

STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS	54-87 K-8258-01	2007	364	556

**CONSTRUCTION AND MATERIAL REQUIREMENTS  
FOR SIGNAL INTERCONNECT SYSTEM**

**SIGNAL INTERCONNECT SYSTEM**

THE INTERCONNECT SYSTEM SHALL CONSIST OF MATCHED SYSTEM COMPONENTS INCLUDING BUT NOT LIMITED TO FIBER OPTIC CABLE, FIBER OPTIC DATA LINK, DISTRIBUTION UNITS, CONNECTORS, AND CONDUIT. CONTRACTOR SHALL BE REQUIRED TO VERIFY COMPATIBILITY OF EXISTING EQUIPMENT.

TO ENSURE SYSTEM INTEGRITY, OPERATION AND COMPATIBILITY, ALL NEW COMPONENTS WILL BE FROM THE SAME MANUFACTURER EXCLUSIVE OF CABLE AND CONNECTORS. THE SYSTEM SHALL BE COMPATIBLE WITH 170(E) SIGNAL CONTROLLER AND EXCISING EQUIPMENT.

SYSTEM COMPONENT SPECIFICATIONS

**I. INTERCONNECT CABLE**

THE INTERCONNECT CABLE SHALL BE A 12 FIBER CABLE ASSEMBLY CONSISTING OF TWELVE (12) GEL-FILLED, LOOSE BUFFER TUBES. THERE SHALL BE SIX (6) SINGLE-MODE AND (6) MULTIMODE GRADED INDEX FIBERS. EACH COLOR-CODED BUFFER TUBE SHALL BE FILLED WITH A GEL TO PREVENT MOISTURE PENETRATION. EACH INDIVIDUAL FIBER WITHIN EACH BUFFER TUBE SHALL BE INDIVIDUALLY COLOR-CODED. ALL OTHER AREAS AROUND THE BUFFER TUBES AND CABLE CORE COMPONENTS SHALL BE FILLED WITH WATER-BLOCKING COMPOUNDS FOR ADDED MOISTURE BLOCKING PENETRATION (TAPE SHALL NOT BE USED TO CONFINE THE WATER-BLOCKING COMPOUND). A GLASS-REINFORCED PLASTIC SHALL BE USED FOR THE CENTRAL MEMBER. HIGH TENSILE ARAMID AND/OR FIBERGLASS YARN, HELICALLY STRANDED EVENLY AROUND THE CABLE CORE, SHALL BE UTILIZED FOR ADDITIONAL TENSILE STRENGTH. A MEDIUM DENSITY POLYETHYLENE OUTER JACKET (NOMINAL 1.5 MM THICKNESS) SHALL BE APPLIED OVERALL AND SHALL BE LABELED IN CONSECUTIVELY NUMBERED ONE (1) METER INCREMENTS SO THAT CABLE LENGTHS BETWEEN ANY TWO POINTS CAN BE READILY DETERMINED.

THE ALL-DIELECTRIC CABLE SHALL CONFORM TO THE FOLLOWING SPECIFICATIONS AS A MINIMUM:

- CORE DIAMETER - 62.5 35/64 3.0 MICRONS
- CLADDING DIAMETER - 125.0 35/64 2.0 MICRONS
- COATING DIAMETER - 250 35/64 15 MICRONS
- NUMERICAL APERTURE - 0.275 35/64 0.015
- OPERATING WAVELENGTHS - 850 NM AND 1300 NM FOR MULTIMODE 1310 NM AND 1550 NM FOR SINGLEMODE
- MAXIMUM ATTENUATION @ 850 NM : 7/64 3.0 DB/KM
- MAXIMUM ATTENUATION @ 1300 NM : 7/64 0.7 DB/KM
- MAXIMUM ATTENUATION @ 1310 NM : 7/64 0.5 DB/KM
- MAXIMUM ATTENUATION @ 1550 NM : 7/64 0.4 DB/KM
- MINIMUM BANDWIDTH @ 850 NM - 160 MHZ/KM
- MINIMUM BANDWIDTH @ 1300 NM - 500 MHZ KM
- PROOF TEST - 100 KPSI
- COLOR CODING - EIA/TIA STANDARD
- TENSILE STRENGTH DURING INSTALLATION - 2700 N (608 LBF)
- LONG TERM STRENGTH - 890 N (200 LBF)
- CRUSH RESISTANCE - 220N/CM (NON-ARMORED)
- OPERATING TEMPERATURE RANGE - 40 33/64 C TO 70 33/64 C
- STORAGE TEMPERATURE RANGE - 40 33/64 C TO 70 33/64 C
- INSTALLATION TEMPERATURE RANGE - 30 33/64 C TO 70 33/64 C
- MINIMUM BEND RADIUS (INSTALLATION) - 15 X CABLE O.D.
- MINIMUM BEND RADIUS (LONG-TERM) - 10 X CABLE O.D.

