OUTSIDE PLANT ENGINEERING HANDBOOK

August 1994

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Developed by
AT&T Network Systems Customer Education & Training

AT&T
OUTSIDE PLANT SYSTEMS
QUALITY POLICY

The Outside Plant Systems Quality Policy is to engineer and construct outside plant telecommunications networks and facilities which exceed customer expectations and to achieve significant quality improvement in those networks and facilities in a prudent and profitable manner.

J.E. Hart
Outside Plant Systems
Vice President

How Are We Doing?

Document Title: AT&T Outside Plant Engineering Handbook

Document No.: 900-200-318

Issue: N/A Date: August 1994

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ABOUT THIS DOCUMENT

Overview

This handbook is to be used as a technical reference and includes specifications, AT&T documentation references, and information on AT&T products which can be used in outside plant (OSP) engineering work. The engineering specifications in this handbook are current and applicable, yet may be superseded by customer provided engineering specifications and/or other national/local codes. Therefore, the OSP engineer should be aware that engineering specifications may vary due to individual customer requirements.

This handbook has been completely revised from the last edition (January 1990). Every effort has been made to ensure the information presented in this handbook is current and accurate at the time of printing. We do value your input on this document and have included a customer feedback form on which you may send us any comments you have concerning the information or the presentation of information in this handbook.

Additional Information

If you need more information than is given in the handbook, references to associated documents are given either opposite the topic heading in the text or in the Bibliography at the end of each section.

Additional information about the detailed design and construction of the Outside Plant Network is covered in the 900 through 939 (Outside Plant Engineering), 363 (Loop Transmission Systems — Pair Gain), and 620 through 649 (Outside Plant Construction) series of AT&T documents.

If you have any questions concerning Outside Plant engineering or need further elaboration on any of the information in this handbook, please contact the AT&T Outside Plant Systems Core Team at the following address:

AT&T Outside Plant Systems
4725 River Green Parkway
Duluth, Georgia 30136
U S A

Telephone (404) 813-6866

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Acknowledgments

Many thanks go to all the individuals who have contributed to the revision of this handbook. We especially thank Roger Kimmer and all the people in the Outside Plant documentation group at AT&T's Network Systems Customer Education and Training Organization in Winston-Salem, NC, who were instrumental in preparing this document.

We give special thanks to Howard Kemp and Dave Gibson at Bell Labs in Whippany, NJ, who provided valuable new material as well as excellent technical information and consultation.

We appreciate the extra efforts of Randy Funn, Glenell Smoot, and the rest of the engineering team in Hawaii for their review and field input. Likewise, special thanks go to Rick Kennedy and his engineering group in Duluth, GA, who also reviewed and provided input for this handbook.

John Arroyo and Dave Hancock in Duluth, GA, deserve special thanks for their considerable contribution of cable product information as well as factory liaison assistance and consultation regarding cable related questions.

Finally, thank you to all of the product groups who provided the great diversity of product information contained in this document.

W. J. Menzies	J. L. Tomaszewski
Engineering Manager	Site Supervisor

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Section 1

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Section 1

AT&T OUTSIDE PLANT SYSTEMS

ABOUT OUR BUSINESS

Formed in 1991 and headquartered in Duluth, Georgia (USA), AT&T Outside Plant Systems offers a unique combination of resources to build and modernize telecommunications systems, enabling customers around the world to tap into the benefits of the Information Age.

Part of AT&T Network Systems, AT&T Outside Plant Systems provides turnkey delivery of telecommunications infrastructures globally by combining network cable and transmission systems products with engineering and construction services.

To meet our customers' individual outside plant (OSP) requirements, AT&T's turnkey solutions include network and civil engineering, project management, equipment design and selection, construction, installation, maintenance, training, and restoration.

Our mission is to design, construct, and maintain best-in-class outside plant systems for AT&T's global customers that exceed customer expectations for quality and delivery.

Outside Plant Engineering Core Team

This revised version of the Outside Plant Engineering Handbook is a product of the AT&T Outside Plant Engineering Core Team headquartered in Duluth. The core team provides OSP engineering planning, design practices and procedures, civil engineering, and Computer Aided Design (CAD) engineering support for AT&T Outside Plant Systems' global projects.

The core team presently consists of the following individuals:

Name	Responsibility	Phone
W. J. Menzies (John)	All Engineering	(404) 813-7743
J. V. Monahan (Jim)	CAD Engineering	(404) 813-7759
A. J. Sullivan (Abbe)	Civil Engineering	(404) 813-7758
J. L. Tomaszewski (Jim)	OSP Engineering	(404) 813-6866

If you have any questions concerning Outside Plant engineering or need further elaboration on any of the information in this handbook, please contact the AT&T Outside Plant Systems Core Team at the following address:

AT&T Outside Plant Systems
4725 River Green Parkway
Duluth, Georgia 30136
U S A

Telephone (404) 813-6866

AT&T ENGINEERING DIVISION

The following outline lists the available services provided by the AT&T Outside Plant Systems Engineering Division.

Outside Plant

A. Record and Field Survey (Planning and Design)

1. Network
   - Feeder and Secondary
   - Underground, Aerial, Buried (Cable, Coax, Fiber Optic)
   - Underground Conduit Systems
   - Central Office Main Distribution Frame (MDF)
2. Subscriber Loop
   - Resistance Designs
   - Gauging
   - Loading and Build-Outs
   - Bridged Tap Limitations
   - End Section Requirements
   - Electronics
3. Loop Assignment Records

B. Planning

1. Demand Data
   - Demand Formula Development and Implementation
   - Data Collection (Residential, Commercial, Industrial)
   - Data Entry (Input/Output)

- Collect and Digitize Drawings
- Create Demand Study Manuals
- Special Forecast Studies

2. Long-Range Outside Plant Planning
    - Short-Range or Current Plan Development
    - Medium-Range Plan Development
    - Long-Range Plan Development
3. Transmission and Carrier Planning
4. Underground Conduit System Planning
5. Special or Customized Project Planning
    - Economics Analysis Studies
    - Rehabilitation Analysis Studies
    - Service Activity Studies
    - Network Verification Studies
    - OSP Procedures and Routines Guidelines Projects
    - Trunking Studies
6. Catastrophic Contingency Planning
7. Strategic Implementation Planning
8. Alternate Systems Planning

C. Detail Design (Manual and Computer Aided Design [CAD])

1. Long-Range Outside Plant Plans
    - Current Plan
    - Customized or Modified Plan
    - Special Project Implementation

2. Outside Plant
   - Aerial, Underground, and Buried
   - Special Needs (Submarine, etc.)
   - Underground Conduit Systems
   - Radio Tower, Cellular, Microwave Dish Placements, etc.
   - Central, Remote and Special Building, and Equipment Layout
   - Environmental Vault, Carrier, Transmission Design
   - Catastrophic Contingency Design and Implementation
3. Customized Design Projects
   - Telecommunications
   - Architectural
   - Premises Distribution
   - Project Management Procedures and Routines

D. Training

Premises Distribution Engineering

A. Planning

1. Distribution Services Plan
2. Data Collection
3. Facility Documentation
4. Project Coordination Planning
5. Security, Paging, and Music System Planning

B. Detail Design

1. Telecommunications Room Design

- Locations, Sizing, Amenities, etc.
- Equipment Placement
- Electrical, Grounding, Environmental, and Heating, Ventilating, and Air Conditioning (HVAC), etc.
- Interface Integration

2. Distribution Design

- Copper Cable
- Fiber Optic Cable
- Wireless
- Plenum, Chase, Computer Floor, etc.

3. Feeder and Distribution Conduit Cable Design

4. Microwave Dish Placement

C. Training

Architectural Support

A. Software and Hardware

1. Data Entry
2. Digitalization
3. Plotting
4. Record Archiving and Maintenance
5. Customized Project Management Reports, etc.

B. Subcontractor
   1. Architectural
   2. Electrical
   3. Mechanical
   4. Structural
   5. Interior Design
   6. Landscape Design
   7. Telecommunication Consultation
   8. Construction Management

C. Bids and Proposals Administration

D. Training

System Administration Support

A. Software and Hardware
   1. Systems Architecture Design
      - Research/Development
      - Maintenance
   2. Systems Consultant Services
   3. Systems Analysis Services
   4. Technical Support
      - MS/DOS*
      - UNIX†

* Registered trademark of MICROSOFT CORPORATION.

† Registered trademark of UNIX System Laboratories, Inc.

- CAD Programs
- Databases

5. System Utilities Integration (Importing/Exporting)

B. System Management

1. Network Design and Administration
2. Bids and Proposal Administration
3. On-Site or Remote

C. Program Development

1. Existing Program Integration
2. New Programming
3. Program Modifications
4. Program Customization

D. Training

1. AT&T Training Center Locations
2. Suitcased Locations
   - On-Site
   - Off-Site

Project Management

A. Analysis

1. Team Facilitating
2. Project Function Identifications

3. Team Matrix Building
   - Function Groups Leadership Ownership
   - Sub-Groups Leadership Ownership
   - Affinity Responsibilities
   - Contingency Responsibilities
4. Critical Path Agreements
5. Team Goal and Objectives Agreements
6. Financial Responsibilities Agreements
7. Performance Standards Agreements

B. Administration

1. Leadership
2. Schedule Development
   - Function
   - Material
   - Labor Resource
   - Financial
3. Critical Path Development
4. Contingency and Catastrophic Recovery Plan
5. Accounting and Ledger Development
6. Financial Administration
7. Change Order Administration

C. "Cradle to Grave" Project Management

Section 2

Contents

Section 2

PLANNING

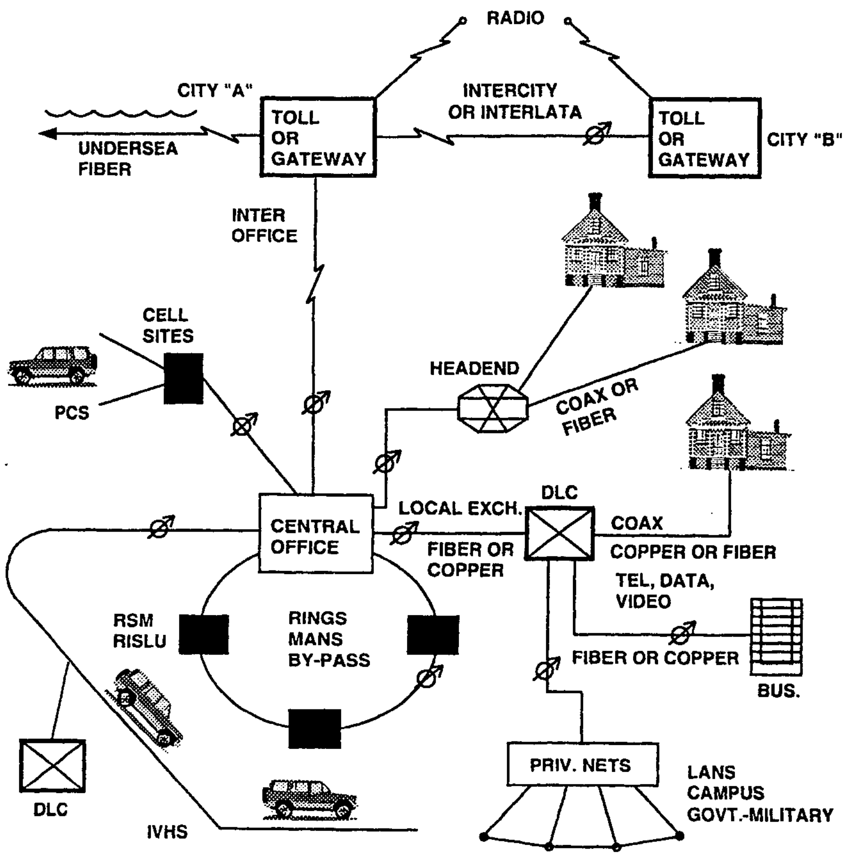
AT&T OSP SYSTEMS

Outside Plant (OSP) Systems capability is represented by the global pipeline diagram on the next page. This global pipeline includes the following types of networks:

- Intercity or Interlata — Long distance fiber optic networks for high-speed information transport between cities
- Interoffice — Intercity junction networks that connect central offices and local exchanges
- Local Exchange — Loop distribution networks, which provide homes and businesses with access to communications services.

These networks may be adapted for the following applications:

- Cable Television
- Metropolitan Area Networks
- Local Area Networks
- Intelligent Vehicle Highway Systems
- Cellular
- Rings
- Private Networks.



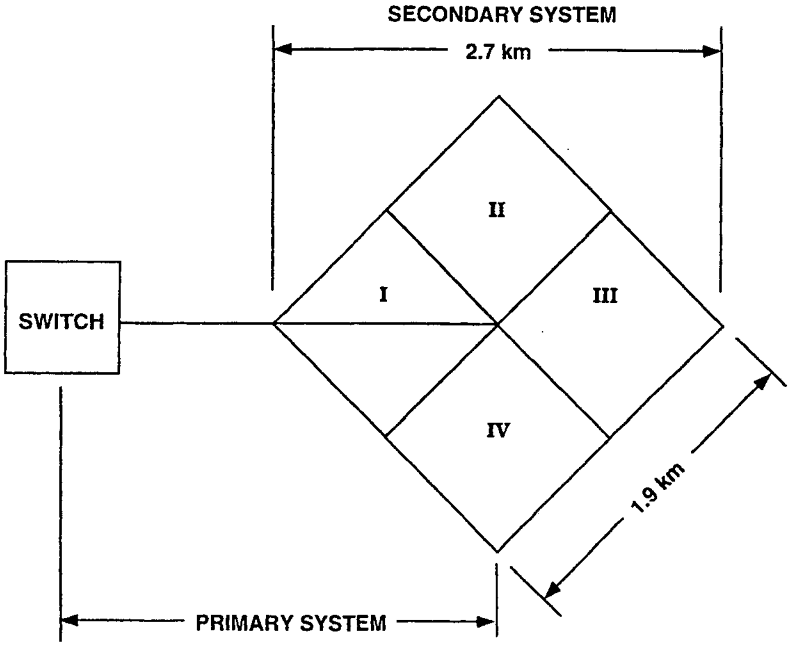
OSP Capability - The Global Pipeline

LOCAL EXCHANGE PLANNING

Planning in the Local Exchange begins with a Geographic Model. There are two systems (segments):

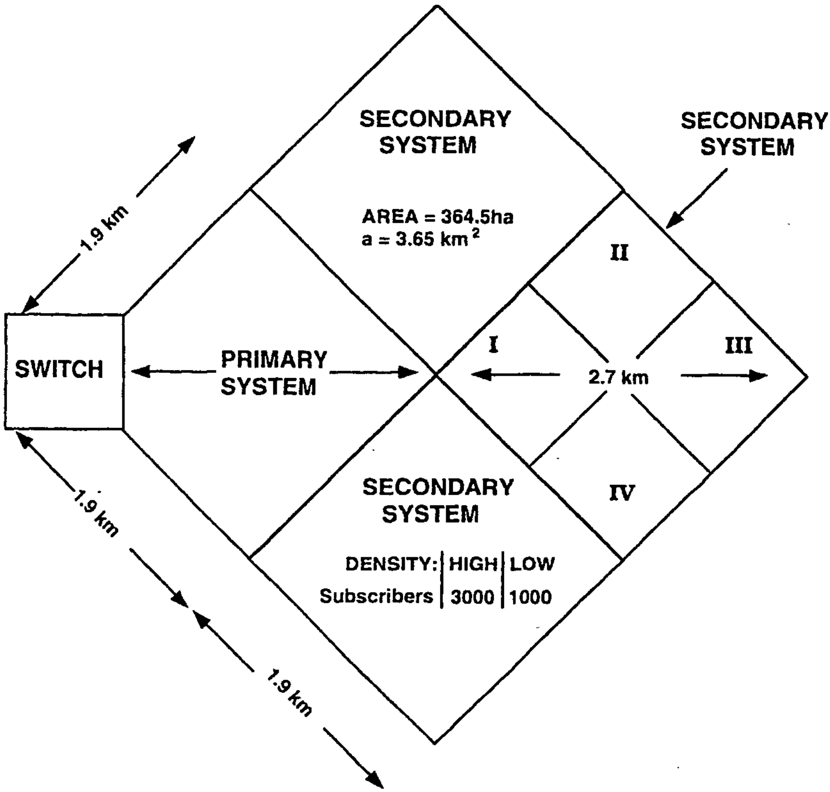
- Primary System (Feeder)
- Secondary System (Distribution).

Following are two examples of geographic models showing Primary and Secondary Systems. Notice that there can be multiple Secondary Systems fed from a serving switch.



Geographic Model - Primary System

The dimensions and density of the Secondary System models may vary due to the characteristics of the geographic area. For example, a Secondary System model can be further subdivided into four smaller segments if required for high density. This is indicated in the example by Roman Numerals I — IV.



Geographic Model - Secondary System

Primary System Transport options include:

- Copper
- Conditioned Copper
- Fiber
- Radio.

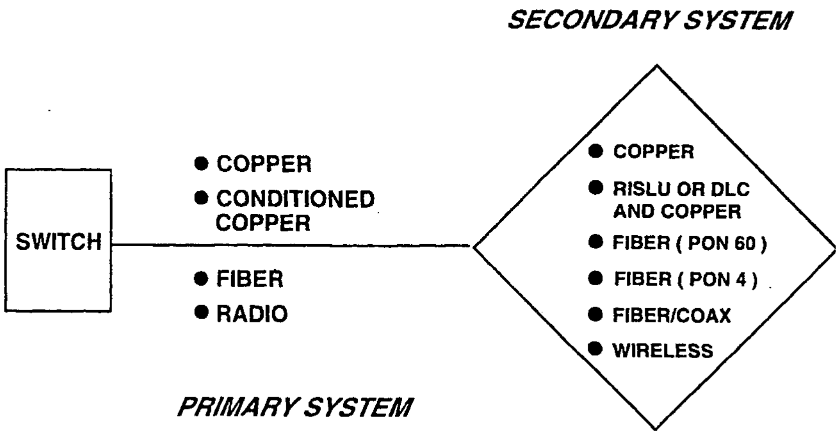
Secondary System Transport options include:

- Copper
- Digital Loop Carrier/Remote Integrated Services Line Unit (RISLU) + Copper
- Fiber (Passive Optical Network [PON 60/PON 4])
- Fiber/Coax
- Wireless.

Transport selection is based on the following considerations:

- Customer Requirements
- Distance and Density
- Proposed Location (topography, accessibility)
- Voice Service and Video Decision Tree (Community Antenna Television [CATV])
- Cost Models.

A diagram showing the Primary and Secondary System Transport options is shown on the next page.



Transport Options

Model Comparisons

Cost Model comparisons are made including:

- Classic Copper both in Primary and Secondary Areas
- A mix of copper and fiber using RISLU or Optical Loop Carrier (OLC) 2000
- A PON Network using Optical Network Unit (ONU) 60
- A PON Network using ONU 4
- Fiber/Coax.

Cost Parameters PON

PON 60 System:

- Cost of concentrated 2 Mb/s (V5.2) on host
- Cost of Optical Line Terminals (OLTs) and ONU 60 inclusive of installation and local powering of ONUs
- Cost of optical cables in Primary and Secondary areas inclusive of trenching, installation, OSP material, and 1:3 splitters
- Cost of Secondary copper cable inclusive of trenching and OSP material
- Installation of OSP.

PON 4 System:

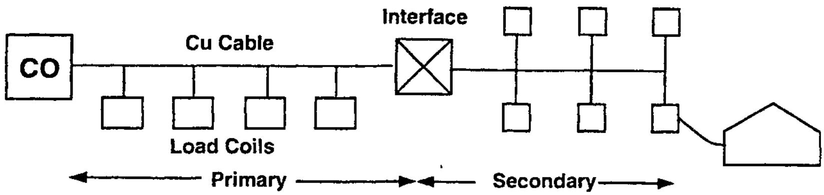
- Cost of concentrated 2 Mb/s (V5.2) on host
- Cost of OLTs and ONU 4 inclusive of installation and centralized powering of ONUs 4
- Cost of optical cables in Primary and Secondary areas inclusive of trenching, installation, OSP material, and 1:32 splitters
- Cost of Secondary copper cable inclusive of trenching and OSP material
- Installation of OSP.

Note: For centralized powering of the ONUs, a combined fiber/copper cable was used.

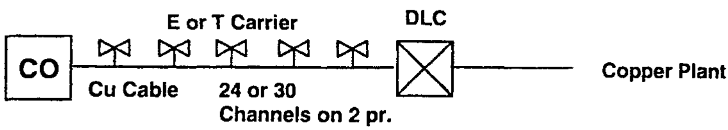
LOCAL EXCHANGE ARCHITECTURE

Examples of loop architectures include:

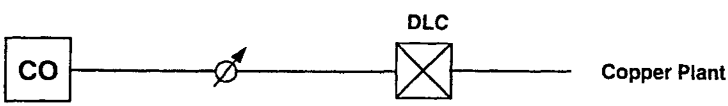
- Classic Copper
- Conditioned Copper Primary + DLC Copper Secondary
- Fiber Primary + DLC Copper Secondary
- Fiber Primary + RISLU Copper Secondary
- Fiber to the Curb
  - — Active Double Star
  - — Passive Optical Network (PON)
  - — Star-Bus
- Cable Loop Carrier - 500 (CLC-500)
- Asymmetrical Digital Subscriber Line (ADSL).



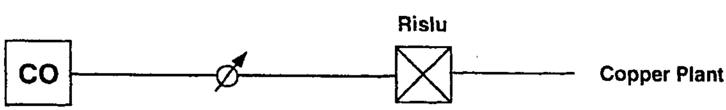
Classic Copper



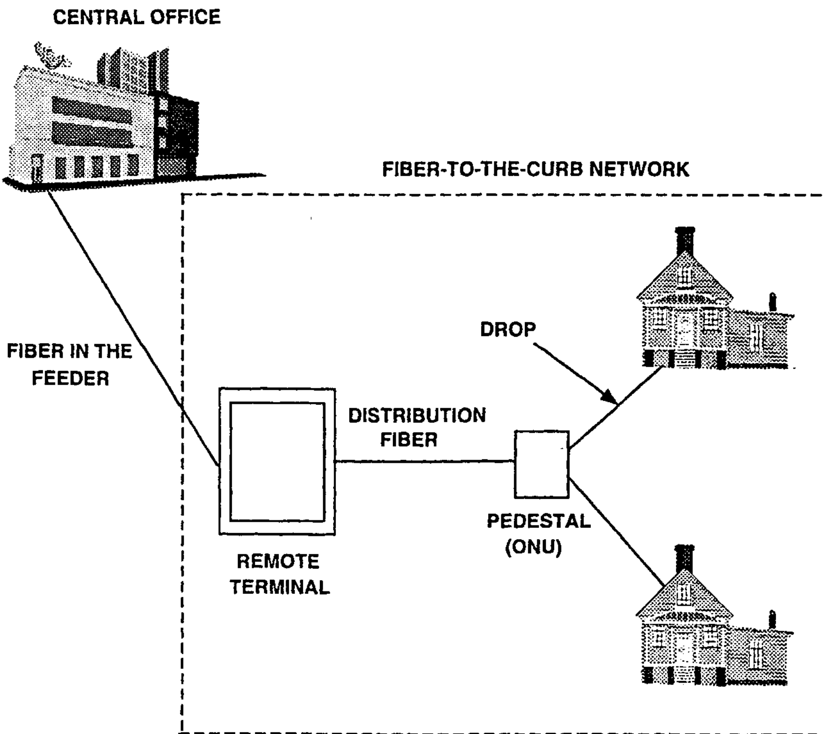
Conditioned Copper Primary + DLC Copper Secondary



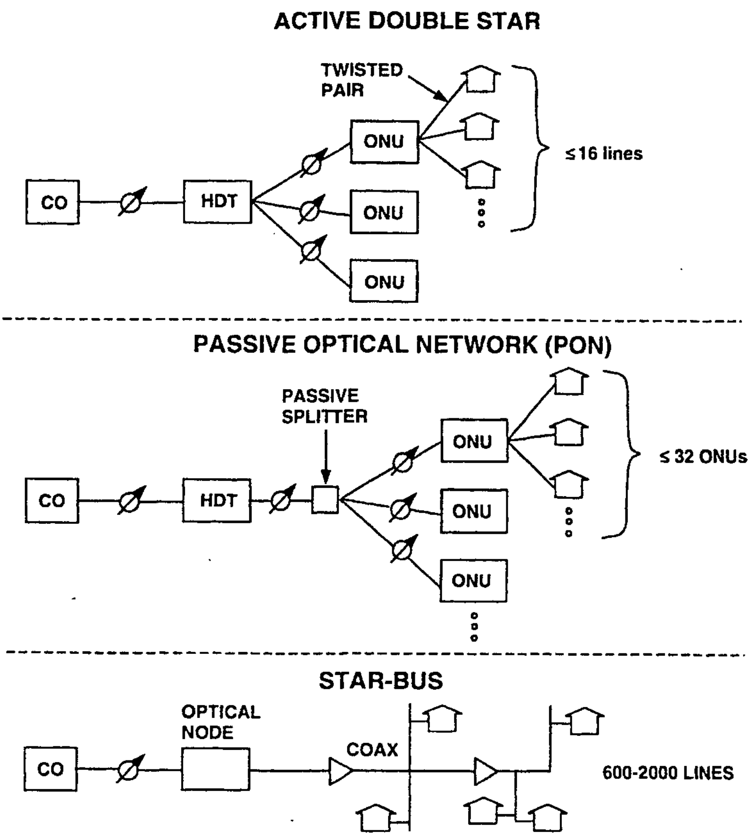
Fiber Primary + DLC Copper Secondary



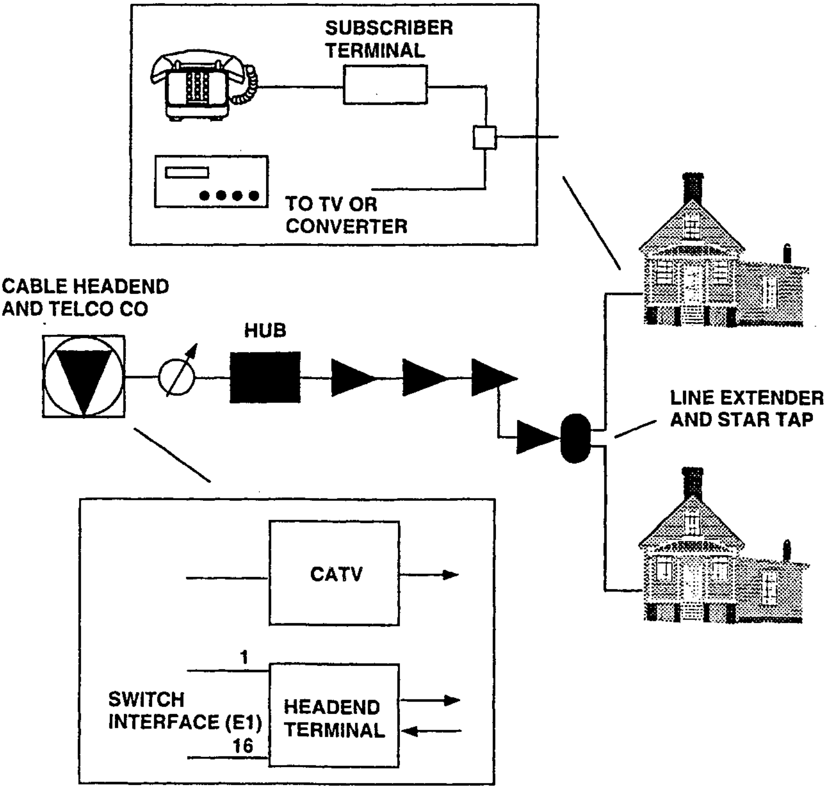
Fiber Primary + RISLU Copper Secondary



Fiber-to-the-Curb Network

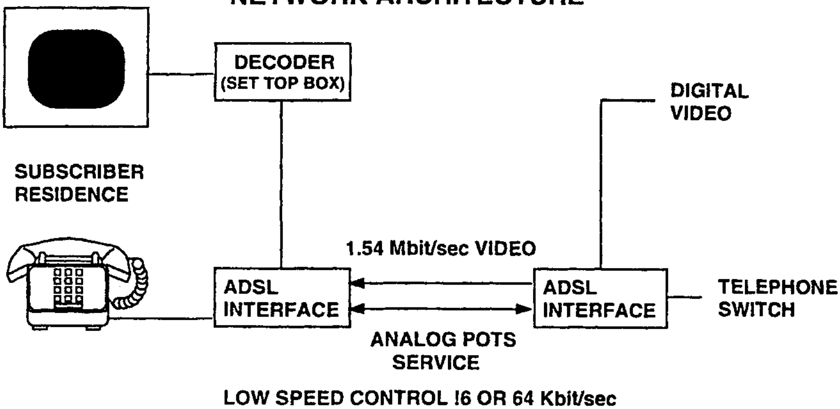


CO=CENTRAL OFFICE
HDT=HOST DIGITAL TERMINAL (RT)
ONU=OPTICAL NETWORK UNIT



Cable Loop Carrier - 500 (CLC-500)

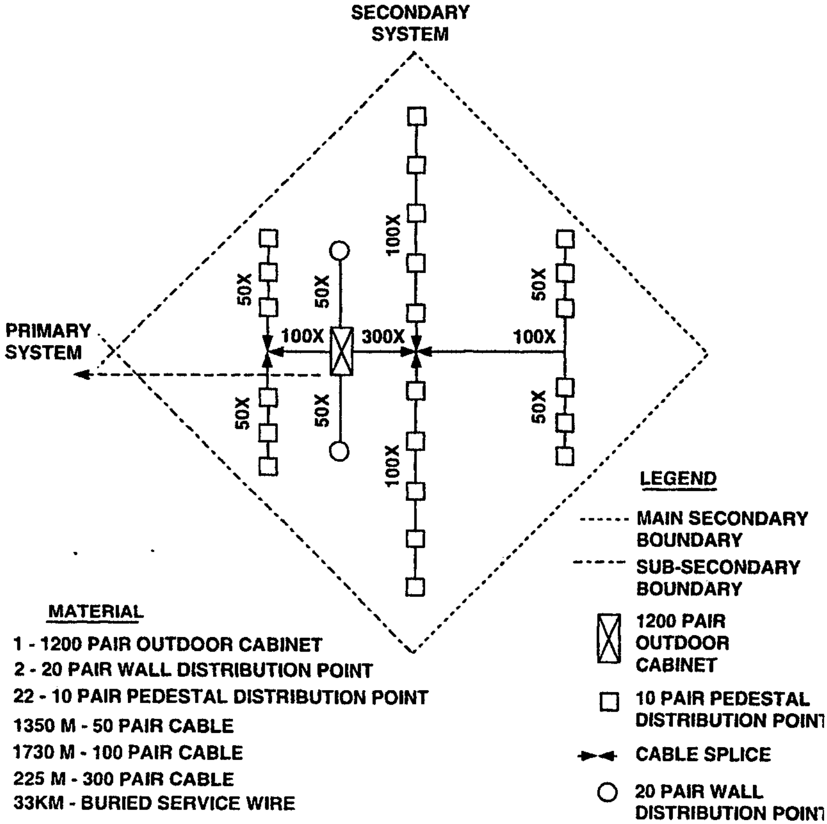
NETWORK ARCHITECTURE



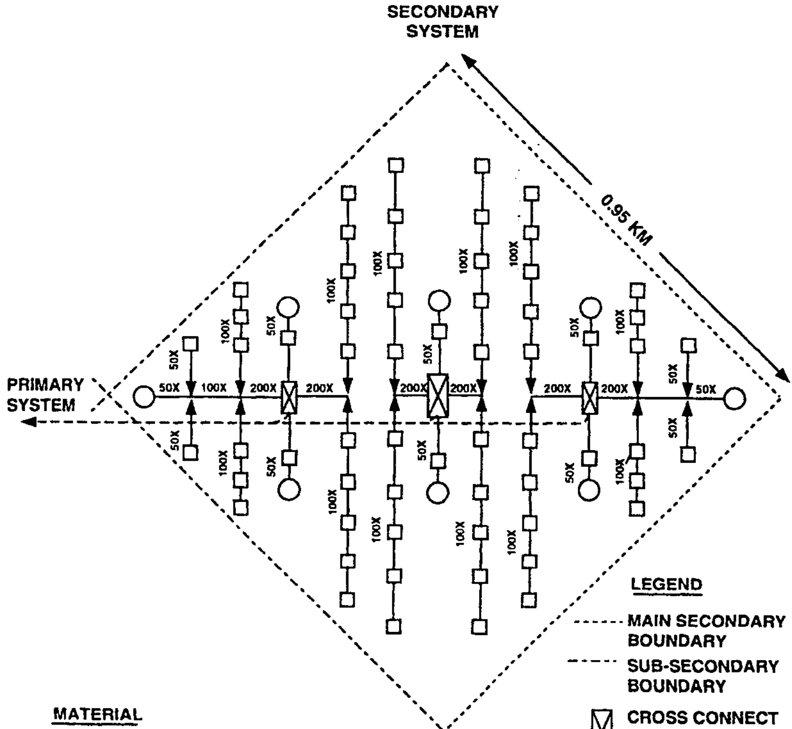
Asymmetrical Digital Subscriber Line (ADSL)

Examples of Secondary (Distribution) Models include:

- Low-Density Copper (Sample Solution)
- High-Density Copper (Sample Solution)
- Low-Density PON 64 (Sample Solution)
- Hybrid Fiber Optic/Coax Network
- Multi-Services Distant Terminal Passive Optical Network (MSDT PON).



Low-Density Copper



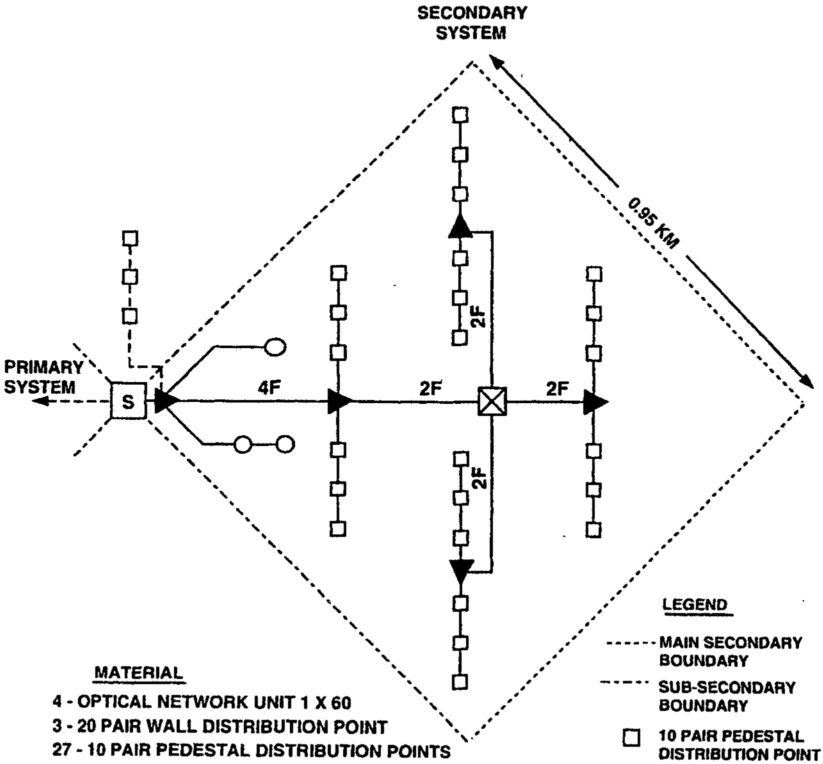
LEGEND

- MAIN SECONDARY BOUNDARY
- SUB-SECONDARY BOUNDARY
- CROSS CONNECT CABINET 1200 PR
- 10 PAIR PEDESTAL DISTRIBUTION POINT
- CABLE SPLICE
- 20 PAIR WALL DISTRIBUTION POINT

MATERIAL

3 - 1200 PAIR CABINETS
8 - 20 PAIR WALL DISTRIBUTION POINT
62 - 10 PAIR PEDESTAL DISTRIBUTION POINTS
1560 M - 50 PAIR CABLE
4790 M - 100 PAIR CABLE
410 M - 200 PAIR CABLE
117,000 M - 2 PR BURIED SERVICE WIRE

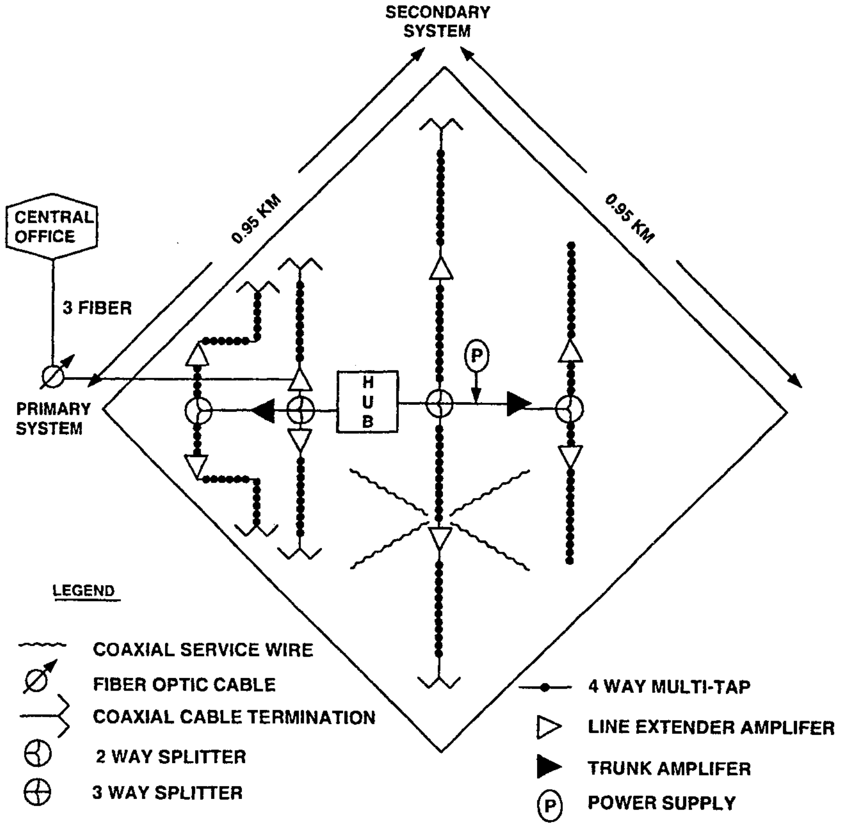
High-Density Copper



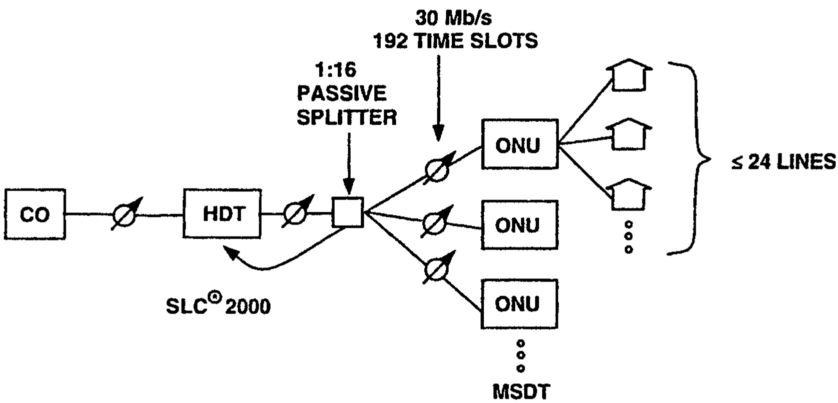
MATERIAL

4 - OPTICAL NETWORK UNIT 1 X 60
3 - 20 PAIR WALL DISTRIBUTION POINT
27 - 10 PAIR PEDESTAL DISTRIBUTION POINTS
1 - OPTICAL SPLITTER
1 - OPTICAL LINE UNIT
36 KM BURIED SERVICE WIRE
1184M - 2 PAIR FIBER OPTIC CABLE
337 M - 4 PAIR FIBER OPTIC CABLE
2295M - 50 PAIR CABLE

Low-Density PON 64



Hybrid Fiber Optic/Coax Network



Multi-Services Distant Terminal Passive Optical Network (MSDT PON)

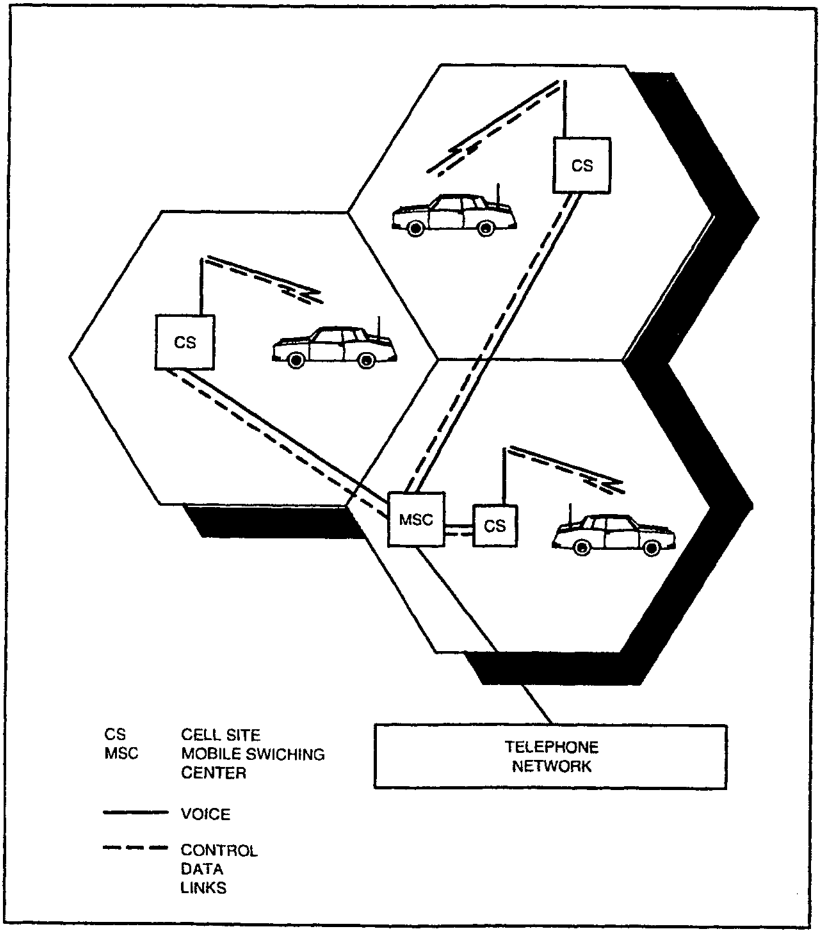
CELLULAR

The *AUTOPLEX*® System 1000 Cellular Telecommunications System embodies the latest radio communication technologies for cellular radio and can accommodate analog and digital cellular technologies. The digital cellular technology, such as Time Division Multiple Access (TDMA) radio technology, provides increased spectral efficiency, system performance improvements (high-quality speech in areas of low signal strength), entirely digital transmission, new and more flexible services, and increased channel privacy compared to analog technology.

In smaller markets, Rural Service Areas (RSAs), or in multiple markets covering a wide geographic area, the *AUTOPLEX* System 1000 provides cellular service with the same ease and economy that it brings in large metropolitan markets. Service may be started in a remote area with a Digital Cellular Switch (DCS) and additional cells without the need to purchase an additional Executive Cellular Processor (ECP). The *AUTOPLEX* System 1000 permits modular growth from a few hundred subscribers to as many as 135,000 subscribers. To accommodate a growing subscriber base and increased calling traffic, multiple DCSs can be added to the system with traffic served by the cell connected to the closest DCS to save facilities costs. Two or more *AUTOPLEX* System 1000s can also be networked to provide all the cellular service subscribers might need.

A cellular telecommunications system divides a service area into regions, or cells. Each cell site is responsible for the radio connection between subscriber units in its area and the rest of the network. The cell site is equipped with radio and control equipment. The cells are connected to the Mobile Switching Center (MSC). The MSC is also connected to the telephone network.

The system locates each subscriber unit (mobile unit or portable unit) in its area and sets up the call as soon as it is requested. As the subscriber drives from one cell into another, the system automatically "hands off" the call from one cell to another cell without service interruption. An illustration of a cellular telecommunications system is shown on the next page.



AUTOPLEX® **System 1000 — Cellular Telecommunications System**

Because the system uses frequency modulation and low power, frequencies may be reused in different parts of a city. This increases the capacity of the system. By the process of "cell splitting," the capacity can be increased even more.

AUTOPLEX System 1000 Hardware

The *AUTOPLEX* System 1000 consists of the following major elements:

- Executive Cellular Processor (ECP)
- Interprocess Message Switch (IMS)
- Digital Cellular Switch (DCS)
- Cell sites
- Interconnecting trunks and data links
- Network interface trunks.

The ECP, IMS, and DCS are based on use of existing AT&T equipment which has proven dependable in many different applications. The ECP, IMS, and DCS equipment is housed in compact and attractive 6-foot (1.83 m) high cabinets. Two models of cell site equipment are available: Series I Model 2, packaged in 6-foot (1.83 m) cabinets; and Series II cell site, packaged in 7-foot (2.13 m) cabinets.

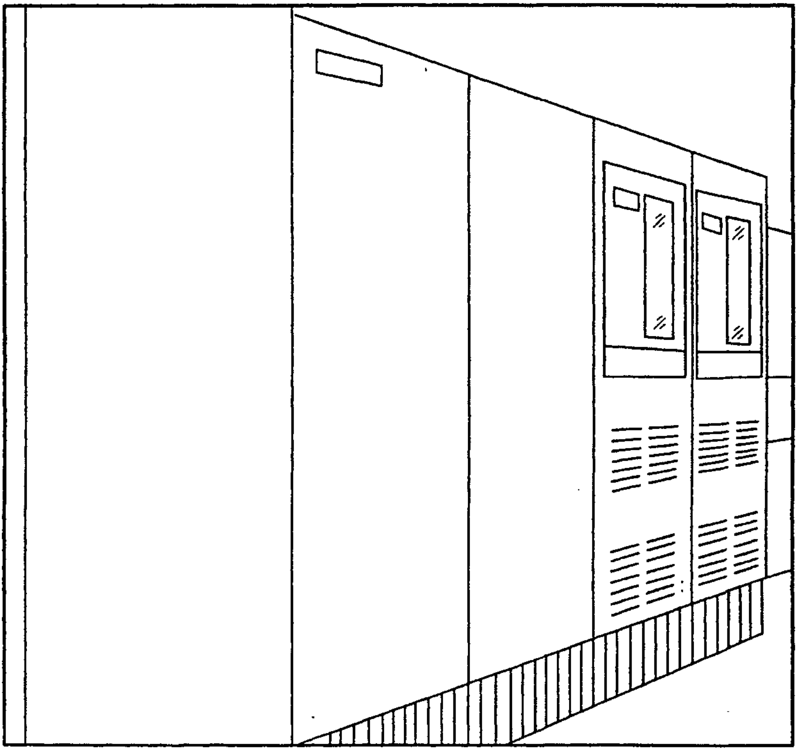
The DCS may, if desired, be remotely located from the ECP. Multiple DCSs may be used, enabling one system to serve several different Cellular Geographic Service Areas (CGSAs).

The cell sites contain radio and control equipment. The Series I cell sites may provide up to 96 voice channels, and the Series II cell sites may provide up to 192 analog voice channels or up to 288 digital voice channels (see "Series II TDMA Digital Radio Unit"). Specially designed antenna masts are available in several heights up to 150 feet (45.7 m) (up to 500 feet [152.4 m] for RSA). Other antenna-mounting arrangements are also available, such as roof mounts.

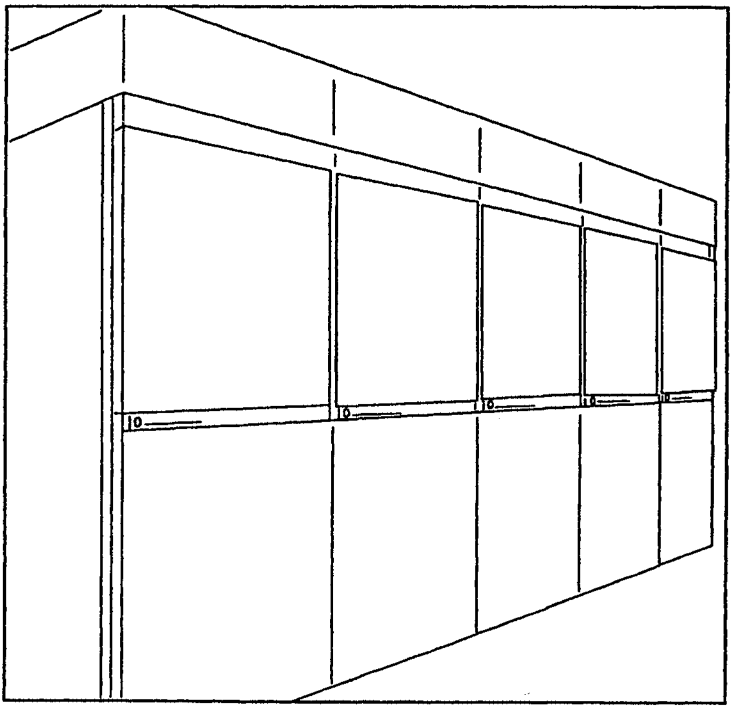
The ECP, IMS, DCS, and cell sites all have the features of optional redundant equipment and built-in maintenance equipment.

The following diagrams of *AUTOPLEX* System 1000 equipment are included:

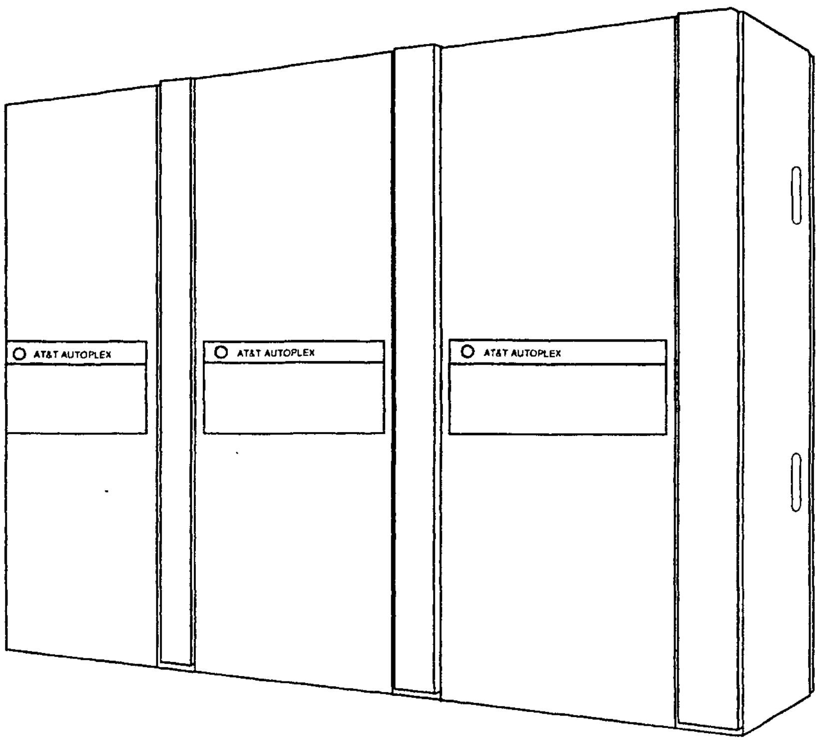
- Executive Cellular Processor (ECP)
- Digital Cellular Switch (DCS)
- Model 2 Cell Site Cabinets
- Transportable Cell Site Building
- Series II Cell Site Cabinet (Radio Channel Frame/Linear Amplifier Frame [RCF/LAF])
- Primary Radio Channel Frame
- Linear Amplifier Frame
- Antenna Interface Frame
- Series II TDMA Digital Radio Unit.



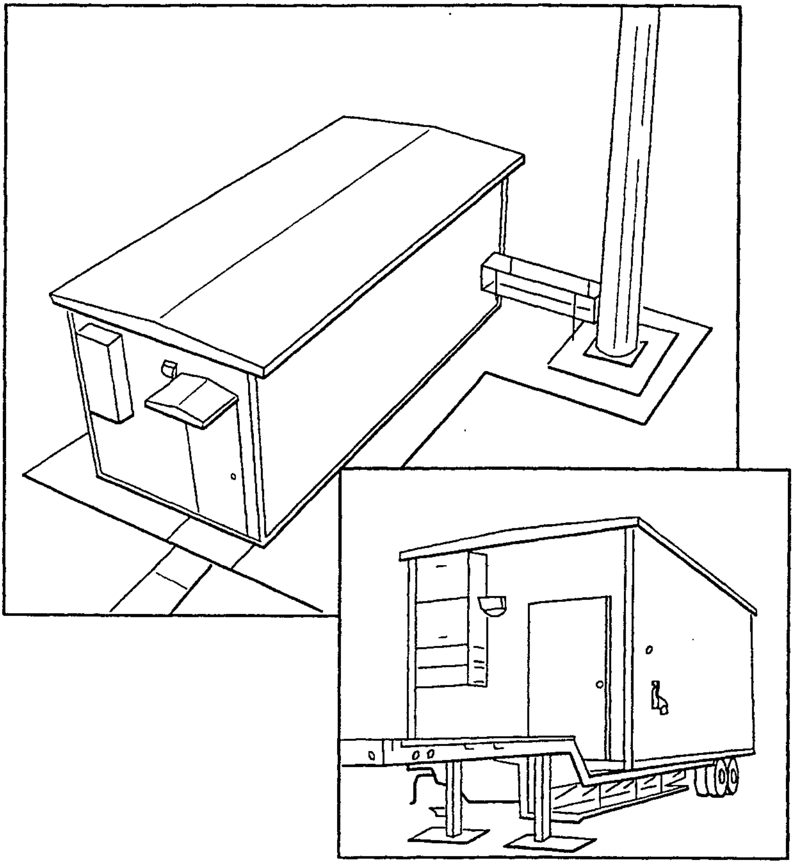
AUTOPLEX System 1000 — Executive Cellular Processor (ECP)



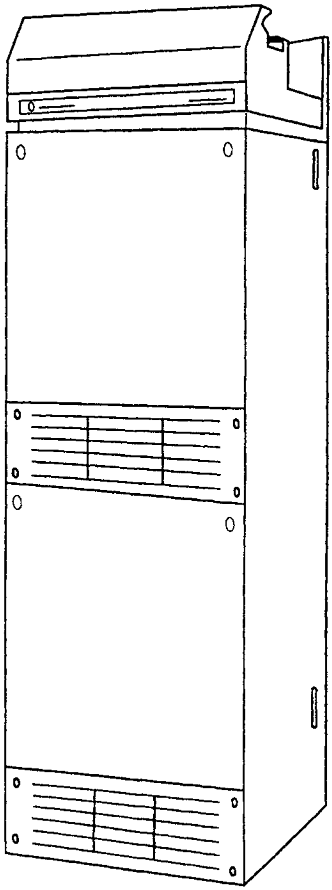
AUTOPLEX System 1000 — Digital Cellular Switch (DCS)



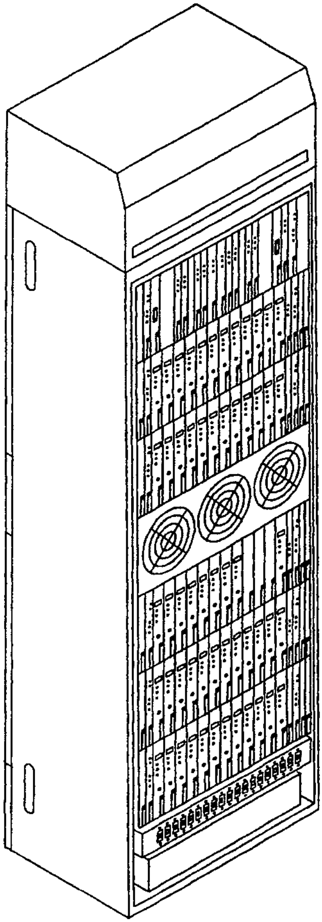
AUTOPLEX System 1000 — Model 2 Cell Site Cabinets



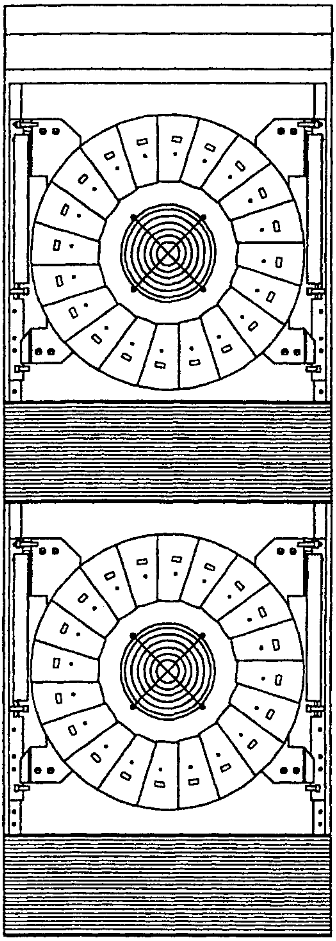
AUTOPLEX System 1000 — Transportable Cell Site Building



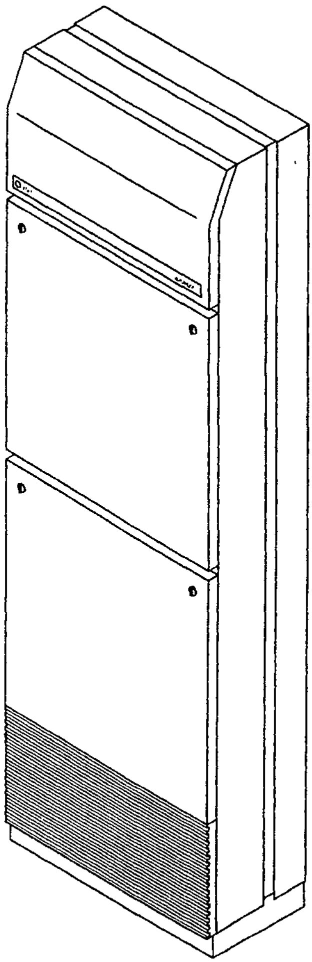
AUTOPLEX System 1000 — Series II Cell Site Cabinet
(Radio Channel Frame/Linear Amplifier Frame [RCF/LAF])



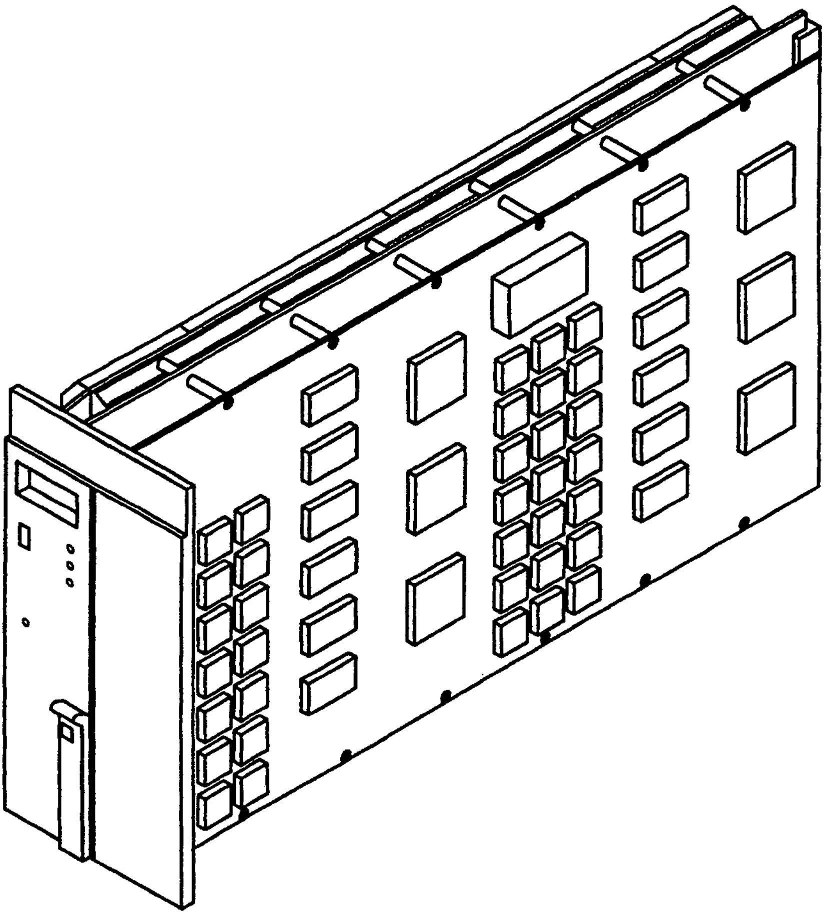
AUTOPLEX System 1000 — Primary Radio Channel Frame



AUTOPLEX System 1000 — Linear Amplifier Frame



AUTOPLEX System 1000 — Antenna Interface Frame



AUTOPLEX System 1000 — Series II TDMA Digital Radio Unit

Cellular Engineering

In the initial planning phase, the system operator must make some decisions concerning the area and the population to serve:

- Size of serving area
- Traffic potential in Cellular Geographic Service Area (CGSA) - market studies
- Cellular analysis to determine cell type and size
- Determine cell sites, Mobile Switching Center (MSC) site, tower locations
- File for construction permit with FCC.

Locating Cell Sites and MSC

Cell site antennas may take advantage of existing towers, but take into account the shielding effect of mounting the antenna on the side of a tower. Standard *AUTOPLEX* masts, which provide the best possible mounting for antennas, are available. Roof mounts are also available. To maximize coverage, an RF engineer should be consulted early in the planning process. Planning for cell site antenna installation is covered in AT&T 401-200-300 *Cell Site Antenna Equipment Installation Planning Guide.*

Cellular engineering service can be provided by AT&T which includes:

- Assisting in laying out the cell sites
- Determining RF propagation characteristics for each cell site
- Recommending the proper number of channels for each cell
- Recommending the right equipment
- Planning for future growth of the system.

AT&T will also help you with technical information needed to file the FCC application for a construction permit.

System Layout

Basic questions that should be considered concerning laying out a system include the following:

- Will there be more than one CGSA?
- How many subscribers will be served at each CGSA?
- Will there be more than one DCS?
- Will a DCS be collocated with the ECP?
- Will a cell site be collocated with the DCS?
- How many cell sites will be needed with each DCS?
- How many channels will be needed at each cell site?
- Will the plan for growth of cell sites include planning for addition of more channels?
- Are there plans for any future cell sites?
- Are there plans for any directional cell sites?
- Are there plans for any dual (dual omni, dual directional, or dual omni/directional) cell sites?
- Will there be a multimodule DCS?
- How many DCS data links are needed?
- How many data links are needed between the IMS and cell sites?
- How many voice trunks are needed between each cell site and the DCS?
- How many voice trunks are needed between each DCS and the network?
- Are there plans to have redundancy options in the DCS?
- Are there plans for redundancy options at the cell sites?

- Are there plans to use the dynamic power control option?
- What other options are needed at the MSC or cell sites?
- Will existing facilities be used for the MSC or cell sites?
- Is it planned to use existing towers or building roofs for cell sit antennas?
- What height towers are needed at each cell?

FCC Application

Filing the FCC application is a critical step in establishing a domesti cellular system. Although there have been changes in the way the FCC wi grant construction permits, there is still a great deal of information that i required on FCC Form 401 and associated exhibits. Much of this informatio can be supplied only by the system operator. However, AT&T can help i supplying the technical information for the application. AT&T is als experienced in working with FCC applications, and the Cellular Engineerin group can assist in preparing applications.

Cellular Configurations

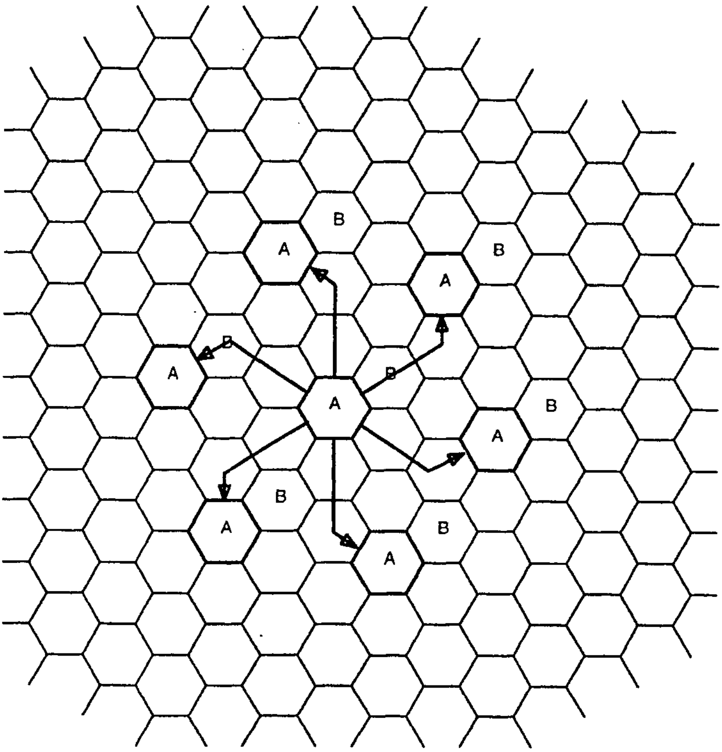
Laying out cellular configurations can become rather complicated. Th following description should be used as a general reference only.

Normally, a CGSA will gradually grow from a low-traffic startup to a increasing traffic volume. During its evolution, the cell size, cell site, setu channels, etc., are configured differently because of the particular needs i each stage. During transition, however, changes to the existing equipmen channel assignment, cell sites, etc., are kept at a minimum to reduce expens and ensure uninterrupted service.

Cochannel Cell Layout

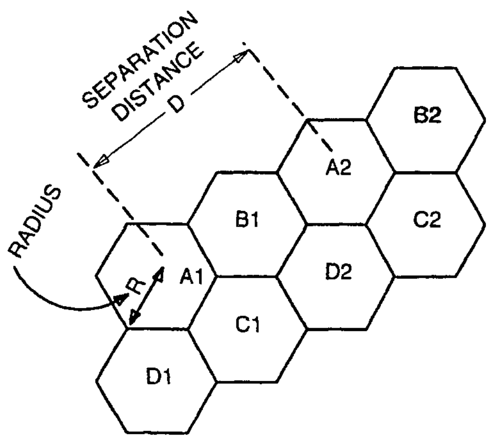
The CGSA is sectionalized into hexagonal shapes to start the cochann layout. One cell is chosen as a reference and labeled "A." Chains c hexagons are drawn from the reference cell, one from each side, and terminate in a cochannel cell. These cochannel cells are labeled "A."

To continue the cellular layout, another cell close to the reference is chosen and labeled (such as "B"). The six chains emanating from this cell also terminate in B cochannel cells. This procedure is repeated until a sufficient number of cells have been labeled.



Determination of Cochannel Cells with 7-Cell Reuse Pattern

The number of cells per cluster determines how many channel sets must be formed out of the total allocated spectrum. The ratio of D (the distance between the centers of the nearest neighboring cochannel cells) to R (the cell radius) is called the "cochannel reuse ratio (D/R)." The number of cells per cluster is governed by the tradeoff cochannel interference and traffic capacity. As the number of cells per cluster decreases, the traffic capacity per cell increases. See illustration below, "Cochannel Reuse Ratio (D/R) for 4-Cell Reuse Pattern" for patterns such as N = 4 and D/R = 3.5.

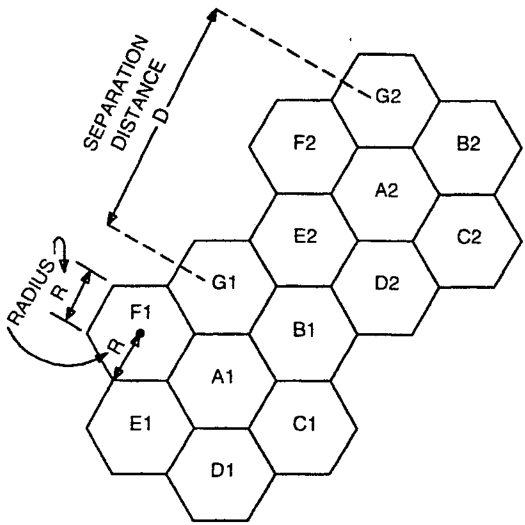


NOTE:

1. Four-cell repeat pattern; D/R = 3.5 (four channel sets: A-D). Each channel set is used twice (subscript 1,2). For example, channel set A is used in cells A1 and A2. This pattern is used in a growth configuration.

Cochannel Reuse Ratio (D/R) for 4-Cell Reuse Pattern

As the number of cells per cluster increases, the relative separation distance between cochannel cells will increase. The illustration below, "Cochannel Reuse Ratio (D/R) for 7-Cell Reuse Pattern" shows patterns such as N = 7 and D/R = 4.6.



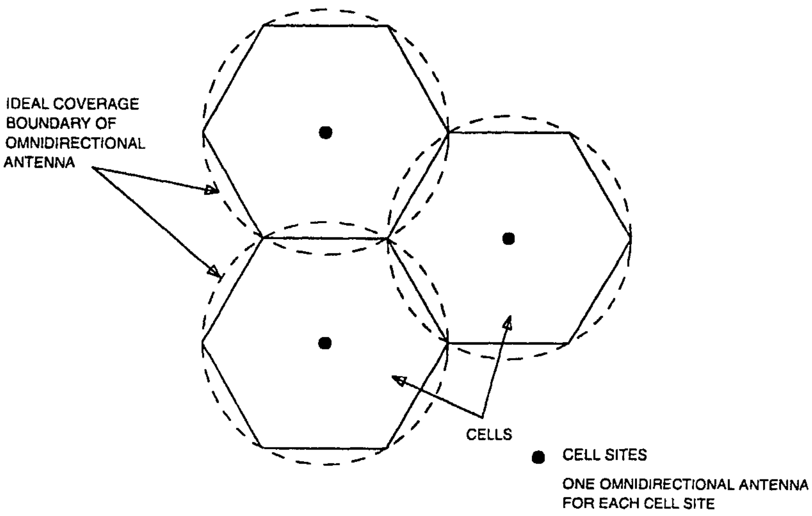
NOTE:

1. Seven-cell repeat pattern; D/R = 4.6 (seven channel sets: A-G). Each channel set is used twice (subscript 1,2). For example, channel set A is used in cells A1 and A2. This pattern is used in a growth configuration.

Cochannel Reuse Ratio (D/R) for 7-Cell Reuse Pattern

Startup

When an *AUTOPLEX* system is first planned and installed in a new service area, the system design goal is to have a startup configuration to serve the CGSA at minimum initial cost. This implies, in most cases, using a minimum number of cell sites (that is, using the largest size cell which can still provide adequate coverage). For a startup cell, the typical cell radius may range from 8 to 10 miles (12.9 to 16.1 km). Generally, in a startup configuration, omnidirectional antennas and centrally located cell sites are used for each cell.



Cells Served by Omnidirectional Antennas

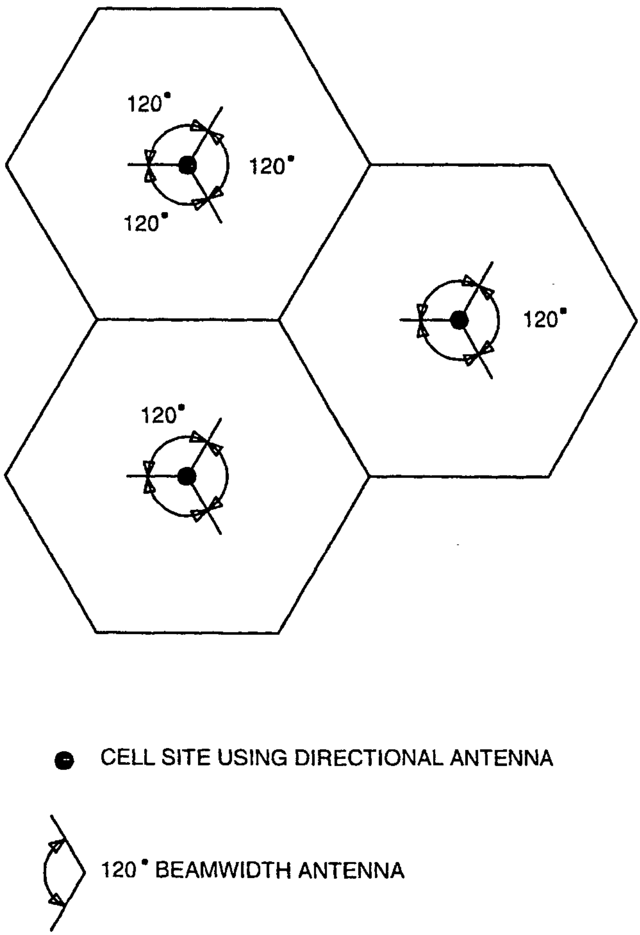
The cell radius depends on the terrain and environment of the particular CGSA of interest. It is preferable to use startup cells of uniform size in one CGSA. The total number of cells required must be sufficient to cover the entire CGSA.

