Information Technology Department (ITD)
Infrastructure Engineering

Tucson Regional Communications and Networking Standards

City of Tucson Proprietary
Requirements for New and Existing City Facilities

Local and Wide Area Networks
Radio Communications

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Purpose

In order to meet the City of Tucson's (City's) current and future communications requirements, a comprehensive Wide Area Network (WAN) is being developed. This network will provide connection to all existing and new city buildings of significance. All city buildings or campus communication infrastructures (intra-building and inter-building data, voice, and video services), known as Local Area Networks (LAN) will be connected to the WAN.

To facilitate the implementation of this system in an economic and community responsive manner, portions of the system will be constructed in association with other public improvement projects being undertaken by various City Departments. This practice can provide a reduction in the initial capital and Operating costs of the system. Specifically, by integrating the installation of the communications system with other projects, the adverse impact of this installation will be mitigated by reducing the number of construction projects occurring within the City's Right-of- Way.

Such developments are in need of clearly defined communications requirements. Implementation will be initiated during the planning stage, carried through all phases of conceptual development, and sustained through execution.

The City is also involved in efforts to explore the advantages of regional partnering with other governmental and educational entities. Within this context, such entities are encouraged to make use of the guidelines herein, to the end of a consistent regional application.

This document is intended to set forth the basic criteria for the WAN and LAN, and to address the pertinent aspects of its design, construction, and testing. Specific requirements have been established for City Architecture & Engineering projects on City real property, for City Engineering projects in City Right-of-Way, for developments, and for in-building radio coverage. Requirements have also been identified for non-City entities working in City Right-of-Way in the sections entitled "Project Managerial Requirements for Private Projects in City Right-of-Way" and "Project Execution Requirements for Private Projects in City Right-of Way."

This is a document which is anticipated to be updated minimally annually and as needs and technology change. If any portion of this document has conflicts or errors, is subject to misinterpretation, or is not workable or constructible, please bring it to the attention of the City of Tucson Infrastructure Engineering (IE) Unit.

Definitions

Access Floor - A floor system that has removable floor panels.

Building Industry Consulting Service International (BICSI) - An organization of telecommunications professionals dedicated to the development of technical manuals and standards, training, and registration manuals.

Building Backbone Cabling – Cabling used to connect Floor Distributors (FD) or other local collection points to the Building Distributor (BD). Building backbone cabling typically carries aggregate traffic and, as such, impacts multiple network devices and users. Building backbone cabling may include either fiber optic or copper cabling or both.

Building Distributor (BD) – Termination point from which all building backbone cabling emanates and interconnection point for the network backbone. Commonly referred to as BDF in Americas, Main Comms Room in EMEA and Communication Room, IT Lab or IT Room in AsiaPac. Referred to as BD in international and European industry standards and Intermediate Cross-connect (IC) in American industry standards. There is one BD for each building and it feeds all FD's in the same building. The BD should be located so that all FD's served are within 300 cable meters (984 cable feet). All BD's are linked to the

Campus Backbone Cabling – Cabling used to connect Building Distributors (BD) or other key network segments to the Campus Distributor (CD). With rare exceptions, campus backbone cabling carries aggregate traffic and typically impacts entire buildings worth of network devices and users and, as such, link redundancy with diverse routing is highly recommended. Campus backbone cabling almost exclusively consists of fiber optic cabling. Copper cabling may be used in short-distance (< 90m) applications. In such cases, lightning protection will usually be required by code.

Campus Distributor (CD) – Termination point from which all campus backbone cabling emanates and highest-level interconnection point for the network backbone. Commonly referred to as NOC in Americas and Main Comms Room in EMEA. Referred to as CD in international and European industry standards and Main Cross-connect (MC) in American industry standards. On smaller campuses, there is one CD for the campus. On larger campuses there might be several CD's with each CD serving several buildings. Besides linking to each of the BD's it serves, the CD is also the network interconnection point for data center links and links to service providers.

Category 3 (Cat 3) – A category of transmission performance, defined in EIA standards, that specifies electrical properties up to 10 MHz. Cat 3 is the minimum performance grade permissible and is used typically for analog voice distribution.

Category 5e (Cat 5e) / Class D – A category/class of transmission performance that specifies electrical properties up to 155.5 MHz. Capable of supporting copper-based, four-pair Gigabit Ethernet (IEEE 802.3ab 1000BASE-T) applications. Category 5e is defined in TIA/EIA 568B.2 standard. Class D is defined in the ISO 11801 standard.

Category 6 (Cat 6) / Class E – A category/class of transmission performance that specifies electrical properties up to 250 MHz. Refer to the TIA/EIA 568B family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class E requirements. Also refer to CENELEC EN50173.

Category 6A (Cat 6) / Class E_A– A category/class of transmission performance that specifies electrical properties up to 500 MHz and capable of supporting data applications operating at 10Gbps. Refer to the TIA/EIA 568B family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class EA requirements.

Certification – The testing and documentation of the transmission performance (e.g., Category 5e / Class D) of a permanent link or channel, based on sweep frequency (where applicable) testing of numerous parameters with results compared to a range of acceptable values. This project requires 100% certification (with documentation) of all permanent link cabling at the time of installation. Channel certification is optional and is the responsibility of the group using the channel.

Channel – The entire physical pathway between active equipment ports, inclusive of all patch cords, patch panels, jacks and cabling segments.

Class C – A category of transmission performance, defined in ISO and EN standards, that specifies electrical properties up to 16 MHz (equivalent to EIA

Conduit - A raceway of circular cross-section.

Entrance Facility (EF) – Termination point of service provider cables that have entered the building and location of service demarcation point (MPOE) and interconnection point to the network. Commonly referred to as Telco Room in Americas, POP Room in EMEA and Building Entrance in AsiaPac. Referred to as Building Entrance Facility in international and European industry standards and Entrance Facility (EF) in American industry standards. The EF is linked to the CD, where present, or to the BD.

Floor Distributor (FD) – Termination point for horizontal cabling and interconnection point for network access. Commonly referred to as IDF in Americas and AsiaPac and as Sub Comms Room in EMEA. Referred to as Floor Distributor (FD) in international and European industry standards and Horizontal Cross-connect (HC) - FD quantities and locations are determined by building size and geometry so that all points served are within 90 cable meters (295 cable feet) of an FD. The FD feeds all Telecommunications Outlets (TO's) in its service zone. All FD's in a building are linked to the building's Building Distributor (BD) via backbone cabling.

Horizontal Cabling – Cabling used to connect individual work area outlets to local Floor Distributors (FD) or other collection points. Unlike backbone cabling, horizontal cabling does not typically carry aggregate traffic and, as such, impacts only single network devices or users. In buildings, horizontal cabling almost exclusively consists of copper cabling. Fiber optic cabling may be used where situations dictate but, unlike horizontal copper cabling, horizontal fiber optic cabling is not installed in advance as default building facilities. At this writing, horizontal copper cabling in many networks is capable of supporting Gigabit (1Gb/s) Ethernet applications as well as other applications of similar bandwidth.

Information and Communications Technology (ICT) - ICT covers the spectrum of voice, data, electronic safety & security, project management and audio & video technologies. It encompasses the design, integration and installation of pathways, spaces, optical fiber- and copper-based distribution systems, wireless-based systems and infrastructure that supports the transportation of information and associated signaling between and among communications and information gathering devices.

Infrastructure Engineering (IE) - A Division of the City of Tucson Department of Information Technology which has been assigned as one of its principal missions the oversight, planning, coordination and execution of a comprehensive City-wide communications master plan.

Local Area Network (LAN): - A geographically limited data communications system for a specific user group consisting of a group of interconnected group of computers sharing applications, data, and peripheral devices such as printers and CD-ROM drives intended for the local transport of data, video, and voice. Such a system can serve either a single building or a campus environment.

Permanent Link – A stationary cabling segment, consisting of the permanently installed cable and the permanently affixed jack at both ends (typically at the outlet faceplate and closet patch panel, or on a patch panel on both ends). The concept is based on the assumption that, while patch cords might be disconnected or moved over time, the permanent cable and jacks will not be disturbed and the electrical characteristics of the permanent link will remain unaltered.

Plenum -A space within the building designed for the movement of environmental air; i.e., a space above a suspended ceiling or below an access floor.

Raceway - Any channel designed for holding wires or cables; i.e. conduit, electrical metal tubing, busways, wireways, ventilated flexible cableway.

Registered Communications Distribution Designer (RCDD): - The title awarded to BICSI members who demonstrate expertise in the design, integration, and implementation of telecommunications (voice, data, video, audio, and other low-voltage control) transport systems and their related infrastructure components. This designation has become a de facto certification for professional competence within the telecommunications industry.

Spine – also called a backbone, the main communications cables in an IDF.

Telecommunications Room (TR) - defined by BICSI as an enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. This room is the recognized cross-connect between the backbone cable and horizontal cabling.

Wide Area Network (WAN) - An internetwork that uses telecommunications links to connect geographically distant LANs. Tucson's WAN is comprised of City fiber run in its Right-of- Way.

City General Service Department Architecture & Engineering Project Managerial Requirements

Design Standards

Design shall conform to sections CSI Format, Telecommunications Infrastructure. Project Managers shall instruct their consultant/engineer designers to insure that any written specifications are formatted as applicable to each project such that there is no room for misinterpretation on the part of any contractor or field inspector. Although Project Managers and their Consultants may import the content of these requirements and guidelines into their project designs, said requirements and guidelines are not substitutions for due diligence in design, procurement, and construction. **Details and specifications shall reflect actual project conditions.**

The sections below entitled "City General Service Department Architecture and Engineering Project Execution Requirements", "City General Service Department Architecture and Engineering General On-Site Design Requirements", and "800 Mhz In-Building Amplification System Requirements" have been broken out for the convenience of all Project Managers. However, it is the General Service Department Architecture & Engineering Project Manager's responsibility to verify that any work delegated to outside consultants is performed in compliance with these City of Tucson (City) Guidelines.

Project Drawings

- General Drawing Specifications: Detail and elevation drawings shall be D size (24" x 36") with a minimum scale of 1/4" = 1'0" or larger. ER, TR and other enlarged detail floor plan drawings shall be D size (24" x 36") with a minimum scale of 1/4" = 1'0" or larger. Building composite floor plan drawings shall be D size (24" x 36") with a minimum scale of 1/8" = 1' 0".

- Building composite floor plans: Provide building floor plans showing outlet locations and jack configuration, types of jacks, run distance for each jack cable, and cable routing/locations. Identify TO's that, according to location and available pathway systems, require cable length greater than allowed by standards. Recommend alternatives for Owners Representative's consideration.

- Telecommunications space plans/elevations: Include enlarged floor plans of TRs indicating layout of equipment and devices, including receptacles and grounding provisions. Submit detailed plan views and elevations of telecommunications spaces showing racks, termination blocks, and cable paths.

- Logical Drawings: Provide logical riser or schematic drawings for all systems. Include schematic symbol key.

Project Managers' Responsibilities, (PM)

Project Managers, (PM,) shall coordinate with Infrastructure Engineering (IE) to determine the optimum connection point and routing to the WAN. Final cost estimation for said connections shall be detailed as a part of the subject project.

It is the responsibility of the Project Manager to determine whether any pathway, conduit system, horizontal or riser cable, copper or optical fiber, will be installed in plenum air spaces. Unless otherwise allowed, all cables shall be plenum rated within the plenum air space

Project Managers shall provide customers and end users with the information detailed in the section entitled "For City Architecture and Engineering Division End Users and Customers".

Upon project completion, the Project Manager shall verify that the Contractor has supplied new drawings and electronic files, both PDF and DWG formats, which reflect all changes and "as-built" information.

Project Construction Administrators' Responsibilities, (CA)

Project Construction Administrators shall coordinate with IE during the construction period. This coordination shall include a discussion of all system modifications, and the schedule of inspections and system testing. The PM shall forward any and all relevant submittals and project time lines for IE review and acceptance and allow a 2 week period for review, and comment.

Special Testing Requirements

All tests of Telecommunications Systems shall be witnessed by a IE representative. Final acceptance of the project shall not be issued until such time that IE or its representative provides written acceptance of all aspects of the Telecommunications Systems.

Special Note All under and above ground conduit systems require intended for the existing and future use of Telecommunications Infrastructure require the witnessing representative of IE observing the testing of the conduits to install a tag labeled

"DEDICATED CITY OF TUCSON COMMUNICATION CONDUIT.
CONTACT INFRASTRUCTURE ENGINEERING BEFORE USING."

upon acceptance, after the conduit run has satisfactorily passed all testing. No party other than IE shall remove said plug and label once it is installed.

IE shall be included in the review and approval process for all Architecture/Engineering Division projects. It shall be the ultimate responsibility of the Project Manager to insure that all IE comments are conveyed to any designer, and are properly addressed. Proof of implementation of IE comments shall be returned to IE before its approval of the plans and specifications.

Upon approval of City of Tucson Developmental Services, one complete set of drawings shall in both full size hard copy and electronic, (PDF,) format shall be forwarded to IE. One complete set of drawings shall be forwarded in both full size hard copy and electronic, (PDF,) format to Communication Maintenance.

City Architecture & Engineering Division Project Execution Requirements

System Design

All Information and Communications Technology (ICT) Systems shall be designed by a Registered Communications Distribution Designer (RCDD) with a current Building Industry Consulting Service International (BICSI) registration number stamp.

Communications/Data drawings shall be identified by T series numbers in the approved

Construction Drawings

The Communications/Data section of specifications manual shall be numbered separately and distinctly from other sections. Format shall follow the section entitled "SECTION 27-0000– TELECOMMUNICATIONS INFRASTRUCTURE". "DETAILS" also have been incorporated into City of Tucson (City) requirements for Architecture and Engineering projects.

As part of each submittal, ITD Infrastructure Engineering (IE) shall be furnished with a tabulation of the following system information.

The station and offset of each pull box and vault.

The total lengths of each conduit run between pulling points.

The total degree of bends of all vertical and horizontal bends between pulling points.

The latitude and longitude of the centerline of the pull boxes and vaults.

Specific stub-out locations proposed for each pull box and vault. (Butterfly Plan)

Plans depicting installations interior to buildings shall be prepared using the drafting standards of the department responsible for the project. Plans depicting installations exterior to buildings shall be drafted in accordance with Pima County/City of Tucson Standard Detail Numbers 100 and 101. The conduit shall be clearly indicated with respect to its horizontal and vertical alignment. The locations of all pull boxes and vaults shall be indicated by its station and offset. The identification number of each pull box and vault shall be included on the plans.

Any pathway, conduit system, horizontal or riser cable, copper or optical fiber installed in plenum spaces shall be rated as suitable for installation in Plenum environments.

Design Document Requirements

(All drawings shall include the following general notes)

Wide Area Network (WAN) Conduit System General Notes:

All existing City fiber facilities shall be protected in-place unless specifically noted otherwise on the construction documents. No existing City fiber optic conduit system or cable shall be altered in any way without

the written approval of the City ITD Infrastructure Engineering unit.

All new City fiber conduit systems shall cleaned and mandrel tested by the contractor in the presence of a Infrastructure Engineering (IE) representative. Provide 72 hour advance notice to ITServiceDesk@tucsonaz.gov or calling IT Service Desk at (520) 791-4370.

Conduit ends shall be capped when work is not in progress. Upon completion and acceptance by IE of the conduit system(s), all conduit ends shall be fitted with watertight alibi.

It shall be the sole responsibility of the Contractor to repair all existing City conduit systems and appurtenances damaged by construction. Immediate notification of any damaged existing conduit system, whether occupied or unoccupied, shall be reported to the Construction Administrator and the Communication Maintenance Division, at 791-4634 Monday through Friday between 7:30am to 4:30pm or 791-4830 after hours and weekends.

For repairs of occupied City fiber conduit systems, the Contractor shall repair, clean and mandrel test the conduit systems in the presence of a Communication Maintenance representative. The contractor shall install, re-terminate, and test new approved optical fiber cable as directed by the Communication Maintenance representative. The Contractor shall present such representatives with test results, in booklet form and as the original file recorded by the testing equipment, with a licensed version of the test equipment software, that will allow the City to view the test results as if viewed by the testing equipment. Acceptance of the work shall not occur before all documentation, test results, certification of test results and operation by such representatives has been approved.

For repairs of unoccupied City fiber conduit systems, the Contractor shall repair, clean and mandrel test the conduit systems in the presence of a Communication Maintenance representative.

