

# Project Special Provisions

(Version 06.1)

## Signals and Intelligent Transportation Systems

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## 1. 2006 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1098 REVISIONS

*The 2006 Standard Specifications are revised as follows:*

### 1.1. General Requirements (1098-1)

Page 10-268, Subarticle 1098-1(H)

In the second paragraph, add “Use 200 amp meter base for underground electrical service”.

### 1.2. Wood Poles (1098-6)

Page 10-272, Delete article. Refer to Subarticles 1082 –3(F) and 1082-4(G).

## 2. ELECTRICAL REQUIREMENTS

Ensure that an IMSA certified, or equivalent, Level II traffic qualified signal technician is standing by to provide emergency maintenance services whenever work is being performed on traffic signal controller cabinets and traffic signal controller cabinet foundations. Stand by status is defined as being able to arrive, fully equipped, at the work site within 30 minutes ready to provide maintenance services.

## 3. SIGNAL HEADS

### 3.1. MATERIALS

#### A. General:

Fabricate vehicle signal head housings and end caps from die-cast aluminum. Fabricate 12-inch and 16-inch pedestrian signal head housings and end caps from die-cast aluminum. Fabricate 9-inch pedestrian signal head housings, end caps, and visors from virgin polycarbonate material. Provide visor mounting screws, door latches, and hinge pins fabricated from stainless steel. Provide interior screws, fasteners, and metal parts fabricated from stainless steel or corrosion resistant material.

Fabricate tunnel and traditional visors from sheet aluminum.

Paint all surfaces inside and outside of signal housings and doors. Paint outside surfaces of tunnel and traditional visors, messenger cable mounting assemblies, pole and pedestal mounting assemblies, and pedestrian pushbutton housings. Have electrostatically-applied, fused-polyester paint in highway yellow (Federal Standard 595A, Color Chip Number 13538) a minimum of 2.5 to 3.5 mils thick. Do not apply paint to the latching hardware or rigid vehicle signal head mounting brackets.

Have the interior surfaces of tunnel and traditional visors painted an alkyd urea black synthetic baking enamel with a minimum gloss reflectance and meeting the requirements of MIL-E-10169, “Enamel Heat Resisting, Instrument Black.”

For pole mounting, provide side of pole mounting assemblies with framework and all other hardware necessary to make complete, watertight connections of the signal heads to the poles and pedestals. Fabricate the mounting assemblies and frames from aluminum with all necessary hardware, screws, washers, etc. to be stainless steel. Provide mounting fittings that match the positive locking device on the signal head with the serrations integrally cast into the brackets. Provide upper and lower pole plates that have a 1 ¼-inch vertical conduit entrance hubs with the hubs capped on the lower plate and 1 ½-inch horizontal hubs. Ensure that the assemblies provide rigid attachments to poles and pedestals so as to allow no twisting or swaying of the signal heads. Ensure that all raceways are free of sharp edges and protrusions, and can accommodate a minimum of ten Number 14 AWG conductors.

For pedestal mounting, provide a post-top slipfitter mounting assembly that matches the positive locking device on the signal head with serrations integrally cast into the slipfitter. Provide stainless steel hardware, screws, washers, etc. Provide a minimum of six 3/8 X 3/4-inch long square head bolts for attachment to pedestal. Provide a center post for multi-way slipfitters.

## **B. Vehicle Signal Heads:**

Comply with the ITE standard "Vehicle Traffic Control Signal Heads". Provide housings with provisions for attaching backplates.

Provide visors that are 8 inches in length for 8-inch vehicle signal head sections. Provide visors that are 10 inches in length for 12-inch vehicle signal heads.

Provide a termination block with one empty terminal for field wiring for each indication plus one empty terminal for the neutral conductor. Have all signal sections wired to the termination block. Provide barriers between the terminals that have terminal screws with a minimum Number 8 thread size and that will accommodate and secure spade lugs sized for a Number 10 terminal screw.

Mount termination blocks in the yellow signal head sections on all in-line vehicle signal heads. Mount the termination block in the red section on five-section vehicle signal heads.

Furnish vehicle signal head interconnecting brackets. Provide one-piece aluminum brackets less than 4.5 inches in height and with no threaded pipe connections. Provide hand holes on the bottom of the brackets to aid in installing wires to the signal heads. Lower brackets that carry no wires and are used only for connecting the bottom signal sections together may be flat in construction.

For messenger cable mounting, provide messenger cable hangers, wire outlet bodies, balance adjusters, bottom caps, wire entrance fitting brackets, and all other hardware necessary to make complete, watertight connections of the vehicle signal heads to the messenger cable. Fabricate mounting assemblies from malleable iron and provide serrated rings made of aluminum. Provide messenger cable hangers and balance adjusters that are galvanized before being painted. Fabricate balance adjuster eyebolt and eyebolt nut from stainless steel or galvanized malleable iron. Provide messenger cable hangers with U-bolt clamps. Fabricate washers, screws, bolts, clevis pins, cotter pins, nuts, and U-bolt clamps from stainless steel.

For mast-arm mounting, provide rigid vehicle signal head mounting brackets and all other hardware necessary to make complete, watertight connections of the vehicle signal heads to the mast arms and to provide a means for vertically adjusting the vehicle signal heads to proper alignment. Fabricate the mounting assemblies from malleable iron or aluminum, and provide serrated rings made of aluminum.

Provide light emitting diode (LED) vehicular traffic signal modules (hereafter referred to as modules) that consist of an assembly that uses LEDs as the light source in lieu of an incandescent lamp for use in traffic signal sections. Use LEDs that are aluminum indium gallium phosphorus (AlInGaP) technology for red and yellow indications and indium gallium nitride (InGaN) for green indications. Install the ultra bright type LEDs that are rated for 100,000 hours of continuous operation from -40°F to +165°F. Design modules to have a minimum useful life of 60 months and to meet all parameters of this specification during this period of useful life.