A typical pattern for voice channels in a startup system is N = 7. Access channels are assigned in an N = 21 pattern. In areas where there is minimum cochannel interference, repeat patterns for voice channels (N = 4 or N = 3) may be used. Where interference is expected to be high, larger repeat patterns may be used. It is desirable to use the smallest repeat pattern possible without cochannel interference. As the system matures, pattern N = 7 or N = 4 will require the use of directional antennas in a high-traffic area. This will maximize frequency reuse and therefore will increase traffic capacity.

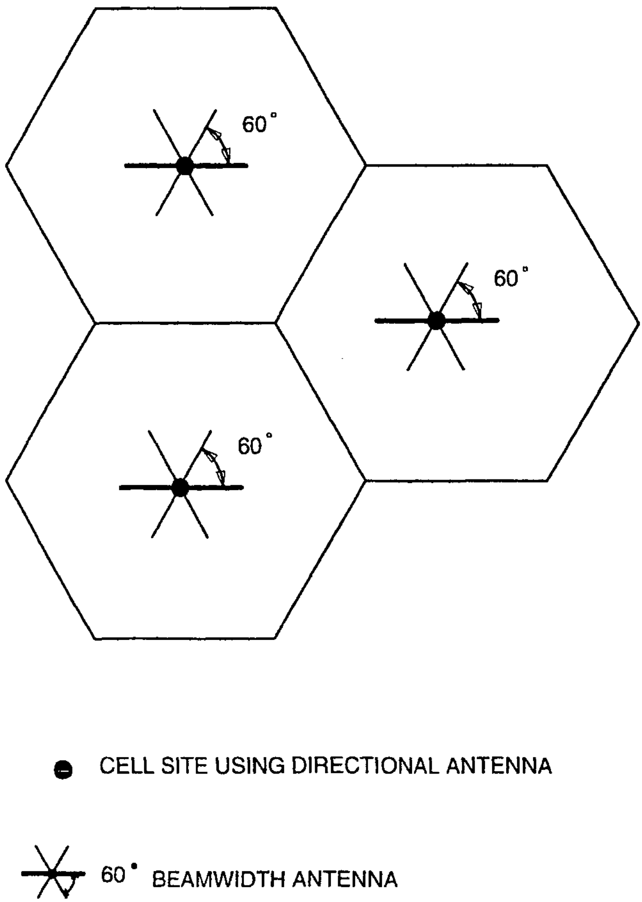
Growth

A growth configuration is a pattern developed by using growth schemes after the capacity offered by the startup configuration is saturated. The demand for growth can be met by the cell attachment technique when the demand is to serve new geographical areas outside the existing CGSA or by the cell-splitting technique when the demand is to serve more subscriber traffic within the existing service area. Cell splitting can be accomplished in several ways, including cell overlay, cell addition, or "going directional."

Going directional can normally be accomplished by replacing an omnidirectional antenna configuration with a three 120-degree sector antenna configuration or six 60-degree sector antenna configuration. By using the 120-degree directional antennas, the complete coverage of each cell is provided by three different antennas at the centrally located cell site. The 60-degree sectorization concept consists of two control frames (or cabinets). Each control frame controls its own half-cell with three 60-degree directional antennas, and therefore the complete cell consists of six 60-degree antennas. The 60-degree sectorization reduces interference and allows the use of the N = 4 channel reuse pattern. The use of directional antennas creates cells whose idealized boundary forms a regular hexagon, as in the omnidirectional case. Illustrations of a cell configuration served by three directional antennas and six directional antennas are shown on the next two pages.

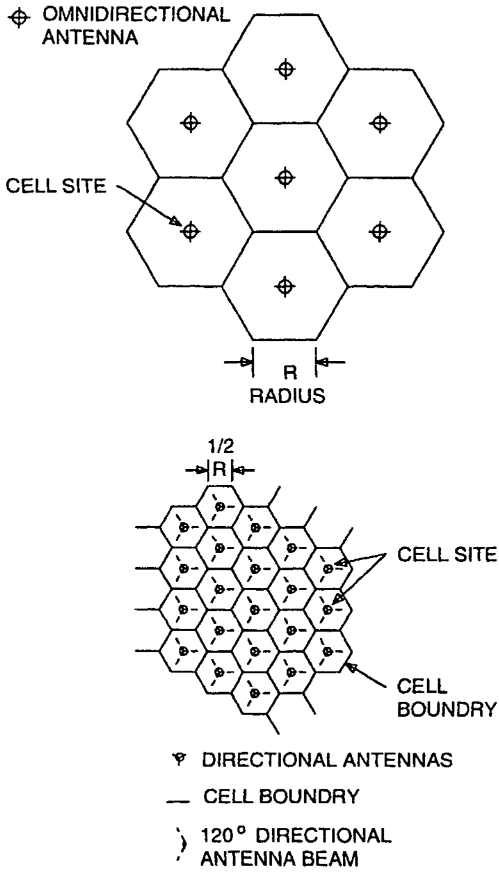


Cells Served by Three Directional Antennas



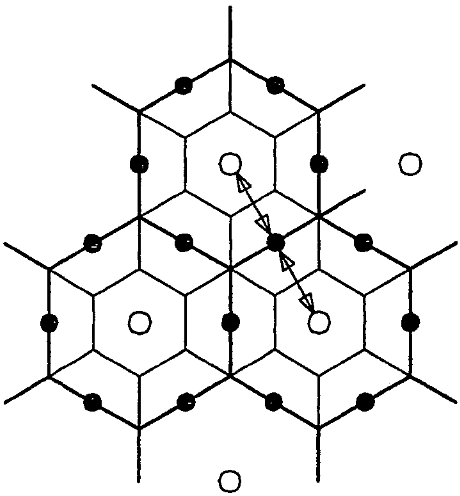
Cells Served by Six Directional Antennas

When the first cell split is required, the transition from startup to growth configurations begins. The growth plan requires that, in addition to the use of directional antennas, the cell radius be reduced by half. This is illustrated below.



Cell Split (Startup-to-Growth Configurations)

"Location of Cell Sites in Cell-Splitting Process" below illustrates the details of locating new cell sites in a cell-splitting process. New cell sites are added midway between two existing cell sites. The original site will remain in a smaller coverage area. For all subsequent cell splits, the cell radius is reduced to one-half of the previous cell radius. Using directional antennas in this arrangement reduces cochannel interference.



○ ORIGINAL CELL SITE

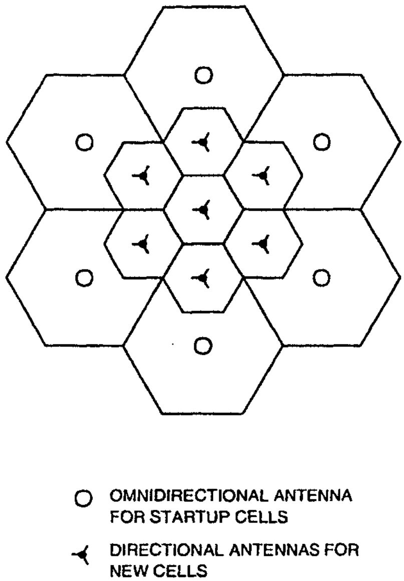
— ORIGINAL CELLS (RADIUS R)

● NEW CELL SITE AT MIDWAY BETWEEN ORIGINAL SITES

— NEW CELLS (RADIUS 1/2 R)

Location of Cell Sites in Cell-Splitting Process

In a realistic growth pattern, traffic demand may be heavy only in a few cells in part of the CGSA. Cell splitting may, therefore, initially involve only the few cells that encounter the heaviest traffic in the CGSA. After such a cell split, the resulting pattern contains larger cells overlaid by a grid of smaller cells. This is illustrated below.



Cell Site Antenna Arrangement After Cell Splitting

Cell Site Location

The actual cell site location will depend upon many factors, including available real estate, possible locations for antenna towers, etc. AT&T 401-200-300, *Cell Site Antenna Equipment Installation Planning Guide,* provides guidelines for locating antennas.

BIBLIOGRAPHY

AT&T	Title
636-299-125	Wire Center Modernization Distribution Systems Architecture Guide
900-200-210	Lightguide Cable Systems OSP Standards Handbook
627-400-001	CATV Aerial Lightguide Cable Planning, Engineering, and Installation
	AUTOPLEX Cellular Telecommunications Systems
401-200-300	Cell Site Antenna Equipment Installation Planning Guide
401-300-610	System 1000 - Series II Digital Cellular Switch Applications Engineering Manual
401-610-014	System 1000 Growth Procedures
401-610-005	System 1000 Series II, System Requirements and Planning Guide

Section 3

Contents

Section 3

EXCHANGE NETWORK DESIGN

DETERMINING THE TYPE OF OUTSIDE FACILITIES DESIGN

The outside facilities engineer is responsible for determining the type of outside facilities design that will best meet the needs of the company and the area to be served. There are three basic choices:

- Aerial
- Underground
- Buried.

The engineer should evaluate the following for each type of facilities prior to proposing its construction:

- What is the Initial First Cost?
- When is reinforcement of the facility likely to be required?
- What are the potential maintenance costs and problems?
- Is the potential for service disruption more likely with one type of facility than another due to storms, dig-ups, etc.?
- Is there a governmental or company policy in place that dictates the type of facilities that must be constructed?

These considerations apply to both primary (feeder) and secondary (distribution) cables.

Although the engineer is responsible for making the decision on the type of facilities to construct, there are a variety of resources that should be used to assist in the process:

1. **The Long-Range Outside Facilities Plan** for a central office (CO) usually contains an economic analysis comparing the cost of each

type of facility for the main and branch primary routes. Long-range proposals for these critical routes are often contained within the plan and are to be implemented when reinforcement on these routes is required.

2. **Maintenance and trouble history** for problem areas may be documented as part of the plan or may be available from other sources.
3. **Governmental or company policies** on the type of facilities required in given areas are usually well documented and generally available to the engineer.

Initial First Cost Considerations

The initial first cost can be defined as the cost to build the job without considering future costs or benefits. The decision to propose one type of facility over another is often influenced by existing conditions, primarily because existing conditions influence initial first costs.

The initial first cost, although an important consideration because it impacts today's money, should not be the only consideration. Evaluation of the remaining considerations may indicate a low initial first cost — but excessive future costs — either due to future reinforcement requirements or excessive maintenance costs. Consider the following:

1. If there is an existing structure, such as a pole line, the initial first cost of an aerial cable will be far less expensive compared to an underground cable requiring the construction of a conduit structure. However, consider this same situation with the following additional information:
   a. The long-range plans for the area propose the placement of conduit and underground cable. All aerial cables and poles are to be removed when the conduit system is built.
   b. In addition to the initial first cost of the aerial cable, consideratior must also be given to advancing the conduit structure so that the new cable can be placed underground. This eliminates the cost of placing a short-term aerial cable, and the associated

rearrangements of the facilities that would be served by this cable, in favor of advancing the conduit structure.

2. If there are both an existing pole line and an underground conduit structure, then the initial first cost of each type of facility, although still a factor, has less impact. Other factors become more critical, such as:

   a. Is it intended to maintain both aerial and underground facilities in the area?

   b. Is the proposed cable being placed to serve customers in the area of the pole line or is it for requirements further out the route? If it is for requirements further out the route, then the underground structure should be used, saving the remaining pole line positions for the local distribution.

3. If there are no existing facilities in an area, then the initial first cost along with future reinforcement requirements becomes more critical. An area that is expected to have low growth may be more conducive to aerial or buried facilities than an area with high growth. High-growth areas will likely require more cable facilities to meet the demands. These needs are best met with underground facilities where the number of ducts in the structure has been sized to accommodate the anticipated demand.

Future Reinforcement Requirements

Consideration must always be given to the next requirement that will affect an area currently being evaluated for relief. A job built today must not eliminate future alternatives; rather, it should be constructed considering the next relief requirement. Consider the following:

1. If a pole line has been designed to have four usable pole positions for telephone facilities, and a proposed job will use the last position, then the engineer must consider alternatives:

   a. Can the existing job be changed to accommodate the removal of an existing aerial cable? For example: Increase the proposed cable size to permit the removal of a smaller existing cable, resulting in a spare pole position available for another future aerial cable placement.

Note: When a cable is removed specifically to recover its pole position or the underground conduit that it occupies so that the space is available for future use (deferring structure reinforcement), it is referred to as "mining a cable."

b. If it is not possible to recover a pole position, should the next job be to build conduit and place underground cable?

c. Should the next job propose buried cable?

2. If it is proposed to bury a cable, then consideration must be given to:

    a. How long will the facility last?

    b. How many cables can ultimately be buried in the area?

    c. If demand increases, how will that impact the existing buriec facilities as well as the long-range plans for providing facilities to the area?

    d. If the right-of-way is congested, how difficult will it be to place a conduit with the buried cable?

The point to remember when proposing any job is to consider how it impacts the next job as well as the long-range plans for the area.

Maintenance Cost Considerations

The ongoing maintenance costs associated with a particular type of outside facilities construction must be evaluated before deciding to continue to reinforce with the same type of facilities. Consider the following:

1. Existing aerial cables may experience some or all of the following, making it advantageous to consider another type of construction:

    a. In heavily wooded areas, lengthy service disruptions may resu' due to fallen trees.

b. Excessive maintenance problems are sometimes experienced due to squirrels or other rodents causing sheath damage or building nests in splice cases.

c. In areas where high winds are known to be a problem, wind-whipping of the cables causes them to wrap around themselves resulting in mechanical damage to the cable sheath.

d. In areas where roadways exist, extensive damage to poles and cables can result from automobile accidents.

e. In areas prone to lightning, damage to poles, cables, and hardware can result.

2. An area with a high water table may cause underground or buried facilities to deteriorate at an accelerated rate. In most cases, this problem can be alleviated through the use of filled cables or by maintaining proper air pressure on the cables. Air pressure systems increase maintenance costs, however, as continuous monitoring is required to identify leaks that will cause a decrease in the air pressure and ultimately permit water to enter the cables and splice cases.

Potential Service Disruptions

The consideration of potential service disruptions differs from maintenance considerations in that the former tend to be man-made versus acts of nature. The most common service disruptions are:

1. **Dig-ups** — For example, contractors working in areas without first having existing underground or buried facilities located often dig up the cables of other utilities. In the worst cases, the result is temporary loss of service for the customers served by the facility. It is possible, however, to dig up a cable and only damage the sheath of the cable or break the duct. In these cases, permanent repairs can be made without disrupting service. However, this type of situation causes unscheduled repair work and time required to repair the damage.

2. **Sheath or cable damage** — This damage can result from other construction activities, such as placing signs, posts, or fences. In these situations, objects can be driven down into the cable, causing service disruption and the need for repairs.

If another buried cable is proposed in such an area, consideration should be given to:

1. Choosing another location less susceptible to construction activity
2. Increasing the depth of the proposed buried cable
3. Placing additional buried cable markers warning individuals of the presence of buried cable.

If it is decided to place underground or buried facilities, consideration must be given to locating the facility in an area least likely to be subject to potential service disruptions.

Governmental or Company Policy

There are often governmental or company policies in place that preclude any decision that the engineer may make:

1. There may be a government or company policy dictating underground or buried facilities in certain size residential housing developments.
2. There may be requirements along certain types of roadways. Major highways often require the construction of underground or buried facilities for safety as well as aesthetic reasons.

Most policies that dictate type of construction are common knowledge throughout the telephone industry. Requirements are usually well documented and generally available to the engineer.

COPPER CABLE—PRIMARY (FEEDER) DESIGN

Basic Strategies

Spare primary facilities should be apportioned along an entire primary route to defer cable relief as long as possible. This is accomplished by dividing the primary route into secondary system (distribution) areas during the Long-Range Outside Plant Planning process. Spare facilities should then be allocated along the route based on the transmission limitations of each secondary system area. Relief intervals (2 to 5 years) can then be established for various cross sections of the primary route.

Allocated spare pairs are then committed to laterals along the route based on identified growth. (Committed means physically spliced to a lateral and available in the secondary system area or appears on the primary side of a primary-secondary interface.) These pairs should always be committed in one or more binder groups (complements). The allocated spare pair groups which may remain in a secondary system area after commitment for identified growth can then be made available for future growth as required.

The methods of administering the primary facilities using paired cable are as follows:

Type I — Serving Area Concept (SAC) Dedicated. Primary pairs are permanently assigned (dedicated) for primary services. All primary pairs are committed to the interface in binder groups and are multiple-free.

Type II — SAC Connect-Through (CT). In areas of low penetration, sufficient nonmultipled primary pairs are committed (in binder groups) to provide for the requirements. Jumpers are left intact when service is disconnected, although on idle pairs the CT may be broken as required.

Type III — Interfaced Plant with Multipled Primary Pairs. Where there are insufficient primary pairs available for Type I or II administration, or where growth is subject to shifts between two contiguous serving areas, binder groups may be multipled between two interfaces. The number of pairs multipled should not exceed 15 percent of the committed pairs. Also, binder groups should not be multipled outside of their secondary system area. Multipled pairs within a secondary system area must meet the transmission criteria for the secondary system area.

These methods are covered in AT&T 915-251-200 and 915-251-300.

Sizing Guidelines

Copper primary cable is normally sized to satisfy the growth requirements on a primary route for a period of 5 to 7 years. However, there are many factors to consider that may affect the cable size and the growth period used to assist in determining cable size. For example:

1. Economic constraints may necessitate the placement of a less than optimum size primary cable.
2. Company policy may dictate a shorter or longer growth period.
3. Changes in anticipated growth patterns for an area may impact the amount of time a cable lasts, increasing or decreasing the amount of time the cable is able to satisfy requirements.
4. The type of structure being utilized may affect the optimum size cable, for example:
    - **Aerial construction** — The lack of spare pole positions for additional aerial cable placement may necessitate the placing of a larger primary cable to avoid major rearrangements or structure reinforcement. This type of construction does have weight limitations, which can restrict the size or number of cables that can be installed.
    - **Underground construction** — Larger underground primary cables may be placed as the number of available spare ducts decreases. This practice can defer major conduit reinforcement for a significant period of time. Also, deployment of fiber optic cables can defer or eliminate conduit reinforcement.
    - **Buried construction** — Larger cables may be placed to avoid high construction costs associated with burying another cable in the not-too-distant future.

An economic analysis of the alternatives will assist the engineer in choosing the best solution. Good engineering judgment, however, is essential in applying these guidelines to actual field requirements.

COPPER CABLE—SECONDARY (DISTRIBUTION) DESIGN

Urban and Suburban—Paired Cable

AT&T 901-350-250, 915-251-300, -301

Urban and suburban areas are divided into secondary systems during the Long-Range Outside Plant Planning process. A secondary system is a defined geographic area in the developed or soon-to-be-developed areas of a wire center.

Note: In the United States, the primary (feeder) network is typically addressed by feeder administrators and the secondary (distribution) system is typically addressed by design engineers in the planning stages.

A secondary system area may be one of the following:

- A serving area under the Serving Area Concept (AT&T 915-251-300)
- An interfaced area that meets the secondary system criteria given in the following paragraph but is not administered under the SAC
- An area that meets the secondary system criteria and is administered as Multiple Outside Plant (MOP).

Each secondary system must have the following characteristics:

- Has defined boundaries, usually corresponding with streets, property lines, railroads, rivers and creeks, or fence lines.
- Contains a definite number of ultimate living units (or business lines) based on the proposed land usage (not necessarily what exists today). A typical size is from 1000 to 3000 living units.

Note: The ultimate living unit criterion is based on typical customer demand per unit and size of the primary side of the interface. In areas where three and four lines per unit are common, a lower figure may be used. Much of the existing, domestic secondary (distribution) system design is based on Distribution Areas (DAs) of 200 to 600 living units. The ultimate criteria used in the design of a secondary (distribution) system should be defined and approved by the customer.

- All pairs within the area will either require or not require loading.
- One secondary system gauge is desirable and is the objective in establishing the secondary system boundaries. A gauge change in the secondary system may be an alternative in the administration and design of the secondary cables. However, the transmission requirements of the primary pairs should not be mixed for administrative reasons.
- All primary pairs will be interchangeable, and it must be possible to connect them to any secondary pair without exceeding the resistance limit for the area. However, it is recommended that the first primary pair assigned to a living unit or business location be permanently connected to the secondary pair permanently assigned to the customer address.
- Each secondary system will have one documented design point, the measurement from the CO to the longest ultimate loop in the area.
- Each secondary system will have one point of interface between the primary and secondary plant. During the planning process, the point may be theoretical. However, when designing the actual secondary system, this point must be permanently established before designing the secondary cables within the area.

Interfaced Cable Sizing Guidelines

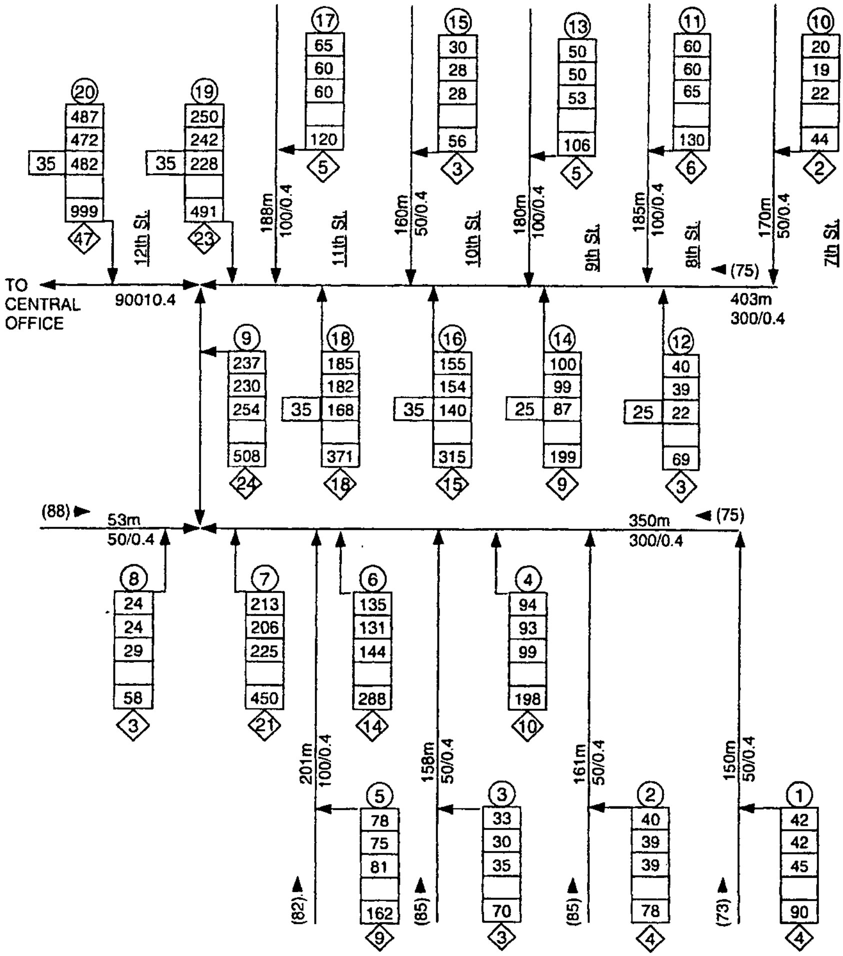
Interfaced secondary cables are sized for the "ultimate" pair requirements. Accepted standards for pair allocations are as follows:

- **Residential** — two pairs per living unit.
  There are occasions when fewer than or more than two pairs per living unit are the optimum choice.
- **Small business** — five pairs per business.
  When determining ultimate business lines, it is usually best to be liberal.

Good engineering judgment should be used in determining requirements. The engineer should also have a knowledge of the land usage and the existing pair requirements in the area to be served by the interfaced secondary system cables. A study of the area should reveal:

- The number of existing living units
- The ultimate number of living units
- The ultimate business line requirements.

Using this information, the ultimate pair and binder group requirements can be developed for each lateral. These ultimate requirements for each lateral are then accumulated, working back toward the Serving Area Interface (SAI). To develop interfaced secondary cable sizes, the engineer should create a secondary system chart of the cables in the area being studied. An example is included on the next page.



Secondary System Chart

Establish Fill Points

Notice that "Points of Fill" are reflected at specific locations along the entire secondary system chart. The typical "Point of Fill" locations are:

(1) Field (secondary system) side of each cross-connect box

(2) Major splits or tapers of cables in the secondary system.

"Point of Fill" locations are identified by a "fill" box. The fills are cumulative so as to reflect totals (pairs or binder groups) required along the secondary system route back to the interface.

Complete Fill Boxes

Two types of fill boxes are used on the secondary system chart. One type labeled "New Cable" is used to calculate potential growth on new cable runs, and the other type labeled "Existing Cable" is used to calculate potential growth on existing cable runs. Determine the appropriate fill box to use at the designated fill points on your chart. The following instructions show how to populate the individual fill box requirements.

New Cable Fill Box

When developing the plan for new cable in existing plant areas, only four entries will be completed:

(1) Cumulative ultimate living units

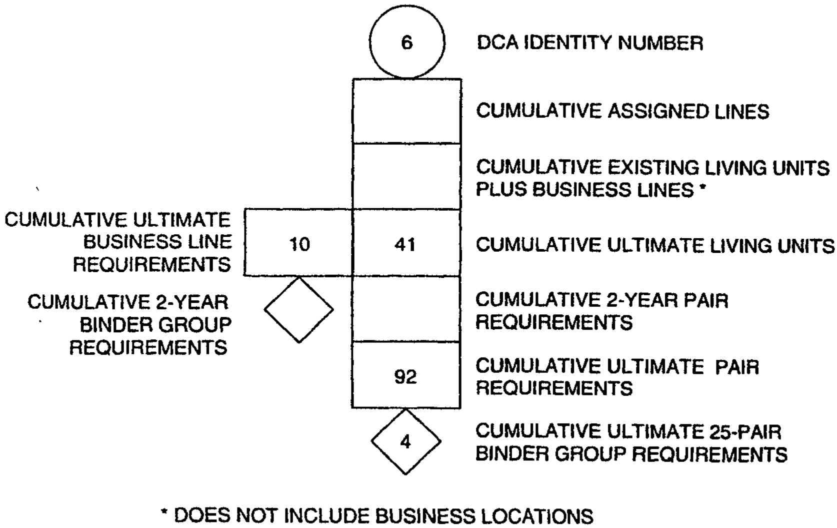
(2) Cumulative ultimate business lines

(3) Cumulative ultimate pairs required

(4) Cumulative ultimate binder groups required.

Note that ultimate business locations are not shown in the fill box, only business line requirements. The block for ultimate business lines is added only if there are business locations along the cable route involved. If the area is made up of all residential units, the additional block would not be added. Once the block is added, it will be carried on all fill boxes in that secondary system path to the interface.

The number of binder groups required for each lateral appears in the diamond shaped box at the bottom of the "fill" box. This number is compared to available cable sizes to determine the cable size that will accommodate the required number of binders.



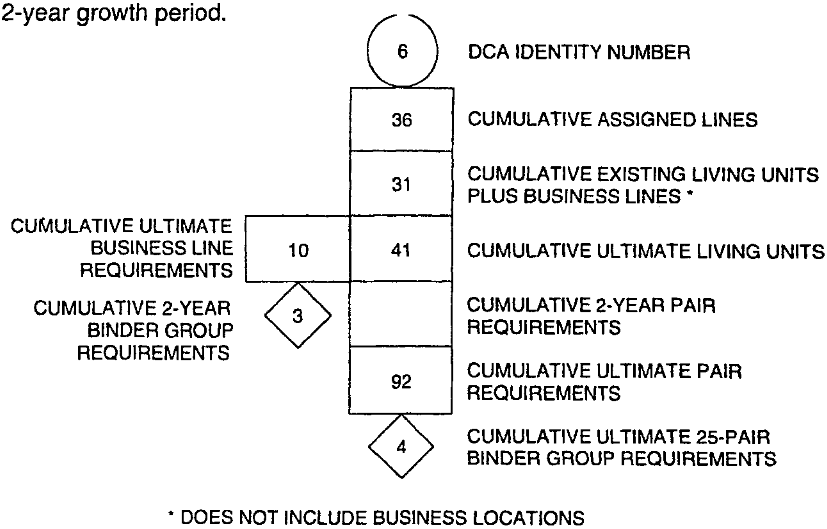
New Cable Fill Box

Existing Cable Fill Box

When designing a cable job in areas involving existing plant, other entries on the fill box are needed. Cumulative assigned pairs are developed from an in-service count made on a terminal-by-terminal basis. A suggestion would be to post individual terminal counts on a copy of the cable records, and then establish boundaries around the proper groups of terminals to obtain a count of working lines.

The entry for "cumulative existing living units plus business lines" can be developed using the secondary system base map (existing living unit count) and the business line data from the in-service count.

The "cumulative 2-year pair requirements" entry is developed by adding the expected growth to the working lines. This total will provide the number of primary (feeder) pairs and secondary (distribution) pairs required for the 2-year growth period.



Existing Cable Fill Box

CARRIER SERVING AREA (CSA) DESIGN

Copper Pair Secondary System Cables

The design and administration of the secondary system network, as previously discussed, is based on twisted pair copper cable and the associated resistance design zones as explained in Section 5 "TRANSMISSION." Demands for sophisticated services are requiring the outside plant network to support services ranging from low-bit rate transmission to high-bit rates. To meet this demand, a digital subscriber carrier is being placed into the network starting at 12,000 feet (3658 m) from the serving CO or at 9,000 feet (2743 m) if 26-gauge (0.4 mm).

The existing outside plant network beyond 12,000 feet (3658 m) may be divided into Carrier Serving Areas (CSAs). To meet the 64-kb/s transmission rate, the secondary system cables within a CSA must not exceed 9,000 feet (2743 m) in a 26-gauge (0.4 mm) design area and 12,000 feet (3658 m) in a 24/22/19-gauge (0.5/0.6/0.9 mm) area. If there is a concentration of special services in the area, these limitations may have to be reduced. The carrier equipment is housed in a Remote Terminal (RT) with an associated interface between the secondary system and primary network.

The preceding limitations are based on the secondary system cables not exceeding 900 ohms. In sparsely populated areas, secondary system cables beyond a remote terminal can be extended to 1,500 ohms by use of range extension plug-ins at the RT. The boundaries of these areas are called Expanded Carrier Serving Areas or ECSAs. However, as growth occurs in the sparsely populated areas, ECSAs should be divided into CSAs.

FIBER OPTIC CABLE DESIGN

Selecting Areas for Potential Fiber Applications

Factors that should be considered when selecting and prioritizing areas for fiber applications include:

- Evaluating the growth on a primary route by type, amount, and location
- Evaluating the structures used to support the cables
- Considering existing maintenance conditions.

Additionally, company or government policies may be established that will influence the placement of fiber optic cables.

The engineer must take into account each of these factors individually and collectively so that the ***total*** impact is considered.

Evaluating Growth

The engineer should evaluate the growth on a primary route by location and by type and amount. In general, any growth that will cause the engineer to terminate a new cable at the central office (CO) should be considered for fiber optic cable deployment.

Location: The location where the growth is occurring is an important factor in selecting areas for fiber applications. If the growth is occurring near the CO at a distance less than 9,000 feet (2743 m), provision of facilities using copper will most likely be less expensive. At these short distances, copper cables will support most special services without requiring conditioning of individual pairs. Growth occurring further away from the CO, distances beyond 9,000 feet (2743 m), increases the possibility of conditioning being required to support certain types of special services. Additionally, growth beyond 18,000 feet (5486 m) requires heavier gauge cables and loading when completely on copper and also requires conditioning of copper pairs when using copper-fed digital loop carrier systems. For these reasons, fiber optic cable should be considered for all growth beyond 9,000 feet (2743 m).

Type and amount: The type and amount of anticipated growth determines the priority for considering a primary route for fiber optic cable. The engineer must determine whether the anticipated growth will be generated by residential or business customers and how much growth is expected. Generally, it is more critical to provide fiber optic facilities to areas with existing business establishments or areas where business growth is expected. Business customers are more likely to have a greater demand for the number of facilities as well as the special services available on fiber optic cable than are residential customers. Fiber-fed digital loop carrier systems provide the most efficient means of meeting these demands. However, any concentration of new growth, business or residential, beyond 9,000 feet (2743 m) should be considered a candidate for fiber optic cable and digital loop carrier equipment.

Evaluating Cable Support Structures

The engineer must evaluate the structures used to support the outside plant cables and hardware when designing any new cable installation. A structure may not be able to support another large, heavy copper cable but may be able to accommodate a smaller, lightweight fiber optic cable. In fact, the small size and light weight of fiber optic cables provide a significant advantage in all types of structures.

Underground Construction

Underground conduit structures must be evaluated based on the number of spare ducts available for future cable placement and on manhole congestion.

Number of spare ducts: Through the use of innerduct in underground installations, as many as three fiber optic cables can be placed in a 4-inch (102 mm) duct versus one copper cable. Innerduct is a flexible plastic conduit that can be placed inside existing rigid ducts in underground conduit structures. The use of innerduct provides protection for the cable as well as more efficient use of the ducts available. It can also be used in buried applications to provide additional sheath protection for fiber optic cable.

Manhole congestion: The size, weight, and lack of flexibility of copper cables and their associated large splice cases may cause manholes to become congested. Manhole congestion affects splicing configurations, blocks access to spare ducts, and prohibits the placement of carrier cases used in conditioning additional copper facilities serving digital loop carrier equipment. Manhole congestion can cause conduit structures to be reinforced even though there may be spare ducts available. Because fiber optic cable is small in size and lightweight, it can be pulled for longer lengths, avoiding splicing in congested manholes.

As the fiber network continues to grow and the new growth as well as existing service is transferred to fiber-fed digital loop carrier systems, the large copper cables can be removed, thus providing more spare ducts and eliminating manhole congestion. It is possible, therefore, to indefinitely defer or eliminate underground structure reinforcement.

Aerial Construction

If the facilities are aerial, the condition of the pole line must be evaluated. Many telephone companies have guidelines that consider four basic pole positions for the placement of aerial telephone cables: two on the road side of the pole and two on the field side of the pole. A pole line may be too congested for the placement of another large copper cable, but it may be able to support a small, lightweight fiber optic cable.

Additionally, fiber optic cables do not require load coils and apparatus cases that contribute to congestion on pole line structures.

Buried Construction

The small size and light weight of fiber optic cables also offer advantages in buried applications. Fiber optic cables can be buried for longer distances without requiring splices, and they do not require apparatus cases or load coil cases. Buried dielectric sheathed cable can be used to eliminate potential problems with stray current or voltage.

Maintenance Conditions

When conditions warrant replacement of outside plant cables, either due to old telephone plant or due to deterioration of the plant causing excessive maintenance time, fiber optic cable should be considered. Many telephone companies keep records of the maintenance hours spent on cables to assist in determining when it is no longer economical to maintain a cable, but more practical to replace it. Although maintenance is not usually the sole reason for considering cable replacement with fiber optic cable, it is a contributing factor.

Company or Government Policy

To assist in implementing digital loop carrier systems in the subscriber loop network, many telephone companies established policies that favored the conditioning of copper cable pairs to serve digital loop carrier systems and prohibited placement of heavy gauge cables and loading. Thus, the only option for providing the facilities to areas requiring loading and heavy gauge cables was conditioned copper serving digital loop carrier equipment.

Some telephone companies have extended this philosophy into the implementation of the fiber network by prohibiting the conditioning of additional copper cables to serve digital loop carrier systems. Thus, growth occurring beyond 9,000 feet (2743 m) must be provided on fiber optic cable serving digital loop carrier equipment.

To further assist in fiber optic cable deployment, some telephone companies have implemented a policy of prioritizing CO areas based on ***potential*** for requiring high-bit rate services, such as customer requests for individual CEPT Level 1 (international) or DS1 (domestic) service. For information on the digital hierarchy, see Page 5-2 in Section 5, "TRANSMISSION." In CO areas where significant concentrations of business customers exist, or where there are universities and hospitals, these telephone companies have elected to build fiber optic cables in the major primary cable portions of the network so that the fiber is established on the route and ready for immediate extension to customers as requests are received. This "fiber ready" network can be an influencing factor for majo. businesses considering relocation to an area.

BIBLIOGRAPHY

These references are no longer sufficient methods and procedures for designing and administering primary and secondary systems. They are included here for reference only as a guide to the sectionalization process that was used in much of the existing domestic local exchange network.

AT&T	Title
901-350-200	Long Range Outside Plant Planning (LROPP) Overview
901-350-201	Development of the Long Range Outside Plant Plan (LROPP)
901-350-250	Detailed Distribution Area Planning (DDAP)
915-251-100	Serving Area Concept (SAC) Guidelines
915-251-200	Serving Area Concept (SAC) Primary Cable Design
915-251-300	Serving Area Concept (SAC) Distribution Area Design
915-251-301	Serving Area Concept (SAC) Conversion of Existing Plant to SAC
915-710-110	SLC® 96 Subscriber Loop Carrier System — Engineering and Implementation
915-710-111	Fiber SLC® 96 Carrier Systems

Section 4

Contents

Page

Section 4

PRESSURIZATION

APPLICATION

In general, pressurization is recommended for the following air-core cable plant:

- All underground cable
- Buried pulp and air-core fiber optic cable
- All buried air-core trunk/toll polyethylene-insulated conductor (PIC) cable
- Buried exchange or feeder cable, 400 pairs and larger
- Aerial pulp trunk/toll cable
- Aerial pulp cable, 200 pairs and larger, or carrying critical circuits.

The pressurization of aerial PIC cable is no longer recommended.

See AT&T 930-200-010 for specific recommendations as to the proper upkeep system to be employed.

RULES FOR JOINING PRESSURIZED AND NONPRESSURIZED CABLES

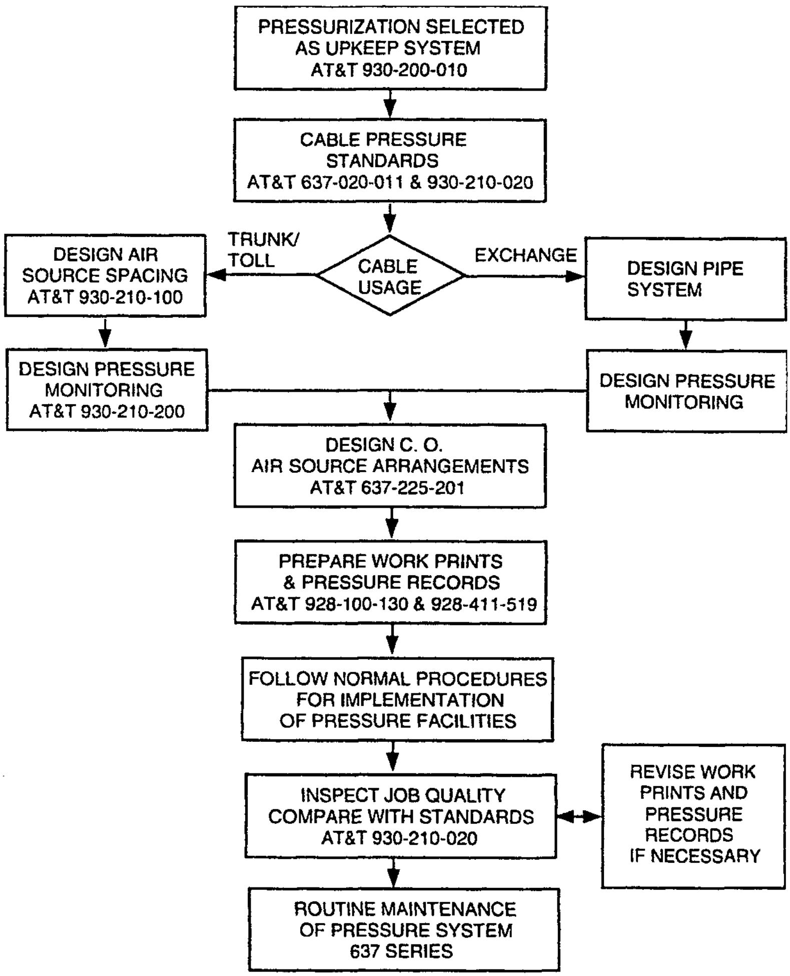
AT&T 632-410-200

1. If filled PIC is to be connected to pressurized cable, use a 10- or 12-type stub (see AT&T 631-020-101).
2. Where pressurized paper- or pulp-insulated conductor cable is to be extended with air-core PIC that is not to be pressurized, the PIC cable must be plugged close to the splice that will join them.

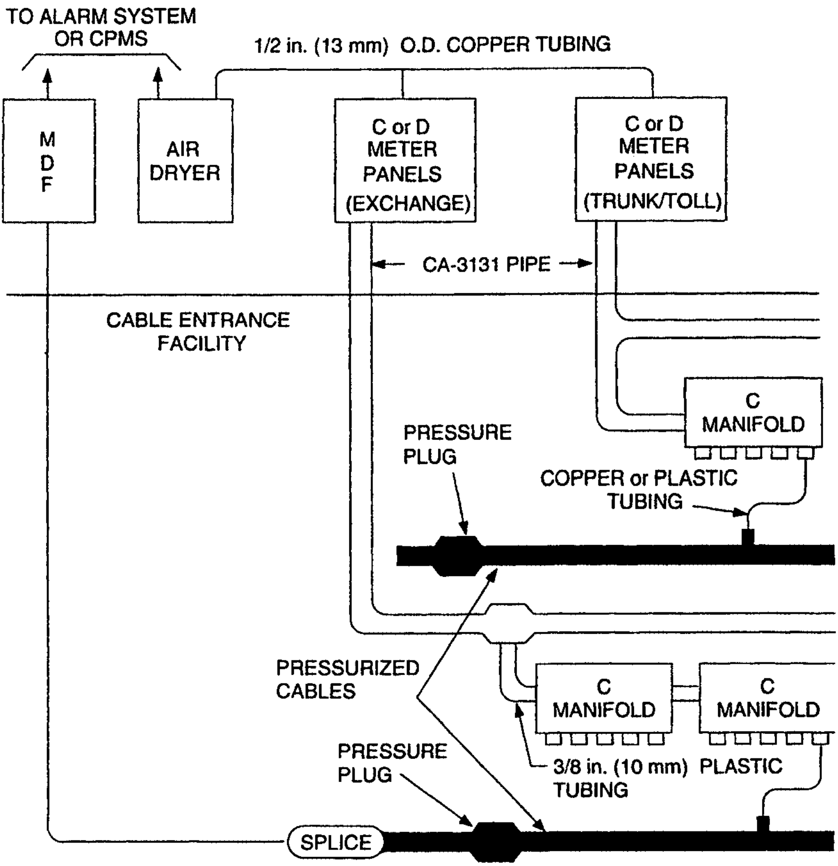
3. When air pressure is fed to pulp-insulated conductor cable through DUCTPIC® cable, moisture may collect in the pulp insulation at the PIC-pulp junction. PIC absorbs less moisture than pulp insulation. Air pressure flowing into the pulp cable may cause moisture in the pulp insulation. Therefore, when splicing DUCTPIC to pulp-insulated cable, a factory-prepared, 10-type stub should be used (see AT&T 631-020-101). If air-core PIC cable is spliced to pulp-insulated cable and circumstances dictate that the PIC cable must be pressurized, then block (plug) the air-core PIC cable near the splice and install a 3/8-inch (9.5 mm) bypass, with in-line check valve. This will prevent any moisture in the PIC cable from backing up into the pulp-insulated cable in case of a failure before the splice.

SYSTEM DESIGN

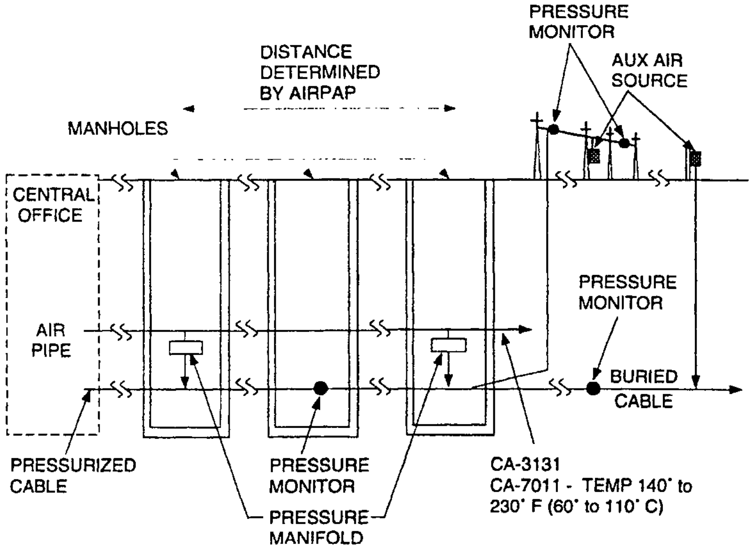
The chart on the next page outlines the major steps in designing a pressure system and gives references.


PRESSURIZATION SELECTED
AS UPKEEP SYSTEM
AT&T 930-200-010
CABLE PRESSURE
STANDARDS
AT&T 637-020-011 & 930-210-020
TRUNK/
TOLL
CABLE
USAGE
EXCHANGE
DESIGN AIR
SOURCE SPACING
AT&T 930-210-100
DESIGN PIPE
SYSTEM
DESIGN PRESSURE
MONITORING
AT&T 930-210-200
DESIGN PRESSURE
MONITORING
DESIGN C. O.
AIR SOURCE ARRANGEMENTS
AT&T 637-225-201
PREPARE WORK PRINTS
& PRESSURE RECORDS
AT&T 928-100-130 & 928-411-519
FOLLOW NORMAL PROCEDURES
FOR IMPLEMENTATION
OF PRESSURE FACILITIES
INSPECT JOB QUALITY
COMPARE WITH STANDARDS
AT&T 930-210-020
REVISE WORK
PRINTS AND
PRESSURE
RECORDS
IF NECESSARY
ROUTINE MAINTENANCE
OF PRESSURE SYSTEM
637 SERIES

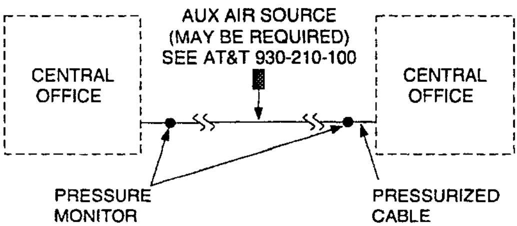
The central office portion of a typical pressure system is shown below. The outside plant portion is shown on the next page. For details not shown here, see AT&T 637-225-201.



The outside plant portions of typical exchange and trunk/toll pressure systems are shown below. For details not shown here, see AT&T 637-225-201.



EXCHANGE



TRUNK / TOLL
AT&T 930-210-200

DESIGN AND MAINTENANCE STANDARDS

Recommended standards are given below. A monitoring system is essential for maintaining these standards. The use of the Cable Pressure Monitoring System (CPMS) on a company or area basis should be considered.

RECOMMENDED STANDARDS					
Environment	Cable Type	Min. Pres (Psi)	Max. Avg. Leak Rate Level (Scfd/Mi)*	Notification Interval†	
				Transducer (Hrs.)	Contractor (Hrs.)
Underground	Exchange	5	20‡	24	24
	Trunk, Toll	5	5	3	2
Buried	Exchange	3	5‡	24	24
	Trunk, Toll	3	2	3	2
Aerial	Exchange	2	8‡	24	24
	Trunk, Toll	2	5	3	2

* Standard cubic feet per day per mile.

† The desired maximum time from alarm until maintenance personnel are notified.

‡ The leak rate is provided in AIRPAP, a computer program used to design an exchange pressure system.

GAS SOURCES

Commercial Air Dryers

Select commercial air dryers, using guidelines in AT&T 930-210-500.

Nitrogen Cylinders

AT&T 637-300-100

Nitrogen cylinders are listed below.

NITROGEN CYLINDERS				
Type		Dimensions		
	Capacity Cu ft* (Cu m)	Length Inches (mm)	Diameter Inches (mm)	Gross Weight Lb. (Kg)
B	24 (.68)	32 (813)	4.5 (114)	30.0 (13.6)
Commercial	112 (3.17)	44 (1118)	7.0 (178)	83.5 (37.9)
Commercial	224 (6.3)	52 (1321)	9.0 (229)	150.0 (68.0)
* At atmospheric pressure and 70° F (21° C).				

Liquid Nitrogen

Where a large capacity is required, see AT&T 637-300-102.

PRESSURE TRANSDUCERS AND CONTACTORS

The following is a list of transducers and contactors and their uses:

<table>
<tr><th colspan="6">PRESSURE TRANSDUCERS AND CONTACTORS</th></tr>
<tr><th>Device</th><th>Type of Cable</th><th>Location</th><th>Range or Setting (Psi)</th><th>Resistance (Megohms)</th><th>Reference</th></tr>
<tr><td>C Transducer</td><td>Aerial subscriber</td><td>At or near riser pole</td><td>0 to 8.0 in 0.5 steps</td><td>0.1 to 0.898</td><td>636-220-110</td></tr>
<tr><td>F, G, or H Transducer *</td><td>All underground</td><td>In manhole</td><td>0. to 9.5 in 0.5 steps</td><td>0.1 to 3.82</td><td>637-222-101</td></tr>
<tr><td>L Contactor</td><td rowspan="2">Aerial subscriber</td><td>On pole or wall near distribution terminal</td><td rowspan="2">Factory-set at 3. Adjustable from 1 to 10</td><td rowspan="2">Low = 0.27
High = 0.54</td><td rowspan="2">637-214-100</td></tr>
<tr><td>M Contactor</td><td>On cable</td></tr>
<tr><td>N Contactor †</td><td>All</td><td>In splice or apparatus</td><td rowspan="2">Factory-set at 6. Adjustable from 0 to 7</td><td rowspan="4">Low = 0
High = inf.</td><td>637-213-100</td></tr>
<tr><td>P Contactor †</td><td>All underground or buried</td><td>In manhole or cable closure</td><td>637-211-100</td></tr>
<tr><td>R Contactor</td><td colspan="2">In T1 app. case with WP case</td><td>20</td><td>637-213-110</td></tr>
<tr><td>W Contactor</td><td colspan="2">In T1 app. case</td><td>20</td><td>637-213-112</td></tr>
</table>

* G Transducer is F Transducer with mounting for single installation.
H Transducer is F Transducer with adapter plate for use with E Pressure Transducer System.

† Requires dedicated pair; all others bridged across working pairs.

BIBLIOGRAPHY

AT&T	Title
637-020-011	Cable Pressure Systems — Cable Pressurization Responsibilities and Standards
637-020-020	Cable Pressure Systems — Pneumatic Resistance of Cables
637-020-200	Cable Pressure Systems — Reinforcing Lead Sleeves
637-025-010	Cable Pressure Systems — Precautions
637-050-100	Cable Pressure Systems — Pipe Systems — General
637-050-200	Cable Pressure Systems — Pipe Systems Installation
637-050-300	Cable Pressure Systems — Upkeep
637-200-100	Cable Pressure Systems — 37-Type Cable Terminals — Description, Mounting, and Wiring Diagrams
637-210-100	Cable Pressure Systems — Superseded Contactors and Contactor-Terminals — Description
637-210-300	Cable Pressure Systems — Contactors and Contactor-Terminal — Replacement of Contactor Mechanism
637-211-100	P Pressure Contactor — Description and Installation
637-213-100	N Pressure Contactor — Description and Installation
637-213-110	R Pressure Contactor — Description and Use
637-214-100	L and M Pressure Contactors — Description and Installation
637-220-100	Cable Pressure Systems — C Pressure Transducer (AT-8311) — Description, Use, and Installation

AT&T	Title
637-222-101	F Underground Pressure Transducer System — Use, Description, and Installation
637-222-103	G Underground Pressure Transducer — Description and Installation
637-225-050	Cable Pressure Systems — Superseded Meter Panels
637-225-105	Cable Pressure Systems — Air Meter and Air Rate Indicators — Description and Arrangements
637-225-201	Cable Pressure Systems — C and D Meter Panels — Description, Use, and Installation
637-225-205	Cable Pressure Systems — Superseded KS-16648 Dual Pressure Kit — Description and Adjustments
637-225-215	Cable Pressure Monitoring System (CPMS) — B Airflow Transducer (AT-6720)
637-235-100	Cable Pressure Systems — Valves, Tubings, and Fittings — Description and Use
637-235-201	Flanges and Screw Plugs for Lead or Plastic Sheathed Cable — Description and Installation
637-241-011	Cable Pressure Systems — Pressure Plugs — General
637-300-100	Cable Pressure Systems — Nitrogen Gas Cylinders — Description and Use
637-300-102	Cable Pressure Systems — Liquid Nitrogen Cylinders — Description and Use
637-300-102	Addendum

AT&T	Title
637-301-300	Continuous Feed Pressure Systems — B and C Air Dryers — Maintenance and Replacement Parts
637-301-301	Continuous Feed Pressure Systems — D Air Dryer — Maintenance and Replacement Parts
637-302-801	E Air Dryer — AT-8670 — Maintenance and Replacement Parts
637-305-303	Cable Pressure System — Buffering
637-400-504	Cable Pressure Systems — Correction of Pressure Measurements
637-410-011	Cable Pressure Systems — Leak Location Procedures — General
637-410-011	Addendum
637-410-504	Cable Pressure Systems — Gradient Method of Approximate Leak Location
637-416-501	Cable Leak Location — Helium Method
637-450-011	Cable Pressure Systems — Construction Test — General
637-450-011	Addendum
637-500-014	Cable Pressure Systems — Continuous Feed — Maintenance Cable Pressurization Computer
637-500-015	Cable Pressure Systems — Continuous Feed — Maintenance Contactors and Contactor Terminals — General
637-500-502	Cable Pressure Systems — Continuous Feed — Maintenance — Fault Locating
920-400-050	Fiber Optic Cable — Installation Planning

AT&T	Title
928-100-130	Outside Plant Location Records — Cable Pressure System
928-411-519	Preparation of Work Prints — Cable Pressurization
930-200-010	Cable Upkeep System Selection
930-210-020	Cable Pressure Standards
930-210-100	Design of Air Sources — Trunk and Toll Cable
930-210-200	Design of Trunk and Toll Cable Monitoring
930-210-500	Guidelines of Selecting Air Dryers

Section 5

Contents

Section 5

TRANSMISSION

STANDARDS

Multiple standards evolved over time in the digital telephone hierarchy. The standard used in Europe is referred to as either CEPT for Conference of European Postal and Telecommunications Administration or CCITT for Consultative Commission on Telephone and Telegraph. North American telephone companies use what is referred to as the North American Standard originally established by AT&T.

Vendors have developed equipment to meet the transmission rates specified by each standard. However, equipment manufactured by different vendors cannot necessarily be mixed within a telecommunications network.

In 1985, Bell Communications Research, commonly referred to as Bellcore, proposed the development of the Synchronous Optical Network (SONET) standards to address compatibility problems. Consensus was achieved in early 1988 on key technical issues concerning standards. These standards address signal rates and formats, multiplexing schemes, network element functions, synchronous network operation, and single-mode optical interface.

Bellcore's efforts to develop SONET standards gained international attention, resulting in the jointly developed international SONET specification referred to as the Synchronous Digital Hierarchy or SDH.

The following table provides information on the rates used in the CEPT, North American, and SONET standards. SONET rates are expressed as Optical Carrier or OC. The rate for Optical Carrier-1, designated OC-1, is 51.840 megabits per second or 51.840 Mbps. The CEPT or CCITT rates are expressed as Levels, such as CEPT Level 1, 2, and so on, based on a single-circuit line rate of 0.064 Mbps. The North American Standard rates are referred to as Digital Signal (DS), such as DS1, DS2, and so on, also based on the single-circuit line rate of 0.064 Mbps. These rates are not integral multiples of lower rates because at each level, bits are added to facilitate multiplexing and other functions, such as signaling.

DIGITAL HIERARCHY CHART

SONET			CEPT or CCITT			North American		
Rate Name	**Line Rate (Mbps)**	**Voice Circuits**	**Rate Name**	**Line Rate (Mbps)**	**Voice Circuits**	**Rate Name**	**Line Rate (Mbps)**	**Voice Circuits**
			Single Circuit	0.064	1	DSO	0.064	1
						DS1	1.544	24
			Level 1	2.048	30			
						DS2	6.312	96
			Level 2	8.448	120			
			Level 3	34.304	480			
						DS3	44.736	672
OC-1	51.840	672						
						DS3C	90	1,344
			Level 4	139.264	1,920	DS4NA	139.264	1,920
OC-3	155.520	2,016						
						DS4	274	4,032
OC-9	466.560	6,048						
						None	560	8,064
			Level 5	565.148	7,680			
OC-12	622.080	8,064						
OC-18	933.120	12,096						
OC-24	1244.160	16,128						
OC-36	1866.240	24,192						
OC-48	2488.320	32,256						

RESISTANCE DESIGN

AT&T 901-350-202, 902-115-100, -101

Resistance design is predicated upon controlling transmission losses by limiting the maximum conductor loop resistance. This design is used with the traditional twisted-pair copper cable. The demand for high-speed transmission rates has changed the guidelines for designing outside plant. To meet these demands, the outside plant network is being conditioned by the use of digital subscriber carrier systems. These systems are being served via either a T1 or E1 carrier with repeaters or fiber optic cable.

Because of these factors and for planning purposes, it is recommended that the point where resistance design should stop and subscriber carrier or long-route design should begin is at 12,000 feet (3658 m) from the central office. Under this premise, resistance design rules are as follows:

1. Maximum conductor loop resistance of 1500 ohms without loop electronics (central office range permitting).
2. Load all loops over 18,000 feet (5486 m), which includes bridged tap.
3. Limit bridged tap on nonloaded loops to 6,000 feet (1829 m) or less.
4. Limit end section plus bridged tap on loaded loops to 12,000 feet (3658 m) or less. Business loop end sections are limited to 9,000 feet (2743 m) with no bridged tap.
5. Design load spacing deviations normally within ±120 feet (37 m).
6. No bridged tap between load points.
7. No loaded bridged taps.
8. No stations (Customer Services) are allowed between load points.

These rules are illustrated on the next page.

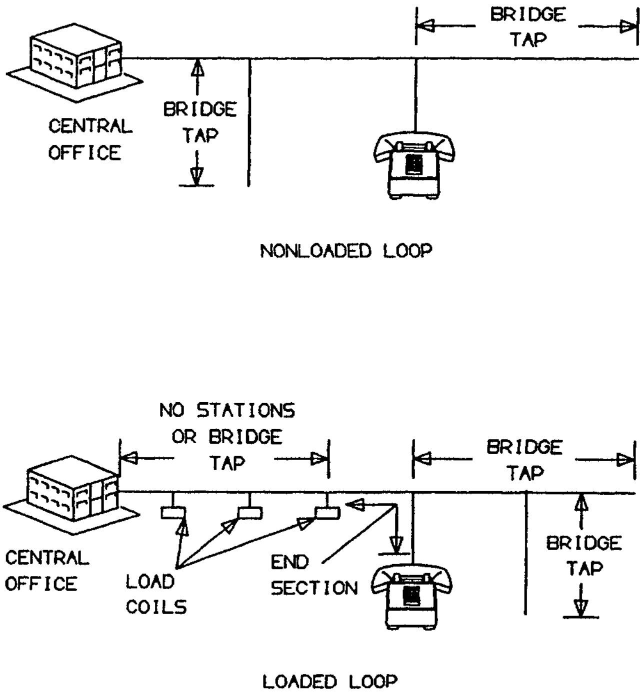


Illustration of Bridge Tap and End Section

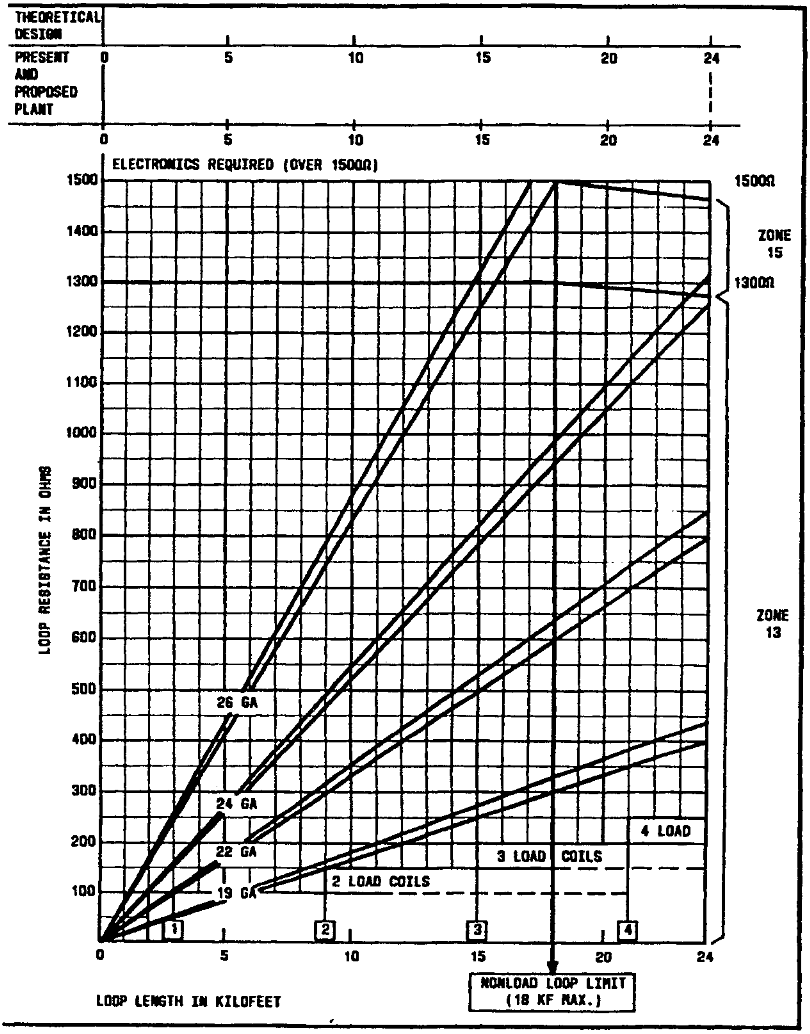
Loading Rules

Loading Rules

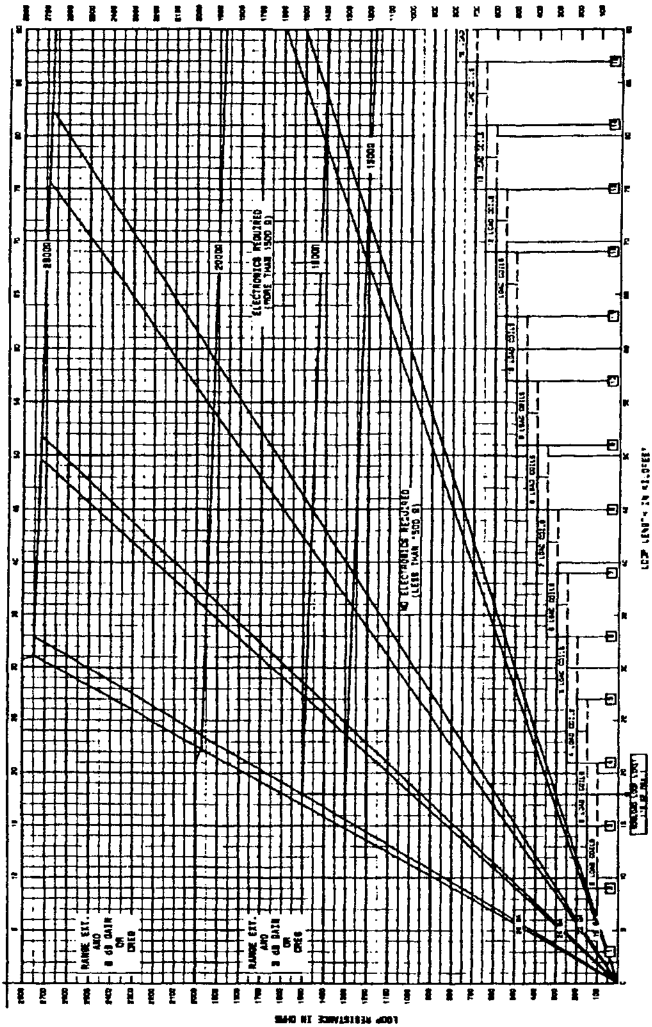
• Load coil inductance	88 mH
• Load spacing	6,000 ft (1829 m) nominal
• Load spacing deviation	±120 ft (37 m)
• Central office end section (including office wiring)	equivalent in capacitance to 3,000 ft (914 m) of cable
• Sum of customer end section and bridge tap (residential)	3,000 to 12,000 ft (914 to 3658 m)
• Sum of customer end section and bridge tap (business)	3,000 to 9,000 ft (914 to 2743 m)
• Loaded bridge tap	none permitted
• Bridge tap between load coils	none permitted
• Stations between load points	none permitted

Cable Gauge Selection

Cable gauge can be selected by using the resistance design charts on the next two pages.



Resistance Design Chart 0 - 24,000 ft (7,315 m)



Resistance Design Chart 0 - 90,000 ft.(27,432 m)

Loops up to 15,500 ft (4724 m) can be served by 26-gauge (0.4 mm) cable. Loops over that length require either a 2-gauge design or a single-coarser gauge. The most economical 2-gauge design may also be determined using the following values.

2-GAUGE DESIGN FORMULAS		
Loop Length = L ft. (m)	**Gauges Used ***	**Length of Coarser Gauge ft. [m]**
15,500 to 18,000 (4,724 to 5,486)	26 and 24 nonloaded	2.66 x (L – 15,600) 2.66 x (L – [4,755])
18,000 to 24,500 (5,486 to 7,468)	26 and 24 loaded	2.7 x (L – 15,400) 2.7 x (L – [4,694])
24,500 to 38,000 (7,468 to 11,582)	24 and 22 loaded	2.8 x (L – 24,500) 2.8 x (L – [7,468])
38,000 to 73,000 (11,582 to 22,250)	22 and 19 loaded	2.1 x (L – 38,000) 2.1 x (L – [11,582])
* Metric equivalent for wire gauges: 19 ga. = 0.9 mm, 22 ga. = 0.6 mm, 24 ga. = 0.5 mm, and 26 ga. = 0.4 mm.		

Example: A 20,000-foot loop requires a 2-gauge design of 24- and 26-gauge (0.5 and 0.4 mm) loaded cable consisting of (from the third line in the table above):

2.7 x (20,000 – 15,400) = 2.7 x 4,600 = 12,420 ft. of 24-gauge (0.5 mm) cable.

The remainder of the loop consists of:

20,000 – 12,420 = 7,580 ft. of 26-gauge (0.4 mm) cable

with the 26-gauge (0.4 mm) cable closer to the central office.

In an actual design, constraints such as existing cable or the location of possible gauge change points may require deviation from the above theoretical design. **If so, any deviation must increase the amount of coarser gauge cable used.**

COIN LINES

AT&T 332-211-100, 506-900-503

Transmission, coin control, and supervision and signaling requirements impose the following limits on coin lines.

Transmission

Loops over 1600 ohms require an E6 repeater.

Coin Control

- Maximum ground resistance: 50 ohms.
- Maximum DC earth potential: ±3 volts.
- Maximum loop resistance as follows:

Type of Central Office	Minimum Coin Voltage (Volts)	Maximum Loop Resistance (Ohms)			
		Multislot Sets With:		Single-Slot Sets With:	
		48-mA Relay	41-mA Relay	48-mA Relay	41-mA Relay
Step-by-Step and Panel	100	1500	2200	1400	1900
No. 1 Crossbar	115	2100	3000	2000	2700
No. 5 Crossbar and ESS™ Switching Equipment	125	2500	3400	2400	3100

Supervision and Signaling

Type of Central Office	Maximum Loop Resistance (Ohms)
Step-by-Step	1050
Panel	885
No. 1 Crossbar	1200
No. 5 Crossbar and ESS Switching Equipment	1300

TRANSMISSION IMPROVEMENT AND RANGE EXTENSION DEVICES

Standard devices for transmission improvement and range extension are listed below and on the following page.

PASSIVE TRANSMISSION ENHANCEMENT DEVICES		
Device	**Description**	**Reference**
Load Coil	Series inductance inserted in loop to counteract the effect of distributed capacitance and thereby to reduce transmission loss over the voice-frequency band	Section 16 of this handbook, AT&T 643-020-011, AT&T 643-200-101
Inductor (Bridge Lifter)	Saturable reactor inserted in loop at bridging point to minimize transmission loss caused by bridge tap	Section 16 of this handbook, AT&T 902-815-150, AT&T 902-815-151
4B11F Protector Unit-Type Bridge Lifter	Solid-state bridge lifter combined with 4B-type protector unit	AT&T 902-815-153, AT&T 201-200-050

ACTIVE GAIN DEVICES		
Device	**Description**	**Reference**
E6 Repeater	Two-wire adjustable-gain voice-frequency repeater for central office or remote installation	AT&T 332-206-120, AT&T 852-305-ZZZ

RINGER COUPLING DEVICES		
Device	**Description**	**AT&T Reference***
426A Gas Tube	Three-element gas tube used in station sets with grounded ringers to improve line balance and mitigate inductive interference	500-112-100
425A Gas Tube	Four-element gas tube used when the induced voltage exceeds the capability of the 462A gas tube	500-112-100
426N Diode	Used in place of 426A gas tube in PRINCESS® and TRIMLINE® telephones in 4-party, fully-selective and 8-party, semi-selective ringing service	500-112-100
D180489 Kit of Parts	Resistor-inductor circuit used to provide balanced path-to-ground for tip-party identification in severe noise environment	501-376-100
D180036 Ringer Isolator Kit	Solid-state circuit used in place of gas tubes when central office ringing voltage is not compatible with gas tubes	501-375-100
28A Isolator	Solid-state replacement for any of the above devices to provide increased ringing range and ringer isolation for all grounded ringers. Only one 28A is required per main station.	501-375-101
603A Ringing Extender	Solid-state device with switch that provides a low impedance path to ground during ringing. For use on long loop individual lines over 1300 ohms with bridged ringers that require increased ringer capability.	501-380-102

*See AT&T 500-114-100 for limitations on number of ringers and AT&T 873-505-109 for ringer isolation.

ELECTRICAL CHARACTERISTICS OF CABLES (METALLIC)

Loop Resistance

LOOP RESISTANCE	
Gauge and Material	**Loop Resistance (Ohms/kft at 68°F (20°C)***
16 ga. (1.3 mm) Copper	8.0
19 ga. (0.9 mm) Copper	16.3
22 ga. (0.6 mm) Copper	32.8
17 ga. (1.1 mm) Aluminum	16.5
20 ga. (0.8 mm) Aluminum	33.0
24 ga. (0.5 mm) Copper	51.9
25 ga. (0.45 mm) Copper	65.5
26 ga. (0.4 mm) Copper	83.3
* For resistance at a temperature (T) other than 68°F (20°C), use the following formula: $RT = R68^{\circ} + 0.0022\,(T - 68^{\circ})R68^{\circ}$	

Attenuation

AT&T 855-351-101, 902-216-110

The values listed on the next page are engineering losses for T1 carrier systems. T1 carrier is engineered on the basis of 772-kHz attenuation at the maximum anticipated temperature.