City Architecture & Engineering Division End Users and Customers

Local Area Network (LAN) Station Cable

Definition:
The workstation cable refers to a category six data cable rated at a minimum 400 MHz that connects the user's equipment to the in-building data wiring system.

Standard:

- Workstation cable shall not exceed 15 feet from modular plug to modular plug.
- Workstation cable shall be purchased pre-assembled with a category six certification meeting the same properties as the workstation cable .

Exception:
Contact Communications Maintenance at 791-3121 for special situations that require greater than 15-foot cables.

Computer Workstation/Peripherals AC Power Surge Protection

Definition:
A portable multi-outlet passive protection device used to remove, filter or clamp harmful or disruptive AC power deviations.

Standard:
The surge protector shall be a Tripp Light, Model ISOBAR x or approved equal.

Exceptions:
Contact Communications at 791-3121 for special surge protection requirements.

Local Area Network (LAN) Information Outlet

Definition:
A Quadaplex wall, furniture or other mounted data connection device that provides up to four (4) in-building data jacks.

City Architecture & Engineering Division General On-Site Design Requirements

Conduit Design. The design of the conduit system shall at a minimum adhere to:

TIA/EIA 569 TELECOMMUNICATIONS PATHWAYS AND SPACES, Revision C,

TIA/EIA 758 CUSTOMER-OWNED OUTSIDE PLANT TELECOMMUNICATIONS INFRASTRUCTURE STANDARD Revision B and

TIA/EIA 568 COMMERCIAL BUILDING TELECOMMUNICATIONS CABLING STANDARDS SET, Revision C 1 thru 4 including all addenda and errata Standards

City Department of Transportation Project Managerial Special Considerations

Unless otherwise noted, all Department of Transportation Project Managerial Considerations shall follow all aspects of the City General Service Department Architecture & Engineering Project Managerial Requirements.

Design shall conform to sections 27-0000 but may use the Departments of Transportations numbering scheme 975, Telecommunications Infrastructure.

The section entitled "City Department of Transportation Project Execution Requirements" has been broken out for the convenience of all Project Managers. However, it is the Department of Transportation (DOT) Project Manager's responsibility to verify that any work delegated to outside consultants is performed in compliance with these City of Tucson Standards.

Project Managers shall coordinate with ITD Infrastructure Engineering (IE) to determine the optimum routing of the City fiber conduit.

IE shall be included in the review process for all DOT projects. It shall be the ultimate responsibility of the Project Manager to insure that all IE comments are conveyed to any designer, and are properly addressed.

City Department of Transportation Project Execution Special Requirements

Unless otherwise noted, the City Department of Transportation Project Execution Special Requirements, shall follow the City General Service Department Architecture & Engineering Project Execution Requirements.

For applications where conduit for fiber optic infrastructure is to be installed under funding specific to the subject project, the installation of four 4" conduits, including 2500# rated pull strength traceable mule tapes in each, conduit end caps, and approved pull boxes will meet the intent of these standards.

The plans shall be prepared using the drafting standards of the department responsible for the project. Plans depicting installations exterior to buildings shall be drafted in accordance with,

Pima County/City of Tucson Standard Detail Numbers 100 and 101.

The conduit shall be clearly indicated with respect to its horizontal and vertical alignment.

The alignment of the conduit shall follow the general horizontal alignment of new water lines, street lighting and traffic signal conduits, or other underground utilities to the fullest extent possible. The utilization of a joint trench shall be employed as much as practicable. When street lighting or traffic signal conduit is encased in concrete, the fiber optic conduit shall be encased in concrete also. When the alignment of the trenching for the other utilities does not allow for the installation of the City fiber conduit, the conduit shall be installed in a separate trench.

When installed adjacent to water mains, the conduit shall be encased in Controlled Low Strength Material (CLSM). The conduit shall be supported on plastic spacers capable of preventing displacement of the conduit

during the placement of the CLSM. During the placement of the encasement material, the conduits shall be tied down to prevent the conduit from floating. The minimum cover on all sides of the conduit shall be 3 inches.

In all areas where the depth of cover above the conduit is less than 30", the conduit shall be encased in concrete. The concrete encasement shall be a minimum of Class B (2,500 PSI) in accordance with Pima County/City of Tucson Standard Specifications and provide a minimum cover on all sides of the conduit of 3 inches.

When the conduit is installed in a joint trench with a water main, the bedding and shading material shall be aggregate bedding material meeting the specifications for the water main. The conduit shall be installed at an invert equal to, or above, that of the water line and offset from the water line as indicated on the Standard Details (Appendix B). The selection of the location of the conduit shall be approved by Tucson Water. The conduit(s) shall generally be installed at a uniform depth of cover. However, when the vertical alignment of the water main offers a smoother profile for the conduit, the conduit(s) may follow the general alignment of the water main. At crossings of other utilities, where the water main is rolled under another utility line, effort(s) shall be made to maintain the vertical alignment of the conduit. In cases where it is impossible to maintain the alignment of the conduit at the utility crossing, the grade of the conduit shall be transitioned using the minimum number and the longest radius bends. To accomplish this, the water system design shall consider the use of 11-1/4 degree bends, or 22-1/2 degree bends for the water line.

In the selection of pull box locations, consideration shall be given to potential location of future City fiber optic conduit runs intersecting the project. At all locations where existing, or future, conduit runs cross the project, a pull box shall be located near the point of intersection. At all locations where new conduit crosses an existing City fiber conduit, a pathway shall be provided between the conduit runs. At locations of future conduit runs, a conduit stub-out shall be installed along the future alignment, to a location which is outside of the limits of any future pavement. Pull boxes shall be located in the vicinity of City facilities scheduled to be connected to the City fiber system. When pull boxes are located near a signalized intersection, the pull box shall be located as near as practicable to the Control Cabinet, and connected to it.

Equipment areas should not be fenced unless such fencing is installed to meet Code requirements or standard design practice as applicable to life safety issues; in such cases this fencing shall meet the intent of this paragraph in its aesthetic presentation. The equipment must not emit detectable noises or sounds unless they are placed far enough from pedestrian traffic flow that the noise is undetectable. The telephone number for Graffiti Abatement shall be discreetly posted toward the bottom of the equipment. It shall be the responsibility of any vendor or provider to periodically check equipment to ensure that it complies with these standards. Noncompliant vendors may be fined or directed to relocate or remove equipment. Obsolete or unused facilities which have not served a customer for 90 days shall be removed in a timely manner. Cost of removal shall be the responsibility of the vendor or provider.

Private Communications Projects in City Right-of-Way Project Managerial Special Requirements

Unless otherwise noted, all Project Managerial Special Requirements for Private Communications Projects in City Right-of-Way shall follow all aspects of the City Architecture & Engineering Division Project Managerial Requirements.

Private Communications Projects in City Right-of-Way Project Execution Special Requirements

Unless otherwise noted, the Project Execution Special Requirements for Private Communications Projects in City Right-of-Way shall follow the City Architecture & Engineering Division Project Execution Requirements.

Division 27 – Telecommunications Infrastructure: CSI Format

NOTE-The enclosed specification is a guideline for Architects and Engineers to follow and contains many of the requirements for all City of Tucson Division 27 work. Ensure necessary edits and additions are fulfilled.

The following sections should be considered for all Projects

27 01 00	**Operation and Maintenance of Communications Systems**
27 01 00	Operation And Maintenance Of Communications Systems
27 01 10	Operation And Maintenance Of Structured Cabling And Enclosure
27 01 20	Operation And Maintenance Of Data Communications
27 01 30	Operation And Maintenance Of Voice Communications
27 05 00	**Common Work Results for Communications**
27 05 05	Selective Demolition For Communications
27 05 10	Structured Cable Recycling
27 05 26	Grounding And Bonding For Communications Systems
27 05 28	Pathways For Communications Systems
27 05 29	Hangers And Supports For Communications Systems
27 05 33	Conduits And Backboxes For Communications Systems
27 05 36	Cable Trays For Communications Systems
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27 05 53	Identification For Communications Systems
27 08 00	**Commissioning of Communications**
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27 11 00	**Communications Equipment Room Fittings**
27 11 13	Communications Entrance Protection
27 11 16	Communications Cabinets, Racks, Frames, and Enclosures
27 11 19	Communications Termination Blocks and Patch Panels
27 11 23	Communications Cable Management and Ladder Rack
27 11 26	Communications Rack Mounted Power Protection and Power Strips
27 13 00	**Communications Backbone Cabling**
27 13 13	Communications Copper Backbone Cabling
27 13 13.13	Communications Copper Cable Splicing and Terminations
27 13 23	Communications Optical Fiber Backbone Cabling
27 13 23.13	Communications Optical Fiber Splicing and Terminations
27 13 33	Communications Coaxial Backbone Cabling
27 13 33.13	Communications Coaxial Splicing and Terminations
27 13 43	Communications Services Cabling
27 15 00	**Communications Horizontal Cabling**
27 15 01	Communications Horizontal Cabling Applications

27 15 01.16	Voice Communications Horizontal Cabling
27 15 01.19	Data Communications Horizontal Cabling
27 15 01.23	Audio-Video Communications Horizontal Cabling
27 15 01.46	Paging Communications Horizontal Cabling
27 15 01.49	Intermediate Frequency/Radio Frequency Communications Horizontal Cabling
27 15 01.53	Antennas Communications Horizontal Cabling
27 15 13	Communications Copper Horizontal Cabling
27 15 23	Communications Optical Fiber Horizontal Cabling
27 15 33	Communications Coaxial Horizontal Cabling
27 15 43	Communications Faceplates and Connectors
27 16 00	**Communications Connecting Cords, Devices, and Adapters**
27 16 13	Communications Custom Cable Assemblies
27 16 16	Communications Media Converters, Adapters, and Transceivers
27 16 19	Communications Patch Cords, Station Cords, and Cross Connect Wire
27 51 00	**Distributed Audio-Video Communications Systems**
27 51 13	Paging Systems
27 51 13.13	Overhead Paging Systems
27 51 16	Public Address Systems
27 51 19	Sound Masking Systems
27 51 23	Intercommunications and Program Systems
27 51 23.20	Commercial Intercommunications and Program Systems
27 51 26	Assistive Listening Systems
27 53 00	**Distributed Systems**
27 53 13	Clock Systems
27 53 13.13	Wireless Clock Systems
27 53 16	Infrared and Radio Frequency Tracking Systems
27 53 19	Internal Cellular, Paging, and Antenna Systems

28 00 00	**ELECTRONIC SAFETY AND SECURITY**
28 01 00	Operation and Maintenance of Electronic Safety and Security
28 01 10	Operation and Maintenance of Electronic Access Control and Intrusion Detection
28 01 20	Operation and Maintenance of Electronic Surveillance
28 01 30	Operation and Maintenance of Electronic Detection and Alarm
28 01 30.51	Maintenance and Administration of Electronic Detection and Alarm
28 05 00	**Common Work Results for Electronic Safety and Security**
28 05 13	Conductors and Cables for Electronic Safety and Security
28 05 13.13	CCTV Communications Conductors and Cables
28 05 13.16	Access Control Communications Conductors and Cables
28 05 13.19	Intrusion Detection Communications Conductors and Cables
28 05 13.23	Fire Alarm Communications Conductors and Cables
28 05 26	Grounding and Bonding for Electronic Safety and Security
28 05 28	Pathways for Electronic Safety and Security
28 05 28.29	Hangers and Supports for Electronic Safety and Security
28 05 28.33	Conduits and Backboxes for Electronic Safety and Security
28 05 28.36	Cable Trays for Electronic Safety and Security
28 05 28.39	Surface Raceways for Electronic Safety and Security
28 05 53	Identification for Electronic Safety and Security
28 06 00	Schedules for Electronic Safety and Security
28 06 10	Schedules for Electronic Access Control and Intrusion D etection
28 06 20	Schedules for Electronic Surveillance
28 06 30	Schedules for Electronic Detection and Alarm
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28 08 00	Commissioning of Electronic Safety and Security
28 10 00	**ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION**
28 13 00	**Access Control**
28 13 13	Access Control Global Applications
28 13 16	Access Control Systems and Database Management
28 13 19	Access Control Systems Infrastructure
28 13 26	Access Control Remote Devices
28 13 33	Access Control Interfaces
28 13 33.16	Access Control Interface's to Access Control Hardware
28 13 33.26	Access Control Interface's to Intrusion Detection
28 13 33.33	Access Control Interface's to Video Surveillance
28 13 33.36	Access Control Interface's to Fire Alarm
28 13 43	Access Control Identification Management Systems
28 16 00	**Intrusion Detection**
28 16 13	Intrusion Detection Control, GUI, and Logic Systems
28 16 16	Intrusion Detection Systems Infrastructure
28 16 19	Intrusion Detection Remote Devices and Sensors
28 16 33	Intrusion Detection Interfaces
28 16 33.13	Intrusion Detection Interfaces to Remote Monitoring

28 16 33.16 Intrusion Detection Interfaces to Access Control Hardware
28 16 33.23 Intrusion Detection Interfaces to Access Control System
28 16 33.33 Intrusion Detection Interfaces to Video Surveillance
28 16 33.36 Intrusion Detection Interfaces to Fire Alarm
28 16 43 Perimeter Security Systems
28 16 46 Intrusion Detection Vehicle Control Systems

28 20 00 ELECTRONIC SURVEILLANCE
28 23 00 Video Surveillance
28 23 13 Video Surveillance Control and Management Systems
28 23 16 Video Surveillance Monitoring and Supervisory Interfaces
28 23 19 Digital Video Recorders and Analog Recording Devices
28 23 23 Video Surveillance Systems Infrastructure
28 23 26 Video Surveillance Remote Positioning Equipment
28 23 29 Video Surveillance Remote Devices and Sensors
28 26 00 Electronic Personal Protection Systems
28 26 13 Electronic Personal Safety Detection Systems
28 26 16 Electronic Personal Safety Alarm Annunciation and Control Systems
28 26 19 Electronic Personal Safety Interfaces to Remote Monitoring
28 26 23 Electronic Personal Safety Emergency Aid Devices

28 30 00 ELECTRONIC DETECTION AND ALARM
28 31 00 Fire Detection and Alarm
28 31 13 Fire Detection and Alarm Control, GUI, and Logic Systems
28 31 23 Fire Detection and Alarm Annunciation Panels and Fire Stations
28 31 33 Fire Detection and Alarm Interfaces
28 31 33.13 Fire Detection and Alarm Interfaces to Remote Monitoring
28 31 33.16 Fire Detection and Alarm Interfaces to Access Control Hardware
28 31 33.23 Fire Detection and Alarm Interfaces to Access Control System
28 31 33.26 Fire Detection and Alarm Interfaces to Intrusion Detection
28 31 33.33 Fire Detection and Alarm Interfaces to Video Surveillance
28 31 33.43 Fire Detection and Alarm Interfaces to Elevator Control
28 31 43 Fire Detection Sensors
28 31 46 Smoke Detection Sensors
28 31 49 Carbon-Monoxide Detection Sensors
28 31 53 Fire Alarm Initiating Devices
28 31 53.13 Fire Alarm Pull Stations
28 31 53.23 Fire Alarm Level Detectors Switches
28 31 53.33 Fire Alarm Flow Switches
28 31 53.43 Fire Alarm Pressure Sensors
28 31 63 Fire Alarm Integrated Audio Visual Evacuation Systems
28 31 63.13 Fire Alarm Horns and Strobes
28 33 00 Fuel-Gas Detection and Alarm
28 33 13 Fuel-Gas Detection and Alarm Control, GUI, and Logic Systems
28 33 23 Fuel-Gas Detection and Alarm Integrated Audio Evacuation Systems
28 33 33 Fuel-Gas Detection Sensors

28 34 00 Fuel-Oil Detection and Alarm
28 34 13 Fuel-Oil Detection and Alarm Control, GUI, and Logic Systems
28 34 23 Fuel-Oil Detection and Alarm Integrated Audio Evacuation Systems
28 34 33 Fuel-Oil Detection Sensors
28 35 00 Refrigerant Detection and Alarm
28 35 13 Refrigerant Detection and Alarm Control, GUI, and Logic Systems
28 35 23 Refrigerant Detection and Alarm Integrated Audio Evacuation Systems
28 35 33 Refrigerant Detection Sensors

28 40 00 ELECTRONIC MONITORING AND CONTROL
28 46 00 Electronic Detention Monitoring and Control Systems
28 46 13 Hard-Wired Detention Monitoring and Control Systems
28 46 16 Relay-Logic Detention Monitoring and Control Systems
28 46 19 PLC Electronic Detention Monitoring and Control Systems
28 46 23 Computer-Based Detention Monitoring and Control Systems
28 46 26 Discreet-Logic Detention Monitoring and Control Systems
28 46 29 Discreet-Distributed Intelligence Detention Monitoring and Control Systems

33 00 00 Utilities

33 81 00	**Communication Structures**
33 80 00	Common Work Results for Utilities
33 71 19	Communication Underground Ducts
33 21 19.13	Communication Manholes and Handhole

Division 27 COMMUNICATIONS

This section serves as a guideline and Minimum Requirement for work on City of Tucson Information Transportation Systems (ITS). It is the responsibility of the Design team to ensure all specifications are met and any additional specifics are included for Information Engineering review before release of final documents.

