematically in the figures at their appropriate locations. A framework for the system plan is established as described below.

- The system plans for the year 2000 (short term) have been prepared for the study routes.
- The system planning network for the motorway 1500 km is illustrated.
- Five traffic control rooms will be established at Izmit, Izmir, Ankara, Adana and Istanbul.
- A total of 27 traffic operation rooms will be established as the next level of traffic control unit below the traffic control rooms.
- The communications network using fiber-optic cable/metallic cable and carrier transmission cable will be established between the offices and the roadside facilities.
- In particular, traffic volume distribution of the first and second peripheral road in Istanbul is very unbalanced in the Istanbul central area, and traffic congestion on the first peripheral road is severe. In this study, planning for traffic management and operations on the second peripheral road was in the primary focus, but planning on both peripheral roads is necessary for relieving the severe traffic congestion mentioned above. However, detailed traffic data collection and analysis in the Istanbul urban area is not being conducted presently and adequate facilities have not been installed on the first peripheral road. In the future, an intensive study to establish an areawide traffic control system enabling to collect and analyze detailed traffic data in this area will be necessary. Accordingly, proposed facilities installation on the first peripheral road was minimized necessarily.

See Figure 6.2.5



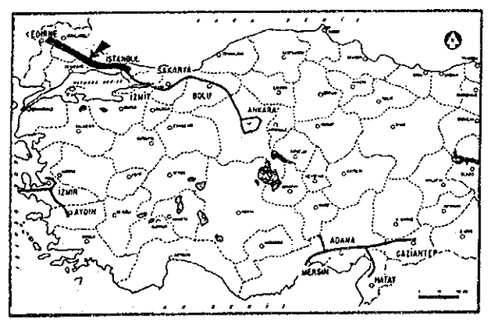


Figure 6.2.4 Proposed Traffic Management & Operation Facilities Installation Plan on EDIRNE - ISTANBUL Motorway (17th Regional Division)

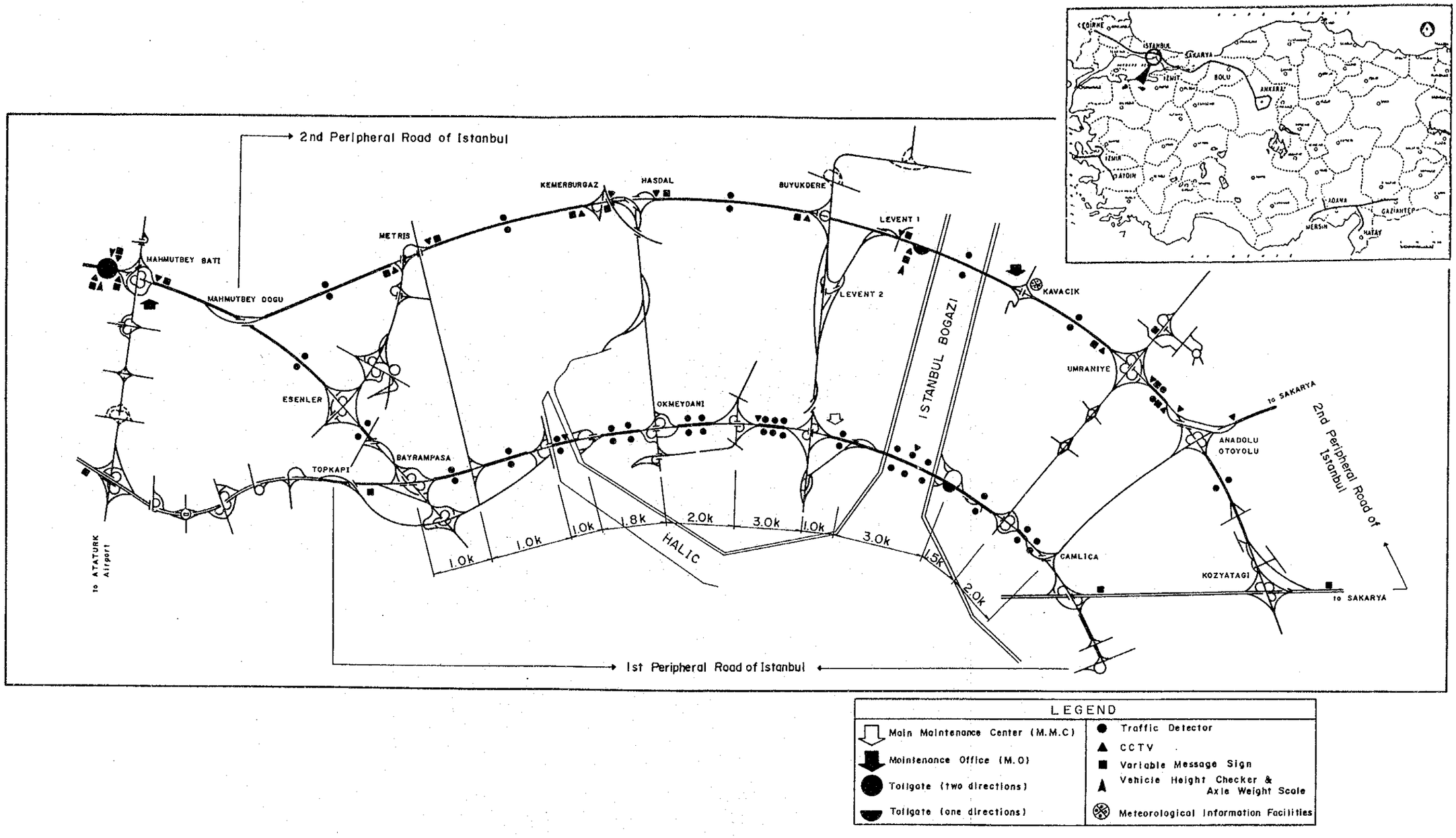


Figure 6.2.5 Proposed Traffic Management & Operation Facilities Installation Plan in ISTANBUL Central Area (17th Regional Division)

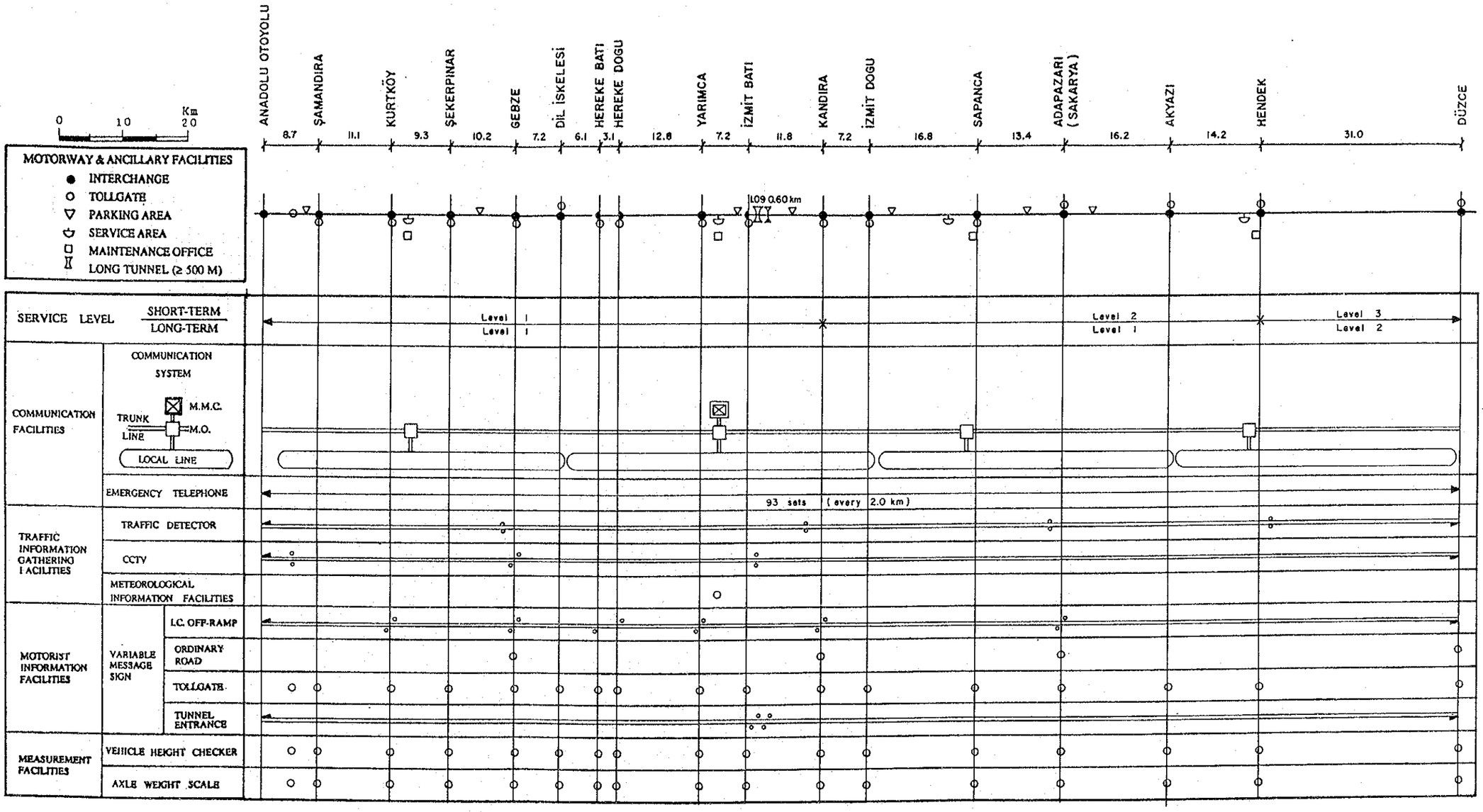
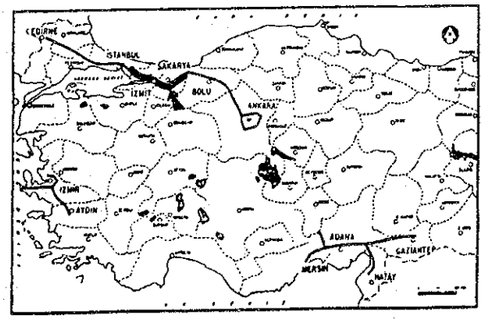
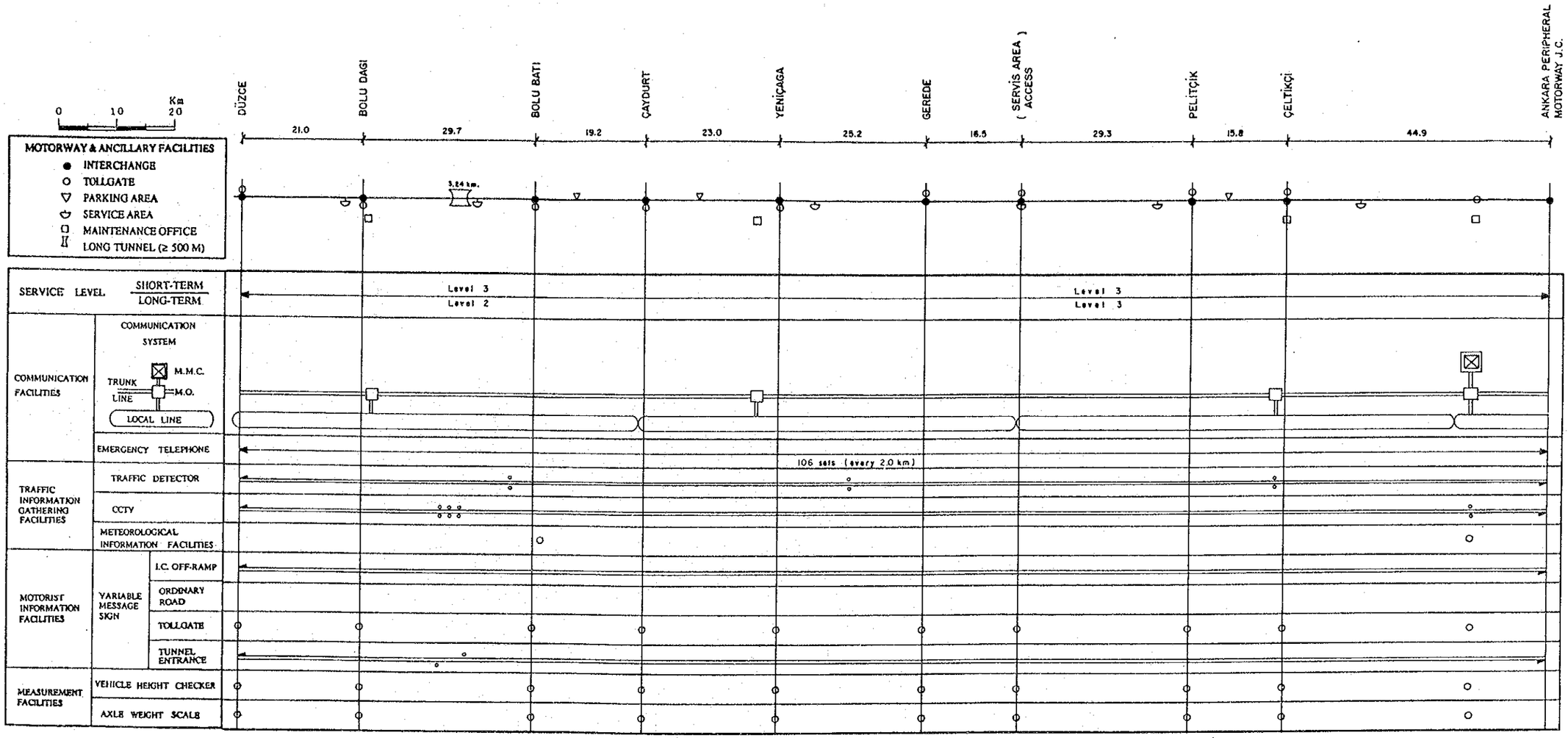


Figure 6.2.6 Proposed Traffic Management & Operation Facilities Installation Plan on ISTANBUL - DUZCE Motorway (1st Regional Division)





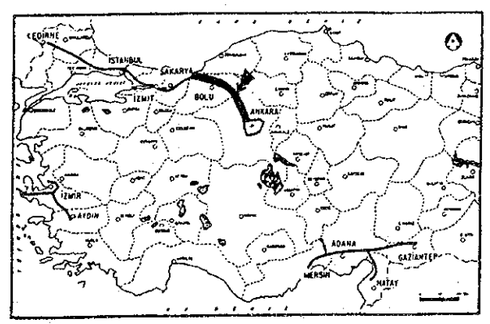


Figure 6.2.7 Proposed Traffic Management & Operation Facilities Installation Plan on DUZCE - ANKARA Motorway (4th Regional Division)

