STATE OF NEW JERSEY
DEPARTMENT OF TRANSPORTATION
TRENTON, NEW JERSEY 08625

METRIC SPECIFICATIONS FOR A CLOSED LOOP SYSTEM ON-STREET MASTER

N. J. Specification No. EBM-OSM-1 Effective Date: July 1, 2001

New Jersey Department of Transportation Specifications for a Microprocessor Based, Closed Loop System On-Street Master.

The purpose of these specifications is to describe minimum acceptable design and operating requirements for a microprocessor based, closed loop system on-street master.

GENERAL - I

1-1 The on-street master shall consist of a digital microprocessor based unit, modem, fiber optic interface, printer and other miscellaneous equipment in a complete and fully wired in a traffic signal controller aluminum weatherproof cabinet provided under the controller item of the contract. Serial numbers for master shall be engraved into the frame of the unit.

1-2 For the purpose of these specifications, a system is defined as a group on intersections under the control of an on-street master. However, in contracts to which these specifications apply which contain more than one master, the word "system" will be used to describe the operation of each subsystem in the contract.

1-3 The system shall consist of the following:

A. An operator, maintenance, and engineering console in conformance with the current New Jersey Department of Transportation Specification No. EBM-OC-1, No. EBM-MC-1, and No. EBM-EC-1 respectively.

B. An on-street master in conformance with these specifications.

C. Local controller assembly in conformance with the current New Jersey Department of Transportation Specification No. EBM-TSC-8CL.

D. Communication link, operation and software in conformance with the current New Jersey Department of Transportation Specifications No. EBM-CL-1 and No. EBM-CL-2.

1-4 The on-street master if required in the contract to which these specifications apply shall operate with a Multi-Arterial System. The system will conform with the current New Jersey Department of Transportation Specification No. EBM-MATS-1.

1-5 The complete on-street master shall conform to the requirements of current NEMA Standards No. TS-1 sections 1, 2, 5, 6, 8, 13, 14 and 15, except as amended and

supplemented hereinafter. The manufacturer must supply certification by an independent technical laboratory as to equipment compliance with NEMA environmental standards in accordance with NEMA testing procedures.

1-6 Materials not specifically covered in these specifications shall be in accordance with the accepted standards of the National Electrical Manufacturers Association, The Underwriters Inc., The National Electrical Code, and the American Society for Testing and Materials.

DEFINITIONS - II

2-1 The NEMA Standards referred to in this specification shall be the current NEMA Standards Publication No. TS 1 entitled "Traffic Control Systems". All terms not defined in these specifications shall be as defined in Section 1 of the NEMA Standards.

2-2 Event time is the hour and minute of a 24 hour day. The function shall start at the first second of the minute assigned.

2-3 Day event is turning on or off an output circuit at a specified time. This output need not be external to the controller unit but its effect is the same, the controller will initiate the proper action.

2-4 Coordination plan shall be composed of a programmed cycle length, offset and cycle split.

2-5 Day program is any combination of day events. These events specify which coordination plan is selected.

2-6 Week program is any combination of seven day programs.

2-7 Year program is any combination of fifty-two week programs.

2-8 An exception day shall override the normal day program and utilize a specified day program.

ON-STREET MASTER AND WIRING HARNESS - III

3-1 A metal dust proof case suitable for shelf mounting shall be provided to house the master unit. It shall be completely equipped and wired to provide the specified operation.

3-2 The on-street master unit shall be microprocessor based.

3-3 The on-street master unit shall be furnished with programmable read only memory (PROM) with permanent control program RAM, EEPROM, or nonvolatile RAM shall be used to store program variables and sampled real time data.

3-4 Operator programmable data entry shall be accomplished by the use of keyboard mounted on the front of the on-street master. Time-of-day, day-of-week and week-of-year data entry shall also be accomplished with the keyboard.

3-5 A menu driven format shall be utilized. The menu format shall preclude the need for programming cards or tables. All data shall be entered utilizing the keyboard supplied on each on-street master.

3-6 All ROM's, EEPROM's and nonvolatile RAM's shall be installed in IC sockets. As an alternate, IC's that contain software programming may be installed without sockets if the IC's are installed on a removable card. If a card is utilized, one spare card shall be provided with the first unit supplied under each contract or proposal to which this specification applies. One additional card shall be provided with every five units supplied thereafter under each contract.

