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THE DETAILED DESIGN STUDY ON AREA TRAFFIC CONTROL PROJECT IN BANGKOK IN THE KINGDOM OF THAILAND

SUMMARY VOLUME

FINAL REPORT

OCTOBER 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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CHAPTER 1 INTRODUCTION

1.1 Background

Roughly 200 intersections in the Bangkok Metropolitan Area-- including all major intersections-- are currently signal controlled. Of these, 47 intersections, most of which are located in the Old City, are subject to a computer-controlled ATC System. Although the OCMRT had been operating the ATC System since March 1979, responsibility for the operation of the system was subsequently transferred to the BMA. Simply extending this system to the entire Bangkok Metropolitan Area, is expected to have little effect in improving traffic flow in the area, as the existing system are considered to be unsuitable for the purpose.

The signalized intersection were initially under the ATC or isolated control modes without updating the control parameter as years go by, and these signals were found to be incapable of coping the much increased traffic. Traffic police which was organized into 4 operational divisions in Bangkok, then started to control these signals manually and has been doing so up to today.

Meanwhile, since the existing road network is believed to be inadequate for alleviating traffic congestion in Bangkok, the construction of additional roads is believed to be necessary. At the same time, it should be possible to alleviate congestion still further by applying more efficient traffic control plans to the new road network that will result from the completion of ongoing projects.

A feasibility study on improving and expanding Bangkok's Area Traffic Control System was carried out between November 1988 and March 1990 with the technical cooperation of the Japanese Government.

Pursuant to the feasibility study and in response to the request of the Thai Government, the Japanese Government agreed to extend technical assistance in the execution of The Detailed Design Study on Area Traffic Control Project in Bangkok in The Kingdom of Thailand (the Study). The Japan International Cooperation Agency (JICA), which is responsible for implementing technical cooperation programs of the Japanese Government, dispatched a preliminary survey mission to Bangkok in December 1989 to conduct a reconnaissance survey and to finalize the Scope of Works for the Study. After the Scope of Works was agreed upon by the Bangkok Metropolitan Administration (BMA), the JICA dispatched a study team to Bangkok in March 1990 to help carry out the Study.

1.2 Objective of The Study

The objective of this Study is to carry out the detailed design study and prepare the necessary documents for the implementation of the first stage of the Area Traffic Control (ATC) system Project in Bangkok as proposed by JICA in August 1989.

1.3 Study Area

The study covers the area as examined by the previous the JICA Feasibility Study, and particularly the area identified as the Stage I for the implementation of the proposed ATC System. This area is shown in Figure 1.1.

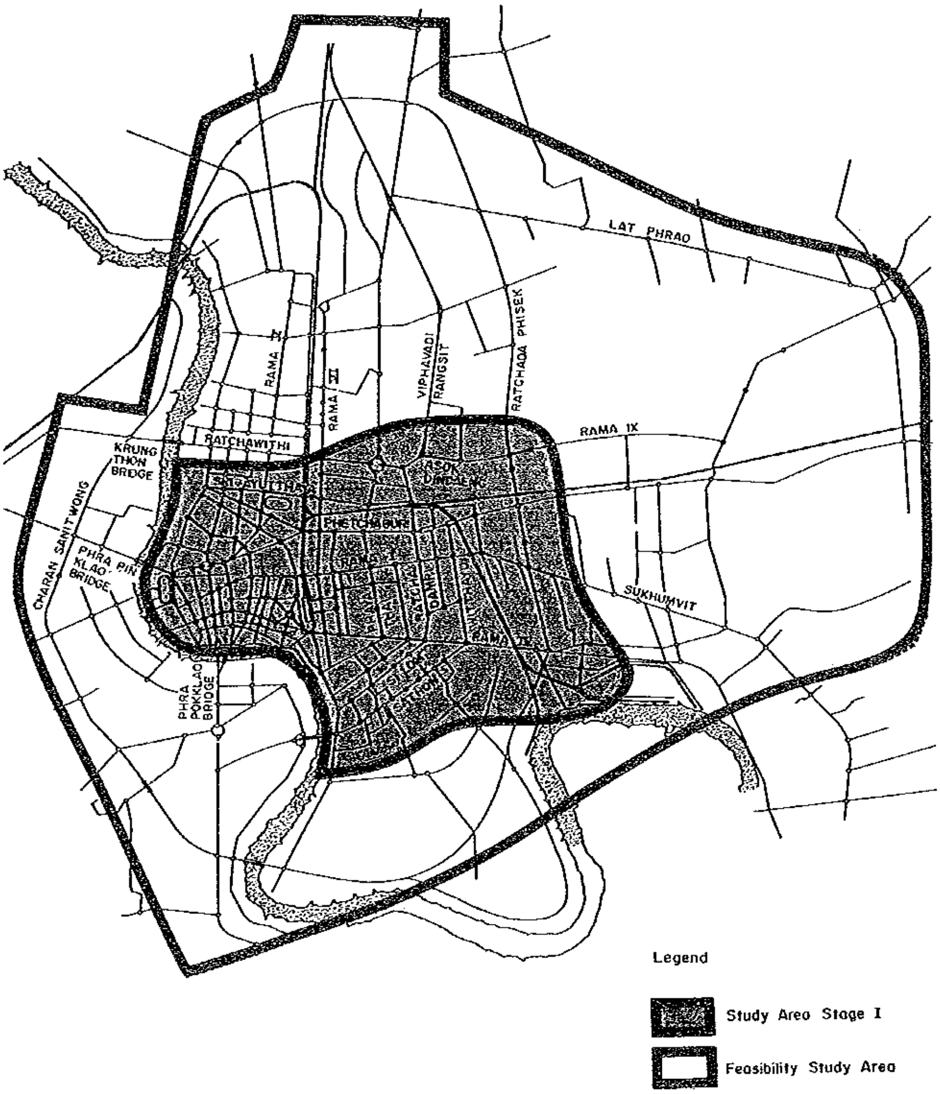


Figure 1 The Study Area

1.4 Study Organization

This Study was carried out by Japan International Cooperation Agency in conjunction with the Bangkok Metropolitan Administration. The organization for the Study is as follows:

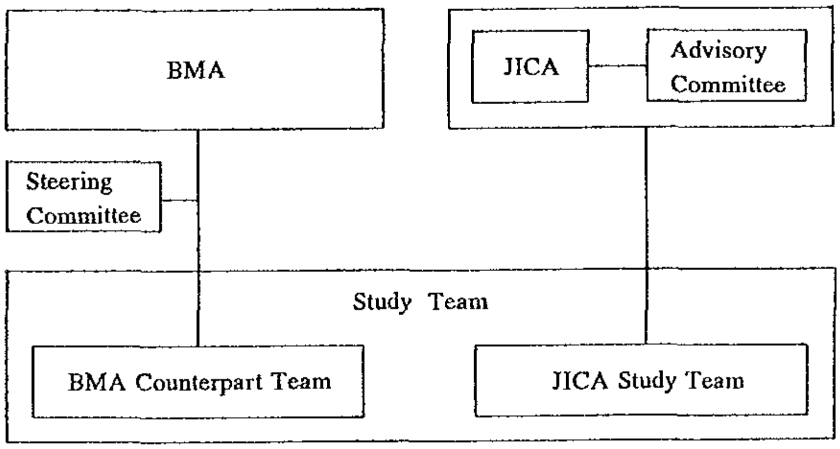


Figure 1.2 Study Organization

STEERING COMMITTEE

1.	Mr.Boonyawat Tiptus (Chairman)	-	Director of Traffic Engineering Division, BMA
2.	Dr.Prapon Wongwichien	-	Director of Public and Integrated Planning Division ,BMA
3.	Col.Sanong Krittayabarn	-	Traffic Police Division, Police Department
4.	Mr.Rapw Charutula	-	Office of Committee for the Management of Road Traffic (OCMRT), OPP, MOI
5.	The Late Mr.Tanit Srichu	-	Public Work Department, BMA
6.	Mrs.Krittaya Satcharak	-	Policy and Planning Department
7.	Mr.Anek Chaowakasem	-	Chief of Traffic System, Sub-Division, Traffic Engineering Division, BMA
8.	Mr.Surapol Wattanavicharn	-	Chief of Traffic Sign & Marking Sub-Division, Traffic Engineering Division, BMA
9.	Mr.Suphachai Tangsriwong	-	Chief of Traffic Signal Sub-Division, Traffic Engineering Division, BMA
10.	Mr.Nikom Porntharakcharoen	-	Chief of Design & Planning Section, Traffic Engineering Division, BMA
11.	Mr.Somkid Wongthangswad	-	Chief of Traffic Signal Planning Section, Traffic Engineering Division, BMA
12.	Ms.Hansa Khamthong	-	Chief of Transport Study Section, Traffic Engineering Division, BMA
13.	Mr.Tripob Khantayaporn	-	Chief of Traffic Signal Control Section, Traffic Engineering Division, BMA

JICA ADVISORY COMMITTEE

1.	Prof.Masaki KOSHI	-	University of Tokyo
2.	Mr.Michimasa IKEDA	-	Ministry of Construction
3.	Mr.Akio MIYACHI	-	Ministry of Construction
4.	Mr.Keizo KAGAWA	-	JICA Headquarters

JICA STUDY TEAM

1.	Mr.Juro KODERA	-	Team Leader
2.	Mr.Kokuro HANAWA	-	Contracting/Implementation Planning
3.	Mr.Kimio KANEKO	-	Traffic Management
4.	Mr.Yasuo NABESHIMA	-	Contracting/Maintenance Planning
5.	Mr.Saburo SHIMAUCHI	-	Signal Design (hardware)
6.	Mr.Yoshio YOSHIDA	-	Signal Design (software)
7.	Mr.Yutaka TAKAHASHI	-	Building Facility
8.	Mr.Tetsuya TAHIRA	-	Facility Design I
9.	Mr.Tsukasa TOMOTANI	-	Facility Design II
10.	Mr.Koji HIRANO	-	Facility Design III
11.	Mr.Mok YOU CHUA	-	Bidding Documents
12.	Mr.Akio TATSUNO	-	System Analysis
13.	Mr.Kenjiro MATSUMOTO	-	Cost Estimate

CHAPTER 2 BASIC TRAFFIC CONDITIONS FOR ATC SYSTEM

2.1 ATC Planning Area and Current Traffic Conditions

2.1.1 Planning Area and Existing Road Network to be covered by ATC

Figure 2.1 shows the target area for Stage I and the existing road network to be covered by ATC. There are five east-west arterial roads and five north-south arterial roads that serve traffic within the ATC Planning Area.