### **1. LED Circular Signal Modules:**

Provide modules in the following configurations: 12-inch circular sections, and 8-inch circular sections. All makes and models of LED modules purchased for use on the State Highway System shall appear on the current NCDOT Traffic Signal Qualified Products List (QPL).

Ensure, unless otherwise stated in these specifications, that each module meets or exceeds the ITE “*Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement*” dated June 27, 2005 (hereafter referred to as *VTCSH Circular Supplement*).

Certify compliance with paragraphs 3.3.2, 3.3.3, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.2.2, 5.2.1, 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.3, 5.4, 5.5.1, 5.5.2, 5.6.2, 5.7 of the *VTCSH Circular Supplement*.

Provide quick connect Molex terminals (part # 19092026 female housing, part # 02091615 female pin, part # 19092027 male housing, and 02092101 male pin) or equivalent, and spade terminals appropriate to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard signal head. Ensure the replacement module provided has the Molex male connector 6 inches from the module.

Ensure the power supply is integral to the module assembly. On the back of the module, permanently mark the date of manufacture (month & year) or some other method of identifying date of manufacture.

Tint the red, yellow and green lenses to correspond with the wavelength (chromaticity) of the LED. Transparent tinting films are unacceptable.

Provide modules that meet the requirements of Tables 1098-1 and 1098-2.

In addition to meeting the performance requirements for the minimum period of 60 months, provide a written warranty against defects in materials and workmanship for the modules for a period of 60 months after installation of the modules. During the warranty period, the manufacturer must provide replacement modules within 45 days of receipt of modules that have failed at no cost to the State. Provide manufacturer’s warranty documentation to the Department during evaluation of product for inclusion on Qualified Products List (QPL).

**Table 1098-1**

**Maximum Power Consumption (in Watts) at 77°F**

	Red	Yellow	Green
12-inch circular	12	22	15
8-inch circular	8	13	12

Table 1098-2

Minimum Maintained Luminous Intensity/Minimum Initial Luminous Intensity (in cd) at 77°F

Vertical Angle	Horizontal Angle	Red 8"		Yellow 8"		Green 8"		Red12"		Yellow 12"		Green 12"	
		Main.	Initial	Main.	Initial	Main.	Initial	Main.	Initial	Main.	Initial	Main.	Initial
+12.5	2.5	17	21	41	51	22	28	37	46	91	114	48	60
	7.5	13	16	33	41	17	21	29	36	73	91	38	48
+7.5	2.5	31	39	78	98	41	51	69	86	173	216	90	113
	7.5	25	31	62	78	32	40	55	69	137	171	71	89
	12.5	18	23	45	56	24	30	40	50	100	125	52	65
+2.5	2.5	68	85	168	210	88	110	150	188	373	466	195	244
	7.5	56	70	139	174	73	91	124	155	309	386	162	203
	12.5	38	48	94	118	49	61	84	105	209	261	109	136
	17.5	21	26	53	66	28	35	47	59	118	148	62	78
	22.5	12	15	29	36	15	19	26	33	64	80	33	41
-2.5	2.5	162	203	402	503	211	264	358	448	892	1115	466	583
	7.5	132	165	328	410	172	215	292	365	728	910	380	475
	12.5	91	114	226	283	118	148	201	251	501	626	261	326
	17.5	53	66	131	164	69	86	117	146	291	364	152	190
	22.5	28	35	70	88	37	46	62	78	155	194	81	101
	27.5	15	19	37	46	19	24	33	41	82	103	43	54
-7.5	2.5	127	159	316	395	166	208	281	351	701	876	366	458
	7.5	106	133	262	328	138	173	234	293	582	728	304	380
	12.5	71	89	176	220	92	115	157	196	391	489	204	255
	17.5	41	51	103	129	54	68	91	114	228	285	119	149
	22.5	21	26	53	66	28	35	47	59	118	148	62	78
	27.5	12	15	29	36	15	19	26	33	64	80	33	41
-12.5	2.5	50	63	123	154	65	81	110	138	273	341	143	179
	7.5	40	50	98	123	52	65	88	110	218	273	114	143
	12.5	28	35	70	88	37	46	62	78	155	194	81	101
	17.5	17	21	41	51	22	28	37	46	91	114	48	60
	22.5	8	10	21	26	11	14	18	23	46	58	24	30
	27.5	5	6	12	15	6	8	11	14	27	34	14	18
-17.5	2.5	23	29	57	71	30	38	51	64	127	159	67	84
	7.5	18	23	45	56	24	30	40	50	100	125	52	65
	12.5	13	16	33	41	17	21	29	36	73	91	38	48
	17.5	7	9	16	20	9	11	15	19	36	45	19	24
	22.5	3	4	8	10	4	5	7	9	18	23	10	13
-22.5	2.5	17	21	41	51	22	28	37	46	91	114	48	60
	7.5	13	16	33	41	17	21	29	36	73	91	38	48
	12.5	10	13	25	31	13	16	22	28	55	69	29	36
	17.5	5	6	12	15	6	8	11	14	27	34	14	18
-27.5	2.5	12	15	29	36	15	19	26	33	64	80	33	41
	7.5	8	10	21	26	11	14	18	23	46	58	24	30

Note 1: Luminous intensity values for equivalent left and right horizontal angles are the same.

Note 2: Tabulated values of luminous intensity are rounded to the nearest whole value.

**2. LED Arrow Signal Modules**

Ensure arrow modules meet or exceed the electrical and environmental operating requirements of sections 3 and 5 of the Interim Purchase Specification of the ITE VTCSH part 2 Light Emitting Diode (LED) Vehicular Traffic Signal Modules (hereafter referred to as VTCSH-2), the chromaticity requirements of Section 4.2, and the requirements of Sections 6.3 (except 6.3.2) and 6.4 (except 6.4.2).

