TELECOMMUNICATIONS NETWORK STANDARDS

AND GUIDELINES

FOR THE NEW ADMINISTRATION BULDING

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1.0 NEW CONSTRUCTION

This section identifies the major components of a telecommunications distribution system and provides general guidelines for architects and facility planners. The material contained in this section is designed to assist in the program planning for new construction and remodeling projects. Its focus is on space planning and development of an understanding of the structural components necessary for a telecommunications distribution system.

This section should be used in conjunction with Section 3, Infrastructure & Pathways Details, which contains greater detail on each of the major structure components in order to prepare actual working designs.

1.1 DESIGN ELEMENTS

There are two major aspects of a good telecommunications distribution design: spaces, and pathways. Each of these two aspects consists of multiple components as defined below:

1.1.1 Spaces

Building Service Entrance - The room in which voice, data, and video distribution media systems enter the building.

Equipment Room - The space allocated to housing (and supporting) telecommunications systems which will service the building, such as a PBX, backbone network equipment, and/or video transmission equipment.

Telecommunication Closet - The space or spaces on each floor of a building which are utilized to interconnect the Building Backbone (Riser) system to station (user) locations on a given floor and house local (department-based) electronic equipment.

1.1.2 Pathways

Interbuilding Distribution System - The conduit, tunnel system, or buried media support structures between buildings.

Building Backbone (Riser) - The pathways which connect all telecommunications rooms and spaces throughout an individual building.

Horizontal Pathways - The pathways from the Telecommunication Closet to the station (user) locations on a given floor.

Station Outlet - The ultimate termination of a voice, data, video, or signal circuit.

The building design must address each of the above areas as a service or a component of an entire system. Problems occur when designs focus on only one or two of the components and do not consider how the entire building's distribution system will be utilized. For example, it is not enough to provide a cable tray in the building design; the tray must be of a usable type, be properly installed, be routed to the best advantage of the cable, and be interconnected with the Telecommunication Closets. Examples of potential problems include cable tray designs with lids that cannot be opened, HVAC and water pipes in and through the tray, trays over fixed ceilings, and Telecommunication Closets which are separated from the tray by a fire-rated wall (without a pathway.)

Avoid designing a building in which the cable installer will be required to drill holes in walls and place sleeves through fire partitions. While technology will change between the time of the initial architectural planning and building occupancy, the infrastructure (pathways and spaces) will be in place for the life of the building and must be capable of supporting multiple changes in technology.

1.1.3 Telecommunications Spaces

The term "telecommunications spaces" refers not only to specific rooms but in some cases to space dedicated to telecommunications services in a room designated for other uses.

There are three main categories of spaces as previously defined: Service Entrance, Equipment Room, and the Telecommunication Closet. Each area has a distinct function; however, all are very inter-dependent. In some cases a single space can fulfill the function of all three spaces; however, it must be emphasized that the size and environmental support requirements are additive. If a building requires 150 square feet for an equipment room, 50 feet cannot be provided by space designated as a service entrance.

1.1.3.1 Service Entrance Room

The Service Entrance is a room in which outside cable is terminated and interconnected with the backbone (data and/or voice) cable used throughout the building. It provides facilities for large splice containers, cable termination mountings, and possibly electrical protectors. This space is in addition to any space required for network switching equipment or active system components.

This space should be located on a lower level and within 50 feet of an outside wall, allowing direct access by the entrance conduit. Consideration should be given to locating this space adjacent to any equipment rooms or backbone (riser) spaces, which might be required. Although two or even all three of these functions can be combined in a single space, adequate wall space must be provided. Design and location of room should also take into consideration the route and placement of the City’s fiber/copper backbone connecting buildings.

The Service Entrance room must be dry, not subject to flooding, and free of overhead water, steam, or drain pipes.

Access to the room should be provided directly from a central hallway, not through another room. The Service Entrance room must be a dedicated, enclosed room.

The minimum floor space requirements are five (5) feet by seven (7) feet.

1.1.3.2 Equipment Room

The equipment room is the central space used to house telecommunications equipment intended to service users throughout the building.

The equipment room should be located near the service entrance room as well as the vertical backbone distribution pathways. The assigned space should be located to allow for future expansion and where access to the space from outside can be provided for large equipment (direct hallway access or direct outside access). Locations which might be subject to flooding, electrical interference, or other hazards should be avoided.

The minimum floor space requirements are ten (10) feet by fifteen (15) feet. The final room sizing must take into consideration issues such as; the need for auxiliary power (UPS/batteries), local requirements for a separate battery room, HVAC equipment, and any known special needs when determining actual floor space.

Although the equipment room may incorporate the space requirements of the Building Service Entrance (by increasing the size of the room), it must be designed as a true equipment room in terms of its support environment. A full office environment air handling system is an absolute minimum requirement. This room will house sensitive electronic components, which will generate heat 24 hours a day, 365 days a year and must be cooled to maintain operating performance. The optimum temperature is 68 (F) degrees.

The air handling system for equipment rooms must be designed to provide positive air flow and cooling even during times when the main building systems are shut down. This may require separate air handlers and/or small stand-alone cooling systems. If this room is to be used as a central communications hub, the air handling system should be connected to the buildings backup power generation system. The room should have it's own cooling unit, own backup power unit, and own power circuit.

This room should be located near the Service Entrance Room and must have adequate access from outside the building to allow for the placement of large equipment frames.

The room must be equipped with ceiling space with a minimum of water pipes, air conditioning ducts, or other utilities crossing through. It should not be equipped with a false ceiling.

Do not equip the equipment room with a drop tile other false ceiling.

1.1.3.3. Telecommunication Closet

The telecommunication closet is the space that supports the cable and equipment necessary for transmission between the building's backbone system and user (station) locations. This room was formally known as a "telephone closet"; a term that is very misleading. Although that term is still in use today within the construction industry and in some telecommunications standards documentation, the City has adopted the more descriptive "Telecommunication Closet".

This space is called upon to terminate not only the cable from station outlets and backbone (riser) systems, but is also expected to house and support local area network equipment, multiplexing equipment, video distribution equipment, and system monitoring components. Individual departments frequently need to install components in these spaces to support advanced workstations or local computing needs. Space for such equipment is frequently not designed into office space, and the hardware is more cost effectively connected within the closet compared to its placement in user spaces.

In addition to the actual floor space needs, the cost of the advanced electronics required to support technology today should be taken into consideration when planning for these spaces. If multiple rooms on a single floor are being considered because it is difficult to find a central space, the costs of installing and operating additional data hubs should be weighed against the additional construction costs required to locate the room near the center of the building. These rooms must be stacked and should be centrally located within the building reducing the distance from the room to all user locations.

The Telecommunication Closet(s) serving an individual floor must be of sufficient size to support an extensive list of voice, data, and video equipment. This room must be dedicated to telecommunications and must be at least five (5) feet by Seven (7) feet in size.

1.1.4 Telecommunications Pathways

Pathways refer to the facilities and supporting structures used to transport telecommunications media from one location to another. It is important to think in terms of pathways as more than simply conduit in order to properly design these portions of the distribution system.

1.1.4.1 Interbuilding Distribution System

The designer must consider where the distribution system originates and determine what is required to make it meet the needs of the new construction. The City has 12 strands of dark fiber and 100 pair copper cable sitting in a vault in the North-west corner of LaPorte and Howes. Both of these media will need to be taken to the new Administration Building and terminated.

Although most design projects for individual City buildings do not specifically address communications outside the building, care must be taken in developing plans for making connections to these resources. In some cases, a separate construction and/or installation contract might be required to provide adequate pathways up to the point at which the building project can be interconnected.

1.1.4.2 Intra-Building Backbone (Riser)

In general this is the path used for placement of telecommunications media between the Service Entrance, Equipment Rooms, Telecommunication Closets, and Station Outlets. These pathways must typically support copper, fiber optic, and coaxial cables serving equipment and will be cross-connected to end-users located on each floor of the building.

1.1.5 Horizontal Cabling

The horizontal pathways between the Telecommunication Closet and the station outlet locations receive the heaviest usage and the most complaints of any component of a telecommunications distribution system. It is an area with a significant number of alternatives and one which frequently falls victim to budget cuts. When working on this issue, the building designer should identify methods for placing and supporting both the initial station cable and future cable additions.

Cable trays installed over fixed ceilings are worthless once the ceiling is complete. Trays which require an installer to manipulate and open a lid every three to four feet, in order to place cable, will not be used once the initial installation is complete. Floor trench, duct systems, and raised floors do not stand up well to floor care services and inevitability foster broken tiles, missing screws, and flooded ducts. Dedicated conduit runs and floor mount poke through are expensive and very inflexible in meeting the changing demands of instructional technology.

Our preferred horizontal distribution method is a flexible cable tray used in conjunction with plenum cable in the false ceiling.

Every Telecommunication Closet must provide a minimum of twice the amount of horizontal pathway access as is required to support the initial installation. A closet, which is served by four (4) four-inch backbone conduits, should not be equipped with a single two-inch horizontal pathway conduit.

Any outlet separated from the main horizontal support system (such as a tray) by a fire or smoke partition must be provided a rated pathway such as a sleeve, which can be fire-stopped after cable is installed, or an enclosed conduit or raceway directly from the outlet to the tray side of the partition.

Every room must be designed with a specific pathway from the false ceiling area used to access user locations to the main horizontal distribution pathway (such as the cable tray.)

1.1.5.1 Station Outlet

The station outlet will ultimately be configured to serve a variety of different telecommunications needs. An outlet which today may only require a voice connection may easily require multi-media data and video by the time the building construction is complete.

The prime point to remember about the station outlet is the need to design outlet locations for future needs, not just today's applications. If they are not initially required, they can be capped and used at a later time. By paying attention to potential telecommunications locations and the route by which they are served, the designer can save significant time and future costs from later attempts to meet changing needs. Station conduit will be a minimum of one-half inch, and is to be stubbed into the ceiling space.

1.2 DESIGN ISSUES

In addition to the Telecommunications Industry space and pathway issues, there are a variety of environment-specific issues that must be factored into the design of a new facility. Significant changes are taking place in how information is being delivered and that is reflected by fundamental changes in information system-related infrastructure requirements. New facilities simply cannot be designed using formula and criteria developed twenty years ago.

This subsection provides an overview of the minimum telecommunications infrastructure requirements in specific areas of new construction. It is intended to be used during program planning. Please refer to Section III, Infrastructure and Pathway Details for a more in-depth look at individual specifications.

1.2.1 Office Spaces

Office spaces range from the standard one-person space to multi-room office suites, and all need to be suitability equipped to access various City telecommunication resources. All offices must be designed to support multiple voice and data outlets situated to allow changes in furniture layouts.

All offices must be equipped with a minimum of two (2) duplex communication outlets, preferably on opposite walls and near electrical outlets. Larger offices and open suite areas should have multiple communication outlets, two per 75 square feet. Selected staff and office locations should be provided an additional video outlet.

1.2.2 Conference Rooms

Smaller conference rooms should be equipped with a two (2) duplex communication outlets (voice/data outlet) on walls, and a minimum of two (2) video outlets on opposite walls.

Larger conference rooms should be equipped as follows:

- Rooms longer than twelve (12) feet should be equipped with one or more floor outlet boxes which provide power and three signal pathways. One signal pathway is for connection to a building network, another is for voice equipment, and the third for video.
- Separate lighting controls should be provided to provide task lighting and a switch-activated power outlet. The walls should contain additional sound proofing material to reduce outside noise.
- The building should be equipped with a conference room, configured for use as a tele-conferencing and/or video-conferencing room. This will require additional acoustic material on the walls, storage space for equipment, and enhanced power and lighting controls.

1.3 SUMMARY

There is no such thing as a "perfect" telecommunications distribution design. Building planners can, however, provide a significantly improved design, with minimal cost impacts, by keeping the following in mind:

- Telecommunications pathways and spaces are designed for the life of the building, not a specific system or technology.

- Much of the ongoing costs involved with maintaining telecommunications systems is in the placement and rearrangement of cable and wire. The designer must ensure that the City staff can easily reconfigure the cables as telecommunication needs change over time.

SECTION II - INFRASTRUCTURE AND PATHWAYS DETAILS

2.0 INFRASTRUCTURE DETAILS

This section provides detailed information regarding the design of telecommunications pathways and spaces in new construction and facility remodel projects. It is intended to be used by architects and their sub-consultants during the detailed design phase of a project in the preparation of specifications and working drawings and by telecommunications and facility planning staff as a checklist for construction design projects.

This section outlines various sizing and selection criteria, provides sample configurations and "typical" drawings, documents various construction-related specifications, and highlights recommendations for improving the methods used to address telecommunications issues.

2.1 TELECOMMUNICATIONS SPACES

Telecommunications spaces include the rooms and facilities required to bring cable into the building, house specialized equipment, and terminate user-level facilities. It consists of the Building Service Entrance, an Equipment Room, and the Telecommunication Closets. It is very important to understand the requirements for all three types of spaces. The City's use of information and telecommunications technology depends, in a large part, upon its ability to cost effectively distribute such services.

This subsection defines the minimum space requirements for all new and remodeled facilities.

2.1.1 Building Service Entrance

The building service entrance space provides a location in which to terminate cables entering the building and interconnect them with internal building cables. In buildings without a dedicated equipment room, it also provides support for the electronic components utilized to distribute the telecommunication systems. It must provide sufficient room and structural additions to support the installation of a variety of cables, locations for splice cases and electrical protectors, and possibly network interface devices.

2.1.1.1 Space Design

The entrance room or space must contain the following support items:

- Three of the four walls are to be covered with 3/4 inch A-C plywood, painted with WHITE fire-retardant paint (not fire-retardant plywood unless required by local fire codes), mounted vertically starting 6" above the finished floor, and secured to the walls. All plywood panels must be mounted in contact with one another leaving no gaps between sheets.

- Sufficient overhead lights shall be installed to provide a minimum of 540 lux (50 foot candles) illumination measured 3 feet above the finished floor. These lights must be separately switched (within the room) and must be mounted a minimum of 8.5 feet above the finished floor.

- The door to the room must be a minimum of 36" wide by 6’6” high and must be equipped with a separate lock. The lock will be keyed to the level of the City’s Grand Master. Door will open outward.

- An electrical ground (as defined by local codes) must be provided on a six-inch bus bar mounted six inches above the finished floor. This grounding bar should be connected to either building steel (main building ground electrode), a separate concrete-encased electrode, or a buried ring ground with a 00 copper wire using a short feed to actual ground. **NOTE:** The NEC stipulates that communications cable shields be grounded as close as possible to the entrance into the building (NEC Article 800-4).

- A minimum of two 20 Amp, 110 volt AC quad electrical outlets, each on separate circuits, shall be installed on every wall of the entrance room. One of these dedicated circuits must be located six feet above the finished floor located behind the area designated for the equipment rack.

- All conduits entering the building from outside shall be plugged with reusable stoppers to eliminate the entrance of water or gases into the entrance room. All conduits leaving the entrance room for other portions of the building will be fire-stopped after the installation of cable.

