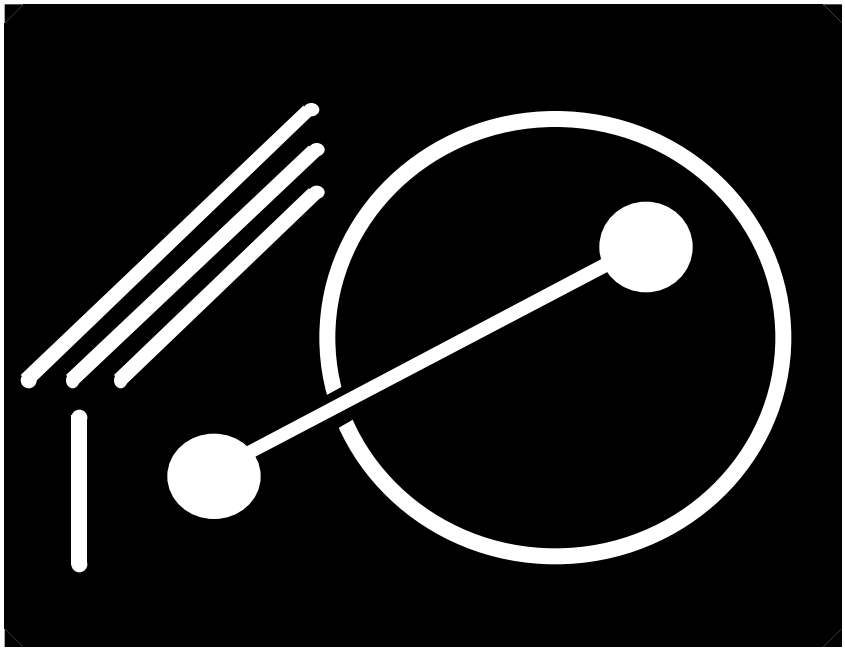

BLACKSBURG
electronic village

Virginia Tech/BEV Cabling Guidelines

Technical Report 1999-02

An outreach effort of

Virginia Tech

A university putting knowledge to work

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The Village information servers can be reached
via the World Wide Web at <http://www.bev.net/>

The BEV provides additional information about starting and managing comunity-based networks on the BEV Web site. Check <http://www.bev.net/evupstart/> for additional reports and information.

The BEV staff is also grateful to Judy Lilly, Director, VT Communications Network Services, for her advice and support, and to Erv Blythe, Vice President of Information Systems at Virginia Tech, for his guidance and support of the project.

The BEV is an outreach project of Virginia Tech
<http://www.vt.edu>.

Organizationally, the BEV is part of
Communications Network Services
<http://www.cns.vt.edu>.
CNS is a Virginia Tech department that provides
voice, video, data, and related services to the
university.

Virginia Tech/BEV Cabling Guidelines

June 1998

The Virginia Tech/BEV Cabling Standard was originally developed by Communications Network Services, which is part of Virginia Tech Information Systems. The Blacksburg Electronic Village staff are also part of CNS and VT Information Systems. Chris Fischer of CNS edited the original document from which this one is derived. It specifies applicable subsets of industry wide standards as they are currently implemented by Virginia Tech. No warranty as to their fitness for any particular building, network, or system is expressed or implied, and this chapter is provided for information purposes only. When installing cabling, a licensed electrical contractor should always be used, and it may be necessary to secure the services of a licensed engineer as well. Virginia Tech and/or the Blacksburg Electronic Village will not be responsible for the misuse or misapplication of this information.

These standards are continually evolving to encompass new communications technologies and to more adequately address the implementation of previous technologies. The EIA/TIA standards are being adopted as both Federal and State standards.