THE CONTRACTOR SHALL DELIVER TO THE ENGINEER A COPY OF THE CABLE MANUFACTURER'S TEST RESULTS ATTESTING TO THE PROOF OF PERFORMANCE OF THE FIBER PRODUCT USED BY THE MANUFACTURER.

**II. DUPLEX FIBER OPTIC JUMPER CABLE**

DUPLEX FIBER OPTIC JUMPERS SHALL BE PROVIDED TO CONNECT THE FIBER TERMINATED IN THE DISTRIBUTION CENTER IN THE CONTROLLER CABINET WITH THE FIBER OPTIC DATA LINK (MODEM) IN THE SIGNAL CONTROLLER UNIT. THE DUPLEX JUMPER SHALL BE HEAVY DUTY AND SHALL CONSIST OF TWO INDIVIDUALLY TIGHT BUFFERED, GRADED INDEX, MULTIMODE 62.5/125 M FIBERS, WITH A 2.8MM JACKET AND AN ADDITIONAL OUTSIDE JACKET ENCAPSULATING BOTH FIBERS, TERMINATED WITH ST CONNECTORS AS DESCRIBED IN THE NEXT SECTION OF THESE SUPPLEMENTAL SPECIFICATIONS. THE DUPLEX JUMPER CABLE SHALL BE APPROXIMATELY TWO (2) METERS LONG AND POSITIVELY IDENTIFY EACH OF THE TWO FIBERS. THE CABLE SHALL BE THE MOST PLIABLE, ALLOWING THE TIGHTEST BENDING RADIUS AVAILABLE WITHOUT COMPROMISING SYSTEM OPERATION. EACH JUMPER ASSEMBLY SHALL BE SUPPLIED WITH OPTICAL PERFORMANCE TEST DATA INDICATING INSERTION LOSS FOR THAT JUMPER ASSEMBLY.

**III. ST CONNECTORS**

ALL FIBER OPTIC CABLE END CONNECTORS SHALL BE INDUSTRY STANDARD ST STYLE CONNECTORS DESIGNED FOR FIELD INSTALLATION AND TO OPERATE WITHIN A TEMPERATURE RANGE OF -35C TO 75C. THE CONNECTOR SHALL BE A LOW LOSS TYPE, COMPRISED OF A FERRULE, CRIMP SLEEVE AND A TWO-INCH STRAIN RELIEF BOOT. THE NOMINAL LOSS PER CONNECTOR SHALL BE LESS THAN 59/64 DB. THE FERRULE SHALL HAVE A CERAMIC TIP AND HAVE A KEYED, BAYONET COUPLING MECHANISM FOR SECURE REPEATABLE MATINGS. EACH CONNECTOR SHALL BE PROVIDED WITH A DUST CAP. THE ST CONNECTOR USED SHALL BE DESIGNED FOR THE TYPE OF FIBER TO WHICH IT IS ATTACHED.

**IV. FIBER OPTIC CABLE INSTALLATION**

THE FIBER OPTIC INTERCONNECT CABLE SHALL BE INSTALLED IN A CONTINUOUS RUN, IN CONDUIT AND BETWEEN THE TRAFFIC SIGNAL CONTROLLER CABINETS. NO SPLICES OUTSIDE OF THE CONTROLLER CABINETS WILL BE ALLOWED.

THE FIBER OPTIC CABLE INSTALLATION SHALL BE SUPERVISED BY TRAINED AND EXPERIENCED PERSONNEL. INSTALLATION OF THE FIBER OPTIC CABLE SHALL BE BY A CONTRACTOR HAVING PROVEN INSTALLATION EXPERIENCE IN FIBER OPTIC SYSTEMS IN THE PAST TWELVE (12) MONTHS. WRITTEN PROOF OF EXPERIENCE SHALL BE SUPPLIED TO THE ENGINEER FOR APPROVAL. PROOF OF EXPERIENCE SHALL INCLUDE NAMES OF CLIENTS, NAME AND PHONE NUMBER OF CLIENT'S REPRESENTATIVE WHO MONITORED THE PROJECT, DESCRIPTION OF PROJECT, SPECIFICALLY THE CONTRACTOR'S INVOLVEMENT IN THE PROJECT; AND KEY CONTRACTOR PERSONNEL INVOLVED WHO WOULD BE INVOLVED IN THIS PROJECT. THE INFORMATION NEED BE SUPPLIED FOR NO MORE THAN THREE (3) PROJECTS IN THE LAST TWELVE (12) MONTHS. EACH END OF THE INTERCONNECT CABLE SHALL BE SEALED WITH A

MANUFACTURER APPROVED END CAP OR PULLING GRIP FOR USE DURING INSTALLATION. THESE CAPS OR GRIPS WILL BE REMOVED ONLY AFTER COMPLETE INSTALLATION OF THE CABLE AND FOR CABLE ACCEPTANCE TESTING. END CAPS SHALL BE INSTALLED TO REMAIN IN PLACE WHERE FIBERS ARE NOT TO BE TERMINATED.