- If the building is not equipped with a separate equipment room and the service entrance is used for that function also, the room must be equipped with a constant positive air flow sufficient to provide a minimum of two air changes an hour. It must also be equipped with a separately controlled HVAC capable of maintaining an office environment temperature. (See equipment room specifications for additional details.) If this room will be used only as a Service Entrance Room, and not double as an Equipment Room, there no special air handling is required beyond that provided in a standard office of equivalent size.

- The floor of the entrance room must be with anti-static vinyl compositional tile. Tile should be a light color. The floor structure should support a minimum of 200 lbs. per square foot loading capability.

- If additional equipment, such as fire alarm panels and/or building monitoring equipment, is housed in the entrance room, additional space and plywood backboards must be provided for such equipment. In no event should such equipment be mounted in the center of a wall or directly over entrance or riser conduits. Location of these devices are to be discussed with the City's Telecommunication Staff prior to installation.

- Do not install a suspended acoustical tile or other false ceiling.

- See Appendix A, within this section, for generic layout of the service building entrance.

2.1.2 Equipment Room

The equipment room is the space used to house telecommunications equipment intended to service users throughout the building. If the building design incorporates the entrance space with the equipment room, the space and support requirements for each function must be included in the final room design. If there are differences in specifications, such as the fire suppression system and HVAC requirements, the more stringent must be utilized.

2.1.2.1 Space design

The specific components that should be designed into an average equipment room are:

- Two of the four walls are to be covered with 3/4 inch A-C plywood, painted with WHITE fire-retardant paint (not fire-retardant plywood unless required by local fire codes), mounted vertically starting 6" above the finished floor, and secured to the walls. All plywood panels must be mounted in contact with one another leaving no gaps between sheets.

- Limit the possibility of flooding by not placing any water or drainage pipes directly over the room, configuring the surrounding floor area to drain accidental leaks before the equipment room becomes involved, or installing a floor drain if the danger of water entrance cannot be overcome in any other way. In addition, tray covers should be placed above the equipment in case of water leaks. Trays should provide a path for getting water to the floor drain, while not coming in contact with any of the equipment. Trays should be aluminum.

- Utilize a pre-action fire suppression system for coverage of this space. This should be linked to the equipment electrical panel to disconnect power in the event of system activation.

- The Equipment Room must support an average floor loading of 200 lbs. per square foot. Specialized services, such as major UPS systems and batteries, may require floor loading of over 400 lbs. per square foot over a specified area and must be coordinated between City and architectural staff. The floor must be tiled with anti-static tile to reduce airborne contaminates. Tile color should be light in color. If raised flooring is used, it must be crossed braced, and drilled anchors must be utilized to fix the pedestals to the structure's floor. This is required in order to permit the installation of equipment cabinets and racks up to eight feet tall while limiting the potential for damage during a seismic event. The raised floor must also be designed to support a minimum load of 200 lbs. per square foot.

- The equipment room shall be situated so as to reduce the potential for electromagnetic interference to 3.0 V/m throughout the frequency spectrum. Consideration should be given to not locating the equipment room near power supply transformers, motors and generators, x-ray equipment, and radio transmitters.

- Entrance doors must be a minimum of 36 inches wide by 6’6” tall. Consideration should be given to utilizing double doors on larger size rooms. Door will have a lock, and lock will be keyed to the City’s Grand Master key. Door(s) will open outward.

- Sufficient heating, ventilating, and air conditioning (HVAC) sensors and control equipment must be installed to provide a constant environment for this space. For this type of environment, it is important to note that some of our equipment can only function in an environment that is between 60 and 72, with 20 to 80 percent relative humidity. Anything outside of that range will cause damage to those units. The maximum change in temperature must not vary more than 8 degrees (F), and humidity should not vary more than 20 percent. The design target is a continuous operating temperature between 60 and 72 degrees with 20 to 80 percent relative humidity. Optimum temperature is 64 degrees.

  The equipment housed in this space will continue to generate heat 24 hours a day, 365 days a year regardless of usage, and the room must be equipped with additional air handling equipment in order to maintain the environment in the event the main building system is shut down. The room air handling system should be linked to the building's emergency power source as a further backup.

- This room should be equipped with a pre-action fire suppression system with high temperature thermal links and cage enclosed heads. A system control link should be provided in order to cut power to the equipment in the event water is discharged from the system. Drainage must be provided to limit the potential of flooding or equipment damage.

- Additional equipment such as fire alarm panels and/or building monitoring equipment should not be housed in the equipment room. However, if conditions mandate such equipment be co-located with telecommunications, additional space and plywood backboards must be provided for such equipment. In no event should such equipment be mounted in the center of a wall or directly over the entrance or riser conduits. Location of these devices are to be discussed with the City's Telecommunication Staff prior to installation.

- Lighting shall be installed to provide a minimum of 50 foot candles illumination measured 3 feet above the finished floor. Light fixtures should be mounted a minimum of 8.5 feet above the floor and should be located in the middle of aisles between frames or cabinets. Equipment rooms should be equipped with emergency backup lighting sufficient to allow a technician to service the system during a power failure.

- A minimum of four 20 Amp, 110 volt AC quad electrical outlets, each on separate circuits with isolated grounds to the breaker box, shall be installed in the equipment room. One of these dedicated circuits must be located six feet above the finished floor located behind the area designated for the equipment rack. In addition, the room shall be equipped with auxiliary duplex outlets placed 6" above the finished floor, at six foot intervals around the perimeter walls. A maximum of four of the auxiliary outlets may occupy a single branch circuit.

- An isolated electrical ground (as defined by Article 250-74 of the NEC) must be provided on a six-inch bus bar mounted six inches above the finished floor. This grounding bar should be connected to either building steel (main building ground electrode), power service ground, a separate concrete-encased electrode, or a buried ring ground with a 00 copper wire.

- If batteries are to be used, the type specified is a Gel cell battery. Additional ventilation, acid dams, and floor load bracing may be required. Local codes may require batteries to be housed in a separate room adjacent to the equipment room. Batteries are to be enclosed, yet easily accessible for maintenance purposes.

- See Appendix A, in this section, for generic layout of the Equipment Room.

2.1.3 Telecommunications Closet

The telecommunications Telecommunication Closet on each floor serves not only as part of the vertical pathway system on a multi-story building, but it also must support all station cabling and cross-connects, user and department-specific electronics, and specialized distribution equipment such as local area network hubs and fiber optic multi-plexors. These rooms will have frequent access by technicians installing and maintaining various network services and must be sized and equipped to meet this demanding role.

As one of the primary focal points for all communication services, the Telecommunication Closet must be designed as an integral part of the overall building. It cannot be "fit in" wherever there is room left over after all other spaces have been defined; it must be identified as a fixed location similar to an elevator, mechanical shaft, or electrical room. These rooms must be sized to accommodate the City's needs. Access to these rooms should be directly from hallways, not through offices, or mechanical spaces.

2.1.3.1 Space Design

The Telecommunications Close or space must contain the following support items:

- Each floor's Telecommunication Closet should be centrally located within the building and must be stacked one above the other in this multi-floor building.

- The Telecommunication Closet must be located within 290 cable feet of the farthest outlet location and should be designed to provide an average distance of 150 feet. Cable feet distance is defined as the total distance of the route the actual station cable must follow, both horizontally and vertically, between the Telecommunication Closet and the outlet location. An additional room is required if this distance is exceeded. The average distance between the uesr outlets and the Telecommunications Closet should be in the 100 to 150 foot range.

- If the building requires two or more rooms on every floor, each series of rooms must be stacked one above the other. The Telecommunication Closets must be located directly above one another in this multiple story building. If the entire space cannot be located in-line, provide at a minimum, space for the in-line placement of backbone (riser) conduit.

- Multiple rooms located on the same floor must be interconnected with conduits. See backbone pathway subsection for number and type.

- These rooms must be dedicated to the exclusive use of telecommunications equipment to provide proper environment and security. They cannot occupy partial spaces within mechanical or electrical rooms. In many cases faculty, staff, and even students need access to the Telecommunication Closets and adequate safeguards cannot be provided in shared use environments.

- The environment of these rooms shall be equal to or better than a normal office (positive 24 hour air flow cooling, sealed or vinyl compositional tile floor - no carpet).

- The Telecommunication Closet must support an average floor loading of 100 lb. per square foot. The floor must be covered with anti-static tile, light in color, to reduce airborne contaminates.

- The Telecommunication Closet shall be situated so as to reduce the potential for electromagnetic interference to 3.0 V/m throughout the frequency spectrum.

- Entrance doors must be a minimum of 36 inches wide by 6'6" tall and must open outward. Door will have a lock, and be keyed to the City's Grand Master.

- Sufficient heating, ventilating, and air conditioning (HVAC) sensors and control equipment must be installed to provide a constant environment for this space. Unless specific requirements otherwise dictate, the room environment should approximate an office and the engineer should assume a 3,500 BTU load from installed equipment. In addition, a passive heat exchange must be designed into the space to reduce overheating of equipment during times of building HVAC shut-down.

- Additional equipment, such as fire alarm panels and/or building monitoring equipment, should not be housed in the Telecommunication Closet. However, if design constraints mandate joint usage of this space, additional floor space and plywood backboards must be provided for such equipment. In no event should such additional equipment be mounted in the center of a wall or directly over entrance or riser conduits. Location of these devices are to be discussed with the City's Telecommunication Staff prior to installation.

- Lighting shall be installed to provide a minimum of 50 foot candles illumination measured 3 feet above the finished floor. Light fixtures should be mounted a minimum of 8.5 feet above the floor.

- A minimum of two 20 Amp, 110 volt AC quad electrical outlets, each on separate circuits (individual branch circuits) with isolated grounds to the breaker box, shall be installed in each Telecommunication Closet. One of these dedicated circuits must be located six feet above the finished floor located behind the area designated for the equipment rack. In addition, the room shall be equipped with auxiliary duplex outlets placed six inches (6") above the finished floor, at six foot intervals around the perimeter walls.

- An isolated electrical ground (as defined by Article 250-74 of the NEC) must be provided on a four-inch bus bar mounted six inches above the finished floor near, but not behind, the riser conduit. This grounding bar should be connected to either building steel (main building ground electrode), a separate concrete-encased electrode, or a buried ring ground with a 00 copper wire and must be common to all Telecommunication Closets and the equipment room.

- The Telecommunication Closet must not be equipped with a suspended acoustical or other false ceiling.

- One wall must be covered with ¾-inch A-C plywood, painted with WHITE fire-retardant paint (not fire-retardant plywood unless required by local design codes), mounted vertically starting six inches (6") above the finished floor, and secured to the wall. All plywood panels must be mounted in contact with one another leaving no gaps between sheets.

- See Appendix B, in this section, for generic layout of the Telecommunications Closet.

2.2 TELECOMMUNICATIONS PATHWAYS

Telecommunications pathways include the inter-building conduit and manholes used to transport cables between buildings and the conduit and cable trays used to distribute cable within a building. These pathways must be designed as a specific part of an overall telecommunications infrastructure plan, not as a system or technology-specific component.

2.2.1 Conduit and Manhole System

- Conduits should generally be schedule 40 PVC or, if concrete encased, type C signal conduit with a four-inch (4") internal diameter. Conduit runs should be made in large straight sections utilizing wide (40 foot or more) sweeps rather than ninety degree bends. If ninety degree bends cannot be avoided, they should be located at either end of the conduit run (not in the center of a long run) and must not have less than a 12 1/2 foot radius.

- All conduits should be buried a minimum of 24 inches below grade. The trench must be back-filled with Flow-fill non-shrink backfill. See Appendix C, in this section, for a detailed description of this material.

- The entrance conduits must be designed to allow the placement of various types of cables including large copper cables, fiber optic cable (within innerduct), and coaxial cables.

- At a minimum, four (4) four-inch conduits are required to service this building.
- All conduits shall be fitted with a collar or bell end to limit damage to the cable during pulling.
- The entrance conduits must be designed to allow the placement of various types of cables including large copper cables, fiber optic cable (within innerduct), and coaxial cables.
- Utility vaults, if needed, must be situated to allow the conduit to enter the building with no more than two (2) ninety degree bends.
- **Vault dimensions;** Vaults will be acquired from City of Fort Collins, Light & Power Department via CITEL. The vaults that are to be used are the fiberglass vaults as follows:

  V - Small oval vault - 6 foot by 3 foot
  HV - Large hand vault - 24 inch by 36 inch
  SHV - Small hand vault - 12 inch by 18 inch

  Vaults will be labeled as follows: Vault identifier-Street name/location-direction from CHW.

  Example V-HOW-E1
  V - meaning 6 x3 foot vault
  HOW - vault is on Howes Street
  E1 - is the first vault to the East

- **Conduit labeling:** Conduits are to be numbered from left to right in rows from top to bottom. Conduits will be labeled with direction and conduit number. For example if the vault has 4 conduits entering the vault from the West, the labeling would be W1 through W4. The vault labeling scheme will continue with the conduits as follows:

  W1- meaning the first conduit leaving to the West

- **Inter-duct specs:** Inter-ducts should be Orange in color and one inch in diameter to allow for four (4) one inch inter-ducts to be placed in each four inch conduit. The inter-ducts will be labeled starting with I1 through the total number of inter-ducts that will fit in the conduit size. For example I1 through I4 for a four inch conduit. The vault labeling scheme will continue with the inter-ducts as follows:

  I1 - meaning the inter-duct labeled number 1

  Vaults, conduits, and inter-ducts will be labeled as follows: Vault identifier-Street name/location-direction from CHW- conduit number and direction-interduct number.

Example V-HOW-E1-W1-I1
V - meaning 6 x3 foot vault
HOW - vault is on Howes Street
E1 - is the first vault to the East
W1- meaning the first conduit leaving to the West
I1 - meaning the inter-duct labeled number 1

2.2.2 Intra-building Backbone

The intra-building backbone pathways connect the entrance room, equipment room, and all Telecommunication Closets in a given structure. It consists of conduit, sleeves, and trays. The designer should be aware that open cable trays are not an option for supporting large copper cables from the entrance room to the equipment room or to the telecommunication closet if the ceiling space will be a plenum. While many systems use fiber optic and/or coaxial cable which can be purchased with plenum-rated sheaths, the large copper cables used to support much of today's voice telephone services are generally sized to meet the building's requirements.

General requirements are as follows:

- pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations
- Grounding/earthing and bonding of pathways shall comply with applicable codes and regulations
- pathways shall not have exposed sharp edges that may come into contact with telecommunications cables
- the number of cables placed in a pathway shall not exceed manufacturer specifications, nor will the geometric shape of a cable be affected.
- pathways shall not be located in elevator shafts.
- All backbone conduits and sleeves must be four (4) inches in diameter.
- Pathways must be designed with no more than two (2) ninety (90) degree bends.
- The minimum number of vertical backbone (riser) conduits is three (3). For specific sizing requirements, refer to Section II of this document.
- There must be a plenum-rated pathway between all telecommunications spaces within a building. If an open cable tray is used, then the cabling used must be plenum-rated.