It is the responsibility of ITD Infrastructure Engineering (IE) to insure that a fully compliant and efficient communication infrastructure is in place for the city's needs. These standards are in place to accomplish that goal. These standards are developed for the use of all departments as well as all Architects, Developers and Contractors involved in construction on COT campus. All SOW and project proposals/ designs shall be in accordance to BICSI recommended installation practices and standards/ codes stated below. Cost for materials and installation of all Telecommunications related items should be part of the Project Budget. Coordination with COT/IE shall be required prior to actual construction and wiring placement.

Approved Contractor Requirements

A. The Telecommunications Contractor shall have an RCDD on staff and shall be an approved Uniprise Systems Installer

B. A copy of the certification documents must be submitted with bid documents.

C. Overall project management/ installation oversight shall be by a BICSI certified RCDD on a weekly basis.

D. The System Installer shall have a certified BICSI Technician Lead employed on staff and on-site during project construction at all times. The Lead Technician shall be OSHA 30 Certified.

E. All Installers/ Technicians shall be minimally manufacture certified all members of the installation team shall be OSHA 10 certified.

F. A Commscope Uniprise 20 year Extended Warranty Program covering all components, equipment and workmanship shall be submitted in writing with As-Built documentation.

G. Should the cabling system fail to perform IE expected operation within the warranty period due to inferior or faulty material and/or workmanship, the contractor shall promptly make all required corrections without cost to the City of Tucson.

H. No portion of the Telecommunications cabling contract may be subbed out to another entity unless prior approval is granted by COT/ IE

I. All subcontractors/ contractors shall wear in plain sight photo ID at all times during project construction stating company name, employee name and current BICSI credential.

Codes and Standards Compliance

Materials and equipment shall be the standard products of the manufacturer regularly engaged in the manufacture of the products and shall be of the manufacturer's latest standard product design that has been in satisfactory use for at least 2 years prior to bid opening.

All materials shall comply with the most current applicable sections of the following Codes for installation of telecommunications cabling:

Uniform Building Code (UBC)

National Electrical Code (NEC/NFPA 70)

National Electrical Safety Code (NESC IEEE C 2)

Local Codes, amendments and ordinances.

All materials and installation practices shall comply with the applicable sections of the following Telecommunications Industry Standards and all applicable addendums:

Reference Standards

The following Reference Standards shall be used as needed

ANSI/NFPA 70/250 - National Electric Code – Ground and Bonding

ANSI/NFPA 70/318 – National Electric Code – Cable Trays

ANSI/TIA/EIA-568-C.1-2009+A1:2012, Commercial Building Telecommunications Cabling Standard,

ANSI/TIA/EIA-568-C.2-2009+A1:2010, Balanced Twisted Pair Telecommunications Cabling and Components Standard

ANSI/TIA/EIA-568-C.3-2009+A1:2010,Optical Fiber Telecommunications Cabling Systems Standard

ANSI/TIA/EIA-568-C.3-2009+A1:2011, Optical Fiber Cabling and Components Standard

ANSI/TIA/EIA-568-B.2-1: Transmission Performance Specification for 4-Pair 100 Ω Category 6 Cabling (Standard).

ANSI/TIA/EIA-569-C.0-2009+A1:2010+A2:2012,Generic Telecommunications Cabling for Customer Premise Standard

ANSI/TIA/EIA-569-C-2012, Commercial Building Standards for Telecommunications Pathways and Spaces

ANSI/TIA/EIA-570-C-2012, Residential Telecommunications Infrastructure Standard

ANSI/TIA/EIA-606-B-2012, The Administration Standard for Commercial Telecommunications

ANSI/TIA/EIA-607-B-2013, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

ANSI/TIA/EIA-758-B-2012, Customer Owned Outside Plant Telecommunications Infrastructure Standard

TIA/EIA-1005-A-2012 Telecommunications Infrastructure Standard for Industrial Premises

BICSI/NECA-607 Telecommunications Bonding and Grounding, Planning and Installation Methods for Commercial Buildings

TIA/EIA-942-A-2012 Telecommunications Infrastructure Standard for Data Centers

TIA-TSB-190, 2011 Guidelines on Shared Pathways and Shared Sheath

NFPA 780- Standard for Installation of Lightening Protection Systems, latest issue

BICSI Information Transport Systems Installation Methods Manual (ITSIM), current edition

BICSI Network Design Reference Manual (NDRM), current edition

BICSI Telecommunications Distribution Methods Manual (TDMM), current edition

BICSI Wireless Design Reference Manual (WDRM), current edition

Telecommunications Designers/ Contractors and Installers shall have read the above documents and must be familiar with the requirements that pertain to this installation. The documents may be obtained from:

Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, fax: 303-397-2740, http://global.his.com/

IEEE-Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY, 10017-2394, 800-678-IEEE, fax: 732-981-9667, http://standards.ieee.org/

For any questions or further information on ITS cabling standards, designs and layouts, please contact the ITServiceDesk@tucsonaz.gov or calling IT Service Desk at (520) 791-4370.

27 01 00 OPERATION AND MAINTENANCE OF COMMUNICATIONS SYSTEMS

27 01 10 OPERATION AND MAINTENANCE OF STRUCTURED CABLING AND ENCLOSURES

The operation and maintenance of all structured cabling systems are the responsibility of COT/IE and any and all changes or modification shall be coordinated with COT/IE.

27 01 20 OPERATION AND MAINTENANCE OF DATA COMMUNICATIONS

The operation and maintenance of all data communications are the responsibility of COT/IE and any and all changes or modification shall be coordinated with COT/IE

27 01 30 OPERATION AND MAINTENANCE OF VOICE COMMUNICATIONS

The operation and maintenance of all voice communications are the responsibility of COT/IE and any and all changes or modification shall be coordinated with COT/IE

27 02 00 WARRANTY REQUIREMENTS

27 02 10 Contractors Warranty

Contractor warranty: Provide all services, materials and equipment necessary for successful operation of entire telecommunications system and SCS system for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, wiring, accessories, software, hardware, installation, programming, and configuration required to maintain a complete and operable system. Provide manufacturer's published recommended preventative maintenance procedures during warranty period. This shall apply to all items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty. Additional warranty responsibilities are:

Provide 2-business day service beginning on date of Substantial Completion and lasting until termination of warranty period. Service shall be at no cost to Owner. Service can be provided by installing contractor or by a separate service organization. Choice of service organization shall be subject to Owner's approval. Submit name and a phone number that will be answered on a 24-hour basis each day of week, for duration of service.

Submit copies of equipment and material warranties to Owner before final acceptance.

A. **Owner's rights:** This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.

B. **Pathways Material and Installation warranty:** Provide all services, materials and equipment necessary to warrant the installation and performance of all pathway materials for a period of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

C. **Grounding and Bonding Material and Installation warranty:** Provide all services, materials and equipment necessary for successful operation of GBS for a period of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

D. **Firestopping Material and Installation warranty:** Provide all services, materials and equipment necessary to warrant the performance of all Firestopping material for a period of one year after beneficial use, or longer if required by the local AHJ. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

E. SCS Systems will be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow on program through the Vendor to provide support and service to the purchaser. The first part is an assurance program, which provides that the certified system will support the applications for which it is designed, during the 20-year warranty of the certified system.

F. The second portion of the certification is a 20-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, etc.).

G. In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.

H. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANSITIA/EIA-568-B shall be provided by the Vendor prior to the structured cabling system being installed.

I. The cabling system must conform to the current issue of industry standard ANSI/TIA/EIA-568. All performance requirements of this document must be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSIM manual.

J. Purchaser demands strict adherence to the performance specifications listed in ANSI/TIA/EIA-568-B series standards.

K. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacturer the product used in this cabling system.

27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

The City of Tucson ITS consists of a complete Uniprise solution for the structured cabling system to conform to all TIA/EIA Telecommunications Building Wiring Standards, latest edition of BICSI Telecommunications Method Manual and covered by the Uniprise 20 year Extended Warranty Program. All structured cabling tasks to be performed by Uniprise Certified Systems Installer

Uniprise Extended Warranty Recommended Part #'s.*

App	Color	Commscope Cable Part#
Voice	White	Ultramedia 6E 7504
Data	Blue	Ultramedia 6E 7504
Wireless	Green	Ultramedia 6E 7504
Security, EMCS	Red	Ultramedia 6E 7504
CCTV	Red	Ultramedia 6E 7504
CATV	White	Plenumax RG-6 2227

Wire Management and Racking: (Black finish only unless otherwise specified)

19" Rack	CPI 55053-503
Rack Ground Bus, (SSGB)	Panduit RGS134-1Y
Vertical Management	CPI 12096-503 (Used for the outside management in a multiple rack design)
	CPI 11729-503 (Used in between racks in a multiple rack design)

(Vertical Management shall run the entire length of the rack)
(Doors, spools and hinges for a complete solution shall be included)

Horizontal Management	CPI 11752-219 & CPI 11753-219 or approved equal
Ladder Rack	CPI 10250-712 or approved equal
Radius Drops	CPI 12101-701 or approved equal

(All hardware kits for connectivity and support shall be included for a complete install)

Patch Panels	Cat6	Uniprise M2000-24 1U, M2000-48 2U

Category 6 cabling shall be the minimum category cable recommended for all communication designs and plenum in type

Star Topology recommended for all building layouts. Consult with COT/IE before following any format that is not a star topology for a building overview with recommendations

27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

All building and Communication grounding to conform to the following codes, standards, and practices: NFPA 70 of NEC, ANSI J-STD-607-B, IEEE, latest edition of any BICSI Design method manual and all applicable National, State and Local building codes.

A Telecommunications Main Grounding Bus bar (TMGB) connected to the Electrical Grounding System is required in all buildings. All communication equipment spaces require a Telecommunication Grounding Bus bar (TGB) connected to the TMBG and bonded to approved building ground. All connections bonded with a minimum 6 AWG conductor. All cable tray, equipment racks, and equipment cabinets bonded to TGB. All Telecommunication protectors and associated metallic cable sheaths to be grounded to selected TGB with a minimum 6 AWG insulated conductor. All copper pairs to be protected at building entrance facility with gas tube type 350VDC protector modules.

27 05 26.10 GROUNDING COMMUNICATION HUTS & TOWERS

Certified lightning arrestors and feed thru devices are to be used at all installations including a common feed ground plate and earth grounds.

All electronic equipment and racks shall be grounded using the Motorola R56 standard as a guideline concerning bus wire thickness and attachments. The ATI-TP-76416 standard can be consulted when applied to communications equipment. Any unresolved issues for this requirement shall be assessed on a case-by-case basis by ITD.

A Master Ground Bus shall be used at all outside/inside installations to provide a common ground point. The MGB shall be grounded using an earth ground.

Data requirements vary from facility to facility depending upon the business information needs of the building occupants. Grounding shall be compliant to the above requirements where practical. Exceptions shall be reviewed on a case by cases basis by ITD

Weatherproof Antenna Ports The penetration of antenna transmission line (coaxial cable and waveguide) into the building may require the installation of a commercially made port assembly. The port assembly should be sized to accommodate the required number of antenna transmission lines with some capacity for future expansion.

Antenna shall be grounded either directly or by connection to support structures that shall use an earth ground. The same is true for towers but multiple ground will be required.

27 05 28 PATHWAYS FOR COMMUNICATIONS SYSTEMS

All communication cabling shall be routed in a designed and approved pathway system per ANSI/TIA/EIA-569-C, (Commercial Building Standard for Telecommunications Pathways and Spaces) and meet or exceed all National, State and Local codes and standards. Pathways shall run parallel to the building design. Design shall be documented in floor plans and have built in flexibility for tenant movement and expansion and designed for maintenance and relocation of cables as easy as possible. Any and all pathway sleeves shall be rigidly secured on both sides of the wall. ISP fiber optic cables shall be placed inside inner-duct for the protection of the fiber. Pathways shall not exceed 40% initial fill volume when installed. When necessary additional sleeves and pathways shall be installed to meet the standard to not exceed 40% initial fill volume. A free and clear pull-line with minimum 200lb pull rating will be available for future use will be left in all main pathways and conduits. All cable colors to be bundled separately in the ceiling and in all IDF's or TR's. When cables enter the closets they will be packed neatly ie:(cigarette packing) OSP pathways refer to Div. 33 for standards for pathways.

New construction Telecom Outlet consists of one (1) 4-11/16" square by 2-1/8" deep flush mounted box. Each outlet box shall have a EMT conduit stubbed above the drop ceiling or extended into the hallway cabletray. Conduits size is as follows:

1. For Outlets with 3 or less cables, use a 1" EMT conduit
2. For Outlets with 3-6 cables, use a 1.25" EMT conduit
3. For all other sizes, calculate fill ratio at 40% for proper sized conduit

27 05 29 HANGERS AND SUPPORT FOR COMMUNICATIONS SYSTEMS

All cable supports shall be located on maximum of 48" on center or in accordance to manufacturers' recommendations for the weight it will supporting and attached to both sides of cable tray. All cable supports rated for Fiber Optic, Category 6 and 6a structured cabling system. In a ceiling distribution design a minimum of 3" clearance between ceiling tile and cable or the lowest point of the support system in a tray design should be maintained. All hangers and supports must be suspended from or attached to the structural ceiling or walls with hardware designed to support their load bearing rating. Only Velcro type cable straps shall be used for dressing or securing Fiber Optics, Category 6 Cabling. J-Hook or straps for the support system shall be installed no greater than 48" on center and in accordance to all BICSI Design standards and best practices.

27 05 32 FIRESTOPPING FOR TELECOMMUNICATIONS SYSTEMS

Fire Wall penetrations shall be installed in accordance to the current City of Tucson Division 21 Fire Code guidelines. No exceptions will be taken unless otherwise approved prior to installation by the AHJ or Fire Marshall. Acceptable Manufacturers for Pre-Fabricated Fire Stop solutions are 3M, Hilti and STI (Specified Technologies Inc.).

27 05 33 CONDUITS AND BACK BOXES FOR COMMUNICATION SYSTEMS

New wall work requires a 4 inch square, deep metal box with a single gang plaster ring, for a four port outlet. A double gang plaster ring shall be installed for an eight port outlet. Surface mounted application shall be weather proof deep Bell boxes. Size of conduit entering all boxes shall conform to the standards with a maximum fill not exceed ding 40%.

All outlet conduits shall be stubbed into accessible ceiling space.

No section of conduit shall be longer than 30 m (100 ft.) between pull points.

No more than 180 degrees of conduit bends shall be permitted between pull points.

Above Grade Conduits

Minimum conduit size shall be 3/4 inch.

Conduits1-1/2 inches and smaller shall be steel electrical metallic tubing (EMT). Comply with UL 797. Tubing shall have hot dipped galvanized exterior, enamel-coated interior. EMT couplings and box connectors for EMT shall be of the throated steel compression gland type.

Conduits 2 inches and larger shall be galvanized rigid steel. RGS conduit shall be hot- dipped, galvanized steel with zinc coating or corrosion resistant lacquer on the inside, and be threaded, water and concrete-tight.

All conduits subject to mechanical injury or exposed in wet locations shall be rigid galvanized steel.

