

*Division II: Traffic Signal System*

- (b) The hard disk unit shall consist of a disk controller with two identical disk storage packs, each of which will store the same data for main and standby operations.
- (c) It shall be possible for both CPUs to access the hard disk unit at any time without stopping the System operations.
- (d) It shall be possible to use the standby disk pack for background processing.
- (e) The disk area shall be divided into sectors. The data held on a sector shall be protected by using a CRC code.
- (f) It shall be possible to hardware write protect the data on the disk.
- (g) It shall be capable of outputting malfunction signals to the CPU and correct minor errors.
- (h) The disk heads shall automatically retract in the event of a power failure. The disk shall start up automatically when mains power is applied. This shall not result in any need for head re-alignment.
- (i) The average access time shall not exceed 30 m seconds.
- (j) The disk controller shall be capable of transferring data at, at least 1 megabyte per second.
- (k) Each of the two disk packs shall have a minimum capacity of 1,000 megabytes. The actual disk capacity shall be that required to implement the System facilities and provide 50% spare capacity when the system is expanded to 400 signals.

9.6 FLOPPY DISK DRIVES

Each of the CPUs shall be equipped with a 5-inch floppy drive and a 3.5 floppy drive. Both drives shall be the high density type with over 1 MB capacity.

9.7 MAGNETIC TAPE UNITS

The magnetic tape unit shall meet the following specifications:

- (a) Tape Size -- 9 tracks, 1/2 inch wide, 2400 feet long

- (b) Rate of storage -- 6250 bpi
- (c) Data transfer speed -- 1 MB/sec or more
- (d) Vertical and horizontal parity checking
- (e) Error correction function

9.8 **LINE PRINTER**

The line printer shall be installed in the computer room and normally be connected to the on-line CPU by means of the automatic switching unit. However, it shall be possible to use the line printer in off-line operations without interfering with the ATC system operations.

The line printer shall be an impact printer conforming to the following:

- (a) 96 character font with upper and lower case character set
- (b) Print speed of at least 300 lines per minute continuously
- (c) 132 characters per line
- (d) Vertical formatting for forms
- (e) Produce 4 copies
- (f) Capable of printing all English alpha-numeric

The line printer shall be housed in an integral sound deadening cabinet.

The line printer shall be supplied complete with paper holder and slacker assemblies.

## 10.0 WORK STATIONS

### 10.1 GENERAL

Three identical work stations shall be furnished; two are to be installed in the control room and one is to be placed in the computer room. Each work station shall be a self contained desk top unit consisting of a microprocessor, two floppy disk drives, a CRT-display and a keyboard. A laser printer shall be connected to the two work stations in the control desk, and a dot-matrix printer shall be connected to the other work station in the computer room.

The Tenderer should bear in mind that the control room work stations are to be used as control terminals serving all major database management and operator intervention functions of the ATC system. They shall be designed for pro-longed use and the highest quality will be demanded.

### 10.2 FUNCTIONAL REQUIREMENTS

The work stations shall be capable of performing all man-machine interface functions described in Section 5 of these specifications. All interface equipment or input/output controllers and cabling necessary to connect the work stations to the central computer system and other control center equipment to effect the required operations shall be furnished and installed by the CONTRACTOR. Each of the work stations shall also be capable of stand-alone off-line data processing typical of state-of-the-art microcomputer applications.

All operation and signal control softwares shall be furnished by the CONTRACTOR.

### 10.3 WORK STATION UNITS SPECIFICATIONS

#### 10.3.1 MICRO-PROCESSOR

The work station microcomputer shall conform to the following:

- (a) 32-bit 20 MHz processor
- (b) 4 MB or more RAM
- (c) Self contained 5-inch and 3.5-inch floppy disk drives (one each)
- (d) 100 MB or larger hard disk

**10.3.2 CRT UNIT**

The CRT display unit of the work stations shall conform to the following:

- (a) Full cursor control from the key-board and mouse
- (b) 14-inch or larger color VGA display
- (c) Resolution of not less than 700 x 340 Pixels

**10.3.3 KEY-BOARD**

Work station keyboards shall be full sized with numeric pad and separate arrow keys.

**10.3.4 PRINTERS**

One laser printer and one dot-matrix printer shall be furnished. The laser printer shall conform to the following:

- (a) Full 128 character ASCII standard character set
- (b) Print quality of 300 or more dots per inch
- (c) Print speed of 8 or more pages per minute
- (d) 2 megabytes or larger memory
- (e) A4 size paper tray with 200 sheets or larger capacity

An automatic printer switch box shall be furnished to allow sharing of the laser printer by the two workstations in the control room.

The dot-matrix printer shall be a 24-pin printer conforming to the following:

- (a) Full 128 character ASCII standard character set
- (b) Print speed of 265 CPS in draft mode and 90 CPS in letter quality mode
- (c) Font Pitch - 10, 12, 15, 17, and 20 PT, selectable from the printer panel
- (d) 48K Bytes of buffer memory
- (e) Continuous and cut-sheet paper
- (f) 15-inch paper capacity

## **11.0 WALL MAPS**

### **11.1 GENERAL**

The CONTRACTOR shall furnish and install two wall maps: a traffic condition monitoring wall map in the Control Room and an equipment monitoring wall map in the Computer Room. The installation shall meet the requirements of Section 5, "Man-Machine Interface," and these specifications.

The CONTRACTOR shall present his artwork for the background street network and landmarks, a recommended color scheme and a sample map light unit for review and approval by the ENGINEER before map fabrication is started.

The preferred basic colors are black streets on light grey background. The front surface of the maps shall be glare-free under normal indoor illumination.

The design of the maps and display lights shall provide clear indications of the information displayed to operators sitting by or standing at the control desk under all normal lighting conditions.

The CONTRACTOR shall submit, for the ENGINEER's approval, the proposed methods, techniques for indication and also design of structure, material with calculation report.

### **11.2 TRAFFIC CONDITION MONITORING WALL MAP**

#### **11.2.1 INDICATIONS**

The background street network shall cover the area as indicated on Plan No.1205. The following information shall be included:

- (a) All major streets and geographic features in the map area. These may be in the form of a schematic drawing instead of a scaled drawing.
- (b) All signalized intersections and pedestrian crossings. Signals which are not part of the ATC system will have a painted symbol but no display lights.
- (c) Reference number of intersection and pedestrian crossing signals.

- (d) All CCTV camera sites.
- (e) City monuments, landmarks, and major civic buildings.
- (f) Indication of one-way streets, reversible lane streets, etc. by means of magnetic or removable color tapes.

#### **11.2.2 MATERIAL AND STRUCTURE**

The wall map panels shall be constructed of standard 50mm x 50mm mosaic tiles of polycarbonate material which will allow easy replacement and maintenance. The entire map shall be 6m x 6 m in size.

A conceptual sketch of the mounting structure is shown on Plan No.1206.

#### **11.2.3 DISPLAY LIGHTS**

Display of the traffic conditions and control status shall be provided by using multi-color LED.

#### **11.2.4 MODIFICATIONS**

For future modifications the map design shall take into consideration the following:

- (a) It should be easy to amend the map to show new roads and intersections with skills and materials readily available in Bangkok.
- (b) It should be relatively simple to add new display lights and reference numbers for new signals.
- (c) The wall map display circuit and controller shall include sufficient spares and capacity to allow future addition of 250 signals and 250 queue detectors.

### **11.3 EQUIPMENT MONITORING WALL MAP**

#### **11.3.1 GENERAL**

This wall map shall be composed of three sections: a central equipment monitoring panel, a field equipment monitoring map, and a project area map.

The arrangement of the three sections are shown conceptually on Plan No.1207. All three sections shall have the same background color. Detailed design shall be provided by the CONTRACTOR in the system design report.

**11.3.2 CENTRAL EQUIPMENT MONITORING PANEL**

This panel shall display, in block diagram format, all major equipment in the control center including the emergency power supply system. The displays shall meet the requirements of Section 5.

The panel shall be approximately 1m x 1m in size and shall be constructed of acrylic plastic. The display blocks shall be translucent with black legend.

**11.3.3 FIELD EQUIPMENT MONITORING MAP**

This section of the equipment monitoring wall map is to be used to display operating status of local controllers and detectors. The displays shall conform to the requirements of Section 5. The background street network shall be identical or similar to that shown on the control room wall map, but the scale is smaller. Deletion of non-essential details, if necessary due to the resolution limitations, may be permitted.

The map panel shall be constructed of 15mm x 15mm mosaic tiles and multi-color LEDs shall be used for the status displays.

**11.3.4 PROJECT AREA MAP**

This section of the equipment monitoring wall map is to be used to identify the areas to be covered in various stages of the Bangkok Area Traffic Control System Project. The map shall include a background major streets network, drawn to scale, covering the entire Metropolitan Bangkok area. Major geographic features and landmarks shall also be shown on the map. Superimposing on this Metro-wide map shall be shown boundaries of Stage I, Stage II, and future expansion areas. These boundaries shall be easily modified by using, for example, color transparent tapes.

The map panel shall be approximately 1m x 1m in size and shall be constructed of a one-piece steel plate or acrylic plastic. The map drawing shall be made of material and finishing which will not show any discoloring or marks when the area boundaries are modified

## **12.0 CONTROL DESK**

### **12.1 GENERAL**

A control desk shall be furnished and installed in the Control Room by The CONTRACTOR. The control desk shall be equipped with the following:

- (a) Two work stations conforming to the requirements of Section 10.
- (b) A wall map control panel conforming to the requirements of Section 11.
- (c) A central equipment monitoring panel conforming to the requirements of Section 4.
- (d) A manual control monitoring/enablement panel conforming to the requirements of Section 5.
- (e) A CCTV control and recording system including a camera controller, a TV monitor, a video tape recorder and a video monitor conforming to Division 3 of Technical Specifications.
- (f) Two telephone handsets with 5 lines
- (g) A facsimile machine
- (h) Two microphones for use in connection with two radio systems, one is managed by the BMA and the other is managed by the Central Traffic Police Division. The radio systems are to be installed later by others.

Except the radio system microphones, all equipment installed shall be fully functional as specified and the installation shall include any controller and/or interface devices and wiring as necessary for the intended operations.

### **12.2 EQUIPMENT LAYOUT**

The equipment layout on the control desk is shown conceptually on Plan No.1208. The final layout shall be prepared by the CONTRACTOR and approved by the ENGINEER. The final layout shall take into consideration the various operator functions that will be required and shall insure that no crowding will occur.



All equipment to be installed below the desk surface shall be securely attached to the desk with mounting brackets and adequately shielded or covered to avoid accidental damages. All wiring shall be neatly arranged behind the desk and supported above the floor.

12.3 **DESK CONSTRUCTION**

Physical size, height, and other design details of the desk shall meet the equipment installation requirements but human factors shall also be considered to insure the comfort and efficiency of the operator.

The desk surface shall be constructed of manufactured, laminated type, sheet or equivalent with high impact and scratch resistance. Desk edges shall be rounded and shall be constructed of material which will not chip or dent under normal uses.

It is preferred that the control desk itself be of the modular type design and which are commonly produced by normal office furniture manufacturer. The Tenderer shall provide details of the proposed control desk, including material and design drawings, in his Technical Proposal.

12.4 **CHAIRS AND ACCESSORIES**

Five (5) chairs consistent in design characteristics and style with the control desk shall be furnished. The upholstery shall be of durable cloth material. The chairs shall have rolling casters and back support. Both height and back support angle shall be adjustable. The Tenderer shall provide details of the proposed chair, including material and design drawings, in his Technical Proposal.

### **13.0 LOCAL CONTROLLER**

#### **13.1 GENERAL**

All local controllers to be installed under this Contract shall be of microprocessor design and shall be of the same model produced by the same manufacturer. The proposed controller shall be of proven reliability. The Tenderer is required to identify the model number and the manufacturer of the controllers to be supplied in his Technical Proposal. The Tenderer shall also provide evidence that the expected mean time between failures for the proposed controller is in excess of 20,000 hours.

The local controller shall be controlled by a single set of operating programs which can be used at any of the project intersections and pedestrian crossings. The database structure shall also be identical to simplify data entry and editing. The local controller programs and any required initialization database shall be stored in a EPROM which shall be fully interchangeable between controllers.

Appropriate keyboard(s), data display window, status indication lamps, power switch, and a flashing control switch shall be provided on the front panel of the controller.

The controller shall have the capability of uploading and downloading RAM stored database to and from the central computer system on command of the operator at any time. It shall also be possible to change the RAM database from the controller keyboard.

#### **13.2 SIGNAL CONTROL FUNCTIONS**

##### **13.2.1 MODES OF OPERATION**

The local controller shall be capable of operating under the following modes:

- (a) Central computer control
- (b) Local time-of-day control
- (c) Local isolated control
- (d) Fail-safe fixed time control
- (e) Actuation control
- (f) Flashing
- (g) Lantern-off
- (h) Manual control

Except the manual control which shall conform to the requirements of Section 13.3, it shall be possible to change the control mode from the control center through operator intervention or automatically by the computer on the time-of-day basis.

Except flashing and lantern-off operations, change-over from one control mode to another shall not abruptly change the phasing sequence or result in an unexpected change in the control pattern noticeable by the motoring public.

### 13.2.2 NORMAL AND FAIL-SAFE OPERATION

Normal and fail-safe operation of the local controller shall conform to the following:

(a) Central Computer Control

The local controller shall normally be under central computer control and execute timing plans transmitted from the central computer.

(b) Local Time-of-day Control

If central computer control is not possible due to central equipment or communication failure, the local controller shall maintain offset coordination by continuing to execute the last timing plan transmitted from the central computer for 4 or 5 cycles then changing to operate on locally stored time-of-day timing plans. The same locally stored time-of-day timing plans may be executed while central computer control is possible if it receives a command from the control center to change to local time-of-day mode.