2.2.3 Sizing

In determining the proper number of conduits or sleeves required to connect an entrance room to an equipment room or telecommunication closet, it is important to understand how various types of cables will be utilized. The primary focus for cable within the building is the equipment room. Here the electronic components serving users within the building will be interconnected with the cable feeding in from other parts of campus.

For riser pathways, start with three (3) four-inch conduits or sleeves and add one (1) additional conduit for each 40,000 square feet of space served above that point. For example, a six story building with 20,000 assignable square feet per floor needs a minimum of three (3) conduits serving each of the top two floors

(5th & 6th). The third and fourth floors each would have four (4) conduits (because of the additional space on the upper floors). The second floor would be served by five (5) four-inch conduits.

Additional conduit is required in situations such as non-stacked closets which must be fed by off-set conduit runs. Such conduit can only be filled to less than half of its capacity and will restrict the number of cables which can be placed. The final quantity and placement of backbone conduit must be analyzed in light of the services to be installed, the route taken, and the potential for expansion of services; however, a minimum of one or two additional conduits should be added in these situations.

2.2.4 Design

Sleeves are to be used in backbone riser pathways. Sleeves should extend a minimum of two (2) inches above the finished floor in the upper room and four (4) inches below the true ceiling (or past any obstructions) in the lower room. All sleeves should be placed to provide short and straight pathways between floors.

Conduits used to interconnect entrance and/or equipment rooms should be placed above the false ceiling with no more than a total of two 90 degree bends. Do not angle these conduits down into the termination space. Fix the conduit four to six inches inside the room at a right angle to the wall. All metal conduits must be fitted with a collar or end bushing to eliminate damage to the cables during pulling.

Pull boxes shall be placed in conduit runs which exceed 100 feet or in situations which require more than two 90 degree bends. Such pull boxes must be located so as to provide free and easy access, in straight sections of conduit only (pull boxes should never be used for a right angle bend), and must be installed to allow cable to pass through from one conduit to another in a direct line See Appendix D, of this section, for Pull box sizing.

All riser sleeves must be fire stopped and sealed following code and manufacturers instructions.

2.2.5 Horizontal Pathways

The horizontal pathways are facilities which support the installation and maintenance of cables between the Telecommunication Closet and the station outlet locations. The City promotes the use of plenum-rated telecommunications cable supported by a cable tray serving station conduit stubbed into the false ceiling space as the general distribution method.

2.2.6 Cable Tray

The cable tray will be NEMA Class Designation 12B (75 lbs per linear foot). The City has standardized on the use of Flextray cable trays. Trays can vary between six (6) to twenty (20) inches in width, with a minimum depth of two (2) inches. Trays must qualify under NEC Section 318-7(b) as equipment grounding conductor. Smaller buildings and secondary tray sections serving fewer than 25 stations may utilize a four (4) to eight (8) inch wide tray.

Trays are to be sized to accommodate both copper cable and fiber. The fiber will be protected in interduct. There will be a minimum of two (2) one inch inter-ducts allowed per cable tray.

Trays should be secured on ten foot centers using a single center-mounted steel supporting rod and bottom "T" connector or angled wall supports. If there will not be access to both sides of the tray, or; other limitations will prohibit the placement of cable equally in both sides of the tray, a standard trapeze type support system may be used. Trays must meet seismic bracing standards #4.

The cable tray should be routed in a manner which will reduce the need for long unsupported cable runs. However, the tray need not be extended to cover all areas of a floor simply to transport cables to one or two locations. Cable installers can utilize "J" hooks (on 6' centers) to support individual runs of cable, or a zoned conduit system can be used to supplement the cable tray.

Cable trays must only be utilized over areas with ceiling access and must transition to a minimum of three (3) four-inch conduits when routed over fixed ceiling spaces larger than 15 feet or containing any angle greater than 20 degrees. **Trays should be bonded end-to-end.**

Trays should enter telecommunication closet six (6) inches into the room then utilize a drop out to protect station cables from potential damage from the end of the tray. All penetrations through fire walls must be designed to allow cable installers to fire-seal around cables after they are installed. The use of tray-based mechanical fire stop systems instead of changing to conduit is encouraged when a tray must penetrate a fire barrier.

Cable trays may not be placed closer than six (6) inches to any overhead light fixture and no closer than twelve (12) inches to any electrical ballast. A minimum of eight (8) inches of clearance above the tray must be maintained at all times. All bends and T-joints in the tray must be fully accessible from above (within one foot). Trays should be mounted no higher than twelve (12) feet above the finished floor and must not extend more than eight (8) feet over a fixed ceiling area.

A separate conduit sleeve (minimum of two inches) must be provided as a pathway through any wall or over any obstruction (such as a rated hallway) from the cable tray into any room having a communications outlet. Such conduit runs must be continuous over fixed ceiling areas, but may be sleeves between false ceiling spaces which have access.

2.2.7 Station Outlets

The "standard" wall outlet should be a 4 11/16 inch square (duplex) outlet box served by a ½-inch conduit (with no more than a total of 180 degrees of bend) covered with a duplex mud ring. Other specific station pathway configuration information is defined below:

- If flush mounted floor outlets are required, do not use poke-through outlets fed from the floor below. Instead, place a dual use (signal & power) preset outlet in the floor surface and feed the conduit (1/2" for signal only) through the floor slab to the nearest wall and into the false ceiling. Flush mount units must provide a space for telecommunications comparable to the standard quad NEMA outlet box.

- If a large number of such outlets are required, consider the use of a presets with feeder duct (Walkerduct) served by multiple two-inch conduits directed into the ceiling space.

- Custom counter or workstation installations requiring telecommunications services, should be connected to a wall-mounted junction box fed by a one-half inch conduit. Conduit should be stubbed out at in the ceiling space. There should be two conduits, on opposing walls, servicing a workstation. See Appendix E, of this section, for labeling of station outlets.

- Station outlets should not be "daisy-chained" one to the other. However, if absolutely necessary, increase the feeder conduit size by a half-inch to the first outlet in line (two maximum).

- Station outlets shall;

- accommodate a minimum of two 8 position / 8 conductor modular jacks
- utilize compliant pin technology 110 style insulation displacement connectors which allows the use of a 4 pair impact tool
- allow for a minimum of 200 re-termination's without signal degradation
- utilize reactance balanced pair technology to address data circuit applications up to 100 MHz
- provide universal application / multi-vendor supportive
- support industry standards for T568A wiring options
- have removable from the front with the faceplate mounted in place, and allows for the jack to pass through the faceplate without re-termination
- have a hinged door option for areas having excessive air born contaminants
- provide color coded snap in icons available for circuit identification
- be constructed of high impact flame retardant thermoplastic
- have available a gravity feed (45 degree angled) design
- be available in screened version for 100 ohm ScTP cable
- be UL Verified for TIA/EIA category 5 electrical performance

- The City has standardized on SIEMON's Angled Category 5 CT Couplers that are CAT 5 rated for outlets. The CT Couplers will be white in color for the voice, blue in color for data, and orange for radio.

- Where indicated in the Project Specifics section, fiber outlets will be used. Specifics on these outlets are as follows:

- be available in ivory
- flush mounted gravity feed (45 degree angled) design
- accommodate a minimum of two SC or ST style adapters
- universal application for both multi-mode and single mode connectors

- multi-vendor supportive
- removable from the front with the faceplate left mounted in place
- pass through design, so adapter can pass through the faceplate opening
- provide a dust cover for unused ports
- color coded snap-in icons available for circuit identification
- made of high impact flame retardant thermoplastic
- be made by an ISO 9001 and 9002 Certified Manufacturer

The City has standardized on SIEMON Company CT Series Fiber Couplers.

2.2.8 Faceplates

All faceplates shall:

- be applicable to both fiber and copper applications
- have write on designation labels for circuit identification with a clear plastic cover
- be available in single gang, and double gang configurations
- have the standard color of ivory
- have optional modular furniture adapters available
- be made by an ISO 9001 and 9002 Certified manufacturer.

The City has standardized on SIEMON Company CT or MAX faceplates.

2.2.9 Surface Mount Boxes

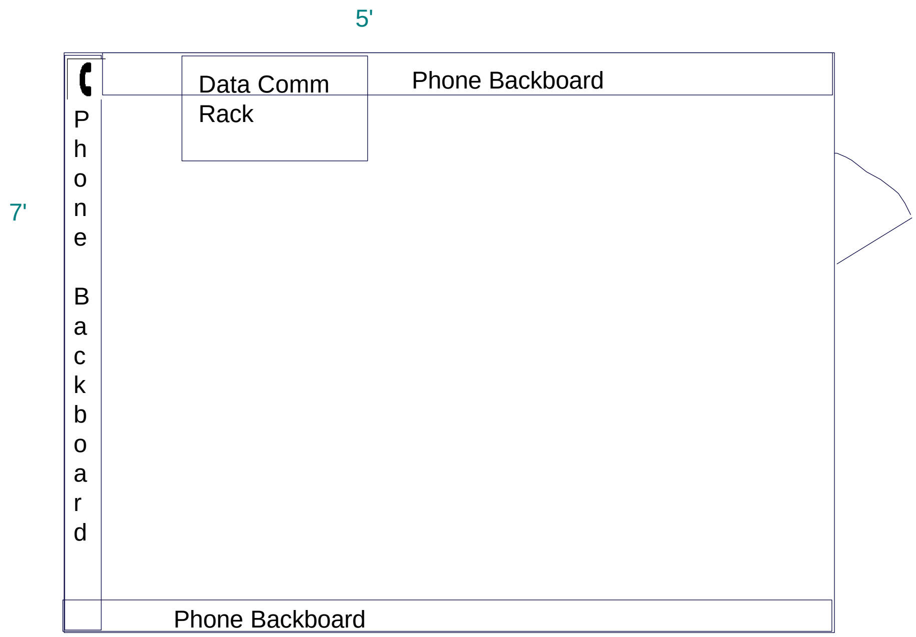
All low profile surface mount boxes used for mounting surface mount information outlets shall:

- be available in 1, 2, 4, or 6 port versions
- have built in cable management for both fiber and copper applications
- be ivory in color
- have at least three sides with breakouts and an opening in the base for cable or raceway entry
- provisions for an optional spring-loaded shutter door for added protection from dust and other air born contaminants
- have a designation area for printed or adhesive labels for circuit identification
- have optional magnets which can be internally mounted
- color coded snap in icons shall be available for circuit identification
- be made by an ISO 9001 or 9002 Certified Manufacturer.

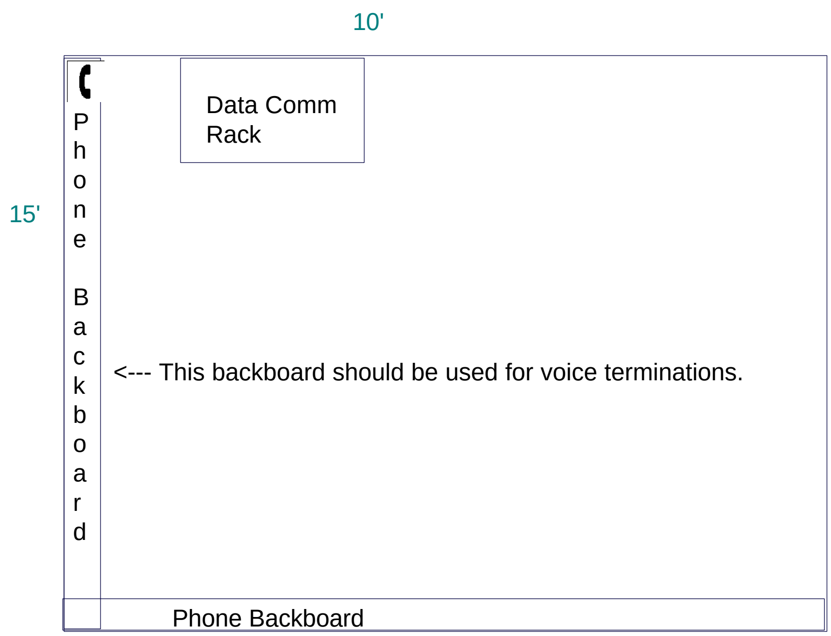
The City has standardized on SEIMON Company SM Series Surface Mount Box.

APPENDIX A

Service Entrance Room



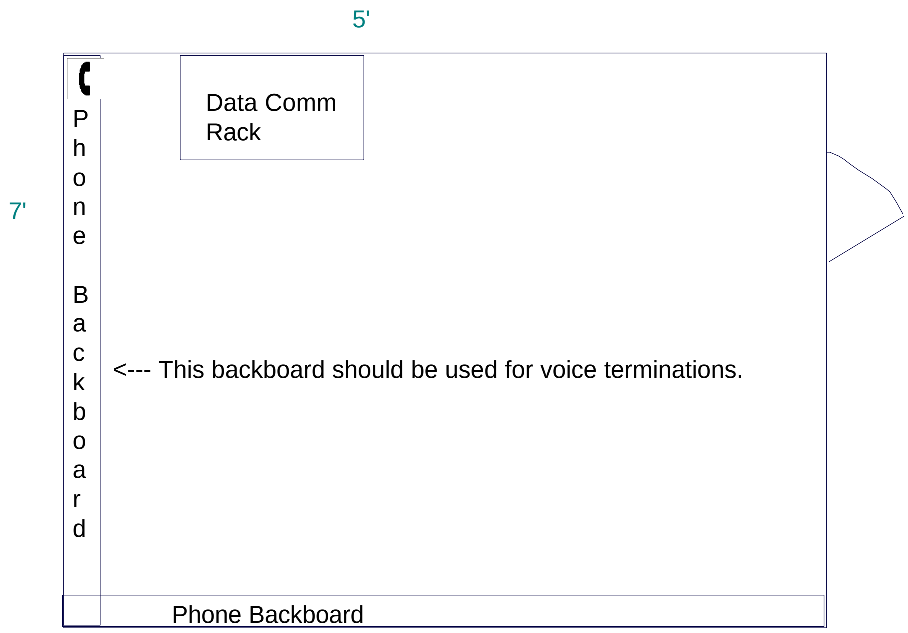
Equipment Room



DRAWINGS ARE NOT TO SCALE

APPENDIX B

Telecommunications Closet



DRAWING NOT TO SCALE

APPENDIX C

Flow-fill Non-shrink Backfill Specifications

MIX PERFORMANCE

24 Hour Strength
- 8 psi Minimum
- 12 psi Maximum

28 Day Strength
- 60 psi Maximum

Maximum aggregate size = 1”

Cement - Type I-II Ideal (ASTM C 150)

SLUMP – at point of placement
- 5” Minimum
- 8” Maximum

Mix Proportions (per cubic yard of concrete)

		Absolute Volume
Cement – 0.45 sacks	42#	0.21 Cu. Ft.
Water --- 39 gallons	325#	5.20 Cu. Ft
Air (Entrapped) --- 1.5%		0.41 Cu. Ft.
1” Aggregate - ASTM C 33, Size No. 57	1700#	10.17 Cu. Ft.
Sand --- ASTM C 33	1845#	11.24 Cu. Ft.
TOTAL	3912#	27.23 Cu. Ft.