3-7 The maximum DC voltage generated within the on-street master unit shall not exceed 50 volts.

3-8 Extender boards must be available for use with the on-street master, and will be required to be supplied with this bid. One set of extender boards will be supplied with the first master supplied and an additional board with every fifth unit.

3-9 A programmed diagnostic package must be available for use with the on-street master unit, a programmed diagnostic package will be supplied with the first unit supplied under each contract or proposal to which this specification applies. An additional programmed diagnostic package will be provided with every five on-street master units supplied thereafter under each contract, to a maximum of five programmed diagnostic packages. This diagnostic package must be supplied for demonstration and testing prior to approval of manufacturer's unit. The program must be capable of checking all software control programs, ROM's, EEPROM's, Processor, RAM's and localizing defective circuit components. All internal wiring, connections and integrated circuit socket for the diagnostic chip must be furnished and installed in on-street master unit for immediate use.

3-10 A 25 pin RS- 232C connector for the printer port shall be provided for interconnecting to a printer. It shall transmit (data, letters, headings, etc.) to a printer at 1 200 baud. The printer shall be able to receive ASCII coded data. All on-street master unit operational data, coordination program data, system data, and reports shall be transmitted to the printer. The unit to printer transmissions shall may interrupt normal interconnect operation.

3-11 Total solid state circuitry shall be employed in the controller unit. All components shall be identified by the industry standard except manufacturer's LSI Devices.

3-12 Liquid crystal displays shall be utilized. The display shall have a backlite for viewing at night. Incandescent indicator lights are not acceptable. As a minimum, the model number and software version shall be displayed.

3-13 All programmable functions shall be performed by keyboard. No foil deletions will be permitted to achieve any programming requirements.

3-14 A lithium or NiCad battery shall be provided for the quartz controlled clock.

3-15 Connectors shall be provided for interconnecting all inputs and outputs with their external control circuits. The open ends of the conductors shall terminate with vinyl insulated spade type terminal lugs which shall be individually labeled or identified. The spade ends shall be attached to 30 amp barrier type terminal blocks but no connection shall be made to any of the other equipment in the cabinet. A separate panel shall be provided for these terminal blocks.

3-16 The on-street master shall be designed for use on nominal 120 volt, 60 hertz single phase alternating current. It shall conform to NEMA TS1-2.1.2 and 2.1.3.

3-17 All DC inputs shall conform to NEMA TS1-13.2.3

3-18 All DC outputs shall conform to NEMA TS1-13.2.4

3-19 With power applied, the timing of the on-street master shall relate directly to the line frequency. In the event of power failure, accuracy for the time-of-day, day-of-week, week-of-year clock shall be maintained to ±0.005% or better.

3-20 The unit shall conform to all applicable portions of the Environmental and Operating Standards as described in the NEMA Standards TS1-1989, Part 2.

3-21 A surrestor shall be installed for all copper interconnect lines. The surrestor shall comply with the following specifications:

Peak Surge Current: 10 kiloamps (8 X 20 microsecond waveshape)
Occurrences at 2 000 amps: 50 typical
Response Time: < 5 nanoseconds
Voltage Clamp: 8, 12, 20, 30, or special
Series Resistance: 24 ohms total
Operating Temperature: -40 °C to +85 °C
Primary Protector: Three element gas tubes, 10 kiloamps, 8 X 20 microsecond, per side
Secondary Protector: Solid Sate Clamps, 1.5 kilowatts minimum

All components, circuits and accessories considered necessary by the manufacturer to adequately protect the controller assembly and associated equipment from damage due to voltage surge shall be furnished. All devices shall be readily accessible for ease of replacement and not mounted behind any panel or enclosure.

TRAFFIC RESPONSIVE MODE - IV

Traffic responsive operation shall be controlled by the on-street master using traffic volume and occupancy data from the system sampling detectors located throughout the system.

4-1 System Counting Detectors - Each of the counting detectors shall be configured as a volume detector, and not assigned to the calculation process.

The local intersection controller shall preprocess the detector data. The on-street master shall sample the preprocessed detector data in intervals not to exceed once per second. There shall be a data buffer for each detector, of the total of 90 buffers as specified hereinafter.