THE MINIMUM BEND RADIUS AND THE MAXIMUM PULLING FORCE OF THE INTERCONNECT CABLE SHALL NOT BE EXCEEDED DURING INSTALLATION. THE PULLING OF THE CABLE SHALL BE HAND ASSISTED AT EACH PULL BOX AND CONTROLLER CABINET. THE CABLE SHALL NOT BE KINKED, CRUSHED OR FORCED AROUND A SHARP CORNER. PULLING EQUIPMENT MAY BE USED, HOWEVER, ALL PULLING EQUIPMENT AND HARDWARE MUST MAINTAIN THE CABLE'S MINIMUM BEND RADIUS. SUCH EQUIPMENT THAT MAY CONTACT THE CABLE INCLUDES SHEAVES, CAPSTANS, BENDING SHOES, AND QUADRANT BLOCKS DESIGNED FOR USE WITH FIBER OPTICS. WHERE PULLING EQUIPMENT SUCH AS A WINCH IS USED, CABLE TENSION MUST BE CONTINUOUSLY MONITORED. THIS MAY INCLUDE USE OF A WINCH WITH A CALIBRATED MAXIMUM TENSION OR A DYNAMOMETER OR IN-LINE TENSION METER.

IF A LUBRICANT IS USED, IT SHALL BE OF THE WATER-BASED TYPE AS APPROVED BY THE CABLE MANUFACTURER AND SHALL BE COMPATIBLE WITH THE RIGID GALVANIZED STEEL. IF USED, LUBRICANT TYPE AND MANUFACTURER SHALL BE SUPPLIED TO THE ENGINEER FOR APPROVAL.

INSTALLATION OF THE FIBER OPTIC CABLE SHALL ALSO BE IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND RECOMMENDED PRACTICES. SHOULD THE MANUFACTURER'S SPECIFICATIONS AND/OR RECOMMENDED PRACTICES APPEAR TO CONFLICT WITH THIS SPECIAL PROVISION, THE MATTER SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER FOR RESOLUTION.

SUFFICIENT SLACK SHALL BE LEFT AT EACH CONTROLLER CABINET TO ALLOW PROPER TERMINATIONS. EACH CABINET SHALL HAVE A MINIMUM OF 10 FEET OF CABLE LEFT AVAILABLE, UNLESS OTHERWISE NOTED IN THE PLANS. ADDITIONAL SLACK OF TWO TURNS OF CABLE SHALL BE LEFT AT EACH PULL BOX, NEATLY COILED AS PER THE MANUFACTURER'S MINIMUM BENDING RADIUS SPECIFICATION.

AT EACH PULL BOX AND CONTROLLER CABINET, THE INTERCONNECT CABLE SHALL BE VISIBLY MARKED "CAUTION - FIBER OPTIC CABLE" BY SELF-ADHESIVE, WEATHERPROOF TAGS.

AFTER THE FIBER OPTIC CABLE INSTALLATION, EACH FIBER IN EACH SECTION SHALL BE TESTED FOR CONTINUITY AND ATTENUATION, AS A MINIMUM. THE TESTS SHALL BE CONDUCTED AT BOTH 850 NM AND 1300NM FOR MULTIMODE FIBER AND AT BOTH 1310NM AND 1550NM FOR SINGLE-MODE FIBER. THESE TESTS SHALL BE DONE USING AN APPROPRIATE SOURCE AND POWER METER. IF THE ATTENUATION IS FOUND NOT TO BE WITHIN THE ACCEPTABLE NOMINAL VALUES, THE CONTRACTOR SHALL USE AN OPTICAL TIME DOMAIN REFLECTOMETER (OTDR) TO LOCATE POINTS OF LOCALIZED LOSS CAUSED BY BENDS, KINKS OR FRACTURES. THE CONTRACTOR WILL TRY TO RELAX ANY IDENTIFIED BENDS OR KINKS. IF THIS IS NOT SUCCESSFUL, THE CONTRACTOR SHALL REPLACE THE DAMAGED CABLE AT HIS EXPENSE AND RETEST THE SECTION. THE CONTRACTOR SHALL PROVIDE THE ENGINEER WITH A WRITTEN REPORT SHOWING ALL OF THE VALUES MEASURED DURING THESE TESTS, AS WELL AS CALCULATED AND ALLOWABLE VALUES, AND ANY CORRECTIVE ACTIONS TAKEN TO ATTAIN SATISFACTORY RESULTS. OTDR MEASUREMENTS SHALL BE MADE OF ALL FIBER LENGTHS AND A PRINTOUT OF THE TRACES FOR EACH FIBER SHALL BE PROVIDED TO THE ENGINEER.