Theoretical Unit Weight --- 143.7# / Cu. Ft. @ 1.5% air
Theoretical Yield --- 27.23 Cu. Ft. @ 1.5% air
% Sand of Total Aggregate --- 52%

NOTE: Aggregate Weights are based upon materials being in a saturated surface dried condition.

APPENDIX D

Pull Box Sizing

Minimum space requirements in indoor pull boxes
having one conduit each in opposite ends of the box

MAXIMUM TRADE SIZE OF CONDUIT IN INCHES	SIZE OF BOX			FOR EACH ADDITIONAL CONDUIT INCREASE WIDE
	WIDTH	LENGTH	DEPTH	
0.75 in.	102 mm (4 in.)	305 mm (12 in.)	76 mm (3 in.)	51 mm (2 in.)
1.0 in.	102 mm (4 in.)	406 mm (16 in.)	76 mm (3 in.)	51 mm (2 in.)
1.25 in.	152 mm (6 in.)	508 mm (20 in.)	76 mm (3 in.)	76 mm (3 in.)
1.5 in.	203 mm (8 in.)	686 mm (27 in.)	102 mm (4 in.)	102 mm (4 in.)
2.0 in.	203 mm (8 in.)	914 mm (36 in.)	102 mm (4 in.)	127 mm (5 in.)
2.5 in.	254 mm (10 in.)	1067 mm (42 in.)	127 mm (5 in.)	152 mm (6 in.)
3.0 in.	305 mm (12 in.)	1219 mm (48 in.)	127 mm (5 in.)	152 mm (6 in.)
3.5 in.	305 mm (12 in.)	1372 mm (54 in.)	152 mm (6 in.)	152 mm (6 in.)
4.0 in.	381 mm (15 in.)	1524 mm (60 in.)	203 mm (8 in.)	203 mm (8 in.)

Regulating Bends

All bends must be long, sweeping bends with a radius not less than six time the internal diameter of conduits two (2) inches or smaller **OR** ten (10) times the internal diameter of conduits larger than two (2) inches.

Reaming Conduit

All ends of metallic conduit must be reamed and brushed.

APPENDIX E

Station Outlet Labeling

Cable, Equipment Room, Telecommunication Closet

Equipment Room and Telecommunication Closet labeling will begin on the first floor and continue to other floors if necessary. They will be identified by an Alpha Character starting with: A

ROOM labeling will start with 100 and continue upwards. If possible the 200 number series will start on the second floor, the 300 number series in the third floor and etc. This would change to 1000 number series if there is more than 100 rooms per floor.

FACE PLATE labeling will start with A and C if it is a duplex plate, with A being the white voice jack and C being the black data jack, continued in the following fashion:

A B E F I J M N Q R U V Y
C D G H K L O P S T W X Z

AA BB EE FF II JJ MM NN
CC DD GG HH KK LL OO PP

QQ RR UU VV YY
SS TT WW XX ZZ

A typical faceplate numbering series would be as follows for a single drop:

A100A for Voice
A100C for Data

A typical faceplate numbering series would be as follows for a Quad drop:

A100A & A100B for Voice
A100C & A100D for Data

For Telecommunication Closet cabling use the following format:

A1B for a cable running from Equipment Room A to Telecommunication Closet B at Equipment Room A location.

B1A for a the same cable running from Equipment Room A to Telecommunication Closet B at Telecommunication Closet B location.

SECTION III: WIRE, CABLE & SUPPORT SYSTEMS

3.0 WIRE, CABLE, AND SUPPORT SYSTEMS

Although many of the existing City Buildings have used differing design guidelines for the telecommunications cable installed to support their systems, this section identifies a suggested approach centered around developing industry standards for voice and data communications. The use of manufacturers brand names does not indicate these are the only providers of a particular component.

The components in this section are divided into three major groups. The first is the copper cable and associated hardware used to install and terminate this media. The second is fiber optic products, and the third is coaxial cable products. While some explanation is provided regarding system usage, this section is not intended to identify all of the potential uses of a given product.

It must be understood that these guidelines are based upon local needs and standards regarding the utilization of telecommunications media.

3.1 COPPER CABLE SYSTEMS

Copper cable systems have been in use in all City buildings for a variety of purposes for many years. Recent changes in the industry, however, have given new life to this medium as a means to meet higher performance telecommunications needs. The adoption of the EIA/TIA-568A standards identifies minimum performance characteristics for a standard approach to station wire utilizing unshielded twisted station cable.

This standard defines several characteristics for copper backbone (inter-building and riser) cable and station cables. Subsequent technical bulletins have also been issued defining higher performance alternative specifications for station cable and connecting hardware.

The product vendors have reacted to these recent bulletins by providing a variety of new cable types aimed at filling the requirement for high speed station cable connections. In addition to cable, several new terminal blocks and station jacks have been introduced which are designed to assist with the provision of higher data rates. As with any high performance product, the new types of cable must be installed using components and techniques which will provide and maintain a high quality environment.

Copper cable is classified by many parameters including size (gauge), performance characteristics, type of conductor, and cable composition. All of the type of cable utilized as part of these guidelines is solid wire rather than stranded. The gauge is generally 24 American Wire Gauge (AWG) however, in some cases 22 AWG (a larger size cable) is required to meet distance-sensitive performance parameters.

The composition of the cable will be discussed later in this section as it relates to the various types of cables (inter-building, riser, station). Performance characteristics also vary by type and usage of cable and include a wide variety of electrical and mechanical aspects. There are three measurements which are frequently used to "grade" a copper telecommunications cable. These measurements are:

- *Nominal mutual capacitance* is the measurement of the effects of electrostatic charges on adjacent surfaces (cable pairs) and is measured in farads or picofarads (trillionth of a farad). Within specific parameters a lower number can provide better performance.
- *Attenuation* is a measurement of the loss of signal over a cable pathway. It is measured in decibels (-dB) and the lower the number the better performance offered by the cable.
- *Cross-talk* (Near-End Cross talk - NExT) is the level of signal which passes from one cable pair to another within a single cable sheath. It is also measured in -dB's. However, the higher the number the better.

These descriptions are offered not as the only, or even as the best, means of analyzing performance specifications, but they are important components in determining what cables should be used in a particular situation.

3.1.1 Station Cable

Station cable, the cable connecting the users jack to the terminal blocks in the Telecommunication Closet, has undergone significant changes in the last few years. Several vendors started offering cables with improved performance characteristics and classified such cable as "data grade" or "LAN" cable.

The industry responded to this need for different cable performance levels by adopting the EIA/TIA 568A (plus TSB-67) cable specifications which identifies five performance categories for unshielded twisted copper cables. In general, the first two categories of cable are not recognized as part of the standard and are classified only for voice and low speed data applications. The third and fourth categories are no longer used within the City. The fifth category is:

- Category 5: This highest level cable is intended for applications up to 100 Mb/sec (such as FDDI).

It is important to note that simply installing a Category 5 cable will not provide the user with a 100 Mb/sec pathway. All of the hardware components which make up the wire pathway, such as the terminal blocks, patch cords/jumper wires, user jack, and line cord, must also meet Category 5 specifications and should be designed to work together. In addition, installation techniques used to implement a Category 5 pathway contain very strict guidelines regarding cable terminations, routing, and layouts in order to maintain performance specifications.

The City "standard" Category 5 wire configuration consists of two (2) four-pair unshielded copper pairs (UTP) / Screened twisted pair (ScTP) cables; one for voice and one for data. This standard has been adopted based on historical usage within the City and the extensive support available within the industry. The City’s standard is to use Belden’s DataTwist 350. This standard has been adopted based on historical usage within the City, the support available within the industry, the stable performance across the frequency range, and the capabilities to meet our future networking needs.

The "standard" station outlet will consist of two (2) four-pair DataTwist 350 cables terminated in two (2) modular 8 position jacks. The cable types are defined below:

- *Voice station four-pair* - shall be Category 5, four-pair, (24 AWG, CMP rated) as defined in the ANSI/EIA/TIA 568A standard.
- *Data station four-pair* (high speed) - shall be Category 5, four-pair, (24 AWG, CMP rated) as defined in the EIA/TIA 568A.
- All Category 5 installations must also conform to the component configurations and installation practices contained in EIA/TIA 568A.
- Cable, at the station end, should have a minimum of a foot of extra cable for ease of service in the future. The slack should be looped and left in the box.

The use of plenum rated cable is required in all situations; does not matter whether the cable is being placed within a ceiling space used as an air plenum.

3.1.2 Station Jacks

The jack or outlet which terminates the station cable at the users location becomes an integral part of the distribution system if a true Category 5 cable system is to be installed. It must terminate the cable with an electrically sound connection and should provide some flexibility in allowing for the connection of various communication devices.

The City standard is for the termination of the two four-pair station cables in two separate 8 position modular jacks. See Appendix A, in this section, for details on how station jacks are to be terminated. See Section 2 for specifics on Station outlets, Faceplates, and Surface Mount Boxes.

Each telecommunication closet will be connected to the building's equipment/ entrance room riser with cables sized to provide a pair count of four-pair to each station served.

3.1.3 Riser Cable

It is important to use UTP Category 5 grounded shielded cable in the building risers to lessen the impact of interference. Using a shielded but ungrounded cable actually increases the potential for electrical interference in the cable. Riser cables should be grounded at the point of origination and at any floor in which pairs leave the cable sheath. If the ground is not adequate for use as a shield ground, it must be reworked or replaced to provide the proper connection. See Section 2 for grounding specifications.

All riser cables shall be CMR rated, bonded, shielded, air-core, 24 gauge, with staggered twists and a mutual capacitance of not more than 19 nF per 1000 feet. All riser cables must be of a type compliant with the specifications of EIA/TIA 568A

3.1.4 Inter-building Cable

Inter-building cable is available in a variety of different configurations, sizes, and performance specifications. Normally the cable will be 24 gauge with a standard capacitance of 83 to 87 nanofarads per mile and a staggered twist design. For distance beyond 2,500 feet, consider the use of 22 gauge cable to improve performance levels for many PBX electronic instruments.

Cable placed in a conduit should have a stalpeth or alpeth sheath and must have a water-exclusion gel filling to limit the introduction of moisture into the cable. This type of "gel-fill" or "icky-pik" cable cannot be brought directly into a building and terminated without first being enclosed in conduit and terminated into an enclosed splice. Do not terminate filled cables directly onto protector or terminal blocks.

If steam or high temperature is a potential problem, cable specially made with additional mechanical protection should be installed for such environments.

Any cable pulled through a long or difficult conduit path, should be equipped with a bonded sheath.

3.1.5 Cable Routing

All horizontal cables regardless of media type shall not exceed 90 m (295 ft) from the telecommunications outlet in the work area to the horizontal cross connect. The combined length of jumpers, or patch cords, and equipment cables in the telecommunications closet and the work area should not exceed 10m (33 ft).

Two horizontal cables shall be routed to each work area. The horizontal cables shall be: connected to a station outlet (jack), four pair unshielded twisted pair (UTP) / Screened twisted pair (ScTP).

Horizontal pathways shall be installed or selected in such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.

In open ceiling cabling, cable supports shall be provided by means that are structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 m (5 ft) apart.

Telecommunications pathways, spaces and metallic cables which run parallel with electric power or lighting shall be installed with a minimum clearance of 50mm (2 in).

For voice or data applications, 4-pair UTP or fiber optic cables shall be run using a star topology from the telecommunications closet on each floor to every individual information outlet. All cable routes shall be approved by the City prior to installation of the cabling.

The Contractor shall observe the bending radius and pulling strength requirements of the 4-pair UTP/ScTP and fiber optic cable during handling and installation.

Each run of the UTP/ScTP cable between horizontal portion of the cross-connect in the telecommunication closet and the station outlet shall not contain splices.

In the telecommunications closet where cable trays or cable racking are used, the contractor shall bundle together the horizontal cable with reusable color coded hook and loop cable managers (velcro tie wraps) to create a neat appearing and practical installation. SIEMON Company VCM Series recommended. Tie wraps shall be used at appropriate intervals to secure cable and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath.

Hook and loop cable managers shall be used in the closet where reconfiguration of cables and terminations may be frequent.

The Contractor will use station conduit, to be a minimum of one-half inch, and is to be stubbed into the ceiling space.

In a false ceiling environment a minimum of three (3) inches (75mm) shall be observed between the cable supports and the false ceiling.

Continuous conduit runs installed by the contractor should not exceed 100 feet or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.

3.1.6 Cable Termination

3.1.6.1 Blocks

In most cases the recommended cable termination blocks, also called terminals, terminal blocks, and punch down blocks, are SEIMON CAT 5 S66M-50 blocks, M Series.

All block assemblies should include sufficient 188B2 jumper backboards or similar devices mounted adjacent to the 66 blocks for effective use as cross-connect wire holders. The proper size retaining clips must be used for all cable termination's.

Labeling for the blocks, both room and color indicators, will be handled as outlined in Section 2.

3.1.6.2 Modular Patch Panel

The termination panels shall support the appropriate Category 5 applications and facilitate cross-connection and inter-connection using modular patch cords. The panels shall be sized to fit an EIQ standard

19 inch relay rack or be capable of mounting to a wall. Modular Patch Panels will be used for data terminations.

The panel shall:

- be made of black anodized aluminum in 16, 24, 28, 32, 48, 64 and 96 port configurations
- accommodate at least 24 ports for each rack mountable space
- have Cat 5 outlets (jacks) available in T568A. See Section 2 for specifics on outlet types to be used
- allow for a minimum of 200 re-terminations without signal degradation
- have modular ports compliant with FCC CFR 47 part 68 subpart F and IEC 603.7 with 50 microinch gold plated contacts
- allow for the use of a 5 pair 110 style impact termination tool
- have cable tie eyelets and a rear cable management bar
- be fully enclosed front and rear for physical protection of printed circuit board
- have port identification numbers provided on both the front and rear of the panel
- have an optional adhesive circuit identification and color coding designation strips provided with the panel
- have self adhesive clear label holders, and white designation labels shall be provided with the panel with optional color labels available to the City
- be available in a 24 port ScTP veision which exceeds the transfer impedance requirements of ISO/IEC 11801. This panel must accept two types of cable preparation for termination
- be consistent with the electrical specifications outlined within this document
- be UL Verified for TIA/EIA category 5 electrical performance
- accept 100 style patch plugs as a means of termination
- be made by an ISO 9001 and 9002 Certified Manufacturer.

SIEMON HD5 Series Patch Panels Recommended.

3.1.7 Cable Protection

Cable protectors are used in conjunction with proper bonding and grounding to provide electrical hazard protection to staff and sensitive electronic equipment. The decision of where and how to use protectors is not clear cut and must be viewed as part of an overall cable design process. Generally, copper cables serving a voice switching system should be protected. The station end (other buildings) protection requirements are based on the individual layout, potential for lighting strikes or power faults, and historical electrical fault problems.

