



Illinois Department of Transportation

2300 South Dirksen Parkway / Springfield, Illinois / 62764

January 7, 2011

SUBJECT: FAI Route 80
Project ACIM-080-4 (190) 142
Section 99 (5 & 5-l) Y-1
Will County
Contract No. 60M59
Item No. 111, January 21, 2011 Letting
Addendum A

NOTICE TO PROSPECTIVE BIDDERS:

Attached is an addendum to the plans or proposal. This addendum involves revised and/or added material.

1. Replaced the Schedule of Prices.
2. Revised page iv of the Table of Contents to the Special Provisions.
3. Revised pages 63 - 73 & 93 - 96 of the Special Provisions.
4. Added pages 261 - 315 to the Special Provisions.
5. Added sheets 179A, 179B & 188A - 188R to the Plans.

Prime contractors must utilize the enclosed material when preparing their bid and must include any Schedule of Prices changes in their bidding proposal.

Bidders using computer-generated bids are cautioned to reflect any and all Schedule of Prices changes, if involved, into their computer programs.

Very truly yours,

Scott E. Stitt, P.E.
Acting Engineer of Design and Environment

A handwritten signature in cursive script, reading "Ted B. Walschleger P.E." with a small "P.E." to the right.

By: Ted B. Walschleger, P. E.
Engineer of Project Management

cc: Diane O'Keefe, Region 1, District 1; Mike Renner; D. Carl Puzey;
Estimates

TBW:MS:jc

ILLINOIS DEPARTMENT OF TRANSPORTATION
 SCHEDULE OF PRICES
 CONTRACT
 NUMBER -

60M59

State Job # - C-91-141-11
 PPS NBR - 1-77247-0700
 County Name - WILL - -
 Code - 197 - -
 District - 1 - -
 Section Number - 99 (5&5-1) Y-1

Project Number
 ACIM-0804/190/142

Route
 FAI 80

* REVISED : JANUARY 6, 2011

Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
K0029618	WEED CONT BROADLF TRF	GALLON	23.000				
K0029624	WEED CONTROL TEASEL	GALLON	7.500				
K0029632	WEED CONT N SEL/N RES	GALLON	25.000				
K1003660	MOWING CYCLES	EACH	2.000				
K1005418	TEMPORARY SEEDING	ACRE	7.000				
X0300247	REMOV WOOD POST	EACH	3.000				
X0320532	CONC BR DECK SCAR 3/8	SQ YD	2,491.000				
X0321750	REM TEMP CONC BAR SO	FOOT	18,442.000				
X0322118	REM CON FLAR END SEC	EACH	9.000				
X0322446	CAB HOUSING EQU TY 3	EACH	8.000				
X0322944	BR DK TH POLY OVL 3/8	SQ YD	3,520.000				
X0323260	SEDIMENT BASIN	EACH	3.000				
X0323898	CCTV DOME CAMERA	EACH	5.000				
* X0323914	FOC SPLICE - LATERAL	EACH	14.000				
X0323957	FOC SPLICE - MAINLINE	EACH	6.000				

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* X0325040	FO INNERDUCT 1 1/4"	FOOT	48,150.000				
X0325222	WEED CONT BASAL TRTMT	GALLON	10.000				
X0325748	ACRYLIC COATING	SQ YD	16.000				
X0325749	FIBER WRAP	SQ FT	260.000				
* X0325815	REMOVE EXISTING CABLE	FOOT	250.000				
X0326266	ETHERNET SWITCH	EACH	9.000				
X0326445	CONC BAR DBL FACE SPL	FOOT	1,087.000				
X0326465	MOD EX VID DSTN SYS	L SUM	1.000				
X0326945	CCTV CAMERA EQUIPMENT	EACH	5.000				
X0326946	CCTV CAMERA INSTALL	EACH	5.000				
X0326948	CCTV CAMERA STR 50 MH	EACH	5.000				
X0326949	CCTV CAMERA ST FD 30D	FOOT	80.000				
X0326964	FO INTERCONNECT CAB	EACH	1.000				
X0327113	MAN CONN OV EX CULVRT	EACH	5.000				
X0327114	RADAR VEH SENSING SYS	EACH	16.000				

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X0327115	RS232 ETHERNET CONVRT	EACH	16.000				
X0327116	SOLAR POWER ASSEMBLY	EACH	8.000				
X0327117	ATMS SYS INTEGRATION	L SUM	1.000				
X0327118	SP RVSD SSR ANT POLE	EACH	10.000				
X0327119	RVSD POLE ON BAR WALL	EACH	7.000				
* X0327129	DYN MS SN POW CAB CIP	EACH	3.000				
* X0327130	DMS F NTCIP 1203 V2 C	EACH	3.000				
X2020110	GRADING & SHAP SHLDRS	UNIT	278.000				
X2501800	SEEDING CL 4 MOD	ACRE	3.000				
X2503110	MOWING SPL	ACRE	0.250				
X2503315	INTERSEED CL 4A MOD	ACRE	23.000				
X6020091	MAN TA 6D T20 FG R-P	EACH	7.000				
X6300130	SPBGR TY A SPL	FOOT	38.000				
* X6310176	TRAF BAR TERM T2 SPL	EACH	1.000				
X6350120	DELINEATOR REMOVAL	EACH	40.000				

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X6370250	C BAR VAR X-SEC 42HT	FOOT	6,380.000				
X6370279	CONC BAR 1F 42HT SPL	FOOT	141.000				
X6700410	ENGR FLD OFF A SPL	CAL MO	12.000				
* X7010218	TRAF CONT & PROT SPL	EACH	6.000				
X7011015	TR C-PROT EXPRESSWAYS	L SUM	1.000				
X7030035	WET REF TEM TAPE T3 5	FOOT	1,930.000				
X8050010	SERV INSTALL GRND MT	EACH	3.000				
X8130360	JUN BX CC ES 20X13X12	EACH	2.000				
X8360105	LT POLE FDN INT BW 24	FOOT	70.000				
X8710035	FIB OPT CBL 96F SM	FOOT	53,500.000				
* X8710036	FIB OPT CBL 12F SM	FOOT	4,650.000				
X8710054	FO TERM PANEL 12F 24F	EACH	8.000				
Z0001050	AGG SUBGRADE 12	SQ YD	51,210.000				
Z0012710	CONC HDWL - P UNDR RM	EACH	61.000				
Z0012754	STR REP CON DP = < 5	SQ FT	24.000				

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Z0013798	CONSTRUCTION LAYOUT	L SUM	1.000				
Z0014800	CULVERT TO BE CLEANED	FOOT	1,714.000				
Z0023600	FILL EXIST CULVERTS	EACH	2.000				
Z0029999	IMPACT ATTENUATOR REM	EACH	1.000				
Z0030030	IMP ATTEN FRD NAR TL3	EACH	2.000				
* Z0030130	IMPACT ATTEN PRD TL3	EACH	2.000				
Z0030250	IMP ATTN TEMP NRD TL3	EACH	7.000				
Z0033028	MAINTAIN LIGHTING SYS	CAL MO	10.000				
Z0033052	COMMUNICATIONS VAULT	EACH	30.000				
Z0042002	POROUS GRAN EMB SUBGR	CU YD	595.000				
Z0048665	RR PROT LIABILITY INS	L SUM	1.000				
Z0056220	SAND MOD IMP ATT REM	EACH	2.000				
Z0064800	SELECTIVE CLEARING	UNIT	998.000				
Z0065700	SLOPE WALL REPAIR	SQ YD	108.000				
Z0076870	UNDR CONNECT TO STR	EACH	88.000				

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* 20100110	TREE REMOV 6-15	UNIT	245.000				
* 20100210	TREE REMOV OVER 15	UNIT	203.000				
* 20101300	TREE PRUN 1-10	EACH	76.000				
* 20101350	TREE PRUN OVER 10	EACH	53.000				
20200100	EARTH EXCAVATION	CU YD	18,059.000				
20201200	REM & DISP UNS MATL	CU YD	13,034.000				
20800150	TRENCH BACKFILL	CU YD	11,907.000				
21001000	GEOTECH FAB F/GR STAB	SQ YD	3,960.000				
* 21101605	TOPSOIL F & P 2	SQ YD	112,500.000				
21101615	TOPSOIL F & P 4	SQ YD	19,360.000				
* 25000210	SEEDING CL 2A	ACRE	1.360				
* 25000400	NITROGEN FERT NUTR	POUND	187.000				
* 25000500	PHOSPHORUS FERT NUTR	POUND	187.000				
* 25000600	POTASSIUM FERT NUTR	POUND	187.000				
25000750	MOWING	ACRE	40.000				

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* 25100105	MULCH METHOD 1	ACRE	4.360				
25100115	MULCH METHOD 2	ACRE	3.000				
* 25100630	EROSION CONTR BLANKET	SQ YD	6,278.000				
28000305	TEMP DITCH CHECKS	FOOT	735.000				
28000400	PERIMETER EROS BAR	FOOT	3,597.000				
28000500	INLET & PIPE PROTECT	EACH	225.000				
28100101	STONE RIPRAP CL A1	SQ YD	230.000				
28100107	STONE RIPRAP CL A4	SQ YD	230.000				
28200200	FILTER FABRIC	SQ YD	230.000				
31200502	STAB SUBBASE HMA 4.5	SQ YD	54,580.000				
42001300	PROTECTIVE COAT	SQ YD	16,650.000				
42001420	BR APPR PVT CON (PCC)	SQ YD	823.000				
44000100	PAVEMENT REM	SQ YD	445.000				
* 44001980	CONC BARRIER REMOV	FOOT	47.000				
* 44004250	PAVED SHLD REMOVAL	SQ YD	11.000				

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44200577	CL A PATCH T2 12	SQ YD	40.000				
44200581	CL A PATCH T3 12	SQ YD	140.000				
44213000	PATCH REINFORCEMENT	SQ YD	180.000				
44213200	SAW CUTS	FOOT	780.000				
44213204	TIE BARS 3/4	EACH	220.000				
48101200	AGGREGATE SHLDS B	TON	1,028.000				
48101500	AGGREGATE SHLDS B 6	SQ YD	488.000				
* 48300705	PCC SHOULDERS 12 1/4	SQ YD	48,542.000				
50102400	CONC REM	CU YD	214.400				
50104400	CONC HDWL REM	EACH	1.000				
50105220	PIPE CULVERT REMOV	FOOT	15.000				
50157300	PROTECTIVE SHIELD	SQ YD	197.000				
50300100	FLOOR DRAINS	EACH	12.000				
* 50300225	CONC STRUCT	CU YD	56.200				
50300255	CONC SUP-STR	CU YD	426.800				

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50300300	PROTECTIVE COAT	SQ YD	551.000				
50500105	F & E STRUCT STEEL	L SUM	1.000				
50500505	STUD SHEAR CONNECTORS	EACH	2,748.000				
* 50800205	REINF BARS, EPOXY CTD	POUND	118,450.000				
50800515	BAR SPLICERS	EACH	156.000				
51500100	NAME PLATES	EACH	2.000				
52000110	PREF JT STRIP SEAL	FOOT	364.000				
52100010	ELAST BEARING ASSY T1	EACH	8.000				
52100020	ELAST BEARING ASSY T2	EACH	4.000				
52100520	ANCHOR BOLTS 1	EACH	24.000				
52100530	ANCHOR BOLTS 1 1/4	EACH	8.000				
54213669	PRC FLAR END SEC 24	EACH	1.000				
54213675	PRC FLAR END SEC 30	EACH	1.000				
54213681	PRC FLAR END SEC 36	EACH	2.000				
54215442	CIP RC END SEC 42	EACH	3.000				

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54247130	GRATING-C FL END S 24	EACH	1.000				
54247150	GRATING-C FL END S 30	EACH	1.000				
54247170	GRATING-C FL END S 36	EACH	2.000				
550A0340	STORM SEW CL A 2 12	FOOT	733.000				
550A0360	STORM SEW CL A 2 15	FOOT	945.000				
550A0380	STORM SEW CL A 2 18	FOOT	2,285.000				
550A0400	STORM SEW CL A 2 21	FOOT	750.000				
550A0410	STORM SEW CL A 2 24	FOOT	3,251.000				
550A0430	STORM SEW CL A 2 30	FOOT	3,333.000				
550A0450	STORM SEW CL A 2 36	FOOT	3,484.000				
550A0470	STORM SEW CL A 2 42	FOOT	1,105.000				
550A0480	STORM SEW CL A 2 48	FOOT	1,280.000				
55200900	STORM SEWERS JKD 24	FOOT	91.000				
55201100	STORM SEWERS JKD 30	FOOT	83.000				
55201300	STORM SEWERS JKD 36	FOOT	270.000				

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55201500	STORM SEWERS JKD 42	FOOT	307.000				
58600100	SAND BACKFILL	CU YD	35.000				
58700300	CONCRETE SEALER	SQ FT	2,815.000				
59000200	EPOXY CRACK INJECTION	FOOT	120.000				
60107700	PIPE UNDERDRAINS 6	FOOT	36,410.000				
60108200	PIPE UNDERDRAIN 6 SP	FOOT	528.000				
60201310	CB TA 4 DIA T20F&G	EACH	90.000				
60201320	CB TA 4 DIA T21F&G	EACH	6.000				
60219510	MAN TA 4 DIA T20F&G	EACH	19.000				
60221100	MAN TA 5 DIA T1F CL	EACH	9.000				
60222210	MAN TA 5 DIA T20F&G	EACH	67.000				
60222220	MAN TA 5 DIA T21F&G	EACH	6.000				
60224035	MAN TA 6 DIA T20F&G	EACH	15.000				
60500050	REMOV CATCH BAS	EACH	7.000				
60500060	REMOV INLETS	EACH	4.000				

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60618320	CONC MEDIAN SURF 6	SQ FT	325.000				
* 63000001	SPBGR TY A 6FT POSTS	FOOT	1,138.000				
63100089	TRAF BAR TERM T6B	EACH	2.000				
* 63100167	TR BAR TRM T1 SPL TAN	EACH	4.000				
63200310	GUARDRAIL REMOV	FOOT	1,300.000				
63301210	REM RE-E SPBGR TY A	FOOT	150.000				
63700175	CONC BAR 1F 42HT	FOOT	141.000				
* 63700275	CONC BAR 2F 42HT	FOOT	10,260.000				
63700805	CONC BAR TRANS	FOOT	174.000				
* 63700900	CONC BARRIER BASE	FOOT	18,041.000				
64200105	SHOULDER RUMBLE STRIP	FOOT	49,630.000				
66700205	PERM SURV MKRS T1	EACH	4.000				
66700705	FUR ERECT DRAIN MKRS	EACH	7.000				
67100100	MOBILIZATION	L SUM	1.000				
70102620	TR CONT & PROT 701501	L SUM	1.000				

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* 70104205	TC-PROT 701401 LOC 1	EACH	2.000				
* 70104210	TC-PROT 701401 LOC 2	EACH	2.000				
* 70104215	TC-PROT 701401 LOC 3	EACH	2.000				
* 70106800	CHANGEABLE MESSAGE SN	CAL MO	25.000				
70300520	PAVT MARK TAPE T3 4	FOOT	85,460.000				
70300550	PAVT MARK TAPE T3 8	FOOT	1,810.000				
70300560	PAVT MARK TAPE T3 12	FOOT	210.000				
70301000	WORK ZONE PAVT MK REM	SQ FT	29,903.000				
* 70400100	TEMP CONC BARRIER	FOOT	43,055.000				
70400200	REL TEMP CONC BARRIER	FOOT	3,500.000				
70400500	TEMP CON BAR ST OWN	FOOT	522.000				
70400600	REL TEMP CONC BAR SO	FOOT	18,410.000				
72000100	SIGN PANEL T1	SQ FT	13.000				
72000200	SIGN PANEL T2	SQ FT	466.000				
72000300	SIGN PANEL T3	SQ FT	1,980.000				

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72400100	REMOV SIN PAN ASSY TA	EACH	10.000				
72400200	REMOV SIN PAN ASSY TB	EACH	18.000				
72400330	REMOV SIGN PANEL T3	SQ FT	2,013.000				
72600100	MILEPOST MKR ASSEMBLY	EACH	16.000				
72800100	TELES STL SIN SUPPORT	FOOT	76.000				
73000100	WOOD SIN SUPPORT	FOOT	506.000				
73100100	BASE TEL STL SIN SUPP	EACH	1.000				
* 73300300	OVHD SIN STR-SPAN T3A	FOOT	290.000				
* 73301810	OSS WALKWAY TY A	FOOT	126.000				
* 73400200	DRILL SHAFT CONC FDN	CU YD	77.800				
73700100	REM GR MT SIN SUPPORT	EACH	2.000				
73700200	REM CONC FDN-GR MT	EACH	2.000				
78008210	POLYUREA PM T1 LN 4	FOOT	75,031.000				
78008220	POLYUREA PM T1 LN 5	FOOT	19,225.000				
78008240	POLYUREA PM T1 LN 8	FOOT	6,792.000				

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78008250	POLYUREA PM T1 LN 12	FOOT	3,628.000				
78100100	RAISED REFL PAVT MKR	EACH	925.000				
78100105	RAISED REF PVT MKR BR	EACH	25.000				
78100300	REPLACEMENT REFLECTOR	EACH	154.000				
78200100	MONODIR PRIS BAR REFL	EACH	95.000				
* 78200410	GUARDRAIL MKR TYPE A	EACH	104.000				
* 78200530	BAR WALL MKR TYPE C	EACH	3,083.000				
78201000	TERMINAL MARKER - DA	EACH	3.000				
78300100	PAVT MARKING REMOVAL	SQ FT	26,705.000				
* 80400100	ELECT SERV INSTALL	EACH	3.000				
80400200	ELECT UTIL SERV CONN	L SUM	1.000		3,000.000		3,000.000
* 81000500	CON T 1 1/2 GALVS	FOOT	90.000				
* 81000600	CON T 2 GALVS	FOOT	1,095.000				
* 81000800	CON T 3 GALVS	FOOT	275.000				
* 81012600	CON T 2 PVC	FOOT	1,235.000				

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81013000	CON T 4 PVC	FOOT	18,200.000				
* 81018600	CON P 2 1/2 GALVS	FOOT	1,380.000				
81018700	CON P 3 GALVS	FOOT	1,210.000				
81018900	CON P 4 GALVS	FOOT	430.000				
81101005	CON AT ST 4 PVC GALVS	FOOT	220.000				
* 81200230	CON EMB STR 2 PVC	FOOT	40.000				
81300960	JUN BX SS AS 42X36X12	EACH	2.000				
* 81400200	HD HANDHOLE	EACH	20.000				
81603037	UD 2#6#6G XLP USE 1.25	FOOT	1,600.000				
* 81702400	EC C XLP USE 3-1C 2	FOOT	1,200.000				
* 81702415	EC C XLP USE 3-1C 6	FOOT	535.000				
* 81702460	EC C XLP USE 3-1C 3/0	FOOT	1,250.000				
* 81800300	A CBL 3-1C2 MESS WIRE	FOOT	250.000				
* 81900200	TR & BKFIL F ELECT WK	FOOT	23,050.000				
83600200	LIGHT POLE FDN 24D	FOOT	100.000				

ILLINOIS DEPARTMENT OF TRANSPORTATION
 SCHEDULE OF PRICES
 CONTRACT
 NUMBER - 60M59

State Job # - C-91-141-11
 PPS NBR - 1-77247-0700
 County Name - WILL - -
 Code - 197 - -
 District - 1 - -
 Section Number - 99 (5&5-1) Y-1

Project Number
 ACIM-0804/190/142

Route
 FAI 80

* REVISED : JANUARY 6, 2011

Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
83800105	BKWY DEV TR B 11.5BC	EACH	10.000				
84200600	REM LT U NO SALV	EACH	3.000				
* 87301715	ELCBL C COMM 18 6 PR	FOOT	150.000				
87800200	CONC FDN TY D	FOOT	40.000				
89502200	MOD EX CONTR	EACH	2.000				

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Switching method: store and forward
Switching latency shall be less than 10 us.
Switching bandwidth shall be more than 1.5 Gbps
MAC address table size shall be at least 16 Kbytes
Priority Queues: 4 or greater
Frame buffer memory: 1MBit or greater
VLANS: 4096 or greater
IGMP multicast groups: 256 or greater
Port rate limiting: 128 kbps, 256, 512, 4, 8 Mbps

14.0 Approvals: The Ethernet switch must have the following approvals:

ISO: Designed, and manufactured using ISO 9001: 2000 certified quality program
Emissions: FCC Part 15 (Class A) EN 55022 (CISPR22 Class A)
Safety: UL 60950
Laser Eye Safety: (FDA/CDRH): complies with 21 CFR Chapter 1, Subchapter J
IETF RFC 894 – IP over Ethernet

15.0 Warranty: The Ethernet switch shall have a minimum 5 year warranty in design and manufacture

16.0 METHOD OF MEASUREMENT: This item shall be measured ETHERNET SWITCH, installed each, tested, operational and complete

17.0 BASIS OF PAYMENT

This work shall consist of furnishing all labor, materials, equipment, setup and testing to supply and install an ETHERNET SWITCH, complete in accordance with the contract drawings and these special provisions. Miscellaneous connectors, cables and Ethernet cables shall be included in the unit price.