Provide modules that meet the requirements of Table 1098-3. Ensure that fluctuations of line voltage have no visible effect on the luminous intensity of the indications. Design the module to have a normal operating voltage of 120 VAC rms, and measure all parameters at this voltage.

**Table 1098-3**

**Maximum Power Consumption (in Watts) at 77°F**

	Red	Yellow	Green
12-inch arrow	9	10	11

Certify that the module meets the requirements of VTCSH-2, Section 5.7. Ensure all wiring meets the requirements of Section 5.1 of the VTCSH-2. In addition, provide quick connect Molex terminals (part # 19092026 female housing, part # 02091615 female pin, part # 19092027 male housing, and 02092101 male pin) or equivalent, and spade terminals appropriate to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard signal head. Ensure the replacement module provided has the Molex male connector 6 inches from the module.

Ensure that the module is compatible with signal load switches and conflict monitors. Design the module to provide sufficient current draw to ensure proper load switch operation while the voltage is varied from a regulated 80 Vrms to 135 Vrms. Design off-state for green and yellow modules to be 30Vrms or less, and on-state to be 40 Vrms or greater. Design the voltage to decay to 10 Vrms or less in 100 milliseconds. Ensure that the control circuitry prevents current flow through the LEDs in the off state to avoid a false indication.

Design all modules to meet existing NCDOT monitor specifications for each of the following types of signal monitors: NEMA TS-1 conflict monitors (including so-called NEMA plus features such as dual indication detection and short yellow time detection); NEMA TS-2 Malfunction Management Units (MMU); and 170 cabinet Type 210ECL and 2010ECL conflict monitors (including red monitoring and so-called plus features such as dual indication detection and short yellow time detection).

Ensure that the modules and associated onboard circuitry meet Class A emission limits referred to in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

Provide modules that meet the requirements of Table 1098-4. Design and certify the modules to meet or exceed the maintained minimum luminous intensity values throughout the warranty period based on normal use in a traffic signal operation over the operating temperature range. Test the Red and Green arrow modules for maintained luminous intensity at 165°F (ITE 6.4.2.2). Use LEDs that conform to the chromaticity requirements of VTCSH-2, Section 2 throughout the warranty period over the operating temperature range. Make chromaticity coordinate compliance measurements at 77°F.

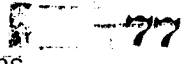
**Table 1098-4**

**Minimum Initial and Maintained Luminance for Arrow Indications (in cd/ft<sup>2</sup>)**

	Red	Yellow	Green
Arrow Indication	511	1022	1022

Design the modules as retrofit replacements for installation into standard incandescent traffic sections that do not contain the incandescent lens, reflector assembly, lamp socket and lens gasket. Ensure that installation does not require special tools or physical modification for the existing fixture other than the removal of the incandescent lens, reflector assembly, lamp socket, and lens gasket.

Provide modules that are rated for use in the operating temperature range of -40°F to +165°F. Ensure that the modules (except yellow) meet all specifications throughout this range. Fabricate the module to protect the onboard circuitry against dust and moisture intrusion per the requirements of NEMA Standard 250-1991 for Type 4 enclosures to protect all internal components.



Design the module to be a single, self-contained device with the circuit board and power supply for the module inside and integral to the unit.

Design the assembly and manufacturing process for the module to ensure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources. Group the individual LEDs such that a catastrophic loss or the failure of one LED will result in the loss of not more than 20 percent of the signal module light output. Solder the LEDs to the circuit board.

Fabricate the lens and signal module from material that conforms to ASTM specifications. Ensure enclosures containing either the power supply or electronic components of the module are made of UL94VO flame retardant materials. The lens of the signal module is excluded from this requirement.

Permanently mark the manufacturer's name, trademark, model number, serial number, date of manufacture (month & year), and lot number as identification on the back of the module.

Permanently mark the following operating characteristics on the back of the module: rated voltage and rated power in watts and volt-amperes.

If a specific mounting orientation is required, provide permanent markings consisting of an up arrow, or the word "UP" or "TOP" for correct indexing and orientation within the signal housing.

Provide a lens that is integral to the unit with a smooth outer surface and UV stabilized to withstand ultraviolet exposure for a minimum period of 60 months without exhibiting evidence of deterioration. Coat the front of a polycarbonate lens to make it more abrasion resistant. Seal the lens to the module to prevent moisture and dust from entering the module.

Tint the red, yellow, and green lens to match the wavelength (chromaticity) of the LED.

Ensure that the module meets specifications stated in Chapter 2, Section 9.01 of the ITE Equipment and Materials Standards for arrow indications. Design arrow displays to be solid LEDs (spread evenly across the illuminated portion of the arrow or other designs), not outlines. **Determine the luminous intensity using the CALTRANS 606 method or similar procedure.**

**Burn In** - Energize the sample module(s) for a minimum of 24 hours, at 100 percent on-time duty cycle, at a temperature of +165°F before performing any qualification testing. Any failure of the module, which renders the unit non-compliant with the specification after burn-in, is cause for rejection. All specifications will be measured including, but not limited to:

- (a) **Photometric (Rated Initial Luminous Intensity)** - Measure at +77°F. Measure luminous intensity for red and green modules upon the completion of a 30 minute 100 percent on-time duty cycle at the rated voltage. **Measure luminous intensity for yellow modules immediately upon energizing at the rated voltage.**
- (b) **Chromaticity (Color)** - Measure at +77°F. Measure chromaticity for red and green modules upon the completion of a 30 minute 100 percent on-time duty cycle at the rated voltage. **Measure chromaticity for yellow modules immediately upon energizing at the rated voltage.**
- (c) **Electrical** - Measure all specified parameters for quality comparison of production quality assurance on production modules. (rated power, etc)

NCDOT evaluates and approves all LED Traffic Signal modules for the QPL by a standard visual inspection and blind operational survey, a compatibility test, current flow, and other random tests, in addition to reviewing the lab reports and documentation from the manufacturer. The tests are conducted at the Traffic Electronics Center in Raleigh. Ensure each 12-inch arrow

module is visible at 300 feet during sway conditions (extended view) until obscured by the visor. Sufficient luminance during the extended views will be determined during this blind survey evaluation.