2.1.2 Current Traffic Circulation Method

The major circulation methods in Bangkok are one-way road method, unbalanced lane method and bus lane methods (See Figure 2.2). At present, contra-flow lane, reversible lanes and fixed unbalanced flow are used in combination with the one-way system on arterial roads. In principle, however, clockwise operation of one-way loops has basically been maintained. In principle, a bus lane is designed as a contra-flow lane when it is combined with a one-way road or an unbalanced lane road.

2.1.3 Vehicular Traffic Flow

1) Current Traffic Volume

Two-way 12-hours traffic volumes on major arterial roads in the Study Area range approximately between 36,800 pcu and 108,900 pcu (See Table 2.1 and Figure 2.3)

Two-way traffic volumes on major arterial roads om the Study Area range approximately between 9,100 pcu and 2,300 pcu during the morning peak hour (8:00-9:00) and 10,300 pcu and 2,200 pcu during the afternoon peak hour (16:00-17:00).

2) Hourly Fluctuation

The fluctuation patterns shown in figure are complicated and vary widely. Peak hours generally occur during 7:00-9:00 in the morning, 13:00-14:00 in the afternoon, and 16:00-18:00 in the evening. Especially large fluctuations are seen from morning to afternoon owing to changes in traffic congestion that occur during business hours.

To see how traffic volumes fluctuate during a week, traffic volumes vary greatly depending on the day of the week.

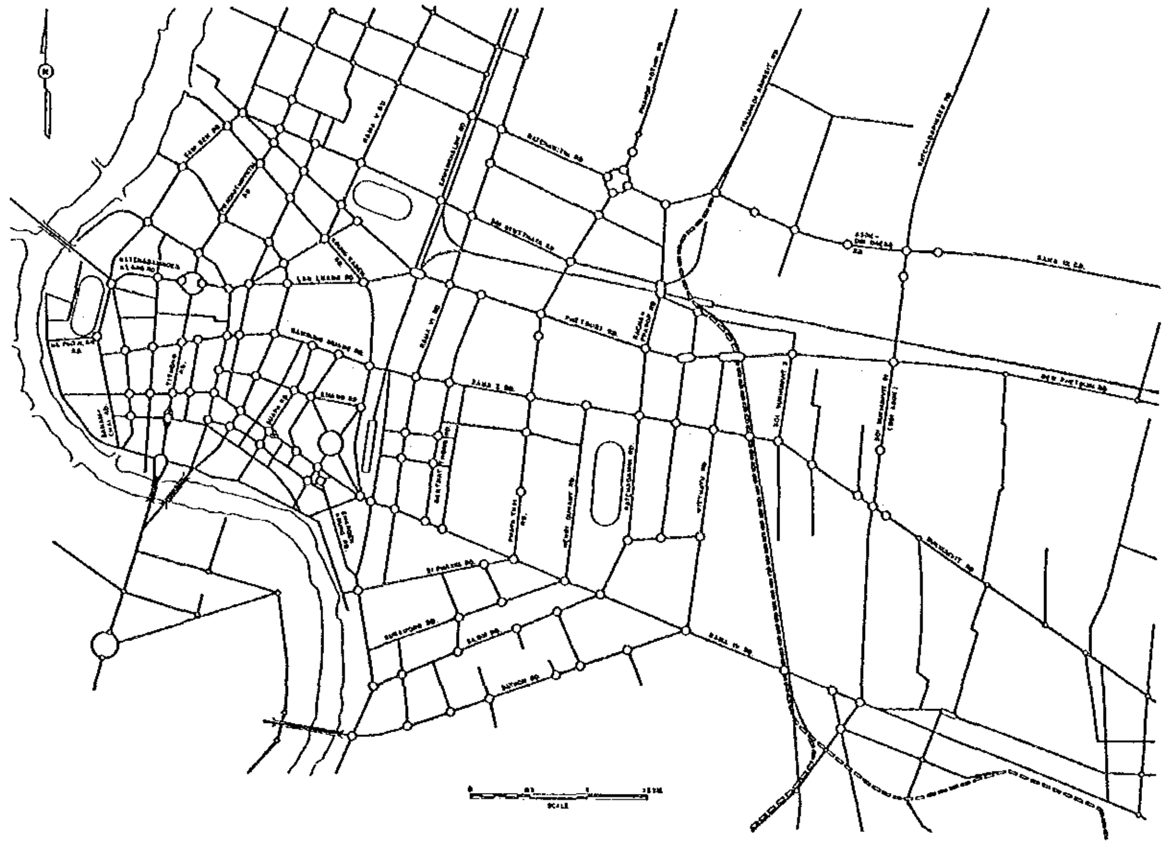


Figure 2.1 Existing Road Network on ATC System Planning Area

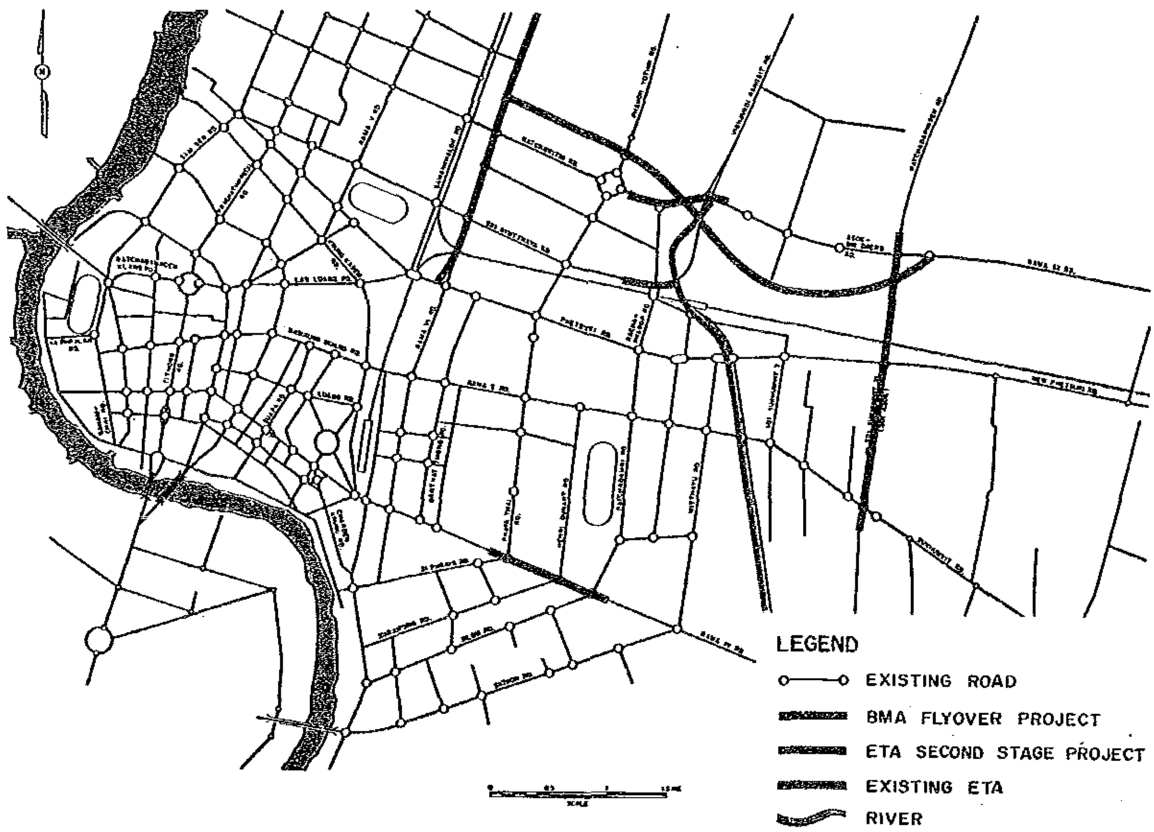


Figure 2.2 One-Way Road, Unbalanced Lanes and Bus Lane

Table 2.1 Traffic Volume on Major Roads (1989)

PCU, both directions

Road	Range of Volume		
		Peak Hour	
	12 Hours	08:00 - 09:00	16:00 17:00
Rama IV	108,900-55,200	9,100-4,700	10,300-4,100
Phetchaburi	83,500-66,900	6,400-2,900	6,600-2,600
Sukhumvit	70,200-73,900	6,800-6,900	5,400-5,900
Phloen Chit	79,100-66,600	7,700-6,400	6,200-4,900
New Phetchaburi	78,600-56,200	6,800-2,300	7,900-2,300
Din Daeng	73,700-53,900	6,700-5,200	5,500-3,600
Phaya Thai	72,400-43,100	5,400-3,200	5,400-4,000
Sathon	71,300	6,100	6,300
Ratchadamnoen-Klang	70,300	5,900	6,900
Rama I	62,000-42,900	5,700-4,100	5,100-3,200
Ratchaprarop	50,200-42,400	3,700-3,600	4,400-3,700
Soi Asok (Sukhumvit 21)	43,500-48,200	3,800-4,600	3,400-3,700
Ratchadamri	36,800	3,100	3,200