The following documents, or standards, should be referred to for more details:

- ❏ EIA/TIA-568 Commercial Building Telecommunications Wiring Standard
- ❏ EIA/TIA TSB-36 Technical Systems BulletinAdditional Cable Specifications for Unshielded Twisted Pair Cables
- ❏ EIA/TIA TSB-40A Telecommunications Systems BulletinAdditional Transmission Specifications for Unshielded Twisted-Pair Connecting Hardware
- ❏ EIA/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
- ❏ EIA/TIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- ❏ Commonwealth of Virginia, Council on Information Management, ITRM Standard, Telecommunications Cabling (http://www.cim.state.va.us/pubs/standards/s-96-1.htm#sec3). Note that this document supercedes portions of EIA/TIA-569

Some of the relevant standards and regulatory organizations include:

- ❏ ANSI: American National Standards Institute
- ❏ ASTM: American Society for Testing and Materials
- ❏ Bellcore

- ❏ ETL: Electronic Testing Laboratories
- ❏ FCC: Federal Communications Commission
- ❏ IEEE: Institute of Electrical and Electronics Engineers
- ❏ ICEA: Insulated Cable Engineers Association
- ❏ ISO: International Organization for Standardization
- ❏ NEMA: National Electrical Manufacturers Assoc.
- ❏ NIST: National Institute for Standards and Technologies
- ❏ NFPA: National Fire Protection Assoc.
- ❏ REA: Rural Electrification Association
- ❏ UL: Underwriters Laboratories, Inc.
- ❏ EIA/TIA: Electronic Industries Association; Telecommunications Industries Association

A source for many standards documents is:
Global Engineering Documents
15 Iverness Way East
Englewood, CO 80112-5704
Tel (800) 624-3974; Fax (303) 792-2192
http://global.his.com

Inside Plant

Station Wiring and Jacks

1. The typical horizontal station wiring consists of 2 Category 5, 4-pair, 24 AWG cables to each station outlet box terminated on a 4 x 4 duplex style faceplate. The cable consists of two separately jacketed 4-pairs, or a siamese type cable which has 2 4-pair cables joined together. Where desired, two 62.5/125 micron, dual window, multimode fibers may also be installed. Fiber requires the use of a more spacious outlet box, which should be designed to store about 1 meter of extra cable and to minimize stress on the fiber cable and connectors.

2. The first 4-pair station cable terminates on the upper CAT-5 RJ-45 jack and is typically used for an integrated voice/data connection to an analog or digital telephone system. It is wired in accordance with T568A jack/pin assignments. The second 4-pair station cable terminates on the lower CAT-5 RJ-45 jack, which may be used for high-speed data connectivity to the Local Area Network. Alternately, it could be used for additional voice connections. It is also wired in accordance with T568A jack/pin assignments.

3. Install the cabling, jacks and faceplates. A pullstring is also installed in each conduit along with the station cables to accommodate future cable pulls.

4. Each jack is labeled individually on the faceplate. A typical label would be 201TP03A, where 201 is the room number, TP03 indicates that it is the third twisted pair outlet in the room and A would be the top jack. See Figure 1.

5. Each RJ-45 jack has a bezel color that designates the type of service: an orange bezel is used for Ethernet service; a black bezel is used for ATM service; a white bezel is used for voice, analog or pre-wires.
6. The outlets in each room are numbered sequentially, starting from the main entry door to the room and rotating around the room in a clockwise direction, and spiraling inward if there are outlets in the center of the room. If outlets are added after the original outlets are installed and numbered, they shall be numbered sequentially, beginning after the last outlet number previously assigned to the room. This may lead to a situation where the outlets are numbered out of numerical sequence when going clockwise: e.g.:1, 2, 3, 8, 4, 5, 6, 7, with 8 being the newly installed outlet.

7. On blueprints, the standard symbol for an outlet box is a solid triangle, regardless of whether the outlet is being used for voice, data, voice/data, Ethernet, or any combination. Any of these can be accommodated on one 4 pair station cable, but all cannot be used on the same 4 pair at the same time. The only variation is when video is to be installed: this is signified by a solid triangle with a TV located adjacent to the triangle.

8. Station UTP cable shall not exceed 90 meters in length.

Inside Plant Conduit

1. In new construction projects, the electrical contractor installs the conduits, fittings and boxes.

2. The standard station-cable conduit size is 1-inch diameter minimum. All conduits shall have threaded bushings on both ends.

3. There shall be no back-to-back outlet feeds from 1 conduit. Each conduit serves only 1 outlet.

4. Conduits shall either be continuous home-run from the outlet box to the TC (telecommunications closet), or shall be stubbed out within 1 foot of a cable tray. Station conduit runs shall have no junction boxes.

5. Maximum conduit length per section is 30 m (100 ft) with no more than two 90- degree bends between pull boxes, or pull points.