Design and installation of conduits should be run in most direct route possible with no more than two 90 degree bends and should not contain any electrical condulets (LB's). Conduit should not be placed over or adjacent to boilers, incinerators, hot water lines, electrical convertors/rectifiers/panels or steam lines. Conduits 2" or smaller

require a bend radius of 6 times the internal conduit diameter, more than 2"require 10 times the internal conduit diameter. All conduit ends should be reamed and fitted with insulated bushing. Specify a minimum two 1" conduits to each office type room on opposite walls and stubbed out to accessible location in the same room. All other rooms (labs, classrooms, etc.) require consultation with COT/IE. Conduits to terminate in a 5"x5"" double gang box with a single gang device cover and routed to communication cable tray or stubbed to accessible location. Equip all conduits with a pull cord that has a minimum test rating of 200 lb. All conduits dedicated to communication structured cabling system and shall not be shared with any other services. Underground Conduits that contain OSP telecommunications cables shall terminate with Conduit End Bells inside the BDF, vault or manhole and sealed when not in use. Conduits seals shall be re-enterable. Type of seal shall be approved by COT/IE/ ITS. No rigid foams permitted.

27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

Cable Tray Materials:

— Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.

Type and design of cable tray distribution system shall be pre-approved by COT/IE. Cable tray installation must be installed to meet NEC article-392 and all state and local codes. Cable tray should be dedicated to telecommunication use only and not shared with electrical. A/V (Audio/ Video) and Security may reside in the same pathway as Telecommunications **ONLY** with prior approval through COT/IE. Physical separation shall be required when multiple applications other than telecommunications reside in the same tray. Design should be such that all requirements for a maximum 40% initial fill volume and a certified Category 6 and 6a structured cabling system will be met i.e. bend radius, clearances and distances etc.

Cable tray to be sized so as not to exceed the allowable initial maximum fill volume of 40% for all services residing in the cable tray or support system. All metallic cable trays shall be grounded and clearly marked in accordance with ANSI/TIA/EIA-606-A and ANSI J-STD-607-B-2013

27 05 39 SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS

Surface raceway should only be considered as last resort and with prior coordination with COT/IE. Raceway design should be of a type that conforms to Category 6 certification for bend radius, interference and separation. Raceway must be capable of accepting Uniprise wiring products including jacks and faceplates. If electrical power and telecommunications services are both run in raceway separate compartments are required and must comply with applicable electrical codes. If a metallic barrier is provided, it must be bonded to ground. Raceway shall be sized so as not to exceed manufacturers fill rating.

All raceway shall be secured to surfaces via anchors of the appropriate type for the wall being attached to. Color of raceway shall match the wall being attached to.

Raceway shall be either Wiremold 6000, 3000, 700 series metallic, or Composite Plastic raceway including all components intended for a proper professional installation as required.

27 05 40 FURNITURE RACEWAYS AND PATHWAYS

All furniture pathways to adhere to ANSI/TIA/EIA-569-C current standards. Maximum pathway fill shall be 40%. Minimum size pathway shall not force the cable into a bend radius less than 1" under condition of maximum fill.

Any parallel pathway to electrical must have proper separation. All furniture pathways must be capable of accepting Uniprise brand termination hardware.

27 05 43 UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATION SYSTEMS

See section 33.81.26 for Site communications ducts, manholes. Under floor ducts systems shall be dedicated space for telecommunication cables and not shared with any other utility. The guideline for planning duct capacity is $1in^2$ of cross section for each $100ft^2$ of useable floor space. Junction boxes shall be placed at a maximum of 60 ft to allow access for cable placement. All distribution ducts must be physically linked to a telecommunication room directly or through no more than one feeder duct. Ducts entering the telecommunications room must terminate in either a slot or elbow.

Conduit Types

Examples of conduit types include:

- EB-20 – For encasement in concrete;
- EB-35 – For encasement in concrete;
- DB-60 – For direct burial or encasement in concrete;
- DB-100 – For direct burial or encasement in concrete;
- DB-120 – For direct burial or encasement in concrete;
- Rigid Nonmetallic Conduit Schedule 40 – For direct burial or encasement in concrete;
- Rigid Nonmetallic Conduit Schedule 80 – For direct burial or encasement in concrete;
- Multiple Plastic Duct (MPD) – For direct burial or installation in conduit;
- Rigid Metallic Conduit – For direct burial or encasement in concrete;
- Intermediate Metallic Conduit – For direct burial or encasement in concrete;
- Fiberglass Duct – For direct burial or encasement in concrete;
- Innerduct Polyethylene (PE) – For direct burial or installation in conduit;
- Innerduct Polyvinyl Chloride (PVC) – For direct burial or installation in conduit

The length of conduit between pulling points shall not exceed 600 ft (183m).

Manufactured bends should be used whenever possible. No section of conduit shall contain more than two 90-degree bends, or equivalent between pull points.

Rigid Steel Conduit Sweeps. Conduit sweeps shall be listed by UL and conform to NEC standards. The bends shall be steel, hot dipped zinc coated, meeting the requirements of UL 6 and ANSI C80.1, and shall carry the Underwriters Laboratory label. Non-thread couplings shall not be used. Sweeps shall have a minimum radius of 12 times the nominal or manufacturer's standard bend but never less than 10 times the diameter, radius, double wrapped with 10 mil PVC tape specifically manufactured for corrosion protection of metallic conduit installed below grade.

Flexible Conduit. When specifically indicated on the plans and where approved by the engineer, flexible solid wall direct bury conduit may be used. The conduit shall be specifically manufactured for direct buried fiber optic raceway systems. Flexible conduit shall not be utilized for making bends in conduit system. Connection between the flexible conduit and conduit of other materials shall be made with a watertight transition coupling manufactured for the specific type of material.

Plastic Conduit Spacers. Spacers shall be constructed of Polyvinyl Chloride (PVC) or other non-metallic material. The spacers shall be vertical and horizontal interlocking and provide a minimum of 3-inch clearance between

conduits. Base spacers shall be provided with a wide base plate to provide solid support on the bottom of the trench. The base spacers shall provide for a minimum clearance of 3 inches between the bottom of the trench and the conduit. The spacers shall be tied down to prevent displacement during concrete encasement.

Detectable Warning Tape. An electronically detectable 6" Fiber Warning tape shall be installed 18" above the conduit. Tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with a minimum thickness of 0.004 inch. The tape shall have a minimum strength of 7500 PSI lengthwise and 1,500 PSI crosswise. The tape shall be manufactured with integral wires, foil backing, or other means to enable IE detection by a metal detector when the tape is buried up to a depth of 3 feet deep. The tape shall be orange in color and have the following diameter of the conduit. Steel conduit sweeps shall have a factory applied 40 mil PVC coating continuous inscription,

"CAUTION - FIBER OPTIC CABLE BURIED BELOW".

The inscription shall be 2-inch black letters.

Backfill Material. The backfill material shall conform to that of the subject project.

Innerduct. Innerduct shall be PVC/PE smooth walled exterior/wave interior with 1250 pound test muletape installed. No corrugated innerduct will be accepted.

Watertight Alibi. Watertight Alibi shall consist of a Quadaplex Duct Plug designed to seal around, organize, and support innerduct where it emerges at the top of all risers, pull boxes, and vaults. Fasteners shall be stainless steel. Plug shall support a minimum of 400 lbs of cable, and shall be removable. Jackmoon or equivalent. No chemical seals will be accepted.

Blank Duct Plugs. Blank Duct Plugs shall be installed in each individual innerduct where it emerges at the top of all risers, pull boxes, and vaults. Shall be all plastic construction, corrosion proof, water and air tight to 30 psi. Jackmoon or equivalent.

27 05 53 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

All horizontal fiber optic cables shall be labeled according the same scheme as horizontal cable runs described elsewhere.

All vertical or interbuilding Fiber Optic Cables will be identified with the following labeling scheme. Within 3 feet of termination, a Panduit part # PST-FO or equal yellow and black "CAUTION Fiber Optic Cable" plastic label will be attached. It will be labeled according to the following scheme:

EXAMPLE: COT-001-96MM-CHXXX-149/PWXXX-213

		Local Site Cable	Remote Site Cable
COT-	001-	96MM	CH
City of Tucson Fiber Optic Cable	Cable Number 001 to 1000 or greater	Indicates that cable contains 96 Multimode Fibers	Cable runs between CH= City Hall Basement Room #149

OSP =	Outside Plant Cable	SM =	Singlemode
3 DFX =	Multimode Outside	HY =	Hybrid
4 DNX =	Singlemode Outside	0 =	Basement
OFNR =	Riser Cable Indoor	1 =	First floor
OFNP =	Plenum Cable Indoor	2 =	Second floor
MM =	multimode	3 =	Third floor, etc.

27 08 00 Commissioning Of Communications Systems

Provide installation testing of equipment where required by manufacturer's installation instructions.

Provide complete end to end testing for all copper and fiber optic systems/channels based on latest applicable standards. Document all testing and submit with final as-built submittal package

27 08 13 Commissioning Of Communications Systems - Copper Cable

All tests must be witnessed by a representative of the City of Tucson Communications Maintenance Division.

Test equipment shall be a device providing for active sweep testing of Digital Signal Processing (DSP) of circuit. Contractor shall provide proof of recent factory calibration, (within the previous 12 months) of all test equipment. Copper test equipment shall be Level III+ Compliant

All Copper OSP twisted pair cable to be tested with complete wire map and 100 % pass rate for following:

- DC loop resistance
- Wire map
- Continuity to remote end
- Shorts between two or more conductors
- Crossed pairs
- Reversed pairs
- Split pairs
- Any other miss-wiring

All Voice and Data Category 6 twisted pair cables will be tested with a 100% pass rate to the cable categories applicable standard for the following in accordance to Amendment 10 of the TIA/EIA-568-B.2 document:

- Insertion Loss (IL)
- Near End Crosstalk (NEXT)
- Power Sum Near End Crosstalk (PSNEXT)
- Attenuation to Crosstalk Ratio (ACR)
- Power Sum Attenuation to crosstalk Ratio (PSACR)
- Far End Crosstalk (FEXT)
- Equal Level Far End Crosstalk (ELFEXT)
- Power Sum Equal Level Far End Crosstalk (PSELFEXT
- Return Loss (RL)
- Wire Map
- Propagation Delay
- Delay Skew
- Length

27 08 16 - Commissioning Of Communications Systems - Optical Fiber

Optical test equipment shall be suitable for measuring the attenuation and optical characteristics of the installed Fiber Optic plant. Optical test shall include but not limited to End to End attenuation via an Optical power loss

set; Optical Time Domain Reflectometer (OTDR), optical loss of all connectors, microbending, and conformance to optical specifications; and a power meter capable of performing end-to-end loss test on SM/MM fiber. Optical characteristic testing shall be an average of not less than 15 seconds of active measurement. Contractor shall provide proof of factory calibration within the previous 12 months of all test equipment.

The Contractor shall supply factory reeling test, which shows compliance with all fiber cable optical, attenuation and bandwidth criteria.

Optical Fiber Testing

Fiber Optic Cabling tests shall be performed on the completed end-to-end spans that include a near-end pre-connectorized single-fiber cable assembly, outside plant or riser as specified, and a far-end pre-connectorized single-fiber cable assembly. Two optical tests shall be performed as follows.

OTDR Testing:
Test wavelengths [850], [1300], [1310], and [1550], shall be tested. OTDR tests are required for lengths of fiber exceeding 1,000 feet or have inline splices

The OTDR test shall be measured bidirectional.

A reference length of fiber, 100 m minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature.

Attenuation Test
End-to-end attenuation measurement shall be made on all fibers, in bidirectional, using a [850] [1300] [1310] [1550] nanometer light source at one end and the optical power meter in the other end. This test will be used to verify that the cable system attenuation requirements are met.

Acceptance
Acceptance of system shall occur after all required documentation, test results, certification of test results and operation by the City of Tucson, Final acceptance shall include a visual inspection of the system in IE entirety and approval of City of Tucson, or their appointed representative(s).

27 10 20.30 Test Documentation

Electronic Format
Certification Test Reports shall be submitted in electronic format using the appropriate software supplied by the test equipment manufacturer. The data format should be that of the test report software (i.e. *.flw files for Fluke). The contractor shall provide any necessary software to view and evaluate the test data.

The following list is provided as a reference:

Tester	Test Report Software
Fluke	LinkWare
Ideal	LanTek Reporter

One electronic copy of the Test Reports shall be provided.

27 15 00 STRUCTURED CABLING

27 11 00 Communications Equipment Room Fittings

All buildings shall have at least one (depending on building size, footprint and design possibly more) Telecommunications room per floor. Building design shall be such that no permanent link horizontal cable run exceeds 90 meters'. Design should be that Telecommunications rooms are as close to the core of the building as possible. Multiple story buildings should be designed so that Telecommunications rooms are stacked. A minimum of two 4"conduits from each room to main BDF is required. The space shall be dedicated to Telecommunications equipment and not shared with electrical or any other building system. Equipment not related to the support of telecommunications closet (e.g., piping, ductwork, etc.) shall not be installed in, pass through, or enter the telecommunications room. Minimum size shall be 10'X12' with no ceiling. Wall finish shall be light in color. Lighting shall be a minimum of 500 lx measured 3ft. above finished floor. Room shall be environmentally controlled to maintain operating range of 65°F to 75° F 24/7. Flooring shall be static free, no carpeting. Power requirements are based on individual building design and need approval of COT/IE but a minimum of 2 20amp quad convenience outlets are required. Each Telecommunications room shall be equipped with a grounding bus bar connected to the building TMGB. All walls shall be covered with 3/4" fire rated A-C plywood painted with (2) coats of white fire retardant paint on all (6) side. Entrance door shall be minimum of 36" opening outward. Backbone and horizontal cable pathways shall terminate into room. Room cable management shall consist of ladder racks above all wall mount frames and all equipment racks

27 11 13 Communications Entrance Protection

All copper entrance cable to be terminated on 110 In/Out or a comparable substitute pre-approved by COT/IE and protected by gas tube type modules capable of handling surges higher than 300 volts, sneak currents and incorporates a positive temperature coefficient self-resetting current limiter as is UL497 listed.

Protectors shall be 4B1-EW five pin protectors with Heat Coil. Protectors shall have a DC Voltage breakdown within 265-425V @ 2kV/sec, Surge Breakdown within 200-500V @100V/sec, and a minimum 300A (10 x 1000 μsec waveform): >50 operations

27 11 16 Communications Cabinets, Racks, Frames, and Enclosures

All network and telecommunication equipment will be housed in 7' 19" Clear equipment racks, any other enclosure type requires pre-approval of COT/ITS. Equipment rack shall meet ANSI/EIA-310-D standard. Rack secured and grounded per manufacturers and all applicable codes. Rack positioned a minimum 4' from any wall in front of or behind it. Rack equipped with horizontal cable management above and below all patch panels and active equipment. Vertical cable management required on both sides of the rack and on all rack designs. Racks shall be equipped with rack mount 19" power strip 20A/120v with minimum of 8 NEMA5 -20R receptacles. Rack configuration requires pre- approval of COT/IE.

27 11 19 Communications Termination Blocks and Patch Panels

Patch panel shall be constructed of high strength steel with satin chrome finish and designed for wall or 19-inch rack mounting.

Category 6/Class E Patch Panels

Approved Manufacturer:

CommScope Uniprise Patch Panels

- UNP-U-610-1U-24 (760180042)
- UNP-U-610-2U-48 (760180059)

Fiber Optic Shelf Panels

Approved Manufacturer:

Leviton OPT-X

- 1U, 2U and 4U sizes

The Connector Housings shall have a labeling scheme that complies with ANSI/TIA/EIA-606. The housings shall be available with duplexing coupling panels for SC connector types. The housing shall have the ability to accommodate fusion splicing with additional hardware. The housing shall be provided with a locking assembly to secure access.

27 11 23 Communications Cable Management and Ladder Rack

All cable management to conform to industry standards and comply with the specified warranty solution for Category 6 systems. All active and passive rack mount equipment to be separated by horizontal cable management. Vertical cable management required in all rack designs. Ladder rack required to all racks and for cable entrance into all telecommunication rooms.

Fiber jumpers on framework, typically running vertically, shall be protected by finger stock raceway, Panduit or equivalent. Fiber jumpers on racks, typically running horizontally, shall be in suitable fiber cable trough, including elbows with their inner curve swept, couplings, down spouts, and cover

27 11 26 Communications Rack Mounted Power Protection And Power Strips

Minimum of one horizontal power strip 20A/120V with 8 NEMA5-20R receptacles. Power cord length shall be a minimum 8' with NEMA5-20R plugs.

27 13 00 Communications Backbone Cabling

See section 33 82 00 for site communications distribution and outside plant requirements All buildings will be fed with twisted pair copper, 8.3 micron single-mode fiber OS2, and 50 micron Laser optimized multi-mode fiber OM4. Number of conductors to be determined by COT/IE on a per project basis. 20' Service loops shall be placed in all vaults and manholes. Minimum size service loop shall be 8' and not to exceed minimum bend radius.