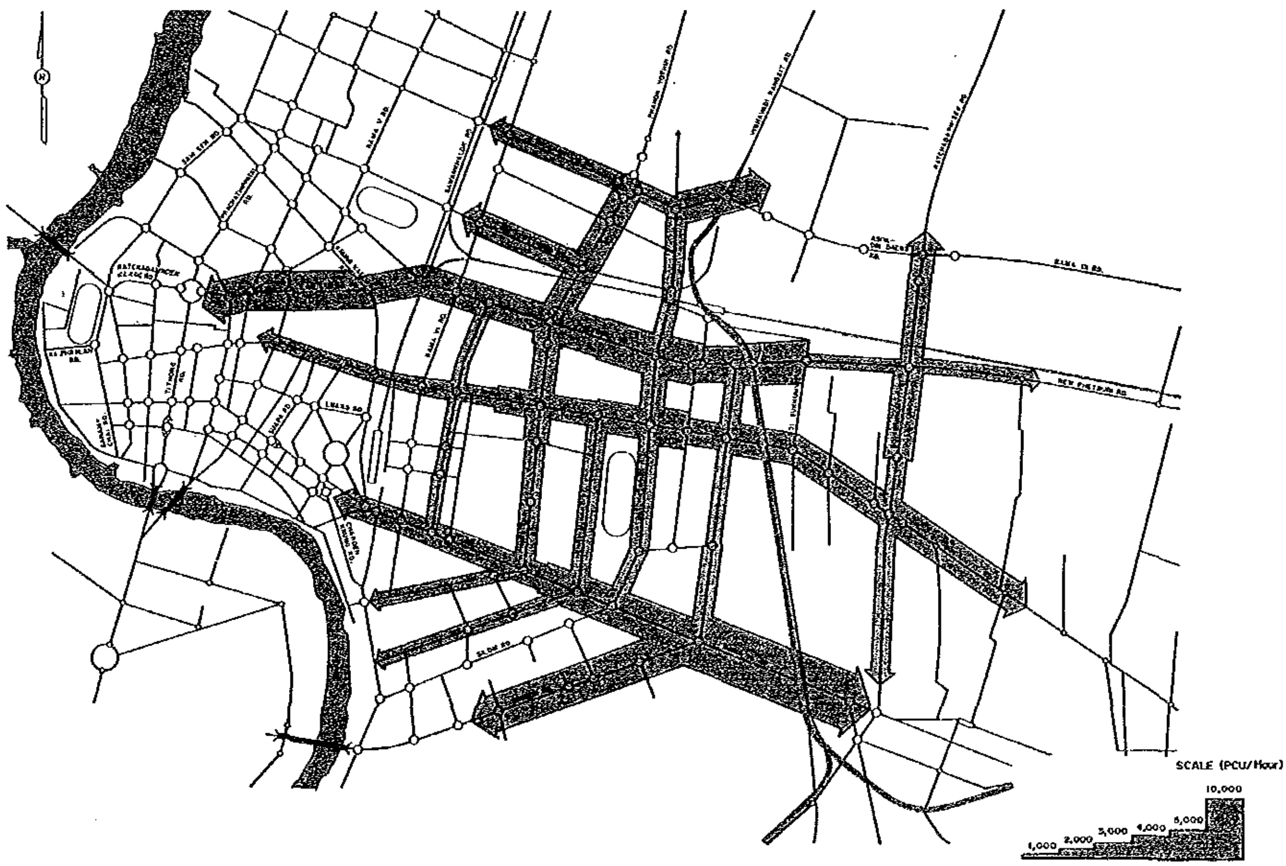


Figure 2.3 Existing Traffic Volume in 1989 (12 Hours)

2.2 Framework for ATC System Plan

2.2.1 Target Year

The target year is established as 1993, when a part of the ETA's second Stage Expressway will be completed.

2.2.2 Future Road Network to be Covered by ATC System

The future road network to be served by ATC System will comprise the existing road and other roads which are presently under construction or planned and scheduled to be complete by 1993.

The subject road sections in ATC planning area are assumed to be operated by the method of Two-way/reversible lane system (See Figure 2.4).

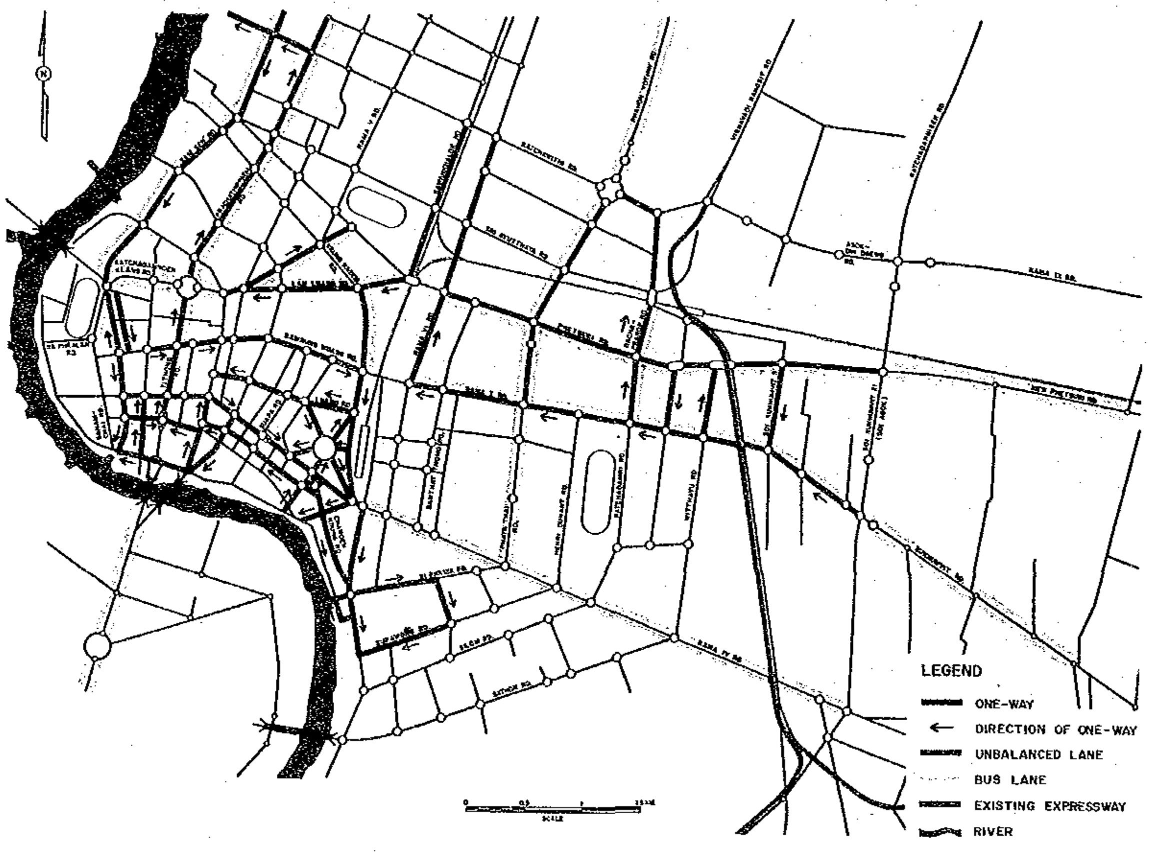


Figure 2.4 Future Road Network (1993) on ATC System Planning Area

2.2.3 Intersection to be Covered by ATC System

Figure 2.5 gives the locations of intersections to be signalized in ATC System. A total of 143 intersections were identified. The above-mentioned 143 intersections subject to control by the ATC System were divided into 35 key intersections and 108 ordinary intersections.

2.2.4 Future Traffic Conditions

The volume of future vehicular traffic was forecast according to the method of Figure 2.6. This volume is used as the design volume for ATC System.

The forecast volume of vehicular traffic in 1993 was assigned to the subject road network by time period and by direction. The design traffic volume of the 143 subject intersections are given in detail in Supplementary Volume, Part 6.

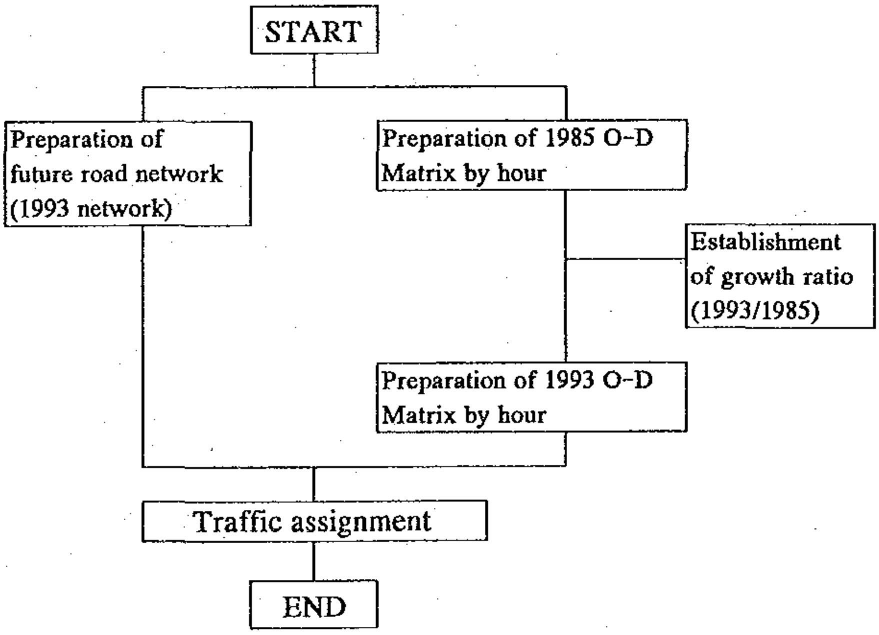
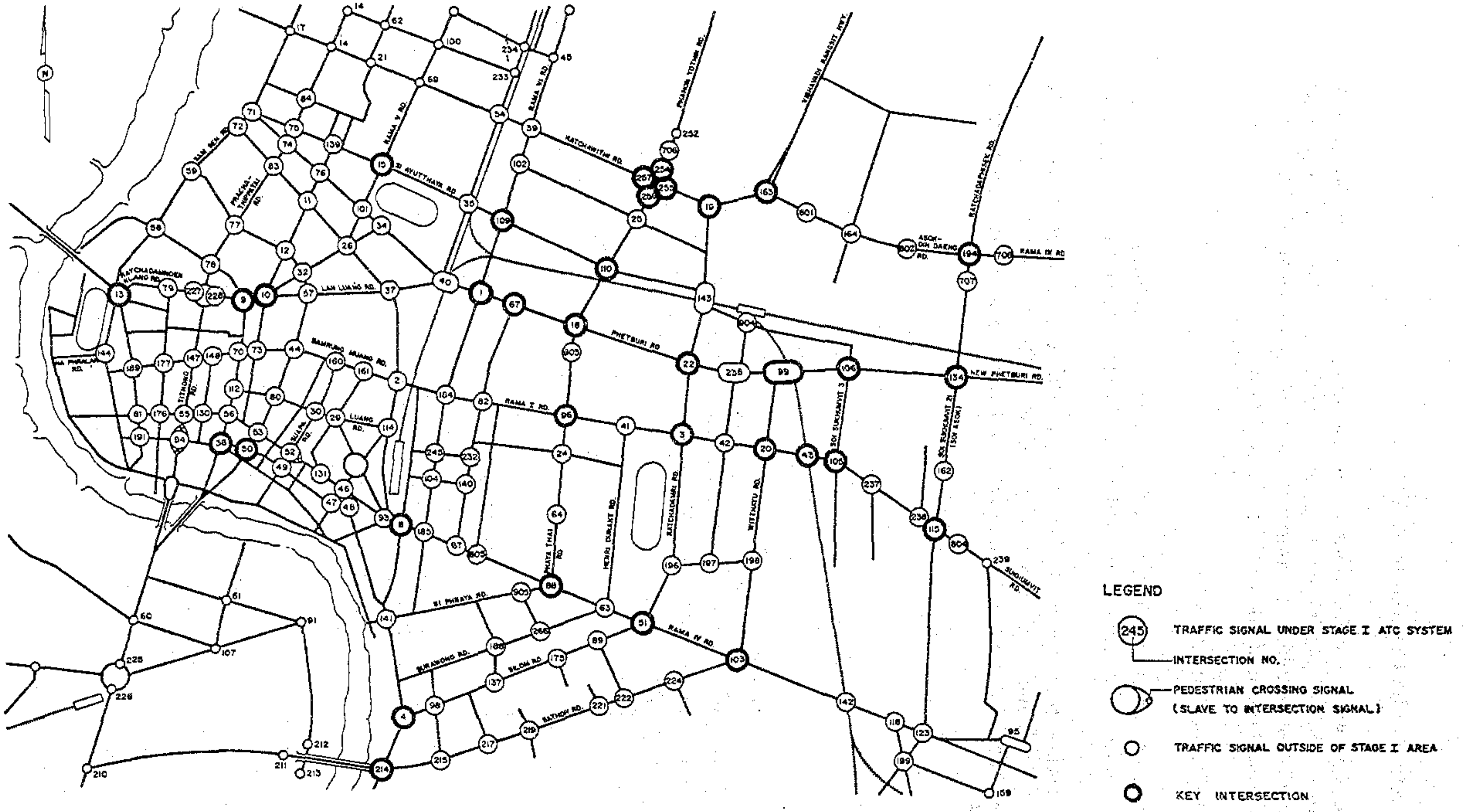