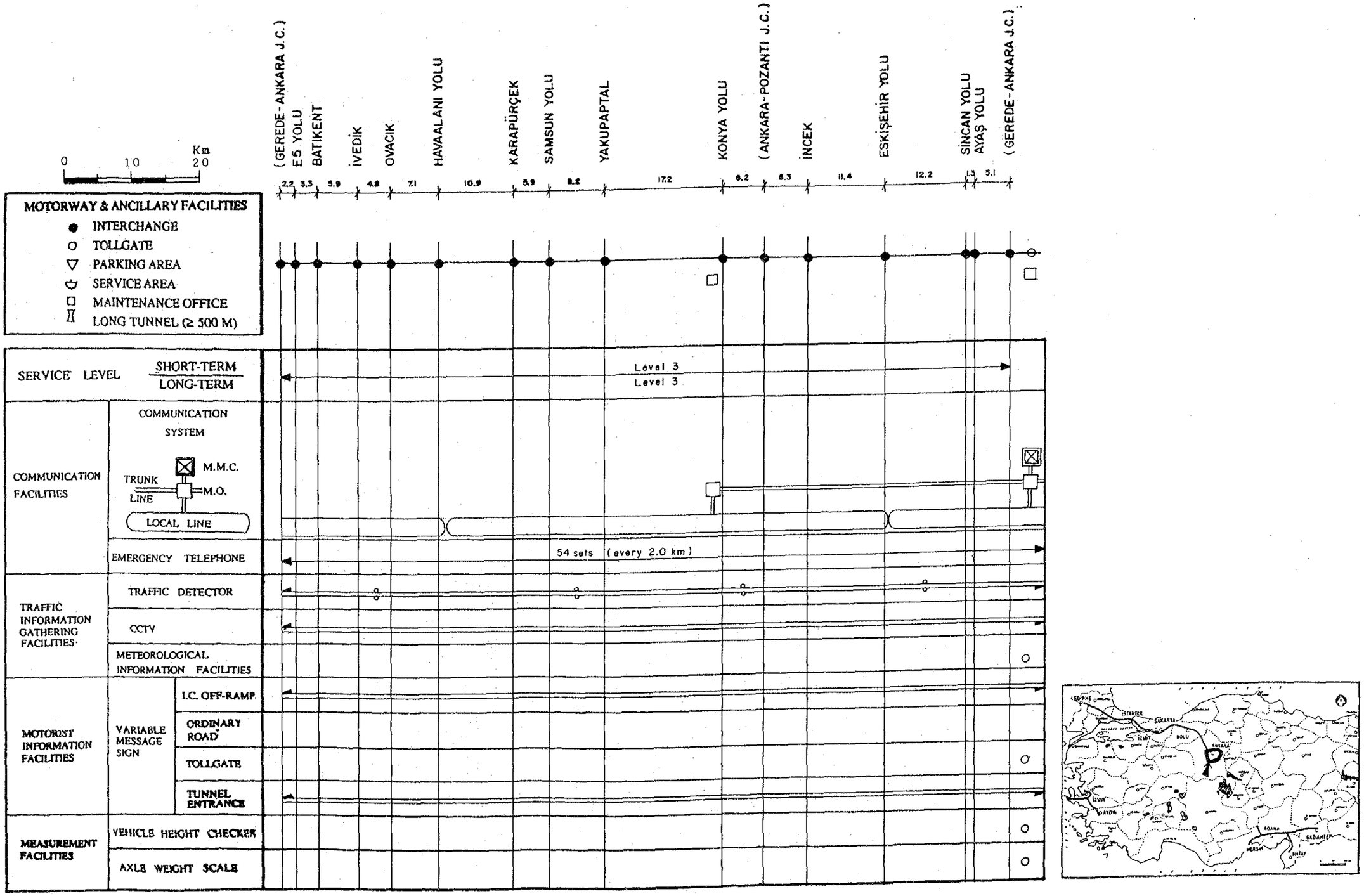


Figure 6.2.8 Proposed Traffic Management & Operation Facilities Installation Plan on ANKARA Peripheral Motorway (4th Regional Division)

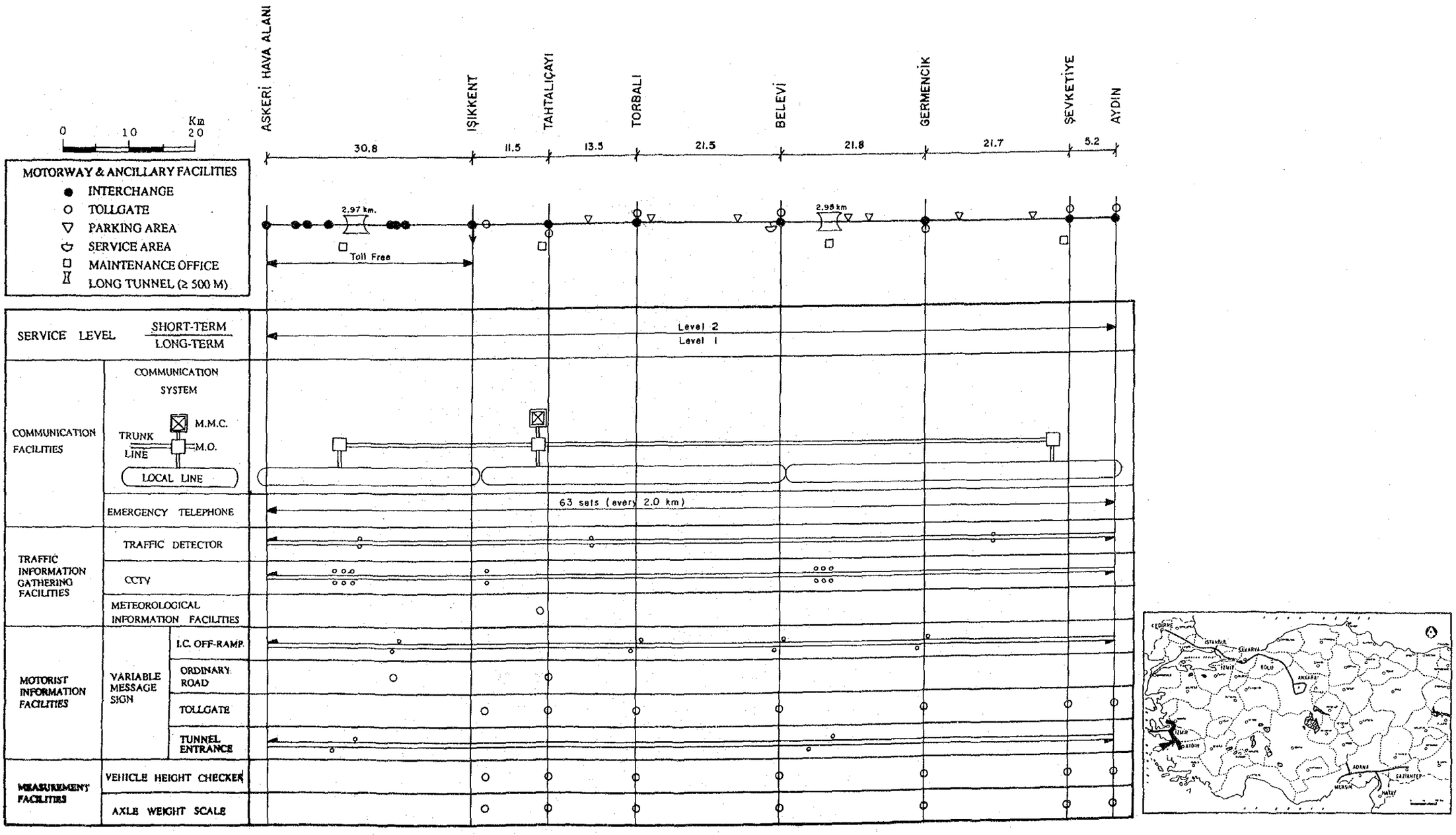


Figure 6.2.9 Proposed Traffic Management & Operation Facilities Installation Plan on IZMIR - AYDIN Motorway (2nd Regional Division)

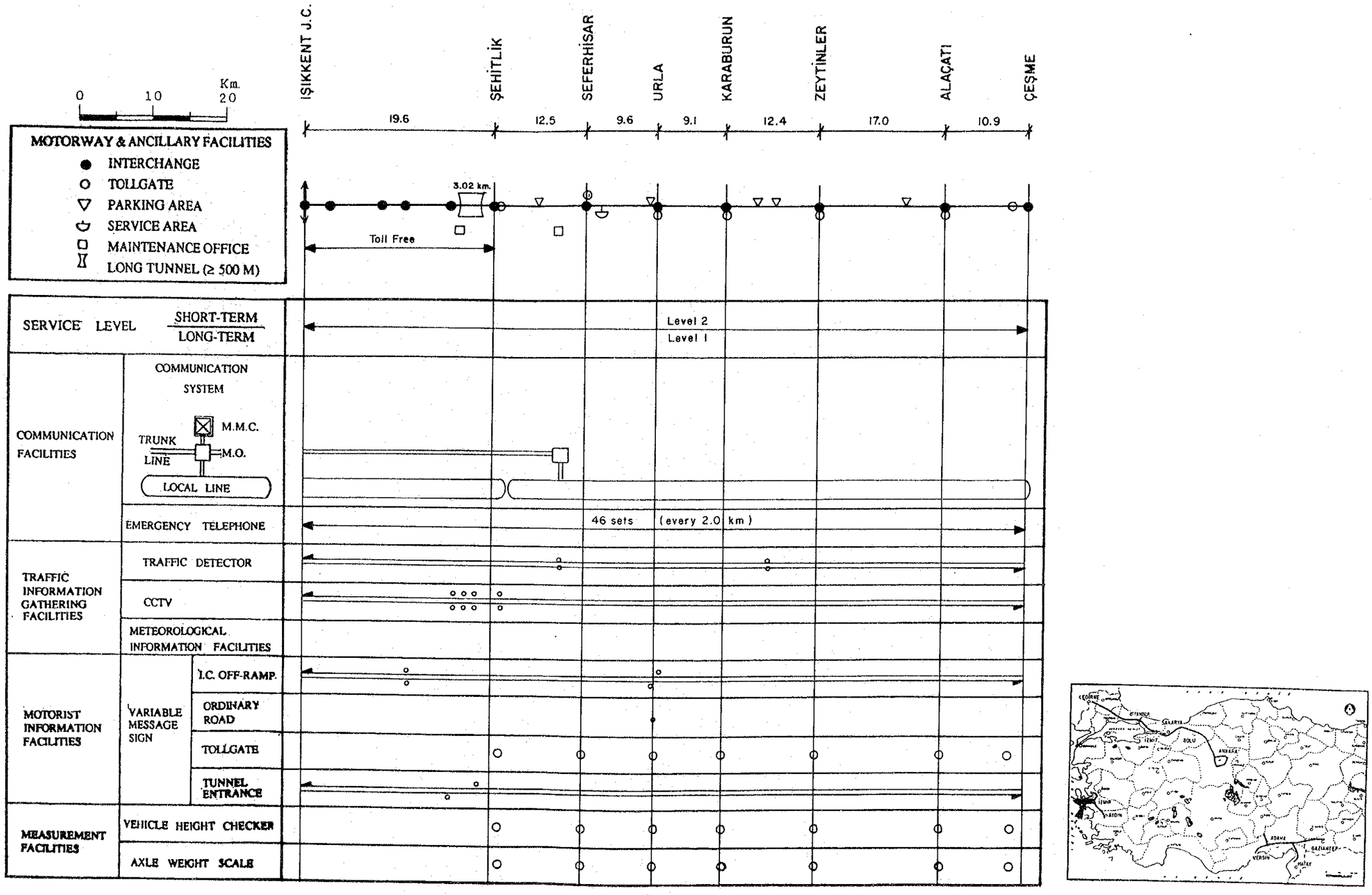
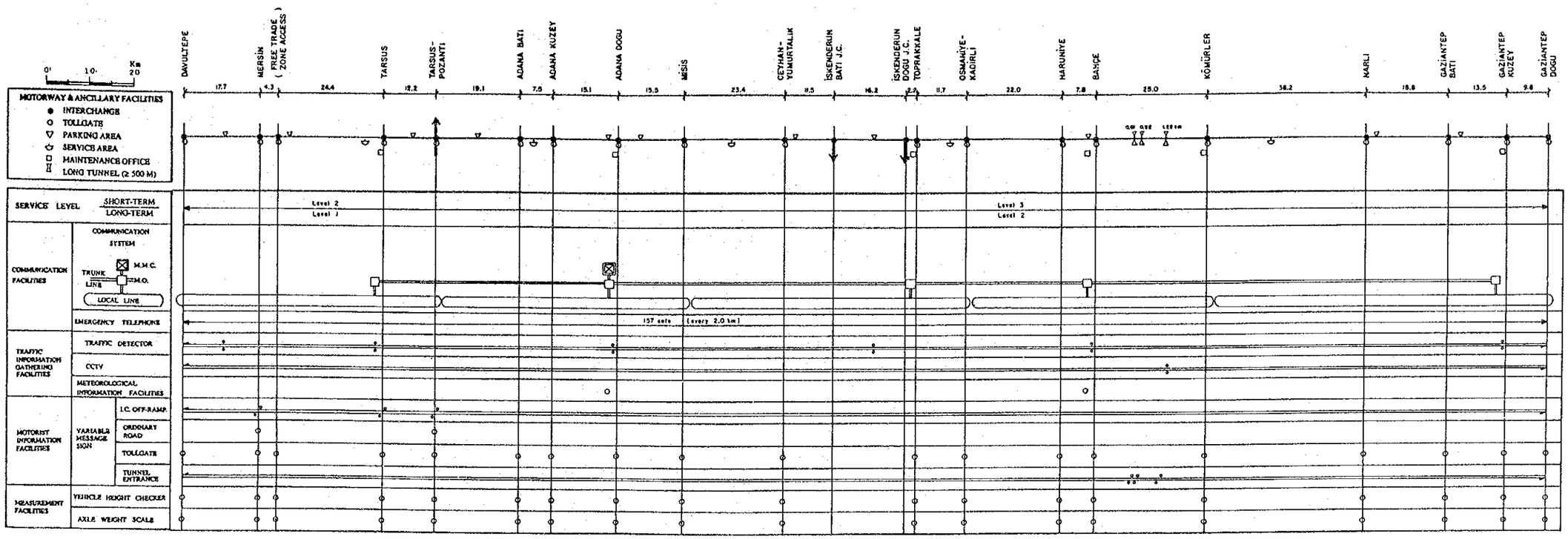


Figure 6.2.10 Proposed Traffic Management & Operation Facilities Installation Plan on IZMIR - CESME Motorway (2nd Regional Division)



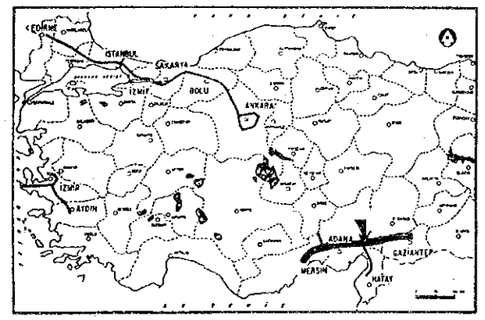


Figure 6.2.11 Proposed Traffic Management & Operation Facilities Installation Plan on MERSIN - GAZIANTEP Motorway (5th Regional Division)