FIBER OPTIC CABLE, SINGLE MODE

Effective: January 1, 2011

Description. The Contractor shall furnish and install loose-tube, single-mode, fiber optic cable of the number of fibers specified as shown in the plans and as directed by the Engineer.

Other ancillary components, required to complete the fiber optic cable plant, including but not limited to, moisture and water sealants, cable caps, fan-out kits, etc., shall be included in the cost of fiber optic cable and will not be paid for separately.

Materials The single-mode, fiber optic cable shall incorporate a loose, buffer-tube design. The cable shall be an accepted product of the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 and meet the requirements of ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-1999 for a single sheathed, non-armored cable, and shall be new, unused and of current design and manufacture.

Fibers.

The cables shall use dispersion unshifted fibers. The optical and physical characteristics of the un-cabled fibers shall include:

The single-mode fiber shall meet EIA/TIA-492CAAA, "Detail Specification for Class Iva Dispersion-Unshifted Single-Mode Optical Fibers," and ITU recommendation G.652.D, "Characteristics of a single-mode optical fiber cable."

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Physical Construction			
Requirement		Units	Value
Cladding Diameter		(μm)	125.0 \pm 0.7
Core-to-Cladding Concentricity		(μm)	\leq 0.5
Cladding Non-Circularity			\leq 0.7 %
Mode Field Diameter	1310 nm	(μm)	9.2 \pm 0.4
	1550 nm		10.4 \pm 0.5
Coating Diameter		(μm)	245 \pm 5
Colored Fiber Nominal Diameter		(μm)	253 - 259
Fiber Curl radius of curvature		(m)	> 4.0 m

Optical Characteristics			
Requirement		Units	Value
Cabled Fiber Attenuation	1310 nm	(dB/km)	\leq 0.4
	1550 nm		\leq 0.3
Point discontinuity	1310 nm	(dB)	\leq 0.1
	1550 nm		\leq 0.1
Macrobend Attenuation	Turns	Mandrel OD	
	1	32 \pm 2 mm	< 0.05 at 1550 nm
	100	50 \pm 2 mm	< 0.05 at 1310 nm
	100	50 \pm 2 mm	< 0.10 at 1550 nm
	100	60 \pm 2 mm	< 0.05 at 1550 nm
100	60 \pm 2 mm	< 0.05 at 1625 nm	
Cable Cutoff Wavelength (λ_{cct})		(nm)	< 1260
Zero Dispersion Wavelength (λ_0)		(nm)	1302 \leq λ_0 \leq 1322
Zero Dispersion Slope (S_0)		(ps/(nm ² •km))	\leq 0.089
Total Dispersion	1550 nm	(ps/(nm•km))	\leq 3.5
	1285-1330 nm		\leq 17.5
	1625 nm		\leq 21.5
Cabled Polarization Mode Dispersion		(ps/km ²)	\leq 0.2
IEEE 802.3 GbE - 1300 nm Laser Distance		(m)	up to 5000
Water Peak Attenuation: 1383 \pm 3 nm		(dB/km)	\leq 0.4

Cable Construction.

The number of fibers in each cable shall be as specified on the plans.

Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm. Each buffer tube shall contain up to 12 fibers. The fibers shall not adhere to the inside of the buffer tube.

Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." The fibers shall be colored with ultraviolet (UV) curable inks.

Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

For cables containing more than 12 buffer tubes, standard colors are used for tubes 1 through 12 and stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.

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In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and shall not be subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.

Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm or 3.0 mm in outer diameter.

The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod (optional steel central member). The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be overcoated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

Each buffer tube shall contain a water-swellable yarn for water-blocking protection. The water-swellable yarn shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn will preclude the need for other water-blocking material; the buffer-tube shall be gel-free. The optical fibers shall not require cleaning before placement into a splice tray or fan-out kit.

Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process.

Water swellable yarn(s) shall be applied longitudinally along the central member during stranding.

Two polyester yarn binders shall be applied contrahelically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

The cables shall contain one ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by the central member, and additional dielectric yarns as required.

The dielectric yarns shall be helically stranded evenly around the cable core.

The cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members (as required) and water swellable tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

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The jacket or sheath shall be free of holes, splits, and blisters.

The cable jacket shall contain no metal elements and shall be of a consistent thickness.

Cable jackets shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESC), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more co-extruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

The maximum pulling tension shall be 2700 N (608 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be -30°C to +70°C.

General Cable Performance Specifications

The fiber optic cable manufacturer shall provide documentation and certify that the fiber optic cable complies with the following EIA-455-~~xxx~~ Fiber Optic Test Procedures (FOTP):

When tested in accordance with FOTP-3, "*Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components*," the change in attenuation at extreme operational temperatures (-40°C and +70°C) shall not exceed 0.15 dB/km at 1550 nm for single-mode fiber and 0.3 dB/km at 1300 nm for multimode fiber.

When tested in accordance with FOTP-82, "*Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable*," a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

When tested in accordance with FOTP-81, "*Compound Flow (Drip) Test for Filled Fiber Optic Cable*," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 70°C.

When tested in accordance with FOTP-41, "*Compressive Loading Resistance of Fiber Optic Cables*," the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fibers and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-104, "*Fiber Optic Cable Cyclic Flexing Test*," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-25, "*Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies*," except that the number of cycles shall be two at three locations along a one meter cable length and the impact energy shall be at least 4.4 Nm (in accordance with ICEA S-87-640)", the change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.

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When tested in accordance with FOTP-33, "*Fiber Optic Cable Tensile Loading and Bending Test*," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670N (601 lbf) and residual load of 30% of the rated installation load. The axial fiber strain shall be $\leq 60\%$ of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load. The axial fiber strain shall be $\leq 20\%$ of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.15 dB at 1550 nm for single mode fiber and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-85, "*Fiber Optic Cable Twist Test*," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-37, "*Low or High Temperature Bend Test for Fiber Optic Cable*," the cable shall withstand four full turns around a mandrel of ≤ 20 times the cable diameter after conditioning for four hours at test temperatures of -30°C and $+60^{\circ}\text{C}$. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or other openings. The change in attenuation shall not exceed 0.30 dB at 1550 nm for single mode fiber and 0.50 dB at 1300 nm for multimode fiber.

Quality Assurance Provision

All cabled optical fibers > 1000 meters in length shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel. The cable manufacturer shall be TL 9000 registered.

Packaging

Top and bottom ends of the cable shall be available for testing. Both ends of the cable shall be sealed to prevent the ingress of moisture. Each reel shall have a weather resistant reel tag attached identifying the reel and cable. The reel tag shall include the following information:

- Cable Number
- Gross Weight
- Shipped Cable Length in Meters
- Job Order Number
- Product Number
- Customer Order Number
- Date Cable was Tested
- Manufacturer Order Number
- Cable Length Markings
 - a: Top (inside end of cable)
 - b: Bottom (outside end of cable)

The reel (one flange) marking shall include:

- Manufacturer
- Country of origin
- An arrow indicating proper direction of roll when handling
- Fork lift-handling illustration
- Handling Warnings.

Each cable shall be accompanied by a cable data sheet. The cable data sheet shall include the following information:

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- Manufacturer Cable Number
- Manufacturer Product Number
- Manufacturer Factory Order Number
- Customer Name
- Customer Cable Number
- Customer Purchase Order Number
- Mark for Information
- Ordered Length
- Maximum Billable Length
- Actual Shipped Length
- Measured Attenuation of Each Fiber

The cable shall be capable of withstanding a minimum-bending radius of 20 times its outer diameter during installation and 10 times its outer diameter during operation without changing the characteristics of the optical fibers.

The cable shall meet all of specified requirements under the following conditions:

- Shipping/storage temperature: -58° F to +158° F (-50° C to +70° C)
- Installation temperature: -22° F to +158° F (-30° C to +70° C)
- Operating temperature: -40° F to +158° F (-40° C to +70° C)
- Relative humidity from 0% to 95%, non-condensing

Optical Patch Cords and Pigtails.

The optical patch cords and pigtails shall comply with the following:

- The optical patch cords shall consist of a section of single fiber, jacketed cable equipped with optical connectors at both ends.
- The factory installed connector furnished as part of the optical patch cords and pigtails shall meet or exceed the requirements for approved connectors specified herein.
- The fiber portion of each patch cord and pigtail shall be a single, jacketed fiber with optical properties identical to the optical cable furnished under this contract.
- The twelve fiber single-mode fiber optic cable shall be installed as a pigtail with factory installed ST compatible connectors.
- The patch cords shall comply with Telcordia GR-326-CORE

Connectors.

The optical connectors shall comply with the following:

- All connectors shall be factory installed ST compatible connectors. Field installed connectors shall not be allowed.
- Maximum attenuation 0.4dB, typical 0.2dB.
- No more than 0.2dB increase in attenuation after 1000 insertions.
- Attenuation of all connectors will be checked and recorded at the time of installation with an insertion test minimum 5 times checked with an OTDR.
- All fibers shall be connectorized at each end.
- All fibers shall terminate at a fiber patch panel
- Unused fibers will be protected with a plastic cap to eliminate dust and moisture.
- Termination shall be facilitated by splicing factory OEM pigtails on the end of the bare fiber utilizing the fusion splicing method. Pigtails shall be one meter in length.

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CONSTRUCTION REQUIREMENTS

Experience Requirements.

Personnel involved in the installation, splicing and testing of the fiber optic cables shall meet the following requirements:

- A minimum of three (3) years experience in the installation of fiber optic cables, including fusion splicing, terminating and testing single mode fibers.
- Install two systems where fiber optic cables are outdoors in conduit and where the systems have been in continuous satisfactory operation for at least two years. The Contractor shall submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the installed fiber optic systems.
- One fiber optic cable system (which may be one of the two in the preceding paragraph), which the Contractor can arrange for demonstration to the Department representatives and the Engineer.

Installers shall be familiar with the cable manufacturer's recommended procedures for installing the cable. This shall include knowledge of splicing procedures for the fusion splicer being used on this project and knowledge of all hardware such as breakout (furcation) kits and splice closures. The Contractor shall submit documented procedures to the Engineer for approval and to be used by Construction inspectors.

Personnel involved in testing shall have been trained by the manufacturer of the fiber optic cable test equipment to be used, in fiber optic cable testing procedures. Proof of this training shall be submitted to the Engineer for approval. In addition, the Contractor shall submit documentation of the testing procedures and a copy of the test equipment operation manual for approval by the Engineer.

Installation in Raceways.

The Contractor shall provide a cable-pulling plan, identifying where the cable will enter the underground system and the direction of pull. This plan will address locations where the cable is pulled out of a handhole, coiled in a figure eight, and pulled back into the hand hole. The plan shall address the physical protection of the cable during installation and during periods of downtime. The cable-pulling plan shall be provided to the Engineer for approval a minimum of 15 working days prior to the start of installation. The Engineer's approval shall be for the operation on the freeway and does not include an endorsement of the proposed procedures. The Contractor is responsible for the technical adequacy of the proposed procedures.

During cable pulling operations, the Contractor shall ensure that the minimum bending of the cable is maintained during the unreeling and pulling operations. Entry guide chutes shall be used to guide the cable into the handhole conduit ports. Lubricating compound shall be used to minimize friction. Corner rollers (wheels), if used, shall not have radii less than the minimum installation-bending radius of the cable. A series array of smaller wheels can be used for accomplishing the bend if the cable manufacturers specifically approve the array.

The pulling tension shall be continuously measured and shall not be allowed to exceed the maximum tension specified by the manufacturer of the cable. Fuse links and breaks can be used to ensure that the cable tensile strength is not exceeded. The pulling system shall have an audible alarm that sounds whenever a pre-selected tension level is reached. Tension levels shall be recorded continuously and shall be given to the Engineer.

The cable shall be pulled into the conduit as a single component, absorbing the pulling force in all tension elements. The central strength member and Aramid yarn shall be attached directly to the pulling eye during cable pulling.

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"Basket grip" or "Chinese-finger type" attachments, which only attach to the cable's outer jacket, shall not be permitted. A breakaway swivel, rated at 95% of the cable manufacturer's approved maximum tensile loading, shall be used on all pulls. When simultaneously pulling fiber optic cable with other cables, separate grooved rollers shall be used for each cable.

To minimize the exposure of the backbone cable and to facilitate the longer lengths of fiber optic cable, the Contractor shall use a "blown cable" (pneumatically assisted) technique to place the fiber optic cable.

Where cable is to be pulled through existing conduit which contains existing cables, optical or other, the existing cables shall be removed and reinstalled with the fiber optic cable as indicated on the plans. The removal of the cable(s) shall be paid for separately. Reinstallation of the existing cables, if indicated on the plans, along with the fiber optic cable shall be included in this item for payment.

Tracer Wire

A tracer wire shall be installed with all fiber optic cable runs. One tracer wire shall be installed along with the fiber optic cable in each raceway. If a raceway has more than one fiber optic cable, only one tracer wire per raceway is required. If there are parallel raceways, a tracer wire is required in each raceway that contains a fiber optic cable. Tracer wire shall be installed in raceway segments which are metallic to provide a continuous tracer wire system.

The tracer wire shall be a direct burial rated, number 12 AWG (minimum) solid (.0808" diameter), steel core soft drawn high strength tracer wire. The wire shall have a minimum 380 pound average tensile break strength. The wire shall have a 30 mil high density yellow polyethylene (HDPE) jacket complying with ASTM-D-1248, and a 30 volt rating.

Connection devices used shall be as approved by the tracer wire manufacturer, except wire nuts of any type are not acceptable and shall not be used.

The cost of the tracer wire shall be included in the cost of the fiber optic cable and not paid for separately.

Construction Documentation Requirements

Installation Practices for Outdoor Fiber Optic Cable Systems

The Contractor shall examine the proposed cable plant design. At least one month prior to starting installation of the fiber optic cable plant, the Contractor shall prepare and submit to the Engineer for review and approval, ten (10) copies of the Contractor's "Installation Practices for Outdoor Fiber Optic Cable Systems" manual. This manual shall address the Contractor's proposed practices covering all aspects of the fiber optic cable plant. This submittal shall include all proposed procedures, list of installation equipment, and splicing and test equipment. Test and quality control procedures shall be detailed as well as procedures for corrective action.

Operation and Maintenance Documentation

After the fiber optic cable plant has been installed, ten (10) complete sets of Operation and Maintenance Documentation shall be provided. The documentation shall, as a minimum, include the following:

- Complete and accurate as-built diagrams showing the entire fiber optic cable plant including locations of all splices.
- Final copies of all approved test procedures
- Complete performance data of the cable plant showing the losses at each splice location and each terminal connector.
- Complete parts list including names of vendors.

Testing Requirements

The Contractor shall submit detailed test procedures for approval by the Engineer.

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All fibers (terminated and unterminated) shall be tested bi-directionally at both 1310 nm and 1550 nm with both an Optical Time Domain Reflectometer (OTDR) and a power meter with an optical source.

For testing, intermediate breakout fibers may be concatenated and tested end-to-end. Any discrepancies between the measured results and these specifications will be resolved to the satisfaction of the Engineer. Unterminated (non-connectorized) fibers shall be tested with an approved bare fiber adapter.

The Contractor shall provide the date, time and location of any tests required by this specification to the Engineer at least 5 days before performing the test. Upon completion of the cable installation, splicing, and termination, the Contractor shall test all fibers for continuity, events above 0.1 dB, and total attenuation of the cable. The test procedure shall be as follows:

A Certified Technician utilizing an Optical Time Domain Reflectometer (OTDR) and Optical Source/Power Meter shall conduct the installation test. The Technician is directed to conduct the test using the standard operating procedures defined by the manufacturer of the test equipment. All fibers installed shall be tested in both directions.

A fiber ring or fiber box shall be used to connect the OTDR to the fiber optic cable under test at both the launch and receive ends. The tests shall be conducted at 1310 and 1550 nm for all fibers.

At the completion of the test, the Contractor shall provide two copies of documentation of the test results to the Project Engineer. The test documentation shall be submitted as both a bound copy and a CDROM and shall include the following:

Cable & Fiber Identification:

- Cable ID
- Cable Location - beginning and end point
- Fiber ID, including tube and fiber color
- Wavelength
- Pulse width (OTDR)
- Refractory index (OTDR)
- Operator Name
- Date & Time
- Setup Parameters
- Range (OTDR)
- Scale (OTDR)
- Setup Option chosen to pass OTDR "dead zone"

Test Results shall include:

- OTDR Test results
- Total Fiber Trace
- Splice Loss/Gain
- Events > 0.10 dB
- Measured Length (Cable Marking)
- Total Length (OTDR)
- Optical Source/Power Meter Total Attenuation (dB/km)

Sample Power Meter Tabulation:

Power Meter Measurements (dB)									
Location		Fiber No.	Cable Length (km)	A to B		B to A		Bidirectional Average	
A	B			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
		1							
		2							
Maximum Loss									
Minimum Loss									

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The OTDR test results file format must be Bellcore/Telcordia compliant according to GR-196-CORE Issue 2, OTDR Data Standard, GR 196, Revision 1.0, GR 196, Revision 1.1, GR 196, Revision 2.0 (SR-4731) in a “.SOR” file format. These results shall also be provided in tabular form, see sample below:

Sample OTDR Summary				
Cable Designation:	<i>TCF-1K-03</i>	OTDR Location:	<i>Pump Sta. 67</i>	Date: <i>1/1/00</i>
Fiber Number	Event Type	Event Location	Event Loss (dB)	
			1310 nm	1550 nm
<i>1</i>	<i>Splice</i>	<i>23500 Ft.</i>	<i>.082</i>	<i>.078</i>
<i>1</i>	<i>Splice</i>	<i>29000 Ft.</i>	<i>.075</i>	<i>.063</i>
<i>2</i>	<i>Splice</i>	<i>29000 Ft.</i>	<i>.091</i>	<i>.082</i>
<i>3</i>	<i>Splice</i>	<i>26000 Ft.</i>	<i>.072</i>	<i>.061</i>
<i>3</i>	<i>Bend</i>	<i>27000 Ft.</i>	<i>.010</i>	<i>.009</i>

The following shall be the criteria for the acceptance of the cable:

The test results shall show that the dB/km loss does not exceed +3% of the factory test or 1% of the cable's published production loss. However, no event shall exceed 0.10 dB. If any event is detected above 0.10 dB, the Contractor shall replace or repair the fiber including that event point.

The total loss of the cable (dB), less events, shall not exceed the manufacturer's production specifications as follows: 0.5 dB/km at both 1310 and 1550 nm.

If the total loss exceeds these specifications, the Contractor shall replace or repair that cable run at the no additional cost to the state, both labor and materials. Elevated attenuation due to exceeding the pulling tension during installation shall require the replacement of the cable run at no additional cost to the State, including labor and materials.

Splicing Requirements

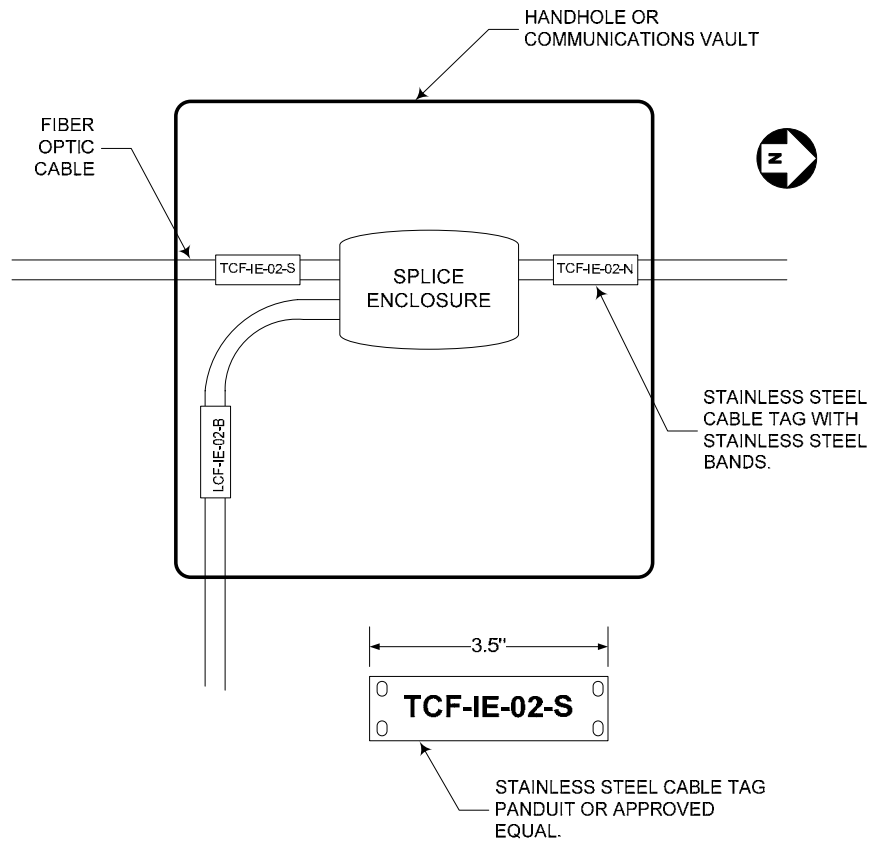
Splices shall be made at locations shown on the Plans. Any other splices shall be permitted only with the approval of the Engineer. Splices will be paid for separately.

Slack Storage of Fiber Optic Cables.