In addition to meeting the performance requirements for the minimum period of 60 months, provide a written warranty against defects in materials and workmanship for the modules for a period of 60 months after installation of the modules. During the warranty period, the manufacturer must provide replacement modules within 45 days of receipt of modules that have failed at no cost to the State. Provide manufacturer's warranty documentation to the Department during evaluation of product for inclusion on Qualified Products List (QPL).

### C. Signal Cable:

Furnish 16-4 and 16-7 signal cable that complies with IMSA specification 20-1 except provide the following conductor insulation colors:

- For 16-4 cable: white, yellow, red, and green
- For 16-7 cable: white, yellow, red, green, yellow with black stripe tracer, red with black stripe tracer, and green with black stripe tracer. Apply continuous stripe tracer on conductor insulation with a longitudinal or spiral pattern.

Provide a ripcord to allow the cable jacket to be opened without using a cutter. IMSA specification 19-1 will not be acceptable. Provide a cable jacket labeled with the IMSA specification number and provide conductors constructed of stranded copper.

## 4. CABINETS AND CONTROLLERS

### 4.1.DESCRPTION

The intersection(s) on this project will be part of the Town of Cary Traffic Signal System. The TS-2 signal cabinet(s), 2070LN2 controller(s), and all hardware, cabling, adapters, and other components in this project shall be compatible with the Cary Signal System. This section describes the cabinet(s), controller(s), and local controller software required for this project.

Furnish and install controller from the California Department of Transportation (CALTRANS) family of Model 2070 advanced traffic controllers.

Furnish and install new controller cabinets that meet or exceed the requirements of the NEMA TS-2 specification and the NCDOT standard specifications.

Modify existing Model 2070 controllers to be: fully compatible and interoperable with new 2070 controller furnished under the Cary Signal System project; fully compatible and interoperable with the communications systems furnished and installed under the Cary Signal System project, and fully compatible and interoperable with the central distributed processing system software furnished and installed under the Cary Signal System project. This may require upgrade of local 2070 controller operating system software, upgrade of 2070 controller modules, and/or update or addition of 2070 controller device drivers.

Furnish 2070 controller equipment that is listed on the CALTRANS qualified product list (QPL) unless otherwise approved by the engineer.



The local software (firmware) for this project will be supplied by the Town of Cary Traffic Engineer.

Comply with the provisions of Section 1700 of the 2006 Standard Specifications for Roads and Structures.

## 4.2.MATERIALS

### A. TYPE 2070 LN2 CONTROLLERS:

Furnish and install new model 2070 LN2 controllers in new NEMA TS-2 Type 1 traffic signal controller cabinet at the location(s) shown on the plan.

For the traffic signal controller unit power supply, clearly identify the amperage level of the unit using a permanent marking.

Furnish and install 2070 Lite controller into new NEMA TS-2 Type 1 traffic signal controller cabinet. Referred to in the CALTRANS TEES (California Department of Transportation *Transportation Electrical Equipment Specifications*) as a 2070 LN2, the furnished unit shall meet all requirements of CALTRANS TEES (8-16-2002 with errantums 1&2) except as noted in these Project Special Provisions. Furnish units configured as follows:

- Unit CHASSIS
- 2070 1B CPU Module
- 2070-2N Field I/O Module
- 2070-3B Front Panel Module
- 2070-4N (A) Power Supply Module
- 2070-7A, Asynchronous Serial Communication Module (9-pin, RS-232)

Furnish all accessories necessary to connect the controller to the system hardware components, including the communications cable and necessary pin adapters needed to connect the 9 pin RS-232 communications port to the fiber optic transceiver.

Ensure that removal of the CPU module from the controller will place the intersection into flash.

For each master location and central control center, furnish a U.S. Robotics V.92 or approved equivalent auto-dial/auto-answer external modem to accomplish the interface to the Department-furnished microcomputers. Include all necessary hardware to ensure telecommunications.

### B. NEMA TS-2 DETECTOR CARDS AND RACKS

Furnish NEMA TS-2 multi-channel detector cards and racks.

Provide cards that sequentially scan each of its channels. Provide channels with a minimum of eight sensitivity levels.

On a multi-channel detector, ensure that it is possible to turn a channel off and disable its operation from the front panel.

Ensure that detector units meet the requirements of NEMA TS-2 Specifications except as follows:

- Class 2 vehicle output is maintained for a minimum of 4 minutes, and

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- Class 3 vehicle output is maintained for a minimum of 30 minutes, maximum 120 minutes.

Where required, furnish detector cards equipped with required timing features. Provide a delay that is settable in one second increments (maximum) over the range of zero to thirty seconds. Provide an extend that is settable in 1/4 second increments (maximum) over the range of 0 to 15 seconds. Provide cards that can set both delay and extend timing for the same channel. If both timings are set, ensure that the delay operates first. After the delay condition has been satisfied, ensure that the extend timer operates normally and that it is not necessary to satisfy the delay timing for an actuation arriving during the extend portion.

Ensure that two-channel detector cards operate normally with the same loop connected to both channels.

Provide lightning and surge protection that is incorporated into the design of the detector. Ensure that each channel operates properly when used with the loop detector surge protector.

In addition to NEMA TS-2 Specifications, ensure that each channel is capable of tuning to and operating on any loop system inductance within the range of 50 to 2,000  $\mu$ h. Ensure that the channel will operate properly even on a loop system that has a single-point short to earth ground.

**C. MATERIALS - GENERAL CABINETS**

Provide a moisture resistant coating on all circuit boards.