4-2 System Sampling Detectors - Each of the system sampling detectors shall be capable of being configured as both a volume and an occupancy detector, and assignable to the calculation process for each parameter of cycle, offset, and/or split. The local intersection controller shall preprocess the detector data, at an interval not to exceed once per second. The on-street master shall sample the preprocessed detector data in intervals not to exceed once per second. There shall be three data buffers for each detector, one for volume, one for density and one for speed, for a total of 90 buffers.

4-3 Detector Accumulation and Weighting - Each system sampling detector buffer shall be assignable to any of 30 accumulators associated with each of the three parameters to be calculated, i.e., cycle, split and offset for a total of 90 accumulators. Sampling periods for each type of accumulator (cycle, split or offset) shall be adjustable between the limits 10 seconds to 15.0 minutes in increments of one (1) second. An additional set of sampling periods shall be provided and implemented via activation of an external command. The additional set of sampling periods shall have the same adjustable increments as the system sampling periods.

Sampling periods for the detector accumulators may, as an alternate to the above, be based on a cycle by cycle basis variable from 1 to 15 cycles or a minute to minute basis variable from 1 to 15 minutes.

A weighting factor shall be assignable for each accumulator to indicate its 100% value. The range of volume accumulators shall be 100 to 4 800 Vehicles Per Hour (VPH) in 100 VPH increments. The range of the occupancy detectors shall be 10 to 300 Vehicles Per Kilometer (VPKM) in 10 VPKM increments.

4-4 Computation Process - It shall be possible to select the method for which the accumulated values (percentages) are ultimately compared with the threshold settings. Each calculation for the selection of cycle, split and offset shall be made independently. For each process, it shall be possible to select the average, highest or total (A, H, or T) for each consecutive group of four accumulators.

4-5 Cycle Selection - After the A, H, or T is assigned for the four groups of accumulators, these four resulting values shall be processed further by selecting the average, highest or total of these four. The exponential smoothing process shall then be applied to this resulting percentage and compared with preset thresholds to select a cycle level.

4-6 Split Selection - After the A, H, or T is assigned for the four groups of accumulators for the split calculation, each of two groups of these four shall be processed further to select the average, highest or total resulting in two percentages (percent "Highway" and percent "Cross St."). The exponential smoothing process shall then be applied to these percentages and compared with preset thresholds to determine a "Highway" split level and a "Cross St." split level. These levels shall then be processed through a split matrix which shall select the specific split to be implemented.

4-7 Offset Selection - The process for offsets shall be identical to that for splits in that two offset percentages will be generated (inbound offset and outbound offset) and an exponential smoothing shall be applied to each percentage.

The calculation of the offset selection shall be based on a proportional difference between inbound and outbound compared with a preset threshold.

4-8 Smoothing of Data - An exponential smoothing factor shall be included to allow the calculations to be adjusted as each sampling period is completed.

There shall be two selectable values of the factor, each settable between the range 0.1 and 1.0. The selection of the alternate factor shall be via an external input. The value one (1) shall be used for the first six minutes following a power interruption exceeding 500 to 1 000 milliseconds or upon initial application of power.

4-9 Output Filter - An output filter shall be provided to filter out unwanted combinations of cycle, split and offset. The output filter shall allow any input combination of cycle, split and offset to develop any other combination of cycle, split and offset.

4-10 As an alternate to paragraphs 4-3 through 4-9, the on-street master shall be capable of accumulating the detectors in 12 detector sets, each containing a programmable combination of primary detectors and alternate detectors. Weighting factors for each detector shall be selectable from 0.05 to 10.0. The detector sets shall be programmable as volume, occupancy, speed, density, or volume plus weighted occupancy, and detector sets. The results of these 12 detector sets are then compared to a plan selection chart which will be selected from a plan matrix. Each plan then shall be implemented by the local controller.