Included as a part of this item, slack fiber shall be supplied as necessary to allow splicing the fiber optic cables in a controlled environment, such as a splicing van or tent. After splicing has been completed, the slack fiber shall be stored underground in handholes or in the raised base adapters of ground mounted cabinets in accordance with the fiber optic cable manufacturer's guidelines. Fiber optic cable slack shall be 100 feet for each cable at each splice location, above or below ground. Fiber optic cable slack shall be 50 feet for each cable at access points, above or below ground, where splicing is not involved. This slack shall be measured for payment.

Fiber optic cable shall be tagged inside handholes with yellow tape containing the text: "CAUTION - FIBER OPTIC CABLE." In addition, permanent tags, as approved by the engineer, shall be attached to all cable in a hand hole or other break-out environment. These tags shall be stainless steel, nominally 0.75" by 1.72", and permanently embossed. These tags shall be attached with stainless steel straps, and shall identify the cable number, the number of fibers, and the specific fiber count. Tags and straps shall be Panduit or approved equal. See figure below:

Revised 01/07/2011



NOTES:

1. INNER DUCT NOT SHOWN FOR CLARITY.
2. CABLE SLACK NOT SHOWN FOR CLARITY.
3. CONFIRM CABLE DESIGNATIONS WITH ENGINEER DURING SHOP DRAWING SUBMITTAL.

Label the destination of each trunk cable onto the cable in each handhole, vault or cable termination panel.

Method of Measurement Fiber optic cable will be measured for payment in feet in place installed and tested. Fiber optic cable will be measured horizontally and vertically between the changes in direction, including slack cable. The entire lengths of cables installed in buildings will be measured for payment

Basis of Payment This work will be paid for at the contract unit price per foot for **FIBER OPTIC CABLE** of the type, size, and number of fibers specified. Payment shall not be made until the cable is installed, spliced and tested in compliance with these special provisions.

Revised 01/07/2011

One copy of the wiring diagrams for each cabinet shall be retained in each field cabinet. Wiring diagram shall be contained in a plastic pouch that shall be permanently mounted to the door of each cabinet. Contractor shall permanently mark the cabinet for each termination and each terminal connection.

Incidental to the cost of each cabinet, the Contractor shall construct 5" (127mm) P.C.C. sidewalk of a rectangular area 3' x 4' (1 meter by 1.2m) immediately adjacent to the cabinet foundation on the same side of the foundation as the cabinet door, with the 4' (1.2m) dimension of the rectangle parallel to the cabinet door when closed. If the width of the required cabinet foundation is greater than the 3 feet (1 meter) width of the standard concrete foundation. Type D, the 4' (1.2m) dimension of the sidewalk area shall be increased to equal the width of the foundation plus 1ft (30 cm), the area to extend 6" (15cm) beyond each side of the foundation. This paragraph shall be applicable at all cabinet locations included in this Section. The only situations where this paragraph shall not apply are as follows: When the foundation is immediately adjacent to or within a paved sidewalk or shoulder area and no further surfacing is required. The Engineer shall be the sole judge as to the applicability of this paragraph in all questions arising there from.

No raceways shall be allowed to enter cabinet through the sides, top or back walls.

Anchor bolts shall be installed for pedestal and base mounted cabinets. These shall be considered as incidental to the cost of the cabinets.

Cable harnesses, terminal boards, and mounting hardware shall be installed as needed. These items shall be considered as incidental to the cost of the contract.

Terminal blocks provided in field cabinets shall be the heavy duty barrier type. The terminal block shall be a minimum of 2" (50.8mm) wide and 1-3/16" (30.2mm) deep. Center to center of the terminal screws or studs shall be a minimum of 21/32" (16 mm) with barriers in-between. Terminal blocks shall be rated at 45 amps 600 volts breakdown RMS line to line 11,000 V. and breakdown RMS line to ground 13,800 V. A marking strip shall be provided with each terminal block.

METHOD OF MEASUREMENT

Cabinets will be accepted as concrete foundation mounted, pole mounted, pedestal mounted, or attached to structure. Each cabinet installed complete and in place will be counted as a single unit.

BASIS OF PAYMENT

This work will be paid for at the contract price each for CABINET HOUSING EQUIPMENT, mounting and size specified, installed complete and in place.

ELECTRIC SERVICE INSTALLATION – GROUND MOUNT

Effective: January 1, 2011

Revise Section 805 of the Standard Specifications to read:

Revised 01/07/2011

Description.

This work shall consist of all materials and labor required to install, modify, or extend the electric service installation.

General.

The electric service installation shall be the electric service disconnecting means and it shall be identified as suitable for use as service equipment.

The electric utility contact information is noted on the plans and represents the current information at the time of contract preparation. The Contractor must request in writing for service and/or service modification within 10 days of contract award and must follow-up with the electric utility to assure all necessary documents and payment are received by the utility. The Contractor shall forward copies of all correspondence between the contractor and utility company. The service agreement and sketch shall be submitted for signature to the Engineer.

Materials.

General. The completed control panel shall be constructed in accordance with UL Std. 508A, Industrial Control Panel, and carry the UL label. Wire terminations shall be UL listed.

Enclosure. The cabinet shall be UL 50, NEMA Type 3R unfinished single door design with back panel. The cabinet shall be fabricated from Type 5052 H-32 aluminum with the frame and door 0.125-inch (3.175 mm) thick, the top 0.250-inch (6.350 mm) thick and the bottom 0.500-inch (12.70 mm) thick. Seams shall be continuous welded and ground smooth. The door and door opening shall be double flanged. The door shall be approximately 80% of the front surface, with a full length tamperproof stainless steel .075-inch (1.91 mm) thick hinge bolted to the cabinet with stainless steel carriage bolts and nylocks nuts. The locking mechanism shall be slam-latch type with a keyhole cover. The cabinet shall be sized to adequately house all required components with extra space for arrangement and termination of wiring. A minimum size of 40-inches (1000 mm) high, 16-inches (400 mm) wide and 15-inches (375 mm) in depth is required. The cabinet shall include a meter socket compatible and coordinated with the electric utility. The cabinet shall be mounted upon a square Type A concrete foundation as indicated on the plans. The foundation shall be included in the cost of this item and not paid for separately.

Surge Protector. Overvoltage protection, with LED indicator, shall be provided for the 120 volt load circuit by the means MOV and thermal fusing technology. The response time shall be <5n seconds and operate within a range of -40C to +85C. The surge protector shall be UL 1449 Listed.

Circuit Breakers. Circuit breakers shall be standard UL listed molded case, thermal-magnetic bolt-on type circuit breakers with trip free indicating handles. 120 volt circuit breakers shall have an interrupting rating of not less than 65,000 rms symmetrical amperes. Unless otherwise indicated, the main disconnect circuit breaker for the traffic signal controller shall be rated 60 amperes, 120 V and the auxiliary circuit breakers shall be rated 10 amperes, 120 V.

Fuses, Fuseholders and Power Indicating Light. Fuses shall be small-dimensional cylindrical fuses of the dual element time-delay type. The fuses shall be rated for 600 V AC and shall have a UL listed interrupting rating of not less than 10,000 rms symmetrical amperes at rated voltage.

Revised 01/07/2011

The power indicating light shall be LED type with a green colored lens and shall be energized when electric utility power is present.

Ground and Neutral Bus Bars. A single copper ground and neutral bus bar, mounted on the equipment panel shall be provided. Ground and neutral conductors shall be separated on the bus bar. Compression lugs, plus 2 spare lugs, shall be sized to accommodate the cables with the heads of the connector screws painted green for ground connections and white for neutral connections.

Utility Services Connection. The Contractor shall notify the Utility Company marketing representative a minimum of 30 working days prior to the anticipated date of hook-up. This 30 day advance notification will begin only after the Utility Company marketing representative has received service charge payments from the Contractor. Prior to contacting the Utility Company marketing representative for service connection, the service installation controller cabinet and cable must be installed for inspection by the Utility Company.

Ground Rod. Ground rods shall be copper-clad steel, a minimum of 10 feet (3.0m) in length, and 3/4 inch (20mm) in diameter. Ground rod resistance measurements to ground shall be 25 ohms or less. If necessary additional rods shall be installed to meet resistance requirements at no additional cost to the contract.

Concrete Foundation. This work shall include a concrete foundation as specified and as indicated in the plans. Add the following to Article 878.03 of the Standard Specifications:

All anchor bolts shall be according to Article 1006.09, with all anchor bolts hot dipped galvanized a minimum of 12 in. (300 mm) from the threaded end. foundations shall be a minimum depth of 48 inches (1220 mm).

Installation.

General. The Contractor shall confirm the orientation of the traffic service installation and its door side with the engineer, prior to installation. All conduit entrances into the service installation shall be sealed with a pliable waterproof material.

Pole Mounted. Brackets designed for pole mounting shall be used. All mounting hardware shall be stainless steel. Mounting height shall be as noted on the plans or as directed by the Engineer.

Ground Mounted. The service installation shall be mounted plumb and level on the foundation and fastened to the anchor bolts with hot-dipped galvanized or stainless steel nuts and washers. The space between the bottom of the enclosure and the top of the foundation shall be caulked at the base with silicone.

Basis of Payment.

The service installation shall be paid for at the contract unit price each for **SERVICE INSTALLATION** of the type specified which shall be payment in full for the work described herein. Utility company charges shall be paid for under the pay item Electric Utility Service Connection..

Revised 01/07/2011

UNDERGROUND RACEWAYS

Effective: January 1, 2007

Revise Article 810.03 of the Standard Specifications to read:

“Installation. All underground conduit shall have a minimum depth of 30-inches (700 mm) below the finished grade.”

Add the following to Article 810.03 of the Standard Specifications:

“All metal conduit installed underground shall be Rigid Steel Conduit unless otherwise indicated on the plans.”

Add the following to Article 810.03 of the Standard Specifications:

“All raceways which extend outside of a structure or duct bank but are not terminated in a cabinet, junction box, pull box, handhole, post, pole, or pedestal shall extend a minimum of 300 mm (12”) or the length shown on the plans beyond the structure or duct bank. The end of this extension shall be capped and sealed with a cap designed for the conduit to be capped. The ends of rigid metal conduit to be capped shall be threaded, the threads protected with full galvanizing, and capped with a threaded galvanized steel cap. The ends of rigid nonmetallic conduit and coilable nonmetallic conduit shall be capped with a rigid PVC cap of not less than 3 mm (0.125”) thick. The cap shall be sealed to the conduit using a room-temperature-vulcanizing (RTV) sealant compatible with the material of both the cap and the conduit. A washer or similar metal ring shall be glued to the inside center of the cap with epoxy, and the pull cord shall be tied to this ring.”

Add the following to Article 810.03(c) of the Standard Specifications:

“Coilable non-metallic conduit shall be machine straightened to remove the longitudinal curvature caused by coiling the conduit onto reels prior to installing in trench, encasing in concrete or embedding in structure. The straightening shall not deform the cross-section of the conduit such that any two measured outside diameters, each from any location and at any orientation around the longitudinal axis along the conduit differ by more than 6 mm (0.25”).” The longitudinal axis of the straightened conduit shall not deviate by more than 20 mm per meter (0.25” per foot” from a straight line. The HDPE and straightening mechanism manufacturer operating temperatures shall be followed.

EXPOSED RACEWAYS

Effective: January 1, 2007

Revise the first paragraph of Article 811.03(a) of the Standard Specifications to read:

“General. Rigid metal conduit installation shall be according to Article 810.03(a). Conduits terminating in junction and pull boxes shall be terminated with insulated and gasketed watertight threaded NEMA 4X conduit hubs.

Revised 01/07/2011

TRENCH AND BACKFILL FOR ELECTRICAL WORK

Effective: January 1, 2011

Revise the first sentence of Article 819.03(a) of the Standard Specifications to read:

“Trench. Trenches shall have a minimum depth of 30 in. (760 mm) or as otherwise indicated on the plans, and shall not exceed 12 in. (300 mm) in width without prior approval of the Engineer.”

Revise the second sentence of Article 819.03(b) of the Standard Specifications to read:

“The installation depth shall have a minimum depth of 30 in. (760 mm) below the finished grade or as shown on the plans.”

Revise the first sentence of Article 819.05 of the Standard Specifications to read:

“Underground cable marking tape shall have a reinforced metallic detection strip.”

Revise the second paragraph of Article 1066.05 of the Standard Specifications to read:

“The tape shall be a woven reinforced polyethylene tape with a metallic core or backing that is detectable.”

CCTV EQUIPMENT

Effective: January 1, 2011

Description.

This item shall consist of furnishing and installing equipment for the control and distribution of CCTV video from the CCTV camera to the Fiber Optic Interconnect Cabinet. Transmission for the video and control signal shall be by fiber optic cable as specified elsewhere herein and as indicated in the plans. Distribution from the Fiber Optic Interconnect Cabinet shall be as specified for the item Modification of Existing Video Distribution System.

The transmission of the video over fiber shall include fiber transceivers at the camera location and the VCP. The video CODEC encoder specified herein shall be co-located in the CCTV equipment cabinet.

The CODEC encoders are specified and included as a part of this item and shall be fully coordinated with the decoders.

The CODEC decoders are specified and paid for as a part of the Modification of Existing Video Distribution System pay item and shall be fully coordinated and of the same manufacturer as the video CODEC encoders specified herein.

Added 01/07/2011

CODEC Quantity Tabulation

CODEC Type	Location							
	At Camera		D1 H.Q.		ITS Office		TSC	
Contract	60I47	60M59	60I47	60M59	60I47	60M59	60I47	60M59
Encoder	4	5	0	0	0	0	0	0
Decoder	0	0	2	2	1	1	2	2

Construction Requirements

General. The Contractor shall prepare and submit a shop drawing detailing the complete closed-circuit television cabinet equipment installation. The shop drawings shall identify the installation and specifications of all components to be supplied, for approval of the Engineer. Particular emphasis shall be given to the cabling and the interconnection of all of the components.

The Contractor shall demonstrate a prototype assembly using the proposed components. This demonstration shall take place at a Contractor selected and Engineer approved location. These conformance tests shall be completed prior to the delivery of any completed assemblies to the project site. Any deviations from these specifications that are identified during this testing shall be corrected prior to shipment of the assembly to the project site.

Appropriate connectors shall be furnished and installed to interface the in-cabinet components to the integrated dome camera assembly. The Contractor shall mount the in-cabinet components in the equipment cabinet and connect them to AC power, communications, and video feeds.

Testing. The Contractor shall test each installed CCTV Cabinet Equipment. The test shall be conducted from the field cabinet using the standard communication protocol and a laptop computer. The Contractor shall verify that the camera can be fully exercised and moved through the entire limits of Pan, Tilt, Zoom, Focus and Iris adjustments, using both the manual control and presets. In addition, a video monitor and an oscilloscope shall verify that the video signal meets or exceeds the specified requirements.

The Contractor shall repeat the test at the Fiber Optic Interconnect Cabinet.

The Contractor shall maintain a log of all testing and the corresponding results. A representative of the Contractor and a representative of the Engineer shall sign the log as witnessing the results. Records of all tests shall be submitted to the Engineer prior to accepting the installation.

Documentation. One copy of all operations and maintenance manuals for each CCTV component shall be delivered for each assembly installed. In addition, full documentation for all software and associated protocols shall be supplied to the Department on a CD-ROM. The Department reserves the right to provide this documentation to other parties who may be contracted with in order to provide overall integration or maintenance of this item.

Added 01/07/2011

Warranty. The Contractor shall warranty all materials and workmanship including labor for a period of two years after the completion and acceptance of the installation, unless other warranty requirements prevail. The warranty period shall begin when the Contractor completes all construction obligations related to this item and when the components for this item have been accepted, which shall be documented as the final completion date in the construction status report. This warranty shall include repair and/or replacement of all failed components via a factory authorized depot repair service. All items sent to the depot for repair shall be returned within two weeks of the date of receipt at the facility. The depot location shall be in the United States. Repairs shall not require more than two weeks from date of receipt and the provider of the warranty shall be responsible for all return shipping costs.

The depot maintainer designated for each component shall be authorized by the original manufacturer to supply this service. A warranty certificate shall be supplied for each component from the designated depot repair site indicating the start and end dates of the warranty. The certificate shall be supplied at the conclusion of the system acceptance test and shall be for a minimum of two years after that point. The certificate shall name the Department as the recipient of the service. The Department shall have the right to transfer this service to other private parties who may be contracted to perform overall maintenance of the facility.

Materials.

Enclosure.

CCTV Cabinet. The CCTV Cabinet, as a minimum, shall be a Hoffman Enclosures Model A30H2410SS6LP, Electromate Enclosures Model E-30H2410SSLP, or approved equal. The cabinet shall be NEMA 4X compliant. The nominal dimensions of the cabinet shall be 30 inches high by 24 inches wide by 10 inches deep. These manufacturers and model numbers are included as a guide to indicate the type of cabinet to be provided and may not be the exact manufacturer and part numbers. Due to contractor selection of equipment to be utilized, the cabinet may need to be larger. The contractor shall be responsible for providing an adequately sized cabinet and shall be included in the bid unit price for this item.

The cabinet shall be fabricated of 14 gauge Type 304 or Type 316L stainless steel. All seams shall be continuously welded and ground smooth with no holes or knockouts. The cabinet shall be fabricated with a rolled lip around three sides of the door and on all sides of the enclosure openings to exclude liquids and contaminants. A stainless steel door clamp assembly shall assure a watertight seal. A seamless gasket shall be included to assure a watertight and dust-tight seal.

The cabinet shall have provisions for padlocking in the closed position. The lock shall be Corbin #2 and two keys shall be supplied to the Department with each lock. The keys shall be removable in the locked position only.

A data pocket of high impact thermoplastic material shall be provided. The nominal dimensions of this pocket shall be 12 inches by 12 inches.

Collar studs shall be provided for mounting the stainless steel backboard panel.

The cabinet shall be unpainted. Cover, sides, top, and bottom shall have a smooth brushed finish.

Added 01/07/2011

Stainless Steel Panel. The cabinet shall be furnished with a stainless steel panel. It shall mount on the collar studs fabricated with the CCTV cabinet.

Installation. The cabinet shall be installed as indicated on the detail drawings by means compatible with the type of CCTV camera structure selected by the Contractor.

Closed Circuit Television Camera Power Supply.

The Closed Circuit Television Camera Power Supply shall supply power to the camera dome assembly. The power supply shall be a Treehaven Technologies RVSFB120XLB or approved equal. The requirements include:

Input voltage	120 VAC \pm 10%
Output voltage	24 VAC \pm 10%
Operating Temperature Range:	-40°C to +70°C (minimum)
Storage Temperature Range:	-40°C to +75°C (minimum)

The power supply shall include an AC power indicator with power on/off switch. All outputs shall be fused. The power supply shall be sized for the dome units being supplied, considering pan/tilt, heating, and blower requirements, and shall not be less than 100 VA.

Over-voltage Protection. Over-voltage protection shall be provided on the power conductors, camera control conductors, and the video cables. The specific protection is based on the elements being protected.

Incoming Power Protection. The incoming power shall be protected with a filtering surge protector that absorbs power line noise and switching transients. The specified performance shall be as follows:

Peak current	20 kA (8x20 μ s waveshape)
Life Test	5% change
Clamp voltage	280 V typical @ 20 kA
Response time	\leq 5 ns
Continuous service current	10 amps max. 120 VAC/60 Hz
Operating Temperature	-40°C to +75°C (minimum)
Nominal dimensions	7.15 inches by 3.13 inches by 2.3 inches

Video Cable Protection. The coaxial cable from the camera shall be protected with gas tubes and silicon avalanche devices. The units shall include re-settable fuses to protect against sneak currents. Specific requirements include:

Frequency	0 to 20 MHz
Peak surge current	20 kA (8x20 μ s waveshape)
Technology	Hybrid, solid-state
Attenuation	0.1 dB at 10 MHz
Response time	\leq 1 ns
Protection	Line-to-shield
Input/output connectors	BNC
Impedance	75 ohms
Temperature range	-40°C to +75°C (minimum)
Humidity	0% to 95% (non-condensing)
Clamping voltage	6 V
Nominal dimensions	4.5 inches by 1.5 inches by 1.25 inches

Added 01/07/2011

The video cable protector shall be UL listed.

Camera Control Cable Protection. The camera control cable protector shall protect the RS-422/RS-485 signal and bi-phase signal leads going to the camera dome assembly. Specific requirements include:

Technology	Hybrid, solid-state
Response time	≤5 ns
Protection	Line-to-ground
Input/output connectors	terminal block
Temperature range	-40°C to +75°C (minimum)
Humidity	0% to 95% (non-condensing)
Clamping voltage	7.25 V (maximum); ≤7.0 V (typical)
Nominal dimensions	4.5 inches by 3.3 inches by 1.8 inches

The protector shall protect a minimum of four conductors. [Transmit Data (2 wires) and Receiver Data (2 wires)]

Fiber Optic Cable Termination

The Contractor shall include all necessary wires and cables necessary to interconnect the components of the CCTV cabinet. The Contractor shall provide a factory terminated patch block with a 12 fiber pigtail of sufficient length to connect to the lateral splice handhole without the use of any intermediate splices. The patch block shall be a Fiber Connections, Gator Patch II or approved equal..