Provide one V150LA20 MOV or equal protection on each load switch field terminal.

Provide a power line surge protector that is a two-stage device that will allow connection of the radio frequency interference filter between the stages of the device. Ensure that a maximum continuous current is at least 10A at 120V. Ensure that the device can withstand a minimum of 20 peak surge current occurrences at 20,000A for an 8x20 microsecond waveform. Provide a maximum clamp voltage of 280V at 20,000A with a nominal series inductance of 200 $\mu$ h. Ensure that the voltage does not exceed 280V. Provide devices that comply with the following:

Frequency (Hz)	Minimum Insertion Loss (dB)
60	0
10,000	30
50,000	55
100,000	50
500,000	50
2,000,000	60
5,000,000	40
10,000,000	20
20,000,000	25

**D. MATERIALS – NEMA TS-2 TYPE 1 CABINETS:**

**3. NEMA TS-2 Type 1 Cabinets General:**

Comply with the *NEMA Standards Publication TS-2* (NEMA TS-2) except as otherwise stated herein.

Furnish unpainted, natural, aluminum cabinet shells that comply with Section 7 of NEMA TS-2. Ensure all non-aluminum hardware on the cabinet is stainless steel or a Department approved non-corrosive alternate. Provide a roof with a slope from front to back at a minimum ratio of 1 inch drop

per 2 feet. Ensure that each exterior cabinet plane surface is constructed of a single sheet of aluminum and is seamless.

Ensure all components are arranged for easy access during servicing. When modular in construction, provide guides and positive connection devices to insure proper pin alignment and connection.

Provide a moisture resistant coating on all circuit boards.

Furnish all accessories required to accomplish base mounting and cabinet grounding.

Assign cabinet phases to components as indicated on the table entitled "16-Position Cabinet Phase Assignments".

#### **4. NEMA TS-2 Type 1 Cabinet Physical Requirements:**

Provide a handle and three point latching mechanism designed to be disassembled using hand tools. Provide a shaft connecting the latching plate to the door handle by passing through the door within a bushing, bearing, or equivalent device. Provide a latching plate at least 3/16 inch thick and that mates securely with the lock bolt. Provide a lock bolt with a flat end (no bevel) and that has at least 1/4 inch of length in contact with the latching plate.

Ensure that the handle and lock are positioned so that the lock does not lie in the path of the rotating handle as the door is unlatched and that the handle points down in the latched position.

Provide continuous welds made from the inside wherever possible. On the exterior, provide smooth and flush joints. Ensure that no screws, bolts, or rivets protrude to outside of cabinet shell.

Provide a main door opening that encompasses the full frontal area of the cabinet shell exclusive of the area reserved for plenums and flanges. Provide a rear door in base-mounted cabinets, unless otherwise specified. Ensure that the rear door complies with all requirements for the front door, except as follows:

- Hinge the rear door on the left side as viewed from the rear of the cabinet shell facing the door.
- No police compartment is required on a rear door.

Ensure that the cabinet shell is sturdy and does not exhibit noticeable flexing, bending or distortion under normal conditions except that a minor amount of flexing is permitted in the main door and rear door only when the cabinet is open. In such case, the flexing must not result in permanent deformation of the door or damage to components mounted on the door. Ensure that pedestal-mounted cabinets have sufficient framing around the slipfitter attachment so that no noticeable flexing will occur at or about this point.

Provide NEMA TS-2, Type 1 cabinets with 2 shelves. Ensure top shelf has an unobstructed depth of at least 12 inches for base-mounted cabinets. Ensure top shelf has an unobstructed shelf depth of at least 13 inches for pole-mounted cabinets. Locate the top shelf at least 12 inches below the top of the door opening. Provide a lower shelf for mounting detector racks, its associated BIU, and other auxiliary equipment. Locate the lower shelf at least 10 inches below the top shelf, and provide at least 13 inches of unobstructed shelf depth. Secure card racks and associated BIU connector housings to the shelf by a removable means. Place the rack so that the front of the rack is not obscured by any object and so that backpanel terminals are not obscured even when the rack is fully utilized.

Provide a back panel hinged at the bottom for access during service.

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Provide a minimum 12 x 14 inch plastic envelope or container located in the cabinet so that it is convenient for service personnel.

Furnish two sets of non-fading cabinet wiring diagrams and schematics in a paper envelope or container and placed in the plastic envelope or container.

Do not locate permanently mounted equipment in such a way that will restrict access to terminals.

**5. NEMA TS-2 Type 1 Cabinet Electrical Requirements:**

Provide a neutral that is not connected to the earth ground or the logic ground anywhere within the cabinet. Ensure the earth ground bus and the neutral ground bus each have ten compression type terminals each of which can accommodate wires ranging from number 14 through number 4.

Provide surge suppression in the cabinet and ensure that all devices operate over the temperature range of -40 to 185 degrees F.

Provide a loop surge suppresser for each set of loop terminals in the cabinet. Use terminal mount or stud mount devices for terminating the loop surge suppresser. Ensure that the device can withstand a minimum of 25 peak surge current occurrences at 100A in differential and common modes for a 10x700 microsecond waveform. Ensure that the maximum breakover voltage is 170V and the maximum on-state clamping voltage is 30V. Provide a maximum response time less than 5 nanoseconds and an off-state leakage current less than 10  $\mu$ A. Ensure that a nominal capacitance less than 220pf for both differential and common modes.

Provide surge suppression on each communications line entering or leaving a cabinet. Ensure that the communications surge suppresser can withstand at least 80 occurrences of an 8x20 microsecond waveform at 2000A, or a 10x700 microsecond waveform at 400A. Provide a maximum clamping voltage suited to the equipment protected. Provide a maximum response time less than 1 nanosecond with a nominal capacitance less than 1500pf and a series resistance less than 15  $\Omega$ .