6. For conduit up to 2 inches in diameter, the bend radius shall be at least 6 times the inside diameter. Beyond 2 inches, the bend radius shall be at least 10 times the inside diameter.

7. The contractor shall provide a pullstring in each conduit. . Pullstrings must be secured at both ends of the conduit.

8. The standard outlet box shall consist of a 4 x 4 metal box

9. Home run conduits to an outlet box must be run to an Intermediate Distribution Frame room (IDF) on the same floor.

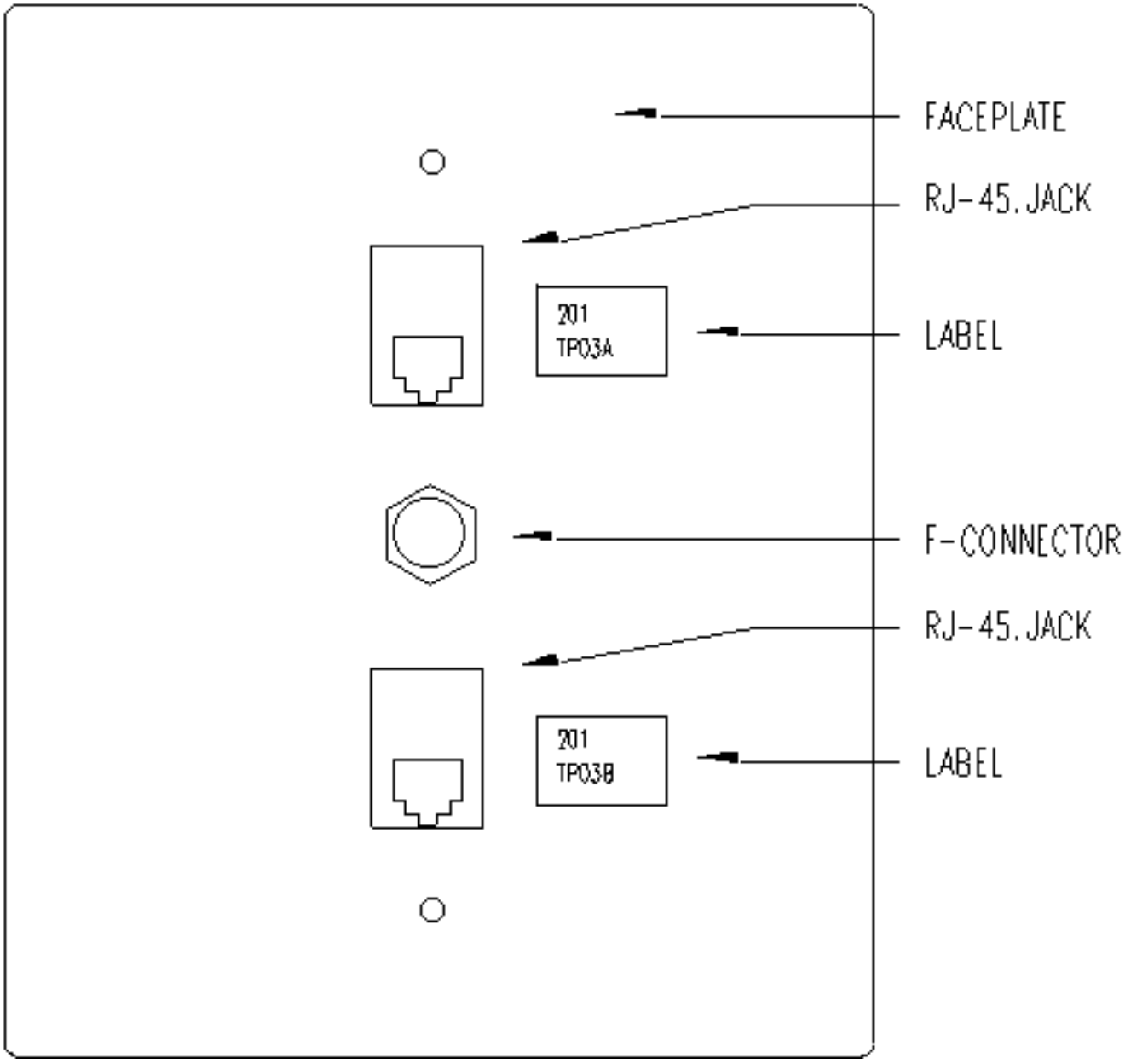

Figure 1. Typical Duplex Faceplate for Communications Outlet

10. No conduit shall exceed 80% fill capacity.

Cable Trays

Cable trays provide an excellent cable distribution system for communications cabling. They are installed above lay in ceilings in hallways and require at least 3 inches of clear space above for access. All communications cable trays shall have a minimum of 12 clearance from any sort of light fixtures (incandescent, fluorescent, or other). Communications conduits from each room are stubbed to the cable tray. An acceptable cable tray is made of galvanized steel or aluminum, and its minimum size measures 4 inches deep by 9 inches wide and has a rung spacing of 12 inches. Larger

cable trays should be used in areas that have high-density communications requirements. Cable trays are to be installed at the same elevation within the ceiling throughout the building floor. When grounding cable tray, no hardware shall penetrate into the cable area of the cable tray.

Building LAN Backbone

The standard LAN connection in most networked buildings today is 10Base-T Ethernet. Ethernet unshielded twisted-pair station cables are cross-connected at TCs (Telecommunications Closets) to 10Base-T hub or concentrator ports. Hubs/concentrators are connected to a building Ethernet backbone that consists of optical fiber or RG-58 coaxial cable that passes through all TCs. The building backbone typically