Fiber Optic Distribution

Fiber Optic Media Converter Pair. The CCTV Cabinet Equipment shall include a matched pair fiber optic media converter pair as described herein. The media converter pair shall be industrially hardened and have an operating temperature range of -40°C to +85°C without the use of fans. The media converter pair shall be single mode, ST type connector, Ruggedcom RMC or approved equal with a minimum range of 15km. The far end of the media converters shall be installed in the fiber optic interconnect cabinet and the installation shall be fully coordinated with any adjacent contractors. All connections/cables to the media converters shall be included in this item.

Video CODEC

Video Encoders and Decoders. Video encoders and decoders (codecs) shall be dedicated hardware devices, and except for differences between encoders and decoders they shall all of the same type from the same common manufacturer. The codec shall be a single video channel type to transfer "full motion" 30 frame-per-second high quality D1 color video via H.264, MPEG-4, and MPEG-2 video compression at up to 20 Megabits per second. The units shall operate to produce a robust data communications stream that shall allow for both video and audio transmission and shall be immune to timing disruptions in the existing IP multi-cast system.

The units shall be rack-mountable, or single unit chassis for single unit installation complete with power supplies as required, operating from a 120-volt single phase AC power input. Unit mounted in VCPs or other control building shall include a standard 19" rack with dual redundant power supplies.

Added 01/07/2011

Encoder units shall accept NTSC video BNC input, Ethernet RJ-45 communications, and RJ45 serial data input connections.

Approvable codecs shall be compatible with and demonstrably interoperable with the standard codec product of at least one other vendor. Final approval of codec equipment shall be dependent upon a demonstration test of multi-vendor interoperability. Initial submittal information shall include documentation of this interoperability and a demonstration testing plan for approval by the Engineer.

The CODEC encoders shall be Optelecom-NKF series C-60 E-MC, or approved equal by the Engineer. The Approved equal shall be 100% interchangeable with the specified unit with respect to functionality and performance.

The encoders shall interface the serial communications port of the CCTV camera assembly through the fiber optic video link where indicated. Using the Ethernet port on the encoder and its IP address, commands shall be exchanged between the camera control computer at the Communications Center and the serial port of the CCTV camera.

Materials shall be supplied to satisfy the following:

VIDEO	Requirements
Video channels	1x PAL/NTSC (Auto/PAL/NTSC)
Input level	1 V _{pp} (±3 dB)
Compression algorithm	H.264 BP (ISO/IEC 14496-10) MPEG-2 (ISO/IEC 13818-2), MJPEG, MPEG-4 (ISO/IEC 14496-2, ISMA comp.)
Type of streaming	UDP/IP (multi- and/or unicast)
Number of output streams	Up to 20
Input impedance	75Ω/Hi-Z selectable
Video Motion Detection	Yes (user-defined masking)
Encoding latency	<130 ms typ.
Resolution	D1, ½D1, 2CIF, CIF, QCIF, VGA
GOP structure	I, IP (selectable/user profiles)
Frame rate	1 to 30 fps
Quad streaming	1 D1@30fps H264 + D1@30fps MPEG-2+ D1@30fps MPEG-4 + CIF@1fps MJPEG
Output data rate	up to 20 Mb/s (CBR or VBR selectable/user profiles)
Video settings	User profiles, contrast, brightness, color saturation, hue, sharpness
On Screen Display (OSD)	3x Text lines (configurable: position, color, border/outline color, font size), 1x image in BMP, GIF, or JPEG format (configurable: position, scaling)
Live View Encoder (MJPEG)	HTTP, FTP pull
Connector type	BNC 75Ω (gold plated center pin)

Added 01/07/2011

DATA	Requirements
Number of channels	2 (full-duplex)
Number of streams	2x 3 (multi- and/or unicast)
Interfaces	1x RS232
	1x RS422/485 (2- or 4-wire)
Stream	TCP/UDP/MX configurable
Data rate	300 b/s to 230.4 kb/s
Connector type	RJ45

TRANSMISSION	Requirements
Number of interfaces	1
Interface 10/100Base-TX	Fast Ethernet
	Auto Negotiation, half-duplex/full-duplex, 10/100 Mb/SFP option
	Empty SFP slot for 100 Mbps SFP device
Protocols	H. 264 BP, MPEG-4 ES, MPEG-2 TS, MPEG-2 ES, (M)JPEG, RTP, RTCP, RTSP, TCP, UDP, IP, DHCP, IGMPv2,
	(S)NTP, MX/IP, HTTP, SNMP v2, FTP, TelNet, DiffServ, SAP, UPnP
Connector type	RJ45

Management	
LED status indicators	
DC	Power-on indicator (green)
NV	No video on input (red)
SYNC	All links are operational (green); failure in RX stream(s) (yellow); failure in TX stream(s) (red)
Ethernet port	Green LED: on=100 Mb, off=10 Mb; Amber LED: on=link okay, flashes with activity
Network Management & Control	SNMP v2, MX™, HTTP API, HTML (password protected)

Power	
Power consumption	<5W
Rack-mount units	MC 10 and MC11 power supply cabinets
Stand-alone units (/SA)	11 to 19 VDC (PSA-12 DC/25 or PSR-12 DC)

ENVIRONMENTAL	Requirements
Operating temperature	-40° F to +165° F (-40 °C to +74 °C)
Relative humidity	<95%,no condensation.

The encoders and decoders shall be UL listed and be type-accepted to 47 CFR (FCC), Part 15, Type A.

The Codecs shall be the standard product of an established North American manufacturer. The manufacturer shall have been in business for a minimum of 7 years. The manufacturer shall provide a minimum of a twelve (12) month warranty from the date of installation. The manufacturer shall provide technical support via email, fax and telephone. The above forms of support shall be provided Monday through Friday, 8:00am to 5:00pm EST. The Manufacturer shall also have a repair facility within North America.

Added 01/07/2011

The units shall be 19-inch rack-mountable, complete with power supplies as required for the rack configurations indicated on the plans, operating from a 120-volt single phase AC power input

The codecs shall be fully capable of transmitting the PTZ commands of the CCTV camera manufacturer being furnished under this contract as well as existing Philips/Bosch, Pelco, Vicon and Cohu camera commands. Serial data will be transmitted over TCP-IP. Each serial port must support IP addressing with the ability to select the appropriate IP socket number. The codecs must provide the ability to establish an IP connection directly from a workstation to any encoder IP address and socket number to pass serial data. Transmission of serial data must be independent of the video stream. Any serial data conversion required by the codec to communicate to the camera shall be included in this pay item and shall not be paid for separately.

The Encoder/Decoder serial data port must support Multicast data to broadcast a single serial data input to multiple remote encoder serial data port recipient. Bi-directional data must be supported on the codecs.

A demonstration of this low speed serial data transfer shall be required before material submittal approval is given. See submittal requirements in this Special Provision.

Codec operation and management.

Each unit must support a local console accessible using one of the serial interfaces to provide access to all configuration menus of the product including the initial IP address configuration as well as for troubleshooting purposes. The interface must be menu driven for novice users.

All units (encoders and decoders) must support SNMPv2 management protocol to provide the ability to control and monitor all configuration parameters and diagnostics from any 3rd party SNMP management application.

The Encoders/Decoders must support firmware updates from a central site. Updates must be downloadable to a single unit or by bulk via a single command from a firmware utility application via the Ethernet network. The firmware utility application must provide confirmation of the successful and unsuccessful updates. Upon completing of the update, the units must resume to original configuration without the need to reload the unit configuration.

Still Picture Capture

The codec shall be capable of capturing a still image in JPEG format and automatically transferring this image to an FTP site. The resolution of the image shall be user selectable with a default size of 704x480 pixels. The frequency of captures shall be user settable and shall as a minimum range from 1 picture every 30 seconds to 1 picture every five minutes..

Still picture logo placement capability. As a part of the still image capture, a graphic overlay image shall be added to the captured image. The graphic image shall be user selectable, in JPEG, BMP or GIF formats. The overlay shall also be user positional.

Special Submittal Requirements and Operational Demonstration

Added 01/07/2011

As a part of the product catalog cut submittal, the Contractor shall provide a demonstration of the codecs at the time of the initial product submittal. The manufacturer shall demonstrate the following interoperability with at least one other codec manufacturer. Compatibility shall also include successful transmission of PTZ commands. The demonstration shall be comprised of the following parts:

- **Codec CCTV camera PTZ compatibility.** The demonstration shall include a pair of the proposed codecs, a proposed CCTV camera, and a CCTV camera of another manufacturer other than the proposed CCTV which is of a manufacturer already installed in the State system.
- **Video interoperability.** The demonstration shall demonstrate the following interoperability: The proposed encoder shall be capable of encoding a video stream that is decodable by at least one other Manufacturer compiling with this specification, or of a manufacturer which equipment is presently in use by IDOT District 1 at the time of bidding. The interoperability demonstration shall be conducted in multicast mode.
- **Software video decoding.** A software based video decoder with PTZ control shall be provided for viewing and controlling a video stream remotely over the IP network.
- **Video snapshot capability.** A fully functional copy of the proposed video snapshot program shall be provided for the demonstration and throughout the 10 day period described herein.

After a successful demonstration of the above requirements, the codec pair shall remain with the Department for 10 working days for further observation. After 10 working days, the Contractor may pick up the codec pair. All costs for this demonstration shall be included in the cost of this pay item. It is the Contractor's responsibility to provide all hardware (including dome CCTV cameras and Ethernet switches) and software to perform the demonstrations as specified.

Method Of Measurement. CCTV equipment shall be counted, each installed.

Basis Of Payment. This item shall be paid at the contract unit each for **CCTV EQUIPMENT** of the distribution method specified.

DMS FRONT ACCESS, FULL MATRIX, NTCIP 1203 V2-COLOR (IDOT)

1.0 GENERAL REQUIREMENTS

This specification shall govern the furnishing and installation of DMS FRONT ACCESS, FULL MATRIX, NTCIP 1203 V2 – COLOR (IDOT) at field locations and associated equipment cabinets as shown in the plans and as detailed in this specification. The display shall be a full matrix configuration of **27 pixels high by 125 pixels wide**. The size of the sign shall be as shown in the plans. All display elements and modules shall be solid state. No mechanical or electromechanical elements or shutters shall be used.

Equipment to be furnished at each dynamic message sign (DMS) field site shown in the plans shall include, but not be limited to the following:

LED DMS, sign controller, cabling, maintenance diagnostic software, sign enclosure, documentation, warranties, mounting hardware, etc.

Vendor to furnish latest vendor diag. software with 20 licenses to load software on Department's maintenance force laptops.

The Central Controller resides at the Traffic Systems Center. The DMS Central Software was developed by 360 Surveillance, Inc. The successful sign vendor shall perform an on-site working sample demonstration test to prove their product is compatible with the 360 Cameleon Client/Server Software. The Working Sample demonstration test criteria are outlined in Section 2.0 of this document.

Each DMS assembly shall consist of a LED DMS sign case including contents, mounting brackets, its associated sign controller unit (SCU), and communication unit, cabling between the DMS case and the sign controller unit, opto-coupled interface from controller to sign, and DMS walkway platforms with permanent safety and mounting brackets and hardware.

Each LED DMS shall be capable of displaying three lines of text. Each line shall consist of a string of 18 alphanumeric characters. Each character shall be composed from a luminous dot matrix system. The matrix system shall consist of 35 dots composed of 5 columns and 7 rows. There shall be an appropriate blank spacing between each 5 by 7 matrix for maximum readability at various distances. A luminous pixel shall consist of a LED pixel array. All display elements and modules shall be solid state. No mechanical or electromechanical elements or shutters shall be used.

All characters, symbols, and digits shall be 18 inch nominal character size and shall be clearly visible and legible at a distance of 900 feet within a 30 degree cone of vision centered around the optical axis of the pixel.

The signs shall be capable of displaying the following:

- A static message
- A flashing message
- Two alternating messages, either flashing or static

The changing from one message to another shall be instantaneous.

The total weight added to the sign structure shall be no greater than 2200 pounds. The dimensions of the sign housing will not exceed 8'0" tall, 30'0" wide, and 1'6" deep and access to the electronics shall be achieved through the front display panels of the DMS. Larger signs may be submitted, but they will require additional review time to evaluate the structural adequacy of the Department's standard sign trusses.

The Contractor shall provide structure mounted service equipment to provide power to each sign. The cost of this shall be considered incidental to the unit price for the DMS.

All field equipment shall remain fully functional over an ambient temperature range of -40°F to +149°F with relative humidity of up to 95%. All field equipment enclosures shall be designed to and shall withstand the effects of sand, dust, and hose-directed water. All connections shall be watertight.

2.0 WORKING SAMPLE DEMONSTRATION (DYNAMIC MESSAGE SIGN)

To ensure timely delivery for installation, it is imperative that the DMS manufacturer be regularly engaged in the manufacture of the specified equipment and capable of immediately demonstrating a sample DMS that is in clear compliance with the key portions of the specifications. Delay in this regard will result in liquidated damages, as specified, and failure to present the sample in a timely manner may result in termination of the contract, at the discretion of the Engineer.

The DMS manufacturer shall provide a satisfactory, approvable demonstration of a working sample DMS within 14 calendar days after contract execution. The sample shall be a complete mock-up of a working DMS based on the proposed equipment to be furnished under this contract and identified in the submittal material. The sample demonstration may utilize a portable sample at the IDOT Traffic Systems Center, or it may be at the manufacturer's production facility if located within District 1. A demonstration of an identical installed unit for some other contract will be acceptable.

The sample demonstration will be for purposes of review and approval by the engineer. The Engineer will issue review comments based on examination of the unit and its operation at the time of the demonstration, and the Engineer may require a subsequent revised sample demonstration if, in the Engineer's judgment, the comments warrant re-work of the sample unit.

Delay in presenting the specified demonstration or delay in attaining "Approved" or "Approved as Noted" status will result in the assessment of liquidated damages in the amount of \$3,000 per calendar day until a satisfactory sample and demonstration are attained.

For a demonstration to be held at the IDOT Traffic Systems Center, the manufacturer shall coordinate the exact date, time, demonstration location, and power requirements with the Traffic Systems Center Engineer.

The sample unit shall be in substantial compliance with the contract requirements. The Engineer may elect to waive minor deviations for purposes of the demonstration, or may waive minor deviations completely if alternative provisions are judged superior to specified requirements, but deviations from key specified requirements will not be accepted.

3.0 MATERIALS

All materials furnished, assembled, fabricated or installed under this item shall be new, corrosion resistant and in strict accordance with the details shown in the plans and as detailed in this specification. All details and functionality listed in this specification will be thoroughly inspected and tested by the department. Failure to meet all details and functionality detailed in this specification shall be grounds for rejection of the equipment.

4.0 TERMINOLOGY

Due to the varying definitions used in Dynamic Message Sign technology, this section defines specific terms as they apply to this specification.

Sign: The sign housing and its contents.

Sign Controller: Located in a ground cabinet or in the sign (as detailed in this specification), the sign controller specifies the message to be displayed. Messages can be selected either remotely from the central controller, locally from a laptop computer or from the front panel of the sign controller.

Central Controller: The MS Windows Server computer system and related software, which operates the system from a remote control site.

Workstation: This computer operates as a remote client to the central controller. A workstation operator can dial-in to the central controller and gain access to the functions of the central controller by using the appropriate access codes.

LED: Light Emitting Diode

Pixel: Any of the small discrete elements that, when arranged in a pixel matrix, create a character. A pixel contains a cluster of LEDs.

Pitch: Distance measured from center to center of adjacent pixels within a matrix. This distance is measured both horizontally and vertically.

Poll: The central controller and laptop computer are said to "poll" a sign when they request the sign's status information. The term is derived from the periodic status polling, which a central controller can perform, but is loosely used to refer to any status request.

Message: Text; the information shown on the sign.

Display: The message seen by the motorist. A display may include more than one page of text (an alternating display). Any character or set of characters of a display may be flashed (a flashing display).

Neutral State: Sign is blank, or displaying a predefined message that is displayed regularly.

WYSIWYG: What You See IS What You Get. In this specification, this is the functionality of the LED DMS system where the central, workstation or laptop display mimics the actual message that is visibly displayed on the sign on an individual pixel basis.

5.0 DMS MANUFACTURE REQUIREMENTS

The company that designs and manufactures the LED DMS shall be currently ISO 9001 certified as of the bid date for this project and shall have received its ISO 9001 certification a minimum of three years prior to the bid date for this project. The scope of this company's ISO 9001 certification shall be for the Design, Manufacture, Installation, Maintenance and Sales of Dynamic Message Sign Systems. The facility where this company actually designs and manufactures the LED DMS shall be ISO 9001 certified. This company, this scope and the address of this facility shall all be listed on the ISO 9001 certificate. This ISO 9001 certificate shall be provided with the bid. The name, phone number and address of both the Authorized ISO 9001 Registrar that certified this company and the Authorized ISO 9001 Accreditation Body that accredited this Registrar shall be provided with the bid. Failure to fully comply with these requirements and to provide all this information will cause this company's equipment and software to be rejected. ISO 9002 and ISO 9003 certifications are not adequate and do not meet this requirement.

Experience Requirements:

The LED DMS System Manufacturer shall submit a State Department of Transportation reference for minimum of three (3) different states that have been successfully operating a highway LED dynamic message sign system, and that completely meets these specifications, manufactured and supplied by this manufacturer, for a period of no less than five (5) years.

The LED DMS Signs and System shall be fabricated by an established DMS manufacturer having the minimum of:

- 10 years experience, under the current corporate name, in the design and manufacturing of State Highway or Interstate Highway, permanently-mounted, overhead dynamic message signs and central control systems installed in freeway service. This 10 years of experience shall include the complete design and manufacturing of all aspects of the dynamic message signs, including the electronic hardware, software and sign housings.
- 100 State Highway or Interstate Highway, permanently-mounted, overhead dynamic message signs installed in freeway service, under the current corporate name.
- 50 State Highway or Interstate Highway, permanently-mounted, overhead LED dynamic message signs that completely meet this specification with three lines of 18-inch characters and Front Access housings installed in freeway service, under the current corporate name.
- The manufacturer of the LED DMS Signs and System shall submit documentary evidence and reference data for the above requirements. Reference data shall include the name and address of the organization, and the name and telephone number of an individual from the organization who can be contacted to verify the above requirements. The name of the DMS manufacturer that meets these experience requirements shall have the same corporate name as the DMS manufacturer that meets the ISO 9001 requirements stated elsewhere in this specification. This information shall be provided prior to documentation submittal. Failure to furnish the above references will be sufficient reason for rejection of the supplier's equipment.

- The Contractor shall submit the information described in this section to the Engineer within 15 days of award of the contract. The Engineer will review the submitted information and provide comments and approval of the information to the Contractor within 15 calendar days after receipt. Review of the submittal information by the Engineer shall not relieve the Contractor of the contractor's obligation to furnish and install the work in accordance with the contract documents. No time extensions will be granted to the Contractor as a result of the need to resubmit various items to review.
- Shop drawings shall be submitted in accordance with Article 105.04 of the Standard Specifications and as specified in these special provisions.
- Prior to purchase or fabrication of any equipment or materials for use in this project, the Contractor shall submit, for review by the Engineer, appropriate catalog cuts sheets, and specifications for all standard, off-the-shelf items and shall submit shop drawings and other necessary data for all non-catalog or custom-made items.
- The Contractor shall furnish five sets of submittal data directly to the Engineer. Two copies of this information, with appropriate notations, will be returned to the Contractor after the review.
- If reprinted literature, such as catalog cut sheets, is used to satisfy the submittal data requirements, there shall be no statements on the literature which conflict with the requirements of the contract documents. Any such statements shall be crossed off and initialed by the Contractor. Explanation of how specifications shall be met pertaining to items changed from the literature shall be documented in writing and included with the submittal information.
- All items shall be submitted together.
- Each submittal shall contain sufficient information and details to permit full evaluation of each item, and its interrelationships among the various items shall be carefully addressed.
- The Contractor shall prepare and submit detailed shop drawings for each sign type indicating types of materials proposed for each component of each sign, parts lists, assembly techniques, layout of all display elements and wiring schematics. The shop drawings shall also illustrate in detail how the Contractor proposes to mount and connect the DMS sign case to the sign support structure (truss). The DMS sign case shall include any support mechanism necessary for the installation of the DMS sign case that is not included in the truss. These drawings shall be submitted to the Engineer for review and approval prior to fabrication of any sign. Parts lists shall include circuit and board designation, part type and class, power rating, component manufacturer and mechanical part manufacturer.
- As part of the submittals for the DMS assembly, the Contractor shall submit an engineering drawing illustrating the DMS character set including 26 upper case letters, 10 numerals, a dash, a plus sign (+), and slash. The Contractor shall also submit complete technical information, shop drawings, photographs, graphs, circuit diagrams, instruction manuals, security provisions, and any other necessary documents to fully describe the DMS assembly and associated equipment.

6.0 PRODUCT TESTING

The DMS manufacturer shall provide documentation indicating that the DMS product has been tested to the following standards. It shall be acceptable for the testing to be performed on scale-sized versions of the actual DMS provided that the test unit is functionally and structurally equivalent to the full size DMS.

Failure to conform to these testing requirements shall be grounds for rejection. Rejected equipment may be offered for test or retest provided all non-compliant items have been corrected and tested or retested by the DMS manufacturer. Any corrections deemed necessary by the Engineer shall be made by the DMS manufacturer, at no additional cost to the Department.