Furnish a fluorescent fixture as required by NEMA TS-2 Specifications with a second lighting fixture mounted under the bottom shelf to light the terminals. Ensure that the second fixture is a fluorescent lighting fixture that complies with NEMA TS-2 Specifications or is a flexible gooseneck fixture containing a protected incandescent reflector bulb of at least 25 Watts. Furnish all bulbs. Ensure that the lamps are door switch actuated.

Provide connector type harnesses for all equipment installed in the cabinet, including detector racks. Furnish a harness with connectors to adapt the NEMA TS-2, Type 2 controller "A" connector to the NEMA TS-2, Type 1 "A" connector furnished with the cabinet assembly.

Tag all conductors that are likely to be disconnected from time to time with non-fading, permanent sleeve labels at the ends of the conductors.

In cabinets that are not base mounted, have no terminals closer than 4 inches to the bottom of the cabinet.

Fasten all wiring and harness supports to the cabinet with screws or other removable mechanical means. Do not use adhesives.

Provide harnesses in the cabinet for non-permanently mounted equipment that are long enough to allow the equipment to be relocated in an upright position to the roof of the cabinet or to be located to the ground 1 foot below cabinet level.

Do not locate terminals on the underside of shelves or at other places where they are not readily visible and accessible, or where they may be a hazard to personnel. Provide a clear plastic guard for

exposed 120 volt AC terminals on the power panel and the rear of terminal facilities accessible from the rear door.

Provide compression type earth grounds with 10 position terminal buses sized for four Number 14 AWG wires. Provide screw-type terminals for signal feed, detector lead-in, NEMA I/Os, backpanels, and interconnect terminals. Provide screw terminals for all other devices not defined by NEMA TS-2 Specifications. Ensure that wiring by the manufacturer is terminated either on double terminal strips with crimped-on lugs or soldered to rear terminals.

Ensure that upon leaving any cabinet or malfunction management unit (MMU) initiated flashing operation, the controller reverts to its programmed start-up operation through the use of the START UP FLASH CALL feature. Do not require special controller software to implement the return from flash in the start up mode of operation. Wire one of the output relays of the MMU to apply a logic ground to the STOP TIME input for rings 1 and 2 when the MMU initiates flashing operation because of a sensed failure. Ensure that the MMU is interlocked within the cabinet control circuitry as to prevent normal signal operation with the MMU disconnected. Ensure that the 24Vdc supply to the load switches is disconnected when cabinet flashing operation is initialized. Provide a momentary pushbutton, or equivalent method, to apply 24Vdc to the load switches during cabinet flash for troubleshooting purposes.

Unless otherwise required, provide switches that are heavy-duty toggle switches.

Provide a technician panel mounted on the inside of the door with an EQUIPMENT POWER (ON/OFF) switch and an AUTO/FLASH switch. Ensure switches are protected against accidental activation by a flip-up switch guard that does not affect switch position when closed. Provide an EQUIPMENT POWER (ON/OFF) toggle switch that connects or disconnects protected equipment power to all devices in the cabinet and does not affect AC power to the flasher. Provide an AUTO/FLASH toggle switch which immediately places the intersection into flashing operation, disconnects the STOP TIME input generated by the MMU, and applies a logic ground to the LOCAL FLASH STATUS input of the MMU. When placed in the AUTO position, ensure that this switch causes the return of the intersection to normal operation at the programmed start up phases and intervals via the START-UP FLASH CALL feature of the controller unit. Provide a DETECTOR CHANNEL CALL three position detector test switch (on, normal, momentary on) installed for every detector channel in the detector racks. Provide four pedestrian detector test switches (on normal, momentary on) to the 4 pedestrian detector inputs of BIU no. 1. The switches may be installed on the door or on the non-door hinge side of the cabinet at the front of the cabinet.

Provide a police compartment constructed such that neither water nor dust will enter the interior of the cabinet through the police compartment, even when the police compartment door is open. Provide a rigid enclosure over the terminals of its components. Do not use flexible guards. Provide a SIGNAL POWER (ON/OFF) switch, an AUTO/FLASH switch, and an AUTO/MANUAL switch. Provide a locking jack for an optional manual push-button. Provide a SIGNAL POWER (ON/OFF) toggle switch which, when in the "OFF" position, disconnects AC power to the field terminals, applies logic ground to the LOCAL FLASH STATUS input of the MMU, and disconnects the STOP TIME input generated by the MMU. Ensure that a means to prevent recognition of red failure by the malfunction management unit is used and the switch does not affect power to equipment in the cabinet. When the SIGNAL POWER switch is switched to the "ON" position, ensure controller reverts to the programmed start-up phases and intervals via the START-UP FLASH CALL feature of the controller unit. Provide an AUTO/FLASH toggle switch that immediately places the intersection into flashing operation, and applies logic ground to the MMU LOCAL FLASH STATUS input. When placed in the AUTO position, ensure this switch allows the return of the intersection to normal operation at the programmed start-

up phases and intervals via THE START-UP FLASH CALL feature of the controller unit. Provide an AUTO/MANUAL toggle switch that selects between normal operation (in the AUTO position) and manually controlled operation (in the MANUAL position). When in the MANUAL position, ensure that a logic ground is applied to the Manual Control Enable input of the controller. Ensure that only when a logic ground signal is applied to Manual Control Enable, the optional manual push-button can be used to advance the phases by applying and removing a logic ground signal to the Interval Advance input.

Provide one flash transfer relay and flasher for each corresponding socket. Provide 2 spare terminals for each flasher circuit output. Provide 1 MMU and 1 cabinet DC power supply (shelf mounted) with all necessary harnesses wired to the appropriate cabinet/back panel termination points. Terminate unused MMU inputs. Provide BIUs with sockets and terminal facilities. BIUs 3 and 4 may be mounted in a rack separate from the back panel.

Provide a minimum of 2 sets of loop terminals and a single earth ground terminal between the 2 sets of loop wire terminals for each slot in each detector rack provided.