Figure 2.6 Work Flow



Year	Existing Signalized Intersection	Planned Signalized Intersection	U-turn Signalized Intersection	Total
1993	128	10	5	143

Figure 2.5 Intersections to be Signalized in ATC System

2.3 Traffic Engineering Improvement

2.3.1 Traffic Circulation Method

Figure 2.7 shows the location of planned Two-way/Reversible Lane System. As a general rule, time periods for reversible lanes were established so that priority is given to inbound traffic during the morning hours (6:00-11:00) and to outbound traffic after 11:00.

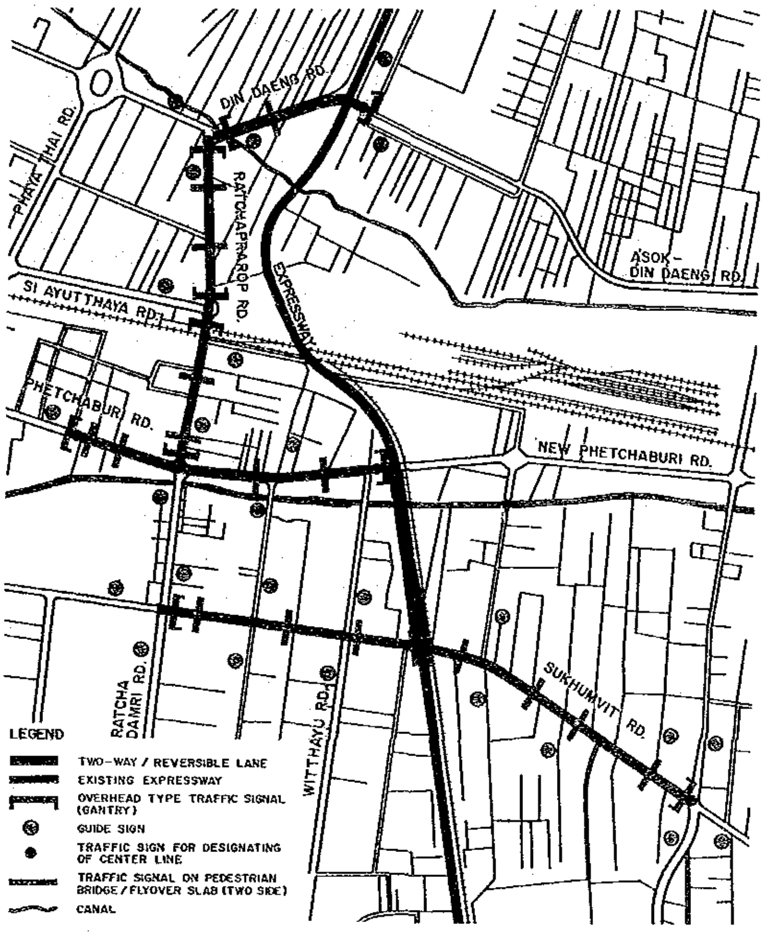


Figure 2.7 Locations of Two-Way / Reversible Lane and Traffic Facilities

Reversible lanes will be operated by the traffic police. Reversible lane usage will be notified to drivers by overhead lane direction signals and signs attached to gantry or pedestrian bridge, variations in lane line color, and lane-use designators (the temporary sign used currently by the Police).

Standard traffic operation methods to be applied to intersections and other road sections are shown in Figure 2.8. Standard designs of traffic facilities required for reversible lane operation are shown in Figure 2.9.

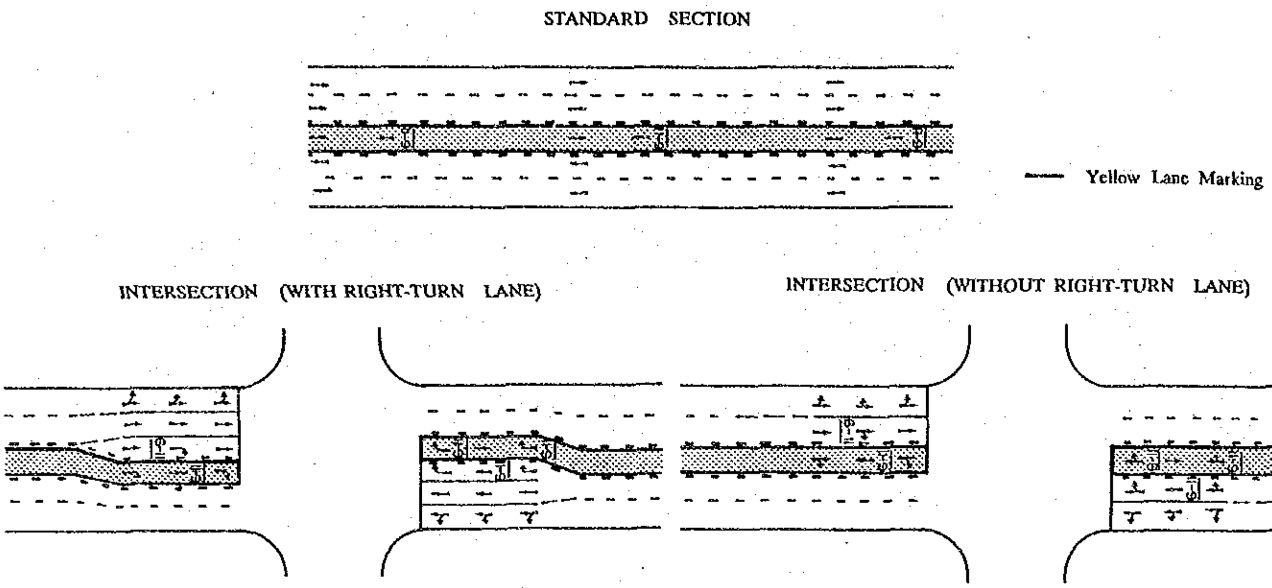


Figure 2.8 Standard Traffic Operation Method

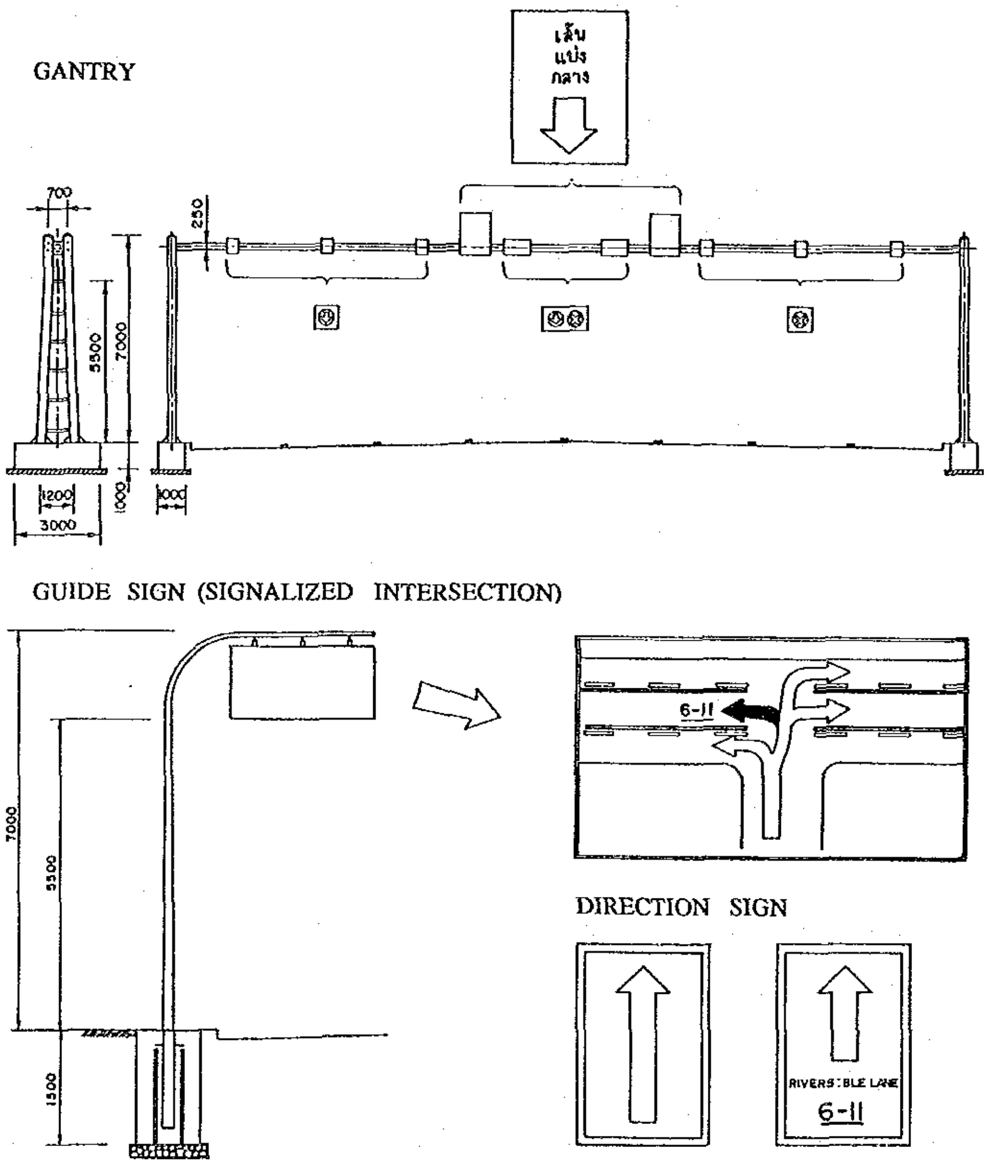


Figure 2.9 Standard Traffic Facilities

2.3.2 Intersection Improvement

In conjunction with the reversion of the lane at existing signalized intersections, as called for in the Traffic Circulation Plan, a pavement marking plan for the intersections was prepared in order to achieve the smooth flow of traffic. In addition, in conjunction with the installation of traffic signals at non-signalized intersections, a channelization plan for these intersections was prepared in order to control traffic flow on major and minor approaches and to ensure the safety of pedestrians. These improvements are listed in Table 2.2.