The Main Distribution Frame (MDF) should be served by wall or rack mounted protectors designed to be connected to the terminals. For large installations, it is often better to use a protector panel which is separate from the cross-connect field to allow testing of cables and a separation within the work area.

In individual buildings and in smaller installations, the recommended protector panels utilize an integrated termination and protector panel unit which incorporates the terminal blocks with the protector panel housing. Protector modules shall be fast acting, 3 element, (5 pin) gas-tube units with sneak current (low voltages) protection. Brand of lightening protectors that can be used, are AT&T 188ENA1.

3.1.8 Splice Cases

All splices must be contained within a splice case. All outdoor (vault and tunnel) splice cases should be encapsulated, re-enterable units fully dressed and enclosed to fit the number and type of cables terminated. All end plates must be designed for the number and size of cables served by the splice case and be designed to seal around each cable individually.

Splice cases are designed for specific environments such as for use in vaults, buried underground, for use within a building, or mounted on a pole. The designer must select and specify an appropriate unit when installing copper cable systems. Poor products, inadequate installation techniques, or incorrect use of a particular product can lead to moisture leaks and ultimately cable troubles.

Outdoor vault and tunnel splice cases should be heavy duty stainless steel. Indoor cases used to terminate inter-building cable filled with water-exclusion gel should also be capable of completely sealing around all cables at each end of the case.

Cable shields must be bonded through all splices.

3.2 FIBER OPTIC CABLE SYSTEMS

Fiber optic cable is used to support voice, data, and video systems in a wide range of installations. An increasing number of manufacturers, improvements in splicing methods, developing standards, and reduced cost electronics have all helped push this medium into the forefront of telecommunications services. A prime point to remember, however, is that any fiber-based product needs an interface and electronic components to make them active. This means that in several instances copper cable is still a good choice for basic telecommunications services, and in some cases, the only practical choice.

The cost tradeoffs of fiber versus copper cable installations are very complex and due to the nature of the industry, are in a constant mode of change. Unless otherwise indicated in the Project Specifics of this document, the City is not wanting to install fiber to the desk top. However, the City does want to have the inter-duct in place, for when the need has arrived for this type of technology, fiber can be easily installed. Thus the reason for installing inter-duct on the cable trays outlined in Section 2.

This document will focus on the types of fiber cable and support equipment required rather than the specific applications to which fiber may be used.

3.2.1 Station Cable

The inter-building station fiber should be a multi-mode, 62.5/125 um, dual (two optics) cable, plenum-rated (OFNP), with a dielectric strength member and/or a reinforced yarn covering for physical protection. These cables should be terminated in "ST" connectors mounted in the users station outlet and capped if not immediately used. The performance of this fiber must comply with the Fiber Data Distributed Interface (FDDI) specifications. Each pair of fibers should terminate in a fiber patch panel (rack mounted for more than 24 stations) in the Telecommunication Closet.

3.2.2 Fiber Riser Cable

Multi-mode fiber optic cable should be installed in all building telecommunications (riser) rooms to support today's data communications needs. At a minimum, the fiber riser cables should consist of twelve (12) fibers to each Telecommunication Closet from a master panel in the building's equipment room. These cables should be "home-run" cables directly from the equipment room into the individual Telecommunication Closets. All fiber cables should be contained within an innerduct and be clearly marked as optical cables for additional physical protection. All fiber riser cables must be OFNR rated, multi-mode, 62.5/125 um, tight buffered, fan out cables with a dielectric central member and must carry a crush resistance rating of at least 1100 lbs/in. Cables must have a 900 um buffer and must meet the following performance characteristics:

- Maximum attenuation: 3.5 dB/km @ 850 nm; 1.5 dB/km @ 1300 nm
- Minimum bandwidth: 160 MHz/km @ 850; 500 MHz/km @ 1300 nm

3.2.3 Inter-building Fiber Cable

This building will be connected to the City’s main telecommunications distribution point with both multi-mode and single mode optical fibers.

This building should contain an additional 20 foot loop of fiber cable which is neatly coiled and secured before reaching the final termination point which can be utilized as splicing slack in the event of a cable break. The cable should be installed within an orange, one-inch interduct in a tunnel or conduit and within each building. Four (4) one-inch interducts should be placed in one four-inch conduit feeding to every building for use by the fiber optic cable. The inter-building cables must be water- exclusion gel-filled, dielectric, loose tube construction with a tensile strength of 600 lbs (long term) and designed for installation in underground ducts. Fiber optic cable should be pulled through conduct using a swivel and special fiber cable grip.

All gel-filled cable should either be terminated into a splice case or have the ends of the cable dressed with a blocking kit to eliminate the seepage of the gel.

The cables should meet or exceed ANSI/EIA/TIA-492 AAAA specifications and should have the following characteristics:

Multi-Mode Optics

- 62.5/125 um (core/cladding) dual window (850 and 1300 nanometers)
- Maximum attenuation: 3.5 dB/km @ 850 nm and 1.75 dB/km @ 1300 nm
- Minimum bandwidth: 160 MHz/km @ 850 and 500 MHz/km @ 1300 nm
- .275 numerical aperture
- Minimum pulling tension of 600 lbs.

3.2.4 Fiber Optic Patch Panels

All fiber optic cables should be terminated on ceramic ST connectors (with compatible bulkheads) in individual patch panels. In each Telecommunication Closet these panels should generally be pre-loaded, wall-mount units equipped with a lockable cover. These units will terminate the riser fiber optics and provide a pathway for interconnecting to fiber-based electronics. The fiber optic patch panel connections should provide .4 dB or less insertion loss. However, if fiber optic station cables are to be installed, consideration should be given to installing a frame-mount patch panel equipped to terminate 24 or more optics.

In each building's equipment room, there should be installed a wall- or frame-mounted fiber patch panel equipped to terminate the incoming inter-building fiber and the riser cables. Patch cords (pre-made), should be provided, to interconnect one pair of fibers from each Telecommunications Closet to the inter-building fiber cable. The patch cords (jumpers) should be impact-resistant double-fiber cables of the same performance characteristics as the multi-mode fiber. These fiber optic patch panel connections should provide .4 dB or less insertion loss.

The City’s Service Entrance Room should be equipped with a frame mounted fiber optic patch panel which will terminate all inter-building fiber cables and any riser cables which serve that building. At a minimum, this unit must be fully equipped (pre-loaded) to terminate 24 optics. The frame should be equipped with a jumper tray.

As the City has standardized on SEIMON products for all of it’s copper cable terminations, it is recommended that the Contractor continue with that standard in the fiber optic arena.

3.2.5 Fiber Optic Interconnect Centers, Panels and Trays

All interconnect centers, panels and trays (units) shall provide cross-connect, inter-connect, splicing, capabilities and contain cable management for supporting and routing the fiber cables/jumpers.

3.2.5.1 Wall Mount

The wall mount interconnect center shall:

- have a low profile compact design, able to accommodate up to 12, 24 and 48 port configurations
- be modular in design with management clips that provide two independent levels of slack storage to comply with fiber bend radius and the recommended slack storage length
- have a door which is hinged and lockable
- have an administrative labeling system, and must be available on a hinged door, capable of locking for protection

- have color coded bezels available for color coding connectors
- have an optional jumper guard which has a hinged and lockable door separate from the main cable management section
- have anchor points, strain relief and ground lug shall be provided for the fiber cable entry to the unit
- accommodate splice trays which manage up to 48 splices
- be available in black or ivory and constructed of 18 guage steel
- be UL listed 1863
- be made by an ISO 9001 and 9002 Certified Manufacturer

SIEMON Wall-Mount Interconnect Center (SWIC) Recommended

3.2.5.2 Rack Mounted High Density Fiber Interconnect Center

The high density rack mounted fiber interconnect center shall:

- be available in white or black and occupy no more than four rack mountable spaces, and accommodate up to 72 ST or 144 SC fibers using snap-in pre-loaded adapter plates
- have fiber managers to effectively store fiber cable slack and comply with fiber bend radius requirements
- have six port fiber adapter plates which allow for color coding connectors
- have fiber adapter plates with snap-in installation and one-finger removal
- lockable front and rear transparent doors that have spring release hinges for removal
- accommodate splice trays which mange up to 72 splices
- have an adapter plate mounting bracket which slide out to the front and to the rear of the unit for increased access
- have cable access points for fiber jumpers entering and exiting the unit with rotating grommets to facilitate cable loading and to minimize microbending stress
- have anchor points for fiber cable(s) entering the unit
- have labeling which meets or exceed ANSI/TIA/EIA-606 requirements and also be laser printable
- be UL list 1863 and cUL C22.2 approved
- be made by an ISO 9001 and 9002 Certified Manufacturer

SIEMON Rack Mount Interconnect Center (RIC) Recommended

3.2.5.3 Rack Mounted Low Profile Fiber Connect Panel

The low profile fiber connect panel shall:

- not be bigger than one rack mount space and accommodate up to 32 SC or ST Adapters
- be modular in design with fiber managers that provide slack storage to comply with fiber bend radius and the recommended slack storage length
- have available color coded bezels for color coding connectors
- have a snap-on front shield to be used as a labeling surface and protect jumpers
- accommodate splice trays which manage up to 48 splices

- be available with a drawer mechanism which slides from the front of the rack and has defeatable latches to allow removal
- have quarter turn fasteners to lock it closed and a smoke polycarbonate cover for protection
- have anchor points, helical wrap and ground lug for the fiber cable entering the unit
- by made by an ISO 9001 and 9002 Certified Manufacturer

SIEMON Fiber Connect Panel Recommended

3.2.5.4 Rack Mounted Fiber Tray

The rack mounted fiber tray shall:

- be made of 18 guage steel with a black finish
- available in 16, 24, 48, 32, and 48 port configurations and be able to double that port count utilizing 4 port adapters
- accommodate both SC and ST adapters
- have changeable ports which are removed fromthe front of the unit to allow custom configuration or modification
- have silk screened port identification numbers provided on both the front and rear of the unit
- have ANSI/EIA-310 compatible mounting slots
- include fiber managers that manage slack storage so as to comply with fiber bend radius requirements and slack storage length recommendations
- accommodate splice trays which manage up to 48 splices
- have a cover with quarter turn screws for easy access
- not exceed a 10” depth for mounting in standard cabinets and enclosures
- be provided with strain relief lugs for fiber entering the unit from the side of back
- be made by an ISO 9001 and 9002 Certified Manufacturer

SEIMON CT Fiber Management Tray Recommended

3.3 CROSS CONNECT WIRE AND PATCH CORDS

3.3.1 Cross Connect Wire

The cross-connect wire shall:

- have pair condutors bonded together to maintain pair twist
- be available in 1, 2, 3, and 4 pair reels of 1000 feet
- be color coded
- be made by an ISO 9001 and 9002 Certified Manufacturer
- exceed ANSI/TIA/EIA 568-A and ISO/IEC 11801 specifications for category 5

SIEMON Category 5 Cross-connect Wire Recommended

3.3.2 Patch Cords

Where applicable the contractor shall supply patch cords (factory assembled Plug-ended jumpers) for patch panel and terminal blocks.

3.3.2.1 Modular Patch Cords: Category 5

Category 5 modular patch/equipment cords shall:

- be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color coded twisted pairs within a flame retardant jacket
- be equipped with modular 8 position (RJ45style) plugs on both ends wired straight-through with standards compliant wiring
- modular plugs exceed FCC CFR 47 part 68 subpart F and IEC 603-7 specifications, and have 50 microinches of gold plating over nickel contacts
- modular cords should include a molded strain relief boot
- ScTP cords, shield continuity shall bemaintained through the modular plug shield and not via the contacts
- be available in any custom length and standard lengths of 3, 5, 7 , 10, 15, 20 and 25 feet.
- be made by an ISO 9001 and 9002 Certified Manufacturer

SIEMON COMPANY MC5 Series Modular Cords Recommended

3.3.2.2. 110 Patch Cords: Category 5

110 patch cords shall:

- be factory or field assembled using category 5 compliant 110 patch plugs and stranded category 5 cable
- have plugs available in 1, 2, 3, and 4 pair sizes
- be available in factory made standard lengths of 3, 5, 7, 10, 15, 20, and 25 feet and any custom length
- be made by an ISO 9001 and 9002 Certified Manufacturer

SIEMON Company S110P Series Plugs and Cords Recommended

3.3.2.3 Modular patch Cords: Category 5

The 110 to modular patch cords shall:

- be factory or field assembled using category 5 compliant 110 patch plugs and stranded category 5 cable
- be available in 2 and 4 pair sizes with eight position modular plugs
- be made from factory assembled modular cords for field assembly or performance is not guaranteed
- have modular plugs which exceed FCC CFR 47 part 68 subpart F and IEC 603-7 specifications, and have 50 micro-inches of gold plating over nickel contacts
- be available in factory made cords of any custom length and standard lengths of 3, 5, 7, 10, 15, 20 and 25 feet
- have available colored boots at the base of the modular connector and snap in icons on the 110 connector for administrative purposes
- be made by an ISO 9001 and 9002 Certified Manufacturer

SIEMON S110P to Modular Patch Cords Recommended

3.3.2.4 Fiber Patch Cords (Jumpers)

Fiber equipment cords shall:

- be available in standard lengths of 1, 3, and 5 meters, custom lengths shall also be available, and shall meet or exceed standards as defined in ANSI/TIA/EIA-568-A and ISO/IEC 11801
- utilize simplex or duplex fiber cable that is 62.5/125 micron multimode, OFNR riser grade, and meets the requirements of UL 1666
- attenuation shall not exceed 3.5 dB/km @ 850 nm wavelength or 1.0 dB/km @ 1330 nm
- cable jacket color shall be orange. The connects shall be SC or ST in accordance with TIA/EIA-568-A and must include a ceramic ferrule
- ST connectors must have a metal coupling nut
- terminated connects shall exhibit a maximum insertion loss of 0.75 dB with an average of 0.50dB when tested at either 850 nm or 1300 nm wavelengths
- be made by an ISO 9001 and 9002 Certified Manufacturer
- be UL 1666 approved

SIEMON Company FJ Series Fiber Jumpers Recommended

3.4 COAXIAL CABLE SYSTEMS

Prior to the vendor installing a Cable TV system, vendor should meet with the City's Cable Production Director to develop a design that is compatible with the City's needs.

Although not utilized as much as it was only a few years ago, coaxial cable still plays an important role in the distribution of multi-channel video programming within and between buildings. Other forms of coaxial cable are used for special purposes such as connecting particular data vendor products and as Ethernet baseband cables (thick and thin cable.) For purposes of this document we are assuming the "standard" coaxial cable configuration is the distribution of multi-channel video signals.

There are a variety of cost effective, high quality, multiple channel fiber optic based video distribution systems on the market today. Most of these, however, are targeted as an alternative to major video feeder trunks and are designed to bring several channels into a building. This type of configuration can be very cost effective if fiber cable is already available or will be installed regardless of the need for video distribution. This alternative should be explored before expanding a broadband inter-building coaxial cable system. All coaxial cable will be plenum rated regardless of where it's located.