6.1 Third Party Testing

Third party test reports shall be submitted for the following testing:

- *NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements – Section 2, Environmental Requirements.* Test report shall detail results of mechanical vibration and shock, electrical noise and immunity, temperature, and humidity.
- Underwriters Laboratories (UL), *UL 48 Standard for Electric Signs, UL 50 Enclosures for Electrical Equipment, and UL 1433 Standard for Control Centers for Changing Message Type Electric Signs.* The UL report number(s) for all DMS and control equipment manufactured by the DMS manufacturer shall be submitted and the products shall bear the UL mark.

The supplier shall provide a record of each test performed including the results of each test. The report shall include a record of the 3rd party test laboratory and the test lab's representative that witnessed the tests, including the signature of the lab's representative. The test reports shall be provided to the Engineer for review as part of the technical submittal.

6.2 Self Certification

The DMS manufacturer shall provide self-certification, including a statement of conformance and copies of test reports, indicating that the following tests have been performed and passed.

Third party test reports shall be submitted for testing of the following National Transportation Communication for ITS Protocol (NTCIP) standards:

- *NTCIP 1201:1996, NTCIP Global Object Definitions (including Amendment 1)*
- *NTCIP 1203:1997, Object Definitions for Dynamic Message Signs (including Amendment 1)*
- *NTCIP 2101:2001, Point to Multi-Point Protocol Using RS-232 Subnetwork Profile.*
- *NTCIP 2103 (Draft v1.13), Point-to-Point Protocol Over RS-232 Subnetwork Profile.*
- *NTCIP 2104 V01.11 Ethernet Subnetwork Profile*

The NTCIP testing shall have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon's NTTester, Intelligent Devices' Device Tester, and/or Frontline's FTS for NTCIP. The NTCIP test report(s) shall include testing of sub-network communications functionality, all mandatory objects in all mandatory conformance groups, and a subset of the remaining objects.

7.0 PHYSICAL CONSTRUCTION

7.1 Wiring and Power Distribution

7.1.1 Power and Signal Entrances

Two threaded conduit hubs shall be located on the rear or side wall of the DMS housing. One hub shall be for incoming AC power and the other shall be for incoming DMS signal cabling or a communications line.

7.1.2 Panel Board

The DMS shall contain a power panel board and circuit breakers that meet the following minimum requirements:

- Service entrance-rated
- Minimum of 20 circuit breaker mounting positions
- Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
- UL listed panel board and circuit breakers

7.1.3 Internal Wiring

Wiring for LED display module control, environmental control circuits, and other internal DMS components shall be installed in the DMS housing in a neat and professional manner. Wiring shall not impede the removal of display modules, power supplies, environmental control equipment, and other sign components. Wires shall not make contact with or bend around sharp metal edges. All wiring shall conform to the National Electrical Code.

7.2 EARTH GROUNDING

The DMS manufacturer shall provide one earth ground lug that is electrically bonded to the DMS housing. The lug shall be installed near the power entrance location on the DMS housing's rear wall. The DMS installation contractor shall provide the balance of materials and services needed to properly earth ground the DMS. All earth grounding shall conform to the National Electrical Code.

7.3 DMS ENCLOSURE

The LED DMS shall enable the display of text, consisting of a string of alphanumeric and other characters. The size of the sign shall be as shown in the plans, and elsewhere in the specification. Each character shall be formed by a matrix of luminous pixels. The matrix of a standard character shall consist of 35 pixels over 5 columns and 7 rows.

The equipment design and construction shall utilize the latest available techniques with a minimum number of different parts, subassemblies, circuits, cards and modules to maximize standardization and commonality. The equipment shall be designed for ease of maintenance. All component parts shall be readily accessible for inspection and maintenance. Test points shall be provided for checking essential voltages.

The sign shall be designed for a minimum life of 20 years.

The sign shall be designed and constructed so as to present a clean and neat appearance. Poor workmanship shall be cause for rejection of the sign.

All cables shall be securely clamped/tied in the sign housing. No adhesive attachments will be allowed.

The dynamic message sign, including the sign housing and all modules and assemblies, shall be designed and manufactured in the USA.

The complete sign housing shall be designed and manufactured in-house by the LED DMS Sign Manufacturer.

A registered structural engineer in the State of Illinois shall analyze the DMS structure and certify that the DMS will withstand the temporary effects of being lifted by the provided eye bolts, will comply with the applicable requirements of AASHTO Standard Specs for Structural Supports for Highway Signs, Luminaries and Traffic Signals, Fourth Draft, 2001, and will support a front face ice load of 4 lbs. per square foot.

The equipment within the sign housing shall be protected from moisture, dust, dirt and corrosion. The sign shall be constructed of aluminum alloy 5052-H32 or 3003-H14 which shall not be less than 1/8" thick, unless otherwise specified in this document. Framing structural members shall be made of aluminum alloy 6061-T6 or 6063-T5.

All welding shall be by an inert gas process in accordance with the American Welding Society (AWS) Standards, ANSI/AWS D1.2-97. The LED DMS manufacturer's welders and welding procedures shall be certified by an ANSI/AWS Certified Welding Inspector to the 1997 ANSI/AWS D1.2-97 Structural Welding Code for Aluminum. Proof of certification of all the LED DMS manufacturer's welders and applicable welding procedures shall be supplied with the submittals. The name, phone number and address of the ANSI/AWS Certified Welding Inspector that certified the LED DMS manufacturer's welders and procedures shall also be provided with the submittals.

The DMS housing's right, left, and rear walls shall be vertical. The top and bottom sides shall be horizontal.

The sign housing shall be capable of withstanding a wind loading of 120 M.P.H. without permanent deformation or other damages.

All 120/240 VAC wiring located inside the sign housing shall be run in conduit pull-boxes, handy-boxes, power supply boxes, control cabinets, and circuit breaker boxes.

The performance of the sign shall not be impaired due to continuous vibration caused by wind, traffic or other factors. This includes the visibility and legibility of the display.

The presence of power transients or electromagnetic fields, including those created by any components of the system, shall have no deleterious effect on the performance of the system. The system shall not conduct or radiate signals which will adversely affect other electrical or electronic equipment including, but not limited to, other control systems, data processing equipment, audio, radio and industrial equipment.

All DMS structural hardware shall be stainless steel and appropriately sized for the application.

The DMS Manufacturer shall provide a signed and sealed copy of these certifications by the registered Structural Engineer as part of the catalog cut submittal.

7.3.1 Electronic Components

All electronic components, except printed circuit boards, shall be commercially available, easily accessible, replaceable and individually removable using conventional electronics repair methods.

All workmanship shall comply with ANSI/IPC-1-610B Class 2 titled "Acceptability of Electronic Assemblies", ANSI/IPC-7711 titled "Rework of Electronic Assemblies", and ANSI/IPC-7721 titled "Rework and Modification of Printed Boards and Electronic Assemblies".

All electronic components shall comply with Section Electronic Materials and Construction Methods, located in this document.

All Printed Circuit Boards (PCBs) shall be completely conformal coated with a 0.010 inch (10 MIL) minimum thickness silicone resin conformal coat. The LED mother boards shall be completely conformal coated, except at the pixels on the front of the PCB, with a 0.010 inch (10 MIL) minimum thickness silicone resin conformal coat. The material used to coat the PCBs shall meet the military specification: MIL-I-46058C Type SR.

7.3.2 Mechanical Components

All external screws, nuts, and locking washers shall be stainless steel. No self-tapping screws shall be used. All parts shall be made of corrosion resistant materials, such as plastic, stainless steel or aluminum. All materials used in construction shall be resistant to fungus growth and moisture deterioration. An inert dielectric material shall separate dissimilar metals.

7.3.3 CONVENIENCE OUTLETS

The DMS housing shall contain a utility outlet circuit consisting of a minimum of one (1) 15-A NEMA 15-R, 120 VAC duplex outlet, with ground-fault circuit interrupters. This outlet shall be located near the panel board.

If the sign controller and communication equipment is to be mounted in the sign, a second outlet circuit shall be included consisting of a minimum of two (2) 15-A NEMA 15-R, 120 VAC duplex outlets. These outlets shall be located near the controller and communication equipment mounting location.

7.4 Front Face Construction

The DMS front face shall be constructed with multiple vertically hinged rigid door panels, each of which contains a full-height section of the LED display matrix. The door panels shall be fabricated using aluminum sheeting on the exterior and polycarbonate sheeting on the interior of the panel.

The DMS housing shall provide safe and convenient access to all modular assemblies, components, wiring, and subsystems located within the DMS housing. All of those internal components shall be removable and replaceable by a single technician.

7.4.1 Doors

One (1) access door shall be provided for each 10 or 15 pixel wide section of the sign housing. These doors shall be vertically hinged and shall contain a section of the sign's front face. The doors shall swing out from the face to provide access to the cabinet interior. Each door shall extend the full height of the display matrix.

To prevent open doors from blowing in wind, they shall each have a retaining latch mechanism to hold the door open at a 90-degree angle.

Each door shall form the face panel for a section of the sign. The LED modules shall be mounted to the door and be removable from the door when in the open position. Other sign components, such as power supplies, wiring, etc. shall be located inside the sign cabinet and be accessible through the door opening. Each door shall cover an opening that is a minimum of 23-inches (584 mm) wide and the same height as the display pixel matrix.

Each door shall contain a minimum of two (2) screw-type latches to lock them in the closed position. These latches shall be captive to prevent them from falling off. They shall pull the door tight and compress a gasket located around the perimeter of each door. They shall also be capable of providing leverage to easily release the gasket seal when opening the doors. The gasket shall prevent water from entering the cabinet around the doors.

7.4.2 Face Panels

Front face panels shall provide a high-contrast background for the DMS display matrix. The aluminum mask of each door panel shall be painted black and shall contain an opening for each pixel. Openings shall be large enough to not block any portion of the viewing cones of the LEDs.

Each door panel shall have a single polycarbonate sheet attached securely to the inside of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The polycarbonate shall be sealed to prevent water and other elements from entering the DMS. The polycarbonate shall contain UV inhibitors that protect the LED display matrix from the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate itself. Polycarbonate sheets shall have the following characteristics:

- Tensile Strength, Ultimate: 10,000 PSI
- Tensile Strength, Yield: 9,300 PSI
- Tensile Strain at Break: 125%
- Tensile Modulus: 330,000 PSI
- Flexural Modulus: 330,000 PSI
- Impact Strength, Izod (1/8", notched): 17 ft-lbs/inch of notch
- Rockwell Hardness: M75, R118
- Heat Deflection Temperature Under Load: 264 PSI at 270F and 66 PSI at 288F
- Coefficient of Thermal Expansion: 3.9×10^{-5} in/in/F
- Specific Heat: 0.30 BTU/lb/F
- Initial Light Transmittance: 85% minimum
- Change in Light Transmittance, 3 years exposure in a Southern latitude: 3%
- Change in Yellowness Index, 3 years exposure in a Southern latitude: less than 5%

LED display modules shall mount to the inside of the DMS front face door panels. Common hand tools shall be used for removal and replacement.

DMS front face borders (top, bottom, left side, and right side), which surround the front face panels and LED display matrix, shall be painted black to maximize display contrast and legibility.

In the presence of wind, the DMS front face shall not distort in a manner that adversely affects LED message legibility.

7.4.3 Exterior Finish

DMS front face panels and front face border pieces shall be coated with semi-gloss black Kynar 500 resin or an equivalent brand of oven-fired fluoropolymer coating, which has an expected outdoor service life of 20 years.

All other DMS housing surfaces, including the DMS mounting brackets, shall be natural mill-finish aluminum.

7.4.4 Heating

The lens panel shall be heated to prevent fogging and condensation. An eight watt-per-foot, self-regulating, heat tape shall be provided along the bottom of the message area, between the glazing and the display modules. The sign controller shall control the heat tape. All heat tape terminal blocks shall be covered for safety.

7.5 HUMIDITY CONTROL

A humidity sensor shall be provided and sensed by the sign controller from zero percent to 100 percent relative humidity in one percent or fewer increments. The sensor shall operate and survive from 0 percent to 100 percent relative humidity.

The sensor shall have an accuracy that is better than +/- five percent relative humidity. The sign controller shall read the internal temperature sensors, external ambient temperature sensor and the humidity sensor. The sign controller shall use these readings in an algorithm that turns on the heat tape and/or the fans at the appropriate times to reduce both frost on the face of the sign and condensation on the display modules and other electronic circuitry.

7.6 DRAIN HOLES

The bottom panel of the housing shall have a minimum of four drain holes, with snap-in, drain filter plug inserts, in each section formed by internal structural members. Water drain filter plug inserts shall be replaceable.

7.7 VENTILATION SYSTEM

The ventilation system shall be a positive-pressure, filtered, forced-air system which cools both the display modules and the sign housing interior. The sign housing shall have two exhaust ports. Each exhaust port shall be filtered and protected by an aluminum hood assembly.

The ventilation system shall have four fans. Air shall be drawn into the sign housing through hoods near the bottom of the housing, and then filtered before reaching the fan units. There shall be two aluminum hood assemblies and inlet filters.

The inlet and exhaust filters shall be electrostatic and shall be sized to properly accommodate the air flow and pressure drop requirements of the ventilation system. The inlet filters shall have an Initial Atmospheric Dust Spot Efficiency of 64 at 20 cm/s in accordance with ASHRAE 52.1. These filters shall be easily removable from within the sign housing without the use of tools.

Each fan shall be capable of providing a minimum of one sign housing volume change per minute at the pressure drop developed throughout the entire ventilation system with all fans operating. The fans shall have ball or roller bearings, shall be permanently lubricated and shall require no periodic maintenance. The fans are to be positioned in such a manner so as to provide a balanced air flow to the ventilation system in the event of failure of any fan.

Adequate air flow shall be automatically tested once a day and tested on command from the central controller or laptop computer. Inadequate airflow will cause an error message to be sent to the central controller or laptop computer when the sign controller is polled by the central controller or laptop computer.

Adequate air flow shall be tested with a 100% solid state air flow detection device downstream from each fan. The entire message area shall be ventilated by an efficient forced air system. Air shall be ducted directly from the fans to the bottom of the entire message area. The air shall be directed to provide equal distribution of air to the bottom of the cavity between the lens panel and the LED modules. The air shall be exhausted out of the top of the cavity into the sign housing interior. Air flow shall be sufficient to exchange a minimum of one volume of air every eight (8) seconds in the void between each display module and the lens panel.

The air plenums shall be sealed and designed to keep any water that gets through the louvers from getting into the sign housing interior.

All duct work that impedes access to any sign components shall be easily removable, without tools, for servicing of these components.

All ductwork shall be 0.040 minimum aluminum and shall be designed to be extremely efficient with minimal pressure drop throughout the system.

Multiple temperature sensors shall activate the ventilation system. There shall be a minimum of one sensor located near the middle of the sign, at the top of the display area in the exhaust stream from the cavity between the display modules and the lens panel. There shall be an additional temperature sensor located to accurately measure the ambient temperature outside the sign housing. The temperature sensors shall have an accuracy of +/- 1.5 degrees C. and a range from -40 to +70 degrees C.

The temperatures from the sensors shall be continuously measured and monitored by the sign controller. A temperature reading greater than a user selectable critical temperature shall cause the sign to go to blank and the sign controller shall report this error message to the central controller.

The LED modules and electronic equipment shall be protected by a fail-safe, back-up fan control system in the event of an electronic fan control failure or shutdown of the sign controller.

Alternate sign ventilation systems can be submitted to the Engineer for approval. Extra time and additional demonstration testing and documentation of the proposed alternate system may be needed to secure the necessary approval from the Engineer. No extra compensation shall be awarded to the Contractor for the alternate design but if the alternate design is rejected, liquidated damages may apply.

8.0 LED DISPLAY MODULES

The DMS shall contain LED display modules that include an LED pixel array, LED driver circuitry, and mounting hardware. These modules shall be mounted adjacently in a two-dimensional array to form a continuous LED pixel matrix. Each LED display module shall be constructed as follows:

- Each LED display module may consist of one or two circuit boards. If two boards are used, they shall be mounted physically to each other using durable non-corrosive hardware. They shall be electrically connected via one or more header-type connectors. The header connectors shall be keyed such that the boards cannot be connected incorrectly.
- All LED modules shall be manufactured using laminated fiberglass printed circuit boards.
- Each LED display module shall be mounted to the rear of the display's front face panels using durable non-corrosive hardware. No tools shall be required for module removal and replacement. The modules shall be mounted such that the LEDs emit light through the face panel's pixel holes and such that the face panel does not block any part of the viewing cone of any of the LEDs in any pixels.
- LED display module power and signal connections shall be a quick-disconnect locking connector type. Removal of a display module from the DMS, or a pixel board or driver circuit board from its display module, shall not require a soldering operation.
- All exposed metal on both sides of each printed circuit board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of conformal coating. Bench level repair of individual components, including discrete LED replacement and conformal coating repair, shall be possible.
- Individual addressing of the each LED display module shall be configured via the communication wiring harness and connector. No on-board addressing jumpers or switches shall be allowed.
- Removal or failure of any LED module shall not affect the operation of any other LED module or sign component. Removal of one or more LED modules shall not affect the structural integrity of any part of the sign.
- It shall not be possible to mount an LED display module upside-down or in an otherwise incorrect position within the DMS display matrix.
- All LED display modules, as well as the LED pixel boards and driver circuit boards, shall be identical and interchangeable throughout the DMS.
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8.1 LED Pixels

Each LED module shall contain a printed circuit board to which LED pixels are soldered. The LED pixel matrix shall conform to the following specifications:

- Each LED module shall contain a minimum of 45 LED pixels configured in a two dimensional array. The pixel array shall be a minimum of nine (9) pixels high by five (5) pixels wide.
- The distance from the center of one pixel to the center of all adjacent pixels, both horizontally and vertically, shall be 2.6-inches (66 mm).
- Each pixel shall consist of a minimum of one (1) independent string of discrete LEDs for each color. All pixels shall contain an equal quantity of LED strings.
- The failure of an LED string or pixel shall not cause the failure of any other LED string or pixel in the DMS.
- Each pixel shall contain the quantity of discrete LEDs needed to output white colored light at a minimum luminous intensity of 12,400 candelas per square meter when operated within the forward current limits defined in these specifications.
- Each pixel shall also be capable of displaying amber colored light with a minimum luminous intensity of 7,440 candelas per square meter when operated within the forward current limits defined in these specifications.
- Each LED pixel shall not consume more than 1.5 watts.
- The circular base of the discrete LEDs shall be soldered so that they are flush and parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.
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8.2 Discrete LEDs

DMS pixels shall be constructed with discrete LEDs manufactured by Avago Technologies (formerly Agilent Technologies), Toshiba Corporation, Nichia Corporation, OSRAM, or equivalent. Discrete LEDs shall conform to the following specifications:

8.2.1 DMS Front Access, Full Matrix, NTCIP 1203 V2 – Color (IDOT)

- All LEDs shall have a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed +/- 3 degrees.
- Red LEDs shall utilize AlInGaP semiconductor technology and shall emit red light that has a peak wavelength of 650 ± 5 nm.
- Green LEDs shall utilize InGaN semiconductor technology and shall emit green light that has a peak wavelength of 525 ± 5 nm.
- Blue LEDs shall utilize InGaN semiconductor technology and shall emit blue light that has a peak wavelength of 470 ± 5 nm.
- The LED lenses shall be fabricated from UV light resistant epoxy.
- The LED manufacturer shall perform color sorting of the bins. Each color of LEDs shall be obtained from no more than two (2) consecutive color "bins" as defined by the LED manufacturer.
- The LED manufacturer shall perform intensity sorting of the bins. LEDs shall be obtained from no more than two (2) consecutive luminous intensity "bins" as defined by the LED manufacturer.
- The various LED color and intensity bins shall be distributed evenly throughout the sign and shall be consistent from pixel to pixel. Random distribution of the LED bins shall not be accepted.
- LED package style shall be either through-hole flush-mount or surface-mount. Through-hole LEDs with standoffs will not be accepted.

- All LEDs used in all DMS provided for this contract shall be from the same manufacturer and of the same part number, except for the variations in the part number due to the intensity and color bins.
- The LEDs shall be rated by the LED manufacturer to have a minimum lifetime of 100,000 hours of continuous operation while maintaining a minimum of 70% of the original brightness.

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8.3 Pixel Drive Circuitry

One (1) electronic driver circuit board shall be provided for each LED pixel module and shall individually control all pixels on that module. The driver circuit boards shall conform to the following specifications:

- Each LED driver board shall be microprocessor-controlled and shall communicate with the sign controller on a wire or fiber optic communication network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostic tests, and report pixel and diagnostic status.
- Constant current LED driver ICs shall be used to prevent LED forward current from exceeding the LED manufacturer's recommended forward current whenever a forward voltage is applied. To maximize LED service life, LED drive currents will not be allowed that exceed the manufacturer's recommendations for the 100,000-hour lifetime requirement.
- The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.
- The LED driver circuitry shall receive updated display data at a minimum rate of ten (10) frames per second from the sign controller.
- Each LED driver circuit shall be powered by 24 VDC from external regulated DC power supplies. Each driver circuit shall receive power from a minimum of two (2) independent power supplies. Indicator LEDs shall be provided to indicate the status of each power source.
- Each LED driver circuit shall contain a microprocessor-controlled power regulation circuit that controls the voltage applied to the LED strings. The power circuit shall automatically adjust the voltage supplied to the LEDs to optimize power consumption efficiency as the temperature changes.
- The voltage of each power input shall be measured to the nearest tenth of a volt and reported to the sign controller upon request. Each driver circuit shall also contain one status LED for each power source that indicates if the power source is present or not.
- The LED driver circuitry shall be able to detect that individual LED strings or pixels are stuck off and shall report the pixel status to the sign controller upon request.
- The LED driver board shall contain a seven segment numeric LED display that indicates the functional status of the driver and pixel boards. At a minimum, it shall indicate error states of the LED pixels and communication network.