**V. FIBER OPTIC DATA LINK (MODEM)**

THE DATA LINK BETWEEN THE FIBER OPTIC CABLE AND THE MASTER OR LOCAL INTERSECTION TYPE 170 CONTROLLER ARRANGED IN A CLOSED-LOOP SYSTEM SHALL BE ACCOMPLISHED USING A DATA LINK (REFERRED TO AS A MODEM IN THE PLANS) COMPATIBLE WITH DAISY CHAIN OPERATION TO TRANSCEIVERS-232 DATA USING FIBER OPTICS. THIS DATA LINK MUST BE COMPATIBLE WITH AND INSTALLED IN THE TYPE 170 CONTROLLER.

THE FIBER OPTIC DATA LINK SHALL BE CAPABLE OF OPERATING IN A FULL DUPLEX MODE OF OPERATION, EMPLOYING ASYNCHRONOUS RS-232 DATA LINK PROTOCOLS UP TO A 19.2 BAUD RATE. RS-232 SIGNALS SHALL BE CONVERTED TO LIGHT AND TRANSMITTED FROM DATA LINK TO DATA LINK UNTIL THE LIGHT IS RECONVERTED TO RS-232 ELECTRICAL SIGNALS DIRECTED TO A PARTICULAR CONTROLLER. THE FIBER OPTIC DATA LINK SHALL OPERATE IN A DAISY CHAIN COMMUNICATION MODE.

THE FIBER OPTIC DATA LINK SHALL BE A PRINTED CIRCUIT BOARD ASSEMBLY 238.1 mm LONG BY 158.7 mm HIGH AND SHALL FIT IN THE 400 MODEM SLOT OF THE CONTROLLER. ON THE ASSEMBLY THERE SHALL BE AN EDGE CONNECTOR WHICH SHALL MATE WITH THE INTERNAL CONNECTOR ON THE CONTROLLER MOTHERBOARD.

ON THIS ASSEMBLY, THERE SHALL BE TWO PAIRS OF OPTICAL EMITTERS AND OPTICAL DETECTORS LABELED PAIR "1" (ONE) AND PAIR "2" (TWO), DESIGNED TO ATTACH TO STANDARD ST CONNECTORS. THERE SHALL BE TWO LEADS PROVIDED, ONE LABELED "T" FOR TRANSMIT AND ONE LABELED "R" FOR RECEIVE. THESE LEADS SHALL ILLUMINATE WHEN THE FIBER OPTIC DATA LINK IS EITHER RECEIVING OR TRANSMITTING AT THE LOCAL CONTROLLER. THERE SHALL BE A SLIDE SWITCH LABELED "M" FOR MASTER OPERATION AND "L" FOR LOCAL OPERATION. IN THE MASTER POSITION, THE ELECTRICAL DATA ENTERING THE FIBER OPTIC DATA LINK VIA THE EDGE CONNECTOR SHALL BE TRANSMITTED AS OPTICAL SIGNALS IN A PARALLEL MODE FROM EACH OF THE TWO EMITTERS. THE OPTICAL SIGNALS RECEIVED BY THE TWO DETECTORS SHALL BE CONVERTED TO ELECTRICAL SIGNALS AND SENT IN PARALLEL TO THE CONTROLLER VIA THE EDGE CONNECTOR.

IN THE LOCAL MODE OF OPERATION, OPTICAL SIGNALS RECEIVED BY DETECTOR 1 SHALL BE CONVERTED TO ELECTRICAL SIGNALS AND SENT TO THE 170 CONTROLLER VIA THE EDGE CONNECTOR. THESE SAME SIGNALS SHALL BE REGENERATED AND TRANSMITTED BY EMITTER 2 TO THE NEXT ADJACENT FIBER OPTIC DATA LINK DOWNSTREAM IN THE DAISY CHAIN. OPTICAL SIGNALS RECEIVED BY DETECTOR 2 SHALL BE REGENERATED AND TRANSMITTED BY EMITTER 1 TO THE NEXT ADJACENT FIBER LINK UPSTREAM. ELECTRICAL SIGNALS RECEIVED BY EMITTER 1 FROM THE CONTROLLER SHALL BE TRANSMITTED TO THE NEXT ADJACENT FIBER LINK UPSTREAM. REGENERATION SHALL MAINTAIN PULSE FIDELITY WITHIN + OR - 0.1 PERCENT FOR EACH DATA LINK.

THE FIBER OPTIC DATA LINK SHALL DERIVE + 12VDC FOR ITS OPERATING POWER FROM THE CONTROLLER CONNECTOR PINS OR FROM A SEPARATE POWER SUPPLY EXTERNAL TO THE MODEM.