(c) Local Isolated Control

The local controller shall execute the local isolated mode of control when the controller is initially turned on and, afterward, on command of the control center and when the local time-of-day control is not possible due to equipment failure. The local isolated timing plan shall be a single timing plan pre-stored in the RAM area of the local controller.

(d) Fail-safe Fixed Time Control

If both local time-of-day control and local isolated control are not possible due to equipment failure but the power is still on, a fixed-time isolated timing plan, pre-stored in a separate ROM or PROM, shall be executed by instructions from a special LSI circuit to provide a low level fail-safe control. If even this fail-safe control is

not possible, the signal shall be switched to the flashing (Red/Yellow or Red/Red which shall be set for each intersection by hardware) mode as the last backup mode of operation.

(e) Actuation Control

If properly equipped with actuation detectors, the local controller shall perform actuation control under central computer control and local time-of-day control without loss of offset synchronization. Local actuation control shall also be executed under local isolated mode of control (RAM data) but not under the Fixed-time fail-safe control (ROM data).

13.2.3 MINIMUM CAPABILITIES

In addition to the normal and fail-safe operational requirements as specified above, the local controller shall also have the following minimum capabilities:

- (a) Execute any one of several (up to 4) different phasing sequences under central computer control and local time-of-day control.
- (b) Execute time-of-day control from 20 locally stored timing plans on the time-of-day basis and maintain offset synchronization under local control. It shall be possible to store 20 schedules of time-of-day plans (i.e. twenty 24-hour schedules) which were developed through a learning process from normal operations when the controller is under central computer control. These local timing plans and time-of-day schedules shall be updated automatically once a day by the central computer through a database download process. It shall be possible to assign each time-of-day schedule to three or several days of the week or to a special event day by specifying the calendar date.

The Tenderer shall describe in detail in his Technical Proposal how the local time-of-day timing plans will be structured in the database and how the learning process will transform the computer controlled timing operation into the local time-of-day plans.

- (c) It shall be possible to change the locally stored time-of-day timing plans from the controller keyboard.
- (d) It shall be possible to change the local isolated timing plan, timing constants, and various control flags from the control center and from the controller keyboard.

- (e) The local controller shall have self-diagnostic and monitoring capability which will detect error conditions such as green conflict and timing error (i.e. step length less than minimum or exceeding maximum) and transmit the time and type of error to the central computer as they occurs.
- (f) Provide central enablement and override of manual control.
- (g) Allow flashing and turning off of all signal lanterns (Lantern off) from police panel switches.
- (h) Contain an accurate and battery backed internal clock and calendar. It shall be possible to set the date and time from the controller keyboard.
- (i) Receive actuation detector signal from 16 detectors for actuation control.
- (j) Transmit the start of each phase or routinely transmit the current phase code to the central computer system for monitoring purposes.

#### 13.2.4 OFFSET TRANSITION

An offset transition procedure shall be executed by the local controller for smooth synchronization of signals according to selected offsets. The offset transition procedure shall be applied whenever a change of timing plan introduces new cycle lengths or offsets and when the monitoring routine detects an offset error greater than one second. Offset transition shall be done through cycle and split adjustments which will achieve synchronization within 4 cycles, but the procedure shall avoid abrupt change in the timing pattern and display of extremely short intervals.

The CONTRACTOR shall provide detailed descriptions of the proposed offset transition procedure in the system design report for approval by the ENGINEER. Notwithstanding the approval of the system design, the CONTRACTOR shall be responsible for providing an effective and safe offset transition procedure for the system.

To insure that the offsets of all signals are with respect to a common zero reference point, the date and the clock time of every local controller shall be routinely checked with the system date and clock time of the central computer system and corrected to within one second if necessary.

**13.3 MANUAL CONTROL**

Manual control of the local controller shall be provided through a set of push-buttons and switches located on the police panel. The required buttons and switches, and other indicator lamps are shown on Plan No.1209.

Allowable movements in each phase of the manual control, which are to be activated by one of the control buttons, shall be as shown on Volume 3: " Design Traffic volume and Signal Phase Plans". The phasing shall be either programmable through the controller keyboard or factory installed and permanently stored in the ROM (or PROM) area of the controller. If the former method is used, consistency checks to insure safe operations shall be performed before the data is accepted and permanently stored in the database. If the latter method is used, phasing changes shall be possible by replacing the ROM chip.

**13.3.1 OPERATING PROCEDURE**

Operating procedures and functions of the buttons, switches and lamps shall conform to the specifications of this section.

The "Auto/Manual" switch shall normally be on the "Auto" position. If the controller is off-line, switching to the "Manual" position shall enable manual control. If the controller is on-line, this switch shall be functional only if the manual control has been enabled from the control center. The normal procedure to begin manual control shall be as follows:

1. Push the "Manual Request" button. This will send a signal to the control center indicating that manual control is desired. If the signal is sent successfully, the central computer shall echo the request signal which shall cause this button to light up in yellow indicating the request has been received.
2. Upon receiving the request signal, the control center operator shall decide whether or not to permit manual control. To permit manual control, the operator shall push the corresponding intersection button on a manual control operating panel located on the operator console. This will send a signal to the controller to activate the "Auto/Manual" switch and light up the "Manual O.K." indicator lamp.

3. Upon noting that the "Manual O.K." lamp is lit, the "Auto/Manual" switch can be changed to the "Manual" position and manual control can begin. The "Manual" status indicator lamp shall begin flashing in red as a reminder that the controller is in manual mode. All other indicator lamps shall be extinguished.
4. If the control center operator does not push the manual control enablement button within 10 seconds, the "Manual No" indicator lamp shall begin flashing; at the same time, an audible alarm (Buzzer) shall be activated. Both the flashing and the alarm shall last only 5 seconds, after which the alarm shall be silenced and the light shall be changed to steady. The traffic control personnel then will have to call the control center for further action.

Once manual control is enabled and the "Auto/Manual" switch is set to "Manual", the signal shall stop timing at the current phase and the manual control button corresponding to the current phase shall light up. After that, any of the manual control buttons (up to 8 buttons) can be pushed down to display a particular phase. The pushed button shall light up as confirmation.

Once under manual control, if the current phase has been displaying for more than 60 seconds, the button shall begin flashing as a reminder for phase change.

The allowable movements for each phase shall be permanently etched on the button.

### 13.3.2 MANUAL CONTROL OVERRIDE

Means shall be provided to allow control center override of local manual control. This will require that communication between the control center and the local controller be maintained even when the local controller is in the manual control mode.

When the override signal is received from the control center, the "Manual No" lamp shall be flashing and the audible alarm shall be activated for 30 seconds before the controller is set to the "Auto" mode and begin the pick-up procedure. The indicator lamp shall remain lit for one more minute then be extinguished.

To guard against the error of accidentally left the "Auto/Manual" switch in the "Manual" position after completing manual control, a micro-switch shall be provided on the police panel door so that whenever the

door is closed the circuit is automatically set to automatic control regardless of the switch position and all indicator lamps shall be extinguished.

**13.4 ACTUATION CONTROL**

The local actuation control shall be executed by the local controller under all modes of operation except the fail-safe fixed-time mode if actuation detectors are provided. It shall be possible to operate 4 or more actuated phases.

The actuation control shall combine the phase skip and extension features in the sense that if there is no demand on the actuation phase, the phase shall be skipped and, if there are demands, the normal green extension logic shall apply.

If the signal is operating in a time-of-day mode, the split shall be adjusted in such a way that the main street (or coordinated phase) green phase will not be shortened and will be displayed at the time as determined by the selected offset.

Under actuated extension control, all phases shall be subject to the constraints of minimum and maximum times which values shall be changeable from the control center and from the controller keyboard separately for each controller. The value of unit extension shall also be similarly changeable.

The length of extension shall be controllable within the range of 0.9 to 9.9 seconds with a resolution of 0.1 seconds.

Means shall be provided via the local controller database to disable the actuation control of any of the actuated phase. This may be done by setting a recall flag which will cause a continuous vehicle presence signal to be sent to the controller. It shall be possible to set/reset this flag at any time by the operator from the control center and from the controller keyboard.

**13.5 RAILROAD PREEMPTION**

A railroad preemption mechanism shall be provided in the local controllers at the following locations:

- (a) Sawankhalok - Si Ayutthaya (No. 35)



- (b) Sawankhalok - Phetchaburi - Lan Luang (No. 40)
- (c) Expressway - Ploen chit (No. 43)
- (d) Sawankhalok - Rachawithi (No. 54)
- (e) Witthayu - New Phetchaburi (No. 99)
- (f) Chua ploeng - Rama IV - Expressway (No.142)
- (g) Ratchaprarop - Si Ayutthaya (No. 143)

The method to be employed for train detection shall be manual switching but the local controller shall be capable of accepting both manual and automatic detector inputs in parallel. Under manual switching, a push-button switch in the guardhouse and a switch on the crossing gate shall be used to send a preemption signal to the local controller when either of the switches is activated. The actual equipment and mechanism shall be designed by the CONTRACTOR.

The CONTRACTOR shall furnish and install the switches and necessary wiring connecting to the local controller through underground conduit.

The preemption mechanism shall allow selection of one of the phases as the preemption phase and shall have a preemption phase timer. The timer shall begin its counting when the signal enters the preemption phase. If the preemption signal is present when the timer reaches the end, the preemption mechanism shall cause the timer to stop and hold the signal in the preemption phase until the preemption signal is released. If the signal is not in the preemption phase when the preemption signal is received, the preemption mechanism shall cause the signal to advance directly to the preemption phase after the minimum duration of the current phase has elapsed and the yellow and the red transition indications have been displayed. The preemption phase timer shall operate as indicated above.

The signal shall restore the offset through the normal offset adjustment process after its release from preemption.

#### 13.6 START-UP PROCEDURE

Anytime power is restored after an interruption, the start up procedure shall be as follows:

1. Display all red for five seconds or such other period as may be specified in the local controller database.

2. Start normal operation in main street green in local isolated mode and establish communication with the central computer.
3. If communication is established within 1 minute, start pick-up procedure. Otherwise, switch to local time-of-day mode.

**13.7 TIME DURATION OF DISPLAYS**

The time duration of display shall be controllable at least within the following limits:

|                     |                  |
|---------------------|------------------|
| Green               | 3 to 179 seconds |
| Amber               | 1 to 10 seconds  |
| All red             | 0 to 10 seconds  |
| Walk                | 5 to 179 seconds |
| Flashing Don't Walk | 5 to 59 seconds  |

The timing of each display interval shall have a resolution which is not greater than one second. It shall be possible to establish cycle lengths in the range of 40 seconds to 240 seconds.

**13.8 SUPPLY VOLTAGE**

Local controllers shall be designed to operate directly from a power source of 220 volts AC plus 15 percent or minus 20 percent, 50 hertz plus or minus 4 percent. The CONTRACTOR shall provide as part of each local controller any necessary over-current and over-voltage protection equipment.

The Tender shall identify the protection equipment to be installed and describe their capabilities in the proposal.

**13.9 ENVIRONMENTAL CONDITIONS**

Local controller shall be designed and fabricated to provide reliable operation in the Bangkok environment where ambient temperature ranges from +10 C to +60 C with relative humidity of 40 to 100 percent. Heat rise in the controller cabinet due to power dissipation and absorption of solar energy must also be considered. Protection from moisture, fungus, dust and electrical disturbances including lightning shall be provided.

- 13.10 WIRING DIAGRAMS**  
Controller wiring diagrams shall be contained in the controller operations and/or maintenance manual.
- 13.11 CABINET**
- 13.11.1 GENERAL CONSTRUCTION**  
The controller mechanism shall be housed in a rust-proof, water- and dust-tight metallic cabinet of adequate size to contain all accessories necessary for system operation, including detectors, detector data pre-processor, and telemetry. The exterior of the cabinet shall be smooth with rounded corners.
- 13.11.2 DOORS AND KEYS**  
A hinged door shall be provided on the front of the cabinet and a smaller police panel door shall be provided on one side of the cabinet. Both doors shall close tightly against a weather-and dust-proof gasket.
- The main door and the police panel door shall be fitted with a cylinder lock. The key types for the main door and the small space door shall be different.
- The hinge pins of both the main door and the small door shall be made from stainless steel or other non-ferrous materials and shall be securely fixed in position.
- 13.11.3 MOUNTING FACILITIES**  
The controller cabinet shall be mounted on top of a metal pedestal to insure that the bottom of the cabinet be above local flood level. (see Plan No. 1210).
- The conduit opening shall be sealed off against the entry of gas or water when the cabling work is finished.
- 13.11.4 MAIN TERMINAL, PANEL AND WIRING**  
There shall be an insulated terminal panel which shall be easily accessible and removable without special tools. All panel wiring shall be neat and firm and all flying leads shall be clearly identified either by color or number code. In either case, full information shall be given on the circuit diagram which shall be provided with each complete unit.

The following terminals, as a minimum, must be provided and clearly identified on the panel:

- (a) Power supply hot side
- (b) Power supply grounded side
- (c) Ground, which shall be connected to the cabinet
- (d) Signal return or common
- (e) At least 30 signal lamp circuit terminals
- (f) At least 16 detector input circuit terminals

Cabinet wiring shall be standardized.

**13.11.5 MAINTENANCE LOCAL CONTROLLER CONNECTOR PLUG**  
An appropriate connector plug shall be provided on a panel inside the local controller cabinet for connection to a portable local controller. When maintenance of the local controller requires that it be shut down, it shall be possible to use the portable controller to operate the signal.

**13.11.6 POWER OUTLET FOR MAINTENANCE AND TESTING EQUIPMENT**  
A 5 Ampere 220 V AC power outlet shall be provided within the local controller cabinet for maintenance and testing equipment use.