Table 2.2 Improvement Measures

Improvement Measures	Traffic Circulation Plan	Lane Operation for Future Traffic Flow	Planned Signalized Intersection
1. Improvement of pavement markings where lane operation is to be altered	o	o	o
2. Addition of exclusive right-turn lane	o	o	o
3. Improvement of channelizing	o	o	o
4. Improvement of median	o		o
5. Installation of pedestrian crossing	o		o
6. Plan in conjunction with introduction of reversible lanes	o		o

Of the 143 intersections subject to control by the ATC System, 67 require one or more of the improvements. These intersections are shown in Figure 2.10.

2.4 Evaluation of ATC System

2.4.1 Effect of ATC System on Reduction of Delay Time and Stopping

In order to estimate the benefits by applying the ATC System, traffic flow in 1993 is simulated using a main frame computer.

For both cases of "with-" and "without ATC control" total delay time and total number of stopping are obtained as the simulation results, based on which savings in VOC and TTC are quantified.

Future traffic flow is simulated under the condition of two way reversible lane system. "With-" and "Without ATC control" are specified by the different control conditions concerning to traffic responsive control, saturation flow rate and signal coordination. Simulation is conducted for one hour each of morning peak time, daytime and evening peak time. Total delay time and number of stopping are shown in Table 2.3.

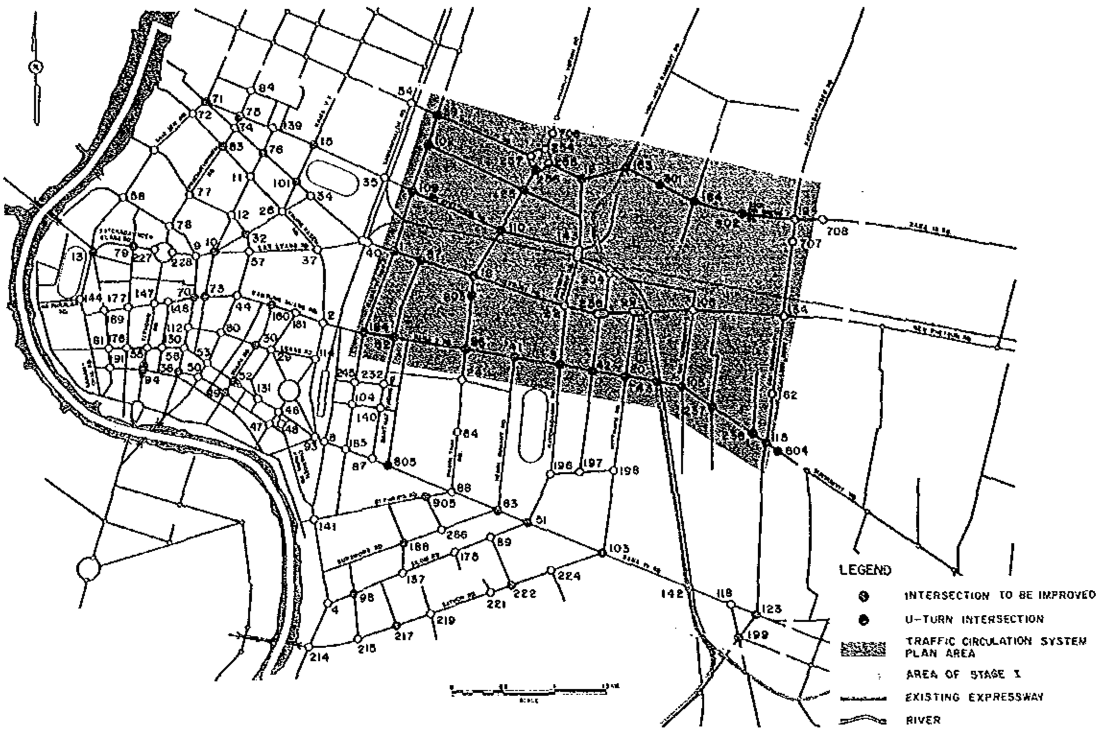


Figure 2.10 Intersection to be Improved

Table 2.3 Reduction of Total Delay Time and Stopping by ATC System

	Without ATC			With ATC		
	Morning 07-08:00	Daytime 13-14:00	Evening 17-18:00	Morning 07-08:00	Daytime 13-14:00	Evening 17-18:00
Total Delay Time (hours)	12,371 (1.00)	6,632 (1.00)	10,199 (1.00)	8,654 (0.70)	5,078 (0.77)	7,360 (0.72)
Total Number of stopping (1000 times)	1,012 (1.00)	518 (1.00)	870 (1.00)	664 (0.66)	416 (0.80)	616 (0.71)

Note: Figure in ( ) shows the rate to "without ATC" case

In addition, the effects of the ATC System on traffic flow at the near Key intersections during morning peak was estimated. Although disparities exist between locations, the table indicates that total delay time is reduced by about 15-35% and total number of stopping by about 20-35%.

2.4.2 Economic Benefit of ATC System

Road Network used for simulation consists of 447 links in total. The sum of products of traffic volume and unit VOC plus TTC of each link will give the total hourly traffic costs. The difference of above-mentioned of sum between "with" and "without" ATC case is regarded as the benefit of the ATC System.

Above-mentioned calculation is conducted using such data as unit VOC/TTC and the vehicle type composition, hourly fluctuation of traffic volume. Table 2.4 shows the estimated annual benefits in 1993 to 2007.

Table 2.4 Economic Benefits in 1993 to 2007

(Million Baht)

Year	VOC Saving	TTC Saving	Total
1993	181	540	722
1994	185	570	755
1995	189	599	788
1996	192	629	821
1997	195	654	848
1998	198	678	876
1999	200	703	903
2000	203	727	931
2001	206	752	958
2002	209	777	985
2003	212	805	1,017
2004	215	835	1,049
2005	218	866	1,082
2006	221	898	1,116
2007	224	931	1,151

CHAPTER 3 ATC SYSTEM DESIGN

3.1 System Plan

3.1.1 Signal System Functions

1) Functions

The ATC System for Bangkok requires the following functions:

a) Area Wide Coordinated Signal Control Function
b) Data Gathering and Processing Function
c) Equipment Monitoring Function
d) Man-Machine Interface Function
e) Data-Recording Function

2) Basic Control Methods

The signalized intersections in the ATC are categorized into two groups which are key intersections and ordinary intersections. Key intersections are those which have higher degree of saturation and need more careful and precise control. They are usually crossings of major streets. Ordinary intersections are those other than key intersections. Key and ordinary intersections are designated in the stage of system design. Control of key intersections will correspond to their saturation levels at any given point in time, as indicated by on-line data obtained from vehicle detectors. Control of ordinary intersections will be subordinated to that of neighboring key intersections.

The control method to be applied to key intersections is as follows: Traffic conditions at the key intersection will be divided into the three levels of under-saturation, near-saturation, and over-saturation, and splits, cycle lengths and offsets will be determined separately for each level. Table 3.1 outlines the traffic conditions and control parameters applicable to each level.

a) Cycle : Cycle is determined based on plan selection method depending on the detector data.
b) Offset : Offset is determined based on time-of-day plan selection method.
c) Split : Split is decided in the traffic responsive manner. The method is having an adjustment value which is a constant in seconds or percent of cycle time added to the phase for the most congested approach while subtracting such value from the phase for the least congested one at each cycle.

Table 3.1 Control Method Principles

	Under-saturation[(1)]	Near-saturation[(2)]	Over-saturation[(3)]
CYCLE			
Each Subarea		Selection (depending on the Occupancy and Volume)	
SPLIT			
Key Intersection		Adjustment[(4)]	
Ordinary Intersection		Adjustment (depending on given key intersection)	
OFFSET		Time-of-day Selection [(5)]	

Notes:

(1) Under-saturation : Vehicles arriving in the last cycle time are all cleared in the current cycle with appropriate split control.

(2) Near-saturation : Vehicles arriving in the last cycle time are not at times cleared in the current cycle depending on the cycle, even with appropriate split control. However, the number of uncleared vehicles are not large to form a long queue.

(3) Over-saturation : Traffic demand which is the sum of the vehicles arriving at the intersection in the last cycle and the vehicles already existing in the queue exceeds the service volume of the current cycle. When the arrival rate exceeds the service rate, the queue grows.

(4) The adjustment shall be executed cycle by cycle. When queues have simultaneously exceeded the furthest detector points on two or more approaches where signal phases are different, the split adjustment is impossible. In such case, some constraints such as limit of queue length or limit of occupancy shall be given for each approach of intersection.