THE FIBER OPTIC DATA LINK SHALL HAVE AN EMERGENCY BACKUP POWER SOURCE THAT ALLOWS CONTINUED DAISY CHAIN OPERATION WHEN THE TYPE 170 CONTROLLER IS REMOVED OR IF THE POWER TO THE CONTROLLER HAS BEEN TURNED OFF. THIS BACKUP POWER SOURCE SHALL PROVIDE UNINTERRUPTED OPERATION OF THE DAISY CHAIN INTERCONNECT SYSTEM, BOTH UP AND DOWNSTREAM FROM THE AFFECTED DATA LINK, FOR A PERIOD OF 12 HOURS. THE BACKUP POWER SOURCE SHALL BE A 9-VOLT BATTERY, AN RJ11/4 JACK SHALL BE AVAILABLE ON THE ASSEMBLY TO INTERFACE AN EXTERNAL DATA LINK, ALLOWING FIBER OPTIC COMMUNICATIONS IN FOUR DIRECTIONS.

THE DATA LINK SHALL OPERATE WITH ALL FIBER RANGING FROM 50/125 GLASS TO 1 MM PLASTIC FIBER AND SHALL MEET THE FOLLOWING ELECTRICAL REQUIREMENTS:

ELECTRICAL REQUIREMENTS	WAVELENGTH
VOLTAGE 12 VDC	850 NM
CURRENT 26 MA	
CONTINUOUS 165 MA PEAK	
DATA LINK SENSITIVITY	DATA RATE
MAX 0 DBM	100 TO 19.2K BAUD
MIN -40 DBM	
OPERATING RANGE	TEMPERATURE RANGE
3 KM FROM DATA LINK TO DATA LINK	-35C TO 75C

**VI. FIBER DISTRIBUTION UNIT FOR CONTROLLER CABINETS**

EACH CONTROLLER CABINET SHALL BE EQUIPPED WITH A FIBER OPTIC DISTRIBUTION UNIT TO PROVIDE A TERMINATION AND SERVICE ACCESS POINT FOR FIBER OPTIC CABLES. THE 6-FIBER INTERCONNECT CABLE EXTENDING BETWEEN CONTROLLERS SHALL BE TERMINATED ON ONE SIDE AND DUPLEX JUMPERS WILL EXTEND ON THE OTHER SIDE TO THE DATA LINK (MODEM) INSTALLED IN THE CONTROLLER UNIT. THE FIBER DISTRIBUTION UNIT SHALL BE MOUNTED ON THE 480 mm RACK CAGE AND SHALL BE A MODULAR DESIGN TO SUPPORT A TERMINATION/CONNECTION CAPACITY OF 24 FIBERS. THE CONNECTOR PANEL SHALL BE DESIGNED TO ACCOMMODATE ST CONNECTORS FOR MULTIMODE FIBERS, AS APPROPRIATE. ST COUPLINGS WITH CERAMIC INSERTS SHALL BE PROVIDED TO ACCOMMODATE ALL FIBERS BROUGHT INTO THE CONTROLLER CABINET. THE UNIT SHALL PROVIDE BOTH FRONT AND REAR ACCESS WITH HINGED DOOR ACCESS. THE UNIT SHALL BE CONSTRUCTED OF DURABLE ALUMINUM CONSTRUCTED FOR OUTDOOR APPLICATIONS. PLASTIC DOORS MAY BE CONSIDERED FOR APPROVAL. B. THE CONTRACTOR SHALL TERMINATE ALL FIBERS BROUGHT INTO THE CONTROLLER CABINET. DUST CAPS SHALL BE INSTALLED ON THE SIDE OF THE COUPLINGS NOT USED. VII. CONDUIT FOR INTERCONNECT A. UNLESS OTHERWISE INDICATED IN THE PLANS, CONDUIT TO BE INSTALLED AND OCCUPIED BY FIBER OPTIC INTERCONNECT CABLE SHALL BE SMOOTH, FOR ADDITIONAL REQUIREMENTS.

CONDUIT RUNS SHALL BE AS STRAIGHT AS POSSIBLE BETWEEN POINTS OF TERMINATION. SLIGHT ADJUSTMENTS MAY BE NECESSARY TO FACILITATE CONSTRUCTION AND TO AVOID UNDERGROUND UTILITIES AND OTHER OBSTACLES. WHERE ADJUSTMENTS ARE MADE IN A CONDUIT RUN, THE MAXIMUM BEND AT ANY ONE POINT SHALL BE 30 DEGREES (EXCEPT AT THE CONTROLLER CABINET) WHILE THE TOTAL ACCUMULATED BEND BETWEEN OUTLETS IN BOTH THE VERTICAL AND HORIZONTAL DIRECTIONS SHOULD NOT EXCEED 180 DEGREES.