4-11 Printout Capability - The on-street master shall have the capability of outputting data to an printer, system status and information stored in memory. A portable printer shall be provided for this function, for each on-street master. The printer as a minimum shall have a 254 millimeter carriage and a print rate of eighty characters per second. The printer shall have a minimum of a 14 pin print head and the printer shall be suitable for field use. Current operational data shall also be capable of being printed out at a programmed time interval adjustable from 5 to 60 minutes in 5 minute increments. The data shall include the following:

A. Cycle, offset and split in effect

B. Mode of operation (traffic responsive, time of day, manual, slaved

C. Parameters selected via the output matrix and split matrix

D. Percentages computed for cycle, offset, and split and the level selected for each

E. Intermediate percentages calculated based on the average, highest, or total as programmed

F. Detector data associated with the volume accumulators

4-12 Detector Failure - A detector failure routine shall be incorporated in the on-street master to determine if any of the 30 system sampling and counting detectors are operating outside of their programmed limits. The upper and lower limits for each detector shall be capable of being set independently. In the event a detector operates outside its limits for one sampling period, that detector shall be removed from the computational routine. If the detector returns to operation within the prescribed thresholds, it shall be returned to the computational routine. In the event that more detectors fail than are allowed by a programmable value, the on-street master shall place the system in backup operation. The backup operation will allow each intersection to revert to its time base operation.

To prevent unwarranted detector failure logging, a means shall be provided to reduce the lower threshold limit to 0 by means of external command.

A system log shall be kept that contains the time any detector is logged in or out of service.

TIME OF DAY (TOD) MODE - V

The on-street master shall have capability of implementing time of day, day of week and week of year control using an internal clock that follows the AC line frequency.

5-1 Cycle, Split and Offset Control - The cycle selection, split selection, and offset selection shall be individually and independently controlled by the time clock when that particular function is enabled by a TOD command. It shall be possible to control either one (1), two (2) or three (3) of these functions by TOD while, at the same time, controlling the remaining traffic functions by traffic responsive control.

5-2 Time Clock - The time clock shall be resident in the on-street master and have the following minimum capabilities:

A. 200 Events

B. 15 Day Programs
C. 8 Week Programs

D. 1 Year Program

E. 35 Exception Days

F. Daylight Savings Time Adjustment

G. Holiday Adjustment

H. Catch-up Routine

I. Four Auxiliary Outputs

Cycle changes shall be made at the end of the current complete cycle. The catch-up routine shall be such that in the event of a power failure greater than 1 000 milliseconds, the outputs shall be in the same condition as if there were no power failure. The time clock shall be based on 52 week year and all control commands shall be configured from events made into day programs which are part of a week program.

The time clock shall have the capability of maintaining accurate time in the event of the loss of 60 hertz as a time reference or in the event of a loss of power to the clock module. The carry over power capability shall be for a minimum of 60 days.

5-3 As an alternate to paragraph 5-2, The time clock shall be resident in the on-street master and have the following minimum capabilities:

A. 9 schedulers each with 32 events with day of week for each event.

B. Any of the 9 schedules can be called any day of the year.

C. Daylight Savings Time Adjustment

D. 32 Exception Days

Cycle changes shall be made at the end of the current complete cycle. The catch-up routine shall be such that in the event of a power failure greater than 1 000 milliseconds, the outputs shall be in the same condition as if there were no power failure. The time clock shall be based on 52 week year and all control commands shall be configured from events made into day programs which are part of a week program.

The time clock shall have the capability of maintaining time within ± 0.005% time in the event of the loss of 60 hertz as a time reference or in the event of a loss of power to the clock module. The carry over capability shall be for a minimum of 60 days.

5-4 Remote Reset Capability - The time and date of the on-street master shall be resettable from the operator and/or maintenance console. The on-street master shall have the capability to download the time and date into each local intersection controller or control unit. It shall also be possible to re-synch all local intersection clocks from the clock in the on-street master when required by the consoles. This re-synch operation shall automatically occur at midnight or resynch may be programmable another time of day. The clock reset shall also conform to the requirements of Paragraph 6-1 for operation of the contiguous system control mode.

CONTIGUOUS SYSTEM CONTROL MODE - VI

6-1 The system shall have an alternate mode of operation where by coordination is established between contiguous systems. These feature shall be used to allow the coordination of a number of systems. Synchronization of the on-street masters shall be a function of software and not hardware. Each on-street master in this mode of operation shall backup the local intersection clocks at least every fifteen minutes.

CROSS ARTERIAL SYNCHRONIZATION - VII

7-1 The system shall have an alternate mode of operation whereby both the cycle selection and synch pulse originate from an external source to provide coordination between two independent on-street masters located on crossing arterial systems. The coordination shall be established through the common intersection of both systems in order to maintain coordinated traffic flow along each of the arterials simultaneously. The synchronization shall be enabled by a time of day function. To prevent oscillation this mode of operation shall be "lock-in" for a programmable period.

