

**SECTION 16740 VOICE AND DATA CABLING  
INFRASTRUCTURE**

## SECTION 16740

### VOICE AND DATA CABLING INFRASTRUCTURE

#### PART 1- GENERAL

##### 1.01 SECTION INCLUDES

- A. This section will include all the specifications for the installation of a Structured Cabling System (SCS) for the purpose of supporting voice, data and video communications.

##### 1.02 REFERENCES

- A. Telecommunications Industry Association /Electronic Industries Association (TIA/EIA) 568A-Commercial Building Telecommunications Wiring Standards.
- B. TIA/EIA-569-Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. TIA/EIA-TSB-67- Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems, October 1995.
- D. TIA/EIA-72-Centralized Optical Fiber Cabling Guidelines, October 1995.
- E. TIA/EIA PN-3398 (Cabling practices for Open Offices), March 7, 1995.
- F. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS 11801, January 6, 1994.
- G. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program.
- H. National Electrical Manufacturers Association (NEMA).
- I. American Society for Testing Materials (ASTM).
- J. National Electric Code (NEC®).
- K. Institute of Electrical and Electronic Engineers (IEEE).
- L. UL Testing Bulletin.
- M. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps.
- N. Lucent Technologies SYSTIMAX® SCS Zone Cabling Guidelines for High 5® Products, Latest Issue.

### VOICE AND DATA CABLING INFRASTRUCTURE

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- O. Lucent Technologies SYSTIMAX® Structured Cabling Systems, Performance Specifications, Latest Issue.
- P. Lucent Technologies SYSTIMAX® Structured Cabling Systems, Components Guide, Latest Issue.
- Q. Lucent Technologies Generic Specifications: Fiber Optic Outside Plant Cable, Latest Issue.

#### 1.03 DEFINITIONS AND ABBREVIATIONS

- A. American Wire Gauge – AWG
- B. Asynchronous Transfer Mode - ATM
- C. Gigabits Per Second - Gbps
- D. Main Cross Connect – MC
- E. Megabits Per Second - Mbps
- F. Polyvinyl Chloride - PVC
- G. Structured Cabling System - SCS
- H. Telecommunications Closet - TC

#### 1.04 DESIGN AND PERFORMANCE STANDARDS

- A. Applications standards supported should include, but be not limited to, IEEE 802.3, 10Base5, 10BASET, 100BaseTX, IEEE 802.5, 4 Mbps, 16 Mbps (328 ft [100m], 104 Workstations) and TP-PMD. In addition, evolving high-end applications such as 100 Base-T, 52/155/622 Mbps ATM and 1 Gbps Ethernet applications shall be supported.
- B. Cable Standards
  - 1. Copper Cable
    - a) Horizontal Copper Cable
    - i) General Performance Specifications

The minimum requirements for all 4 pair, Unshielded Twisted Pair (UTP), Enhanced Category 5 cables shall conform to TIA/EIA 568A Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section, and be part of the UL® LAN Certification and Follow-up Program. Cables shall be marked as UL verified with a minimum of an Enhanced Category 5 rating. Application standards supported

should include, but not limited to, IEEE 802.3, 10Base5, 10BaseT, IEEE 802.5, 4 Mbps, 16 Mbps (328 ft [100m], 104 Workstations) and TP-PMD. In addition, these cables shall be capable of supporting evolving high-end applications such as 100 Base-T and 52/155 Mbps ATM plus the added application of 1000 BASE-T Gigabit Ethernet.

Shielded Twisted Pair (STP) cable shall only be used for Security or any application that specifically requires it. All 4-pair cable shall be Unshielded Twisted Pair (UTP) unless specified otherwise.

Cable shall be round, and shall meet the following electrical requirements:

Attenuation (Guaranteed)

Frequency (MHz)	Attenuation (dB/100m)
0.772	1.73
1	1.96
4	3.89
8	5.53
10	6.20
16	7.90
20	8.87
25	9.96
31.25	11.19
62.5	16.15
100	20.80
155	26.45
200	30.47
255	34.93
300	38.31
400	45.20
550	54.46

Near End Cross Talk (NEXT) (Guaranteed)

Frequency (MHz)	Power Sum NEXT (dB)	NEXT (dB)
0.772	72.0	74.0
1	70.3	72.3
4	61.3	63.3
8	56.8	58.8
10	55.3	57.3
16	52.3	54.3
20	50.8	52.8
25	49.3	51.3
31.25	47.9	49.9
62.5	43.4	45.4
100	40.3	42.3
155	37.5	39.5
200	35.8	37.8
255	34.2	36.2
300	33.2	35.2
400	31.3	33.3
550	29.2	31.2

Attenuation to Crosstalk Ratio (Guaranteed)

Frequency (MHz)	ACR (dB/90m)
0.772	72.4
1	70.6
4	59.8
8	53.8
10	51.7
16	47.1
20	44.8
25	42.4
31.25	39.8
62.5	30.8
100	23.6
155	15.7
200	10.4
255	4.8
300	0.7
400	NA
550	NA

Structural Return Loss (Guaranteed)

Frequency (MHz)	SRL (dB)
0.772	26.0
1	26.0
4	26.0
8	26.0
10	26.0
16	26.0
20	26.0
25	25.3
31.25	24.6
62.5	22.5
100	21.1
155	19.8
200	19.0
255	18.3
300	17.8
400	16.9
550	15.9

- ii) Plenum, Enhanced Category 5, Unshielded Twisted Pair (UTP) cable shall be composed of 24 AWG bare solid-copper conductors, insulated with TEFLON. The insulated conductors are twisted into pairs and sheathed with a low smoke PVC jacket. Cable shall be UL rated CMP. All 4-pair UTP cable shall be plenum rated unless specified otherwise.
  
- b) Backbone Copper Cable (Inside Plant)
  - i) Unshielded 24 AWG multi-pair copper cables shall be used as the vertical riser cables. The cable shall support voice, data, and building service applications. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation. The multi-pair copper cables shall be in plenum form unless placed in conduit or specified otherwise.

- ii) The non-shielded, plenum cable shall consist of 24-AWG solid-copper conductors insulated with color-coded PVC. 100 to 400 pair cable shall be conformance tested to meet TIA/EIA 568A for Category 3 cables. The cable shall be UL® and c (UL®) Listed for Fire Safety and ISO 9001 Certified. The non-shielded cable shall be available in 100, 200, 300, and 400 pair. The copper cable shall meet or exceed the following electrical specifications listed below:

Maximum DC Resistance	28.6 Ω/1,000 ft (9.38 Ω/100m)
Maximum DC Resistance Unbalanced	5%
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 ft. (328 pF/m)
Mutual Capacitance @ 1kHz	16 nF/1000 ft (5.2 nF/100 m), maximum

Attenuation (dB/100 m [328 ft.])

Frequency	Attenuation (Max.)
1.00 MHz	7 dB
4.00 MHz	15 dB
10.00 MHz	26 dB
16.00 MHz	35 dB

Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]

Frequency	Pair-To-Pair NEXT
1.0 MHz	41 dB
4.0 MHz	32 dB
10.0 MHz	26 dB
16.0 MHz	23 dB

- iii) The non-shielded, nonplenum cable shall consist of 24-AWG solid-copper conductors insulated with color-coded PVC. 25 to 1800 pair cable shall be conformance tested to meet TIA/EIA 568A for Category 3 cables. The cable shall be UL® and c (UL®) Listed for Fire Safety and ISO 9001 Certified. The non-shielded cable shall be available in 25, 50, 75, 100, 200, 300, 600, 900, and 1800 pair.

Maximum DC Resistance	28.6 Ω/1,000 ft (9.4 Ω/100m)
Maximum DC Resistance Unbalanced	5%
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 ft. (328 pF/m)
Mutual Capacitance @ 1kHz	18 nF/1000 ft (5.9 nF/100 m),

	maximum
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Attenuation (dB/100 m [328 ft.])

Frequency	Attenuation (Max.)
1.00 MHz	2.3 dB
4.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]

Frequency	Pair-To-Pair NEXT
1.0 MHz	13.8 dB
4.0 MHz	11.2 dB
10.0 MHz	10.2 dB
16.0 MHz	9.2 dB

c) Security Copper Cable

- i) The Shielded Twisted Pair (STP) cable shall only be used for Security or any application that specifically requires it. The STP cable shall be used as a vertical riser or horizontal cable.
- ii) The shielded, plenum cable shall consist of 2-pair, 24-AWG solid-copper conductors. The cable shall be UL® and c (UL®) Listed for Fire Safety and ISO 9001 Certified. The copper cable shall meet or exceed the following electrical specifications listed below:

Characteristic Impedance	75 ± 15 Ω
Mutual Capacitance	26 pF/ft. (85 pF/m)

Attenuation

Frequency	Nominal Attenuation
1.00 MHz	12 dB/1000 ft
4.00 MHz	28 dB/1000 ft
10.00 MHz	43 dB/1000 ft
16.00 MHz	54 dB/1000 ft

d) Outside Plant Cables

- i) ASP-filled 24 AWG multi-pair copper cables shall be utilized for underground conduit or direct buried applications. The cable shall support voice, low-speed data, and building service applications. The bending radius and pulling strength requirements of all outside plant cables shall be observed

during handling and installation. Refer to section 16402 regarding underground duct banks.

- ii) The copper cable shall meet or exceed the following electrical specifications listed below:

Characteristic Impedance	100 $\Omega$ (25-pair)
Mutual Capacitance	15.7 nF/1,000 ft. (5.15 nF/100 m) (25-pair)

Attenuation

Frequency	Nominal Attenuation
0.772 MHz	5.90 dB/328 ft
1.000 MHz	6.70 dB/328 ft

- e) Video Coaxial Cable

- i) The coaxial cable shall be used as the vertical riser or horizontal cable. The cable shall support video, multimedia, and security applications.
- ii) The shielded, plenum RG59/U cable shall consist of a 20-AWG solid-copper conductor. The cable shall be UL® and c (UL®) Listed for Fire Safety and ISO 9001 Certified. The copper cable shall meet or exceed the following electrical specifications listed below:

Characteristic Impedance	75 $\Omega$ @ 50 MHz
Mutual Capacitance	17.5 pF/ft. (57 pF/m)

Attenuation

Frequency	Nominal Attenuation
1.00 MHz	2.5 dB/1000 ft
5.00 MHz	5.4 dB/1000 ft
10.00 MHz	7.5 dB/1000 ft
22.50 MHz	11.5 dB/1000 ft
50.00 MHz	17.0 dB/1000 ft
100.00 MHz	27.0 dB/1000 ft

2. Fiber Optic Cable

- a) Multimode Fiber Specifications

All fiber optic cables within a single premise shall use multimode (unless the distance exceeds 2 km), graded-index fibers with 62.5 micron cores only. Fibers must comply with TIA/EIA 492 specifications and IS 11801 standards. Fibers will have dual

wavelength capability; transmitting at 850 and 1300nm ranges. All fibers shall be color coded to facilitate individual fiber identification. Fibers will have D-LUX<sup>®</sup> coating or approved equivalent to ensure color retention, minimize microbending losses and improve handling. The coating shall be mechanically strippable.

Specifications

Attenuation	3.4 dB/km @ 850 nm 1.0 dB/km @ 1300 nm
Bandwidth	200 MHz km @ 850 nm 500 MHz km @ 1300 nm
Core	62.5 μm ± 3 μm
Core Non-Circularity	<6%
Core/Cladding Concentricity Error	<3.0 μm
Numerical Aperture	0.275 ± 0.015
Cladding diameter	125 μm ± 1 μm
Cladding Non-Circularity	<2.0%
Colored Fiber Diameter	250 μm ± 15 μm
Buffering Diameter	890 mm ± 50 mm
Minimum Tensile Strength	100,000 psi
Fiber Minimum Bending Radius	.75 in. (1.91 cm)
Cable Minimum Bending Radius During Installation: After Installation:	20 times cable diameter 10 times cable diameter
Operating Temp. Range	32°F to 122°F (0°C to 50°C)
Storage Temp. Range	-40°F to 149°F (-40°C to 65°C)
Maximum Fiber Loss	3.4 dB/km at 850 NM (typical range 2.8 to 3.4 dB/km) 1.0 dB/km at 1300 NM (typical range 0.5 to 1.0 dB/km)
Minimum Bandwidth	200 MHz at 850 NM 500 MHz at 1300 NM

b) Single Mode Fiber specifications

All fiber optic cables installed for inter-building or outside cable plants shall be single mode. Fiber must comply with TIA/EIA 455 and IEC 793 test methods for required attributes. All fibers shall be color coded to facilitate individual fiber identification. Fiber will have D-LUX<sup>®</sup> coating or approved equivalent to ensure color retention, minimize microbending losses, and improve handling. The coating shall be mechanically strippable.

Fiber Attribute	Depressed Cladding
Attenuation	0.35 dB/km @ 1310 nm

	0.23 dB/km @ 1550 nm
Cladding Diameter	125.0 ± 1.0 μm
Cladding Non-Circularity	≤ 1.0%
Colored Fiber Diameter	250 ± 15 μm
Core Diameter	8.3 μm
Index of Refraction	0.37%
Core/Cladding Concentricity	≤ 0.8 μm
Mode Field Diameter	8.8 ± 0.5 μm @ 1310 NM
Minimum Proof Strength	100,000 psi
Maximum Attenuation	.40 dB/km @ 1310 NM .30 dB/km @ 1550 NM
Maximum Dispersion	2.8 ps/NM-km 1285 to 1330 NM
Fiber Cutoff Wavelength	≥ 1130 NM. ≥ 1300 NM
Fiber Macrobend (100 turns @ 32 mm diameter)	≥ 0.05 dB @ 1310 NM ≥ 0.10 dB @ 1550 NM
Coating Strip Force	1.3 N ≤ F ≤ 8.9 N

c) Sheath Construction

iii) Outside Plant Cables

The LXE-Metallic Sheath (GSX) fiber optic cable shall be utilized for underground conduit, direct buried, or aerial applications. The LXE-Metallic Sheath (DSX) fiber optic cables may be used as a suitable substitute.

ii) Building Cables

Nonplenum, riser rated cable consisting of multiple fibers, shall have an orange, Polyvinyl Chloride (PVC) outer jacket. The cable should have a non-filled ribbon structure with a nonmetallic crossply PVC core tube. The cable shall be UL listed and meet the NEC requirements for OFNR.

Plenum rated cable consisting of multiple fibers shall have a Plenum PVC outer jacket. Each group of fibers shall have a color coded Low Smoke PVC buffer. The buffered fibers are organized in subunits of fibers, reinforced with aramid yarn

for extra strength and surrounded with a color coded Low Smoke tube. The cable and each subunit shall be UL listed and meet the NEC requirements for OFNP.

C. Termination Standards

1. Copper Terminations

a) Outlets

Unless otherwise noted on the floor plans or within this document, all outlets shall be 8-position/8-conductor, insulation displacement modular outlets that conform to TIA/EIA 568A Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section, and be part of the UL® LAN Certification and Follow-up Program, and shall meet or exceed the following electrical and mechanical specifications:

- i) Enhanced Category 5 minimum requirements and support 1 Gbps Ethernet
- ii) T568B eight-position jack pin/pair assignments
- iii) Insulation resistance: 500 MW minimum
- iv) Dielectric withstand voltage 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
- v) Contact resistance: 20 mW maximum
- vi) Current rating: 1.5 A at 68° F(20°C) per IEC Publication 512-3, Test 5b.

Worst pair NEXT

Frequency	M100 Outlet Pair-To-Pair	MPS100 Outlet Power Sum
1.00 MHz	85 dB	87
4.00 MHz	74 dB	75 dB
8.00 MHz	68 dB	69 dB
10.00 MHz	66 dB	67 dB
16.00 MHz	62 dB	63 dB
20.00 MHz	60 dB	61 dB
25.00 MHz	58 dB	58 dB
31.25 MHz	56 dB	56 dB
62.50 MHz	50 dB	49 dB
100.00 MHz	42 dB	42.9 dB

Attenuation (maximum) (dB)

Frequency	M100	MPS100
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		Power Sum
1.00 MHz	0.02 dB	0.02 dB
4.00 MHz	0.02 dB	0.02 dB
8.00 MHz	0.02 dB	0.02 dB
10.00 MHz	0.02 dB	0.02 dB
16.00 MHz	0.03 dB	0.03 dB
20.00 MHz	0.03 dB	0.03 dB
25.00 MHz	0.03 dB	0.03 dB
31.25 MHz	0.05 dB	0.04 dB
62.50 MHz	0.14 dB	0.08 dB
100.00 MHz	0.25 dB	0.17 dB

b) Termination Blocks

110 blocks shall provide for the termination of horizontal, equipment, or tie cables. This high-density modular design shall be compatible with all voice and data circuits. The block shall be Underwriter's Laboratories (UL) listed.

c) Modular Patch Panel System

The termination block on the patch panel shall support the appropriate Enhanced Category 5 applications, including 100 Base-T, 52/155 Mbps ATM, and 1000 BASE-T Gigabit Ethernet, and facilitate cross connection and inter connection using modular patch cords. All Modular jack panels shall be wired to T568B. The wiring block shall be able to accommodate 24 AWG cable conductors. All modular cross connect panels shall be UL listed.

Electrical Requirements

Near End Cross Talk

Frequency	NEXT (dB) Pair to Pair	NEXT (dB) Power Sum
1.0 MHz	83.7	80.4
4.0 MHz	73.7	70.3
8.0 MHz	67.1	64.2
10.0 MHz	65.1	62.3
16.0 MHz	60.9	58.3
20.0 MHz	58.8	56.2
25.0 MHz	56.8	54.3
31.25 MHz	54.8	52.3
62.50 MHz	47.9	45.7
100.0 MHz	42.5	40.5

Attenuation

Frequency	Attenuation (dB)
1.0 MHz	.03
4.0 MHz	.03
8.0 MHz	.03
10.0 MHz	.03
16.0 MHz	.03
20.0 MHz	.03
25.0 MHz	.03
31.25 MHz	.04
62.50 MHz	.06
100.0 MHz	.13

Structural Return Loss

Frequency	Return Loss (dB)
1.0 MHz	51
4.0 MHz	50
8.0 MHz	45
10.0 MHz	42
16.0 MHz	38
20.0 MHz	37
25.0 MHz	35
31.25 MHz	33
62.50 MHz	28
100.0 MHz	24

d) Modular Patch Cords

Provide Enhanced Category 5, Modular Patch Cords for each assigned port on the patch panel. All cords shall conform to the requirements of TIA/EIA 568A Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL® LAN Certification and Follow-up Program. Cords shall be equipped with an 8 pin modular connector on each end and shall conform to the length(s) specified on the detailed drawing. All Enhanced Category 5 cordage shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pairs and shall meet or exceed the electrical specifications listed below:

DC Resistance per lead	9.4Ω/100m (328 ft), maximum
DC resistance unbalance	5%, Maximum
Mutual Capacitance	6.6 nF/100m (328 ft), maximum
Characteristic Impedance	100Ω ± 15% from 1 to 100 MHz

Worst Pair Near-End Crosstalk, Power Sum NEXT, attenuation and Structural Return Loss, dB/100 m [328 ft.]

Frequency	Pair-To-Pair NEXT	Power Sum NEXT	Attenuation (Max.) dB/100 m	SRL
1.00 MHz	76.0 dB	73.0 dB	1.9 dB	36 dB
4.00 MHz	64.0 dB	61.0 dB	3.9 dB	36 dB
8.00 MHz	60.2 dB	57.0 dB	5.5 dB	30 dB
10.00 MHz	59.0 dB	56.0 dB	6.3 dB	30 dB
16.00 MHz	56.0 dB	53.0 dB	8.0 dB	31 dB
20.00 MHz	55.0 dB	52.0 dB	8.9 dB	29 dB
25.00 MHz	54.0 dB	51.0 dB	10.0 dB	30 dB
31.25 MHz	52.0 dB	49.0 dB	11.2 dB	31 dB
62.50 MHz	48.0 dB	45.0 dB	16.1 dB	27 dB
100.00 MHz	45.0 dB	42.0 dB	20.7 dB	25 dB

UTP Patch cord lengths will be deployed as follows:

Length	Location/Application
3 ft	MDF, IDF, Computer Room, and Lab
5 ft	MDF, IDF, Computer Room, and Lab
7 ft	MDF, IDF, Computer Room, and Lab
9 ft	MDF, IDF, Computer Room, Office, Cubicle, or Lab
15 ft	Office, Cubicle, or Lab

2. Fiber Terminations

a) Fiber Optic Interconnect Units (LIU) and Distribution Shelves

The enclosure is used in fiber optic interconnection, cross-connection, and splicing applications. The enclosure shall be modular in design and suitable for outside plant (OSP), riser, and building cables.

b) Fiber splicing and closures

The fiber splice module shall meet the following specifications:

Mechanical

- i) Joins singlemode and multimode fibers
- ii) Establishes a permanent mechanical splice
- iii) May be used in outside plant and/or premises applications.
- iv) Accept 250 and 900 micron fibers
- v) Reenterable, rearrangeable and reusable
- vi) Require no polishing
- vii) Require no adhesives
- viii) No loose parts
- ix) One part index matching gel
- x) Unlimited shelf life

Optical

- i) Splice loss < 0.20 dB
- ii) Reflection < 50 dB
- iii) Stable from -40°F to 185°F (-40°C to 85°C)

c) Fiber Patch Cords

The fiber patch cord shall consist of buffered, graded-index fiber with a 62.5 micron core and a 125 micron cladding for multimode and a stepped-index 8.3 micron core with a 125 micron cladding for single mode. The fiber cladding shall be covered by aramid yarn and a jacket of flame-retardant PVC.

i) Multimode Fiber Patch Cord

Specifications

Mated Connector Loss	$\mu = 0.3 \text{ dB}, \sigma = 0.2 \text{ dB}$
Operating temperature	-4° to 158° F (-20 to 70° C)
Cable Retention	50 lb. (220 N) minimum
Connection Repeatability	0.20 dB maximum change per 100 reconnects
Operating temperature	-4° to 158° F (-20 to 70° C)
Manufacturer	ISO 9001 Certified Manufacturer

ii) Multimode Mini-Cord (high density applications)

These mini-cords are specified because the application is expected to be high density and the smaller diameter is necessary to accommodate the number of terminations. The minicords shall be available in duplex configurations.

Specifications

Simplex diameter	1.65 ± 0.05 mm
Duplex diameter	1.9 ± .05 mm x 4.2 ± 0.1mm
ST II+ insertion loss	0.3 dB typical and 0.5 dB maximum
ST II+ loss change (max)	0.3 dB for 500 reconnections
SC insertion loss	0.2 dB typical and 0.5 dB maximum
SC loss change (max)	0.2 dB for 500 reconnections
Operating temperature range	- 40°C to 75°C.
ST II+ Cable retention	10 lbs. maximum
SC Cable retention	20 lbs. maximum
Manufacturer	ISO 9001 Certified Manufacturer

iii) Singlemode Fiber Patch Cord

Specifications

Return Loss	-50 dB maximum
Operating temperature	-4° to 158° F (-20 to 70° C)
Mated connector loss	$\mu = 0.35$ dB, $\sigma = 0.2$ dB
Cable Retention	50 lb. (220 N) minimum
Connection Repeatability	0.20 dB maximum change per 200 reconnects
Manufacturer	ISO 9001 Certified Manufacturer

iv) High Density Fiber Optic Patch Cords

The factory terminated fiber patch cords shall be connectorized with the high density connectors as specified above. The high density connector shall have a trigger mechanism that shall allow the connector to be easily engaged and disengaged from the coupler/outlet. The trigger shall prevent the plug from snagging as jumpers are being routed and shall allow the two plugs to be simultaneously disengaged. The patchcords shall utilize 1.6 mm cordage to assure maximum fill capacity in fiber management paths. Duplex cordage shall be 1.6 by 3.6 mm in a figure-8 design that has two single fiber cords joined together with a web. The assembly shall be designed to prevent accidental disconnects to assure optimal performance.

Specifications

Fiber Type	Multimode	Singlemode
Loss $\mu$ , $\sigma$	0.1, 0.1 dB	0.1, 0.7 dB
Return Loss Maximum	-20 dB	-50 dB
Cable OD	1.6 mm	1.6 mm
Cable Retention (cordage)	20 lb	20 lb
Mating Durability for 500 Reconnects		
Insertion Loss Change	<0.2 dB	<0.2 dB
Temperature Stability (-40°C to +75°C)		
Insertion Loss Change	<0.3 dB	<0.3 dB
Tip Material	Ceramic	Ceramic

1.05 SUBMITTALS

- A. Follow Section 01340 and item 3.03 K of this section.
- B. Cable inventory data must be submitted for all copper, fiber, and coaxial cabling and termination equipment. Submit data electronically on forms furnished by City on data diskettes in "Microsoft Excel 97" format, listing products furnished, including:
  - 1. Manufacturer's name.
  - 2. Manufacturer's part numbers and com code numbers.
  - 3. Cable numbers utilizing the City's cable numbering standard. (See 3.03 I).
  - 4. Location and riser assignments.
  - 5. City will provide submittal form on a data diskette in "Microsoft Excel 97" format. This requirement applies to copper cable, fiber optic cable, and all termination equipment.
- C. Record Drawings: Follow Section 01700. Furnish CAD drawings, following format in Section 01340, of completed work including cable numbers.

1.06 QUALITY ASSURANCE

- A. Contractor Qualifications
  - 1. Must be a certified and currently registered Authorized Lucent Technologies Reseller capable of providing a numbered Registration Certificate from Lucent Technologies for the entire cabling system. In the event, that substitute materials are allowed, the contractor must be certified by the substitute manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project
  - 2. Must be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC standards and codes.

3. All members of the installation team must be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team should be provided along with documentation of completed training courses.
4. Must provide five (5) references for projects of equivalent scope, type and complexity of work completed within the last 5 years.

#### 1.07 WARRANTY

- A. A twenty (20) year Extended Product Warranty and System Assurance Warranty for this wiring system shall be provided.

1. Extended Product Warranty

The Extended Product Warranty shall ensure against product defects, that all approved cabling components exceed the specifications of TIA/EIA 568A and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of TIA/EIA TSB 67 and ISO/IEC IS 11801 for cabling links/channels, that the installation will exceed the loss and bandwidth requirements of TIA/EIA TSB 67 and ISO/IEC IS 11801 for fiber links/channels, for a twenty (20) year period. The warranty shall apply to all passive SCS components.

2. System Assurance

The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the TIA/EIA 568A or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty (20) year period.

3. Extended Product Warranty

The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s).

4. System Certification

Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

PART 2- PRODUCTS

2.01 MANUFACTURERS

- A. Unless otherwise specified, furnish products manufactured by Lucent Technologies.
- B. Substitutions: Follow Section 01630.

2.02 MATERIALS

A. Copper Cable

1. Horizontal Cable

- a) Lucent Technologies 2071 GigaSpeed high performance, green plenum cable consisting of 4, unshielded twisted pairs of 24 AWG, solid copper conductors with the following part numbers:

Plenum Rated

Product Number	Color	Comcode
2071004ABE	Berry Red <sup>1</sup>	107 987 851
2071004ABE	Berry Red <sup>1</sup>	107 987 869
2071004AGR	Green <sup>2</sup>	107 987 877
2071004AGR	Green <sup>2</sup>	107 987 885
2071004ALL	Lilac <sup>3</sup>	107 987 901
2071004ALL	Lilac <sup>3</sup>	107 987 919
2071004AYL	Yellow <sup>4</sup>	107 987 810
2071004AYL	Yellow <sup>4</sup>	107 987 828

**NOTES:**

- <sup>1</sup> Berry Red grandfathered for use by Continental Airlines voice/data cables
- <sup>2</sup> Green cabling to be used for HAS data cables
- <sup>3</sup> Lilac cabling to be used for HAS and tenant voice cables
- <sup>4</sup> Yellow cables to be used for tenant data cables

2. Backbone Copper Cable (Inside Plant)

- a) Non-Plenum: Lucent Technologies ARMM Riser rated copper cables consisting of multiple twisted pairs of 24 AWG bare, solid copper conductors individually insulated and jacketed to meet all applicable standards for installation as backbone cable with the following part numbers:

Product Number	Number of Pairs	Comcode
ARMM NCA 4051	25	107 526 873
ARMM NCA 4051	50	107 527 111
ARMM NCA 4051	100	107 527 129
ARMM NCA 4051	200	107 527 285
ARMM NCA 4051	300	107 527 293

ARMM NCA 4051	600	107 527 319
ARMM NCA 4051	900	107 527 327
ARMM NCA 4051	1800	107 527 350

- b) Plenum: Lucent Technologies plenum rated copper cables consisting of multiple twisted pairs of 24 AWG bare, solid copper conductors individually insulated and jacketed to meet all applicable standards for installation as backbone cable with the following part numbers:

Product Number	Number of Pairs	Comcode
2010 025BWH RVAR	25	107 765 016
2010 050BWH RVAR	50	107 766 024
2010 100BWH RVAR	100	107 766 073
2001 200C RVAR	200	106 505 639
2001 300C RVAR	300	106 507 767
2001 400C RVAR	400	106 507 783

3. Security Copper Cable

- a) Lucent Technologies Shielded Twisted Pair (STP), plenum cables consist of 2-pairs of 24 AWG bare, solid copper conductors individually insulated and jacketed to meet all applicable standards for installation with the following part numbers:

Product Number	Number of Pairs	Comcode
2101 002C R1000	2	105 303 481

4. Outside Plant Cable

- a) Lucent Technologies ASP-filled copper cables consisting of multiple twisted pairs of 24 AWG bare, solid copper conductors individually insulated and jacketed to meet all applicable standards for installation as direct-buried cable with the following part numbers:

Product Number	Number of Pairs	Comcode
ANMW-0025	25	106 583 909
ANMW-0050	50	106 583 917
ANMW-0100	100	106 583 933
ANMW-0200	200	106 583 958
ANMW-0300	300	106 583 966
ANMW-0400	400	106 583 974
ANMW-0600	600	106 583 982
ANMW-0900	900	106 584 154
ANMW-1200	1200	106 584 162
ANMW-1500	1500	106 584 170
ANMW-1800	1800	106 584 188

5. Video Coaxial Cable

- a) Lucent Technologies RG59/U, shielded, plenum coaxial cable consists of a 20-AWG solid-copper conductor and shall meet all

applicable standards for installation as a vertical or horizontal cable with the following part numbers:

Product Number	Comcode
2734A R1000	106 309 214

B. Fiber Optic Cable

1. Fiber Optic Riser Cable (Inside Plant)

- a) Multimode/Non-Plenum: Lucent Technologies 3FLX AccuRibbon, High Density, Riser Rated Cable consisting of multiple multimode 62.5/125m fibers with the following part numbers:

Product Number	Number of Fibers	Comcode
3FLX-012	12	106 222 144
3FLX-024	24	106 222 151
3FLX-036	36	106 222 169
3FLX-048	48	106 222 177
3FLX-060	60	106 222 185
3FLX-072	72	106 222 193
3FLX-084	84	106 222 201
3FLX-096	96	106 222 219
3FLX144	144	106 222 250

- b) Multimode/Plenum: Lucent Technologies LGBC Accumax Backbone/Riser Rated Cable consisting of multiple multimode 62.5/125m fibers with the following part numbers:

Product Number	Number of Fibers	Comcode
LGBC-006D-LRX	06	106 291 024
LGBC-012D-LRX	12	106 291 073
LGBC-018D-LPX	18	107 893 372
LGBC-024D-LPX	24	107 754 772
LGBC-030D-LPX	30	107 893 489
LGBC-036D-LPX	36	107 754 798
LGBC-048D-LPX	48	107 752 982
LGBC-060D-LPX	60	107 893 497
LGBC-072D-LPX	72	107 753 048

2. Fiber Optic Inter-Building Cable

- a) Lucent Technologies Multimode, 3GSX LXE-Metallic Outdoor Cable designed for underground conduit, direct buried or aerial applications with steel armor for rodent and lightning protection consisting of multiple multimode 62.5/125m fibers with the following part numbers:

Product Number	Number of Fibers	Comcode
3GSX-012-HXM	12	106 355 167
3GSX-024-HXM	24	106 355 175
3GSX-036-HXM	36	106 355 183
3GSX-048-HXM	48	106 355 191
3GSX-060-HXM	60	106 355 209
3GSX-072-HXM	72	106 355 217

3GSX-084-HXM	84	106 355 225
3GSX-096-HXM	96	106 355 233
3GSX-120-HXM	120	106 355 258
3GSX-144-HXM	144	106 355 274

- b) Lucent Technologies Single Mode, 4GSX LXE-Metallic Sheath Outdoor Cable designed for underground conduit, direct buried or aerial applications with steel armor for rodent and lightning protection with the following part numbers:

Product Number	Number of Fibers	Comcode
4GSX-012-BXC	12	106 355 164
4GSX-024-BXC	24	106 355 172
4GSX-036-BXC	36	106 355 180
4GSX-048-BXC	48	106 355 198
4GSX-060-BXC	60	106 355 206
4GSX-072-BXC	72	106 355 214
4GSX-084-BXC	84	106 355 222
4GSX-096-BXC	96	106 355 230
4GSX-120-BXC	120	106 355 255
4GSX-144-BXC	144	106 355 271
4GSX-168-BXC	168	106 355 297
4GSX-192-BXC	192	106 355 313
4GSX-216-BXC	216	106 376 726

## 2.03 COMPONENTS

### A. Outlets

1. Lucent Technologies MGS200 Modular GigaSpeed Information Outlets - 8 position/8 conductor non-keyed modular outlets for applications up to 1 Gbps and TIA/EIA compliant for Enhanced Category 5 transmission requirements with the following part numbers (Standard installations will utilize white outlets for voice and orange outlets for data). Dust Cover/Blanks should match faceplate cover.