27 13 13 Communications Copper Backbone Cabling

Intra-Building Backbone (Inside buildings (ISP))
Cable shall meet the requirement of ANSI/TIA/EIA-568 series Standards for Category 3 performance, suitable rated inside cable between BDF and all IDF's. All cable will be homerun and terminated at both ends on 110 blocks. All pairs tested for continuity, shorts grounds and wire map.

Inter Building Copper Cable Backbone (Outside Buildings (OSP))

All cable shall be manufactured and constructed for use in the Outside Plant Environment PE 39 or better.

Cable shall meet the requirement of ANSI/TIA/EIA-568 series Standards for Category 3 performance.

27 13 13.13 Communications Copper Cable Splicing

All splicing and splice closures to conform to TIA/EIA-758 and be of the water tight and re-enterable type unless otherwise approved by COT/IE. All splicing shall be completed with 710 type multiple pair connectors only. No bridge-taps and 25-pair binder groups shall not be split between termination points. All splices housed in a closure compatible with all materials used in the construction of cable, filling compounds, bonding and grounding devices, chemicals, and sealants that the closure would come in contact under normal conditions. Closure construction shall be reusable and re-enterable without factory refurbishing. All closures to be filled with filling compound. Replacement parts shall be readily available.

27 13 23 Communications Optical Fiber Backbone Cabling

OM4 Multimode Fiber Specification

Cable shall support current and next generation LAN, SAN, and WAN applications through laser-optimized 50/125 micrometer optical fibers and shall extend distance of low-cost 850 nanometer vertical cavity surface-emitting laser (VCSEL) based electronics OM4 or better

OS2 Single-mode 8.3 Micrometer Fiber

The OS2 Single-mode Fiber SCS shall be capable of supporting, at minimum, the following IEEE Ethernet applications:

100M	100BASE-LX10
1G	1000BASE-LH
	1000BASE-BX10
	1000BASE-LX10
	1000BASE-PX10-D
	1000BASE-PX10-U
	1000BASE-PX20-D
	1000BASE-ZX
10G	10GBASE-LR
	10BASE-LX4
	10GBASE-ER
40G	40GBASE-LR4
100G	100GBASE-LR4

Approved Manufacturer

Basis for Design Specifications: CommScope SYSTIMAX TeraSPEED or LazrSPEED multimode optical fiber (OS-2, OM4) unless otherwise noted, in strand-count identified on Telecommunications Drawing and/or the Bid Document, and with the appropriate jacket material [OFNR, OFNP, OFN (LS)] for the pathway in which the cable will be routed.

27 13 23.13 Optical Fiber Splicing and Terminations

Connectors LC Singlemode

Connector shall be 3M-Hot Melt or pre-approved equal compliant with industry standard ANSI/TIA/EIA-568-B.3. The connector shall comply with the TIA/EIA Fiber Optic Connector Inter-mate ability Standard (FOCIS) document, TIA/EIA-604-2. The connector installation shall not require the use of epoxies, adhesives or ovens. The connector shall be installable upon 900 µm buffered fiber in one minute or less and upon 2.9 mm jacketed cable in three minutes or less total time. The connector shall be installable upon single-mode optical fiber. Ferrule material shall be ceramic. Connector shall be consistently capable of insertion losses of 0.3 dB (typical) and shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171. Connector reflectance shall be measured after manufacture to be less than or equal to -40/-55 dB ultra physical contact (UPC). Manufacturer shall be ISO 9001 and TL 9000 registered.

Connectors LC Multimode 50um Laser Optimized OM4

Connector shall be 3M Hot Melt or pre-approved equal compliant with industry standard ANSI/TIA/EIA-568-B.3. The connector shall comply with TIA/EIA Fiber Optic Connector Inter-mate ability Standard (FOCIS) document,

TIA/EIA-604-2. The connector installation shall not require the use of epoxies, adhesives or ovens. The connector shall be installable upon 900µm buffered fiber in one minute or less and upon 2.9 mm jacketed cable in three minutes or less total time. The connector shall be installable upon 50/125 µm multimode optical fiber. Ferrule material shall be ceramic. The connector crimp on mechanism shall protect the bare fiber from the ingress of air or waterborne contaminants. Connector shall be consistently capable of insertion losses of 0.3 dB (typical) and shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171. Connector reflectance shall be less than or equal to -20 dB. Manufacturer shall be ISO 9001 and TL 9000 registered.

27 13 50 Communications OSP Fiber Splice Closures

Splice closures shall be available in canister (butt) and in-line styles to fit most applications. All end-caps feature minimum two express ports for uncut feeder cables.

Approved manufacture

Fusion splice 96 strands or less
3M 2178 XSB or XLB series
3M Cable Addition Kit 2181-XB/XB-FR

Fusion spice greater than 96 strands
3M 2178 LS series

27 15 00 Communications Horizontal Cabling

27 15 01.21 Wireless Data Communication Horizontal Cabling

All Wireless stations shall be fed by one (1) 4-pair 100 ohm balanced Category 6 plenum rated with blue jacket cables. All Data jacks should have a Gigabit Ethernet (GbE) capability

27 15 01.55 Other Data Communication Horizontal Cabling

EMCS All EMCS stations shall be fed by one (2) 4-pair 100 ohm balanced Category 6 plenum rated with blue jacket cables. All Data jacks should have a Gigabit Ethernet (GbE) capability

27 15 13 Communication Copper Horizontal Cabling

Data Communications Horizontal Cabling (Category 6/ClassE)
All office work stations shall be fed by one (4) 4-pair 100 ohm balanced Category 6 plenum rated with White jacket cable. No Horizontal permanent link cable run shall exceed 90 meters. All Voice jacks should have Gigabit Ethernet (GbE) capability.

All office work stations shall consist of one (1) White Cat6 and three (3) blue Cat6 cables. All cable colors to be bundled separately in the ceiling and all closets. When cables enter the closets they will be packed neatly ie:(cigarette packing)

Approved Manufacturer:

CommScope Uniprise
- 65N4 4 pair Media 6® 65N4+ Cat 6 U/UTP Cable, non-plenum
- 75N4 4 pair UltraMedia® 75N4 Cat 6e U/UTP Cable, non-plenum
- 6504 4 pair Media 6® 6504+ Cat 6 U/UTP Cable, plenum
- 7504 4 pair UltraMedia® 7504 Cat 6e U/UTP Cable, plenum
- 65N4ZH-I 4 pair Media 6® 65N4ZH-i Cat 6 U/UTP Cable, LSZH
-

27 15 23 Communication Optical Fiber Horizontal Cabling

Indoor UL Rated, Tight Buffered Distribution Cable

Approved Manufacturer: CommScope SYSTIMAX OS2, OM4

Example Catalog/Manufacturer Part Number

- P-012-DS-5M-FSUAQ (plenum 12f for NAR)
- N-024-DS-5K-FSUAQ (24F LSZH for EMEA)
- R-006-DS-5L-FSUAQ (6F Riser for APAC and CALA)

27 15 43 Communications Faceplates And Connectors

27 15 43.10 Communications Copper Jack/Information Outlets and Connectors

Workstation locations fed by four (4) Category 6 4-pair cables shall terminate with Uniprise Category 6 modular jacks as follows;

Information Outlets shall Uniprise UNJ600 series l for Wall, Modular Furniture, and other appropriate applications. Black, White, Ivory, Grey with M20AP-246 Blank. The outlet labeled #1 is black, #2 is ivory, #3 is gray, and #4 is white.

Uniprise Extended Warranty Recommended Part #'s.*

App	Color	Commscope Cable Part#
Voice	Blue	UNJ600-BL
Data	Black, Ivory	UNJ600-BK, UNJ600-WH
	Gray, White	UNJ600-GY, UNJ600-IV
Wireless	Green	UNJ600-GR
Security, EMCS	Red	UNJ600-RD
CCTV	Orange	UNJ600-OR
CATV, A/V	SS	M81C

27 15 43.15 Communications Fiber Connectors, Adapters and Adapter Panels

Multimode adapter for use with 50/125 OM2+,OM3 and OM4 Fiber
1. Color – Aqua

Single-mode adapter for use with G.652.D or G.652.D, OS2 fiber
1. Color – Blue

SC Fiber Connectors

Multimode adapter for use with 50/125 OM2+,OM3 and OM4 Fiber
1. Color – Aqua

Single-mode adapter for use with G.652.D or G.652.D, OS2 fiber
1. Color – Blue

Connector shall be 3M-Hot Melt or pre-approved equal compliant with industry standard ANSI/TIA/EIA-568-B.3.

- The connector installation shall not require the use of epoxies, adhesives or ovens.
- Ferrule material shall be ceramic. Connector shall be consistently capable of insertion losses of 0.3 dB (typical) and shall be 0.75 dB (maximum)
- Connector reflectance shall be measured after manufacture to be less than or equal to -40/-55 dB ultra physical contact (UPC). Manufacturer shall be ISO 9001 and TL 9000 registered.

27 15 43.20 Multimedia audio/video connectors and adapters

Coaxial cable adapters:

Modular BNC coupler: 50 ohm impedance module designed for data applications

M-Series F-81 coaxial coupler: 75 ohm module designed for video applications

Approved Manufacturer:

CommScope

M81C 108009432 F-Coax Pass Through Coupler

27 15 43.25 Work Area Faceplate/Wall Plates and Surface Mount Boxes

Faceplates and Surface Mount Boxes (SMB)
Approved Manufacturer:

CommScope

- M13FP-262 – Single Gang Flexible Frame White
- M30FP-2RJ45-262 – Double port adapter for Flexible frame white
- M30FP-BLANK-262 – Double Blank adapter for Flexible Frame white

— M102SMB-B-262 – 2 port surface mount box white
— M104SMB-B-262 – 4 port surface mount box white
— 630B8 – Stainless Steel wall Phone jack (T-568B)
— M81LS-LS – 4 port faceplate for LC M81LS-XX fiber spools

27 16 00 Communications Connecting Cords, Devices, and Adapters

27 16 13 Communications Custom Cable Assemblies

All custom built cable assemblies tested and certified to appropriate category level and meet performance level of all applicable codes and standards.

27 16 19 Copper Patch Cords

All Patch/Equipment Cords shall be new.

On new installations, Patch/Equipment Cords shall be made by the same manufacturer as the Horizontal Cable

Category 6 /Class E Patch Cords
Approved Manufacturer:

(The following Catalog/Part numbers are shown as examples, contact your CommScope Representative to specify correct Catalog/Part numbers)

CommScope Uniprise

— UNC6 (UC1BBB2) Uniprise Category 6 U/UTP Patch Cord, RJ45 to RJ45, 4-pair, Non-Plenum
— UNC6-P (UC1BBC2) Uniprise Category 6 U/UTP Patch Cord, RJ45 to RJ45, 4-pair, Plenum

Optical Fiber Patch Cords and Pigtails

To maintain channel integrity, optical fiber patch cords and pigtails shall be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors shall be equipped with boots, and shall have same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords and pigtails shall be available with the following options as indicated on the bid document.

SC Patch cord outside diameters:

1. Simplex: 3.0 mm (0.118 inches)

2. Duplex: 3.0 mm x 5.9 mm (0.063 in x 0.232 in)

3. Pigtails: Ruggedized and tight-buffered optical fiber, 0.9 mm (0.035 in) outside diameter

Approved Manufacturer

. CommScope SYSTIMAX

— FEXSCSC42-MXMxxx– A 2 fiber optic jumper, riser, LazrSPEED 550 Multimode glass with SC connectors on both ends. Substitute xxx in part number with actual length in meters.

— FEWSCSC42-JXMxxx – A 2 fiber optic jumper, riser, TeraSPEED Single mode glass, with SC connectors on both ends. Substitute xxx in part number with actual length in meters. part number with actual length in meters.

Copper: Jumpers shall be yellow for IO port one, Red for IO port two, Green for IO port three and Blue for IO port four. Provide two workstation jumpers for each information outlet, one 7' and one 15' in length.

Fiber: Fiber jumpers shall be duplex SC 2.0 meters in length meeting the same requirements for all other fiber cable. Provide two each duplex jumpers for each 12 strands of multi-mode backbone cable installed and two each duplex jumpers for each 6 strands on single-mode cable installed.

27 21 00 - DATA COMMUNICATIONS NETWORK EQUIPMENT

All Data Communication Equipment furnished by COT/IE

27 31 00 - Voice Communications Switching And Routing Equipment

All equipment furnished by COT/IE.

27 32 00 -Voice Communications Telephone Sets, Facsimiles, And Modems

All telephone sets and ancillary equipment furnished by COT/IE except Elevator and Emergency Telephones.

27 53 00 DISTRIBUTED SYSTEMS

27 53 19 Internal Cellular, Paging, and Antenna Systems

VHF/UHF, 800 MHz IN-BUILDING BIDIRECTIONAL AMPLIFICATION (BDA) SYSTEM REQUIREMENTS

Reference Documents

Wireless Signal Boosters (Home, Commercial, Industrial, and Part 90): aka, Bidirectional Amplification (BDA) and FCC February 2013 Part90 Revisions

New regulations see below

With the proliferation of wireless technology, more people have become aware of the intermittent problems associated with cellular telephone coverage, particularly within buildings. Radio systems experience similar problems when used in and around large buildings or structures. City services, primarily public safety, routinely use radios to perform lifesaving operations. Accommodation must be made for reliable public safety radio coverage inside buildings in order to provide those critical services to the public. There are several significant functions which are enabled by providing uninterrupted radio communications capacity inside buildings and within the city limits.

BDA's are used to provide extended cellular telephone and wireless radio coverage when used in and around large buildings or structures. City services, primarily public safety and Transportation use radios to perform routine and lifesaving operations.

Accommodation must be made for reliable public safety radio coverage inside buildings in order to provide those critical services to the public. There are several significant functions which are enabled by providing uninterrupted radio communications capacity inside buildings and within the city limits.

1) Public safety needs -police, fire, medical, and other critical emergency services.
2) Response to major incidents, disasters.
3) Event coordination
4) City worker efficiency - interoperability among departments and with other agencies
5) Vehicular communication between staff and equipment

There are various factors affecting the quality of radio signals inside buildings. Internal factors include but are not limited to building mass, size, and composition; location of transmitting and receiving devices within a building; windows with reflective coatings; and presence of elevator shafts. External factors include but are not limited to the composition of barriers in the immediate physical location of buildings; building configuration with respect to natural barriers such as mountain ranges and densely foliated trees; terrain variations; and manmade barriers such as other large buildings.

All Project Managers shall coordinate with the Infrastructure Engineering (IE) Division to determine whether mitigating technologies are to be designed and constructed to the end of assuring adequate radio coverage. The list in the above paragraph is intended to provide the Project Manager with some insight into the considerations involved, and is no substitute for proper coordination with IE Division.

Consideration shall be given to signals generated within building core and transmitted outside of building, signals generated outside of building and received from within building core, and signals transmitted and received point-to-point within a structure. The intent is to provide an in-building coverage area reliability of 95%. The radio frequency signal level at the receiver's input for both talk-out and talk-in shall be adequate to support CM 4(DAQ-3.4) voice quality. The coverage shall be based on using portable units on the hip for receive, and held at five (5) foot level for transmit, in each above-ground level floor of the building. The Channel Performance Criteria, defined in TSB-88, within these areas shall be applied to 95% ofthe area in the presence of noise and interference.

Radio Coverage and Allowed Systems. For purpose of this section, adequate radio coverage is required, and is defined as circuit merit 3 or better and shall include all of the following:

- A minimum signal strength of -95 dBm available in 95% of the area of each floor of the building or structure when transmitted from the transceiver of the 800 MHz trunked communications

system;

- A minimum signal strength of -95 dbm received at the transceiver of the 800 MHz trunked communications system when transmitted from 95% of the area of each floor of the building
- The frequency range which must be supported shall be 821-824 MHz and 866-869 MHz; and
- A 100% reliability factor.