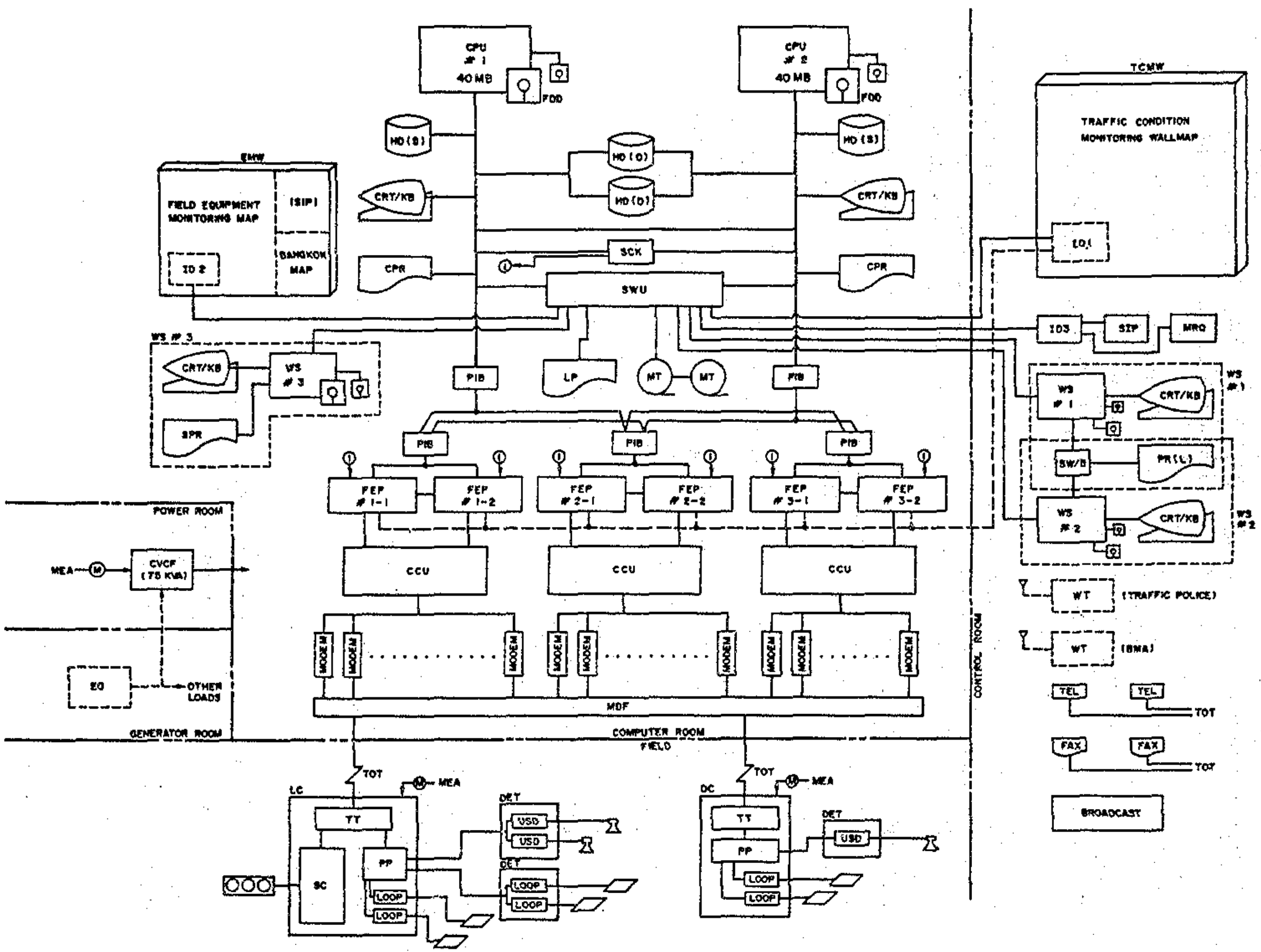
(5) Offsets for use in over-saturation should be determined in such a way that the numbers of vehicles which can be stored in the approach links to the over-saturated intersection are maximized. The purpose of this is to minimize the area which is affected by the over-saturation.

3) System Composition

The hardware configuration of the ATC System is shown in Figure 3.1.

3.1.2 Software System

Figure 3.2 shows the software configuration. Software will consist of system programs and application programs. System programs consist of operating system, language support system, dualization option, and other options (data base management system etc.)



ABBREVIATION	NAME IN FULL
CPU	CENTRAL PROCESSING UNIT
FDD	FLOPPY DISK DRIVE
HD (S)	HARDDISK UNIT FOR STORING PROGRAMS
HD (D)	HARDDISK UNIT FOR STORING WORK DATA
CRT/KB	CRT DISPLAY / KEYBROAD
CPR	CONSOLE PRINTER
SCK	SYSTEM CLOCK
SWU	SWITCHING UNIT
LP	LINE PRINTER
MT	MAGNETIC TAPE UNIT
TCMW	TRAFFIC CONDITION MONITORING WALLMAP
EMW	EQUIPMENT MONITORING WALLMAP
ID 1-3	INDICATION DRIVER
SIP	SYSTEM INDICATION PANEL
MRQ	LOCAL MANUAL REQUEST PANEL
WS	WORK STATION
PR (L)	LASER PRINTER
SW/B	PRINTER SWITCHING BUFFER
PIB	PARALLEL INTERFACE BUS
FEP	FRONTED PROCESSOR
CCU	CENTRAL COMMUNICATION UNIT INCLUDING PROCESSOR
MODEM	MODULATOR / DEMODULATOR
MDF	MAIN DISTRIBUTION FRAME
TOT	LEASED LINE FROM THE TELEPHONE ORGANIZATION OF THAILAND
MEA	POWER SUPPLY FROM THE METROPOLITAN ELECTIC AUTHORITY
M	WATT-HOUR METER
LC	LOCAL CONTROLLER
TT	TERMINAL TELEMETRY
SC	SIGNAL CONTROLLER
DC	DETECTOR CONTROLLER
PP	PRE-PROCESSOR FOR DETECTOR
DET	DETECTOR CABINET
VSD	ULTRASONIC DETECTOR
LOOP	LOOP INDUCTIVE DETECTOR
SPR	SERIAL PRINTER
CVCF	CONSTANT VOLTAGE / CONSTANT FREQUENCY SUPPLY
EG	ENGINE GENERATOR
WT	WIRELESS
IEL	TELEPHONE SET
FAX	FACSIMILE

Figure 3.1 Traffic Signal System Configuration Diagram

3.2 Facilities Plan

3.2.1 Central Facilities

1) Control Center

The Traffic Control Center will be located on the first floor of the BMA 1 building. The layout of the Control Center will be as shown in Figure 3.3.

2) Central Computer System

The System will have a hierarchy architecture and a dual system. The peripheral devices will be provided; console CRT display keyboard, console printer, harddisk for system storage, floppy disk drive, magnetic tape device, and work station. The CPU will be a minicomputer-class machine of 1MPIS level, with a 32-bit, 25-MHz core processor. Processing capacity will correspond to 400 local controllers.

3.2.2 Transmission System and Communication Lines

Transmission equipment will be composed of a communication control unit (CCU), gathered modems, main distribution frames (MDF), and terminal transmitter-receivers (TTR) in the field. The System will adopt a decentralized back-up system with traffic responsiveness as a precondition. Communication Lines will consist of lines leased from the TOT. A single two-wire cable system will be used.

3.2.3 Signal Control Equipment and Vehicle Detectors

1) Local Controller

Local controller will execute signal control according to the control modes, shown in Table 3.2. Local controller will be installed at all the intersections and linked to the control center to afford on-line control. Their functions are to control traffic signals in an appropriate manner and to transmit data obtained from nearby detectors.

2) Vehicle Detectors

(1) Functions

Vehicle detectors are to detect the presence of motor vehicles for the collection of traffic data related to traffic-responsive control, collection of congestion status, and compilation of traffic statistics.