Product Numbering	# per pack	Color	Comcode
MGS200BH-112	1	ORANGE	107 971 541
MGS200BH-246	1	IVORY	107 971 574
MGS200BH-262	1	WHITE	107 971 582
M20AP-246	100/pack	IVORY	107 067 860
M20AP-262	100/pack	WHITE	107 067 928
MGS200BH-B1K-112	1000	ORANGE	107 971 632
MGS200BH-B1K-246	1000	IVORY	107 971 665
MGS200BH-B1K-262	1000	WHITE	107 971 673

NOTE: Use either Ivory or White to match the faceplate.

2. Lucent Technologies M-Series Modular Faceplates designed for use with M-Series Modular Information Outlets. Simplex Wall (M10AW), Duplex (M12) and Quadplex (M14):

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Product Numbering	# per pack	Color	Comcode
M10AW-246	1	IVORY	106 849 706
M10AW-262	1	WHITE	106 849 714
M12AP-246	1	IVORY	107 276 172
M12AP-262	1	WHITE	107 276 180
M14A-246	1	IVORY	106 313 646
M14A-262	1	WHITE	106 313 653

3. Lucent Technologies M-Series Modular Surface Mount Box designed for use with one to four M-Series Modular Information Outlets. May be mounted on a flat surface with screws, adhesive tape, or mounting magnet. Box color should match wall/furniture surface color.

Product Numbering	# per pack	Color	Comcode
M104SMB-A-003	1	BLACK	107 952 475
M104SMB-A-246	1	IVORY	107 952 442
M104SMB-A-262	1	WHITE	107 952 459
M104SMB-A-270	1	GRAY	107 952 467

B. Termination Hardware

1. Patch Panels and Associated Components

Product Number	Description	Wiring	Comcode
DM2151B-GS	Distribution Module	T568B	108 075 169
PM2151B-24GS	24 port panel	T568B	108 075 136
PM2151B-48GS	48 port panel	T568B	108 075 144

2. Field-Terminated, 110 Wiring Blocks

Product Number	Description	Comcode
<b>110 Wiring Blocks With Legs (Small Installations)</b>		
110AB2-100FT	4-pair	107 058 919
110AB2-300FT	4-pair	107 058 943
<b>110 Wiring Block System With Back Panel (Larger Installations)</b>		
110PB2-300FT	4-pair	107 058 810
110PB2-900FT	4-pair	107 058 869

3. Protectors (Outside Plant applications)

Product Number	Description	Comcode
188ECA1-100G	188-Type, multipair protector panel	106 086 796
4B1-EW	Wide-gap, gas-tube protector unit for standard service (black)	104 401 856
4C3S-75	Solid-state protector unit for nonringing circuits (red)	105 581 086

3. Fiber Optic Distribution System

Product Number	Description	Comcode
<b>23 inch Frames (for MDF and Large Installations)</b>		
ED8C501-50-G1	Network Bay Frame (7ft.)	601 390 271
ED8C501-50-G2	Network Bay Frame (9ft)	601 390 289
ED8C321-50-G2	LGX Frame Parts (includes sheet metal ducts, brackets, retainers)	601 248 354
ED8C321-50-G1	LGX Distribution Frame (includes 7 ft. frame and parts)	601 426 794
<b>19 inch Frames (for IDF)</b>		
SB-556-084-XU	B-Line, 7 ft., Aluminum Equipment Rack or equivalent	NA
SB-571-66S-084	B-Line, 7 ft., Aluminum, Single Side, Vertical Cable Section or equivalent	NA
<b>Fiber Distribution Shelves (for 19 inch or 23 inch frames)</b>		
100A3 LIU <sup>1</sup>	Modular wall-mount 12 port enclosure (premise or OSP cable)	106 896 947
600A2 <sup>2</sup>	1.72 in high, rack mounted 24 port combination shelf (premise cable) (termination and splice)	107 260 580
LSC2U-024/5 <sup>3</sup>	5 in. high rack mounted combination shelf (OSP cable) (termination and splice)	106 455 355
LST1U-072/7 <sup>4</sup>	7 in. high rack mounted termination shelf (premise or OSP cable)	105 335 871
LST1U-144/9 <sup>5</sup>	9 in. high rack mounted termination shelf (premise or OSP cable)	107 535 569
<b>Splice Trays</b>		
LT1A-M/M	Retains 24 mechanical splices	105 339 907
LT1A-MF/MF	Retains 12 mass fusion splices	107 562 241
LT1A-F/F	Retains 32 single fusion splices	105 339 899
<b>Fiber Connector Panels</b>		
10A ST-e/w <sup>1</sup>	Panel equipped with 6 MM ST couplings (6 each C2000A2)	107 005 068
10 SC1-e/w <sup>1</sup>	Panel equipped with 6 MM/SM SC simplex couplings (6 each C6000)	107 212 490
24ST-EW <sup>2</sup>	Panel equipped with 24 ST multimode couplings	107 260 184
1000SC1 – Duplex	Retains 3 SC duplex couplings	107 153 462
1000 SC1 <sup>3,4</sup>	Retains 6 SC simplex couplings	106 372 121
1000 SC1-8 <sup>3,4</sup>	Retains 8 SC simplex couplings	106 970 981
1200SC1-12 <sup>5</sup>	Retains 12 SC simplex couplings	107 581 720
1000ST <sup>3,4</sup>	Retains 6 ST couplings	105 392 005
1000ST <sup>3,4</sup>	Retains 6 ST couplings (12 pack)	105 428 486
1000ST1-8 <sup>3,4</sup>	Retains 8 ST couplings	107 026 130
1200ST1-12 <sup>5</sup>	Retains 12 ST couplings	107 599 649
<b>Fiber Couplings</b>		
C6000A-4	SC MM/SM simplex coupling (for use with 1000SC1, 1000SC1-8, and 1200SC1-12 panels)	106 703 200

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C6060A-4	SC MM/SM duplex coupling (for use with 1000SC1-Duplex panel)	106 817 380
C2050A-2	ST MM coupling, bayonet/threaded (for use with 1000ST and 1000ST1-8)	105 777 288
C3050A-2	ST SM coupling, bayonet/threaded (for use with 1000ST and 1000ST1-8)	105 777 270
A2000	Nonattenuated coupling (for use with 1200ST1-12 panel)	106 733 546

Miscellaneous		
183U1 <sup>2</sup>	Cover Plate	107 260 614
11A Door <sup>4</sup>	7 in. High metal front door and pair of brackets	104 436 878
145A Brackets <sup>3,4</sup>	Lock brackets for 5 in. And 7 in. high splice doors	104 436 852
LGX Lock Set	Lock set	106 386 857
JR1A	Pair of jumper retainers for 19 in. rack	104 411 277
JR2A	Pair of jumper retainers for bay frame	104 436 092
12S1-8X12	Labels for 1000ST1-8Panels	106 972 334
12S1-36	label for 36-port panels	106 718 877
12A1 Clamp	Metallic cable clamp	104 384 490
12A2 Clamp	Non-metallic cable clamp	106 230 337

C. Patch Cords

1. Copper Patch Cords

Product Number	Length	Comcode
D8GS-3FT	3FT	108 063 561
D8GS-5FT	5FT	107 965 632
D8GS-7FT	7FT	108 063 603
D8GS-9FT	9FT	108 063 637
D8GS-15FT	15FT	108 063 652

NOTE: 15 ft. UTP patch cords shall be used at the workstation only.

2. Fiber Patch Cords

Product Number	Length	Comcode
Multimode, 62.5 Micron, Duplex, ST II+ to ST+, Cable Type 9861A		
FL2EP-EP-02	2FT	107 150 302
FL2EP-EP-04	4FT	107 150 310
FL2EP-EP-06	6FT	107 150 322
FL2EP-EP-10	10FT	107 150 344
FL2EP-EP-15	15FT	107 150 351
FL2EP-EP-20	20FT	107 150 369
FL2EP-EP-25	25FT	107 150 377
FL2EP-EP-30	30FT	107 150 385
Multimode, 62.5 Micron, Duplex, SC to SC, Cable Type 9861A3		
LL2SC-SC-04	4FT	107 122 624

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LL2SC-SC-10	10FT	107 122 640
LL2SC-SC-15	15FT	107 122 657
LL2SC-SC-20	20FT	107 122 665
LL2SC-SC-25	25FT	107 122 673
LL2SC-SC-30	30FT	107 122 688

Singlemode, 8.3 Micron, Duplex, ST II+ to ST+, Cable Type 9001A3		
FS2EP-EP-04	4FT	107 149 650
FS2EP-EP-06	6FT	107 149 668
FS2EP-EP-10	10FT	107 149 684
FS2EP-EP-15	15FT	107 149 692
FS2EP-EP-20	20FT	107 149 700
FS2EP-EP-25	25FT	107 149 718
FS2EP-EP-30	30FT	107 149 726
Singlemode, 8.3 Micron, Duplex, SC to SC, MiniCord		
MS2SC-SC-04	4FT	107 265 233
MS2SC-SC-10	10FT	107 198 665
MS2SC-SC-15	15FT	107 198 830
MS2SC-SC-20	20FT	107 198 848
MS2SC-SC-25	25FT	107 198 855
MS2SC-SC-30	30FT	107 198 863

#### 2.04 ACCESSORIES

- A. Re-enterable Enclosure (3M): 50-pair, no. 3924; 100-pair, no. 3925; 300-pair, no. 3926.
- B. Better buried closures (3M): 2BB/SC 2 inch, 3BB/SC 3 inch, 4BB/SC 4 inch, 5BB/SC 5 inch, 7BB/SC 7 inch, 9BB/SC 9 inch.
- C. Encapsulant 4441 (3M): BB2-12/GEL 600 grams, BB2-24/GEL 1200 grams, BB3-24/GEL 3000 grams, BB4-24/GEL 4500 grams, BB5-26/GEL 7200 grams.

#### PART 3- EXECUTION

##### 3.01 EXAMINATION

- A. Verify conduit, raceways, boxes, handholds and manholes are properly installed following Sections 16111. Verify ductbank is properly installed following Section 16402.
- B. Verify backboards are properly installed following Section 06105.
- C. Verify conduit is minimum 1 inch diameter.
- D. Verify main grounding system is properly installed and tested following Section 16170.

- E. Verify liquid-carrying pipes are not installed in or above voice and data system equipment rooms. Do not proceed with installation in affected areas until removed.

### 3.02 PREPARATION

- A. Maintain temperature of between 65 degrees Fahrenheit and 78 degrees F and between 30 and 50 percent humidity in areas of voice and data system work, following Section 01500.

### 3.03 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data will be included on the drawings.
- B. All installation shall be done in conformance with TIA/EIA 568A and BICSI standards and Lucent Technologies' High-5 installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- C. The SCS installation should meet all applicable national and local codes pertaining to low voltage cable system installations.
- D. The contractor will adhere to the installation schedule of the general contractor and should attend all construction meetings scheduled by the general contractor.
- E. The contractor will be responsible for the cross connection of the horizontal cable runs to the backbone cable system. The connection to voice and data systems will be performed by the vendors installing and/or maintaining those systems.
- F. The contractor will provide service loops (slack) for cables terminating in the main equipment room or the telecommunications closets. A 6 foot service loop will be provided above the access ceiling or cable trays unless specified otherwise. This will allow for future changes or expansion with having to install new cables.
- G. The installation will include coordination, testing and problem resolution with the system vendors.
- H. Label cable terminations on designation strips. Coordinate numbering with

automated cable management system through the City.

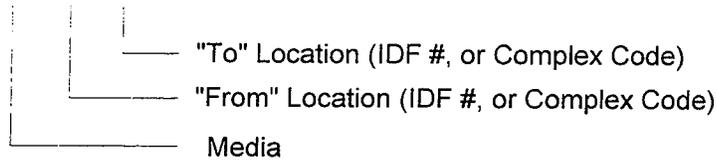
- I. Label cables on jack face plates, on cable end inside back boxes, junction boxes, and handholds, above the terminations in the TC, and on patch panel.
  
- J. Cable labels shall be placed in the following locations: on jack face plates, on cable inside back boxes, junction boxes, access points, and manholes/handholds, on cable above the terminations in the IDF and MDF, on patch panels, and every 50 feet when not in conduit. Conduits shall be labeled "communications" every 50 feet and at the origination and destination.

K. Cable labeling scheme will be as follows:

**Cable Labeling**

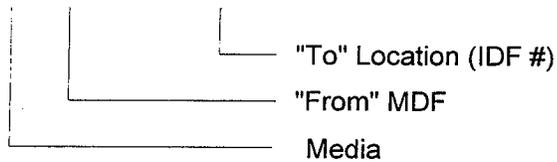
**Tie Cable:**

XXX-XX>XX



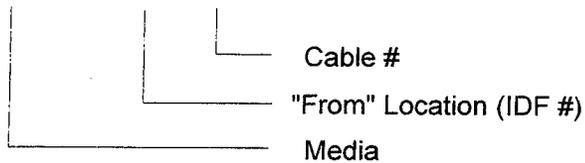
**Riser Cable:**

XXX-MDF>IDF XXXXX



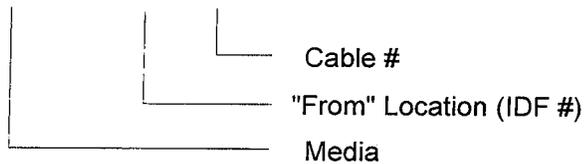
**Horizontal Cable:**

XXX-IDF XXXXX-XXX



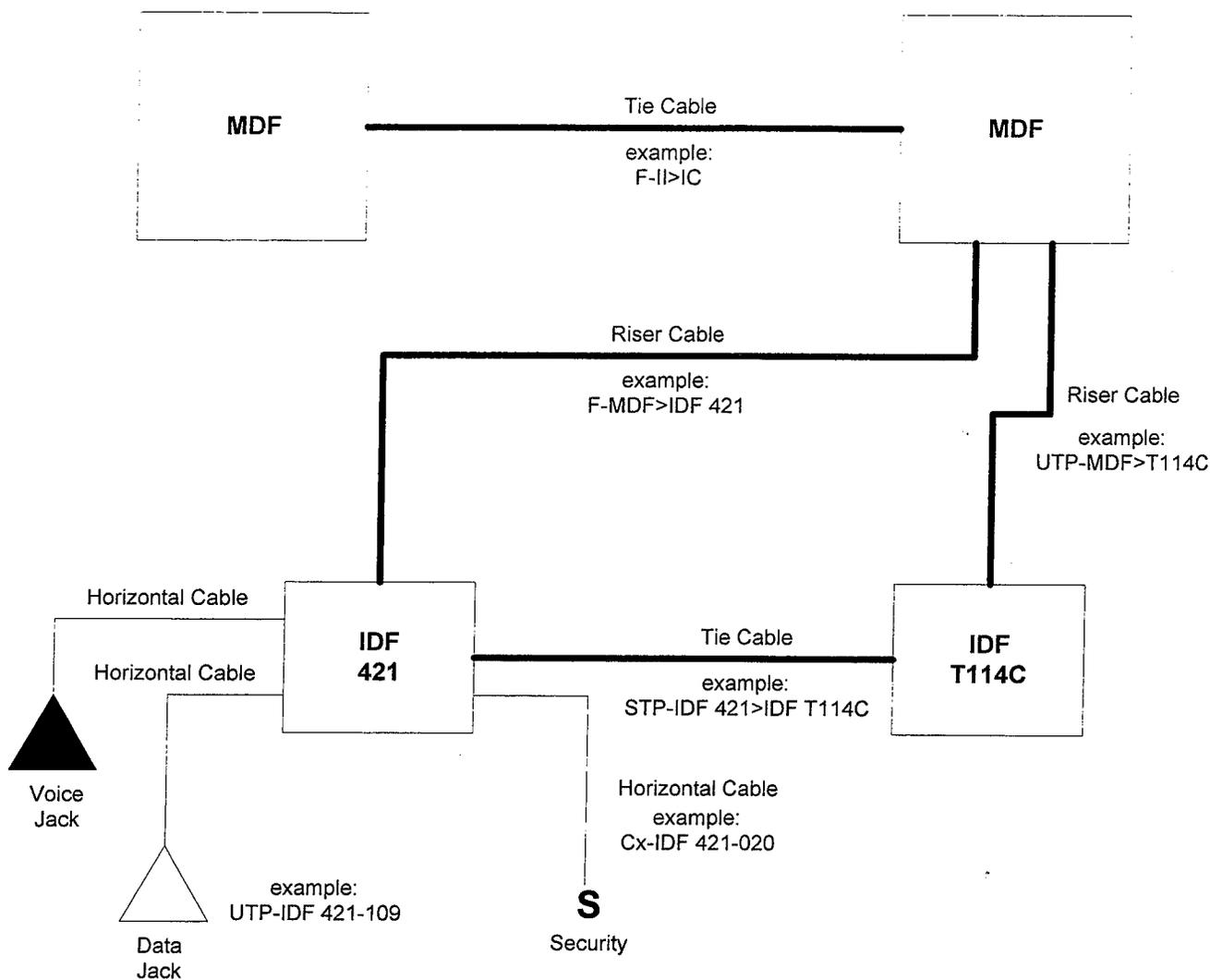
**Jack/Outlet Labeling:**

XXX-IDF XXXXX-XXX



**Media:**

F Fiber Optic  
UTP Unshielded Twisted Pair (Copper)  
STP Shielded Twisted Pair (Copper)  
Cx Coaxial (Copper)



L. Upon completion of the installation, Contractor will prepare as built documentation of the entire SCS. This documentation should include:

1. Drawings

- a) All drawings shall be provided on disk in a form compatible with AutoCad Version 13. A complete set of project plans will be provided to the Contractor on disk. The Contractor will modify the drawings by placing the cable information on a separate layer. All of the requested drawings will be placed on these plans so that all cable routes are to scale and provide accurate information for use in the future when changes are made and the exact location of cables are required to avoid service interruptions.

- b) A complete diagram of all terminations in the Telecommunications Closets.
- c) A complete diagram of all copper, fiber, and coax riser cable.
- d) A complete diagram of all copper, fiber, and coax inter-building cable.
- e) Floor plans showing exact cable routings with each outlet clearly marked with cable number.
- f) A complete diagram of all cable tray, conduits and conduit sleeves.

2. Documentation

- a) All cable inventory data documentation will be submitted in designated Microsoft Excel 97 format, or ASCII, comma delimited files with fields in identical order so that data can be incorporated into existing databases.
- b) Documentation on horizontal cable will include cable number and length of cable.
- c) Documentation on riser cable and interbuilding cable will include cable number, source and destination, type of cable, length of cable and number of pairs or fibers.
- d) Complete cross connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.

3.04 CONTRACTOR'S FIELD QUALITY CONTROL

A. Tests under Section 01400

B. Manufacturer's Testing

1. Copper Cable testing

- a) Testing of all copper wiring shall be performed prior to system cutover. 100 percent of the horizontal and riser wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage. Voice and data horizontal wiring pairs shall be tested from the telecommunications outlet to the TC. The Category 3 riser cable runs shall be tested for conformance to the specifications of TIA/EIA 568A Category 3. The Enhanced Category 5 cable runs

shall be tested for conformance to the specifications of TIA/EIA 568A Enhanced Category 5 and Lucent Technologies GigaSpeed System. Testing shall be done with a TIA/EIA TSB-67 UL Certified Level 2 test set at a minimum. Test shall include length, mutual capacitance, characteristic impedance, attenuation, and near-end crosstalk. Near end crosstalk measurements shall be done at both the information outlet and the cross connect. Both ends shall pass TSB-67 requirements. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor at no charge to the City. Complete end to end test results must be submitted to the City.

- b) At a minimum, a City inspector or their designated representative shall randomly perform unannounced, on-site reviews during the installation. In addition, this person shall perform a final inspection and a complete review of the test results before the installation is accepted.

2. Optical Fiber Cable Testing w/ OTDR

- a) The Contractor shall test all lightguide cable prior to the installation of the cable. The Contractor shall assume all liability for the replacement of the cable should it be found defective at a later date.
- b) All fiber testing shall be performed on all fibers in the completed end to end system. Testing shall consist of a bidirectional end to end OTDR trace performed per TIA/EIA 455-61. The system loss measurements shall be provided at 850 and 1310 nanometers for multimode fibers and 1310 and 1550 for single mode fibers.
- c) Fiber links shall have a maximum loss of:  
 $(\text{allowable cable loss per km})(\text{km of fiber in link}) + (.4\text{dB})(\text{number of connectors}) = \text{maximum allowable loss}$
- d) Loss numbers for the installed link shall be calculated by taking the sum of the bidirectional measurements and dividing that sum by two.
- e) Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no charge to the City.
- f) Documentation shall be provided in both hard copy and 3 1/2 inch diskette to the point of contact.

3. Optical Fiber Cable Testing w/ Power Meter

- a) Multimode Horizontal Link Segments should be tested in one direction at the 850-nm or 1300-nm wavelength.
- b) Multimode Backbone and Composite Link Segments should be tested

in one direction at both 850-nm and 1300-nm wavelengths.

- c) Singlemode Horizontal Link Segments should be tested in one direction at the 1310-nm or 1550-nm wavelength.
- d) Singlemode Backbone and Composite Link Segments should be tested in one direction at both 1310-nm and 1550-nm wavelengths.

Note: The minor attenuation differences due to test direction are on par with the accuracy and repeatability of the test method. Therefore, testing in only one direction is warranted. Horizontal Link Segments are limited to 90 meters. Therefore, attenuation differences caused by wavelength are insignificant, and as a result, single wavelength testing is sufficient.

4. In compliance with TIA/EIA-526-14A "Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant" and TIA/EIA-526-7 "Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant", the following information should be recorded during the test procedure:

- a) Names of personnel conducting the test.
- b) Type of test equipment used (manufacturer, model, serial number).
- c) Date test is being performed.
- d) Optical source wavelength, spectral width, and for multimode, the coupled power ratio (CPR).
- e) Fiber identification.
- f) End point locations.
- g) Test direction.
- h) Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
- i) Measured attenuation of the link segment.
- j) Acceptable link attenuation.

Note: Horizontal Link Segments are limited to 90 meters, therefore, the acceptable link attenuation can be based on the longest installed link without introducing a significant error.

5. Acceptable Attenuation Values

The general attenuation equation for any link segment is as follows:

Acceptable Link Attn. = Cable Attn. + Connection Attn. + Splice Attn. + CPR Adj.

Note: A connection is defined as the joint made by mating two fibers terminated with remateable connectors (e.g. ST, SC, LC).

62.5µm Multimode Attenuation Coefficients

- a) Cable Attn. = Cable Length (km) × (3.40 dB/km@850nm or 1.00 dB/km@1300nm)
- b) Connection Attn. (ST or SC connectors) = (Connections × 0.39 dB) + 0.42 dB
- c) Connection Attn. (LC connectors) = (Connections × 0.14 dB) + 0.24 dB
- d) Splice Attn. (CSL or Fusion) = Splices × 0.30 dB
- e) CPR Adj. = See table below

Multimode Light Source CPR Adjustment					
	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5
Links with ST or SC Connections	+ 0.50	0.00	- 0.25	- 0.50	- 0.75
Links with LC Connections	+ 0.25	0.00	- 0.10	- 0.20	- 0.30

Coupled Power Ratio Measurement

Note: The Coupled Power Ratio of a light source is a measure of the modal power distribution launched into a multimode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multimode fiber produces a more over-filled condition and is classified as a lower category than a light source that launches more of its power into just the lower order modes producing an under-filled condition. Under-filled conditions result in lower link attenuation, while over-filled conditions produce higher attenuation. Therefore, adjusting the acceptable link attenuation equation to compensate for a light source's launch characteristics increases the accuracy of the test procedure.

Procedure:

CPR Test Jumper-1 shall be multimode, 1 - 5 meters long with connectors compatible with the light source and power meter and have the same fiber construction as the link segment being tested.

CPR Test Jumper-2 shall be singlemode, 1 - 5 meters long with connectors compatible with the light source and power meter.

- 1) Clean the test jumper connectors and the test coupling per manufacturer's instructions.
- 2) Follow the test equipment manufacturer's initial adjustment instructions.
- 3) Connect multimode test jumper-1 between the light source and the

power meter. Avoid placing bends in the jumper that are less than 100 mm (4 inches) in diameter. See Figure 1.

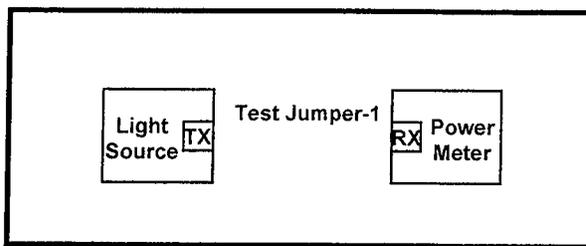


Figure 1

- 4) If the power meter has a Relative Power Measurement Mode, select it. If it does not, record the Reference Power Measurement ( $P_{ref}$ ). Note: If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.
- 5) Disconnect test jumper-1 from the power meter. Do NOT disconnect the test jumper from the light source.
- 6) Connect jumper-2 between the power meter and test jumper-1 using the test coupling. The singlemode jumper should include a high order mode filter. This can be accomplished by wrapping the jumper three times around a 30 mm (1.2 inches) diameter mandrel. See Figure 2.

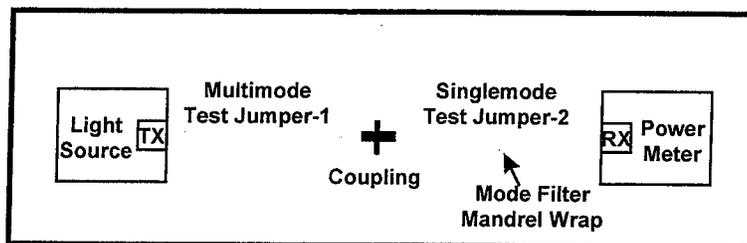


Figure 2

- 7) Record the Power Measurement ( $P_{sum}$ ). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR value. If the meter does not have a Relative Power Measurement Mode, perform the following calculation:  
If  $P_{sum}$  and  $P_{ref}$  are in the same logarithmic units (dBm, dBu, etc):  
$$CPR (dB) = | P_{sum} - P_{ref} |$$
  
If  $P_{sum}$  and  $P_{ref}$  are in watts:  
$$CPR (dB) = | 10 \times \log_{10} [ P_{sum} / P_{ref} ] |$$

### 3.05 CLEANING

- A. Follow Section 01500 for disposal of debris and excess products, and interim cleaning.
- B. Follow Section 01700 for final cleaning.

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### SECTION 17120

#### COMMUNICATIONS MEDIA INFRASTRUCTURE

##### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Provide a Structured Cabling System (SCS) for the purpose of supporting voice, data and video communications at various locations within the Houston Airport System. The Houston Airport System (HAS) has established Systimax as the standard for cabling infrastructure installations.
- B. Related Work:
  - 1. Section 17130: Interior Communication Pathways
  - 2. Section 17140: Exterior Communication Pathways
  - 3. Section 17165: Telecommunications Grounding and Bonding

##### 1.02 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.05A below.
- B. Manufacturers' data, including part numbers, cut sheets and detailed descriptions, for all proposed equipment.
- C. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Submit data electronically on forms furnished by City on CD-Rom disc in "Microsoft Excel 2003" format, listing products furnished, including:
  - 1. Manufacturer's name.
  - 2. Manufacturer's part numbers and com code numbers.
  - 3. Cable numbers utilizing the City's cable numbering standard. (See 3.03 K, L).
  - 4. Location and riser assignments.
  - 5. City will provide submittal form on a data diskette in "Microsoft Excel 2003" format. This requirement applies to copper cable, fiber optic cable, and all termination equipment.
- D. Record Drawings: Furnish CAD drawings, following format in Section 01340, of completed work including cable numbers. Refer to item 3.03 L of this section for labeling conventions. Contractor's on-site Building Industry Consulting Services International (BICSI) Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

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- E. Cable Testing Reports.
  - 1. Submit Testing Plan prior to beginning cable testing.
  - 2. Submit certified test reports of Contractor-performed tests in accordance with paragraph 3.04.D. of this document.
  - 3. Electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable identification.
  - 4. Test reports shall be reviewed, approved and stamped by the Contractor's on-site RCDD.
  