Amplification Systems Allowed. Buildings and structures which cannot support the required level of radio coverage shall be equipped with either (a) an internal multiple antenna or radiating cable system bi-directional 800 MHz amplifiers. Bi-directional amplifiers shall include filters to reduce adjacent frequency interference at least 35 db below the National Public Safety Planning Advisory Committee (NASPAC) band. The filters shall be tuned to 825 MHz and to 870 MHz so that they will be 35 db below the NPSPAC frequencies of 824 MHz and 869 MHz respectively. Other settings may be used provided that they don't attenuate the NPSP AC frequencies and further provided that they are not more than one (1) MHz from the NPSPAC frequencies.

Secondary Fiber Optic System. If there is dark fiber present or can be economically installed from the network to the proposed building (use of existing fiber plant or adequate conduit capacity allowing additional fiber runs to be pulled), then a fiber based secondary system with amplification devices as required may be viable and preferred. This determination will be made by the Communications Engineer (CE). If proposed, a fiber-based system shall integrate to existing network infrastructure and management protocols.

Off-Air Repeater. If dark fiber is not present or too expensive to route to the building, in building coverage can be provided through the use of bi-directional amplifiers and distributed antenna system or leaky feeder radiating cable. Extra RF filtering may be required and engineered into the system design to reject unwanted signals.

Testing Requirements: Upon completion of each installation, the radio system will be tested to ensure adequate two-way coverage within the facility as specified below:

- Each above-ground level floor of the building shall be divided into a grid of approximately twenty (20) equal areas.
- The test shall be conducted using a portable radio such as the City is using at the time of the test for the intended purpose, talking through the transceiver of the 800 MHz trunked communications system.
- A spot located approximately in the center of a grid area will be selected for the test.
- The radio will be keyed to verify two-way communications to and from the outside of the building to and from the 800 MHz trunked radio system.
- Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted.
- Each grid area will be tested for transmission/reception; minimum signal strength of -95 dbm. If signal strength fails to meet the requirement, the grid area shall be marked as a fail.
- A maximum of two (2) nonadjacent areas will be allowed to fail the test. In the event that three (3) of the areas fail the test, in order to be more statistically accurate, the floor may be divided into forty (40) equal areas.

- After the forty (40)-area test, if the system continues to fail, the system shall be altered to meet the 95% coverage requirement.
- The gain values of all amplifiers shall be measured and the test measurement results provided as part of required system documentation.

Management Systems Any management system introduced into the core network for the purpose of remote monitoring, configuration or tuning of the proposed RF amplification system must be compatible with, or be non-intrusive to, existing management platforms.

Equipment Considerations: Vendor equipment shall, where applicable, meet the standards set by the IETF, ITU-T, ISO, IEEE, and UL. All Ethernet devices provided by the vendor shall meet at a minimum IEEE 802.3 and 802.31 specifications.

All vendor supplied devices shall accurately process date/time data. Furthermore, when interoperating with other vendors' products, all vendor supplied devices shall accurately process date/time data interchanged with other vendor's products to the extent that the other vendor's products properly conform to year 2000 requirements.

The Contractor shall provide documentation in both machine-readable formats (Microsoft Project, Excel, Word, AutoCAD, and others upon approval by City) and in limited volume (two sets) on hardcopy as required herein.

Hardware, firmware, software, and configuration of monitoring shall operate within the stated environment and shall intemperate with the existing network infrastructure and radio communications system without any loss of performance or functionality as defined by the requirements and standards listed to the extent that the other vendor's products properly conform to these requirements and standards.

Special Considerations
Under Section 90.219(d)(5)1 of the Commission's rules,

All Part 90 Class B signal booster installations must be registered with the FCC.2 In February 2013, as part of the Commission's efforts to support the continued use of signal boosters in the Private Land Mobile Radio Services and Public Safety Radio Services, the Commission adopted a registration requirement for existing and future Part 90 Class B signal booster installations.3 The Commission found that a Class B signal booster registration system would be a valuable tool to help resolve interference should it occur.

All Part 90 licensees and signal booster operators must register existing Part 90 Class B signal boosters with the Commission by November 1, 2014.5 In addition, any new Class B signal booster installed after November 1, 2014 must be registered prior to operation.6

FCC - IT IS ILLEGAL TO USE A BDA WITHOUT THE EXPRESS PERMISSION OF THE CELLULAR COMPANY

Division 28 Electronic Safety and Security

This section serves as a guideline and Minimum Requirement for work on City of Tucson Electronic Safety and Security systems. It is the responsibility of the Design team to ensure all specifications are met and any additional specifics are included for Information Engineering review before release of final documents.

It is the responsibility of Infrastructure Engineering, (IE) to insure that a fully compliant and efficient communication infrastructure is in place for the city's needs. These standards are in place to accomplish that goal. These standards are developed for the use of all departments as well as all Architects, Developers and Contractors involved in construction on COT campus. All SOW and project proposals/ designs shall be in accordance to BICSI recommended installation practices and standards/ codes stated below. Cost for materials and installation of all Telecommunications related items should be part of the Project Budget. Coordination with COT/IE shall be required prior to actual construction and wiring placement.

Approved Contractor Requirements

A. The Electronic Safety and Security Contractor shall have an RCDD on staff and shall be an approved Manufacturere Systems Installer
B. A copy of the certification documents must be submitted with bid documents.
C. Overall project management/ installation oversight shall be by a BICSI certified RCDD on a weekly basis.
D. The System Installer shall have a certified Lead employed on staff and on-site during project construction at all times. The Lead Technician shall be OSHA 30 Certified.
E. All Installers/ Technicians shall be minimally manufacture certified all members of the installation team shall be OSHA 10 certified.
F. Should the cabling system fail to perform IE expected operation within the warranty period due to inferior or faulty material and/or workmanship, the contractor shall promptly make all required corrections without cost to the City of Tucson.
G. No portion of the Electronic Safety and Security contract may be subbed out to another entity unless prior approval is granted by COT/ IE
H. All subcontractors/ contractors shall wear in plain sight photo ID at all times during project construction stating company name, employee name and current credential.

Codes and Standards Compliance

Materials and equipment shall be the standard products of the manufacturer regularly engaged in the manufacture of the products and shall be of the manufacturer's latest standard product design that has been in satisfactory use for at least 2 years prior to bid opening.

All materials shall comply with the most current applicable sections of the following Codes for installation of telecommunications cabling:

Uniform Building Code (UBC)

National Electrical Code (NEC/NFPA 70)

National Electrical Safety Code (NESC IEEE C 2)

Local Codes, amendments, and ordinances.

All materials and installation practices shall comply with the applicable sections of the following

DIVISION 28 – ELECTRONIC SECURITY AND SAFETY

Telecommunications/ Electronic Safety and Security Industry Standards and all applicable addendums:

Reference Standards

The following Reference Standards shall be used as needed

ANSI/NFPA 70/250 - National Electric Code – Ground and Bonding

ANSI/NFPA 70/318 – National Electric Code – Cable Trays

ANSI/TIA/EIA-568-C.1-2009+A1:2012, Commercial Building Telecommunications Cabling Standard,

ANSI/TIA/EIA-569-C.0-2009+A1:2010+A2:2012,Generic Telecommunications Cabling for Customer Premise Standard

ANSI/TIA/EIA-569-C-2012, Commercial Building Standards for Telecommunications Pathways and Spaces

ANSI/TIA/EIA-606-B-2012, The Administration Standard for Commercial Telecommunications

ANSI/TIA/EIA-607-B-2013, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

ANSI/TIA/EIA-758-B-2012, Customer Owned Outside Plant Telecommunications Infrastructure Standard

TIA/EIA-1005-A-2012 Telecommunications Infrastructure Standard for Industrial Premises

BICSI/NECA-607 Telecommunications Bonding and Grounding, Planning and Installation Methods for Commercial Buildings

TIA-TSB-190, 2011 Guidelines on Shared Pathways and Shared Sheath

NFPA 780- Standard for Installation of Lightening Protection Systems, latest issue

ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling

NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

BICSI Telecommunications Distribution Methods Manual (TDMM), current edition

ANSI/BICSI 005-2013, Electronic Safety and Security (ESS) System Design and Implementation Best Practices

Telecommunications Designers/ Contractors and Installers shall have read the above documents and must be familiar with the requirements that pertain to this installation. The documents may be obtained from:

Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, fax: 303-397-2740, http://global.his.com/

IEEE-Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY, 10017-2394, 800-678-IEEE, fax: 732-981-9667, http://standards.ieee.org/

For any questions or further information on ITS cabling standards, designs and layouts, please contact the ITServiceDesk@tucsonaz.gov or calling IT Service Desk at (520) 791-4370.

28 02 00 WARRANTY REQUIREMENTS

28 02 10 Contractors Warranty

Contractor warranty: Provide all services, materials and equipment necessary for successful operation of entire telecommunications system and SCS system for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, wiring, accessories, software, hardware, installation, programming, and configuration required to maintain a complete and operable system. Provide manufacturer's published recommended preventative maintenance procedures during warranty period. This shall apply to all items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty. Additional warranty responsibilities are:

Provide 2-business day service beginning on date of Substantial Completion and lasting until termination of warranty period. Service shall be at no cost to Owner. Service can be provided by installing contractor or by a separate service organization. Choice of service organization shall be subject to Owner's approval. Submit name and a phone number that will be answered on a 24-hour basis each day of week, for duration of service.

Submit copies of equipment and material warranties to Owner before final acceptance.

A. **Owner's rights:** This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.

B. **Pathways Material and Installation warranty:** Provide all services, materials and equipment necessary to warrant the installation and performance of all pathway materials for a period of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

C. **Grounding and Bonding Material and Installation warranty:** Provide all services, materials and equipment necessary for successful operation of GBS for a period of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

D. **Firestopping Material and Installation warranty:** Provide all services, materials and equipment necessary to warrant the performance of all Firestopping material for a period of one year after beneficial use, or longer if required by the local AHJ. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

E. SCS Systems will be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow on program through the Vendor to provide support and service to the purchaser. The first part is an assurance program, which provides that the certified system will support the applications for which it is designed, during the 20-year warranty of the certified system.

F. The second portion of the certification is a 20-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, etc.).

G. In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.

H. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANSITIA/EIA-568-B shall be provided by the Vendor prior to the structured cabling system being installed.

I. The cabling system must conform to the current issue of industry standard ANSI/TIA/EIA-568. All performance requirements of this document must be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSIM manual.

J. Purchaser demands strict adherence to the performance specifications listed in ANSI/TIA/EIA-568-B series standards.

K. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacturer the product used in this cabling system.

28 05 00 Common Work Results For Electronic Safety And Security Systems

The City of Tucson IESS consists of a complete solution for the structured cabling system to conform to all TIA/EIA Telecommunications Building Wiring Standards, latest edition of BICSI Telecommunications Method Manual and following all Manufacturers recommended installation practices.

(Unless otherwise noted, all 28 05 00 work shall comply with division 27 05 00 Common Work Results for Communications)

28 08 00 Commissioning Of Electronic Safety And Security Systems

Provide installation testing of equipment where required by manufacturer's installation instructions.

Provide complete end to end testing for all copper and fiber optic systems/channels based on latest applicable standards. Document all testing and submit with final as-built submittal package

(Unless otherwise noted, all 28 08 00 work shall comply with division 27 08 00 Commissioning Of Electronic Safety And Security Systems)

PRE-FUNCTIONAL CHECKLISTS

The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the IE and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission.

CONTRACTORS TESTS

Contractor tests as required by other sections of Division 28 shall be scheduled and documented. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

SYSTEMS FUNCTIONAL PERFORMANCE TESTING

The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed.

TRAINING OF PERSONNEL

Training of the operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of the contract. The instruction shall be scheduled in coordination with the IE Engineer after submission and approval of formal training plans.

28 13 00 Access Control

Access control shall be considered for all City of Tucson facilities to include a minimum of;

2. All entrance and egress points
3. Telecommunication rooms
4. Elevators and stairwells

5. Other point to ensure the security of the facility

The current access control system is Lenel and all system must be compatible.

Operable considerations of the access control system shall include but not be limited to;

Physical Access Control:

A. Regulating access through doors, gates, traffic-control bollards
B. Anti-passback
C. Visitor assignment
D. Surge and tamper protection
E. Secondary alarm annunciator
F. Credential cards and readers
G. Biometric identity verification equipment
H. Push-button switches
I. RS-232/485 ASCII/Network IP interface
J. Credential creation and credential holder database and management
K. Monitoring of field-installed devices
L. Interface with paging HVAC elevator control
M. Reporting

28 13 26 Access Control Remote Devices

Devices, components and operation of the access control system shall include but not be limited to ;

Physical Access Control System (PACS) shall consist of:

1. Head-End equipment server,
2. One or more networked PC-based workstations,
3. Physical Access Control System and Database Management Software,
4. Credential validation software/hardware,
5. Field installed controllers,
6. PIV Middelware,
7. Card readers,
8. Biometric identification devices,
9. PIV <PIV-I>, <Legacy CAC>, <CAC NG>, <CAC EP>, <TWIC>, <FRAC> cards,
10. Supportive information system,
11. Door locks and sensors,
12. Power supplies,
13. Interfaces with:
    a. Video Surveillance and Assessment System,
    b. Gate, turnstile, and traffic arm controls,
    c. Automatic door operators,
    d. Intrusion Detection System,
    e. Intercommunication System
    f. Fire Protection System,
    g. HVAC,
    h. Building Management System,
    i. Elevator Controls

28 13 33 Access Control Interfaces

Contactless Smart Cards and Readers

1. Smart card readers shall read credential cards whose characteristics of size and technology meet those defined by ISO/IEC 7816, 14443, 15693.
2. The readers shall have "flash" download capability to accommodate card format changes.
3. The card reader shall have the capability of reading the card data and transmitting the data to the main monitoring panel.
4. The card reader shall be contactless iCLASS SE compatible

28 20 00 ELECTRONIC SURVEILLANCE

28 23 13 Video Surveillance Control and Management Systems

All VSC and management systems shall be compatible with existing systems

28 23 16 Video Surveillance Monitoring and Supervisory Interfaces

ALL VSM and Supervisory Interfaces shall be compatible with existing systems

28 23 19 Digital Video Recorders

DVR systems shall be software/server based for use in the enterprise and be compatible with existing systems

28 23 29 Video Surveillance Remote Devices and Sensors

Video Surveillance Devices shall be minimum

1. 2 Megapixel 1080p Full High Definition Day/Night Network CMOS
2. Vandal Camera.

Performance Requirements

3. Provide surveillance with high definition detail images – day or night.
    1. Possesses advanced intelligence features.
    2. Provide onboard IR as needed
4. Designed for commercial/industrial continuous 24/7 use.
5. The camera shall be based upon standard components and proven technology and as approved by IE

33 81 00 COMMUNICATION STRUCTURES

33 81 10 Common Work Results for Utilities

General Alignment

Where installed along side of other utilities, conduit alignment shall follow the general horizontal alignment of such underground utilities to the fullest extent possible. Utilize joint trenching as much as practicable to reduce the cost associated with trench work. When the alignment of the trenching for the other utilities does not allow for the installation of the City fiber conduit, the conduit shall be installed in a separate trench.

Distance Between Pull Boxes or Vaults

The absolute maximum length of the conduit between pull boxes or vaults shall not exceed 600 feet. In special circumstances, IE may allow for greater distances between pull boxes, not to exceed 1000, however these requests must be made at Schematic Design and no later than the Design Development phase of the project. IE reserves the right to deny any and all requests to exceed the 600' maximum distance.

Vertical and Horizontal Alignment

The horizontal and vertical alignment of the conduit system shall be the straightest alignment feasible. The design shall minimize horizontal and vertical drift in the conduit runs. Transitions and bends shall be made using the longest radius possible.

Maximum Bends Between Pulling Points

The sum of all horizontal and vertical bends shall not exceed 270 degrees in any conduit run. Bends with a radius of 500 feet, or greater, may be excluded from this criterion. However, under no circumstances shall the deflection cause the Maximum Tension Pull Coefficient to exceed the manufacturers published Maximum Pull Tension Coefficient.

In special Circumstances, IE may allow, in lieu of the AWG 10 tracer wire, a traceable innerduct substituted for one of the 4 innerducts installed: however these requests must be made at Schematic Design and no later than the Design Development phase of the project. IE reserves the right to deny any and all requests for substitutions.

Concrete Encasement

All conduits installed under roadways and parking lots on City property shall be encased in Class B (2500psi) concrete a minimum of 3" on all sides. All other conduit runs on City property and City Right of Way shall be given serious consideration as candidates for encasement in concrete. Coordinate with IE, who will balance such considerations as the critical nature of the facility, existence of alternate paths, backup communications paths, and the costs involved. Details and specifications shall reflect actual project conditions.