**13.11.7 CABINET WIRING DIAGRAM**  
At least ten (10) copies of cabinet wiring diagrams shall be furnished to the BMA.

**13.12 POLICE PANEL**  
In addition to the switches, buttons, and indicator lamps associated with manual control (see Section 13.3), the following switches shall be provided and mounted on the police panel. A protective, insulated cover shall be fitted to the back of the switch panel in such a way as to completely cover the back of the switches.

- (a) "Lantern On/Off" switch
- (b) Three-way "All Red - Normal - Flashing" switch.
- (c) "Lamp Check" switch

The lantern-on/off switch shall normally be at the on position. When it is changed to "Off", all signal lanterns at the intersection shall be extinguished but the controller shall continue to operate normally.

When the switch is returned to the "On" position, the signal shall first display an all-red period of 5 seconds and then resume displaying the normal phase sequence.

The three-way switch shall normally be at the "Normal" position. Switching to the "All Red" or "Flashing" positions shall cause the signal to display red in all directions or flashing. Returning this switch to the normal position shall cause the signal to display an all red interval of 5 seconds and then resume normal display.

The lamp check switch shall be a non-locking bush-button switch and shall be used to test burnt out lamps on the police panel.

**13.13 TELEMETRY UNIT**

The local controllers shall be equipped with telemetry units to transmit and receive data to and from the front-end processor. The transmission shall be consistent with the functional requirements of these specifications.

**13.14 ROM READER/WRITER**

The CONTRACTOR shall furnish to the BMA suitable equipment for installing database in the ROM chip. A user manual containing general instructions as well as step by step procedures specific to the database of the local controller shall be provided.

## **14.0 TRAFFIC SIGNAL INSTALLATIONS**

### **14.1 TRAFFIC SIGNAL HEADS**

#### **14.1.1 GENERAL**

The design and construction of vehicle signal heads, visors (cowl) and target board shall conform to accepted industry standards in Thailand and the specifications or drawings in Drawing Volume 2: "Traffic Signal Installation Plans". But the existing pedestrian signal heads and poles shall be used for pedestrian signal. The Tenderer is required to identify the model numbers and the manufacturer(s) of the proposed signal heads in the tender document. The CONTRACTOR is required to submit a sample of the signal heads for approval by the ENGINEER prior to installation.

#### **14.1.2 CONSTRUCTION**

Signal heads shall be of sub-unit construction and shall be possible to replace individual sub-units.

Covers to all openings shall make a weather-proof and dust-proof joint. Openings for lamp replacements shall be readily accessible and their covers shall be hinged and secured by captive type thumbscrews or other nondetachable device of such designs that no special tools are required for gaining access to the interior. All hinges shall be of the lift-off type, enabling the hinged sections to be readily removed without the use of tools.

The entire construction of the signal head and its mounting facilities shall be such that it is capable of surviving wind speeds of up to 120 km/hr.

Provision shall be made for any water which accidentally enters any part of the signal head to escape to the exterior.

Provision shall be made in the construction of the signal head to provide ready access to all wiring and cable terminating points.

The optical unit shall be so designed and assembled that no light can escape from one section to another.

**14.1.3 COLOR**

The body of the signal head shall be light green and with a matt finish, with the exception of the interior surface of the cowls which shall be matt black. Prior to any painting, all surfaces shall be adequately treated to provide a secure and lasting adhesion of the coating and to resist atmospheric corrosion.

Where the material of the body is self-colored, it need not be painted if it can be shown that it will retain the required color and finish for at least ten years when exposed to the weather.

**14.1.4 ELECTRICAL REQUIREMENTS**

All conductors shall be insulated using rigid steel conduit.

All wiring shall be supported by clips, saddles, ties or other means so that no stress is occasioned to any connection. No cable shall exert pressure against any unprotected edge of metal with equipment in normal use. All wiring shall be color-coded.

**14.1.5 VEHICLE SIGNAL HEADS**

All vehicle signal heads to be installed under this Contract shall be of the same manufacturer and shall be fitted with visors and a target board.

All mast-arm mounted signal heads shall have all 300 mm sections with target board. All pole mounted signal heads shall have all 200 mm sections with a target board unless otherwise specified on the Plans.

The weight of a finished 3 section assembly with cowls shall not exceed 15 kg for a 200 mm signal and 18 kg for a 300 mm signal.

The signal heads are to be mounted vertically on poles and horizontally on mast-arms by the use of mounting brackets or straps. The minimum height above the pavement to the bottom of the signal head assembly shall be 3.5 meters for a pole mounted head and 5.8 meters for a mast-arm mounted head.

Mounting brackets and attachment facilities shall be such as to enable up to 4 signal heads to be grouped with standard attachments and aligned to provide:

- (1) an unobstructed view of the intended signal face to the driver of vehicle on any selected approach,

- (2) sufficient clearance so that ready access is maintained to the interior of each section for the purpose of lamp replacement and cleaning of the optical assembly. It shall not be necessary to loosen a signal head from its mountings, or remove visors or target boards to gain access to the interior of the signal head.

The mounting arrangements of the signal head shall be such as to enable it to be directed to a point located at a height of 1.4 meters within 150 meters of, but not less than 15 meters from the stop-line on the approach to which the signal is directed.

All positioning attachments shall permit the signal head to be locked in position by a mounting bracket or equivalent means.

## 14.2 SIGNAL POLES

### 14.2.1 GENERAL

Poles and supports shall be furnished and installed by the CONTRACTOR as shown on Plan Nos. 1211-1212, and shall meet the following requirements.

Four types of poles are required:

Type A -- A mast arm (cantilever) type pole to support traffic signal heads that are to be located over the road surface with a minimum clearance of 5.8 m between the road surface and the lower most part of the mounted signal head assembly or any part of the cantilever. Type A pole shall conform to Plan No.1211 unless otherwise approved by the ENGINEER.

Type B -- A pole measuring 4.5 m from pavement to the top of the pole. Type B pole shall conform to Plan No.1212 unless otherwise approved by the ENGINEER.

### 14.2.2 MATERIAL

The material used for signal poles shall be mild steel.



**14.2.3 WIND LOADING**

All signal poles shall be constructed to withstand a wind velocity of 120 km/hr, when carrying 4 x 3 aspect 300 mm diameter signal heads including target boards and visors.

**14.2.4 FINISH**

All steel surfaces including interior surfaces shall be hot-dip galvanized or spray zinc treated. The fabricated items shall be finished in a workman-like manner and shall be free from all welding scale, sharp corners and projections. The top of the pole shall be sealed off to prevent ingress of water. A hole or holes shall be made at the side of the lowest part of the pole to allow any water which accidentally enters the inside of the pole to escape to the exterior.

**14.2.5 FOOTINGS**

Poles shall be designed with a baseplate for bolting down on a prepared concrete footing. The mounting bolts and nuts shall be adequately treated to resist corrosion when buried (See Plan No.1215).

Type B poles may be cast directly in a concrete base (instead of bolted down) if it can be shown that site conditions prevent the installation of the required footing for a bolt down type installation.

**14.3 LOCAL WIRING**

The CONTRACTOR shall furnish and install the wiring between the local controller, power switch box, and the signal heads. Wiring shall be installed in underground rigid steel conduit, which shall also be furnished and installed by the CONTRACTOR. Conduit shall generally be buried at a depth of at least 75 cm. Wire gauge shall be suitable for the lamp load with at least 50% safety factor. Wire insulation sheath shall be color-coded for easy identification.

The Tenderer shall consider the possibility of local flooding and design the installation of local controller accordingly.

Each cable run shall contain at least one (1) spare conductor.

A complete set of local wiring diagrams will be furnished to the CONTRACTOR for reference in installing local wiring. However, the CONTRACTOR is responsible for installing a complete functional intersection signal system. The CONTRACTOR is required to examine the diagrams prior to actual installation and report any inconsistencies

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to the ENGINEER. Any additional cables, if required, shall be installed by the CONTRACTOR.

A copy of the as-built local wiring diagram shall be kept in the controller cabinet and another copy shall be furnished to the BMA.

## **15.0 VEHICLE DETECTORS**

### **15.1 GENERAL**

Vehicle detectors shall be inductive loop type or ultrasonic type which have been field tested and used for traffic signal applications.

The CONTRACTOR shall furnish and install the required numbers of loops, ultrasonic transmitters/receivers, detector units, detector cabinets as indicated on the Plans as well as all data transmission and power supply wiring and equipments necessary to complete the installation for system control and local actuation or phase recall control.

The detector units shall be of digital, microprocessor type design with auto-tuning and frequency, sensitivity, and presence time settings which can be adjusted. The front panel shall be provided with indicator lamps for monitoring detection and fault.

### **15.2 POSITIONING**

Detector locations as shown on Plan No.1216 and Volume 4: "Vehicle Detector Installation Plans" indicate the approximate longitudinal and lateral positions of the loops or the ultrasonic transmitters/receivers. The final placement shall be determined based on the need to minimize the possibility of missing or double counting vehicles and faulty detection due to parked cars. Therefore, the locations of detectors may require adjustment at the time of installation based on the actual geometric or surface and traffic conditions.

The CONTRACTOR shall mark the location of the sensing units in the field and request inspection by the ENGINEER before commencing saw cut of the loops or excavation for the footing of the mounting structure for ultrasonic transmitters/receivers.

### **15.3 SENSITIVITY**

The detectors shall be designed and installed to detect vehicles ranging in size from small vehicles to buses and tractor-trailer trucks without over or under counting or detecting vehicles on adjacent lanes, and to produce accurate occupancy readings.

**15.4 OUTPUT SIGNAL**

The output pulse of the detectors shall be proportional to the length of time a vehicle is in the zone of detection.

The output of the detectors shall be low (off) in the presence of a vehicle and high (on) in the absence of a vehicle.

**15.5 DETECTOR DATA PRE-PROCESSOR**

Each detector shall be connected to a pre-processor which will receive the vehicle presence data from the detector, compile them into volume and occupancy counts, cumulate the counts in two counters, and transmit the data (through terminal transmitter) to the central computer system. A more detailed description of the requirements of the detector data pre-processor is provided in Section 3.2 of these specifications.

**15.6 HOUSING OF DETECTOR UNITS AND TERMINAL TRANSMITTERS**

Detector units, pre-processor, transmitters, and power supply units shall be mounted inside local controller cabinets or detector cabinets.

The size of the housing shall be large enough to provide ample space for 8 detector units, the pre-processor, associated power units, a terminal transmitter, and terminals. There shall be sufficient clearance between the mounting chassis and the bottom of the housing for the cable connection. Detector cabinets shall be mounted on a steel post; the bottom of the cabinet shall be above the local flood level.

The CONTRACTOR shall submit, for the ENGINEER's approval, details of the proposed housing design and equipment layout.

**15.7 INTERCHANGEABILITY**

All detectors of the same type (i.e, loop or ultrasonic) and all detector cabinets, pre-processor, power supply and transmitter units installed under this Contract shall be fully interchangeable.

**15.8 LOOP DETECTOR INSTALLATION**

Loop detector installation shall conform to Plan Nos.1217-1220 and these specifications.

A special type of pre-molded loop cable containing 2 or 4 individually insulated conductors within a protective jacket shall be used. Additional specifications for the loop cable are provided in the Plans. Where the cable is connected to form the loop, the splices shall be made permanently water-proof by using an approved splice enclosure.

Loop feeder shall be the same as the power cable unless otherwise specified by the detector manufacturer.

**15.9 ULTRASONIC DETECTOR INSTALLATION**

Ultrasonic detectors shall be mounted either on a mast arm type pole or under an existing pedestrian overhead crossing as indicated on Plan Nos.1221-1223.

In the case of installation under a pedestrian overhead crossing, the mounting methods and required hardware may be different for different type of structures. The CONTRACTOR shall conduct a field survey to determine the installation requirements. The mounting method(s) shall be approved by the ENGINEER.

**15.10 DETECTOR INSTALLATION TESTS**

In addition to functional tests which shall be included in tests on completion, detector installations shall be inspected for size and sealant condition, and tested for circuit continuity, circuit resistance, and insulation resistance. These tests shall be conducted in the presence of the ENGINEER or his representative and the test results must be documented and submitted to the ENGINEER for review.

## **16.0 COMMUNICATIONS**

### **16.1 GENERAL**

The communications system equipment, installation, and services furnished by the CONTRACTOR shall meet the functional requirements of the ATC system and the provisions of this section.

The CONTRACTOR shall assume full responsibility for proper operation and interfacing of the communications system for the two-way transmission of control commands, equipment monitor data and detector data between the traffic control computer at the Control Center and field located traffic signal controller and detector equipment.

The transmission system shall be suitable for operation over voice grade lines leased from the TOT and line transmission shall be by individual line to each field unit. The CONTRACTOR shall be responsible for obtaining any TOT approval necessary to connect his equipment to their lines.

The Tenderer shall provide details of the communication system including method and data formats to be used for this System in his Technical Proposal. The details shall include, as a minimum, the following:

- (a) frame or character structure (start, data and stop bits)
- (b) error detection or correction method
- (c) Protocol
- (d) Alternative use of transmission lines, if required

Any questions the Tenderers wish to raise with the TOT shall be relayed to the TOT through the BMA. However, the BMA will assume that all proposals made by Tenderers for use of lines and multiplexing, have been agreed upon with the TOT, and the CONTRACTOR will be responsible for any problems arising where such agreement has not been obtained.

### **16.2 MINIMUM REQUIREMENTS**

As a minimum the communications system shall provide the following:

- (a) Transmit control data from the central computer to each of the centrally controlled intersections once every 5 minutes and as

frequently as required according to the various functional requirements of the control system.