- F. Product data for all termination and test equipment to be used by Contractor to perform work.
  - 1. Equipment shall be calibrated with traceability to National Institute of Standards and Technology (NIST) requirements.
  - 2. Contractor shall include copy of calibration and certification that equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.
  - 3. Test equipment data shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.
  - 4. Refer to 3.04.E. in this document for test equipment requirements.
  
- G. Submit Technology Implementation Plan in accordance with 1.07 below.
  
- H. Submit Cable Pulling Plan, as follows:
  - 1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
  - 2. Indicate contents of each conduit.
  - 3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
  - 4. Cable Pulling Plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submittal.
  - 5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the Architect/Engineer.
  
- I. Submit installation plan indicating:
  - 1. Equipment and personnel
  - 2. Materials and staging area
  - 3. Start and completion dates
  - 4. Locations, including floor, room and building
  - 5. Installation plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.
  
- J. Cable Splicing Submittals
  - 1. Submit fiber fusion splicing method and procedures.

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2. Submit schedules of copper and fiber cables to be spliced.
  3. Submit copper splicing method and procedures.
  4. Submit certification documents for all splicing personnel.
  5. Submit cut sheets, showing accurately scaled components, of fiber and copper splice closures, accessories, clamps, brackets, hangers, splice connectors, splice joint assemblies and fittings,
  6. Submit manufacturer's data on fiber and copper splice closures including, but not limited to types, materials, finishes, and inside and outside dimensions (cross-sectional properties).
- K. Equipment Console and Chair Submittals
1. Submit product data for equipment consoles and chairs, including colors, and surface types.
  2. Chair fabric and color shall be submitted for owner approval and shall not be ordered until owner has approved.
  3. Submit pre-production review drawings and component listing, complete with samples of selected finish materials. The submittal shall be reviewed by the owner for verification of console configuration, equipment layout, and exterior finish selections, prior to commencing with production.
  4. Provide two copies of the console installation and maintenance manuals containing the following information: Product Data, Project Specific Documentation, Console and Equipment Layout drawings and components list, color and finish samples, installation acceptance and sign-off documentation, maintenance and cleaning information, and a spare parts list.

### 1.03 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.
- C. Maintain temperature of between 64 degrees Fahrenheit and 75 degrees Fahrenheit and between 30 and 55 percent humidity in areas of voice and data system work.

### 1.04 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

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- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect two weeks prior to the date of the Bidding Documents unless the document is shown dated.
- C. Conflicts.
1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
  2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- D. References.
1. ANSI/TIA/EIA-568-B, Commercial Building Telecommunications Wiring Standards
  2. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces
  3. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
  4. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS11801, January 6, 1994
  5. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program
  6. National Electrical Manufacturers Association (NEMA)
  7. American Society for Testing Materials (ASTM)
  8. National Electric Code 2002(NEC®)
  9. National Electrical Safety Code (NESC) 2002
  10. Institute of Electrical and Electronic Engineers (IEEE)
  11. UL Testing Bulletin
  12. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps
  13. SYSTIMAX Structured Cabling Systems, Performance Specifications, Latest Issue
  14. SYSTIMAX Structured Cabling Systems, Components Guide, Latest Issue
  15. Systimax Generic Specifications: Fiber Optic Outside Plant Cable, Latest Issue
  16. BICSI Telecommunications Distribution Methods Manual (TDMM)
  17. Rural Utilities Service (RUS) Section 1755
- E. All splicing methods, procedures and products shall comply with the following:
1. Rural Utilities Service (RUS) Section 1755
  2. National Electrical Safety Code (NESC) 2002
  3. National Electrical Code (NEC)
  4. Fiber closures: GR-771-Core
  5. Copper splice cases: Bellcore Testing Requirement PUB-55003 (Pressure Tight Splice Closure)

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*(NOTE TO DESIGNER/SPECIFIER: These Guidelines are basic minimum criteria to be met in preparing the final specifications for this section, which is the responsibility of the Designer.)*

6. UL 1863 classified
7. Applicable local codes, statutes, ordinances, regulations, license requirements.

### 1.05 QUALITY ASSURANCE

- A. Submit written proof that the following experience requirements are being met.
  1. Contractor Qualifications
    - a. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
    - b. Must be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC methods, standards and codes.
    - c. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses.
    - d. The contractor shall provide five references for projects of equivalent scope, type and complexity of work completed within the last five years.
    - e. The contractor who is installing the cabling infrastructure shall be a certified and currently registered Systemax Value Added Reseller (VAR) capable of issuing a numbered registration certificate for the entire cable system.
    - f. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.
  2. Copper cable splicing personnel/technicians requirements:
    - a. All copper splicing personnel/technicians shall have a minimum of 900 pair in one project splicing experience.
    - b. All copper splicing personnel/technicians shall have outside plant (OSP) and inside plant splicing experience.
    - c. All copper splicing personnel/technicians shall be familiar with and shall have installed "710" and "MS<sup>2</sup>" splicing modules.
    - d. All copper splicing personnel/technicians shall have installed in-line and butt splicing configurations.
    - e. All copper splicing personnel/technicians shall have installed OSP, underground, direct buried, aerial, pedestal, and vault splice closures.
  3. Fiber splicing personnel/technicians requirements:
    - a. All fiber splicing personnel/technicians shall have a minimum of 144 fibers in one project splicing experience.
    - b. All fiber splicing personnel/technicians shall have OSP and inside plant splicing experience.

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- c. All fiber spicing personnel/technicians shall be familiar and have installed fusion, rotary and mechanical splicing modules.
  - d. All fiber spicing personnel/technicians shall be familiar and have installed mass fusion splice trays.
  - e. All fiber spicing personnel/technicians shall be familiar and have installed ribbon fusion and mass fusion splicing.
  - f. All fiber spicing personnel/technicians shall have installed in-line and butt splicing configurations.
  - g. All fiber spicing personnel/technicians shall have installed OSP, underground, direct buried, aerial, pedestal, and vault splice closures.
  4. Console installers shall be certified by console manufacturer and experienced in the installation of systems of similar complexity.
  5. Manufacturer's hardware experience: All components shall be produced by manufacturers who have been regularly engaged in the production of telecommunications cabling components of the types to be installed in this project for a period of five years.
- B. Materials and equipment: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. The equipment shall meet the following requirements:
1. Interior controlled environment: 60 to 100 degrees F dry bulb and 20 to 90 percent relative humidity, non-condensing.
  2. Interior uncontrolled environment: 0 to 130 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing.
  3. Exterior environments: Minus 30 degrees to 130 degrees F dry bulb, and 10 to 100 percent relative humidity, condensing.
  4. Hazardous environment: All system components located in areas where fire or explosion hazards may exist because of flammable gas or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings, shall be rated and installed according to Chapter 5 of the NFPA 70 and as shown.
- C. Standard products:
1. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.
  2. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.
- 1.06 CONTRACTOR'S DUTIES
- A. Contractor's RCDD shall provide all calculations and analysis to support design and engineering decisions as specified in the Submittals section.

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- B. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.
- C. Secure and pay for plan check fees, permits, fees, and licenses necessary for the execution of Work as applicable for the project.
- D. Give required notices.
- E. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

### 1.07 PROCUREMENT

- A. Procure equipment specified in this document as dictated by the timeline in Appendix A "Technology Implementation Schedule" in order to ensure that the technology is acquired in a timely fashion, but not outdated by the installation date.
- B. Submit a copy of Appendix A "Technology Implementation Schedule" as a part of the equipment submittals required elsewhere in this document. Complete the columns headed "Quantity", "Purchasing Lead Time", "Start Date or Dependent", and "Installation Duration".
- C. The "Procurement Lead Time" shall be expressed in days or weeks, and shall include time required for the contractor's personnel to order and receive the material. Substantiation may be required.
- D. "Start Date or Dependent" and "Installation Duration" should be an accurate estimate based upon known facts in the project. Substantiation may be required.
- E. The Contractor shall not purchase any materials requiring submittals until the owner approves the product submittal and the Technology Implementation Schedule for that material.
- F. The Contractor shall not purchase any materials requiring submittals until the date established by the owner as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the "Purch Auth" column of Appendix A as a part of the Submittal Review process.

### 1.08 MAINTENANCE AND SUPPORT

- A. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use

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the ANSI/TIA/EIA 568B or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty-year period.

- B. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.
- C. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty period.

### 1.09 EXTENDED WARRANTY

- A. A 20-year Extended Product Warranty and System Assurance Warranty for this wiring system shall be provided.
- B. The Extended Product Warranty shall ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568B and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for cabling links/channels, that the installation will exceed the loss and bandwidth requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for fiber links/channels, for a twenty year period. The warranty shall apply to all passive SCS components.
- C. Warrant Installation against all product defects, and that all approved cabling components meet or exceed the requirements of TIA/EIA-568B and ISO/IEC 11801 for a period of 20 years.
- D. The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products.
- E. Console Warranty: Warrant that all consoles will be free from defects in materials and workmanship from the date of owner sign off on installation as follows:
  - 1. All fixed steel and aluminum structural components for a period of twenty years.
  - 2. All static exterior panels and work surface components for a period of five years.
  - 3. All adjustable, sliding or hinged mechanisms or parts for a period of one year.
  - 4. All electrical components for a period of one year.
- F. Console Chair Warranty: Chairs shall have a lifetime warranty against defects due to normal use.

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### 1.10 DELIVERY AND STORAGE

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
- C. Consoles shall be delivered undamaged and complete.
- D. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the City.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to SYSTIMAX SCS and other manufacturers as referenced in this document. However, substitutions for Systimax products are not permitted.

### 2.02 GENERAL

- A. Provide all cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in the Main Distribution Facility (MDF) and the Intermediate Distribution Facilities (IDFs).

### 2.03 FIBER OPTIC CABLE GENERAL REQUIREMENTS

- A. SYSTIMAX SCS Depressed Clad Singlemode or OptiSPEED 62.5 Multimode as required.
- B. Fiber optic cable shall be certified to meet all parts of EIA-455 and comply with the NEC.
  - 1. Cable installed in plenums or air-handling spaces shall meet UL 910 and shall be marked OFNP (optical fiber non-conductive plenum) in accordance with the NEC.
  - 2. Riser cable shall meet UL 1666 and be marked OFNR (optical fiber non-conductive riser) in accordance with the NEC.

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- C. All fiber optic cable shall utilize the appropriate sheath for the particular application. This shall be in accordance with ANSI/EIA/TIA 568-B standards. Any cable placed in space used as an air return or in any way connected with air handling plenums or building ventilation shall be low-smoke, fire retarding cable, and shall comply with the National Electrical Code Articles 725, 760, and 800. No cabling shall be placed in plenums without written approval from HAS.
- D. Outside Plant Fiber Cables.
  - 1. Stranded loose tube dielectric fiber optic cable shall be utilized for underground conduit, direct buried, or aerial applications.
  - 2. Underground cable, including cable installed in conduits or duct banks, shall contain an additional moisture barrier in the form of a flooding compound.
- E. Building Fiber Cables.
  - 1. Non-plenum, riser rated cable consisting of multiple fibers, shall have an orange, Polyvinyl Chloride (PVC) outer jacket. The cable shall be UL listed and meet the NEC requirements for OFNR.
  - 2. Plenum Fiber rated cable consisting of multiple fibers shall have a Plenum PVC outer jacket. Each group of fibers shall have a color-coded Low Smoke PVC buffer. The buffered fibers are organized in subunits of fibers, reinforced with Aramid yarn for extra strength and surrounded with a color-coded Low Smoke tube. The cable and each subunit shall be UL listed and meet the NEC requirements for OFNP.
- F. Optical fibers conductors shall follow standard color code schemes.
  - 1. Fiber numbers and binders shall correspond to the color codes as follows:
    - a. Fiber/Binder No. 1 – blue
    - b. Fiber/Binder No. 2 – orange
    - c. Fiber/Binder No. 3 – green
    - d. Fiber/Binder No. 4 – brown
    - e. Fiber/Binder No. 5 – slate
    - f. Fiber/Binder No. 6 – white
    - g. Fiber/Binder No. 7 – Red
    - h. Fiber/Binder No. 8 – Black
    - i. Fiber/Binder No. 9 – Yellow
    - j. Fiber/Binder No. 10 – Violet
    - k. Fiber/Binder No. 11 – Rose
    - l. Fiber/Binder No. 12 – Aqua
- G. Preparation for delivery: The fiber optic cable shall be shipped on reels in lengths as specified with a minimum overage of 10 percent.
  - 1. The cable shall be wound on the reel so that unwinding can be done without kinking the cable.

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2. Two meters of cable at both ends of the cable shall be accessible for testing.
  3. Marking: Each reel shall have a permanent label attached showing length, cable identification number, cable size, cable type, attenuation, bandwidth, and date of manufacture. Labels shall be water resistant and the writing on the labels shall be indelible.
- H. Storage: The cable shall have a minimum storage temperature range of minus 40 C to plus 70 C.
- I. Unless otherwise specified, all fiber cables shall be installed in innerduct.

### 2.04 MULTIMODE FIBER OPTIC CABLE SPECIFICATIONS

- A. Manufacturer: SYSTIMAX SCS – OptiSPEED Multimode Cable.
- B. Fibers shall comply with TIA/EIA 492, ISO/IEC DIS 11801, ANSI/ICEA S-83-596 and ANSI/ICEA S-83-640. Fibers shall have dual wavelength capability; transmitting at 850 and 1300nm ranges. Fibers shall have D-LUX ® coating or approved equivalent to ensure color retention, minimize microbending losses and improve handling. The coating shall be mechanically strippable.
- C. Required Characteristics:

Core	62.5 $\mu\text{m} \pm 2.5 \mu\text{m}$
Core Non-Circularity	5% maximum
Core/Cladding Concentricity Error	$\leq 3.0 \mu\text{m}$
Numerical Aperture	$0.275 \pm 0.015$
Cladding diameter	$125 \mu\text{m} \pm 1 \mu\text{m}$
Cladding Non-Circularity	$\leq 1\%$
Colored Fiber Diameter	$254 \mu\text{m} \pm 7 \mu\text{m}$
Buffering Diameter	$890 \text{ mm} \pm 50 \text{ mm}$
Minimum Tensile Strength	100,000 psi
Fiber Minimum Bending Radius	.75 in. (1.91 cm)
Cable Minimum Bending Radius	
During Installation:	20 times cable diameter
After Installation:	10 times cable diameter
Operating Temp. Range	-76°F to 185°F (-60°C to 85°C)
Storage Temp. Range	-40°F to 149°F (-40°C to 65°C)
Maximum Fiber Loss	3.0 dB/km at 850 NM 1.0 dB/km at 1300 NM
Minimum Bandwidth	200 MHz at 850 NM 500 MHz at 1300 NM

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- D. Outdoor Cables. Systimax Multimode, Stranded Loose Tube Dielectric OptiSPEED Outdoor Cable designed for underground conduit, direct buried or aerial applications consisting of multiple multimode 62.5/125m fibers with the following part numbers:

Product Number	O.D.	Number of Fibers	COM code
5024-012A-MXBK	.46	12	760 002 709
5024-024A-MXBK	.46	24	760 002 725
5024-048A-MXBK	.46	48	760 002 741
5024-072A-MXBK	.50	72	760 002 758
5024-096A-MXBK	.58	96	760 002 766
5024-144A-MXBK	.74	144	760 002 865

- E. Building Cables. Multimode/non-plenum, Systimax OptiSPEED Backbone/Riser Rated Cable, consisting of multiple multimode 62.5/125m fibers and an orange, PVC outer jacket with the following part numbers:

Product Number	O.D.	Number of Fibers	COM code
5200-006A-MRSL	.20	06	700 009 509
5200-012A-MRSL	.23	12	700 009 384
5300-024A-MRSL	.56	24	700 009 269
5300-036A-MRSL	.62	36	700 009 178
5300-048A-MRSL	.77	48	700 009 087
5300-072A-MRSL	.75	72	700 008 998
5300-096A-MRSL	.80	96	700 007 730

2.05 SINGLE MODE FIBER OPTIC CABLE SPECIFICATIONS

- A. Fibers shall comply with TIA/EIA 492, ISO/IEC DIS 11801, ANSI/ICEA S-83-596 and ANSI/ICEA S-83-640. Fiber shall comply with TIA/EIA 455 and IEC 793 test methods for required attributes. Fiber shall have D-LUX<sup>®</sup> coating or submitted and owner-approved equivalent to ensure color retention, minimize microbending losses, and improve handling. The coating shall be mechanically strippable.

- B. Each fiber shall be buffered with color-coded PVC.

- C. Required Characteristics:

Fiber Attribute	Depressed Cladding
Attenuation	0.35 dB/km @ 1310 nm 0.24 dB/km @ 1550 nm
Cladding Diameter	125.0 ± 1.0 μm
Cladding Non-Circularity	≤ 1.0%
Colored Fiber Diameter	245 ± 10 μm

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Fiber Attribute	Depressed Cladding
Core Diameter	8.3 μm
Index of Refraction	0.37%
Core/Cladding Concentricity Error	≤ 0.5 μm
Mode Field Diameter	8.8 ± 0.5 μm @ 1310 nm
Minimum Tensile Strength	100,000 psi
Maximum Attenuation	.40 dB/km @ 1310 nm .30 dB/km @ 1550 nm
Maximum Dispersion	2.8 ps/nm-km 1285 to 1330 nm
Fiber Cutoff Wavelength	≥1130 nm ≥1300 nm
Fiber Macrobend (100 turns @ 32 mm diameter)	≥0.05 dB @ 1310 nm ≥0.10 dB @ 1550 nm
Coating Strip Force	1.3 N ≤ F ≤ 8.9 N

- D. Outdoor Cables. Systimax Singlemode, Stranded Loose Tube Dielectric Outdoor Cable designed for underground conduit, direct buried or aerial applications with the following part numbers:

Product Number	O.D.	Number of Fibers	COM code
5024-012A-WXBK	.46	12	760 002 592
5024-024A-WXBK	.46	24	760 002 618
5024-048A-WXBK	.46	48	760 002 634
5024-072A-WXBK	.50	72	760 002 642
5024-096A-WXBK	.58	96	760 002 659
5024-144A-WXBK	.74	144	760 002 667

- E. Building Cables. Singlemode/Non-plenum: TeraSPEED Backbone/Riser Rated Cable consisting of multiple singlemode fibers and an yellow PVC outer jacket, with the following part numbers:

Product Number	O.D.	Number of Fibers	COM code
5200-006A-WRYL	.19	06	760 049 424
5200-012A-WRYL	.22	12	700 009 343
5300-024A-WRYL	.51	24	700 009 228
5300-036A-WRYL	.54	36	700 009 137
5300-048A-WRYL	.60	48	700 009 046
5300-072A-WRYL	.75	72	700 008 956
5300-096A-WRYL	.80	96	700 008 940

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### 2.06 COPPER CABLE GENERAL REQUIREMENTS

- A. Manufacturer Qualifications: ISO 9001 Certified and included in the Underwriters Laboratories LAN Certification and Follow-up Program.

### 2.07 COPPER HORIZONTAL CABLING

- A. Manufacturer: SYSTIMAX SCS XL7-XX71.
- B. All horizontal cabling shall meet or exceed the ANSI/EIA/TIA-568B.2 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components.
- C. Cables shall be marked as UL verified with a minimum of Category 6 rating.
- D. All horizontal cabling shall be color-coded as follows to differentiate between voice and data cabling and tenant and owner cabling.
  - 1. Green – HAS data.
  - 2. Orange – Continental data
  - 3. Blue – Southwest Airlines data
  - 4. Yellow – Tenant Data
  - 5. Lilac – Voice
  - 6. Red – Special circuits, including Automated External Defibrillation (AED) Circuits
- E. High performance (71 Series) Category 6 UTP, 4 Pair cabling shall be utilized to provide the signal medium from the individual workstation location to the IDF(s) unless denoted otherwise on the drawings. This cabling shall be installed in accordance with the contract drawings and shall adhere to the specifications listed below:
  - 1. 4 pair UTP
  - 2. 23 AWG Solid Bare Copper
  - 3. Cable jacket shall comply with NEC Article 800 for use as a plenum cable and shall be UL and c (UL) Listed Type CMP.
  - 4. Cable shall terminate on 8 pin modular jack at each outlet.
- F. The high performance Category 6 UTP cable shall be of the traditional round design with mylar separator tape between pairs 2/3 and 1/4. The cable shall support Voice, Analog Baseband Video/Audio, Fax, Modem, Switched-56, T-1, ISDN, RS-232, RS-422, RS-485, 10BASE-T Ethernet, Token Ring, 100Mbps TP-PMD, 100BASE-T Ethernet, 155 Mbps ATM, AES/EBU Digital Audio, 270 Mbps Digital Video, 622 Mbps 64-CAP ATM and emerging high-bandwidth applications, including 1 Gbps Ethernet, gigabit ATM, as well as all 77 channels (550 Mhz) of analog broadband video.

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- G. The high performance Category 6 cables shall meet or exceed the following electrical characteristics:

Mutual Capacitance	47.8 nF/m
Characteristic Impedance	(± 3%) of 100 Ohms 1-550 MHz
DC Resistance Max	9.83 Ohms/100m)
Positive ACR	Out to 395 MHz-km

- H. The high performance Category 6 cable shall be specified to 550 MHz and shall meet the guaranteed electrical performance and physical specifications as follows:

Freq (MHz)	Attn dB/100m	NEXT (dB)	PS NEXT (dB)	ELFEXT (dB)	PS ELFEXT	Return Loss
0.772	1.6	76.0	74.0	70.0	67.0	‡
1	1.8	74.3	72.3	67.8	64.8	20
4	3.6	65.3	63.3	55.7	52.7	23
8	5.1	60.8	58.8	49.7	46.7	24.5
10	5.8	59.3	57.3	47.8	44.8	25
16	7.3	56.3	54.3	43.7	40.7	25
20	8.2	54.8	52.8	41.7	38.7	25
25	9.2	53.3	51.3	39.8	36.8	24
31.25	10.4	51.9	49.9	37.9	34.9	24
62.5	15.0	47.4	45.4	31.8	28.8	22
100	19.3	44.3	42.3	27.8	24.8	20
200	28.3	39.8	37.8	21.7	18.7	18
250	32.1	38.3	36.3	19.8	16.8	17
300	35.6	37.2	35.2	18.2	15.2	17
350	38.9	36.2	34.2	16.9	13.9	16
400	42.0	35.3	33.3	15.7	12.7	16
450	45.0	34.5	32.5	14.7	11.7	16
500	47.9	33.8	31.8	13.8	10.8	15
550	50.6	33.2	31.2	12.9	9.9	15
‡ Not Specified						

- I. Systimax part numbers for Plenum-rated Horizontal Cabling are as follows:

Product Number	Color	COM code	Qty per Unit
2071004EWH	White	700208101	W1000
2071004EWH	White	700210032	R1000
2071004EWH	White	700210057	R3000
2071004EWH	White	700210040	R4750
2071004EBL	Blue	700208093	W1000

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Product Number	Color	COM code	Qty per Unit
2071004EBL	Blue	700210081	R1000
2071004EBL	Blue	700210107	CUSTL
2071004EBL	Blue	700210099	R3000
2071004EYL	Yellow	700210123	W1000
2071004EYL	Yellow	700210131	R1000
2071004EYL	Yellow	700210149	CUSTL
2071004EGR	Green	700210164	W1000
2071004EGR	Green	700210156	R1000
2071004EGR	Green	700210172	CUSTL
2071004EGR	Green	700210180	R4750
2071004ELL	Lilac	700210214	W1000
2071004ELL	Lilac	700210206	R1000
2071004ERD	Red	700210263	W1000

### 2.08 BACKBONE COPPER CABLE – INSIDE PLANT

- A. Manufacturer: Systimax, unless otherwise noted.
- B. Non-plenum Backbone Cable – 24 AWG
1. ARMM 24 AWG multi-pair insulated with color-coded PVC copper cables shall be used as the vertical riser cables. The cable shall support voice, data, and building service applications. All 50-pair and larger cable shall be conformance tested to meet ANSI/TIA/EIA 568B for Category 3 cables. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation.
  2. Systimax part numbers for ARMM cable are as follows:

Product Number	Number of Pairs	COM code
ARMM-0025	25	107 526 873
ARMM-0050	50	107 527 111
ARMM-0100	100	107 527 129
ARMM-0200	200	107 527 285
ARMM-0300	300	107 527 293
ARMM-0600	600	107 527 319
ARMM-0900	900	107 527 327
ARMM-1800	1800	107 527 350

- C. Non-plenum Backbone Cable – 22 AWG
1. Manufacturer – Superior Essex or submitted and owner-approved equivalent

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2. ARAM 22 AWG 100-pair insulated with color-coded PVC copper cables shall be used only transition splices from OSP to inside cable. The ARAM cable shall be routed from the splice closure to the protector panel, as indicated in Drawings.
3. Superior Essex part number is 02-069-03.

**D. Plenum Backbone Cable**

1. The plenum cable shall consist of 24-AWG solid-copper conductors insulated with color-coded PVC. All 50-pair and larger cable shall be conformance tested to meet ANSI/TIA/EIA 568B for Category 3 cables. The cable shall be UL® and c (UL®) Listed for Fire Safety and ISO 9001 Certified. The plenum cable shall be available in 25, 50, and 100 pair.
2. Systimax part numbers are as follows:

Product Number	Number of Pairs	COM code
2010 025BWH	25	107 765 992
2010 050BWH	50	107 766 040
2010 100BWH	100	107 766 057

- E.** The backbone copper cable shall meet or exceed the following electrical specifications listed below:

Maximum DC Resistance	28.6 $\Omega$ /1,000 ft (9.38 $\Omega$ /100m)
Maximum DC Resistance Unbalanced	$\leq 5\%$
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 ft. (328 pF/m)
Mutual Capacitance @ 1kHz	16 nF/1000 ft (5.2 nF/100 m), maximum

Attenuation (dB/100 m [328 ft.])

Frequency	Attenuation (Max.)
1.00 MHz	7 dB
4.00 MHz	15 dB
10.00 MHz	26 dB
16.00 MHz	35 dB

Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]

Frequency	Pair-To-Pair NEXT
1.0 MHz	41 dB
4.0 MHz	32 dB
10.0 MHz	26 dB
16.0 MHz	23 dB

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### 2.09 BACKBONE COPPER CABLE – OUTSIDE PLANT

- A. Manufacturer: Superior Essex or submitted and owner-approved equivalent
- B. Superior Essex or submitted and owner-approved equivalent ASP-filled 22 AWG multi-pair copper cables shall be utilized for underground conduit or direct buried applications. The cable shall support voice, low-speed data, and building service applications. The bending radius and pulling strength requirements of all outside plant cables shall be observed during handling and installation.

1. The copper cable shall meet or exceed the following electrical specifications:

a.

Characteristic Impedance	100 $\Omega$ (25-pair)
Mutual Capacitance	15.7 nF/1,000 ft. (5.15 nF/100 m) (25-pair)

b. Attenuation

Frequency	Nominal Attenuation
0.772 MHz	5.90 dB/328 ft
1.000 MHz	6.70 dB/328 ft

2. Outside Plant Cable part numbers are as follows:

Product Number	Number of Pairs	Essex Part #
ANAW-0025	25	22-062-83
ANAW-0050	50	22-065-83
ANAW-0100	100	22-069-83
ANAW-0200	200	22-073-83
ANAW-0300	300	22-075-83
ANAW-0400	400	22-077-83
ANAW-0600	600	22-081-83
ANAW-0900	900	22-083-83
ANAW-1200	1200	22-085-83

### 2.10 VIDEO COAXIAL CABLE

- A. Manufacturer: CommScope or approved equivalent.
- B. The 0.750 coaxial cable shall be used as the vertical riser where specified in the Contract Drawings.
1. The shielded cable shall have a copper clad aluminum center conductor; expandable polyethylene dielectric; continuous aluminum outer conductor; and a flame retardant jacket.