connects through a fiber optic transceiver at the main equipment room over multimode fiber cable to a router port at the nearest cable center. Multi-building LAN backbones that have very high network demand may consist of a mesh of 622 Mbps and 155 Mbps ATM circuits, high end ATM attached routers. Other options for a multi-building backbone include 100 Mbps FDDI or a fiber Ethernet. Smaller buildings may be bridged together before connecting to a router port.

Future network applications may require replacing the current shared media networks with switched internetworks. Switched network speeds of 10 Mbps to 155 Mbps may soon become common for user connections, especially as the use of videoconferencing becomes more common.

Riser, or Backbone, Cabling

1. The voice/data backbone riser cable for a building should use 24 AWG conductors with an overall cable shield. It should contain approximately 3 pairs for each outlet served from the telecommunications closet (assuming dual 4-pair station cables per outlet). For example, if a telecommunications closet feeds 24 outlets, then the riser pair count should be 3 times that, or 72 pairs, which could be rounded up to the nearest available cable size.

2. The video riser is typically a CAC-11 coax cable that is terminated with crimp-on F-connectors.

3. LAN fiber optic riser cable will consist of 36 multimode fibers plus 12 single-mode from the main equipment room and cross-connect to each telecommunications closet, or as needed.

Firestopping

1. All penetrations through fire-rated walls and floors will be firestopped to restore the fire ratings. A two-hour fire rating is desired. Penetrations through walls containing cables that are not enclosed in metal conduits, and empty penetrations in walls being reserved for future cables, will be firestopped on both sides of the penetration. Generally, it will be sufficient to firestop a penetration through a fire rated floor from above only.