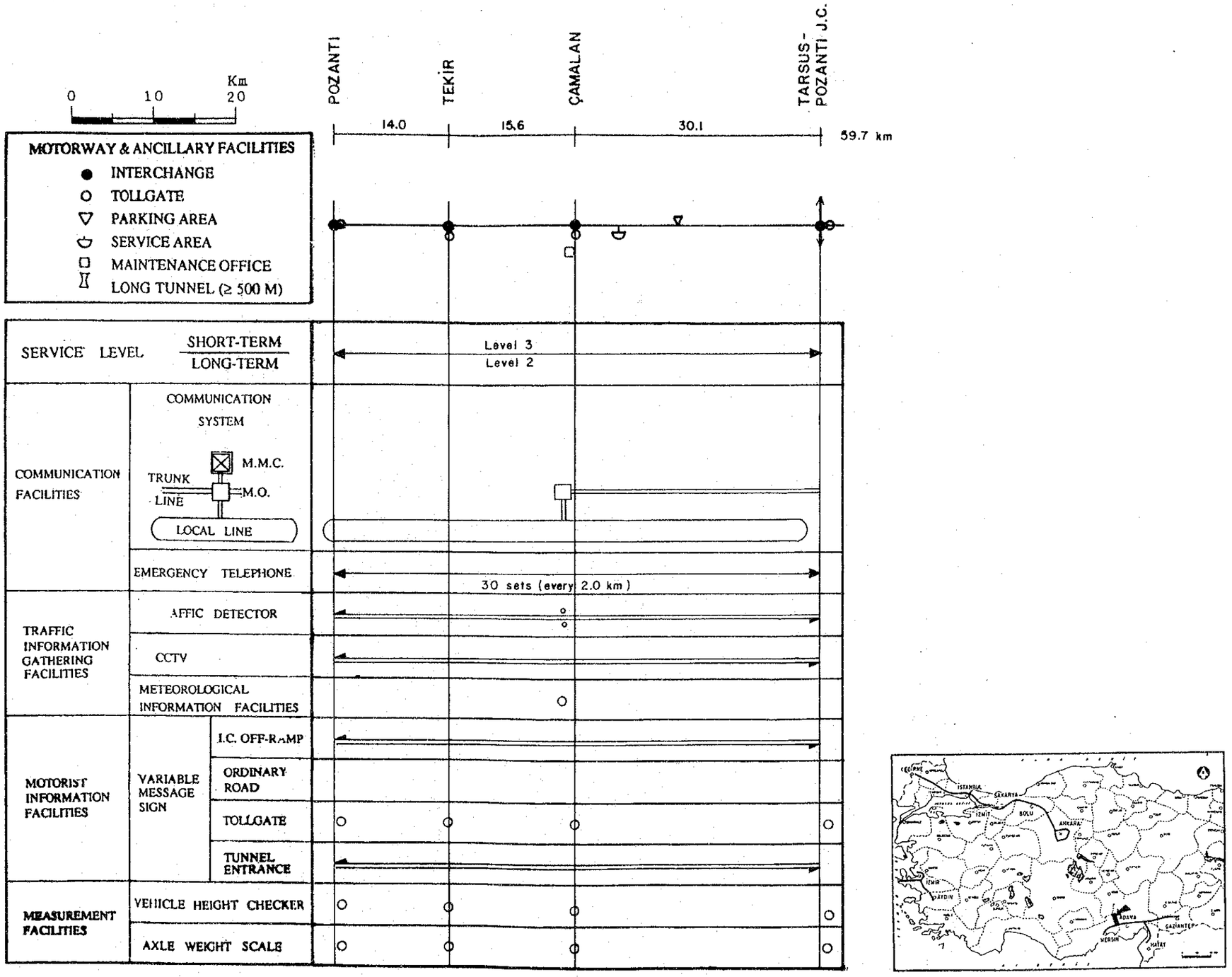
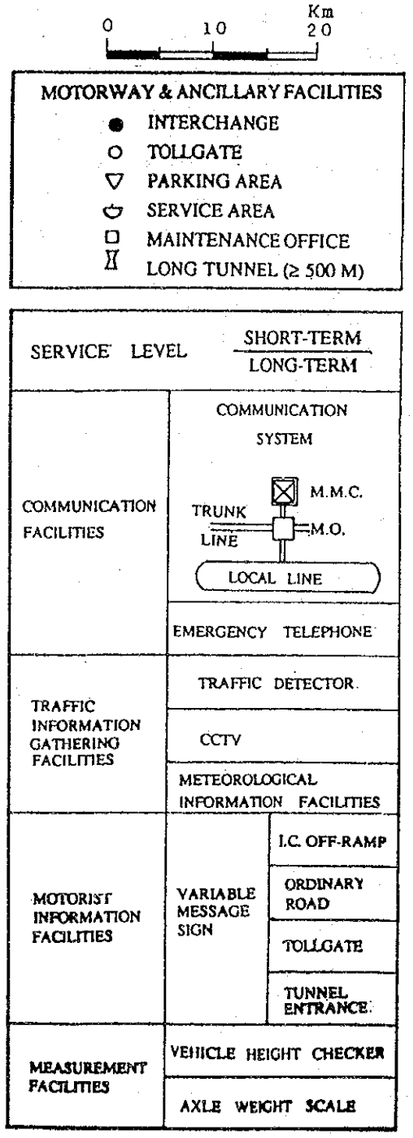
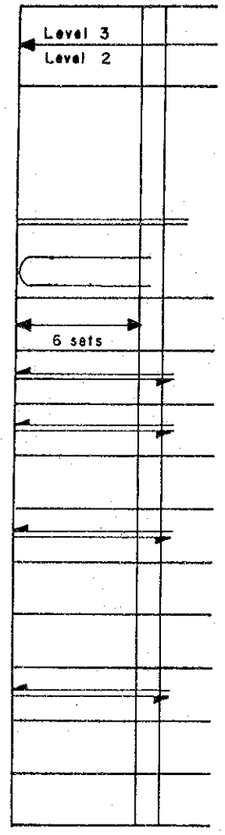
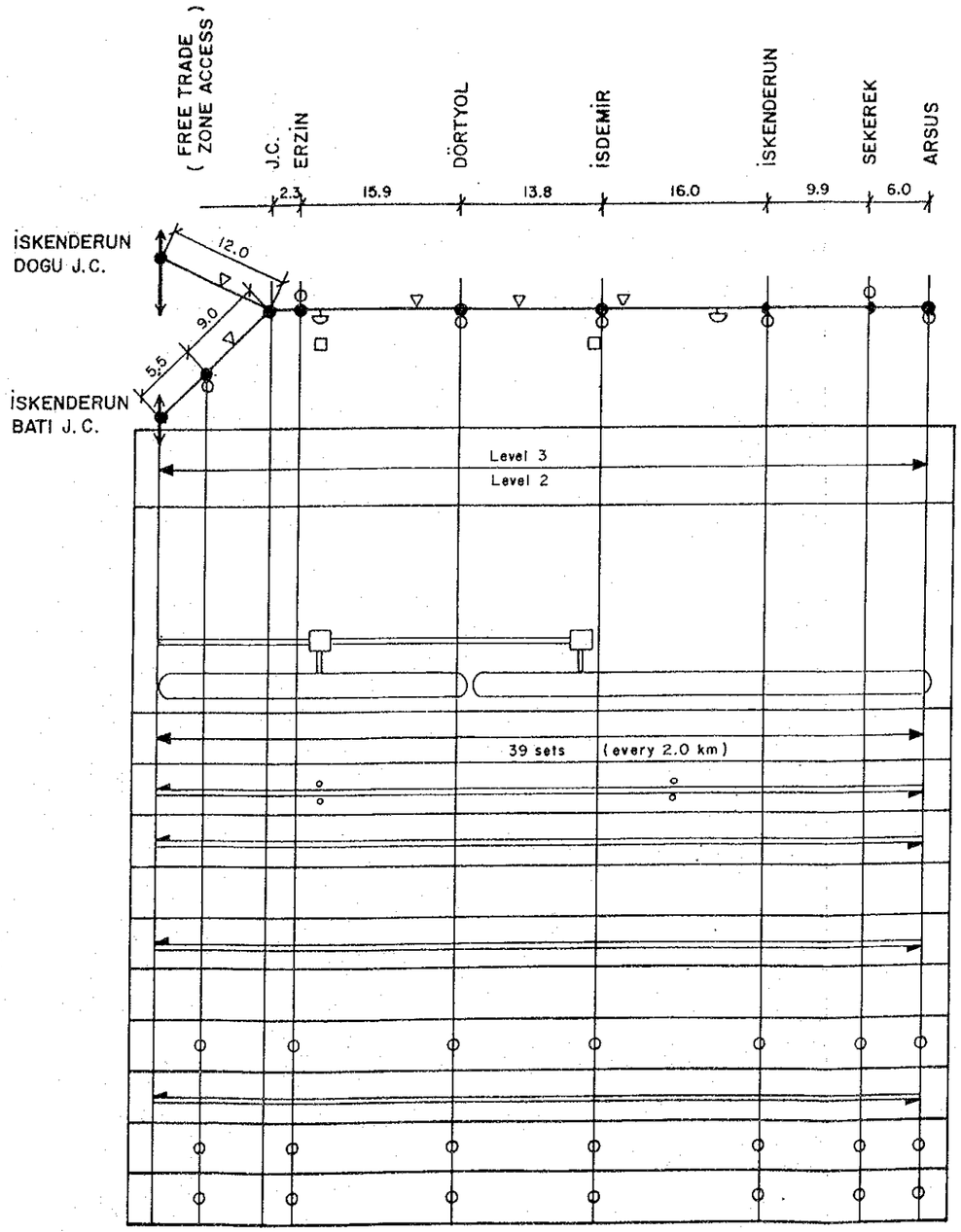


Figure 6.2.12 Proposed Traffic Management & Operation Facilities Installation Plan on TARSUS - POZANTI Motorway (5th Regional Division)







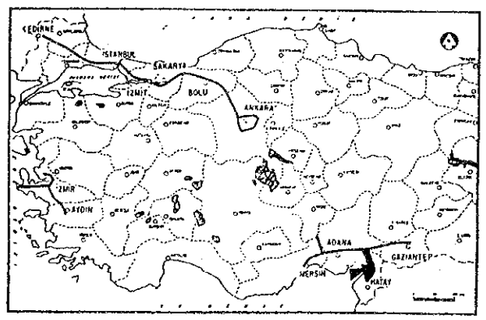


Figure 6.2.13 Proposed Traffic Management & Operation Facilities Installation Plan on TOPRAKKALE - ISKENDERUN Motorway (5th Regional Division)

5) Preliminary Engineering Design

(1) Emergency Telephone

(a) Function

Emergency telephones are communication tools for road users who need to contact the road management body for assistance in case of an accident, car trouble or running out of fuel on the motorway where no other means of communication is available. The emergency telephone system must be designed with the following requirements in mind:

- Handling and operation of emergency telephones by the user must be simple and straightforward
- The system must be capable of automatically identifying the calling telephone without asking the caller.
- Communication between the calling telephone and the receiver must be clear even when the calling telephone is adjacent to intense traffic noise.
- The system must be capable of automatically recording communication between the caller and the operator on a tape with a time stamp.

The present emergency telephone system is designed as a wireless system and is installed on a partial section of the Kinali - Sakarya motorway. The recommended new system is designed to include in a cable system which will also allow data transmission for traffic management and operation. It is anticipated that existing roadside telephones will be retained in the new system.

(b) System Configuration

Emergency telephone system consists of roadside telephones along the motorway, emergency telephone central controller, and emergency telephone receiving desk in the traffic control rooms.

Monitoring equipment is provided to the maintenance office to monitor the call from the telephone within its jurisdiction and to receive a call when it is not attended to by the operator in the traffic control center due to multiple calls or malfunction of the equipment at the traffic control center.

(c) Type of Telephone set

Basically, there are two types of emergency telephone sets, the first one has a built-in speaker, microphone and one or more push buttons to initiate a call. The second type has a handset similar to the one provided with an ordinary telephone set. In the latter case, the call is initiated automatically by lifting up the handset from the cradle. Functionally, these two types of emergency telephones operate the same. The former type is already in use in Turkey.

(d) Installation Standards

(i) Installation intervals

Emergency telephones are installed at a specific intervals along the motorway. In other countries, the installation intervals range from as short as 200 meters in tunnel, to a distance of 800 meters to 2.0 km along open air sections of motorway.

The existing emergency telephone system in Turkey has adopted an installation interval of 2.0 km away from Istanbul, and 1.5 km in the Istanbul metropolitan area. The proposed system will adopt these same installation intervals.

Guide signs showing the direction to the nearest telephone must be installed at intermediate locations. An illuminated sign at each telephone location is desirable for easy identification at night. However, illuminated signs require power which may not be easily available at the locations along the routes under study, so reflective sheeting on the telephone housing is recommended as an alternative.

(ii) Installation Locations

Two telephones must be installed at the same location on opposite sides of the motorway to discourage drivers from crossing the motorway.

The following locations must be avoided when installing emergency telephones:

- Within 100 meters upstream or 50 meters downstream of a sign, with the exception of the overhang type sign,
- Within 100 meters of an overpass section.

(e) Operations

When a road user initiates a call by pressing the push-button switch on the emergency telephone panel, an indicator on the graphic panel will light up, a chime will sounds and schematic diagram of the calling telephone location is displayed on the CRT terminal in the traffic control room to notify the operator of the call. By pressing the appropriate key, a conversation is possible between the roadside caller and the operator in the traffic control room. Tape recorder is provided with the system for automatic recording.

(2) Vehicle Detectors

(a) Function

Vehicle detectors are used to automatically detect up-to-date traffic information such as volume, occupancy and speed on the motorway. Detector data is transmitted to the traffic control room, and are then processed collectively in such a manner that traffic management officials can continuously monitor the traffic situation and react promptly when administering the necessary first aid countermeasures.

(b) System Configuration

The vehicle detector system consists of vehicle detectors installed along the motorway, detector data processors at the traffic operation room and a central computer system at the traffic control room. Figure 6.2.14 illustrate the functional design of the vehicle detector system.

(c) Types of Vehicle Detectors

There are two types of vehicle detectors in wide use, those being loop and sonic detectors. The loop detector is recommended for use on the motorway because the motorway is wide with three or more lanes in each direction. The type of loop detector recommended is the single loop type. The outline of vehicle detectors by type is shown below:

- Loop Detectors

  Loop detectors generate an electro-magnetic field when current is passed through a loop of wire. The iron component of vehicles interrupts magnetic field and this interference is detected by the electronics component of the detector.