TRAFFIC INCIDENT MANAGEMENT CONTROL MODE - VIII

8-1 The system shall have an alternate mode of operation that allows for defining system criteria for implementation of system operation plans in response to traffic incidents. This operation shall be executed as a result of combinations of detector thresholds, speed monitoring and time of day. When the detection criteria is met, the master controller shall generate a message at the operator console locating the master controller node, and execute a batch file associated with its identity. The master shall also turn on a special function (i.e., actuate a CCTV camera) when the timing plan is implemented.

MANUAL CONTROL MODE - IX

9-1 Manual control shall be accomplished through the on-street master keypad. The controls shall, as a minimum, include the following:

A. Control of backup program copy operation

B. Control to load, alter or read data

C. Control to restart program

D. Control to clear memory in computer memory or time clock

E. Control to manually select cycle, split and/or offset

F. Control to initiate catch-up routine

G. Display on/off via keyboard command

H. Print control to allow individual and both printing of time clock and/or on-street master information

SYSTEM CONTROL MODE - X

10-1 The on-street master shall be controlled from the operator, maintenance, and/or engineering console via the dial-up modem communications link. The system control shall, as a minimum, include the following:

A. Print control for local intersection information or of both clock and master information

B. Control of a system wide sync

C. Control of backup program copy operation

D. Control to load, alter or read data

E. Control to restart program

F. Control to clear memory in computer or time clock memory

G. Control to manually select cycle, split and/or offset

H. Control to initiate catch-up routine

10-2 When the on-street master is used in a closed loop system in conformance with the current New Jersey Department of Transportation Specification No. EBM-CL-2 the requirements of the above paragraph shall be accomplished as follows:

A. Control of the on-street master from the operators console shall be through the fiber optic communications link.

B. Control of the on-street master from the maintenance and engineering consoles shall be through the operators console using dial-up modems or the operator console network.

PREEMPTION CONTROL MODE - XI

11-1 The system shall have capability of implementing preemption control of the system, subsystem or intersection. The control shall allow the system to receive a preemption status from a local controller and shall cause the system to implement a preemption timing plan. The preempt shall include a high level preempt for railroad and emergency vehicles. In addition a low level preempt shall be provided for bus and transit vehicles.

PRIORITY OF CONTROL - XII

12-1 The order of priority of control from the highest to the lowest is as follows:

A. Manual Control (from the on-street master)

B. Manual Control (from the operator, maintenance, and/or engineering console)

C. Time Clock Control

D. Contiguous and Cross Arterial Control

E. Detector Fail Control

F. Traffic Responsive Control

SYSTEM REQUIREMENTS - XIII

13-1 Security Code - A security code capability shall be included in the on-street master. This code shall prevent any change to the data or to the mode of operation unless the current security code is first entered. The security code access shall be automatically rescinded after a period of time greater than 30 minutes. A means shall be provided to change or to remove the security code protection.

13-2 Back-Up Programming - It shall be possible to copy a backup program from a permanent memory into the data memory. The permanent memory shall have the capability of being erased and programmed by external devices.

13-3 Coordinated Phase Control - It shall be possible to change the coordinated phase(s). The command to do this shall originate from the operator, maintenance, and/or engineering console and be passed to local intersections via the on-street master.

UPLOADING CAPABILITY - XIV

14-1 The on-street master shall have the capability of uploading system and timing data from the operator, maintenance, or engineering consoles and then downloading the data to each local intersection controller assembly. The system operator using the consoles keyboards shall have the capability of entering the timing and system data via the keyboard into the RAM memory.

14-2 The information to be transmitted shall include all interval times as defined in the NEMA Standards TS1-1989, Section 14. The Min Green, Yellow, Red and Ped Clearance times shall be subject to predefined minimums.

14-3 In addition to the interval time, the following parameters shall also be capable of being uploaded from the consoles and downloaded to the local controllers.

A. Offset Times (3)

B. Force Off Associations and Times*

C. Permissive Phase Associations and Times*

D. Time Clock Information

E. Time, Day and Date

F. Security Code

G. Detector Delay

H. Initialization Phases(s) and Interval(s)

I. Last Car Passage Control

J. Dual Entry Operation

K. Offset Seeking Mode

L. Dwell Time*

*If the controller has the capability of calculating the necessary parameters, uploading is not required.