In cabinets with less than 16 loadbay positions, provide flash transfer relay circuits for load switches used to implement pedestrian signals that are brought out to separate terminals but not connected for flashing operation when pedestrian signals are assigned to the load switch channel. Ensure that the flash circuit inputs and outputs are available for easy connection to allow conversion of a pedestrian movement load switch for use as an overlap (vehicle phase) movement load switch. Provide a reserved flash transfer relay circuit for four vehicle movements and all necessary flash transfer relay input and output wiring and flash circuit wiring that can be made available at each pedestrian load switch position.

Comply with the applicable tables for the type of cabinet furnished:

**TS-2 Type 1 Cabinet Configurations**

CABINET CONFIGURATION	LOAD SWITCH SOCKETS	FLASH RELAY SOCKETS	FLASHER SOCKETS	BIU'S REQUIRED (BACK PANEL/ DETECTOR)	DETECTOR RACK TYPE/ QUANTITY	TS-2 CABINET TYPE*
NC-1	4	2	1	1/1	1/1	4**
NC-2	8	4	1	1/1	2/1	5
NC-3	12	6	1	2/1	2/1	6
NC-3A	12	6	1	2/2	2/2	6
NC-3B	12	6	1	2/2	2/1 1/1	6
NC-4	12	6	1	†3/1	2/1	6
NC-4A	12	6	1	†3/2	2/2	6
NC-4B	12	6	1	†3/2	2/1 1/1	6
NC-5	12	6	1	‡4/1	2/1	6
NC-5A	12	6	1	‡4/2	2/2	6
NC-5B	12	6	1	‡4/2	2/1 1/1	6
NC-6	16	6	1	2/2	2/2	6
NC-6A	16	6	1	2/2	2/1 1/1	6
NC-7	16	6	1	†3/2	2/2	6
NC-7A	16	6	1	†3/2	2/1 1/1	6
NC-8	16	6	1	‡4/2	2/2	6
NC-8A	16	6	1	‡4/2	2/1 1/1	6

\*See NEMA TS-2-1998, Table 7-1 for actual dimensions.

\*\*Type 5 cabinet may be substituted for four position base mount cabinet.

† BIU 3 required along with BIU 1, BIU 2, and detector BIU(s).

‡ BIU 3 and BIU 4 required along with BIU 1, BIU 2, and detector BIU(s).

**8-Position Loadbay Cabinet Phase Assignments**

PHASE /OL NUMBER	MALFUNCTION MANAGEMENT UNIT CHANNEL ASSIGNMENT	ASSIGNED TO LOAD SWITCH POSITION NUMBER	ASSIGNED TO FLASH RELAY NUMBER	ASSIGNED TO FLASHER CIRCUIT/	PROGRAM FLASH COLOR
1	1	1	1	1	R
2	2	2	1	2	Y
3	3	3	2	1	R
4	4	4	2	2	R
2 PED-O/LA †	5	5	†3	†1	D
4 PED O/L .B†	6	6	†3	†2	D
O/L C	7	7	4	1	R
O/L D	8	8	4	2	R

† Prepare this load switch position for the pedestrian movement indicated. Wire pedestrian signals to flash dark. Make flash circuitry for this load switch position available and accessible at a separate terminal to allow connection to the load switch and field terminal circuit for a vehicle movement at a later date if desired.

**12-Position Loadbay Cabinet Phase Assignments**

PHASE /OL NUMBER	MALFUNCTION MANAGEMENT UNIT CHANNEL ASSIGNMENT	ASSIGNED TO LOAD SWITCH POSITION NUMBER	ASSIGNED TO FLASH RELAY NUMBER	ASSIGNED TO FLASHER CIRCUIT/	PROGRAM FLASH COLOR
1	1	1	1	1	R
2	2	2	1	2	Y
3	3	3	2	1	R
4	4	4	2	2	R
5	5	5	3	2	R
6	6	6	3	1	Y
7	7	7	4	2	R
8	8	8	4	1	R
2 PED or O/L A†	9	9	†5	†1	D
4 PED or O/L B†	10	10	†5	†2	D
6 PED or O/C†	11	11	†6	†1	D
8 PED or O/L D†	12	12	†6	†2	D

† Prepare this load switch position for the pedestrian movement indicated. Wire pedestrian signals to flash dark. Make flash circuitry for this load switch position available and accessible at a separate terminal to allow connection to the load switch and field terminal circuit for a vehicle movement at a later date.

**16 Position Loadbay Cabinet Phase Assignments**

PHASE/OL NUMBER	MALFUNCTION MANAGEMENT UNIT CHANNEL ASSIGNMENT	ASSIGNED TO LOAD SWITCH POSITION NUMBER	ASSIGNED TO FLASH RELAY NUMBER	ASSIGNED TO FLASHER CIRCUIT/	PROGRAM FLASH COLOR
1	1	1	1	1	R
2	2	2	1	2	Y
3	3	3	2	1	R
4	4	4	2	2	R
5	5	5	3	2	R
6	6	6	3	1	Y
7	7	7	4	2	R
8	8	8	4	1	R
2 PED	9	9	-	-	D
4 PED	10	10	-	-	D
6 PED	11	11	-	-	D
8 PED	12	12	-	-	D
O/L A	13	13	5	1	R
O/L B	14	14	5	2	R
O/L C	15	15	6	1	R
O/L D	16	16	6	2	R

Provide flasher circuits and flash transfer relay outputs and inputs that are brought out to terminals which provide a convenient means of changing flash color and flash circuit at each load switch position. Ensure that changing flash color of a given phase or overlap involves no more than moving three wires. Ensure that the selected phase or overlap flash color load switch output is easily movable to connect to the normally open flash transfer relay input assigned to the phase or overlap. Ensure that the common output of the flash transfer relay circuit assigned to the phase or overlap is easily movable to the selected field terminal (input) of the phase or overlap flash color. Ensure that the non-flashed load switch output is easily moved to provide power directly to the phase or overlap field terminal for that color.