The indicator shall be positioned such that a maintenance technician can easily view the status code for diagnostic purposes. The status codes shall also be reported to the sign controller upon request.

8.4 CHARACTERS DISPLAYED

The signs shall be capable of displaying ASCII characters 32 through 126 (including all upper and lower case letters and digits from 0 to 9) at any location in a message line. The display area shall be 27 pixels wide by 125 pixels high.

The sign shall normally display single stroke (4 x 7) characters with single-column spacing between characters. The operator shall be able to display normal (5 X 7), expanded (6 x 7) or double-stroke (7 x 7) character fonts or change the default spacing between characters. The spacing options shall be one, two or three pixel columns. Font access privileges shall be assigned by the system supervisor.

The full matrix display shall be capable of displaying other sized character, graphics/symbols, and other number of lines depending on the height of the character utilized.

The separation between the last column of one module and the first column of the next shall be equal to the horizontal distance between the columns of a single display module. The separation between the last row of one module and the first row of the next shall be equal to the horizontal distance between the rows of a single display module.

18-inch characters shall be legible under all light conditions at a distance of 900 feet within a 30 degree cone of vision centered around the optical axis of the pixel. The cone perimeter shall be defined by its 50% intensity points.

The sign shall be the proper brightness in all lighting conditions for optimum legibility. It shall be bright enough to have a good target value, but not be the point where the pixels bloom, especially in low ambient light level conditions.

The brightness and color of each pixel shall be uniform over the entire face of the sign within the 30 degree cone of vision from 900 feet to 200 feet in all lighting conditions. Non-uniformity of brightness or color over the face of the sign under these conditions shall be cause for rejection of the sign.

8.5 Display of Graphic Images

The DMS control software shall support the inclusion of graphics in messages. If the NTCIP 1203 v2 standard has not reached a "recommended" or "approved" state by the time of contract award, the vendor shall support graphics using manufacturer-specific objects and MULTI tags.

If a manufacturer-specific means of supporting graphics is used, the vendor shall commit to provide NTCIP 1203 v2 firmware updates at no cost to the customer. These updates will include all current requirements of these specifications and also standard graphics support. The vendor shall install the updates no later than six months after the NTCIP 1203 v2 standard reaches the "approved" state.

9.0 REGULATED DC POWER SUPPLIES

The LED pixel display modules shall be powered with auto-ranging regulated switching power supplies that convert the incoming AC to DC at a nominal voltage of 24 volts DC. Power supplies shall be wired in a redundant parallel configuration that uses multiple supplies for the DMS display matrix.

Power supplies shall be arranged in redundant pairs within the display such that each pair supplies power to a defined region of the sign. Each pair of power supplies shall contain two (2) physically and electrically independent supplies. Each pair of power supplies shall be parallel, but shall not be wired in a current sharing configuration.

Power supplies within each pair shall be redundant and rated such that if one supply fails, the remaining supply shall be able to operate 100% of the pixels in that display region at 100% brightness when the internal DMS air temperature is +140°F (60°C) or less.

Each power supply within each pair shall receive 120VAC power from separate circuits on separate circuit breakers, such that a single tripped breaker will not disconnect power from both supplies. It shall be acceptable for a single circuit breaker to power multiple DC power supplies provided that none of those power supplies are in the same power supply pair.

The power supplies shall be sufficient to maintain the appropriate LED display intensity throughout the entire operating input voltage range.

The output of each power supply shall be connected to multiple circuits that provide power to the LED modules. Each output circuit shall not exceed 15 amperes and shall be fused.

Each group of power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and the status of each output circuit's fuse. The power supply voltages and fuse states shall be reported to the sign controller upon request.

The power supplies used to power the LED pixel modules shall be identical and interchangeable throughout the DMS.

Regulated DC power supplies shall conform to the following specifications:

- Nominal output voltage of 24 VDC +/- 10%
- Nominal maximum output power rating of 1000 watts
- Operating input voltage range shall be a minimum of 90 to 260 VAC
- Operating temperature range shall be a minimum of -30°F to +165°F (-34°C to +74°C)
- Maximum output power rating shall be maintained over a minimum temperature range of -30°F to +140°F (-34°C to +60°C)
- Power supply efficiency shall be a minimum of 80%
- Power factor rating shall be a minimum of 0.95
- Power supply input circuit shall be fused
- Automatic output shut down and restart if the power supply overheats or one of the following output faults occurs: over-voltage, short circuit, or over-current

- Power supplies shall be UL listed
- Printed circuit boards shall be protected by an acrylic conformal coating

9.1 PHOTOELECTRIC SENSOR DEVICES

Three (3) photocells shall be installed on the sign. These devices shall permit automatic light intensity measurement of light conditions at each sign location.

These photocells shall be mounted in a manner to measure front, rear and ambient light conditions.

9.2 BRIGHTNESS CONTROL

Automatic adjustment of the LED brightness shall occur in small enough increments so that the brightness of the sign changes smoothly, with no perceivable brightness change between adjacent levels. Provision shall be made to prevent perceivable brightening of the sign due to stray headlights shining upon the photo sensors at night.

Pixel brightness shall be controlled by pulse width modulation of the DC current. The pixel current waveform shall have a frequency of 100 +/-5 Hertz at nighttime brightness levels and 2400 ± 120 Hertz at daytime brightness levels with an adjustable duty cycle of 0.03 to 99.9% in 0.5% or finer increments. Brightness shall be manually settable from the front panel of the controller and remotely from the central computer in 1% increments. Brightness control shall be able to be returned to automatic from the sign controller front panel and the central computer

9.3 PIXEL STATUS FEEDBACK

Two separate types of pixel status feedback shall be provided to the central controller from the local sign controller. These include a pixel test and a pixel read:

Pixel Test: The pixel test shall be performed from the central controller on command and automatically once a day. During a pixel test, the full operational status of each string of LEDs in each pixel shall be tested and then transmitted to the central controller or laptop computer. This pixel status test shall distinguish the difference between half out, full out, half stuck-on and fully stuck-on pixels. A list of defective pixels shall be provided, listing pixel status, line number, module number, column number and row number for each defective pixel. The pixel test may briefly disturb the displayed message for less than 0.5 seconds.

Pixel Read: The pixel read shall be performed during both message downloads and during every sign poll from the central controller or laptop computer. The pixel read shall perform a real-time read of the displayed message and shall return the state of each pixel to the central controller as it is currently displayed to the motorist, including any errors. This shall allow the central controller operator to see what is visibly displayed to the motorist on an individual pixel basis. During a pixel read, the state of each pixel (full-on, half-on or off) in the sign shall be read by the sign controller to allow the central controller or laptop computer to show the actual message, including static flashing and alternating messages, that is visibly displayed on the sign in a WYSIWYG format. This pixel reading shall take place while a message is displayed on the sign without disturbing the message in any way. Any flashing, flickering, blinking, dimming, or other disturbance of the message during this pixel read shall be cause for rejection of the sign.

The pixel read shall be an actual real-time read of the current flowing through each string of LEDs at the time of the associated sign poll or message download and shall not be accomplished by simulating errors based on the last pixel test.

10.0 ENVIRONMENTAL OPERATING PARAMETERS

All DMS components shall be capable of operating without any decrease in performance over a temperature range of -40°C (-40°F) to $+70^{\circ}\text{C}$ ($+158^{\circ}\text{F}$) with a relative humidity of up to 95% non-condensing, unless otherwise noted in this specification.

11.0 SIGN CONTROLLER

11.1 General Requirements

Each DMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with DMS control software in order to perform most DMS control functions.

The sign controller shall meet the following operational requirements:

- Communicate using the NTCIP protocol
- Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
- Include a front panel user interface with LCD and keypad for direct operation and diagnostics as described herein
- Contain a minimum of three (3) NTCIP-compliant RS232 communication ports
- Contain a minimum of one (1) NTCIP-compliant Ethernet port with RJ45 connector
- Contain a built-in Hayes-compatible modem with standard RJ11 connector
- Contain DMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface

NTCIP shall be natively supported in the DMS controller. External protocol converter or translator devices shall not be allowed.

11.2 Controller Location

The sign controller and associated communication equipment shall be installed inside the DMS housing.

11.3 Environmental

The sign controller shall meet the following environmental requirements defined in *NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements*.

11.4 Mechanical and Electrical

The sign controller shall meet the following electrical and mechanical requirements:

- Mount in a standard EIA 19-inch (480 mm) equipment rack with a maximum 4U space requirement

- Weigh no more than 10 pounds, including its enclosure
- Consume no more than 30 watts of power
- Powered by an internal regulated DC power supply capable of operating on 120VAC or 240VAC at both 50Hz and 60Hz
- All printed circuit boards shall be sealed with an acrylic conformal coating

11.5 Operational Requirements

Front Panel User Interface

The sign controller's front panel shall include a keypad and LCD. These devices shall be used to perform the following functions with the sign controller and DMS:

- Monitor the current status of the sign controller, including the status of all sensors and a monochromatic what-you-see-is-what-you-get (WYSIWYG) representation of the message visible on the display face
- Perform diagnostics testing of various system components, including pixels, power systems, sensors, and more
- Activate messages stored in memory
- Configure display parameters, including display size and colors
- Configure communications port settings and NTCIP options

The front panel interface shall also include:

- Power switch to turn the controller on and off
- LED power "on" indicator
- "Local/remote" switch that places the controller in local mode such that it can be controlled from the front panel interface, instead of via the primary NTCIP communication channel
- LED to indicate state of the "local/remote" mode switch
- Reset switch to quickly restart the controller
- LED "Active" indicator that blinks when the controller is operating correctly
- LED to indicate when any of the NTCIP communication channels are active

11.6 MEMORY

The sign controller shall have non-volatile electronically changeable memory. This memory shall be formed by flash or battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power loss. This changeable memory shall be used to store messages and schedules. The controller memory shall be capable of storing a minimum of 100 changeable messages in non-volatile RAM.

11.7 Internal Clock

The DMS sign controller shall contain a computer-readable clock that has a battery backup circuit. The battery shall keep the clock operating properly for at least 5 years without external power, and the clock shall automatically adjust for daylight savings time and leap year using hardware, software, or a combination of both. The clock shall be set electronically by the sign controller microprocessor and shall be accurate to within one (1) minute per month.

11.8 Communications

All remote communication ports shall be NTCIP-compatible as defined in the "Requirements for NTCIP Compatibility" section of these specifications.

11.9 Communication Modes

The DMS sign controller shall be able to receive instructions from and provide information to a computer containing DMS control software using the following communication modes:

- Remotely via direct or dial-up communications with a remotely located computer. The system communications backbone, as well as all field modems or signal converters, shall provide the DMS sign controller with an RS232 signal.
- Locally via direct connection with a laptop computer that is connected directly to the sign controller using an RS232 null modem connection.

Serial Communication Ports

The DMS sign controller shall contain a minimum of three (3) NTCIP-compatible RS232 communication ports. These ports shall support multiple communication interfaces, including, but not limited to, direct null-modem (for local laptop control), dial-up and leased-line modems, radio systems, cellular modems, and fiber optic modems. The RS232 ports shall all have standard DB9M connectors.

The baud rate, connection type, and NTCIP communication protocol shall be configurable. Each port must support all typical serial baud rates ranging from 1200 to 115,200 baud. All three ports shall be capable of supporting either of the following sub network profiles: NTCIP 2101 (PMPP) or NTCIP 2103 (PPP). They shall also be capable of supporting either NTCIP 2201 (Null) or NTCIP 2202 (Internet) transport profiles. Only one each of the transport and sub network profiles shall be active at any time on each port.

Ethernet Port

The DMS sign controller shall contain a minimum of one (1) 10/100Base-T Ethernet communication port. This port shall be available for use for communicating from the central control system to the DMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.

Communications on the Ethernet port shall be NTCIP-compatible using the NTCIP 2202 Internet transport profile and the NTCIP 2104 Ethernet sub network profile. This shall permit the controller to be operated on any typical Ethernet network using the TCP/IP and UDP/IP protocols.

For purposes of this contract this DMS shall connect via a layer 3 switch at the Dan Ryan/I-55 Interchange to the Traffic Systems Center.

Dial-Up Modem Communication Port

The DMS sign controller shall include one (1) built-in Hayes-compatible dial-up modem. The modem port shall have a standard RJ11 connector.

This modem shall be configured to support either the NTCIP 2101 (PMPP) or the NTCIP 2103 (PPP) sub network profile. At least one of the following transport profiles shall also be available for configuration: NTCIP 2201 (Null) or NTCIP 2202 (Internet). Only one each of the transport and sub network profiles shall be active at any time on the port.

The modem shall be configurable to support both incoming and outgoing calls as supported by NTCIP. The modem shall support a minimum communication speed range from 1200 baud to 28,800 baud. The modem shall support the following protocols at a minimum: Hayes-compatible "AT" command set, MNP5, MNP10, and V.42bis.

Controller Addressing

The DMS sign controller shall use whatever addressing scheme is appropriate for the NTCIP network types used for communications. The controller addressing shall be configurable through the front panel user interface.

NTCIP 2101 (PMPP) networks shall be configured with an address in the range 1 to 255 with a default address of 1. NTCIP 2104 (Ethernet) networks shall use a static IP address. Both the IP address and subnet shall be configurable. NTCIP 2103 (PPP) networks shall not require network addressing.

12.0 TRANSIENT PROTECTION

The DMS and sign controller signal and power inputs shall be protected from electrical spikes and transients as follows:

12.1 Sign AC Power

The AC power feed for all equipment in the sign cabinet shall be protected at the panel board by a parallel-connection surge suppresser rated for a minimum surge of 40 kA. This device shall conform to the following requirements:

- Withstand a peak 80,000-ampere surge current, 40kA L-N, 40kA L-G
- Designed, manufactured, & tested consistent with: IEEE C6.41.1-2002, C62.41.2-2002, C2.45-2002, ANSI/IEEE C62.41-1991, C62.45-1992, NEMA LS-1, and NEC 285.6
- Less than 0.5 nanosecond response time
- Temperature range of -40°F to +158°F (-40°C to +60°C)
- Approximate dimensions of 3-inches (76 mm) wide by 8-inches (203 mm) long by 3-inches (76 mm) high
- 5000 Category (C3 High) impulses with <10% drift, short circuit current rating of 200,000 rms symmetrical amperes (UL Listed)
- UL listed to: UL 1449 200kA SCCR, UL 1283 4th Edition, and Canadian safety standards

12.2 Control Equipment AC Power

A series-connected surge suppressor capable of passing 15 amps of current shall protect the sign controller and other control and communication equipment. This device shall conform to the following requirements:

- Withstand a peak 50,000 ampere surge current for an 8x20 microsecond wave form

- Maximum continuous operating current of 15 amps at 120 VAC, 60 Hz
- Series inductance of 200 micro henrys (nominal)
- Temperature range of -40°F to +158°F (-40°C to +70°C)
- Approximate dimensions of 3-inches wide by 5-inches long by 2-inches high (76 mm by 127 mm by 50 mm)
- The device shall be UL-1449 recognized
- UL 1449 surge rating of 400 V or less

12.3 Communication Signals

Transient voltage surge suppressors shall protect all communication signals connecting to the control equipment from off-site sources using copper cables.

Transient voltage surge suppressors shall protect all copper communication lines used to pass data between the sign controller and sign.

12.4 Protection

A series/parallel two-stage suppression device shall protect the modem communication port from over-voltage and over-current conditions. This surge protection shall be integrated internally within the controller.

13.0 LOCAL USER AUXILIARY INTERFACE WHEN DMS SIGN CONTROLLER IS LOCATED INSIDE OF DMS ENCLOSURE

13.1 Auxiliary Control Panel

The DMS shall include an auxiliary control panel that will provide a secondary user interface panel for DMS control, configuration, and maintenance. The auxiliary control panel shall meet the same electrical, mechanical, and environmental specifications as the DMS controller. It shall be powered independently from a 120 VAC outlet. There also shall be a 120 volt convenience outlet for maintenance personnel lap top computers and a hinged shelf which folds from inside the cabinet and is suitable for the laptop computer to rest on.

13.2 Interface Panel

The auxiliary control panel shall have an LCD panel and keypad identical to those found on the DMS controller. It shall also contain a local/remote switch, a reset switch, status LEDs, and one NTCIP compatible RS232 communication port that meet the same specifications as the DMS controller.

13.3 DMS CONTROL INTERFACE

The auxiliary control panel shall include an identical menu system to the DMS controller with all of its features and functionality.

13.4 LOCATION

When the DMS controller is located up in the DMS sign, the auxiliary control panel shall be mounted inside a pole-mounted cabinet for maintenance access from the ground. The pole mounted cabinet shall be attached to the DMS support structure.

13.5 CONTROLLER SIGNAL INTERFACE

The auxiliary control panel shall interface to the DMS controller using outdoor-rated Category 5 copper cable. It shall be capable of operating up to 4000 feet from the DMS controller.

14.0 DMS POLE MOUNTED CABINET

The minimum cabinet dimensions shall be approximately 15 inches high by 15 inches wide by nine inches deep.

There shall be a hinged shelf which folds from inside the cabinet and is suitable for the laptop computer to rest on.

The cabinet shall be a NEMA 3R single-door enclosure.

The cabinet shall be constructed using stainless steel with a minimum thickness of 0.125 inch. Material used in the cabinet shall meet NEMA standards.

The cabinet shall be completely weatherproofed to prevent the entry of water. All exterior seams for cabinets and doors shall be continuously welded. All exterior welds shall be smooth.

The cabinet shall be provided with one full-size door to provide access to the cabinet. The door shall be provided with a full length stainless steel piano hinge, with a stainless steel pin spot welded at the top. The hinge shall be mounted so that it is not possible to remove it from the door or cabinet without first opening the door.

The door and hinges shall be braced to withstand a 100 pound per vertical foot of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed.

The cabinet door shall be fitted with a number 2 Corbin brass lock. Two keys shall be provided for each cabinet. The cabinet door shall also be fitted for a padlock locking provision in addition to the Corbin brass lock.

The door opening shall be double flanged on all four sides.

A gasket shall be provided to act as a permanent dust and weather resistant seal at the cabinet door facing. The gasket material shall be closed-cell neoprene and shall maintain its resiliency after exposure to the outdoor environment. The gasket must show no sign of rolling or sagging and must insure a uniform dust and weather resistant seal around the entire door facing.

The voice/data/control cable shall be terminated with a single champ type IDC connector on each end.

The power-on indicator shall show when the display system interface circuits are energized.

All shop drawings of the cabinet, as described in this specification and the plans, shall be submitted to the Engineer for approval before installation.

All shop drawings of the cabinet, as described in this specification and the plans, shall be submitted to the Engineer for approval before installation.

All markings and identification shall be silk screened on the panel and sealed with a clear sealer or as approved by the Engineer.

The Contractor shall be responsible for all phone, data, control and confirmation connections between the sign and ground control box and for any required wiring harnesses and connectors.

15.0 SIGN CONTROLLER FUNCTIONS

The sign controller shall be capable of being controlled from the central controller or the laptop computer.

The controller software shall be capable of performing the following functions:

Display a message, including:

1. Static messages
2. Flashing messages
3. Alternating messages

Messages shall be capable of displaying text, graphics or a combination of both. The graphics area shall be downloaded from the central controller with each message. It shall be possible to separately vary the flashing and alternating frequencies.

Flashing messages shall have the following adjustable timing:

1. Message time on from 0.5 to 5.0 seconds in 0.1 second increments.
2. Message time off from 0.5 to 5.0 seconds in 0.1 second increments

It shall be possible to flash any character or set of characters in a static message.

Alternating messages shall have the following adjustable timing:

1. Primary message time on from 0.5 to 5.0 seconds in 0.1 second increments.
2. Primary message time off from 0 to 5.0 seconds in 0.1 second increments.
3. Alternative message time on from 0.5 to 5.0 seconds in 0.1 second increments.
4. Alternate message time off from 0 to 5.0 seconds in 0.1 second increments.

It shall be possible to flash any character or set of characters in an alternating message at the adjustable frequencies listed above for flashing messages. The flashing period shall be a sub-multiple of the alternating on-time it is associated with.