- (b) Acquire local controller mode of control, phasing and status data from each of the centrally controlled intersections at a constant repetition rate of once per second.
- (c) Acquire detector data once every 5 minutes and also every cycle when such data is required for the traffic responsive control.
- (d) Transmit data between the central computer system and the local controller on command the operator and daily for database update purposes.
- (e) Advise the computer of transmission errors detected by central communications equipment.
- (f) The message format of the regular information shall be modular in structure. It shall be possible to expand the amount of data being transmitted by including extra bytes. This expansion shall not require the addition of any extra equipment. It shall be possible to alter the message length at any time by reprogramming the instation and outstation.

### 16.3 LINE TRANSMISSION STANDARDS

Either synchronous or asynchronous data transmission will be necessary to meet the functional requirements of the ATC system. Message protocols and formats should follow accepted standards.

Modems and transmission standards shall be in accordance with TOT requirements. Technical details of TOT lines are provided as Appendix A of this Section for general references; the Tenderer shall obtain additional information from the TOT, if necessary.

### 16.4 ERROR RATE

The central communications equipment and each communications unit shall provide received message error detection and checking. Regardless of the error detection and testing techniques selected, the following error protection criteria shall apply:

- (a) The probability that unsafe or undesired events occur shall be less than one over one ten millionth (ten to the seventh power). An unsafe or undesired event is defined to be:
  - 1. A wrong controller reacting to a command message (for example, due to crosstalk).
  - 2. A controller reacting to a command as though it were a different command (for example, due to corruption of the message by electrical noise).
- (b) The probability that valid (noise-free) commands are rejected shall be less than one over hundred thousandth (ten to the fifth power).
- (c) The probability that valid status monitor messages or detector data are rejected, or corrupted messages or detector data are accepted, shall be less than one over hundred thousandth (ten to the fifth power).

16.5 TRANSMISSION SECURITY

- (a) The data transmission line signalling equipment shall have a bit error rate better than one over hundred thousandth (ten to the fifth power) with a signal to white noise ratio of 20dB measured within the channel.
- (b) Messages shall be protected by parity or Cyclic Redundancy Check (CRC). The Tenderer shall state the calculated undetected message error rate for:
  - 1. regular messages, and
  - 2. non-regular messageswith their proposed arrangements, in the presence of the bit error rates which have been specified previously.
- (c) The terminal telemetry shall check each message received and detect the following fault conditions:
  - 1. Parity error or CRC error
  - 2. Protocol error
- (d) If a fault is detected the data in that message shall not be used. The terminal telemetry shall use the data contained in the last



correctly received message. If no correct message has been received for a period pre-stored in the terminal telemetry, then the associated controller shall revert to the local control mode.

- (e) One bit in each reply message shall be used to indicate that a correct control message has been received.
- (f) Message protocol generation and management shall be a software/firmware function and shall be stored in PROM.

## 16.6 CENTRAL COMMUNICATIONS EQUIPMENT

### 16.6.1 GENERAL

The data transmission equipment in the Control Center shall consist of communications processor(s), modems, line termination and protection equipment, and a Main Distribution Frame (MDF).

Each equipment shall have its own built-in regulated power supply. The equipment shall meet all its specified performance requirements for the input power of 220 VAC, 50 Hertz.

The equipment design shall be such that failure of any one of equipment shall not cause failure of any other equipment.

The required time for any of the equipment to become operational after application of power shall not exceed two seconds.

### 16.6.2 CENTRAL COMMUNICATIONS UNIT

The communications processor(s) shall be programmable so that the message structures and terminal telemetry numbers can be changed.

If a communications processor controls more than 64 terminal telemetries then it shall have a standby available that will automatically take over control in the event of a failure. If the communications processor controls less than 64 terminal telemetries, it is acceptable that it need not be duplicated but it shall be readily interchangeable and reprogrammed automatically without affecting the operation of the other communications processors. In these circumstances a spare communications processor shall be supplied for each type used in the System.

**16.6.3 MODEM**

Modems and line units shall be arranged in groups. Each group shall control a maximum of 128 terminal telemetries. Each group shall have its own power wiring and fuses so that it can be isolated without affecting the other groups.

Each line signalling group shall have a replaceable label that shows the terminal telemetry and installation references.

The installation equipment shall be housed in cabinets. The System shall be supplied initially fully equipped to control all terminal telemetries included in the system, including spare outstation equipment ordered.

The System shall have cabinets, interfaces, power supplies and be fully wired so that it can be expanded by the addition of 'plug-in' modem units only, to control 256 terminal telemetries.

**16.6.4 MAIN DISTRIBUTION FRAME (MDF)**

The CONTRACTOR shall furnish, install and make all the internal connections to a Main Distribution Frame (MDF). This shall provide termination, protection, and test points for the transmission lines and shall conform to a standard approved by TOT.

The transmission lines will be terminated on one side of the MDF (line side) by the TOT. The cabling from the modems shall be terminated on the other side (the equipment side) by the CONTRACTOR.

As the TOT transmission system uses P.C.M., and the terminating equipment is located in the Control Center, there is no specific requirement for surge protection mechanism etc. The Tenderer shall ensure that his equipment provides any terminating facilities necessary to ensure compatibility with TOT equipment.

The MDF shall contain access and patching facilities to provide for the following:

- (a) Isolation of any line or equipment.
- (b) Connect test equipment to either the line or the equipment side breaking the connection to the other, or jack across the line to monitor transmission.

These facilities shall be provided using plugs and sockets.

All connections shall be clearly marked and labelled.

The MDF shall be housed in standard cabinets matching the rest of the equipment cabinets.

The CONTRACTOR shall provide the following:

- (a) Sufficient isolating jacks to isolate all equipment and lines +10% spare.
- (b) 5 sets of cables for connecting test equipment.

The MDF design shall be equipped and fully wired to cater for 600 lines which have already been provided in the Computer Room without MDF.

## 16.7 FIELD COMMUNICATION EQUIPMENT

### 16.7.1 GENERAL

Terminal telemetry equipment including modem, transmission processor, and terminals shall be provided in local controller and detector cabinets to transmit and receive data to and from the front-end processors.

The telemetry units shall be designed and built to operate satisfactorily in the extreme environmental conditions experienced in Bangkok.

All electronic components shall be sufficiently rated to provide reliable operation over a temperature range of +10 to +60 degrees Celsius. Printed circuit boards shall be protected by means of a coating or other approved methods to insure proper operation under extreme atmospheric condensation conditions.

The operation of equipment shall be unaffected by any electrical noise within the controller cabinet.

### 16.7.2 COMMUNICATION PROCESSOR

The controller/Detector terminal telemetry shall contain test points where a data transmission test set can be connected. These shall be plug/socket connections and shall allow access to the transmission line to simulate either instation or outstation operation and to monitor data passing between the instation and outstation.

The terminal telemetry shall contain a Line Protection Unit which shall contain fuses and PD device, or surge arresters to protect the terminal telemetry and controller from surges on the transmission line. The CONTRACTOR shall note that TOT lines are distributed in overhead cables, and shall take all necessary precautions against lightning and electrical storms.

The terminal telemetry modem shall be isolated from the TOT line by an isolating transformer. All equipment connected to TOT lines shall be approved by TOT. The CONTRACTOR shall be responsible for obtaining this approval.

16.8 **TRANSMISSION SPECIFICATIONS TO BE APPROVED**  
The following transmission system specifications shall be approved by the ENGINEER prior to ordering equipment:

- (a) Frame or character structure.
- (b) Full details of the protocol to be used.
- (c) Modem operating frequencies.

16.9 **TRANSMISSION TEST EQUIPMENT**

16.9.1 **GENERAL**

The CONTRACTOR shall provide 3 Transmission Test Sets (TTS). The TTS shall be capable of simulating both the Control Center and field equipment operation and also monitoring the transmission messages on the line.

16.9.2 **TRANSMISSION TEST SETS (TTS)**

The TTS shall conform to the following:

- (a) The TTS shall be portable and suitable for use at the instation and outstation. It shall be supplied completed with carrying case, connecting leads etc.
- (b) The TTS shall be controlled by a microprocessor and contain mains power supply equipment, modems, and display equipment.

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- (c) It shall be possible to set up the message to be transmitted using keys or switches. It shall be possible to monitor the contents of the message before it is transmitted.
- (d) The TTS shall be capable of transmitting a message once, continuously or for a preset number of times.
- (e) It shall be possible to monitor received messages on indicators. These indicators shall be sufficiently bright to permit the TTS to be used outdoors.
- (f) The TTS shall contain a memory which shall allow an operator to enter a sequence of messages to be transmitted and also to store a sequence of received messages. The memory shall be sufficient to store the sequence to transmit or receive 2 traffic signal control plans.
- (g) It shall be possible to connect a printer to the TTS; one printer shall be supplied with each TTS. These printers shall be used to record messages transmitted and or received. They shall be portable and of robust construction, suitable for use outdoors.
- (h) Consideration will be given to a modular design TTS providing this is based on functional modules i.e.:
  - (a) Outstation Simulator
  - (b) Instation Simulator
  - (c) Line Monitor
- (i) It shall be possible to adjust the transmit level of the TTS through the range of 0 to -50dBm. It shall also be possible to switch an adjustable attenuator into the receive signal. The attenuator shall have a range of 30dB.
- (j) The TTS shall have carrier fail indicators for each receive modem fitted.

**APPENDIX A**

**TOT DATA TRANSMISSION SYSTEM**

1. The TOT will provide a data transmission system based upon the use of Pulse Code Modulation (P.C.M.) lines.
2. The P.C.M. instation terminating equipment will be provided and installed by the TOT in the Control Center. The CONTRACTOR shall make suitable space available for this equipment.
3. The performance of the P.C.M. system is shown on the attached specification.
4. The TOT will make connections between their equipment and the MDF installed by the CONTRACTOR.
5. At the outstation, the CONTRACTOR will provide a suitable terminal for connection of the TOT cable. The TOT cable used will be the Telephone Dropwire, as detailed on the attached specification.
6. The TOT will connect between the CONTRACTOR's terminal, and their nearest exchange. At the exchange, lines will be interconnected, as agreed with the CONTRACTOR, and sent over P.C.M. links to the Control Center.

APPENDIX A  
ANNEX 1

TWO WIRE AUDIO POINT OF PCM EQUIPMENT

1. GENERAL

This requirement is provided for the two wire audio point with DC loop signalling which is prepared by the TOT for Area Traffic Control.

The two wire audio point output from the Time Division Multiplex/Pulse Code Modulation (TDM/PCM) Equipment for Data Transmission Equipment.

2. TERMINAL CHARACTERISTICS

2.1 Two wire audio point

Nominal levels

Transmit : 0 dBr  
Receive : -3 dBr

Level adjustable range

Transmit : +2 to -2 dBr, in step of 0.5 dB  
Receive : 0 to -5 dBr, in step of 0.5 dB

Nominal impedance

Transmit and receive: 600 ohms balance with a return loss of at least 20 dB in the range of frequency 300-3400 Hz.

Insertion loss : 6 dB at 300-3400 Hz.

2.2 System characteristics

The P.C.M. system shall work on unload or deload cable pairs on a four-wire basis with separates go and return pair.

Frequency response : The variation of overall loss with frequency for each pair of channel transmitting and receiving equipment shall not exceed the limits indicated in CCITT Rec.

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**Idle channel noise :** The maximum weighted noise in the band 300-3400 Hz shall not exceed -65 dBmop. The unweighted noise in the same audio band shall not exceed -60 dBmop.

**Quantization distortion :** The ratio of measured signal power to quantization distortion power (weighted) resulting from the application of sinusoidal test signals in the band 300-3400 Hz and over the input level range from +3 to -42 dBmo shall be more than 29 dB.

**Intermodulation distortion :**

- a. The second and third order intermodulation products of two equal level test in the range of 300-3400 Hz band shall be at least -35 dB below the level of each fundamental.
- b. This ratio shall be met for fundamental levels in the range of -4 to -21 dBmo.

**Crosstalk between circuit:**

- a. The far end crosstalk measured between any two circuit in the same system of the same rack shall not exceed -65 dBmo.
- b. The near end crosstalk measured between one channel and its associated return channel shall not exceed -60 dBmo.



APPENDIX A  
ANNEX 2

**P.V.C. INSULATED AND SELF-SUPPORTED TELEPHONE DROPWIRE**

1. **GENERAL**

This requirement covers the P.V.C. Insulated and Self-Supported Telephone Dropwire to be provided by the TOT for the Area Traffic Control (ATC).

The dropwire shall be P.V.C. insulated copper conductor and steel wire supporting.

2. **CONDUCTORS**

2.1 The conductors shall be of solid, round annealed copper wire, uniformly and smoothly drawn, circular in cross section, uniform in quality and free from all defects, conforming to all requirements of the latest issue of ASTM B 3, or equivalent.

2.2 The conductor size shall conform to the following:

| Conductor size | Nominal diameter (mm) |
|----------------|-----------------------|
| 0.65 gauge     | 0.6426                |
| 0.90 gauge     | 0.9119                |

3. **ELECTRICAL PERFORMANCE CHARACTERISTICS**

At the completion of the manufacturing, all the dropwire lengths shall pass all the following test.

Conductor resistance: The DC resistance of any conductor as measured in the completed wire shall not exceed the following value when measured at or corrected to 20 degree C.

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| Conductor sizes | Maximum resistance (ohm/km) |
|-----------------|-----------------------------|
| 0.65 mm gauge   | 57.1                        |
| 0.9 mm gauge    | 28.5                        |

Note: Temperature coefficient of DC. loop resistance is 0.00393/degree Celsius.

The manufacturer shall supply certified copies of the results of all tests.



## DIVISION III : CLOSED CIRCUIT TELEVISION SYSTEM

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## **DIVISION III : CLOSED CIRCUIT TELEVISION SYSTEM**

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### **1.0 SYSTEM DESCRIPTION**

#### **1.1 GENERAL**

The Closed Circuit Television (CCTV) System to be introduced in the Bangkok Area Traffic Control System Project - Stage I for the purpose of traffic surveillance and control is to be made up of color CCTV cameras installed on site, color TV monitors and video recorder at the Traffic Control Center.