ATTENUATION OF CABLES					
Cable	C* (nF† / Mile)	772 kHz dB/kft 55°F (13°C)	100°F (38°C)	140°F (60°C)	k ‡
Pulp and Paper					
19 ADB	83	3.9	4.1	4.2	§
ANB,DNB,GNB,TB	66	3.0	3.1	3.2	0.025
BNB,CNB,ENB,FNB	84	3.8	3.9	4.0	0.028
22 ADA,BDA,CDA	83	5.2	5.4	5.5	§
ANA,NA	73	4.6	4.8	4.9	0.040
CSA,DSA,ESA	82	5.1	5.3	5.5	0.047
24 ADM,CDM	83	6.3	6.6	6.7	§
ASM,BSM,CSM,ESM	72	5.8	6.1	6.3	0.057
DSM,FSM	84	6.8	7.1	7.4	0.066
26 ADT,CDT	83	7.8	8.1	8.3	§
BST	79	7.7	8.1	8.5	0.093
AST,CST	69	6.8	7.15	7.5	0.081
DST	83	8.2	8.6	9.0	0.096
Air-Core PIC					
19 BHB,CHB	83	3.3	3.5	3.6	0.034
22 BHA,CHA,DHA,KHA	83	4.6	4.8	5.0	0.045
24 BKM,DKM	83	5.8	6.05	6.3	0.055
25 (MAT Cable Type)	64	5.1	5.3	5.6	0.055
26 BKT,DKT,DCT	83	7.3	7.6	7.9	0.068
Filled Solid PIC					
19 AJB	83	2.9	3.0	3.1	0.020
22 AJA,BJA,CJA,DHA	83	4.0	4.2	4.3	0.035
24 AJM,DKM	83	5.0	5.2	5.4	0.048
26 AJT,DKT	83	6.3	6.6	6.9	0.065
Filled DEPIC					
19 ALB	83	3.2	3.3	3.4	0.027
22 ALA	83	4.4	4.6	4.7	0.040
24 ALM	83	5.5	5.7	5.9	0.052
26 ALT	83	6.9	7.2	7.5	0.067
17 ALC	83	3.2	3.4	3.5	0.034
20 ALD	83	4.4	4.6	4.8	0.043

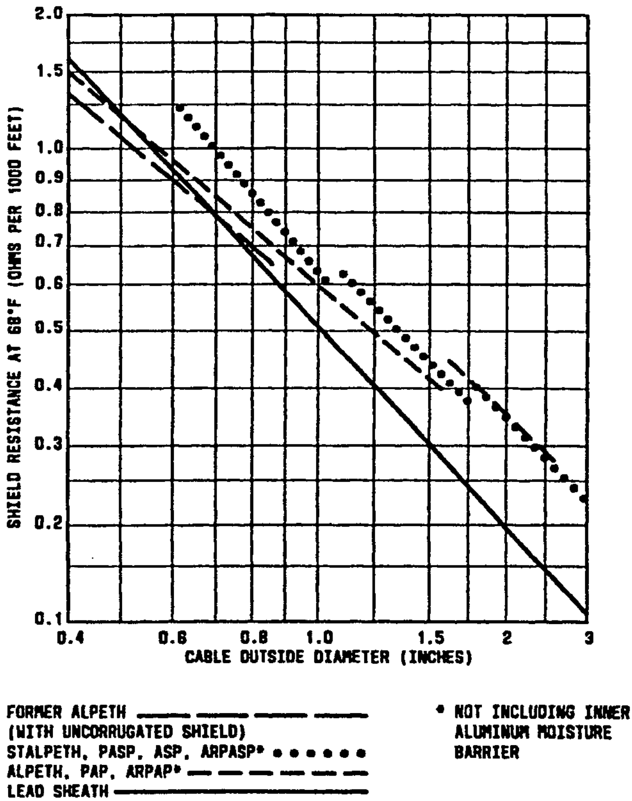
* C = capacitance
† nF = nanofarad
‡ K = temperature coefficient (dB/kft/10°F)
§ Temperature coefficient varies. Interpolate for temperatures not given.

Sheath and Shield Resistance

AT&T 626-020-00

The resistances of sheaths and steel and aluminum shields are show below for a temperature of 68°F (20°C). For any other temperature (T), use th formula:

$$R_T = R_{68}[1 + .0023\ (T-68)]$$

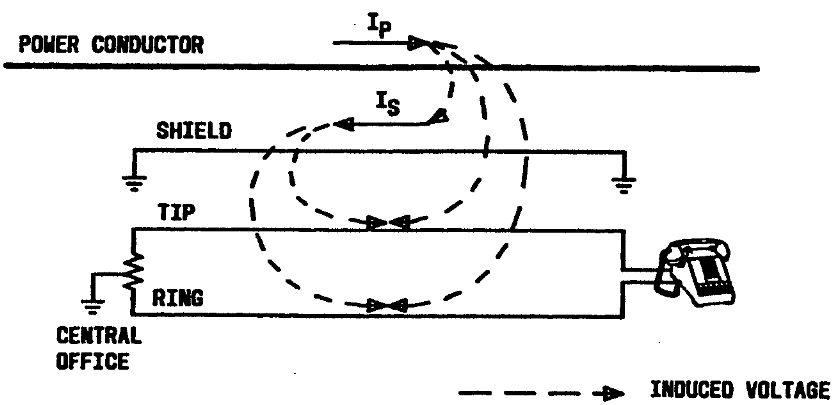


NOISE

Induction from power lines may cause noise in customer loops. External magnetic fields, such as those of nearby power conductors, induce voltages in telephone loops. The voltages induced on the tip and ring conductors are nearly equal; however, imbalances in central office equipment, the line facility, and the station equipment will result in a slight voltage difference between tip and ring. This voltage difference causes noise currents to flow in the loop, and transmission is impaired if the currents contain power-frequency harmonies.

Shielding

Shielding can reduce noise induction currents in telephone loops. The shield conductor is usually part of the cable sheath, but it can also be a separate wire parallel to the telephone conductor. Current I_p in the power conductor induces a voltage in the shield, which, in turn, causes a current I_s to flow in the direction opposite to the flow in the power conductor. These two currents induce opposing voltages in the telephone loop.



If the opposing voltages were equal, shielding would be perfect. In practice, shielding is most effective when the total resistance of the shield circuit (shield resistance and resistance to ground) is as small as possible. **It is important to ensure and maintain cable-sheath continuity and low resistance to ground.**

FIBER OPTIC DESIGN

Loss Calculation Worksheet

The following instructions describe how to fill out and use the "Loss Calculation Worksheet for Singlemode Fiber." A worksheet is shown after the instructions with the corresponding numbers. A blank loss calculation worksheet is provided on Page 5-22 for personal use.

(1) Enter the name of the Engineer.

SYSTEM DATA:

(2) Enter the location where the equipment originates. This is normally the Central Office; however, it can be a fiber hub or a regenerator site.

(3) Enter the location where the equipment terminates, normally the remote equipment carrier site.

(4) Enter the cable number.

(5) Enter the span length in kilometers. This is the distance between the originating location and the termination location.

(6) Enter the span length in miles. (Optional.)

(7) Enter the manufacturer's name of the multiplexer used.

(8) Enter the transmission rate (bit rate) of the multiplexer.

(9) Enter the wavelength of the multiplexer.

Loss Calculation

1. Enter the system gain. This information is available from the multiplexer manufacturer. The system gain is loss allocated to the fiber cable and splices. Some equipment manufacturers give a transmitter output level and a receiver sensitivity instead of a system gain. The system gain can be calculated by subtracting the receiver sensitivity from the transmitter output level.
2. Enter the system margin. The loss, typically 3 dB, is to allow for equipment degradation due to aging over the life of the system. Consult the manufacturer's specifications for this number.
3. Enter an engineering allowance if appropriate. This allowance may be for future technology such as Wave Division Multiplexing or other engineering considerations.
4. Enter the wavelength variation. This item adds an additional loss to compensate for variations in the laser's wavelength over the length of the fiber. To determine this loss, enter the fiber length in kilometers and multiply it by 0.1.
5. Enter the connector loss for the ST® type connectors. If ST connectors are used at the multiplexer and the fiber distribution shelf, enter the number of connections made and multiply them by 0.5. The number of connections is normally four, two at the Central Office and two at the remote carrier equipment enclosure. However, in a patch panel arrangement where fibers are extended to other locations, more connections will be made and must be accounted for.
    a. Enter the connector loss for the SC connectors. If SC connectors are used at the multiplexer and the fiber distribution shelf, enter the number of connections made and multiply them by 1. The number of connections is normally four, two at the Central Office and two at the remote carrier equipment enclosure. However, in a patch panel arrangement where fibers are extended to other locations, more connections will be made and must be accounted for.

6. Enter the loss for the planned splices. The planned splices are the total of all of the splices from the placing drawings. This includes the splices made at the fiber distribution shelf to join the fiber cable to the pigtail. Multiply the total planned splices by 0.2 (the average loss per splice) to calculate the total loss.
7. Enter the loss allocated for maintenance splices. The number of maintenance splices allocated is generally a local decision based on a history of maintenance problems. If no local policy exists, then one maintenance splice per kilometer can be used. To calculate the loss for maintenance splices, multiply the length of the fiber cable in kilometers by 1 (the number of splices per kilometer) by 0.2 (the loss per splice).
8. Enter the maximum fiber loss. The maximum fiber loss is the loss available for the fiber cable after the calculated loss for all other items has been subtracted from the system gain. Add Items 2 through 7 and subtract the answer from Item 1.
9. Enter the span length, in kilometers, from the cable placing prints.
10. Enter the maximum loss per span. This is the calculated loss in dB/km for the fiber cable derived by dividing the maximum fiber loss (Number 8) by the span length (Number 9). This answer, expressed in decibels per kilometer, is used to select the fiber cable with the proper loss. The cable loss must fall at or below this figure.
11. This calculation can be used to determine the remaining loss available after the fiber cable loss has been chosen. In the calculation, Number 8 is multiplied by 0.35. This number (0.35) represents the loss for the selected fiber cable. If another fiber cable loss is chosen, such as a 0.4, then this number should be changed to reflect the one selected.

Dispersion Calculation

12. Enter the source spectral line width, in root mean square (RMS), of the transmitter as stated by the multiplexer manufacturer for the specified wavelength.

13. Enter the chromatic dispersion of the fiber. This information is available from the fiber cable manufacturer and is expressed in picoseconds (ps) per nanometer (nm)—kilometer (km).

14. The end-to-end root mean square (RMS) pulse broadening is the total span length (Number 9) multiplied by the RMS source spectral line width (Number 12) multiplied by the chromatic dispersion of the fiber (Number 13) and the result divided by 1000.

15. Enter the maximum allowable RMS pulse broadening in nanoseconds (ns) as stated by the multiplexer manufacturer. This number must always be greater than the end-to-end RMS pulse broadening as calculated in Number 14 above.

SINGLE MODE CABLE

LOSS CALCULATION WORKSHEET

ENGINEER ____1____ DATE ________

SYSTEM DATA

Originating Location ____2____ Termination Location ____3____

Cable Number ____4____ Span Length: Kilometers ____5____ Miles ____6____

Equipment Type ____7____ Transmission Rate ____8____ Wave Length ____9____

LOSS CALCULATION

1. System Gain ________ dB
2. System Margin ________ dB
3. Engineering Allowance (5 to 7dB) ________ dB
4. Wavelength Variation (km) ____X 0.1 ________ dB
5. Connector Loss (ST) ____X 1.0 ________ dB
   (SC) ____X 1.0 ________ dB
6. Planned Splices (n) ____X 0.2 ________ dB
7. Repair Splices (km) ____X 0.2 ________ dB
8. Maximum Fiber Loss 1 - (2+3+4+5+6+7) ________ dB
9. Span Length ________ km
10. Maximum Loss Per Span 8 ÷ 9 ________ dB/km
11. To determine the loss available for additional splices at critical locations or patch panels substitute in the formula, assuming 0.35 dB/km cable

    8 ____ - [(8 ____ X 0.35) ÷ 10 ____] = ________ dB

DISPERSION CALCULATION (Systems operating above 500 Mb/s)

12. Source spectral line width (RMS) ________ nm
13. Chromatic Dispersion of fiber ________ ps/nm-km
14. End to End RMS pulse broadening

    ______(9) km X ______ (12) X ______ (13) ÷ 1000 = ____ ns
15. Maximum allowable RMS pulse broadening ________ ns

SINGLE MODE CABLE

LOSS CALCULATION WORKSHEET

ENGINEER ______________________________ DATE ____________

SYSTEM DATA

Originating Location ________________ Termination Location ________

Cable Number____________ Span Length: Kilometers _____ Miles _____

Equipment Type __________ Transmission Rate _____ Wave Length ___

LOSS CALCULATION

1.	System Gain		______ dB
2.	System Margin		______ dB
3.	Engineering Allowance (5 to 7dB)		______ dB
4.	Wavelength Variation	(km) ____X 0.1	______ dB
5.	Connector Loss	(ST) ____X 1.0	______ dB
		(SC) ____X 1.0	______ dB
6.	Planned Splices	(n) ____X 0.2	______ dB
7.	Repair Splices	(km) ____X 0.2	______ dB
8.	Maximum Fiber Loss	1 - (2+3+4+5+6+7)	______ dB
9.	Span Length		______ km
10.	Maximum Loss Per Span	8 ÷ 9	______ dB/km

11. To determine the loss available for additional splices at critical locations or patch panels substitute in the formula, assuming 0.35 dB/km cable

8____ - ((8____X 0.35) ÷ 10____) = ________ dB

DISPERSION CALCULATION (Systems operating above 500 Mb/s)

12. Source spectral line width (RMS) ______ nm

13. Chromatic Dispersion of fiber ______ ps/nm-km

14. End to End RMS pulse broadening

______(9) km X _____ (12) X _____ (13) ÷ 1000 = ______ ns

15. Maximum allowable RMS pulse broadening ______ ns

TRANSMISSION ON DIGITAL LOOP CARRIER (DLC) SYSTEMS

Transmission on Digital Loop Carrier (DLC) systems is covered in Section 13, "DIGITAL LOOP CARRIER SYSTEMS."

BIBLIOGRAPHY

AT&T	Title
332-206-100	E6 Repeater
332-210-102	8A Coin Range Extender
500-112-100	Reference — Inductive Noise
500-114-100	Ringing Limitations
501-320-100	Electron Tubes 425A and 426A
501-375-100	Ringer Isolator (D180036 Kit of Parts)
501-375-101	28A Ringer Isolator
501-376-100	D18049 Kit of Parts
501-380-102	603A Ringing Extender
506-900-503	Coin Telephone Maintenance Check
626-020-007	Resistance of Cable Shields and Sheaths
626-XXX-XXX	Cable, Description and Use
643-XXX-XXX	Load Coil Cases
801-405-152	E6 Telephone Repeaters
855-351-101	Transmission and Outside Plant Design Features — T1
855-355-101	T1 Digital Line Transmission and Outside Plant Design Procedures
873-800-178	Fundamental Frequency Electromagnetic Shielding
902-115-101	Application of Resistance Design

AT&T	Title
902-815-150	Bridge Lifters — Characteristics and Operation
902-815-151	Bridge Lifters — 1574-Type Inductors
902-815-153	4A11C Protector Unit Type — Mini-Bridge Lifter
915-710-110	SLC 96® Subscriber Loop Carrier System

Manual

201-200-050	Distributing Frame Systems Products Manual

Training

OE 1800	Basic Outside Plant Engineering
OE 1908	Outside Plant Fiber Optic Engineering

Refer to the following divisions for transmission topics not included in this handbook:

Division	Title
103	Transmission Test Equipment
300	Transmission Systems and Testing — Cross-Reference Lists
301	Transmission Performance Measurement Plans
302	Transmission Test Line Directories
304	Transmission Data

Division	Title
309	Switched Services Networks
310	Nonswitched Special Services Systems
311	Switched Special Services Systems
312	Private Line Data Systems and Services
314	Digital and Analog Data Transmission Systems
318	Television Systems
320	Program Transmission Systems and Services
330	Cable and Open-Wire Testing and Trouble Location Methods
331	Transmission and Noise Testing, Central Office PBX Customer Lines and Equipment
333	Overall Signaling Arrangements and Testing
354	Frequency Generating Systems
355	K Carrier
356	J, K, and L Multiplex Terminals
357	Wire Entrance Links and Broadband Entrance Links and Interconnection
358	L1 Carrier
359	L3 and L4 Carrier
360	Maintenance Center Tests — L Carrier
361	Service Center Tests — N, O, and ON Carrier
362	N, O, and ON Carrier and Associated Equipment Components
363	Subscriber Pair Gain Systems

Division	Title
365	Digital Transmission Systems
371	Broadband Restoration
851	Special Services
852	Exchange Area Transmission
853	Toll Transmission
854	Telephone Repeaters
855	Carrier Engineering
857	Program and Television Engineering
859	Signal Transmission
870	Noise Engineering
873	Inductive Coordination
874	Supply Systems Data
876	Protection Practices
877	Corrosion Practices
880	Data Communications Engineering
886	Digital Data Systems

Section 6

Contents

Page

Section 6

ELECTRICAL PROTECTION

GENERAL

Electrical protection refers to methods and devices used to control or mitigate potentials and currents of magnitudes that could possibly constitute a hazard to people, property, and telecommunications equipment. The source of these abnormal potentials and currents is extraneous to the telecommunications system and is frequently referred to as "foreign potentials." The purpose of electrical protection is twofold:

1. To minimize, as far as practical, electrical hazards to telecommunication system users and to protect those who are engaged in construction, operation, and maintenance of the system.
2. To reduce, as far as practical, electrical damage to aerial, buried, or underground equipment and plant, central office equipment, and to buildings or structures associated with such plant.

Where telecommunication system user and plant personnel are concerned, safety from shock hazard is the prime consideration when providing protection.

This section describes devices and methods that must be applied to control or mitigate foreign potentials. These are minimum measures that must be applied. There are situations where special protection is required as shown on Page 6-3.

In 1985, AT&T made available a single-volume reference book titled "TELECOMMUNICATION ELECTRICAL PROTECTION." This comprehensive resource emphasizes functional and practical application of electrical protection. It is available by contacting your AT&T Commercial Sales Representative or through the AT&T Customer Information Center (under select code 350-060).

Determining Exposure to Foreign Potentials

AT&T 918-216-100

Outside plant may be subject to the following sources of foreign potentials, either singly or in combination: lightning, power contacts, power induction, and ground potential rise. The terms exposed and unexposed are used to define the plant with respect to its vulnerability to these sources of current and voltage. Outside plant that is subject to electrical disturbances from any of these sources is exposed. Plant not subject to their effects is unexposed. A station or central office is exposed or unexposed according to the classification of the outside plant which serves it.

Exposure to Lightning

Lightning strokes are a very common source of hazardous foreign potentials. Plant is always classified as exposed to lightning except when located:

- In areas having 5 or fewer thunderstorm days per year and where the ground resistivity is less than 100 meter-ohms. Such areas are found only along the Pacific coast.
- In metropolitan areas where buildings are close and sufficiently high (relative to the telephone plant) to provide cone-of-protection shielding and where extensive underground metallic piping systems exist to dissipate large currents.

Power Contacts

Since power and telephone companies serve the same customers, their outside plant facilities are necessarily located close together. Aerial or buried plant that is subject to possible contact by power conductors operating at more than 300 volts (rms) to ground is considered to be exposed to power contacts. All primary power systems operate at more than this voltage, while most secondaries operate at lower voltages.

Power Induction

Disturbances from magnetic power induction can occur wherever telephone and power lines run parallel for long distances. Plant subject to power induction of more than 300 volts (rms) to ground is considered to be exposed. Although lower voltages may exist as a result of unbalanced power line operation, induced voltages exceeding 300 volts (rms) to ground are most likely to be caused by power line faults.

Ground Potential Rise

Plant subject to a ground potential rise of more than 300 volts (rms) to ground is considered to be exposed. The danger of a ground potential rise is greatest in the vicinity of a power generating station or a substation. Ground potential rises can develop between the power station ground and remote grounds from a fault anywhere in the power network, and the situation may persist until the fault is cleared. See box on this page.

Unexposed Plant

Where none of the above conditions for exposed plant exist, the plant is considered unexposed.

IMPORTANT
SPECIAL PROTECTION IN THE VICINITY OF POWER STATIONS

The plant serving power generating stations, substations, and switchyards requires special protection methods. The hostile electrical environment during power fault conditions often requires that special protection measures be applied at the power station, a remote drainage location, and the central office. In addition, special protection may be required to prevent damage to cables in close proximity to the power station. Unless the measures outlined in AT&T 876-310-100 are applied, service interruptions, plant damage, and personnel hazards may result. Non-dielectric fiber optic cables have the same problems that metallic cables have to dissipate foreign potentials.

Electrical Protection Devices

AT&T 201-200-050, 918-216-100

Electrical protection is accomplished by bonding, grounding, shielding, and other appropriate construction methods and also by the use of protection devices. The types of protection devices used are:

- Air gap discharge protectors
- Gas tube protectors
- Solid-state protectors
- Surge arresters
- Current-interrupting (fusing) devices
- Varistors (nonlinear resistors and semiconductor diodes)
- Isolating transformers
- Neutralizing transformers
- Mutual drainage reactors
- High-voltage repeaters.

CENTRAL OFFICE PROTECTION

AT&T 201-200-050, 918-216-100

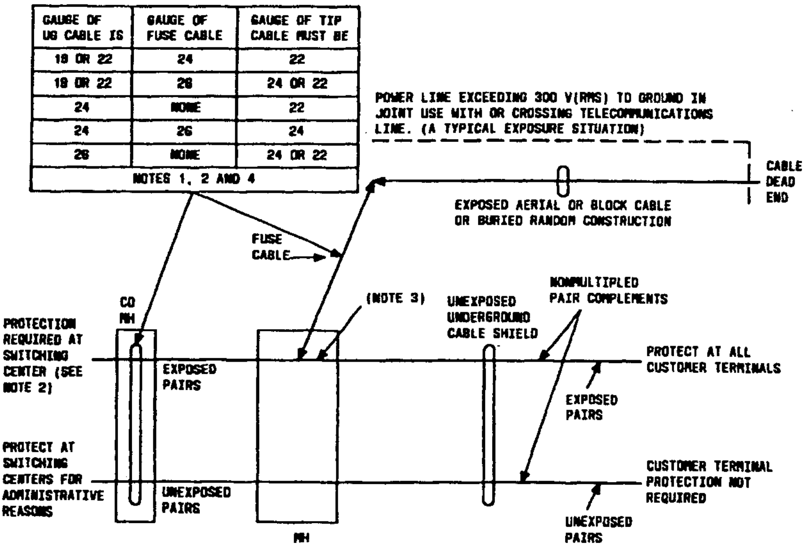
All exposed interoffice and subscriber cables require protection at the central office. It is advisable to also provide protective devices on unexposed subscriber cables, both for administrative reasons and possible rearrangements causing cables to be exposed.

Fuse Cables

AT&T 918-216-100

Fuse cables are recommended in some situations in the outside plant network. They are short sections of finer gauge cable than normally required for transmission purposes. In the event of prolonged current flows caused by foreign potentials (such as power contacts), the fuse cable will burn open, protecting terminating equipment or wiring from dangerous overheating. The application of fuse cables is shown on Page 6-6.

If a central office entrance cable that is exposed to power has 24- or 26-gauge copper conductors, no fuse cable is necessary provided that the conductors of the connector stubs (tip cable) are at least two gauges coarser than those of the entrance cable. Where the length of fine-gauge cable must be minimized for transmission reasons, a minimum of 2 feet (610 mm) of fine-gauge cable may be placed.



GAUGE OF UG CABLE IS	GAUGE OF FUSE CABLE	GAUGE OF TIP CABLE MUST BE
19 OR 22	24	22
19 OR 22	26	24 OR 22
24	NONE	22
24	26	24
26	NONE	24 OR 22
NOTES 1, 2 AND 4		

NOTES:

1. THE FUSE CABLE IN THIS CASE MAY SERVE 3 PURPOSES:
   (A) PROVIDES THE REQUIRED FUSE LINK FOR THE MAIN FRAME TERMINATING (TIP) CABLE.
   (B) ISOLATES EXPOSED AERIAL COMPLEMENT FROM UNEXPOSED UNDERGROUND COMPLEMENT.
   (C) PROVIDES REQUIRED FUSE LINK BETWEEN THE POWER EXPOSURE AND CUSTOMER TERMINALS SERVED FROM UNDERGROUND COMPLEMENT WHICH ARE MULTIPLED WITH EXPOSED PAIRS.
2. THE GAUGE OF THE SWITCHING CENTER TIP OR TERMINATING CABLE MUST BE AT LEAST TWO GAUGE SIZES LARGER THAN ANY FINE-GAUGE CONDUCTORS USED AS FUSE CABLE.
3. FOR LIGHTNING PROTECTION CONSIDERATION.
4. FUSE CABLE DOES NOT PROVIDE LIGHTNING PROTECTION.

Cables Containing Exposed and Unexposed Cable Pairs
Fuse Cable Application

Cable Terminating Apparatus

AT&T 636-3XX-XXX Series,

640-250-246, 916-559-770, 918-216-100

201-200-050

Connectors

AT&T offers a complete line of central office connectors for terminating and protecting outside plant cables. The connectors available include units with cross-connect terminal fields such as the 307D, 311, 310, 310M, 309, and 303 types and also connectors without cross-connect terminal fields such as the 307C, 308, 302, and 195 types. The connectors use the 3-, 4-, 5-, or 7-type protector units (ordered separately) to provide electrical protection. Some of these connectors may also be used for bulk protection at customer locations. The table on the next page lists the AT&T connectors and the frame types they fit.

CONNECTOR SELECTION GUIDE

Connector Type	*Cosmic®* Frames: II, IIA, Mini	Protector Frames: Modular	Protector Frames: Double-Sided Modular	Protector Frames: Low-Profile Double-Sided	Conventional Distributing Frames	Arranged for Protector Units Type
311					X	3, 4, 7
310, 310M					X	3, 4, 7
309				X	X	3, 4, 7
308		X*		X*		3, 4, 5, 7
307	X					3, 4, 7
305†					X	3, 4, 5, 7
303					X	3, 4, 5, 7
302		X	X	X		3, 4, 5, 7
UL‡ 310 310M, 311				X	X	3, 4, 5, 7
UL 307	X					3, 4, 5, 7
REA 310 310M, 311					X	3, 4, 5, 7
301†			X		X	None
300†			X		X	1A, 1B
444C†			X		X	None
C50/C52†			X		X	Equipped with coils and blocks

Note: The 195 protector is mounted on the extra-large building entrance terminal (XLBET) or also on walls and backboards.

* High density

† Discontinued Availability

‡ Registered trademark of UNDERWRITERS LABORATORIES, INC.

Most connectors (except 307-type) are equipped with a factory-terminated, CMR-rated, shielded, color-coded, 22- or 24-gauge (0.6- or 0.5 mm) stub cable. Stub cables are ordered separately for use with 3- and 7-type connectors. The gauge of the connector stub is determined by the gauge of the feeder or riser cable to be terminated. The connector stub should be at least two gauges larger (coarser) than the cable to be terminated; for example, a 24-gauge (0.5 mm) feeder to a 22-gauge (0.6 mm) stub. Stubless units for field terminations are also available. UL-listed connectors, 310L- and 311L-types, are equipped with 26-gauge (0.4 mm) stub cables.

STUB CABLE SELECTION GUIDE

Feeder or Riser Cable Gauge (mm)	Connector Stub Cable Gauge (mm)
26(0.4) Exposed or unexposed	22(0.6) or 24(0.5)
24(0.5) Exposed or unexposed	22(0.6)
22(0.6) Exposed	22*(0.6)
19(0.9) Exposed	22*(0.6)
22(0.6) Unexposed	22(0.6)
19(0.9) Unexposed	22(0.6)

* Provide a length of 24- or 26-gauge (0.5 mm or 0.4 mm) protective fusing cable.

The number of pairs that may be terminated per vertical using the various type connectors are shown below:

NUMBER OF PAIRS TERMINATED FOR VARIOUS FRAMES														
Frame Types		Termination Pairs Per	Frame Height	Connector Codes 300	301	302	303	305	307	308	309	310 310M	311	195
Modular distributing frames	***Cosmic***® II (DA)	Facility module	8'-2"						10,000					
	Cosmic IIA		8'-2"						10,200					
	Cosmic II mini	Facility bay	7'-0"						1,000					
Conventional distributing frames	Dbl-sided LPCDF (low-profile conv. distributing frame)	Vertical	8'-0"				400	800			800	800	800	
			8'-10"				500	1,000			900	1,000	900	
	Double-sided standard frames		9'-0"				500	1,000			800	1,000	800	
			11'-6"	300	600		600	1,200			1,000	1,200	1,000	
			12'-5"	300	600		600	1,200			1,000	1,200	1,000	
			14'-5"	400	800		800	1,200			1,200	1,200	1,200	
	SSLPDF (single-sided, low-profile distributing frame)		7'-0"				300	700			600	700	600	
			7'-6" *				400	800			700	800	700	
			7'-6" †				300	700			600	700	600	
			9'-0"				400	800			700	800	700	
			11'-6"				400	800			700	800	700	
Protector frames	Hi-density modular	12-vertical module	8'-0"							9,600				
	Modular	12-vertical module	8'-0"			6,000								
	LPDPF (low-profile, double-sided protector frame)	6 verticals	8'-0"			6,000				9,600	9,600			
	AT-9049	1 bay	6'-0"						900					
	SDA (slide drawer assembly	6 drawers	5'-4"								7,200			
	XLBET (extra-large bldg. entrance term.)	1 bay	7'-0"											3,600

* with 1 wireway
† with 2 wireways

The various types of connectors and their applications are covered in the 636 series of practices and also in AT&T 201-200-050, *Distributing Frame Systems Products Manual.* The types of connectors are so numerous it is impossible to cover all of them in this handbook. The 307-type is the most widely used connector and therefore will be expanded on here.

- The 307-type connectors are designed for use on the ***Cosmic*** II, ***Cosmic*** IIA, ***Cosmic*** II Mini-Distributing Frame Systems, and the wall-mounted AT-9049 or KA9049 protector frames. They are also used for ***SLC***® carrier system applications in 80- and 51A-type cabinets.
- Except for the 307C type, the 307 connectors consist of two components, the protector panel and connecting block, which are interconnected with a 100-pair wiring harness. This harness consists of 200 individual leads of 26-gauge (0.4 mm) wire or four 25-pair, 24-gauge (0.5 mm) twisted-pair cables.
- The 307-type connectors are available with standard 78-type blocks (4-beam terminals) and 112-type blocks equipped with either 3-beam terminals (bifurcated quick clips) or new wire-wrap terminals.
- The 307C-type connectors are intended for use as a protector panel only. They are not equipped with a connecting block. Codes available include the 307C1-100 used for T1 Carrier terminations, for which cross-connect capability is not required. Special 307C2-C7 connectors are used with ***SLC*** carrier systems.
- High density 307F- and 307H-type connectors can be used on ***Cosmic*** IIA frames to provide 10,200 protected pairs and 1,800 unprotected pairs per facility module. Ten 307F/H-type connectors can be installed on a shelf with space for two additional 112H-100 series connecting blocks. The 307H-type connectors can be used on ***Cosmic*** II frames with shelf adapters per ED-6C142-30, G3 and G4.
- The 307-type connectors have additional backplane wiring which interconnects the protector panel to four 710-SD-25 connectors. These connectors provide for rapid connection to 100-pair cable stubs (11C, 11D, or 11E type) equipped with mating 710-BD-25 connectors.
- The 307-type connectors use 3C-, 4C-, etc., type protector units equipped with access points.

The following table shows the frame/cabinet applications for the 307-type connectors.

307-TYPE CONNECTOR FRAME/CABINET APPLICATIONS					
Application Frame/Cabinet	**Shelf**	**Equipped With Connecting Block**	**Terminal Type (Note)**	**Connector Item Code**	**Comcode**
Cosmic II	2-10	78C1B-100	BQC	307A1-100*	103069985
Cosmic II	1 or 11	78C1B-50 78C2B-50	BQC	307B1-100*	103069993
Cosmic II, IIA	2-10	112C1B-100	BQC	307D1-100	103318309
Cosmic II, IIA	1 or 11	112C1B-50 112C2B-50	BQC	307E1-100	103318317
Cosmic II, IIA	2-10	112H1B-100	BQC	307F1-100†	104367768
Cosmic II, IIA	1 or 11	112H1B-50 112H2B-50	BQC	307G1-100†	104367776
Cosmic II, IIA	2-10	112C1BB-100	BWW	307D1B-100	104447818
Cosmic II, IIA	2-10	112C1BS-100	SWW	307D1S-100	104447826
Cosmic II, IIA	1 or 11	112C1BB-50 112C2BB-50	BWW	307E1B-100	104447834
Cosmic II, IIA	1 or 11	112C1BS-50 112C2BS-50	SWW	307E1S-100	104447842
Cosmic II, IIA, Mini Twisted Pair	2-10‡	112C1B-100	BQC	307D2-100	103554747
Cosmic II, IIA, Mini Twisted Pair	2-10‡	112C1BB-100	BWW	307D2B-100	105571699

307-TYPE CONNECTOR FRAME/CABINET APPLICATIONS (Contd)					
Application Frame/Cabinet	Shelf	Equipped With Connecting Block	Terminal Type (Note)	Connector Item Code	Comcode
Cosmic II, IIA, Mini Twisted Pair	2-10‡	112C1BS-100	SWW	307D2S-100	105571707
Cosmic II, IIA Twisted Pair	2-10	112H1BS-100	SWW	307H1S-100†	105571715
Cosmic II, IIA, Mini	—	None§	N/A	307C1-100¶	103334009
SLC 96 on AT-9049	—	None§	N/A	307C2-100¶	103835120
SLC 96 on AT9049	—	None E/W Pnl MTD 710 conn for OE and 25 ft (7.6 m), 24 AWG tip cable stub for OSP	N/A	307C2-100-A25	106391014
SLC 5—Used in 80-Type Cabinet	—	None§	N/A	307C3-100¶	104179858
		None§	N/A	307C4-100¶	104179866
		None§	N/A	307C5-100¶	104179874
SLC 5—Used in 51A-Type Cabinet	—	None§	N/A	307C6-100¶	104387667
		None§	N/A	307C7-100¶	104387675

Note: BQC = Bifurcated quick clip, SWW = Single wire wrap, BWW = Bifurcated wire wrap

* Limited Availability (LA).
† Requires shelf adapter for ***Cosmic*** II frames.
‡ Shelves 1-10 for ***Cosmic*** II mini frames.
§ This code is equipped with 25-pair 710-type connectors instead of a connecting block.
¶ Outside plant side is 22 gauge (0.6 mm) and equipment side is 26 gauge (0.4 mm).

Protector Units

AT&T 201-200-050

AT&T plug-in protector units are used with central office connectors and customer premises building entrance protectors to safeguard personnel, equipment, and the network from hazards such as electrical shock, equipment damage, and fire caused by lightning and AC power faults. Each protector unit provides protection for one tip-ring subscriber pair. The family of plug-in protector units is categorized by three types: voltage-only protection, voltage and sneak-current protection, and continuity-only.

For **overvoltage protection**, three protection technologies are available from AT&T:

1. Carbon blocks
2. Gas tubes
3. Solid-state electronics (new).

Note: Fiber optic cables serving ***SLC*** carrier systems do not require protector blocks or heat coils.

The protector types and their corresponding AT&T and Bellcore designation codes are shown below.

Protector Type Code	AT&T Designation Code	Bellcore Designation Code	Description
Voltage-only	3-Type	7A	Provides protection against abnormal voltage surges only.
Voltages and Sneak Current	4-Type	7C	Includes heat coils for sneak-current protection, and devices for over-voltage protection.
Continuity-only	5-Type	7AA8	"Dummy" protector units that provide continuity only; used only where protection is not required.

Coding Scheme

Protector units are coded using a sequence of characters that denote the voltage and/or sneak-current limiting type, the color and intended application of the unit, and the housing type (that is, with or without test access). The following diagrams show the coding scheme for 3-, 4-, and 5-type units and for 7-type units.

3 B 1 A

Denotes - Voltage Limiter Type

A	Carbon blocks
C	Carbon blocks
E	General purpose gas tubes
E-R	REA approved gas tubes
E-W	General purpose gas tubes (wide gap)
F	*5ESS* ® gas tubes
S	Balanced Solid-state
FS	*5ESS* ® Balanced Solid-state

Denotes - Color/Application

1 = Black	Standard Service
2 = Green	Denied Service
3 = Red	Special Service
4 = Yellow	PBX Battery
9 = White	Tip/Ring Reversal
11 = Orange	Minibridge Lifter
12 = Gray	Continuity Only

Denotes - Housing Type

A, B = Without test access
C = With test access

Denotes - Type

3-Type = Voltage protection only
4-Type = Voltage and sneak current
5-Type = Continuity only

Note: The end of the housing handle is typically stamped with symbols to further identify type/application information.

Coding Scheme for 3-, 4-, and 5-Type Protector Units

EXAMPLE:

7 A B 0 T

Denotes - Test Access

T = With test access
= No test access

Denotes - Color/Application

0 = Black	Standard Service (with protection)
1 = Brown	High-Exposure Customer Stations
2 = Red	Special Service
3 = Orange	Bridge Lifter
4 = Yellow	PBX Battery
5 = Green	Denied Service
8 = Gray	Standard Service (no protection)

Denotes - Balanced Voltage Limiting Capability

A = Not equiped with balanced voltage limiting capability.

B = Balanced voltage limiting capability for COs, Customer Stations (including High Exposure Customer Stations), and T1-carrier with regulated power supply.

Denotes - Type of Current Limiting Protection

A = Not equipped with any current limiter.

C = Equipped with non-resetting current limiter.

Denotes - Intended Service

7 = Basic protection for COs, most customer stations, and T1-carrier with or without regulated power supply.

Note: The end of the housing handle is typically stamped with symbols to further identify type/application information.

Coding Scheme for 7-Type Protector Units

Stamping and Symbols

The stamping and symbols embossed on the top of the protector housing handle specify certain characteristics of the protector unit. The protector unit tables show the stamping and test point holes for each protector unit. The symbol definitions are shown below:

None (Blank)	— Carbon blocks or no carbon blocks or gas tubes in the case of continuity-only units
⌇	— Resistor connected between tip and ring terminals
○	— General purpose gas tubes
Φ	— Gas tubes for ***5ESS*** switch
×	— Polarity (tip and ring) reversing circuit board
S	— General purpose solid-state devices
S⃒	— ***5ESS*** range balanced Solid-State Protector (SSP)
R	— Rural Electrification Administration (REA) approved gas tubes
S-75	— 75-volt balanced solid-state devices
Δ	— Grounding device
•	— Basic Telecommunications Line Protector Unit (TLPU), voltage protection only
c•	— Basic TLPU with non-resetting current limiter
• •	— These are test points; actually holes through the top of the 3C- and 4C-type protector housings that provide test access via a P2FL or W2HN test cord.

For many protector unit codes, a combination of the symbols is used. Protector codes with combination symbols are noted in the tables for the 3- and 4-type protector units.

3-Type and 7AB-Type Protector Units

The 3-type and 7AB-type plug-in protector units provide voltage protection only, using carbon blocks, gas tubes, or balanced solid-state devices for voltage limiting. If sneak-current protection is a concern, 4-type protector units with heat coils should be considered.

3-TYPE AND 7AB-TYPE PROTECTOR UNITS—VOLTAGE PROTECTION ONLY				
Carbon Block Protector Units				
Circuit Application	**Housing**		**Code (Note)**	**Product Comcode**
	Color	**Stamping**		
Standard	Black	None	3B1A	102381779
Service denied	Green		3B2A	102381787
Special	Red		3B3A	102381795
PBX battery	Yellow		3B4A	102381803
Check cable fault	Green	⌇	3B13A	103157228
Gas Tube Protector Units				
Standard	Black	O	3B1E*	
		R	3B1E-R	105499248
		O	3B1E-W	104410147
		• O •	3C1E	104030671
Service denied	Green	O	3B2E*	
			3B2E-W	104410154
Special	Red	O	3B3E*	
		R	3B3E-R	105499255
		O	3B3E-W	104410162
		• O •	3C3E	104411129
PBX battery	Yellow	O	3B4E*	
			3B4E-W	104410170
5ESS switch LNIs	White	Φ	3D1F*	
Non-Working OSP-BET Gnd Plug	Gray	⏚	3B1D†	106209224

Note:

3B-type protector units are compatible with AT&T 302-, 303-, 305-, 308-, 310-, 310M-, and 311-type central office connectors and 188-, 189-, 190-, and 195-type building entrance protectors.

3C-type protector units are intended primarily for AT&T 307- and 309-type central office connectors that do not have a separate test field. However, 3Cs may also be used with all AT&T 300-series connectors and building entrance protectors where test access through the protector unit is desirable.

* Discontinued Availability (DA) 7-1-88. The 3B-Es are replaced by 3B-E-Ws.

† The 3B1D is for grounding Outside Plant pairs only and does not provide continuity to building pairs or overvoltage protection.

3-TYPE AND 7AB-TYPE PROTECTOR UNITS—VOLTAGE PROTECTION ONLY (Contd)				
Solid-State Protector Units				
Circuit Application	Housing		Product Code	Comcode
	Color	Stamping		
Standard	Black	•S•	3C1S	105514756
Special	Red		3C3S	105695969
Bellcore - Standard	Black	●	7AB0	106945066
Bellcore - Standard (with test ports)*	Black	•●•	7AB0T*	106945074
Bellcore - Special	Red	●	7AB2	106945462
Bellcore - Special (with test ports)*	Red	•●•	7AB2T*	106945470
Bellcore - PBX Battery†	Yellow	●	7AB4	106945488
Bellcore - PBX Battery† (with test ports)*	Yellow	•●•	7AB4T*	106945496
Bellcore - Service Denied	Green	●	7AB5	106945504
Bellcore - Service Denied (with test ports)*	Green	•●•	7AB5T*	106945512

* Bellcore Specification TR-NWT-000974 does not discuss provision of circuit test access. This feature is incorporated into the indicated protector unit codes manufactured by AT&T. We have added a "T" to the product code to identify protector units with test access.

† Bellcore Specification TR-NWT-000974 does not address protector codes for PBX battery circuits, and yellow housing color is listed as "Not in Use" in Issue 1, dated August 1991. AT&T offers this product in response to customer interest, and a product code consistent with the Bellcore coding scheme has been deployed.

4-Type and 7CB-Type Protector Units

The 4- and 7CB-type plug-in protector units provide both overvoltage and sneak-current protection. Heat coils are used to protect against sneak current (abnormal overcurrent conditions too low to cause firing of the voltage-limiting devices). The 4-type protector unit options for overvoltage protection include protector units with carbon blocks, gas tubes, or balanced solid-state devices. The 7CB protectors incorporate balanced solid-state voltage limiting.

4B-TYPE PROTECTION UNITS—VOLTAGE AND SNEAK-CURRENT PROTECTION				
Carbon Block Protector Units				
Circuit Application	**Housing**		**Code (Note)**	**Product Comcode**
	Color	**Stamping**		
Standard	Black	None	4B1C	102904893
Service denied	Green		4B2C	102904901
PBX battery	Yellow		4B4C	102904927
Reverse ring & tip	White	X	4B9C*	DA*
Minibridge lifter	Orange	None	4B11C*	DA*
Continuity only	Gray		4B12C†	103626016
Gas Tube Protector Units				
Standard	Black	O	4B1E*	DA*
			4B1E-W	104401856
		Φ	4B1F	DA‡
Service denied	Green	O	4B2E*	DA*
			4B2E-W	104401864
		Φ	4B2F	DA‡
Special	Red	O	4B3E*	DA*
			4B3E-W	104401872
		Φ	4B3F	DA*
PBX battery	Yellow	O	4B4E*	DA*
			4B4E-W	104401880
		Φ	4B4F	DA‡
Reverse ring & tip	White	⊠	4B9E*	DA*
		⊠	4B9F	DA‡
Minibridge lifter	Orange	O	4B11E*	DA*
		Φ	4B11F	DA‡

Note: 4B-type protector units are compatible with AT&T 302-, 303-, 305-, 308-, 310-, 310M-, and 311-type central office connectors; and 188-, 189-, 190-, and 195-type building entrance protectors.

* Discontinued Availability (DA) 4B9C and 4B9E are replaced by 4B9F; 4B11C and 4B11E are replaced by 4B11F; and 4B-Es are replaced by 4B-E-Ws.

† 4B12C is used for continuity only and does not have carbon blocks or gas tubes for protection.

‡ DA product codes replaced by 4C-F series listed in the tables on the next two pages.

4C-TYPE PROTECTION UNITS—VOLTAGE AND SNEAK-CURRENT PROTECTION				
Carbon Block Protector Units				
Circuit Application	Housing		Code (Note)	Product Comcode
	Color	Stamping		
Standard	Black	• •	4C1C	103051470
Service denied	Green		4C2C	103051488
Special	Red	None	4C3C	103051496
	Red	• •	4C3C-2	104152152
PBX battery	Yellow		4C4C	103051504
Reverse ring & tip	White	X	4C9C*	DA
Minibridge lifter	Orange	• •	4C11C*	DA
Continuity only	Gray		4C12C†	103290755

Note: 4C-type protector units are intended primarily for AT&T 307- and 309-type central office connectors that do not have a separate test field. However, 4Cs may also be used with all AT&T 300-series connectors and building entrance protectors where test access through the protector unit is desirable.

* Discontinued Availability (DA) 4C9C and 4C9E are replaced by 4C9F; 4C11C and 4C11E are replaced by 4C11F; and 4C-Es are replaced by 4C-E-Ws.

† 4C12C is used for continuity only and does not have carbon blocks or gas tubes for protection.

4C-TYPE PROTECTION UNITS—VOLTAGE AND SNEAK-CURRENT PROTECTION (Contd)				
Gas Tube Protector Units				
Circuit Application	Housing		Code (Note)	Product Comcode
	Color	Stamping		
Standard	Black	•O•	4C1E*	DA
			4C1E-W	104401898
		•Φ•	4C1F	106622707
Service Denied	Green	•O•	4C2E*	DA
			4C2E-W	104401906
		•Φ•	4C2F	106622830
Special	Red	O	4C3E*	DA
			4C3E-W	104401914
		Φ	4C3F	106622913
		•O•	4C3E-2	104271093
		•Φ•	4C3F-2	DA
PBX battery	Yellow	•O•	4C4E*	DA
			4C4E-W	104401930
		•Φ•	4C4F	106622947
Reverse ring & tip	White	•⊗	4C9E*	DA
		•⊗•	4C9F	106622970
Minibridge lifter	Orange	•O•	4C11E*	DA
		•Φ•	4C11F	106622996

Note: 4C-type protector units are intended primarily for AT&T 307- and 309-type central office connectors that do not have a separate test field. However, 4Cs may also be used with all AT&T 300-series connectors and building entrance protectors where test access through the protector unit is desirable.

* Discontinued Availability (DA) 4C9C and 4C9E are replaced by 4C9F; 4C11C and 4C11E are replaced by 4C11F; and 4C-Es are replaced by 4C-E-Ws.

† 4C12C is used for continuity only and does not have carbon blocks or gas tubes for protection.

4C-TYPE PROTECTION UNITS—VOLTAGE AND SNEAK-CURRENT PROTECTION (Contd)				
Solid-State Protector Units				
Circuit Application	Housing		Product Code	Comcode
	Color	Stamping		
AT&T Standard	Black	• S •	4C1S	104386545
AT&T Special	Red		4C3S	105605596
AT&T - ***5ESS*** switch - Standard	Black	• $ •	4C1FS	105605620
AT&T - ***5ESS*** switch - Special	Red	• $ •	4C3FS	105605646
AT&T - Low Voltage - Special	Red	• S-75 •	4C3S-75	105581086
Bellcore - Standard	Black	C●	7CBO	106945520
Bellcore - Standard (with test ports)*	Black	• C● •	7CBOT	106945538
Bellcore - Special	Red	C●	7CB2	106945546
Bellcore - Special (with test ports)*	Red	• C● •	7CB2T	106945553
Bellcore - PBX Battery†	Yellow	C●	7CB4	106945561
Bellcore - PBX Battery† (with test ports)*	Yellow	• C● •	7CB4T	106945579
Bellcore - Service Denied	Green	C●	7CB5	106945587
Bellcore - Service Denied (with test ports)*	Green	• C● •	7CB5T	106945595

* Bellcore Specification TR-NWT-000974 does not discuss provision of circuit test access. This feature is incorporated into the indicated protector unit codes manufactured by AT&T. We have added a "T" to the product code to identify protector units with test access.

† Bellcore Specification TR-NWT-000974 does not address protector codes for PBX battery circuits, and yellow housing color is listed as "Not in Use" in Issue 1, dated August 1991. AT&T offers this product in response to customer interest, and a product code consistent with the Bellcore coding scheme has been deployed.

5-Type Units

The 5-type protector units provide no electrical protection and contain no carbon blocks, gas tubes, or heat coils. They are used to maintain circuit continuity between outside plant and central office equipment.

- The 5A2D protector unit, used to deny service, does not provide continuity to the central office equipment.
- The 5A9D protector unit contains a polarity-reversing circuit board. Tip and ring out is reversed from tip and ring in.
- The 5AGND protector unit is a grounding device used to ground unused feeder pairs for customer premises applications.

5-TYPE PROTECTOR UNITS—CONTINUITY ONLY—NO PROTECTION					
Circuit Application	Connector Application	Housing		Product Code	Comcode
		Color	Stamping		
Standard	302, 303, 305, & 308	Gray	None	5A1D	100828268
Service denied		Green		5A2D	100828276
Special		Red		5A3D	100828284
PBX battery		Yellow		5A4D	100828292
Reverse ring & tip		White	X	5A9D	102234481
Grounding tip & ring	188, 189, 190, & 195 building entrance protectors	Gray	Δ	5AGND*	

* Discontinued Availability (DA) 11-1-93. The 3B1D listed on Page 6-19 provides this function.

Bonding and Grounding

AT&T 627-020-005, 631-400-102, 633-010-208

The purpose of bonding and grounding in a communication system is to:

1. Reduce the hazard of electrical shock from AC and DC voltages and from lightning surges.
2. Mitigate the destructive effects of lightning and power surge voltages and currents in communication facilities.
3. Facilitate the rapid de-energization of power lines that contact communication plant, thereby reducing shock hazard to personnel and the general public as well as reducing damage to telephone facilities.
4. Provide paths to ground for longitudinal shield currents in metallic cable shields, thereby reducing voltages induced in cable conduc- tors.
5. Reduce noise voltages in sensitive circuitry by providing an effective common reference point for circuit potentials to which extraneously induced currents can drain without disturbing circuit operation.
6. Minimize damage to structures when they are struck by lightning.

Bonding between telephone and power grounds

Note: For more information, see Section H, Article 250, of the National Electrical Code (NEC).*

- Telephone and power ground electrodes that consist of driven rods or pipes should be bonded together.
- Telephone and power grounds connected to the same metallic water piping system close enough to assure continuity need no additional bonding.
- A bond between power and telephone plant should be less than 20 feet (6.1 m) in length.

* Registered trademark of National Fire Protection Association, Inc.

Bonding and grounding of cables

- In a noncorrosion (low-risk) area, bond together the sheaths or shields of all outside plant cables with No. 6 copper wire or bonding ribbon and tie to the central office ground with No. 0 copper wire.
- In a corrosion (high-risk) area:
  - — Install insulating joints on all cables as outlined in Section 7, "CABLE ENTRANCE FACILITIES."
  - — Bridge insulating joints on exposed cables (and on unexposed cables if required because of noise conditions) with KS-14595 capacitors.
  - — Bond together the outside plant sides of shields or sheaths and isolate from the central office ground.
  - — Bond together the central office sides of shields or sheaths with No. 6 copper wire or bonding ribbon and tie to the central office ground with No. 0 copper wire.

Bonding and Grounding — Special Situations

Central office located near power right-of-way

- Inductive exposure should be evaluated for both normal and power fault conditions, as outlined in Practice Division 873.
- Cable should be underground or buried beyond range of possible contact with a broken phase wire.
- Administrative procedures should be established to ensure maintenance of shield continuity and grounds.

Central offices located near, or serving, a power station
See box on Page 6-3.

Central offices combined with radio stations
See AT&T 876-210-100 for special protective measures required.

CABLE PROTECTION

Aerial, buried, and underground cable should be recognized as being exposed and requiring consideration for protective measures when subject to the following:

a. Disturbances from lightning

b. Contact with power conductors operating at more than 300 volts (rms) to ground

c. Rise in ground potential exceeding 300 volts (rms)

d. 60-Hz induction exceeding 300 volts (rms).

Protection considerations for a specific cable installation should include all the exposures encountered, whatever the source, and the protective measures should be coordinated to mitigate these exposures.

The engineer must specify the exposures and required protective measures on all work prints.

Aerial Plant Bonding Requirements for Exposed Aerial Plant (Copper Conductor Cable)

AT&T 918-216-100

- Establish and maintain shield continuity in the cable, in terminals, and in splices.
- Bond the strands of separate cables or wires together:
  - Every 1/4 mile (0.40 Km) accomplished automatically if both strands are mounted on the same through-bolt
  - At each crossover
  - At each branch.

- If copper conductor cable is exposed to lightning, bond the cable shield at all splice locations and all access points, but do not exceed 1-1/4 miles (2.01 km) between bonds. Where additional bonds are required between these points, install splice cases.

Aerial Plant Bonding Requirements — Joint Crossing Pole

- Bond copper conductor cable shield and strand to multi-grounded neutral (MGN) vertical grounding conductor if one exists; if not, use a driven ground rod or a noninsulated guy.

  Note: For more information, see Section H, Article 250, of the National Electrical Code (NEC).

- Install 118A protectors on C rural wire if power is MGN and exceeds 2.9 kV to ground.

Aerial-Underground Junctions

If an aerial cable exposed to lightning is connected to a single underground cable which extends for 1000 feet (304.8 m) or more before paralleling other cables, ground the shield of the aerial cable at the last pole. Bond the shield and supporting strand to an MGN vertical ground lead, if one exists. Otherwise, use a grounded guy or a driven ground rod.

Aerial Plant - Joint Use Copper Conductor Cable

AT&T 627-020-005

Protection recommendations for aerial plant that is in joint use with multigrounded neutral power are given in the table on the next page for cable and on Page 6-35 for wire. Joint use with delta or unigrounded systems operating at more than 2.9 kV to ground is not recommended.

PROTECTION RECOMMENDATIONS FOR AERIAL CABLE PLANT IN JOINT USE WITH MGN POWER				
Minimum Recommendation	Power Voltage to Ground (kV)			
	0.3 - 2.9	2.9 - 11.6	11.6 - 34.6	34.6 - 86.6
Bonding interval (strand to MGN)	Both ends of section and at 1/4 mile intervals			Every pole
Ampacity (I^2t) of strand must be verified*	No	Yes	Yes	Yes
118 protectors or 10-mil blocks required on wire branches to pulp cable	No	Yes	Yes	Wire branches not permitted
Strand must be bonded to MGN at every terminal	No	No	Yes†	Yes
Bonding between protector and power ground must be verified	No	No	Yes	Yes
Metallic shield construction required on branches (no wire)	No	No	No	Yes
Lower voltage power conductors required between cable and power	No	No	No	Yes

* The fault current and time must not exceed the values given below. "I" is the total current delivered from the power system. Where maximum I^2t values cannot be met, bonds must be placed at every terminal.

Strand size:	6M	6.6M	10M	16M
I^2t (kiloamps^2 x seconds)	32	8	48	64

† May be omitted if there is a bond at an adjacent pole.

Bonding Requirements for Aerial Fiber Optic Cable

AT&T 920-400-300

Because the sag of an aerial fiber optic cable is small, the strand to support the cable should occupy the uppermost communication space on a pole. Construction of these cables on jointly used poles creates a problem of mid-span vertical clearance from the power wires. Therefore, placing fiber optic cables on jointly used poles is not recommended unless proper clearances can be maintained.

Steel reinforcing wires and any metallic sheath components of fiber optic cables must be bonded and grounded. In addition, the continuity of these components should be maintained throughout the cable run. **All metallic components of the cable must be bonded to the strand at all splice locations and all access points, but do not exceed 3 miles (4.8 km) between bonds. The metallic strand must be grounded every 1/4 mile (0.40 km).**

Buried Plant Bonding Requirements

AT&T 918-216-100

Less Than 3-Foot (914 mm) Separation From Power. Bond telephone cable shield to power neutral wire or power apparatus at the following locations:

- At the telephone terminal nearest to each transformer. Bond either to the transformer itself or to the primary neutral, secondary neutral, or secondary pedestal served from the transformer.
- At least every other terminal, including pedestal-type cable closures and buried closures supplying service wires or cables. The bond shall not be omitted on any two adjacent terminals.
- At all aboveground telephone terminals, apparatus cases, and cable closures which are located within 10 feet (3.05 m) of any aboveground power apparatus. Such bonds shall be made directly to the aboveground power apparatus.

- Not more than 1000 feet (304.8 m) apart (no point on the telephone cable shall be more than 500 feet [152.4 m] from a bond).

More Than 3-Foot (914 mm) Separation From Power. Bond all aboveground telephone terminals, apparatus cases, or cable closures to aboveground power apparatus located within 10 feet (3.05 m).

In Same Right-of-Way With Aerial Power. Where the overhead power is less than 34.6 kV to ground (60 kV phase-to-phase), bond the cable shield to the MGN at or near both ends of the exposure and at least once every mile (1.61 km). Bond aboveground telephone apparatus cases and terminals to any MGN down-leads that are located within 10 feet (3.05 m) of them. Where the overhead power is greater than 34.6 kV to ground, the telephone plant may not be capable of safely carrying fault currents and an engineering evaluation should be made to determine whether bonding or isolation is preferable.

Types of Sheaths Required for High Lightning Areas

Aerial

AT&T 918-216-100, 940-400-200

Polyethylene-Insulated Conductor (PIC) Cable: PAP or PASP sheath is recommended. Bond cable shield and strand at 1/4-mile (0.40 km) intervals. Use cable protectors in terminals at aerial drop or wire branches where specified by the protection engineer.

Pulp Cable: PASP sheath is recommended. Bond cable shield and strand at 1/4-mile (0.40 km) intervals. Use cable protectors in terminals at aerial drop or wire branches.

Fiber Optic Cable: Rodent/lightning sheath is recommended. When fiber optic cable contains conductive elements such as steel reinforcing wires, metallic shield, or tape armor, it is necessary to bond to the strand at all splice locations and all access points, but do not exceed 3 miles (4.8 km) between bonds. Ground at Line Repeater Stations (LRS) and remote terminal locations.

Buried

AT&T 918-216-100, 940-400-200

PIC Cable: PAP or PASP sheath is recommended. Bond cable shield at all splice locations and access points, not to exceed 1-1/4 miles (2.01 km). Use cable protectors at wire branches where specified by the protection engineer.

Fiber Optic Cable: Rodent/lightning sheath is recommended. When fiber optic cable contains conductive elements such as steel reinforcing wires, metallic shield, or tape armor, it is necessary to ground these conductive elements. Grounding requirements differ depending upon the type of fiber optic plant under consideration. For long-haul fiber trunk plant, metallic members shall be grounded at repeater locations. A path to ground shall be provided at access points (for example, splices) either by direct connection, protective device, or passive circuit. For distribution plant, where there is more maintenance activity, metallic members shall be grounded at splice points, but do not exceed 3 miles (4.8 km) between grounds.

In extremely high lightning areas, buried non-dielectric fiber optic cables may require grounding points at 1-1/4 mile (2.01 km) intervals.

Underground

AT&T 918-216-100, 920-400-100

Bond together apparatus cases and cable sheaths or shields, and connect to manhole bonding ribbon. Plastic sheath cables need not be bonded at pull-through manholes.

Some fiber optic cables have metallic strength members (steel wires) and/or metallic tape armor incorporated into them. **Due to the presence of these conductive members, it is necessary to bond at the manhole splices and ground at the Controlled Environment Vaults (CEV) and line repeater stations to maintain electrical continuity between the metallic members throughout the length of the fiber optic cable span.**

AERIAL WIRE PROTECTION

PROTECTION RECOMMENDATIONS FOR AERIAL WIRE PLANT IN JOINT USE WITH MGN POWER
Documents 876, Division 918-216-100

Wire Type	Power Voltage to Ground (kV)		
	0.3 — 2.9	2.9 — 11.6	11.6 — 34.6*
C Rural†§	No protection required	Protectors required at: Both ends of section‡ Each drop or at least 1.2-mile intervals	Protectors required at: Both ends of section‡ and each drop Bonding between station protector and power ground must be verified

* Joint use with MGN power exceeding 34.6 kV is not recommended.

† Where protector is required, use 118-type protectors and connect ground wire to MGN vertical ground lead.

‡ Only one end if five spans or less.

§ Block wire fuse is required on all station drops connected in fuseless protectors.

Rural Wire: If the station served is highly exposed, use protectors with 6-mil gaps at aerial drop or rural wire junctions.

STATION PROTECTION

Fusing Requirements

AT&T 918-216-100

A fusible link is required in each conductor between plant exposed to power and the station protector. Frequently a 24-gauge (0.5 mm) stub cable of a terminal, terminal block, or the 26-gauge (0.4 mm) stub of a building protector serves as the fusible link. The fusible link may be located within the premises, provided that it is under the metal sheath of a grounded cable.

When ready-access terminals are installed within a building or on an exterior combustible wall, conductors terminated on the terminal must be two gauge sizes larger than the fuse cable. This terminating cable must, therefore, be located between the fusible link and the ready-access terminal. Fusible link requirements are listed below.

Exposed Plant	Fusible Link
Cable 19 or 22 ga (0.9 or 0.6 mm)	24 or 26 ga (0.5 or 0.4 mm)
24 or 26 ga (0.5 or 0.4 mm)	Not required
C Rural Wire	Block wire

Fused Protectors

AT&T 918-216-100

A 106C fused protector must be installed under any of the following conditions.

1. Where no fusible link is provided, for example, where:
   - Drop wire is directly connected to a 107-type wire terminal mounted on C rural wire.
   - Drop wire is run for one or more spans on joint-use poles with no grounded cable strand between the drop wire and the primary power conductor.

- Buried service wire is connected to 19- or 22-gauge (0.9 mm or 0.6 mm) conductors of joint random buried distribution cable in an encapsulated splice closure and the protector is located on or within a building. Exception: 9A1 terminal block in a closure may be used when mounted on the building wall.

2. Where the station has battery feed from two or more drop wires.

Note: Where a fused protector is required, it should be specified on the service order.

Fuseless Protectors

AT&T 462-005-100, 918-216-100

A fuseless protector, protected cable terminal, or protected terminal block should be installed, except where a fused protector is required. Most of these are used at customer building entrances. The types are shown in the following table.

FUSELESS STATION PROTECTORS				
Protector Code	**Pairs**	**Indoor**	**Outdoor**	**Document**
116 Type	6	No	Yes	623-195-205
117 Type	6	Yes	No	
123 Type* 125 Type 128 Type* 142 Type	1 1-6 2 1-5	Yes Yes	Use Customer Service Closure	462-005-100
100 NIU†	1	Yes	Yes	462-005-160
200 NIU†	2	Yes	Yes	462-005-165
400 NIU† and 401	2	Yes	Yes	462-005-171
500 NIU†	5	Yes	MC 10/48 MC 12/25 MC 12/50	462-005-172
600 NIU†	6, 12	Yes	Yes	462-005-173
134 Type	16, 25 50, 100	Yes	MC 10/48 Closure	631-460-111
188 Type	50, 100	Yes	No	631-460-130
189 Type	25, 50, 100	Yes	No	631-460-114
189F Type	50, 100	Yes	No	631-460-123
189M Type	50, 100	Yes	No	631-460-117
189P Type	25, 50, 100	Yes	No	631-460-116
190 Type	50, 100	Yes	No	631-460-115
195 Type	100	Yes	No	631-460-118
* Discontinued availability (DA) † Network interface unit				

FUSELESS STATION PROTECTORS (Contd)				
Protector Code	**Pairs**	**Indoor**	**Outdoor**	**Document**
199 Type	10, 25 50	No	MC 10/48 Closure MC 12/40 Closure	631-470-204, -205
199 E6A Type	100	Yes	Yes	631-460-119
1A4A Terminal Block	10, 16 25, 50	Yes	No	631-440-211
9A1-Type Terminal Blocks	5, 10 25	No	PC-6, -12, -85 Closures	631-604-210, -215
			MC 12/25 MC 12/50	631-470-206
NH Terminal	16, 25	Yes	Yes	631-210-101
300-Type Terminal	50	Yes	No	631-460-120
1500 Type	50	Yes	Yes	631-460-122
1990-Type Terminal	50, 100	Yes	Yes	631-460-125

Note: 300-type connectors which are used for protecting exposed cables at the central office may also be used on customer premises where large numbers of pairs are terminated.

Sneak-Current Protection

AT&T 918-216-100

All circuits exposed to power and serving PBXs require either heat coils or 60-type fuses in addition to regular station protection. These devices must be provided for exposed central office trunks, tie trunks, off-premises extensions, and ringing feeders. For ***DIMENSION***® PBX, only exposed central office trunks require heat coils or fuses.

Bonding and Grounding for Station Protection

Buildings Served by Exposed Cable

AT&T 462-005-100, 918-216-100

- Ground cable shield as close to entrance point as possible and not more than 50 feet (15.2 m) from entrance point.
- Use metallic splice case or 2000-type fire-resistant closure for all splices on the central office side of the protector in entrance cables smaller than 400 pairs. The 189-type protectors equipped with internal splice chambers meet this requirement.
- Where insulating joints are installed inside the building, ground the cable on the building side of the insulating joint. Where there is more than one entering cable, bond cables together on the central office side of insulating joint and isolate from building ground.
- Ground the protector or protected cable terminal in accordance with the guide on Page 6-27, using a No. 6 copper ground wire. The protector ground, power ground, and interior metallic water pipe system must be bonded together.

Buildings Served by Drop or Buried Wires

AT&T 460-300-143, 462-005-100

- Connect the service wire shield to the protector ground terminal.
- Ground the protector in accordance with the guide on Page 6-43. The protector ground, power ground, and interior metallic water pipe system must be bonded together.
- If fed from buried cable, bond the service wire shield at the distribution terminal.
- If fed from aerial cable:
  - And the length of the service wire exceeds 700 feet (213.4 m), bonc the service wire shield at the distribution terminal.

— And the length of service wire is less than or equal to 700 feet (213.4 m), do not bond the shield at the distribution terminal.

Ground Wire

The proper size ground wire must be used for a given number of protected circuits, as shown in the following table.

Ground Wire Size	Maximum No. of Protected Circuits	
	Fuseless	Fused
No. 12	2	6
No. 10	6	7
No. 6	7 or more	8 or more

High-Rise Buildings Containing Electronic Equipment

AT&T 918-216-100

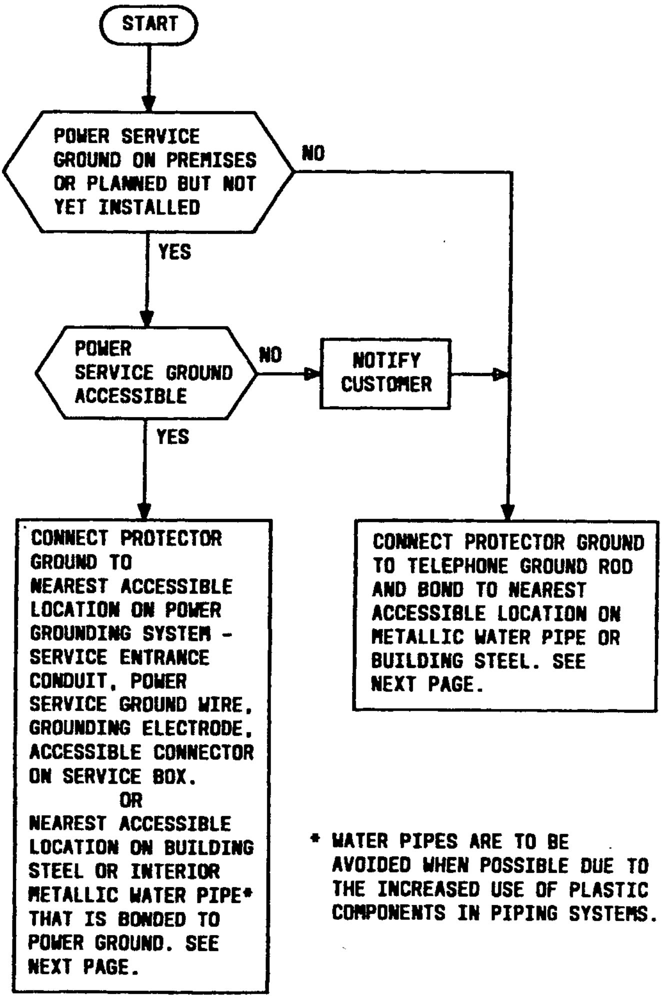
- Use shielded entrance and riser cables, if feasible. Where unshielded cables are used as risers, run a No. 6 ground wire along each unshielded riser cable route and treat it as described below for the riser cable shield.
- Ground the shield of the entrance cable to an approved ground (see Page 6-43) not more than 50 feet (15.2 m) from the entrance.
- Bond together the shields of the entrance and riser cables.
- Maintain shield continuity over the entire cable length.
- Run riser cables in the central part of the building, if possible, and as close as possible to building steel, water lines, power conduits, or grounded conductors.

- Ground the riser cable in the riser closet, using No. 6 ground wire at every point where pairs enter or leave the cable. The shields of cables which do not have pairs entering or leaving on a floor need not be grounded on that floor. Approved grounds for building riser cables are:
  - Building steel
  - Metallic water pipes
  - Power feed conduit that supplies a panel board on the floor
  - The grounding conductor for the secondary side of the power transformer feeding the floor
  - Power ground risers.
- Where unshielded cable is used between a riser (backbone) closet and an equipment room or apparatus closet, run a No. 10 ground wire along the cable route, preferably strapped to the cable(s). Bond the equipment ground to this ground wire, or to the cable shield if shielded cable is used. Provide a terminal such as a 2A ground strip to facilitate bonding.
- Equipment located one floor above or below the riser (backbone) closet from which it is served may be grounded as described above. Equipment more than one floor removed from its associated closet must be connected to an approved ground on its own floor.

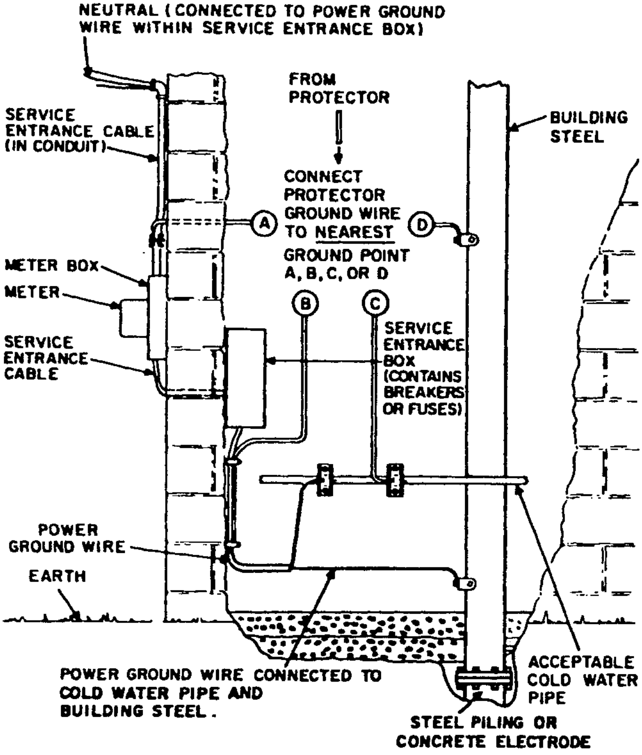
Selection of Approved Grounds

AT&T 462-005-100

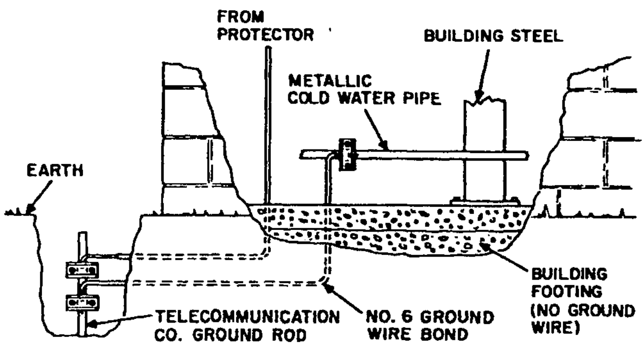
SELECTION OF APPROVED GROUND



* WATER PIPES ARE TO BE AVOIDED WHEN POSSIBLE DUE TO THE INCREASED USE OF PLASTIC COMPONENTS IN PIPING SYSTEMS.