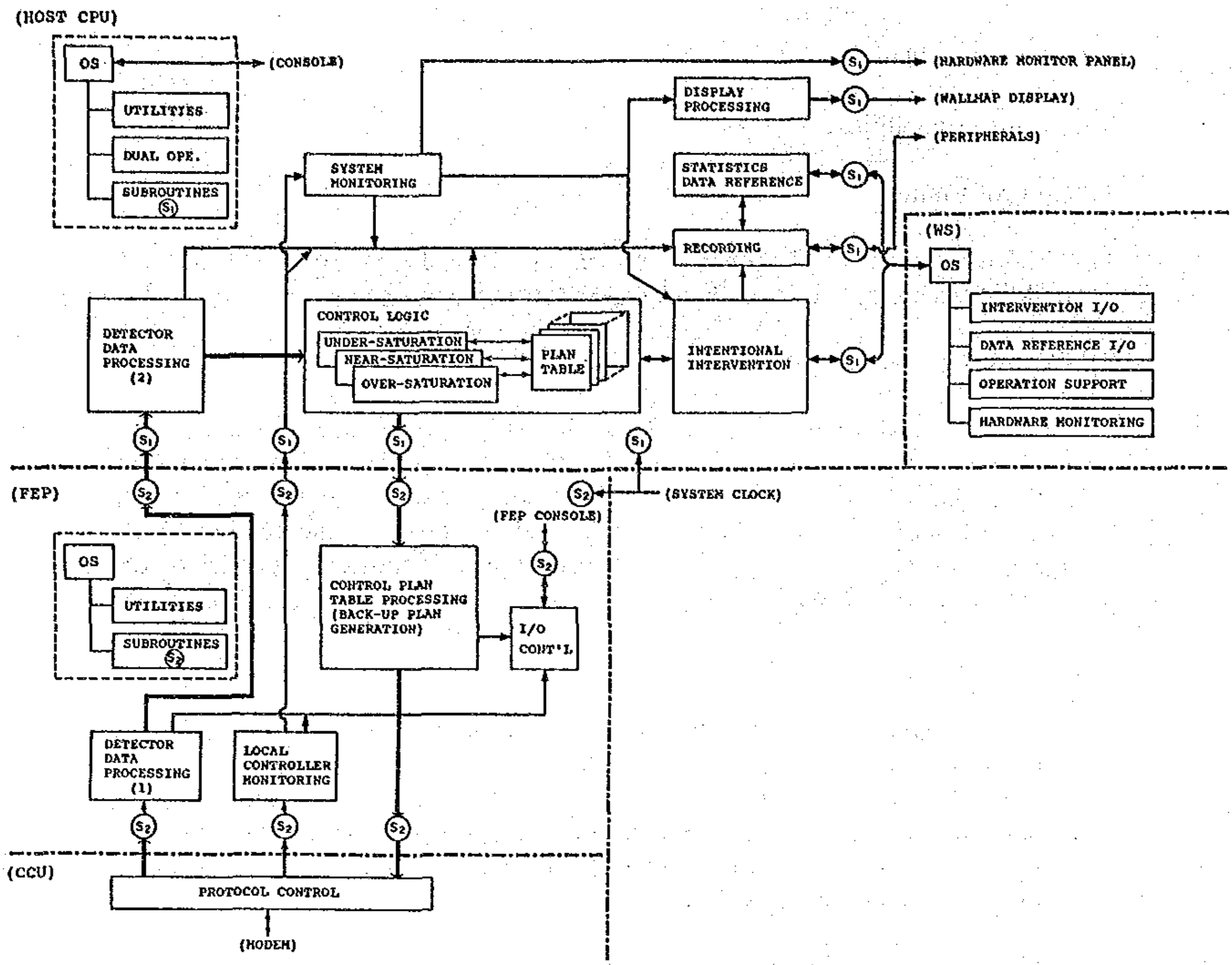


Figure 3.2 Software Configuration

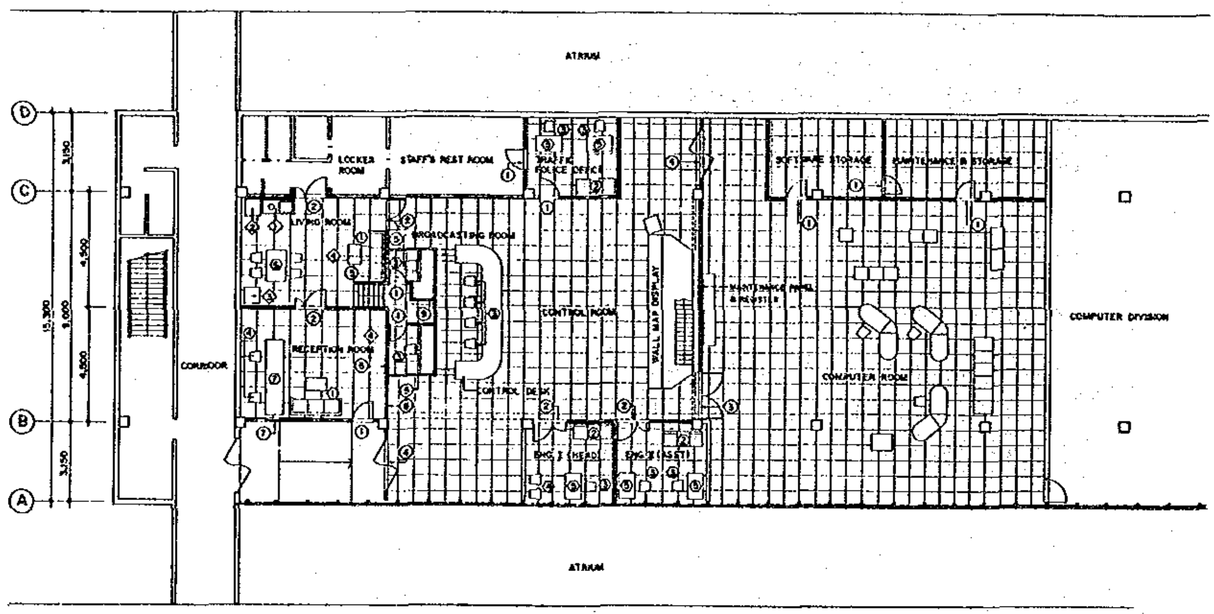


Figure 3.3 Lay-Out of Control Center

Table 3.2 Priority of Modes and Fail-Safe System

Operation Mode	No.	Control Mode	Equipment Controlling	Status of Equipment Condition	Operator Override (Operation)	Operator Override (Table Change)
Central Computer Operation Mode (On-Line)	(1)	Traffic responsive control	CPU	Normal Operation	Yes	Yes
	(2)	Time-of-Day control	FEP	CPU Off-Line		
Standby Operation Mode	(3)	Isolated Time-of-Day control	Local Controller	CPU & FEP or Cable Line Off-Line	Yes	Yes
	(4)	Fixed time control by RAM store	Local Controller	(1),(2),(3) mode Off-Line	Yes	Yes
	(5)	Fixed time control by ROM store	Local Controller	(1),(2),(3),(4) Off-Line	Yes	No
	(6)	Flashing control	Local Controller	(1),(2),(3),(4), (5) Off-Line	Yes	No
Manual Operation Mode	(7)	Manual control	Local Controller Policemen Control	Permit/Reject	No	-
Local Operation Mode	(8)	Extension Actuated Control	Local Controller	No activity under (5),(6),(7)	No	Yes
	(9)	Railway Pre-emption	Local Controller	No activity under (5),(6),(7)	No	Yes
Portable Local Controller Operation Mode	(10)	Portable Local Controller	Portable Local Controller	Existing Local Controller is down	No	No

(2) Standard Placement

The Standard placement of vehicle detectors will be depending on intersection classification. Detectors at key intersection will be placed 150, 300 and 600 meters from the stop line on each approach. Detectors at ordinary intersection will be placed 150 meters from the stop lines for the purpose of determining the sub-area's cycle length and split.

(3) Type of Detector and Selection

Two types of detectors are available; induction loop and ultrasonic. This plan calls for the placement of the less expensive induction loop detectors and the esthetics one as a rule. The type that best fits the placement environment will be chosen. Figure 3.4 shows the two types of detectors.

Ultra Sonic Type Loop Type

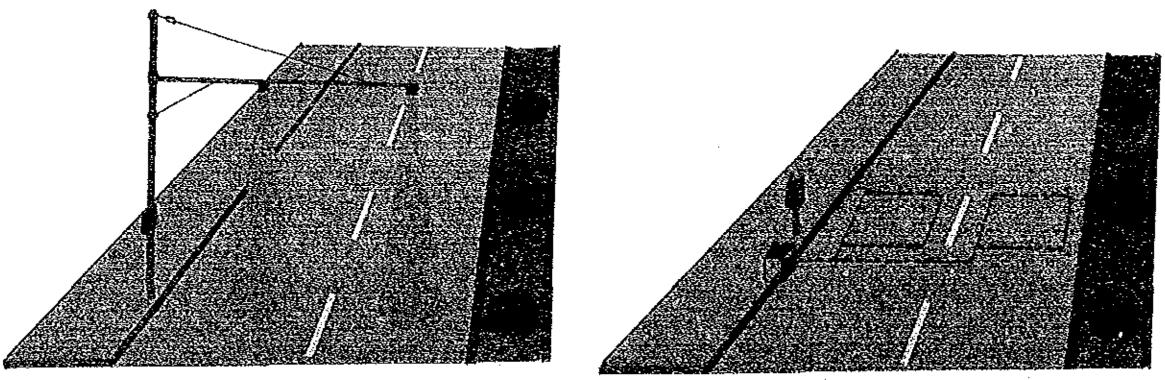


Figure 3.4 Type of Vehicle Detector

(4) Concentration of Detector Pulses

To reduce the number of transmitting lines that must be leased form the TOT, local controllers equipped with transmitters to collect the pulses emitted by a number of nearby detector.

(5) Standard Installation Plan

The standard installation plan for detectors is shown in Figure 3.6.

3) Standard Installation Plan Near Intersections

To reduce the cost of equipment, the existing facilities will be used wherever possible. The existing signal poles, handholes and conduits will be retained if possible (The conduits include of replacement).

3.2.4 CCTV System

The five (5) intersections will be provided with CCTV cameras; Ratchadamnoen Klang - Ratchadamnoen Nai Intersection (No. 13), Phaya Thai - Phetchaburi Intersection (No. 18), Sukhumvit - Soi Sukhumvit 21 - Ratchadapisek Intersection (No. 115), Sathon - Witthayu - Rama IV Intersection (No. 103), and Ratchadapisek - Asok Din Daeng Intersection (No. 194).

The optical fiber network that the TOT is planning to construct will be used for the transmission system, both toward (video signals) and from (camera control signals) the center. The ratio of monitor unit to camera will be 1:1, and twenty one-inch monitor will be used.

The CCTV System will be provided camera operation console, time-lapse VTR and central CCTV controller.