The system shall utilize the latest technology in CCTV system in particular the type of camera and video signal transmission. The system shall make use of the TOT digital optical fiber transmission network in Bangkok for video transmission to the Traffic Control Center.

#### **1.2 SYSTEM COMPOSITION**

The CONTRACTOR shall be responsible for furnishing, installing and carrying all works necessary to produce a complete functional system, including the installation of five (5) color CCTV cameras at specified locations, the communication system consisting of optical fiber and coaxial cable and transmission equipment, and various Control Center equipment. The Control Center equipment shall consist of a total of seven (7) color TV monitors, a video recorder, camera remote control system and other necessary peripheral equipment.

The cameras shall be capable of being remotely controlled by operators at the Traffic Control Center. Five (5) TV monitors shall be installed beside the Traffic Condition Monitoring Wall Map in the Control Room. One (1) TV monitor shall be installed on the Control Desk for the Operator to control the CCTV cameras while another TV monitor shall be installed by the video recorder. The system configuration required is illustrated in Plan No.1301.

#### **1.3 FUTURE EXPANSION**

For future expansion of the system to accommodate a greater number of CCTV cameras in later stages of the Project, the Control Center equipment including their installation layout at the Control Room shall include provision and consideration for such system expansion.

## 2.0 CAMERAS

### 2.1 CAMERA LOCATIONS

The CONTRACTOR shall furnish and install five (5) cameras at the locations shown on Plan No.1302 and described below:

- (1) Corner of Ratchadamnoen Klang - Ratchadamnoen Nai, (No.13)
- (2) Corner of Phaya Thai - Phetchaburi Intersection, (No.18)
- (3) Corner of Sathon - Witthayu - Rama IV Intersection, (No.103)
- (4) Corner of Sukhumvit - Soi Sukhumvit 21 Intersection, (No.115)
- (5) Corner of Ratchadaphisek - Asok Din Daeng Intersection, (No.194)

The CONTRACTOR shall carry out a survey of each site using a hoist or similar equipment and shall provide, for the approval of the ENGINEER, a report indicating the precise pole position and height recommended.

### 2.2 TYPE OF CAMERA

The color cameras to be installed at the above locations shall have the following features.

- |                                |   |                                  |
|--------------------------------|---|----------------------------------|
| (1) Color System               | : | PAL                              |
| (2) Pick-up element            | : | either CCD or MOS type           |
| (3) Number of active pixels    | : | More than 360,000                |
| (4) Horizontal resolution      | : | More than 430 lines              |
| (5) Synchronizing              | : | Internal random or 2:1 interlace |
| (6) White Balance              | : | Both automatic and manual        |
| (7) Minimum scene illumination | : | 10 Lux                           |
| (8) Lens mount                 | : | C-mount                          |
| (9) Output                     | : | 1.0 Vp-p Composite               |

### 2.3 ZOOM LENS

Each camera shall be equipped with a motorized zoom lens with iris and focus control function. The horizontal angle of view shall vary at least between 5 degree (Telephoto) and 40 degree (wide-angle) with a minimum focusing distance of 3 meters. Working range of EE mechanism shall be between F1.6 to approximately F350. Operation speed of the lens shall be:

- (1) Zoom : Less than 7 seconds
- (2) Focus : Less than 10 seconds
- (3) Iris : Less than 5 seconds

The lens shall be attached to the camera by a standard C mount.

**2.4 REMOTE CONTROL FEATURES**

Each camera shall have power on-off, pan, tilt, focus, zoom and wiper control features which can be controlled from the Control Center.

**2.5 CAMERA HOUSING**

The cameras shall be housed in suitable environmental enclosures to protect them from solar radiation, dust and rain. A remote controlled wiper shall be provided to the housing to permit operation of the camera during a rainstorm. The field of view of the camera shall not be obstructed by the housing nor wiper, which shall automatically park out of view. Picture quality or optical performance shall not be degraded by the housing.

**2.6 PAN AND TILT HEAD**

The camera housing shall be mounted on a pan and tilt head, which shall be capable of panning and tilting a camera complete with its housing. Tilt limits shall be at least 0 (horizontal) to -60 degrees, pan limits 0 to 340 degrees.

Pan control shall be capable of at least 3 degrees per second, tilt control shall be capable of at least 3 degrees per second, and zoom and focus shall cover the full range in approximately 20 seconds. Mechanical stops and slip clutches or other motor protection shall be provided. A mechanism shall be provided to prevent pan and tilt coasting.

**2.7 ENVIRONMENTAL CONDITIONS**

Cameras shall be designed to operate in the Bangkok environments where outside air temperature may range from +10 to +60 degrees Celsius with a relative humidity of 40% to 100%.

**2.8 SUPPLY VOLTAGE**

Line voltage supplied for camera operation will be 220 volts AC plus 15% or minus 20% at 50 hertz plus or minus 4%. The CONTRACTOR shall be responsible for getting power from the nearest MEA supply point. Power cables shall be installed in accordance with local electrical regulations.



**2.9 CAMERA INSTALLATION**

Poles and supports shall be furnished and installed by the CONTRACTOR as shown on Plan No.1303, and shall meet the following requirements.

- (1) All cameras shall be mounted on free standing concrete or steel mounting poles or composite pole of three I-shaped steel bars which has been adopted by the ETA in Bangkok, and at least ten (10) meters above the nearest roadway level, except cameras at Phetchaburi-Phaya Thai Intersection (No.18), and Sathon-Witthayu-Rama IV Intersection (NO.103) where height of camera shall be at least six (6) meters above the highest roadway level.
- (2) The concrete mounting poles shall be at least 300 mm or more in external diameter and they shall be cast in a footing of mixed concrete of at least 1200 mm diameter underground to a depth of approximately one-fifth of the pole length.
- (3) Should the CONTRACTOR propose steel mounting poles, they shall be of mild steel and tubular with approximately 200 mm outside diameter and a minimum thickness of 4.5 mm. The diameter and thickness shall be maintained throughout the length of the pedestal.
- (4) All steel surfaces shall be hot-dip galvanized or equivalent. The fabricated items shall be finished in a work-man-like manner and shall be free from all welding scale, sharp corners and projections. The top of the pole shall be sealed off to prevent ingress of water. A hole or holes shall be made at the side of the lowest part of the pole to allow any water which accidentally enters the pole to escape to the exterior.
- (5) Should the CONTRACTOR propose to use mounting poles consisting of three I-shaped steel bars, he shall referred to the existing CCTV camera poles built by the ETA for detailed specifications.
- (6) A platform of suitable size with a safety railing and/or a ladder may be provided to the camera post for maintenance work. If Tenderers have alternatives for maintenance work, they may in their technical proposals, suggest detailed methods with designs.

- (7) For camera mounting poles erected at street level, the minimum clearance between the outer edge of the pole and the nearest curb side shall be 650 mm. Wherever site conditions permit, a clearance of not less than 1000 mm should be provided.
- (8) To protect the camera mounting pole from damage by car accidents, a total of 6 mild steel poles, 650 mm high above the pavement level and 120 mm nominal diameter, shall be installed encircling the base of the camera mounting pole and at a nominal distance of 600 mm from the center of the mounting pole to act as a barrier. The barrier poles shall be connected with two rows of chains. The foundation for these barrier poles shall be separated from the that of the camera mounting pole.
- (9) Lightning rod, grounding and the protection device from lightning shall be provided to each camera pole.
- (10) The camera installation shall be designed to survive winds of 120 km/hr.

Tenderer shall describe the type of pole he proposes to use, in his Technical Proposal and highlighting its economics, technical and maintenance merits.

## 2.10

### **LONG-TERM STABILITY**

Having been set up and installed, the camera and its associated equipment shall operate satisfactorily within specification without adjustment for at least 12 months, apart from any adjustment related to component failure.

### **3.0 CENTRAL REMOTE CONTROL EQUIPMENT**

#### **3.1 GENERAL**

The CONTRACTOR shall provide remote control equipment in such a manner that the system will be capable of controlling at least 5 cameras.

#### **3.2 CONTROL CONSOLE**

Switch panel at the control console shall be provided to accommodate the necessary control switches. Internal wiring, terminal board, connector and cable shall also be provided.

#### **3.3 VIDEO SELECTION SWITCHER**

A video selection switcher equipped with "On" lamps shall be provided for at least 10 inputs using a row of 10 non-locking push buttons. The switcher shall enable the operator to select any camera for control by turning "On" the camera identifying switch.

#### **3.4 VIDEO SELECTION SWITCHER FOR VIDEO RECORDING**

A video switcher equipped with "On" lamps shall also be provided for at least 10 inputs using a second row of 10 non-locking push buttons under the video selection switch. This second switcher shall enable the operator to select any camera for recording by turning "On" the camera identifying switch. The video recording shall function simultaneously and independently from the video selection switches.

#### **3.5 CAMERA CONTROL SWITCHES**

The camera control switches shall be capable of executing the remote control of the following functions independently on a selected camera.

- (a) pan (2 directions left/right)
- (b) tilt (2 directions up/down)
- (c) zoom (2 directions in/out)
- (d) focus (2 directions far/near)
- (e) wiper (on/off)
- (h) camera and TV monitor (on/off)

These controls shall be provided by means of joysticks for all the functions including turning on/off the camera and TV monitor.

A main power supply switch shall be provided to start and end the whole CCTV system except terminal transmission system.

#### **4.0 TV MONITORS**

##### **4.1 GENERAL**

The CONTRACTOR shall furnish and install color TV monitors mounting hardware or console, and any other items needed for satisfactory operation of the CCTV system.

A total of seven (7) color TV monitors; one for the video recording unit, five beside the Traffic Monitoring Wall Map and one at the control desk shall be installed. Each of the five (5) TV monitors on the wall shall be permanently connected to one of the five (5) cameras.

##### **4.2 MONITOR SIZE AND ADJUSTMENTS REQUIRED**

The five TV monitors for installation on the wall shall be 21 inches diagonal and shall have standard adjustments for brightness, contrast, vertical and horizontal hold, and power on-off. The installation shall be such that only the display screen and surrounding frame be normally seen from the control desk. A name plate bearing the names of the intersection shall be provided under each TV monitor. Split screen operation is not required.

The other two TV monitors for installation on the control desk shall be 12 inches or more diagonal and shall have the same standard adjustments as above.

#### **5.0 VIDEO TAPE RECORDING UNIT**

##### **5.1 GENERAL**

The CONTRACTOR shall furnish and install a video tape recording unit on the control desk. The video tape recording unit shall contain one color video tape recorder, one color TV monitor, one time-day-date generator, a control panel and their associated equipment.

##### **5.2 MINIMUM REQUIREMENT**

(1) The video tape recording unit shall be equipped with switches to record any one of the pictures display on the TV monitors on the wall independently from the camera control system. The switches to be used for the selection of the TV monitor shall be installed on the control panel.

(2) The video tape recording unit shall be equipped with a generator to display the time and day, name or number of camera location at one corner of the screen.

(3) The monitor TV shall be capable of displaying the current picture which is being recorded by the video tape recorder during recording.

(4) The video tape recording unit shall be equipped with audio unit to record oral messages.

## **6.0 COMMUNICATIONS**

### **6.1 GENERAL**

The CONTRACTOR shall furnish and install telemetry units at the Control Center, at the field camera locations and at the TOT optical exchange buildings, and cable connection between the telemetry unit and the TOT cable network for the CCTV system. The CONTRACTOR shall use the TOT digital optical fiber cable network in Bangkok for video signal transmission, and also the TOT telephone line network for transmitting central control signal of cameras.

The CONTRACTOR shall be responsible for all equipment including works between the CCTV equipment and TOT line terminations, and optical coders and decoder (Codec). The coder will be installed in the TOT exchange building near each field camera location, and the decoder will be installed in the TOT exchange building near the Control Center.

Plans or drawings showing the locations of TOT exchange buildings shall be supplied to the Tenderer as an addendum.

### **6.2 VIDEO SIGNAL TRANSMISSIONS**

The video signal transmission system should use a leased TOT digital optical fiber cable network that operates between TOT exchanges.

The video signal from the camera should be transmitted to the nearest TOT exchange by means of coaxial cable and then the signal should be converted to the digital signal using an optical coder. The converted digital signal will then be transmitted to the nearest TOT exchange to the Control Center using the TOT optical cable network.

The digital signal arriving at the TOT exchange near to the Traffic Control Center should be converted back to video signal using an optical decoder and the video signal should be transmitted by coaxial cable to the Control Center, or alternatively, the digital signal arriving

at the TOT exchange should be transmitted by optical cable to the Control Center and it should be converted back to video signal using an optical decoder located at the Control Center. Tenderer may propose other alternative, but he should include a report on the technical, economy and maintenance merits of such alternative, in his Technical Proposal.

For compatibility with the TOT transmission system, the code for the video transmission should comply with the TOT Specification No. XM-026-00.

The TOT transmission characteristics are:

- (1) Interface standard : CCITT
- (2) Line bit rate : 34 Mbps

### **6.3 CONTROL SIGNAL TRANSMISSIONS**

The camera control signal transmission shall use a leased telephone line between the cameras site and the Traffic Control Center. The camera control signal shall be transmitted, by carrier between modems installed both at the Traffic Control Center and the field cabinet.

The CONTRACTOR may propose other transmission system provided that the proposed system shall have technical or economic advantages taking into account the locations of the cameras sites.

### **6.4 INTERFACE WITH OTHER SYSTEMS**

The Contractor shall propose a suitable facility for interfacing this system with other CCTV surveillance systems which may likely to be implemented in Bangkok by the Expressway and Transit Authority of Thailand (ETA), and the Central Traffic Police Division.