Acceptable Protector Grounding Connections to the Power Ground



Acceptable Protector Grounding Connections when Power Service is not Grounded, Power Service Grounds not Accessible, or there is no Power Service at the Premises

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460-300-143	Buried Wire Terminations
462-005-100	Station Protection and Grounds
462-005-160	100-Type Network Interface Unit (NIU)
462-005-165	200-Type Network Interface Unit (NIU)
462-005-171	400-Type Network Interface Unit (NIU)
462-005-172	500-Type Network Interface Unit (NIU)
462-005-173	600-Type Network Interface Unit (NIU)
623-195-205	116-Type Protectors — Open Wire
627-020-005	Bonding and Grounding — Aerial Plant
629-020-100	Buried Plant — Urban Installation — Telephone and Power in Same Trench
631-210-101	N-Type Distribution Cable Terminals
631-400-102	Cable and Terminal Grounding in Subscribers Buildings — General
631-440-211	Terminal Blocks — Building Terminals
631-460-111	134-Type Protectors
631-460-130	188-Type Protectors
631-460-114	189-Type Protectors
631-460-115	190-Type Protectors
631-460-116	189P-Type Protectors
631-460-117	189M-Type Protectors

AT&T	Title
631-460-118	195-Type Protectors
631-460-119	199E6A-Type Protectors
631-460-120	300-Type Building Terminal
631-460-122	1500-Type Building Terminal
631-460-125	1990-Type Protectors
631-470-204	MC 10/48 Cable Closure
631-470-205	MC 12/40 Cable Closure
631-470-206	MC 12/25-50 Cable Closure
631-604-210, -215	PC6/48 and PC12/55 Cable Closures
633-020-208	Bonding and Grounding Buried and Underground Plant
636-300-050	3-, 4-, and 5-Type Protector Units
636-300-100	300-Type Connectors
636-310-100	301-Type Connectors
636-320-100	302-Type Connectors
636-330-100	303-Type Connectors
636-330-105	305-Type Connectors
636-330-107	307-Type Connectors
636-330-108	308-Type Connectors
363-330-109	309-Type Connectors

AT&T	Title
636-330-110	310- and 310M-Type Connectors
636-330-111	311-Type Connectors
640-250-246	Expanding Outcounts Using ***SLC*** Series 5 Carrier System
640-250-248	Remote Terminal Splicing (Metallic) ***SLC*** Series 5 Carrier System
873-XXX-XXX	Inductive Coordination Practices
876-XXX-XXX	Protection Practices
916-559-770	***Cosmic*** II — Main Distribution Frame
918-216-100	Electrical Protection of the Subscriber Outside Plant
920-400-200	Fiber Optic Cable — Buried Installation and Planning
920-400-300	Fiber Optic Cable — Aerial Installation and Planning

Manuals

350-060	Telecommunication Electrical Protection
201-200-050	Distributing Frame Systems Products Manual (DFSPM)
2268B	Outside Plant Systems Products Manual

Section 7

Contents

Section 7

CABLE ENTRANCE FACILITIES

GENERAL

The Cable Entrance Facility (CEF) is the interface between outside plant (OSP) cables and the facilities for terminating toll, trunk, and subscriber cables in the central offices (COs). The CEF requires space for proposed and future cables and safe conditions for persons performing the cable pulling and splicing operations.

This section describes the utilization, planning, cable placement procedures, and protection measures applied in the Cable Entrance Facility. This information applies to all three types of central office CEFs:

1. Above-surface (in "vaultless" offices)
2. Subsurface (in cable vaults)
3. Duplex (in multistory offices).

UTILIZATION PLANNING

AT&T 620-100-001, -105, 919-240-610

A comprehensive plan for the utilization of the CEF should be prepared showing the location of existing and future cables, connector stubs, and splices. The plan should include input from departments responsible for the planning and placing of future toll, trunk, and subscriber-type cables. The CEF utilization plan should be followed and kept up-to-date. The plan should consider the following.

Work and Egress Space

Work clearances, aisle dimensions, and means of access and egress must satisfy the National Fire Protection Association (NFPA) Life Safety Code, OSHA requirements, and local regulations. Minimum recommended clearances for splicing operations are:

- Overhead splice
  - — 27 inches (686 mm) between closure and nearest overhead obstruction, 32 inches (813 mm) in hard hat areas.
  - — 25 inches (635 mm) between closures where positioning does not permit closure to be lowered.
- Horizontal splice
  - — 25 inches (635 mm) above the floor (can be a temporary position used only for splicing).
- Vertical splice
  - — Limited by space required to position cable, closure, and supporting structure.

Gas Protection

Prevent gas seepage into the CEF by routing all underground telephone ducts through a gas venting chamber before terminating and plugging them in the CEF. Test for lighter- and heavier-than-air gases before removal of the conduit plugs. Purge chambers containing gas with a standard blower. Remove mud, dirt, silt, and other sediment by forcing high-pressure water into the chamber through a 10-inch (254 mm) purge port and pumping until the water is clear.

Lighting

If the CEF utilization plan is observed, the lighting layout should not be obstructed by the addition of cable or racking structure. Portable lighting units should be used during work periods if needed. Emergency lighting should be tested periodically.

Security

Appropriate security measures should be instituted in CEFs located beyond the visual control of CO supervision to prevent unauthorized entry and to provide for emergency access and egress.

CABLE PLACEMENT

Pulling

In above-surface CEFs, the cable is installed by pulling toward the first manhole. In subsurface or duplex CEFs, the cable may be pulled in either direction. For information on pulling tensions, see Section 8 "CONDUIT."

Bending Radius

The recommended bending radius without mechanical assistance is 12 to 15 times the cable diameter. Paired cables can be bent to a smaller radius, if necessary, but the potential for damage increases as the bend radius decreases. The minimum bending radius for fiber optic cable is:

- 10 times the cable diameter for a cable under ***no-load***
- 20 times the cable diameter for a cable ***under load***.

The ***no-load*** condition is defined as up to 30 percent of the 600 lb/ft (2.7 kN) maximum load rating and the ***under load*** condition is defined as any load over 30 percent of the 600 lb/ft (2.7 kN) load rating.

Slack Storage

In general, slack cable should be coiled in loops that are as large as practical for the given storage area. For instance, cable that is placed in a handhole is typically coiled about the periphery of the handhole. The handhole should be sized such that a closure, for example, can be placed in the handhole without exceeding the cables' minimum bend radius.

Racking

Select rack positions in keeping with the overall CEF design specified in the utilization plan to avoid blocking empty rack space and ducts. Generally, the preferred order of duct utilization in the OSP network is from the bottom up and from the outside in. This strategy should be used in the CEF only if compatible with both inside and underground cable routing. For more information on racking, see Section 8, "CONDUIT."

RISER CABLES

AT&T 627-610-225

Placing

The riser cable may be pulled up to the top floor using an electric winch or lowered by hand from the top floor using a cable shoe or cable sheave. The method used depends on cable type, cable weight, and building construction.

Supporting

- **Strand method**—After the strand has been placed and tensioned, start at the top floor and secure the cable to the strand using tie wires that were inserted into the lay of the strand at 3-foot intervals before tensioning.
- **Non-strand method**—Install split cable grips on the riser cable at every third floor or at every 35 feet (10.7 m) in open shaft construction so the weight of the cable and tension on the cable sheath is distributed equally on each of the split grip supports.

FIRESTOPPING

AT&T 620-100-001, -005, 622-700-102

Fire-stop all penetrations of floors and walls, including riser cable openings and underframe openings. Floor fire-stops must have at least a 2-hour rating and wall fire-stops at least a 1-hour rating. Fire-stops must satisfy the National Fire Protection Association (NFPA) Life Saving Code.

CABLE PROTECTION

Corrosion, electrical, and moisture protection measures applied to outside plant cables entering a CEF include the following.

Isolation Gaps (Insulating Joints)

AT&T 918-216-100

Direct current flowing in a cable shield or sheath contributes to corrosion of the shield or sheath and associated hardware. Where the severity of the problem warrants, place isolation gaps in the cable sheath or shield to interrupt the direct current path.

All areas are subject to some degree of corrosion. The local environment can be classified as either high-risk or low-risk, depending on the number and magnitude of direct-current sources, the amount of lead sheath in the OSP, and the type of soil. Since the degree of risk may change with time, it should be evaluated periodically, preferably by the Distribution Transmission Engineering Center (DTEC).

Isolation gaps should be installed on all cables in the CEF if any portion of the OSP feeder network is in a high-risk area and contains any lead-sheath cables. To be effective, isolation gaps must be installed on all cables.

Isolation must also be maintained between the metal racking framework and the cable sheath, either by placing hardwood insulating members between the cable racks and the framing structure or by placing insulators between the cables and the cable hooks. A metallic air pipe system must also be properly isolated.

Pressurization

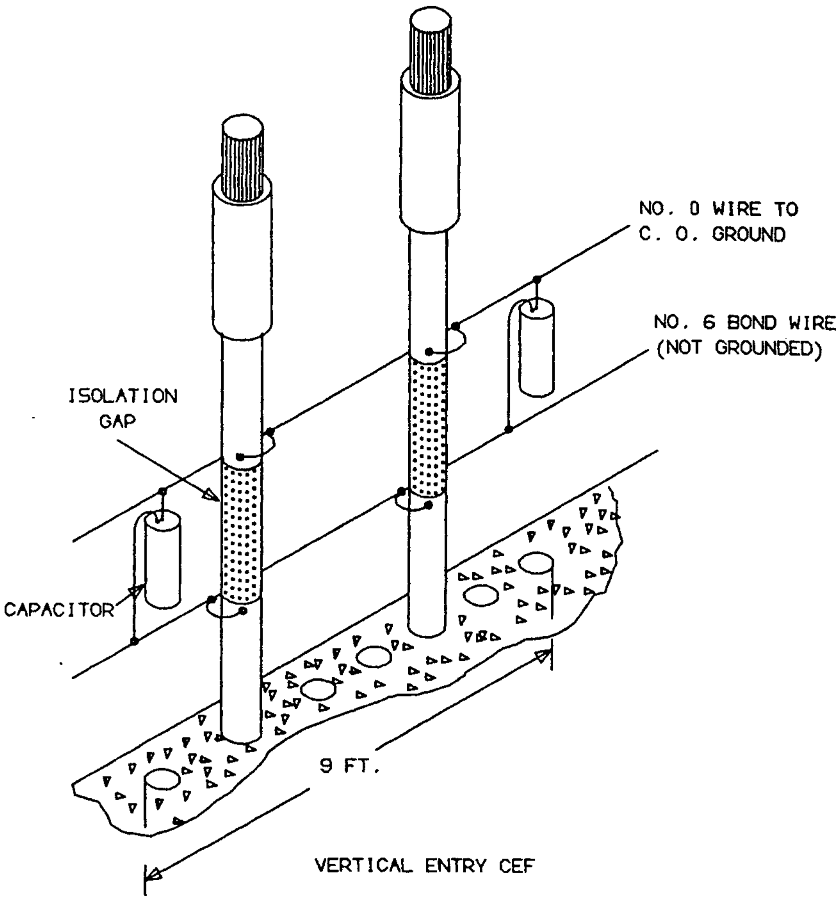
The design of air pressure systems is covered in Section 4 "PRESSURIZATION." The preferred location for pressure injection is between the duct entrance and the isolation gap. An alternate location, if space in the CEF is limited, is in the central office manhole. The construction of pressure dams (pressure plugs) is covered in AT&T 637-241-011 and 637-243-200.

Bonding and Grounding

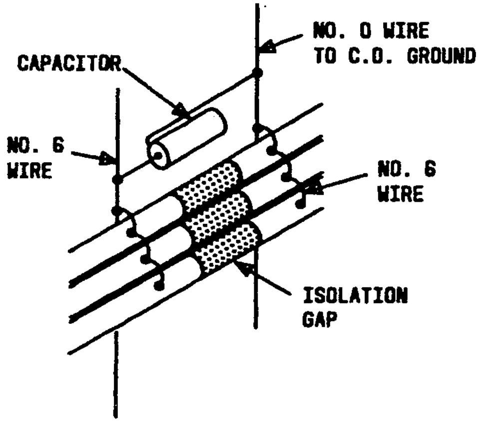
Cables that are exposed to lightning, inductive interference, or power contact must be bonded and grounded as outlined in Section 6 "ELECTRICAL PROTECTION." Isolation gaps on exposed cables must be bypassed by capacitors to restore the path to ground for the alternating currents resulting from exposure, under the following conditions:

- On aerial cables that are exposed to lightning, or cables that are connected to aerial cables within 500 feet (152.4 m) of the CEF, install a 1000 µF capacitor, with no additional lead length, on each cable.
- For all other exposed cables, provide two 10,000 µF capacitors per aisle side, with no more than 25 feet (7.6 m) of additional lead length.
- Where impulse noise on carrier cables is a problem, install a 1000 µF capacitor on each cable, with leads as short as possible.

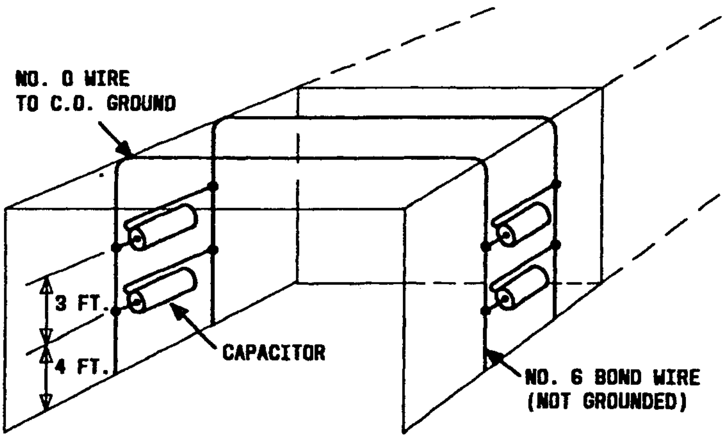
To facilitate future testing, at least one lead of each capacitor should be joined mechanically. Recommended bonding and grounding arrangements are illustrated on the next two pages.



Bonding and Grounding Arrangements



MULTI-CABLE BONDING AND GROUNDING



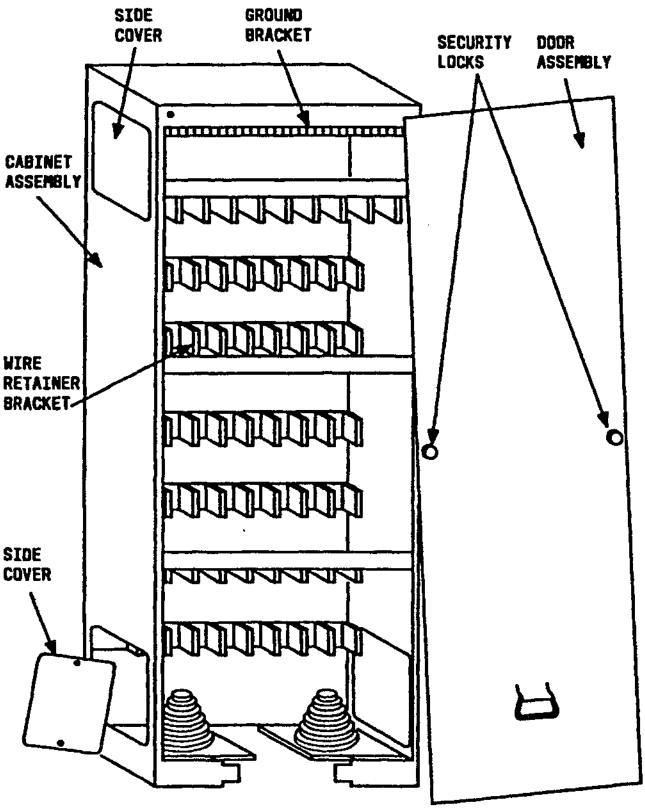
CAPACITOR INSTALLATION (CABLES NOT SHOWN)

Horizontal Entry CEF Bonding and Grounding Arrangements

CABLE REARRANGEMENT FACILITY

AT&T 636-211-101

The Cable Rearrangement Facility (CRF) is a noncompartmentalized splicing interface designed for inside use. It provides a secure, fire-resistant, steel enclosure for up to 5,000 spliced pairs. The CRF cabinet is 15 inches (381 mm) wide, 12 inches (305 mm) deep, and 48 inches (1219 mm) high. The cabinet will accept up to four 4-inch (102 mm) feeder or riser cables. The CRF cabinet is illustrated below.



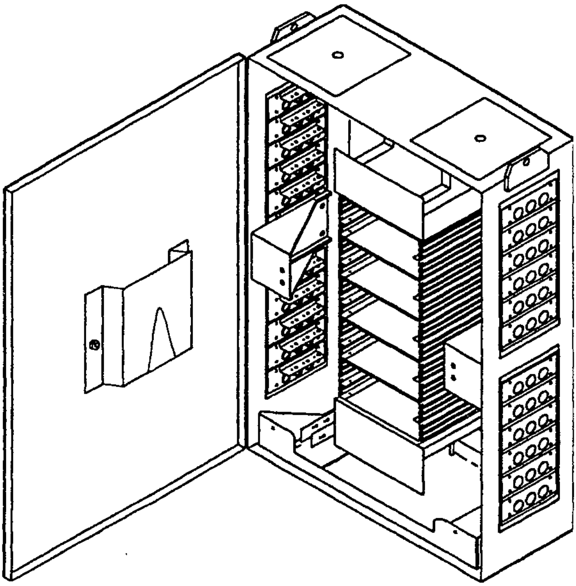
OPTICAL CABLE ENTRANCE FACILITY (OCEF)

The Optical Cable Entrance Facility (OCEF) cabinets are water-resistant enclosures intended for storing a large number of fiber splices between OSP and building-type cables in vault locations. The cabinets accommodate AT&T ***Lightpack***®, riser, and building cable sizes from 0.25-inch (6 mm) to 1.0-inch (25 mm) OD.

The cabinet is designed to accommodate multiple cable sheaths through ports in the bottom, sides, and top. Cable entry ports are sealed, resulting in a National Electrical Manufacturers Association (NEMA) 4/12/13 rating — which means this unit provides protection against dust and water spray. Each cabinet incorporates a hinged, removable, lockable door that provides additional security.

The cabinet accepts the standard AT&T splice organizer tray, allowing complete access to any splice without disturbing other splices. The splice tray provides integrated strain relief for all types of fiber cable and buffer construction. Splice trays are designed for mechanical or fusion splices. The OCEF accepts a standard work shelf to provide a convenient work area immediately outside the cabinet.

The OCEF enclosures are provided in two sizes. Each size OCEF may be ordered for either side entry or top and bottom entry. An OCEF is illustrated on the next page.



Optical Cable Entrance Facility (OCEF1-720/42)

OCEF DIMENSIONS AND CAPACITIES						
Model	Height In. (mm)	Width In. (mm)	Depth In. (mm)	Weight Lb. (kg)	No. of Splices	No. of Cables
OCEF1-288/22	22 (559)	30 (762)	12 (305)	100 (45.4)	288	48
OCEF2-288/22	22 (559)	30 (762)	12 (305)	100 (45.4)	288	24
OCEF1-720/42	42 (1067)	30 (762)	12 (305)	175 (79.4)	720	84
OCEF2-720/42	42 (1067)	30 (762)	12 (305)	175 (79.4)	720	24

BIBLIOGRAPHY

AT&T	Title
620-100-001	Fire Safety Considerations of Cable in Buildings
620-100-005	Fire Stops — General
622-700-102	KS-21947 Cable Penetration Module
627-610-225	Placing Riser Cable
636-211-101	Cable Rearrangement Facility
637-241-011	Pressure Plugs — General
637-243-200	Installing 3A Pressure Plug
877-XXX-XXX	Insulated Joints in Cable Sheaths
918-216-100	Electrical Protection of Subscriber Outside Plant
919-240-610	CEF System Design

Section 8

Contents

Section 8

CONDUIT

PLANNING AND DESIGN GUIDELINES

AT&T 919-240-001, -100

- Obtain information from other utilities and governmental agencies regarding their existing and proposed underground facilities.
- Check with construction forces for information on possible special construction problems.
- Conduct field survey of proposed route(s).
- Select permanent locations for underground structures, taking into account:
  - — Long-range outside plant planning
  - — Future requirements for growth
  - — Present and future requirements for subsidiary and branch conduit
  - — Future road developments
  - — Plans of other utilities
  - — Kinds of road paving used along possible conduit routes
  - — Special problems, such as bridge, railway, and submarine crossings
  - — Need to avoid unstable soil conditions, foreign underground structures, and liquid and gas storage facilities
  - — Safety and convenience of workers and general public.

- Size conduit structure based on customer requirements.
- Select conduit material on basis of minimum total cost. Size manholes and conduit for ultimate number of ducts (40-year growth period).
- Locate manholes away from road intersections.
- Plan cable racking in manholes for maximum utilization of ducts.
- Pitch conduit toward manhole.
- Avoid drainage patterns that could physically expose underground structure by soil erosion.
- Avoid interference with present drainage patterns.
- Schedule job to avoid cold weather and periods of peak demand on contractors.
- Obtain all necessary permits before starting construction.

SIZING

AT&T 919-240-200

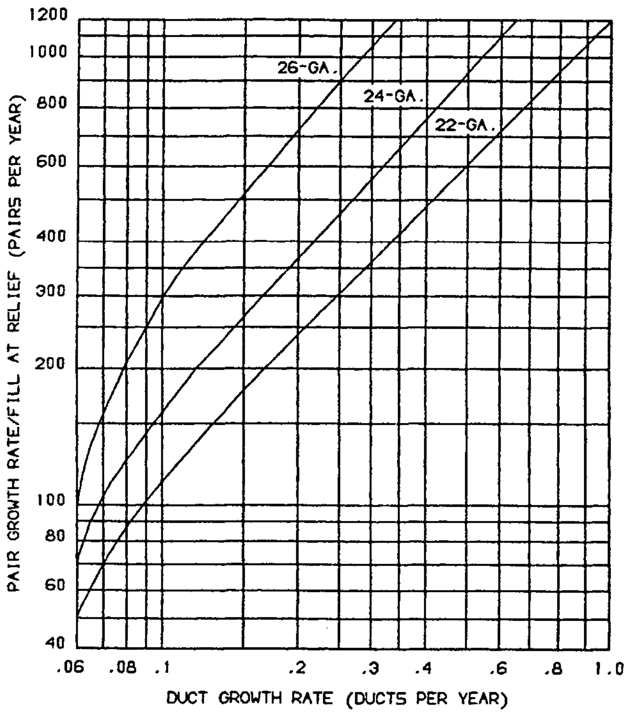
Customer demands for high-speed transmission and the introduction of technology to meet those service demands greatly affect the sizing of future conduit. Some of these changes are:

- The positioning of the loop network to support 64 kb/sec service with the introduction of digital carrier systems. The transmission media for serving these carrier systems being T1 digital lines or fiber optic cable will greatly reduce the requirement for future large, twisted-pair, copper cables.
- The introduction of fiber optic cable(s) to serve the trunk and toll network will also reduce duct requirements.

The curves on Pages 8-3 and 8-4 are for sizing conduit based on twisted-pair copper cables. The gauge of the cables is determined by resistance design limitations covered in Section 5, "TRANSMISSION."

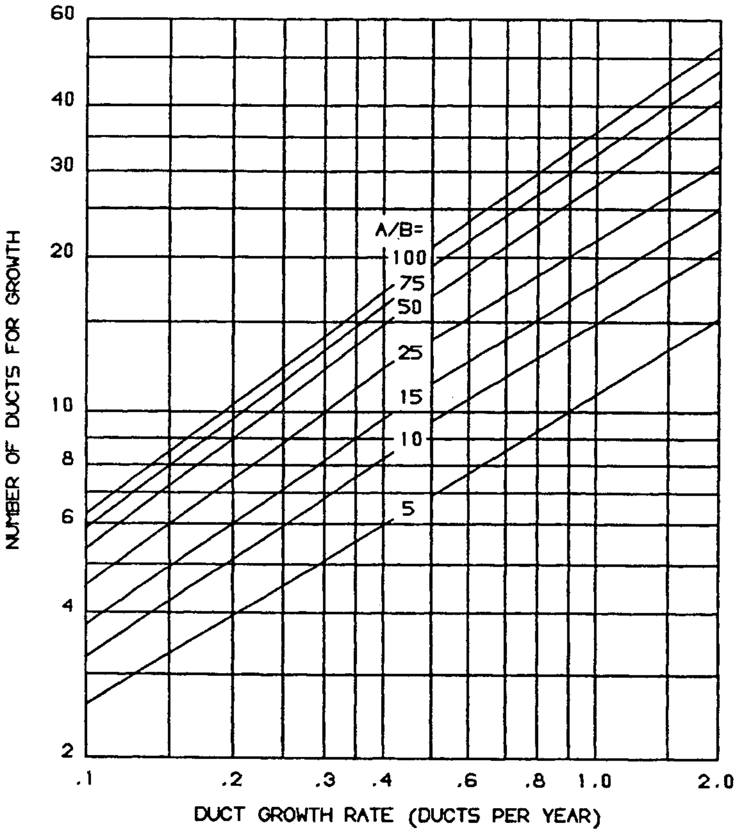
The technology of the digital transmission media is continually changing the service capacity for fiber optic cables. Therefore, it is difficult to arrive at sizing curves for conduit based on the fiber optic cables. The engineer must use sound judgment when sizing conduit in these situations. The size must be based on service requirements along the feeder route, using the latest techniques available.

Determine duct growth rate for each gauge separately, using the curves on the following chart. (These curves assume one cable per duct and average costs.) Use the curves only for rough estimating.



Add the duct growth rates for all gauges from the chart shown on Page 8-3; then, add the growth rates for trunk, toll, and other services. On the following chart, find the number of ducts for growth from the curves, using local "A" and "B" costs. ("A" cost is the getting started cost per trench foot and includes such items as permits and engineering. "B" cost is the cost per duct foot and includes such items as material and labor.)

Add to this result the number of ducts required immediately; this is the required conduit size.



SECTION LENGTHS

Factors Affecting Section Lengths of Conduit

AT&T 919-240-100

Section lengths of conduit are from manhole to manhole or cable entrance facility (CEF) to a manhole. Factors which affect these section lengths are:

- Location of intersecting main, subsidiary, and branch conduit
- Location where the distribution network is to interface with feeder cables
- Location of loading coils, build-out capacitors, or carrier equipment
- Maximum size cable reel lengths
- Pulling tension
- Physical obstructions to manholes
- Safe manhole environment.

PULLING TENSION

AT&T 919-240-100

There is a limit to the amount of tension that can be used to pull cables into a length of conduit.

Pulling tension is determined by the weight of the cable, the coefficient of friction of the conduit, and the geometry of the duct run. Cable weights are listed in Section 14, "CABLE AND WIRE." Design coefficients of friction for types of conduit material are listed on the following page.

DESIGN COEFFICIENTS OF FRICTION			
	Polyethylene Cable Sheath		
Duct Material	No Lubricant	B or C Lubricant	D Lubricant
Concrete	0.60	0.42	0.25
Fiber	0.47	0.44	0.25
Fiber-cement	0.50	0.50	0.25
Plastic	0.43	0.38	0.18

Copper and Aluminum Conductor Cable

Calculate the pulling tension for both directions of pull by the method on the following pages. The calculated tension for either direction must not exceed either (1) the cable strength or (2) 6500 pounds (29 kilonewtons [kN]).

Cable strengths for copper and aluminum conductor cables less than 6500 pounds (29 kN) are given below.

MAXIMUM CABLE PULLING TENSIONS						
Cable Size (Pairs)	Pulling Tension lb (kN)					
	26-Ga Copper	24-Ga Copper	22-Ga Copper	19-Ga Copper	20-Ga Alum	17-Ga Alum
100	400 (1.8)	600 (2.7)	1000 (4.4)	2000 (8.9)	900 (4)	1800 (8)
150	600 (2.7)	900 (4)	1500 (6.7)	3000 (13)	1350 (6)	2700 (12)
200	800 (3.6)	1200 (5.3)	2000 (8.9)	4000 (18)	1800 (8)	3600 (16)

The parameters which determine pulling tension are:

T = pulling tension (lb)
T_o = back tension (lb)
f = design coefficient of friction
w = weight of cable (lb/ft)
s = length of segment (ft)
r = radius of curvature (ft)
θ = angle of curvature (degrees).

The pulling tension in a straight segment of duct is given by:

$$T = T_o + fws$$

The metric equivalent of associated wire gauges are:
17-Ga = 1.15 mm 19-Ga = 0.9 mm 20-Ga = 0.8 mm 22-Ga = 0.6 mm
24-Ga = 0.5 mm 26-Ga = 0.4 mm

MAXIMUM CABLE PULLING TENSIONS (CONTD)						
Cable Size (Pairs)	Pulling Tension lb (kN)					
	26-Ga Copper	24-Ga Copper	22-Ga Copper	19-Ga Copper	20-Ga Alum	17-Ga Alum
300	1200 (5.3)	1800 (8)	3000 (13)	6000 (27)	2700 (12)	5400 (24)
400	1600 (7.1)	2400 (11)	4000 (18)		3600 (16)	
600	2400 (11)	3600 (16)	6000 (27)		5400 (24)	
900	3600 (16)	5400 (24)				
1200	4800 (21)					
1500	6000 (27)					

The parameters which determine pulling tension are:

- T = pulling tension (lb)
- T_o = back tension (lb)
- f = design coefficient of friction
- w = weight of cable (lb/ft)
- s = length of segment (ft)
- r = radius of curvature (ft)
- θ = angle of curvature (degrees).

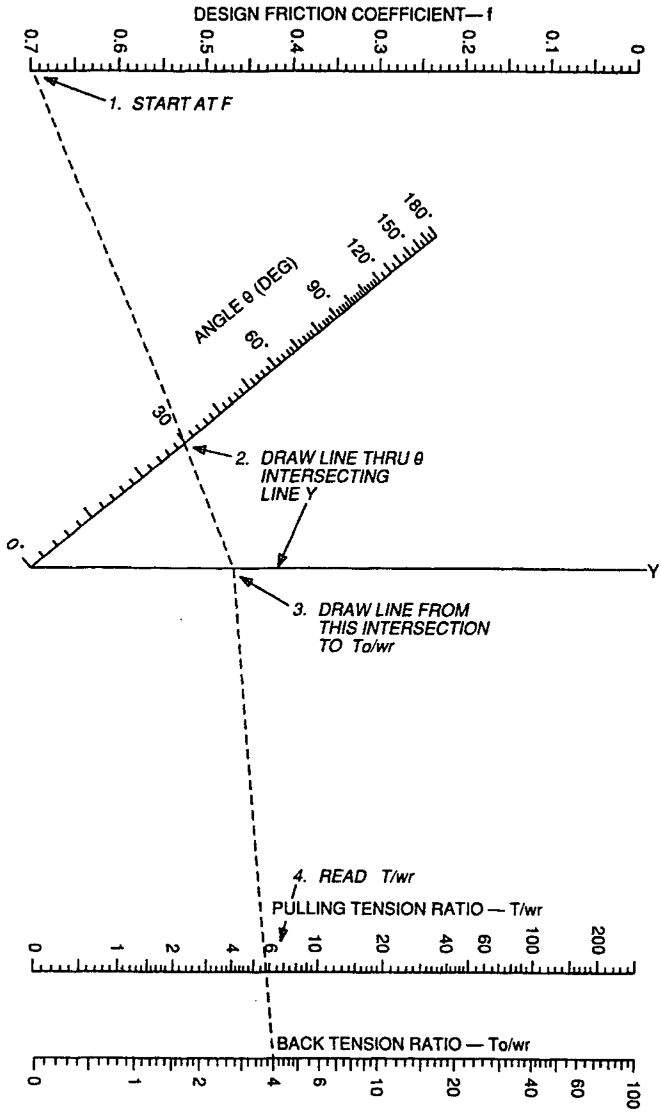
The pulling tension in a straight segment of duct is given by:

$$T = T_o + fws$$

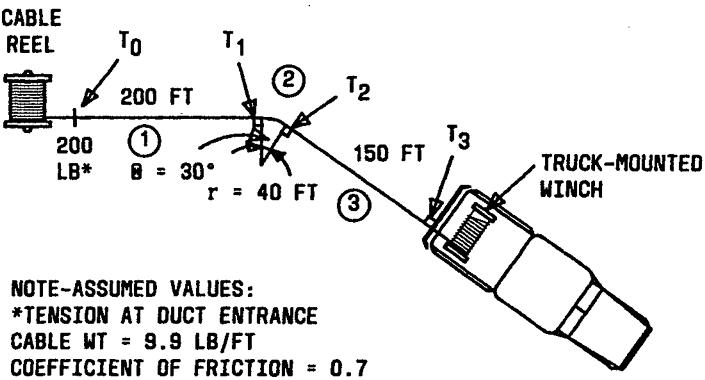
The metric equivalent of associated wire gauges are:
17-Ga = 1.15 mm 19-Ga = 0.9 mm 20-Ga = 0.8 mm 22-Ga = 0.6 mm
24-Ga = 0.5 mm 26-Ga = 0.4 mm

For pulling tension of fiber optic cables, see Page 8-12.

Use the alignment chart on the next page to find the pulling tension in a curved section.


DESIGN FRICTION COEFFICIENT— f
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1. START AT F
ANGLE θ (DEG)
0°
30
60°
90°
120°
150°
180°
2. DRAW LINE THRU θ INTERSECTING LINE Y
Y
3. DRAW LINE FROM THIS INTERSECTION TO To/wr
4. READ T/wr
PULLING TENSION RATIO — T/wr
0
1
2
4
6
10
20
40
60
100
200
BACK TENSION RATIO — To/wr
0
1
2
4
6
10
20
40
60
100

To find the pulling tension for a conduit section containing both straight and curved segments, calculate the tension segment by segment, starting at the feed (or reel) end. T_0 is the tail load on the cable entering the duct. Use the calculated value of T found for the first segment by applying it as T_0 for the second segment, and so on, until the pulling tension on the cable at the winch is obtained. A pulling tension problem is illustrated below.



Solve the problem in three steps:

1. Calculate pulling tension T_1 at the end of the first (straight) section, using the formula at the bottom of the tables on Pages 8-7 and 8-8.
2. Using this result as T_0, use the alignment chart on Page 8-9 to find the pulling tension T_2 at the end of the second (curved) section.
3. Using the second result as T_0, calculate the pulling tension T_3 at the end of the third (straight) section.

The above calculations are shown on the sample worksheet on Page 8-11.

FORM E
MARCH 1977

SHEET NO. ____________

JOB NO. ____________

CABLE PULLING TENSION WORK SHEET

SEGMENT LOCATION	STRAIGHT SECTION						CURVED SECTION										TOTAL TENSION
	T_o +	w(	f X	x	±h)	= T	f	θ	T_o /	(w X	r)	= $\frac{T_o}{wr}$	$\frac{T}{wr}$	X (w	X r)	= T	
1	200	9.9	0.7	200		1590											1590
2							0.7	30	1590	9.9	40	4.0	5.8	9.9	40	2300	2300
3	2300	9.9	0.7	150		3340											3340

ENTER ALIGNMENT CHART WITH THESE VALUES

READ FROM ALIGNMENT CHART

T_o = HOLDBACK TENSION (LBS.)

f = COEFFICIENT OF FRICTION

w = WEIGHT PER UNIT LENGTH OF CABLE (LBS./FT).

x = HORIZONTAL PROJECTION OF SEGMENT

h = VERTICAL PROJECTION OF SEGMENT

T = TENSION FORCE (LBS.)

θ = ANGLE IN DEGREES

r = RADIUS (FT.)

T_o/wr = BACK TENSION RATIO

T/wr = PULLING TENSION RATIO FROM ALIGNMENT CHART

Fiber Optic Cable

AT&T 628-200-215, -216, 920-400-100, 900-200-210

Fiber optic cable will usually be pulled into a duct liner which may be a smooth bore or a corrugated liner. The coefficient of friction for pulling lubricated cable into smooth bore is 0.25 and 0.20 for corrugated duct liner. The use of suitable liners is recommended to maximize the length of fiber optic cable that can be placed in a single pull.

It is recommended that three duct liners be the maximum placed in a 3½- and 4-inch (89 mm and 102 mm) duct where long cable pulls are to be made.

The maximum rated pulling tension for all cables except the self-support cables is 600 lb/ft (2.7 kN). The maximum rated cable tension for figure-eight self-support cables is 3300 lb/ft (14.7 kN). The dielectric circular self-support cable has a maximum rated cable tension of 1300 lb/ft (5.8 kN). These aerial cables would only experience such tension under storm loading. The maximum pulling tension, cable diameter, and cable weight should be obtained from the cable manufacturer.

PULLING DISTANCE AND CABLE TENSION

The tensile load rating specified for fiber optic cable is the limiting tensile force to which the cable can be subjected without risking fiber damage. Although the tensile force in a cable being installed cannot be predicted exactly, an estimate must be made in order to plan the location of each cable splice and maximum pulling distances.

Maximum pulling distance varies in inverse proportion to the friction coefficient. The actual bends and changes of direction of a conduit run (excluding manhole transitions) can be modeled by assuming a continuous large radius curve. Studies by AT&T Bell Laboratories have specified this duct curvature to be 160 degrees per 1000 feet (305 m). This constant accounts for plan and profile bends as well as construction irregularities and is built into the algorithm for pulling tensions as presented in this section.

The charts on Pages 8-15 and 8-16 (one for English measurements and one for metric) shows relationships between cable tension and pulling distance. The ratio "T/W" is the peak tensile force in the cable divided by the unit weight per foot. "L" is the pulling distance in feet, and "f" is the coefficient of friction.

When using the curves in the chart, a coefficient of friction of 0.20 can be used for corrugated polyvinyl chloride (PVC) duct liner and corrugated polyethylene duct liner, assuming that the cable and pulling line are well lubricated during the placing operation. For new smooth wall PVC pipe (lubricated), 0.20 should be used as a coefficient of friction.

When pulling into shorter sections of unlubricated new PVC duct or duct liner or polyethylene duct liner, such as for building entrance back-feeds, a 0.30 coefficient of friction should be used. If cable must be pulled into an existing older duct without an innerduct, for any reason, a 0.45 coefficient of friction should be used.

Note: Back-feeding is a term used to describe a procedure in which the cable is spooled off a partially empty cable reel (after the leading end of the cable has been pulled into the underground plant), stored on the ground in a figure-eight coil at the cable feed point, and pulled into the underground plant in a direction opposite to the initial pull.

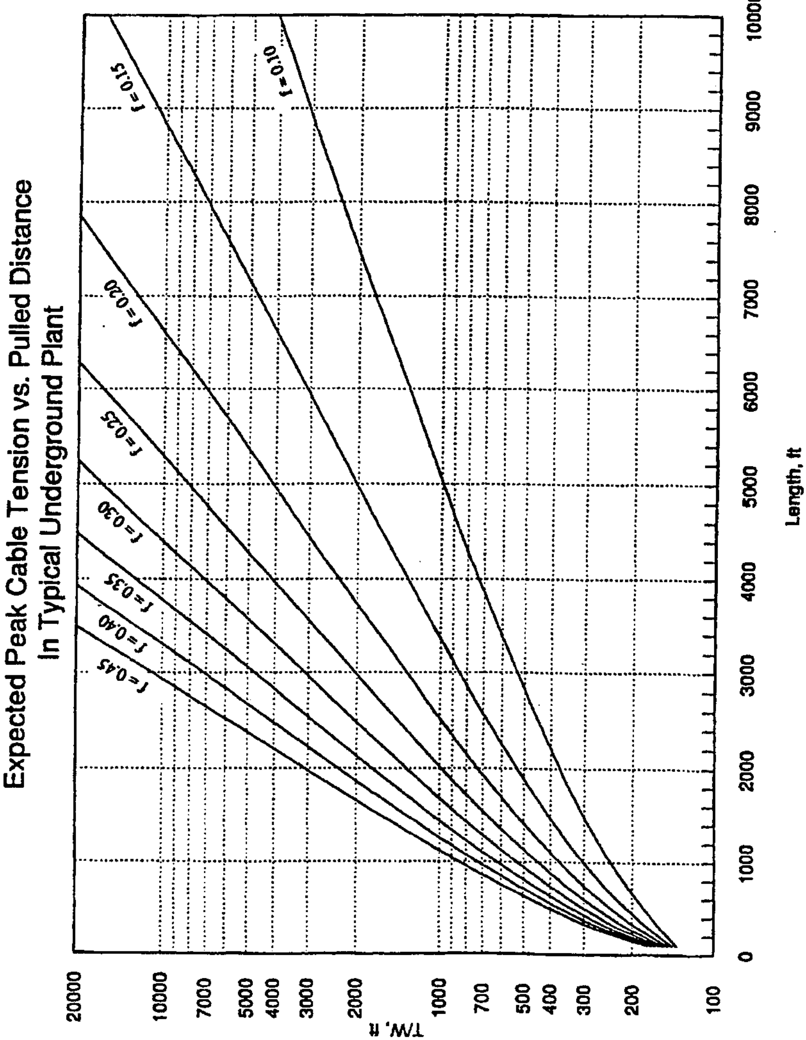
To engineer underground pulling lengths, use one of the charts on Pages 8.15 and 8.16 (English or metric) as described below:

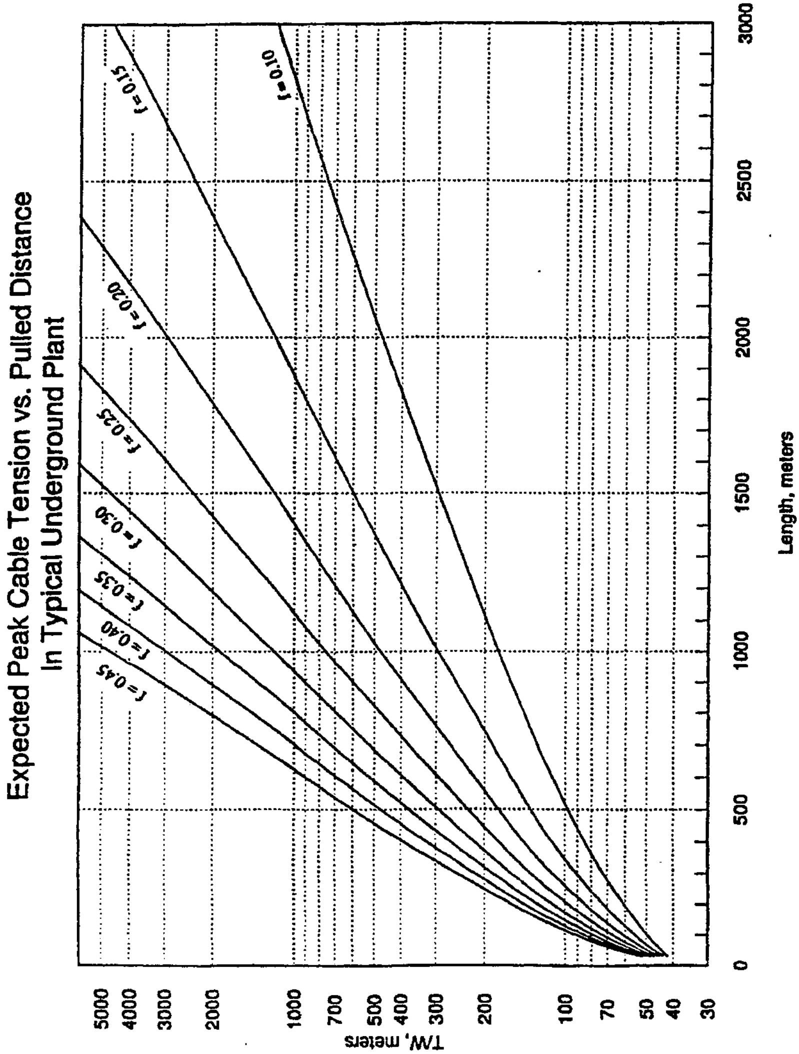
- Given the cable's tensile rating and unit weight per foot, "T/W" can be calculated and a horizontal line drawn at that level on the chart.
- Where the line intersects the proper coefficient of friction curve, the limiting pulling distance can be read directly below on the horizontal scale. If the planned pulling length in question is shorter than the limited pulling distance, it would be acceptable.

A second method would be to select a desired pulling distance, draw a vertical line to the coefficient of friction curve, and then move horizontally to a "T/W" ratio on the vertical scale. By multiplying this ratio by the weight per foot of the cable, a pulling tension estimate can be obtained. The pulling tension estimate calculated by this method must be less than 600 pounds.

Length and tension obtained from using the chart include any pulling restrictions resulting from the 160 degree/1000-foot (305 m) duct curvature constant. To arrive at a final pulling distance estimate, restrictions due to severe manhole bends and transitions must also be considered. Each time the cable is to be pulled through a severe transition curve, such as a 90-degree turn at a "T" or "J" manhole, 500 feet (152 m) should be subtracted from the pulling distance. In addition, where duct offset distances on pull-throughs are greater than one-half the manhole length, an additional 500 feet (152 m) should be subtracted for each case. Cable feed points should be located at manholes with severe transitions, where possible, to minimize these penalties.

As an example, to further illustrate these concepts, if the maximum pulling distance from the figure was 9000 feet (2743 m) and the course of the pull involved a midspan 90-degree "J" manhole and two pull-throughs with severe duct offset, the pulling distance should be reduced to 7500 feet (2286 m). In this case, a figure-eight back-feed would be needed in order to successfully place a 3-kilometer reel.


Expected Peak Cable Tension vs. Pulled Distance
In Typical Underground Plant
f = 0.10
f = 0.15
f = 0.20
f = 0.25
f = 0.30
f = 0.35
f = 0.40
f = 0.45
Length, ft
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
T/W, ft
100
200
300
400
500
700
1000
2000
3000
4000
5000
7000
10000
20000


Expected Peak Cable Tension vs. Pulled Distance
In Typical Underground Plant
f = 0.10
f = 0.15
f = 0.20
f = 0.25
f = 0.30
f = 0.35
f = 0.40
f = 0.45
0
500
1000
1500
2000
2500
3000
Length, meters
5000
4000
3000
2000
1000
700
500
400
300
200
100
70
50
40
30
T/W, meters

The following example illustrates how the English measurement chart may be used:

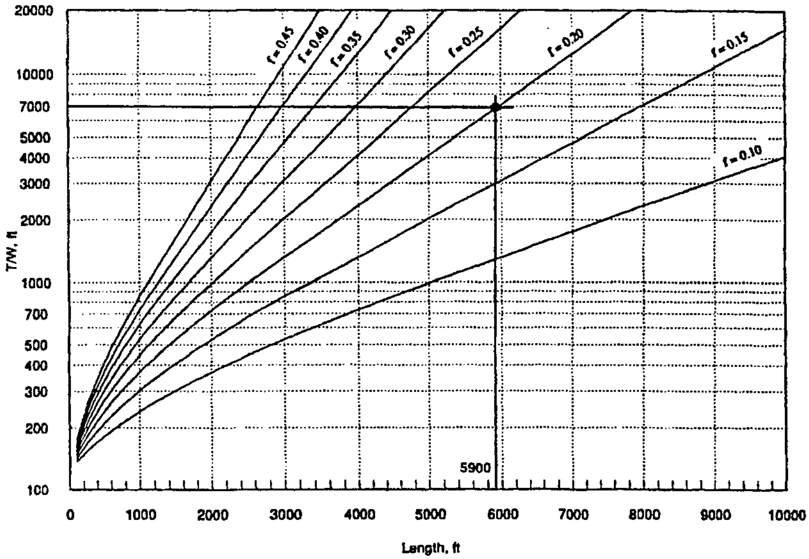
Primary R/L (rodent/lightning) cable:

weight (w) = 0.085 lb/ft
tensile limit (T) = 600 lb

using the equation T/W

$$\frac{600}{0.085} = 7059\,ft$$

(round off to 7000 ft)



From the chart (if f = 0.20), then L = 5900 ft.

The following example illustrates how the metric version of the chart may be used. One difference in the use of the metric version is that cable mass must be converted to cable weight.

Primary RL cable:

mass (m) = 127 kg/km

tensile limit (T) = 2700 N

Use the following equation to find cable weight.

$$W = m \times a \quad (a = 9.81\ m/s^2\text{, acceleration of gravity})$$

$$W = 127\ kg/km \times 9.81\ m/s^2$$

$$W = 1246 \frac{kg - m}{km - s^2}$$

$$W = 1246\ N/km \quad (1\ N = 1\ kg\text{-}m/s^2)$$

Convert weight to N/m

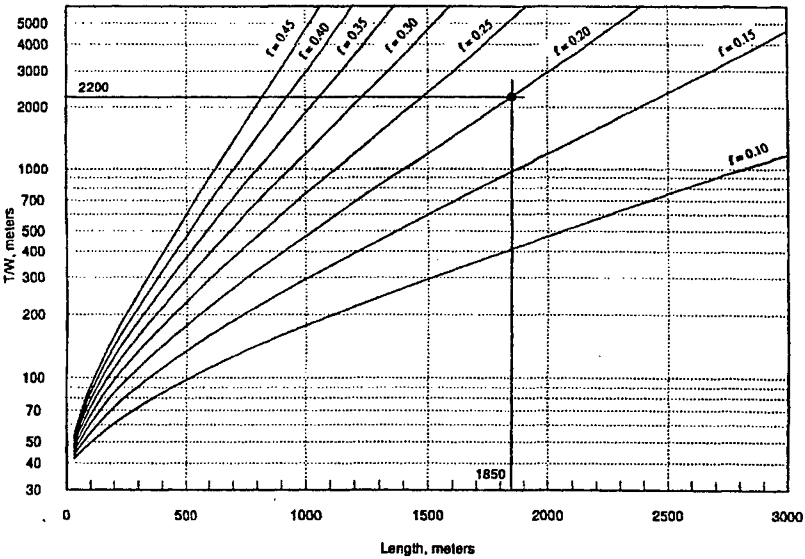
$$W = 1246\ N/km\ (1\ km/1000\ m)$$

$$W = 1.246\ N/m$$

Then, using the equation T/W

$$\frac{2700N}{1.246N/m} = 2167m$$

(round off to 2200 m)



From the chart (if f = 0.20), then L = 1850 m.

CURVE DESIGN

AT&T 919-240-100

The length of a curve can be found using the following formula.

$$L = 2\pi r \left[\frac{\text{angle in degrees}}{360^\circ} \right]$$

r = radius of bend in feet

For example: to find the length of a 64-degree, 35-foot (10.7 m) radius curve

$$L = 2\pi(35)\frac{64^\circ}{360^\circ}$$

$$L = 39.1\,ft\ (11.9m)$$

Subsidiary Conduit

Plastic Conduit. Curves are formed using rigid bends (Pages 8-24 and 8-25).

Steel Pipe. Bends are formed on the job site using a portable pipe bender (AT&T 622-315-200).

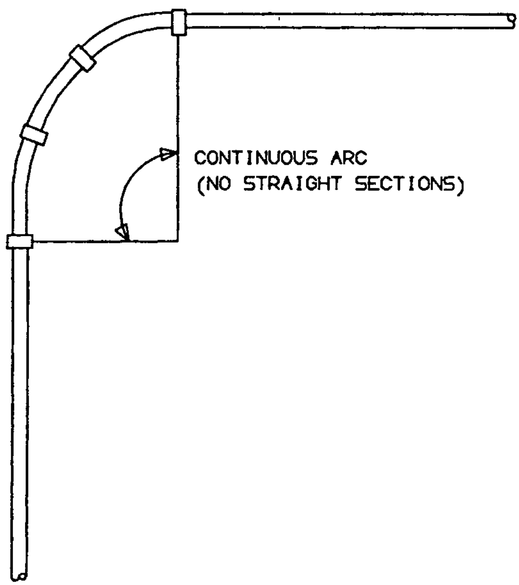
Single-Bore Conduit

Curve Radius 40 Feet (12 m) or More

Plastic Conduit — Manually bend straight conduit. Conduit must be firmly anchored in trench.

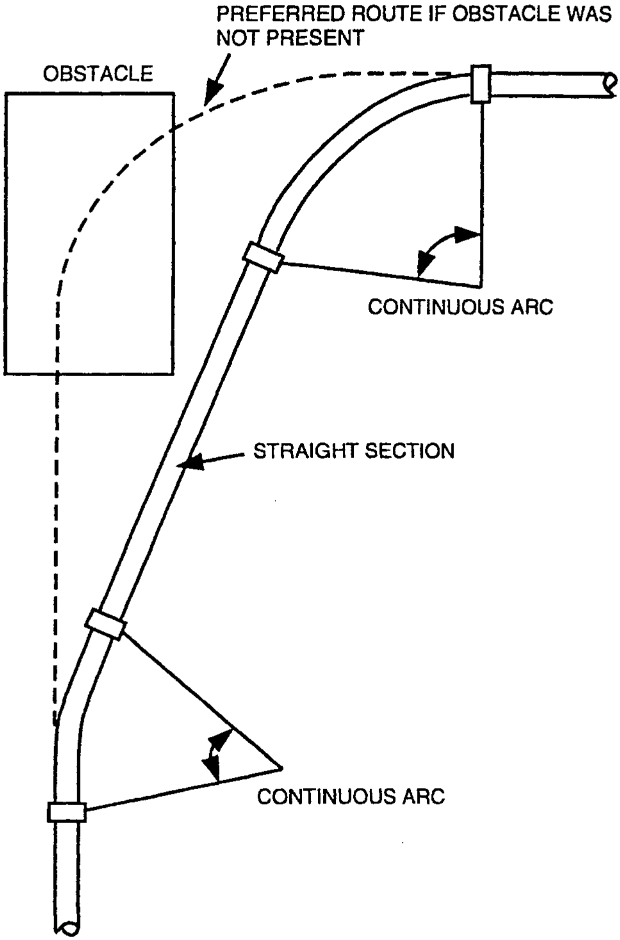
Curve Radius Less Than 40 Feet (12 m)

Construct curve in one continuous arc, if possible, using rigid bends without interspersed straight sections, as illustrated below.



For plastic conduit, use 15-foot (4.6 m) radius bends (7 or 30 degrees, as required). Rigid bends are described on Pages 8-24 and 8-25.

If an obstacle prevents construction of the curve in a single arc, use two arcs connected by a single straight section, as illustrated on the next page.


PREFERRED ROUTE IF OBSTACLE WAS NOT PRESENT
OBSTACLE
CONTINUOUS ARC
STRAIGHT SECTION
CONTINUOUS ARC

CONDUIT AND PIPE

AT&T 919-240-400

Factors to Consider in Selecting Type of Conduit

- Material cost and local availability
- Ease of handling
- Ease of joining
- Concrete encasement and backfill requirements
- Soil conditions
- Special conditions (for example, heat, gas, heavy loads, limited cover).

Advantages of Single-Bore Conduit

- Lightweight: mechanical handling equipment not required
- Good joint integrity
- Strong, stable structure (if concrete-encased)
- Easily rearranged to avoid obstacles
- Can be pneumatically rodded.

Advantages of Multiple-Bore Conduit

- Long trench openings not required
- Select backfill not required
- Ready-mixed concrete not required.

Single-Bore Conduit

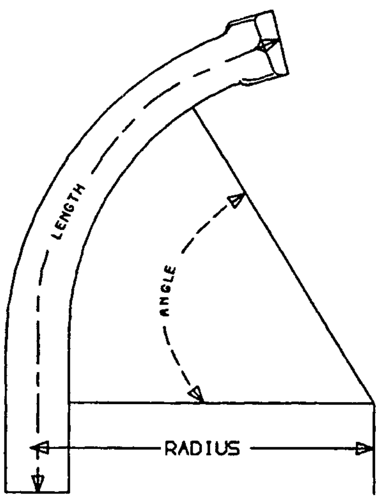
AT&T 622-020-100, 919-240-400

Straight lengths of single-bore conduit are available as follows:

Material	Length ft (m)	Weight lb/ft (kg/m)		
		Type B	Type C	Type D
Plastic	20* (6.1)	0.6-1.0 (.3-.6)	1.0-1.5 (.6-.7)	1.2-1.7 (.5-.8)
* Longer and shorter lengths available from manufacturer.				

- Type B (thin wall) requires concrete encasement.
- Type C (thick wall) may be buried with selected backfill in straight runs.
- Type D is ultraviolet (sunlight) and flame-resistant.

Rigid bends for single-bore conduit are illustrated below and listed on the next page.



PLASTIC

RIGID BENDS FOR 4-INCH (102 mm) SINGLE-BORE CONDUIT			
Material	Angle (Degrees)	Radius ft (m)	Length in. (mm)
B, C, or D Plastic	7	15 (4.6)	28 (711)
	30	15 (4.6)	100 (2540)
	30	12 (3.7)	81 (2057)
	45	9 (2.7)	91 (2311)
	45	9 (2.7)	63 (1600)
	45	3 (0.9)	34 (864)
	90	3 (0.9)	63 (1600)
E Plastic*	90†	3 (0.9)	72 (1829)
	64	3 (0.9)	46 (1168)

* Replaces cast iron for subsidiary conduit.
† Also available in split form for repairs.

For adapters and couplings, see AT&T 622-020-100 and 919-240-400.

Steel Pipe

AT&T 919-240-400

Steel pipe is used where conduit must be pushed or jacked, where environment is too severe for other conduit, and for submarine crossings. When using steel pipe for fiber optic cable, proper measures must be taken to prevent the pipe from filling with water and freezing. Standard weight pipe is available in the sizes shown in the table on the next page.

Nominal Size	Plain End		Bell End	
	OD in. (mm)	ID in. (mm)	OD in. (mm)	ID in. (mm)
1	1.315 (33.4)	1.048 (26.6)	—	—
1-1/2	1.900 (48.3)	1.610 (41.0)	—	—
2	2.375 (60.3)	2.068 (52.5)	—	—
3	3.500 (89)	3.068 (77.9)	3.50 (89)	3.06 (77.7)
3-1/2	4.000 (101.6)	3.548 (90.1)	4.00 (101.6)	3.54 (90.0)
4	4.500 (114.3)	4.026 (102.3)	4.50 (114.3)	4.02 (102.1)

PLACEMENT

Duct Arrangements

Duct arrangements are subject to trench width and/or depth constraints imposed by terrain, the presence of other structures, required working space, etc. The arrangement of ducts in a conduit run should be compatible with the manhole cable racking arrangement. (Refer to "MANHOLES" later in this section.) Generally, 2-, 3-, or 4-wide arrangements are preferred for single- or double-wall racking. Where a large number of ducts or other circumstances require center racking as well as wall racking, wider duct arrangements may be appropriate.

Separation From Other Structures

AT&T 622-100-010, 622-300-205, NESC Rule 320, 919-000-100

The following separations are required for safety of personnel and for protection of telephone equipment:

Structure	Minimum Separation
Power or other foreign conduit	3-in. (76 mm) concrete 4-in. (102 mm) masonry 12-in. (305 mm) of well tamped earth

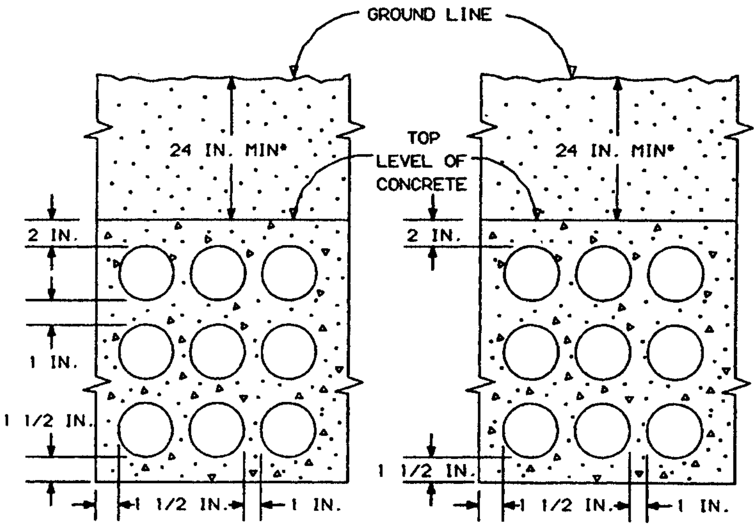
Pipes (gas, oil, water, etc.)	6 in. (152 mm) when crossing, 12 in. (305 mm) when parallel.
Power conduit terminated on poles	Separate poles, if possible. If same pole, preferably 180°, but not less than 90°.
Railroads (except street railways)	Crossing 50 in. (1270 mm) below top of rail.* Terminating on poles; 12 ft (3658 mm) from nearest rail, except 7 ft (2134 mm) at sidings.
Street railways	3 ft (914 mm) below top of rail.*

****Exception:*** Where impractical, or for other reasons, these clearances may be reduced; however, the top of the conduit or conduit protection shall in no case extend above the bottom of the ballast section which is subject to working or cleaning.

Spacing and Backfill Requirements

AT&T 919-240-400

The next three pages show spacing and backfill requirements for single-bore conduit. The volume of concrete or granular backfill will vary with the trench width and the degree of irregularity of the trench surfaces. Volumes given for each arrangement are for the minimum trench width consistent with the specified clearances. Volumes for sand or granular backfill include an allowance of about 1/12 for compaction.



*18 IN. PERMITTED UNDER DRIVEWAYS, SIDEWALKS

CUBIC YARDS OF CONCRETE PER 100 FEET OF TRENCH

	B PLASTIC 3-WIDE	B PLASTIC 4-WIDE
2-HIGH	3.8	4.9
3-HIGH	5.2	6.6
4-HIGH	6.5	8.3

FOR LARGER FORMATIONS USE:

PLASTIC: .35WH + .35W + .28H

	B PLASTIC 3-WIDE	B PLASTIC 4-WIDE
2-HIGH	3.4	4.3
3-HIGH	4.2	5.4
4-HIGH	5.1	6.5

FOR LARGER FORMATIONS USE:

PLASTIC: .22WH + .48W + .23H

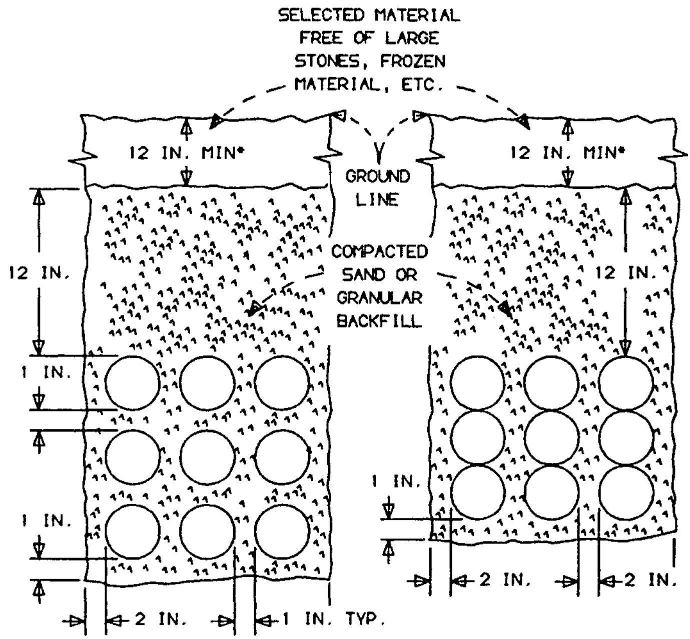
(W = NO. OF DUCTS WIDE, H = NO. OF DUCTS HIGH)

NOTE-OPTIONAL FOR STRAIGHT RUNS OF B PLASTIC.

SINGLE-BORE CONDUIT (ALL TYPES) ON CURVES

NOTE-LIMITED TO 3 TIERS PER POUR. REQUIRES LESS CONCRETE THAN METHOD USING VERT. SEPARATIONS

OPTIONAL ARRANGEMENT FOR B PLASTIC CONDUIT



* 6 IN. PERMITTED UNDER DRIVEWAYS, SIDEWALKS

CUBIC YARDS OF SAND OR GRANULAR BACKFILL PER 100 FEET OF TRENCH

	C PLASTIC 3-WIDE	C PLASTIC 4-WIDE
2-HIGH	10	12
3-HIGH	11	14
4-HIGH	13	16

FOR LARGER FORMATIONS USE:

PLASTIC: .38WH + 1.8W + 4H + 1

C PLASTIC CONDUIT,
STRAIGHT RUNS, ANY
NUMBER OF TIERS

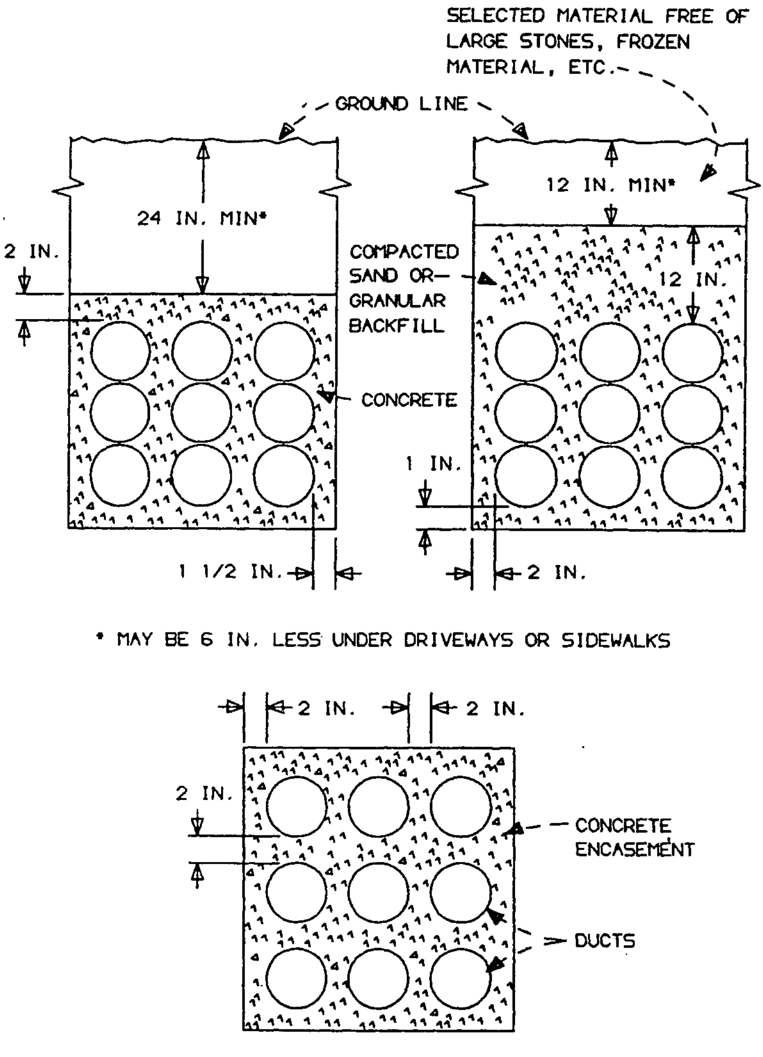
	C PLASTIC 3-WIDE	C PLASTIC 4-WIDE
2-HIGH	10	13
3-HIGH	12	15
4-HIGH	13	16

FOR LARGER FORMATIONS USE:

PLASTIC: .36WH + 2.3W + .2H + 7

C PLASTIC CONDUIT,
STRAIGHT RUNS,
UP TO 4 TIERS

(W = NO. OF DUCTS WIDE, H = NO. OF DUCTS HIGH)



SINGLE-BORE CONDUIT (ALL TYPES)
AT MANHOLE AND VAULT ENTRANCES

Subsidiary Conduit

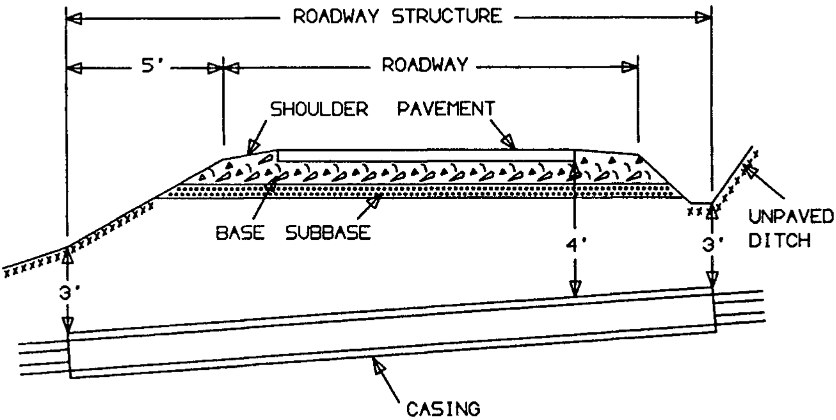
AT&T 919-240-400

- Coordinate with builder regarding termination of conduit in a building.
- Use steel pipe or plastic conduit.
- Place in same trench with main conduit, if practicable, and on top of main formation.

Conduit Casings

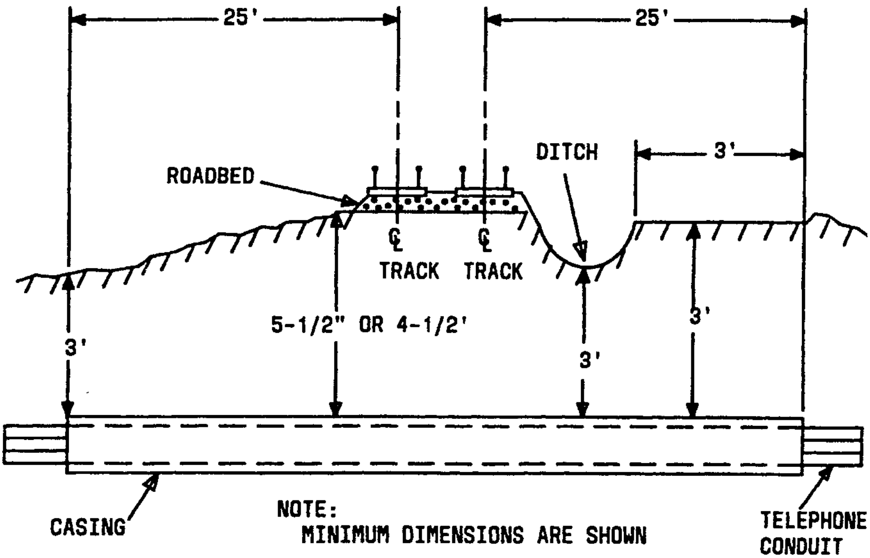
AT&T 919-000-100, 919-240-510

Steel casing pipe is recommended for housing underground conduit under railway and highway crossings. The casings are bored under the crossing to eliminate interference with traffic. Steel casings are also recommended as a supporting structure for conduit placed in unstable soil. Typical installations under a highway and railroad are shown on the following two pages.



NOTE: MINIMUM DIMENSIONS ARE SHOWN

Conduit Casings Under Highways



Conduit Casings Under Railroads

Note: Design runs to avoid conduit failure due to shearing at junction between casing and regular conduit run, which may result from a difference in settlement rates between casing and regular conduit.

The table below lists the duct capacity of standard size casings.

STEEL CASING PIPE — DUCT CAPACITY		
Standard Casing OD in. (mm) (Note 1)	Duct Capacity (Max)	
	Bundled Formation (Note 2)	Spaced Formation
12 (305)	3	3
16 (406)	4	4
18 (457)	7	4
20 (508)	7	7
24 (610)	10	10
30 (762)	19	19
36 (914)	—	24
42 (1067)	—	37
48 (1219)	—	44

Notes:

1. Casings with 22-, 26-, 28-, 34-, and 38-inch (559, 660, 711, 864, and 965 mm) diameters are nonstandard sizes and should be avoided.

2. More than 19 ducts in the bundled formation are not recommended and may result in severe deflection of the bottom ducts when top ducts are filled.