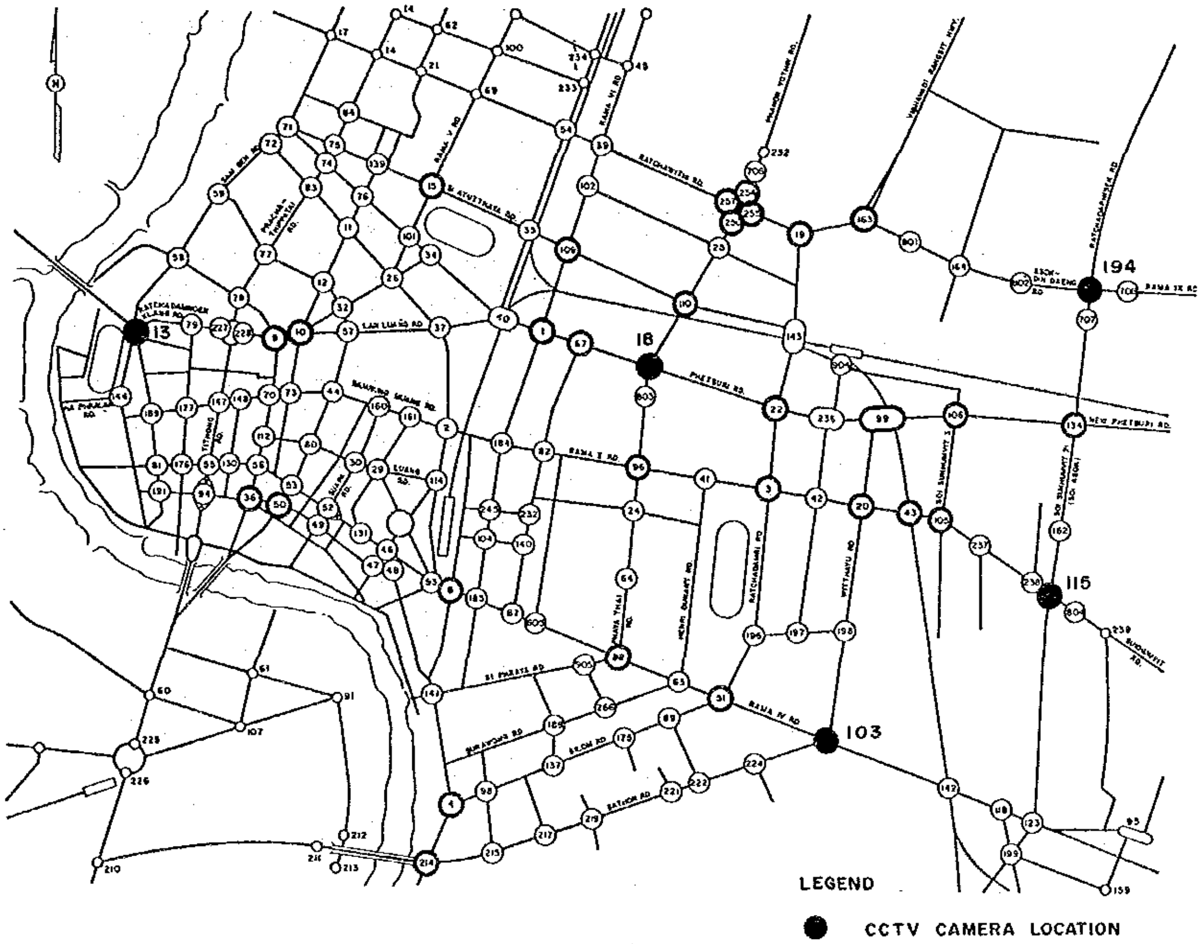


Figure 3.5 CCTV Camera Locations

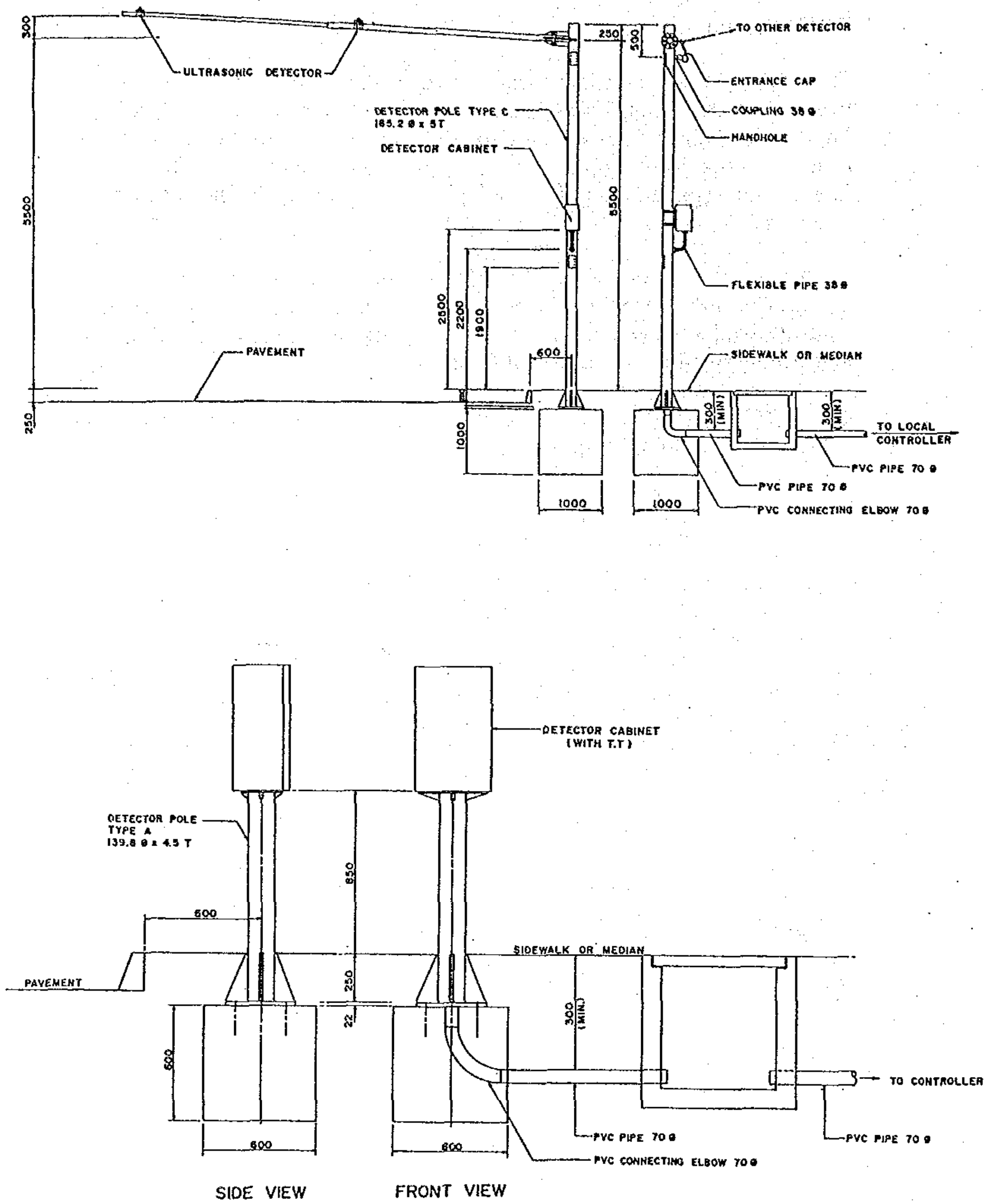


Figure 3.6 Standard Installation Plan for Detector

CHAPTER 4 MAINTENANCE AND OPERATION PLAN

4.1 Operational Management

Operational management is the process by which the intentions of the traffic controller are conveyed to the road users, and is to be directly implemented by the Traffic Engineering Division of the BMA. Therefore, the contractor should take care to design the system equipment in such a way that special skills are not required to operate the control center.

Requirements to be fulfilled by the contractor when designing the operational management plan are as follows:

a) Establishment of action patterns necessary for operating the control center, and preparation of center and equipment operation manuals.
b) Indication of the space and equipment needed for operational management.
c) Indication of the costs required for operational management.
d) Indication of the skills in which the candidate staff must undergo training, as indicated by the staff plan of the Traffic Engineering Division, and of the costs and time frame involved.

4.2 Maintenance

The purpose of this maintenance contract is to keep the signal system and related equipment in operation in the manner originally intended.

1) Scope of Work

The contractor shall furnish all labor, tools, shop facilities, equipment, spare parts, and material and perform all work necessary to maintain in good working manner all traffic signal system and associated equipment.

The various classifications of maintenance and repair work and related services to be performed by the contractor include the following:

a) Preventive Maintenance
The work to be done consists of monthly inspection/cleaning and quarterly or bi-annual checking, cleaning, routine replacement or overhaul of parts as recommended by the manufacturer, and servicing of various system components and related equipment. Minor deficiencies uncovered during the performance of preventive maintenance shall be corrected immediately and all adjustment, tuning, and calibration necessary to keep the equipment in the best operating condition shall be performed. Any

problems which require further attention or use of spare part(s) shall be recorded on the TED/BMA Fault Report Form and they shall be corrected according to the provisions for corrective maintenance or accident repair as appropriate.

b) Corrective Maintenance
The work to be done consists of correcting malfunctions resulting from equipment deterioration and failure under normal operating conditions. However, replacement or servicing of equipment parts which, according to manufacturer's recommendations, should be replaced or serviced at regular intervals, shall be considered as within the scope of the preventive maintenance.

c) Accident Repair
The work to be done consists of repairing damages to the equipment due to accidents, vandalism, act of God, pavement failures, and construction activities of other contractors and includes clean up of debris, erecting necessary warning and safety devices, and hook-up of temporary equipment if required to insure the safety of the public.

d) System Modifications
The work to be done consists of modifying the system to improve the operation or to conform to new operational requirements. The work shall be done as directed by the engineer.

e) Consultation
The contractor shall designate representatives in his organization whom shall be available to TED staff for consultation at no added expenses to TED/BMA. The scope of consultation shall include cost estimates and explanation of functional and operational characteristics of equipment.

f) Maintenance and Repair Records
The contractor shall maintain a comprehensive records of all maintenance and repair activities and spare parts consumptions. The records shall include, as a minimum, maintenance check lists, fault reports, spare parts receiving and consumption records, and work orders.

2) Signal Turn-off and Signal on Flash

The contractor shall notify the TED office in advance of any signal turn-offs or signal on flash necessitated by his operation.

3) Liquidated Damages

The contractor shall be assessed liquidated damages for failure to effect permanent repair within the specified time limit. Liquidated damages shall be deducted from payment due to the contractor.

CHAPTER 5 FUTURE EXPANSION PLAN

The Stage I ATC system and its associated works are expected to enhance significantly traffic conditions within the project boundary of Bangkok. The Stage I project area, however, does not cover the entire Bangkok city, and even within the project boundary there will be still much room for improvements in traffic conditions after the completion of the Stage I project. Thus, the expansion of the traffic control system and its associated works both within and outside the stage I project area is deemed essential.

The basic approach to be taken in the future project will be identical or similar to the ones adopted in the Stage I project. The feasibility study (by JICA in 1989) has indicated the field and observed traffic conditions at those potentially problematic sites covered in the Stage I as well as future projects.

Based on the results of the feasibility study the types of improvements to be implemented for each location, and the level of urgency for each improvement have been identified.

The main categories of works to be included in the project immediate future project are:

a) expansion of the traffic signal system
b) improvement of traffic control devices for reversible lane control
c) introduction of fire lane control function
d) introduction of graphic CRT for TCC operators
e) improvement of the BMA radio system
f) traffic engineering improvements

CHAPTER 6 IMPLEMENTATION PLAN

6.1 Implementation Period

The implementation of the Bangkok ATC Project - Stage I as described below is taken to start from the issuance of the "Letter of Invitation To Tender" (tender call) to the pre-qualified tenderers up to the completion of the project marked by the issuance of the Certificate of Final Acceptance. The whole implementation would likely to take 42 to 46 calendar months.

This whole implementation period, however can be sub-divided into three sub-periods by the nature of activities involved:

a) The first sub-period begins from tender call to the signing of contract with the selected contractor. This period will probably takes about 8-10 months depending on the time taken to appraise the tender proposals from perspective tenderers and the speed the final decision is made.
b) The second sub-period starts from the issuance of Notice To Proceed to System Design Approval. This period involves the issuance of Notice to Proceed to the contractor and such activities as system briefing and finally the approval of the system proposed. It will probably takes about 4-6 months depending on how fast the proposed system can be approved.
c) The third sub-period covers the 18 month installation period of the proposed system and the 12 month guarantee maintenance period.

Table 6.1 Implementation Plan

Sub-period 1	Sub-period 2	Sub-period 3
Tender Call to Contract Signing	Notice to Proceed to System Design Approval	Installation to End of Guarantee Maintenance
8 to 10 months	4 to 6 months	30 months
	42 to 46 months	

6.2 Extended Maintenance

Before the end of the Guarantee Maintenance Period, the BMA has the option to sign a separate Annual Contract with the contractor for maintaining the system based on the proposal submitted by the contractor on "Extended Maintenance". This extended maintenance shall be subjected to annual renewal between BMA and the contractor.

Table 6.2 The Extended Maintenance Contract

This Contract	New Contract	Future Expansion Plan
Bangkok ATC Project Stage I	Annual Renewable Extended Maintenance Contract	Bangkok ATC Project Stage II
42 to 46 months	Every 12 months	

6.3 Future Expansion

The System shall be expanded in future when the need arises to widen the coverage of the ATC System or up-grade the existing system functions.

6.4 Project Monitoring Team to the BMA

Throughout the Implementation Period, the BMA shall have to engage a project monitoring team to provide advice and assist the BMA, particularly on technical matters and in monitoring the implementation of the entire project.

During the first sub-period, the project monitoring team shall assist the BMA in answering enquiries on technical matters from the tenderers, appraising the tender proposals on their compliance to the technical specifications or alternative systems which the tenderers may have proposed and finally tender negotiation with the contractor.

In the second sub-period, the project monitoring team shall assist the BMA in appraising the work program and examining/approving the detail system design submitted by the contractor.

For the final sub-period, the project monitoring team shall monitor the installation and maintenance work throughout the entire 30 months. These would include assisting the BMA in verification of actual work done on site for progress payment, trouble shooting, among other things.

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