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2. Tested and marked to comply with the NEC requirements for (CATVR) Riser Rating.
- C. The shielded, plenum RG-6 cable shall be used as horizontal where specified in the Contract Drawings.
1. Shall consist of a 20-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
  2. The copper cable shall meet or exceed the following electrical specifications listed below:

Characteristic Impedance	75 $\Omega$ @ 50 MHz
Mutual Capacitance	17.5 pF/ft. (57 pF/m)

3. Attenuation

Frequency	Nominal Attenuation
1.00 MHz	2.5 dB/1000 ft
5.00 MHz	5.4 dB/1000 ft
10.00 MHz	7.5 dB/1000 ft
22.50 MHz	11.5 dB/1000 ft
50.00 MHz	17.0 dB/1000 ft
100.00 MHz	27.0 dB/1000 ft

### 2.11 FIBER HARDWARE TERMINATION STANDARDS

- A. Fiber Terminations – Fiber Optic Interconnect Units (LIU) and Distribution Shelves. The enclosure is used in fiber optic interconnection, cross-connection, and splicing applications. The enclosure shall be modular in design and suitable for OSP, riser, and building cables.
- B. Fiber splicing and closures. The fiber splice module shall meet the following specifications:
  1. Fusion
  2. Joins single mode or multi-mode fibers
  3. Establishes a permanent fusion splice
  4. May be used in OSP and/or premises applications
  5. Accept 250 and 900 micron fibers
  6. Re-enterable, re-arrangeable and reusable
  7. Require no polishing
  8. Require no adhesives
  9. No loose parts

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10. One part index matching gel
11. Unlimited shelf life

C. Fiber Optic Distribution System: Systimax part numbers are as follows:

Product Number	Description	COM code
<b>Fiber Distribution Shelves (19 inch rack-mountable)</b>		
100A3 LIU	Modular wall-mount 12 port enclosure (premise or OSP cable)	106 896 947
600A2	1.72 in high, rack mounted 24 port combination shelf (premise cable) (termination and splice)	107 260 580
100LS LIU	SYSTIMAX 100LS LIU with SC Panels	108 548 868
200LS LIU	SYSTIMAX 200LS LIU with SC Panels	108 548 876
PM2304SC/SC-24	2 rack unit, high rack mounted fiber panel kit, ( fiber station cable)	108 662 065
LST1F-072/7	7 in. high rack mounted termination shelf (premise or OSP cable)	700 007 271
LST1U-144/9	9 in. high rack-mounted termination shelf (premise or OSP cable)	700 007 214
<b>Splice Trays</b>		
LT1A-MF/MF	Retains 12 mass fusion splices	107 562 241
LT1A-F/F	Retains 32 single fusion splices	105 339 899
<b>Fiber Connector Panels</b>		
10 SC1-e/w	Panel equipped with 6 MM/SM SC simplex couplings (6 each C6000)	107 212 490
1000SC1 – Duplex	Retains 3 SC duplex couplings	107 153 462
1000 SC1	Retains 6 SC simplex couplings	106 372 121
1000 SC1-8	Retains 8 SC simplex couplings	106 970 981
1200SC1-12	Retains 12 SC simplex couplings	107 581 720
10PSC-LS	Retains 12 SC duplex couplings	108 627 274
1000ST	Retains 6 ST simplex couplings	700 011 109
<b>Fiber Couplings</b>		
C6000A-4	SC MM/SM simplex coupling (for use with 1000SC1, 1000SC1-8, and 1200SC1-12 panels)	106 703 200
C6060A-4	SC MM/SM duplex coupling (for use with 1000SC1-Duplex panel)	106 817 380
<b>Miscellaneous</b>		
M40A1-B-262	Fiber Outlet	107 992 927
M40DSC-B-262	Fiber Outlet SC Panels 4 duplex	107 239 493
183U1	Cover Plate	107 260 614
11A Door	7 in. High metal front door and pair of brackets	104 436 878

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Mated connector loss	$\mu = 0.35$ dB, $\sigma = 0.2$ dB
Cable Retention	50 lb. (220 N) minimum
Connection Repeatability	0.20 dB maximum change per 200 reconnects
Manufacturer	ISO 9001 Certified Manufacturer

### 2. Single mode Fiber Patch Cord Part Numbers

Singlemode, 8.3 Micron, Duplex, SC to SC		
FS2SC-SC-05	5FT	700 011 026
FS2SC-SC-10	10FT	700 011 018
MS2SC-SC-15	15FT	107 198 830
MS2SC-SC-20	20FT	107 198 848
MS2SC-SC-25	25FT	107 198 855
MS2SC-SC-30	30FT	107 198 863

- E. High-Density Fiber Optic Patch Cords: The factory terminated fiber patch cords shall be connectorized with the high-density connectors as specified above. The high-density connector shall have a trigger mechanism that shall allow the connector to be easily engaged and disengaged from the coupler/outlet. The trigger shall prevent the plug from snagging as jumpers are being routed and shall allow the two plugs to be simultaneously disengaged. The patch cords shall utilize 1.6 mm cordage to assure maximum fill capacity in fiber management paths. Duplex cordage shall be 1.6 by 3.6 mm in a figure-8 design that has two single fiber cords joined together with a web. The assembly shall be designed to prevent accidental disconnects to assure optimal performance.

#### 1. Specifications

Fiber Type	Multimode	Singlemode
Loss $\mu$ , $\sigma$	0.1, 0.1 dB	0.1, 0.7 dB
Return Loss Maximum	-20 dB	-50 dB
Cable OD	1.6 mm	1.6 mm
Cable Retention (cordage)	20 lb	20 lb
Mating Durability for 500 Reconnects		
Insertion Loss Change	<0.2 dB	<0.2 dB
Temperature Stability (-40°C to +75°C)		
Insertion Loss Change	<0.3 dB	<0.3 dB
Tip Material	Ceramic	Ceramic

- F. Patch Cord Quantity. Patch cords shall be provided for each fiber strand assignment as shown in the fiber cable schedules included in the Drawings.

## 2.13 COPPER HARDWARE TERMINATION STANDARDS

### A. Copper Termination Blocks

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1. Modular Patch Panels System and Associated Components
  - a. Manufacturer: SYSTIMAX SCS – PatchMAX GS3
  - b. The termination block on the patch panel shall support the appropriate Category 6 applications, including 100 Base-T, 52/155 Mbps ATM, and 1000 BASE-T Gigabit Ethernet, and facilitate cross connection and inter connection using modular patch cords. All Modular jack panels shall be wired to T568B. The wiring block shall be able to accommodate 24 AWG cable conductors. All modular cross connect panels shall be UL listed.
  - c. Systemax part numbers are as follows:

Product Number	Description	Wiring	Comcode
DM-GS3-6	GS 6-port snap-in module	T568B	700 173 776
PM-GS3-24	24 port panel	T568B	700 173 735
PM-GS3-48	48 port panel	T568B	700 173 743

2. 110 Wiring Blocks
  - a. Manufacturer: SYSTIMAX
  - b. 110 blocks shall provide for the termination of horizontal, equipment, or tie cables. This high-density modular design shall be compatible with all voice and data circuits. The block shall be Underwriter's Laboratories (UL) listed.
  - c. Field-terminated, wall-mounted 110 Wiring Block part numbers are as follows:

Product Number	Description	COM code
<b>110 Wiring Blocks With Legs (Small Installations)</b>		
110AB2-100FT	4-pair	107 058 919
110AB2-300FT	4-pair	107 058 943
<b>110 Wiring Block System With Back Panel (Larger Installations)</b>		
110PB2-300FT	4-pair (Station)	107 058 810
110PB2-900FT	4-pair (Station)	107 058 869
110PB2-300FT	5-pair (Riser)	107 058 802
110PB2-900FT	5-pair (Riser)	107 058 851
<b>188 Backboards w/distributing rings for 110 blocks</b>		
188D3	300 pair	107 151 193
188C3	900 pair	107 151 185

- d. Field-terminated, rack and cabinet mounted 110 Wiring Block part numbers are as follows:

Product Number	Description	COM code
<b>110 Connector System Mounting Brackets</b>		
110RD2-200-19	(2) 100-Pair Bracket	107 058 919
<b>110 Wiring Block for Wiring Bracket</b>		
110DW2-100	110 100-Pair Wiring Blocks	107 059 909
<b>110 Jumper Troughs</b>		
110B3	110 Troughs	107 831 141

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3. Electrical requirements of Copper Termination Equipment:

a. Near End Cross Talk

Frequency	NEXT (dB) Pair to Pair	NEXT (dB) Power Sum
1.0 MHz	83.7	80.4
4.0 MHz	73.7	70.3
8.0 MHz	67.1	64.2
10.0 MHz	65.1	62.3
16.0 MHz	60.9	58.3
20.0 MHz	58.8	56.2
25.0 MHz	56.8	54.3
31.25 MHz	54.8	52.3
62.50 MHz	47.9	45.7
100.0 MHz	42.5	40.5

b. Attenuation

Frequency	Attenuation (dB)
1.0 MHz	.03
4.0 MHz	.03
8.0 MHz	.03
10.0 MHz	.03
16.0 MHz	.03
20.0 MHz	.03
25.0 MHz	.03
31.25 MHz	.04
62.50 MHz	.06
100.0 MHz	.13

c. Structural Return Loss

Frequency	Return Loss (dB)
1.0 MHz	51
4.0 MHz	50
8.0 MHz	45
10.0 MHz	42
16.0 MHz	38
20.0 MHz	37
25.0 MHz	35

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Frequency	Return Loss (dB)
31.25 MHz	33
62.50 MHz	28
100.0 MHz	24

**B. Wire Managers for Copper Termination Equipment**

1. Vertical Wire Manager – Wall-mounted 110 Patch Panel System Backboard
  - a. Manufacturer: Chatsworth or submitted and owner-approved equivalent
  - b. One on each side
  - c. Chatsworth part number(s) are as follows:

Product Number	Description	COM code
<b>Single-Sided Narrow Vertical Cabling Section</b>		
11730-7XX	Vertical Cabling Mgr (Black)	N/A

2. Vertical Wire Manager – 300-pair through 900-pair for 110 patch panels
  - a. Manufacturer: Chatsworth or submitted and owner-approved equivalent
  - b. One on each side
  - c. Chatsworth part number(s) are as follows:

Product Number	Description	COM code
<b>Double-Sided Narrow Vertical Cabling Section (one on each side)</b>		
12096-7XX	Vertical Cabling Mgr	

3. Horizontal Wire Managers –Wall-mounted 110 Patch Panel System Backboard
  - a. Manufacturer: Systimax
  - b. Above and below each hardware shelf.
  - c. Systimax part number(s) are as follows:

Product Number	Description	COM code
<b>110 Jumper Troughs</b>		
110B3	110 Troughs	107 831 141

4. Horizontal Wire Managers – Racks and cabinets
  - a. Manufacturer: Chatsworth or submitted and owner-approved equivalent
  - b. Above and below each equipment shelf
  - c. Not required with RJ45 patch panels
  - d. Chatsworth part number(s) are as follows:

Product Number	Description	COM code
<b>Horizontal Wire Managers</b>		
11753-719	19" Medium Wire Manager	

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C. Modular Patch Cords

1. Manufacturer: Systimax SCS-GS8E
2. Provide Category 6, Modular Patch Cords for each installed port designated as "Data" in the Drawings.
3. All cords shall conform to the requirements of ANSI/TIA/EIA 568-B.2 Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL® LAN Certification and Follow-up Program. Cords shall be equipped with an 8 pin modular connector on each end and shall conform to the length(s) specified on the detailed drawing. All Category 6 cordage shall be round, and consist of 23-AWG copper, stranded conductors, tightly twisted into individual pairs and shall meet or exceed the electrical specifications listed below.
4. Specifications:

DC Resistance per Lead	9.4Ω/100m (328 ft) maximum
DC Resistance Unbalance	5% maximum
Mutual Capacitance	6.6 nF/100m (328 ft), maximum
Characteristic Impedance	100Ω ± 15% from 1 to 100 MHz

- a. Worst Pair Near-End Crosstalk, Power Sum NEXT, attenuation and Structural Return Loss, dB/328 ft.

Frequency	Pair-To-Pair NEXT	Power Sum NEXT	Attenuation (Max.) dB/100 m	SRL
1.00 MHz	76.0 dB	73.0 dB	1.9 dB	36 dB
4.00 MHz	64.0 dB	61.0 dB	3.9 dB	36 dB
8.00 MHz	60.2 dB	57.0 dB	5.5 dB	30 dB
10.00 MHz	59.0 dB	56.0 dB	6.3 dB	30 dB
16.00 MHz	56.0 dB	53.0 dB	8.0 dB	31 dB
20.00 MHz	55.0 dB	52.0 dB	8.9 dB	29 dB
25.00 MHz	54.0 dB	51.0 dB	10.0 dB	30 dB
31.25 MHz	52.0 dB	49.0 dB	11.2 dB	31 dB
62.50 MHz	48.0 dB	45.0 dB	16.1 dB	27 dB
100.00 MHz	45.0 dB	42.0 dB	20.7 dB	25 dB

5. UTP Patch cord lengths will be deployed as follows

Length	Location/Application
3 ft	MDF, IDF, Computer Room, and Lab
5 ft	MDF, IDF, Computer Room, and Lab
7 ft	MDF, IDF, Computer Room, and Lab
9 ft	MDF, IDF, Computer Room, Office, Cubicle, or Lab
15 ft	Office, Cubicle, or Lab

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6. Copper patch cord part numbers are as follows:

Product Number	Length	Material ID
GS8E-3ft	3FT	CPC3312-03F003
GS8E-5ft	5FT	CPC3312-03F005
GS8E-7ft	7FT	CPC3312-03F007
GS8E-9ft	9FT	CPC3312-03F009
GS8E-15ft	15FT	CPC3312-03F015

NOTE: 15 ft. UTP patch cords shall be used at the workstation only.

D. Hybrid RJ45 to 110 Patch Cords.

1. Manufacturer: Systimax 119P2PS
2. Provide Category 6, Hybrid Patch Cords for each assigned voice port on the patch panel. All cords shall conform to the requirements of ANSI/TIA/EIA 568-B.2 Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL® LAN Certification and Follow-up Program.
3. Cords shall be one-pair stranded D8PS (RJ45) connector on one end and 110GS on the other end. Cords shall be provided in appropriate lengths to accommodate all voice ports as shown in detailed Drawings. All Category 6 cordage shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pair and shall meet or exceed the Category 5e specifications.
4. Hybrid patch cords shall conform to the TIA 568B wiring scheme.
5. Hybrid patch cords shall be provided for each installed port designated as "Voice" in the Drawings.
6. Hybrid patch cord part numbers are as follows:

Product Number	Length	Material ID
119P2PS	8FT	CPC8662-03F008
119P2PS	10FT	CPC8662-03F010

E. Outlets

1. Manufacturer: Systimax
2. Systimax MGS400 Modular GigaSpeed Information Outlets - 8 position/8 conductor non-keyed modular outlets for applications up to 1 Gbps and ANSI/TIA/EIA 568-B compliant for Category 6 transmission requirements and be part of the UL® LAN Certification and Follow-up Program.
3. Outlets shall meet or exceed the following electrical and mechanical specifications:
  - a. Category 6 minimum requirements and support 1 Gbps Ethernet
  - b. T568B eight-position jack pin/pair assignments
  - c. Insulation resistance: 500 MW minimum
  - d. Contact resistance: 20 mW maximum
  - e. Current rating: 1.5 A at 68° F(20°C) per IEC Publication 512-3, Test 5b.
  - f. Worst pair NEXT

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- g. Dielectric withstand voltage 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
- h. Near End Cross Talk (NEXT)

Frequency	M100 Outlet Pair-To-Pair	MPS100 Outlet Power Sum
1.00 MHz	85 dB	87
4.00 MHz	74 dB	75 dB
8.00 MHz	68 dB	69 dB
10.00 MHz	66 dB	67 dB
16.00 MHz	62 dB	63 dB
20.00 MHz	60 dB	61 dB
25.00 MHz	58 dB	58 dB
31.25 MHz	56 dB	56 dB
62.50 MHz	50 dB	49 dB
100.00 MHz	42 dB	42.9 dB

- i. Attenuation (maximum) (dB)

Frequency	M100	MPS100 Power Sum
1.00 MHz	0.02 dB	0.02 dB
4.00 MHz	0.02 dB	0.02 dB
8.00 MHz	0.02 dB	0.02 dB
10.00 MHz	0.02 dB	0.02 dB
16.00 MHz	0.03 dB	0.03 dB
20.00 MHz	0.03 dB	0.03 dB
25.00 MHz	0.03 dB	0.03 dB
31.25 MHz	0.05 dB	0.04 dB
62.50 MHz	0.14 dB	0.08 dB
100.00 MHz	0.25 dB	0.17 dB

- 4. Standard installations shall utilize white outlets for voice (to match the faceplate) and orange outlets for data. Dust Cover/Blanks shall match faceplate cover.
- 5. All IMO's shall have at a minimum 2-voice and 2-data ports at each location unless otherwise specified by the contract documents.

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6. Systimax MGS400 Modular GigaSpeed Information Outlets part numbers are as follows:

Product Numbering	# per pack	Color	COM code
MGS400-112	1	Orange	700 206 683
MGS400-262	1	White	706 206 725

7. Systimax M-Series Modular Faceplates designed for use with M-Series Modular Information Outlets:

Product Numbering	# of ports	# per pack	Color	COM code
M10L-262	1	1	White	108 258 427
M10LW-262	1 (wall)	1	White	108 258 468
M12L-262	2	1	White	108 168 469
M14L-262	4	1	White	108 168 543

8. Systimax M-Series Modular Surface Mount Box designed for use with one to four M-Series Modular Information Outlets. May be mounted on a flat surface with screws, Box color shall match wall/furniture surface color.

Product Numbering	# per pack	Color	COM code
M104SMB-262	1	White	107 952 459
M104SMB-270	1	Gray	107 952 467

F. Protectors (Outside Plant applications)

Product Number	Description	COM code
331901	Circa 1880NA1/NSC-200: 188-Type, 200-pair protector panel. Input on left side for front of cabinet.	N/A
331902	Circa 1880NA1/NSC-200: 188-Type, 200-pair protector panel. Input on right side for back of cabinet.	N/A
750031	Circa C4B1S: 5-pin solid-state protector module, black shell, 300 volt, sneak current protection and built-in test points.	N/A
4C3S-75	Solid-state protector unit for nonringing circuits (red)	105 581 086

G. Copper Cable Splice System

1. Copper Splice Systems are defined to include, but not limited to copper MS<sup>2</sup> splice module, components, closure kits, supports and required accessories to provide a turnkey copper network system.

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2. Copper cable to be spliced shall be 22 AWG OSP and 22 AWG inside cable as specified in the previous paragraphs.
3. Splices shall be inline, from underground OSP cable (filled metallic) to indoor cable (air core metallic).
4. Splice method shall be MS<sup>2</sup> (splicing modules).
5. Copper Splice Kit
  - a. Manufacturer: Preformed Line Products or submitted and owner-approved equivalent.
  - b. Splice kit for one 600-pair OSP copper cable (in) and six 100-pair inside copper cables (out).
  - c. Preformed part number 800011406.
  - d. The splice kit contains the following components. Individual component part numbers provided for information only.
    - 1) 1 each 6.5" x 28" ARMADILLO® splice case shell.
    - 2) 1 each 2-section End Plate with ground insert, EP #8003551.
    - 3) 1 each 3-section End Plate, EP #8003094.
    - 4) 1 each 4oz. C-Cement, EP #80802377.
    - 5) 1 each ARMADILLO® Bonding Kit, EP #80802798.
    - 6) 1 each LOCK-TAPE Sealant, EP #80801953.
    - 7) 8 each MORAY Shield Connectors, EP #8000745.
    - 8) 24 each 3M MS<sup>2</sup> Super Mini Splice Modules, EP #4000-C.
    - 9) 1 each Mounting Kit, EP #8003460.
6. Copper Splice Closure Requirements
  - a. Manufacturer: Preformed Line Products or submitted and owner-approved equivalent.
  - b. Provide an inline, re-enterable copper cable closure.
    - 1) Metallic stainless steel.
    - 2) Finish shall be non-corrosive in all intended environments (see Drawings).
  - c. Re-enterable without the need for special re-entry kit.

### 2.14 RELAY RACKS

- A. Manufacturer: Cooper B-Line or submitted and owner-approved equivalent.
- B. Seven-foot double-sided, high cable density style relay rack shall comply with following specifications:
  1. 19" rack width
  2. Double-sided universal mounting spacing
  3. #12-24 panel mounting holes
  4. Conformance to EIA-310-D
  5. Twin 2" x 2" top angles
  6. Self squaring with tapped assembly holes

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7. Material: 6061-T6 aluminum alloy
  8. Finish: Telco Gray Powder Coat
  9. Part number SB-556-084-19-U6TG
  10. Isolation kit for mounting
- C. To be provided and installed in the MDF switch room as indicated in the Drawings.
- 2.15 FREESTANDING VERTICAL EQUIPMENT CABINETS
- A. Manufacturer: DAMAC Products, Inc. Axis Cabinet with Flo-Trac rear door ventilation system or submitted and owner-approved equivalent.
- B. General
1. The work covered here consists of the furnishing of all necessary labor, supervision, materials, accessories, parts, equipment, and services to provide and install a complete freestanding equipment cabinet.
  2. The standard freestanding equipment cabinets are defined to include, but not limited to, cabinet frames, cabinet front and rear doors, top and side panels.
  3. All internal cabinetry hardware shall be 19-inch rack mountable.
  4. Provide and install freestanding vertical cabinets, with hinge placement as indicated in the Drawings.
- C. Standard-sized Vertical Cabinets: DAMAC part number CCD84Z20028-3-Fx-Bx (F = front door; B = back door; x = "R" for cabinet door right hinge and "L" for left hinge). Shall comply with the following specifications.
1. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
  2. Cabinet Frame
    - a. DAMAC part number F84Z200028-3
    - b. Dimensions: 84"H x 30"W x 30"D
    - c. Each frame shall include four adjustable 19" EIA mounting rails tapped #12-24.
    - d. Frame assembly to include two three-inch wide dedicated cable compartments located each side between mounting rails and frame.
      - 1) Cable compartments shall run full depth and height of frame.
      - 2) Three horizontal cable trays (19" length x 3 ½" deep x 3" wide) shall be mounted equally spaced, between mounting rails and frame.
      - 3) Each cable tray shall have three 2 ½" holes (with grommet) aligned with top knockouts to provide vertical cable access.
      - 4) Each cable compartment shall contain two adjustable Cable-Trac vertical cable managers located front and rear each side of cabinet. Each vertical manager shall have six adjustable cable rings 3" x 4". Each ring shall rotate and adjust 360 degrees and lock in any position.

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- e. Frame Color: Black epoxy powder coat
  - f. 16 Ga. Tubular steel (1" x 1" min), S/M parts, 16 Ga. CRS construction
  - g. All welded construction, shipped fully assembled
  - h. Four adjustable leveling feet
  - i. Frame bottom shall have 11Ga. weld-in floor mounting gussets in each corner
  - j. Bottom side kick plates with knockouts for power and ground conduit access
  - k. Rear kick plate with power receptacle J-box mounting bracket
  - l. Ganging hardware
  - m. Anchoring hardware
  - n. Grounding hardware
  - o. 1200 lb. Capacity
3. Mounting rails shall have rack unit labels.
4. Cabinet Door – Front
- a. DAMAC part number DC8430Vx-3, where x is hinge placement right (R) or left (L) as indicated in Cabinet Layout Drawings.
  - b. Dimensions: 84"H x 30"W
  - c. Vented perimeter sheet metal with flame retardant ¼" thick smoked Plexiglas center. Tubular steel perimeter reinforcement for strength and security.
  - d. Each door shall have three easy lift-off security hinges allowing door to open 135 degrees+ for aisle access.
  - e. Heavy duty compression type latching system with keyed lock
  - f. Door shall not interfere with usable interior space and shall have 3/16" perimeter venting.
  - g. High quality 16 Ga. CRS construction
  - h. Keyed-locking door mechanism
  - i. Door color: Black epoxy powder coat
5. Cabinet Door – Rear
- a. DAMAC part number DC8430Hx-3, where x is hinge placement right (R) or left (L) as indicated in Cabinet Layout Drawings.
  - b. Dimensions: 84"H x 30"W
  - c. Full mesh with tubular steel perimeter reinforcement for strength and security.
  - d. Each door shall have three easy lift-off security hinges allowing door to open 135 degrees+ for easy aisle access.
  - e. Door shall be prepared for FLO-TRAC fan ventilation kit (#3AD3FTK30).
  - f. Color: Black epoxy powder coat
  - g. 16 Ga. CRS construction
  - h. Top and bottom quick release hinge design
  - i. Heavy-duty compression type latching system with keyed lock
6. Side Panels

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- a. DAMAC part number SC8430M-3
  - b. Dimensions: 84"H x 30"W
  - c. Color: Black epoxy powder coat
  - d. 18 Ga. CRS construction
  - e. Perforated with three cable knockouts
  - f. Recessed key locking type
7. Top Panel
- a. DAMAC part number TA3030V-3
  - b. Vented top panel with cable access and two, fan-ready grill guards.
  - c. Eight 3" diameter cable access knockout holes with knockout plate in place and grommet material for all holes.
  - d. One-inch and 1 ½" knockouts on left side (facing rear) for top power conduit access, with knockout plate in place and grommet material for all holes
8. Fan Assembly – Universal top, or rear door fan assembly kit as shown in Drawings:
- a. DAMAC part number 3AD3FTK30
  - b. 220 CFM AC fan assembly kit
  - c. Rated at 110 Volt, 60 Hz
  - d. All standard size cabinets shall be provided with one rear door fan assembly – installed on the upper fan mounts of rear door.
  - e. Eight foot power cord, plugged into upper power strip in cabinet
  - f. Additional fan assemblies (in some cases) – refer to cabinet layout drawings
9. Power Strip – Provide and install two power strips in each vertical cabinet, as shown in Drawings:
- a. DAMAC part number 9D4419GM311T
  - b. 20 amp, 19" Rack-mountable (horizontal mounting)
  - c. Ten-foot cord length - Male plug shall be a standard 20 amp and shall match the cabinet bottom side kick plate duplex receptacle plug
  - d. Provide with four outlets on front and four outlets on back.
  - e. Provide with surge protection.
  - f. Provide with lighted on/off switch.
  - g. Install one at the top of the cabinet frame and one in the center of the cabinet frame.
10. Grounding Bus Bar-
- a. DAMAC part number AGRB019
  - b. Copper construction, 19" rack-mountable ground bus bar with six 10/32 tapped mounting holes
11. Top mount power and ground conduit kit – Provide, as necessary, power/ground conduit kit.
- a. DAMAC part number AFPSK9
  - b. Kit includes:

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- 1) One 1" insulated flex conduit 8' long with top and bottom mounting fittings and restraint hardware to feed the cabinet duplex power receptacle
  - 2) One 1" insulated flex conduit 8' long with top and bottom mounting fittings and restraint hardware – to feed the cabinet ground bus bar
  12. Cabinet Coupler Kit, Axis Top Access – DAMAC part number ATMCK2-3
  13. Floor Mounting Kit with 3/8" bolts and concrete anchors – DAMAC part number ARRFCK-38
  14. Isolation kit for floor isolation
- D. Large Size Cabinet – same characteristics as standard size cabinet, except the following:
1. Dimensions: 84"H x 30"W x36"D
  2. Cabinet Frame Dimensions: 84"H x 30"W x36"D
  3. Side Panel Dimensions: 84"H x 36"W
  4. Use only where indicated in Drawings.
- E. Standard Cabinet to match existing in MDF
1. Use where indicated in MDF Drawings to ensure fit in existing bays.
  2. Cabinet Frame
    - a. Cooper B-Line part number E2-FO-842930-19-24-BL or submitted and owner-approved equivalent
    - b. Dimensions shall be 84"H x 29"W x30"D
    - c. EIA Mounting: 19 inches
    - d. Frame Color: Black
    - e. 16 Ga. (1.5mm) CRS construction
    - f. All welded construction
    - g. Four adjustable leveling feet
    - h. Supplied with two pair of tapped (#12-24) mounting rails
    - i. Removable cable entry panels on base (sides and back)
  3. Cabinet Door – Front
    - a. Cooper B-Line part number E2-PD-SG-8429-xx-BL, where xx is hinge placement right (RH) or left (LH) as indicated in Drawings, or submitted and owner-approved equivalent.
    - b. Dimensions: 84"H x 29"W
    - c. Smoked Plexiglas removable locking door
    - d. High quality 16 Ga. (1.5mm) CRS construction
    - e. Top and bottom quick release hinge design
    - f. Keyed-locking door mechanism
    - g. 1/4" (6mm) thick smoked Plexiglas
    - h. Door color: Black
  4. Cabinet Door – Rear

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- a. Cooper B-Line part number E2-SD-FP-8429-xx-BL, where xx is hinge placement right (RH) or left (LH) as indicated in Drawings, or submitted and owner-approved equivalent
  - b. Dimensions: 84"H x 29"W
  - c. Full-perforated removable door
  - d. Color: Black
  - e. 16 Ga. (1.5mm) CRS construction
  - f. Top and bottom quick release hinge design
  - g. Keyed-locking door mechanism
5. Side Panels
- a. Cooper B-Line part number E2-SP-FP-8430-BL or submitted and owner-approved equivalent
  - b. Dimensions: 84"H x 30"W
  - c. Color: Black
  - d. 18 Ga. (1.2mm) CRS construction
  - e. Full-perforated
  - f. One-touch lift-off design
  - g. Keyed-locking panel mechanism
6. Top Panel
- a. Cooper B-Line part number E2-TP-P-BL or submitted and owner-approved equivalent
  - b. Perforated top panel with cable access and fan
  - c. Four three-inch cable access holes (one in each corner as shown in Drawings) with protective grommets and hole cap covers
7. Fan Assembly – Provide and install fan assembly with the following specifications in each cabinet top panel, as shown in Drawings:
- a. Cooper B-Line part number E2-FA-TM-500-AC or submitted and owner-approved equivalent
  - b. 500 CFM AC top mount fan assembly
  - c. Rated at 110Volt, 60 Hz, .037 FLA
  - d. Six-foot (6') grounded power cord, plugged into upper power strip in cabinet
8. Power Strip – Provide and install one power strip in each compartment. Power strips shall comply with specifications set forth in Paragraph 2.15.C.9 above.
9. Cable Management Ring – Provide and install on front, rear and sides of all cabinets, as shown in Drawings.
- a. Cooper B-Line part number E2-MA-CMR2 or submitted and owner-approved equivalent
  - b. Metallic material
  - c. Spaced 12 inches (12") apart
10. Ground bus bar – Provide and install ground bus bar in each cabinet
11. Isolation Kit for floor isolation

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- F. Co-location Cabinet – three compartment: DAMAC part number CC-RB-3-842430-XX. Shall comply with the following specifications.
1. Dimensions: 84"H x 24"W x 30"D
  2. Each frame shall include six 19" EIA mounting rails untapped.
  3. Cabinet shall have three compartments with two divider shelves.
  4. Frame construction shall be of fully welded 16 gauge tubular steel.
  5. Frame shall have four adjustable levelers.
  6. Frame bottom shall have four weld-in floor-mount gussets.
  7. Frame shall be capable of supporting 1000 pounds of equipment.
  8. Cable routing to top of cabinet shall be in a 2" x 2" rear duct and shall be secure in each cabinet.
  9. Cabinet shall have a ventilated base frame.
  10. Front doors: Custom 1/3 door, Plexi-glass, right hinge placement
  11. Rear doors: Custom 1/3 door, louvered, right hinge placement
  12. Side panels shall be fully perforated.
  13. Mounting hardware shall be included.
  14. Each compartment shall be supplied with Master lock combination change-list (five combinations).
  15. Provide and install one power strip in each compartment. Power strips shall comply with specifications set forth in Paragraph 2.15.C.9.
  16. Mounting rails shall have rack unit labels.
  17. Isolation kit for floor isolation
- G. Co-location Cabinet – two compartment: DAMAC part number CC-RB-2-842430-XX. Shall comply with the following specifications.
1. Dimensions: 84"H x 24"W x 30"D
  2. Each frame shall include six 19" EIA mounting rails untapped.
  3. Cabinet shall have two compartments with one divider shelf.
  4. Frame construction shall be of fully welded 16 gauge tubular steel.
  5. Frame shall have four adjustable levelers.
  6. Frame bottom shall have four weld-in floor-mount gussets.
  7. Frame shall be capable of supporting 1000 pounds of equipment.
  8. Cable routing to top of cabinet shall be in a 2" x 2" rear duct and shall be secure in each cabinet.
  9. Cabinet shall have a ventilated base frame.
  10. Front doors: Custom 1/2 door, Plexi-glass, right hinge placement
  11. Rear doors: Custom 1/2 door, louvered, right hinge placement
  12. Side panels shall be fully perforated.
  13. Mounting hardware shall be included.
  14. Each compartment shall be supplied with Master lock combination change-list (five combinations).
  15. Provide and install one power strip in each compartment. Power strips shall comply with specifications set forth in Paragraph 2.15.C.9.