Multi-channel video distribution within a building, however, is still most economical with coaxial cable. It is generally easy to work with, is available from a variety of sources, and can be installed without extensive training. Television monitors can be directly connected to the cable and can access multiple channels without the need to purchase separate converters. The components necessary to drive the system are relatively inexpensive and easy to install.

A design of a video distribution system is beyond the scope of these guidelines. It is expected that a contracted video system designer will develop a distribution plan which highlights the cable locations and individual components necessary to make the system fully functional. It is fairly straight-forward for a one-way system within a building. Bi-directional or two-way systems are more complex and specific performance calculations must be prepared indicating the expected levels at all portions of the system. This task is made easier if two separate cables are used, one for outbound and a second for the return channels.

These guidelines provide general media specifications for the inter- and intra-building cable commonly used to support a 450 MHz video distribution system.

The final selection of the inter-building coaxial cable will be the end result of the design engineers calculations. However, such feeder and trunk cables are generally 1/2 or 3/4 inch semi-rigid coaxial cables. In situations with limited potential for cable damage, either during placement or after installation, a standard polyethylene jacketed cable can be sufficient. However, if the cable will be placed in a position where it might become bent or crushed, a cable with a corrugated armor inter-sheath is advisable. As with both the copper and fiber cables, coaxial cable placed in conduits and in steam tunnels should be flooded with a water-exclusion gel compound.

3.4.1 Inter-building Cable

Coaxial cables are very susceptible to signal degradation due to cable damage; especially at higher frequencies. Since many large systems are designed to operate up to 500 MHz it is critical that the integrity of the cable be maintained. Standard cable installation practices must be followed including proper bonding and grounding of the cables. The minimum performance specifications for 3/4 inch inter-building coaxial cable is as follows:

- Capacitance: 15.6 pF/ft +/- 1 pF/ft
- Impedance: 75 +/- 2 ohms
- RF Attenuation: 1.18 dB/100 feet @ 500 MHz
- Velocity of propagation: 87%
- dc resistance @ 68 F (per 1,000')
- - .38 for copper inner conductor
- - .61 for copper clad aluminum inner conductor
- - .16 for outer conductor
- Structural return loss: 26 dB minimum

3.4.2 Riser Cable

Coaxial riser cable is generally placed from the entrance or equipment room in a building to the Telecommunication Closet on each floor. This cable interconnects the main inter-building video feed to splitters or directional couplers on each floor to the station cable terminated in the rooms. As with any cable which connects between floors of a building it must be riser-rated.

This is generally a ½-inch semi-rigid cable and care must be taken during placement not to kink or bend it. It must be adequately supported on each floor and must be physically protected from damage. It should have the same capacitance and impedance measurements as the inter-building cable, however the attenuation (loss) will be greater. The specific performance measurements should be as defined below:

- Capacitance: 15.6 pF/ft +/- 1 pF/ft
- Impedance: 75 +/- 2 ohms
- RF Attenuation: 1.65 dB/100 feet @ 500 MHz
- Velocity of propagation: 87%
- dc resistance @ 68 F (per 1,000')
- - .86 for copper inner conductor
- - 1.34 for copper clad aluminum inner

Conductor

- - .39 for outer conductor
- Structural return loss: 26 dB minimum

3.4.3 Station Cable

Coaxial station cable can be distributed in several methods. One way is to loop the cable into and out of each outlet location calculating the expected loss at each point until you reach a 3 dBmV signal level. Another is to bring a feeder cable down a central passageway (such as a cable tray) and connect multiple port taps and distribute individual station cables to each outlet.

The third is to home run each cable between the Telecommunication Closet and each outlet. This method is very straight forward if the system is expected to serve a two-way role of both transmitting and receiving video signals. If this method is utilized, it is often advisable to install a fixed length of cable to each outlet thereby fixing a standard signal value from any tap in the system. A similar result can be achieved through the use of pads and attenuators.

The recommended methods are the latter two; using a feeder cable and individual station cables, and installing individual home run cables. The final determination will be the responsibility of the system designer and will be based upon known and expected utilization of the system.

Any cable installed must be plenum-rated. These cables should be RG-6 coaxial cables with a bonded foil aluminum braid foam polyethylene dielectric and a .04" copper clad steel center conductor. The cables should be rated for use up to 600 MHz and tested up to 500 MHz. "F" connectors with a matching smaller (than for PVC) diameter crimp sleeve must be used.

SECTION IV: PLANNING & DESIGN

4.0 DESIGN PROCESS

Detailed planning must be carried out with City design team staff utilizing the building's program planning document. By utilizing the initial portions of this document (Pathways and Spaces), the architect should be able to develop a clear definition of a "generic" building distribution system capable of meeting a wide range of changing needs; applying these early in the process will reduce the potential for costly change orders later.

This type of information should then be provided to the architect's electrical and telecommunications consultant(s) for inclusion in planning and construction documents.

Telecommunications distribution design must be viewed as a specialty service, much like audio visual or laboratory design, and a member of the architect's team must be specifically responsible for consultation with the City and preparation of detailed designs. It is not enough to simply have the electrical engineer include "power and signal" in their work. A specific process of consultation and design must be utilized which will expand upon the design guidelines in this document and result in the preparation of detailed construction drawings and specifications.

The project R.F.P. specifications shall direct the architect to include a specialty telecommunications design firm as part of the project design team. It is expected that as a qualification factor, the selected specialty consultant will have achieved an acceptable experience level in the design of telecommunications distribution systems as a minimum criteria for selection by the architect.

The City can greatly enhance its potential to obtain usable long-term telecommunication designs in new buildings by recommending that a Registered Communications Distribution Designer (RCDD) be included in the design team and defining that person's involvement as a consulting function.

4.1 CONSTRUCTION PROCESS

During construction, tight coordination must be maintained between the distribution designer and the City on-site inspectors. As submittals are made outlining the placement of particular equipment and building components, the designer should be consulted as to the impact of any potential modifications of the original design. A minor item, such as moving conduit from one wall to another to make room for HVAC equipment, can mean the difference of several thousand dollars in additional telecommunications equipment.

The designer can also be used as a resource to assist with inspections of work in progress to determine compliance with specifications and industry standards.

4.2 PLANNING – FORM A

4.2.1 Inter-Building Telecommunications Planning

New buildings and renovation of existing facilities require adequate access to the City- wide telecommunications cabling system which supports voice, data and video communications. These inter-building costs should be included as site costs on the Budget Estimate Form.

1. Are building entrance conduits planned for the access to telecom network facilities? ____ Yes ____ No

2. Estimate the number, size, and distance to point of connection of cabling conduits required for building access to the campus-wide network.

   Number: ________
   Size: ________
   Distance to point of connection: __________ ft.
   Estimated total cost of access conduits to the building. $ ____________

3. Estimate the VOICE cable medium type, size, and length for connection to the network facilities.

   Medium Type: _________
   Cable/Wire (AWG) Size: _________
   Length: _______________ ft.

   Estimated total cost of VOICE cable pairs to the building. $ ___________

4. Estimate the DATA cable medium type, size, and length for connection to the network facilities.

   Medium Type: _________ Size: _________ Length: __________ Ft.

   Estimated total cost of DATA lines to the building. $ ____________

5. Estimate the VIDEO cable medium type, size, and length for connection to the network facilities.

   Medium Type: _________ Size: _________ Length: __________ Ft.

   Estimated total cost of VIDEO connection to the building. $ ____________

6. Have the costs for items 2 thru 5 been accounted for in the construction site cost? If so, please attach. If "No" please explain below: ____ Yes ____ No

4.3 PROCUREMENT SPECIFICATIONS

This section of the Request For Proposal provides detailed specifications for the materials and services to be provided by the Contractor. Bidders are cautioned to review these specifications closely to ensure a complete understanding of both the defined requirements and the intent of the City. As with any major public works project, not every minor component required to complete the installation is identified in this document.

If something does not look right, bring it to the attention of the City before submitting your bid. Every effort will be made to resolve any inconsistencies in this document and to discuss alternative technical approaches. Do not assume you can "straighten things out" after a contract award.

The following identifies the specific materials the City wishes to obtain from this procurement.

4.3.1 Materials

This subsection identifies the particular cable and hardware which must be used on this project. Where specific reference brands are given, the Contractor must either bid those items or provide an equivalent type product. If an equivalent vendor is used, the successful contractor will be required to submit technical data sheets (and/or catalog pages) for each major system and hardware component prior to receiving final approval to proceed.

4.3.1.1 Cable

1. Copper Station Cable. Belden DataTwist 350.

2. Copper Riser Cable Specifications. Each Telecommunication Closet will be connected to the building distribution frame (BDF) with riser cables. All riser cables shall be CMR rated, bonded, shielded, air- core, 24 gauge, with staggered twists and a mutual capacitance of not more than 19 nF per 1,000 feet. All riser cables must be of a type compliant with the specifications of EIA/TIA 568B. All riser cables shall be high pair count designed to make the best use of the available conduit. Specific pair count splits between floors must be confirmed with the City prior to installation. Reference brand is Belden.

3. Inter-building Copper Cable Specifications. The inter-building cables shall be bonded Stalpeth sheath, plastic insulated conductor (PIC), water-exclusion gel-filled cable suitable for duct and tunnel installation. Cable will be 24 gauge with a standard capacitance of 83 to 87 nanofarads per mile and a staggered twist design.

4. Fiber Station Cable Specifications. Dual (2 optics in a single sheath) fiber optic cables will be installed in selected locations to

support high speed data networking and video origination links. These cables will be installed between patch panels in the Telecommunication Closets and wall outlets in the work areas. The cables must be FDDI compliant (as defined in EIA/TIA-568B), 62.5/125 um, plenum rated cables designed for placement into the work area. The cables must contain a dielectric strength member and/or a reinforced yarn covering for physical protection. The cables must comply with EIA/TIA-568 and performance measurements of EIA/TIA-455-46, -61, or -53.

- Maximum loss: 3.5 dB/km @ 850 nm, 1.5 dB/km @ 1,300 nm
- Minimum bandwidth: 160 MHz @ 850 nm and 500 MHz @ 1,300 nm
- Requires a minimum of 24 strands for each new City building. Reference brands are Siecor DIB and AT&T Accumax.

This particular project will not be using Fiber Station Cable.

5. <u>Fiber Riser Cable Specifications</u>. Fiber optic cables will be installed in the riser rooms within the building as detailed in the attached drawings. These cables will provide twelve (12) fibers in each Telecommunication Closet and will be terminated in a master panel in the BDF. All fiber riser cables must be OFNR rated, multi-mode, 62.5/125 um, tight buffered, fan out cables or MIC cables with a dielectric central member and must carry a crush resistance rating of at least 1100 lbs/in. Cables must have a 900 um buffer, must comply with ANSI/EIA/TIA-492 AAAA, and must meet the following performance characteristics:

   - Maximum attenuation: 3.5 dB/km @ 850 nm; 1.5 dB/km @ 1300 nm
   - Minimum bandwidth: 160 MHz/km @ 850; 500 MHz/km @ 1300 nm
   - All riser cable shall be certified (OFNR) for placement in the riser spaces. Reference brands are Siecor and AT&T.

6. <u>Inter-building Fiber Optic Cable</u>. Inter-building fiber optic cable will be installed between the buildings identified in the attached drawings. **NOTE:** For this building, fiber will be brought in from the manhole located at the north-west corner of LaPorte Avenue and Howes Street. Contractor will be expected to run twelve (12) strands of the fiber from the manhole to this new City Building.

   This building shall contain an additional 20 foot loop of fiber cable which is neatly coiled and secured before reaching the final termination point (two loops in those buildings in which the cable extends to another building. The cable will be installed within an orange, one-inch inner-duct in the tunnel and in each building. Four one-inch inner-ducts shall be placed in one four-inch conduit feeding from the tunnel/vault into each building for use by the fiber optic cable. These cables shall be dielectric, loose tube construction with a tensile strength of 600 lbs (long term) and designed for installation in underground ducts. The cables shall meet or exceed ANSI/EIA/TIA-492 AAAA specifications and shall have the following characteristics:

- Multi- Mode Optics (as defined by EIA/TIA 568)
- 62.5/125 um (core/cladding) dual window (850 and 1300 nanometers)
- Maximum attenuation: 3.75 dB/km @ 850 nm and 1.5 dB/km @ 1300 nm
- Minimum bandwidth: 160 MHz/km @ 850 and 500 MHz/km @ 1300 nm
- .275 numerical aperture
- Minimum pulling tension of 600 lbs.

7. Coaxial station drops. Coaxial cable shall be utilized for all in-building wiring of the RF distribution system drops. This cable shall be plenum rated CATVP with a bonded foil aluminum braid (60% minimum), foam teflon dielectric with a .04 inch copper clad steel center conductor. The cable must be compatible with RG- 6 CATV grade coax for use with frequencies between 5- 550 MHz. The nominal attenuation must not exceed 4.27 dB per 100 feet at 500 MHz. Reference brands are Comm/Scope and Belden or equivalent.

8. Coaxial Riser Cable. Coaxial riser cable shall be utilized to distribute the video signals between floors of the building. The riser layout shall be as defined in the City-attached drawings. The cables shall be riser rated CATVR one-half inch, 75 , foamed teflon dielectric coaxial cables. This cable must be engineered and tested to support frequencies ranging between 5- 550 MHz. The nominal attenuation must not exceed 2.32 dB per 100 feet at 500 MHz. Reference brands are Comm/Scope and Belden or equivalent.

- Capacitance: 15.6 pF/ft +/- 1 pF/ft
- Impedance: 75 +/- 2 ohms
- RF Attenuation: 1.65 dB/100 feet @ 500 MHz
- Velocity of propagation: 87%
- dc resistance @ 68 F (per 1,000')
- - .86 for copper inner conductor
- - 1.34 for copper clad aluminum inner

Conductor

- - .39 for outer conductor
- Structural return loss: 26 dB minimum

9. Coaxial Distribution Cable. Coaxial cable shall be utilized to distribute the video signals along floors of buildings between the riser tap and individual drop taps. The distribution layout shall be as defined in the City-attached drawings. The distribution cables shall be plenum rated CATVP RG-11, 75 , foamed teflon dielectric coaxial cables with a bonded foil aluminum braid (60% minimum). This cable must be engineered and tested to support frequencies ranging between 5- 550 MHz. Reference brands are Comm/Scope and Belden or equivalent.