In cabinets requiring a Type 1 detector rack, route to and terminate on a conveniently located terminal block on the back panel or elsewhere in the cabinet, the eight unused detector BIU Vehicle Call inputs. Tie the 8 unused detector BIU Detector Status inputs to the logic ground.

Provide detector racks and associated detector rack BIUs that are removable and replaceable from the cabinet either as a complete assembly or separately. Ensure that disconnection and reconnection of these units is through quick disconnect type connectors.

**4.3.CONSTRUCTION METHODS**

**A. General:**

Locate cabinet so as not to obstruct sight distance of vehicles turning on red.

At the controller cabinet where fiber optic cable is routed, coil a minimum of 20 feet of fiber optic cable in the cabinet as shown in the Plan.

Provide the Engineer with the serial number and cabinet identification number for each new controller and cabinet installed.

Furnish a cabinet wiring diagram on 22" by 34", non-fading sheet, for each cabinet (new and or reused). Wiring diagram shall meet or exceed the requirements of the Standard Specifications and



include complete diagrammatic representation of each field input and output and it's cabinet terminal connections. Provide to the Engineer digital files of the cabinet wiring diagram in MicroStation format for each intersection on a single CD. Provide a similar single CD with cabinet wiring diagrams in AutoCAD formats. File compression using the latest version of the PKZIP compression software is permitted.

Program local controller. Perform all data entry necessary to input timing parameters into the controllers. Install controller and perform wiring required to provide proper phasing and color sequence.

Furnish new fully tested and operational equipment.

Provide complete equipment documentation and warranties, to assure full and complete utilization of all equipment furnished.

Provide a certification that all controller hardware required for this project, which is unmodified from the CALTRANS TEES, or CALTRANS TSCES, and is included on the most current version of the CALTRANS Qualified Products List (QPL).

Provide a contact name, address, and telephone number of a person who shall be available for software support and technical questions. Response time for technical questions shall be 24 hours or less. Provide telephone technical support for a period of one year after final acceptance of the project.

Deliver a copy of the software/firmware in machine readable object code form, installed and tested as provided for in these Technical Specifications. Provide a copy of all source code on suitable magnetic or optical media and the corresponding source listings for the firmware to the Engineer prior to the system operational tests.

Furnish documentation for the communication protocol to the Engineer.

Provide two (2) copies of notebook computer software (either on CD or 1.44 megabyte, 3.5 inch diskettes).

#### **B. Local Controller and Cabinet Testing:**

Perform shop and field testing (both pre- and post-installation) on the 2070L controllers, cabinets, and related hardware.

Pre-Installation Tests The Contractor shall supply new controllers and cabinets to the Town of Cary Public Works Department, 400 James Jackson Avenue in Cary, a minimum of one (1) week prior to installation of the controller in the new cabinet. The Town of Cary will load the new software and observe the controller operating in the new cabinet in the traffic signal shop for a period no less than 72 hours prior to installation in the field.

Demonstrate to the Engineer that all of the equipment furnished and/or installed by the Contractor operates in full compliance with the Plans and these Technical Specifications.

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Conduct a diagnostic test for each and every new controller unit provided under this contract. The diagnostic test program shall test the operation of the Model 2070 controller unit, including but not limited to:

- Internal memory
- Real-time clock
- Input-output circuitry
- Operating system
- The display
- The keyboard

The program shall be capable of operating with an external notebook computer as well as with controller keypad entries and displays. The diagnostic test shall include the OS/9 validation suite diagnostic application described in the CALTRANS TEES. Full documentation of the program is required. Diagnostic Test Program features like those of the City of Los Angeles Department of Transportation are desired. Alternatives will be considered, but must be noted in the submittals.

The cost of the diagnostic testing programs shall be incidental to the controller assembly.

Following installation, a controller operation check-out shall be conducted for each new controller that has been furnished by the Contractor as part of this project. The Engineer reserves the right to direct the Contractor to make any and all adjustments to the controller timing to fully verify the functional operation of the equipment installed and to provide the required operation. These timing adjustments shall not relieve the Contractor of any responsibility otherwise set forth in the Plans, these Technical Specifications or the NCDOT Standard Specifications.

Install new fiber optic interconnect centers in accordance with the 2006 NCDOT Standard Specifications, article 1098-11.

#### **4.4.MEASUREMENT AND PAYMENT**

2070L Controller, Cary Compatible will be measured and paid as the actual number of traffic signal controller units furnished, installed, and accepted. No payment will be made for wiring, testing, modules, coprocessor boards, and controller operating system, as this work is considered incidental to furnishing and installing traffic signal controllers.

Detector Cards will be measured and paid as the actual number furnished, installed, and accepted.

NEMA TS-2 Cabinet (Base Mount), Cary Compatible will be measured and paid as the actual number of traffic signal cabinets furnished, installed, integrated, and accepted.

No direct payment will be made for the signal conflict monitor, malfunction management units, external electrical service disconnect, grounding systems, modems, meter bases, workshops, connectors, load switch packs, flashers, relays or other isolation devices, and other cabinet plug-in and harness-connected components. No direct payment will be made for radio interference suppressers and cabinet surge protection equipment. No direct payment will be made for painting

inventory numbers on the cabinet as described in the NCDOT Standard Specifications, as these will be considered incidental to furnishing and installing traffic signal cabinets.

The local controller software/firmware will be measured on a lump sum basis and shall include the license, source code, and documentation. No direct payment will be made since the Town of Cary is supplying the software and installation is incidental to installation of cabinet and controller.

Payment will be made under:

- 2070L Controller, Cary Compatible .....Each
- NEMA TS-2 Detector Card .....Each
- NEMA TS-2 Cabinet (Base Mount), Cary Compatible.....Each