Report errors and failures, including:

1. Power failure
2. Power recovery
3. Pixel string failure
4. Fan failure
5. Over a user selectable critical temperature
6. Power supply failure
7. Data transmission error
8. Receipt of invalid data
9. Communication failure recovery

Message and status monitoring:

The sign controller shall respond to the central controller whenever it receives a request for status (a poll). The return message shall be capable of providing the following information:

1. Actual message that is visibly displayed on the sign on an individual pixel basis (full-on, half-on or off)
2. Current sign illumination level
3. Local Control Panel switch position (central, local or local override mode)
4. Error and failure reports
5. Temperature readings
6. LED power supply voltage levels
7. Origin of display message transmission (laptop, manual or central)
8. Heater status
9. Heat tape status
10. Address of sign controller
11. Uninterruptible power supply status
12. AC Surge protection status
13. Communication line protection status
14. Operational status of the following sensors
 - Each temperature sensor
 - Each photocell
 - Each airflow sensor
 - Humidity sensor
 - Each power supply sensor
 - Severe error condition response

In dial-up mode, the sign controller shall initiate a call to the central controller and report any severe error conditions. In multi-drop mode, the sign controller shall report severe error conditions to the central controller during the next polling

The severe error conditions are:

1. AC power failure
2. AC power recovery
3. Surge protection has been tripped
4. The sign housing door is open

Each time the sign controller is polled by the DMS Master Controller or laptop computer, the sign controller shall test the operation status of the sensors listed below and return this information to the DMS Master Controller. This operational status test shall determine if each of the following sensors are functioning properly.

1. Each temperature sensor
2. Each photocell
3. Humidity sensor
4. Each airflow sensor
5. Each LED power supply

The sign controller shall provide a library with a minimum of 50 permanent messages, consisting of 30 or less characters per line, stored in PROM. The sign controller shall also be able to accept a downloaded library from the central or laptop computer of a minimum of 25 changeable messages stored in non-volatile RAM. These messages may be called for display on the sign from the keypad on the front panel of the DMS Controller.

The sign controller shall also be capable of displaying messages on the sign that are downloaded from the central controller or laptop computer, but are not located in the library stored in non-volatile memory of the sign controller.

The sign shall normally display single stroke (4 X 7) characters with single-column spacing between characters. The sign shall also be able to display single stroke (5 X 7), expanded (6 X 7) or double-stroke (7 X 7) nominal character fonts or change the default spacing between characters. The spacing options shall be one, two or three pixel columns. Each font may be edited and downloaded to the sign controller from the central controller or laptop computer at any time without any software or hardware modifications.

The full matrix display shall also be capable of displaying other sized characters, graphics/ symbols, and other number of lines depending on the height of the character utilized. The interline spacing shall be variable.

The sign controller shall monitor the photo cell circuits in the sign and convert the measured light intensity into the desired pixel brightness. The photo circuit readings shall be correlated with a brightness table in the sign controller. The brightness table shall have a minimum of 255 brightness levels. Automatic adjustment of the LED driving waveform duty cycle shall occur in small enough increments so that brightness of the sign changes smoothly, with no perceivable brightness change between adjacent levels. The brightness table in each individual sign controller shall be adjustable from the central controller and can be customized according to the requirements of the installation site. Each sign shall have its own, independent brightness table.

Brightness shall be manually settable from the front panel of the controller and remotely from the central computer in one percent increments from one to 99%.

There shall be a means to adjust how rapidly the sign responds to changes in ambient light as measured by the photocells. This can be used, for example, to prevent the sign from changing its brightness due to a vehicle's headlight momentarily hitting the sign. The adjustment shall be made from the central controller or laptop computer and shall have two different settings, one for daytime control and one for nighttime control, with the day/night ambient light threshold also being an adjustable value. In addition, there shall be a means to specify different weighting factors for each photocell, to specify how prominently each photocell figures in the calculation of nighttime ambient light.

In the event of a power failure, the sign controller shall activate a programmable default message (which shall be a blank message) and shall report the AC power failure to the central controller.

The operational status of each pixel in the sign shall be automatically tested once a day and tested when a pixel test is requested from the central controller or laptop computer.

A list of defective pixels shall then be transmitted to the central controller or laptop computer, listing pixel status test shall distinguish the difference between half-out, full-out, half-stuck on and fully stuck-on pixels. This test shall not affect the displayed message for more that 0.5 seconds.

When the sign controller is polled and when messages are downloaded from the central controller or laptop computer, each pixel in the sign shall be read and its current state (full-on, half-on or off), for the currently displayed message, shall be returned to the central controller. This will allow the central controller or laptop computer to show the actual message that is visibly displayed on the sign on an individual pixel basis in a WYSIWYG format. (This is different from the pixel test listed above.) This pixel status read shall not affect the displayed message in any way. The pixel read shall be an actual real-time read of the current flowing through each string of LEDs at the time of the associated sign poll or message download and shall not be accomplished by simulating errors based on the last pixel test.

The operational status of the fans shall be automatically tested once a day and tested on command from the central controller or laptop computer. Any failure will cause an error message to be sent to the central controller or laptop when the sign controller is polled by the central controller or laptop computer.

The sign controller shall read the internal temperature sensors, external ambient temperature sensor and the humidity sensor. The sign controller shall use these readings in an algorithm that turns on the heat tape and/or the fans at the appropriate times to reduce both frost on the face of the sign and condensation on the display modules and other electronic circuitry.

Temperature sensors shall be continuously measured and monitored by the sign controller. A temperature greater than a user selectable critical temperature shall cause the sign message to go to blank and the sign controller shall report this error message to the central controller. This user selectable critical temperature shall be capable of being changed by the central controller or laptop computer. The central controller and laptop computers shall have the ability to read all measurements from the sign controller.

All LED module power supply voltages shall be continuously measured by the sign controller. The sign controller shall provide these voltage readings to the central controller or laptop computer when the sign controller is polled by the central controller or laptop computer.

There shall be no perceivable blinking, flickering or ghosting of the pixels at any time, except during a pixel test as described above. The displayed message will not be affected in any way at any time for the pixel status read as described above.

In the event the central controller fails to communicate with the sign controller within a programmable time limit, the sign shall activate a programmable default message (which shall be a blank). This function shall apply only when the sign controller is in central control mode.

Failure of any sign shall not affect the operation of any other sign in the system.

The sign controller shall perform a consistency check of messages downloaded from the central controller or laptop computer to ensure that the message will fit in the display area of the sign. If any part of the message fails this check, the downloaded message shall not be displayed and an error message shall be displayed on the operator's GUI.

The sign controller internal time clock shall ensure that a message is taken down at the correct time, even in the event of a communications loss.

The sign controller shall maintain its internal time clock during power outages less than 255 minutes and display the proper message when power is restored.

The sign controller shall be able to put a self-updating time, temperature and/or date display on the sign.

The sign controller shall allow a moving arrow to be displayed by the central controller or laptop computer. The moving arrow shall be on one line with a standard message on the other lines. The moving arrows shall be from the left or right and shall start from one end or in the middle of the sign and continue to the end of the sign.

The sign controller shall blank the sign in the event of a communication failure or power failure. The controller shall blank the sign if failure lasts greater than 5 minutes. Communication failures are either on the field transmit, field receive, or both.

The sign controller shall have a special function output bit to control an auxiliary blank-out sign. This shall be a closure to ground capable of sinking at least 10 mA. It shall be controlled from the central controller.

The sign controller shall be capable of being remotely reset from the central controller.

The system power shall be protected by two stages of transient voltage suppression devices as required in the AC Power Section of this specification. Tripping of each stage (or both if tripped simultaneously) of the surge protection shall cause the sign controller to call central and report the error condition (for dial-up operation) or report the error condition to central on the next poll (for multi-drop operation). There shall be an option that is either enabled or disabled and is selected and downloaded from the central controller to the sign controller. When this option is enabled, tripping of the second stage of surge protection shall prevent power from reaching any components of the sign until the surge protection has been replaced. When this option is disabled, the sign will continue to function normally after the second stage of surge protection is tripped.

Communication lines shall be protected by two stages of transient voltage suppression devices as required in the Sign Controller Communication Interface Section of this specification. Tripping of each stage (or both if tripped simultaneously) of the surge protection shall cause the sign controller to call central and report the error condition (for dial-up operation) or report the error condition to central on the next poll (for multi-drop operation). There shall be an option that is either enabled or disabled and is selected and downloaded from the central controller to the sign controller. When this option is enabled, tripping of the second stage of surge protection shall disconnect the communication lines until the surge protection has been replaced. When this option is disabled, tripping of the second stage of surge protection shall disconnect the communication lines until the surge protection has been replaced.

When this option is disabled, the sign will continue to function normally after the second stage of surge protection is tripped.

15.1 MODES OF OPERATION

The mode of operation determines which level of control governs the DMS message selection. The three modes of operation are:

Central Mode: The local control panel switch is off and the central controller control and monitors the sign

Local Mode: The local control panel switch is on and the laptop computer is used to locally control the sign. The central controller only monitors the sign (i.e. status poll).

Local Override: The local mode has been overridden by the central to allow the central to control the sign in case the local control panel switch was unintentionally left in local mode.

15.2 AC POWER

The sign and its sign controller shall be capable of operating with 120/240 VAC, 50 amp per leg, 60 hertz, single-phase power.

The sign shall have a 50 amp per leg, 120/240 VAC, two-pole load center with 16 circuit capability. Each circuit in the sign shall be powered from a separate circuit breaker.

The system shall be protected by two stages of transient voltage suppression devices including MOVs and spark gap arrestor. If enabled by the central controller, tripping of the second stage shall prevent power from reaching any components of the sign until the surge protection has been replaced. Tripping of each stage of the surge protection shall cause the sign controller to call central and report the error condition (for dial-up operation) or report the error condition to central on the next poll (for multi-drop operation).

15.3 TRANSIENT TEST REQUIREMENTS

The sign housing electronics and the control cabinet shall be separately capable of withstanding a high-energy transient having the following characteristics repeatedly applied to the AC input terminals:

A ten microfarad oil filled capacitor charged to 1000 VDC \pm 5% shall be discharged into the power input terminals a minimum of three times for each polarity. Immediately following this test the unit under test shall perform all of its defined functions upon the restoration of normal AC power.

16.0 ELECTRONIC MATERIALS AND CONSTRUCTION METHODS

16.1 PRINTED CIRCUIT BOARDS

Printed Circuit Boards (PCB) design shall be such that components may be removed and replaced without damage to boards, traces or tracks.

Only FR-4 0.062 inch material shall be used. Inter-component wiring shall be copper clad track having a minimum weight of 2 ounces per square foot with adequate cross section for current to be carried. Jumper wires will not be permitted, except from plated-through holes to component.

The maximum number of jumper wires allowed per circuit board is two.
All PCBs shall be finished with a solder mask and a component identifier silk screen.

16.2 COMPONENTS

All components shall be of such design, fabrication, nomenclature, or other identification so as to be purchased from a wholesale electronics distributor, or from the component manufacturer, except for printed circuit board assemblies:

Circuit design shall be such that all components of the same generic type, regardless of manufacturer, shall function equally in accordance with the specifications.

All discrete components, such as resistors, capacitors, diodes, transistors, and integrated circuits shall be individually replaceable. Components shall be arranged so they are easily accessible for testing and replacement.

16.2.1 Capacitors

The DC and AC voltage ratings as well as the dissipation factor of a capacitor shall exceed the worst case design parameters of the circuitry by 50%

A capacitor which can be damaged by shock or vibration shall be supported mechanically by a clamp or fastener.

Capacitor encasements shall be resistant to cracking, peeling and discoloration.

16.2.2 Resistors

Resistors shall be within 5% of tolerance over the specified temperature range.

Any resistor shall not be operated in excess of 50% of its power rating.

16.2.3 Semiconductor Devices

All transistors, integrated circuits, and diodes shall be a standard type listed by EIA and clearly identifiable.

17.0 TECHNICAL ASSISTANCE

The DMS manufacturer's technical representative shall provide on-site technical assistance in the following areas:

1. Sign to structure installation
2. Sign controller cabinet installation
3. Sign to controller cabling

The initial powering up of the sign(s) shall not be executed without the permission of the DMS manufacturer's technical representative.

18.0 TESTING REQUIREMENTS

The equipment covered by this specification shall be subjected to design approval tests (DAT), factory demonstration tests (FDT), stand-alone tests, systems tests and 72 hour and 90 day test periods to determine conformance with all the specification requirements. The Engineer may accept certification by an independent testing lab in lieu of the design approval tests to verify that the design approval tests have previously been satisfactorily completed.

The DMS vendor shall arrange for and conduct the tests in accordance with the testing requirements stated herein. Unless otherwise specified, the DMS vendor is responsible for satisfying all inspection requirements prior to submission for the Engineer's inspection and acceptance. The contract periods will not be extended for time lost or delays caused by testing prior to final Department approval of any items. The Engineer reserves the right to have his representative witness any and all tests. The results of each test shall be compared with the requirements specified herein. Failure to conform to the requirements of any test shall be counted as a defect, and the equipment shall be subject to rejection by the Engineer. Rejected equipment may be offered again for a retest provided that all non-compliances have been corrected and retest by the DMS vendor and evidence thereof submitted to the Engineer.

Final inspection and acceptance of equipment shall be made after installation at the designated location as shown on the plans, unless otherwise specified herein.

18.1 TEST PROCEDURES

The DMS vendor shall provide five (5) copies of all design approval, factory demonstration, stand-alone and system test procedures and data forms for the Engineer's approval at least sixty (60) days prior to the day the tests are to begin. The test procedures shall include the sequence in which the tests will be conducted. The test procedures shall have the Engineer's approval prior to submission of equipment for tests.

The DMS vendor shall furnish data forms containing all of the data taken, as well as quantitative results for all tests. The data forms shall be signed by an authorized representative (company official) of the equipment manufacturer. At least one copy of the data forms shall be sent to the Engineer.

The DMS vendor shall be responsible for providing the test fixtures and test instruments for all of the tests.

18.2 DESIGN APPROVAL TESTS

Design approval tests shall be conducted by the DMS vendor on one or more samples of equipment of each type, as approved by the Engineer, to determine if the design of the equipment meets the requirements of this Specification. The test shall be conducted in accordance with the approved test procedures as described in section 19.0.

If the design approval tests have not previously been satisfactorily completed by an independent testing lab and accepted by the Engineer, the Engineer shall be notified a minimum of thirty (30) calendar days in advance of the time these tests are to be conducted.

The design approval tests shall cover the following:

18.2.1 Temperature and Condensation

The DMS sign system equipment shall successfully perform all the functionality requirements listed in this specification under the following conditions in the order specified below:

1. The equipment shall be stabilized at -40°F (-40°C). After stabilization at this temperature, the equipment shall be operated without degradation for two (2) hours.
2. Moisture shall be caused to condense on the equipment by allowing it to warm up to room temperature in an atmosphere having relative humidity of at least 40% and the equipment shall be satisfactorily operated for two (2) hours while wet.
3. The equipment shall be stabilized at 149°F (65°C). After stabilization, the equipment shall be satisfactorily operated for two (2) hours without degradation or failure.

18.2.2 Primary Power Variation

The equipment shall meet the specified performance requirements when the nominal input voltage is 115 V ± 15 V. The equipment shall be operated at the extreme limits for at least 15 minutes during which the operational test of the FDT shall be successfully performed.

18.2.3 Power Service Transients

The equipment shall meet the performance requirements, specified in the parent specification, when subjected to the power service transient specified in 2.1.6 "Transient, Power Service", of the NEMA standard TS1. The equipment shall meet the performance requirements specified in the parent specification.

18.2.4 Relative Humidity

The equipment shall meet its performance requirements when subjected to a temperature of (149°F / 65°C) and a relative humidity of 90%. The equipment shall be maintained at the above condition for 48 hours. At the conclusion of the 48 hour soak, the equipment shall meet the requirements of the operational test of the FDT within 30 minutes of beginning the test.

18.2.5 Vibration

The equipment (excluding cabinets) shall show no degradation of mechanical structure, soldered components, or plug-in components and shall operate in accordance with the manufacturer's equipment specifications after being subjected to the vibration tests as described in Section 2.2.5, "Vibration Test", of the NEMA standard TS1.

18.2.6 Consequences of Design Approval Test Failure

If the unit fails the design approval test, the design fault shall be corrected and the entire design approval test shall be repeated. All deliverable units shall be modified without additional costs to the Department, to include design changes required to pass the design approval tests.

19.0 DMS CONTROLLER UNINTERRUPTIBLE POWER SUPPLY

A UPS shall be provided to allow the sign controller to notify the central controller when an improper power condition at the DMS persists for longer than 30 seconds.

The UPS shall meet the following minimum specifications:

1. Line Transient Protection: Passes ANSI/IEEE C62.41 Category A testing
2. Safety Compliance: UL listed to UA1778

3. EMC Compliance: FCC Class B
4. Efficiency:>95% on line
5. Capacity VA/Watts @ 0.67P.F. : 425VA/285W
6. Voltage Nominal: 120 VAC
7. Voltage Range: 100-142 VAC
8. Typical run time (minutes): Full load: 3 minutes. Typical load: 5 minutes
9. Transfer time: 4 ms typical
10. Battery: Sealed, maintenance-free, valve regulated, UL 924 recognized.
11. Battery recharge time (to 95% of capacity): 8 hours with output fully loaded
12. Over current protection (on line): circuit breaker
13. Input fault current (maximum): 15A
14. Operating temperature: Range minimum -10°F -140°F (-23°C to 60°C)
15. Humidity: 5% - 95% RH (non-condensing)

20.0 FACTORY DEMONSTRATION TESTS

The DMS vendor shall be responsible for conducting Factory Demonstration Tests on all units at the DMS Vendor's Manufacturing Facility. These tests shall be performed on each unit supplied. The Engineer shall be notified a minimum of sixty (60) calendar days before the start of tests. The DMS Vendor shall pay for all travel expenses, including airfare, rental car, hotel, meals, etc., for up to three (3) department personnel or designated representatives for the Engineer to witness the Factory Demonstration Tests on the first unit at the vendor's manufacturing facility. All tests shall be conducted in accordance with the approved test procedures of Section 18.0. All equipment shall pass the following individual tests:

EXAMINATION TESTS

Each equipment shall be examined carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of the Specification.

CONTINUITY TESTS

The wiring shall be checked to determine if it conforms with the requirements of the appropriate paragraphs in the Specifications.

20.1 OPERATIONAL TEST

Each piece of equipment shall be operated long enough to permit equipment temperature stabilization, and to check and record an adequate number of performance characteristics to ensure compliance with the requirements of this Specification.

20.2 CONSEQUENCES OF FACTORY TEST FAILURE

If any unit fails to pass its demonstration test, the unit shall be corrected and another unit substituted in its place and the test successfully repeated.

If a unit has been modified as a result of a demonstration test failure, a report shall be prepared and delivered to the Engineer prior to shipment of the unit. The report shall describe the nature of the failure and the corrective action taken.

If a failure pattern develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the Department or extension of the contract period.

21.0 STAND-ALONE TESTS

The DMS vendor shall conduct an approved stand-alone test of the equipment installation at the field site. The test shall, as a minimum, exercise all stand-alone (non-network) functional operations of the field equipment with all of the equipment installed as per the plans, or as directed by the Engineer.

Approved data forms shall be completed and turned over to the Engineer as the basis for review and rejection or acceptance. At least thirty (30) working days' notice shall be given prior to all tests to permit the Engineer or his representative to observe each test.

21.1 CONSEQUENCES OF STAND-ALONE TEST FAILURE

If any unit fails to pass its stand-alone test, the unit shall be corrected or another unit substituted in its place and the test successfully repeated.

If a unit has been modified as a result of a stand-alone test failure, a report shall be prepared and delivered to the Engineer prior to the re-testing of the unit. The report shall describe the nature of the failure and the corrective action taken.

If a failure pattern develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the Department or extension of the contract period.

22.0 SYSTEM TEST

The DMS vendor shall conduct approved DMS system tests on the field equipment with the central equipment. The tests shall, as a minimum, exercise all remote control functions and display the return status codes from the controller.

Approved data forms shall be completed and turned over to the Engineer as the basis for review and for rejection or acceptance.

23.0 CONSEQUENCE OF SYSTEM TEST FAILURE

If system tests fail because of any components(s) in the subsystem, the particular components(s) shall be corrected or substituted with other components(s) and the tests shall be repeated. If a component has been modified as a result of the system test failure, a report shall be prepared and delivered to the Engineer prior to retest.

24.0 72 HOURS AND 90 DAYS TEST FAILURE

After the installation of the DMS system is completed and the successful completion of the System Test, the DMS vendor shall conduct one continuous 72-hour full operating test prior to conducting a 90-day test period. The type of test to be conducted shall be approved by the Engineer, and shall consist primarily of exercising all control, monitor and communications functions of the field equipment by the central equipment.

The 90-day test period shall commence on the first day after the successful completion of the approved 72-hour continuous full operating test period.

During the 90-day test period, downtime, due to mechanical, electrical and/or other malfunctions, shall not exceed five (5) working days. The Engineer may extend the 90-day test period by a number of days equal to the downtime in excess of five (5) working days.

The Engineer will furnish the DMS vendor with a letter of approval stating the first day of the 90-day test period.

25.0 FINAL SYSTEM ACCEPTANCE

Final system acceptance shall be defined as when all work and materials provided for in this item have been furnished and completely installed, and all parts of the work have been approved and accepted by the Engineer and the Dynamic Message Sign System has been operated continuously and successfully for ninety (90) calendar days with no more than five (5) working days downtime due to mechanical, electrical and/or other malfunctions.