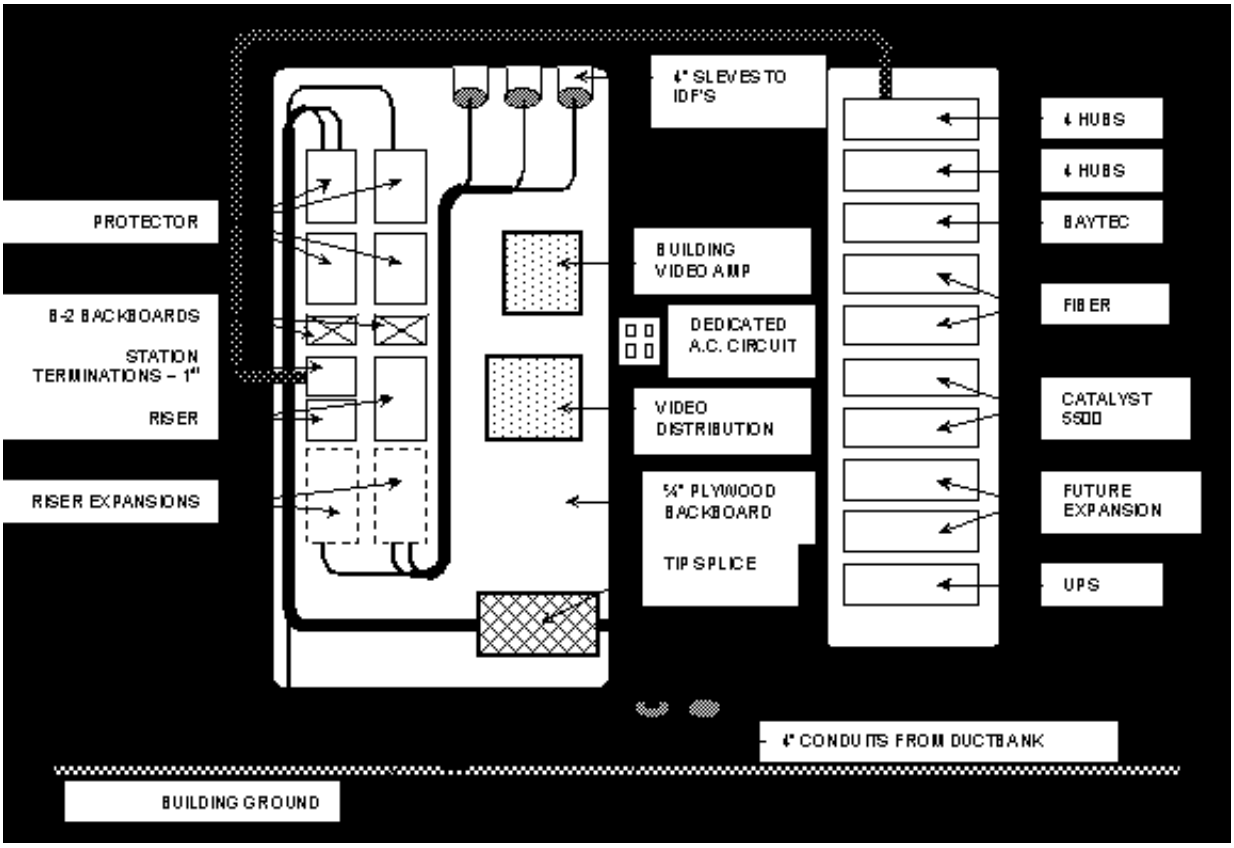

Figure 3. Typical IDF Layout

Equipment rooms

Main Equipment Rooms, also known as Building Distribution Frame (BDF) Rooms, and the Intermediate Distribution Frame (IDF) rooms serve as the communication equipment rooms for each building.

Common Features

The following apply to both BDFs and IDFs:

1. Ventilation: an active ventilation system is required to dissipate heat generated from communications equipment with controlled temperature and humidity (which should be similar to office environment). HVAC requirements will be based on each ERs heat rejection calculation. If an air-conditioner is required, then both the indoor and outdoor units will be connected to the electrical room electrical panel. The indoor unit should be mounted above the door, while the outdoor unit should be mounted on the roof or other suitable location.

2. Entrance: 3/0 door opening outward, door fire rated for at least 1Ω hours. The door shall be keyed to an existing CNS code.

3. Lighting: fluorescent lighting to provide 30 foot-candles at floor level.
4. Electrical: 100 Amp, three phase, 208 VAC, four wire electrical panel equipped with a main breaker. This panel will provide for the electrical needs for the entire room including lighting, air-conditioning, and the power for the telecommunications equipment. Each telecommunications rack equipment rack will have its own 20 Amp, 120VAC, circuit connected to a stand alone UPS, which itself is connected to the telecomm network via a SNMP adapter. No transformers or any other heat generating equipment will be allowed in an Equipment Room.

5. Firewalls: equipment rooms should be enclosed in at least a two-hour rated firewall.

6. Sole Usage: Equipment rooms will not share the space with any other storage spaces, custodial closets or electrical rooms. The equipment rooms will be used exclusively for communications equipment and cable termination hardware.

Building Distribution Frame (BDF) Room and Main Cross Connect

This space serves as the main communications equipment room for each building. The following criteria should be used when designing main equipment rooms:

1. Minimum size: 11 x 9 x 8 capable of containing up to three 33 x 29 x 85 telecommunications racks. This may vary depending on building size. Doors, pathways, pipes, etc., must not obstruct what might have been usable space.