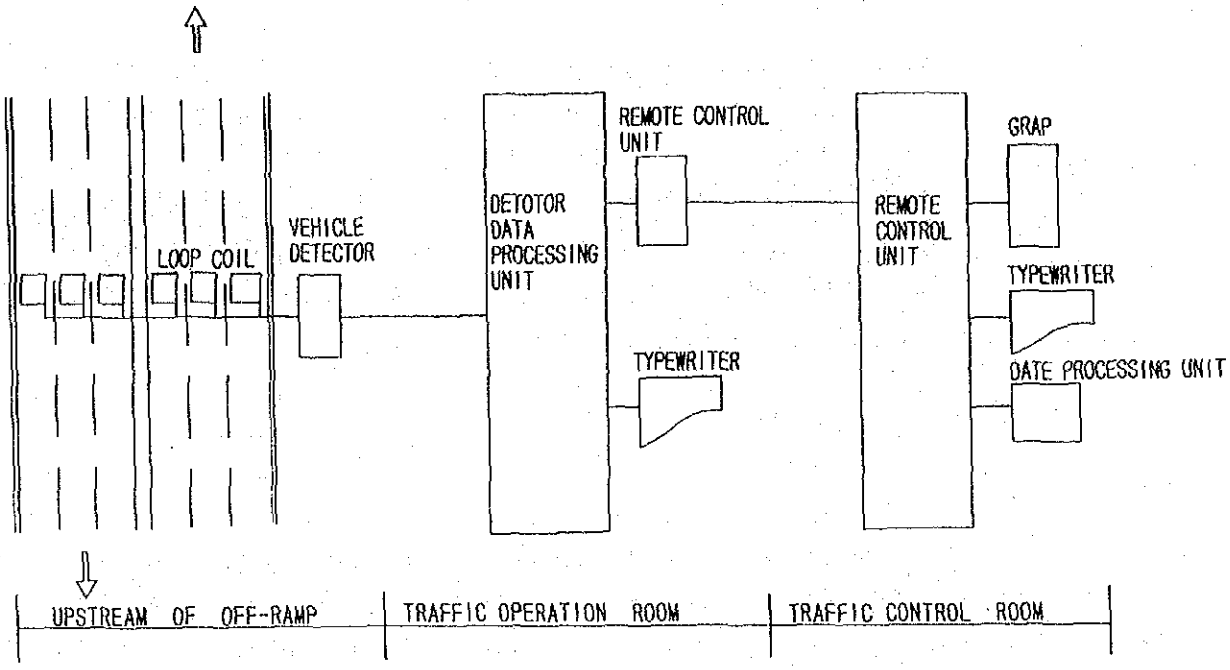


Figure 6.2.14 Functional Design of a Vehicle Detector System

- Sonic Detectors

  Sonic detectors transmit pulse beams of ultrasonic energy through a transducer towards the roadway. These beams are then reflected back by the presence of a vehicle to the transducer which converts them to electrical energy.

(d) Installation Locations

Vehicle detectors are mainly installed in all through lanes at representative locations between interchanges to determine traffic volumes and speed. For this purpose, loops are installed about 500 meters upstream of an off-ramp taper. For other purposes such as congestion detection on the first peripheral road in Istanbul, detectors should be placed at intervals of approximately one (1) kilometer in the congestion prone area. Figure 6.2.15 shows the loop detector installation plan. Table 6.2.2 shows the number of detector installations.

(e) Operations

Detector data from each vehicle passing over the loop detector is transmitted in a realtime mode from the detector unit at the site to the detector data processor in the traffic operations room. The data is processed in five-minute intervals to provide such traffic data as traffic volumes, average speeds and occupancy rates.

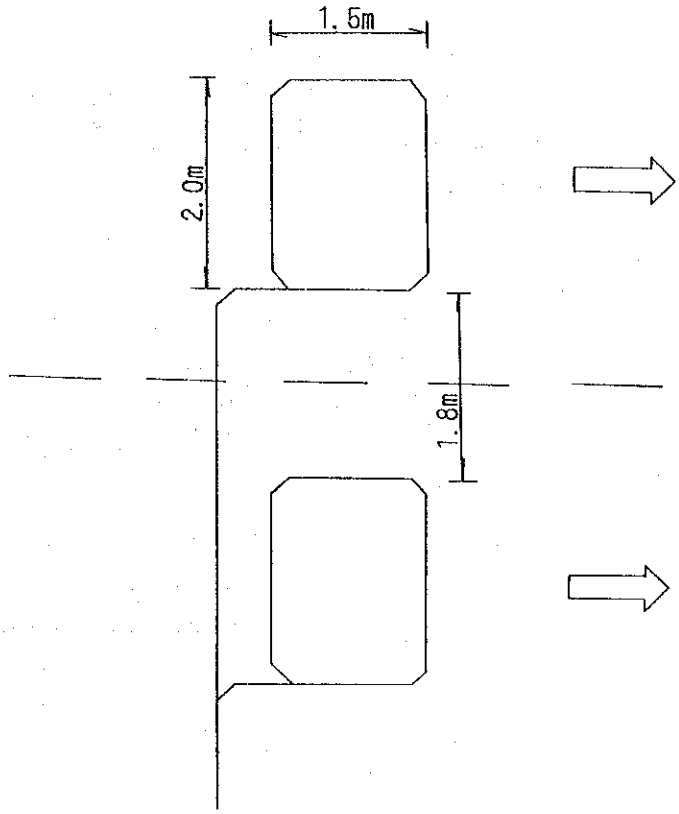


Figure 6.2.15 Loop Detector Installation

Table 6.2.2 Number of Detector Installations

Division	Div. 1	Div. 2	Div. 4	Div. 5	Div. 17	Total
No. of Detectors	4 ⇌ 4	5 ⇌ 5	7 ⇌ 7	9 ⇌ 9	31 ⇌ 31	56 ⇌ 56

Note: 1 set = Loop Coil x No. of Lane x Direction

The processed data is then sent to the traffic control room for monitoring and recording. In the traffic operations room, traffic data is displayed on the monitor and hard copies are made on the printer, if necessary. In the traffic control room, data is displayed on the graphic panel or on the CRT to help the operators in the traffic control room grasp the traffic conditions, and then stored on the magnetic tape for future analysis.

(f) Specifications

- Loop Sensor
  - Standard size: 1.5 m (longitudinal) x 2.0 m (lateral)
  - Number of turns: 3 turns or more
  - Installation depth: 60 - 100 mm below road surface
- Detector Unit
  - Number of loops: 4 loops/direction, maximum
  - Transmission method: FS-TDM
  - Number of channels: 18 channels/line
- Detector Data Processor
  - Unit time: 5 minutes or 1 hour
  - Processed data:
    - Accumulated total volume per unit of time
    - Average occupancy rate per unit of time
    - Average speed per unit of time

(3) Meteorological Information Facilities

(a) Function

The meteorological information facilities are used to gather weather information necessary to prepare for the eventuality of rainfall, winds, fog, snow and ice. They are installed at weather observation stations located along the motorway to monitor weather conditions for the purpose of preventing traffic accidents due to a worsening of climatic conditions. Meteorological observation instruments necessary to measure atmospheric temperature, road surface temperature, amount of rainfall or snowfall, and wind direction and velocity are combined in one unit. Instruments used to measure the visibility of atmosphere are also used, depending on local weather conditions and road administration status.

(b) System Configuration

Weather observatory system consists of an air temperature thermometer, a road surface thermometer, a rain gauge, an anemometer, a visibility meter and a snow gauge all located at the outdoor observation station, with a weather observation panel including a dot recorder at the traffic operation room. Functionally, meteorological data is transmitted from the outdoor observatory station on panel to the traffic control room for further processing, monitoring and recording.

(c) *Installation Locations*

Meteorological information facilities are installed at representative locations with severe weather conditions such as heavy rain, heavy snow or strong cross winds. In particular, locations with heavy snow and icy road conditions must be considered for installation because of long motorway sections passing through mountainous areas in this case of the motorway.

(4) Closed Circuit Television System (CCTV System)

(a) Function

The CCTV system is one of the information collection tools and is used to confirm the occurrence of congestion or other incidents in conjunction with the quantitative data obtained by detectors.

Although visual data provided by the CCTV system do not produce any quantitative data, they contain numerous unquantifiable information and the system enables operators to investigate traffic conditions in greater details in the traffic control room.

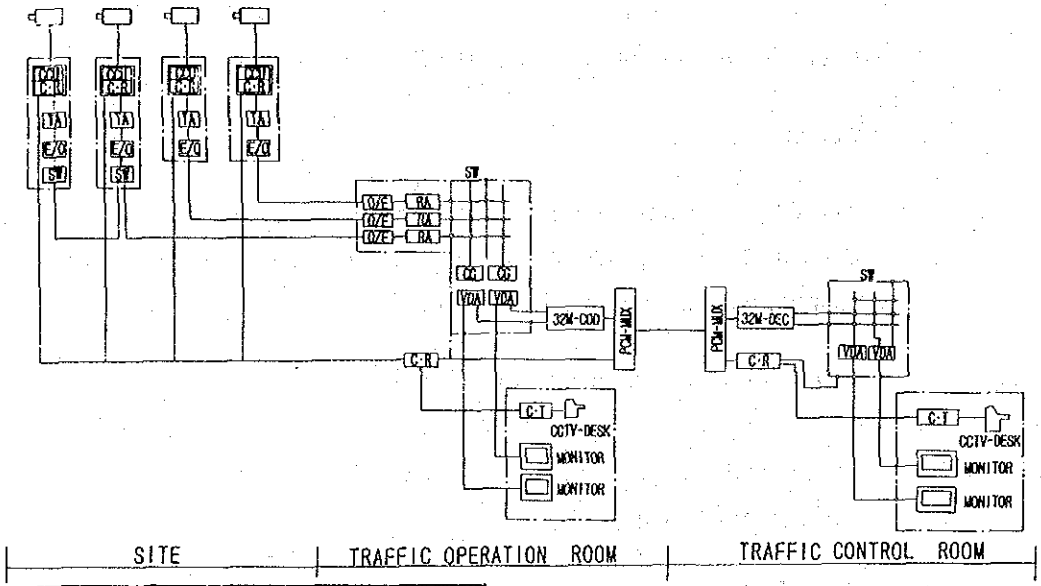
The CCTV system in a traffic management and operation system is used mainly for the following applications:

- Traffic flow monitoring
- Disaster prevention in tunnels
- Weather observations
- Others

(b) System Configuration

The CCTV system consists of a camera and camera controller at the site, a slave remote control unit at the traffic operations room, and a master remote control unit, operator console and monitor TVs at the traffic control room. The video signal taken by the camera is transmitted to the traffic operations room and the traffic control room over the fiber optic cable.

From the traffic control room, command signals such as power on/off, pan, tilt, zoom, telescope, etc. are sent to the camera controller. A video tape recorder with a time signal generator is included with the central equipment for recording and replaying the video image. Cameras in tunnels are controlled from the tunnel maintenance unit, but monitoring is also possible from the traffic operations room and the traffic control room. Figure 6.2.16 illustrate the schematic design of the CCTV system.



ABBREVIATION	WORD IN FULL
	CAMERA
CCU	CAMERA CONTROL UNIT
C·T	CONTROL TRANSMISSION
C·R	CONTROL RECEIVER
TA	TRANSMIT AMPLIFIER
RA	RECEIVE AMPLIFIER
VDA	VIDEO DISTRIBUTING AMPLIFIER
CG	CHARACTER GENERATOR
E/O, O/E	ELECTRIC/OPTICAL, OPTICAL/ELECTRICAL
SW	VIDEO SWITCHER

Figure 6.2.16 Schematic Design of the CCTV System

(c) Installation Locations

CCTV cameras are installed at the following strategic locations:

- Sections or locations where recurrent congestion is frequent or expected such as interchanges in large cities.
- In tunnels
- Sections or locations where incidents or accidents are expected to occur due to heavy weaving traffic, poor geometric design, frequent adverse weather condition, etc.
- Other places like toll gates where monitoring of the motorway is required

Table 6.2.3 shows the number of CCTV camera installations and Figure 6.2.17 shows the CCTV camera installation plan.

Table 6.2.3 Number of CCTV Camera Installations

Division	Div. 1	Div. 2	Div. 4	Div. 5	Div. 17	Total
No. of CCTV Cameras	3 ⇌ 3	11 ⇌ 11	4 ⇌ 4	1 ⇌ 1	13 ⇌ 9	32 ⇌ 28

(d) Specification

- Camera
  - Image taking device: 2/3 or 1/2 inch CCD
  - Minimum brightness of object: 5 lux.
  - Horizontal revolution: More than 350 degrees at the center
- Lens

  A zoom lens with an automatic iris function shall be used. The focal distance will be determined according to the conditions at each installation location.

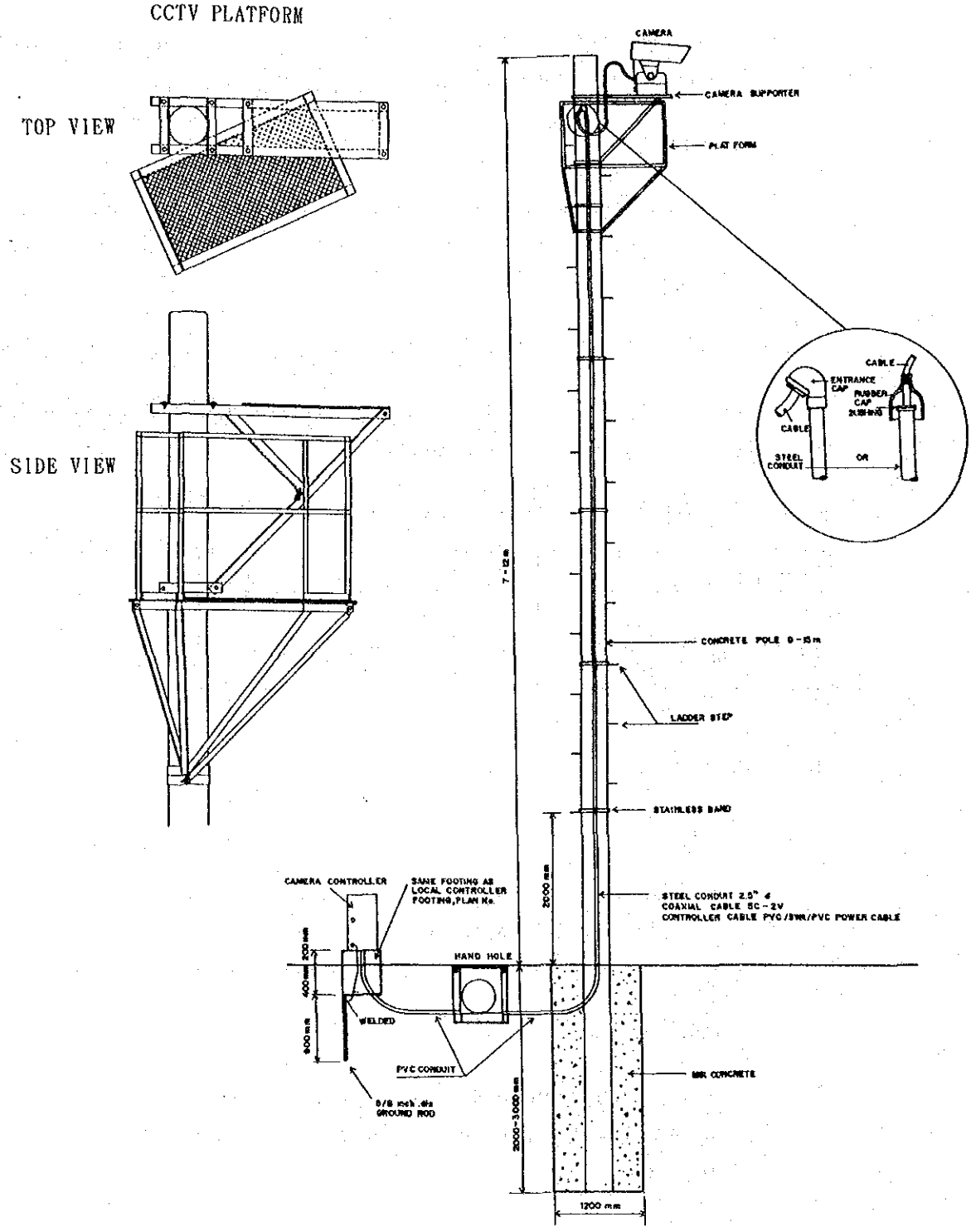


Figure 6.2.17 CCTV Camera Installation Plan

- Universal Head
  - Pan: More than +/-170 degrees
  - Tilt: +15 degrees or more
    -60 degrees or more
- Camera Controller
  - Video transmitter: PFM-IM (Pulse Frequency Modulation-Intensity modulation)
  - Wave length: 1.3 micro-meter
  - Control signal receiver: Transmission system - Time division cyclic transmission
    Modulation - Frequency shifting
    Transmission rate - 1,200 bits/s

(5) Variable Message Signs (VMS)

(a) Function

Variable message signs (VMS) are visual communication facilities which are installed at strategic points on the motorway to give the drivers important information such as congestion, accidents, road conditions and detour recommendations. The information (message) displayed at the terminal is determined automatically by computer or by manual operator.