Peripheral Communications Equipment

Any peripheral equipment associated with shall be installed in as unobtrusive, discreet, and disguised manner as is practicable given all design constraints. If at all possible, such devices shall be buried. Where this is not possible, every effort must be made to install communication devices either:

- Hidden from public view, or
- Disguised as a natural part of the environment (such as a rock or boulder, natural vegetation, etc.) or building.
- Hidden or disguised equipment must not interfere with pedestrian flow.

Boring and Jacking

The boring and jacking method shall be approved by the engineer prior to the commencement of work. Where a conduit run is required by the plans to be installed by boring or jacking, the trenching method shall not be utilized except with prior written approval of the Engineer.

When casing is used, the casing shall be schedule 40 "standard wall" steel pipe. The casing shall not deviate more than 0.20 feet from the design grade. The joints in the casing shall be fully welded in accordance with A.S.M.E. Section 9. Concrete end seals shall be provided at each end. The intervening annular space shall be filled with sand material approved by the Engineer.

Boring and jacking pit shall be located a minimum of two feet outside the pavement edge.

The diameter of the bore shall be as close to the outside diameter of the conduit such that it will enable the conduit to be installed. At all locations where the diameter of the bore is 2 inches, or greater, than the outside diameter of the conduit, the interstitial space between the conduit and the bore shall be filled with slurry. All boring and jacking methods used shall neither damage nor deform the conduit. The installed conduit shall conform with the alignment and grade shown on the plans.

Pole Risers.

All risers off power poles shall consist of a 2" or 4" Intermediate Metallic Conduit (IMC) Riser with a quantity of 1" Innerducts, Watertight Alibi, and Blank Duct Plugs. Installed per TEP Electric Service Requirements for Riser Details – Telco/CATV/CAP, SR-221 or per most current Revision

33 81 19 Communication Underground Ducts

General Requirements for Underground Ducts

Standard Conduit Requirements

Unless otherwise approved, all Wide Area Network (WAN) conduits shall be 4 inch, schedule 40 PVC conduit buried a minimum of 36" to the top of the conduit below finished grade. In special cases, such as in association with borings, rolled pipe (HDPE) may be utilized when approved by the City of Tucson Construction Representative and the IE Representative. The number and size of the HDPE will be selected based on the specifics of the location.

In addition to the (2) 4" schedule 40 PVC conduits for the WAN, (1) 4" schedule 40 PVC conduit shall be installed for cable television (CATV) facilities, and (1) 4" schedule 40 PVC conduit shall be installed to the Entrance Facility (EF) for Telephone, or the current Long Distance Carrier. Coordinate with the Authority Having Jurisdiction (AHJ) for Telephone and CATV conduit routing, terminations, and project-specific requirements

Conduit Sweeps

Conduit sweeps shall be as follows

4" Conduits: 48" large radius sweeps
3" Conduits: 36" large radius sweeps
2" Conduits: 24" large radius sweeps

Innerduct And Tracer Wire

All 4 inch conduits, except those referred to below as dedicated to Telephone and CATV, shall have 4 (quantity) 1 inch ***smooth-wall exterior waved interior*** innerducts with a continuous 1250 pound test mule tape installed in each innerduct, along with 1 (quantity) AWG 10, green continuous non-spliced copper tracer wire installed in the 4 inch conduit, outside of all innerducts.

NOTE: Deviations from this standard must be approved by the City of Tucson Infrastructure Engineering before the Construction Document phase.

Watertight Alibi

Watertight Alibi shall consist of a Quadaplex Duct Plug designed to seal around, organize, and support innerduct and cables where it emerges at the top of all risers, pull boxes, and vaults and conduit ends. Fasteners shall be stainless steel. Plug shall support a minimum of 400 lbs of cable, and shall be removable. Jackmoon or equivalent. No chemical seals will be accepted

Duct Plugs

Blank Duct Plugs shall be installed in each individual innerduct where it emerges at the top of all risers, pull boxes, and vaults. Shall be all plastic construction, corrosion proof, water and air tight to 30 psi. Jackmoon or equivalent.

Marking

An electronic marker, 3M model 1255 mini-marker shall be placed by the Contractor at the location of any capped conduit not terminating in a building or a pull box and any pull box whose cover is not exposed..

33 81 20 Testing Communication Underground Ducts

All completed conduit runs shall be cleaned and tested prior to final acceptance.

Cleaning

Cleaning shall consist of pulling a swab through the conduit and removing all foreign material from within the conduit. If water is allowed to enter the conduit during construction, it shall be blown out or removed by other satisfactory means prior to the acceptance of the system. Vaults and pull boxes shall be cleaned of all debris. Upon completion of the cleaning operations, the ends of the conduit shall be capped.

Pre-Final Test (optional)

All conduit runs shall be clearance tested after the completion of all backfilling and subgrade preparation operations. This test shall consist of pulling a *Test* mandrel through the conduit run. The *Test* mandrel shall be segmented with an outer diameter not less than 80% of the inside diameter of the conduit, and shall be minimum 10" inches in length. The test shall be considered acceptable when the mandrel can be passed through the entire conduit run with a pulling force of 300 pounds or less. Each conduit run shall be verified for continuity along its entire length, as noted on the plans, and by means of an underground line locator. The installed conduit system shall be marked on the ground using standard bluestake color code and markings procedures. Further, it is recommended that this test be preceded by the use of a *clearing mandrel* to assure a successful final test result. The *clearing mandrel* shall be of the type and choice of the contractor.

Certification Test

All conduit runs shall be clearance tested after the completion of all backfilling and subgrade preparation operations. This test shall consist of pulling a mandrel through the conduit run. The mandrel shall be segmented with an outer diameter not less than 80% of the inside diameter of the conduit, and shall be minimum 10" inches in length. The test shall be considered acceptable when the mandrel can be passed through the entire conduit run with a pulling force of 300 pounds or less. Each conduit run shall be verified for continuity along IE entire length, as noted on the plans, and by means of an underground line locator. The installed conduit system shall be marked on the ground using standard bluestake color code and markings procedures.

All modifications, testing and final inspection of the system shall be scheduled with, and conducted in the presence of the ITD Infrastructure Engineering (IE) unit of the City of Tucson Information Technology Department Representative. Provide 72 hour advance notice. The field inspector shall notify IE of the construction schedule to facilitate inspection of the City fiber conduit. All portions of the system that do not pass the specified testing shall be repaired by the contractor, and retested, at no additional cost.

33 81 29 Communication Manholes, Pull boxes and Handholes

General Requirements for Hand holes and Boxes:

Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

Approved Manufacturers:

Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- NewBasis PCX Polymer Concrete 1703012 Minimum
- Oldcastle Precast, Inc.; 1730 Minimum for pull boxes,

Cover Legend: Molded lettering, "COMMUNICATIONS."

Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

Handholes 17 Inches Wide by 30 Inches Long and Larger dependent to its use:

Installation

Prior to setting the pull box or vault, verify that the excavation is to the design elevation and alignment.

Pull boxes shall be:

- Placed on a minimum of five cubic feet of clean 1" (size #57) crushed stone to provide drainage.
- Encased in a concrete ring a minimum 10" wide and a minimum of 12" deep on compacted soil or as specified by COT Infrastructure Engineering

Vaults shall be:

- Placed on a minimum of 16 cubic feet of clean 1" (size #57) crushed stone with a minimum 8" sump hole knocked out to provide drainage.
- Placed such that the crushed stone does not wash away or into the conduit.
- NOT be placed in a location of water drainage or standing water. The top plane of the cover shall be a minimum of 6" above possible standing water level for the location.
- Set true and plumb.
- Provided with a 5/8" by eight foot ground rod and acorn, driven vertically in the corner with six inches of rod exposed above the top of the drainage rock

Section 975 – SPECIAL TELECOMMUNICATIONS INFRASTRUCTURE: DOT FORMAT

975-1 DESCRIPTION

The work covered under this section shall consist of a Complete-in-Place installation, furnishing all material, labor and equipment, and installing conduit, pull boxes, vaults, and tracer wires for an underground fiber optic conduit system, including excavation, backfilling, compacting, jacking, and boring in accordance with the details.

975-2 MATERIALS

975-2.01 Polyvinyl Chloride (PVC) Conduit. All conduit shall be listed by UL and conform to NEC standards. Unless otherwise specified, all conduits to be installed underground or installed in concrete structures shall be 4-inch diameter, rigid Polyvinyl Chloride (PVC) Non- Metallic Conduit. The PVC conduit shall be schedule 40, heavy wall, sunlight resistant, manufactured from high impact material and shall be rated for use at 90 degrees centigrade. The conduit shall meet the specifications of UL 651 and NEMA TC-2, and furnished with interface fit bell ends. Fittings shall be schedule 40 PVC, meeting the specifications of NEMA TC-3 and UL 514.

975-2.02 Not Used

975-2.03 Solvent Cement for Polyvinyl Chloride (PVC) Conduit and Couplings. All solvent cement shall meet the requirements of ASTM D 2564. The cement shall be of medium or heavy bodied cement capable of making watertight joints. The cement and primer shall be of a type recommended by the manufacturer of the conduit.

975-2.04 Rigid Steel Conduit Sweeps. Conduit sweeps shall be listed by UL and conform to NEC standards. The sweeps shall be steel, hot dipped zinc coated, meeting the requirements of UL 6 and ANSI C80.1, and shall carry the Underwriters Laboratory label. Non-thread couplings shall not be used. Sweeps shall have a minimum radius of 12 times the nominal diameter of the conduit. Steel conduit sweeps shall have a factory applied 40 mil PVC coating or be doubled (half overlap) wrapped with a 10 mil PVC plastic tape specifically manufactured for corrosion protection of metallic conduit installed below grade.

975-2.05 Flexible Conduit. When specifically indicated on the plans and where approved by the engineer, flexible solid wall direct bury conduit may be used. The conduit shall be manufactured of Polyvinyl Chloride (PVC), or Polyethylene (PE) plastic. The conduit shall be specifically manufactured for direct buried fiber optic raceway systems. Flexible conduit shall not be utilized for making bends in conduit system. Connection between the flexible conduit and conduit of other materials shall be made with a watertight transition coupling manufactured for the specific type of material.

975-2.06 Plastic Conduit Spacers. Spacers shall be constructed of Polyvinyl Chloride (PVC) or other non-metallic material. The spacers shall be vertical and horizontal interlocking and provide a minimum of 3-inch clearance between conduits. Base spacers shall be provided with a wide base plate to provide solid support on the bottom of the trench. The base spacers shall provide for a minimum clearance of 3 inches between the bottom of the trench and the conduit.

975-2.07 Aggregate Bedding Material. Aggregate material for bedding material shall meet the gradation indicated in the specifications and on the drawings for the subject project. The plasticity index shall also conform to the specifications under which the subject project is designed and constructed.

975-2.08 Controlled Low Strength Material (CLSM). Materials comprising the controlled strength material shall conform to the requirements of Section 1006. CLSM mix designs shall be in accordance with Table 975-2. Unless otherwise designated on the plans, in the special provisions or directed by the Engineer, the CLSM shall be Mix No. 2.

Table 975-2

Mix Proportions For Controlled Low Strength Material

	CLSM No. 1	CLSM No. 2	CLSM No. 3
Compressive Strength, 28 days PSI	50	500	1000
Portland Cement (lb)	60	190	280
Water (lb)	475	460	440
Fly Ash (lb)	290	300	300
Fine Aggregate (lb)	2,770	2,680	2,650

975-2.09 Detectable Warning Tape. On open trenching an electronically detectable 6" Fiber Warning tape shall be installed 18" above the conduit. Tape shall be acid and alkali- resistant polyethylene film, with a minimum thickness of 0.004 inch. The tape shall have a minimum strength of 7500 PSI lengthwise and 1,500 PSI crosswise. The tape shall be manufactured with integral wires, foil backing, or other means to enable IE detection by a metal detector when the tape is buried up to a depth of 3 feet deep. The tape shall be orange in color and have the following continuous inscription, "CAUTION - FIBER OPTIC CABLE BURIED BELOW". The inscription shall be 2 inch black letters.

975-2.10 Backfill Material. The backfill material shall conform to that of the subject project.

975-2.11 Tracer Wire. The cable and wire shall be listed by UL and conform to NEC standards. The wire shall be a continuous unspliced stranded CU 10AWG, rated for 600 volts, and shall be type THW or XHHW. The color of the wire shall be green. The wire shall be of the required length to eliminate all splices within conduit.

975-2.12 Pull Boxes. Communications pull boxes shall be UL listed. Pull boxes shall be of a reinforced composite material of a neutral color. The pull box shall have a bolt-down cover secured by a minimum of two (2) recessed hex-head bolts. The pull box cover shall have the word "COMMUNICATIONS" in permanent raised, stamped or welded lettering. The pull box cover shall have a skid-resistant surface. Pull boxes shall be open base. The pull box cover shall have two (2) ½" x 4" pull slots. The pull box base shall have two (2) 4 ½" x 4 1/2" mouse holes, one at each end. Pull boxes may be extended by means of an "extension". The extension shall have eight (8) 4 1/2" x 4 1/2" knockouts, two on each side. Contractor shall provide all necessary collars, extensions, hardware, sealant, and conduit caps. All conduit entrances shall be sealed. The assigned pull box number shall be painted on the box at the time of installation. Chipped, cracked, or otherwise damaged boxes and covers will not be accepted.

975-2.13 Vaults. Communications vaults shall be UL listed. Vault base shall be pre-cast concrete with a minimum thickness of 4". Vault cover shall be pre-cast concrete with a minimum 36" x 36" galvanized steel locking lid secured by a minimum of one (1) recessed hex- head bolt. The cover lid shall have "COMMUNICATIONS" written on it in permanent raised, stamped or welded lettering. The vault base and vault cover shall be gasket and weather proof. Vaults shall have a minimum outside dimension of 48" long

by 48" wide by 50" high with a minimum thickness of 4". The base shall have one (1) 8" diameter by 4" deep sump hole knockout in the floor. The base interior shall have a minimum of one (1) 2 ½" diameter ground rod knockout in the floor, at a corner; the base interior shall have four (4) 7/8" diameter pulling irons, one centered on each side. The base exterior walls shall have four (4) 36" "C" channels precast in the sides, one on each side; the base exterior shall have four (4) 18" x 18" knockouts, one on each side; and, the base exterior shall have sixteen (16) 4 1/2" diameter knockouts for 4" conduit entrances, four on each side. Contractor shall provide all necessary collars, extensions, hardware, sealant, and conduit caps. All conduit entrances shall be sealed. The assigned box number shall be painted on the box at the time of installation. Chipped, cracked, or otherwise damaged boxes and covers will not be accepted.

975-2.14 Portland Cement Concrete. Concrete shall be Class B meeting the requirements of Section 1006 of the Pima County/City of Tucson Standard Specifications for Public Improvements.

975-2.15 Innerduct. Innerduct shall be 1" PVC constructed of a Ribbed smooth walled exterior and a ribbed interior with a continuous unknotted 1250 pound test muletape installed. No corrugated innerduct will be accepted.

975-2.16 Watertight Alibi. Watertight Alibi shall consist of a Quadaplex Duct Plug designed to seal around, organize, and support innerduct where it emerges at the top of the risers, pull boxes, and vaults. Fasteners shall be stainless steel. Plug shall support a minimum of 400 lbs of cable, and shall be removable. Jackmoon or equivalent. No chemical seals will be accepted.

975-2.17 Blank Duct Plugs. Blank Duct Plugs shall be installed in each individual innerduct where it emerges at the top of the risers, pull boxes, and vaults. All plugs shall be all plastic construction, corrosion proof, water and air tight to 30 psi. Jackmoon or equivalent.

975-3 CONSTRUCTION DETAILS

975-3.01 Conduit.

(A) Handling and Storage. All conduits shall be transported in modules or bundled in a straight and level position. The straps securing the conduit to the vehicle shall be a minimum of 4 inches in width and shall not deform or damage the conduit in any manner. Conduit shall be unloaded in accordance with the manufacturer's recommendations and shall not be dropped to the ground.

Conduit shall be stored in a straight and level position in stacks not exceeding 8 feet in height. Materials shall be stored in an approved manner and covered to prevent ultraviolet deterioration due to the exposure to sunlight. When stored, conduit ends shall not be capped nor shall conduit be subject to temperatures in excess of 140^{O} F.