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16. Mounting rails shall have rack unit labels.
  17. Isolation kit for floor isolation
- H. Co-location Cabinet – two compartment: DAMAC part number CC-RB-3-843030-XX. Shall comply with the following specifications.
1. Dimensions: 84"H x 30"W x 30"D
  2. Each frame shall include six 19" EIA mounting rails untapped.
  3. Cabinet shall have three compartments with two divider shelves.
  4. Frame construction shall be of fully welded 16 gauge tubular steel.
  5. Frame shall have four adjustable levelers.
  6. Frame bottom shall have four weld-in floor-mount gussets.
  7. Frame shall be capable of supporting 1000 pounds of equipment.
  8. Cable routing to top of cabinet shall be in a 2" x 2" rear duct and shall be secure in each cabinet.
  9. Cabinet shall have a ventilated base frame.
  10. Front doors: Custom 1/3 door, Plexi-glass, right hinge placement
  11. Rear doors: Custom 1/3 door, louvered, right hinge placement
  12. Side panels shall be fully perforated.
  13. Mounting hardware shall be included.
  14. Each compartment shall be supplied with Master lock combination change-list (five combinations).
  15. Provide and install one power strip in each compartment. Power strips shall comply with specifications set forth in Paragraph 2.15.C.9.
  16. Mounting rails shall have rack unit labels.
  17. Isolation kit for floor isolation
- I. Cabinet Accessories – provide and install as indicated in cabinet layouts in the Drawings.
1. Fixed shelf for standard (30"D) cabinets
    - a. Perforated
    - b. Adjustable shelf mounting brackets
    - c. 19" rack mountable
    - d. Black in color
    - e. 125 lb. load rating
    - f. DAMAC part number SH1929-3
  2. Fixed shelf for large (36"D) cabinet
    - a. Solid
    - b. Adjustable shelf mounting brackets
    - c. 19" rack mountable
    - d. Black in color
    - e. 200 lb load rating
    - f. DAMAC part number SH1929H-3
  3. Keyboard shelf with mouse pad

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- a. Black in color
- b. 19" rack mountable
- c. DAMAC part number SH19KMM-3
4. Document drawer
  - a. Manufacturer – Cooper B-Line or submitted and owner-approved equivalent
  - b. 5" deep
  - c. 100 lb. capacity
  - d. 19" rack mountable
  - e. Black in color
  - f. B-Line part number for standard (30"D) cabinets is E2SHDRW19245B.
  - g. B-Line part number for large (36"D) cabinet is E2SHDRW19305B.

### 2.16 WALL BACKBOARDS

- A. All walls in telecommunication rooms (MDF/SDF's, Tenant etc.) will be covered with  $\frac{3}{4}$  inch plywood from finished floor to a height of 8 feet. Plywood to be covered with 2 coats of fire retardant paint. Plywood is to be free of voids and to be installed in 4 x 8 sheets.

### 2.17 LABELS AND LABELING SYSTEM

- A. Manufacturer: Brady Corporation or submitted and owner-approved equivalent.
- B. Labeling system shall consist of a hand-held portable thermal transfer printer, Brady part number TLS2200, or submitted and owner-approved equivalent. The printer shall be used in conjunction with the label parts specified below.
- C. Cabinets and fiber termination hardware (cover): General purpose label designed for powdered coated surfaces, trade name, "Mondo Bondo", Brady part number PTL-42-483 (1.00 X continuous) used with an R6010 ribbon.
- D. Fiber termination hardware (designation strip): Thermal transfer printable label with a permanent acrylic adhesive, Brady part number PTL-10-423 (.75 X .25) used with an R6010 ribbon.
- E. Patch panels: Gloss white film with a permanent acrylic based adhesive, Brady part number PTL-39-422 (.375 X .60) used with an R6010 ribbon.
- F. 110 Copper termination hardware: Laser printable, non-adhesive label designed for 110 terminal block marking, Brady part number LAT-177-124 (available in various colors).

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- G. Modular Faceplate (M14L): Highly durable, non-adhesive, polypropylene tag stock used for thermal transfer printing of faceplate designation strip, Brady part number PTL-40-412 (1.938 x .375) used with an R6210 ribbon.
- H. Horizontal cabling, patch cords, inside copper and low pair count (12 strands or less) fiber optic cable: Permanent acrylic adhesive, self-laminating vinyl wire and cable identification, Brady part number PTL-31-427 (1.00 X 1.50 X .50) used with an R4310 ribbon.
- I. Outside plant copper cable: Permanent acrylic adhesive, self-laminating vinyl wire and cable identification, Brady part number PTL-34-427 (1.50 X 6.00 X 1.50) used with an R4310 ribbon.
- J. Outside and outside plant fiber cables: Permanent acrylic adhesive, self-laminating vinyl wire and cable identification, Brady part number PTL-33-427 (1.50 X 4.00 X 1.00) used with an R4310 ribbon.
- K. All labels shall be permanent, i.e. will not fade, peel, or deteriorate due to environment or time.
- L. All cables labels at both termination ends shall be covered with a clear heat shrinkable tubing.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Verify raceways, boxes, hand holes and maintenance holes are properly installed following Sections 17130, and 17140.
- B. All communication media must be installed in conduit or cable tray unless an alternate method has been approved by HAS/IT.
- C. Verify horizontal conduit is minimum 1-inch diameter.
- D. Verify backboards are properly installed.
- E. Verify telecommunications grounding system is properly installed and tested following Section 17165.
- F. Verify liquid-carrying pipes are not installed in or above voice and data system IDFs. Do not proceed with installation in affected areas until removed.

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### 3.02 PREPARATION

- A. Environmental controlled communication rooms shall maintain temperature of between 64 degrees Fahrenheit and 78 degrees F and between 30 and 55 percent humidity in areas of voice and data system work.
- B. Cable Splicing: Exact cable routing, splice enclosure locations, distances, elevations, work space and purpose of splice will be governed by actual field conditions. Contractor shall perform field surveys prior to submitting layout drawings.
- C. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

### 3.03 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data are included on the drawings.
- B. All installation shall be done in conformance with ANSI/TIA/EIA 568B standards, BICSI methods, Industry standards and SYSTIMAX SCS installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- C. The SCS installation shall comply with all applicable national and local codes pertaining to low voltage cable system installations.
- D. The contractor shall adhere to the installation schedule of the general contractor and shall attend all construction meetings scheduled by the general contractor.
- E. Upon structural completion of the communications room(s) and prior to the installation of any communications equipment or supporting devices inside the room, the City Engineer shall consult the Communications Designer in order to:
  - 1. Perform construction administration activities to compare as-built configuration to the design.
  - 2. Observe all "not-to-design" compliance issues and issue corrective advisement of actions.
  - 3. Upon completion of 1 and 2 above, the Communications Designer shall mark with masking tape the general layout of the equipment placement.

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4. Upon completion of 3 (above) by the Communications Designer, the Contractor shall prepare the communications room by stenciling equipment position in accordance with Appendix B.
- F. Vertical Cabinet Installation
1. All Cabinets shall be properly positioned, leveled, ganged, anchored, grounded and powered.
  2. All Cabinets shall be populated as noted in drawings with termination hardware, equipment, proper patch cord lengths, and power outlets.
  3. Install and anchor all vertical equipment cabinets to floor following the Drawings and manufacturer's instructions.
  4. All cabinets shall be properly ganged in each bay as shown in the Drawings.
  5. All cabinet doors shall be configured as shown in the Drawings.
  6. All cabinets shall be properly labeled with permanent typewritten labels, easily visible from finished floor. Label as indicated in Drawings.
  7. After final acceptance of the cabinets, coordinate with Owner to replace key/lock with silver barrel on front and back doors.
- G. Cable Splicing
1. Splicing optical fibers shall be accomplished with the fusion method only; mechanical splices are not allowed.
  2. Copper splicing shall be accomplished using 3M MS<sup>2</sup> modules.
  3. Copper splicing shall be done using the fold-back method.
  4. All closures and splice cases shall be installed according to the manufacturer's installation procedures.
  5. All closures and splice cases shall be "flash tested" to ensure they are properly sealed.
  6. All splicing work and splicing hardware shall comply with the following:
    - a. Cables shall be neatly routed and properly secured.
    - b. Minimum bending radius for fiber and copper cables shall not be exceeded.
    - c. Closures shall be properly mounted and secured.
  7. All closures, entry and exit cabling shall be labeled with permanent typewritten labels, easily visible from the finished floor.
- H. The contractor shall perform all required cross connections of the horizontal cable runs to the backbone cable system. The equipment connections to the voice and data systems shall be performed by the vendors installing and/or maintaining those systems.
- I. The contractor shall provide service loops (slack) for cables terminating in the IDFs. A 6-foot service loop shall be provided above the access ceiling or cable trays unless specified otherwise. This allows for future changes or expansion without installing new cables.

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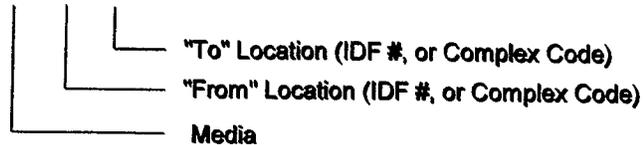
- J. The installation contractor shall be responsible for coordination, testing and problem resolution with the system vendors.
- K. Label cable terminations on designation strips. Coordinate numbering with the City's automated cable management system as shown in Paragraph 3.03.L below.
- L. Cable labels shall be placed in the following locations: on jack face plates, on cable inside back boxes, junction boxes, access points, maintenance holes, and hand holes, on cable above the terminations in the IDF and MDF, on patch panels, and every 50 feet when not in conduit. Refer to 2.16 in this section to determine label type for each component. Cable labeling scheme shall be as follows. "IDF #" refers to permanent room number as shown in the Graphics/Signage Drawings.

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**Cable Labeling**

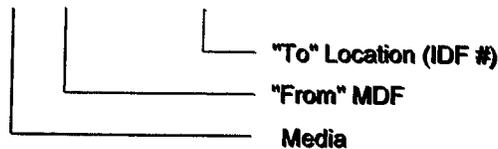
**Tie Cable:**

XXX-XX>XX



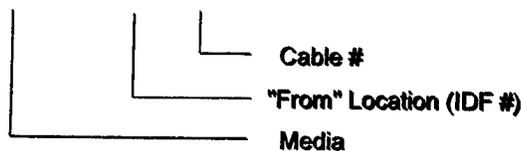
**Riser Cable:**

XXX-MDF>IDF XXXXX



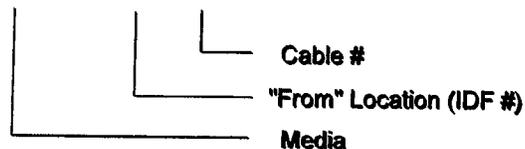
**Horizontal Cable:**

XXX-IDF XXXXX-XXX



**Jack/Outlet Labeling:**

XXX-IDF XXXXX-XXX



**Media:**

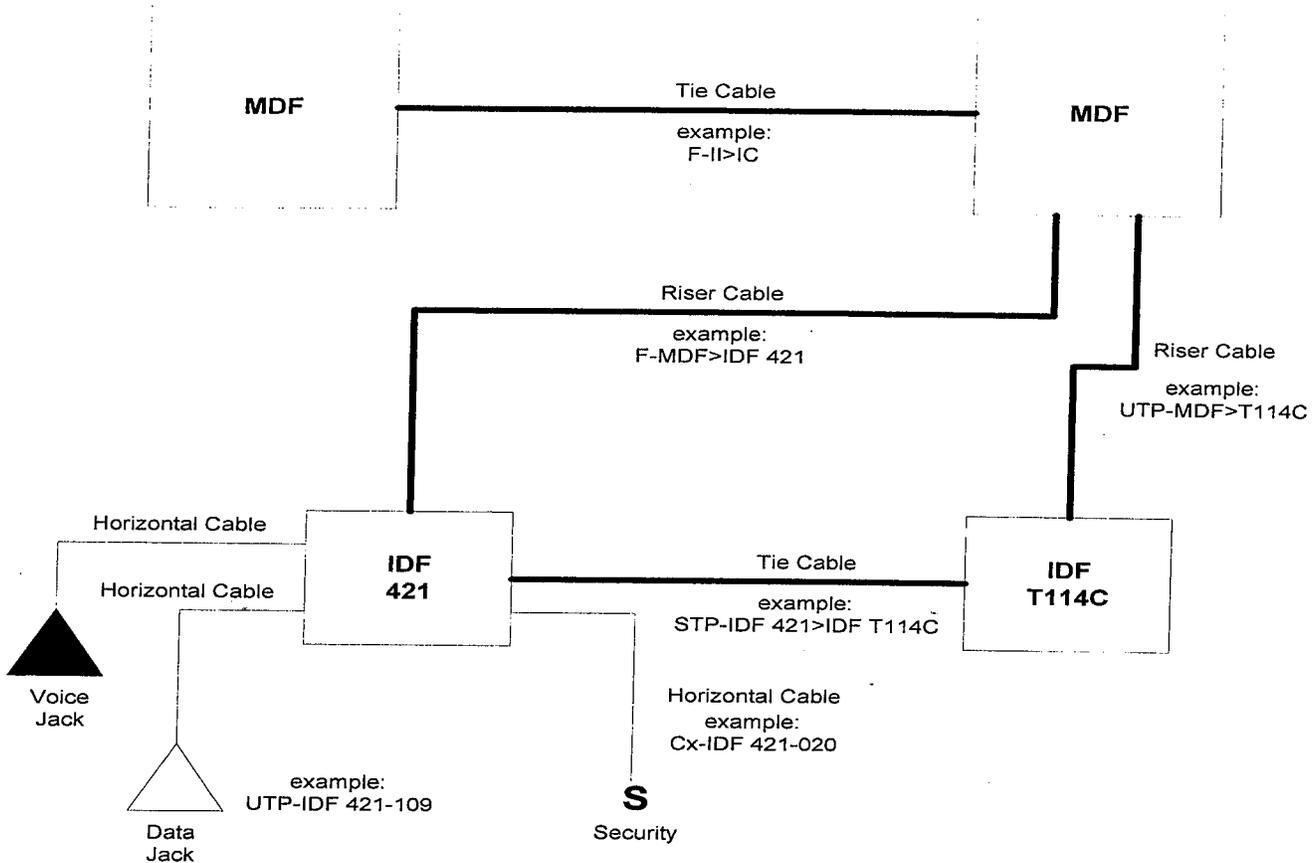
- F Fiber Optic
- UTP Unshielded Twisted Pair (Copper)
- STP Shielded Twisted Pair (Copper)
- Cx Coaxial (Copper)

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- M. Conduits and junction boxes shall be labeled in accordance with conduit labeling requirements set forth in Section 17130.
- N. City inspector or their designated representative shall randomly perform unannounced, on-site reviews during the installation. In addition, this person shall perform a final inspection and a complete review of the test results before the installation is accepted.
- O. Upon completion of the installation, Contractor shall prepare as-built documentation of the entire SCS. This documentation shall include:
  - 1. As-Built Drawings
    - a. All drawings shall be provided on disk in a form compatible with AutoCAD Version 14. A complete set of project plans will be provided to the Contractor on disk. The Contractor shall modify the drawings by placing the cable information on a separate layer. All of the requested drawings shall be placed on these plans so that all cable routes are to scale and

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- provide accurate information for use in the future when changes are made and the exact location of cables are required to avoid service interruptions.
  - b. A complete diagram of all terminations in the IDFs.
  - c. A complete diagram of all copper, fiber, and coax riser cable.
  - d. A complete diagram of all copper, fiber, and coax inter-building cable.
  - e. Floor plans showing exact cable routings with each outlet clearly marked with cable number.
  - f. A complete diagram of all cable tray, conduits and conduit sleeves.
2. Documentation
- a. All cable inventory data documentation shall be submitted in designated Microsoft Excel 2003 format, or ASCII, comma delimited files with fields in identical order so that data can be incorporated into existing databases.
  - b. Documentation on horizontal cable shall include cable number and length of cable.
  - c. Documentation on riser cable and inter-building cable shall include cable number, source and destination, type of cable, length of cable and number of pairs or fibers.
  - d. Complete cross connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.
3. As-built Drawings and Documentation shall be reviewed, approved and stamped by Contractor's on-site RCDD.

### 3.04 POST-INSTALLATION TESTING AND CERTIFICATION

#### A. Contractor Requirements

- 1. Contractor shall provide sufficient skilled labor to complete testing within a reasonable test period.
- 2. Contractor shall have a minimum of three years experience installing and testing structured cabling systems. All installers assigned by the Contractor to the installation shall be certified by the factory to install and test the provided products.
- 3. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.
- 4. Contractor is responsible for submitting acceptance documentation as defined in 3.04.D below. No cabling installation is considered complete until test results have been completed, submitted and approved as defined in 3.04.D below.

#### B. Test Procedure

- 1. City Engineer reserves the right to be present during any or all testing. Notify City Engineer at least 48 hours prior to beginning test procedures.

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2. Testing shall be of the Basic Link. However, Contractor shall warrant performance based on Channel performance and provide patch cords that meet channel performance.
  3. All cabling not tested strictly in accordance with these procedures shall be re-tested at no additional cost to the Owner.
  4. Testing of all copper and fiber wiring shall be performed prior to system(s) cutover.
  5. 100% of the installed cabling shall be tested. All tests shall pass acceptance criteria defined in 3.05 below.
  6. Cable testing shall be performed by a fully charged tester, and the charging unit shall be disconnected during testing.
  7. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor at no charge to the City. Complete end-to-end test results shall be submitted to the City.
- C. Standards Compliance and Test Requirements
1. Copper Cabling shall meet the indicated performance specifications:
    - a. Category 3 Riser Cabling – ANSI/TIA/EIA 568B.2 Category 3 Backbone Cabling
    - b. Category 6 Horizontal Cabling – ANSI/TIA/EIA 568-B.2-1 Category 6 Cabling and SYSTIMAX SCS GigaSpeed System.
  2. Fiber Optic Cable shall meet the indicated performance specifications:
    - a. ANSI/TIA/EIA 568-B.3 Optical Fiber Cabling Components Standard
  3. All test equipment used shall meet the performance specifications defined in 3.04.E. below.
- D. Cable Test Documentation
1. Test reports shall be submitted in hardcopy and electronic format and certified by the contractor's RCDD to be a complete and accurate record of cabling installed. Hand-written test reports are not acceptable.
  2. Hardcopy reports are to be submitted in labeled three-ring binders with an attached affidavit verifying passing execution of all tests. For large installations (greater than 300 pair copper and/or greater than 72 strand fiber), electronic reports with hardcopy summaries are preferred. Hardcopy summary reports shall contain the following information on each row of the report: circuit ID, test specification used, cable length, date of test, and pass/fail result.
  3. Electronic reports shall be submitted on 3.5-inch diskettes or CD format. If proprietary software is used, disk or CD shall contain any necessary software application required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., software to read these files is not required. Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of

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- the electronic report. Certificate shall reference traceable circuit numbers that match the electronic record.
4. Hardcopy and electronic reports for each cable route shall be submitted together in one submittal. The submittal description shall include the type of test performed, type of cable, and cable ID (including originating and terminating room numbers) of cable tested. Partial or unclear documentation will be returned without reviewing.
  5. Test reports shall include the following information for each cabling element tested:
    - a. Wiremap results that indicate that 100% of the cabling has been tested for shorts, opens, miswires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
    - b. For Category 3 cabling: Attenuation and NEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 to 16 MHz. Information shall be provided for all pairs or pair combinations and in both directions. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
    - c. For Category 6 cabling: Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards. Any individual test that fails the relevant performance specification shall be marked as a FAIL. Test shall also include mutual capacitance and characteristic impedance.
    - d. Length (in meters), propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
    - e. Cable manufacturer, cable model number/type, and NVP
    - f. Tester manufacturer, model, serial number, hardware version, and software version
    - g. Circuit ID number and project name
    - h. Autotest specification used
    - i. Overall pass/fail indication
    - j. Date of test
  6. Test reports shall be submitted within seven business days of testing.

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E. Test Equipment

1. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.
  - a. Category 6 – Wirescope 350 or submitted and owner-approved equivalent.
  - b. Category 3 copper backbone/riser – 3M Dynatel 965 DSP Subscriber Loop Analyzer with Far End Device or submitted and owner-approved equivalent.
  - c. Fiber Optic – Wirescope 350 or submitted and owner-approved equivalent.
2. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.
3. Test adapter cables shall be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable.
4. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.
5. Test equipment shall be capable of certifying Category 6 links.
6. Test equipment shall have a dynamic range of at least 100 dB to minimize measurement uncertainty.
7. Test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
8. Test equipment shall include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
9. Test equipment shall be capable of running individual NEXT, return loss, etc measurements in addition to autotests. Individual tests increase productivity when diagnosing faults.
10. Test equipment shall include a library of cable types, sorted by major manufacturer.
11. Test equipment shall store at least 1000 Category 6 autotests in internal memory.
12. Test equipment shall be able to internally group autotests and cables in project folders for good records management.
13. Test equipment shall include DSP technology for support of advanced measurements.
14. Test equipment shall make swept frequency measurements in compliance with TIA standards.
15. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
16. The Category 3 copper backbone/riser test equipment shall be capable of making frequency sweeps at an impedance of 135 Ohms at the following frequencies (kHz): 20, 30, 50, 69, 90, 110, 138, 276, 400, 600, 800, 1000, and 1100. A far-end device shall be used for all frequencies measurements. The loss at 138kHz shall

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- not exceed -46 dB. The test set shall have the ability to store 100 tests and be able to upload to a PC.
17. The Category 3 copper backbone/riser test equipment shall be able to measure resistance between the following conductors: tip to ring, tip to ground, ring to ground. All measurements shall be greater than 9999 mOhms.
- F. Optical Fiber Cable Testing w/ Optical Time Domain Reflectometer (OTDR)
1. Test all lightguide cable prior to the installation of the cable. Assume liability for the replacement of the cable should it be found defective at a later date.
  2. All fiber testing shall be performed on all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end to end OTDR trace performed per TIA/EIA 455-61. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode fibers and 1310 and 1550 for single mode fibers.
  3. Fiber links shall have a maximum loss of: (allowable cable loss per km)(km of fiber in link) + (.4dB)(number of connectors) = maximum allowable loss
  4. Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.
  5. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no charge to the City.
  6. End point locations.
  7. Test direction.
  8. Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
  9. Measured attenuation of the link segment.
  10. Acceptable link attenuation.
  11. Note: Horizontal Link Segments are limited to 90 meters; therefore, the acceptable link attenuation can be based on the longest installed link without introducing a significant error.
  12. Acceptable Attenuation Values
    - a. The general attenuation equation for any link segment is as follows:
      1. Acceptable Link Attn. = Cable Attn. + Connection Attn. + Splice Attn. + Coupled Power Ration (CPR) Adjustment.Note: A connection is defined as the joint made by mating two fibers terminated with remateable connectors (e.g. SC, LC).
    - b. 62.5µm Multimode Attenuation Coefficients
      - 1) Cable Attn. = Cable Length (km) × (3.40 dB/km@850nm or 1.00 dB/km@1300nm)
      - 2) Connection Attn. (SC connectors) = (Connections × 0.39 dB) + 0.42 dB
      - 3) Connection Attn. (LC connectors) = (Connections × 0.14 dB) + 0.24 dB

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- 4) Splice Attn. (CSL or Fusion) = Splices × 0.30 dB
- 5) CPR Adjustment – See table below:

Multimode Light Source CPR Adjustment					
	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5
Links with SC Connections	+ 0.50	0.00	- 0.25	- 0.50	- 0.75
Links with LC Connections	+ 0.25	0.00	- 0.10	- 0.20	- 0.30

c. **Coupled Power Ratio Measurement.** The Coupled Power Ratio of a light source is a measure of the modal power distribution launched into a multimode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multimode fiber produces a more over-filled condition and is classified as a lower category than a light source that launches more of its power into just the lower order modes producing an under-filled condition. Under-filled conditions result in lower link attenuation, while over-filled conditions produce higher attenuation. Therefore, adjusting the acceptable link attenuation equation to compensate for a light source's launch characteristics increases the accuracy of the test procedure.

d. **Procedure:**

- 1) CPR Test Jumper-1 shall be multimode, 1 - 5 meters long with connectors compatible with the light source and power meter and have the same fiber construction as the link segment being tested.
- 2) CPR Test Jumper-2 shall be singlemode, 1 - 5 meters long with connectors compatible with the light source and power meter.
- 3) Clean the test jumper connectors and the test coupling per manufacturer's instructions.
- 4) Follow the test equipment manufacturer's initial adjustment instructions.
- 5) Connect multimode test jumper-1 between the light source and the power meter. Avoid placing bends in the jumper that are less than 100 mm (4 inches) in diameter. See Figure 1.

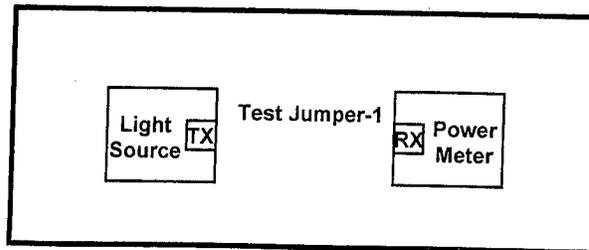


Figure 1

- 6) If the power meter has a Relative Power Measurement Mode, select it. If it does not, record the Reference Power Measurement ( $P_{ref}$ ). Note:

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If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.

- 7) Disconnect test jumper-1 from the power meter. Do NOT disconnect the test jumper from the light source.
- 8) Connect jumper-2 between the power meter and test jumper-1 using the test coupling. The singlemode jumper should include a high order mode filter. This can be accomplished by wrapping the jumper three times around a 30 mm (1.2 inches) diameter mandrel. See Figure 2.

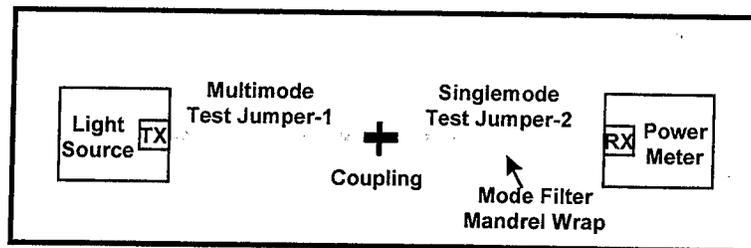


Figure 2

13. Record the Power Measurement ( $P_{sum}$ ). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR value. If the meter does not have a Relative Power Measurement Mode, perform the following calculation:

If  $P_{sum}$  and  $P_{ref}$  are in the same logarithmic units (dBm, dBu, etc):

$$CPR (dB) = | P_{sum} - P_{ref} |$$

If  $P_{sum}$  and  $P_{ref}$  are in watts:

$$CPR (dB) = | 10 \times \log_{10} [P_{sum}/P_{ref}] |$$

### 3.05 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and City Engineer is satisfied that all work is in accordance with contract documents, the City Engineer will notify Contractor in writing of formal acceptance of the system.
- B. Acceptance Requirements
  1. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified under 3.04.C. "Standards Compliance & Test Requirements" above.
  2. City reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent of the cable plant to confirm documented results. Random re-testing, if performed, shall be at the expense of the City, using standard labor rates. Any failing cabling shall be re-tested and restored to a passing condition at no cost to the City. In the event more than two percent of the

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cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.

3. City Engineer may agree to allow certain cabling runs to exceed standardized performance criteria (e.g. length). In this event, such runs shall be explicitly identified and excluded from requirements to pass standardized tests.
4. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and submittal and approval of full documentation as described in 3.04.D.

### 3.06 DEMOLITION

- A. The contractor shall be responsible for maintaining voice and data communications service to areas of the building scheduled to remain in service during the period of renovation.
- B. Notify HAS Information Technology (IT) department 30 days prior to the start of demolition work taking place in existing communications rooms. Coordinate removal of equipment and cabling within existing communications rooms with HAS IT.
- C. Where removal is indicated in Drawings, remove communications cable from termination point back to originating communications room, MDF or tenant communications room. Coordinate removal at terminating blocks and panels with HAS IT. Coordinate removal of cross-connects and patch cables with HAS IT.
- D. Ensure systems and circuits are no longer active before removing and prior to the demolition of existing communications rooms. If active circuits exist at time of scheduled demolition, coordinate with City Engineer to reroute or deactivate circuit(s).
- E. Demolition and removal of cabling shall not impact the operation of active systems.
- F. Unless otherwise noted, discard all removed cable, patch cables and cross-connects. Except where re-routing of cable is specified in Drawings or by Designer, do not reuse cable.