The wall thickness of the casing pipe is dependent on several factors such as the live or dynamic load from vehicular traffic, the dead or earth load, and the diameter of the casing used. (See table on the next page.) The dynamic load is dependent on the type and weight of the vehicle, the type of roadbed, and the depth of the casing. The earth load is dependent on the composition of the soil and the depth of the casing. Dynamic loads decrease and earth loads increase with casing depth.

STEEL CASING WALL THICKNESS	
Nominal Wall Thickness in. (mm)	Nominal Casing Diameter in. (mm)
0.188 (4.8)	Under 14 (356)
0.219 (5.6)	14 to 16 (356 to 406)
0.250 (6.4)	18 (457)
0.281 (7.1)	20 (508)
0.312 (7.9)	22 (559)
0.344 (8.7)	24 (610)
0.375 (9.5)	26 (660)
0.406 (10.3)	28 to 30 (711 to 762)
0.438 (11.1)	32 (813)
0.469 (11.9)	34 to 36 (864 to 914)
0.500 (12.7)	38 to 48 (965 to 1219)

Bridge Crossings

AT&T 919-240-520

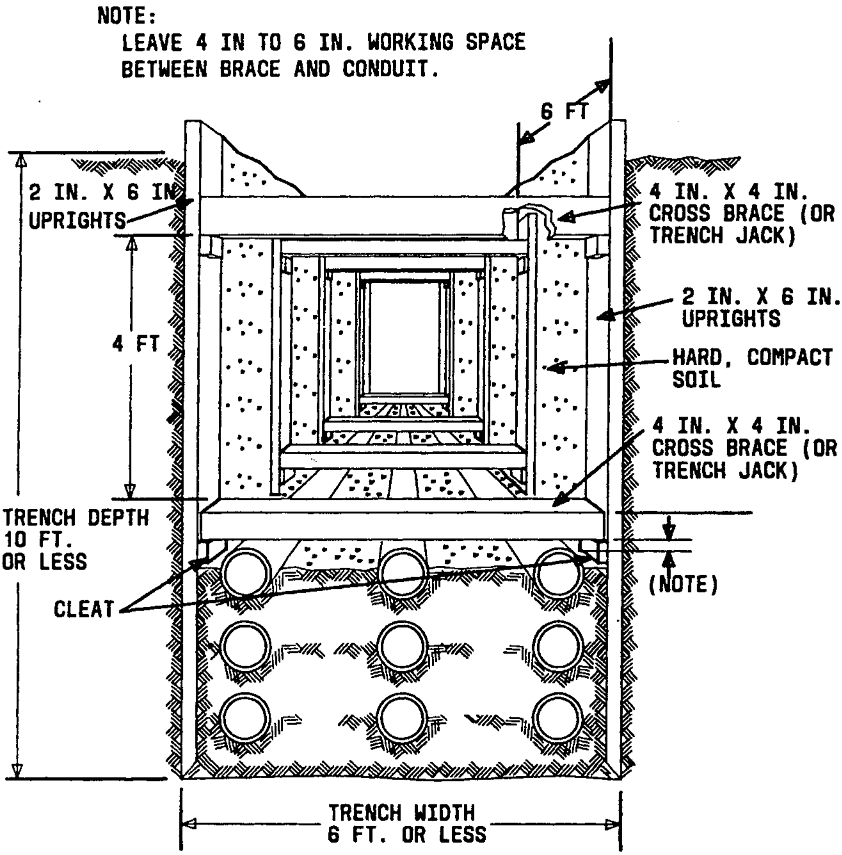
The diversity of bridge designs makes it impractical to prescribe a standard method of designing conduit on bridges. However, there are certain fundamentals which must be considered. These are covered in the document referenced above.

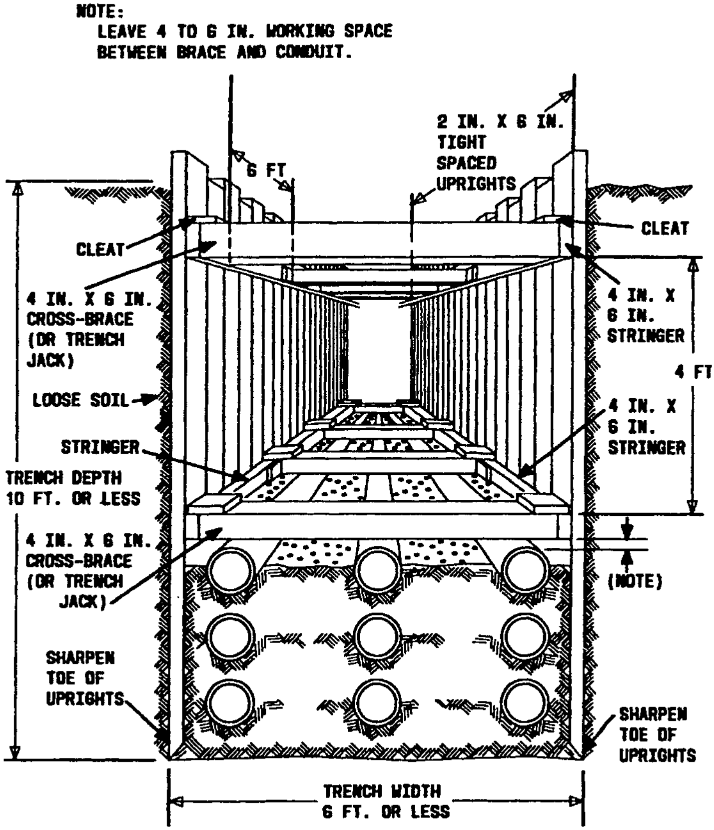
TRENCH WORK

AT&T 622-020-020

The Occupational Safety and Health Act (OSHA) requires that all excavations deeper than 5 feet (1524 mm), wherein a craft person is required to enter and work, shall have walls shored, sheeted, braced, or otherwise supported unless the excavation is in solid rock, hard shale, hard slag, or where the sidewalls are cut to a slope of 1 foot (305 mm) horizontally for each 2 feet (610 mm) of rise.

Typical shoring arrangements are shown below and on the next page.





Trenches less than 5 feet (1524 mm) deep should be shored if they constitute a hazardous work location. Someone shall be stationed on the surface to keep the persons in the excavation in sight at all times.

Minimum shoring requirements are listed below:

TRENCH SHORING — MINIMUM REQUIREMENTS
(Wood Member Dimensions in Inches)

Trench Depth (ft)	Soil (Note 1)	Uprights		Stringers (Note 2)	Cross-Braces for Trench Width up to (Note 3)			
		Size	Spacing (ft)		6 ft	9 ft	12 ft	15 ft
5 to 10	A	3 x 4 or 2 x 6	6	None	4 x 4	4 x 6	6 x 6	6 x 8
	B		3	4 x 6				
	C		Tight	4 x 6	4 x 6	6 x 6	6 x 8	8 x 8
	D		Tight	6 x 8				
10 to 15	A	3 x 4 or 2 x 6	4	4 x 6	4 x 6	6 x 6	6 x 8	8 x 8
	B		2	4 x 6				
	C		Tight	4 x 6	6 x 6	6 x 8	8 x 8	8 x 10
	D	3 x 6	Tight	8 x 10				
15 to 20	All	3 x 6	Tight	4 x 12	6 x 8	8 x 8	8 x 10	10 x 10
>20	All	3 x 6	Tight	6 x 8	8 x 8	8 x 10	10 x 10	10 x 12

Notes:

1. Soil type or condition: A — Hard, compact
   B — Likely to crack
   C — Soft, sandy, or filled
   D — Hydrostatic pressure.
2. Stringer spacing = 4 ft.
3. Cross-braces spaced 4 ft vertically, 6 ft horizontally.

Trench jacks may be used in lieu of, or in combination with, cross-braces.

MANHOLES

AT&T 622-500-011, 919-240-300

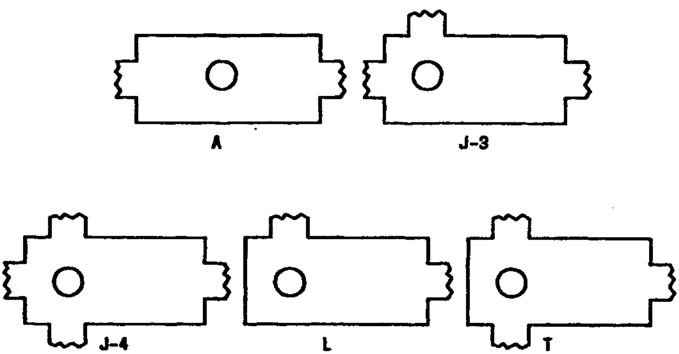
Planning and Design Considerations

- Locate manhole to make optimum use of the connecting conduit structure for cable-placing operations.
- Use precast manholes wherever possible for economy, uniformity, quality control, and quick installation.
- Use cast-in-place construction when: (a) required manhole size exceeds range of precast manholes, (b) obstructions prevent use of precast manholes, (c) manhole is to be rebuilt, or (d) nonstandard designs are required.
- Size manhole for ultimate duct requirements.
- Plug all ducts to minimize entry of water into manholes.

Sizes and Types of Manholes

Basic Manholes

Basic manholes are designated A, J-3, J-4, L, and T, according to the directions in which ducts enter and leave the manhole, as illustrated below.

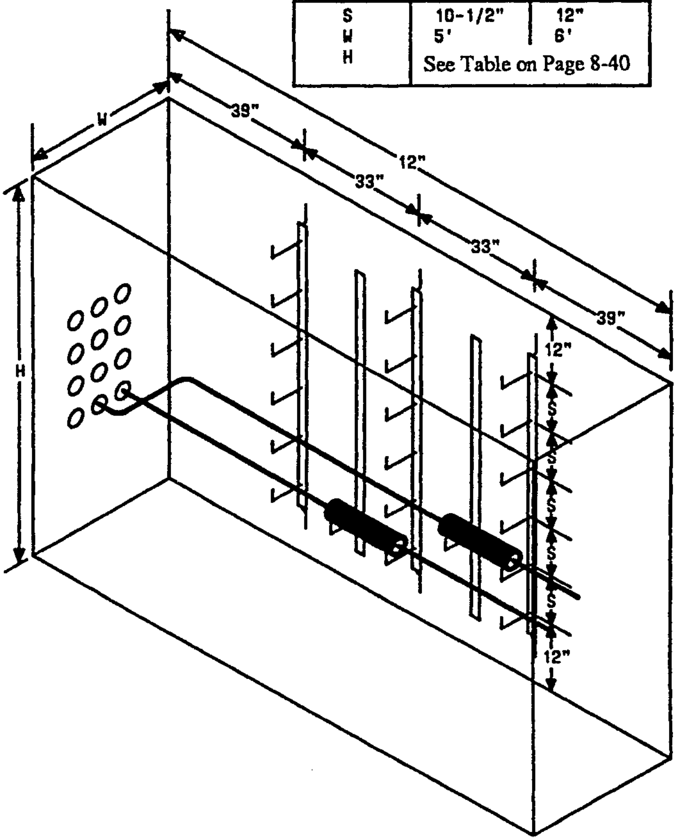


Sizes

Recommended dimensions of basic manholes are shown below. These sizes allow racking space to accommodate one stub for every four main cables. The ultimate number of main cables must be distributed equally among all racking positions.

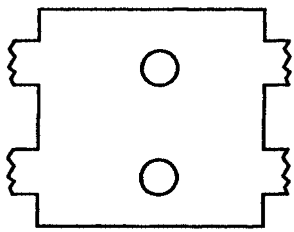
BASIC MANHOLE INSIDE DIMENSIONS				
Type of Racking	**Ultimate No. of Main Cables (Note)**	**Width ft (m)**	**Length ft (m)**	**Headroom ft (m)**
Single	Up to 10	5 (1.5)	12 (3.7)	7 (2.1) plus one for every two cables in excess of 20
Double	Up to 20	6 (1.8)	12 (3.7)	7 (2.1)
	>20	6 (1.8)	12 (3.7)	7 (2.1) plus one for every tier of ducts in excess of 20
Note: The ultimate number of main cables shown are for copper paired cables. The capacity would be increased with fiber optic cables.				

DIMENSION	SINGLE-RACK	DOUBLE-RACK
S	10-1/2"	12"
W	5'	6'
H	See Table on Page 8-40	



Center Rack Manholes

When the planned cable capacity calls for a manhole of impractical or uneconomical depth, a wider and shallower cast-in-place manhole may be built and arranged for center racking as well as wall racking. A center rack manhole is essentially a double-width manhole with a center cable racking frame.



For the same depth and type of racking, a center rack manhole is twice as wide as a basic manhole and can accommodate twice as many main cables.

Precast Manhole

AT&T 622-506-100, 919-240-300

Precast manholes are available with cast-in single or multiple plastic duct terminators to accept single-bore conduit. Thin concrete knockout sections may also be provided for terminating multiple-bore concrete conduit. The top section contains knockouts for subsidiary or lateral ducts.

Precast manholes for general use are listed below. Manholes for loading and carrier apparatus are listed below and on the next two pages.

PRECAST GENERAL-USE MANHOLES

Basic Manhole Designation	Midsection Designation	Config-uration	Number of Sections	Inside Dimensions ft (m)			Capacity (Number of Main Cables) (Notes)
				W	L	H	
38Y-4046-1 38Y-4046-3	— —	A J, L, T	2	6 (1.8)	12 (3.7)	7 (2.1)	20
38Y-4046-1 38Y-4046-3	38Y-4049-1 38Y-4049-3	A J, L, T	3*	6 (1.8)	12 (3.7)	10* (3.0)	28
38Y-4046-1 38Y-4046-3	38Y-4050-1 38Y-4050-3	A J, L, T	3*	6 (1.8)	12 (3.7)	12* (3.7)	36
38Y-4052	—	A	2	4 (1.2)	8 (2.4)	6 (1.8)	4†

Note: Based on copper paired cables.

* Including midsection.
† For splicing on light, secondary conduit runs or buried cable runs.

PRECAST CARRIER APPARATUS MANHOLES								
Basic Manhole Designation	Midsection Designation	Configuration	Number of Sections	Inside Dimensions (ft)			Carrier System	Capacity
				W	L	H		
38Y-436-6	—	A	2	6	12	6-1/2	T2	2 dual-cable systems using 52-pair cables, or 1 dual-cable system using 104-pair cables
38Y-4036-7	—	Single-ended						
38Y-4046-1	—	A	2	6	12	7	T1, T1C	Dual 600-pair cables
38Y-4046-1	38Y-4049-1	A	3*	6	12	10*	T1, T1C	Dual 900-pair cables
38Y-4046-1	38Y-4050-1	A	3*	6	12	10*	T1, T1C	Dual 1200-pair cables
38Y-4046-4	—	A	2	6	12	7	T4M	One 22-tube coaxial cable
38Y-4046-4	38Y-4049-4	A	3*	6	12	10*	T4M	Two 22-tube coaxial cables
38Y-4052	—	A	2*	4	8	6	T1, T1C	Four 475- or 479-type apparatus cases

* Including midsection.

PRECAST LOADING MANHOLES							
Basic Manhole Designation	Midsection Designation	Config-uration	Number of Sections	Inside Dimensions ft (m)			Capacity (Number of Coil Cases) (See Note)
				W	L	H	
38Y-4046-1	—	A	2	6 (1.8)	12 (3.7)	7 (2.1)	4
38Y-4046-1	38Y-4050-1	A	3*	6 (1.8)	12 (3.7)	12* (3.7)	10
38Y-4048	—	A	3	6 (1.8)	15 (4.6)	9 (2.7)	20
38Y-4048	36Y-4051	A	4*	6 (1.8)	15 (4.6)	12* (3.7)	28

Note: Can vary depending on local practice.

* Including midsection.

Separation From Other Structures

AT&T 622-100-010

Minimum recommended separations between telephone manholes and outside surfaces of foreign structures are as follows:

Structure	Separation
Electric light, power, or other conduits	3 inches (76 mm)
Pipes such as gas, water, oil mains	6 inches (152 mm) when crossing; 12 inches (305 mm) when parallel

FRAMES, COVERS, AND COLLARS

AT&T 622-520-100, 919-240-300

For frames and covers, the 30-inch (762 mm) size is recommended for all applications and should be specified for use with precast manholes. Although 27-inch (686 mm) frames and covers are available, their use is not generally recommended, particularly where only one manhole opening is provided. It is easier to get into and out of the 30-inch (762 mm) size, especially with a blower or pump hose in the opening, and there is more room for placing apparatus into the manhole. **The 24-inch (610 mm) frame and cover should not be used in new construction.** Available frames and covers are listed in the following table.

MANHOLE FRAMES AND COVERS			
Type	**Opening Dia. in. (mm)**	**Height of Frame in. (mm)**	**Remarks**
A	27, 30 (686, 762)	11 (279)	Has inner cover and sealing gasket; recommended for central office, carrier-equipped, loading, and critical junction manholes or wherever a watertight or secured cover is required
SA	27, 30 (686, 762)	5-5/8 (143)	Shallow version of A type
G	27, 30 (686, 762)	10 (254)	Has 4 equally spaced 1-in. (25 mm) diameter holes in the frame flange to permit securing the frame to concrete collars and to 38Y manhole roofs. Used with both the G (nonlocking) and H (locking) covers
SG	27, 30 (686, 762)	5-5/8 (143)	Shallow version of G type. Same remarks as G type
R	27, 30 (686, 762)	1-1/2 (38)	Used where not subject to vehicular traffic
D	30 (762)	1-1/2 (38)	Modified R with pentagonal head locking bolts
H	30 (762)	—	Covers only are equipped with two captive bolts with attached locking plates that engage the rim of either the G or the SG frame
Caution: For safety, use only one size frame on manholes with more than one opening.			

A manhole collar provides a means for raising the manhole frame and cover to grade. Brick-and-mortar collars and concrete collars may be constructed to any height. Alternatively, the following precast concrete collars can be used, either alone or in combination, to attain the desired height for up to 10 feet (3.1 m) of cover.

38Y PRECAST MANHOLE COLLARS		
Type	**Height in. (mm)**	**Use**
38Y-4039-1	5-1/2 (140)	Not a normal collar, but an apron designed to fit around the manhole cover at grade in unpaved areas to provide a solid, ground-level work area
38Y-4039-3 38Y-4039-9 38Y-4039-15	3 (76) 9 (229) 15 (381)	Used with any of the frames listed in table on Page 8-47 except for D and R types. Can also be used under 38Y-4039-15R collar
38Y-4039-15R	15 (381)	Includes a 30-inch R-type frame fabricated into collar. For use with R and D covers

The above collars can be used with precast or cast-in-place manholes. At least one opening should be provided for manholes up to 12 feet (3.7 m) in length, two openings beyond 12 feet (3.7 m) in length, and three openings beyond 20 feet (6.1 m) in length. The number of manhole openings required is doubled for center-racked manholes.

Manhole Extension Rings

AT&T 622-520-201

Pavement resurfacing operations sometimes necessitate the raising of manhole covers. This may be conveniently accomplished with manhole extension rings, which are described in the AT&T document referenced above.

DUCT ASSIGNMENT AND CABLE RACKING

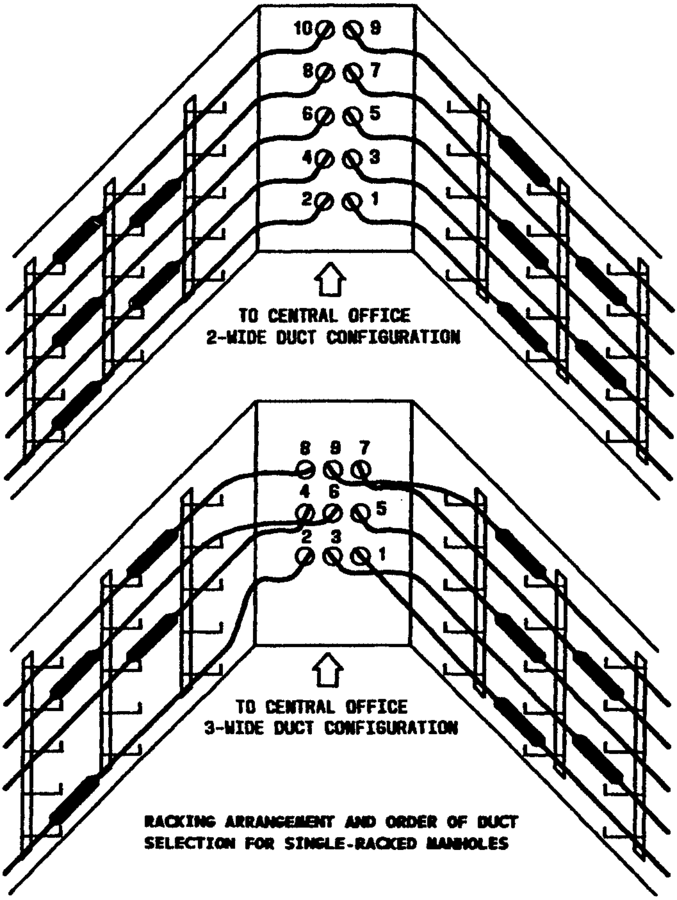
AT&T 632-305-215, 919-240-300

Cable rack space should be used in the specified sequence to permit work on cables after placement and to preserve work space for splicing additional cables. With double-racking arrangements, it is better to use all the outer (against the wall) rack spaces before using any inner (toward the center of the manhole) spaces. With either single or double racking, spaces should be used from the bottom up.

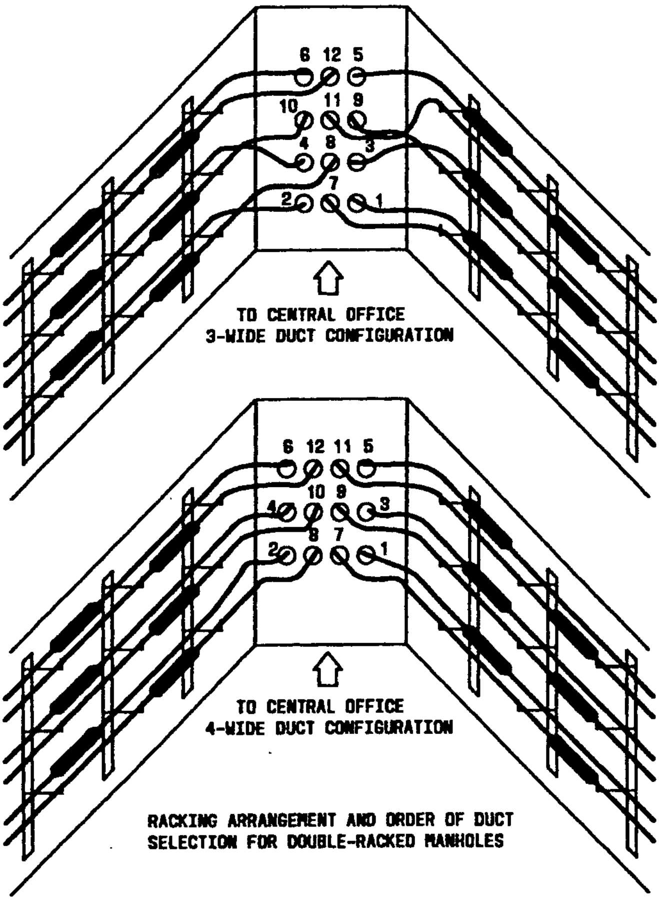
Ducts should be selected to avoid:

1. Cable crossovers between the duct entrance and the cable rack
2. Blockage of future access to vacant ducts.

Racking arrangements and order of duct selection for line manholes are shown on the next two pages. For A-, L-, and T-type manholes, see referenced practices. Single-racked manholes are shown on Page 8-50. Double-racked manholes are shown on Page 8-51.



RACKING ARRANGEMENT AND ORDER OF DUCT SELECTION FOR SINGLE-RACKED MANHOLES



RACKING ARRANGEMENT AND ORDER OF DUCT
SELECTION FOR DOUBLE-RACKED MANHOLES

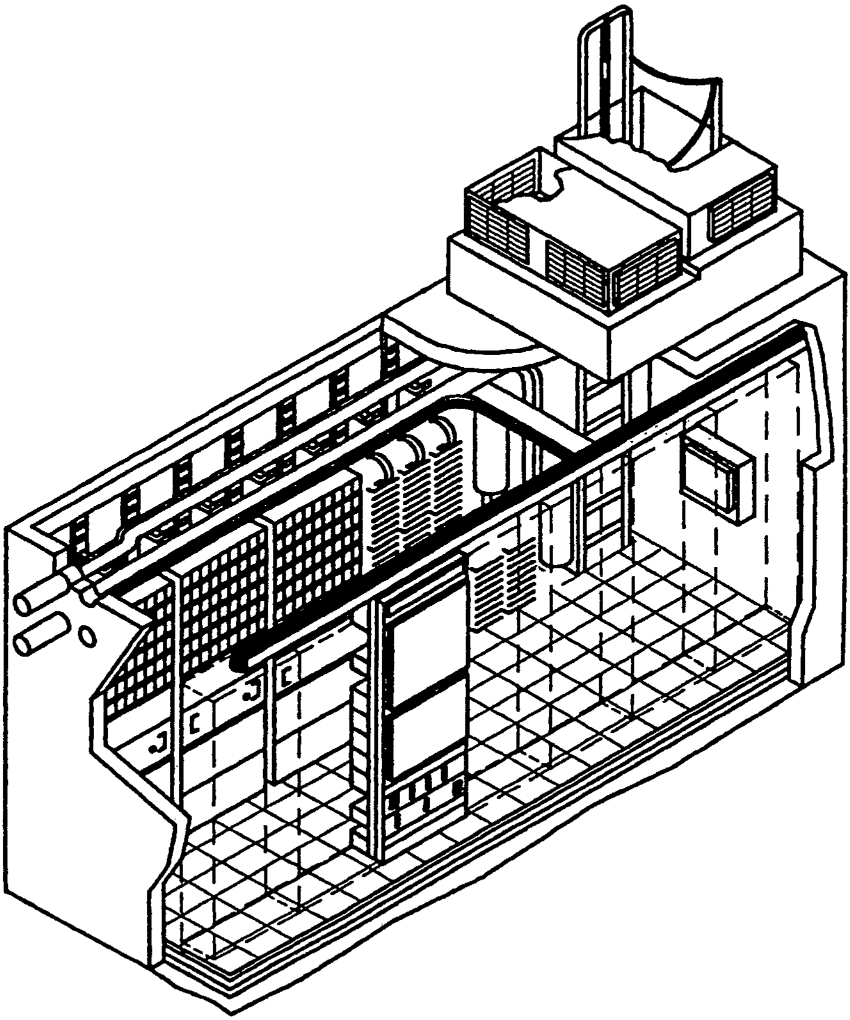
CONTROLLED ENVIRONMENT VAULT (CEV)

AT&T 622-506-225 to -228, 919-240-302

The Controlled Environment Vault (CEV) is designed to provide an underground facility suitable to house electronic equipment such as subscriber loop carrier systems or FT3/FT3C lightwave digital transmission system regenerators. **The CEV is not equipped to support through underground cable, as are regular manholes. They are generally placed in proximity to a manhole on a main underground route.**

The CEV is a precast concrete structure consisting of a top and bottom section. CEVs are available in 16- and 24-foot (4.9 and 7.3 m) length sizes, depending on the amount of electronics equipment to be housed. They have an inside dimension of 6 feet (1829 mm) wide and 9 feet (2743 mm) of headroom.

A CEV equipped with subscriber loop carrier equipment is shown on the following page. CEVs are equipped with AC power, lights, sump pump, dehumidifier, ventilation blower, heater, and atmospheric monitor. Air conditioning is optional depending on where they are being installed. **The engineer must use caution when choosing a site for a CEV. The bottom of the exhaust air vent must be above the 100-year flood level.** This information is available from insurance companies or local government agencies. Some of the equipment is above ground, which may be hazardous to the public. This aboveground equipment will be exposed to moisture such as snow.



Controlled Environment Vault (CEV) Equipped With
Subscriber Carrier Equipment

BIBLIOGRAPHY

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622-020-020	Conduit and Manhole Construction — General
622-020-100	Conduit Types and Uses
622-100-010	Conduit and Manholes — Precautions
622-300-205	Conduit — Special Construction
622-315-200	Steel Pipe — Laying
622-340-200	B Plastic Conduit
622-340-201	C Plastic Conduit
622-500-011	Manholes — General
622-505-210	Cast-in-Place Construction of Manholes
622-506-100	Precast Concrete Manholes — 38Y-Types
622-506-225	16-Foot (4.9 m) Controlled Environment Vault (CEV) Installation
622-506-227	24-Foot (7.3 m) Controlled Environment Vault (CEV) Installation
622-506-236	KS-23038 (CEV) Controlled Environment Vault Installation
622-520-100	Manholes — Equipping
622-520-111	Loading Manhole Racking
622-520-201	Extension Rings
628-200-215	Innerduct Placing — Underground
628-200-216	Fiber Optic Cable Placing — Underground
632-305-215	Cable Racking in Manholes
640-527-230	T1C System Manhole Layout
640-530-230	T2 Manhole Layout and Equipping
640-540-230	T4M Manhole Layout and Equipping
900-200-210	Fiber Optic Cable Systems Outside Plant Standards Handbook (*Note:* This document is AT&T Proprietary.)
919-000-100	Design of Communication Lines Crossing Railroads

AT&T	Title
919-240-001	EIMS for Underground Conduit
919-240-100	Conduit System Design
919-240-200	Conduit Sizing
919-240-300	Underground Conduit Manholes
919-240-301	Deep Neck Manholes
919-240-302	16-Foot (4.9 m) Controlled Environment Vault (CEV)
919-240-310	Manholes and Service Boxes for T1 Carrier
919-240-400	Underground Conduit Materials
919-240-510	Placing Steel Casing Pipe — Special Construction
919-240-520	Bridge Crossings
920-400-100	Fiber Optic Cable Planning — Underground
928-100-400	Conduit Record
928-411-510	Preparation of Work Prints — General
928-411-511	Preparation of Work Prints — Underground Conduit

Section 9

Contents

Section 9

BURIED PLANT

PLANNING AND DESIGN GUIDELINES

AT&T 917-356-001

Buried plant is recommended as the first choice of providing outside plant (OSP) facilities beyond the underground network.

Selecting Placing Locations

- Select a permanent location for all buried plant, considering such factors as right-of-way limitations, soil type, natural obstacles (that is, rocks and trees), other underground utilities, and possible future excavation, such as that involved in road widening, fences, or ditching.
- Comply with all ordinances and regulations. Where required, secure permits before placing, excavating on private property, crossing streams, pushing pipe, or boring under streets and railways.
- Determine location of existing underground utilities.

Urban and Suburban Residential Areas

AT&T 917-356-100

Place distribution cables along the front property line or in a utility easement along the rear property line. Factors to be considered in selecting cable location are:

- Soil and subsurface conditions
- Natural obstacles such as rocks, trees, and unfavorable terrain
- Location of other utilities and the possibility of joint construction

- Existing or future obstructions such as topsoil storage, fences, swimming pools, and road paving
- Ease of locating plant: The front curb provides a convenient reference for locating cables and closures; electronic markers are used to locate out of sight closures where subsequent reentry is expected.

Low-Density (Rural) Areas

AT&T 917-356-201

When planning to bury cable in low-density areas, consider these factors:

- Protection from damage due to future road construction
- Adequate right-of-way for future cables
- Greater potential customer density from either side of road
- Highway authority requirements.

Possible locations are:

- Private property parallel to road
- Between ditch and property line
- Road shoulder.

Mobile Home Parks

AT&T 917-352-310

Cable should be buried along the rear lot line, with the distribution terminal located to serve homes. Protector mounting may be on a joint pedestal with power, a Telco-provided steel post, or a wood post provided by the park operator. If the protector is within 12 inches (305 mm) of the mobile home, station wire may span the space between them.

Cable and Sheath Selection—Copper

AT&T 626-101-010

Filled polyethylene insulated conductor (PIC) cable is the only cable recommended for direct burial in the ground. This cable is available in pair sizes from 6 to 3000, depending on the gauge. See Section 14, "CABLE AND WIRE" for a complete listing of AT&T copper cables.

Cable and Sheath Selection—Fiber Optic

There are also several fiber optic cables which are available for direct buried application. See Section 14, "CABLE AND WIRE" for a complete listing of AT&T fiber optic cables.

CABLE SIZING

AT&T 917-152-200

Distribution Cables—Copper

Urban and Suburban Areas

AT&T 901-350-250, 915-251-300

Buried distribution cables should be sized for the ultimate requirements of the living units and business locations within the area served by the cable. A minimum of one to two pairs per ultimate living unit is standard. However, the number of pairs provided should be consistent with customer requirements. The number of pairs required for business locations in an area is variable, depending on the type of business. Therefore, the number of pairs required for each business location is left to the judgment of the engineer.

The recommended design in predominantly residential areas is the Secondary system distribution concept. This is where the geographical area of a wire center is divided into discrete areas. An interface is placed between the Primary (feeder) system and the Secondary (distribution) system. The distribution cables are sized for the ultimate requirements in each block or cable area and then extended back to the interface multiple free. Therefore, it is important that the site for the interface be finalized before sizing the distribution cables to serve the various blocks or cable areas within the Secondary system.

In business office complexes or industrial areas, buried distribution cables should be sized for the ultimate based on known service requirements and sound engineering judgment.

Low-Density (Rural) Areas

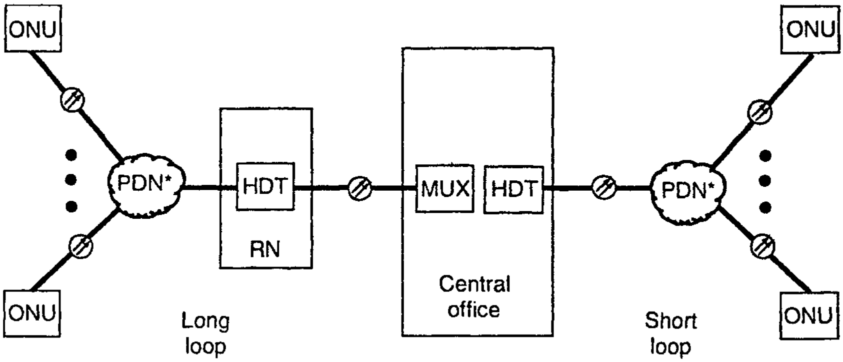
Sizing of buried distribution cables in rural areas is generally difficult due to the following:

- Difficulty in identifying the ultimate service requirements.
- The majority of the cables in rural areas contain both feeder and distribution facilities.
- Services beyond 18 kilofeet (5.5 km) of the central office (CO) must be on loaded facilities (resistance design). Therefore, the distribution pairs within a cable must be tailored to serve customers within each load section (6000 feet [1.8 Km] plus end section). Hence, the engineer must forecast the number of pairs required in each load section.

The engineer should consider the extent of the area to be served by the buried cable, the number and type of customers served, and the forecasted growth when sizing cables in rural areas.

Feeder Cables—Fiber Optic

Bellcore has defined the elements of a FITL system in TR909, as illustrated on the next page. Optical network units (ONUs) are generally located to serve multiple subscribers; for example, at curbside in residential applications. These ONUs connect a host digital terminal (HDT) over a fiber optic link. The HDT then interfaces to the switch. For short loop applications, the HDT may be located in a central office building; for long loops, the HDT may be remotely located in a cabinet, hut, or controlled environment vault (CEV).



*PDN - Passive Distribution Network

The ***SLC***®-2000 multiservices distant terminal (MSDT) is AT&T's ONU product. The HDT may be either a ***SLC*** Series 5 or a ***SLC***-2000 remote terminal. The ***SLC***-2000 MSDT feature uses one singlemode fiber along with 1310 nm optical components to provide a bidirectional transmission link between each ***SLC***-2000 MSDT and the HDT. Telephone and data distribution from the ***SLC***-2000 MSDT to the subscriber is accomplished with standard twisted-pair metallic drops. The distribution of video services, including Video Dial Tone, may also be accomplished through the ***SLC***-2000 MSDT with the installation of the optional ***SLC***-2000 Broadband Video Channel Unit. Using a separate fiber from a video head-end, high quality analog and/or digitally compressed video signals are delivered to the ***SLC***-2000 MSDT for distribution to subscribers over coax drops.

Buried fiber optic feeder cables will generally be sized on the number of digital subscriber carrier systems they will serve and the number of fibers required for each system.

Distribution Cables—Fiber In The Loop (FITL)

The size of the distribution cable is based on the number of MSDTs rather than on pairs per customer as with copper facilities. In some situations it may be economical to place paralleling single-fiber cables in the same trench to each MSDT rather than place a multifiber cable and introduce numerous branch splices into the network. A more detailed explanation and illustrations showing FITL with the AT&T ***SLC***-2000 MSDT is located in Section 13, "DIGITAL LOOP CARRIER SYSTEMS."

Feeder Cables—Copper

Urban and Suburban Areas

Buried feeder cables in urban areas should be sized for an economical period. Caution must be taken when determining the location of a buried feeder cable so that it will not interfere with the placing of future feeder cables or underground conduit.

Low-Density (Rural) Areas

Feeder pairs and distribution pairs in rural areas are generally contained in the same cable. Therefore sizing of feeder cables in rural areas should include the pairs required in each distribution section.

JOINT CONSTRUCTION

AT&T 629-020-100

In areas where both power and telephone utilities plan to bury their facilities, a joint trench is usually advantageous. Besides saving in installation cost, there is less likelihood of damage during construction. Successful joint operations require advance planning and close coordination with the utilities involved. **Joint trenching with power facilities should be employed only for distribution cables and service wires, not for feeder or trunk cables.**

IMPORTANT

Do not use joint construction for dedicated cables serving power stations. See Page 6-3 in this handbook.

Random Separation Between Power and Telephone Facilities

NESC Rule 354

Power and telephone conductors may be buried in the same trench, without deliberate separation. The following requirements must be met.

Random Separation—Additional Requirements

General

- These rules apply to cables or conductors when the radial separation between them will be less than 12 inches (305 mm).
- Supply circuits operating above 300 volts to ground or 600 volts between conductors shall be so constructed, operated, and maintained that when faulted they shall be promptly deenergized initially or following subsequent protective device operation (phase-to-ground faults for grounded circuits, phase-to-phase faults for ungrounded circuits).
- Communication cables and conductors, and supply cables and conductors, buried in random separation may be treated as one system when considering separation from other underground structures or facilities.

Supply Cables or Conductors

The cables or conductors of a supply circuit and those of another supply circuit may be buried together at the same depth with no deliberate separation between facilities, provided all parties involved are in agreement.

Communication Cables or Conductors

The cables or conductors of a communication circuit and those of another communication circuit may be buried together and at the same depth with no deliberate separation between facilities, provided all parties involved are in agreement.

Supply and Communication Cables or Conductors

Supply cables or conductors and communication cables or conductors may be buried together at the same depth with no deliberate separation between facilities, provided all parties involved are in agreement and the applicable rules in 354D1 are met and either Rule 354D2 or 354D3 is met.

- General
  - Grounded supply systems shall not be operated in excess of 22,000 volts to ground.
  - Ungrounded supply systems shall not be operated in excess of 5300 volts phase to phase.
  - Cables of an ungrounded supply system operating above 300 volts shall be of effectively grounded concentric shield construction. Such cables shall be maintained in close proximity to each other.
  - Ungrounded supply circuits operating above 300 volts between conductors and in random separation with communication conductors shall be equipped with a ground-fault indication system.
  - Communications-protective devices shall be adequate for the voltage and currents expected to be impressed on them in the event of contact with the supply conductors.
  - Adequate bonding shall be provided between the effectivel grounded supply conductor or conductors and the communication cable shield or sheath at intervals not exceeding 1000 feet (305 m).

- In the vicinity of supply stations where large ground currents may flow, the effect of these currents on communication circuits should be evaluated before communication cables are placed in random separation with supply cables.

- Grounded Bare or Semiconducting Jacketed Neutral Supply Cables

  - A supply facility operating above 300 volts to ground shall include a bare or semiconducting jacketed grounded conductor in continuous contact with the earth. This conductor, adequate for the expected magnitude and duration of the fault current that may be imposed, shall be one of the following:

    a. A sheath, an insulation shield, or both

    b. Multiple concentric conductors closely spaced circumferentially

    c. A separate conductor in contact with the earth and in close proximity to the cable, where such cable or cables also have a grounded sheath or shield not necessarily in contact with the earth. The sheath, shield, or both, as well as the separate conductor, shall be adequate for the expected magnitude and duration of the fault currents that may be imposed.

       Note: This is applicable when a cable in nonmetallic duct is considered as a direct-buried cable installation and random separation is desired.

    Exception: Where buried cable passes through a short section of conduit such as under a roadway, the grounded conductor's contact with earth can be omitted, provided the grounded conductor is continuous through the conduit.

  - The bare conductor or conductors in contact with the earth shall be of suitable corrosion-resistant material. The conductor covered by a semiconducting jacket shall be compatible with the jacketing compound.

Note: Experience has shown that in many geographic areas, bare concentric copper neutral conductors experience severe corrosion.

— The radial resistivity of the semiconducting jacket shall be not more than 100 Ωm and shall remain essentially stable in service. The radial resistivity of the jacket material is that value calculated from measurements on a unit length of cable, of the resistance between the concentric neutral and a surrounding conducting medium. Radial resistivity is equal to the resistance of a unit length times the surface area of the jacket divided by the average thickness of the jacket over the neutral conductors. All dimensions are to be expressed in meters.

- Insulating Jacketed Grounded Neutral Supply Cables

  — Each phase conductor of a multigrounded supply system operating above 300 volts to ground and having an overall insulating jacket shall have an effectively grounded copper concentric conductor meeting all of the following requirements:

  a. A conductance not less than one half that of the phase conductor.

  b. Adequate for the expected magnitude and duration of fault current that may be imposed.

  c. Grounded in accordance with Rule 314 except that the grounding interval required by Rule 96C shall be not less than eight in each mile of the random buried section, not including grounds at individual services.

- Insulating Jacketed Grounded Neutral Supply Cables in Nonmetallic Duct

  — Insulating jacketed grounded neutral supply cables meeting the rules of 354D3, when installed in a nonmetallic duct, may be random-laid with communication cables.

CABLE PLACING

Placing PIC Cable—Copper

AT&T 629-200-206

- Show existing subsurface structure on the work prints with the name of the person to contact for exact locations (by test pit) after construction has started.
- Stake the locations of closures.
- When specifying reel lengths, allow for looping cable through closures.
- Obstructions may vary the reel lengths that can be employed; plan reel lengths to minimize the number of splices.
- Avoid having reel ends fall in the center of roads or streams or in other undesirable locations.
- Show on work plans all foreign objects that are in close proximity to the cable path.
- For record purposes, refer the cable location to some permanent reference, such as road right-of-way, curb, or centerline.
- When crossing a buried power cable or duct, provide earth or concrete separation as indicated on Page 9-8.
- Place cable at the recommended depths listed in the table on the next page.

RECOMMENDED DEPTHS FOR PLACING PIC CABLE	
Facility	**Depth of Cover in. (mm) Normal (Note 1)**
Toll, trunk cable	30 (762)
Feeder, distribution cable	24 (610)
Service wire	12 (305)
Fiber optic cable	36-48 (914-1219) (Note 2)

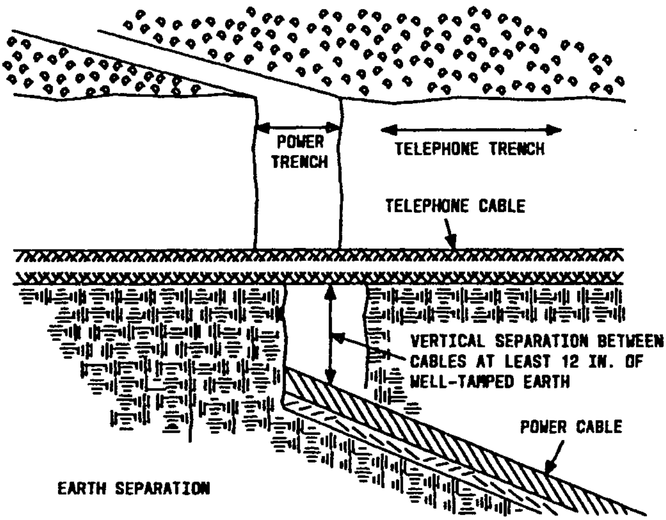
Notes:

1. Minimum required depth is listed. Greater depth will reduce risk of trouble due to dig-ups and should be provided wherever future digging is likely to occur, for example, under ditches. Trench depth is governed by the National Electrical Safety Code (NESC) (Rule 353D) requirements for power cables:

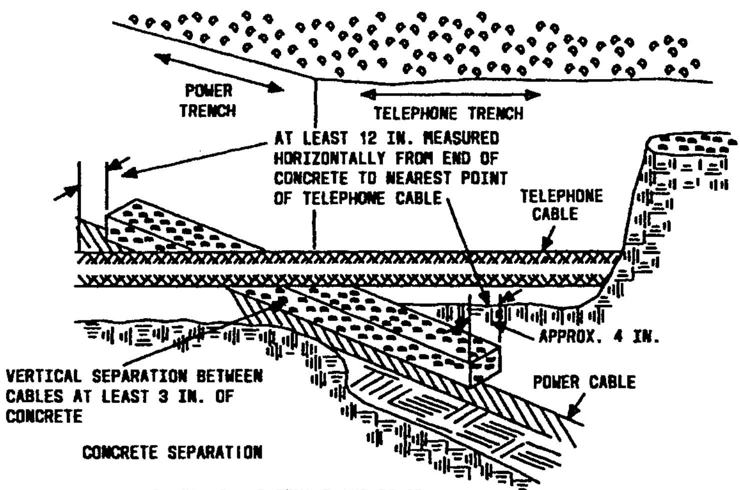
Voltage Phase-to-Phase	Depth of Burial (in)	Depth of Burial (mm)
0 to 600	24	610
601 to 50,000	30	762
50,001 and above	42	1067

This requirement exceeds ANSI/EIA/TIA-590, -591 standards.

2. Actual depth of cover for fiber optic cable will depend upon customer requirements and local field conditions.



EARTH SEPARATION



CONCRETE SEPARATION

SEPARATION OF TELEPHONE AND POWER CABLES WHERE TRENCHES CROSS

Placing Fiber Optic Cable

AT&T 629-200-205, -206, 629-240-001, 900-200-210, 920-406-200

Designing a buried fiber optic cable is similar to conventional exchange cable. Due to the large circuit-carrying capacity of fiber optic cable and the class of service being transmitted, it is important that the cable be placed in a safe location.

For buried fiber optic cable routes, some of the requirements that are different from those in metallic conductor exchange cable routes are as follows:

1. **The minimum depth of cover below final grade for buried fiber optic cable is 36 inches (914 mm).** In locations where frequent digging operations are likely (ditches, public roads, etc.), the depth of cover should be increased appropriately or some kind of protection placed.
2. When existing subsurface facilities are encountered which cross the fiber optic cable route, the cable should cross underneath the existing facility, with at least 1 foot (305 mm) of vertical separation, if possible.
3. At major subsurface intersections as well as at all intersections with permanent surface obstacles such as roads, railroads, stream crossings, etc., a separate, empty, capped duct extending at least 10 feet (3.1 m) on either side of the obstruction shall be considered at the time of construction. The duct may be metal or rigid plastic. If fiber optic cable is installed in direct-buried duct liner, the recommended duct liner is smooth bore polyethylene with a minimum I.D. of 1-1/2 inches (38 mm).
4. Fiber optic cables which contain conductive elements are susceptible to lightning. In high lightning areas, consideration should be given to the use of all dielectric cable or rodent/lightning (R/L) cable. Some high lightning areas may require the use of "B" oversheath type cable.

It is recommended that the design engineer and construction supervisor field-survey the route prior to design to determine:

- The safest location for the cable
- Optimum splice locations
- Method of placement (plowing versus trenching)
- Surface and subsurface conditions requiring special attention or construction
- Hazardous locations.

See Section 14, "CABLE AND WIRE" for a complete listing of AT&T fiber optic cables.

Plowing

Plowing fiber optic cable with static or vibratory plows is permissible. The minimum bending radius should not be violated when plowing. A ripping pass, or passes, if more than one is necessary to obtain the full depth, should be made in the same direction as the cable being installed. Ripping makes the installation of the cable easier and and ensures that all obstacles below the surface have been located.

A starting (finishing) pit should be dug at the location of each buried splice. At road crossings, both ends of the casing must also be exposed. Pits should be opened before plowing begins.

Trenching

Trenching is preferred over plowing for installation in rocky soil, in urban or suburban environments with many obstacles, or in areas with difficult access.

Note: Under normal conditions with stable soil, shoring is not required unless trenches, pits, or excavations are 5 feet (1524 mm) or more in depth and employees have occasion to enter them. This 5-foot (1524 mm) guide should be modified to shallower depths if unstable soil conditions or rainy weather exists or if heavy equipment or traffic is in proximity to the trench, excavation, or pit.

The trench should be as straight as possible to assist in future cable location. If the conduit is placed in the trench, it should be aligned so that it is as straight and level as possible. Joint-use trenching should not be considered or used as co-occupants present future cable damage hazards.

During open trench construction, large rocks should be removed from the soil before it is used for backfilling. The bottom of the trench should be rock-free and smooth. When backfill contains little soil (for example, in areas where blasting was required), the cable should be surrounded with at least 6 inches (152 mm) of select fill prior to backfilling. Slurry should not be used with direct buried cable.

CABLE INSTALLATION

Do not exceed cable pulling tensions when placing cables through innerduct, conduits, or casings. Do not violate the minimum bending radius for fiber optic cable (20 times the cable diameter) when plowing or installing cable in trenches. This requirement should be enforced by the construction supervisor on the job.

A pit should be dug at the location of the splice for each reel of cable. Pits should be opened before trenching of the cable section begins.

Splices should be made in belowground closures whenever possible. Where a buried splice is required, it will be necessary to provide an excavation sufficient in size for the splicing operations specified on the detailed plans. It is important when installing buried cable to make proper arrangement for ar adequate extra length of cable at both ends of a section for testing and splicing. This length must be sufficient to enable construction of splices and sheath closures at a convenient work position. Enclosures used to house splices shall be capable of withstanding American Association of State Highway and Transportation Officials (AASHTO) H-20 loading when placed in traveled ways. This loading requirement also applies to handholes and manholes placed in traveled ways. Electronic markers should be placed to facilitate subsequent locating of buried splices.

Where cable placement parallels high-tension power lines, the stationary end of the cable should be temporarily grounded to prevent induced voltages from being a hazard to cable placement personnel.

BURIED SERVICE WIRES

AT&T 631-600-214, 928-411-513

It is recommended that buried service wires be placed at the same time as the buried distribution cable. In urban and suburban areas, this takes cooperation between the telephone company and a subdivider or builder. Property lines have to be marked, building locations known, and semifinal grade completed. The following guidelines apply:

a. When a building or its foundation is present, the service wire should be placed at the same time as the distribution cable.

b. When the structure has not yet been built, the following options are available:

- ***Aboveground or Flush-With-Ground Closures***. Wait until building foundation is completed before installing service wire.
- ***Belowground Encapsulated Closures.*** Service connection can be made according to one of the following procedures:
  - — Using a sufficient length of service wire to reach the future structure, connect to the distribution cable. Store the wire either aboveground on a stake or in a temporary closure (such as a B wire storage closure), or belowground in a plastic bag or other suitable protective enclosure. Encapsulate the end of the service wire if it is stored below ground.
  - — Connect the service wire to the cable, stub out to a readily identifiable location, and store as above. An electronic marker may be used.

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626-108-101	Ribbon Type — Multimode Fiber Optic Cables
626-108-102	Stranded Single and Multimode Fiber Optic Cables
626-108-103	***LIGHTPACK***® Fiber Optic Cable
629-020-009	B Wire Storage Closure
629-020-100	Buried Cable — Urban Installation — Power and Telephone in Same Trench
629-200-205	Guidelines for Trenching, Backfilling and Ground Restoration
629-200-206	Buried Plant — Placing
629-200-215	Buried Plant — Plowing
629-240-001	Plowing Guidelines for Placing Fiber Optic Cable
901-350-250	Detailed Distribution Area Planning
915-251-300	Serving Area Concept — Distribution Cable Design
917-152-200	Distribution Cable — Sizing and Transmission
917-300-100	Preterminated Cable — Engineering and Design Guidelines
917-352-310	Distribution Cable Design — Serving Mobile Homes
917-356-001	EISM for New Buried Distribution Facilities
917-356-100	Buried Urban Distribution Systems
917-356-101	Joint Random Separation
917-356-201	Buried Nonurban Cable Systems
920-400-200	Fiber Optic Cable — Installation Planning — Buried

AT&T	Title
928-411-510	Preparation of Work Prints — General
928-411-513	Preparation of Work Prints — Buried Cable
937-217-150	Joint Agreements With Power Companies — Random Buried Installations

National Electric Safety Code

Rule 353D	Direct Buried Cable — Depth of Burial
Rule 354	Direct Buried Cable — Random Separation

Manual

363-205-002	***SLC***® Series 5 Carrier Fiber-to-the-Home Feature

Section 10

Contents

Section 10

AERIAL PLANT

PLANNING AND DESIGN GUIDELINES

AT&T 919-120-100

- Consider aerial design only if buried design is significantly more expensive or is not feasible.
- Select permanent locations for pole lines considering:
  - Future road widening or realignment
  - Expansion of other utilities
  - Special problems such as road, railway, and power line crossings
  - Safety and convenience of workers and the general public.
- Obtain necessary permits for:
  - Building and maintaining pole lines on private property and public right-of-way
  - Crossing railroads
  - Crossing over navigable waterways.
- Coordinate with other utilities with respect to:
  - Possible joint use
  - Minimizing inductive interference.
- Design pole line for ultimate needs, considering pole line classification, storm loading, and clearance requirements.
- Use the most economical span length within the constraints imposed by the design guidelines herein.

- When adding cable to an existing line or when establishing a joint-use line, check that the pole strength and clearances are adequate.
- Use self-supporting cable rather than lashed cable if it is available in the required size and if (1) there is no existing strand or (2) new cable cannot be lashed to an existing cable.

POLES

Pole Classes

AT&T 621-020-111, 919-120-700

The strength of a pole is indicated by a class number, with the strongest rated at 1 and the least strong rated at 10. All poles of the same class, regardless of length and timber species, must be able to withstand the same horizontal load, applied 2 feet (610 mm) from the top of the pole. The minimum breaking loads are given below. These loads are computed with the assumption that the break would occur at the ground line.

The pole class for a given installation is based on the expected loading and a safety factor that is determined by the pole line classification (see Page 10-6).

CHARACTERISTICS OF POLES			
Pole Class	Breaking Load 2 ft From Top (lb)	Longest Available Pole (ft)	Weight of Longest Pole (lb) (Note)
1	4500	125*	10850
2	3700	125*	9510
3	3000	110*	6610
4	2400	80*	3430
5	1900	70*	2400
6	1500	60	1620
7	1200	50	1040
8		(This is not a standard class.)	
9	740	30	340
10	370	25	210

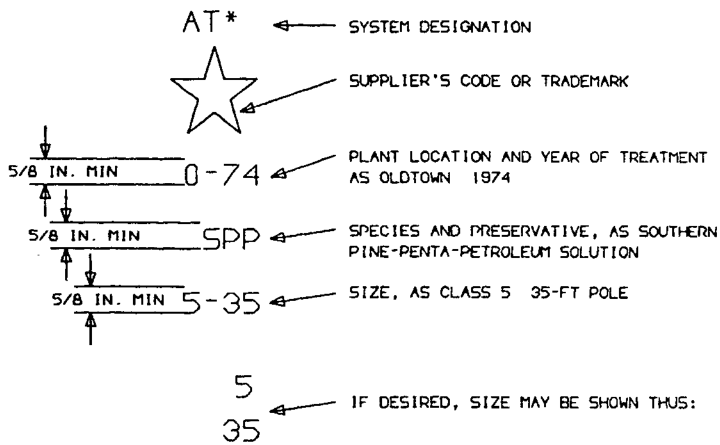
Note: Weight is for the heaviest species (Southern Pine); the lightest species (Western Red Cedar) is 30 to 40 percent lighter.

* The longest Jack Pine, Lodgepole Pine, or Red Pine pole is 60 feet (18.3 m).

Markings on Poles and Stubs

AT&T 621-020-013, 919-120-400

Since 1974, poles and stubs have been marked as illustrated on Page 10-4. Between 1964 and 1974, the markings were the same except that the AT and AT-R designations were not used. Prior to 1964, only poles (not stubs) were marked. Codes used in these markings are listed on Page 10-5.



*AT R FOR RE-TREATED OR RECONDITIONED POLES

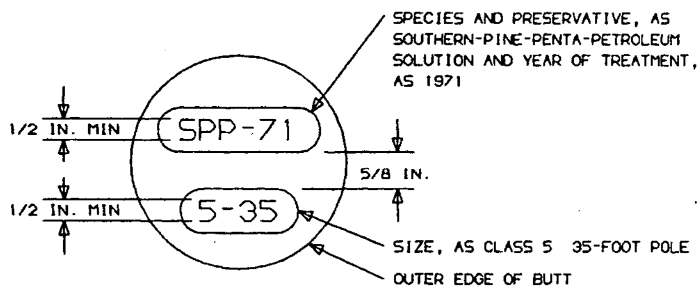
NOTE* LOCATION OF LOWEST PART OF MARKINGS IS 10 FEET FROM BUTT, EXCEPT:

10-FOOT STUBS 9-1/2 FEET FROM BUTT

55-FOOT AND LONGER POLES SINCE 1964 14-FEET FROM BUTT

80-FOOT AND LONGER POLES FROM 1955 TO 1964 15 FEET FROM BUTT

POLES PURCHASED AND PLACED BY OTHER COMPANIES



NOTE THE BUTT MARKING SHOULD BE LOCATED WITH RESPECT TO OUTER EDGE OF BUTT, APPROXIMATELY AS SHOWN

MARKINGS MAY ALSO BE BRANDED

Timber Species Codes

WC	Western Red Cedar
WP	Ponderosa Pine
JP	Jack Pine
LP	Lodgepole Pine
NP	Red Pine
DF	Douglas Fir
SP	Southern Pine
WL	Western Larch

	Preservative Treatment Codes	Used on Timber Species
	Copper Naphthenate	
A	Creosote Pentachlorophenol (Discontinued code)	SP
C	Creosote* (Discontinued code)	SP
G	Pentachlorophenol in LP Gas (Cellon Process)	WP, LP, DF, SP
P	Pentachlorophenol in Petroleum	All
S	CHEMONITE† or greensalt (Discontinued code)	—
SB	Ammoniacal Copper Arsenite (ACA-CHEMONITE)	All
SC	Chromated Copper Arsenate (CCA) Type A	All
SK	CCA Type C	All

* Furnished only on specific authorization of operating company.

† Registered trademark of the J. H. Baxter Company.

For a description of preservative treatments, see AT&T 919-120-400.

In 1946-47, poles treated with a preservative other than creosote were marked with symbols that are now obsolete and do not correspond to the codes listed above.

POLE LINE DESIGN

Pole Line Classification

AT&T 919-120-200

Pole lines are classified according to their service value. Those carrying more critical services are designed with a higher strength-to-load ratio. Classifications are as follows:

CLASS OF LINE	DESCRIPTION (NOTE)	DESIGN STRESS FOR TRANSVERSE STORM LOADING (% OF MAX STRENGTH)	
		AT INSTALLATION	AT REPLACEMENT
AA	More than 180 toll circuits or 1800 exchange pairs, Priority I defense circuits	25	37.5
JB	Both communication circuits and power circuits of NESC Grade B construction	25	37.5
A	100-180 toll circuits or 1000-1800 exchange pairs, Priority II defense circuits	40	60
JC	Both communication circuits and power circuits of NESC Grade C construction	50*	75
B	Fewer than 100 toll circuits or 400-1000 exchange pairs, Priority III defense circuits	60	90
C	25-400 exchange pairs only	70	105
R	Fewer than 25 exchange pairs, one 6M or lesser strand, two multiple line wires, or one crossarm of open wire	80	120

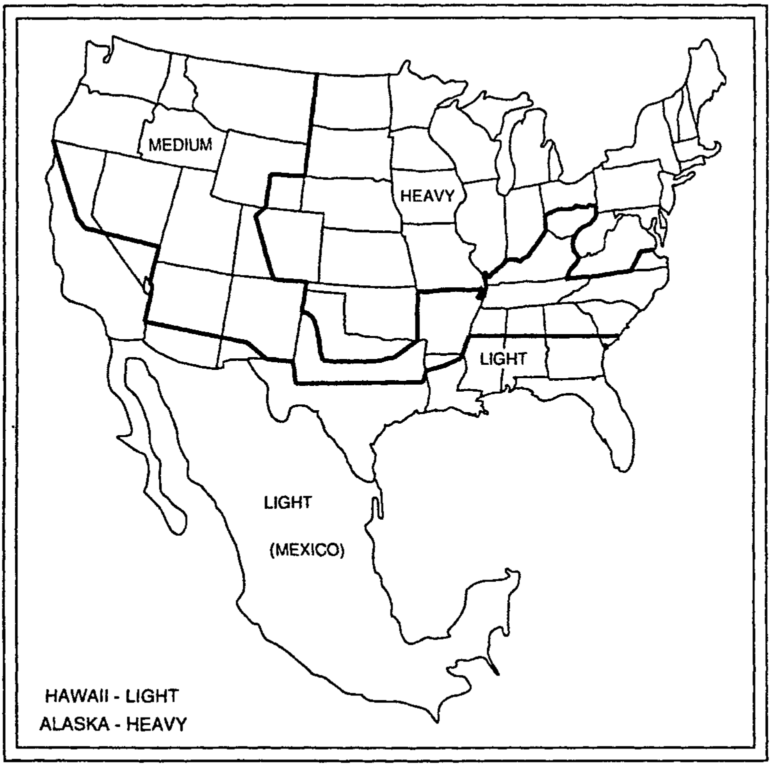
Note: One toll circuit is equivalent to ten exchange pairs. For broadband circuits, 4 kHz is equivalent to one toll circuit, for example, one 50-kHz circuit equals 12-1/2 toll circuits.

* 37.5 at railroad crossings.

Storm Loading Areas

AT&T 919-120-200, 1993 NESC Section 25

The National Electric Safety Code (NESC) divides the United States into three storm loading areas based on the frequency, severity, and damaging effects of ice and wind storms. These areas and the design load data for each are defined below.



POLE LINE DESIGN LOADS				
Storm Loading Area	Radial Thickness* of Ice Coating on Conductors and Messengers (in.)	Transverse Wind Pressure* lb/ft^2 of Projected Area	Minimum Temperature (°F)	Additive Constant (lb/ft)
Heavy	1/2	4	0	0.30
Medium	1/4	4	15	0.20
Light	None	9	30	0.05

* When computing transverse wind loading, ignore ice coating on poles and towers.

Pole Loading

AT&T 919-120-200, -700

Poles are subjected to three types of loading:

1. Transverse storm loading due to wind pressure on the attachments and on the aboveground portion of the pole itself. (In heavy and medium storm loading areas, loading includes the wind force on the ice-coated attachments but not on the ice coating of the pole itself.)
2. Vertical loading due to the weight of the attachments and, on guyed poles, the vertical component of the tensions in the guys. (In heavy and medium storm loading areas, loading includes the weight of the ice coating on the attachments.)
3. Bending moments due to eccentric loads or to unbalanced tensions at unguyed corners and dead ends.

For most poles, transverse storm loading determines the required pole class. Vertical loads may be controlling factors for poles carrying large cables or transformers, while bending moments are usually controlling at unguyed corners and dead ends.

Transverse Storm Loading

AT&T 919-120-700

To determine transverse loading on the pole:

- Find the storm load of each pole attachment.
- Translate that load to an equivalent load 2 feet (610 mm) from the top of the pole.

Storm loads for some common attachments are given on the next two pages.

TRANSVERSE STORM LOADS FOR POWER ATTACHMENTS

AT&T 919-120-200

Power Company Attachment	Diameter Without Ice (in.)	Storm Loading Area — Heavy	Medium	Light
		Transverse Storm Load (lb/ft)		
Covered Wire: #8 AWG or smaller	0.26	0.42	0.25	0.20
#6 AWG	0.32	0.44	0.27	0.24
#4 AWG	0.38	0.46	0.29	0.29
#0000 AWG	0.65	0.55	0.38	0.49
500,000 circular mils	1.11	0.70	0.54	0.83
1,000,000 circular mils	1.53	0.84	0.68	1.15
2,000,000 circular mils	2.15	1.05	0.88	1.61
Power Cable on Strand	2.56	1.19	1.01	1.92
Spacer Cables: Consider each conductor separately.				
Suspension wire extending transversely between two poles and supporting trolley wires —				
One contact wire		2.21	2.01	1.95
Two contact wires		4.42	4.02	3.90
Four contact wires		6.62	6.03	5.85
Bracket and one trolley contact wire on one side of pole line		0.74	0.40	0.62
Brackets and two trolley contact wires, one on each side of pole line		1.10	0.60	0.70
Bracket and two trolley contact wires, over tracks on same side of pole line		1.84	1.21	1.48
Transformers, 37.5 kVA or less		0.37	0.20	0.47
Transformers, over 37.5 kVA		0.37	0.40	0.70
Transverse clearance attachment for service drop above telephone attachments, per wire		0.37	0.40	0.31
Service drops, per unbalanced drop wire		0.37	0.20	0.23
Street lamp supported by mast arm (not bracket)		0.37	0.20	0.23

TRANSVERSE STORM LOADS FOR TELEPHONE ATTACHMENTS

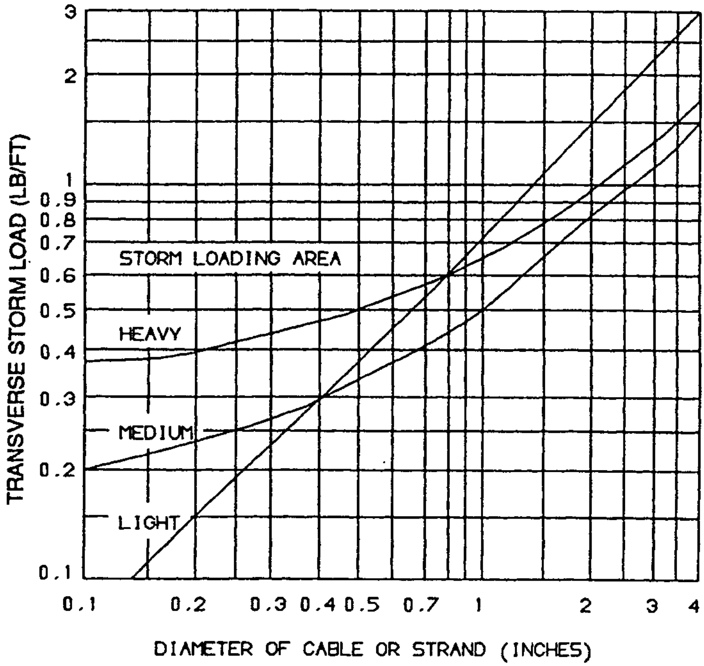
AT&T 919-120-200

Telephone Plant Attachment	Approx. Diameter Without Ice (in.)	Storm Loading Area / Transverse Storm Load (lb/ft)		
		Heavy	Medium	Light
Bare Open Wire*: 80, 83	0.08	0.36	0.20	0.06
(per wire) 104, 109	0.10	0.37	0.20	0.08
128, 134,	0.13	0.38	0.21	0.10
165	0.16	0.39	0.22	0.12
C Drop Wire	0.33	0.44	0.28	0.25
F Drop Wire	0.30	0.43	0.27	0.23
C, E, or F Multiple Drop Wire	0.56	0.52	0.35	0.42
C Rural Wire	0.28	0.43	0.26	0.21
Strand: 2.2M	0.17	0.39	0.22	0.13
6M	0.31	0.44	0.27	0.23
6.6M	0.25	0.42	0.25	0.19
10M	0.37	0.46	0.28	0.28
16M	0.44	0.48	0.31	0.32
25M	0.50	0.50	0.33	0.38
Cables (see next page)				
Cable Terminal—202-pair or less		0.37	0.20	0.31
Cable Terminal—More than 202-pair		0.37	0.20	0.47
Loading Coil Case		0.37	0.20	0.09
Unbalanced Service Drops—Per drop		0.37	0.20	0.16

* In heavy and medium storm loading areas, the larger diameter of ice-covered wires shields adjacent wires. Where there are more than ten wires on a crossarm, at a pin spacing not greater than 15 inches, calculate transverse storm loading using two-thirds the actual number of wires (but not less than ten) to compensate for this shielding effect. This reduction in effective number of wires does not apply at railroad crossings.

Transverse Storm Loads for Telephone Cables

Lashed cable:	Add the diameter of the cable to the diameter of the strand. Use this diameter in the chart on the following page. Diameters of cables are covered in Section 14, "CABLE AND WIRE."
Self-supporting cable:	Add 0.46 inch (11.7 mm) to the cable diameter. Use this diameter in the chart on the following page.
Cable in rings:	Determine loads for the strand and cable separately. Obtain the strand load from the previous page and the cable load from the chart on the following page.
Fiber optic cables:	Storm loads for fiber optic cables are covered in AT&T 627-400-001, *Construction Reference Guide.*



Equivalent Storm Load of Attachments

Convert the actual storm load of attachments to the equivalent load 2 feet (610 mm) from the top of the pole by:

$$\textit{Equivalent Load (lb/ft)} = \frac{\textit{Actual Load (lb/ft) x Height of Attachment (ft)}}{\textit{Height To 2 ft From Top Of Pole}}$$

Pole Class Based on Transverse Storm Loading

AT&T 919-120-700

To determine the pole class:

1. Find the combined equivalent storm load per foot of span length at a point 2 feet (610 mm) from the top of the pole for all attachments.
2. Multiply by the average length of the two adjacent spans to get the total load of attachments.
3. Using this load, tentatively determine the pole class from the table below (note that the load used does not include the load of the pole itself).
4. Determine the wind load on this class of pole from the table on the next page and add to the result of (2) to determine the total storm load.
5. Using the result of (4), return to the table below and redetermine the pole class.
6. If (5) results in a different pole class, repeat (4) and (5), using the pole class determined in (5).

See example on Page 10-16.

MAXIMUM ALLOWABLE TRANSVERSE STORM LOAD									
*Class of Line	Class of Pole								
	1	2	3	4	5	6	7	9	10
	Transverse storm load 2 feet below top of pole								
AA or JB	1125	925	750	600	475	375	300	185	93
A	1800	1480	1200	960	760	600	480	296	148
JC	2250	1850	1500	1200	950	750	600	370	185
B	2700	2220	1800	1440	1140	900	720	444	222
C	3150	2590	2100	1680	1330	1050	840	518	259
R	3600	2960	2400	1920	1520	1200	960	592	296

* For class of pole line, see table on Page 10-6.