(b) System Configuration

Variable message sign system consists of the variable message signboard and controller installed on the motorway or access road, slave remote controller located at the traffic operation room or tunnel maintenance office, and a master remote controller and operator console located at the traffic control room.

Variable message sign at a tunnel entrance is mainly controlled from the tunnel maintenance office. It is also controlled from the traffic control room when necessary. Monitoring is possible at the traffic operation room.

(c) Type of Signboard

The widely used signboard is categorized into two types; the scroll type and the matrix type.

(i) Scroll type

The viewing face of the scroll sign is formed by a continuous belt of flexible cloth or plastic material containing a number of messages. The belt is stretched between two storage drums which are rolled until the desired message is displayed. If desired, a blank space may be positioned on the belt so that no message is visible when the belt is rotated to that space. In many cases the message belt is made of translucent material permitting back illumination.

Scroll type variable message signs may be applicable at entrance to toll booths and will display traffic, road and environmental conditions on the motorway and the location of ramp-closures.

(ii) Matrix type

This type of sign is applicable for large size signs on the mainline or access road because its viewing surface is formed by a matrix arrangement.

This type of sign can be divided into two types depending on the matrix element. These two types are the Lamp (Light Bulb) Matrix and the LED (Light Emitting Diode) Matrix.

- Lamp (Light Bulb) Matrix

  The viewing surface of the lamp matrix display is formed by an array of incandescent bulbs for each message line. The array can either be a continuous field of bulbs or a fixed number of matrix modules. Typically, the number of message lines varies from one to four.

  By independently controlling the on or off state of each bulb, messages or graphic symbols can be displayed. Messages can be displayed statically or flashed. Messages change instantaneously when a new message is selected.

  Because of the use of incandescent bulbs, this type of display has adequate visibility in bright daylight.

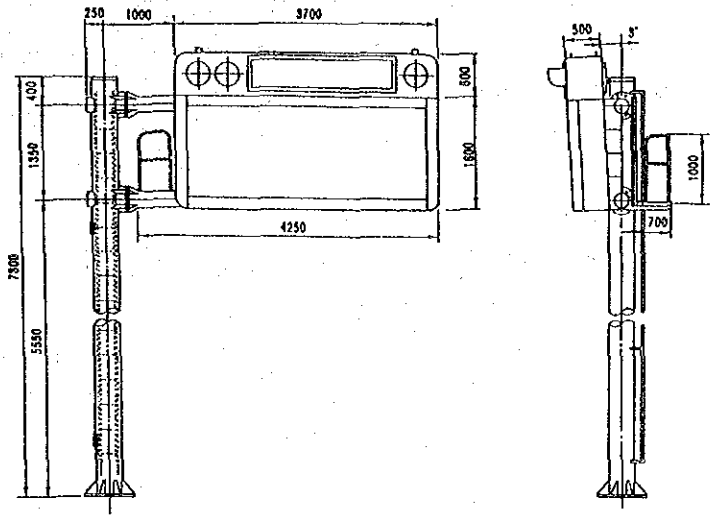


Figure 6.2.18 Example of a Variable Message Signboard (overhang type)

- LED (Light Emitting Diode) Matrix

  This type of sign is identical to the lamp matrix type except that a LED matrix is used in place of incandescent bulbs. There are two variations of LED layout. One type of signboard has a matrix of LED arranged in four columns by four rows which would replace one incandescent bulb. LEDs of two different colors, red and yellow, are used so that messages and symbols can be displayed in red, yellow or orange.

  A second type of signboard is made up of LEDs of the same color and where one LED replaces one bulb. Thus, the size of the signboard is much smaller than the lamp matrix type and only suitable for toll booths.

  Because of high density of light emitting sources used in LED signs, a LED sign can display a sharper and smaller image than the lamp matrix type. Use of LED also provide longer life and lower power

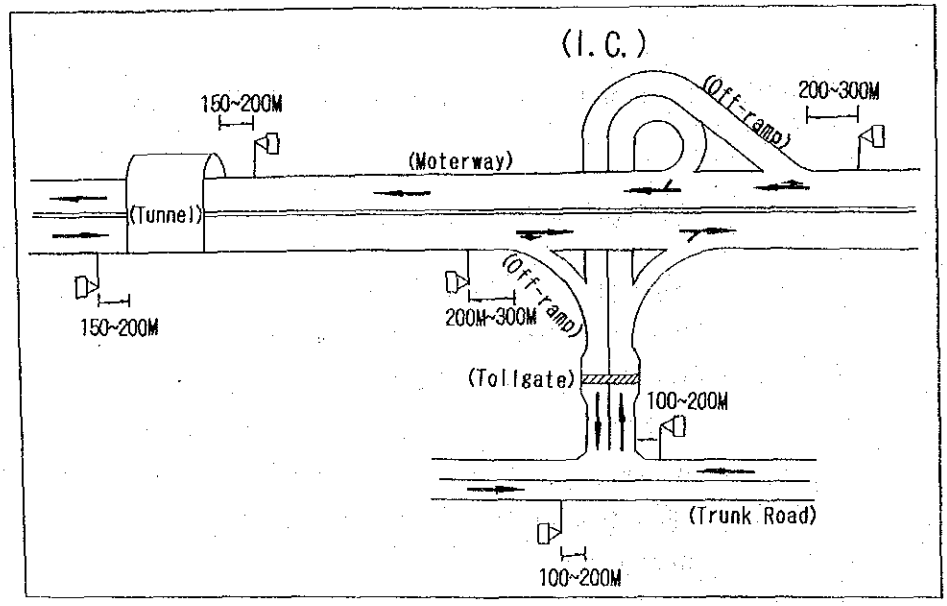
consumption compared with lamp matrix type signs. Equipment cost, however, is slightly higher than a lamp matrix sign of the same size.

From among the type of signs described above, the LED matrix type is recommended for variable message sign placed before interchange off-ramps, intersections on principal trunk roads connecting to the motorway and at the entrance for long tunnels. The matrix type was selected because of the possibility of requiring many different message and need to provide good legibility.

(d) Installation location

Variable message signs are typically installed at the following locations:

- before interchange off-ramp
- before intersection on principal trunk road connecting to the motorway
- at entrance booth at tollgate
- at the entrance for a long tunnel



Note: At locations with sharp curves visibility should be taken into consideration when installing VMS.

Figure 6.2.19 Typical installation Location for Variable Message Sings

(e) Message to be Displayed

Because length of the message is limited physically by the size of display surface, the message to be displayed must be concise and comprehensible to road users. In addition, the messages will be displayed in the Turkish language.

In general, a typical message consists of a combination of words and phrases describing the location, cause, and the result of the traffic incident, in addition to the instructions to the drivers as shown below. This must be done within limitation of the total numbers of letters available which is limited by the size of the signboard. As mentioned above, the actual message will be in the Turkish language.

- Location of an incident
  Typical phrases for locations are shown as follows:
  - between XXX I.C. & XXX I.C.
  - XXX I.C. exit
  - ahead
  - XX km ahead

- Cause of an incident
  Typical phrases for the cause of incidents are shown as follows:
  - accident
  - fire
  - snowy
  - cross wind
  - under construction
  - icy road
  - foggy

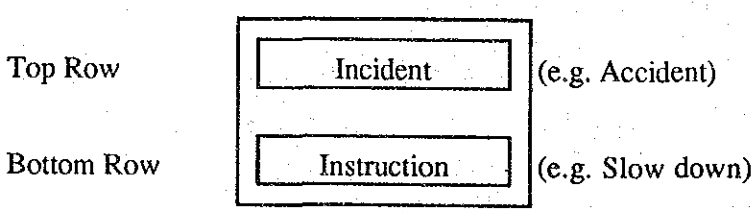
- Result of an incident
  Typical phrases for the result of an incident are show as follows:
  - traffic congestion
  - section closure
  - lane closure

- Instructions to drivers
  Typical phrases for the instructions or suggestion to drivers are shown as follows:
  - exit here
  - drive on the right side
  - drive on the left side
  - entering forbidden area
  - slow down

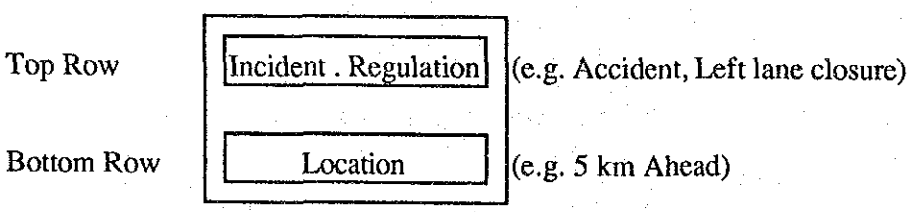
(f) Display Format

The variable message sign (VMS) display format differs slightly according to the message contents, VMS type and location. The sequence of messages for each of the three types of display are given below. All displays on VMS are organized into two rows. For instruction-type messages, the "incident" is displayed on the top row and the "instruction" on the bottom row. For traffic regulation-type and caution-type messages, the "incident" and "traffic regulation" or "caution" are displayed on the top row and the "location" on the bottom row.

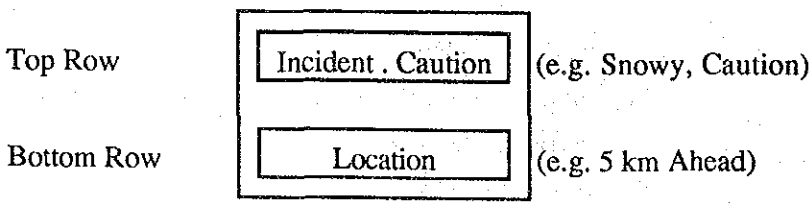
(i) Instruction-type Messages



(ii) Traffic Regulation-type Messages



(iii) Caution-type Messages



(g) Priority Ranking of Messages

When several incidents occur simultaneously along a certain section of the motorway, it is not advisable to try to display all the incidents on the message boards. Such a practice will confuse the motorway users. Instead, the highest priority message should be selected according to the ranking as given below:

Table 6.2.4 Priority Ranking of Messages

Incident	Priority	Example of Display Message
• Section closure traffic	1	"Accident, Exit Here"
• Traffic accident, fire, disaster	2	"Accident, Caution, XX km Ahead" "Fire, Caution, XX km Ahead" "Slope Failure, Caution, XX km Ahead"
• Fallen objects on carriageway, Breakdown vehicles	3	"Fallen Objects, Caution, XX km Ahead" "Breakdown Vehicle, Caution, XX km Ahead"
• Congestion	4	"Accident, Congestion, XX km Ahead"
• Maintenance works	5	"Under Construction, Right Lane Closure, XX km Ahead"
• Slow moving vehicle carrying out works	6	"Slow Moving Vehicle, Caution, xx km Ahead"
• Snowy	7	"Snow, Caution, Between XXX IC & XXX IC"
• Foggy	8	"Fog, Caution, XX km Ahead"
• Cross wind	9	"Strong Cross Wind, Caution, XX km Ahead"
• Rain	10	"Heavy Rain, Caution, Between XXX IC & xxx IC"

(6) Radio broadcasting

(a) Function

Radio broadcasting is one of the most common means of information dissemination. It utilizes broadcasting stations owned and operated by other agencies or companies. Because of this, the system can operate with only a small amount of investment.

Radio broadcasting booth is constructed in the traffic control room and connected to the outside broadcasting station through the telephone line. Announcer at the traffic control room obtains traffic-related information through the wall map, CCTV monitor, CRT terminal, etc. and broadcasts timely and accurate information periodically in ordinary radio programs. Drivers receive traffic information through the standard car radio which acts as a driver information tool.

(b) System Configuration

As the radio broadcasting system for traffic information makes use of the existing commercial and public broadcasting system, only a microphone and a transmitter to broadcasting stations are necessary and are provided in the traffic control room.

(7) Transmission System

(a) Function

The basic function of transmission system is to transfer information from one location to another. A transmission system consists of a three tier hierarchy including a trunk line transmission system, a local line transmission system and an access line transmission system. Figure 6.2.20 shows the three tier hierarchy of transmission system.

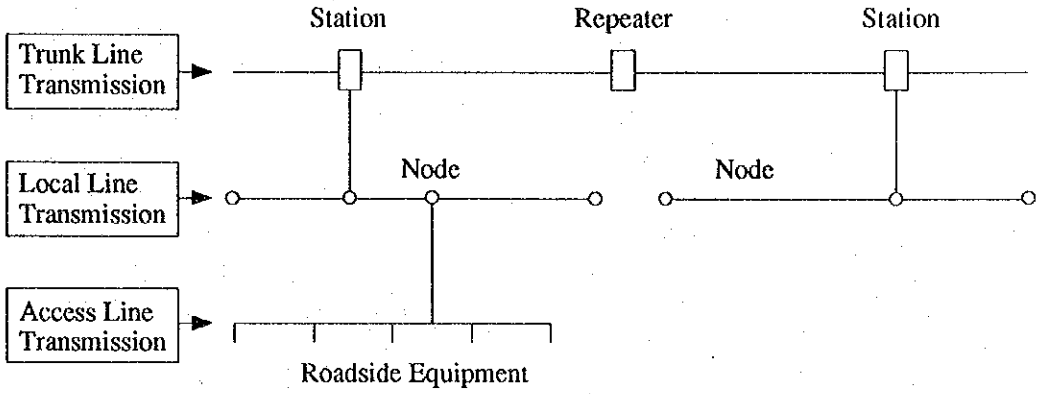


Figure 6.2.20 Three Tier Hierarchy of Transmission System

Each type of transmission system is described below:

- Trunk Line Transmission System:

  A trunk line transmission system links the main maintenance centers and maintenance offices and transmits the bulk of voice and data signals, and in some cases video signals through high speed transmission channels over a long haul (up to several hundred kilometers).

- Local Line Transmission System:

  A local line transmission system provides multiple transmission channels between the nodes established at 2 to 5 km intervals and collects voice and data signals at trunk line transmission stations usually established at every maintenance office.

- Access Line Transmission System:

  An access line transmission system connects facilities and equipment in offices and the roadside to a node for local line transmission. The transmission distance is short and normally less than 5 km.

(b) Trunk Line Transmission System

The trunk line transmission system technologies can be divided into two groups, the analog method and digital method. However, because of

limitations such as short transmission distances and repeater intervals, inferior quality, lack of technological prospects for the future, the analog method is not recommended.

Two alternatives for the trunk line transmission system are compared to select the most suitable system. The results of the comparison are shown in Table 6.2.5.