## **7.0 ENGINEER'S APPROVAL**

The CONTRACTOR shall be responsible for preparing the layout of the monitor TV arrangement, and switches and control lever arrangement on the control desk for the ENGINEER's approval. The CONTRACTOR shall also submit the design of pole and the camera mounting for the ENGINEER's approval.



## DIVISION IV : TRAFFIC CONTROL CENTER

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## **DIVISION IV: TRAFFIC CONTROL CENTER AND STORAGE YARD**

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### **1.0 SCOPE OF WORK**

The CONTRACTOR is required to furnish materials, equipment and machinery and carry out all works, both temporary and permanent, for the modification of the existing rooms at the BMA Building to act as the Traffic Control Center and a power supply room; construction of an emergency power generator room; installation of a fire prevention and protection system, an emergency power supply system; a central air conditioning system; all internal furnishing work, electrical supply, lighting, plumbing, grounding and lightning protection as shown on Plans No.1401 to 1411. The CONTRACTOR is also required to carry out modification work at the space beneath the overpass over Bangkok-Yai Canal at Ratchadapisek Road to act as a storage yard.

### **2.0 CIVIL AND INTERNAL FINISHING WORK**

#### **2.1 GENERAL**

- (1) The CONTRACTOR will only be responsible for all the civil, electrical, plumbing and internal finishing work within the area indicated on the drawings as being the Control Room, Computer Room, Engineers' rooms, Traffic Police Officer's Room, Software Storage, Maintenance and Storage Room, Power Supply Room and Generator Room; and the Storage Yard.
- (2) The CONTRACTOR shall fit Free Access Floors throughout the area indicated. The flooring shall be of a type specifically designed for installation in the computer room and control room, having removable panels on adjustable supports. The material shall be fire resistant and anti-electric.
- (3) All cabling shall be concealed beneath the floor and the CONTRACTOR shall provide as built drawings showing the location of all such cabling.
- (4) The CONTRACTOR shall provide a suspended false ceiling throughout the accommodation. The suspension framework shall be of a metal construction with metal supports, and acoustic tiles shall be used to form the ceiling. Flush mounted light fittings shall be used. The design standard for lighting in the computer room and other working areas shall be 500 lux, but the lighting in the control room shall be designed

*Division IV : TCC and Storage Yard*

to illuminate the working surfaces and wall map, but not to cause glare and reflection. It is expected that a combination of spot/flood lights and fluorescent lights will be required.

- (5) The CONTRACTOR shall provide and install all internal partition walls necessary and shall construct them to a similar standard as the other walls in the building.
- (6) The internal surface of the walls shall be finished with vinyl wall paper. Windows shall be fitted with vertical aluminum blinds.
- (7) The accommodation shall be fitted with environmental control units specifically designed for use in computer accommodation. The units shall be capable of controlling temperature and humidity. The environmental control system shall conform to the following:
  1. Design shall be based upon a number of self contained units, such that an individual failure, or removal from service for maintenance shall still allow the temperature and humidity to be kept within suitable operational limits.
  2. The system shall be designed to feed air via the under floor cavity for distribution through perforated floor panels.
  3. A suitable chart recorder to record over one week temperature and humidity shall be provided.
  4. The system shall be designed such that the temperature within the center can be controlled to 22 degree centigrade +2 degrees and 50% humidity +5%.
- (8) For electric power feeding, the existing room beside the BMA co-op shop shall be modified to a power supply room. A transformer, CVCF and the necessary switchgear shall be furnished and installed in the power supply room. If the existing room doesn't have enough space to install such equipment, the CONTRACTOR should proposed to modify and enlarge the existing room and submit such proposal to the ENGINEER for his approval.
- (9) The CONTRACTOR shall design and construct a generator Room shown on Plan No.1405. A diesel engine and generator, batteries, battery charger and associated accessories shall be furnished and installed in the generator Room. A fuel tank which has a capacity to

continuously operate the generator for 24 hours shall be furnished and installed beside the generator room.

## **2.2 CONCRETE WORK**

### **(1) MATERIALS**

Cement to be used for concrete shall conform to the standards required by the BMA and all aggregate to be used shall be clean, hard, durable and shall be free from unacceptable quantities of thin or slender particles, organic matter or other deleterious matter. The use of admixtures shall be dependent on the written approval of the ENGINEER. Reinforcement steel to be used shall conform to standards required by BMA or as approved by the ENGINEER. Reinforcement steel shall be stored in a way that will prevent excessive rusting or contamination with grease, oil, dirt, and other objectionable materials.

### **(2) PROPORTION OF CONCRETE**

Concrete for building structures, equipment foundation and other structural members shall have a compressive cylinder strength at 28 days of at least 210 kg/cm<sup>2</sup> while concrete for other uses shall have a strength of at least 150 kg/cm<sup>2</sup>. Aggregate used for the concrete mix shall not exceed 25 mm in size.

The CONTRACTOR shall determine the concrete mix proportions and batch weights which shall be governed by the compressive strength of concrete considering the coefficient of variance of compressive strength. The coefficient of variance shall be selected by the CONTRACTOR to the approval of the ENGINEER, in consideration of the control conditions and capacity of the plants to be used in the work and the CONTRACTOR's experience. The concrete mix proportion shall be subject to the ENGINEER's approval.

### **(3) MIXING AND PLACING**

Concrete shall be mixed in a batch mixer of the type and capacity to be approved by the ENGINEER. Concrete shall only be placed after the inspection and approval of the ENGINEER on the form setting, reinforcement fixing, installation of underground facilities, treatment of the foundation or the surface upon which concrete is to be placed, clearing the section to be placed, and all the other necessary provisions for placing has been obtained.

*Division IV : TCC and Storage Yard*

Conveyance of concrete shall be done as rapidly as possible by methods that shall prevent segregation or loss of the ingredients, and shall be placed immediately. Even if placing of concrete is delayed under special circumstances, the period between the start of mixing and completion of placing shall not exceed one hour. During this time, concrete shall be protected from sun, rain, wind and other noxious matters, and shall be remixed without adding water before placing. Concrete which has partially hardened shall not be used. When segregation occurs during handling and placing, concrete shall be remixed to obtain the desired uniformity. Segregated coarse aggregate shall be placed into the wet concrete. Sufficient compaction of concrete shall be made during and immediately after placement by means of vibrators.

The surfaces of all joints shall be well chipped, brushed clean, washed before further concrete is placed. The roughing of the concrete for horizontal construction joint shall be carried out while the concrete is still green and not be done after it is set hard. Where structural continuity is required between the old and the new, the reinforcement in existing concrete shall be exposed, cleaned of adhering concrete with wire bush and properly spliced to new bars.

All exposed surface of concrete shall be covered with mats, sand or other suitable materials immediately after final finishing of the surface. These materials shall be kept thoroughly wet for the entire curing period. If forms are allowed to remain in place during the curing period, they shall be kept moist at all times.

**(4) SAMPLING AND TESTING**

Samples are to be taken from concrete as it is being delivered at the point of placement and tests carried out to determine its conformity to the strength as specified herein. Results of the testing shall be delivered to the ENGINEER for his approval.

**(5) FORMWORK**

Forms shall be of timber, plywood or other suitable materials sufficiently strong and shall conform to the shapes, lines and dimensions shown on the Drawings.

Surfaces of the form in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, groove, splits or other defects. The CONTRACTOR shall take full responsibility that the curing time has elapsed for the concrete to attain sufficient strength

before forms are removed. Nevertheless, the forms shall not be struck without the prior approval of the ENGINEER.

**(6) REINFORCEMENT**

All reinforcement shall be free of dirt, grease or oil and shall be placed accurately and secured. It shall be supported by suitable chairs or spacers or by metal hangers. When reinforcement has been placed and is ready for concreting, it shall be inspected and approved by the ENGINEER. The CONTRACTOR shall inform the ENGINEER, at least 24 hours in advance, of his intention to have the reinforcement ready for inspection. Splicing of reinforcement bars at tension zone of members shall be prohibited unless approved by the ENGINEER.

**2.3 STRUCTURAL STEEL WORKS**

The CONTRACTOR shall prepare all necessary shops drawings in appropriate scale showing all necessary details of structural steel work and submit to the ENGINEER for his approval.

**(1) FABRICATION**

Section of each material shall be cut perpendicular to axis unless otherwise directed in the Drawings. Automatic gas cutter shall be used for gas cutting, and a cut section shall be free of any noticeable defect or deformation.

**(2) WELDING**

Welding requirements shall conform to Thailand standard or equivalent as directed by the ENGINEER, using alternate or direct current type welding machines. Welding rod shall be always kept in a dry area and welding surface shall be free of water, scale or others which are injurious to welding work. Slag appeared on the creator surface in the middle of welding shall be cleaned before starting again. Injurious deformation left on welding material shall be corrected or reinforced.

**(3) HIGH TENSILE BOLT CONNECTION**

Holes for the bolts shall not be larger by more than 1.5 mm the nominal bolt diameter plus 1.5 mm, except those for M20 or smaller bolts which shall be 1 mm larger than the nominal bolt diameter or less. Deviation of the bolt holes from the alignment shall be adjusted by a mechanical reamer. Friction face shall be free of paint, oil, mill scale, rust, dust or others which are injurious to friction.

- (4) **ERECTION**  
Erection shall be orderly carried out by the method approved by the ENGINEER. All anchor bolts and anchor connections shall be installed to an accurate alignment and elevation in accordance with the ENGINEER's instructions. Temporary bracing or other reinforcement shall be placed to resist any loads during erection.
- (5) **SHOP PAINTING**  
Steel surfaces to be painted shall be free of any mill scale, rust, spatter, slag, oil, grease. Two coats of approved oil based anti-corrosive primer shall be applied without delay in accordance to the manufacturer's specifications.

#### 2.4 PLASTERING WORK

- (1) **MATERIALS**  
Cement and sand to be used for plaster shall conform to those as specified for concrete work. Sand to be used for base coat or under coat shall pass 100% through the 5 mm sieve, while that for the finish coat shall pass 100% through the 2.5 mm sieve. The mortar mix for plaster by volume of cement to sand shall be 1:2 for the base coat and 1:3 for the brown or finish coat. When lime is used, the proportion shall be 1:3:0.3.
- (2) **APPLICATION**  
The standard total thickness of plaster coats shall be 25 mm for floor, 20 mm for interior and exterior walls, and 15 mm for ceiling and eaves. Before plastering, deformation or unevenness on wall or floor shall be promptly corrected, backing or base coat shall be cleaned and wetted. Protection against cracking at joints of concrete, concrete blocks or bricks shall be properly secured to the approval of the ENGINEER. The finished surface shall be perfectly plumb or level as the case may be and without any bulge, runs or stains, except where otherwise specified.

#### 2.5 TILE WORK

- (1) **MATERIALS**  
Ceramic tiles shall conform to the standard quality requirement of BMA. The quality of cement and sand shall conform to those specified for plastering work. The proportion of mortar mix by volume of cement to sand shall be 1:3 for setting and bedding mortar; and 1:1 for joint filler.

**(2) SETTING**

Preparation for setting bed-levelling mortar shall be applied by cleaning, brushing, scrubbing or other appropriate manners. When mosaic tiles are laid on the wet mortar, their surfaces shall be tapped with wooden trowel until the mortar shows up in joints. Grout shall be applied to joints after the tiles have been set and cured for more than 24 hours. For wall tiles, a resin mixed mortar shall be applied to the under coat before the tiles are laid and pressed until mortar squeeze out of joints. All surfaces of tiles are to be cleaned with sawdust, cloth and further washed with water after the joint has been cured for more than a week.

**2.6 WOOD AND WOODEN DOORS**

Timber to be used for internal finishing works shall be of suitable kinds for the purposes designated on the drawing and/or specifications and available locally. Selection of timber shall be subject to the approval of the ENGINEER. All timber shall be well-seasoned, free from large knots, flaws, shakes or blemishes of any kind, treated with anti-insect chemicals and wood preservatives. Plywood to be used shall conform to Thailand standards or equivalent.

Wooden doors shall not be less than 40 mm. thick. The hardwares to be used shall conform to Thailand standard or approved equivalent and sample or catalogues shall be submitted to the ENGINEER for his approval.

**2.7 METAL DOOR AND WINDOW**

All steel doors, frames and aluminum window and hardwares shall conform to Thailand standard or equivalent. Sample or catalogues shall be submitted to the ENGINEER for his approval.

The CONTRACTOR shall prepare all necessary shop drawings in appropriate scale showing the details of the various parts, indicating the methods of anchoring and securing the work and the schedule listing the quantities of all doors and windows and its location, and submit to the ENGINEER for his approval.

Frame and casing of steel doors shall be jointed miter or abut and welded. Threshold shall be welded from back to the side frame with flashing while the sides and top frame of fitting shall be jointed miter and welded, splice jointed and welded or screwed or jointed abut and welded.



The joint and corner of aluminum window frames shall be properly and firmly rivetted screwed or welded and caulking shall be provided from back. All surfaces shall be provided with anodic oxidation coating (9 micron thick) and transparent paint film (7 micron thick) unless otherwise directed by the ENGINEER.

When installing, the frames shall be temporary set in designated position with wedges or other proper means. Where frames are to be fixed to concrete, concrete block or brick structures, the frame anchors shall be welded to the embedded anchors and the space between the frame and the structure shall be packed with 1:3 cement mortar unless otherwise directed by the ENGINEER. Where frames are to be welded to steel structures, the frame anchors shall be welded, screwed or clipped to steel frame without any damage to the steel structure. The spacing of welding, screwing or clipping shall be approximately 600 mm unless otherwise directed by the ENGINEER.