DOWNLOADING CAPABILITY - XV

15-1 The on-street master shall have the capability of downloading all of the data from each local controller unit to the operator, maintenance and/or engineering console. The data that shall be available for downloading is specified in subsection 10. During the uploading operation, the normal interconnected operation shall be suspended.

MODEM - XVI

16-1 The modem shall be an external or internal 9 600 baud modem - Hayes compatible and shall provide full duplex operation using a 2 wire dial up or leased lines. The modem shall comply with part 68, FCC docket 19528.

16-2 The data rates shall be 300, 1 200, 2 400, 4 800 and 9 600 bits per second, and support asynchronous and synchronous communication.

16-3 The modulation shall be frequency shift keying (FSK) for low speed and phase shift keying (PSK) on a dibit basis for high speed.

16-4 Originate, manual, permanent auto answer or controlled auto answer operating modes shall be provided.

16-5 The modem shall have a line impedance of 600 ohms ± 10% transformer coupled and transient protected. The transmitter output level shall be 0 to -12 dBm programmable, with an external programming resistor.

16-6 The modem shall provide a RS-232-C and CCITT V.32 and V.22 digital interface via a DB-25S connector.

16-7 The carrier detect sensitivity at low speed shall be -50 dBm ± 4 dB and at high speed shall be -45 dBm ± 4 dB.

16-8 The modem shall provide an auto disconnect function that will disconnect the modem due to a lack of carrier for approximately 18 seconds.

16-9 The front panel of the modem enclosure shall contain 8 diagnostic LEDs. The indicators shall indicate modem ready, terminal ready, make busy, high speed, modem check, receive data, transmit data and test modem.

16-10 A power on-off switch shall be mounted on the modem along with the DB-25S connector, an 8-pin RJ45 data jack, and an RJ-11 telephone jack.

COMMUNICATIONS INTERCONNECT - XVII

17-1 The on-street master shall be provided with full duplex operation using a 4 wire interconnect or leased lines for communication interconnect with local controllers. The communications shall comply with part 68, FCC docket 19528.

17-2 The data rate shall be a minimum of 1 200 bits per second ± 0.01% asynchronous.

17-3 The modulation shall be time division multiplex/frequency shift keying (TDM/FSK).

17-4 The communications module shall function with a line impedance of 600 ohms ± 10% meeting the requirements of Bell 3002 unconditioned.

17-5 The communications shall provide through an RS-232-C interface via a DB-25S connector.

17-6 The front panel of the controller unit shall contain an indication which shall indicate the carrier status.

CLOSED LOOP FIBER OPTIC DATA INTERFACE - XVIII

18-1 The on-street master shall be capable of communication with local controllers utilizing a single mode fiber optic communications link. This will be accomplished by using a fiber optic data splitter and interface units which will be provided and connected the on-street masters RS- 232 output and to the fiber optic interconnect.

18-2 The fiber optic data interface unit shall be capable of operating in a full duplex mode of operation, employing asynchronous RS-232 data link protocols up to 9 600 baud rate. The RS-232 signals shall be converted to light and transmitted from interface unit to interface unit until the light is reconverted to RS-232 electrical signals at the closed loop controllers. The unit shall have a data speed of 100 to 24 000 baud.

18-3 The fiber optic data splitter and interface units each shall contain two pairs of optical emitters and optical receivers with "ST" connectors. The unit shall contain LED's that indicate the current state of the unit and indicate if the unit is receiving or transmitting data. The unit shall provide daisy chain operation over both fiber optic cables. The unit shall regenerate the signal prior to transmission to subsequent modems.

18-4 The fiber optic data splitter and interface units shall be powered from an external power supply and contain a battery backup for 24 hours of operation.

18-5 The fiber optic data splitter and interface units shall operate on a wave length of 1 300 nanometers for a distance between controllers of a minimum of 4.5 kilometers. The modem shall have an optical budget of at least 15 decibels.

18-6 The fiber optic data splitter and interface units shall have a data sensitivity of 0 dBm maximum and -40 dBm minimum.

18-7 The fiber optic data interface unit shall also include a lightguide interconnection/crossconnection unit. The unit will allow the termination of the fiber optic interconnect cable in the cabinet and the connection of fiber optic jumper assemblies to the interface. The unit shall contain split ring fiber bend limiters and allow top and bottom cable entry, with a slack storage section. The unit shall have a lock for security, all units shall be keyed alike. The unit shall include all jumpers and connectors required.