Table 6.2.5 Trunk Line Transmission System

System	Cable Type	Signal Type	Capacity	Repeater Interval	Quality	Cable	Remarks
Metallic Cable System	Balanced Pair	Telephone	24 ch	2 km	Fair	PEF	• Not suitable for long haul transmission
		Video	1 ch	2 km	Fair	PEF	• Susceptible to induction due to use of Metallic Cable
Fiber Optic Cable System	Optical Fiber	Telephone	480 ch ~ 5,760 ch	40 km	Good	SM	• Suitable for long haul transmission
		Video	1 ch ~ 12 ch	40 km	Good	SM	• Longer repeater interval • Not susceptible to induction

Notes : PEF : Formed Polyethylene Cable
SM : Single Mode Optical Fiber Cable

As shown in the Table, the fiber optic system has many advantages over a metallic cable system such as better transmission quality, capacity, and longer transmission distance without a repeater. In a fiber optic system, the video signal is multiplexed with the telephone channels. In a metallic cable system, the video signal transmission is separate from the telephone circuits.

Therefore a fiber optic transmission system is recommended for the motorway in those areas where CCTV will be installed. The remaining segments of motorway can be served with metallic cable until CCTV is installed.

(c) Local Line Transmission System

A local line transmission system covers a section of motorway of about 50 km, which is the recommended length of route coverage of a maintenance office. Depending on the coverage length of a local line transmission system, a metallic cable system is recommended for the motorway.

(d) Access Line Transmission System

An access line transmission system connects terminal equipment such as emergency telephones, CCTV cameras, vehicle detectors and variable message signs installed along the motorway to the nearest node. Because of short transmission distance, a metallic cable system is recommended for the motorway.

(e) Cable

- Trunk Line Cable

  The single mode fiber optic cable is recommended for the trunk line cable. The cable has a small core diameter that allows only single mode (an axial ray) of light to travel through the fiber. This produces no pulse dispersion and offers wide band width.

  The types of fiber optic cable recommended are as follows:

  - Trunk Line : F-32M, F-100M

- Local and Access Line Cable

  Color coded polyethylene insulated subscriber's cable (CCP cable) is commonly used for local and access line. In the case of metallic cable, the transmission distance is limited by two factors; alternation by loss and current decrease by resistance.

(f) Installation

Table 6.2.6 shows the length of cable by type as below.

Table 6.2.6 Length of Line by Type

(Unit : km)

Division	Div. 1	Div. 2	Div. 4	Div. 5	Div. 17	Total
Length of Cable						
• Trunk Line	186	139	267	334	242	1,168
• Local Line	186	217	320	464	330	1,517
• Access Line	143	153	185	285	258	1,024

(8) Wireless system

(a) Function

Wireless communication system facilitates the communication between the wireless control desk at the traffic control room and maintenance offices and mobile units traveling on the motorway. Patrol cars will be equipped with the mobile radios and communications with the control desk is possible all times. Toll collection offices and other manned stations will also be provided with a stationary radio to back-up the wired telephone.

(b) System Configuration

The system consists of the radio control equipment installed in the traffic control room and the maintenance offices, base station equipment including an antenna at the base station, and mobile units installed in patrol cars. Portable radio units are also included in the system.

(9) Exclusive Telephone System

(a) Function

Since motorway management involves organizations and offices scattered along the entire motorway network, efficient communications between various locations must be provided. Particularly, in the case of a severe incident, securing a communications channel is essential for executing countermeasures. In this sense the subscriber's telephone system provided by PTT is neither adequate nor economical. For this reason, exclusive telephone system (or in-house telephone system) covering all the offices is required. The system makes use of the communication cable system to be established for the entire stretch of the motorway, so that a closed telephone network within the motorway administrative body can be created.

(b) System Configuration

The exclusive telephone system consists of digital exchanges of various capacities placed at headquarters, division offices, main maintenance centers, maintenance offices and toll collection offices, and telephone sets, etc. Data terminals such as those provided for facsimile and videotext can also be connected to this digital exchange.

(10) Central Computer System

(a) Function

There are six fundamental functions located at the central computer facility including information collection, terminal equipment control, the man-machine interface, countermeasures formation, reporting, recording, systems operations monitoring and data communication. They are described as follows:

- Information collection
  The purpose of information collection is to collect various information concerning not only traffic but also other related information such as weather, construction work, events, etc. This information is gathered by means of equipment such as vehicle detectors, weather sensors, emergency telephones, and CCTV. Some of the information is automatically collected by equipment, while others are input by the operator.

- Terminal equipment control

  The computer system automatically or in accordance with a command by an operator controls roadside facilities such as variable message signs.

- Man-machine interface
  Various data are displayed on a display terminal in letters or in graphic form. It provides all the information that the computer system has collected, including traffic and incident data. The system is operated upon request to an operator who assists them understand the current motorway conditions, and can take countermeasures when necessary. The report will be displayed on a display terminal and will include but not be limited to:

  - Current or historical traffic volume on the through lanes
  - Occupancy rate or congestion level
  - Weather conditions
  - Operational status of variable message sign
  - Incident information
  - System status including equipment malfunctions

  A graphic display panel will be installed in the traffic control room to provide an overall visual presentation of the motorway condition by lamp

and other display elements, automatically or manually. The following information is likely to be displayed on the graphic display panel:

- Congestion
- Incidents
- Regulations
- Motorway conditions
- Variable message sign operation
- Emergency telephones

- Countermeasures formation
  Part of countermeasures formation is provided by the computer system. For instance, the message to be displayed on variable message signs will be prepared automatically by the system based on the incident information stored in the system. Message are issued to the roadside facilities automatically or after confirmation by the operator.

- Reporting and recording
  Reports are printed as records of traffic data and system operation.

- Systems operation monitoring
  The computer system monitors the operations of the system itself and equipment connected to it including roadside facilities.

- Data communications
  The computer system performs on-line data exchange (such as incident information) with other traffic control systems through data channels.

(b) Hardware Configuration

The computer system consists of a central processing unit (CPU), peripherals such as a magnetic disk, magnetic tape unit, printer and CRT display, a graphic display panel, a control desk and interface units for connection to a central controller for variable message signs and detector data processors.

Figure 6.2.21 depicts the hardware configuration of the traffic control room and traffic operation room.

The estimated memory sizes of the control processing unit for the traffic control room and traffic operation room, respectively, are about 500 KB and 600 KB. The sizes of the external memory unit which stores the various programs,

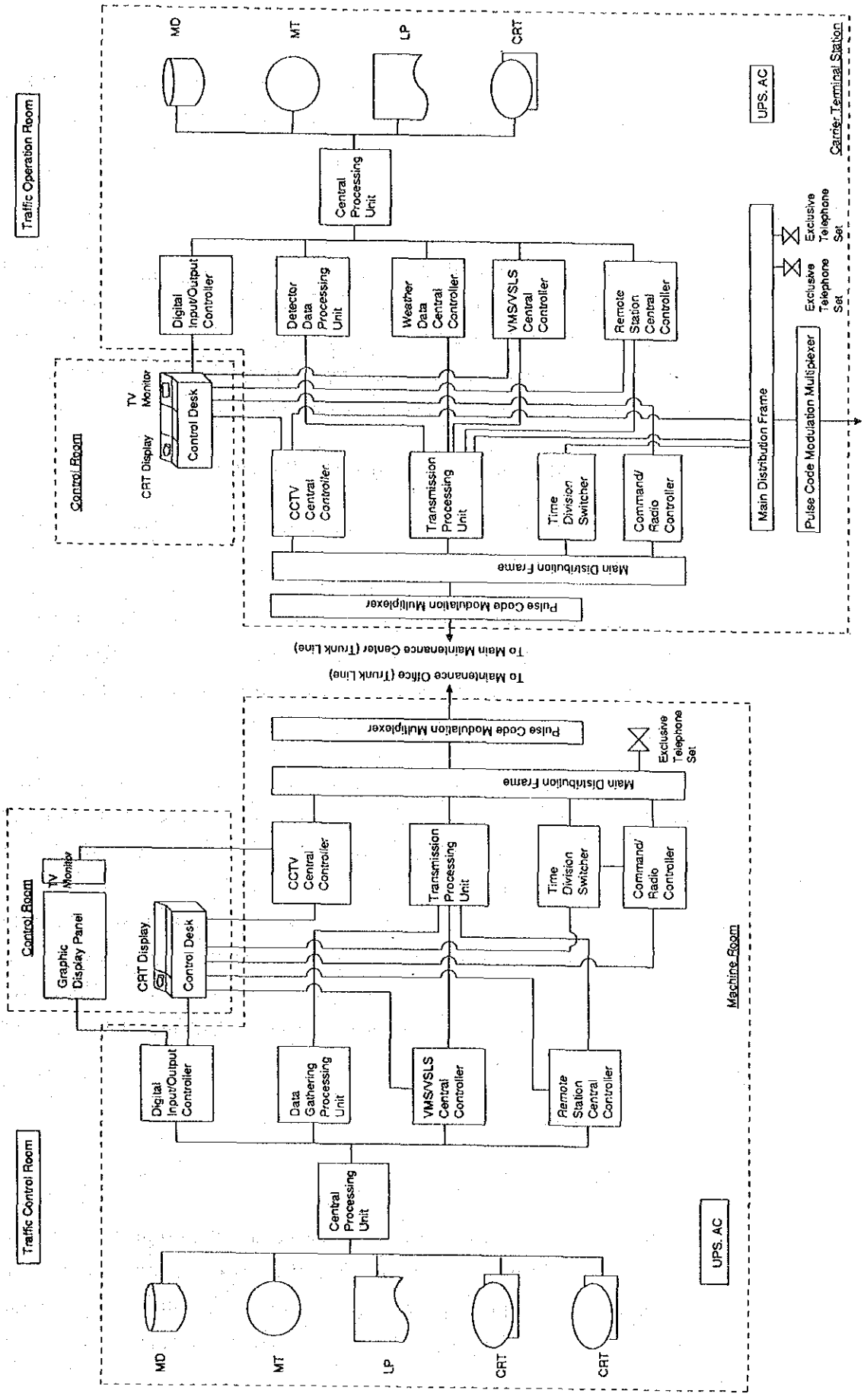


Figure 6.2.21 Hardware Configuration of Traffic Control Room and Traffic Operation Room

parameters and data are about 4000 KB and 500 KB, respectively. Therefore, the total estimated memory size including a safety margin will be above 50 MB, respectively.

(c) Software Configuration

The software is defined as the internal programs or routines prepared to simplify programming and computer operations. These internal programs fall into several categories, the totality of which facilitates the efficient use of the computer. These programs are the operating system, utility programs and application programs. The last two are controlled by the operating system.

(d) Layout of the Traffic Control Room and Traffic Operations Room

Figures 6.2.22 and 6.2.23 illustrates the traffic control room and traffic operations room layout plans.

In laying out the equipment in the traffic control room and the traffic operations room, the functions of the equipment, the operation of the equipment by the operator and the inter-connection between equipment must be carefully considered.

The traffic control room is divided into three separate areas; a control room, a machine room and a power room. The control room is where the operation of the system is performed by operators and is the focal point of the traffic control and management system. Because of this, the room must be separated from noise and heat sources and its color and lighting must be well coordinated in order to ensure efficient operation. Various equipment such as the computer and transmission devices are to be placed in the machine room. The power room accommodates power supply equipment like the uninterruptible power supply, rectifier and battery.

(e) Environmental Conditions

- Air conditioning

  Control room and machine room must be air-conditioned to provide suitable environmental condition for the operators and equipment. Although some equipment operate within the broad temperature range, the reliability of the equipment will be enhanced at the constant temperature.