## 2.8 GLAZING WORK

All glaze materials shall conform to the Thailand standards or equivalent. All glass shall be correctly cut to approximately 1.5 mm less than the net dimension and inserted into the frame at least 5 mm or the thickness of glass plus 2 mm, whichever is the greater.

All glass shall be set in glazing mastic applied on all four sides continuously and using spacer shims and vinyl setting blocks at intervals recommended by the manufacturer except where glazing beads are used. All glass surfaces shall be cleaned at completion without applying any chemical agent.

## 2.9 ROOFING AND SIDING

Asphalt waterproofing shall be adequately provided for the roofing and flooring of the Generator Room as indicated in the Drawings.

The CONTRACTOR shall prepare all necessary drawings showing the details of the roofing including the methods of fixing, installation and securing work, and submit them to the ENGINEER for his approval.

## 2.10 FALSE CEILING

### (1) MATERIALS

Material for the false ceiling as indicated on the drawings shall conform to the BMA standard or equivalent. Light weight gauge steel shall be used for the ceiling frame while gypsum and calcium

silicate boards are to be used as ceiling board. The CONTRACTOR shall furnish samples or catalogues of ceiling materials, ceiling frame, screws, nails and adhesive to the ENGINEER for his approval. Shop drawings shall also be submitted showing the details of the various parts.

(2) **INSTALLATION**

The bolt-hanger shall be 9 mm diameter and welded to purlines unless otherwise specified in the Drawings. The main-frame shall be provided at every 900 mm and jointed to bolt hanger. Sub-frame shall be provided at approximately every 450 mm and jointed to main-frame. Ceiling frame around opening shall be reinforced in accordance with the Shop Drawings. Ceiling board shall be cut in size and planed as indicated in the Drawings. Ceiling board shall be installed flat with joints in line by nailing, screwing or adhesive.

**2.11 PAINTING**

(1) **MATERIAL**

The painting material to be used as specified in the drawings shall conform to the Thailand standards or equivalent. The CONTRACTOR shall submit catalogues and specifications of all paints to be used to the ENGINEER for his approval. The color, luster, color schedule, finish shall be subjected to the approval of the ENGINEER.

(2) **SURFACE PREPARATION**

Surfaces of cement plaster, gypsum board and calcium silicate boards to be painted shall be free of dirt or foreign matter and treated with anti-absorption agent (Synthetic emulsion sealer). Cracks or holes shall be damped and filled with synthetic emulsion putty. Depressions or indents shall be filled with cement filler or equivalent to smooth and even surface.

Steel surfaces to be painted shall be wiped clean of dirt, adhesives, and loose rust or other foreign matter shall be removed with scraper or wire brush.

Wooden surfaces to be painted shall also be free of dirt, oil, adhesives and foreign matters. Sap streaks shall be removed as appropriate by scraping if they are lumped in quantity or by wiping

with heated scraper and benzine. Plane marks, grain blistering or similar imperfections shall be smoothed with Sandpaper. Nail heads or other projections shall be hammered down or pulled out to leave an even surface. Cracks, holes, voids or dents shall be cleaned out and filled with zinc putty or synthetic resin emulsion putty.

**(3) APPLICATION**

Paint shall be evenly and uniformly applied on the surface. Areas of difficult application such as pointed part, internal angle, welded part, etc. shall be thoroughly painted and double coated as necessary to keep uniform coating thickness. Painting shall be properly done by carefully selecting the painting method by the shape of surface and types of paint. Painting shall not be carried out if the humidity exceed 85% or during raining days or if the painting surface is too hot. Generally, each type of painting shall be in accordance with the following standards unless otherwise directed by the ENGINEER.

Exterior Mortar

Material : Acrylic resin emulsion paint (AEP)

Application

- Surface sealing : Sealer for EP use (1 coat)
- Putting : Resin mortar putty (1 coat)
- Sandpapering : Once
- Sport Priming : AEP (1 coat)
- Prime coat : AEP 0.12 - 0.15 kg/m<sup>2</sup> (1 coat)
- Finish coat : AEP 0.11 - 0.14 kg/m<sup>2</sup> (2 coats)

Exterior Wood and Plywood

Material : Synthetic resin mixed paint (SOP)

Application

- Primer : SOP primer 0.13 - 0.15 kg/m<sup>2</sup> (1 coat)
- Primer coat : SOP 0.12 - 0.14 kg/m<sup>2</sup> (1 coat)
- Finish coat : SOP 0.12 - 0.15 kg/m<sup>2</sup> (2 coats)

Interior Wood and Plywood

- Material : Synthetic resin mixed paint (SOP)
- Application
  - Primer : SOP primer 0.13 - 0.15 kg/m<sup>2</sup> (1 coat)
  - Sandpapering : Once
  - Puttying : SOP putty (1 coat)
  - Sandpapering : Once
  - Prime coat : SOP 0.12 - 0.15 kg/m<sup>2</sup> (1 coat)
  - Sandpapering : Repeated twice
  - Finish coat : SOP 0.12 - 0.15 kg/m<sup>2</sup>, repeated twice

Steel

- Material : Synthetic resin mixed paint (SOP)
- Application
  - Primer : Oil based anti-corrosive primer 0.13 - 0.22 kg/m<sup>2</sup> (1 coat) to be coated at shop.
  - Primer coat : Oil based rust-inhibitive primer 0.12 - 0.22 kg/m<sup>2</sup> (1 coat) to be coated at shop
  - Finish coat : SOP 0.12 - 0.15 kg/m<sup>2</sup> (2 coats)

Steel Doors and Frames

- Material : Synthetic resin mixed paint (SOP)
- Application
  - Primer : Etch primer (1 coat)
  - Prime coat : Zinc chromate primer (1 coat)
  - Finish coat : SOP (2 coats)

2.12 METAL WORK

Metal products shall conform to Thailand standard or approved by the ENGINEER. The CONTRACTOR is to furnish sample or full-scale drawing of order-made product to the ENGINEER for his approval.

Dimension of inserts, anchor bolts, sleeves and other fasteners shall be suited for the purpose.

For products that are to be installed before concreting, the position of product or material shall be accurately marked and properly supported according to dimension and weight without obstructing other works such as form work. Level shall be checked and welded, bolted, rivetted or other means to secured. Proper attention shall be paid for replacement during concreting.

For those that are installed after concreting, fastener and other joiners shall be placed in position and at intervals strictly according to drawing and suitable for installation. Product shall be firmly installed in designated position by wedging, supporting-packing and other means. Inserted portion of fastener and other joiners shall be packed with mortar 1:3 volume mixture.

#### 2.13 FURNITURE

The CONTRACTOR shall furnish all internal furniture both built-in and movable, and accessories as indicated in the Drawings and the Schedule of Rates and Prices.

The Operators' chairs shall be fully upholstered and fitted with arms. The chairs shall be mounted on a swivel base and equipped with castors. Other office chairs shall be upholstered. Desks shall be constructed from rigid materials (other than sheet metal) and fitted with not less than three drawers, at least one of which shall be lockable. The desk top shall be a smooth, flat surface and approximately 1500 mm x 800 mm in area.

Filing cabinets shall be of the suspended folder type with not less than four drawers capable of storing A4 sized documents. The cabinets shall be lockable and provided with two sets of keys.

The CONTRACTOR shall submit for approval his proposals for storage of spare disc packs, system documentation, consumable materials etc.

#### 2.14 CAULKING

Caulking compound shall be of polysulphide base compound. The color shall be subjected to the ENGINEER's approval. Joint or space for caulking shall be free from dirt, cement paste, paint and other obstacles, and proper caulking gun shall be prepared to insert and compact

caulking material. Any agent shall not be added to caulking material to adjust consistency.

### **3.0 FIRE PREVENTION AND PROTECTION**

#### **3.1 GENERAL**

Both active and passive systems shall be provided at the Traffic Control Center for fire prevention, fire detection and fire extinguishing. To this end, the building shall be designed with a maximum of non flammable materials and systems provided to give automatic indication of fire detection coupled to automatic warning, alarms and extinguishing systems for controlling hazards without any human intervention.

#### **3.2 DESCRIPTION OF THE SYSTEMS**

##### **(1) PASSIVE SYSTEMS**

The passive systems are intended to prevent and/or confine potential fire hazards. For this purpose, the following requirements have to be observed:

- all construction materials shall be non flammable.
- walls and partitions of individual rooms inside the building shall be one hour fire proof.
- the main transformers in the 12 kV power supply shall be of the dry type.
- all openings in walls for pipes or cable crossings shall be adequately sealed with non flammable materials in order to preserve the quality of the fire proofing of the walls concerned.
- any windows fitted on a fire rated wall shall be armored and have the same fire rating as the wall itself.
- special care shall be taken to ensure proper and durable tightness of the floors slabs in order to prevent any possible water flooding and/or halon leak from one room to the other room below.
- escape routes and emergency exits will be clearly indicated and fitted with safety lighting fixtures.

(2) **ACTIVE SYSTEMS**

The main active systems will consist, depending on the allocations of the rooms, of either portable fire extinguishers or/and halon protection.

In addition, all VAC equipment shall be interlocked with the fire monitoring system in order to stop ventilation and air conditioning fans where a fire has been detected.

**3.3 PORTABLE FIRE EXTINGUISHERS**

ABC dry powder type portable fire extinguishers shall be provided against wood fires, oil fire and electric fires. Extinguishers shall be installed within 20 m from the equipment or machineries that are likely to cause a fire. All portable extinguishers shall be installed around 1.5 m high from the finished floor level with signs clearly posted to identify the location. The CONTRACTOR shall procure and install portable fire extinguishers as stated below:

- Reception Room                    1 bottle
- Living Room                        1 bottle
- Staff Rest Room                   1 bottle
- Traffic Police                      1 bottle
- Officer room/  
engineer's room(I,II)               2 bottles
- Software Storage/  
Maintenance & Storage            2 bottles

The CONTRACTOR shall submit drawings showing the exact locations of extinguishers to be installed for the approval by the ENGINEER.

The ABC dry powder portable fire extinguishers shall have the following characteristics and specifications:

- Powder drugs capacity :    3.0 kg
- Total weight :                about 5.3 kg
- Functional unit :             A-3, B-7, C
- Spray distance :             3 - 5 m
- Spray period :                about 14 seconds
- Effective temperature :    -20°C to +40°C

### **3.4 FIRE MONITORING AND HALON PROTECTION**

The CONTRACTOR shall install a fire monitoring and protection system consisting of installing smoke detectors, fire alarms, automatic halon 1301 release and automatic interlocking signal.

#### **(1) SMOKE DETECTION SENSORS**

Ionization chambers type detectors shall be provided to perform smoke detection within small volume rooms and cabinets while large rooms shall be fitted with optical infra-red smoke detection sensors.

Manual call points (glass break type) shall be located at strategic points in the building and major access paths. Identification boxes shall be provided to transmit all alarms to the local fire monitoring station.

#### **(2) HALON PROTECTION**

Halon protection system to be provided shall have an automatic release into rooms or cabinets Halon 1301. The design and installation of the halon 1301 gas automatic extinguishing systems shall be in accordance with the Thailand's fire fighting requirements or standards.

Cables for fire detection and interlocking signals shall be of the fire resistant type according to IEC 332.

The CONTRACTOR shall furnish cabling network plan and all accessories (horns, push buttons and others) to the ENGINEER for approval.

## **4.0 ELECTRICAL WORK AND POWER SUPPLY**

### **4.1 GENERAL**

Works to be carried out by the CONTRACTOR include furnishing and installing equipment for the main power supply system, an uninterrupted (emergency) power supply system, lighting and socket outlets, telephone and facsimile, grounding and lightning protections.

### **4.2 MAIN POWER SUPPLY SYSTEM**

The CONTRACTOR shall prepare the detailed design (including design calculation), and prepare execution drawings for approval by the ENGINEER. All the equipment and materials to be used for this system shall be of the dust proof type.



The CONTRACTOR shall furnish and install a main power supply system for the ATC System that is independent from the existing BMA building's power supply system. The MEA can supply directly 380 V and 220 V 50 Hz power up to 300 KVA without any devices. If the proposed total power supply for the ATC system exceeds 300 KVA, the CONTRACTOR shall furnish a transformer of suitable make and capacity for stepdown conversion of electrical supply from the main 12 kV power line to the required 380 V and 220 V 50 Hz. The installation at the Power Supply Room shall be carried out in accordance to the requirements or standards of the MEA.

The main power supply to each lighting distribution panel shall be of 3 phases 380 V/220 V 50 Hz. Power line for each equipment shall be 3 phases 380 V 50 Hz and 1 phase 220 V 50 Hz. For main feeder from the 12 kV power supply to each control panels and lighting distribution panels, voltage drop shall be less than 2%. For branch line from each control panels and lighting distribution panels to electrical equipment, voltage drop shall be less than 2%. Rated current of branch line breaker and minimum wiring size for each equipment shall conform to the design standards of BMA or Thailand.

#### **4.3 UNINTERRUPTED POWER SUPPLY SYSTEM**

The CONTRACTOR shall furnish and install an uninterrupted power supply (UPS) system to secure constant power supply to the TCC.

All the equipment in the TCC necessary for the continuous operation of traffic control system including a part of the air-conditioners shall be operable by the UPS system when a power failure occurs. The system shall have adequate reserve capacities to serve the whole system including expanding system in the future.

##### **(1) COMPOSITION**

The UPS system shall consist of a diesel engine, a power generator, a constant voltage/constant frequency device (CVCF), a battery charger, batteries, and an automatic transfer switch between commercial power line and the generator. A fuel tank, with a capacity large enough to operate the generator at least for 24 hours without refueling, and piping between the tank and the generator shall also be furnished and installed by the CONTRACTOR.

The Tenderer shall provide details of the UPS system including drawings of outline dimensions, structure, operation panels and

monitoring panels, and capacities of the generator, CVCF, batteries, battery charger in his Technical Proposal.