WIND MOMENT ON POLES Maximum Equivalent Load 2 Feet From Top (lb)										
		Class of Pole								
Timber Species	Length of Pole (ft)	1	2	3	4	5	6	7	9	10
		Heavy and Medium Storm Loading Access								
WC, WP, JP, NP, or LP	20	31	29	27	25	23	21	19	17	16
	25	38	36	33	31	28	26	24	21	20
	30	47	44	41	38	35	32	29	27	
	35	56	53	50	46	42	39	35		
	40	67	63	59	55	50	46	42		
	45	79	74	69	64	59	54	49		
	50	87	82	77	71	65	60	54		
SP, DF, or WL	20	30	28	26	24	22	20	18	16	155
	25	37	34	32	30	27	25	23	20	19
	30	46	43	40	37	34	31	28	25	
	35	55	51	48	44	40	37	34		
	40	65	61	57	52	48	44	40		
	45	75	71	66	61	56	52	47		
	50	84	79	73	68	64	57	52		
		Light Storm Loading Area								
WC, WP, JP, NP, or LP	20	69	64	60	55	51	46	42	38	36
	25	86	81	75	70	64	59	53	48	45
	30	106	100	93	86	79	72	66	60	
	35	127	120	112	104	95	87	79		
	40	151	142	133	123	113	104	94		
	45	177	167	156	144	132	122	110		
	50	196	185	172	160	146	135	122		
SP, DF, or WL	20	67	62	58	54	49	45	40	37	35
	25	83	78	72	67	62	56	51	46	44
	30	102	96	89	83	76	70	63	57	
	35	123	115	107	99	91	83	76		
	40	145	137	127	118	109	99	90		
	45	170	160	149	138	127	116	105		
	50	189	178	165	152	144	129	117		

Example of Pole Class Based on Transverse Storm Loading

- Class AA line in the light storm loading area
- 35-foot (10.6 m) Southern Pine pole
- 180-foot (54.9 m) and 220-foot (67 m) adjacent spans

1. Assume 1.5 lb/ft equivalent storm load for attachments.
2. Total load of attachments = $\frac{1.5\,(180 + 220)}{2}$ = 300 lb
3. Table on Page 10-14 indicates class 7 pole.
4. Table on Page 10-15 indicates 76-lb wind load on class 7 pole. Total load = 76 + 300 = 376 lb.
5. For a 376-lb load, table on Page 10-14 indicates a class 5 pole.
6. (Repeat 4) Table on Page 10-15 indicates 91-lb wind load on class 5 pole.
7. Total load = 91 + 300 = 391 lb.
8. (Repeat 5) For a 391-lb load, table on Page 10-14 indicates a class 5 pole.

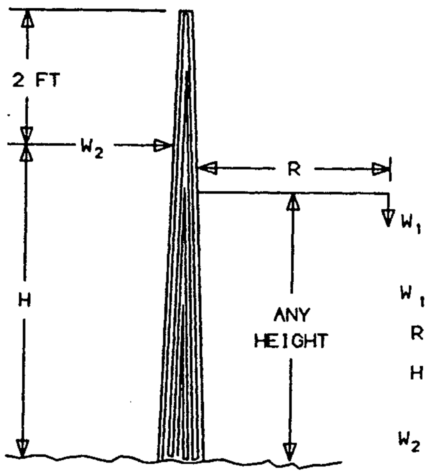
For class of unguyed corner and dead-end poles, see Pages 10-21 to 10-24.

For class of poles for slack spans, see Page 10-26.

Eccentric Loads

AT&T 919-120-700

A bending moment is caused by eccentric loads, such as a cable on an extension arm or a transformer mounted at right angles to the direction of the line. Any such bending moment should be included in the transverse load when determining the pole class. To convert eccentric load to the equivalent transverse load 2 feet (610 mm) from the top of the pole, see below.



W_1 = ECCENTRIC LOAD

R = DISTANCE FROM POLE

H = DISTANCE FROM GROUND TO 2 FEET BELOW TOP OF POLE

W_2 = EQUIVALENT TRANSVERSE LOAD 2 FEET FROM TOP

$$W_2 = \frac{RW_1}{H}$$

If the attachment is a conductor subject to ice coating, see AT&T 919-370-200 for the method of computing weight.

Recommendations:

- When eccentric loads are present, use one class larger pole than the minimum required.
- Guy the poles that have unusually heavy eccentric loads.

Vertical Loading

AT&T 919-120-200, -700

When the class of pole is being determined, the vertical load on an unguyed pole due to the weight of its attachments and ice is usually not significant compared to the transverse storm loading. For treatment of unusually heavy attachments, see the referenced practices.

Vertical loading, however, is usually the controlling factor in determining the class of guyed poles. Size poles to withstand the vertical component of the total force of all guys attached to the pole when the guys are stressed to their breaking strength.

The total vertical load depends on the number and size of guys and their lead-to-height ratios. (For the definition of lead and height, see Page 10-28.)

The table on the next page gives the pole class required when all guys are attached 2 feet (610 mm) from the top of the pole and all have approximately the same lead/height ratio. If the guys are attached at a lower point, a lower pole strength is required. For this and other special cases, see the referenced practices.

CLASS OF GUYED POLES OR STUBS FOR VERTICAL LOADING AT&T 919-120-700								
Lead/ Height Ratio	Length of Pole (ft)	Maximum Sum of Guys						
		6.6M	12M	18M	25M	30M	40M	50M
		Class of Pole						
Less Than 1	20	10	9	9	7	6	6	5
	25	9	9	7	6	6	5	5
	30	9	7	7	6	5	5	4
	35	7	7	6	5	5	4	3
	40	7	7	6	5	4	4	3
	45	7	6	5	4	4	3	3
	50	7	6	5	4	4	3	2
	55	6	6	5	4	3	3	2
	60	6	5	4	4	3	2	2
	65	5	5	4	3	3	2	1
	70	5	5	4	3	2	2	1
1 or Greater	20	10	9	9	7	7	6	6
	25	9	9	9	7	6	5	5
	30	9	9	7	7	6	5	5
	35	7	7	7	6	5	5	4
	40	7	7	6	5	5	4	4
	45	7	7	6	5	5	4	3
	50	7	7	6	5	4	3	3
	55	6	6	5	4	4	3	3
	60	6	6	5	4	4	3	2
	65	5	5	5	4	3	2	2
	70	5	5	4	4	3	2	2

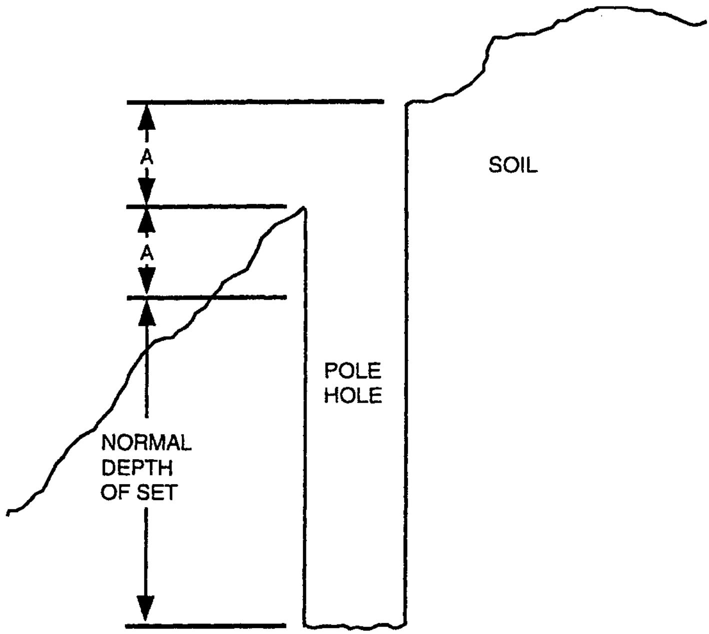
Depth of Setting Poles

AT&T 919-120-600, -700

Length of Pole (ft)	Depth of Set (ft)	
	Firm Earth	Solid Rock
20	4	3
25	5	3
30	5-1/2	3-1/2
35-40	6	4
45	6-1/2	4-1/2
50	7	4-1/2
55	7-1/2	5
60	8	5
65	8-1/2	6
70	9	6
75	9-1/2	6
80	10	7
85	10-1/2	7
90-100	11	7
105-125	12	8

In sloping ground, increase the depth of set by amount A, as shown on the next page.

For depth of setting unguyed corner and dead-end poles, see Page 10-25.



Unguyed Corner and Dead-End Poles

AT&T 919-120-200, -700

Determining Pole Class

Wherever possible, corner and dead-end poles should be guyed or braced. Where this is not practical, determine the pole class based on (1) storm loading and (2) everyday unbalanced tensions for which the pole should not be stressed beyond one-third of its rated breaking strength. Use the larger class pole.

Storm loading has two components:

- Transverse loading on the pole and its attachments
- Unbalanced storm-loaded tensions in the wires or strands resulting from the change in direction of the line.

These two components (as shown below) have different design safety factors which must be applied to each component separately before they are combined.

Class of Pole Line*	Safety Factor	
	Transverse Loading	Unbalanced Tensions
AA or JB	4.0	2.0
A	2.5	1.33
JC	2.0	1.33
B	1.67	1.33
C	1.43	1.0
R	1.25	1.0

* See Page 10-6 for class of pole line.

Transverse storm loading is determined as shown on Pages 10-9 through 10-16 for line poles and is expressed in equivalent load (in pounds) 2 feet (610 mm) from the top of the pole. The unbalanced tension is calculated using the following formula.

$$\textit{Unbalanced tension (lb)} = \frac{[\textit{pull (ft)}] \times [\textit{line tension (lb)}]}{50}$$

For line tension, use 60 percent of the breaking strength of the wire or strand. For tension of power attachments, consult the power company. For pull on a pole, see the next page. Use a pull finder to find the pull on a corner pole (see AT&T 621-400-011).

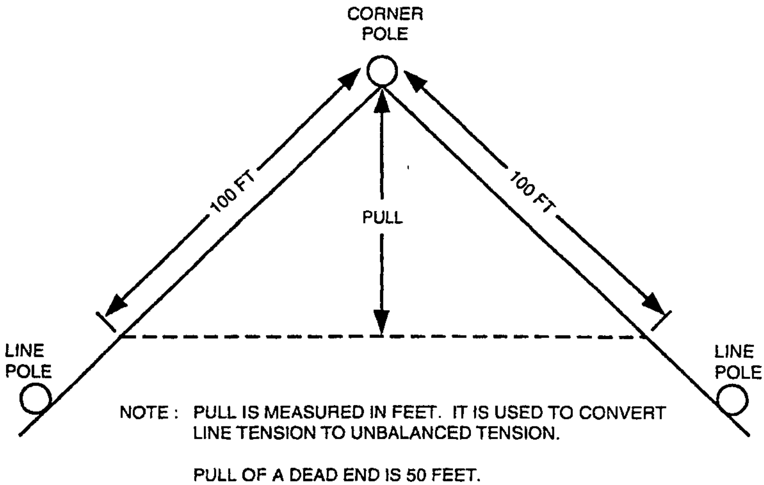


Illustration of Pull on Pole

Convert each unbalanced tension to the equivalent load 2 feet (610 mm) from the top of the pole by using the following formula:

$$\textit{Equivalent Load (lb)} = \frac{[\textit{Unbalanced Tension}] \times [\textit{Height Of Attachment}]}{[\textit{Distance From Ground To 2 Feet From Top}]}$$

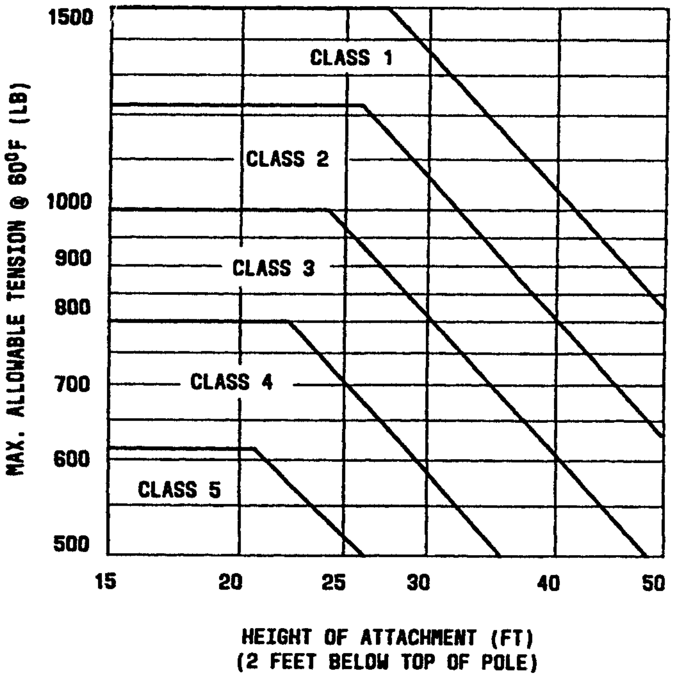
To determine the pole class based on storm loading:

1. Compute the total equivalent load 2 feet (610 mm) from the top of the pole due to the transverse load of all attachments and multiply by the appropriate safety factor from Page 10-22.
2. Compute the total equivalent load 2 feet (610 mm) from the top of the pole due to the unbalanced tensions of all wires and cables and multiply by the appropriate safety factor from Page 10-22.

3. Add the results of (1) and (2), and determine the pole class from the table on Page 10-3.

To determine the pole class based on everyday unbalanced tensions:

1. Using stringing tension of wire or tension of strand with the cable in place, compute the unbalanced tension for each wire and cable by the method outlined on the previous page for storm-loaded tensions.
2. Convert to the equivalent load 2 feet (610 mm) from the top of the pole.
3. Combine the equivalent loads for all attachments and find the pole class from the chart below. The pole class thus determined will have a safety factor of 3 for the breaking strength and a deflection of not more than 1/2 inch (12.7 mm) per foot (305 mm) of pole height.



Depth of Setting Unguyed Corner and Dead-End Poles

AT&T 919-120-700

Unguyed corner and dead-end poles should be set at a greater-than-normal depth to limit tilting. The depth of set depends on the maximum ground-line moment under storm-loading conditions.

To determine ground-line moment, add the equivalent loads determined in steps (1) and (2) under storm loading on Page 10-22 **before** applying safety factors. Multiply this sum by the distance from the ground line to 2 feet (610 mm) below the top of the pole. The result is the ground-line moment in foot-pounds. Recommended setting depths are indicated below.

Frost Depth (ft)	Corner Pull (ft)	Maximum Ground-Line Moment (1000 ft-lb)								
		20	40	50	70	90	110	130	150	200
		Depth of Pole Set (ft)								
0	0-2½	5	5	5½	6	6½	7	7½	8	8½
to	2½-5	6½	6½	7	7½	8	8½	9	9½	9½
1	5-15	6½	7	7	8	8½	9	9	9½	10
	>15	7	7½	8	8½	9	9½	9½	10	10½
1	0-2½	5½	5½	6	6½	7	7½	8	8½	9
to	2½-5	7	7	7½	8	8	8½	9	9½	9½
2	5-15	7	7½	8	8½	9	9½	9½	10	10
	>15	7½	8	8½	9	9	9½	9½	10	10½
2	0-2½	6	6	6½	7	7½	7½	8	8½	9
to	2½-5	7	7½	8	8½	8½	9	9	9½	9½
3	5-15	7½	8	8½	8½	9	9½	9½	10	10½
	>15	8	8½	8½	9	9	9½	9½	10	10½

Slack Span Design

AT&T 627-240-225, 919-120-700

With normal stringing tensions, the unbalanced load on an unguyed dead-end pole may exceed the strength of the largest available pole. This limitation may be overcome by using less-than-normal stringing tension in the dead-end span. Obtain the line tension from the table below; then determine the pole class from the chart on Page 10-24.

LOWER STRINGING TENSION FOR DEAD-END SPAN								
Size of Strand	String Tension (lb)	Span Length (ft)	Tension with Cable in Place at 60°F (lb)					
			Cable Weight (lb/ft)					
			0.5	1	2	3	4	5
6M	300	50	510	675	960	1200	1425	
		75	580	800	1160			
		100	645	940	1390			
	500	50	645	800	1080	1320		
		75	720	925	1290			
		100	840	1090				
	800	50	900	1000	1220	1460		
		75	925	1075	1420			
		100	1030	1265				
6.6M	300	50	460	590	845	1065	1265	1430
		75	510	710	1030	1300		
		100	610	875	1255			
	500	50	605	710	935	1150	1345	
		75	660	815	1120	1380		
		100	715	955	1340			
10M	300	50	520	700	1040	1300	1500	
		75	580	850	1250	1400		
		100	670	1025	1450			
	500	50	670	825	1125	1380		
		75	750	970	1350			
		100	840	1150				
	800	50	910	1035	1280			
		75	975	1150	1500			
		100	1050	1310				
16M 25M	Do not use slack span design							

Push Braces

AT&T 621-205-211

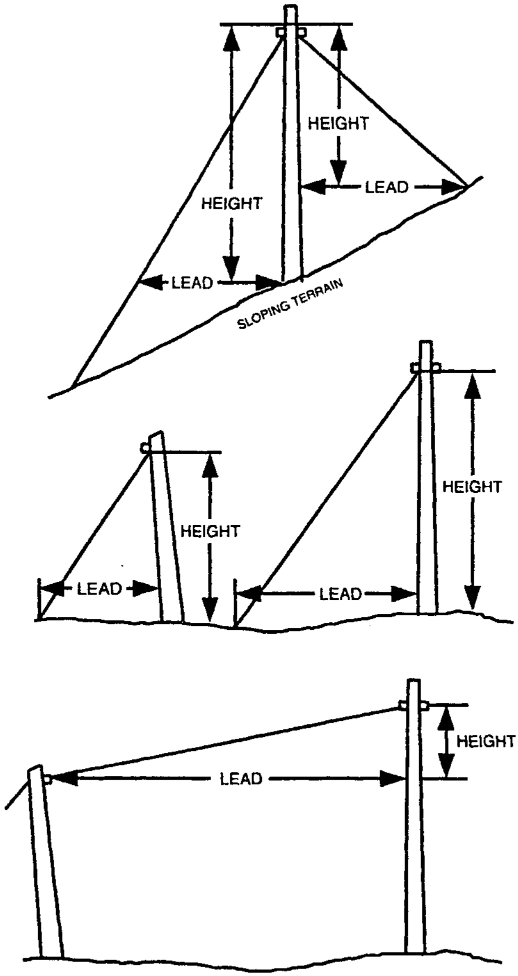
A pole used as a push brace should be of the same class as the pole it supports.

POLE LINE GUYING

AT&T 621-400-011, -013

Dead ends and corners in pole lines usually require guying to support the cable or wire facility. The size of the guy is based on the size of the suspension strand or type of wire, the lead and height of the guy, and the pull on the pole.

- Lead and height are defined on the next page.
- If the lead/height ratio is 3/4 or greater, head guys for cables can be the same size as the suspension strand.
- If the lead/height ratio is between 1/2 and 3/4 and only two or three spans are involved, head guys for cables should be one size larger than the suspension strand.
- For all other guys, use the Guy Rule (AT&T 621-400-013) to determine guy size. Where 6M guy is indicated, 6.6M guy may be used.
- At corner poles use a pull finder to determine the pull on a pole (see AT&T 621-400-011).
- If the pull on a corner pole is less than 50 feet, a guy can be placed at a bisecting angle (see AT&T 621-400-011).
- If the pull is greater than 50 feet, two head guys are required as shown in AT&T 621-410-206.



Definition of "Lead" and "Height"

Guying Cable Lines

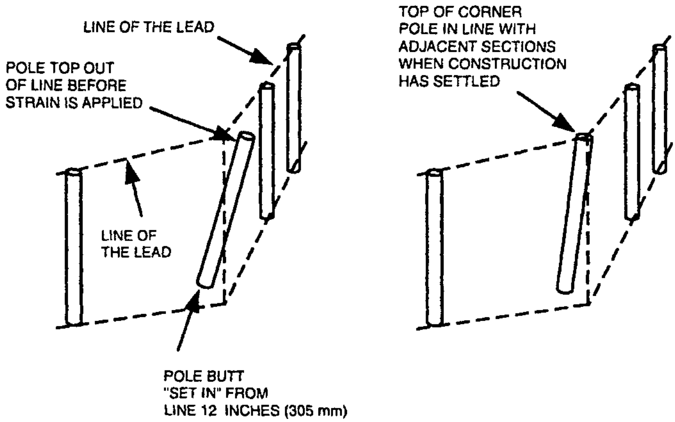
AT&T 621-410-206

Where a pole supports more than one suspension strand, each strand should be guyed separately. Where this is not practical, see the practice referenced above.

All corner poles should be guyed where the pull exceeds the following:

Maximum Allowable Pull for Unguyed Corners	
Size of Suspension Strand	**Maximum Allowable Pull (ft)**
6M or 6.6M	3
10M	2
16M or larger	Any detectable amount

All unguyed corner poles must be set 1 foot (305 mm) inside the line of the pole lead and ground-braced. The rake of unguyed corner poles is 1 foot (305 mm). In some cases, the stabilization of unguyed poles will require heavier class poles and increased depth of setting. Such cases will be detailed by the design engineer.



Unguyed Corner Pole Raked

Suspension Strand Diminishing Points

At suspension strand diminishing points (for example, 16M to 10M), place a head guy away from the heavier strand. The size of guy would be equal to the difference in the strand sizes. In the case above, a 6M or 6.6M guy would be used.

Guying Insulated Wires

AT&T 621-400-015

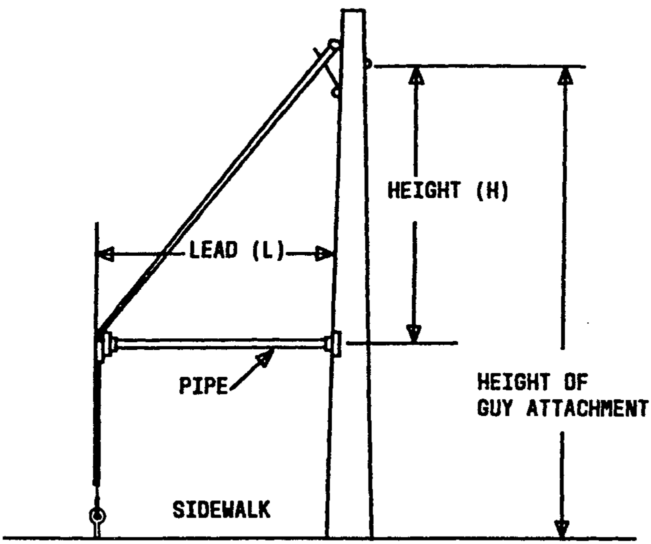
Guying of insulated wires at corners and dead ends is not required if the pull multiplied by the number of wires is less than the values given below. Where these values are exceeded, see the practice referenced above for the method of determining the size of guy. See Page 10-23 for the definition of pull.

MAXIMUM (WIRES × PULL) PRODUCT FOR UNGUYED INSULATED WIRES			
Type of Wire	**Sag**	**Span (ft)**	**Wires × Pull Product**
C Rural Wire	Minimum	100-250	50
		250-450	40
		450-600	35
C or F Drop Wire	Recommended	Any	250
	Minimum	Any	150
C, E, or F Multiple Drop Wire	Recommended	Any	75
	Minimum	Any	50

Sidewalk Anchor Guys

AT&T 621-410-220

Sidewalk anchor guys are used in guying over sidewalks or other pathways where the right-of-way is insufficient to permit placing a guy with the required clearance above the sidewalk.



The strand size required for fabricating a sidewalk anchor guy must be larger than that required for an anchor guy of the usual type having the same lead/height ratio.

To determine the proper size of strand for a sidewalk guy, first determine from the guy rule the size strand that would be required if a usual type having the same lead and height were to be placed. Then, select the size of strand to be used for the sidewalk guy from the table below.

STRAND SIZE FOR SIDEWALK GUYS

HEIGHT OF GUY ATTACHMENT FEET (M)	SIZE OF ANCHOR GUY AS DETERMINED BY GUY RULE				
	2.2M	6M OR 6.6M	10M	12M	16M
	SIZE OF STRAND FOR SIDEWALK ANCHOR GUY				
26 (7.9)	6M or 6.6M	10M	16M	20M	26M*
25 (7.6)	6M or 6.6M	10M	16M	20M	26M
24 (7.3)	6M or 6.6M	10M	16M	20M	26M
23 (7.0)	6M or 6.6M	10M	16M	20M	26M
22 (6.7)	6M or 6.6M	10M	16M	20M	26M
21 (6.4)	6M or 6.6M	10M	16M	20M	26M
20 (6.1)	6M or 6.6M	10M	20M	20M	26M
19 (5.8)	6M or 6.6M	10M	20M	20M	
18 (5.5)	6M or 6.6M	10M	20M	20M	

Note: Where two guy strands are to be attached to the same fixture at different levels, use the height of attachment of the lower guy in determining the size of strand for the guys.

* Where 26M guying is required, place either a 25M guy or a combination of one 16M and one 10M guy.

After this has been determined, the next step is to select the pipe size. The pipe size is dependent upon the length of the pipe and the size of the guy used. The pipe size table below reflects a 2-tier matrix that may be used in pipe sizing.

PIPE SIZE FOR SIDEWALK GUYS						
LENGTH OF PIPE (FEET)	SIZE OF SIDEWALK ANCHOR GUY					
	6M OR 6.6M	10M	12M	16M	20M	25M
	SIZE OF PIPE (INCHES)					
6	2	2	2	2	2	2
7	2	2	2	2	2	2
8	2	2	2	2	2	2-1/2
9	2	2	2	2	2-1/2	2-1/2
10	2	2	2	2-1/2	2-1/2	2-1/2
11	2	2	2-1/2	2-1/2	2-1/2	2-1/2
12	2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2

Pole Size for Use with Sidewalk Anchor Guy

In most cases, placing a sidewalk guy will necessitate placing a larger class pole. This is due to a bowing action caused by the sidewalk guy. The size of the pole required is dependent upon the lead-to-height ratio and the size of the guy.

The size of pole used with a sidewalk guy depends on the size of the guy and the lead/height ratio. The critical pole dimension is the ground-line circumference. The table below provides a 2-tier matrix to determine the class of a 30-foot (9.1 m) Southern Pine (SP) pole.

POLE SIZE TABLE

Lead/ Height	Size of Sidewalk Anchor Guy					
	6M	10M	12M	16M	20M	25M
	Class of 30-ft SP Pole					
2/5	7	5	4	3	2	2
1/2	6	4	4	3	2	1
3/5	5	4	3	2	1	1
4/5	5	3	2	1	1	1
1/1	5	3	2	1	1	1

Note: Poles of other lengths may also be used, provided their circumferences 6 feet from the butt are not less than that of the 30-foot (9.1 m) Southern Pine poles indicated above.

Guy Rods and Anchors

AT&T 621-415-200 Through -221

Sizes of guy rods and the types and sizes of anchors that can be used with each are given below.

SIZES OF GUY RODS AND ANCHORS					
Guy Rods and Anchors	Markings *				
	6M	12M	18M	26M	32M
Guy Rods					
Diameter (in.)	1/2	5/8	3/4	1	1-1/4
Length (ft)	7	8	9	10	10
Type(s) available†	S	D	D, T	D, T	D, T
Expanding Anchor					
Diameter (in.)	6	8	10	12	12
B Guy Anchor (Screw Type)					
Size No. and Nominal Diameter (in.)	9	11	13 or 15	—	—
Plate Anchor					
Type	617	622	827	1040S	—
Dimensions (in.)	6 x 17	6 x 22	8 x 27	10 x 40	—
Plank Anchor Size	20 or 24	20 or 24	20 or 24	24	—

* Indicates maximum size guy or combination of guys. For example, 18M rod can take three 6M guys, or one 10M and one 6M, or one 16M. (Consider 6.6M guy to be the same as 6M.)

† S = single-thimble eye, D = double-thimble eye, T = triple-thimble eye.

B Rock Anchor

See AT&T 621-415-215.

C Guy Anchors

AT&T 621-415-204

POWER-INSTALLED SCREW ANCHOR				
Soil Grade	**Anchor Size and Type**	**Rod Size Marking**	**Eye Nut**	**Guying Load**
1	5-Twin 4	1" 32M	Triple	Up to 32M
2	3-Twin 8	1" 32M	Triple	Up to 32M
2	6-Single 8	3/4" 18M	Double	Up to 18M
5	1-Twin 10	1" 32M	Triple	Up to 32M
5	4-Twin 8	3/4" 18M	Double	Up to 18M
5	7-Single 8	5/8" 12M	Double	Up to 12M
7	2-Twin 10	3/4" 18M	Double	Up to 18M

Grounding or Insulating Guys

1993 NESC, Section 21

Grounding Guys (Rule 215C2)

Guys shall be effectively grounded if attached to a supporting structure carrying any supply conductor of more than 300 V or if exposed to such conductors.

A guy is exposed if:

- It is attached to the same pole as open power conductors or spacer cable of any voltage.
- It crosses such power conductors.
- It is within 10 feet (3.05 m) horizontally (and any distance vertically) of such power conductors.
- It is attached to the same pole as an exposed guy.

Grounding Exceptions to Rule 215C2

1. This rule does not apply to guys containing an insulator or insulators installed in accordance with and meeting the requirements of Rule 279A (NESC, Section 27).
2. This rule does not apply to guys attached to supporting structures if all supply conductors are in cable conforming to the requirements of Rules 230C1, 230C2, or 230C3 (NESC, Section 23).
3. This rule does not apply if the guy is attached to a supporting structure on private right-of-way if all the supply circuits exceeding 300 V meet the requirements of Rule 220B2 (NESC, Section 22).

Insulating Guys

Grounding is the preferred treatment for exposed guys, except for the following cases in which they must be insulated:

- Where exposed to trolley facilities.
- Within 1/2 mile (0.80 km) of a power station (see AT&T 919-120-560).
- Where electrolytic corrosion of anchors has occurred (unexposed guys, in this case, must be separated from the cable strand at the pole, and electrical connection through hardware must be avoided).

Grounding Methods (1993 NESC, Section 9)

A single anchor or ground rod ordinarily is not an adequate ground. Adequate grounding for telephone guys may be obtained through connection to any of the following:

- Vertical grounding conductor of power system multigrounded neutral (with permission of the power company).
- Suspension strand of grounded telephone cable.
- Common anchor rod with a power guy that is connected to the multigrounded neutral.

Unexposed guys need not be grounded for protection reasons; however, connecting anchor guys to a grounded telephone cable strand is recommended, as it will lower the cable-to-ground impedance. This helps to reduce cable damage caused by lightning. It also helps to reduce telephone noise by increasing the effectiveness of the cable shield.

SAGS AND TENSIONS — COPPER CABLE

Suspension Strand

AT&T 627-200-015

Galvanized suspension strand is available in two types. Class A is for general use under normal field conditions. Class C is for use where severe corrosion problems exist, for example, in industrial or coastal areas.

The 6.6M strand is made of extra high-strength steel and is smaller, lighter, and less expensive than 6M strand. For guying, they are interchangeable. As suspension strands, however, they are limited to different span lengths, as shown on Page 10-39.

The 2.2M strand should not be used to support aerial cable, except small cables in pole-to-building or building-to-building construction.

Dimensions and breaking strengths of strand are shown below.

GALVANIZED STRAND			
Size	Breaking Strength (lb)	Diameter (in.)	Weight (lb/ft)
2.2M	2400	3/16	0.077
6M	6000	5/16	0.225
6.6M	6650	1/4	0.121
10M	11500	3/8	0.270
16M	18000	7/16	0.390
25M	25000	1/2	0.510

Stringing Tension for Strand

AT&T 627-210-018, 919-565-400

The proper stringing tension is a compromise between high tension (which causes cable bowing and creeping) and low tension (which results in excessive sag and requires taller poles to obtain clearances). Recommended stringing tensions for supporting strand are shown in the following table.

Strand	Span Length (ft)	Stringing Tension (lb) at Temperature (°F)					
		0°	20°	40°	60°	80°	100°
6M	Up to 250	1550	1400	1250	1100	900	825
	250-450	1475	1350	1225	1100	1000	900
	Over 450	1375	1275	1175	1100	1025	950
6.6M	Up to 250	900	800	700	600	500	425
	250-450	850	750	675	600	525	475
	Over 450	775	700	650	600	550	525
10M	Up to 400	2675	2475	2275	2100	1900	1725
	Over 400	2600	2425	2250	2100	1925	1800
16M	Any	4425	4150	3875	3600	3325	3075
25M	Any	9125	8800	8400	8000	7625	7250

The proper stringing tension for self-supporting cable depends not only on temperature and span lengths, but also on cable weight. The tables for self-supporting cables are too voluminous to be included here. See AT&T 627-700-011.

Cable Sags

AT&T 627-210-018

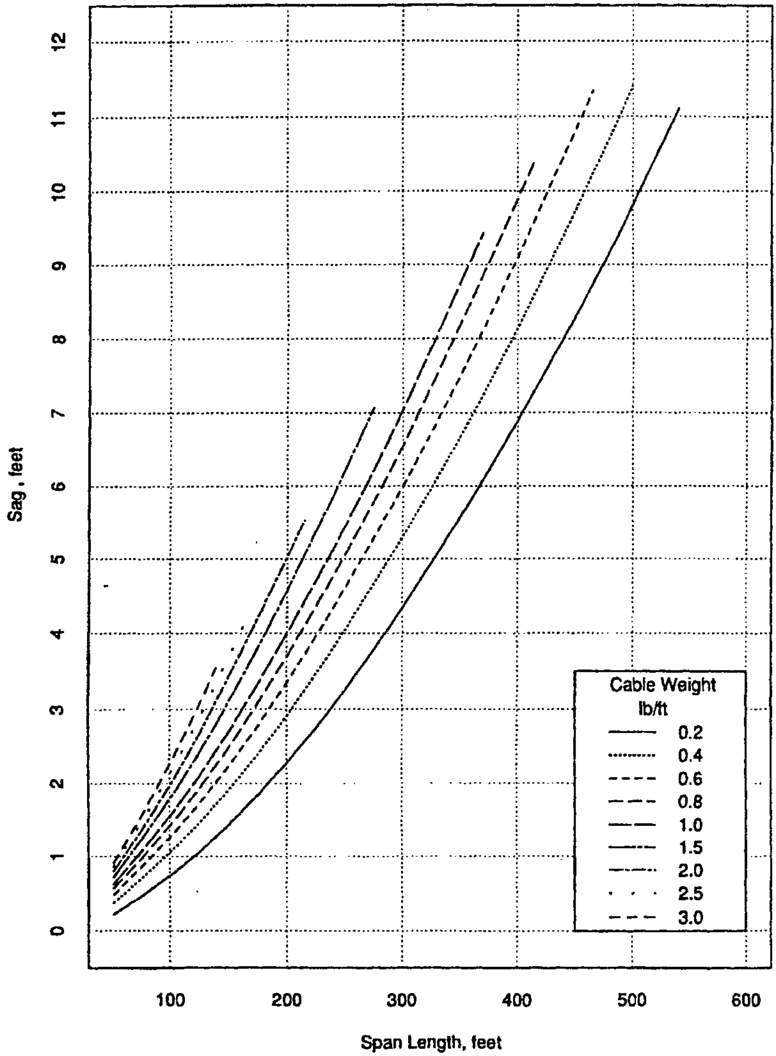
Significant changes concerning vertical clearances were made in the 1990 edition of the National Electrical Safety Code (NESC). Primarily, rather than specify the minimum vertical clearance under nominal operating conditions, that is, no load conditions at 60°F (15.5°C), NESC Rule 232 specifies that vertical clearances apply during maximum sag conditions. For telephone cable, maximum sag may occur at either the high-temperature condition of 120°F (48.9°C) or at 32°F (0°C) with an ice load. The condition that results in the largest cable sag must be used with the minimum clearance requirements to determine the required pole attachment height.

The expected worse-case sag for copper cable supported by 6M, 6.6M, 10M, 16M, and 25M strand in the light, medium, and heavy storm-load region is shown in the following graphs. The sag is based on the recommended stringing-tension shown in the table on page 10-39.

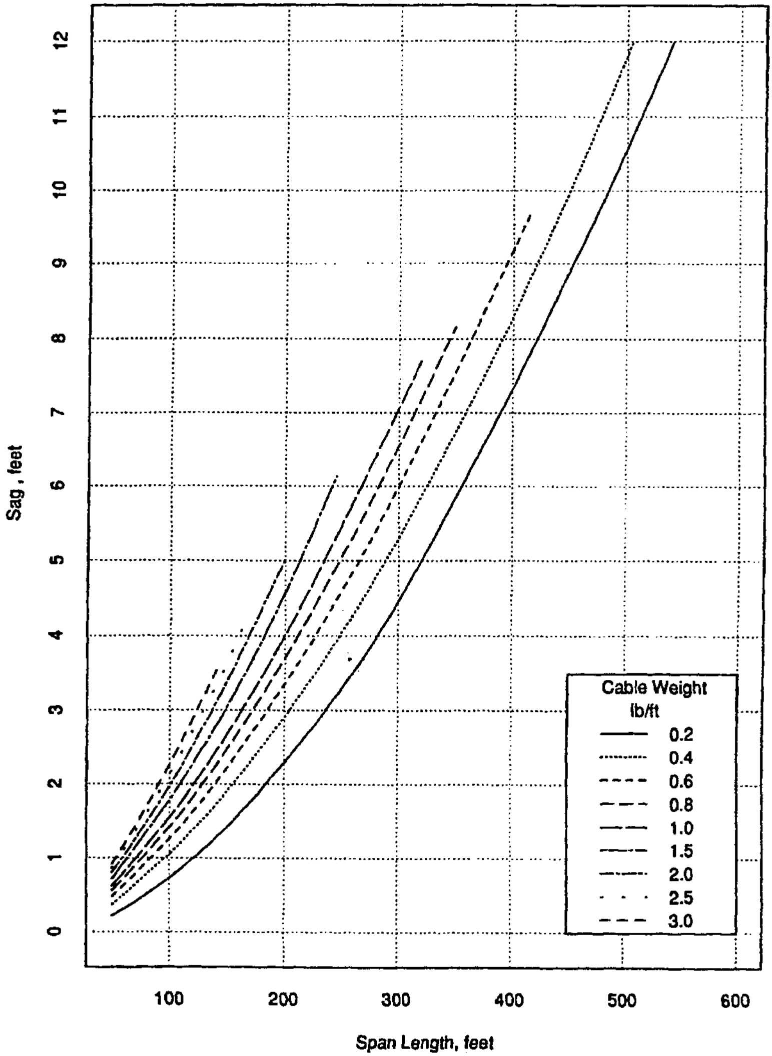
To use the graphs, first select the one that applies to the particular strand and storm-load region of interest. Next, select the curve on the graph that corresponds to the proper cable weight. Cable weights are shown in AT&T 626-101-005 and 626-xxx-xxx and in Section 14, "CABLE AND WIRE" of this document. Locate the span length of interest on the horizontal axis, and draw a vertical line from that point to the appropriate cable-weight curve. From that point, draw a horizontal line that intersects with the vertical axis. This point on the vertical axis corresponds to the worse-case sag condition.

This worse-case sag must be added to the minimum required vertical clearance (see Section 11, "CLEARANCES FOR AERIAL PLANT") to determine the minimum pole-attachment height for that particular combination of cable weight, span length, strand, and storm-load region.

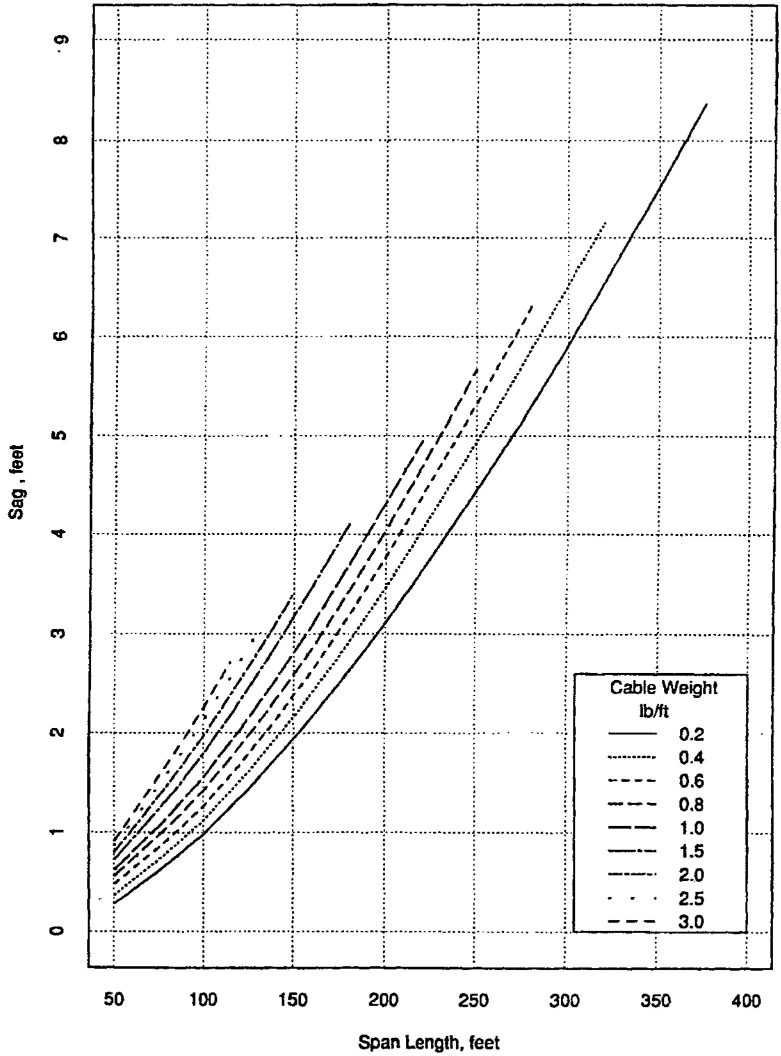
6M Strand - Light Loading Region
(Based on NESC Rule 232)

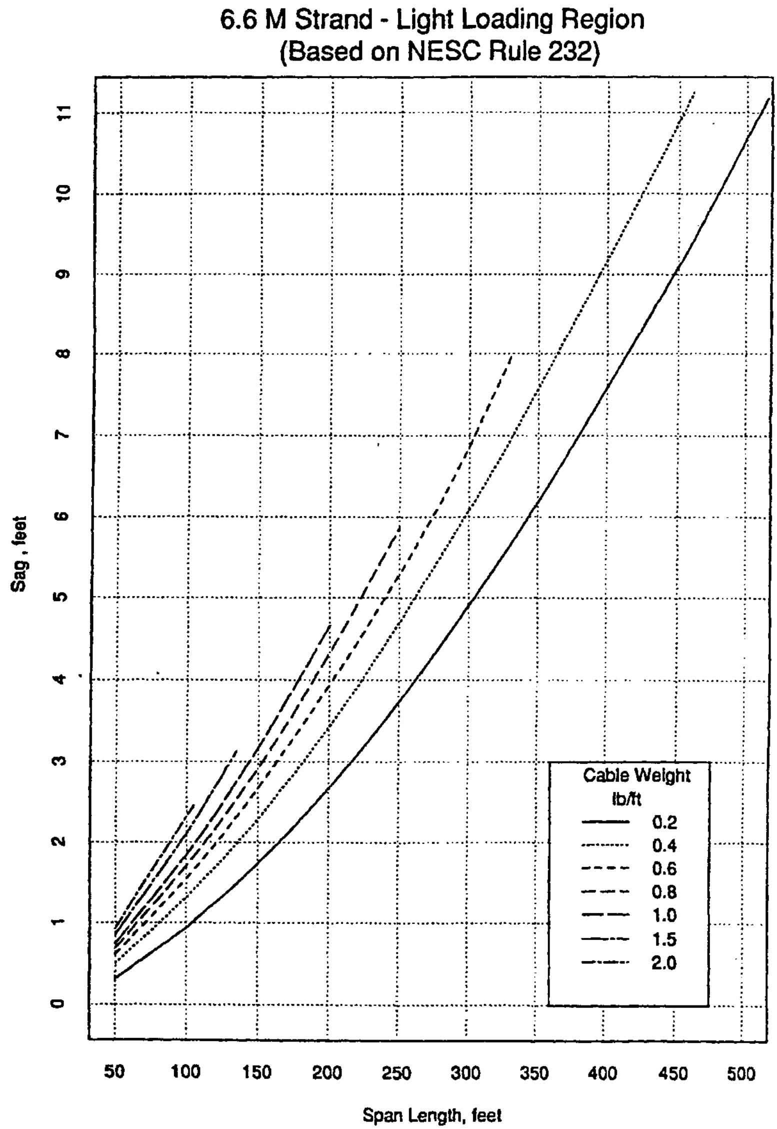


6M Strand - Medium Loading Region
(Based on NESC Rule 232)

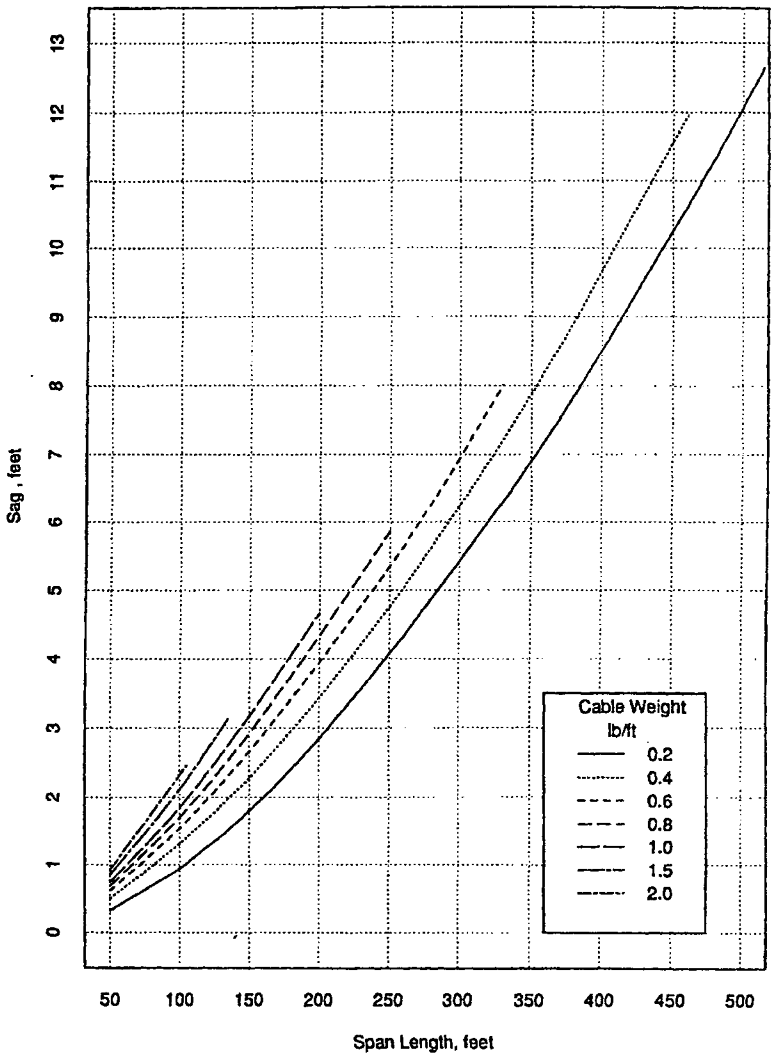


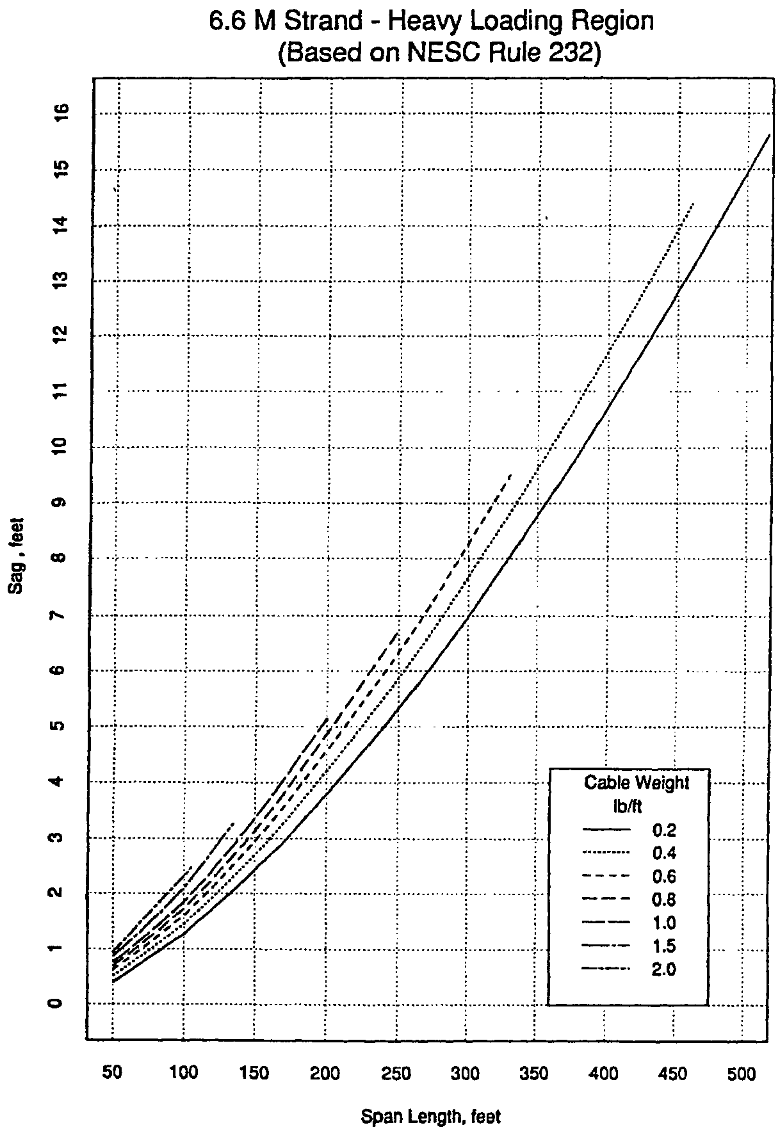
6M Strand - Heavy Loading Region
(Based on NESC Rule 232)



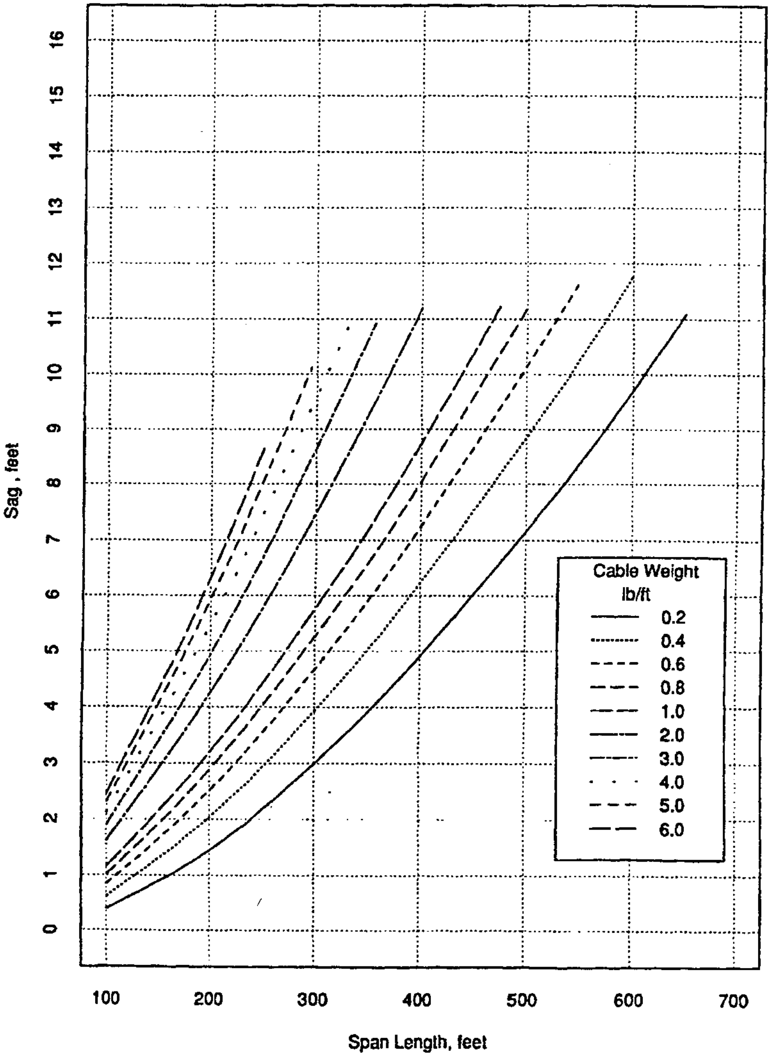

6.6 M Strand - Light Loading Region
(Based on NESC Rule 232)
Sag , feet
0
1
2
3
4
5
6
7
8
9
10
11
Span Length, feet
50
100
150
200
250
300
350
400
450
500
Cable Weight
lb/ft
0.2
0.4
0.6
0.8
1.0
1.5
2.0

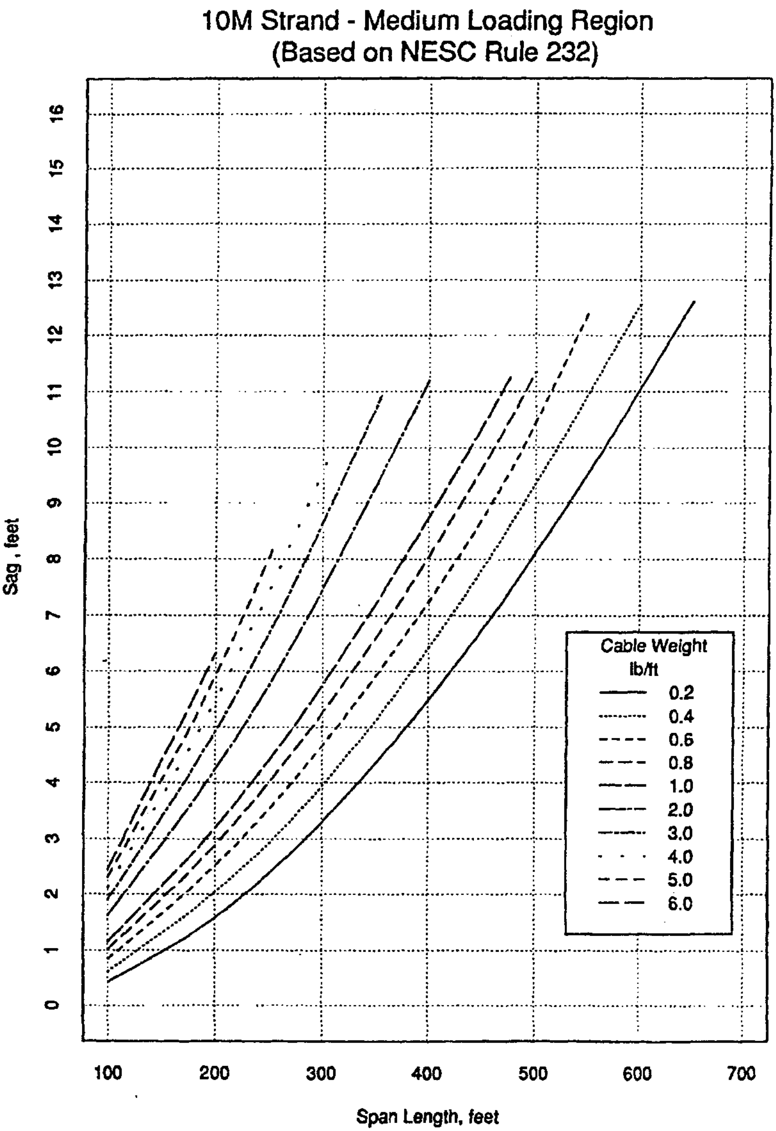
6.6 M Strand - Medium Loading Region (Based on NESC Rule 232)

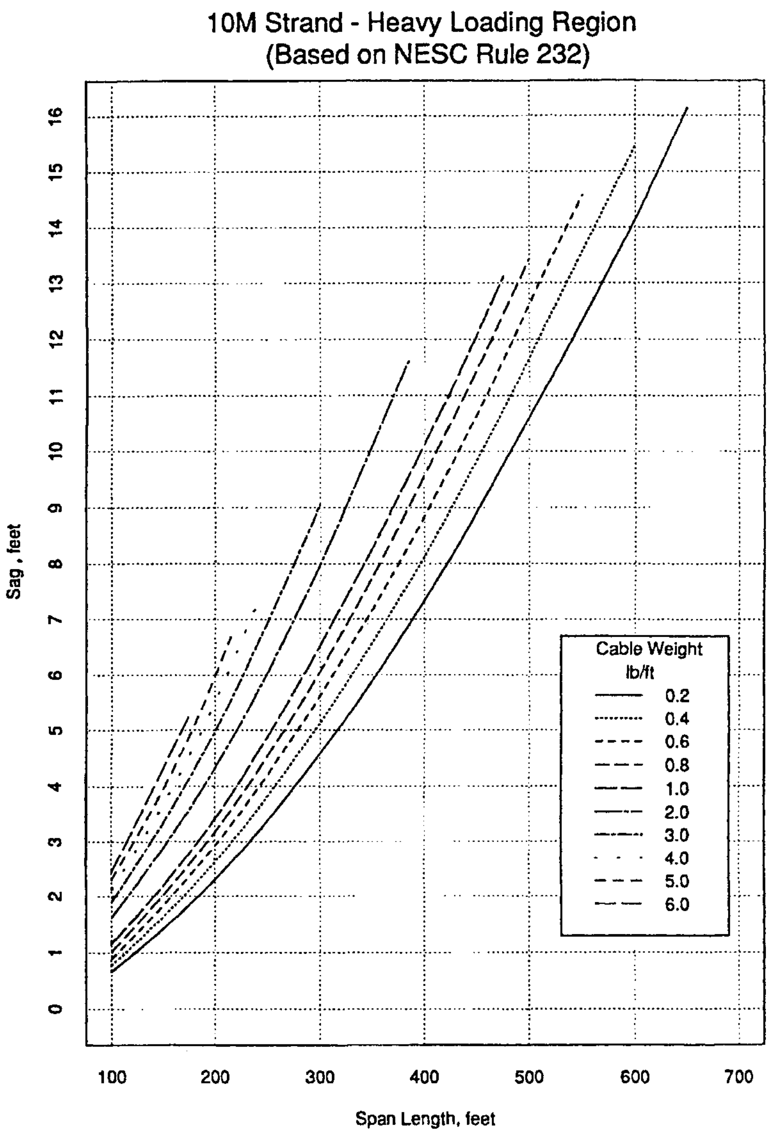


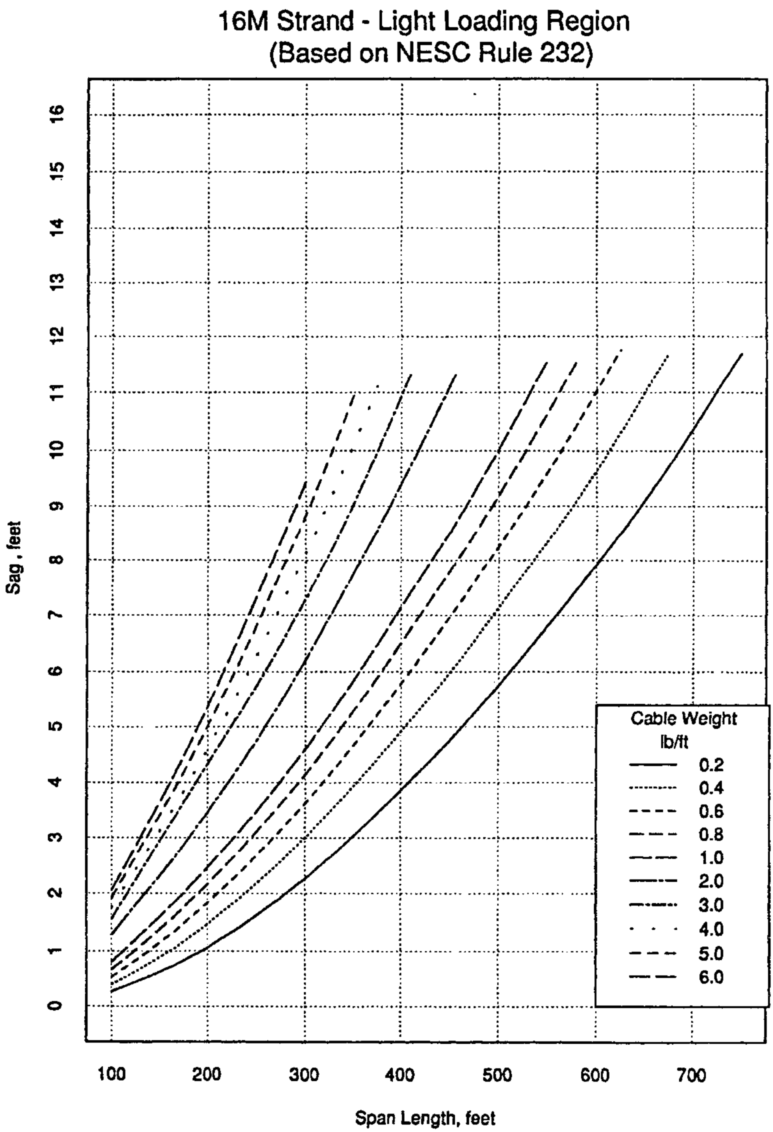

6.6 M Strand - Heavy Loading Region
(Based on NESC Rule 232)
Sag , feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Span Length, feet
50
100
150
200
250
300
350
400
450
500
Cable Weight
lb/ft
0.2
0.4
0.6
0.8
1.0
1.5
2.0

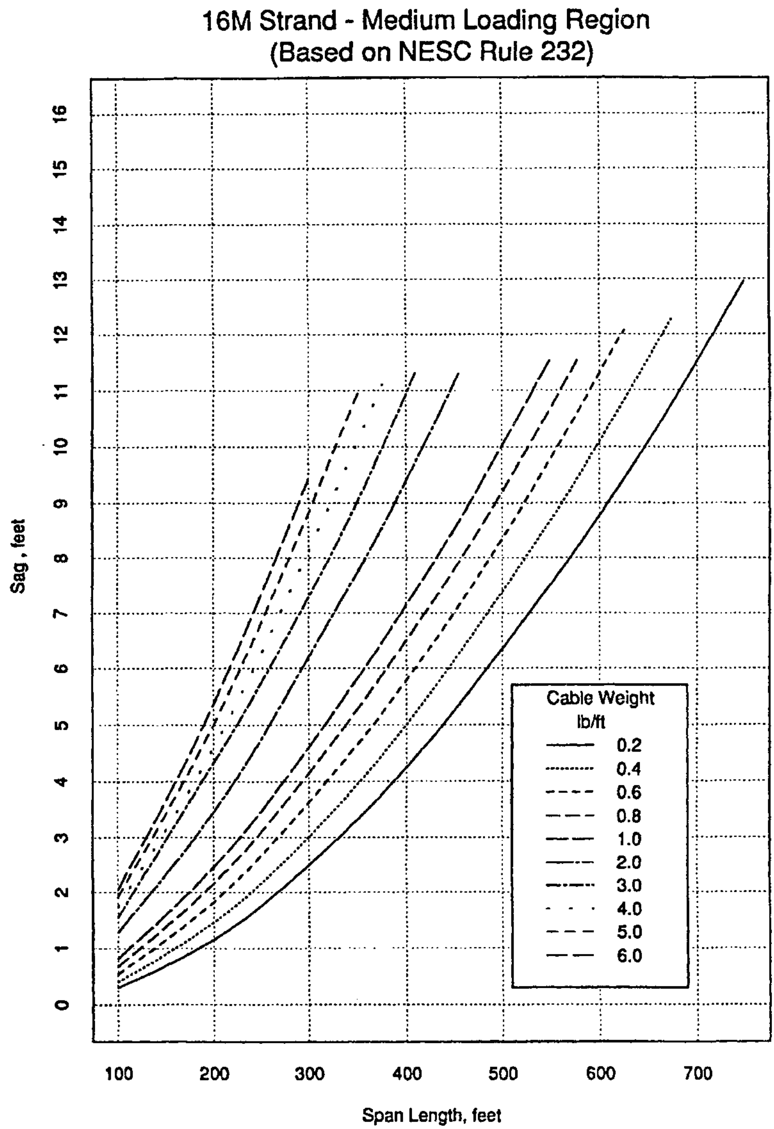
10M Strand - Light Loading Region (Based on NESC Rule 232)



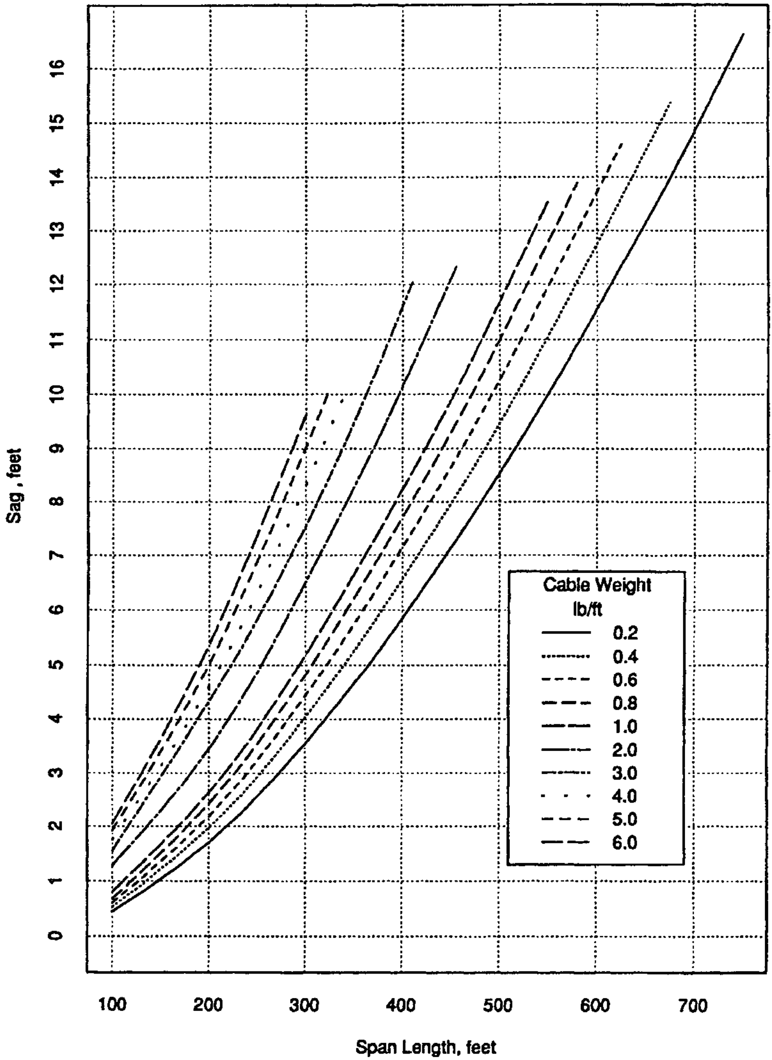

10M Strand - Medium Loading Region
(Based on NESC Rule 232)
Sag, feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Span Length, feet
100
200
300
400
500
600
700
Cable Weight
lb/ft
0.2
0.4
0.6
0.8
1.0
2.0
3.0
4.0
5.0
6.0

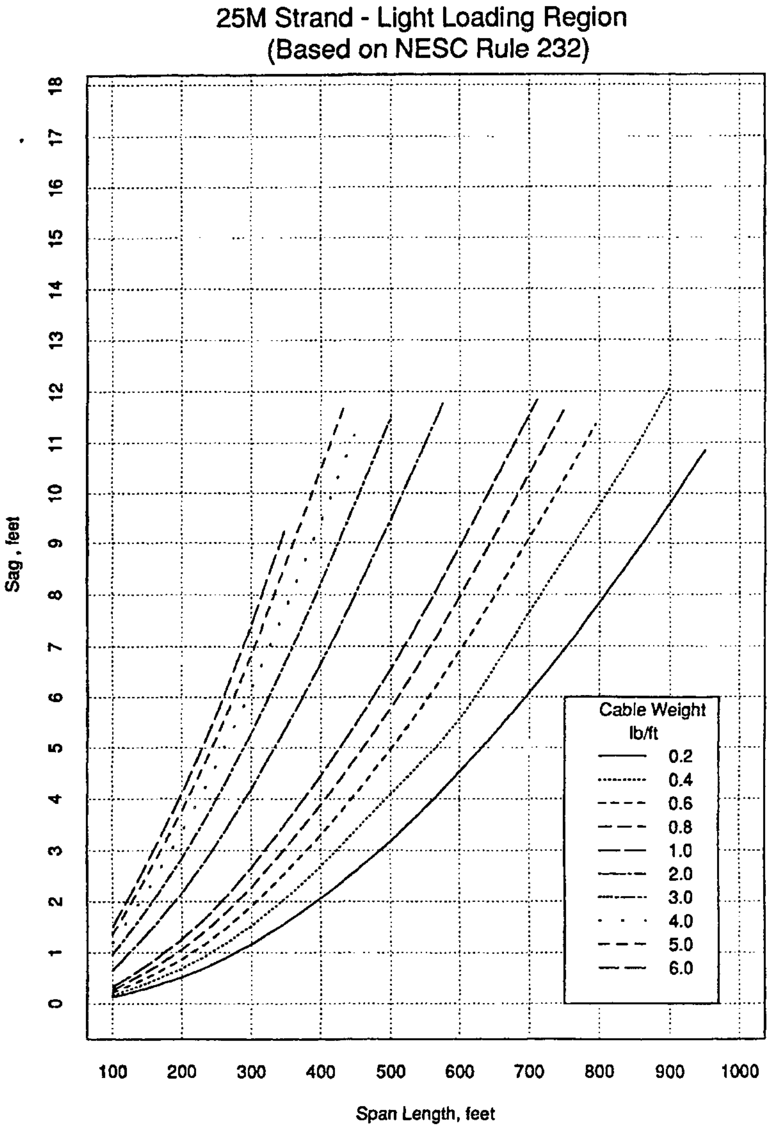

10M Strand - Heavy Loading Region
(Based on NESC Rule 232)
Sag, feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
100
200
300
400
500
600
700
Span Length, feet
Cable Weight
lb/ft
0.2
0.4
0.6
0.8
1.0
2.0
3.0
4.0
5.0
6.0


16M Strand - Light Loading Region
(Based on NESC Rule 232)
Sag, feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
100
200
300
400
500
600
700
Span Length, feet
Cable Weight
lb/ft
0.2
0.4
0.6
0.8
1.0
2.0
3.0
4.0
5.0
6.0

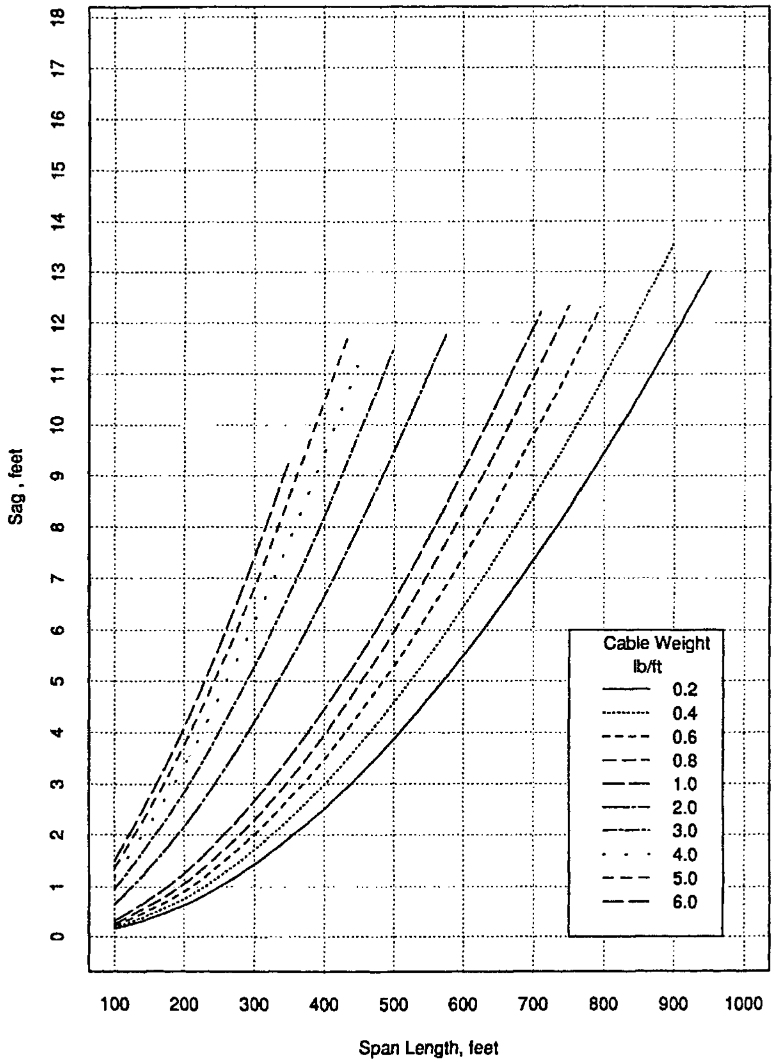

16M Strand - Medium Loading Region
(Based on NESC Rule 232)
Sag , feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
100
200
300
400
500
600
700
Span Length, feet
Cable Weight
lb/ft
0.2
0.4
0.6
0.8
1.0
2.0
3.0
4.0
5.0
6.0