2. Grounding: termination point to the building grounding grid.

3. Backboard: æ CD plywood attached to block walls or to framing members. Backboard size will vary with building size, but is typically 8 x 8.

4. Floor covering: concrete floors shall be sealed or tiled to eliminate masonry dust.

Intermediate Distribution Frame Room (IDF)

These spaces serve as communications telecommunications closets throughout the building. Ideally, they should be vertically stacked above the BDF. Also, they should be located centrally on each floor so as to minimize the average length of station cable and to keep the maximum length to no more than 90 meters.

The following criteria should be used when designing IDFs:

1. Minimum IDF size: 8' x 9' x 8' (with no obstruction due to doors, pathways, pipes, etc.) capable of containing two 33 x 29 x 85 telecommunications racks. This should allow a standard equipment rack to be placed with its side to the center of an 8Ω wall with front and rear access. The plywood backboard for building wiring would be placed on the opposite wall.

2. Backboard: typically one 4 x 8 x 3/4" CD plywood per IDF

3. Copper riser cables terminate on CAT-3, or higher category, 110 type blocks

Outside Plant

Ductbank

1. 4 inch conduit of corrosion resistant material and a multiple duct system consisting of two 2 inch and two 1.5 inch conduits.

2. Base and intermediate spacers are to be used every ten feet of duct.

3. All ductbanks will be concrete encased.

4. All conduits are to be lashed and anchored in the ductbanks to prevent floating when the concrete is poured.

5. All conduit bends will have a radius no less than ten times the internal diameter of the conduit.

6. No bends will be greater than 90-degrees.

7. No more than two 90-degree bends in run.

8. Conduit runs not to exceed 500 feet.

9. All ductbanks to have minimum of 24 inch cover with re-seeding in accordance with Physical Plant specifications.

10. Ductbank must enter and exit manhole at same elevation with no more than 2 penetration into the manhole.

11. Place rigid conduit sleeve through foundation wall and extend 10 feet beyond foundation wall into undisturbed soil.

12. Sleeve shall have a downward slope of one inch per foot of sleeve.

13. All conduits to be plugged with pull string installed.

14. All metallic conduits to be reamed and bushed.

Distribution Frames

Main Distribution Frames (MDF) are used to terminate backbone cable plant between buildings. The cable plant is routed either through existing utility tunnels, concrete encased ductbanks, buried duct, or on existing utility poles.

When new construction or modifications to existing buildings is involved, it is necessary to determine communication needs and outside cable routes. Due to the limited capacities of some

available switch hardware in the MDFs, the nearest MDF to the new building is not always used. The ductbank standards listed are for a typical new building installation. Each building will have its particular requirements for cable size and routing.

Manholes

1. Shall be not less than six feet by eight feet.

2. Traffic bearing construction required.

3. Duct bank knockouts on all four sides.

4. Pulling eyes installed in floor.

5. Drain knockout required.

6. Interior walls pre-drilled for cable racking hardware.

7. Floor drilled for ground rod (æ inch).

8. 30-inch clear opening.

9. Ladder and bracket.

10. Ring and cover shall have 30-inch clear opening and labeled COMMUNICATIONS.

11. When feasible, a floor drain shall be installed using a 2 or larger PVC pipe. The drain line shall run to a storm sewer or ditch.

Tunnels

1. All cables to be placed at furthest accessible point from steam and or water lines.
2. Cables to be sleeved with heat resistant material when situation requires them to be in close proximity of heat producing lines, or lights.
3. Cables to be secured to wall no less than five feet apart.
4. All cable bends will have a radius no less than 15 times the outside diameter of that cable.
5. Cables are required to be sleeved in any area of high traffic.
6. Splice cases shall be mounted to walls in the least obstructive manner.

Building Entrance

1. When a BDF (Building Distribution Frame) is located more than 50-feet away from building entrance, rigid or IMC conduit is required between the two.

2. Conduit runs shall not have more than two 90-degree bends.

3. All conduits will be reamed and bushed.

4. If required, all pullboxes will be no smaller than 36 x 36 x 8 with clear access to cover.