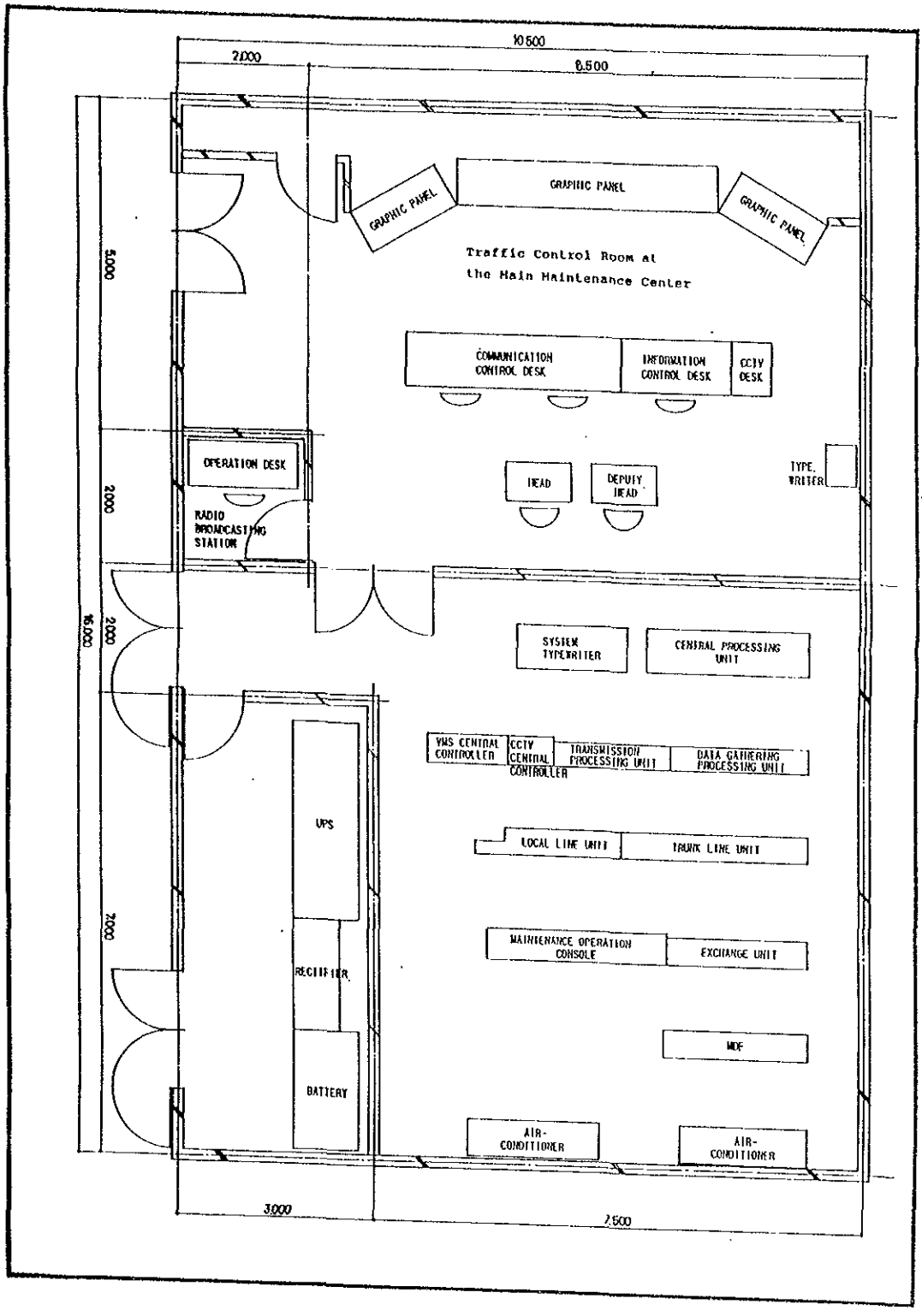


Figure 6.2.22 Layout of Traffic Control Room

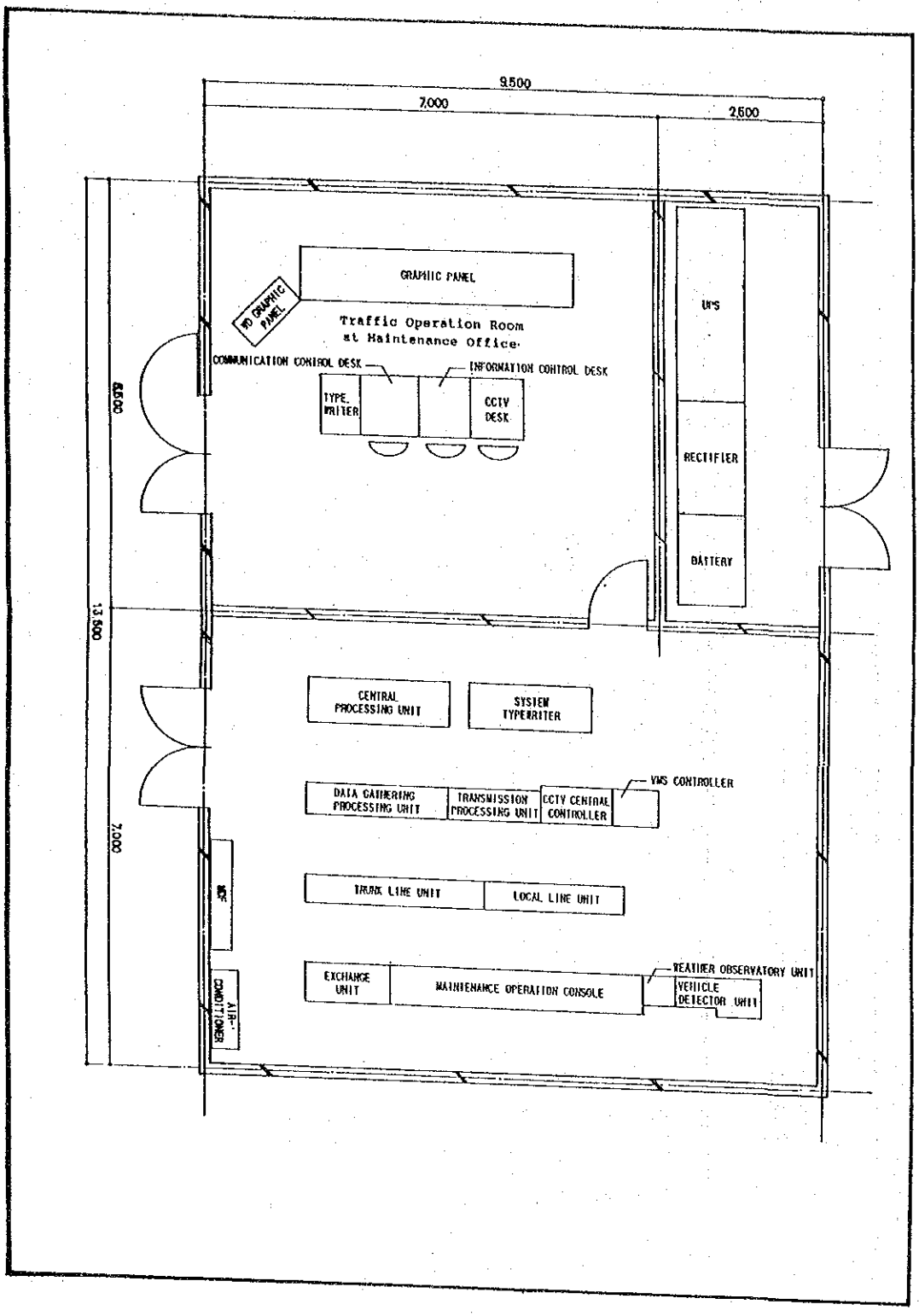


Figure 6.2.23 Layout of Traffic Operation Room

- Lighting

  Lighting plays an important role in the operation of the system and must be designed to create efficient and comfortable working condition for the operator.

  Light sources must be placed in such a way that light reflected by the graphic display panel or CRT screen will not be directly seen by the operator. Illumination of the control console must be bright enough for operator to operate switches or to record the operation.

(11) Uninterruptible Power Supply

As the traffic management and operation system relies on a computer system which operates on a 24-hour basis, a continuous and stable power supply is essential for operation of the traffic control room and the traffic operation room. Uninterruptible power supply system consists of a generator, a constant voltage and constant frequency power supply, a changeover switch, batteries and rectifier.

Under normal condition, the power supply system receives commercial power and supplies power to the equipment through a stabilizing circuit. Should an interruption occur, power is supplied from the batteries until the generator has started and reached a steady state. The changeover switch is provided to switch over automatically between commercial power and the generator.

Capacity of the power supply system is determined by the power requirements of all surveillance and control equipment at the traffic control room, power for air conditioning system and emergency light, and allowance for future expansion. A smaller backup system is provided for carrier terminal stations to maintain the transmission system when commercial power is interrupted.

Power for roadside facilities is directly supplied by commercial power and no backup power is provided for economic reason.

(12) Measurement Facilities

(a) Function

The installation of measurement facilities is intended to preserve the motorway structure and prevent danger to traffic by intensifying control of oversize vehicles which are ever-increasing in size and weight. There are increasing number of damages to tunnel ceiling slabs and lighting fixtures caused by vehicles exceeding the height limit. Vehicles exceeding the weight limit are responsible for damaging the road surface, bridge slabs, and for increasing noise pollution. Traffic congestion on upgrades and traffic accidents on downgrades can also be attributed to oversize vehicles.

(b) Vehicle Height Checkers

- Purpose of installation

  Vehicle height checkers are installed to enforce vehicle height regulations for all vehicles entrance ramps prior to the tollgates

- Types of vehicle height checkers

  The two types are the overhead type and the photoelectric type. The overhead type is used for single lane ramps and the photoelectric type is used for ramps with two or more lanes. A tollgate canopy should be equipped with a device to identify vehicles exceeding the height limit.

  (Overhead (gantry) type)

  As for structures of the overhead type, vehicle height checkers are a steel plate installed across two gateposts (gantry) at the specified height. When an overheight vehicle passes through the gate, it touches the steel plate and activates an alarm.

  (Photoelectric type)

  For this type, a unit emitting a light is installed on one of two poles at the specified height. A second unit receiving the light is installed on another pole. When an overheight vehicle passes, the light path is blocked and the alarm is activated.

- Installation locations

Locations for vehicle height checkers should be determined with practical operations taken into consideration. The vehicle height checkers should be visible from the toll booth so that toll collections can visually check the height of the vehicle which triggered the alarm. A sufficient distance (minimum 50 m) between checkers and toll booth should be provided so that a vehicle can exit prior to the toll booth as shown in Fig. 6.2.24. The overhead type of vehicle height checker should be installed in the narrower ramp locations rather than at the tollgate, considering the cost of installation.

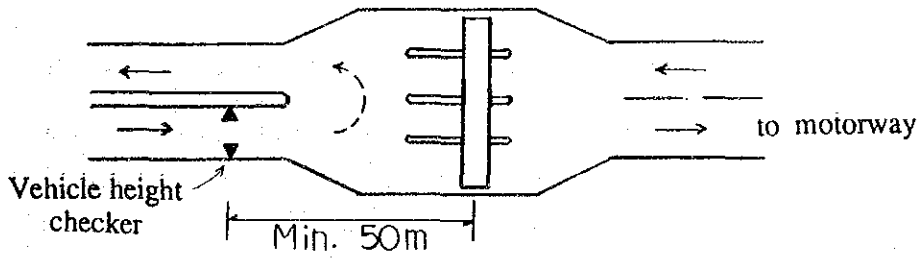


Figure 6.2.24 Installation Location of Vehicle Height Checkers

(c) Axle Weight Scales

- Purpose of installation

Axle weight scales are installed at each entrance to the tollgates to check for violations of the maximum allowable axle weight of vehicles.

- Installation locations

Axle weight scales are installed at 20-25 m ahead of the center of toll booths as shown in Figure 6.2.25.

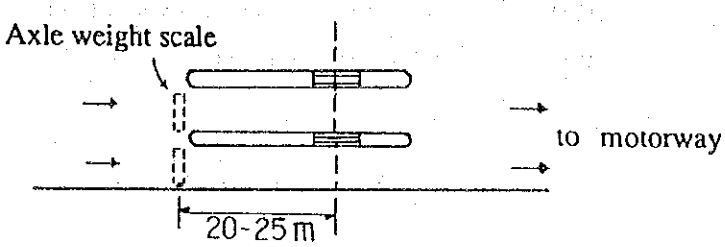


Figure 6.2.25 Installation Location of Axle Weight Scale

- Providing an exit for vehicles in violation of the weight limit

  When determining the location of an exit for overweight vehicles, the motorway structures and the location of the traffic police units should be taken into consideration. Basically, overweight vehicles should be treated as follows:

  (U-turn exit)

  At interchange with relatively small traffic volumes where U-turns would not interfere with other vehicles, the vehicles should make a U-turn before the tollgate or in the toll plaza in the through lanes beyond the tollgate and then make an exit.

  (Leaving from assigned interchanges)

  At interchanges and barriers where U-turns or construction of an exit path is difficult, toll collectors put a stamp on the ticket stating "Violating Regulations, Exit at XXXX Interchange". If the vehicle exits at an interchange other than the one specified, toll collectors should inform the traffic police so that the drivers can be prosecuted.

(13) Data Processing System Related to the Magnetic Card Toll Collection System

(a) General

The potential capabilities of the existing toll collection system utilizing a magnetic card system are not being fully utilized. To make maximum use of the existing system, it will be necessary to provide for an administrative organization and communication cable network connecting to each office.

The data processing system related to the magnetic card toll collection system will be responsible for handling a significant amount of data including many different types of items. Therefore, the system should be designed so that data will not be lost even with a power failure. As with the normal result of data processing, various statistical data will be obtained at each step of the data processing.

(b) Data Flow and Data Storage / Protection

Figure 6.2.26 shows the outline of data flow and data storage / protection

(i) Data Flow

The data handled by this system can be roughly divided into three data types:

- Work data (Tolls collected, numbers of vehicles handled, etc.)
- Traffic data (data classified by IC, vehicle types, time, etc.)
- Other data

- Data initially processed at an entrance or exit booth is sent immediately after the processing mentioned above to the data processor at the toll collection office for data storage. At the same time, the data is accumulated at the entrance or exit booth processor.
- At the end of each operator's duty at an entrance or exit booth (usually one operator works for two or three hours), the data collected is compiled and transmitted from the toll collection office data processor to the maintenance office data processor.
- When the total data for the day has been collected from all the toll collection offices under the jurisdiction of the each maintenance office, each maintenance office data processor sends its data to the main maintenance center data processor.

(ii) Data storage / Protection

- As shown in Figure 6.2.26, data are usually stored or accumulated in two or more places.
- The processed data are stored for two days at the entrance and exit booths. It is for four days at the toll collection office and the maintenance office. Accumulated data and some detailed work data are then preserved for two months at the maintenance office and the main maintenance center.
- If some data were lost for one reason or another, it can be recovered from the data stored in a backup location or by rereading the data record magnetically on tickets which have already been processed.

(iii) Data Processing

Recorded data on the magnetic card is at least as follows:

(Entrance Lane)

- IC number
- Lane number
- Code number of operator
- Date, hour and minute

(Exit Lane)

- Vehicle classification
- Toll
- Code number of operator
- Date, hour and minute

The following outputs will be obtained as the result of processing the data mentioned above (refer to Table 6.2.7).

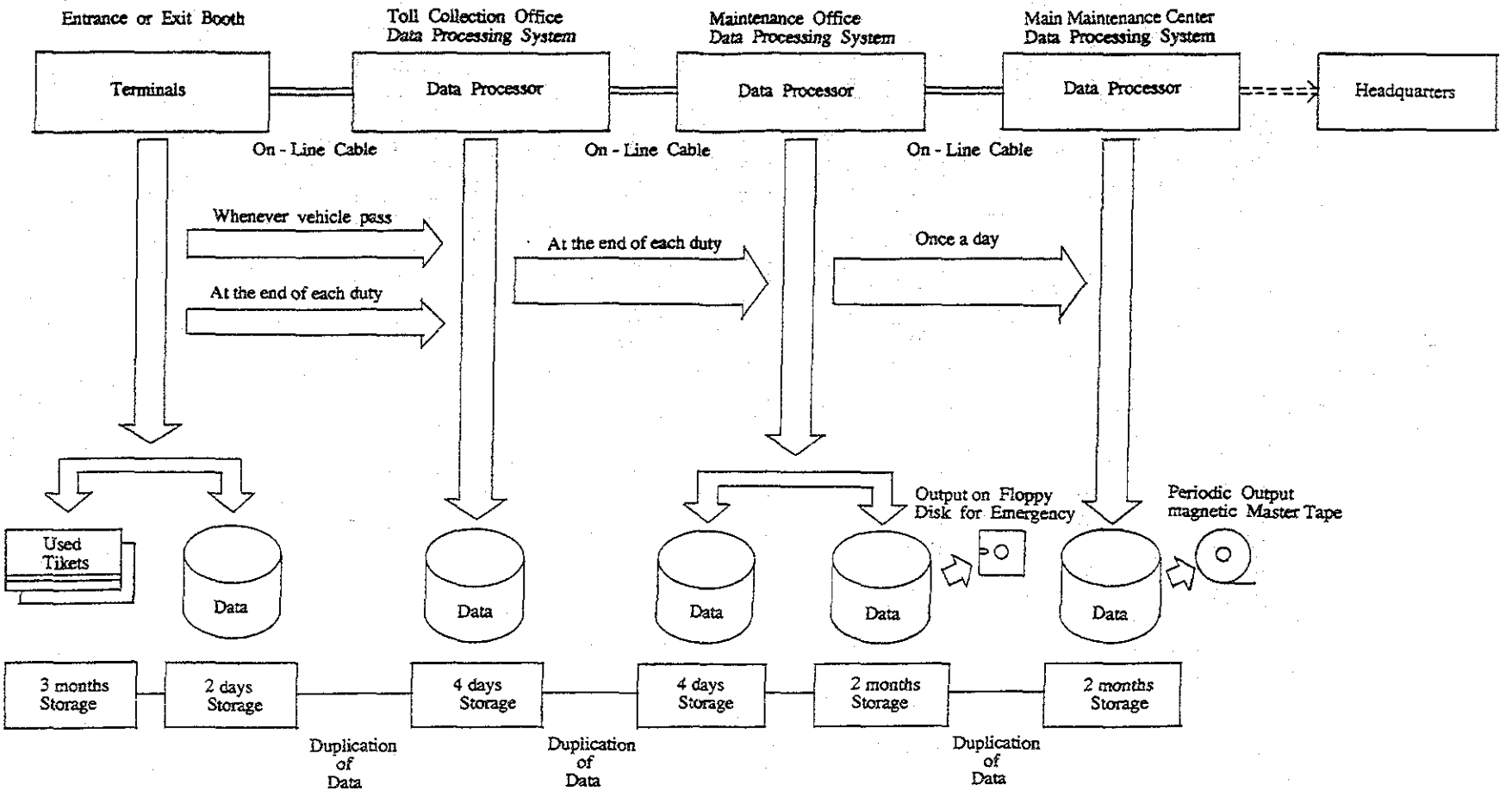


Figure 6.2.26 Data Flow and Data Storage / Protection

Table 6.2.7 Outputs of Data Processing

Offices	Outputs	
	Work Data	Traffic Data
Toll Collection Offices	• Working Reports • Account Reports	• Traffic Volume Daily Report by Vehicles Class and hour • Traffic Volume Daily Report by Vehicle Class and Entering IC
Maintenance Office	• Audit Reports	• Traffic Volume Monthly Report by Vehicle Class and Hour • Traffic Volume Monthly Report by Vehicle Class and Entering IC
Main Maintenance Center	• Toll Lane Operation	• Traffic Volume Monthly Report by Vehicle Class, On and Off of IC • Traffic Volume Monthly Report by Vehicle Class and IC Section
Headquarters		• IC Pair Traffic Volume Table by Vehicle Class on Specific Day
Purposes of Outputs	- To check actual toll collectors working results - To check tolls collected - To inspect personnel management and to audit - To check toll lane operation conditions - To check income / expenditure conditions - To obtain indices in detail for traffic engineering - To obtain basic data regarding motorway maintenance	

6.2.2 Motorway Maintenance and Operations

The purpose of this section is to describe the motorway maintenance and operations for the "Short Term Implementation Program", covering the 1,500 km of motorway in Divisions 1, 2, 4, 5 & 17.