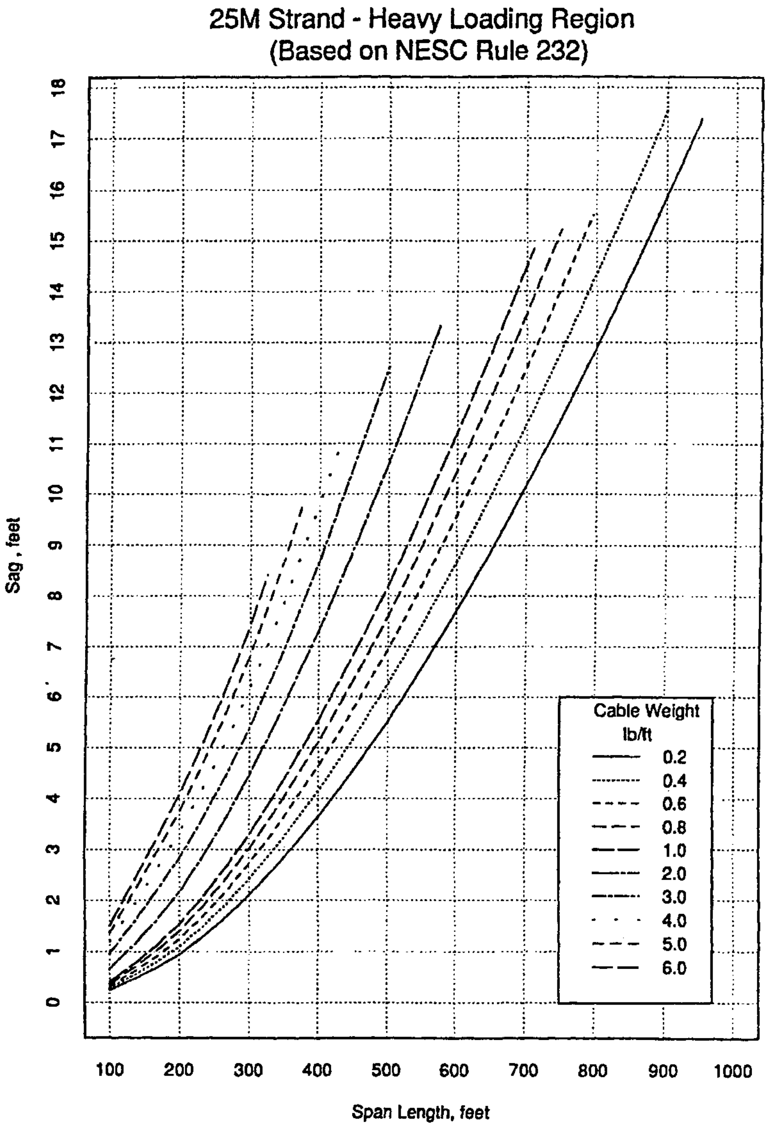
16M Strand - Heavy Loading Region
(Based on NESC Rule 232)

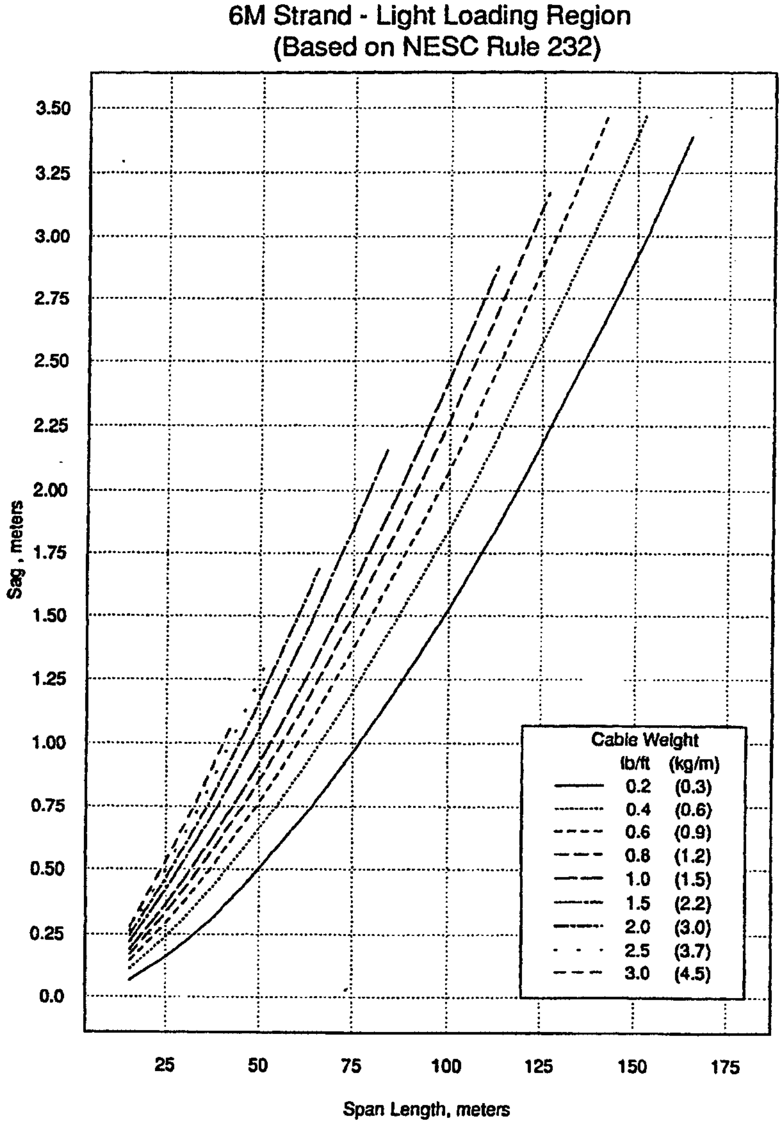


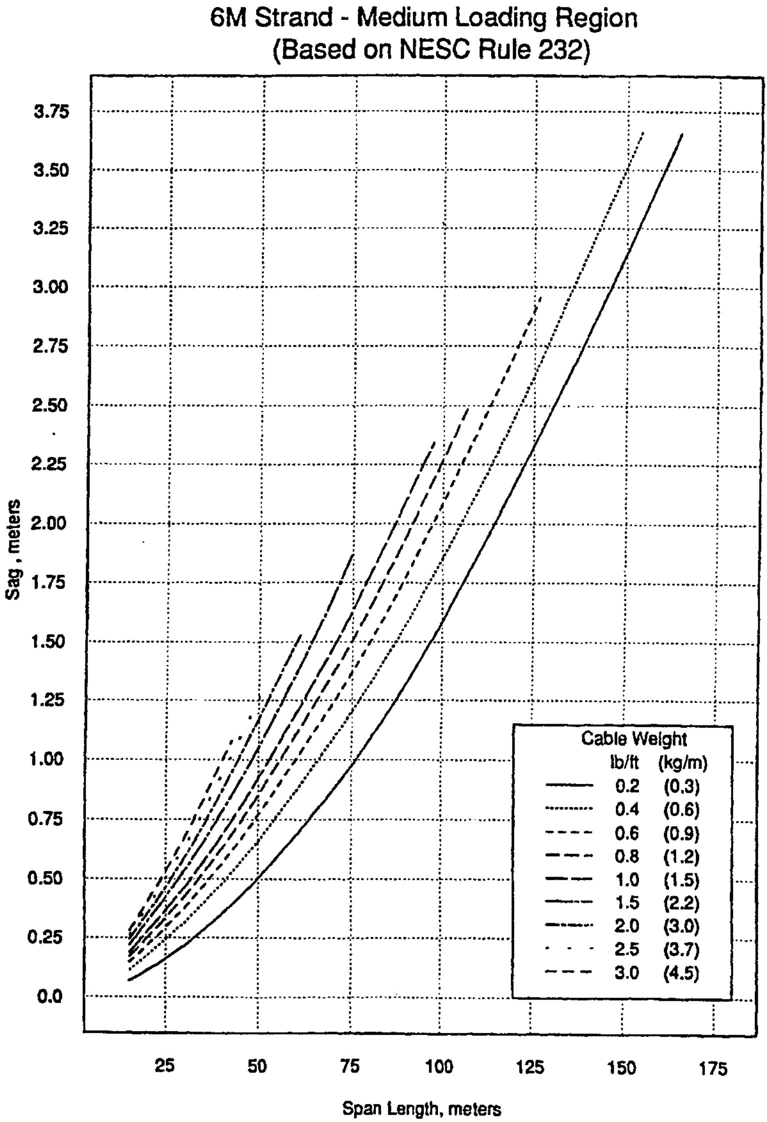

25M Strand - Light Loading Region
(Based on NESC Rule 232)
Sag, feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
100
200
300
400
500
600
700
800
900
1000
Span Length, feet
Cable Weight
lb/ft
0.2
0.4
0.6
0.8
1.0
2.0
3.0
4.0
5.0
6.0

25M Strand - Medium Loading Region
(Based on NESC Rule 232)

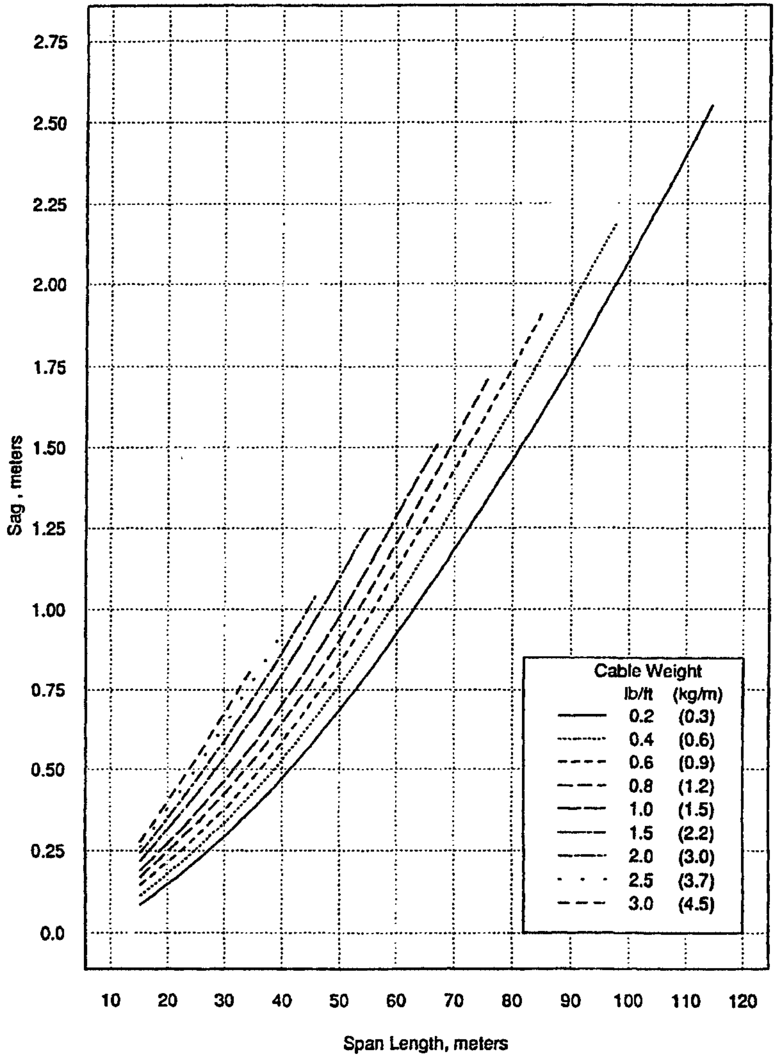



25M Strand - Heavy Loading Region
(Based on NESC Rule 232)
Sag, feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Span Length, feet
100
200
300
400
500
600
700
800
900
1000
Cable Weight
lb/ft
0.2
0.4
0.6
0.8
1.0
2.0
3.0
4.0
5.0
6.0

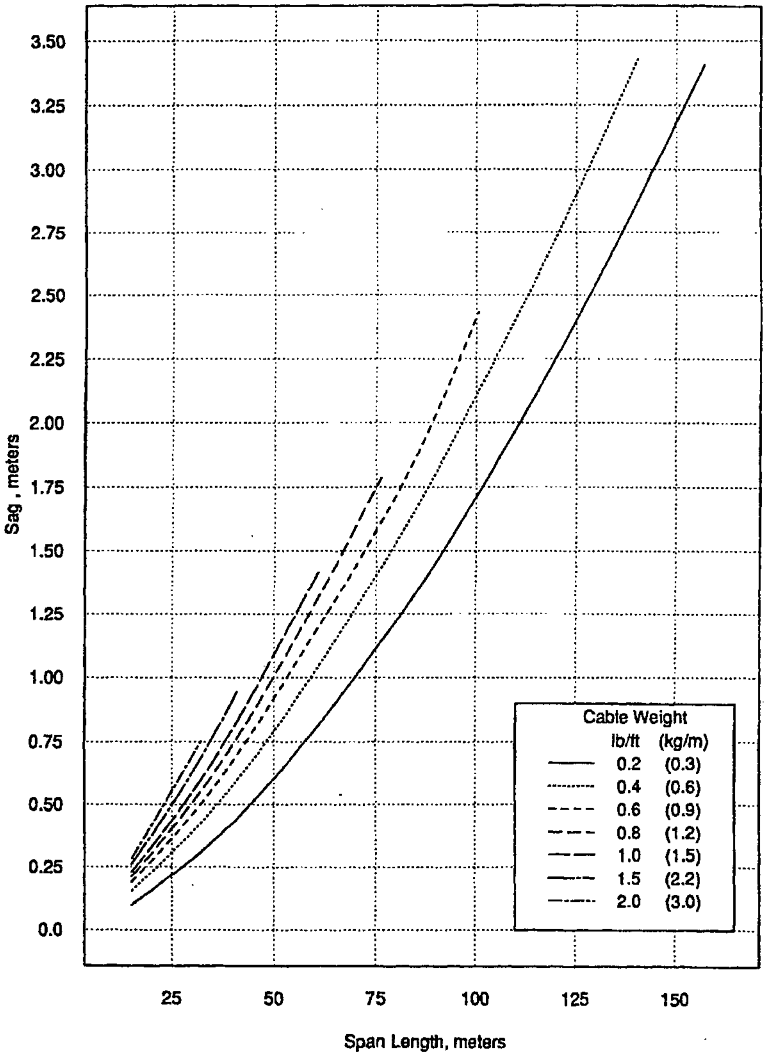

6M Strand - Light Loading Region
(Based on NESC Rule 232)
Sag, meters
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0
25
50
75
100
125
150
175
Span Length, meters
Cable Weight
lb/ft (kg/m)
0.2 (0.3)
0.4 (0.6)
0.6 (0.9)
0.8 (1.2)
1.0 (1.5)
1.5 (2.2)
2.0 (3.0)
2.5 (3.7)
3.0 (4.5)

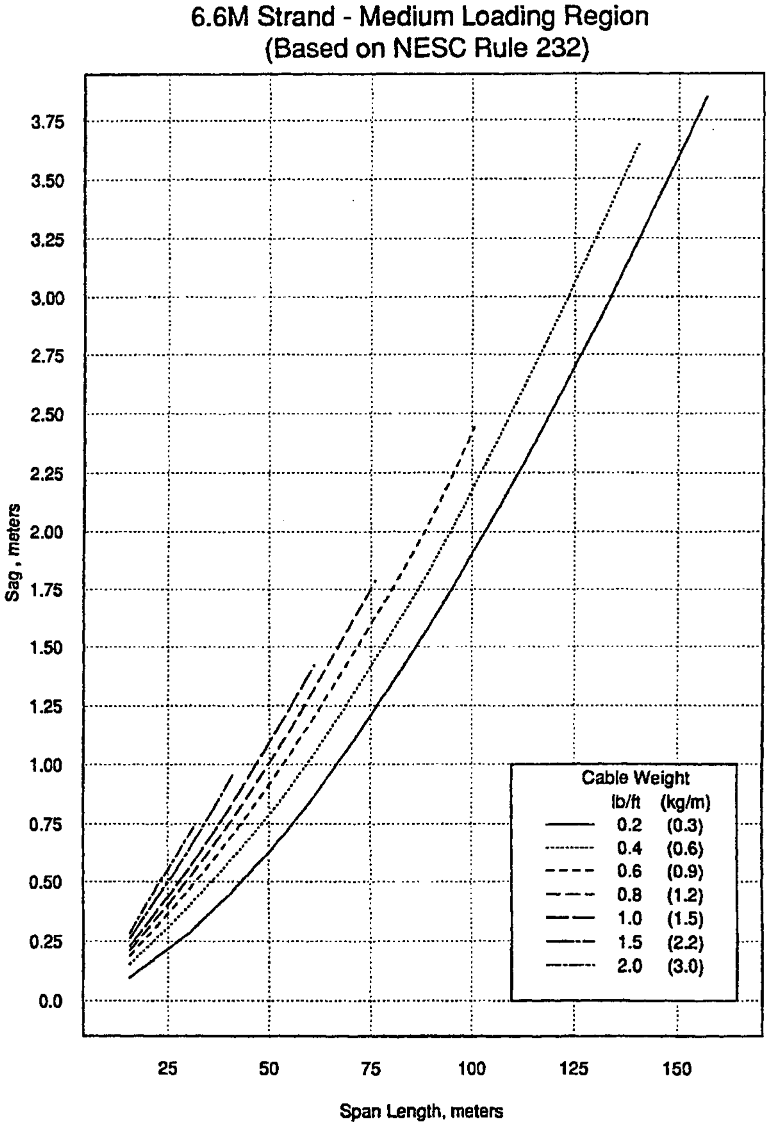

6M Strand - Medium Loading Region
(Based on NESC Rule 232)
Sag, meters
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0
25
50
75
100
125
150
175
Span Length, meters
Cable Weight
lb/ft (kg/m)
0.2 (0.3)
0.4 (0.6)
0.6 (0.9)
0.8 (1.2)
1.0 (1.5)
1.5 (2.2)
2.0 (3.0)
2.5 (3.7)
3.0 (4.5)

6M Strand - Heavy Loading Region
(Based on NESC Rule 232)

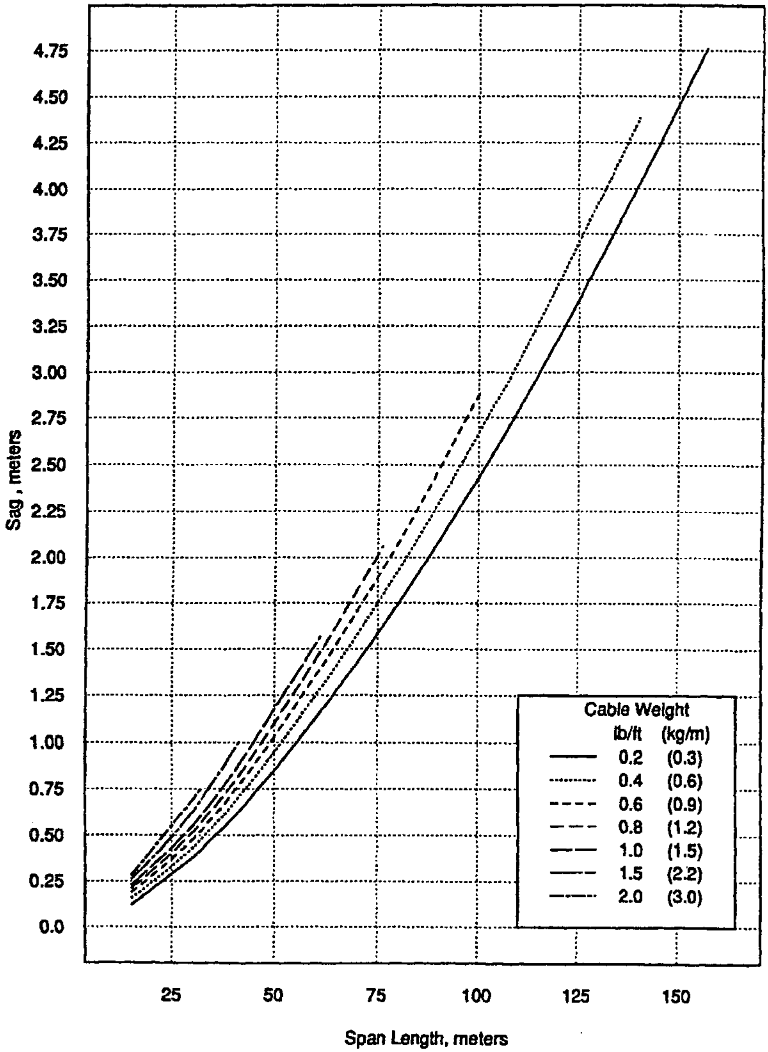


6.6M Strand - Light Loading Region (Based on NESC Rule 232)

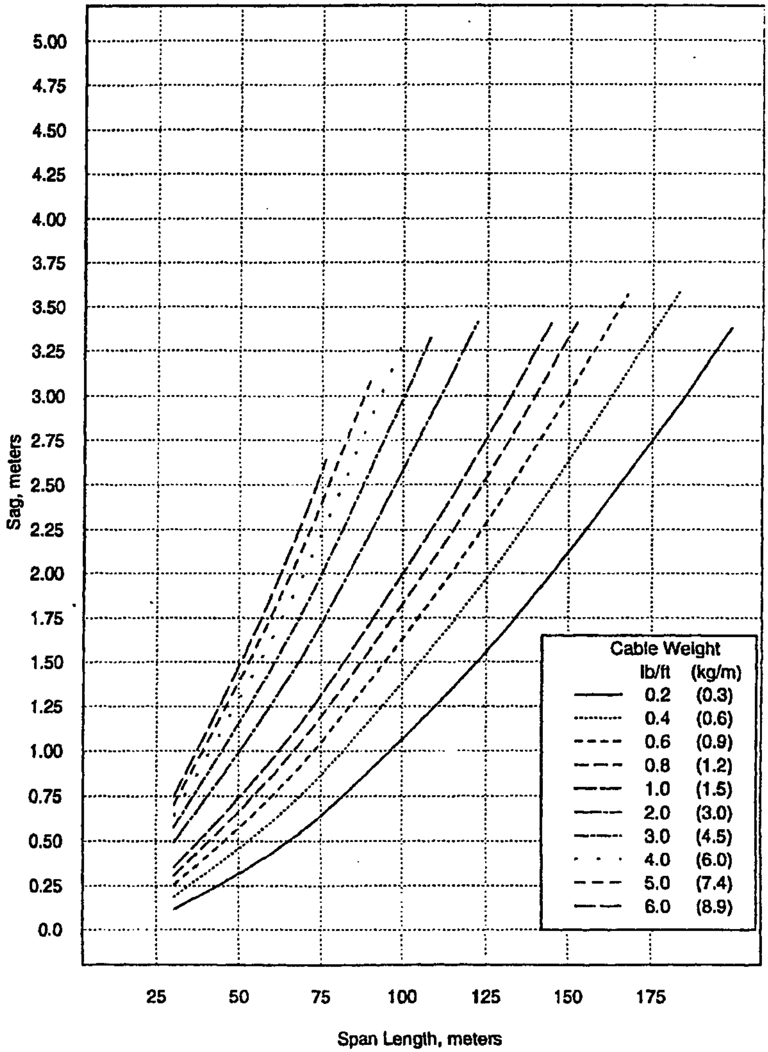



6.6M Strand - Medium Loading Region
(Based on NESC Rule 232)
Sag , meters
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0
25
50
75
100
125
150
Span Length, meters
Cable Weight
lb/ft (kg/m)
0.2 (0.3)
0.4 (0.6)
0.6 (0.9)
0.8 (1.2)
1.0 (1.5)
1.5 (2.2)
2.0 (3.0)

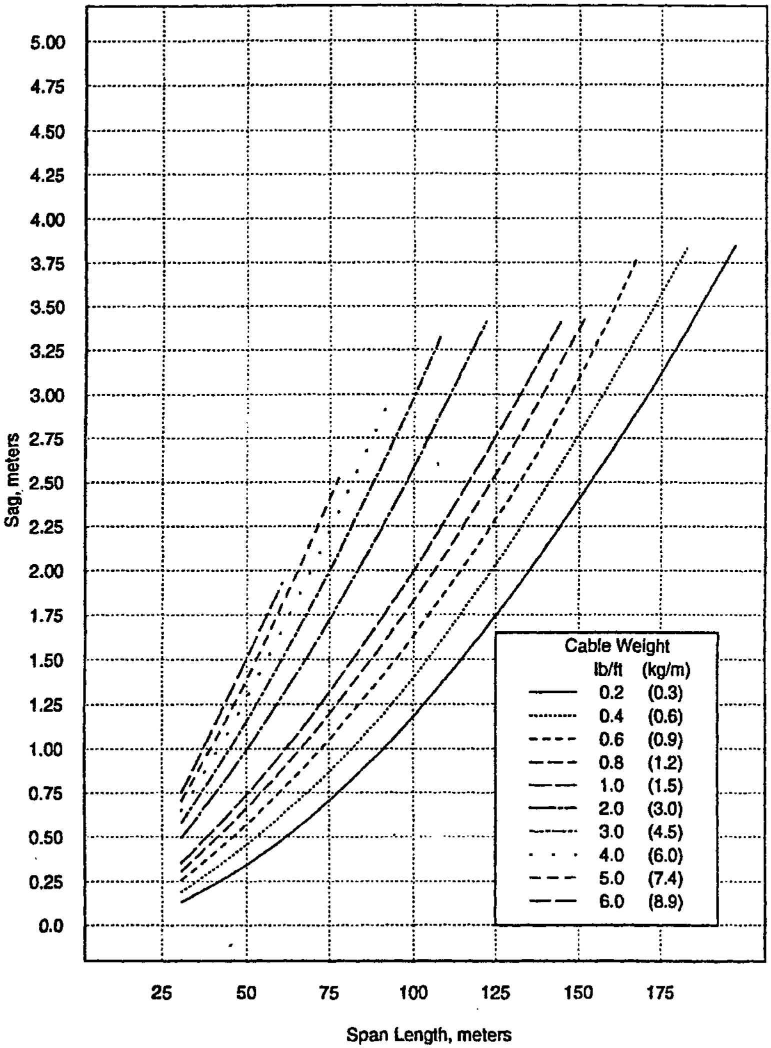
6.6M Strand - Heavy Loading Region (Based on NESC Rule 232)



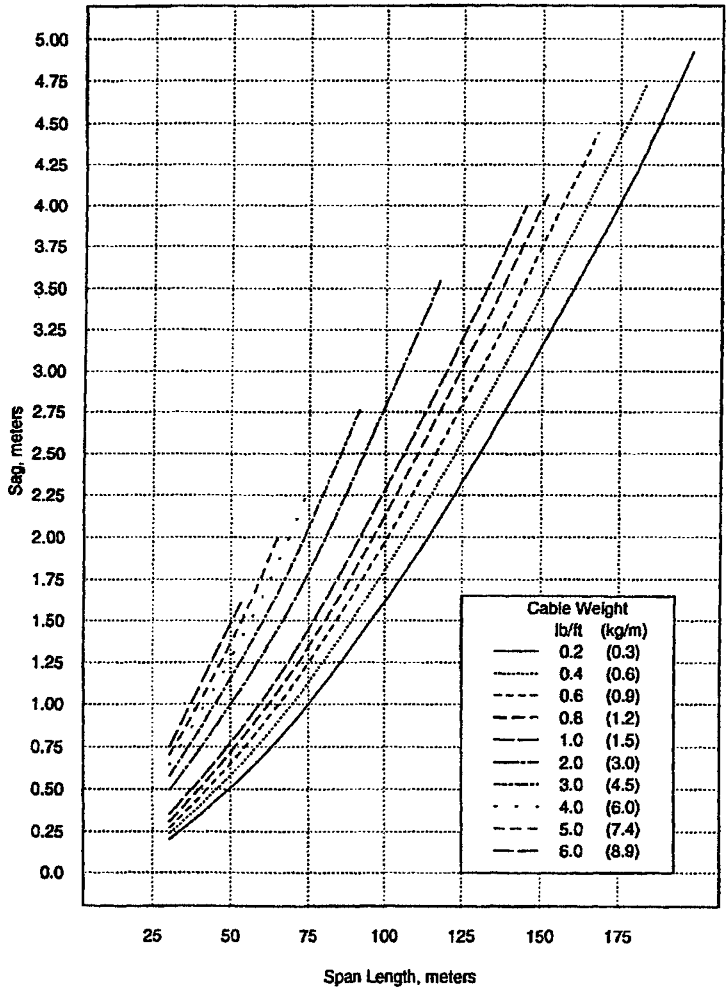
10M Strand - Light Loading Region
(Based on NESC Rule 232)



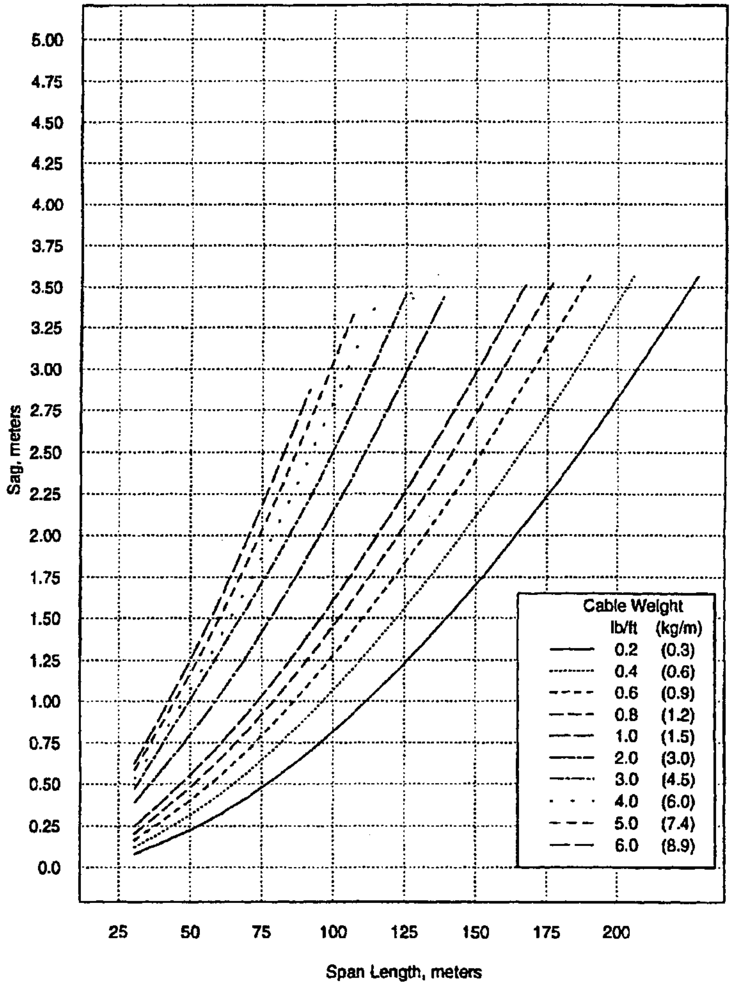
10M Strand - Medium Loading Region
(Based on NESC Rule 232)

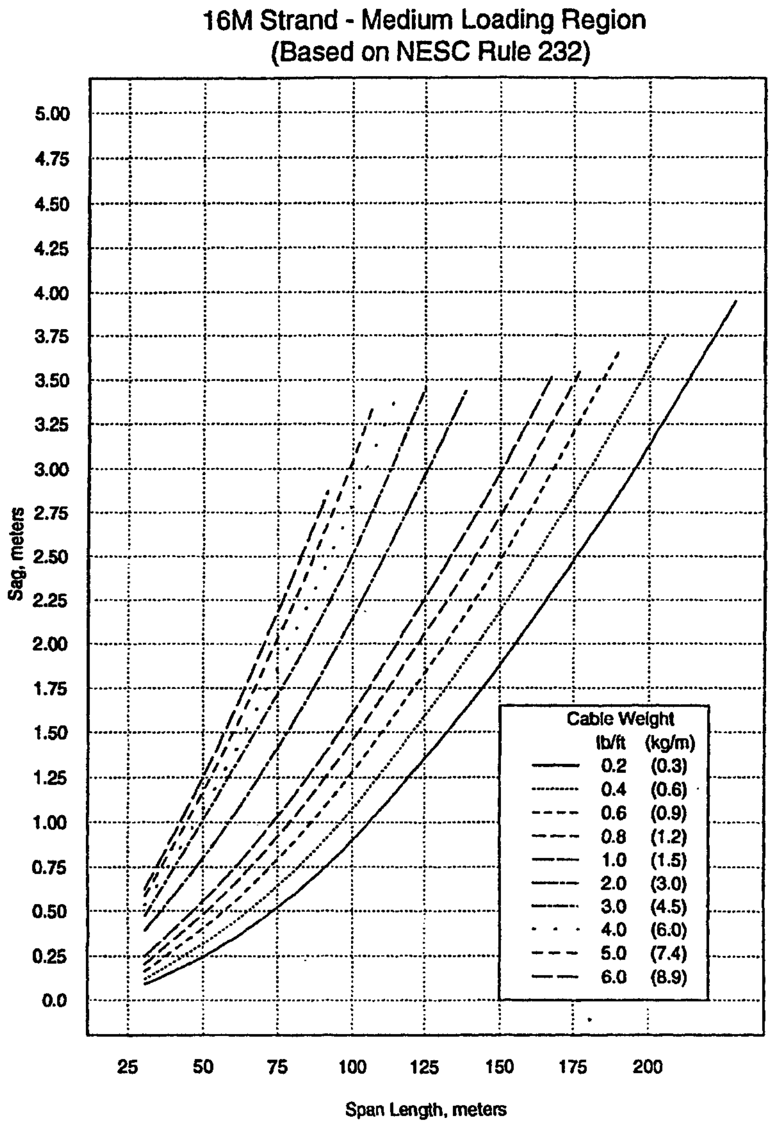


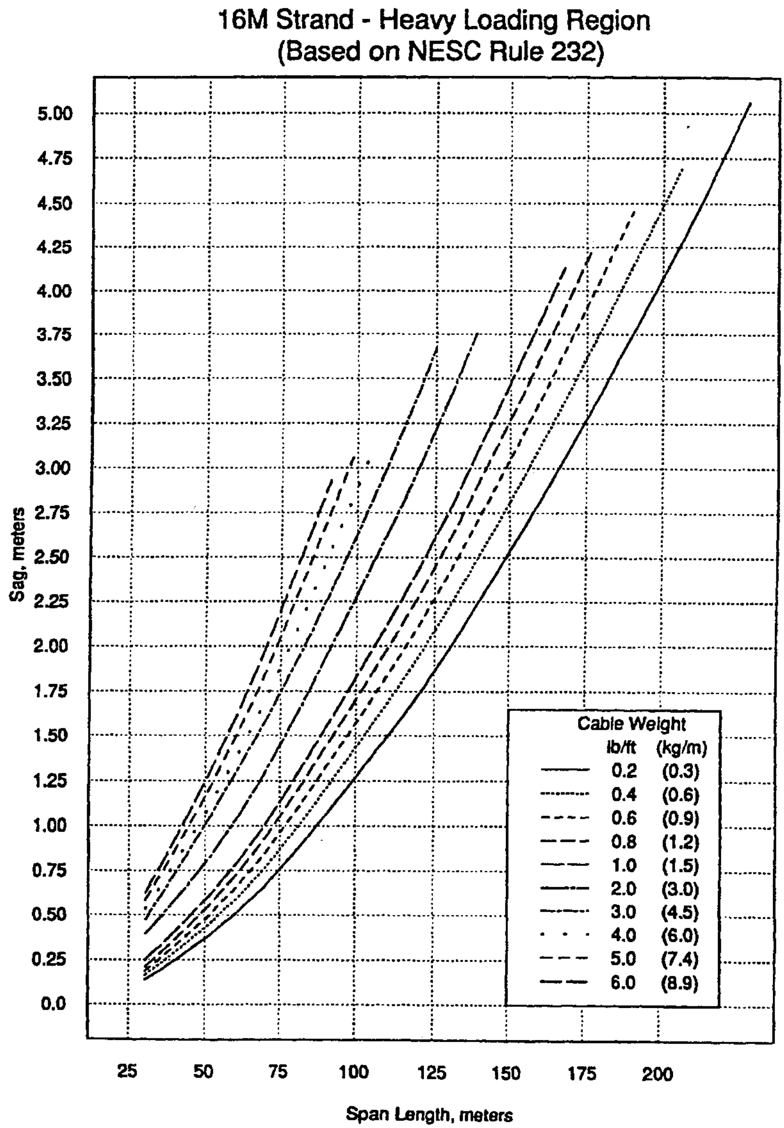
10M Strand - Heavy Loading Region
(Based on NESC Rule 232)

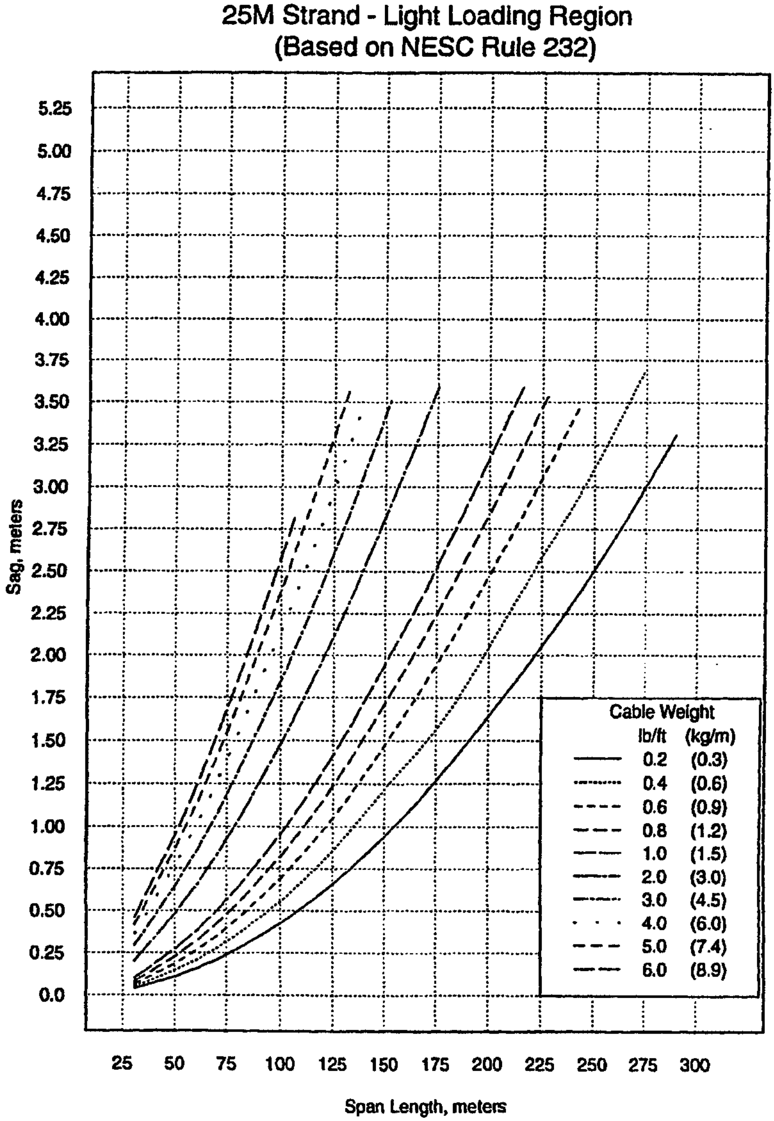


16M Strand - Light Loading Region
(Based on NESC Rule 232)

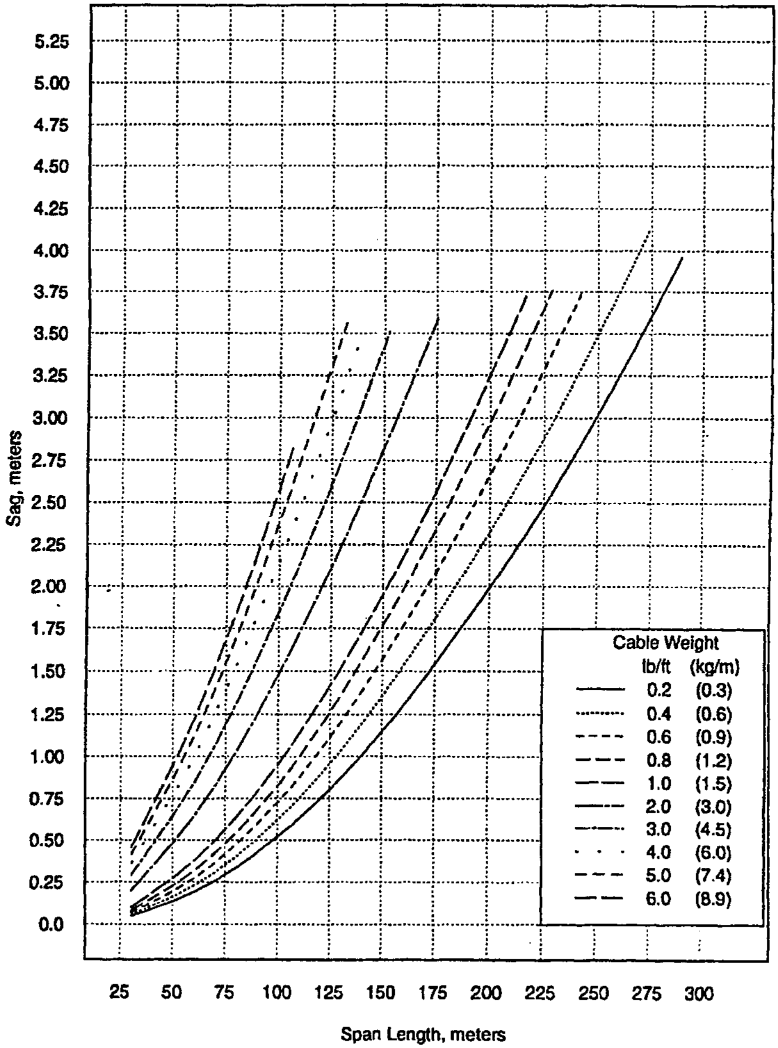


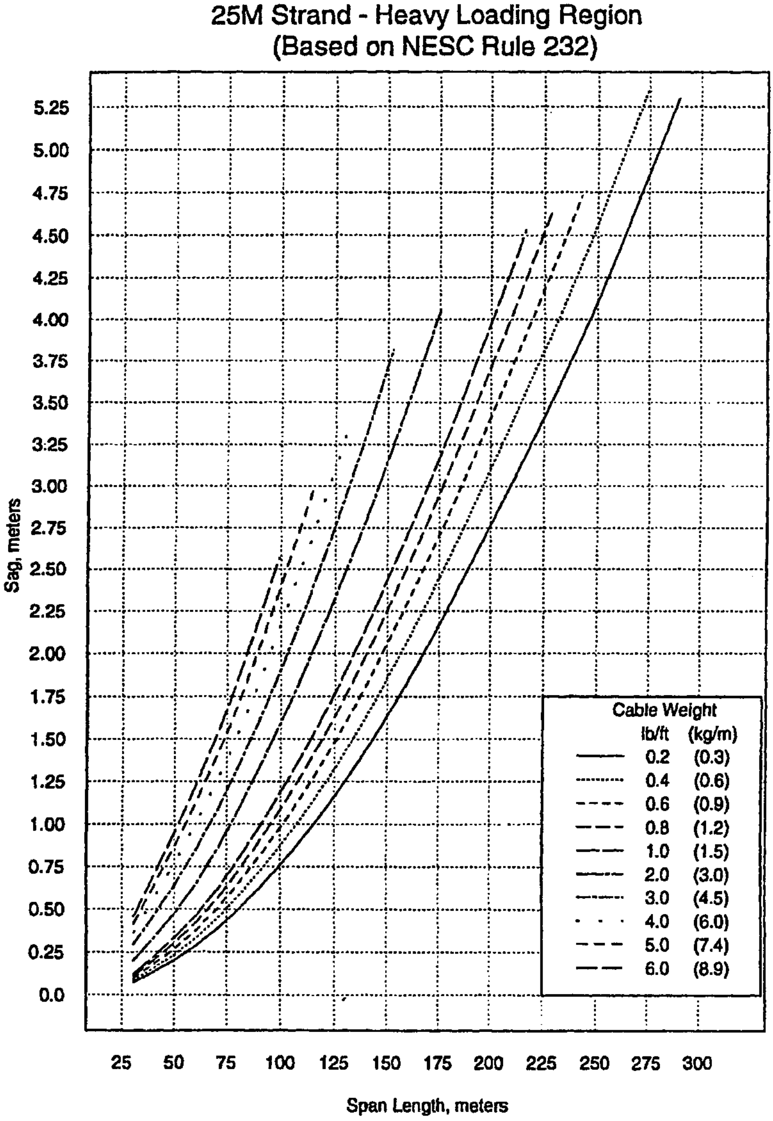

16M Strand - Medium Loading Region
(Based on NESC Rule 232)
Sag, meters
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0
Cable Weight
lb/ft (kg/m)
0.2 (0.3)
0.4 (0.6)
0.6 (0.9)
0.8 (1.2)
1.0 (1.5)
2.0 (3.0)
3.0 (4.5)
4.0 (6.0)
5.0 (7.4)
6.0 (8.9)
25
50
75
100
125
150
175
200
Span Length, meters


16M Strand - Heavy Loading Region
(Based on NESC Rule 232)
Sag, meters
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0
25
50
75
100
125
150
175
200
Span Length, meters
Cable Weight
lb/ft (kg/m)
0.2 (0.3)
0.4 (0.6)
0.6 (0.9)
0.8 (1.2)
1.0 (1.5)
2.0 (3.0)
3.0 (4.5)
4.0 (6.0)
5.0 (7.4)
6.0 (8.9)


25M Strand - Light Loading Region
(Based on NESC Rule 232)
Sag, meters
5.25
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0
Cable Weight
lb/ft (kg/m)
0.2 (0.3)
0.4 (0.6)
0.6 (0.9)
0.8 (1.2)
1.0 (1.5)
2.0 (3.0)
3.0 (4.5)
4.0 (6.0)
5.0 (7.4)
6.0 (8.9)
25 50 75 100 125 150 175 200 225 250 275 300
Span Length, meters

25M Strand - Medium Loading Region
(Based on NESC Rule 232)




25M Strand - Heavy Loading Region
(Based on NESC Rule 232)
5.25
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0
Sag, meters
25
50
75
100
125
150
175
200
225
250
275
300
Span Length, meters
Cable Weight
lb/ft (kg/m)
0.2 (0.3)
0.4 (0.6)
0.6 (0.9)
0.8 (1.2)
1.0 (1.5)
2.0 (3.0)
3.0 (4.5)
4.0 (6.0)
5.0 (7.4)
6.0 (8.9)

MAXIMUM SPAN LENGTHS

Copper Cable

AT&T 627-200-015

Span lengths are limited by the following factors:

1. Strand tension shall not exceed 60 percent of breaking strength under storm loading conditions.
2. Strand tension shall not exceed 70 percent of breaking strength with the cable in place and a 300-pound load concentrated at midspan.
3. Sag shall not exceed 10 feet (3.05 m) at 60°F (15.5°C) with no wind.
4. The 6.6M strand tension shall not exceed 1400 pounds with the cable in place at 60°F (15.5°C).
5. For self-supporting cable, the span length is limited by the simultaneous application of items (3) and (4) above.

Maximum span lengths using recommended stringing tensions are shown on the next four pages.

MAXIMUM SPAN LENGTHS FOR SELF-SUPPORTING CABLE								
Pairs	Maximum Span Length (Feet)							
	Alpeth Sheath				Reinforced Sheath			
	Gauge / Code							
	19 BHBS	22 BHAS	24 BKMS	26 BKTS	19 BHBP	22 BHAP	24 BKMP	26 BKTP
6	650				475			
11	600				475			
16	500	600			425	475		
25	475	550	600	650	400	475	475	500
50	375	475	550	600	350	400	425	475
75		425	475	550		350	400	
100		375	425	500		330	375	425
150			375	425			340	375
200			350	400			310	350
300				350				315

MAXIMUM ALLOWABLE SPAN LENGTHS—ALPETH AND STALPETH SHEATH, COPPER CONDUCTORS, LIGHT LOADING AREA					
Cable Weight (Pounds/Foot)	Maximum Span Length (Feet)				
	6M	6.6M	10M	16M	25M
0.1	580	560	—	—	—
0.2	540	515	650	750	950
0.3	520	485	650	705	885
0.4	500	460	600	675	850
0.5	485	380	575	645	825
0.6	465	330	550	625	795
0.7	445	270	525	600	770
0.8	415	250	500	580	750
0.9	390	210	490	565	725
1.0	370	200	475	550	710
1.2	320	160	450	520	675
1.4	290	140	435	500	645
1.6	260	120	420	485	620
1.8	235	110	410	470	595
2.0	215	105	400	455	575
2.2	195	90	390	445	555
2.4	175	80	380	435	535
2.6	160	—	370	425	525
2.8	150	—	365	415	510
3.0	140	—	355	410	500
3.5	—	—	345	390	475
4.0	—	—	330	375	455
4.5	—	—	315	360	435
5.0	—	—	295	350	425

MAXIMUM ALLOWABLE SPAN LENGTHS— ALPETH AND STALPETH SHEATH, COPPER CONDUCTORS, MEDIUM LOADING AREA					
Cable Weight (Pounds/Foot)	Maximum Span Length (Feet)				
	6M	6.6M	10M	16M	25M
0.1	580	560	—	—	—
0.2	540	515	650	750	950
0.3	520	485	650	705	885
0.4	505	460	600	675	850
0.5	485	380	575	645	825
0.6	415	330	550	625	795
0.7	390	270	525	600	770
0.8	350	250	500	580	750
0.9	335	210	490	565	725
1.0	320	200	475	550	710
1.2	280	160	450	520	675
1.4	260	140	435	500	645
1.6	235	120	420	485	620
1.8	215	110	410	470	595
2.0	200	105	400	455	575
2.2	190	90	390	445	555
2.4	175	80	380	435	535
2.6	160	—	370	425	525
2.8	150	—	365	415	510
3.0	140	—	355	410	500
3.5	—	—	340	390	475
4.0	—	—	305	375	455
4.5	—	—	275	360	435
5.0	—	—	255	350	425

MAXIMUM ALLOWABLE SPAN LENGTHS—ALPETH AND STALPETH SHEATH, COPPER CONDUCTORS, HEAVY LOADING AREA					
Cable Weight (Pounds/Foot)	Maximum Span Length (Feet)				
	6M	6.6M	10M	16M	25M
0.1	400	560	—	—	—
0.2	375	515	650	750	950
0.3	335	485	650	705	885
0.4	320	460	600	675	850
0.5	290	380	575	645	825
0.6	280	330	550	625	795
0.7	260	270	525	600	770
0.8	250	250	500	580	750
0.9	230	210	490	565	725
1.0	220	200	475	550	710
1.2	200	160	450	520	675
1.4	185	140	435	500	645
1.6	175	120	420	485	620
1.8	160	110	405	470	595
2.0	150	105	385	455	575
2.2	145	90	360	445	555
2.4	135	80	345	435	535
2.6	130	—	325	425	525
2.8	125	—	315	415	510
3.0	115	—	300	410	500
3.5	—	—	270	380	475
4.0	—	—	245	345	435
4.5	—	—	230	320	405
5.0	—	—	215	300	375

Lashed Fiber Optic Cables

AT&T 627-320-011, -205, -206, 920-400-300

AT&T 627-400-001

There are a number of construction methods to consider when planning an aerial fiber optic cable route. Three methods will be covered in this section.

- Standard Method
- Matched Sag Method
- Overlashing Method

Standard Method

In the standard method, the support strand is installed at the stringing tension given on page 10-39. Because the fiber optic cable weighs very little, the sag in the cable is relatively small. To avoid mid-span clearance problems with heavy copper-pair cables, fiber optic cable should occupy the uppermost permissible position in the communication space on the pole.

The table on the next page shows the maximum span lengths for fiber optic cable installed using the standard method.

Maximum Permissible Span Lengths (ft) for Fiber Optic Cable

AccuRibbon® Cable

Storm Load Region	Suspension Strand *				
	6.6M	6M	10M	16M	25M
Heavy	225	350	450	675	1100
Medium	375	575	775	1225	2050
Light	375	575	775	1225	2050

Lightpack® Cable

Storm Load Region	Suspension Strand *				
	6.6M	6M	10M	16M	25M
Heavy	275	400	525	775	1250
Medium	450	725	925	1475	2425
Light	450	725	925	1475	2425

Self-Support Cable

Storm Load Region	Cable Type	
	Dielectric Circular †	Figure-8 ‡
Heavy	400	550
Medium	550	600
Light	650	650

* Strand placed at standard tension. Suspension strand and stringing tension are covered in AT&T 627-210-018.

† The maximum recommended installation tension for the dielectric circular-self-support cable is 560 lb. Lower values of installation tension are permissible.

‡ The recommended installation tensions for the figure-8, self-support cable are given in AT&T 627-700-011.

Matched Sag Method

If there is insufficient clearance below power lines on joint-use poles, or if the fiber optic cable must be installed below existing copper-pair or CATV cable, then additional mid-span clearance can be obtained by reducing the strand stringing tension. The tension can be reduced until the sag in the fiber optic cable matches the sag in the other cables on the pole line. This is called the "matched sag construction method." When using this method, the maximum permissible span length shown in the previous table must be reduced by 15 percent to ensure fiber stress stays within acceptable levels under storm-load conditions.

Overlashing Method

Overlashing a fiber optic cable onto an existing aerial fiber optic cable requires special consideration. The presence of a second cable increases the environmental load the existing cable and strand must support without adding much strength to it. It is the stresses in the first existing cable that must be taken into consideration, not the stresses in the second cable being lashed to it.

If a fiber optic cable is overlashed onto an existing fiber optic cable, the strand should be one size larger than required for a single fiber optic cable, or the maximum permissible span given in the table should be reduced by 50 percent.

The criteria for overlashing a fiber optic cable onto an existing copper-pair cable are the same as those for lashing to a strand alone, that is, the span length must be less than the maximum permissible span given in the tables and the strand must be in good condition.

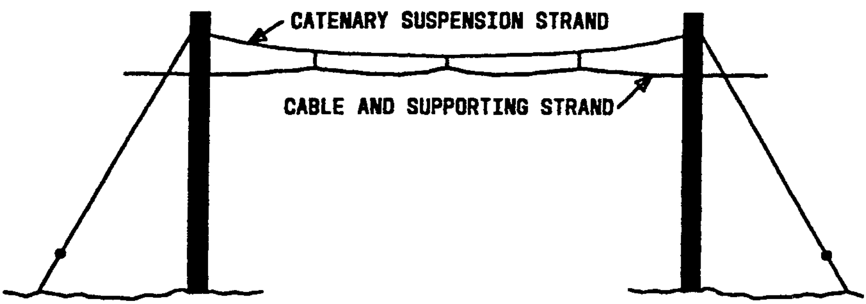
Suspension strand and stringing tensions are covered in AT&T 627-210-018.

Special Long-Span Design

AT&T 627-370-200, -205, 919-565-450

Where the required span length for aerial cable exceeds the limits indicated on the preceding pages, the following alternatives are possible:

1. Where the span length is sag-limited, place the strand at the recommended stringing tension and violate the 10-foot (3.05 m) sag limitation.
2. Where the span is storm load tension-limited, place the strand at a lower stringing tension.
3. Place a catenary suspension strand (see below) above the regular cable suspension strand.



Sags and tensions for these special designs must be calculated since they are not tabulated.

WIRE

The maximum span lengths, sag, and tension of wire are shown in the following documents.

AT&T 917-534-200	C Rural Wire
AT&T 621-400-015	Guying — Insulated Wires

BIBLIOGRAPHY

AT&T	Title
621-020-013	Ordering, Delivery, and Markings on Poles and Stubs
621-020-111	Dimensions and Weights of Poles and Stubs
621-205-200	Erecting Poles and Stubs
621-205-211	Placing Pole Braces and H Fixtures
621-400-011	Guying — Definitions
621-400-013	Guying — Sizes of Guys
621-400-015	Guying — Insulated Wires
621-405-201	Guying — Methods of Insulating
621-410-206	Guying — Aerial Cable Lines
621-410-220	Guying — Sidewalk Anchor Guys
621-415-200	Patent Guy Anchors — Expanding Anchors
621-415-201	Patent Guy Anchors — Screw Type
621-415-202	Patent Guy Anchors — Swamp Anchors
621-415-203	Patent Guy Anchors — Plate Anchors
621-415-204	"C" Guy Anchors — Power Installation
621-415-211	Plank Anchors
621-415-215	Rock Anchors
626-101-005	Air Core PIC Cables — Description and Use
626-101-010	Filled PIC Cables — Description and Use
627-020-005	Bonding and Grounding Aerial Plant

AT&T	Title
627-200-015	Suspension Strand Selection — Copper Conductor Cables — All Loading Areas
627-210-018	Suspension Strand Tensions and Sags
627-240-225	Slack Span Construction
627-370-XXX	Long Span Construction
627-400-001	LXE — Aerial Fiber Optic Cable
627-700-011	Self-Supporting Cable Sags and Tensions
917-534-100	Multiple Line Wire
917-534-200	C Rural Wire
919-000-100	Design of Communication Lines Crossing Railroads
919-120-100	Pole Line Planning
919-120-200	Pole Line Classifications and Loading
919-120-400	Pole Timber Species and Preservative Treatments
919-120-560	Grounding or Insulating Guys
919-120-600	Pole Lines — Detail Design
919-120-700	Pole Lines — Design Data
919-370-200	Wire and Cable Spans — Effects of Ice, Wind and Temperature
919-565-400	Aerial Cable — Selection of Type and Size of Suspension Strand
919-565-401	Aerial Cable — Resultant Storm Loads

AT&T	Title
919-565-450	Special Span Aerial Design
920-400-300	Fiber Optic Cable — Installation and Planning — Aerial
928-411-514	Preparation of Work Prints — Aerial Cable

National Electrical Safety Code

Section 25	General Loading Requirements and Maps

Section 11

Contents

Section 11

CLEARANCES FOR AERIAL PLANT

GENERAL

The recommendations on this section are based on the 1993 Edition of the National Electric Safety Code (NESC). This section contains only a brief summary of the common clearance requirements. The reader is referred to the NESC for requirements, exceptions, and loading conditions not covered herein. This section should only be used as a guideline—the NESC, state, municipality, and/or local company practices shall govern the actual requirements.

BASIC CLEARANCES

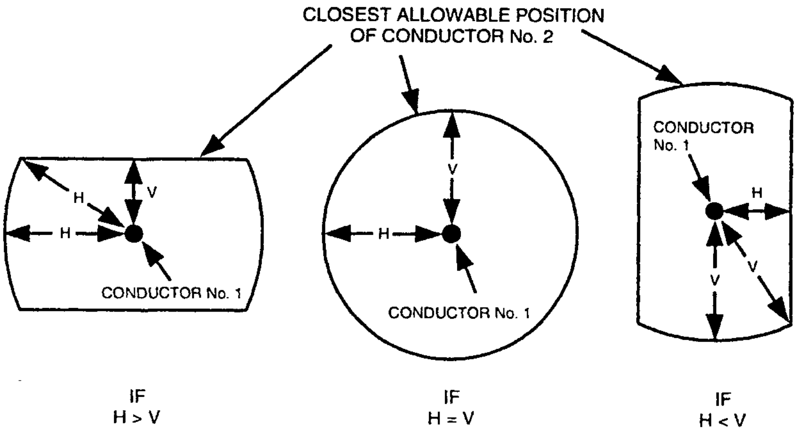
Telephone Conductors From Power Wires on Different Pole Lines

The NESC specifies both horizontal and vertical clearance between any two crossing or adjacent cables that are carried on different supporting structures. Based on the horizontal and vertical clearances, a clearance envelope is developed. The clearance envelope must be maintained under all conditions of conductor loading.

Horizontal Clearance (Rule 233B1)	
Voltage	**Clearance Ft (mm)**
Up to 129 kV	5 (1500)
Over 129 kV	5 (1500) plus 0.4 in.(10) per kV over 129 kV

Vertical Clearance (Rule 233C1)	
Voltage	**Clearance Ft (mm)**
Supply cables meeting Rule 230C1 and supply cables of 0 up to 750 V meeting rule 230C2 or 230C3*	2 (600 mm)
Up to 750 V	4 (1200)
750 V to 22 kV	6 (1800)
22 kV to 470 kV	6 (1800) plus 0.4 in.(10) per kV over 22 kV
Over 470 kV	See NESC Rule 233C3

* For example, insulated cables supported on a bare, grounded messenger. See NESC for details.



Clearance Envelope

H = Horizontal

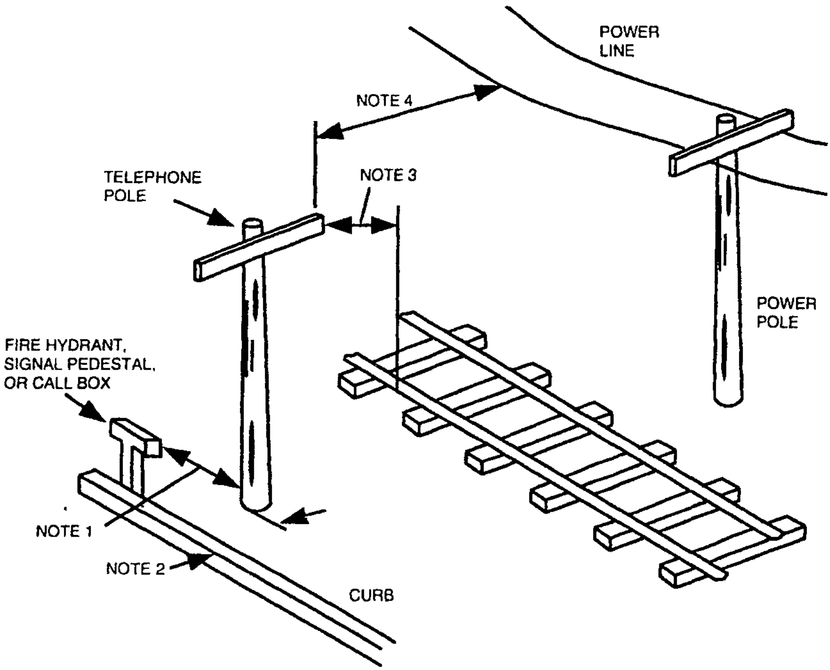
V = Vertical

Telephone Conductors From Power Poles

For telephone conductors, clearance from power poles is the same as between telephone poles and power conductors (see next page).

Telephone Poles and Stubs From Power Conductors and Other Objects

NESC Rule 231



Clearances

Notes are shown on next page.

Notes associated with Page 11-4

Object	Clearance
1. Fire hydrants, signal pedestals, and call boxes.	3 ft (900 mm) minimum, 4 ft (1200 mm) recommended (Rule 231A)
2. Curbs (from street side of curb to nearest part of pole and attachments within 15 ft [4.6 m] above the road surface).	6 in. (150 mm) minimum. (Rule 231B) Shall be located a sufficient distance from the street side of the curbs to avoid contact by ordinary vehicles using and located on the traveled way.
Streets and roads without curbs.	As near as practical to the edge of the right-of-way
3. Railroad tracks (from nearest rail to nearest part of pole and attachments within 22 ft [6.7 m] above rails).	12 ft (3.7 m) Rule 231C
4. Power wires	Not less than the following horizontal clearance (Rule 234B1)
Power wires up to 50 kV	5 ft (1500 mm) min., no wind condition
	OR
Power cable up to 750 V	3.5 ft (1100 mm) when displaced by a 6 psf (287 pascals) wind force at 60°F (15.5°C)
Power wires 750 V to 22 kV	4.5 ft (1400 mm) when displaced by a 6 psf (287 pascals) wind force at 60°F (15.5°C)

Vertical Clearances Above Ground, Roads, Rails, Roofs, Water, Etc.

NESC Rule 232—Tables 232-1 and 234-1

The vertical clearances shown in the following table apply under the following temperature and loading conditions, whichever produces the larges final sag.

1. 120°F (48.8°C), no wind displacement
2. The maximum conductor temperature for which the line is designed to operate, if greater than 120°F (48.8°C), with no wind displacement (Not applicable to telephony cable.)
3. 32°F (0°C), no wind displacement, with radial ice thickness specified in Rule 250B for the loading district concerned.

Maximum expected sags that correspond to the above conditions fo copper-pair cables are given in Section 10, "AERIAL PLANT."

Crossing Over:	Clearance Ft. (m)
Railroad tracks (except electrified railroads using overhead trolley conductors)	23.5 (7.2) [a]
Roads, streets, and other areas subject to truck traffic [c]	15.5 (4.7) [d]
Driveways, parking lots, and alleys	15.5 (4.7) [b, d]
Other land traversed by vehicles such as cultivated, grazing, forest, orchard, etc.	15.5 (4.7)
Roofs accessible to vehicular traffic, but not subject to truck traffic	10.5 (3.2)
Roofs accessible to truck traffic	15.5 (4.7)
Balconies and roofs, accessible to pedestrians only	10.5 (3.2)
Roofs not accessible via doorways, ramps, stairways, or permanently-mounted ladders	3.0 (.9)
Spaces and ways subject to pedestrians only	9.5 (2.9)
Roofs not readily accessible to pedestrians	3.0 (.9)
Water areas not subject to sailboating [f]	14 (4.3)
Other water areas with unobstructed area [f]	
— less than 20 acres	17.5 (5.3)
— 20 to 200 acres	25.5 (7.8)
— 200 to 2000 acres	31.5 (9.6)
— over 2000 acres	37.5 (11.4)
Sailboat rigging and launching areas serving water areas listed above	5 (1.5) more than above
Running Along (But Not Overhanging):	
Roads, streets, or alleys	15.5 (4.7) [d, g]
Rural roads	13 (4.0) [h]
Note: See next page for letter references, for example, [a].	

Letter references from table on previous page.

a. May be reduced by an amount equal to the difference between the highest loaded car and 20 feet (6.1 m).

   1. For railroads, such as mining or logging railroads, which handle only cars lower than standard freight cars. In this case clearance must be at least 15.5 feet (4.7 m).
   2. Adjacent to tunnels and overhead bridges which restrict ca height, if mutually agreed by parties concerned.

b. If the height of attachment to a building does not permit this clearance the clearance may be reduced to 11.5 feet (3.5 m).

c. A truck is defined as any vehicle over 8 feet (2.4 m) high.

d. May be reduced to 15 feet (4.6 m) running along or crossing ove alleys, driveways, and parking lots.

e. For guys and service drops insulated against the highest voltage to which they are exposed (up to 8700 volts), clearance may be reduced to 16 feet (4.9 m) at the side of the traveled way, provided that 18 fee (5.5 m) is maintained at the center. **This reduction does not apply to arterial streets and highways.**

f. If uncontrolled, the surface area is based on annual high water marks and clearances are based on normal flood level. If controlled, the surface area and clearances are based on the design high-water level For rivers, streams, and canals, clearance is based on the larges one-mile-long segment which includes the crossing. Clearance over a waterway providing access for sailboats to a larger body of water shal be that required for the larger body. Where vessel height is restricted by an overwater obstruction, clearances may be reduced to 1.5 feet (.5 m) higher than the obstruction. Where the U.S. Army Corps o Engineers has issued a permit, the clearances of that permit shal govern.

g. May be reduced to 15 feet (4.6 m) where poles are located beyond the cars or other deterrent to vehicular traffic.

h. May be reduced to 9.5 feet (2.9 m) if the cable line is located relative to fences, ditches, embankments, etc., so that vehicular traffic is not expected.

Pole Attachment Height Formula

The following formula can be used to obtain pole attachment height for copper cable.

Pole attachment height = minimum clearance required + maximum cable sag

To use the above formula:

- Determine minimum clearance required from previous table.
- Determine storm loading area from Page 10-7 in Section 10, "AERIAL PLANT."
- Obtain weight of cable from tables in Section 14, "CABLE AND WIRE."
- Obtain maximum cable sag from charts beginning on Page 10-41 in Section 10, "AERIAL PLANT."

For example:

What is the pole attachment height for a BKMA-200 type cable on 6.6M strand spanning 150 ft (45.7 m) crossing over a public road in a medium storm loading area?

Minimum Clearance	= 15.5 ft (4.7 m)
Maximum Sag	= 2.5 ft (0.8 m)
Pole Attachment Height	= 18.0 ft (5.5 m)

Swimming Areas

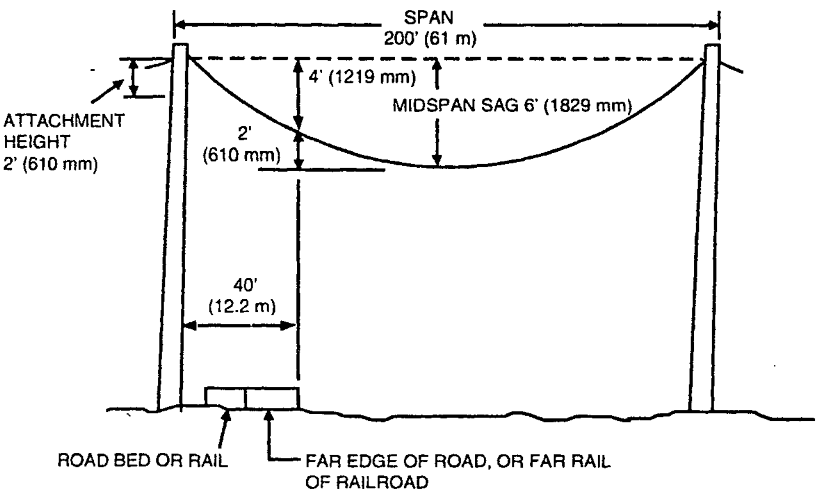
NESC (Rule 234E)

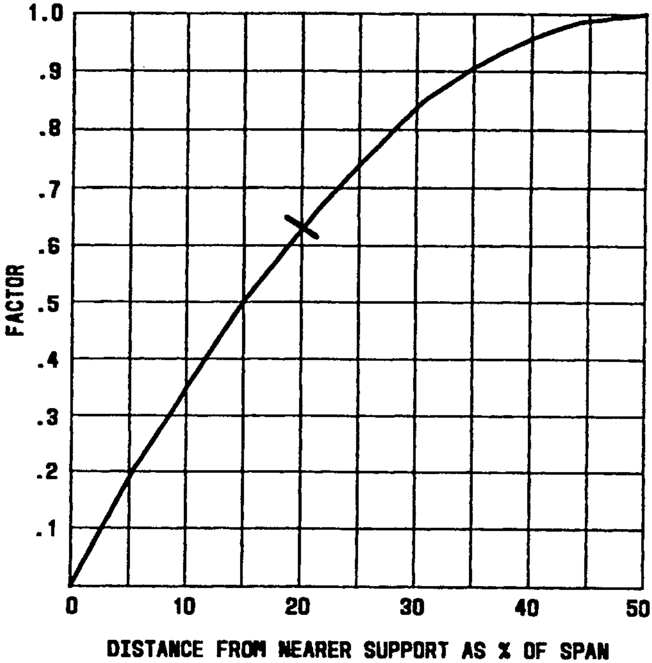
Crossing over a swimming pool or area within 22 feet (6.7 m) of the edge of a pool should be avoided. If such a crossing is necessary, the following clearances are required:

- 22 feet (6.7 m) in any direction from the water level, edge of pool, base of diving platform, or anchored raft.
- 14 feet (4.3 m) in any direction from a diving platform or tower.

Reduced Ground Clearance When Crossing Is Not at Midspan

A saving in pole height may be realized by placing a pole near the point of crossing a road or railroad so that the critical crossing point does not occur at midspan. **Attachment height** may be reduced an amount equal to the reduction in sag by using the chart shown on the next page.





Percentage of Sag at Far Edge of Road or Railroad

For example: In the illustration, the span length is 200 feet (61 m). The distance to the far edge of the road is 40 feet (12.2 m) or 20 percent of the span length. Using the chart, the sag at 20 percent would equal about two-thirds (0.63) of the sag at midspan or 4 feet (1.2 m). The attachment height could then be reduced by 2 feet (0.6 m).