### 3.07 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

END OF SECTION

**COMMUNICATIONS MEDIA INFRASTRUCTURE**

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### APPENDIX B

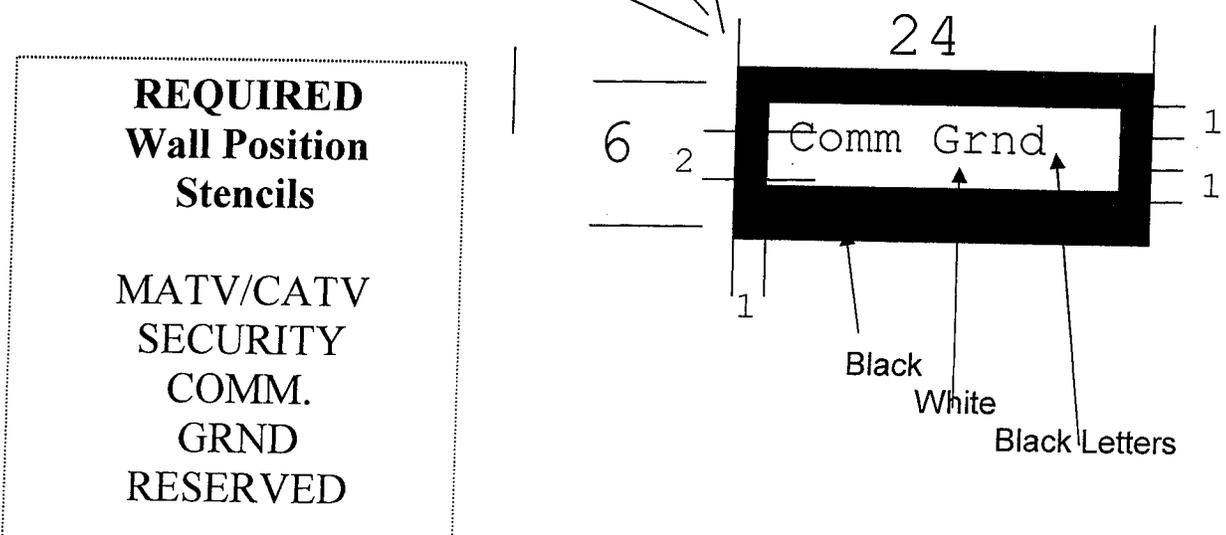
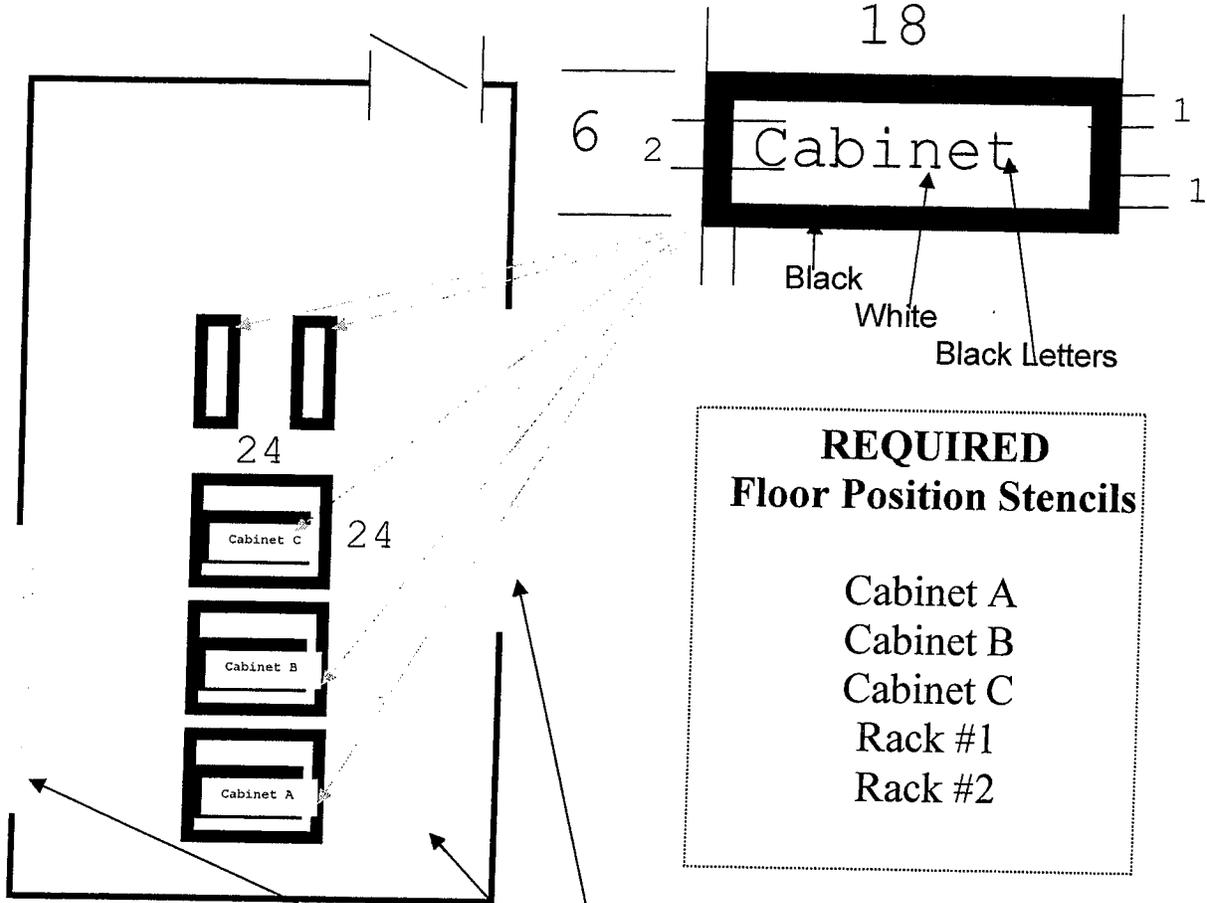
The following page is an example of Communications Room markings prior to equipment installation. (See Room Details in communications drawing set.) Communications Designer shall verify room/equipment layouts. Floor position stencils shall be placed in center of cabinet/rack location. Wall-position stencils shall be placed in center of area at 48" A.F.F.

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END OF APPENDIX B

**SPEC 17130 INTERIOR COMMUNICATION  
PATHWAYS**

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### SECTION 17130 INTERIOR COMMUNICATION PATHWAYS (REV. 07/2006-JAB)

#### PART 1 GENERAL

##### 1.01 PROJECT SCOPE SUMMARY

*Designer shall provide a detailed narrative of the tasks to be performed under this specification sections.*

##### 1.02 SECTIONS INCLUDES

- A. This section includes specifications for the installation of interior communications pathways.
- B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.
- C. Interior Communication Pathways are defined to include, but are not limited to innerduct, conduit, pull boxes, cable hooks, cable trays, supports, accessories, associated hardware and fire stopping materials.

##### 1.03 REFERENCES

- A. Related Sections: *Designer to insert Specification sections as required by the project scope, examples:*
  - 1. Section 17120: Communications Media Infrastructure
  - 2. Section 17140: Exterior Communication Pathways
  - 3. Section 17165: Telecommunication Grounding and Bonding
- B. American National Standards Institute / Telecommunications Industry Association / Electronic Industries Alliance  
(ANSI/TIA/EIA): Most current standard revision
  - 1. 569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.
  - 2. 568-B, Commercial Building Telecommunications Cabling Standard
- C. Building Industry Consulting Services International (BICSI):
  - 1. Telecommunications Distribution Methods Manual
  - 2. Customer Owned Outside Plant Design Manual

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- D. National Electrical Manufacturers Association (NEMA).
    - 1. VE 1-1998 - Metallic Cable Tray Systems
    - 2. VE 2-2000 - Cable Tray Installation Guidelines
  - E. Underwriters laboratories (UL) Cable Certification and Follow Up program
  - F. American Society for Testing Materials (ASTM).
    - 1. ASTM B633 – specification for Electro-deposit Coating of Zinc on iron and Steel.
    - 2. ASTM A653 – Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process.
    - 3. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
    - 4. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability (Formerly ASTM A570 &A607)
    - 5. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A611)
  - G. National Electric Code (NEC).
  - H. Institute of Electrical and Electronic Engineers (IEEE).
  - I. Avaya SYSTIMAX SCS Zone Cabling Guidelines For 5 Products, Latest issue.
  - J. Avaya generic Specifications: Fiber Optic Outside Plant Cable, Latest issue.
  - K. International Standards Organization/International
  - L. Electromechanical Commission (ISO/IEC) DIS 11801
  - M. Conflicts:
    - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
    - 2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.
- 1.04 SUBMITTALS
- A. Submit plan and section drawings detailing proposed communication pathway routing prior to installation. Communication pathway installation plan to include but not limited:
    - 1. Room penetration plan.
    - 2. Communication pathway extension plan.
    - 3. Riser conduit anchoring plan.
    - 4. Conduit chase plan.
    - 5. Communication pathway labeling plan.
    - 6. Junction box, gutter and pull-box labeling plan.

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- B. Submit prototype test reports for all vault covers verifying conformance to the specification requirements in this document and HAS.
- C. Submit catalog data sheets of conduit, innerduct, raceway, cable tray, cable hook and associated hardware. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.
- D. Test Reports: Submit certified test reports indicating compliance with material reference standard indicated for material performance characteristics and physical properties of fire stopping materials
- E. Certificates: Submit product certificates, signed by manufacturer certifying materials comply with specified performance characteristics and physical properties of fire stopping materials.
- F. Copy of Building Industry Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for Contractor's on-site RCDD supervisor. RCDD to supervise all parts of communications installation at all times.
- G. Follow Section 01340.

### 1.05 QUALITY ASSURANCE

- A. Verify conduit, raceway, cable tray runs, etc do not interfere with existing or new systems within each facility.
- B. Fire stopping: Manufacturer trained and approved installer to perform fire stopping work who has specialized in the installation of work similar to that required for this project.
- C. Communication Pathway minimum Clearances:
  - 1. Motors or transformers: 4 feet
  - 2. Power cables and conduits: 1 foot parallel, 3 inches crossover
  - 3. Fluorescent lights: 5 inches
  - 4. Above ceiling tiles: 3 inches
  - 5. Access above cable tray: 12 inches
  - 6. Hot Flues, Steam pipes, Hot water pipes and other hot surfaces: at least 6"
- D. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.
- E. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- F. All installed materials and accessories shall be new from the manufacture. No used components will be accepted by HAS.

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- G. All Documentation submittals shall be reviewed by the supervising RCDD and stamped prior to submittal.
- H. Contractor Qualifications:
  - 1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
  - 2. ALL work shall be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, ANSI/TIA/EIA, UL, and NEC standards and codes. Contractor shall submit proof of RCDD designation.
- I. HAS retains the right to have access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at NO cost to HAS.
- J. All communication media will be installed in conduit or cable tray unless alternate method has been approved by HAS/IT.
- K. Follow Section 01450.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Where conduit, pull boxes, cable tray and other raceway sizes are not specifically shown on contract drawings. All communication pathways shall be sized in accordance with the requirements of BICSI and the NEC. No conduit shall be less than 1".
- B. All raceways shall be Intermediate Metal Conduit. Raceways installed in stud walls or above suspended ceilings shall be Electrical Metallic Tubing.

### 2.02 CONDUIT AND ACCESSORIES

- A. Manufactures:
  - 1. Allied
  - 2. Triangle
  - 3. Wheatland
- B. Intermediate Metal Conduit (IMC) shall be manufactured in accordance with UL 1242. Conduit shall be low carbon, hot-dipped galvanized inside and out, with threaded ends, 1" minimum size, 4 inch maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.

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- C. Electrical Metallic Tubing (EMT) shall be manufactured in accordance with UL 797 and ANSI C80.3. EMT shall be high-strength, zinc-coated, 1 inch minimum size. EMT may be used for sizes greater than 2" where physically protected. EMT shall not be utilized for service entrance conductors. Fittings shall be of same finish and material as tubing. Fittings shall be compression type with insulated throat.
- D. Expansion Joint Fittings: OZ type AX or Appleton type XJB, watertight, permitting two-way movement up to 4 inches, equipped with bonding jumpers around or through each fitting.
- E. Thruwall Sealing Fittings: Type WSK by O-Z Gedney Company.
- F. Fire-Seal Fittings: Type CFSI by O-Z Gedney Company.
- G. Sealing Material for Sealing Fittings: Chico X Fiberdam, and Chico A sealing compound, or Chico A-P interpak by Crouse-Hinds or Apelco sealing cement and fiber filler by Appleton.
- H. Insulated Bushings: Type B or SBT, as applicable, by O-Z Gedney or series B1900, series BU500 or series TC700, as applicable, by Steel City.
- I. Provide a measured pull tape in each empty conduit and innerduct.
- J. Thread lubricant/sealant shall be Crouse-Hinds type STL or T & B Kopr-Shield except, when required on joints for heat producing elements such as lighting fixtures, it shall be Crouse-Hinds type HTL.
- K. PVC Conduit shall not be used in intercommunication pathways. Except when encased in concrete.

### 2.03 INNERDUCT

- A. Manufacturers:
  - 1. Carlon
  - 2. Pyramid
  - 3. Or HAS approved equivalent
- B. Innerduct
  - 1. All fiber shall be installed in innerduct.
  - 2. One-inch corrugated, non-metallic innerduct.

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3. Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024.
4. Only manufacturer's fittings, transition adapters, terminators and fixed bends shall be used.
5. All empty innerduct will be populated with a measured pull tape.
6. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color from end to end (ex. Orange, Blue, Black and White). Do not couple innerduct of different colors without HAS approval.
7. All interior innerduct shall be plenum rated, unless installed in conduit.

### 2.04 CABLE TRAYS

#### A. Manufacturers:

1. B-Line
2. Cope

#### B. CABLE TRAY

1. Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
2. Materials and Finish: Material and finish specifications for each tray type are as follows:
  - a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
  - b. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties in accordance with ASTM A653 SS.
  - c. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray.
  - d. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.

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### 2.05 TYPE OF TRAY SYSTEMS

- A. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 or 12 inches on center. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and pass all tests in accordance with NEMA VE-1, section 5.4.
- B. Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4 inch rectangular holes punched along the width of the bottom.
- C. All tray sizes and types shall have a minimum of 4 inch usable load depth.
- D. All straight sections shall be supplied in standard 10 foot length, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
- E. Tray widths shall be 6, 12, 18, 24, or 36 inches. *Designer to specify width per the infrastructure needs.*
- F. All fittings must have a minimum radius of 12, 24, 36 or 48 inches. *Designer to specify minimum radius per the infrastructure needs.*
- G. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
  - 1. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1.
  - 2. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.

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- H. Cable Tray Support shall be placed so that the support spans do not exceed maximum span indicated on drawings or by the manufacturer. Supports shall be Trapeze style support. Cable trays installed adjacent to walls shall be supported on wall mounted brackets as specified by the manufacturer.
- I. Trapeze hangers shall be supported by 3/8 inch (minimum) diameter all thread rods.
- J. Accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.
- L. All cable tray components and accessories will be from the same manufacturer. Parts from different manufacturer will not be intermixed.

### 2.06 CABLE HOOK SYSTEMS

- A. Cable hooks shall have a flat bottom and provide a minimum of 1-5/8 inch cable bearing surface.
- B. Cable hooks shall have 90-degree radiused edges to prevent damage while installing cables.
- C. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.
- D. Cable hooks shall have a cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.
- E. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.
- H. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.
- L. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.
- M. All Cable Hook shall be supported with minimum 1/4" all thread with the appropriate fasteners.
- N. Cable Hooks must be approved by HAS/IT

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### 2.07 FIRESTOPPING MATERIALS

A. Manufacturers:

1. Johns Manville
2. Hilti
3. 3M

B. Description:

1. Performance requirements: Provide firestopping systems that are produced and installed to resist spread of fire according to requirement indicated, resist passage of smoke and other gases, and maintain fire resistance rating of assembly.
  - a. F-Rated Systems: in accordance with ASTM E 814
  - b. T-Rated Systems: in accordance with ASTM E 814
2. Fire stopping flame spread performance requirements: Provide products with flame-spread ratings of less than 25 and smoke development ratings of less than 50 as determined in accordance with ASTM E 84.
3. Fire Stopping UL performance requirements: Provide products with UL ratings specified for assembly indicated as determined in accordance with UL listings.

### 2.08 JUNCTION BOXES/PULL BOXES

- A. All pull boxes shall be constructed with a minimum of 14 gauge galvanized steel with an ANSI 61 grey polyester powder finish inside and out over phosphatized surfaces or galvanizes steel unless otherwise specified.
- B. All pull boxes shall have flat, removable covers fastened with plated steel screws with unique keyhole screw slots in the cover to permit removal of the cover without extracting screws unless otherwise specified.
  1. All removable box covers shall be connected to box with a safety strap or chain.
- C. All pull boxes shall provide the appropriate provisioning for grounding.

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- D. All pull boxes shall be NEMA Type 1 and sized according to the table below unless otherwise specified.

Maximum Trade Size of Conduit (inches)	Minimum Box Size (inches)			For Each Additional Conduit Increase Width (Inches)
	Width	Length	Depth	
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

### 2.09 WALL BACKBOARDS

- A. All walls in telecommunication rooms (MDF/SDF's, Tenant etc.) will be covered with  $\frac{3}{4}$  inch plywood from finished floor to a height of 8 feet. Plywood to be covered with 2 coats of fire retardant paint. Plywood is to be free of voids and to be installed in 4 x 8 sheets.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Raceways shall be mechanically and electrically connected to all boxes and fittings and shall be properly grounded per NEC.
- B. The routing and location of all conduits, cable tray, cable hooks and other raceways shall be coordinated with other trades prior to and during building construction to avoid delays and conflicts.
- C. Where raceways pass through walls, partitions and floors, seal penetrations to provide a neat installation which will maintain the integrity of the waterproofing or fireproofing, as

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applicable, of the structure. Coordinate installation requirements with roofing installer where conduits pass through the roof.

- D. All Raceways shall be run at least 6" from hot flues, steam pipes, hot water pipes and other hot surfaces.
- E. All raceways entering a building from underground shall be sealed to prevent water, moisture, gas, or any other foreign matter from entering the building. Service conduits shall be sealed in accordance with NEC 230-8.
- F. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and records drawings.
- G. Do NOT route communication pathways under HVAC condensing units.
- H. Expansion Fittings:
  - 1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
  - 2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceways systems

### 3.02 CONDUIT INSTALLATION

- A. IMC shall be installed with threaded fittings and couplings.
- B. All metallic couplings, connectors and fittings shall be malleable iron or steel and finished with zinc plating or by galvanizing.
- C. All conduits shall be plugged immediately upon installation to prevent the entrance of construction dirt and debris. All conduits shall be swabbed and cleaned before wires are pulled.
- D. Expansion fittings shall be utilized in all cases where conduits pass through building expansion joints. Fittings shall be of an approved weatherproof telescopic type permitting a movement of up to four inches and shall be provided with approved bonding jumpers around or through the fitting.
- E. Connection of Conduit to pull / junction Boxes and Enclosures:
  - 1. Connection to NEMA 1 type boxes and enclosures:
    - a. IMC: Install insulated bushings and double locknuts.

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- b. EMT: Install compression box connectors with insulated throats.
  2. Connection to NEMA 3R, 4, 4X, and 12 type boxes: Install insulated bushings and sealing locknuts or hubs.
  3. When conduits enter floor mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit. Bond bushings to ground bus using a conductor the same size as required for an equipment grounding conductor sized for the given circuit.
  4. Install sealing bushing within all conduits which have entered a building from outside, whether from above or below grade.
- F. Each Conduit route shall be installed with the least amount bends as possible. No section of conduit shall be longer than 30m (100 ft) or contain more than two 90 degrees bends (offset is considered to be a 90 degree bend) between pull points, pull boxes or reverse bends.
- G. The inside radius of bends in conduit shall be:
1. 6 times the internal diameter for 2" or less.
  2. 10 times the internal diameter for greater than 2".
- H. A measured pull tape shall be placed in all installed conduit.
- I. Any single conduit run extending from a TR shall not serve more than one outlets.
- J. All communications conduits shall be identified with color coded orange tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-box locations) with the origination and destination location.
- K. Conduit shall be reamed to eliminate sharp edges and terminated with an insulated bushing.
- L. Conduit protruding through the floor shall be terminated at a minimum of 3 inches above the floor surface.
- M. All stubbed conduit ends shall be provided with a ground bushing.
- N. All conduit penetrations shall be provided with the proper conduit sleeves.
1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
  2. Sleeves shall be installed in the communications room floor or ceiling a minimum of two to four inches on center from the wall.
  3. Conduit floor sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.
  4. Shall be installed in a single tier or row from left to right horizontally.

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- If two tiers or rows are required the conduits shall be staggered minimum of 2 inches between tiers.
5. Cable support anchors shall be installed 18 to 24 inches above the sleeves.
- O. All cable (horizontal, riser or backbone) wall or ceiling penetrations shall be provided with the proper conduit sleeves.
1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
  2. Sleeves shall be installed in the floor or ceiling a minimum of two to four inches on center from the wall.
  3. Sleeves shall be installed in the walls at a minimum of two inches extended on each side of the wall.
  4. Cable floor, ceiling and wall sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.
  5. Shall be installed in a single tier or row from left to right horizontally.
  6. If two tiers or rows are required the conduits shall be staggered minimum of 2 inches between tiers.
  7. Cable support anchors shall be installed 18 to 24 inches above the sleeves.
- P. All conduit and cabinet entrances shall be sealed with an approved, re-enter able sealant material to prevent ingress of water, dust or other foreign materials.
- Q. Conduit shall not be embedded in the required fire protective covering of a structural member that is to be individually encased in accordance with BOCA.
- R. Install all exposed conduit parallel or perpendicular to lines of existing construction and grouped together where possible, without interfering with use of premises or working areas. Prevent safety hazards and interference with operating and maintenance procedures.
- S. Conduit Sizing and supports:
1. Support conduit 2 inches and larger at 10 feet on center maximum, and conduit 1½ inch and smaller at eight feet on center maximum.
  2. Fasten 1½ inch and smaller conduit to concrete, masonry or steel with either one-hole malleable iron conduit straps, or "Korn" clamps, or U-bolts; for larger diameters, use two-hole straps. Use "clamp backs" for strapping conduits to planar surfaces.
  3. Multiple runs shall be supported on channel adequately secured to walls or hung from structure above with conduits fastened to channel with clamps designed for the purpose.
  4. Cable fill rates should not exceed 40% of the cross sectional area of the installed conduit.

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- T. Horizontal Conduit Routes:
1. Horizontal (station) conduit is defined as the conduit run between the communications outlet and the cable tray or communications room as indicated on Drawings.
  2. Each horizontal conduit run shall be a one-inch metallic conduit and shall be home run from each communications outlet box to the equipment room, terminating equipment or cable tray, as indicated in Drawings.
  3. Each route shall be installed with the least amount of conduit bends. Each single horizontal conduit run shall be provided with a junction or pull box every 30m (100 ft) or contain more than two 90 degrees bends (offset is considered to be a 90 degree bend).
  4. Each dual horizontal conduit run shall be provided with a junction or pull box every 30m (100 ft) or contain more than two 90 degrees bends (offset is considered to be a 90 degree bend). The quantity of conduits entering the junction or pull box shall equal the number of conduits exiting the junction or pull box.
  5. Each terminating (outlet end) conduit connection shall be provided with the proper connecting insulated bushing or fitting.
  6. Each originating end (communications room end) shall be provided with the proper connecting insulated ground bushing and properly bonded to ground.
- U. Horizontal conduit entrance in communications rooms – wall entry
1. Horizontal conduits shall enter the communications room wall 12 to 18 inches above the top of the cable tray. Maintain cable bend radius with supporting device as required.
  2. Conduit wall stubs shall be spaced in increments equal to the conduit outside diameter (OD) from each other.
  3. All conduit wall stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
  4. Conduit crossovers are not permitted.
- V. Horizontal conduit entrance in communications rooms – ceiling entry
1. Horizontal conduits shall enter or be extended from the equipment room ceiling 12 to 18 inches above the top of the cable tray.
  2. Ceiling conduit stubs shall be spaced in increments equal to the conduit OD from each other.
  3. All ceiling conduit stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
  4. Conduit crossovers are not permitted.
- W. Horizontal conduit entrance in communications rooms – floor entry
1. Horizontal conduits shall enter the communications room floor two inches to four inches on center from the wall and shall be stubbed 3 inches AFF.

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2. Conduit floor stubs shall be spaced in increments equal to the conduit OD from each other.
  3. Conduit crossovers are not permitted.
- X. Horizontal conduit to cable tray
1. Non-communications conduit shall NOT be attached to the cable tray in any fashion.
  2. Conduit terminating end shall be attached to cable tray side rail with "conduit-to-cable tray" clamps. No other form of attachment shall be permitted.
  3. Top or bottom cable tray conduit feeds and attachments are not permitted.
- Y. Horizontal Junction/Outlet Boxes
1. Each horizontal conduit shall be terminated into an outlet box.
  2. Each outlet box shall be a deep four-inch square junction box with a minimum of two one-inch knockouts on each of the sides.
  3. Each conduit home run shall be provided with a deep 4-inch square junction box (w/cover) at 100-foot intervals and six inches above each ceiling and wall intersection.
- Z. Riser conduit entrance in communications rooms – wall entry
1. Riser conduits shall enter the communications room wall a minimum of 24 inches above the top of the cable tray.
  2. Conduit wall stubs shall be spaced in increments to equal the conduit OD from each other.
  3. Riser conduits shall be installed in a single tier or row from left to right horizontally.
    - a. If two tiers or rows are required the conduits shall be staggered between tiers.
    - b. No more than two tiers or rows are permitted.
  4. All conduit wall stubs shall be extended to and over the cable tray to access cable tray pathway.
  5. All riser conduit stubs shall be provided with the proper universal drop-out/ waterfall cable exit runway, which shall be supported by and mounted to channel strut.
  6. Conduit crossovers are not permitted.
- AA. Riser conduit entrance in communications rooms – floor entry
1. Riser conduits shall enter the communications room floor two inches to four inches on center from the wall and shall stub up six inches AFF.
  2. Conduit floor stubs shall be spaced in increments to equal the conduit OD from each other.
  3. Riser conduits shall be installed in a single tier or row from left to right horizontally.
    - a. If two tiers or rows are required the conduits shall be staggered between tiers.
    - b. No more than two tiers or rows are permitted.

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4. Exiting cable shall be extended to the bottom of the cable tray and be provided with cable support anchors and secured with supporting hardware every six inches above the conduit bushings.
5. Conduit floor stubs shall be extended 2 to 4 inches from wall on center and 3 inches above AFF.
6. The riser cable shall be extended in the cable tray to the terminating equipment, as noted in the Drawings.
7. Conduit crossovers are not permitted.

### 3.03 Cable Tray Installation

- A. Cable tray shall be supported as follows:
  1. Where tray is suspended above equipment cabinets it shall be supported by a Trapeze type hanger and per manufacture instructions. In all other applications, the tray shall be supported by uni-strut trapeze type hangers affixed to the structure above via minimum 3/8-inch threaded rod.
  2. Threaded rod shall be fitted with a 6-inch long tube where it resides in cable tray to protect cables.
  3. Minimum of 12 inches of vertical clearance above all cable tray.
- B. Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.
- C. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.
- D. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions.
- E. A support must be place within 24 inches on each side of a connection or fitting.
- F. Maintain a minimum of 12 inches of clearance above cable tray for cable installation. Maintain a minimum of 3 inches between ceiling tile and cable tray support.
- G. Cable tray installation will be completed in one continuous run with no separations between sections.
- H. Vertical cable or ladder racks shall be used to route cable up and down the wall.

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- I. Dropout/Water Fall of the same make and size of the cable tray shall be used to route cables in or out of the tray.
- J. Matted "T" and elbows shall be used of the same make and size for all interchanges and directional changes

### 3.04 JUNCTION BOX/PULL BOX INSTALLATION

- A. Pull boxes shall be installed in sections of conduit that 100 feet or more in length, that contain more than two 90 degree bends, or that contain bends that are 180 degrees or more in the aggregate.
- B. A pull box shall NOT be used in lieu of a conduit bends.
- C. All pull boxes shall be installed in an easily accessible location with unobstructed entry to the pull box access panel.
- D. Pull boxes shall be supported on all four corners in such a manor that the pull box is not supported by the cable running through or conduit attached to the pull box.
- E. Horizontal Junction/Outlet Boxes
  - 1. Each horizontal conduit shall be terminated into an outlet box.
  - 2. Each outlet box shall be a deep four-inch square junction box with a minimum of two one-inch knockouts on bottom and each of the sides.
  - 3. Each conduit home run shall be provided with a deep 4-inch square junction box (w/cover) at 100-foot intervals and six inches above each ceiling and wall intersection.

### 3.05 CABLE HOOK INSTALLATION

- A. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.
- B. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.
- C. Spring steel cable hooks shall be capable of supporting a minimum of 100 pounds with a safety factor of 3 where extra strength is required.
- D. Cable Hook spacing maximum 4 feet on center.

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- E Maintain maximum cable sag between cable hooks of 12 inches
- F. Do not fill cable hook greater than manufactures recommended guidelines.
- G. J-Hook systems must be pre approved by HAS before installed

### 3.06 FIRESTOPPING MATERIAL INSTALLATION

- A. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instruction, and product carton instruction for installation.
- B. Verify substrate conditions are acceptable for product installation in accordance with manufacturer's instructions.
- C. Install fire stopping to comply with performance requirements specified herein.
  - 1. Install fire stopping to comply with listed fire rated assemblies in accordance with ASTM and UL requirements
  - 2. Installer shall be trained and approved by the manufacturer
- D. Protect installed products from damage during construction operations until final completions.
- E. Inspection: Code official or building inspectors to review proper installation using manufacturer guidelines.

**END OF SECTION**

**SPEC 17140 EXTERIOR COMMUNICATION  
PATHWAYS**

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### SECTION 17140 EXTERIOR COMMUNICATION PATHWAY (REV. 07/2006-JAB)

#### PART 1 GENERAL

##### 1.01 PROJECT SCOPE SUMMARY

*Designer shall provide a detailed narrative of the tasks to be performed under this specification section*

##### 1.02 REFERENCES

- A. Related Sections: *Designer to insert Specification sections as required by the project scope, examples:*
  - 1. Section 17130: Internal Communication Pathways
  - 2. Section 17165: Telecommunication Grounding and Bonding
  - 6. Section 17120: Communication Media Infrastructure
- B. Building Industry Consulting Services International (BICSI):
  - 1. Telecommunications Distribution Methods Manual
  - 2. Customer Owned Outside Plant Design Manual
- C. HS20 (AASHTO) highway Fatigue Loading
- D. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Association (ANSI/TIA/EIA):
  - 1. 569 Commercial Building Standard for Telecommunications Pathways and Spaces
  - 2. 758 Customer-Owned Outside Plant Telecommunications Cabling Standard
- E. Conflicts:
  - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
  - 2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

##### 1.03 SUBMITTALS

- A. Follow Section 01340.
- B. Submit plan and section drawings detailing proposed communication pathway routing prior to installation. Communication pathway installation plan to include but not limited:
  - 1. Room penetration plan.