1) System to operate motorway maintenance

Basic plan for the system was discussed in Section 5.7. The system is also applicable to this short term implementation program. Within the formulated system, the following matters are emphasized to achieve efficient and economic motorway maintenance.

- The force account activities of the motorway maintenance shall be reduced gradually in scope and volume, in consideration of the technical capability of contractors and labour intensive works. However, KGM has to undertake activities requiring a quick response and information collection & dissemination.
- A data-base and management system is the major component for planning any maintenance work as it is the source of all historical knowledge concerning any road structure or facilities. It is also important to collect as-built drawings and documents including engineering design documents.
- Training of inspectors is very important to keep motorway maintenance levels high. The inspectors should be trained to be responsible for inspections, recording observations and preparing inspection reports in an efficient manner.

Regarding information and communication system, the following as shown in Figure 6.2.27 is developed to clarify the extent of information and communication among MMC, MO and others.

2) Planning of Motorway Maintenance

Provided herewith will be a breakdown of the planning, implementation methods, inspections, maintenance and repairs, and the required vehicles and equipment necessary to provide maintenance and operations.

(1) Programing

Motorway maintenance and operations programs shall be made on annual, monthly and weekly basis, considering priority for the work, available resources, past work records, road inventories, road structure inventories, traffic volumes, meteorological data, etc.

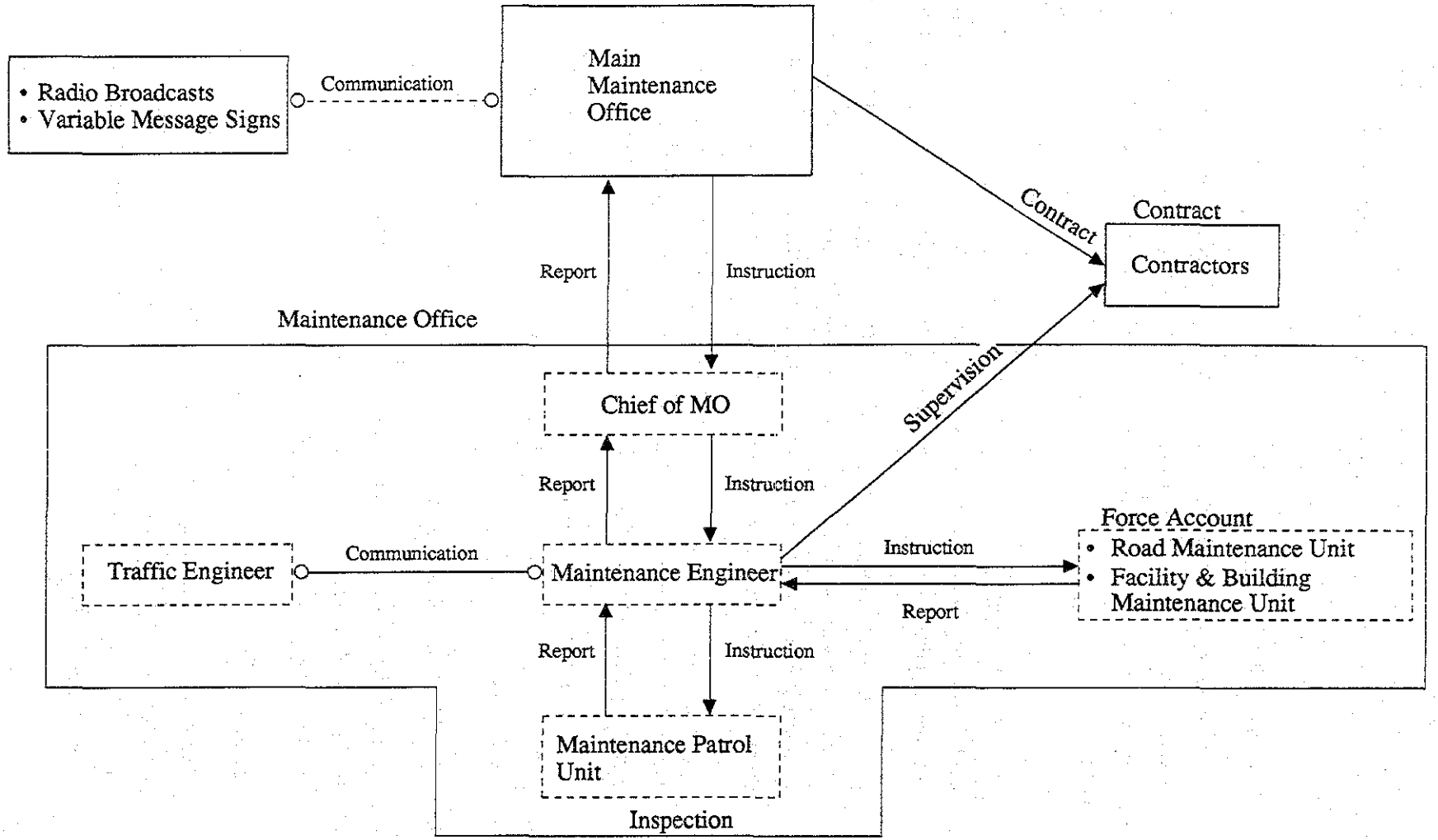


Figure 6.2.27 Information and Communication Flow

(2) Annual program

Annual program will be planned to allocate the scope and scale of monthly work. The following matters shall be included based on the annual budget:

- Appropriate monthly activities for inspection, maintenance and repairs shall be planned based on the characteristics of the work and traffic conditions. The volume of work shall be allocated carefully so as not to concentrate on a limited period.
- Personnel, equipment and materials shall be assigned appropriately.
- The programming shall consider local meteorological conditions (temperature, rainfall, snowfall, etc.).
- Maintenance and repairs of pavement shall be undertaken before the damages become serious. Cracks, potholes and corrugation should be repaired before the winter season, since these problems lead to rapidly increasing damages to the pavement due to rainfall and snowfall.
- The scheduling of grass cutting shall be made based on local meteorological conditions.
- The cleaning and repairs of drainage facilities shall be conducted at an appropriate time for the drainage system to function.
- Painting shall be undertaken at an appropriate period considering the seasonal and local conditions.

(3) Monthly program

A monthly program will be planned to allocate daily maintenance and repairs. Changes to the programs can be made flexibly in case a particular repair work is judged to have a higher priority during the actual implementation of the plan.

A monthly program will be established based on the annual program, considering the following:

- Appropriate daily activities for inspection, maintenance and repairs shall be assigned throughout the month.

- Appropriate traffic control shall be arranged for the maintenance and repairs, considering the characteristics of the work, month, date and time-frame.
- Coordination with other works shall be made for a smooth operation.

(4) Weekly program

A weekly program will be planned to allocate and adjust daily activities for inspections, maintenance and repairs. A weekly program will be made based on the monthly program, considering the following:

- Breakdown of the monthly activities will be made for weekly and daily activities.
- The amount of previous weekly work accomplishment will be checked and reflected in the following week.
- The accumulated amount of weekly work accomplishment in a month will be reviewed for updating the weekly program of the following month.

3) Implementation of Motorway Maintenance

(1) General

Motorway maintenance shall be conducted, in careful consideration of traffic regulations, traffic safety and circumstances along the motorway, since the motorway is always to be opened to public traffic.

(2) Coordination with Police Office

KGM can partially or fully close traffic lanes on the motorway for maintenance and repairs as per the "Highways Traffic Law (approved 13 October, 1983) No. 2918". Therefore, KGM will coordinate with and give a notice in writing to the police office concerned to attain good cooperative result.

(3) Coordination with Offices in Charge of Underground Utilities

Serious accidents can occur if underground utilities are damaged during maintenance and repairs. It is necessary for KGM to investigate and identify those utilities in advance, and coordinate with the office in charge of the utilities.

(4) Safety during Maintenance and Repairs

(a) Safety standards and signs

Traffic signs and safety devices shall be installed to secure safety for workers and motorway users during maintenance and repairs based on the following standards. Personnel in charge of traffic control for safety purpose shall be assigned to the site during the work.

- Section 3.3, Traffic Management during Motorway Maintenance and Repairs of Operations Manual (this study)
- Traffic Markings and Signs Manual (KGM, Publication No. 218, 1975)
- Marking and Signing Standards on Motorways and Expressways (KGM, publication No. 246, 1983)
- Highway Traffic Law (approved 13 October, 1983), No. 2918, item 13

(b) Important items

Attention should be paid to the following while conducting maintenance and repairs:

- Personnel in charge of traffic control shall be assigned on-site for the safety of workers and motorway users.
- Guide signs and traffic markings shall be installed to remark restricted traveling lanes clearly to motorway users.
- Lighting facilities shall be provided during night maintenance and repairs.
- Equipment, facilities and materials shall be neatly located in the work area for efficient and safe work operations.
- Excavated and excess materials shall be disposed of immediately so that the motorway surface is always free from obstacles during the work activities too.

(c) Personnel for traffic control

Personnel in charge of traffic control shall be assigned during the maintenance and repairs. They shall ensure smooth and safe traffic flow and worker's

safety. They shall be familiar with the following items against traffic congestion or accidents:

- To whom contact first
- How to contact
- Countermeasures to be taken first against the congestion or accident

(5) Public Announcement

KGM shall perform public announcement activities through the use of variable message signs, radio broadcasts and billboards for motorway users. The public announcement shall be done well in advance of actual maintenance and repairs which will last for more than one day with partial closure of travel lanes, or full closure of the motorway. The announcement will include the purpose, type of work, working dates and completion date.

Detours shall be announced and coordinated with the agencies concerned in the case of motorway closures.

(6) Meeting with and Instructions to Road Maintenance Units

The chief of the MO (or his representative) shall meet with the chief technician of the maintenance unit prior to the work so that it may be executed smoothly and safely.

The chief or his representative shall discuss the scope and scale of the work with the crew and give sufficient instructions so that the crew of the unit may take appropriate measures against unexpected disasters or accidents.

4) Traffic Control Measures and Impact During Motorway Maintenance

(1) Traffic Control Measures

It is important for KGM to try to avoid any traffic accidents caused by obstacles during the motorway maintenance activities.

The date, time-frame, construction methods and proposed traffic control measures shall be analyzed for the motorway maintenance activities based on traffic volumes, numbers of traffic lanes and detours.

The following types of traffic control measures are discussed based on the characteristics of motorway maintenance. Reference is made to section 3.3, Traffic Management during Maintenance and Repairs of the "Operations Manual":

(a) Time-frame to complete the maintenance activities

The time frame to complete motorway maintenance activities shall be determined based on the following:

(i) Traffic volumes

The time frames with lower traffic volumes shall be selected based on actual hourly traffic volume data.

(ii) Construction methods and equipment

Construction methods which minimize traffic disturbances on the motorway and reduce noise and vibrations for residents along the motorway shall be selected.

(iii) Detours and traffic control measures

A detour shall be selected in the case where the full width of the motorway is occupied by the construction work. KGM shall coordinate with all agencies concerned with the detour. KGM will notify traffic detour to the concerned police office based on the requirements in the "Highway Traffic Law, No. 2918".

(b) Selecting appropriate time-frames

(i) Pavement maintenance

Time-frames with high traffic volumes shall be avoided for pavement maintenance, since the work normally occupies one or two lanes of the carriage way.

Urgent repairs, however, are sometimes required due to road surface damages which may cause traffic flow disturbances.

(ii) Road surface cleaning

Sweeping machines for road surface cleaning do not normally affect the traffic flow since they travel on the right shoulder at relatively high speeds while working.

When cleaning the inner shoulder, however, the work shall be done during off-peak hours.

(iii) Grass cutting

The right shoulder will be utilized for grass cutting on slopes, and the inner travel lane will be occupied for grass cutting in the median.

Therefore, grass cutting in the median will be done during off-peak hours.

(iv) Traffic markings

The painting of traffic markings can be done during the day time since the work can be done in a short time and confined to a certain length.

(v) Repairs to bridges and box culverts

Repairs to bridges and box culverts shall be done during off-peak hours since they occupy one or two lanes and may require pavement maintenance.

(2) Environmental Impacts

Smooth construction activities will be considered in an effort to minimize noise and vibrations during the maintenance and repairs.

5) Tasks of Motorway Maintenance

(1) Inspections

Roadway inspections are one of the most important activities which are necessary for KGM to recognize the conditions of the motorway section as well as its traffic conditions.

(a) Definition and Purpose of Inspections

The inspections are defined as collecting information on physical conditions of road structures and facilities, and on traffic usage to the road structures, and as judging the level of deficit and/or damage in order to keep the motorway in good conditions and to assure traffic safety from aspects of the motorway maintenance and operations.

In addition to the above, it is very important to reiterate the inspections and record the result to know the development and progress of the defect and damage to the road structures.

The inspection is different from an investigation consisting of measurement, analysis and evaluation. The investigation will be required to judge the depth of the defect or damage based on the detailed measurement using measuring devices or equipment, in cases that the information and data produced by the inspection is not sufficient to evaluate and judge the depth of defects.

(b) Types and Frequency of Inspections

There are three (3) types of inspections as follows:

- Routine Inspection
- Periodic Inspection
- Special Inspection

(i) Routine Inspection

Routine inspections cover inspections of damages and unusual conditions on the motorway.

It also covers the traffic usage to the road structures that are tied to traffic safety and smooth flow.

This inspection is normally done visually from a moving patrol car, is augmented occasionally by observations on foot and normally utilizes two or more trained inspectors. One is engineer and the other is non-engineer.

(ii) Periodic Inspection

Periodic Inspection is the detailed inspection of road structures and facilities such as asphalt pavement, drainage, bridges and slopes, and is normally done on foot. Periodic inspections are conducted by specially trained inspectors team, made up of both engineers and non-engineers.

Periodic inspections are split into two types, periodic inspections A and B.