   - Capacitance: 16 pF/ft +/- 1 pF/ft
   - Impedance: 75 +/- 2 ohms
   - RF Attenuation: 3.8 dB/100 feet @ 500 MHz
   - Velocity of propagation: 87%
   - dc resistance @ 68 F (per 1,000')
   - - .86 for copper inner conductor
   - - 1.34 for copper clad aluminum inner

   Conductor
   - - .39 for outer conductor
   - Structural return loss: 26 dB minimum

10. Coaxial Entrance Cable. This cable shall be jacketed, .750 flooded cable suitable for installation in buried conduit. The cable must be engineered and tested to support frequencies ranging between 5-550 MHz and must meet or exceed the following performance specifications:

   - Capacitance: 15.6 pF/ft +/- 1 pF/ft
   - Impedance: 75 +/- 2 ohms
   - RF Attenuation: 1.18 dB/100 feet @ 500 MHz
   - Velocity of propagation: 87%
   - dc resistance @ 68 F (per 1,000')
   - - .38 for copper inner conductor
   - - .61 for copper clad aluminum inner conductor
   - - .16 for outer conductor
   - Structural return loss: 26 dB minimum

4.3.1.2 Copper and Fiber Hardware

Station Outlets. See Section 2 of this document for specifics.

a. *Voice/data wall outlets*. There are two types of these outlets that are used. The first is while in color for voice, and the second is blue in color for data.

b. *Voice/data 4-gang wall outlet*. Many offices will be equipped with dual or 4-gang outlet boxes. Those listed as voice/data only will utilize the two modular jack assemblies identified in (a.) above. Unused spaces shall be covered using the faceplate or two blank insert covers. Those units identified as video equipped must utilize the faceplate with a defined voice and data modules plus an "F" series connector and a blank cover.

c. *Wall phone outlets.* Wall phone outlets shall consist of a single four-pair cable connected to a modular jack assembly with a metal cover plate suitable for setting a wall mounted phone.

d. *Data-only wall outlets*. In selected locations, only a single data four- pair will be required. In those locations the outlet will consist of the blue Communications Outlet Assembly identified in (a.) above, but without the 8- position modular jack (include a blank insert cover).

e. *Voice/data and data-only floor outlets.* There may be a limited number of flush-mounted floor outlet boxes. For pricing purposes, bidders should assume these floor outlets must be served using modular jacks compatible with the standard NEMA electrical. The configuration of the individual jacks shall be the same as that defined for the similar wall-mounted modular outlet.

f. *Single fiber wall outlet*. The single fiber wall outlet will terminate two optical fibers in ST compatible connectors which are protected from accidental damage either by being recessed or angled downward. All specifications for fiber type and termination requirements defined elsewhere in this RFB must be maintained through this outlet. Reference brands are AMP 502603-2 and AT&T or equivalent.

g. *New duplex and 4-gang wall outlets*. There are locations where the City will want outlets which have not been included in the construction process. The cable Contractor shall provide outlets capable of being securely mounted in a plaster (drywall) wall using standard NEMA duplex or dual gang boxes. Cables feeding these outlets shall be fished through the wall from the top of the steel bracing stud. A rubber or plastic grommet shall be placed in the top bracing stud to protect the cables being fed through it to the outlet. The specific outlet types shall be as identified in the previous sections.

2. <u>Cable Termination Blocks</u>. All cable terminations shall be made on Seimon CAT 5 S66M-50 blocks, M series.

   All block assemblies shall include sufficient 188B2 jumper backboards mounted adjacent for effective use as cross-connect wire holders. The proper size retaining clips shall be used for all cable terminations (e.g., four- pair for stations and five- pair for riser).

3. Building Entrance Protector Panel. The entrance panel in the building terminating campus-owned copper cable shall be an integrated termination and protector panel unit which incorporates the 110 terminal blocks with the protector panel housing.

4. MDF Connector/Protector. The MDF shall be equipped with frame/stand mounted high density cable connector/protector panels (with test fields) which reduce the space required to locate cables and protectors. The Contractor will provide the frame, connectors, protectors, and all associated hardware. Reference brands are AT&T 310 or Northern 391.

5. Cable Pair Protectors. All Contractor installed cable pairs entering or leaving a building shall be protected from high voltages or currents with plug- in protector modules. Protector modules shall be fast acting, 3 element, (5 pin) gas- tube units with sneak current protection. All protectors shall be solid-state "special circuit" modules with sneak current and lower voltage (60- 90 volts) protector modules installed for future data link circuits. Reference brand is AT&T, 188ENA1.

6. Ladder Racks. Cable support ladder racks are required in all telecommunication closets. All ladder racks shall be installed in accordance with local earthquake support requirements. The racks shall be a minimum of twelve inches (12”) wide and shall be equipped with a lip or fence on both sides unless located along a wall. The racks must be rated for a minimum of 75 lbs per foot and classified by Underwriters Laboratories (UL) as suitable for equipment grounding.

7. Splice Cases. All splices shall be contained within an approved splice case. All outdoor (vault and tunnel) splice cases shall be encapsulated, re-enterable units fully dressed and enclosed to fit the number and type of cables terminated. All end plates shall be designed for the number and size of cables served by the splice case and shall be designed to seal around each cable individually.

   Splices of 300 or more pairs shall utilize AT&T 710 or 3M modular splice clips. Cable shields shall be bonded through all splices. All splices outside of a building shall be fully encapsulated with a re-enterable sealant. Reference brands for splice cases are Reliable, AT&T and 3M.

8. Innerduct. One-inch (ID) innerduct shall be used to transport the fiber optic cable in any exposed location (such as runs of six feet or longer in equipment rooms) and in all conduits. The innerduct

shall be at least medium wall polyethylene meeting the specifications of ASTM D- 2513.

9. BDF Fiber Patch Panels. The building distribution frame in each equipment/ entrance room shall each be equipped with a frame mounted fiber patch panel equipped to terminate the incoming inter-building fiber and the identified riser or interconnect cables. The Contractor shall provide and install a floor mounted, seven foot tall, 19 inch equipment rack plus the rack mounted panel.

   The Contractor shall provide twenty-four (24) patch cords (pre-made to one meter in length) for use to interconnect equipment and/or inter-building fiber cable in each BDF. The patch cords (jumpers) shall be impact- resistant double-fiber cables of the same performance characteristics as the multi-mode fiber. These fiber optic patch panel connections shall provide .4dB or less insertion loss. Reference brands are Telect, Siecor, or B-Jed fiber patch panels.

10. Main Distribution Frame Patch Panel. The Main Distribution Frame shall be equipped with a frame mounted fiber optic patch panel of the same manufacturer as the BDF frames. This unit will terminate all identified inter-building, riser, tie, and machine fiber optic cables. This unit must be fully equipped (pre-loaded) to terminate 24 optics.

4.3.1.3 Video Distribution System

The following subsection identifies the major passive components of the video distribution and defines certain sizing and performance criteria:

1. Drop Taps. These passive devices are used to drive the floor loops and the drops to the individual displays and recorders. The attached drawings provide suggested values based upon an initial design from records. The Contractor will be requried to conduct field measurements of the installed cable and install taps of sufficient value to meet the overall system performance parameters.

   These are indoor taps made of die- cast metal with machined (not cast) connectors. The band pass shall be 5- 550 MHz minimum; the insertion loss will vary with isolation value but shall be comparable to General Instrument DC series indoor directional couplers. Actual numbers of each will vary according to the location of the taps and the design used by the contractor. All such devices must be installed and labeled as outlined in the City-provided drawings.

2. Riser and Backbone Taps. These are the directional couplers designed to tie into riser and backbone cable (.500 and .750

coax). The Contractor shall install four and eight port units as designated in the attached City-provided drawings. The passband shall be 5- 550 MHz minimum; the insertion loss will vary with isolation value but shall be comparable to General Instrument FFT- series directional couplers. These units shall employ pedestal mounting (to cable tray), corrosion resistant housings, weather proof seals, modular design for swapping of tap assembly without the removal of the housing from the cable, clearly labeled tap value and numbered ports.

3. Drop Splitters. These are 75 splitters designed with the same physical characteristics as the drop taps. They split the RF signal into two legs 3.5 dB down from the input. Electrical characteristics shall be comparable to General Instrument model 159 - series splitters. These come in 2-way, 4- way, and 8-way configurations.

4. F- 56 Connectors. These shall be hex-crimp style plated or unplated brass type "F" connectors for RG-6 with an integral ribbed crimp ring. The proper connector shall be used with the matching type of wire. When using thin- jacketed plenum cable, connectors designed for use with plenum cable (Gilbert GF- 6- AH- P/32, for example) shall be used.

5. F- 81 Connectors. These are standard machined brass Female to Female type "F" connectors. The center clutch shall adapt to both RG- 59 and RG- 6 center conductors.

6. Pin- type Connectors. Comparable to General Instrument PI series connectors, these are pin-type threaded connectors designed to mate with the various passive and active devices on the Riser and Backbone portion of the cable system (.500 and .750 coax). These connectors employ o-ring seals to block moisture and gas entry and a positive seize mechanism for gripping the outer conductor of the coax, be it .500 or .750. The connectors will be sized with a .500" seizing mechanism for .500 coax and with a .750" seizing mechanism for .750 coax. These connectors will require the use of a coring tool for proper installation.

7. Wall Plates (Coax). All television outlets shall utilize a standard duplex wall plate with a single hole for mounting F- 81 connector (Contractor provided) which is labeled with a unique outlet identifier.

8. 75 Terminators. All television outlets shall include a 75 terminator, preferably as a part of the outlet (self-terminating outlet.)

SECTION V: INSTALLATION AND ACCEPTANCE TESTING

5.0 INSTALLATION

Installation

All installation work must be performed according to published industry guidelines, rules, and regulations. If disputes occur, local, state, and national codes have precedence; then City policies and procedures; then standards such as EIA/TIA; then guidelines from firms such as Building Industry Consulting Services International (BICSI), AT&T, GTE, and Northern Telecom; then finally, manufacturer recommendations.

5.0.1 Installation of Station Cables

All station cables shall be neatly dressed and secured throughout the installation. In any building equipped with a cable tray, the tray shall be used to distribute the majority of cable runs. In locations where the cable tray penetrates a fire-rated or smoke-barrier wall, any opening within the cable tray or conduit must be fire stopped after cable installation.

In areas of the building not served by the tray, station cable shall be placed within the false ceiling space and secured neatly to proper supporting structures. The Contractor shall leave ceiling areas exposed until inspected by designated City staff. All station cables must be secured a minimum of six (6) inches above the ceiling T- bar grid. Ceiling grid supports, water pipes, and HVAC ducting may not be used to support cables. In those areas without adequate support structures, the Contractor must install "J" hooks or additional ceiling grid hangers on six foot centers. Cables shall not be placed within 24 inches of overhead lights or any other potential source of electrical interference. It is the responsibility of the Contractor to remove and replace all ceiling tiles.

In any area in which a fire-rated wall, partition, floor, or ceiling is penetrated, the Contractor shall be responsible for sealing around all cables with a UL-classified and City-approved fire seal sufficient to return the structure to its original rating. The Contractor must provide a copy of the fire seal manufacturer's installation instructions and rating information prior to inspection of the installed materials. Fire stopping should not be done without the specific approval of the City inspector.

In station locations not served by a feeder conduit and outlet box, the Contractor shall place a plaster wall retaining ring or metal supporting "ears" around the outlet location to secure the outlet and face plate. No exposed cable shall be permitted, and in these "new" locations the Contractor must fish the wall and place a protective grommet at the point at which the cable leaves the metal stud (if the wall does not extend all the way to the "true" ceiling).

5.0.2 Installation of Copper Riser Cables

All riser cables shall be installed in a neat and orderly manner which provides the maximum amount of room for future cable additions. All riser conduits should be pulled as full as possible. All cables must be supported on each floor using at least three straps (not more than 30 inches apart) per floor. Riser cable shields must be grounded on any floor in which pairs enter or leave the sheath. All shields must be bonded end to end.

All riser conduits must be sealed using a UL-classified firestop approved by the City. The Contractor must provide a copy of the fire seal manufacturer's installation instructions and rating information prior to inspection of the installed materials. Riser and tie cables within the building must be tagged in each room and must indicate cable type, size, and destination.

5.0.3 Installation of Station/Riser/Tile Cable Jumper Wires

The Contractor shall, after approval of the tested station and riser cable, interconnect with jumper wire (of the same AWG and EIA category as the station cable) three cable pairs from each voice outlet through the riser system to the building's building distribution frame (BDF). Upon completion, the Contractor shall provide a typed cable assignment record of all riser cables indicating station and pair assignments.

5.0.4 Installation of Inter-building Copper Cable

The inter-building cables shall be installed according to published guidelines such as REA, EIA, NEC, and AT&T, GTE, or Northern installation practices. Placement of cable in individual conduits and within the vaults shall be done only at the specific direction of the City to ensure the best utilization of the distribution space. All conduits must be pulled as full as possible without damage to the cable. All cables must be secured to the wall of the vault.

All cables shall be clearly labeled using 3-M or carsonite-type plastic letters (black on yellow). The copper cables and splice cases shall carry cable and pair identification and must be so tagged in every vault and building entrance.

5.0.5 Installation of Copper Cable Splices

All splice work must be neat and orderly, and no more than 1 percent of the pairs in any cable will be accepted as defective. If an outdoor splice is required, both the cable and the splice case shall be affixed to the wall of the vault or the tunnel in an orderly fashion using galvanized hooks and in a location agreed upon between the City and the Contractor. All cables shall be bonded through all splices; however, final grounding of the inter-building cable in the vault shall not be made until after end to end cable tests have been conducted.

All splices must be inspected by the City before closure, and when approved, must be wrapped, then sealed with a re-enterable encapsulant. All splices not within a building must be encapsulated and fully sealed. All splice cases must be bonded end-to-end with a 6 AWG ground wire or internal case bond, and the cases must be grounded to the vault.

5.0.6 Installation of Innerduct

Four one-inch (ID) innerducts shall be placed in one four-inch conduit leading into every building. The entrance conduit into the buildings which contains the innerduct shall be equipped with a hole plug designed to seal around each individual innerduct. Each innerduct shall also be sealed to eliminate leakage into the building.

5.0.7 Installation of Inter-building Fiber Optic Cable

No splices shall be made in the inter-building fiber optic cable without the specific agreement of the City. It is recommended all inter-building fiber be terminated on ceramic ST connectors (with compatible bulkheads). Direct termination of the fibers is recommended; however, if pigtail splices are used, the terminating patch panels must provide adequate enclosed splice trays. Any splices must be fusion splices, any pigtails used must be tight buffered Kevlar, and splice loss must not exceed .2dB at 1300 nm. All filled cables must be fully dressed at each end with "blocking kits" to eliminate movement of the water-exclusion gel.

A twenty (20) foot loop of slack cable shall be provided in each building entrance room prior to terminating the cable on connectors. All fiber optic cable must be securely mounted in a manner which will prevent physical damage. All cables (and panels) must be clearly identified at both ends with a unique cable/optic numbering system. The Contractor shall ensure proper placement and pulling techniques are employed throughout the installation and testing of this cable.

Any observed bending of any fiber cable during the installation which exceeds the manufacturer's recommended bending radius shall be cause for complete replacement of that cable at the Contractor's exclusive expense. Such bending can cause micro-cracks undetectable with normal testing which could cause performance problems in later years.