**CONSTRUCTION AND MATERIAL REQUIREMENTS  
FOR COMMUNICATION DUCT SYSTEM**

**I. COMMUNICATION DUCT SYSTEM**

ALL MATERIALS USED IN THE FABRICATION OR ASSEMBLY OF THE ITEMS LISTED BELOW SHALL COMPLY WITH THE APPLICABLE PARTS OF SECTION 700, CITY OF WICHITA STANDARD SPECIFICATIONS WITH THE ADDITIONS AS STATED HEREIN. UNLESS SPECIFICALLY NOTED OTHERWISE, ALL COMMUNICATION DUCT MATERIAL AND EQUIPMENT SHALL BE NEW AND SIMILAR TO THE BEST GRADE OF THIS TYPE OF EQUIPMENT, AND SHALL BE APPROVED BY THE ENGINEER.

THE CONTRACTOR SHALL INSTALL ALL OF THE EQUIPMENT AND WIRING NECESSARY FOR COMMUNICATION DUCT AS INDICATED ON THE PLAN AND IN ACCORDANCE WITH THIS SPECIFICATION. THE SYSTEM SHALL BE COMPLETE, AND THE CONTRACTOR SHALL FURNISH AND INST ALL EQUIPMENT NECESSARY AS INDICATED IN THE PLANS.

**II. HDPE CONDUIT**

FLEXIBLE NONMETALLIC CONDUIT(S) SHALL BE 75 mm SCHEDULE 40, HIGH DENSITY POLYETHYLENE CONDUIT (HDPE). THE CONDUIT SHALL BE ORANGE IN COLOR AND SMOOTH WALLED INSIDE AND OUT. THE CONDUIT SHALL BE MANUFACTURED TO ASTM D2447 SPECIFICATIONS AND SHALL MEET THE FOLLOWING APPLICABLE REQUIREMENTS:

MINIMUM WALL THICKNESS:	75 mm SCH. 40 - 5.5 mm W.T.
TENSILE STRENGTH	22,750 KPA      ASTM D-638
ELONGATION	800 %      ASTM D-638
DENSITY	961 KG/CM <sup>3</sup> ASTM D-1505
MELT INDEX	0.01 OZ/10 MIN.      ASTM D-1238(E)
BRITTLE TEMP.	<-39°C      ASTM D-74
ESCR (BELL TEST)	>1500 (ENGL) F50 HRS.      ASTM D-1693(C)
ROCKWELL HARDNESS L	49 (ENGL)      ASTM D-785
SHORE HARDNESS D	61 (ENGL)      ASTM D-2240

A POLYPROPYLENE PULL ROPE SHALL BE PROVIDED SEPARATE FROM THE CONDUIT AND INSTALLED AFTER INSTALLATION.

**III. LOCATING CABLE**

THE LOCATING CABLE SHALL BE SINGLE CONDUCTOR CABLE WITH MINIMUM 600 VOLT RATING AND SHALL BE AND A #10 AWG THHN/THWN STRANDED ANNEALED COPPER. THE LOCATING CABLE INSULATION SHALL BE COLORED RED. THE POLYETHYLENE INSULATION SHALL MEET THE REQUIREMENTS OF PARAGRAPH 3.9 OF I.P.C.E.A. STANDARD S-61-402 BEFORE APPLICATION TO THE CONDUCTOR, AND PARAGRAPH 3.9.1 AFTER APPLICATION TO THE CONDUCTOR.

**IV. FIBER OPTIC SERVICE BOX**

THE FIBER OPTIC SERVICE BOX SHALL BE CONSTRUCTED OF A POLYMER CONCRETE CONSISTING OF GRADED AGGREGATE OF SAND AND GRAVEL BOUND TOGETHER WITH A POLYMER RESIN SYSTEM AND REINFORCED WITH CONTINUOUS WOVEN GLASS STRANDS. THE USE OF CHOPPED FIBERGLASS STRANDS APPLIED WITH A "CHOPPER GUN" OR THE USE OF HIGH DENSITY POLYETHYLENE OR HIGH DENSITY POLYSTYRENE IS PROHIBITED. TO ASSURE CONSISTENT PRODUCTION FROM PART TO PART, ONLY MATCHED METAL TOOLING IS TO BE USED TO MANUFACTURE THE PRODUCT. THE MATERIAL MUST HAVE THE FOLLOWING MECHANICAL PROPERTIES:

COMPRESSIVE STRENGTH -	75,800 KPA	ASTM C-109
TENSILE STRENGTH -	11,700 KPA	ASTM C-496
FLEXURAL STRENGTH -	51,700 KPA	ASTM D-790

THE BOXES AND COVERS SHALL BE GRAY AND SHALL BE OF THE APPROXIMATE SIZE SHOWN ON THE PLANS OR DETAILS. THE BOX SHALL CONTAIN CLEANOUT HOLES BENEATH THE COVER BOLT SLEEVES FOR EASE OF CLEANING ACCUMULATED DEBRIS. COVERS SHALL BE SKID

RESISTANT WITH "FIBER OPTIC" LOGO PERMANENTLY RECESSED IN THE COVER. THE COVER SHALL BE PROVIDED WITH STAINLESS STEEL BOLTS.