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2. Communication pathway extension plan.
  3. Conduit chase plan.
  4. Duct bank pathway
- C. Submit calculations associated with sizing and arrangements of ducts and cables.
- D. Manufacturers' data: To include but not limited to part numbers, data sheets and detailed descriptions, for ALL proposed equipment and material.
- E. Submit a schematic with the COMM Vault/MH/HH duct bank layout showing the wall to wall, center to center and a MH butterfly detail down to individual innerduct assignments in AutoCAD.
- F. Submit plan and section drawings detailing proposed vault specifications.
- G. Copy of Building Industry Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for Contractor's on-site RCDD supervisor. RCDD to supervise all parts of communications installation at all times.
- 1.04 QUALITY ASSURANCE
- A. Follow Section 01450.
- B. Verify duct banks do not interfere with existing or new underground facilities. Follow Section 01726.
- C. Follow Appendix B of NEC.
- D. Assure that the "as installed" system is correct and complete per construction documents: including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- E. Contractor Qualifications:
1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
  2. ALL work shall be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC standards and codes. Contractor shall submit proof of RCDD designation.
- F. HAS retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

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### 1.05 SHIPPING AND HANDLING

- A. Follow Section 01450.
- B. Clearly mark containers "For Communication Material Only".

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Conduit Measuring Tape:
  - 1. Neptco
  - 2. Greenlee
  - 3. Garvin Industries
- B. Caution Tape:
  - 1. Reef Industries
  - 2. Repnet
  - 3. Panduit
- C. Maintenance/Hand Hole Covers
  - 1. Neehan Foundry
  - 2. Dabico Inc.
  - 3. Inland Foundry

### 2.02 MATERIALS

- A. Ducts: Schedule 40 rigid PVC following this section, with non-magnetic universal interlocking type spacers for both horizontal and vertical duct arrangements. Duct bank will be encased in concrete.
- B. Duct Spacers and Hardware: On all conduit arrays the contractor shall furnish and install a conduit spacer system as required to maintain uniform conduit spacing. The system shall consist of plastic spacers that interlock vertically and horizontally. A spacer assembly shall consist of base spacers, intermediate spacers and top spacers to provide a completely enclosed and locked in conduit assembly. Install spacers per manufacturer's instructions and provide at 5 foot intervals.

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- C. Plastic conduit and fittings shall conform to the requirements of Fed. Spec. W-C-1094 and shall be rigid PVC Schedule 40, with non-magnetic universal interlocking type spacers for both horizontal and vertical duct arrangements.
  
- D. Maintenance Hole (MH) shall be minimum 60" x 102" x 78" constructed with a minimum 5 inch thick concrete (or HAS approved equivalent).
  - 1. MH shall be pre-formed
  - 2. Include a minimum 12" sump drain
  - 3. Include a 1" knockout for ground rod connection
  - 4. Fitted with pulling irons at each end
  - 5. All MH internal components such as racking and ground strips shall be field installable and shall meet the requirements of ANSI/TIA/EIA, NEC, and HAS requirements.
  
- E. MH cover: Shall require a maximum 35-lb lift to open and close
  - 1. Shall be constructed of a lightweight composite material
  - 2. Cover and service lettering shall be abrasion, corrosion, and chemical resistant
  - 3. Door shall use a non-load bearing, internally mounted hinge mechanism and shall have a high visibility warning label affixed to the underside
  - 4. The cover shall be removable from the cover frame assembly
  - 5. A prototype test report for each cover style to be installed shall be submitted. The testing shall be conducted by an independent testing company and shall conform to the following:
    - a. Carry a proof load of 29,250 lbs applied at 150 psi without deformation or injury to the cover
    - b. Carry a maximum HS20 service load, applied at 100 psi for a minimum of 525,000 cycles without losing its service life
    - c. Carry a maximum HS20 service load applied continuously at 100 psi for twelve continuous hours without exhibiting an increase in residual deflection, as measured at the center of the cover, of more than 0.4% (0.004)
    - d. Covers have a modulus of elasticity of, at least, 3,500,000 psi, a flexural strength of 53,000 psi and a compressive strength of 62,000 psi.
  - 6. AOA covers to meet or exceed FAA loading standards.
  - 7. All MH covers shall include the following:
    - a. "HOUSTON AIRPORT SYSTEM" in the upper half of a half circle in 2.5-inch lettering. See attached figure 1.
    - b. "TELECOM" in the center of the circle with lettering four inches high x 18 inches long and solid rectangular lines (0.5 inches wide and 22 inches long) above and below. See attached figure 1.
    - c. Submit proof for approval prior to customizing covers.
    - d. Obtain permanent MH number from HAS IT. Field punch MH number at time of installation.

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- e. Submit cross reference table with construction MH number and permanent MH number.
- F. Hand holes (HH): Will be 4 feet x 4 feet x 4 feet and constructed of 2 inch thick concrete, covered with a 3/8 inch steel plate containing an approved locking device with a 35 pound lift to open and close. An 18-inch concrete apron will be placed around the 3/8-inch steel plate cover at grade level. All HH covers shall include the following:
  1. "HOUSTON AIRPORT SYSTEM" in the upper half of a half circle in 2.5-inch lettering. See attached figure 1.
  2. "TELECOM" in the center of the circle with lettering four inches high x 18 inches long and solid rectangular lines (0.5 inches wide and 22 inches long) above and below. See attached Figure 1.
  3. Submit proof for approval prior to customizing covers.
  4. Cover and service lettering shall be abrasion, corrosion, and chemical resistant
  5. Obtain permanent HH number from HAS IT. Field punch HH number at time of installation.
  6. Submit cross reference table with construction HH number and permanent HH number.
  7. All HH internal components such as racking and ground strips shall be field installable and shall meet the requirements of ANSI/TIA/EIA, NEC, and HAS requirements.
- G. AOA HH will be 4 feet x 4 feet x 4 feet and constructed of 8 inch thick concrete covered with 250 psi, aircraft rated cover plates containing an approved locking device with a 35 pound lift to open and close. All HH covers shall include the following:
  1. "HOUSTON AIRPORT SYSTEM" in the upper half of a half circle in 2.5-inch lettering.
  2. "TELECOM" in the center of the circle with lettering four inches high x 18 inches long and solid rectangular lines (0.5 inches wide and 22 inches long) above and below. See attached Figure 1
  3. Submit proof for approval prior to customizing covers.
  4. Cover and service lettering shall be abrasion, corrosion, and chemical resistant
  5. Obtain permanent HH number from HAS IT. Field punch HH number at time of installation.
  6. Submit cross reference table with construction HH number and permanent HH number.
  7. All HH internal components such as racking and ground strips shall be field installable and shall meet the requirements of ANSI/TIA/EIA, NEC, and HAS requirements.
- H. Concrete and Reinforcing Steel for Encasement: Furnish products following Section 01610 and Division 3 except strengths as follows:

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1. Compressive Strength: 2500 psi at 28 days, class A.
2. Flexural Strength: 500 psi at 28 days.
3. Dye concrete encasement "ORANGE" to identify communications conduit.

### 2.03 ACCESSORIES

- A. Continuous Tape for Underground Conduit: orange warning ribbon, PVC tape (detectable, i.e., containing metallic tracings), minimum 5 mils thick and 3 inches wide, permanently imprinted with "CAUTION--BURIED COMMUNICATIONS LINE BELOW" in black letters, minimum 1-inch high.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Verify materials are on site in proper condition and of sufficient quantity.
- B. Verify proper excavation depth; verify width route and support of work. (Division 2). Ducts shall be installed so that the tops of all ducts are at least 48 inches below the finished grade. Verify proper location of hand holes and MH (maximum every 350 feet). Communications facilities must be placed in separate MH/HH from electrical facilities.
- C. Trenches greater than or equal to 5 feet deep:
  1. Shall be shored to prevent cave-in.
  2. Shall have 2 feet clearance from the dirt pile.
- D. Directional boring is a suitable substitute when trenching is impractical or impossible. Locating existing underground utilities is crucial when directional boring is planned because of the potential for the drilling unit to encounter high voltages. Although directional boring machines are manufactured with electrical strike sensing capabilities which can warn the operator of any contact with a high voltage source, accidents may still occur.
  1. Operators of directional boring machines require special protection due to the potential for exposure to high voltage. Therefore, operators must always have a ground mat grid underfoot as insulation protection. In addition, operators must wear insulating boots and gloves, along with hard hats and safety glasses.
- E. Minimum electrical/communications underground cable separation:
  1. Concrete: 3 inches
  2. Masonry: 4 inches

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EXTERIOR COMMUNICATION PATHWAY

REV 07/2006

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3. Well-tamped earth: 12 inches

- F. Before encasement, verify ducts are free of debris and properly installed in support and spacer system, are properly fitted together and hold-down hardware is properly installed.

### 3.02 INSTALLATION

- A. Install all work following drawings, manufacturer's instructions and approved submittal data.
- B. Install conduit in excavations following Drawings. If directional boring is utilized, cable or flexible conduits can be attached to the unit and pulled back to the origination point (after the drilling unit reaches its destination).
- C. HH will be 64 cubic feet (4 feet x 4 feet x 4 feet) and shall be constructed of two-inch thick concrete covered with 3/8 inch steel plate. The hand hole or MH shall rest on a 4 inch blanket of sand, and 4 inches around the side walls shall be filled with sand
- D. Each MH/HH that contains a pedestal will have four bollards installed 18 inches diagonally from each corner, with a cross member welded at 30 inches connecting the Four Corners. These barriers will be constructed of 4 inch ridged conduit filled with concrete, driven four feet in the ground and extending 36 inches above the protective cover.
- E. Install watertight penetrations through foundation, HH and MH walls. Wherever a hand hole is used to simply pass through, the conduit entrances and exits will be situated at opposite ends of the hand hole instead of 90 degree angles.
- F. Assemble duct banks with non-magnetic saddles, spacers and separators. Position separators for 2 inch minimum concrete separation between outer surfaces of adjacent ducts.
1. Make uniform required bends with a minimum of a 24 inch radius for conduits less than 3 inch diameter, and a 48 inch radius for conduits 3 inches and larger.
  2. Maintain vertical or horizontal separations of 12 inches of well-packed topsoil from any electrical service conduit run parallel to Communications conduits.
- G. Install reinforcing. Install concrete encasement fully surrounding reinforcing steel and ducts. Follow Section 03315 using one-inch maximum size course aggregate concrete.
1. Unless otherwise noted on the drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at maximum parallel spacing of 12 inches

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- o.c., and No. 3 tie-bars transversely placed at 12 inches o.c. maximum longitudinal. Maintain maximum clearance of 2 inches from bars to edge of forms and ducts.
  - 2. Add colorants at mixing site at the rate of ten pounds per cubic yard.
    - a. ORANGE: For voice and data cable.
  - 3. Place concrete with minimum 3 inch cover surrounding ducts and reinforcement.
  - 4. Maintain ducts in proper place during concrete placement.
- H. Transition from non-metallic to PVC coated metallic conduit where duct banks enter structures or turn upward for continuation above grade.
- I. Where ducts enter structures such as HH, MH, pull boxes, or buildings, terminate ducts in proper end bells, insulated L-bushings, Meyers hubs or couplings on steel conduits.
- J. Extend below grade conduits to 4 inches above the finished floor inside a building.
- K. Tag conduits entering pull boxes with stamped stainless steel tags following cable and conduit schedule.
- L. Install continuous, orange warning ribbon, PVC tape (detectable, i.e., containing metallic tracings), 3 inches wide, permanently imprinted with "CAUTION - BURIED COMMUNICATIONS LINE BELOW" in black letters, approximately 12 inches below finished grade following line of duct banks. This warning ribbon shall be 36 inches above the cable.
- M. Place Soil Markers at every MH/HH and along the entire communications pathway, at 100-foot intervals.
- N. Expansion Fittings:
  - 1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
  - 2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceways systems
- 3.03 BACKFILLING
- A. Backfill following Division 2 after concrete cures 24 hours. After concrete encased ducts have been properly installed, and the concrete has had time to set, the trench shall be backfilled in at least two layers with excavated material, not larger than four inches in diameter and thoroughly tamped and compacted to at least the density of the surrounding undisturbed soil. If necessary to obtain the desired compaction, the backfill material shall

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be moistened or aerated as required. Trenches shall not be excessively wet and shall not contain pools of water during backfill operations. The trench shall be completely backfilled and compacted level with the adjacent surface. Any excess excavated material shall be removed and disposed of off site at the contractor's expense.

### 3.04 MAINTENANCE HOLES / HANDHOLES

- A. Installation shall be in accordance with the manufacturer's requirements. Top of MH/HH cover shall be set ¼ inch above finished pavement or one inch above finished grade.
- B. MH/HH shall be bedded on four inches of stabilized sand with ¾ inch gradation.
- C. Have ducts stubbed into the MH/HH, which shall terminate in end bells cast in concrete flush with the inside walls. Ducts shall enter the MH/HH at the lowest knockout window available.
- D. MH shall be fitted on each wall with cable racks and struts. Each rack will be provided with a minimum of four rack type arms. Rack arms will be made of non-flammable polymer.
- E. MH shall be provided with a pulling eye on each end and a drainage sump in the bottom.
- F. HH shall be provided
- G. MH/HH will be provided with a ¾ inch by 10-foot copper clad ground rod in each MH. See Section 17165 for ground rod specification. Do not install the ground rod through the drain sump. Install through a prepared opening and grout fill after installation.
- H. All vacant ducts and innerducts will be sealed with HAS and Industry approved plug.
- I. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color (ex. Orange, Blue, Black and White).
- J. When populating duct bank with innerduct the following apply:
  - 1. Innerduct to be OSP rated
  - 2. 4" duct to be populated with no less than 3-1.25 inch innerducts
  - 3. 4" duct to be populated with no less than 4-1 inch innerducts
- K. All fiber cables must be placed in an innerduct.
- L. All copper cables 100 pairs or less will be placed in an innerduct.

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- M. Pull a 12 inch long mandrel (1/4 inch smaller than duct diameter) through ducts. Pull a rag swab or sponge through to remove debris, until it shows clean.
- N. Provide a conduit measuring tape, with a minimum test rating of 1250 pounds of pulling tension in all underground conduits and innerducts. Label each end of the duct bank in every MH to ensure continuity.

### END OF SECTION

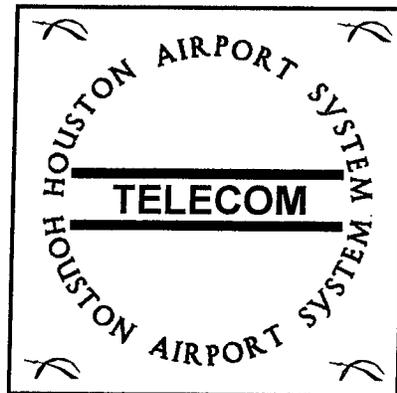


Figure 1

**SPEC 17165 TELECOMMUNICATIONS GROUNDING &  
BONDING**

## GUIDELINES

HAS/PDC/DESIGN DIVISION  
HOUSTON, TEXAS

PROJECT TITLE  
PROJECT/CIP #

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### SECTION 17165 TELECOMMUNICATIONS GROUNDING & BONDING (REV. 07/2006-JAB)

#### PART 1 GENERAL

##### 1.01 PROJECT SCOPE SUMMARY

*Designer shall provide a detailed narrative of the tasks to be performed under this specification section.*

##### 1.02 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.
- D. Communication system grounding.
- E. Electrical equipment and raceway grounding and bonding.
- F. Control equipment grounding.

##### 1.03 REFERENCES

- A. Follow Section 01423  
*Designer to insert Specification sections as required by the project scope, examples:*
  - 1. Section 16190 Supporting Devices
  - 2. Section 16402 Duct Banks
  - 3. Section 17130 Internal Communication Pathways
  - 4. Section 17140 External Communication Pathways
  - 5. Section 16111 Conduit, Fittings and Bodies
- B. American Society for Testing and Materials (ASTM):
  - 1. B 3 Soft or Annealed Copper Wires
  - 2. B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
  - 3. B 33 Tinned Soft or Annealed Copper Wire for Electrical Purposes

## GUIDELINES

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- C. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. 142-82 Recommended Practice for Grounding of Industrial and Commercial Power Systems
  - 2. 383-2.5 IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.
  - 3. 1100 Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems.
- D. Underwriters' Laboratories (UL):
  - 1. 83 Thermoplastic Insulated Wire and Cables
  - 2. 96 Lightning Protection Components
  - 3. 96A System Installation
  - 4. 467 Grounding and Bonding Equipment
- E. National Fire Protection Association (NFPA):
  - 1. 780 Lightning Protection Code
  - 2. 70 National Electrical Code (NEC)
    - a. NEC Article No. 250 - Grounding
- F. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance (ANSI/TIA/EIA):
  - 1. J-STD-607-A Commercial Building Grounding and Bonding Requirements.
  - 2. Telcordia – Network Equipment Building Systems (NEBS) GR-1275.
- G. Building Industry Consulting Services International (BICSI):
  - 1. Telecommunications Distribution Methods Manual
  - 2. Customer Owned Outside Plant Design Manual
- H. Local, county, state and federal regulations and codes in effect as of date of “notice to proceed” shall be complied with.
- I. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be indicated in the proposal the components which may be of foreign manufacture, if any, and the country of origin.
- J. Reference attached Figure 1 for general grounding infrastructure layout and connectivity.
- K. Conflicts:
  - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
  - 2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

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### 1.04 DESIGN REQUIREMENTS

- A. Design grounding system following ANSI J-STD 607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, BICSI Telecommunications Distribution Methods Manual, NEC Article No. 250 - Grounding, IEEE 1100 – Recommended Practices for Powering and Grounding Sensitive Electronic Equipment, and IEEE 142-82 - Recommended Practice for Grounding of Industrial and Commercial Power Systems, by a firm acceptable to Owner's insurance underwriter. All labeling shall follow standards set forth by ANSI/TIA/EIA-606 and Houston Airport System's (HAS) requirements.
- B. Design Standards:
  - 1. Completely protect above-surface structures and equipment.
  - 2. Calculate system on the basis of existing soil resistivity.
  - 3. If cathodic protection for underground sewer pipe is installed (see applicable Division 2 Sections), ensure the pipe is not connected to the general grounding system, either directly through grounding cable or indirectly through grounded electrical devices connected to the pipe. Electrically isolate electrical devices from sewer pipe.

### 1.05 SUBMITTALS

- A. Follow Section 01340 for the following:
- B. Product Data:
  - 1. Manufacturers catalog data and applicable special fabrication and installation details.
  - 2. Installation, terminating and splicing procedures.
  - 3. Instructions for handling and storage.
  - 4. Dimensions and weights.
  - 5. Conformance Certificate and Quality Assurance Release: Signed by QAP Manager (Section 01450). Specifically identify products and include purchase order number, supplements, and item number where applicable. Indicate that requirements are met and identify approved deviations.
- B. Record Documents Follow Section 01700.

### 1.06 QUALITY ASSURANCE

- A. Follow Section 01450.
- B. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.

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- C. Tests for Insulated Cable: Pass vertical tray flame test following IEEE 383-2.5.
- D. HAS retains the right to inspect all work during the entire duration of the project and any items that do not adhere to the reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

### 1.07 SHIPPING AND HANDLING

- A. Follow Section 01450.
- C. Ship on manufacturer's standard reel sizes of one continuous length. Where cut lengths are specified, mark reel quantity accordingly.
- D. Protect wire wood lagging or suitable barrier across the traverse of reels. Provide heat-shrink self-sealing end caps on cable.
- E. Equipment shall be delivered in original packages with labels intact and identification clearly marked. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other containments. Equipment damaged prior to system acceptance shall be replaced at no cost to the HAS.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Cable Manufacturers/Suppliers:
  - 1. Houston Wire and Cable Company
  - 2. Okonite Company
  - 3. Anixter
  - 4. Cablec Continental Cables Company
  - 5. Pirelli Cable Corporation
  - 6. Triangle Wire and Cable, Inc.
- B. Ground Rod and Connector Manufacturers:
  - 1. Copperweld
  - 2. Thomas & Betts
  - 3. Blackburn
- C. Exothermic Connector Manufacturers:
  - 1. Erico Products (Cadweld)
  - 2. Burndy Corporation (Therm-O-Weld)
  - 3. OZ Gedney

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- D. Grounding Connector Manufacturers:
1. Thomas & Betts
  2. Burndy Corporation
  3. O.Z. Gedney

- E. Telecommunications Busbars:
1. Erico Products
  2. Cooper B-Line
  3. CPI Chatsworth

### 2.02 MATERIALS

- A. Grounding Conductors: Bare or insulated copper AWG wire following ASTM-B3, ASTM-B8 and ASTM-B33, of following sizes:
1. A minimum of 6 AWG, stranded, insulated copper conductor should be used for communications since this accommodates different code requirements and allows for future changes.
  3. Metallic cable shield shall NOT be used as a Telecommunication Bonding Backbone (TBB).
  4. Interior water piping system shall NOT be used as a TBB
- B. Grounding Connectors: It is recommended that connectors should be one of the following:
1. Tin-plated copper.
  2. Copper.
  3. Copper alloy.
- C. Ground Rods: A minimum of 10 feet long, 3/4-inch diameter, copper-clad steel.
- D. Where single conductor insulated grounding conductors is required, furnish green color (or tape marking) insulation rated for 600 volts.
- E. Telecommunications Main Grounding Busbar (TMGB):
1. The TMGB shall be a predrilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors to be used.
  2. The TMGB shall be sized for the immediate requirements and allow for 100% growth.
  3. The minimum busbar dimensions are .25" thick x 4" wide x 20" long.
  4. The busbar shall be electrotin plated for reduced contact resistance.
- F. Telecommunications Grounding Busbar (TGB):
1. The TGB shall be a predrilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors to be used.
  2. The TGB shall be sized for the immediate requirements and allow for 100% growth.

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3. The minimum busbar dimensions are .25" thick x 2" wide x 12" long.
4. The busbar shall be electrotin plated for reduced contact resistance.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Follow Section 01450.

#### 3.02 PREPARATION

- A. Complete site preparation and soil compaction before trenching and driving ground rods for underground use.
- B. Verify exact location of stub-up points for grounding of equipment, fences and building or steel structures.
- C. Verify wiring for lighting systems is single conductor cable in conduit and each conduit contains a green-color insulated equipment-grounding conductor connected to lighting system. If no ground conductor is present, install conductors as required.
- D. Copper and copper alloy connections should be cleaned prior to connection.
- E. In new construction, the electrical contractor must provide accessible means to a direct electrical service ground, which is one of the best points for grounding communications systems. NEC Section 250-71(b) requires an intersystem bonding connection accessible at the electrical service equipment, such as:
  1. Approved external connection on the power service panel. The NEC allows direct connection to a provided 6 AWG copper conductor.
  2. Exposed metallic service raceway (using an approved bonding connector).
  3. Grounding electrode conductor.
  4. For connectivity between buildings and rooms, all bonding conductors are to be placed in conduit end to end and conduit should be properly grounded. 3/0 conductor to be placed in 2 inch conduit and 6AWG to be placed in a 1 inch conduit run.

#### 3.03 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data.

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- B. Bonding conductors shall be routed with minimum bends or changes in direction and should be made directly to the points being bonded.
- C. Bonding connections should be made by using:
  - 1. Bolt or crimp connectors, clamps, or lugs. Use listed hardware that has been laboratory tested. For bolt, crimp and lug connectors use 2 hole type connector.
  - 2. Exothermic welding (see NEC Section 250-64) within the ground electrode system, for parts of a grounding system that are subject to corrosion or that must carry high currents reliably, or for locations that require minimum maintenance.
- D. Install main ground loop minimum 18" (inches) below ground surface.
- E. Drive rods vertically, so at least 8 feet of rod is in contact with the soil. All Clamps are suitable for direct burial or exothermic-weld. Install additional ground rods as required to pass resistance test.
- F. Make connections to dry surfaces with paint, rust, oxidation, scales, grease, dirt or other foreign material is removed. Ensure proper conductivity.
- G. Make above-grade grounding connections with Exothermic-weld.
  - 1. Ground small groups of isolated equipment with No. 3/0 minimum insulated conductor connected to the main loop.
- H. Equipment Grounding:
  - 1. Make grounding connections to electrical equipment, vessels, mechanical equipment, equipment enclosure, relay racks, and ground rods in accordance with NEC.
  - 2. Make grounding connections to tanks and vessels to integral structural supports or to existing grounding lugs or pads, and not to the body of the tank or vessel.
- I. Telecommunications Raceway and Support Systems Grounding:
  - 1. Bond and ground raceway, cable rack or tray and conduit together and permanently ground to the equipment grounding busbar. Connection to conduit may be with grounding bushing.
  - 2. Connect ladder-type cable tray to grounding electrode system. Telecommunications cable tray that is located in the same room, as the TMGB shall be connected to the TMGB.
  - 3. Bond and ground raceway at low voltage motor control centers or other low voltage control equipment, except conduit which is effectively grounded to sheet metal enclosure by bonding bushing or hubs need not be otherwise bonded.
  - 4. Where only grounding conductor is installed in a metal conduit, bond both ends of conduit to grounding conductors.

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5. Provide flexible "jumpers" around raceway expansion joints and across cable tray joints parted to allow for expansion and hinged cable tray connections. Provide copper bonding straps for steel conduit.
- J. Telecommunications Grounding and Bonding Infrastructure:
1. Install the TMGB in the Telecommunications Entrance Facility (TEF) or Main Distribution Frame (MDF) as close to the panel-board as possible. The TMGB should also be located so that the bonding conductor is as short and straight as possible. Maintain clearances required by applicable electrical codes.
  2. If a panel-board is not installed in the TEF or MDF, locate the TMGB near the backbone cabling and terminations. *Designer responsible for proper placement of busbar within room.*
  3. The TMGB shall be insulated from its support with a recommended separation of 2 inches.
  4. Connect the TMGB to the electrical service ground and telecommunications primary protectors.
  5. The minimum Telecommunications Bonding Backbone (TBB) conductor size shall be No. 6 AWG. The TBB originates at the TMGB and extends throughout the building using the telecommunications backbone pathways, and connects to the TGB(s) in all telecommunication closets and equipment rooms.
  6. Install the TGBs in the telecommunications closets and equipment rooms as close to the panel-board as possible. The TGB should also be located so that the bonding conductor is as short and straight as possible. Maintain clearances required by applicable electrical codes.
  7. The TGB shall be insulated from its support with a recommended separation of 2 inches.
  8. Properly bond and ground all communications cabinets, equipment racks, raceway, cable rack or tray, and conduit directly to TMGB or TGB. Daisy chaining of equipment is not permitted
  9. Refer to the Telecom Grounding diagram in the design documentation (see figure 1).
  10. Preparation: Copper and copper alloy connections shall be cleaned prior to connecting.
  11. Bonding conductors shall be routed with minimum bends or changes in direction and should be made directly to the point being bonded. Change of direction shall be taken over as wide a radius as possible with a minimum radius of one foot.
  12. Make connections to dry surfaces with paint, rust, oxides, scales, grease and dirt removed. Ensure proper conductivity.
  13. Grounding conductors, by gauge, shall be continuous, with splices, from a larger gauge feeder to the last frame or component served by the grounding lead (ex. 750 KCM to 500 KCM to 1/0, etc.).
  14. C-Taps from Aisle equalizer to a frame can be the same gauge (ex. E.g., 6 AWG to 6 AWG).

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15. Cable to Cable taps shall be made with exothermic weld, or listed compression connectors.
  16. No aluminum conductors or connectors shall be used in any bonding and grounding system.
  17. Ground bars not supplied as part of a standard assembly shall be copper or tinned copper.
  18. Refer Telecommunications Grounding drawings for additional information.
  19. Both ends of the grounding conductors shall be equipped with a printed destination label recording the far end termination. The label shall be applied within 6 inches of the termination and be visible from the floor.
  20. All metallic items that interact electro-magnetically with Network/Telecommunications equipment shall have their framework bonded and grounded to the Telecommunications grounding system with a minimum #6 AWG grounding conductor. Example includes switch frames, power plants frames, battery stands, storage cabinets and other metallic objects, etc. "Daisy Chaining" or frame to frame connecting of these conductors is NOT permitted.
  21. TMGB and TGB shall be stenciled and labeled per HAS requirements.
- K. Fences and Gates in the equipment rooms:
1. Ground fences, fence posts and gates to nearest TMGB or TGB.
- M. Telecommunications Cable Armor and Shield:
1. Terminate and ground shield of shielded control cable at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables. Maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes or other splice points.
  2. Connect ground wire in power cable assemblies at each terminal point to a ground bus, if available, or to the equipment enclosure. Do not extend these ground wires through "doughnut" CTs used for ground fault relaying, but do extend ground leads from stress cones. Ground power cable armor and shield at each terminal point.
  3. Bond and ground exposed cable shields and metallic sheaths according to the manufacturer's guidelines. They should also be grounded as close as possible to the point of entrance.
  4. Intra-building telecommunications cabling that is armored or has a metallic shield must be bonded to the building grounding system at each end.

### 3.04 TESTING

- A. Follow Section 01450.
- B. Test grounding system before grid trenches are back-filled. Test for ground resistance after installation of underground grid and grounding connections.