(B) Cleaning. The interior of the conduit shall be kept clean and free of debris. Prior to installation, all foreign materials shall be removed from the interior of the conduit with compressed air and a swab.

(C) Size. Unless otherwise indicated on the plans or special provisions, all conduits shall be 4-inch diameter.

(D) Cuts and Connections. The conduit shall be cut square, de-burred, and trimmed to remove all rough edges.

PVC conduit connections shall be of the solvent weld type. Wipe conduit dry and clean before joining. Apply a full coat of primer to the pipe and coupling per the manufacturer's recommendations. Apply a full and even

coat of solvent cement to the entire area inserted into the fitting. Prevent excess cement from accumulating in the interior of the conduit. Allow joint to cure a minimum of 20 minutes. The complete joint shall be water tight. Where a connection is made to a steel bend, the coupling used shall be a PVC female adapter.

Expansion fittings shall not be installed in PVC conduit runs unless otherwise specified. Expansion fittings shall be installed in conduit runs where both ends are fixed in-place, such as between two foundations, and within concrete structures. Expansion fittings shall allow for a minimum linear expansion of six inches.

(E) Bends. Bends shall be installed only when absolutely necessary. All bends shall be constructed of rigid steel conduit. Bend shall be factory bent or field bent. Bends shall have a radius of not less than 12 times the nominal diameter of the conduit. Conduit shall be bent without crimping or flattening, using the longest radius practicable. The sum of the deflection angles of all bends in any conduit run shall not exceed 270 degrees between termination and/or junction points. For the purpose of calculating the sum of the deflection angles, bends with a radius of 500 feet or greater may be excluded from this criteria.

(F) End Treatment. Conduit ends shall be capped with conduit end caps at all times when work is not in progress. Rigid steel sweeps terminating in pull boxes shall terminate with an approved plastic bushing.

(G) Placement. Conduit runs shown on the plans shall be changed only to avoid underground obstructions and only as directed by the Engineer and TRP Representative.

Unless otherwise specified, conduit shall be placed with a minimum cover of 36 inches to the top of the conduit below the finished grade; the minimum requirement for Transportation projects is 30" due to the depth of electrical conduit placement. When conduit runs, or any part thereof, cannot be installed at the minimum depth, the run, or part thereof, shall be encased in concrete.

Conduit shall be installed along the straightest horizontal and vertical alignment practicable, and with a uniform depth of cover. Variations in the alignment shall be accomplished with smooth transitions maximizing the radius of the bends. In cases where it is impossible to maintain the alignment of the conduit, the grade of the conduit shall be transitioned using the minimum number and the longest radius bends. Should discovered field conditions necessitate additional bends in the conduit run, the location and number of pull boxes shall be adjusted as directed by the Engineer and City of Tucson Infrastructure Engineering (IE) Representative.

Conduit to be encased within Controlled Low Strength Material (CLSM) or concrete shall be installed on plastic conduit spacers. The spacers shall be placed at suitable locations to prevent sagging of the conduit between spacers or at 10 foot maximum centers. Prior to the placement of the CLSM or concrete, the conduit shall be tied down to prevent them from floating.

Conduit penetrations into pull boxes shall be made using the knockouts or shall be cored in the structure. Conduit entering through the side wall of pull boxes shall be located three inches above the floor and three inches away from the end wall of the box. Conduit entering the bottom of pull boxes shall be located in the near side corner of the box, approximately 3 inches away from the side and end walls. The conduit shall be sloped towards the top center of the box to facilitate pulling of the cables and innerduct. Conduit terminating in pull boxes shall terminate a minimum of three inches inside the box wall. The void between the conduit and the box shall be completely filled with mastic to form a watertight seal.

Conduit entering vaults shall enter through single duct knockouts. The location of the knockout shall be as indicated on the plans, or directed by the Engineer. The joint between the knockout and the conduit shall be filled to form a watertight seal.

At all locations where the conduit cross under a new curb, the letters "FO" shall be cut into the top of the curb directly over the conduit run. The letters shall be three inches tall and shall be clearly defined.

975-3.02 Trenching. Unless otherwise specified, all conduit runs shall be installed by trenching methods. Trenching shall include the removal of all material to the design grade no matter what type of material is encountered. The alignment of the conduit shall be staked in the field per the City of Tucson's standard procedures.

When trenching in excess of five feet is required, the contractor shall submit, in writing to the Engineer, a detailed description of their proposed trenching operations, including shoring methods, prior to the commencement of construction.

All conduit shall be covered with bedding material or Controlled Low Strength Material (CLSM) at the completion of each day's work to prevent shrinkage and thermal expansion that could influence the alignment of the conduit.

Concrete encasement shall be a minimum of Class B (2,500 PSI) in accordance with Pima County/City of Tucson Standard Specifications and provide a minimum cover on all sides of the conduit of 3 inches. Otherwise, bedding and shading of the conduit shall be in accordance with the plans and specifications of the subject project. When installed adjacent to water mains, the conduit shall be encased in Controlled Low Strength Material (CLSM) with the following:

Conduit installed in conjunction with Tucson Water projects shall be designed and installed under the plans and specifications of the subject project.

Conduit installed with traffic signal or street lighting conduit shall be designed and installed under the plans and specifications of the subject project.

Conduit with a depth of cover less than cited above, and where indicated on the plans, shall be encased in concrete. The concrete shall be placed to provide a minimum of three inches of encasement on all sides of the conduit.

(B) Backfill. Upon completion of the conduit and bedding installation, the trench shall be backfilled and compacted. The backfill shall be designed and constructed under the plans and specifications of the subject project. Place the detectable warning tape in the backfill, 18 inches below finished grade and directly above the conduit.

975-3.03 Boring and Jacking. Conduit runs shall be installed by boring and jacking methods when required by the plans or directed by the engineer. The boring and jacking method shall be approved by the engineer prior to the commencement of work. Where a conduit run is required by the plans to be installed by boring or jacking, the trenching method shall not be utilized except with prior written approval of the Engineer.

When casing is used, the casing shall be schedule 40 "standard wall" steel pipe. The casing shall not deviate more than 0.20 feet from the design grade. The joints in the casing shall be fully welded in accordance with A.S.M.E. Section 9. Concrete end seals shall be provided at each end. The intervening annular space shall be filled with sand material approved by the Engineer.

Conduit installed within the casing used for water mains shall consist of either four each one (1) inch, four each one and one-half (1 1/2) inch, or two, or more, two (2) inch diameter flexible conduit. The largest

practical size shall be used. The conduit shall be strapped to the glass reinforced skids installed on the water line, pulled into the casing after the water main is installed, or installed on a hanger welded to the casing. The alignment of the conduit shall be maintained as straight as possible. The placement of sand within the annular space of the casing shall be controlled to a rate that does not displace the conduit.

Boring and jacking pits shall be located a minimum of two feet outside the pavement edge. The diameter of the bore shall be as close to the outside diameter of the conduit such that it will enable the conduit to be installed. At all locations where the diameter of the bore is 2 inches, or greater, than the outside diameter of the conduit, the interstitial space between the conduit and the bore stall be filled with slurry. All boring and jacking methods used shall neither damage nor deform the conduit. The installed conduit shall conform with the alignment and grade shown on the plans.
attached to the reinforcing steel at locations and intervals detailed on the plans. Expansion fittings shall be installed at all locations where the conduit crosses expansion joints in the structure. Expansion joints shall also be installed at the point where the conduit enters and exit the concrete structure. Where it is not possible to install expansion joints, the conduit shall be installed in a conduit sleeve of sufficient size to provide a minimum of 1/2-inch clearance between the outside diameter of the conduit and the inside wall of the sleeve. Sleeves shall be discontinuous across the expansion joints in the structure.

975-3.05 Pull Boxes and Vaults. Prior to setting the pull box or vault, verify that the excavation is to the design elevation and alignment. Pull boxes shall be placed on a minimum of five cubic feet of clean 1" (size #57) crushed stone to provide drainage. Vaults shall be placed on a minimum of 16 cubic feet of clean 1" (size #57) crushed stone with a minimum 8" sump hole knocked out to provide drainage. Pull boxes and vaults shall be placed such that the crushed stone does not wash away or into the conduit. Vaults and pull boxes shall NOT be placed in a location of water drainage or standing water. Set boxes and vaults true and plumb. The top plane of the cover shall be a minimum of one inch above finished grade and six inches above possible standing water level for the location. Backfill and compact around the structure avoiding damage to the structure. The backfill shall be compacted to a minimum of 95 percent of the maximum density as determined by ASTM D698.

Pull boxes shall be encased in a concrete ring a minimum 10" wide and a minimum of 12" deep on compacted soil. Each pull box/vault shall be provided with a 5/8" by eight foot ground rod and acorn, driven vertically in the corner with six inches of rod exposed above the top of the drainage rock.

Install precast sections in accordance with ASTM C891. Joints between the precast sections shall be sealed with a flexible butyl sealant meeting the requirements of AASHTO M-198. Install precast adjustment rings and the frame and cover to finished grade.

Unless otherwise approved, cables passing through pull boxes require a minimum 50 feet service loop where attainable without exceeding manufacturer's minimum bend radius. Cables pulled through manholes/ vaults require not less than 150 feet before exiting.

975-3.06 Innerducts. All 4 inch conduit shall have 4 (quantity) 1 inch Ribbed *smoothwall exterior ribbed interior* innerducts with 1250 pound test rated pull strength mule tape installed.

975-3.07 Tracer Wire, Electronic Marker, Mule Tape. A continuous, separate #10 AWG THW/XHHW CU insulated tracer wire shall be installed in each conduit run, external to the innerducts. All lubricants used in the pulling of the tracer wire shall be water soluble. No splicing of the tracer wire shall be permitted in the conduit runs. The ends of the wire shall extend into each pull box, or vault, a minimum of 5 feet, coiled and secured. Connect the ends of all tracer wires within a pull box, or vault, together to a common lug. An electronic marker, 3M model 1255 mini-marker shall be placed by the Contractor at the

location of any capped conduit not in a building or pull box/vault. All unoccupied or capped conduit shall have a continuous unspliced unknotted 2500 pound test rated 22AWG detectable mule tape installed, secured at each end and shall be labeled with location of opposite end.

975-3.08 Testing and Cleaning. The completed conduit runs shall be cleaned and tested prior to final acceptance. Cleaning shall consist of pulling a swab through the conduit and removing all foreign material from within the conduit. If water is allowed to enter the conduit during construction, it shall be blown out or removed by other satisfactory means prior to the acceptance of the system. Vaults and pull boxes shall be cleaned of all debris. Upon completion of the cleaning operations, the ends of the conduit shall be capped. RGS sweeps terminating in pull boxes shall be plugged.

All conduit runs shall be clearance tested after the completion of all backfilling and subgrade preparation operations. This test shall consist of pulling a mandrel through the conduit run. The mandrel be segmented with an outer diameter of 1/4 inch less than the inside diameter of the conduit, and shall be minimum 10" inches in length. The test shall be considered acceptable when the mandrel can be passed through the entire conduit run with a pulling force of 300 pounds or less. Each conduit run shall be verified for continuity along its entire length, as noted on the plans, and by means of an underground line locator. The installed conduit system shall be marked on the ground using standard bluestake color code and markings procedures.

All testing of the system shall be scheduled with, and conducted in the presence of the Engineer. All modifications, testing and final inspection of the system shall be scheduled with, and conducted in the presence of the ITD Infrastructure Engineering (IE) unit of the City of Tucson Information Technology Department Representative. Provide 72 hour advance notice to ITServiceDesk@tucsonaz.gov or calling IT Service Desk at (520) 791-4370. The field inspector shall notify the Infrastructure Engineering of the construction schedule to facilitate inspection of the City fiber conduit. All portions of the system that does not pass the specified testing shall be Operations repaired by the contractor, and retested, at no additional cost.

975-4 METHOD OF MEASUREMENT

975-4.01 Conduit. Conduit shall be measured by the linear foot for each diameter size of conduit. The measurement shall be from center to center of pull box or vault. No measurement or direct payment will be made for the trenching, bedding, encasement, tracer wire, marking tape, mule tape, backfill and testing, the cost being considered as included in the contract price for the conduit.

975-4.02 Pull Boxes. Pull boxes will be measured as a unit for each pull box installed complete with cover and accessories.

975-4.03 Vaults. Vaults will be measured as a unit for each vault complete with frame and cover and accessories.

975-5 BASIS OF PAYMENT

975-5.01 Conduit. Acceptable quantities of conduit, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for the work, complete in place, including any excavation, removals of obstruction, bedding, encasement, backfill, and any incidentals necessary to complete the work.

975-5.02 Pull Boxes. Acceptable quantities of pull boxes, measured as provided above, will be paid for at

the contract unit price each, which price shall be full compensation for the work, complete in place, including any excavation, removals of obstruction, bedding, coring, knockouts, backfill, and any incidentals necessary to complete the work.

975-5.03 Vaults. Acceptable quantities of vaults, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the work, complete in place, including any excavation, removals of obstruction, coring, knockouts, support channels, bedding, backfill, risers, frames and covers, accessories, and any incidentals necessary to complete the work.

Other Special Considerations

Managing Radio Amplification Systems – (PCWIN)

Policy Statement

It is PCWIN policy to review and approve the design and implementation of any signal boosters, also referred to as bi-directional amplifiers (BDA), used to retransmit Pima County or City of Tucson licensed frequencies that are part of the PCWIN system. As an FCC licensee, PCWIN is subject to Federal regulations. Specifically, and for purposes of this policy, PCWIN and its members are responsible to comply with regulation 47CFR90.219 "Use of Signal Boosters." According to FCC regulation 47CFR90.219, anyone operating a signal booster to retransmit PCWIN licensed frequencies must have the consent of PCWIN.

In addition, Part 90 Class B signal boosters (non-channelized BDAs) must be registered through the FCC Signal Booster Registration & Discovery website. PCWIN reserves the right to verify signal boosters have been properly engineered and do not create interference by performing site

Background

The FCC recognizes two basic classes of signal boosters. The FCC defines Class A signal boosters as a signal booster designed to retransmit signals on one or more specific channels channelized BDA). Class A signal boosters can be used indoors, outdoors and in mobile settings.

The FCC defines Class B signal boosters as a signal booster designed to retransmit any signals within a wide frequency band (wideband BDA). Class B signal boosters may only be installed in a fixed location. Mobile use of Class B signal boosters is prohibited by the aforementioned FCC regulation. As of November 1, 2014, all existing and new Class B signal boosters must be registered with the FCC. The website for registering Class B signal boosters is: www.fcc.gov/signal-boosters/registration.

The FCC requires signal boosters to be used on a non-interference basis. As such, if a signal booster is suspected of causing harmful interference, the operator must turn off or adjust the settings of the device at the request of the PCWIN, the FCC, or any impacted licensee to eliminate the harmful interference. Any signal booster operator who does not comply with such as request, may be subjected to FCC fines as determined by FCC investigation.

Procedure Statement

Installation of a signal booster must conform to local zoning ordinances; local, State and Federal building codes; local, State and Federal fire codes; and any other applicable laws.

The following steps are required to properly obtain PCWIN consent and meet FCC regulations for use of signal booster amplifying PCWIN licensed frequencies.

A. Identify the need for an amplification system by submitting a proposal to the Technical Working Group

B. Submit the PCWIN Signal Booster Consent Request Form to request PCWIN consent to use the proposed signal booster.

C. PCWIN will review the submitted PCWIN Signal Booster Consent Request Form and reserve the right to request additional information regarding the proposed signal booster.

D. Upon approval of the proposed signal booster, the Network Managing Member shall supply a Letter of Consent allowing the use of the signal booster to amplify and retransmit frequencies licensed on the applicable PCWIN provided call signs. This shall be maintained by the signal booster operator to be presented to an FCC representative or a relevant licensee investigating interference, per aforementioned FCC regulation. A copy of the letter and any data collected during the signal booster review will also be retained by PCWIN.

E. For Class B signal boosters, the requestor is required to comply with FCC regulation 47CFR90.219 by registering the approved device through the previously mentioned FCC signal booster registration website.

F. Upon successful registration, the requestor must provide the FCC Booster ID of this device to PCWIN as proof of registration. PCWIN will then document the FCC Booster ID with the previously obtained documentation.

G. The Network Managing Member records the location of the signal booster.

Applies to

All PCWIN users

Supporting Rules

104-D Radio Amplification Systems Policy

Conditions for Exemption or Waiver

None