**V. CONSTRUCTION REQUIREMENTS**

CONDUIT INSTALLATION SHALL CONFORM TO THE APPROPRIATE ARTICLES OF THE NATIONAL ELECTRICAL SAFETY CODE. THE LOCATION OF CONDUIT RUNS SHOWN ON THE PLANS ARE FOR BIDDING PURPOSES ONLY AND MAY BE CHANGED WITH THE PERMISSION OF THE ENGINEER IN CHARGE OF CONSTRUCTION TO AVOID UNDERGROUND OBSTRUCTIONS. THE CONDUIT SHALL GENERALLY BE INSTALLED PARALLEL TO THE STREET LIGHTING OR SIGNAL DIRECT BURIED CABLE/CONDUIT IF APPLICABLE. INSTALLATION IN THE SAME TRENCH IS ACCEPTABLE AS LONG AS THE FIBER OPTIC CONDUIT IS INSTALLED DEEPER THAN THE OTHER FACTORIES.

THE CONDUIT SHALL BE INSTALLED CONTINUOUS FROM OUTLET (TYPE FO SERVICE BOX, OR TRAFFIC SIGNAL SERVICE BOX) TO OUTLET OR AS OTHERWISE SHOWN ON THE PLANS. NO COUPLINGS OR JOINTS WILL BE ALLOWED AT INTERMEDIATE POINTS UNLESS APPROVED BY THE ENGINEER IN CHARGE OF CONSTRUCTION. THE CONDUIT MAY BE DIRECTIONAL BORED TO MINIMIZE DISRUPTION TO THE EXISTING IMPROVEMENTS, OR TRENCHED. BORING PITS SHALL BE KEPT 600 mm CLEAR OF THE EDGE OF ANY TYPE OF PAVEMENT WHEREVER POSSIBLE EXCESSIVE USE OF WATER SUCH THAT PAVEMENT MIGHT BE UNDERMINED, OR SUBGRADE SOFTENED, WILL NOT BE PERMITTED.

THE CONDUIT SHALL BE INSTALLED UNDER STREETS, DRIVES OR WITHIN SHOULDERS OR PARK AREAS AT A DEPTH OF BETWEEN 900 mm AND 1200 mm BELOW THE TOP OF PAVEMENT OR FINISHED GRADE.

CONDUIT ENTERING EQUIPMENT SHALL BE CONTINUOUS INTO THE SERVICE BOX. TYPE FO SERVICE BOX AND CONTROL CENTER. A FACTORY 90 PVC CONDUIT ELBOW SHALL BE USED FOR INSTALLATION INTO A CONTROL CENTER FOUNDATION. AT A TRAFFIC SIGNAL SERVICE BOX OR TYPE FO SERVICE BOX, THE CONDUIT SHALL ENTER AND EXIT THE SIDES OF THE SERVICE BOX TANGENTIALLY SUCH THAT THE CABLE CAN ENTER, BE COILED, AND EXIT WITHOUT EXCEEDING AN 200 mm BENDING RADIUS. FOR STRAIGHT THROUGH CONNECTIONS, THE CONDUIT SHALL ENTER AND EXIT THE SAME SIDE OF THE SERVICE BOX. FOR CHANGES IN DIRECTION, THE CONDUIT SHALL ENTER TANGENTIALLY AND EXIT TANGENTIALLY AT A 90 ANGLE TO THE ENTRANCE.

AN APPROVED FACTORY COUPLING SHALL BE USED FOR CONNECTION OF THE HDPE CONDUIT TO A 90 FACTORY PVC ELBOW OR BETWEEN TWO LENGTHS OF HDPE CONDUIT. THE COUPLING SHALL BE OF HIGH DENSITY POLYETHYLENE. THE COUPLING SHALL HAVE INDIVIDUAL REVERSE-LOCKING THREADS WITH A BUILT-IN CENTER STOP. THE ENDS OF THE CONDUIT SHALL BE GROOVED WITH A GROOVING TOOL TO MATCH THE REVERSE-LOCKING THREADS OF THE COUPLING TO PROVIDE FOR GREATER PULL-OUT RESISTANCE. THE COUPLING SHALL BE INSTALLED WITH A FACTORY RECOMMENDED COUPLING TOOL TO ENSURE AN AIRTIGHT AND WATERTIGHT LOCK.

THE ENDS OF ALL CONDUIT SHALL BE WELL REAMED TO REMOVE BURRS AND ROUGH EDGES. FIELD CUTS SHALL BE MADE SQUARE AND TRUE SO THAT THE ENDS WILL BUTT OR COME TOGETHER FOR THE FULL DIAMETER THEREOF.