MULTI-ARTERIAL FIBER OPTIC DATA INTERFACE - XIX

19-1 The fiber optic interface to be used in a Multi-Arterial traffic control System shall composed of a shelf mounted chassis with 10 card slots, it shall contain multi-drop communications card, diagnostics card, software and power supplies as specified here after. The interface conform to all applicable portions of the Environmental and Operating Standards as described in the NEMA Standards TS1-1989, Part 2.

19-2 The interface shall contain two - 70 watt load sharing power supplies for redundancy. The power supplies shall occupy two slots in the chassis each. An additional power supply shall be provided and not installed.

19-3 The interface shall contain optics control cards sufficient to support the closed loop system supplied plus two additional cards. If a dual optic control card is utilized only one additional card shall be supplied. Each card shall be designed to support the fiber optic network. The cards shall be capable of supporting two areas in a point to point configuration or multiple areas in a logical loop. The cards shall also support a star configuration should a MATS system software supplied require that configuration. The interface shall be capable of operating in the network with the communications server operating in conformance with the current New Jersey Department of Transportation Specification No. EBM-MATS-1 and EBM-OC-1.

19-4 The optics control cards shall be designed to support a fault tolerant system by providing a secondary fiber optic path in which the data frame is traveling in a counter rotating ring with respect to the primary data path. The dual optic control cards shall monitor and control the fiber optic network. In an event of any channel failure the system will continue to run. If the fiber optic cable breaks at any point in the ring to the on-street masters, the communications data path shall wrap around the problem area.

19-5 The optics control cards shall be supplied with diagnostic that allow the system operator to view the entire network from a single node and allows changes to be made if required. The cards will be provided with SMA/ST connectors for 1 300 nanometer fiber optic cable. The cards shall provide a Bit Rate of 20 megabits per second per path, a

sensitivity of -32 dBm at BER $1X10^{-9}$ and a coupled power of -12 dBm (9.5/125). The card shall be provided with 10 dip switches for address setting.

19-6 The interface shall contain a diagnostic card and software. The diagnostic card shall provide a means of monitoring the interface. The software shall monitor all vital communications system function over the entire network.

19-7 The interface shall contain a telephone system card. The card shall provide a 2 wire analog tip and ring signal on an RJ11 six pin connector. The card shall occupy one slot of the chassis. The card shall provide dip switches for address and mode settings.

INSTRUCTIONS AND GUARANTEES - XX

20-1 One set of complete schematics of all equipment required by these specifications and maintenance and operation manuals of all equipment shall be supplied with each unit furnished.

20-2 One reproducible mylar and two prints of the schematic wiring diagram for the cabinet panels and auxiliary equipment shall be supplied with each unit furnished. The schematic wiring diagram shall contain the following information in at least 6 millimeter lettering.

A. Contract and bid date.

B. Model and number of all equipment.

C. Intersection location.*

*When not applicable, the diagram shall have the word "location" and a blank space where the intersection can be added.

20-3 No changes or substitutions in these requirements will be acceptable unless authorized in writing. Inquiries regarding this equipment shall be addressed to the Manager, Office of ITS Engineering, New Jersey Department of Transportation, P.O. Box 613, 1035 Parkway Avenue, Trenton, New Jersey 08625.

20-4 The complete unit and auxiliary equipment shall carry a two (2) year guarantee from the date of operation and acceptance against any imperfections in workmanship or materials.

20-5 The company agrees upon the request of the Manager, Office of ITS Engineering to deliver to the Office, a sample of the equipment to be supplied in compliance with these specifications for inspection and test before acceptance. After completion of the test, the sample shall be returned.

20-6 The company shall furnish any and all equipment which they deem necessary for safe and reliable field operation of the equipment.

20-7 On-street master furnished under this specification must be current production equipment and of recent manufacturer, identical models of which are field operational. Untried or prototype units shall not be considered for acceptance.

20-8 Any repairs made by a manufacturer or representative shall be documented and returned with units when warranty repaired. This documentation shall include an explanation of the exact repairs made and identification of parts replaced by part number and circuit number. All warranty repairs must be made within thirty days upon receiving equipment.