26.0 WARRANTY

Equipment furnished under this Specification shall be guaranteed to perform according to these specifications and to the manufacturer's published specifications. Equipment shall be warranted for a minimum of **five years** return to factory against defects and/or failure in design, materials and workmanship. Unless otherwise specified in the invitation for bids, warranty coverage shall become effective on the date of final acceptance of the system by the Department. The Contractor shall assign to the Department all manufacturer's normal warranties or guarantees, on all such electronic, electrical and mechanical equipment, materials, technical data, and products furnished for and installed on the project. Defective equipment shall be repaired or replaced, at the manufacturer's option, during the warranty period at no cost to the Department. The Contractor shall provide a written document on DMS Vendor letterhead, signed by the DMS Principle, documenting said warranties or guarantees and shall be submitted to the Engineer before project acceptance.

27.0 CENTER TO FIELD COMMUNICATIONS NTCIP REQUIREMENTS

This section describes the minimum specifications for the NTCIP communication capabilities of the DMS controller and DMS control software. The contractor shall provide all the software, firmware, and services necessary to operate a dynamic message sign (DMS) system that fully complies with the NTCIP functional requirements specified herein, including incidental items that may have been inadvertently omitted.

References

These specifications reference standards through their NTCIP designated names. The following list provides the current versions of each of these standards.

Each NTCIP device covered by these project specifications shall implement the version of the standard that is specified in the following table. Refer to the NTCIP library at www.ntcip.org for information on the current status of NTCIP standards.

Document Number and Version	Document Title	Document Status
NTCIP 1101:1996 and Amendment 1	Simple Transportation Management Framework (STMF)	Approved Standard with Amendment
NTCIP 1102:2004	Octet Encoding Rules (OER) Base Protocol	Approved Standard

NTCIP 1103 v1.26a	Transportation Management Protocols	Recommended Standard
NTCIP 1201:1996 and Amendment 1	Global Object (GO) Definitions	Approved Standard
NTCIP 1203:1997 and Amendment 1	Object Definitions for Dynamic Message Signs	Approved Standard with Amendment
NTCIP 2001:1996 and Amendment 1	Class B Profile	Approved Standard
NTCIP 2101:2001	Point to Multi Point Protocol (PMPP) Using RS-232 Subnetwork Profile	Approved Standard
NTCIP 2103:2003	Point-to-Point Protocol Over RS-232 Subnetwork Profile	Approved Standard
NTCIP 2104:2003	Ethernet Subnetwork Profile	Approved Standard
NTCIP 2201:2003	on Transport Profile	Approved Standard
NTCIP 2202:2001	P/IP and UDP/IP) Transport Profile	Approved Standard
NTCIP 2301:2001	sportation Management Framework (STMF) Application Profile	Approved Standard

Table 1: NTCIP Document References

27.1 Subnetwork Profiles

Each serial or modem port on each NTCIP device shall be configurable to support both NTCIP 2101 and NTCIP 2103. Only one of these profiles shall be active at any given time. Serial ports shall support external dial-up modems.

Each Ethernet port on the NTCIP device shall comply with NTCIP 2104.

The NTCIP device(s) may support additional Subnet Profiles at the manufacturer's option. At any one time, only one subnet profile shall be active on a given port of the NTCIP device. All response datagram packets shall use the same transport profile used in the request. The NTCIP device shall be configurable to allow a field technician to activate the desired subnet profile and shall provide a visual indication of the currently selected subnet profile.

27.2 Transport Profiles

Each serial or modem port on each NTCIP device shall be configurable to support both NTCIP 2201 and NTCIP 2202.

Each Ethernet port on the NTCIP device shall comply with NTCIP 2202.

The NTCIP device(s) may support additional transport profiles at the manufacturer's option. Response datagrams shall use the same transport profile used in the request. Each NTCIP device shall support the receipt of datagrams conforming to any of the supported transport profiles at any time.

27.3 Application Profiles

Each NTCIP device shall comply with NTCIP 2301 and shall meet the requirements for Conformance Level 1.

An NTCIP device may support additional application profiles at the manufacturer's option. Responses shall use the same application profile used by the request. Each NTCIP device shall support the receipt of application data packets at any time allowed by the subject standards.

27.4 Object Support

Each NTCIP device shall support all mandatory objects of all mandatory conformance groups as defined in NTCIP 1201 and NTCIP 1203.

Each NTCIP device shall support all mandatory objects in all optional conformance groups required herein. All optional objects listed in these specifications shall be supported.

The NTCIP device(s) shall be required to support the following optional conformance groups.

Conformance Group	Reference
Time Management	NTCIP 1201
Timebase Event Schedule	NTCIP 1201
Report	NTCIP 1201
PMPP	NTCIP 1201
Font Configuration	NTCIP 1203
DMS Configuration	NTCIP 1203
MULTI Configuration	NTCIP 1203
MULTI Error Configuration	NTCIP 1203
Illumination/Brightness Control	NTCIP 1203
Scheduling	NTCIP 1203
Sign Status	NTCIP 1203
Status Error	NTCIP 1203
Pixel Error Status	NTCIP 1203

Table 2: Required Optional Conformance Groups

The following table indicates objects that are considered optional in the NTCIP standards, but are required by this specification. It also indicates modified object value ranges for certain objects. Each NTCIP device shall provide the full, standardized object range support (FSORS) of all objects required by these specifications unless otherwise indicated below.

Object	Reference	Project Requirement
moduleTable	NTCIP 1201 Clause 2.2.3	Shall contain at least one row with moduleType equal to 3 (software).
maxTimeBaseScheduleEntries	NTCIP 1201 Clause 2.4.3.1	Shall be at least 28
maxDayPlans	NTCIP 1201 Clause 2.4.4.1	Shall be at least 20
maxDayPlanEvents	NTCIP 1201 Clause 2.4.4.2	Shall be at least 12
maxEventLogConfig	NTCIP 1201 Clause 2.5.1	Shall be at least 50
eventConfigMode	NTCIP 1201 Clause 2.4.3.1	The NTCIP Component shall Support the following Event Configuration: onChange, greaterThanValue, smallerThanValue
eventConfigLogOID	NTCIP 1201 Clause 2.5.2.7	FSORS
eventConfigAction	NTCIP 1201 Clause 2.5.2.8	FSORS
maxEventLogSize	NTCIP 1201 Clause 2.5.3	Shall be at least 200
maxEventClasses	NTCIP 1201 Clause 2.5.5	Shall be at least 16
eventClassDescription	NTCIP 1201 Clause 2.5.6.4	FSORS
maxGroupAddresses	NTCIP 1201 Clause 2.7.1	Shall be at least 1
communityNamesMax	NTCIP 1201 Clause 2.8.2	Shall be at least 3
numFonts	NTCIP 1203 Clause 2.4.1.1.1.1	Shall be at least 12
maxFontCharacters	NTCIP 1203 Clause 2.4.1.1.3	Shall be at least 255
defaultFlashOn	NTCIP 1203 Clause 2.5.1.1.1.3	The DMS shall support flash "on" times ranging from 0.1 to 9.9 seconds in 0.1 second increments
defaultFlashOff	NTCIP 1203 Clause 2.5.1.1.1.4	The DMS shall support flash "off" times ranging from 0.1 to 9.9 seconds in 0.1 second increments
defaultBackgroundColor	NTCIP 1203 Clause 2.5.1.1.1.1	The DMS shall support the black background color
defaultForegroundColor	NTCIP 1203 Clause 2.5.1.1.2	The DMS shall support the amber foreground color
defaultJustificationLine	NTCIP 1203 Clause 2.5.1.1.1.6	The DMS shall support the following forms of line justification: left, center, and right
defaultJustificationPage	NTCIP 1203 Clause 2.5.1.1.1.7	The DMS shall support the following forms of page justification: top, middle, and bottom
defaultPageOnTime	NTCIP 1203 Clause 2.5.1.1.1.8	The DMS shall support page "on" times ranging from 0.1 to 25.5 seconds in 0.1 second increments

defaultPageOffTime	NTCIP 1203 Clause 2.5.1.1.1.9	The DMS shall support page "off" times ranging from 0.1 to 25.5 seconds in 0.1 second increments
defaultCharacterSet	NTCIP 1203 Clause 2.5.1.1.1.10	The DMS shall support the eight bit character set
dmsMaxChangeableMsg	NTCIP 1203 Clause 2.6.1.1.1.4	Shall be at least 100.
dmsMessageMultiString	NTCIP 1203 Clause 2.6.1.1.1.8.3	The DMS shall support any valid MULTI string containing any subset of those MULTI tags listed in Table 3 (below)
dmsControlMode	NTCIP 1203 Clause 2.7.1.1.1.1	Shall support at least the following modes: local, central, and centralOverride
dmsSWReset	NTCIP 1203 Clause 2.7.1.1.1.2	FSORS
dmsMessageTimeRemaining	NTCIP 1203 Clause 2.7.1.1.1.4	FSORS
dmsShortPowerRecoveryMessage	NTCIP 1203 Clause 2.7.1.1.1.8	FSORS
dmsLongPowerRecoveryMessage	NTCIP 1203 Clause 2.7.1.1.1.19	FSORS
dmsShortPowerLossTime	NTCIP 1203 Clause 2.7.1.1.1.10	FSORS
dmsResetMessage	NTCIP 1203 Clause 2.7.1.1.1.12	FSORS
dmsCommunicationsLossMessage	NTCIP 1203 Clause 2.7.1.1.1.12	FSORS
dmsTimeCommLoss	NTCIP 1203 Clause 2.7.1.1.1.12	FSORS
dmsEndDurationMessage	NTCIP 1203 Clause 2.7.1.1.1.15	FSORS
dmsMemoryMgmt	NTCIP 1203 Clause 2.7.1.1.1.16	The DMS shall support the following Memory management Modes: normal and clearChangeableMessages
dmsMultiOtherErrorDescription	NTCIP 1203 Clause 2.4.1.1.1.20	If the vendor implements any vendor-specific MULTI tags, the DMS shall provide meaningful error messages within this object whenever one of these tags generates an error
dmsIllumControl	NTCIP 1203 Clause 2.8.1.1.1.1	The DMS shall support the following illumination control modes: Photocell, and Manual
dmsIllumNumBrightLevels	NTCIP 1203 Clause 2.8.1.1.1.4	Shall be at least 100

dmsIllumLightOutputStatus	NTCIP 1203 Clause 2.8.1.1.1.9	FSORS
numActionTableEntries	NTCIP 1203 Clause 2.9.1.1.1	Shall be at least 200
watcdogFailureCount	NTCIP 1203 Clause 2.11.1.1.1.5	FSORS
dmsStatDoorOpen	NTCIP 1203 Clause 2.11.1.1.1.6	FSORS
fanFailures	NTCIP 1203 Clause 2.11.2.1.1.8	FSORS
fanTestActivation	NTCIP 1203 Clause 2.11.2.1.1.9	FSORS
tempMinCtrlCabinet	NTCIP 1203 Clause 2.11.4.1.1.1	FSORS
tempMaxCtrlCabinet	NTCIP 1203 Clause 2.11.4.1.1.2	FSORS
tempMinSignHousing	NTCIP 1203 Clause 2.11.4.1.1.5	FSORS
tempMaxSignHousing	NTCIP 1203 Clause 2.11.4.1.1.6	FSORS

Table 3: Modified Object Ranges and Required Optional Objects

27.5 MULTI TAGS

Each NTCIP device shall support the following message formatting MULTI tags. The manufacturer may choose to support additional standard or manufacturer-specific MULTI tags.

MULTI Tag	DESCRIPTION
f1	Field 1-time (12 hr)
f2	Field 1-time (24 hr)
f8	Field 8- day of month
f9	Field 9-month
f10	Field 10-2 digit year
f11	Field 11-4 digit year
fl (and /fl)	Flashing text on a line-by-line basis with flash rates controllable in 0.1-second increments.
Fo	Font
jl2	Justification- line-left
jl3	Justification- line-center

jl4	Justification- line- right
jp2	Justification- page- top
jp3	Justification- page- middle
jp4	Justification- page- bottom
Mv	Moving text
NI	New line
np	New page up to 5 instances in a message (i.e. up to 6 pages/frame in a message counting first page)
Pt	Page times controllable in 0.1-second increments

Table 4: Required MULTI Tags

27.6 DOCUMENTATION

NTCIP documentation shall be provided on a CD-ROM and will contain ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

- The relevant version of each official standard MIB modules referenced by the device functionality.
- If the device does not support the full range of any given object within a standard MIB Module, a manufacturer specific version of the official standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module except that it will have the extension "man".
- A MIB module in ASN.1 format containing any and all manufacturer specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- A MIB containing any other objects supported by the device

27.7 Acceptance Testing

The vendor will provide certification of NTCIP-compliance as part of the vendor's pre-build submittal documentation. This certification shall be in the form of a comprehensive test plan and completed test report as performed by either the vendor or a third-party testing agency. The testing shall have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon's NTester, Intelligent Devices' Device Tester, and/or Frontline's FTS for NTCIP. Data capture files from the FTS software during the performance of the above testing shall be furnished upon request of the Engineer.

The Engineer can elect to perform additional NTCIP testing if desired. This testing shall be conducted on a production DMS in the vendor's facility during the factory acceptance test.

The vendor shall provide a written NTCIP test procedure to the Engineer a minimum of 30 days prior to the NTCIP testing.

27.8 Interpretation Resolution

If the Engineer or DMS manufacturer discovers an ambiguous statement in the standards referenced by this procurement specification, the issue shall be submitted to the NTCIP DMS Working Group for resolution. If the Working Group fails to respond within 90 days, the engineer shall provide an interpretation of the specification for use on the project.

28.0 AS-BUILT DOCUMENTATION

The Contractor shall provide to the Engineer the following documentation of the complete installed equipment prior to testing. Sufficient documentation shall be provided to reflect "as-built" conditions and to facilitate operation, maintenance, modification and expansion of the system or any of its individual components. Manufacturer supplied documentation which covers the intent of this requirement may be used, subject to the approval of the Engineer.

A. Operators Manuals

A manual containing a general description and detailed operating and installation instructions shall be provided for each different type or model of equipment. Five copies of the manual shall include the following information:

1. A general description of the equipment including all information necessary to describe the basic use or function of the system components. This shall include a general block diagram presentation of the equipment. Where auxiliary equipment is required, tabular charts shall be included, list such equipment. These charts shall include the nomenclature physical and electrical characteristics and functions of the auxiliary equipment, unless such information is contained elsewhere in an associated manual. In the latter case, a reference shall be made to the location of the information pertaining to the auxiliary equipment.
2. The theory of operation of the system components in a clear, concise manner supported by simplified schematics, logic, data flow diagrams, one-function diagrams, etc. Timing and waveform diagrams and voltage levels shall be shown as required. A logical development shall be used starting with a system block level and proceeding to a circuit analysis. Circuit analysis shall be detailed whenever circuits are not normally found in standard text books. This application of new theoretical concepts shall be fully described. Where the design allows operation in a number of different modes, an operational description of each mode shall be included.
3. In simple, clear language, the routine of operation, from necessary preparations for placing the equipment into operation, to securing the equipment after operation. This section shall contain appropriate illustrations, with the sequence of operations presented in tabular form wherever feasible.
4. The manufacturer's recommended procedures and checks necessary for preventive maintenance. This shall be specified for pre-operation, weekly, monthly, quarterly, semi-annual, annual and "as required" checks as necessary to assure reliable equipment operation.

- Specification, including tolerances, for all electrical, mechanical, and other applicable measurement, adjustments, or both, shall be listed.
5. Data necessary for isolation and repair of failure or malfunctions, assuming the maintenance technicians to be capable of analytical reasoning using the information provided in the submittal information. Accuracies, limits, and tolerances for all electrical, physical or other applicable measurements shall be described. General instructions shall be included for disassembly, overhaul and reassembly, including shop specifications or performance requirements.
 6. Detailed instructions shall be given only where failure to follow special procedures would result in damage to the equipment, improper operation, danger to operating or maintenance personnel, and consumption of excessive person hours, etc. Such instructions and specifications shall be included only for such maintenance as may be accomplished by specialized technicians and engineers in a modern electromechanical shop. The instructions shall describe special test set-up, components fabrication, the use of special tools, jibs and test equipment.
 7. A detailed physical description of size, weight, special mounting requirements, electrical connections, and all other pertinent information necessary for proper installation and use of the equipment shall be provided.
 8. The parts list shall contain all information required to describe the characteristics of the individual parts, as required for identification. It shall include a list of all equipment within a group and list all assemblies, sub-assemblies and replacement parts of units. The tabular arrangement shall be an alphanumeric order of the schematic reference symbols and shall give the associated description, manufacturer's name and part number. A table of contents or some other convenient means shall be provided for the purpose of identifying major components, assemblies, etc.
 9. Schematic diagrams shall be complete and accurate as required to supplement the text material and to allow the books to be a self-contained technical information source. Maximum size of these diagrams shall be limited to allow their use in close proximity to the equipment, in the class room, etc., part reference symbols, test voltages, waveforms and other aids to understanding of the circuits function shall be included on the diagrams. Test voltages, waveforms and other aids to understanding of the circuits function may be shown on either the simplified schematics and other drawings (as required in the above sections) on theory of operation or maintenance or on the schematic diagrams required for this section. The overall scope of information shall not be less, however, than that stated for the schematic diagrams.

B. Software Manuals

The DMS vendor shall provide manuals and data for the computer software system and components thereof. These shall include the following:

1. Computer programmer's manuals and computer user's manuals (5 copies each). Include manuals for any CPU language used by the Contractor for this project. Include instructions for performing a back-up of all software and message libraries.
2. Two original copies of the computer's operating system manual and compiler and assembly language manuals and an instruction manual for translating source to object code.
3. Manufacturer's documentation (including schematics) for all plug in circuit cards used in the microcomputer chassis.

4. Computer program logic in flow chart form (5 copies).
5. Narrative descriptions of programs and input output formats (5 copies).
6. Two copies of source programs, for master and sign controller software, shall be provided on CD-ROM. An unrestricted license for software use by the Department shall be provided to the Engineer.
7. DMS vendor shall provide the communication protocol used between the DMS master controller and the DMS sign controller for use by the Department without any restrictions.

C. Final Documentation

Final documentation shall reflect all field changes and software modifications and shall be provided before installation. Final documentation shall be approved prior to final system acceptance has begun. This document shall include drawings of conduit layouts, cable diagrams, wiring lists, cabinet layouts, wiring diagrams and schematics for all elements of the communications system. This shall also include detailed drawings identifying by cable type, color-coded function, the routing of all conductors (pairs) in the communications system. Upon completion of the installation, the Contractor shall submit these plans, maps, and/or drawings to reflect an as built condition, incorporating all changes made during installation, such as in pair identification and routing.

29.0 SPARE PART REQUIREMENTS:

The Contractor shall provide additional parts to create two (2) additional character matrices, two (2) load modules to drive a character module, one (1) LED power supply and one complete sign controller unit. The cost of additional parts shall be considered incidental to the price for each DMS.

30.0 DMS TRAINING:

Operational and maintenance training for the entire system shall be provided to designated personnel during installation, testing and debugging. This training shall be provided through practical demonstrations and other related technical procedures. Training shall be limited to a maximum of 15 people and shall be provided at a time and location approved by the Engineer. The training shall include, but not be limited to, the following:

1. Hands-on operation of all sign control hardware
2. Explanation of all system commands, their function and usage.
3. Insertion of data
4. Required preventative maintenance
5. Servicing procedures
6. System trouble-shooting or problem identification procedures

A minimum of 24 hours of instruction shall be provided for the operational and maintenance procedures for the system. The DMS vendor shall submit an agenda for the training and one complete set of training materials along with the qualification of proposed instructors to the Engineer for approval at least 30 days before the training is to begin. The Engineer will review material and approve or request changes. After approval, the vendor shall provide a minimum of 5 copies of the training material that will become the property of the Department after the training period is over.

The DMS vendor shall record the entire training on DVDs and shall provide the recordings to the Engineer for later use. The training shall be conducted at District One Traffic Systems Center building where the control room is located, after the completion of all system integration tests. The schedule of training sessions shall be established by the DMS vendor, with the approval of the Engineer.

31.0 WARRANTY

The equipment and parts furnished for the DMS and DMS control system shall be new, of the latest model, fabricated under high quality standards.

Equipment and parts furnished for the DMS shall be warranted by the manufacturer to be free of defects in assembly or fabrication and materials for a minimum of five years from the date of acceptance and shall be warranted for quality of work for twelve months from the date of final acceptance. If component manufacturer's warranties are for a longer period, they shall apply. Any parts or equipment found to be defective during the warranty period shall, upon the concurrence of the defect by the manufacturer, be replaced free of charge.

The Engineer shall be furnished with a certification stating that the equipment, parts and material furnished for the DMS and DMS control system complies with all the provisions of this special provision. If there are any items which do not comply with this special provision, then a list of those exceptions shall be detailed on the certification.

All manufacturer's warranties and guarantees for the dynamic message sign system shall be transferred to the Department on the date of final acceptance.

32.0 METHOD OF MEASUREMENT

The DMS FRONT ACCESS, FULL MATRIX, NTCIP 1203 V2 – COLOR (IDOT) shall be paid for at the contract unit price as each which cost shall include the cost of furnishing all labor, materials, documentation, warranties, tools and equipment to install, test, and make the location operational.

33.0 BASIS OF PAYMENT

This work shall be paid for at the contract unit price each for DMS FRONT ACCESS, FULL MATRIX, NTCIP 1203 V2 – COLOR (IDOT) which price shall include furnishing and installing the DMS sign, documentation, warranties, spare parts, training, and diagnostic software as directed by the engineer.