CONDUIT SET IN STANDARD CONCRETE FOUNDATIONS SHALL EXTEND APPROXIMATELY 75 mm ABOVE THE FOUNDATION VERTICALLY. CONDUIT SHALL ENTER FROM THE DIRECTION OF THE RUN.

IT SHALL BE THE PRIVILEGE OF THE CONTRACTOR AT HIS OWN EXPENSE TO USE LARGER SIZE CONDUIT IF DESIRED, AND WHERE LARGER SIZE CONDUIT IS USED, IT SHALL BE FOR THE ENTIRE LENGTH OF THE RUN FROM OUTLET TO OUTLET. NO REDUCING COUPLINGS WILL BE PERMITTED.

A 6 mm WIDE POLYESTER/POLYPROPYLENE OR ARAMID PULL TAPE SHALL BE BLOWN CONTINUOUSLY THROUGH THE INSTALLED CONDUIT FOR PURPOSES OF PULLING THE CABLE. THE PULL TAPE SHALL BE LEFT IN PLACE IN THE CONDUIT FOR FUTURE USE.

THE LOCATION OF ENDS OF ALL CONDUIT INSTALLED OR USED IN THIS PROJECT SHALL BE MARKED BY ALUMINUM MARKERS PLACED IN THE FACE OF CURB, GUTTER, OR WALL, DIRECTLY ABOVE THE CONDUIT. THE CONDUIT LOCATION SHALL BE MARKED WITH AN ABOVE GROUND MARKER AS INDICATED IN THE STANDARD DETAILS. MARKERS SHALL BE PLACED MIDPOINT BETWEEN ADJACENT FIBER OPTIC SERVICE BOXES AND/OR SUCH THAT THE SPACINGS ARE APPROXIMATELY 150 m BETWEEN MARKERS.

**VI. LOCATING CABLE**

THE LOCATING CABLE SHALL BE PULLED THROUGH THE INSTALLED CONDUIT BY USE OF A POLYESTER/POLYPROPYLENE PULL ROPE. CAUTION SHOULD BE TAKEN AS TO NOT BURN OR TEAR THE CONDUIT ENDS OR CONDUIT BODY.

A 12 mm X 2400 mm GROUND ROD WITH GROUND ROD CLAMP SHALL BE INSTALLED IN EACH FIBER OPTIC SERVICE BOX FOR ATTACHMENT OF THE #10 AWG THHN/THWN STRANDED COPPER LOCATING CABLE. SEE THE STANDARD DETAILS FOR ADDITIONAL INFORMATION. THE LOCATING CABLE SHALL BE BONDED TO THE GROUND ROD SO AS TO PROVIDE A CONTINUOUS LOCATING SYSTEM THROUGHOUT THE LIMITS OF THE PROJECT.

**VII. FIBER OPTIC SERVICE BOX**

FIBER OPTIC SERVICE BOXES SHALL BE INSTALLED AT THE LOCATIONS SHOWN ON THE PLANS AND AT SUCH ADDITIONAL POINTS AS THE CONTRACTOR, AT HIS OWN EXPENSE, MAY DESIRE TO FACILITATE THE WORK.

THE EXCAVATED OPENING OUTSIDE THE PULL BOX SHALL BE WIDE ENOUGH TO ALLOW COMPACTION OF THE BACKFILL MATERIAL. CINDERS, BROKEN CONCRETE, BROKEN ROCK OR OTHER HARD OR UNDESIRABLE MATERIAL SHALL NOT BE USED FOR BACKFILLING. THE BACKFILL MATERIAL SHALL BE PLACED IN LAYERS NOT TO EXCEED 6" DEEP AND EACH LAYER SHALL BE THOROUGHLY COMPACTED BEFORE THE NEXT LAYER IS PLACED.

THE FIBER OPTIC SERVICE BOXES SHALL BE INSTALLED APPROXIMATELY 25 mm ABOVE EARTH OR SODDED AREAS AND MATCH THE SLOPE OF THE EXISTING GROUND LINE. A MINIMUM OF 450 mm LAYER OF 12 mm GRAVEL SHALL BE CONSTRUCTED BELOW THE FIBER OPTIC SERVICE BOX FOR DRAINAGE PURPOSES.

KANSAS DEPARTMENT OF TRANSPORTATION

**TRAFFIC SIGNAL SPECIFICATIONS  
INTERCONNECT AND  
COMMUNICATION DUCT**

DATE	
BY	
REFERENCE NOTED	
REFERENCE CHECKED	

Drawn by: \_\_\_\_\_  
File: \_\_\_\_\_  
SCALE \_\_\_\_\_  
Plot/text: \_\_\_\_\_