**(2) FUNCTIONAL REQUIREMENTS**

The UPS system shall conform to the following functional requirements:

- (a) Under the input condition of 220V plus 15% or minus 20%, 50 Hertz plus or minus 4% phase 3 wire AC, output tolerances of the UPS shall be as follows.
  - Rated voltage: 220 V plus or minus 2.0% or less
  - Rated frequency: 50 Hz plus or minus 1.5% or less
  - Waveform distortion factor: 8% or less
  - Instantaneous voltage fluctuation: plus or minus 10% or less
- (b) The engine shall automatically start and reach a steady state within 5 minutes after power failure.
- (c) The CVCF shall be of a full wave type and its efficiency shall be 70% or more. The Tenderer shall propose the method of load balancing of the CVCF.
- (d) The battery shall provide power to the CVCF. The battery shall have a capacity to provide 180 to 250 V DC power to the load for 15 minutes for all equipment except the air-conditioners.
- (e) The battery charger shall be able to supply DC power necessary to charge the batteries from the input power of 220 V plus 15% or minus 20%, 50 Hertz plus or minus 4% 3 phase 3 wire AC.

**(3) DESIGN REQUIREMENTS**

The UPS system shall conform to the following design requirements:

- (a) The engine shall be a water-cooled diesel engine using light oil fuel.
- (b) The generator shall be an AC generator.
- (c) The CVCF shall be of a non-break and static type. The inverter of the CVCF shall utilize a thyristor. The Tenderer shall state the type of battery, its quantity and the number of electrolytes in each battery cell, to be used for the UPS.

**(4) INSTALLATION**

(a) The engine and the generator shall be mounted on a channel base with vibration absorber and placed on a concrete bed. An opening with a steel grill shall be constructed on the wall facing the radiator and an air duct shall be provided between the opening and the radiator.

(b) The engine shall be equipped with an exhaust pipe to emit exhaust air from it. The pipe shall be lead to the outdoor through a hole drilled on the wall of the building.

**(5) OPERATION AND MAINTENANCE**

The Tenderer shall describe the detailed requirements for maintenance of the UPS system including intervals, check items and periodic replacement of components in his Technical Proposal.

**(6) FUEL TANK**

The CONTRACTOR shall furnish and install a fuel tank of adequate capacity beside the generator room. The fuel tank shall be shielded in a concrete wall to avoid accidents.

**4.4 LIGHTING SYSTEM**

**(1) GENERAL**

The CONTRACTOR shall prepare the detailed design (including design calculations), execution (working) drawings and as-built drawings for the lighting provisions in the TCC. The CONTRACTOR shall carry out all test and inspections for this system in accordance with the requirements for electrical works in Thailand and the test and inspection results shall be submitted to the ENGINEER.

The CONTRACTOR shall procure all equipment and materials and carried out all installation works for:

- All indoor lighting fixtures including outlet boxes, switchboxes, etc.
- Cabling, wiring and electrical conduit with necessary fittings and accessories from lighting distribution panels (use together with socket outlet system) to lighting fixtures.
- Necessary mounting materials and related works such as painting and bonding of electrical conduit, etc.

**(2) ILLUMINATION LEVEL OF LIGHTING FIXTURES**

Required average illumination level for rooms in the TCC shall in principle be:

- control room : 500 lx on the floor
- computer room : 500 lx on the floor
- reception room : 500 lx on the desk
- living room : 500 lx on the desk
- engineer's room  
(I,II)/Traffic Police  
Officer's room : 500 lx on the desk
- software storage : 500 lx on the desk
- maintenance and  
storage : 500 lx on the floor

The types of lighting fixtures shall be of those specified herein.

- control room/ : fluorescent lamp with reflection shade  
computer room (FL 40 W x 2)
- reception room/ : fluorescent lamp, bottom open recessed type  
living room (FL 40 W x 2)
- engineer's room (I,II)/  
traffic police officer's room : fluorescent lamp, bottom open  
recessed type with louvers  
(FL 110 W x 2 or EL 40 W x 2)
- software storage/ : fluorescent lamp exposed V type  
maintenance & (FL 40 W x 2)  
storage

**(3) ILLUMINATION LEVEL OF EMERGENCY LIGHTING FIXTURES**

The required illumination level shall be:

- control room, computer room, reception and living room, engineer's room (I,II) and the traffic police officer room, broadcasting room : 1 lx on the floor
- software storage, maintenance and storage room. : 2 lx on the floor

The type of emergency lighting fixtures shall be:

- control room and computer room : incandescent lamp Mini IL 40W x 1, pp
- reception room and broadcasting room : incandescent lamp 40 W x 1 suited in fluorescent lighting fixture
- software storage, maintenance & storage room : fluorescent lamp 40 W x 1 (one lamp out of two shall switch on when power fails)

Emergency lighting fixtures shall have enclosed batteries and they shall always be charged by common circuits. When the power failure occurs, power shall automatically changes over from common circuit to the battery circuit.

**(4) ELECTRICAL SYSTEM**

The electrical system for the lighting fixtures in the TCC shall be:

- For fluorescent lamp over 40 W: 1  $\phi$  2 W 220 V
- For fluorescent lamp less than 40 W: 1  $\phi$  2 W 220 V
- For emergency lighting: 1  $\phi$  2 W 220 V

As for common lightings, one (1) switching circuit shall be sized for 6 A as a maximum.

**(5) EMERGENCY GUIDE LAMPS**

Emergency guide lamp shall be provided at exits, corridors and stairs to facilitate evacuation in case of emergency.

Emergency guide lamps shall also have enclosed batteries and power shall automatically be changed from common circuits to battery circuits when the power failure occurs.

Circuits of emergency lighting for control room and computer room and all guide lamps shall in principal be distinct, and shall have no switching circuits. Branch CB in lighting distribution panel shall be used as switches. In case switches are fitted to emergency lighting circuit, batteries enclosed in emergency lighting fixtures shall always be charged.

#### **4.5 SOCKET OUTLET SYSTEM**

The CONTRACTOR shall prepare the detailed design (including design calculations), execution (working) drawings and as-built drawings for the socket outlet system required at the TCC. The CONTRACTOR shall furnish all materials and execute all works such as wiring, cabling and grounding for installing the system including all tests and inspections necessary in accordance with the requirements and standards of BMA or Thailand. The test and inspection results shall be submitted to the ENGINEER.

The socket outlet system shall be provided in two electrical wiring systems of 1 phase 2 wires 220 V 50 Hz and 3 phase 2 wires 380 V 50 Hz in order to satisfy the electrical power supply requirements of various equipment at the TCC including computer equipment such as CPU, Line Printer, Monitor Display.

Both 380 V/220 V socket outlets shall be provided to places where electrical apparatus are to be used and the numbers, positions and capacities shall satisfy the functional requirements of the TCC.

All the equipment and materials to be used for this system shall be of the dust proofing type. 1 phase 220 V and 3 phase 380 V socket outlets shall be fitted in the same panel with necessary circuit breakers. 3 phase 380 V and 1 phase 220 V socket outlets shall be of 4 poles and 3 poles respectively with 1 pole for grounding.

The height of socket outlets shall in principle be 300 mm above the finished floor level in all rooms in the TCC.

All socket outlets shall have their own grounding wire in the same power line conduit.

#### **4.6 TELEPHONE AND FACSIMILE**

The CONTRACTOR shall conduct the detailed design and prepare the execution (working) drawings and as-built drawings. The CONTRACTOR shall furnish all materials, equipment and install all telephones and facsimile as specified including the necessary wiring, cabling terminal boxes and carry out necessary tests and inspections including commissioning in accordance with the requirements or standards of BMA or the Telephone Organization of Thailand.

Individual conduit pipe for wiring of both telephone and facsimile shall be provided. In case pull boxes are used for both telephone and facsimile, steel partitions shall be provided. All cabinets, terminal boxes and conduit pipes shall be grounded in accordance with the requirements described above.

The number and location of telephones and facsimile equipment shall be:

- Control Desk : 2 sets of telephone handsets with same 5 lines and 1 facsimile
- Engineer's Room (I,II) : 1 Telephone
- Reception Room : 2 telephones and a facsimile
- Living Room : 1 Telephone
- Traffic Police Officer Room: 1 Telephone
- Staff Rest Room : 1 Telephone
- Broadcasting Room : 1 Telephone
- Software Storage : 1 Telephone
- Maintenance & Storage : 1 Telephone

#### **4.7 GROUNDING SYSTEM**

The CONTRACTOR shall prepare the detailed design, the execution (working) drawings and as-built drawings, including the measuring of the soil resistance ratio and submit to the ENGINEER for approval.

The CONTRACTOR is required to furnish all materials and equipment that conform to the requirements or standards of BMA or Thailand and carry out all works to provide the necessary grounding including tests and inspections.

A grounding terminal box shall in principle be provided in 12 kV power supply. Both body and plate of the grounding terminal box shall be made of bronze finished with white bronze. Grounding wire shall in principle be of PVC wire and bare rope grounding wire shall be of soft copper twisted wire sized more than 50 mm<sup>2</sup>, and shall be provided around Traffic Control Center with two (2) or more grounding points by copper plate.

#### **4.8 LIGHTNING PROTECTION**

The CONTRACTOR shall prepare the detailed design, the execution (working) drawings and as-built drawings for the required lightning protection and furnish lightning rods, conductors, terminal boxes, grounding plates and all other accessories necessary and install them at the TCC. All materials and design shall conform to the requirements or standards of BMA or Thailand.

The protected angle for the lightning arrestor shall be:

- Building more than 20 m height: 60 degree
- Dangerous materials storehouse: 45 degree
- The lightning conductor shall be of soft copper twisted wire sized more than 38 mm<sup>2</sup>.

It shall be less than 10 ohm as total. In case the conductor is grounded individually, it shall be of less than 5 ohm. The connection between the structural steel and the grounding conductor shall be done by mean of thermal welding or other similar means. when the welding is exposed it shall be protected by coating with anti-corrosive paints. The measuring results of the grounding resistance shall be furnished to the ENGINEER by the CONTRACTOR.



## **5.0 PLUMBING AND AIR CONDITIONING WORK**

### **5.1 GENERAL**

Works to be performed by the CONTRACTOR shall consist of calculating the capacity of the air-conditioner based on the power consumption of the equipment at the TCC, building design and other factors which will affect the design; furnishing all labors, materials, equipment, tools and incidentals and performing operations required to complete the works including but not limited to the following.

- (a) General requirement for Mechanical works
- (b) Piping
- (c) Plumbing fixture
- (d) Air conditioning and ventilation equipment
- (e) Shop drawing
- (f) Contractor's testing and reporting
- (g) Inspection
- (h) Protection and cleaning
- (i) Miscellaneous, including hangers, supports, sleeves, and required accessories for complete installation.

### **5.2 VENTILATING AND AIR CONDITIONING WORK**

Air conditioning units shall be air-cooled split type as indicated in the Drawings and Schedule of Rates and Prices. The conditioned air shall be supplied to each room directly under the access floor from the air conditioner. The indoor condition to be maintained by the air-conditioning system shall be 22°C plus and minus 2°C in DB with a humidity of 50% plus and minus 5% throughout the rooms.

Ventilation fans to be used shall be the axial flow fan and propeller fan as indicated in the Drawings. All joints must be tight and all audible leaks properly sealed.

External weather louvers for intake or exhaust shall be constructed from steel and all surfaces shall be painted with prime and finish paint. The dimension of louver for mounting in the building structure shall suit the concrete block or brick modules and shall be fixed to a hardwood frame.

Refrigerant pipe work shall be shown in the CONTRACTOR's furnished drawings. Refrigerant pipe system shall be complete with all support, fixings, fittings, insulation, paint and all other components and/or other related work to ensure a complete installation. All pipes shall be appropriately insulated

with vapor barriers and those that are exposed to the weather shall be insulated with weather proof materials. Vapor barriers shall be continuous and unbroken over the surface of the piping fittings and equipment. The final finish of insulated pipe of 25 mm or less shall be at least 30 mm, while that for pipes up to 32 mm shall not be less than 40 mm. Outdoor and roof insulation shall be protected by covering with wire mesh and two coats of cement plaster to a final thickness of not less than 20 mm. Vapor barrier shall be wrapped with polyvinyl chloride sheet prior to applying plaster to prevent direct contact between plaster and vapor barrier.

### **5.3 PLUMBING WORK**

The CONTRACTOR shall complete the plumbing work in accordance with the specifications and Drawings.

## **6.0 MISCELLANEOUS**

### **6.1 MIRRORS**

Mirrors shall be located above each wash basin in the Living Room and Reception Room. The size shall be 450 mm width x 600 mm height and 5 mm thickness. The mirrors shall be firmly secured with screw using rubber washers.

### **6.2 SEALING AND CAULKING**

The CONTRACTOR shall, at his good judgement, execute sealing or caulking works at places where penetration of rainwater, wind, sand or dust is expected. Plastic sealing materials as well as oil caulking materials shall be employed for setting glass, filling joints, etc. These sealing materials shall be subject to the directions of the manufacturer as to the composition of the base and hardener. Sealing and caulking shall be carried out, as a rule, prior to finishing works such as spraying. In case sealing and caulking should be done after the completion of finishing works, curing with tape shall be carried out so as to prevent the sealing agent from spilling over the joint. After the base treatment, a primer is applied; however, it shall not be applied to 'back-up' materials or bond-breakers. A period of 30-60 minutes shall be allowed after primer application before sealer filling commences.

## **7.0 STORAGE YARD**

### **7.1 WORK FOR THE STORAGE YARD**

The CONTRACTOR shall submit drawing indicating the civil work to be carried out at the specified space beneath the overpass over the Bangkok-Yai Canal at Ratchadapisek Road to the ENGINEER for approval. The storage yard shall be of at least 300 sq.m in usable area.