5.0.8 Installation of Fiber Optic Riser Cable

The fiber riser cables shall be placed in a star configuration from the building distribution frame and shall be continuous (no splices). A total of six feet of slack (in each closet) shall be provided for each cable, and the slack shall be coiled and secured to the wall. The Contractor shall install the fiber optic cables within one- inch innerducts pulling each innerduct as full as possible without damaging the cables. All cables (and panels) must be clearly identified at both ends with a unique cable/optic numbering system. All cables shall be installed using published industry standard procedures, tools, and equipment and must be protected from physical damage. All fiber riser cables must be installed so as to protect the optical fibers and connectors from strain and physical damage. All riser cables shall be supported with strain relief on each floor. All exposed cables shall be contained in an orange innerduct clearly labeled "Fiber Optic Cable."

5.0.9 Conduit Trenching, Backfill and Driveway Restoral

The Contractor shall be responsible for trenching, placing conduit, and restoring the trench area as identified in the drawings. The conduit must be schedule 40 PVC or type "C" telecommunications conduit and must be encased in concrete.

The concrete/sand mix (class 2B) shall have a maximum aggregate size of three-eight's inch. All conduit must be a minimum of 24 inches below finished grade. All backfill material must meet specifications identified in this document**.** All open sidewalk and driveway materials must be restored with material similar to that removed. Approval to begin restoral paving will be granted only after inspection of backfilling.

5.0.10 Installation Management

The Contractor shall provide sufficient trained staff to monitor all work undertaken and to ensure the terms of this proposal are met throughout the installation process. Work completed which is not in compliance with this proposal will not be excused simply because installation staff were not aware of the specific requirements. Additional Contractor costs and delays could develop if equipment must be removed to conduct inspections or correct deficiencies, so it is important the on-site staff are familiar with this document.

5.0.11 Acceptance Testing

The Contractor shall provide trained staff and the equipment necessary to conduct the acceptance testing as defined in this document. Acceptance tests must be conducted in conjunction with City staff to ensure compliance.

5.0.12 Documentation

The Contractor shall provide, prior to system acceptance, two complete sets of building floor plans that indicate outlet locations, length of station cables (from TDR readings), and jack numbers. The City will provide the floor plans from construction drawings (the same plans which accompany this proposal, and the Contractor shall neatly mark the plans with the required information. One set of plans will stay in the communication closet of each floor for temporary use, and one shall be delivered to the City project manager. In addition, the Contractor shall provide updates to City; provide riser and inter-building sketches that indicate cable pair numbers, cable length, and routing. All equipment installed as part of this procurement must have two complete sets of documentation defining proper installation and maintenance procedures. A full listing of the required documentation is defined in the 5.1, Acceptance Testing.

5.1 ACCEPTANCE TESTING

System acceptance shall consist of three parts. The first is a physical inspection of both work in progress and completed work to determine that the installation meets the standards defined in this document and in published industry guidelines. The second is a series of performance tests conducted and documented by the Contractor and witnessed by the City. The third is completion of the documentation required to operate and maintain the system.

5.1.1 Inspection Procedures

The City will conduct periodic inspections of the work in progress and notify the Contractor of any deficiencies at the regular progress meeting. In the event the City determines work is progressing in an incorrect manner and waiting for the regular meeting could cause further problems, the Contractor's on-site project manager will be notified.

Inspection by the City in no way limits the Contractor's responsibility for maintaining a high degree of involvement in the installation process. All installation staff and subcontractors must be fully aware of the requirements of this document; however, the Contractor is ultimately responsible for the successful and timely completion of the project. Failure of the City to notify the Contractor of a problem in no way relieves the Contractor from its responsibility under the contract.

Specific items which the City will inspect include:

1. Cable placement procedures
2. Cable termination procedures
3. Hardware and equipment
4. Cable identification and documentation
5. Fire stop placement
6. Duct utilization and backboard placement
7. Contractor's adherence to applicable codes

5.1.2 Acceptance Testing Procedures

The procedures outlined in this section must be properly completed and witnessed by the City's Telecommunications Project Manager before any acceptance can be provided to the Contractor.

Inter-building Copper: All tests conducted on the inter-building copper cable will be conducted from the campus main distribution frame (MDF) through the Contractor's splices into the building's distribution frame (BDF). All tests must be conducted as defined by the Rural Electrification Association (REA) and EIA/TIA-568A. All tests must be witnessed by the City and documented test results are to be provided to the City's telecommunications project manager. The specific tests to be conducted on the inter-building copper cable are:

1. *Continuity Tests.* Test to confirm that all pairs are free from grounds, shorts, crosses, and opens. Resolve any problems (no more than 1% of the pairs may be designated as "defective").

2. *Shield Resistance/Shield Continuity.* Verify the correct and continuous bonding of cable shields through all cable splices. Conduct this test from the MDF prior to strapping shield grounds at splice or termination points. Existing grounds must be temporarily removed to conduct this test.

3. *Insertion Loss.* This test measures the attenuation of the cable pairs at various frequencies. Insertion loss measurements must be conducted on 2 pair per sheath or building or 1 pair out of every 100 pairs if the cable has more than four splices or serves more than four buildings. Measurements will be made at 6 separate frequencies ranging from 1.0 KHz to 56 KHz.

4. *Noise Circuit.* This test measures the induced noise across a metallic pair (a minimum of 2 pair per feeder cable must be tested). This test is a reflection of the balance of the circuit, the shielding of the circuit, and the

proximity of noise producing electrical fields. Readings should be below -20 dBrnc.

5. *Noise To Ground.* This test measures noise induced on the circuit to ground. Measure 1 pair per feeder cable at 1.0 KHz with Quiet Line termination.

5.1.2.1 Copper Station and Riser Cable

The Contractor is required to conduct witnessed acceptance testing on all station and riser cable installed as part of this procurement as defined below:

1. Test each station cable and all risers cable pairs for crosses, opens, grounds, reversed and/or transposed pairs using a Test-All IV or similar device. Resolve all problems identified with station cables and ensure no more than one "defective" pair exists in any riser cable.

2. Using a pair scanner or similar device, field verify the length of each station cable and note the floor plans. Verify the length of each riser cable and note on riser plan.

3. Using a pair scanner or similar device, confirm that 100 percent of all data cables installed on each floor to verify the installation meets the IEEE 802.3 10BaseT performance specifications for signal loss and near-end-crosstalk. If any outlet does not meet the specification, resolve the difficulty and continue to test other outlets until it can be determined it was an isolated problem. The target performance level for the Category 5 data cable is the proposed FDDI over twisted pair specification as defined in the EIA/TIA 568A and TSB67. All data stations must be capable of meeting or exceeding this performance standards.

5.1.2.2 Fiber

All inter-building fiber cable tests will be conducted from the patch panel in the MDF to the patch panels in the individual BDF's. Fiber riser, tie, and interconnect cables shall be tested end-to-end in each building. All tests shall be conducted as defined in EIA/TIA-568A, EIA/TIA-526-14, and EIA/RS-455. Fiber optic cable tests shall be documented, and test results are to be provided to the City's Telecommunications Project Manager. The Contractor shall use an Optical Time Domain Reflectometer (OTDR) that has been factory calibrated within the last six months. The OTDR shall be configured to provide the highest level of detail on these short lengths of cable and shall detail loss levels in the range of -10 dB or less as required to measure the installed cable.

1. Conduct insertion loss testing (in both directions) on the installed inter-building cable at 850 and 1300 nm for the

multimode and 1310 nm for the single-mode optics. Document the results for each optical fiber in the cable, and provide test results to the City's Telecommunications Project Manager. Ensure attenuation results meet the IFB specifications.

2. Conduct insertion loss testing (power meter) in one direction on the installed riser and station cables at 850 and 1300 nm. Document the results for each optical fiber in each cable. Ensure attenuation results meet the IFB specifications. Document the results for each optical fiber on the building floor plans and riser diagram.

3. Conduct an Optical Time Domain Reflectometer (OTDR) test of each of the installed inter-building optical fibers from the MDF patch panel outward. Be sure to use the appropriate high resolution (single-mode versus multi-mode) OTDR device. Provide the City with the tracing printouts (noting with the appropriate optical fiber designation) mounted on separate pages so that it can be bound into a three-ring notebook.

4. Conduct an OTDR inspection of each riser cable to check for faults and to define overall length. Tracings are not required for these cables; however, results must be noted. If end-to-end attenuation test results have been consistent among fibers terminated on each floor, a test sample of two of the fibers per floor is sufficient. If attenuation test results vary, a 100 percent testing must be done. Document test results on the riser diagram.

5.1.2.3 Video Distribution System

Video Distribution System: The Contractor will conduct witnessed acceptance tests on the complete video distribution system including all cable and all passive and active devices. Overall the system must provide a Carrier/Noise ratio of >43 dB and a minimum signal level (at each jack) of +3 dBmV. Details of the methods which must be followed in conducting the acceptance testing can be found in the current edition of the NCTA (National Cable Television Association) Recommended Practices for CATV Measurement. The following tests must be performed on the completed video system by the Contractor as part of the acceptance procedure:

1. All coaxial cable will be sweep tested after installation for opens, shorts, and kinks with a Time Domain Reflectometer (TDR). Damaged sections will be replaced either by pulling a new line or by splicing out the defective portion. Indicate on the floor plans the actual length of each cable section as installed.

2. NCTA Standard Broadcast Sweep (40 to 500 MHz) tests will be performed on the broadband system in the following manner:

   Conduct a signal sweep test from the input side of the main amplifier to the output side of the Line Extender and from the input side of the MDF to the output at the headend.

   After the sweep of the riser system is completed and the building system is balanced, a sweep will be performed from the input to the building distribution amp to the most distant jack on each floor as the output. An additional sweep will be performed on the return system from the most distant jack on each floor as the input to the headend as the output. The Frequency Response of the installed and operating system should fall within N/10+2 where N is the number of trunk amps and distribution amps in cascade.

3. Visual Carrier/Noise (C/N) shall be measured over the system from the input of the distribution amp to the output of the most distant TV jack in the building. The test procedure will be as outlined in the NCTA. Minimum C/N specifications are no less than 43 dB.

4. Each and every TV jack installed as part of this system will output a minimum signal per channel of +3 dBmV into 75.

5. The signal at each video jack will be free of additional noise and distortion as judged by the City Telecommunication staff. The Contractor will demonstrate (using Sencore Channelizer FS 74 or similar device) the signal at each jack conforms to the quality standard existing throughout other City buildings (both video and audio). If excessive noise is present, the Contractor will be required to either resolve the problem or demonstrate the problem is not caused by the video distribution system installed as part of this project. At a minimum, the following tests may be required to demonstrate the origin of the problem :

   - Modulation distortion at power frequencies
   - Composite third order distortion for CW and modulated carriers
   - Carrier to second order beat ratio
   - Complete Frequency Response testing using the NCTA guidelines

5.2 DOCUMENTATION

All documentation must be neatly and legibly done and must provide a clear understanding of the installed system to someone who is new to the City organization. The items included in the required documentation are defined below:

1. The Contractor shall neatly and clearly annotate the City provided facilities plan to indicate the installed inter-building cables (copper, fiber, and coax). This includes final determination of cable length, pair assignments, splice locations, and loss levels. **Two copies of "D" size** drawings will be provided by the City for the Contractor's use.

2. The Contractor shall prepare "as-built" plans of each floor of each building using City provided floor plan drawings. Information must include jack/outlet number, cable length, outlet location, and closet assignment. Riser diagrams must be updated to indicate cable lengths, sizes, and routing.

3. The Contractor shall prepare a riser and tie cable assignment record indicating the assignments of all jacks to specific riser and tie cable pairs.

4. The Contractor shall provide signed originals of all acceptance testing documents which are:

    - Outside plant acceptance tests (copper cable results)
    - Fiber optic insertion loss results
    - Broadband schematic and associated test results
    - OTDR graphs and printouts and test results (in a 3-ring binder)

5. The Contractor shall provide a written list of any defective cable pairs (using the City's cable numbering scheme).

6. The Contractor shall provide a written statement that all work is completed as indicated in this IFB or as amended through written change order.

7. The Contractor shall prepare a complete "as-built" diagram of the video distribution system indicating cable lengths, signal values, and component locations. This diagram shall be provided as a separate layer on a City provided AutoCad file of the City building layout. The Contractor shall provide two (2) **"D" size copies** and an original Mylar drawing plus the AutoCad file. In addition, the Contractor shall provide a logical schematic of the system (without regard to building locations) which identifies the system components, signal levels, and cable distances. This second deliverable shall be provided in both hard copy **("C" size with two copies**) and a reproducible Mylar document, plus an AutoCad file of the schematic.

8. In addition, the Contractor will ensure all installed cables are labeled using 3-M or carsonite-type plastic letters (black on yellow). The copper cables and splice cases shall carry cable and pair identification, while fiber and coax must indicate "from" and "to" buildings and must be so tagged in every vault and building entrance. Riser and tie cables within each building must be tagged in each room and must indicate cable type, size, and destination.

Section VI: HARDWARE SPECIFICATIONS AND INSTALLATION

6.0 HARDWARE SPECIFICATIONS AND INSTALLATION

Although some of the City buildings have a slight different network (voice, data, video) architecture, the City as developed a standard architecture depending on building location and needs. These standards need to be adhered to in the design of the telecommunications network for this building.

6.0.1 Fiber Serviced Buildings

6.0.1.1 Ethernet Switch

The standard data communications equipment for buildings will include a Fiber Ethernet or Fast Ethernet interface. The type of equipment needed is dependent on the number of people accessing the network. For the purposes of this document, you will be using a Cabletron 6000 switch.

6.0.1.2 Hubs

Hubs within the network should be Networth 2000 product line. The 16 port stackable hub is the basic unit of hub. Additional hubs in the same location can be stacked, and hubs in other IDFs can be connected with Port 16 of the down linked hub.

Repeater rules will be followed so that there are not more than 4 repeater hops between any two users. In buildings with a large number of users, Cabletron Ethernet switches can be substituted, i.e; Cabletron 2200 switch (assuming that this is the current generation of technology).

6.0.1.3 Phones

The Option 81 can service digital phones up to 1500 feet. Distances that are less than 1500 feet from City Hall West, will use the 2000 style of phone sets. For the most part, it is anticipated that 90% or more of the phones utilized in this building, will not need to be purchased. Where new phones are needed, the following guidelines should be used for purchasing Northern Telecom units.

- NorTel, Meridian 2616 w/display: Primary Answering Positions, managers, heavy users
- NorTel, Median basic 2616: Conference rooms
- NorTel, Meridian 2008 sets w/display: average or low users, and can be used in quiet rooms

- NorTel, Meridian M8009 for break rooms, Equipment Room, and can be used in quiet rooms.

Due to security reasons, the contractor will not be responsible for the performing any program changes to the City's PBX. However, this does not relieve the contractor from determining, outlining, and detailing what those changes need to be and provide that same documentation to the City's Telecommunication Project Manager. It has not yet been determined whether the vendor or City staff will be conducting the actual customer requirements.

6.0.1.4 Other Voice Services

The City's fire department requires that fire alarms be serviced through a local carrier. Any fire alarm installed in any City building will require one business line and one City extension.

6.0.1.5 Disaster Recovery (Minor/Major Scenarios)

At least one line to each building will connect to the local operating company (business line). This line is to be installed in the Equipment Room.