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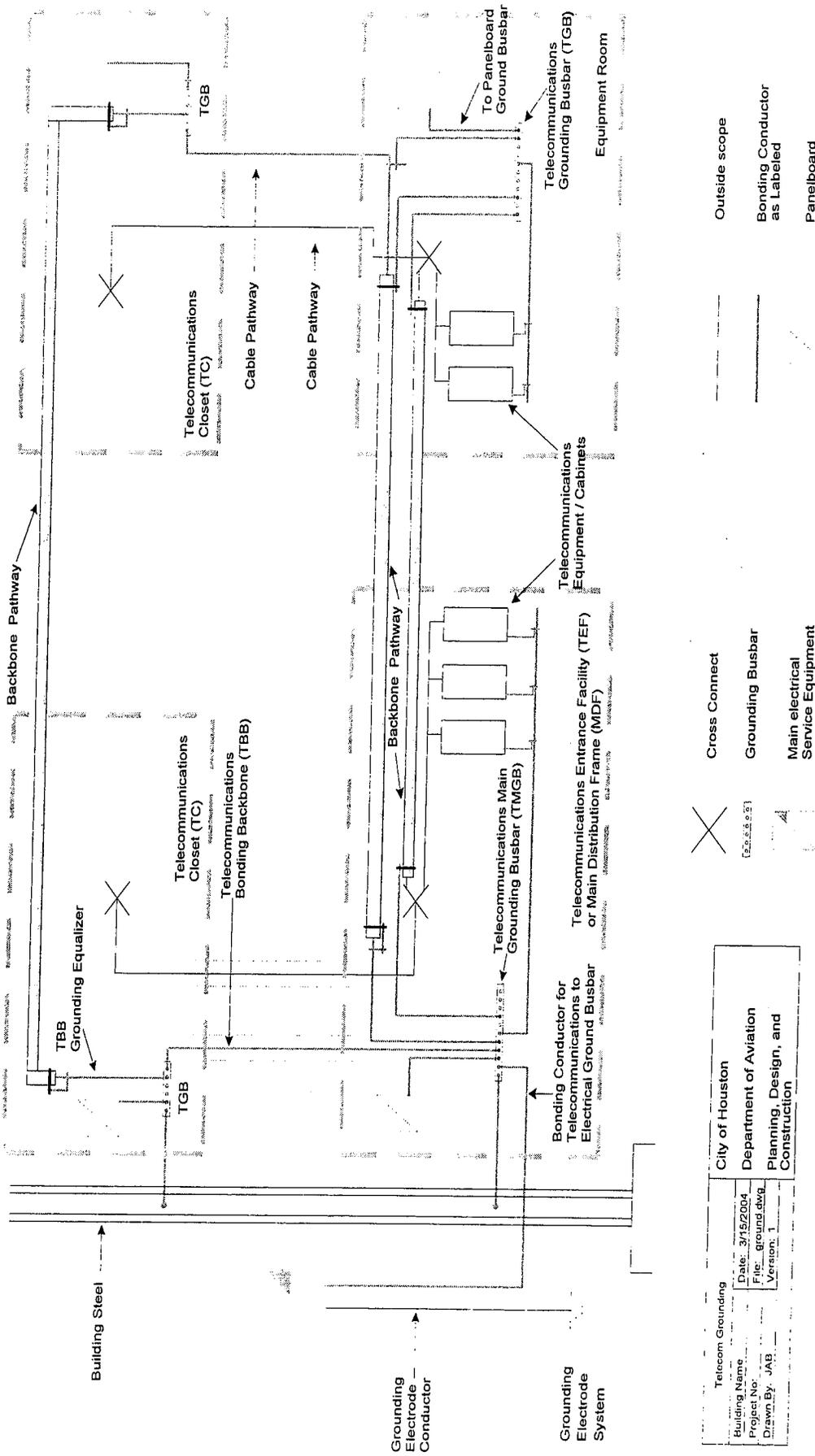
- C. Install test wells at locations as required for testing, using a pipe surrounding the rod and connections with a cover placed on top at grade level.
- E. Test system resistance at each test well using "fall of potential" method: Maximum resistance of 5 ohms.
- F. Upon completion of the electrical system, including all grounding, the Electrical Contractor shall test the system for stray currents, ground shorts, etc. Approved instruments, apparatus, service, and qualified personnel shall be utilized. If stray currents, shorts, etc., are detected, eliminate or correct as required. The test procedure shall be as follows:
  - 1. Open all main disconnects for the system being tested.
  - 2. Disconnect the system neutral from the service entrance or step-down transformer neutral connection.
  - 3. Connect a DC ohmmeter across the system neutral and equipment ground.
  - 4. An ohmmeter reading in excess of 100 ohms shall indicate that the system neutral and equipment ground are properly isolated.
  - 5. An ohmmeter reading less than 100 ohms shall indicate that the system contains ground shorts (stray currents) at some point along the system neutral.
  - 6. Grounded neutrals may be identified by disconnecting individual neutral conductors from the system, one at a time, while monitoring the ohmmeter.
  - 7. The systems shall be re-tested after correction of all ground shorts is complete.

**END OF SECTION**

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**Figure 1**

SECTION 17165 -11  
TELECOMMUNICATIONS GROUNDING & BONDING.  
REV. 07/2006

**EXHIBIT "D"**

**PBX SYSTEM DETAILS AND LOCATIONS**

## **EXHIBIT "D"**

### **PBX SYSTEM DETAILS AND LOCATIONS**

- **DRAWING 1 - PBX LOCATIONS, PRESENT & PROPOSED**
- **TABLE 1 - PBX SYSTEM DETAILS - IAH/Admin. Bldg.**
- **TABLE 2 - PBX SYSTEM DETAILS - IAH/Terminal IAB**
- **TABLE 3 - PBX SYSTEM DETAILS - HOU**



**TABLE 1 - PBX SYSTEM DETAILS - Serial No. Z02012**  
**16930 John F. Kennedy Blvd., Administration Bldg., George Bush Intercontinental Airport**

<b>Column # 0 Module # 0</b> <b>Network Group # 0 Shelf # 0</b> <b>CPU # 0</b>	<b>Network Slots Available</b> 6/7, 8/9, 10/11, 14/15	<b>Possible Card Configuration</b> 6/7 MSDL 8/9, 10/11 Super Loop 14/15 DDP 14/15 CONF *
<b>Column # 0 Module # 1</b> <b>IPE Module</b>	<b>IPE Slots Available</b> 12	<b>Possible Card Configuration</b> XEM, XUT, DLC, SLC, DTR
<b>Column # 0 Module # 2</b> <b>IPE Module</b>	<b>Network Slots Available</b> 2,3,4,6,10,11,12,13,	<b>Possible Card Configuration</b> XEM, XUT, DLC, SLC, DTR
<b>Column # 0 Module # 3</b>	<b>Module Not In Place</b>	
<b>Column # 1 Module # 0</b> <b>Network Group # 0 Shelf # 1</b> <b>CPU # 1</b>	<b>Network Slots Available</b> 22/23, 24/25, 26/27	<b>Possible Card Configuration</b> 22,23 MSDL 24/25 CONF* 26/27 DDP
<b>Column # 1 Module # 1</b> <b>Network Group # 1 Shelf # 0</b>  <b>Move MSDL from 44/45 to 38/39</b>	<b>Network Slots Available</b> 34/35, 38/39, 40/41, 42/43 44/45	<b>Possible Card Configuration</b> 34/35 CONF* 40/41, 42/43 Super Loop 44/45 DDP
<b>Column # 1 Module # 2</b> <b>Network Group # 1 Shelf # 1</b> <b>Move MSDL from 60/61 to 54/55</b>	<b>Network Slots Available</b> 54/55, 58/59, 60/61	<b>Possible Card Configuration</b> 54/55 MSDL 58/59 MSDL 60/61 DDP
<b>Column # 1 Module # 3</b> <b>Inner Group Switch</b>	<b>Groups Available</b> 3	
<b>Column # 2 Module # 0</b>	<b>Meridian Mail EC-MMP 40</b> <b>Node # 1</b>	<b>Rel. 12.12.7 Channels 20</b> <b>54 Hours Storage 2 GB Drive</b> <b>Shadowed</b>
<b>Column # 2 Module # 1</b> <b>IPE Module</b>	<b>IPE Slots Available</b> 12,13,14	<b>Possible Card Configuration</b> XEM,XUT,DLC,ALC,DTR
<b>Column # 2 Module # 2</b> <b>IPE Module</b>	<b>IPE Slots Available</b> 1,2,3,9,10,11,13,14,15	<b>Possible Card Configuration</b> XEM,XUT,DLC,ALC,DTR
<b>Column # 2 Module # 3</b>	<b>Module Not In Place</b>	

**TABLE 1 - PBX SYSTEM DETAILS (continued)**  
**16930 John F. Kennedy Blvd., Administration Bldg., George Bush Intercontinental Airport**

<b>Column # 3 Module # 0</b>	<b>IPE Slots Available</b>	<b>Possible Card Configuration</b>
<b>IPE Module Fiber Remote</b>	<b>1,4,5,6,</b>	<b>XEM,XUT,DLC,ALC,DTR</b>
<b>Column # 3 Module # 1</b>	<b>IPE Slots Available</b>	<b>Possible Card Configuration</b>
<b>IPE Module Fiber Remote</b>	<b>1,3,4,5,</b>	<b>XEM,XUT,DLC,ALC,DTR</b>
<b>Column # 3 Module # 2</b>	<b>Module Not In Place</b>	
<b>Column # 3 Module # 3</b>	<b>Module Not In Place</b>	

**Unused Hardware TN's**

**M2000     225**  
**500        64**  
**Trk T-1    212**  
**Trk XUT    19**  
**Trk XEM    0**

**Used Hardware**

**SL1's        20**  
**500          20**  
**2500        137**  
**M2000's    349**

**SOFTWARE RELEASES: PBX REL 23.55**  
**Mmail 12.14.0**  
**Call Processing Card Part No. NT5D10CA**

**TABLE 2 - PBX SYSTEM DETAILS - Serial No. J00110**  
**3700 North Terminal Road, Terminal IAB, George Bush Intercontinental Airport**

<b>Column # 0 Module # 0</b> <b>Network Group # 0 Shelf # 0</b> <b>CPU # 0</b>	<b>Network Slots Available</b> <b>0</b>	<b>Possible Card Configuration</b> <b>None</b>
<b>Column # 0 Module # 1</b> <b>Network Group # 2 Shelf # 0</b>	<b>Network Slots Available</b> <b>74/75, 76/77, 78/79</b>	<b>Possible Card Configuration</b> <b>74/75 MSDL</b> <b>76/77 DDP</b> <b>78/79 DDP</b> <b>76/77, 78/79 Super Loop</b>
<b>Column # 0 Module # 2</b> <b>Network Group # 2 Shelf # 1</b>	<b>Network Slots Available</b> <b>86/87, 88/89, 92/93</b>	<b>Possible Card Configuration</b> <b>86/87 MSDL</b> <b>88/89 DDP</b> <b>92/93 MSDL</b>
<b>Column # 0 Module # 0</b> <b>DTI/PRI Network Module</b>	<b>Network Slots Available</b> <b>0</b>	<b>Possible Card Configuration</b> <b>None</b>
<b>Column # 1 Module # 0</b> <b>Network Group # 0 Shelf # 1</b> <b>CPU # 1</b>	<b>Network Slots Available</b> <b>22/23, 30/31</b>	<b>Possible Card Configuration</b> <b>22/23 MSDL</b> <b>30/31 MSDL</b>
<b>Column # 1 Module # 1</b> <b>Network Group # 1 Shelf # 0</b>	<b>Network Slots Available</b> <b>0</b>	<b>Possible Card Configuration</b> <b>None</b>
<b>Column # 1 Module # 2</b> <b>Network Group # 1 Shelf # 1</b>	<b>Network Slots Available</b> <b>0</b>	<b>Possible Card Configuration</b> <b>None</b>
<b>Column # 1 Module # 3</b> <b>Inner Group Switch</b>	<b>Groups Available</b> <b>2</b>	
<b>Column # 2 Module # 0</b>	<b>Meridian Mail Modular Option</b> <b>Node # 1</b>	<b>Rel. 12.11.3 Channels 20</b> <b>54 Hours Storage 2 GB Drive</b>
<b>Column # 2 Module # 1</b>	<b>Meridian Mail Modular Option</b> <b>Node # 2</b>	
<b>Column # 2 Module # 2</b> <b>IPE</b> <b>Module</b>	<b>IPE Slots Available</b> <b>None</b>	<b>Possible Card Configuration</b> <b>None</b>
<b>Column # 2 Module # 3</b> <b>IPE</b> <b>Module</b>	<b>IPE Slots Available</b> <b>None</b>	<b>Possible Card Configuration</b> <b>None</b>
<b>Column # 3 Module # 0</b>	<b>IPE Slots Available</b> <b>None</b>	<b>Possible Card Configuration</b> <b>None</b>

**TABLE 2 - PBX SYSTEM DETAILS (continued)**  
**3700 North Terminal Road, Terminal IAB, George Bush Intercontinental Airport**

Column # 3 Module # 1 IPE Module	IPE Slots Available None	Possible Card Configuration None
Column # 3 Module # 2 IPE Module	IPE Slots Available 0	Possible Card Configuration XUT, XEM, DLC, ALC,DTR
Column # 3 Module # 3	IPE Slots Available None	Possible Card Configuration None
Column # 4 Module # 0 IPE Module	IPE Slots Available 9,10,15	Possible Card Configuration XUT, XEM, DLC, ALC,DTR
Column # 4 Module # 1 IPE Module	IPE Slots Available 8,9,10,11,12,13,14	Possible Card Configuration XUT, XEM, DLC, ALC,DTR
Column # 4 Module # 2	Module Not In Place	
Column # 4 Module # 3	Module Not In Place	
Column # 5 Module # 0 IPE Module Fiber Remote	IPE Slots Available None	Possible Card Configuration None
Column # 5 Module # 1 IPE Module Fiber Remote	IPE Slots Available None	Possible Card Configuration None
Column # 5 Module # 2 IPE Module Fiber Remote	IPE Slots Available 0	Possible Card Configuration XUT, XEM, DLC, ALC,DTR
Column # 5 Module # 3	Module Not In Place	

**Unused Hardware**

TN's	
M2000	49
500	92
Trk T-1	39
Trk XUT	4
Trk XEM	14

**Used Hardware**

SL1's	20
500	86
2500	1616
M2000's	402

**SOFTWARE RELEASES: PBX REL 23.37**  
**Mmail 12.11.3**  
**Call Processing Card Part No. NT5D10CA**

**TABLE 3 - PBX SYSTEM DETAILS - Serial No. Z00922  
7800 Airport Blvd., William P. Hobby Airport**

Column # 0 Module # 0 Network Group # 0 Shelf # 0 CPU # 0	Network Slots Available 10/11, 12/13, 14/15	Possible Card Configuration 10/11 MSDL 12/13,14/15 Super Loop 14/15 CONF *
Column # 0 Module # 1 IPE Module	IPE Slots Available 0,10,11,12,13,14	Possible Card Configuration XEM, XUT, DLC, SLC, DTR
Column # 0 Module # 2 IPE Module	Network Slots Available 10,11,1,12,13,14,15	Possible Card Configuration XEM, XUT, DLC, SLC, DTR
Column # 0 Module # 3 IPE Module	IPE Slots Available 1,14	Possible Card Configuration XEM, XUT, DLC, SLC, DTR
Column # 1 Module # 0 Network Group # 0 Shelf # 1 CPU # 1	Network Slots Available 22/23, 24/25, 26/27	Possible Card Configuration 26/27 MSDL 28/29, 30/31 Super Loop
Column # 1 Module # 1 Network Group # 1 Shelf # 0	Network Slots Available 42/43, 44/45, 46/47	Possible Card Configuration 42/43 CONF 44/45 Super Loop
Column # 1 Module # 2 Network Group # 1 Shelf # 1	Network Slots Available 54/55, 58/59, 60/61, 62/63	Possible Card Configuration 54/55 MSDL 58/59 DDP 60/61 Super Loop
Column # 1 Module # 3 Inner Group Switch	Groups Available 3	
Column # 2 Module # 0	Meridian Mail EC-MMP 40 Node # 1	Rel. 12.12.7 Channels 12 24 Hours Storage 2 GB Drive
Column # 2 Module # 1 DTI/PRI Network Module	Network Slots Available 2 Slots for QPC 720	Possible Card Configuration DTI/PRI QPC 720
Column # 2 Module # 2 DTI/PRI Network Module	Network Slots Available 3 Slots for QPC 720	Possible Card Configuration DTI/PRI QPC 720
Column # 2 Module # 3 IPE Module	IPE Slots Available 9,10,11,12,13,14	Possible Card Configuration XEM, XUT, DLC, SLC, DTR

**TABLE 3 - PBX SYSTEM DETAILS - (continued)**  
**7800 Airport Blvd., William P. Hobby Airport**

<b>Column # 3</b>	<b>IPE Slots Available</b>	<b>Possible Card Configuration</b>
<b>Mini-Carrier Remote</b>	<b>6,7,8,9,10</b>	<b>DLC,ALC</b>
Another Local Carrier Remote would have to be configured to support additional IPE Cards for slots 7,8,9 & 10.		

Used Hardware

**SOFTWARE RELEASES: PBX REL 23.37**  
**Mmail 12.12.7**

<b>SL1's</b>	<b>12</b>
<b>500's</b>	<b>11</b>
<b>2500's</b>	<b>242</b>
<b>M2000's</b>	<b>206</b>

**Call Processing Card Part No. NT5D10CA**

## EXHIBIT "E"

### EQUAL EMPLOYMENT OPPORTUNITY

1. The contractor, subcontractor, vendor, supplier, or lessee will not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, or age. The contractor, subcontractor, vendor, supplier, or lessee will take affirmative action to ensure that applicants are employed and that employees are treated during employment without regard to their race, religion, color, sex, national origin, or age. Such action will include, but not be limited to, the following: employment; upgrading; demotion or transfer; recruitment advertising; layoff or termination; rates of pay or other forms of compensation and selection for training, including apprenticeship. The contractor, subcontractor, vendor, supplier or lessee agrees to post in conspicuous places available to employees, and applicants for employment, notices to be provided by the City setting forth the provisions of this Equal Employment Opportunity Clause.

2. The contractor, subcontractor, vendor, supplier, or lessee states that all qualified applicants will receive consideration for employment without regard to race, religion, color, sex, national origin or age.

3. The contractor, subcontractor, vendor, supplier, or lessee will send to each labor union or representatives of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided by the agency contracting officer advising the said labor union or worker's representative of the contractor's and subcontractor's commitments under Section 202 of Executive Order No. 11246, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. The contractor, subcontractor, vendor, supplier, or lessee will comply with all provisions of Executive Order No. 11246 and the rules, regulations, and relevant orders of the Secretary of Labor or other Federal Agency responsible for enforcement of the equal employment opportunity and affirmative action provisions applicable and will likewise furnish all information and reports required by the Mayor and/or Contractor Compliance Officer(s) for purposes of investigation to ascertain and effect compliance with this program.

5. The contractor, subcontractor, vendor, supplier, or lessee will furnish all information and reports required by Executive Order No. 11246, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to all books, records, and accounts by the appropriate City and Federal Officials for purposes of investigations to ascertain compliance with such rules, regulations, and orders. Compliance reports filed at such times as directed shall contain information as to the employment practice policies, program, and work force statistics of the contractor, subcontractor, vendor, supplier, or lessee.

6. In the event of the contractor's, subcontractor's, vendor's, supplier's, or lessee's non-compliance with the non-discrimination clause of this contract or with any of such rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part, and the contractor, subcontractor, vendor, supplier, or lessee may be declared ineligible for further City contracts in accordance with procedures provided in Executive Order No. 11246, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order, or by rule, regulation, or order of the Secretary of Labor, or as may otherwise be provided by law.

7. The contractor shall include the provisions of paragraphs 1-8 of this Equal Employment Opportunity Clause in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontractor or purchase order as the contracting agency may direct as a means of enforcing such provisions including sanctions for noncompliance; provided, however, that in the event the contractor becomes involved in, or is threatened with litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

8. The contractor shall file and shall cause his or her subcontractors, if any, to file compliance reports with the City in the form and to the extent as may be prescribed by the Mayor. Compliance reports filed at such times as directed shall contain information as to the practices, policies, programs, and employment policies and employment statistics of the contractor and each subcontractor.

**EXHIBIT "F"**  
**MWBE SUBCONTRACT TERMS**

Contractor shall ensure that all subcontracts with MWBE subcontractors and suppliers are clearly labeled **"THIS AGREEMENT IS SUBJECT TO BINDING ARBITRATION ACCORDING TO THE TEXAS GENERAL ARBITRATION ACT"** and contain the following terms:

1. \_\_\_\_\_ (MWBE subcontractor) shall not delegate or subcontract more than 50% of the work under this subcontract to any other subcontractor or supplier without the express written consent of the City of Houston's Affirmative Action Director ("the Director").

2. \_\_\_\_\_ (MWBE subcontractor) shall permit representatives of the City of Houston, at all reasonable times, to perform (1) audits of subcontractor's books and records, and (2) inspections of all places where work is to be undertaken in connection with this subcontract. Subcontractor shall keep its books and records available for inspection for at least 4 years after the end of its performance under this subcontract. Nothing in this provision shall change the time for bringing a cause of action.

3. Within 5 business days of execution of this subcontract, Contractor (prime contractor) and Subcontractor shall designate in writing to the Director an agent for receiving any notice required or permitted to be given under Chapter 15 of the Houston City Code of Ordinances, along with the street and mailing address and phone number of the agent.

4. Any controversy between the parties involving the construction or application of any of the terms, covenants, or conditions of this subcontract must, upon the written request of one party served upon the other or upon notice by the Director served on both parties, be submitted to binding arbitration, under the Texas General Arbitration Act (Tex. Civ. Prac. & Rem. Code Ann., Ch. 171 -- "the Act"). Arbitration must be conducted according to the following procedures:

a. Upon the decision of the Director or upon written notice to the Director from either party that a dispute has arisen, the Director shall notify all parties that they must resolve the dispute within 30 days or the matter may be referred to arbitration.

b. If the dispute is not resolved within the time specified, any party or the Director may submit the matter to arbitration conducted by the American Arbitration Association under the rules of the American Arbitration Association, except as otherwise required by the City's contract with the American Arbitration Association on file in the City's Affirmative Action Division Office.

c. Each party shall pay all fees required by the American Arbitration Association and sign a form releasing the American Arbitration Association and its arbitrators from liability for decisions reached in the arbitration.

d. If the American Arbitration Association no longer administers Affirmative Action arbitration for the City, the Director shall prescribe alternate procedures to provide arbitration by neutrals in accordance with the requirements of Chapter 15 of the Houston City Code of Ordinances.

EXHIBIT "G"

PERFORMANCE BOND

THE STATE OF TEXAS §
COUNTY OF HARRIS §

THAT WE, \_\_\_\_\_, as Principal, (the "Contractor") and the other subscriber hereto, \_\_\_\_\_, as Surety, do hereby acknowledge ourselves to be held and firmly bound to the City of Houston (the "City"), a municipal corporation, in the penal sum of \$ \_\_\_\_\_ for the payment of which sum, well and truly to be made to the City, its successors and assigns, Contractor and Surety do bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally.

THE CONDITIONS OF THIS OBLIGATION ARE SUCH THAT:

WHEREAS, the Contractor has on or about this day executed an Agreement in writing with the City for telecommunications services for the City of Houston Airport System all of such work to be done as set out in full in said Agreement therein referred to and adopted by the City Council, all of which are made a part of this instrument as fully and completely as if set out in full herein.

NOW THEREFORE, if the said Contractor shall faithfully and strictly perform the Agreement in all its terms, provisions, and stipulations in accordance with its true meaning and effect, and shall comply strictly with each and every provision of the Agreement and with this Bond, then this obligation shall become null and void and shall have no further force and effect; otherwise the same is to remain in full force and effect. Should the Contractor fail to faithfully and strictly perform the Agreement in all its terms, including but no limited to the indemnifications thereunder, the Surety shall be liable for all damages, losses, expenses and liabilities that the City may suffer in consequence thereof, as more fully set forth herein.

It is further understood and agreed that the Surety does hereby relieve the City or its representatives from the exercise of any diligence whatever in securing compliance on the part of the Contractor with the terms of the Agreement and the Surety agrees that it shall be bound to take notice of and shall be held to have knowledge of all acts or omissions of the Contractor in all matters pertaining to the Agreement.

It is further expressly agreed by Surety that the City or its representatives are at liberty at any time, without notice to the Surety, to make any change in the Agreement and in the Work to be done thereunder, as provided in the Agreement, and in the terms and conditions thereof, or to make any change in, addition to, or deduction from the Work to be done thereunder; and that such changes, if made, shall not in any way vitiate the obligation in this Bond and undertaking or release the Surety therefrom.

IT IS FURTHER EXPRESSLY AGREED AND UNDERSTOOD THAT THE CONTRACTOR AND SURETY WILL FULLY INDEMNIFY AND SAVE HARMLESS THE CITY FROM ANY LIABILITY, LOSS, COST, EXPENSE, OR DAMAGE ARISING OUT OF CONTRACTOR'S PERFORMANCE OF THE AGREEMENT.

If the City gives Surety notice of Contractor's default, Surety shall, within 45 days, take one of the following actions:

- 1. Arrange for Contractor, with consent of the City, to perform and complete the Agreement; or
2. Take over and assume completion of the Agreement itself, through its agents or through independent contractors, and become entitled to the payment of the balance of the Agreement pricing and payments for work performed.

If the Surety fails to take either of the actions set out above, it shall be deemed to have waived its right to perform and complete the Agreement and receive payment of the balance of the Agreement payment and the City shall be entitled to enforce any remedies available at law, including but not limited to completing the Agreement itself and recovering any cost in excess of the Original Contract Price from the Surety.

This Bond and all obligations created hereunder shall be performable in Harris County, Texas. This Bond is given in compliance with the provisions of Chapter 2253, Texas Government Code, as amended, (even though the statute may not apply), which is incorporated herein by this reference.

Notices required or permitted hereunder shall be in writing and shall be deemed delivered when actually received or, if earlier, on the third day following deposit in a United States Postal Service post office or receptacle, with proper postage affixed (certified mail, return receipt requested), addressed to the respective other Party at the address prescribed in the Agreement, or at such other address as the receiving party may hereafter prescribe by written notice to the sending party.

This Bond and all obligations created under it shall be performable in Harris County, Texas, and all are non-cancelable. This Bond must be automatically renewed annually on the anniversary of the effective date of the Bond for the term of the Agreement and any extensions, unless the Surety gives the Principal and the City 30 days written notice before the renewal date that the Surety will not renew this Bond, in which case the Principal shall provide the City with a replacement bond (in the same form as this Bond) before the renewal date.

If the City brings any suit or other proceeding at law on the Agreement or this Bond, or both, the Principal and the Surety shall pay to the City the additional sum of 10 percent of whatever amount the City recovers, which sum of 10 percent is agreed by all parties to be indemnity to the City for the expense of and time consumed by its City Attorney, his or her assistants, and office staff, and other costs and damages to the City. The amount of 10 percent is fixed and liquidated by the parties because the exact damage to the City would be difficult to ascertain.

**IN WITNESS THEREOF**, the said Contractor and Surety have signed and sealed this instrument on the respective dates written below their signatures and have attached current Power of Attorney.

ATTEST/SEAL: (if a corporation)  
WITNESS: (if not corporation)

\_\_\_\_\_  
(Name of Contractor)

By: \_\_\_\_\_  
Name:  
Title:

By: \_\_\_\_\_  
Name:  
Title:  
Date:

ATTEST/SURETY WITNESS (SEAL)

\_\_\_\_\_  
(Full Name of Surety)

\_\_\_\_\_  
(Address of Surety for Notice)

\_\_\_\_\_  
(Telephone Number of Surety)

By: \_\_\_\_\_  
Name:  
Title:  
Date:

By: \_\_\_\_\_  
Name:  
Title: Attorney-in-Fact  
Date:

REVIEWED:

\_\_\_\_\_  
Sr. Assistant City Attorney  
P. O. Box 368  
Houston, TX 77001-0368

**EXHIBIT "H"**

**DRUG POLICY COMPLIANCE AGREEMENT**

I, \_\_\_\_\_ as an owner or officer of  
(Name) (Print/Type) (Title)  
\_\_\_\_\_  
(Name of Company) (Contractor)

have authority to bind Contractor with respect to its bid, offer or performance of any and all contracts it may enter into with the City of Houston; and that by making this Agreement, I affirm that the Contractor is aware of and by the time the contract is awarded will be bound by and agree to designate appropriate safety impact positions for company employee positions, and to comply with the following requirements before the City issues a Notice to Proceed:

1. Develop and implement a written Drug Free Workplace Policy and related drug testing procedures for the Contractor that meet the criteria and requirements established by the Mayor's Amended Policy on Drug Detection and Deterrence (Mayor's Drug Policy) and the Mayor's Drug Detection and Deterrence Procedures for Contractors (Executive Order No. 1-31).
2. Obtain a facility to collect urine samples consistent with Health and Human Services (HHS) guidelines and a HHS certified drug testing laboratory to perform the drug tests.
3. Monitor and keep records of drug tests given and the results; and upon request from the City of Houston, provide confirmation of such testing and results.
4. Submit semi-annual Drug Policy Compliance Declarations.

I affirm on behalf of the Contractor that full compliance with the Mayor's Drug Policy and Executive Order No. 1-31 is a material condition of the contract with the City of Houston.

I further acknowledge that falsification, failure to comply with or failure to timely submit declarations and/or documentation in compliance with the Mayor's Drug Policy and/or Executive Order No. 1-31 will be considered a breach of the contract with the City and may result in non-award or termination of the contract by the City of Houston.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Contractor Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Title

**EXHIBIT "I"**

**CONTRACTOR'S CERTIFICATION  
OF NO SAFETY IMPACT POSITIONS  
IN PERFORMANCE OF A CITY CONTRACT**

I, \_\_\_\_\_,  
(Name) (Title)

as an owner or officer of \_\_\_\_\_ (Contractor)  
(Name of Company)

have authority to bind the Contractor with respect to its bid, and hereby certify that Contractor has no employee safety impact positions, as defined in §5.18 of Executive Order No. 1-31, that will be involved

in performing \_\_\_\_\_  
(Project)

Contractor agrees and covenants that it shall immediately notify the City of Houston Director of Personnel if any safety impact positions are established to provide services in performing this City Contract.

\_\_\_\_\_  
(Date)

\_\_\_\_\_  
(Typed or Printed Name)

\_\_\_\_\_  
(Signature)

\_\_\_\_\_  
(Title)

EXHIBIT "J"

DRUG POLICY COMPLIANCE DECLARATION

I, \_\_\_\_\_ as an owner or officer of \_\_\_\_\_ (Contractor)
(Name) (Print/Type) (Title)
(Name of Company)

have personal knowledge and full authority to make the following declarations:

This reporting period covers the preceding 6 months from \_\_\_\_\_ to \_\_\_\_\_, 20\_\_\_\_.

Initials \_\_\_\_\_ A written Drug Free Workplace Policy has been implemented and employees notified. The policy meets the criteria established by the Mayor's Amended Policy on Drug Detection and Deterrence (Mayor's Policy).

Initials \_\_\_\_\_ Written drug testing procedures have been implemented in conformity with the Mayor's Drug Detection and Deterrence Procedures for Contractors, Executive Order No. 1-31. Employees have been notified of such procedures.

Initials \_\_\_\_\_ Collection/testing has been conducted in compliance with federal Health and Human Services (HHS) guidelines.

Initials \_\_\_\_\_ Appropriate safety impact positions have been designated for employee positions performing on the City of Houston contract. The number of employees in safety impact positions during this reporting period is \_\_\_\_\_.

Initials \_\_\_\_\_ From \_\_\_\_\_ to \_\_\_\_\_ the following testing has occurred: (Start date) (End date)

Random Reasonable Suspicion Post Accident Total

Number Employees Tested

Number Employees Positive

Percent Employees Positive

Initials \_\_\_\_\_ Any employee who tested positive was immediately removed from the City worksite consistent with the Mayor's Policy and Executive Order No. 1-31.

Initials \_\_\_\_\_ I affirm that falsification or failure to submit this declaration timely in accordance with established guidelines will be considered a breach of contract.

I declare under penalty of perjury that the affirmations made herein and all information contained in this declaration are within my personal knowledge and are true and correct.

(Date)

(Typed or Printed Name)

(Signature)

(Title)