Vertical Clearances Between Conductors — Joint-Use Pole Line

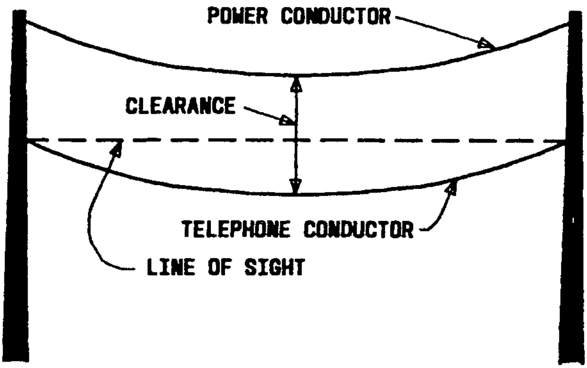
NESC Rule 235C and 23ε

Vertical clearance must be maintained between power and telephonε conductors at the attachment points on joint-use poles. The minimum vertica clearance at the attachment point is shown in the following table.

Vertical Clearances Between Conductors at Supports (Rule 235 and 238)	
Description	**Clearance in. (mm)**
Grounded metal sheath power cables, nonmetallic sheath power cables on grounded messenger, as power cables consisting of insulated conductors lashed to or spiraled around a grounded strand	40* (1000)
Open supply conductors	
0 to 8.7 kV	40 (1000)
8.7 to 50 kV	40 (1000) plus 0.4 (10) per kV over 8.7 kV
Drip loops for luminaires or traffic signal brackets	12 (300)
Grounded supply equipment (transformers, etc)	30 (760)

* May be reduced to 30 inches (760 mm) for supply neutrals meeting Rule 230E1 and cables meeting Rule 230C1 where the supply neutral or messenger is banded to the communications messenger (see NESC for details).

Midspan vertical clearance between power and telephone conductors should be at least 75 percent of the clearance required at the pole. The midspan clearance may be reduced to 12 inches (300 mm) for insulated supply service-drops between 0 and 750 V. For spans longer than 150 feet (45.7 m), additional constraints apply for open supply conductors. Specifically, the sag of the open supply conductor at 60°F (15.5°C) shall not dip below the line-of-sight between the attachment portion of the communications cable. The line-of-sight is illustrated below.



Note: For spans greater than 150 feet (45.7 m), the sag of open-supply conductors shall not dip below the line-of-sight between the telephone-conductor attachment-points at 60°F (15.5°C) with no wind displacement.

VERTICAL CLEARANCES AT THE POLE FOR SPAN WIRES AND BRACKETS FOR LUMINAIRES AND TROLLEY CONDUCTORS (Rule 238C)

Type of Clearance	Clearance Inches (mm)			
	If Effectively Grounded	If Not Effectively Grounded		
		For Luminaires		For Trolley Conductors
		Up to 150 V	Over 150 V	
Above telephone cables	4 (100)	20 (510) *	20 (510) *	12 (300)
Below telephone cables	4 (100)	20 (510)	40 (1000)	12 (300)
From telephone terminal boxes	4 (100)	20 (510) *	20 (510) *	12 (300) †
From telephone brackets, bridle wire rings, and drive hooks	4 (100)	16 (410) *	16 (410) *	4 (100)

* May be reduced to 12 inches (300 mm) for wires or parts of brackets 40 in. (1000 mm) or more from surface of pole.

† If obtainable; if not, maximum obtainable.

CLEARANCES FROM OTHER OBJECTS

Community Antenna Television (CATV) Distribution Systems

No clearances are required by the National Electric Safety Code between CATV and telephone facilities. It is recommended, however, that nonowned CATV cable be placed preferably 2 feet (600 mm) above telephone cable, but not less than 1 foot (300 mm). If a 1-foot (300 mm) vertical clearance is not possible, the nonowned cable may be placed on the opposite side of the pole so as to obtain 1 foot (300 mm) of diagonal clearance. Telephone company-owned CATV cables may be lashed to the same strand as telephone cable.

Police and Fire Alarm Facilities

Like CATV, police and fire alarm systems are considered to be communications facilities and the same comments and recommendations apply as for CATV.

Signs, Chimneys, Tanks, and Other Installations

NESC (Rule 234C3) requires 3 feet (900 mm) in any direction.

CLIMBING SPACE ON JOINTLY USED POLES

NESC (Rule 236)

Climbing space is provided to allow workers to climb above telephone space on a pole and to permit raising and lowering equipment and materia past telephone attachments. Generally, climbing space is defined as a space 30 inches (760 mm) square along the side of the pole and extending 40 inches (1000 mm) above and below the telephone attachments.

The following may be included in climbing space:

- Portions of the pole when included in one side or corner of the space
- Vertical runs securely fastened to the pole and covered by molding or conduit.

The following may not be included in climbing space:

- Unprotected vertical runs
- Drive hooks and pole steps.

The horizontal dimensions of the climbing space may be reduced as follows:

- To 24 by 24 inches (610 by 610 mm) if the pole carries only conductors of not more than 750 volts to ground.
- To 30 inches (760 mm) along the line and 16 inches (410 mm) across if the only power conductors above are secondaries of less than 750 volts supplying airway marker lights or crossing over the telephone line and attached to the pole top or to a pole-top extension.

BIBLIOGRAPHY

1993 Edition of the National Electric Safety Code (NESC)

Section 12

Contents

Section 12

PREMISES NETWORKS

GENERAL

Premises networks are interconnected groups of telecommunications nodes such as controllers, workstations, private branch exchanges (PBXs), phones, etc., that link users to system-common applications. Examples of premises networks are voice to voice, workstation to controller, and voice to voice mailbox.

SYSTIMAX® Structured Cabling Systems (SCS)

AT&T *SYSTIMAX* Structured Cabling Systems (SCS) are a group of integrated communications distribution systems for voice, data, and video networks within a building, factory, or campus of buildings. *SYSTIMAX* SCS are modular systems based on the "star" topology. *SYSTIMAX* SCS currently supports the Premises Distribution System (PDS), Intelligent Building System (IBS), as well as applications in the industrial market and educational markets using 24 AWG unshielded twisted-pair (UTP) cable and 62.5/125- multimode, graded-index fiber optic cable.

The *SYSTIMAX* SCS is designed to be a complete system solution. *SYSTIMAX* SCS can handle analog and digital voice signals, high- and low-speed data transmission, or images produced by facsimile machines, graphic terminals, and plotters. It can also handle video signals for a variety of applications. *SYSTIMAX* SCS have the components to connect controllers, PBXs, and local area networks (LANs) from the building entrance to the workstation via untwisted pair (UTP) or fiber optic cable. Components of the *SYSTIMAX* SCS include:

- Media (UTP and fiber optic)
- Cross-connect hardware (110 and fiber optic)

- Connectors and plugs (cable and fiber optic)
- Information outlets (IOs)
- Adapters
- Multiplexers.

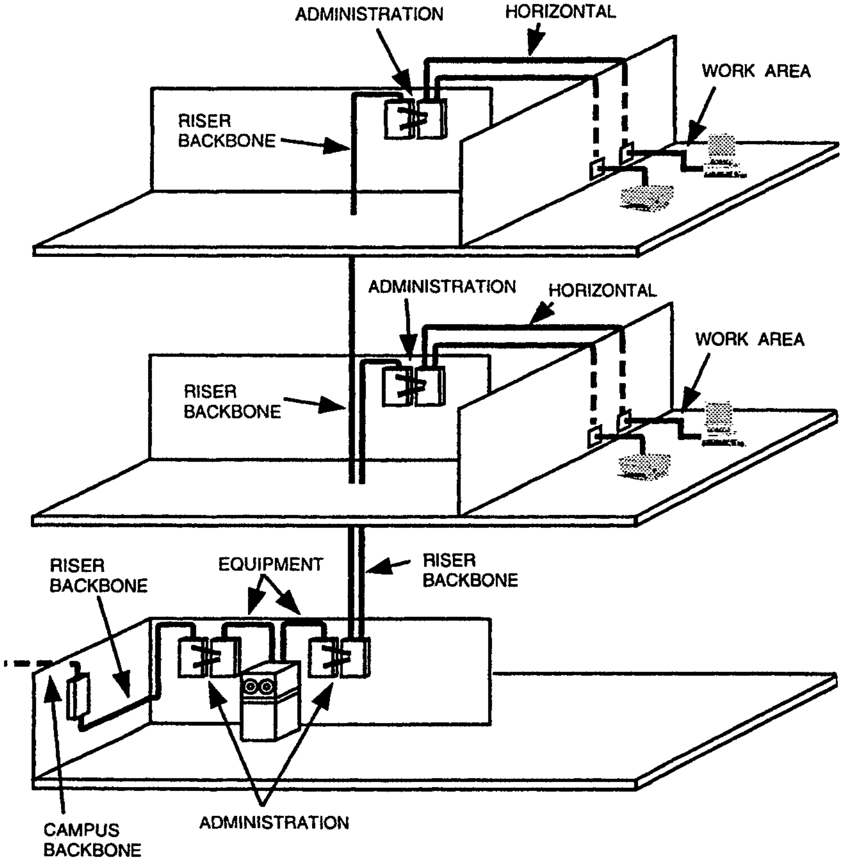
AT&T's HIGH-5™ family of products exceeds the Electronic Industries Association/Telecommunications Industry Association (EIA/TIA)-T568-A "Commercial Building Telecommunications Cabling Standards." The HIGH-5 family of products supports transmission speeds of up to 155 Mbs.

The following six subsystems comprise the *SYSTIMAX* SCS:

- **Equipment Subsystem** — consists of shared (common) electronic communications equipment in the equipment room or telecommunications closet and the transmission media required to terminate this equipment on distribution hardware.
- **Riser Backbone Subsystem** — is the main cable route within a building. It links the main cross connect in the equipment room to intermediate cross connects and horizontal cross connects in the telecommunications closets. It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology, with first-level backbone cables beginning at the main cross connect. If needed, second-level backbone cables begin at intermediate cross connects.
- **Campus Backbone Subsystem** — is a distribution system that encompasses more than one building and the components that provide the link between the buildings. This subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or power surges. It is normally a first-level backbone cable beginning at the main cross connect in the equipment room of the hub building and extending to the intermediate cross connect in the equipment room of a satellite building.

- **Horizontal Subsystem** — provides connections from the horizontal cross connect to the information outlets (IOs) in the work areas. It consists of the horizontal transmission media, the associated connecting hardware terminating this media, and IOs in the work area. Each floor of a building is served by its own Horizontal Subsystem.
- **Work Area Subsystem** — provides the connection between the IO and the station equipment in the work area. It consists of cords, adapters, and other transmission electronics. In *SYSTIMAX* IBS, this subsystem is called the **Coverage Area**.
- **Administration Subsystem** — links all of the previous subsystems together. It consists of labeling hardware for providing circuit identification and patch cords and jumper wire used for creating circuit connections at cross connects.

The diagram on the next page shows a typical *SYSTIMAX* subsystem breakdown.



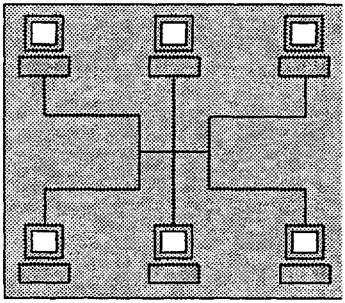
Typical *SYSTIMAX* Subsystem

Local Area Networks (LANs)

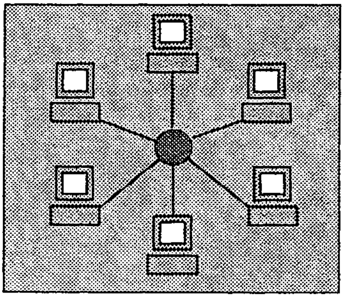
A LAN is a data communications system that enables users to share common data and peripheral equipment, such as printers, fax machines, and computers. A LAN can be as simple as connecting a few workstations, or it can link a complete floor, building, or campus. A LAN consists of the network operating systems (software), adapter cards, adapters, and cable that connects individual users' workstations to the shared controllers and peripheral equipment. *SYSTIMAX* SCS LANs can be wired with cable, fiber optic cable, or a combination of both.

The LAN architecture defines how the LAN equipment is interconnected on the transmission media. Three LAN architectures are possible: star, bus, and ring. The topology of the wiring system defines how the media is laid out in a building. The *SYSTIMAX* SCS star topology accommodates the star, bus, and ring architectures and provides centralized administration at the equipment room or telecommunication closet.

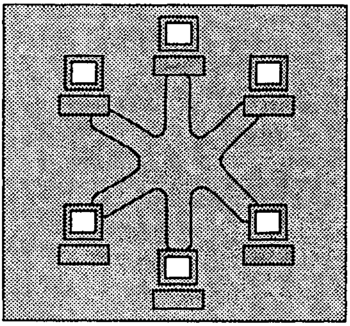
In a **bus topology**, all of the workstations are attached (via the information outlet) to a single cable that carries the signal in both directions through the network. A bus network can be centered by connecting several segments together using bridges, repeaters, and routers. Ethernet (Institute of Electrical and Electronics Engineers Inc. [IEEE] Standard 802.3) is an example of a bus topology.



In a **star topology**, all of the nodes or workstations are connected with UTP or fiber optic cable to a centrally located common controller or concentrator. The central control point permits centralized network administration, management, and troubleshooting. StarLAN is an example of a star topology, as is IEEE 802.3



In a **ring topology**, the network forms a ring. A token carries data through the network. Workstations are connected as in a star topology to a central administration point, such as a multistation access unit (MAU). Token Ring (IEEE 802.5) is an example of a ring topology.



NETWORK INTERFACES

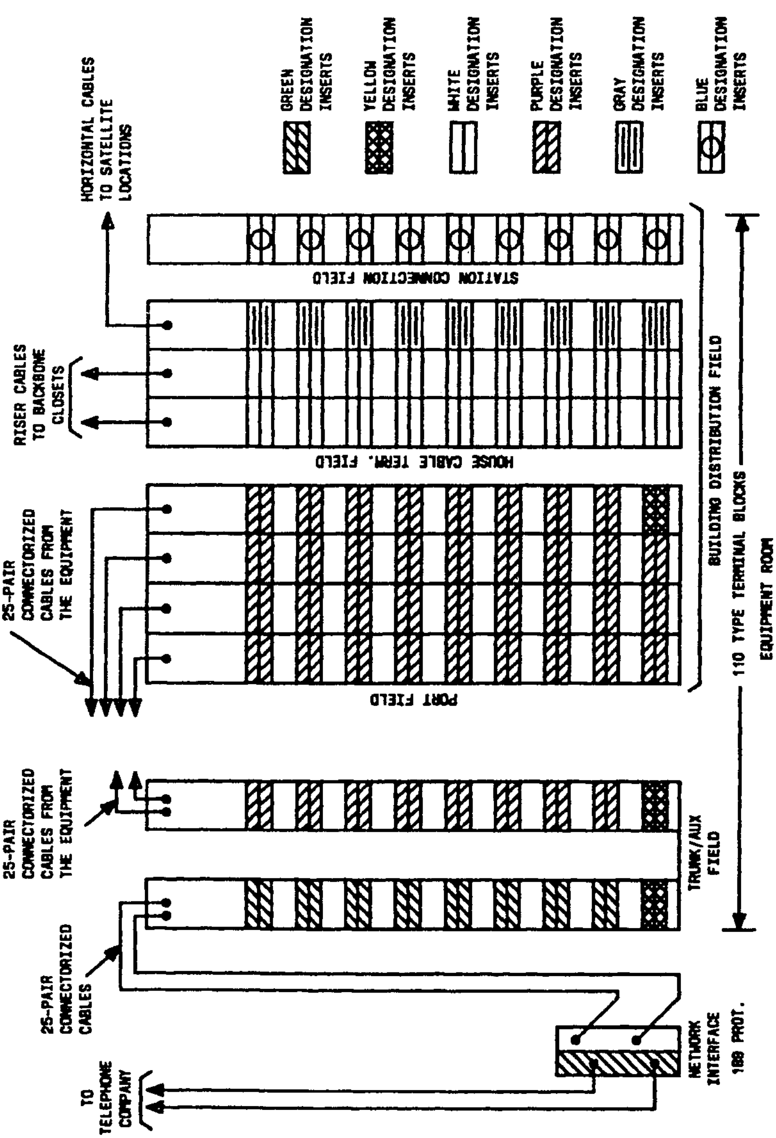
The Federal Communications Commission (FCC) has ruled that the interface between the telephone company equipment and customer-owned equipment would be through a miniature ribbon connector or jack. The RJ11 jack is designed as an NIU (North American ISDN Users) where individual connections are required. See page 12-8 for an illustration of a network interface in an equipment room. The 700-type jacks listed below are also used as network interfaces.

700-Type Jacks

AT&T 461-604-106

The 700-type jacks are intended to serve as network interfaces between the telephone company entrance facility and the PDS as required by the FCC. They are equipped to accept the required miniature ribbon connector. The 700-type jacks are ***not*** designed to provide electrical protection where exposed cables are involved. They are available as shown in the following table.

700-TYPE NETWORK INTERFACE JACKS					
Code	**No. Pairs**	**Input Connector Option**	**Output Connector Option***	**Connect Through Option**	**Back-Board Included**
700A-110-B1-25	25	110	RJ21X	Bridging Clip	No
* 50-position miniature ribbon connector (RJ21X).					


HORIZONTAL CABLES TO SATELLITE LOCATIONS
GREEN DESIGNATION INSERTS
YELLOW DESIGNATION INSERTS
WHITE DESIGNATION INSERTS
PURPLE DESIGNATION INSERTS
GRAY DESIGNATION INSERTS
BLUE DESIGNATION INSERTS
STATION CONNECTION FIELD
RISER CABLES TO BACKBONE CLOSETS
HOUSE CABLE TERM. FIELD
25-PAIR CONNECTORIZED CABLES FROM THE EQUIPMENT
PORT FIELD
BUILDING DISTRIBUTION FIELD
110 TYPE TERMINAL BLOCKS
EQUIPMENT ROOM
25-PAIR CONNECTORIZED CABLES FROM THE EQUIPMENT
TRUNK/AUX FIELD
25-PAIR CONNECTORIZED CABLES
TO TELEPHONE COMPANY
NETWORK INTERFACE 189 PROT.

COLOR CODING

Color-coded backboard, designation strips, and labels are used to identify the various parts of the Premises Network. This provides a means of administering the physical terminations of wire and other media at the cross-connection location. It also aids in installation and troubleshooting by identifying the various cross-connection fields as illustrated on Page 12-8.

The following color codes are used:

COLOR CODES		
Color	**Termination Type**	**Comments**
Orange	Demarcation point	Central office terminations
Green	Network connections	Network connections or auxiliary circuit termination
Purple	Common equipment PBX, Host, LANs, Muxes	Used for all major switching and data equipment terminations
White	First level backbone	Multicontroller (MC) to Intercloset (IC) cable terminations
Gray	Second level backbone	Intercloset (IC) to Telecommunications closet (TC) cable terminations
Blue	Station	Horizontal cable terminations
Brown	Interbuilding backbone	Campus cable terminations
Yellow	Miscellaneous	Auxiliary, maintenance alarms, security, etc.
Red	Key telephone systems	—

The illustration on Page 12-8 does not include all the color codes available. They are not involved in the particular situation illustrated.

BUILDING ENTRANCE AREA

The location where telephone company facilities are terminated on a customer's premise is called the building entrance area. Telephone company entrance cables are generally considered as exposed requiring electrical protection devices to protect people, buildings, and telecommunication equipment from hazardous foreign potentials (see section 6, "ELECTRICAL PROTECTION"). Space must be provided on the customer's premises for these terminating devices and interconnection to the Premises Distribution System. The amount of space required depends on the number of cable pairs to be terminated and the hardware used.

An illustration of the space required for terminating 150 entrance cable pairs using 188-type protectors and 110-type connecting blocks is shown on the next page. From this location the facilities must be connected to the network interface such as a 700-series jack. In this situation, space must also be provided for connecting the stub cables of the protectors to the Telco entrance cable(s).

The illustration referenced above only shows the requirements for the telephone company equipment. ***Generally, there will also be customer premises equipment in the building entrance area as illustrated on Page 12-8.***

Protection devices to be used on exposed entrance cables are covered later in this section.

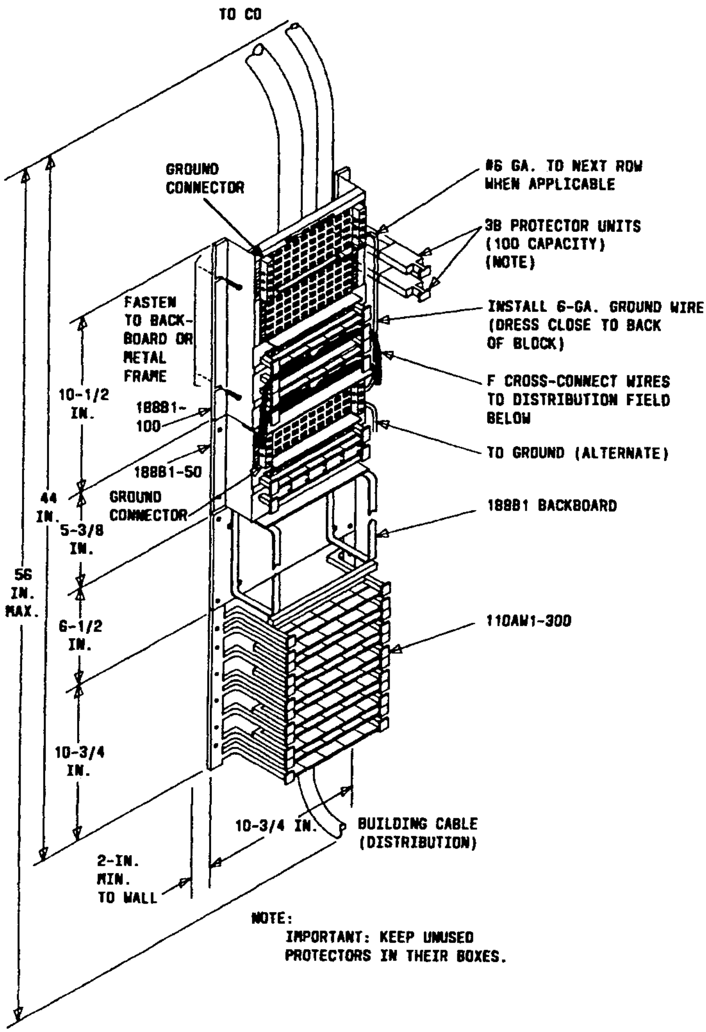


Illustration of 188-Type Protector Use

CABLE LISTINGS

The 1993 NEC requires that communication and signaling wires and cables in a building be listed according to their suitability for a given use. Article 800 of the 1993 NEC lists the following categories that apply to wire cable.

CMP — Use in Plenums

CMR — Use in Risers

CM — General purpose use (except Plenums and Risers)

CMX — Residential and restricted commercial use

MPP — Multipurpose Plenum

MPR — Multipurpose Riser

Cables for telephone (voice) communications within customer premises (commercial and residential) must be tested and listed as satisfying the fire-resistance, mechanical, and electrical standards of the independent testing laboratory (Underwriters Laboratory).

The exception is that outside plant type cables which are not fire-resistant may be used as a building entrance cable. However, they can only be used up to 50 feet (15.2 m) beyond the point of entry.

Note: Underwriters Laboratories (UL) is the most prominent organization that tests and lists electrical equipment and cables.

GUIDELINES FOR DESIGNING AT&T SYSTIMAX STRUCTURED CABLING SYSTEMS (SCS)

Guidelines for designing *SYSTIMAX* SCS are covered in the AT&T *SYSTIMAX* 555-4XX-XXX series of documents.

AT&T	Title
555-400-601	Requirements Survey
555-400-603	Components Guide
555-401-100	Administration Manual
3726C	*SYSTIMAX®* Structured Cabling Systems (SCS) Product Guide
3824B	*SYSTIMAX®* Premises Distribution System — Integrated Comprehensive Systems Structure

The balance of this section will cover the AT&T products available for AT&T *SYSTIMAX* SCS designs. Refer to the AT&T *SYSTIMAX Structured Cabling Systems (SCS) Product Guide* (3726C) for additional and more detailed information on the products.

INSIDE COPPER WIRE CABLE

Inside wire cable includes nonplenum- and plenum-type cables for use in Horizontal and Riser Backbone applications.

The most common type of inside wire used in *SYSTIMAX* SCS is unshielded twisted-pair (UTP). For limited distances, generally 500 to 1000 feet (152 to 305 m), UTP cable can often replace much more expensive and inconvenient coaxial, twinaxial, and shielded twisted-pair cables. *SYSTIMAX* SCS currently support data applications, via UTP cables, at up to 100 Mbps. Network Communications Cable (NCC) supports data applications up to 10 Mbps.

Nonplenum 1010 LAN Cable

1010 Nonplenum LAN Cable consists of 24-gauge (0.5 mm) solid-copper conductors insulated with color-coded PVC. 1010 Nonplenum LAN Cable is a general-purpose cable to be used in many *SYSTIMAX* SCS voice and 16-Mbps data applications to interconnect services from the workstation to the wiring closet. When used in local area network applications, error-free transmission rates of 10 Mbps can be obtained up to 328 feet (100 m) and of 16 Mbps up to 164 feet (50 m) for networks consisting of up to 72 workstations.

Subsystem: Horizontal, Riser Backbone

Physical Specifications:

Gauge: 24 AWG (0.5 mm)

Pair Size: 4 pair is UL certified to EIA/TIA 568 for Category 3

NONPLENUM 1010 LAN CABLE			
Product Number	**Length**	**Packaging**	**Comcode**
1010004AGY W1000	1,000 ft (305 m)	WE TOTE® Wire	106 062 524
1010004AGY R1000	1,000 ft (305 m)	Reel	106 062 532
1010004ABE W1000	1,000 ft (305 m)	WE TOTE Wire	106 300 106
1010004ABL W1000	1,000 ft (305 m)	WE TOTE Wire	106 300 098
1010025AGY R1000	1,000 ft (305 m)	Reel	106 824 329
1010050AGY R1000	1,000 ft (305 m)	Reel	106 824 378
1010075AGY R1000	1,000 ft (305 m)	Reel	106 824 394
10100100AGY R1000	1,000 ft (305 m)	Reel	106 824 469

1041 LAN Cable

1041 LAN Cable is a high-speed, 100 Ω, high-performance LAN cable for use in AT&T's *SYSTIMAX* SCS Premises Wiring Plan. 1041 LAN Cable is composed of 24-gauge (0.5 mm) bare, solid-copper conductors insulated with polyolefin. The insulated conductors are twisted into pairs and jacketed with grey PVC. This cable is available in 4 pairs only.

1041 LAN Cable will transmit 16-Mbps token ring signals for 328 feet (100 m) while supporting up to 72 workstations. This cable complies with EIA/TIA TSB-36 standards.

Subsystem: Horizontal, Riser Backbone

Physical Specifications:
Length: 1,000 ft (305 m)
Gauge: 24 AWG (0.5 mm)
Pair Size: 4
Weight: 21.3 lb/1,000 ft (31.7 kg/km)
Outside Diameter: 0.21 in. (0.53 cm)

1041 LAN CABLE		
Product Number	**Packaging**	**Comcode**
1041004AGy R1000	Reel	106 821 390
1041004AGy W1000	WE TOTE Wire	106 821 408
1041ABL W1000	WE TOTE Wire	106 905 987

1061 Nonplenum LAN Cable

1061 Nonplenum LAN Cable is a high-speed, high-performance, 100 Ω cable for use in AT&T's *SYSTIMAX* SCS Wiring Plan. 1061B Cable is CSA approved for the Canadian market and has a low-smoke halogen jacket. 1061C Cable is composed of 24-gauge (0.5 mm) solid-copper conductors, insulated with high-density polyethylene (HDPE).

1061 Nonplenum LAN Cable is capable of carrying high-bit-rate signaling for extended distances in building distribution systems. Local area network applications include a 4/16-Mbps token ring which links multiple workstations. Signal amplifiers are not required for lobe lengths up to 328 feet (100 m). Transmission rates of 10 Mbps can be obtained up to 492 feet (150 m).

Subsystem: Horizontal, Riser Backbone (only when enclosed in a conduit)

Physical Specifications:

Length: 1,000 ft (305 m)
Gauge: 24 AWG (0.5 mm)
Pair Size: 4
Weight: 1061C - 23.2 lb/1,000 ft (34.5 kg/1,000 m)
1061B - 20.8 lb/1,000 ft (30.9 kg/1,000 m)
Outside Diameter: 1061C - 0.22 in. (0.56 cm)
1061B - 0.21 in. (0.53 cm)

NONPLENUM 1061 LAN CABLE		
Product Number	**Packaging**	**Comcode**
1061004CSL W1000	WE TOTE Wire	106 836 950
1061004CSL W1000	WE TOTE Wire	106 836 943
1061004CSL R4000	Reel	106 836 968
1061004CSL R5000	Reel	107 014 078
1061004BSL R1000*	Reel	106 657 653
1061004CBL R1000	Reel	107 057 853
1061004CBL W1000	WE TOTE Wire	106 871 809
1061004CIV R1000	Reel	107 076 192
1061004CIV W1000	WE TOTE Wire	106 871 817
1061004CSL	Custom Length	106 836 976
1061004CYL R1000	Reel	106 999 071
1061004CYL W1000	WE TOTE Wire	107 001 687
1061004CRD W1000	WE TOTE Wire	106 926 363
*CSA		

2001 Plenum Cable

This 2001 Plenum Cable (ECTFE/ECTFE) has 24-gauge (0.5 mm) twisted-pair copper conductors individually insulated with ECTFE and sheathed with a white ECTFE outer jacket. This type of plenum cable is used for cable runs between the equipment room and the riser/satellite closets. It conforms to the low-flame, low-smoke requirements of the NEC. It can be used in air-handling plenums or above suspended ceilings without the use of conduits. 2001 Plenum Cable can be connectorized in the field or terminated on 110 Wiring Blocks.

Subsystem: Riser Backbone

Physical Specifications:

Length: 1,000 ft (305 m)
Gauge: 24 AWG (0.5 mm)
Pair Size: 25, 50, 75, 100
Insulation Thickness: 0.005 in. (0.0127 cm)
Packaging: Reel

PLENUM 2001 CABLE				
Product Number	**Pair Size**	**Outside Diameter**	**Weight lb/1,000 ft (kg/100 m)**	**Comcode**
2001 025D R1000	25	0.33 in. (0.838 cm)	82 (12.2)	105 296 545
2001 050D R1000	50	0.49 in. (1.24 cm)	180 (26.8)	105 296 552
2001 075D R1000	75	0.60 in. (1.52 cm)	240 (35.7)	105 296 560
2001 100D R1000	100	0.69 in. (1.75 cm)	315 (46.9)	105 296 578

Plenum 2010 LAN Cable

2010 Plenum LAN Cable (ECTFE/LSPVC) has 24-gauge (0.5 mm) twisted-pair copper conductors individually insulated with ECTFE and sheathed with a white LSPVC outer jacket. This type of plenum cable is used for cable runs between an information outlet and a telecommunications closet or between the equipment room and the telecommunications closet. It conforms to the low-flame, low-smoke requirements of the NEC. It can be used in air-handling plenums or above suspended ceilings without the use of conduits. 2010 Plenum LAN Cable can be connectorized in the field or terminated on 110 Wiring Blocks.

2010 Plenum LAN Cable supports 16-Mbps data transmission up to 164 ft (50 m) in an office environment.

Subsystem: Riser Backbone, Horizontal

Physical Specifications:

Length: 1,000 ft (305 m)
Gauge: 24 AWG (0.5 mm)
Pair Size: 4
Weight: 14.5 lb/1,000 ft (2.16 kg/100 m)
Outside Diameter: 0.17 in. (0.43 cm)
Insulation Thickness: 0.006 in. (0.015 cm)

PLENUM 2010 LAN CABLE		
Product Number	**Packaging**	**Comcode**
2010 004A R1000	Reel	106 063 498
2010 004A W1000	WE TOTE Wire	106 063 480
2010 004C R1000	Reel	106 445 901
2010 004C W1000	WE TOTE Wire	106 445 919

Plenum 2041 LAN Cable

2041 Plenum LAN Cable consists of 24-gauge (0.5 mm) solid-copper conductors with *TEFLON*[1] insulation. The outer jacket is low-smoke PVC. The insulated conductors are color-coded with solid colors and twisted into four pairs. The color coding is the same as standard PIC Cable.

2041 Plenum LAN Cable is a 100 Ω, high-performance, unshielded twisted-pair data cable capable of carrying high-bit-rate signaling for hundreds of feet.

Subsystem: Horizontal

Physical Specifications:

Length: 1,000 ft (305 m)
Gauge: 24 AWG (0.5 mm)
Pair Size: 4
Weight: 17.5 lb/1,000 ft (26.04 kg/km)
Outside Diameter: 0.16 in. (0.41 cm)

PLENUM 2041 LAN CABLE		
Product Number	**Packaging**	**Comcode**
2041 004BWH R1000	Reel	107 068 041
2041 004BWH W1000	WE TOTE	107 187 239

1. Registered trademark of E. I. Du Pont De Nemours and Company.

Plenum 2061 LAN Cable

2061 Plenum LAN Cable is a high-speed, high-performance, 100 Ω cable for use in the AT&T *SYSTIMAX* SCS wiring plan. The cable is composed of 24-gauge (0.5 mm) bare, solid-copper conductors, insulated with *TEFLON*. The insulated conductors are twisted into pairs and sheathed with a low-smoke PVC outer jacket.

2061 Plenum LAN Cable is capable of carrying high-bit-rate signaling for extended distances in building distribution systems. Local area network applications include a 4/16-Mbps token ring which links multiple workstations. Signal amplifiers are not required for lobe lengths up to 328 ft (100 m). Transmission rates of 10 Mbps can be obtained up to 492 ft (150 m).

Subsystem: Horizontal, Riser Backbone

Physical Specifications:

Length: 1,000 ft (305 m)
Gauge: 24 AWG (0.5 mm)
Pair Size: 4
Weight: 23.2 lb/1,000 ft (34.5 kg/km)
Outside Diameter: 0.22 in. (0.56 cm)

PLENUM 2061 LAN CABLE		
Product Number	**Packaging**	**Comcode**
2061004BWH W1000	WE TOTE Wire	106 939 325
2061004BWH R1000	Reel	106 939 317
2061004BWH Custom	Custom Length	106 946 833
2061004BWH R5000	Reel	107 014 052
2061004BBL W1000	WE TOTE Wire	106 946 825
2061004BBL Custom	Custom Length	106 946 817
2061004BBL R1000	Reel	106 946 809
2061004BYL W1000	WE TOTE Wire	106 965 379
2061004BYL R1000	Reel	106 965 387
2061004BYL Custom	Custom Length	106 965 395
2061004BOR R1000	Reel	106 974 348
2061004BOR	Custom Length	107 078 891

ARMM Riser Cable

ARMM Riser Cable consists of a core of 24-gauge (0.5 mm), solid-copper conductors insulated with centered polyethylene covered by a PVC skin. The core is covered by a layer of plastic tape and overlaid with a corrugated aluminum shield, which is adhesively bonded to an outer jacket of PVC plastic to form an ALVYN sheath. ARMM Riser Cable is used in riser shafts where a fire-retardant sheath is necessary to meet NEC low-flame requirements. It can be used without conduit.

Subsystem: Riser Backbone

Physical Specifications:

Gauge: 24 AWG
Pair Size: 25, 50, 100, 150, 200, 300, 400, 600, 900, 1200, 1500, 1800
Weight: See Chart
Outside Diameter: See Chart
Insulation Thickness: 0.006 in. (0.015 cm)
Jacket Thickness: 0.045 in. (0.114 cm) (100-pair) to 0.100 in. (0.254 cm) (1,800-pair)

ARMM RISER CABLE				
Product Number	**Pair Size**	**Outside Diameter**	**Weight lb/ft (kg/m)**	**Comcode**
ARMM	25	0.53 in. (1.35 cm)	140 (208.35)	105 462 287
ARMM	50	0.65 in. (1.65 cm)	230 (342.3)	105 462 295
ARMM	100	0.89 in. (2.26 cm)	430 (640)	103 562 609
ARMM	150	0.96 in. (2.44 cm)	590 (878)	103 562 617
ARMM	200	1.09 in. (2.77 cm)	750 (1,116)	103 562 625
ARMM	300	1.30 in. (3.30 cm)	1,090 (1,622)	103 562 633
ARMM	400	1.48 in. (3.76 cm)	1,430 (2,128)	103 562 641
ARMM	600	1.80 in. (4.57 cm)	2,100 (3,125)	103 562 658
ARMM	900	2.15 in. (5.46 cm)	3,070 (4,568.7)	103 562 666
ARMM	1,200	2.42 in. (6.15 cm)	4,050 (6,027)	103 562 674
ARMM	1,500	2.75 in. (6.99 cm)	5,030 (7,485.6)	103 730 198
ARMM	1,800	2.94 in. (7.47 cm)	5,960 (8,869.6)	103 562 682

Aerial Self-Supporting Air Core Cable, Aluminum Shield

Aerial Self-Supporting Air Core Cable with Aluminum Shield consists of a supporting strand and a cable core of plastic-insulated, 24-gauge (0.5 mm) copper conductors. The supporting strand is 6.6 M, high-strength, galvanized steel. The conductors are encased in a plastic core wrap surrounded by an aluminum shield covered by a polyethylene outer jacket. This cable has an undulated core that limits shrinkback. It is used for pole-to-pole and pole-to-building spans.

Subsystem: Campus Backbone

Physical Specifications:

Gauge: 24 AWG (0.5 mm)
Pair Size: 25, 50, 100, 200
Weight: See Chart
Outside Diameter: See Chart

AERIAL SELF-SUPPORTING AIR CORE CABLE, ALUMINUM SHIELD				
Product Number	Pair Size	Outside Diameter	Weight lb/ft (kg/m)	Comcode
BKMS	25	0.59 in. (1.50 cm)	0.28 (0.42)	100 023 944
BKMS	50	0.77 in. (1.96 cm)	0.37 (0.55)	100 023 951
BKMS	100	0.99 in. (2.51 cm)	0.56 (0.83)	101 452 100
BKMS	200	1.23 in. (3.12 cm)	0.89 (1.32)	101 452 126

Aerial Self-Supporting Cable, Reinforced

Self-Supporting Cable with Reinforced Sheath consists of a supporting strand and a cable core of plastic-insulated, 24-gauge (0.5 mm) copper conductors covered with a tough outer jacket. The supporting strand is 6.6 M, high-strength, galvanized steel. The cable conductors are encased in an aluminum core wrap, surrounded by a layer of polyethylene, which is covered by a layer of steel, followed by a polyethylene outer jacket. This cable is used for pole-to-pole and pole-to-building spans in areas prone to high sheath-related maintenance costs due to abrasion and/or wildlife damage.

Subsystem: Campus Backbone

Physical Specifications:

Gauge: 24 AWG (0.5 mm)
Pair Size: 25, 50, 100, 200
Weight: See Chart
Outside Diameter: See Chart

AERIAL SELF-SUPPORTING CABLE, REINFORCED				
Product Number	Pair Size	Outside Diameter	Weight lb/ft (kg/m)	Comcode
BKMP	25	0.90 in. (2.29 cm)	0.45 (0.67)	102 857 174
BKMP	50	1.02 in. (2.59 cm)	0.56 (0.83)	102 857 182
BKMP	100	1.28 in. (3.25 cm)	0.80 (1.19)	102 857 208
BKMP	200	1.52 in. (3.86 cm)	1.18 (1.76)	102 857 224

Lashed Aerial Air Core Cable, ALPETH

ALPETH Sheath Aerial Air Core Cable is a lashed cable consisting of plastic-insulated, 24-gauge (0.5 mm), solid copper conductors covered by a plastic core wrap, surrounded by a corrugated aluminum shield. A nylon binder and tape overlay are applied longitudinally between the shield and a seamless outer jacket of extruded polyethylene. This cable is intended for outdoor use or pole or building runs. It should not be used in direct-buried applications or in areas susceptible to lightning.

Note: Unsoldered mechanical (UM) outer protection consisting of a longitudinal steel tape and polyethylene jacket is factory installed. Designate *-UM* after sheath name when ordering.

Subsystem: Campus Backbone

Physical Specifications:

Gauge: 24 AWG (0.5 mm)
Pair Size: 25 to 1,800
Weight: See Chart
Outside Diameter: See Chart

LASHED AERIAL AIR CORE CABLE, ALPETH				
Product Number	**Pair Size**	**Outside Diameter**	**Weight lb/ft (kg/m)**	**Comcode**
BKMA	25	0.54 in. (1.37 cm)	0.13 (0.19)	100 023 043
BKMA	50	0.68 in. (1.73 cm)	0.22 (0.33)	100 023 076
BKMA	100	0.86 in. (2.18 cm)	0.39 (0.58)	100 023 134
BKMA	200*	1.17 in. (2.97 cm)	0.73 (1.09)	100 023 191
BKMA	300*	1.39 in. (3.53 cm)	1.06 (1.58)	100 023 225
BKMA	400*	1.61 in. (4.09 cm)	1.41 (2.10)	100 023 258
BKMA	600*	1.92 in. (4.88 cm)	2.06 (3.07)	100 023 282
BKMA	900*	2.29 in. (5.82 cm)	3.03 (4.51)	100 023 316
BKMA	1,200*	2.61 in. (6.63 cm)	4.00 (5.95)	103 711 313
BKMA	1,500*	2.89 in. (7.34 cm)	4.95 (7.37)	103 711 305
BKMA	1,800*	3.15 in. (8 cm)	5.92 (8.81)	103 711 297

* A pulling eye is available on these pair sizes; please specify when ordering.

Lashed Aerial Air Core Cable, PASP

PASP Sheath Aerial Air Core Cable is a lashed cable consisting of plastic-insulated, 24-gauge (0.5 mm), solid-copper conductors covered by a plastic core wrap and surrounded by an inner polyethylene jacket, a corrugated aluminum shield, a corrugated steel wrap, and a bonded polyethylene jacket. The cable is used in outdoor areas susceptible to mechanical damage, lightning, or damage from wildlife. It can also be used in underground ducts and direct-buried applications.

Note: Unsoldered mechanical (UM) outer protection consisting of a longitudinal steel tape and polyethylene jacket is factory installed. Designate *-UM* after sheath name when ordering.

Subsystem: Campus Backbone

Physical Specifications:

Gauge: 24 AWG (0.5 mm)
Pair Size: 25 to 1,800
Weight: See Chart
Outside Diameter: See Chart

LASHED AERIAL AIR CORE CABLE, PASP				
Product Number	**Pair Size**	**Outside Diameter**	**Weight lb/ft (kg/m)**	**Comcode**
BKMH	25	0.85 in. (2.16 cm)	0.22 (0.33)	100 023 746
BKMH	50	0.93 in. (2.36 cm)	0.33 (0.49)	100 023 761
BKMH	100	1.13 in. (2.87 cm)	0.53 (0.79)	100 023 803
BKMH	200*	1.35 in. (3.43 cm)	0.94 (1.40)	100 023 845
BKMH	300*	1.57 in. (3.99 cm)	1.31 (1.95)	100 023 860
BKMH	400*	1.74 in. (4.42 cm)	1.70 (2.53)	100 023 886
BKMH	600*	2.03 in. (5.16 cm)	2.42 (3.6)	100 023 902
BKMH	900*	2.48 in. (6.30 cm)	3.47 (5.16)	100 023 928
BKMH	1,200*	2.78 in. (7.06 cm)	4.51 (6.71)	103 711 289
BKMH	1,500*	3.12 in. (7.92 cm)	5.31 (7.90)	103 711 271
BKMH	1,800*	3.28 in. (8.33 cm)	6.55 (9.75)	103 711 263

* A pulling eye is available on these pair sizes; please specify when ordering.

ASP-Filled Core Cable

ASP-Filled Core Cable has an aluminum steel polyethylene (ASP) sheath and a core of 24-gauge (0.5 mm) solid-copper conductors, dual insulated with foam skin and plastic, and surrounded by *FLEXGEL*® III filling compound. The core is surrounded by a plastic core wrap and shielded with corrugated aluminum and steel. Additional filling compound is found between the core wrap and the shielding. The outer jacket is polyethylene. ASP cable is used for direct-buried applications where wet or moist soil conditions threaten electrical performance. ASP is also the preferred sheath for mechanical and wildlife protection.

Note: Unsoldered mechanical (UM) outer protection is available. It consists of a longitudinal steel tape and polyethylene jacket. Designate *-UM* after sheath name when ordering.

Subsystem: Campus Backbone

Physical Specifications:

Gauge: 24 AWG (0.5 mm)
Pair Size: 25 to 1,800
Weight: See Chart
Outside Diameter: See Chart

ASP-FILLED CORE CABLE				
Product Number	**Pair Size**	**Outside Diameter**	**Weight lb/ft (kg/m)**	**Comcode**
GFMW	25	0.61 in. (1.55 cm)	0.22 (0.33)	106 583 909
GFMW	50	0.77 in. (1.96 cm)	0.35 (0.52)	106 583 917
GFMW	100	0.95 in. (2.41 cm)	0.59 (0.88)	106 583 933
GFMW	200*	1.27 in. (3.23 cm)	1.05 (1.56)	106 583 958
GFMW	300*	1.57 in. (3.99 cm)	1.45 (2.16)	106 583 966
GFMW	400*	1.66 in. (4.22 cm)	1.86 (2.77)	106 583 974
GFMW	600*	2.01 in. (5.11 cm)	2.71 (4.03)	106 583 982
GFMW	900*	2.42 in. (6.15 cm)	3.90 (5.80)	106 584 154
GFMW	1,200*	2.78 in. (7.06 cm)	5.05 (7.51)	106 584 162
GFMW	1,500*	3.05 in. (7.75 cm)	6.18 (9.20)	106 584 170
GFMW	1,800*	3.38 in. (8.59 cm)	7.29 (10.85)	106 584 188
* A pulling eye is available on these pair sizes; please specify when ordering.				

Inside Composite Cable

The new 1090 and 2090 composite cables have been introduced. The 1090 cable is a composite of 1010 and 1061 LAN cables and is intended for nonplenum applications. The 2090 cable is a composite of 2010 and 2061 LAN cables and is intended for plenum applications. For more detailed information, see the AT&T *SYSTIMAX Structured Cabling Systems (SCS) Product Guide* (3726C).

OUTSIDE COPPER WIRE CABLE

AT&T's outside copper wire cable can be custom ordered in any length desired. For more information and ordering codes, see the tables in section 14, "CABLE AND WIRE." The selection of outside cable is governed by conditions at the installation site and economic considerations.

FIBER OPTIC CABLES

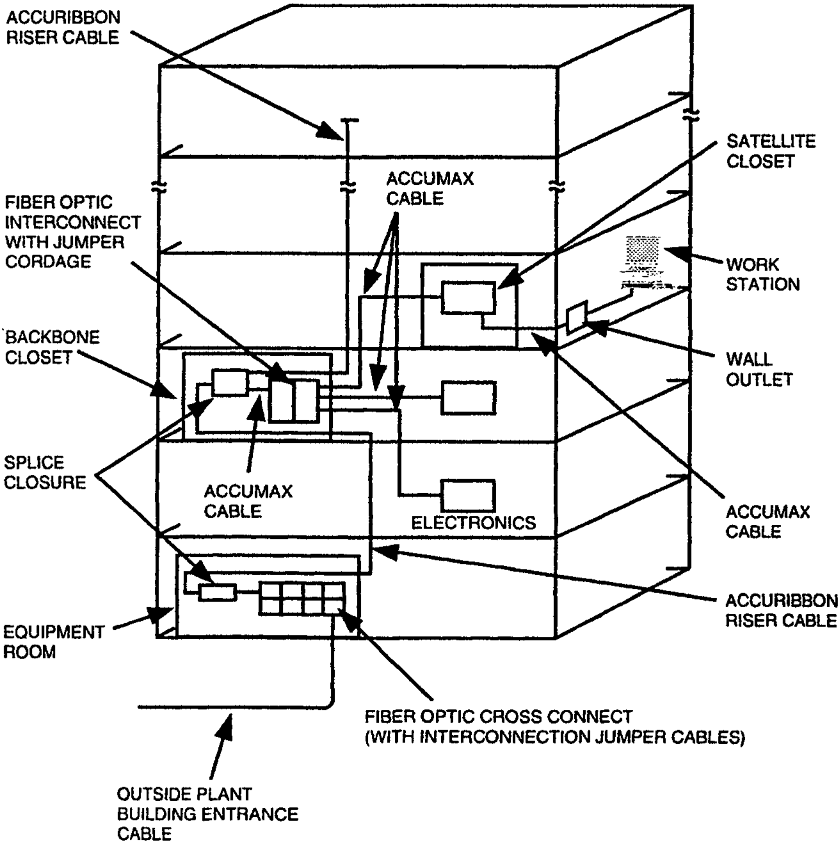
Fiber optic cables and apparatus designed for use in premises applications may be used in many applications such as:

- Local Area Networks (LANs)
- Building Distribution Networks (BDNs)
- Wideband Premises Networks (WPNs)
- Loop electronics in buildings.

A fiber optic premises network may include a combination of several of the above applications. AT&T *SYSTIMAX* SCS was designed to accommodate the above applications.

Premises applications of fiber optic systems (cable and apparatus) generally involve the same configurations as copper-based systems. Vertical distribution requires riser cables and horizontal distribution requires cabling to satellite closets and directly to workstations. The main equipment (terminal) room is generally located in the basement or on one of the lower floors, but may be located on any floor of the building. Apparatus closets or rooms may be spaced several floors apart or there may be one on each floor. The building may have adequate conduit or may have little or none available. Equipment rooms may house Private Branch Exchanges (PBXs), electronic equipment, computer main frames, and metallic splice points. They are the focal points for the building communications systems. A fiber optic premises network may be located in one building or a group of buildings (such as a campus environment).

A *SYSTIMAX* structured cable system for fiber optic cable is illustrated on the next page.



***SYSTIMAX* Structured Cable System**

Design Guidelines (Fiber Optic Cables)

Following are recommendations for installing fiber optic cables in buildings.

- If possible, dedicate a conduit to the use of fiber optic cables.
- If cables are to be pulled through more than four 90-degree bends (minimum radius of 4.5 inches [114 mm]), intermediate pull points should be provided.
- The cable should never be pulled around sharp corners such as those found at junction box connections.
- When Fiber Optic Building Cable (LGBC) *Accumax*® or *AccuRibbon*® risers have to be placed in the same conduit with copper cables, a duct liner may be placed to segregate the two types of cable.
- Guidelines for placing fiber optic cables on customer premises are covered in AT&T 627-610-230.

FIBER OPTIC BUILDING CABLES

The 1993 NEC requires that communication and signaling wires and cables in a building be listed according to their suitability for a given use. Article 770 of the NEC applies to the installation of fiber optic cables along with electrical conductors. For ease of identification, each cable bears the required NEC cable marking. The required markings are listed below.

OFC — Conductive Fiber Optic Cable

OFCP — Conductive Plenum Cable

OFCR — Conductive Riser Cable

OFN — Nonconductive Fiber Optic Cable

OFNP — Nonconductive Plenum Cable

OFNR — Nonconductive Riser Cable

AT&T fiber optic cables jacketed with PVC are UL listed for use in riser backbone applications. Cables with fluoropolymer or PVC jackets meet UL listings for plenum applications. Each fiber optic cable bears the appropriate

UL listing as required by the NEC. Additional limitations on wire and fiber cable are covered by the *1993 National Electrical Code Handbook*.

AT&T has two types of fiber optic cable for use in buildings, *AccuRibbon* riser cable (3FLX) and *Accumax* fiber optic building cable. Both are used primarily in the riser backbone and horizontal subsystems. All fiber optic cable is UL listed and rated OFNR or OFNP per 1993 NEC.

SYSTIMAX SCS have five indoor fiber optic cable designs:

- ***Accumax* Cables** are robust fiber optic building cables and are available in 1, 2, 4, 6, 8, and 12 fibers.
- **Fiber Optic Building Cable (LGBC)** is available in fiber counts of 2, 4, 6, 12, 24, 36, 48, and 72.
- ***AccuRibbon* Riser Cables** are available in multiples of 12 fiber ribbons from 12 to 144 fibers per cable.
- **Heavy Duty Building Cables (HDBCs)** are available in 12-fiber count.
- **Patch cords and jumper cordage** are available in single-fiber, duplex, or quad design.

Accumax Building Cable, Robust LGBC Series

Accumax Building Cable consists of 1, 2, 4, 6, 8, and 12 individual 62.5/125-μm fibers, each with a color-coded PVC buffer. *Accumax* cable is reinforced with Aramid yarn for superior strength and contains no metallic elements. *Accumax* cables are designed for fiber-to-the-workstation applications. *Accumax* cables provide premises distribution systems with one cable that directly connects the building entrance splice to the user's desk-top equipment in both the horizontal distribution and the vertical riser backbone.

Subsystem: Riser Backbone, Horizontal, Work Area Administrative, Campus Backbone, Equipment

Maximum Length: 14,000 ft (approximately 4.2 km)

Accumax BUILDING CABLE ROBUST LGBC SERIES					
Product Number	**No. of Fibers**	**Outside Diameter in. (mm)**	**Weight lb/100 ft. (kg/km)**	**Tension Rating lb (N)**	**Comcode**
LGBC-001D-LRX*	1	0.116 (2.9)	0.5 (7.4)	100 (444)	106 290 927
LGBC-002D-LRX	2	0.180 (4.6)	1.1 (16.4)	200 (888)	106 290 943
LGBC-004D-LRX	4	0.185 (4.7)	1.3 (19.3)	200 (888)	106 291 008
LGBC-006D-LRX	6	0.210 (5.3)	1.8 (26.8)	250 (1110)	106 291 024
LGBC-008D-LRX	8	0.230 (5.8)	1.9 (28.3)	250 (1110)	106 998 529
LGBC-012D-LRX	12	0.275 (7.0)	3.3 (49.1)	300 (1332)	106 291 073
*Designed for twist-lock connectors.					

Accumax Plenum Cable, Robust LGBC Plenum Series

Accumax Plenum Cable consists of 1, 2, 4, 6, 8, and 12 individual 62.5/125-µm fibers, each with a color-coded buffer. *Accumax* cable is reinforced with Aramid yarn for superior strength, contains no metallic elements, and meets the requirements of the NEC for OFNP.

Accumax cables are designed and engineered for fiber-to-desk workstation applications. *Accumax* cables provide premises distribution plenum systems with one cable that directly connects the building entrance splice to the user's desk-top equipment in both the horizontal and vertical riser.

Subsystem: Riser Backbone, Horizontal, Work Area, Equipment, Administration, Campus Backbone

Maximum Length: 14,000 ft (4.2 km)

Accumax PLENUM CABLE ROBUST LGBC PLENUM SERIES					
Product Code	**No. of Fibers**	**Outside Dia. in. (mm)**	**Weight lb/100 ft. (kg/km)**	**Tension Rating in. (N)**	**Comcode**
LGBC-001D-LPX	1	0.116 (3.0)	0.6 (8.93)	100 (445)	106 914 955
LGBC-002D-LPX	2	0.150 (3.8)	0.9 (13.4)	275 (1224)	106 914 963
LGBC-004D-LPX	4	0.180 (4.6)	1.3 (19.3)	275 (1224)	106 914 971
LGBC-006D-LPX	6	0.185 (4.7)	1.5 (22.3)	275 (1224)	106 914 989
LGBC-008D-LPX	8	0.200 (5.1)	1.7 (25.3)	275 (1224)	106 915 127
LGBC-012D-LPX	12	0.225 (5.7)	2.0 (29.8)	300 (1335)	106 914 997

Fiber Optic Plenum Cable

Fiber Optic Plenum Cable consists of 2, 4, 6, and 12 individual 62.5/125-μm fibers, each with a color-coded PVC buffer. Fiber Optic Plenum Cable is reinforced with Aramid yarn for superior strength and contains no metallic elements. Fiber Optic Plenum Cable is used for both vertical and horizontal applications in buildings and meets the requirements of the NEC for OFNP.

Subsystem: Riser Backbone, Horizontal

Maximum Length: 14,000 ft (approximately 4.2 km)

FIBER OPTIC PLENUM CABLE					
Fluoropolymer Jacket (Plenum Classified — OFNP)					
Product Code	**No. of Fibers**	**Outside Diameter**	**Weight**	**Tension Rating**	**Comcode**
LGBC-002B-LPX	2	0.190 in. (4.8 mm)	1.4 lbs/100 ft (20.8 kg/km)	200 lbs (888 N)	106 524 390
LGBC-004B-LPX	4	0.190 in. (4.8 mm)	1.4 lbs/100 ft (20.8 kg/km)	200 lbs (888 N)	106 524 424
LGBC-006B-LPX	6	0.215 in. (5.5 mm)	2.8 lbs/100 ft (41.7 kg/km)	200 lbs (888 N)	106 524 440
LGBC-012B-LPX	12	0.290 in. (7.4 mm)	3.0 lbs/100 ft (44.6 kg/km)	300 lbs (1,332 N)	106 524 465

Multibundle Fiber Optic High Fiber Count Building Cable—Riser Rated

Multibundle Fiber Optic Building Cable (high fiber count) consists of 24, 36, 48, and 72 individual 62.5/125-μm fibers, each with a color-coded PVC buffer. Fiber Optic Building Cable is reinforced with Aramid yarn for superior strength and contains no metallic elements. Fiber Optic Building Cable is used for both vertical and horizontal applications in buildings and meets the requirements of the NEC for OFNR.

Subsystem: Riser Backbone, Horizontal, Equipment, Administration

HIGH FIBER COUNT MULTIBUNDLE FIBER OPTIC BUILDING CABLE — RISER RATED						
PVC Jacket (Riser Classified — OFNR)						
Product Code	No. of Fibers	Outside Diameter in. (mm)	Weight lbs/100 ft (kg/km)	Tension Rating lbs (N)	Maximum Length ft. (km)	Comcode
LGBC-024A-LRX	24	0.492 (12.5)	8.7 (129.5)	150 (666)	10,000 (3.0)	106058142
LGBC-036A-LRX	36	0.492 (12.5)	8.7 (129.5)	150 (666)	10,000 (3.0)	106058159
LGBC-048A-LRX	48	0.551 (14.0)	12.0 (178.5)	150 (666)	6,500 (2.3)	106748775
LGBC-072A-LRX	72	0.630 (16.0)	13.0 (193.5)	150 (666)	6,500 (2.3)	106748791

Heavy Duty Building Cable, HDBC Series

Heavy Duty Building Cable (HDBC) consists of 12 individual 62.5/125-μm fibers, each with a color-coded PVC jacket. HDBC Series Cable is reinforced with Aramid yarn for superior strength and contains no metallic elements. HDBC Breakout Cable is used for both vertical and horizontal applications in buildings and meets the requirements of the NEC.

Subsystem: Riser Backbone, Horizontal

Maximum Length: 6,560 ft (2.0 km)

HDBC SERIES HEAVY DUTY BUILDING CABLE						
Product Number	**No. of Fibers**	**Outside Diameter in. (mm)**	**Weight lbs/100 ft (kg/km)**	**Tension Rating lb. (N)**	**Rating**	**Comcode**
Riser: HDBC-012A-LRX	12	0.59 (14.9)	12 (178)	65 (289)	OFNR	106 057 946
Plenum: HDBC-012A-LPX	12	0.59 (14.9)	12 (178)	65 (289)	OFNP	106 058 050

3FLX AccuRibbon Riser Cable

Note: A description of *AccuRibbon* make-up, color code, and marking code identification can be found in section 14, "CABLE AND WIRE."

3FLX *AccuRibbon* Riser Cable has a core consisting of multimode 62.5/125-µm fibers. The fibers are set side by side in groups of 12 in a matrix material to form an *AccuRibbon.* 3FLX *AccuRibbon* Riser Cable is a non-filled ribbon structure with a nonmetallic crossply PVC sheath. The ribbons are in an orange PVC core tube. The core tube is covered by an inner layer of strands of spirally wound impregnated fiberglass roving, covered by a layer of impregnated fiberglass rods spirally wound in the opposite direction. An orange PVC outer sheath covers the fiberglass strength members. 3FLX *AccuRibbon* Riser Cable is used in the Riser Backbone Subsystem and meets the NEC requirements for OFNR.

Subsystem: Riser Backbone, Horizontal, Campus Backbone, Administration

Physical Specifications:

Tension Rating: 600 lb (2,669 N)
Number of Fibers: 12 to 144
Cable Diameter: 0.49 in. (12.4 mm) for 96 fiber or less;
0.59 in. (15 mm) for 144 fiber
Weight: 9.6 lb/100 ft (14.3 kg/km)

AccuRibbon RISER CABLE		
Product Number	**No. of Fibers**	**Comcode**
3FLX-012	12	106 222 144
3FLX-024	24	106 222 151
3FLX-036	36	106 222 169
3FLX-048	48	106 222 177
3FLX-060	60	106 222 185
3FLX-072	72	106 222 193
3FLX-084	84	106 222 201
3FLX-096	96	106 222 219
3FLX-144	144	106 222 250

OUTSIDE FIBER OPTIC CABLE

Used in underground, direct-buried, and aerial applications between buildings, outside fiber optic cable is filled with a compound formulated to protect the fibers from environmental damage such as moisture. The high-density polyethylene sheath of outside cable, reinforced with steel or fiberglass, provides additional protection from the elements. This category encompasses *AccuRibbon* cable and *Lightpack*® cable. *Lightpack* cable is used when fewer than 96 fibers are needed, while *AccuRibbon* cable is generally used when a higher fiber count is required.

SYSTIMAX SCS include five outside sheath designs to meet the specific requirements of underground, direct-buried, aerial, and building applications:

- A nonarmored fiber optic express entry (LXE) sheath
- A metallic LXE sheath
- A dielectric LXE sheath
- A crossply metallic sheath
- A crossply dielectric sheath using fiberglass strength members.

SYSTIMAX SCS fiber optic cable consists of two core designs for outside use:

- The *Lightpack* cable core design consists of up to eight bundles, each containing a maximum of 12 fibers held together with color-coded yarn binders.
- The *AccuRibbon* core design offers large fiber counts within small cable diameters by packaging 12 parallel fibers together in a ribbon matrix.

3DAX Metallic Crossply Lightpack Cable

3DAX is the standard *Lightpack* cable. It consists of a core containing 4 to 96 multimode 62.5/125-µm fibers. The fibers are separated into color-coded binder groups surrounded by a polyethylene core tube filled with water-blocking compound. The metallic crossply sheath includes an inner jacket and an outer high-density polyethylene jacket with steel strength strands embedded in each jacket layer. 3DAX *Lightpack* cable is used in underground conduit, direct-buried, or aerial applications.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
4 to 48	0.42 in. (10.7 mm)	0.08 lb/ft (0.12 kg/m)
50 to 96	0.49 in. (12.4 mm)	0.09 lb/ft (0.13 kg/m)

Tension Rating: 600 lb (2,669 N)

METALLIC CROSSPLY *Lightpack* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3DAX-004-HXM	4	105 829 253
3DAX-006-HXM	6	105 829 261
3DAX-008-HXM	8	105 829 279
3DAX-012-HXM	12	105 829 295
3DAX-018-HXM	18	105 829 329
3DAX-024-HXM	24	105 829 352
3DAX-036-HXM	36	105 829 410
3DAX-048-HXM	48	105 829 477
3DAX-060-HXM	60	105 829 535
3DAX-072-HXM	72	105 829 592
3DAX-084-HXM	84	105 829 659
3DAX-096-HXM	96	105 829 717

3DFX Nonmetallic Crossply Lightpack Cable

3DFX *Lightpack* cable has a core containing 4 to 96 multimode 62.5/125-µm fibers. The fibers are separated into color-coded binder groups surrounded by a core tube. The core is filled with water-blocking compound and covered by a nonmetallic crossply sheath that consists of fiberglass strength strands embedded in high-density polyethylene. 3DFX *Lightpack* cable is used in underground conduit, direct-buried, or aerial applications. Its nonmetallic, fiberglass-reinforced sheath provides adequate lightning resistance even in high lightning areas.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
4 to 48	0.42 in. (1.06 cm)	0.07 lb/ft (0.10 kg/m)
50 to 96	0.49 in. (1.24 cm)	0.09 lb/ft (0.13 kg/m)

Tension Rating: 600 lb (2,669 N)

NONMETALLIC CROSSPLY *Lightpack* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3DFX-004-HXM	4	105 842 454
3DFX-006-HXM	6	105 842 462
3DFX-008-HXM	8	105 842 470
3DFX-012-HXM	12	105 842 496
3DFX-018-HXM	18	105 842 520
3DFX-024-HXM	24	105 842 553
3DFX-036-HXM	36	105 842 611
3DFX-048-HXM	48	105 842 678
3DFX-060-HXM	60	105 842 736
3DFX-072-HXM	72	105 842 793
3DFX-084-HXM	84	105 842 850
3DFX-096-HXM	96	105 842 918

3DNX Nonmetallic LXE Lightpack Cable

3DNX Nonmetallic Fiber Optic Express (LXE) *Lightpack* Cable has a core containing 4 to 96 multimode 62.5/125-µm fibers. The fibers are separated into color-coded binder groups surrounded by a core tube. The core is filled with water-blocking compound. 3DNX Nonmetallic LXE *Lightpack* Cable is used in underground conduit, direct-buried, or aerial applications.

The LXE sheath has nonmetallic strength members parallel to the core and outside the core. The sheath jacket material is high-density polyethylene for maximum environmental protection.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
4 to 48	0.49 in. (1.24 cm)	0.09 lb/ft (0.13 kg/m)
50 to 96	0.59 in. (1.50 cm)	0.12 lb/ft (0.18 kg/m)

Tension Rating: 600 lb (2,669 N)

NONMETALLIC LXE *Lightpack* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3DNX-004-HXM	4	106 331 358
3DNX-006-HXM	6	106 331 366
3DNX-008-HXM	8	106 331 374
3DNX-012-HXM	12	106 331 390
3DNX-018-HXM	18	106 331 424
3DNX-024-HXM	24	106 331 457
3DNX-036-HXM	36	106 331 515
3DNX-048-HXM	48	106 331 572
3DNX-060-HXM	60	106 331 630
3DNX-072-HXM	72	106 331 697
3DNX-084-HXM	84	106 331 754
3DNX-096-HXM	96	106 331 812

3DSX LXE Metallic Lightpack Cable

3DSX is the standard Fiber Optic Express Entry (LXE) *Lightpack* Cable, containing 4 to 96 multimode 62.5/125-µm fibers, designed for easy midsheath entry. The fibers are separated into color-coded binder groups surrounded by a core tube filled with water-blocking compound. The LXE sheath has two steel wires placed opposite one another parallel to the core and outside the core. The steel armor provides rodent protection and lightning protection. The sheath jacket material is high-density polyethylene for maximum environmental protection. The 3DSX LXE *Lightpack* Cable is used in underground conduit, direct-buried, or aerial applications.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
4 to 48	0.49 in. (12.4 mm)	0.11 lb/ft (0.16 kg/m)
50 to 96	0.59 in. (15.0 mm)	0.13 lb/ft (0.19 kg/m)

Tension Rating: 600 lb (2,669 N)

LXE METALLIC *Lightpack* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3DSX-004-HXM	4	106 346 471
3DSX-006-HXM	6	106 346 489
3DSX-008-HXM	8	106 346 497
3DSX-012-HXM	12	106 346 513
3DSX-018-HXM	18	106 346 547
3DSX-024-HXM	24	106 346 570
3DSX-036-HXM	36	106 346 638
3DSX-048-HXM	48	106 346 695
3DSX-060-HXM	60	106 346 752
3DSX-072-HXM	72	106 346 810
3DSX-084-HXM	84	106 346 877
3DSX-096-HXM	96	106 346 935

3DUX Nonarmored LXE Lightpack Cable

3DUX is nonarmored Fiber Optic Express Entry (LXE) *Lightpack* Cable, containing 6, 12, 18, and 24 multimode 62.5/125-µm fibers, designed for easy midsheath entry. The fibers are separated into color-coded binder groups of six fibers and surrounded by a core tube filled with water-blocking compound. LXE sheath has two steel wires placed opposite one another parallel to the core and outside the core. Sheath jacket material is high-density polyethylene for maximum environmental protection. 3DUX LXE *Lightpack* Cable is used in underground conduit, direct-buried, or aerial applications.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
6, 12, 18, 24	0.40 in. (1.02 cm)	0.06 lb/ft (0.09 kg/m)

Tension Rating: 600 lb (2,669 N)

NONARMORED LXE *Lightpack* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3DUX-006-HXM	6	106 532 278
3DUX-012-HXM	12	106 532 286
3DUX-018-HXM	18	106 532 294
3DUX-024-HXM	24	106 532 302

3GAX Metallic Crossply AccuRibbon Cable

3GAX *AccuRibbon* Cable has a core containing 12 to 144 multimode 62.5/125-µm ribbon fibers in increments of 12. The fibers are set side by side and held together with matrix material to form an *AccuRibbon* Cable. The ribbons are surrounded by a core tube, and the core is filled with water-blocking compound and protected by a sheath consisting of two layers of high-density polyethylene with steel strength strands embedded in each layer of polyethylene. 3GAX *AccuRibbon* Cable is used in underground conduit, direct-buried, or aerial applications.

Note: 3GAX *AccuRibbon* Cable is also available with factory-installed array connectors; specify when ordering.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
12 to 96	0.49 in. (1.24 cm)	0.09 lb/ft (0.13 kg/m)
108 to 144	0.59 in. (1.50 cm)	0.13 lb/ft (0.19 kg/m)

Tension Rating: 600 lb (2,669 N)

METALLIC CROSSPLY *AccuRibbon* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3GAX-012-HXM	12	105 867 519
3GAX-024-HXM	24	105 867 576
3GAX-036-HXM	36	105 867 634
3GAX-048-HXM	48	105 867 691
3GAX-060-HXM	60	105 867 758
3GAX-072-HXM	72	105 867 816
3GAX-084-HXM	84	105 867 873
3GAX-096-HXM	96	105 867 931
3GAX-144-HXM	144	105 868 178

3GFX Dielectric Crossply AccuRibbon Cable

3GFX *AccuRibbon* Cable has a core containing 12 to 144 multimode 62.5/125-μm fibers in increments of 12 fibers. The fibers are set side by side and are held together by a matrix material to form an *AccuRibbon* Cable. The ribbons are surrounded by a polyethylene core tube. The core is filled with water-blocking compound and covered by a nonmetallic crossply sheath that consists of fiberglass strength strands embedded in high-density polyethylene. 3GFX *AccuRibbon* Cable is used in underground conduit, direct-buried, or aerial applications. Its nonmetallic, fiberglass-reinforced sheath provides adequate lightning resistance even in high lightning areas.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
12 to 96	0.49 in. (1.24 cm)	0.09 lb/ft (0.13 kg/m)
108 to 144	0.59 in. (1.50 cm)	0.13 lb/ft (0.19 kg/m)

Tension Rating: 600 lb (2,669 N)

DIELECTRIC CROSSPLY *AccuRibbon* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3GFX-012-HXM	12	105 884 795
3GFX-024-HXM	24	105 884 852
3GFX-036-HXM	36	105 884 910
3GFX-048-HXM	48	105 884 977
3GFX-060-HXM	60	105 885 032
3GFX-072-HXM	72	105 885 099
3GFX-084-HXM	84	105 885 156
3GFX-096-HXM	96	105 885 214
3GFX-144-HXM	144	105 885 453

3GNX Dielectric LXE AccuRibbon Cable

3GNX Dielectric Fiber Optic Express Entry (LXE) *AccuRibbon* Cable has a core containing 12 to 144 multimode 62.5/125-µm fibers in increments of 12 fibers. The fibers are set side by side and held together by a matrix material to form the *AccuRibbon* Cable. The ribbons are surrounded by a core tube. The core tube is filled with water-blocking compound. 3GNX Dielectric LXE *AccuRibbon* Cable is used in underground conduit, direct-buried, or aerial applications.

The dielectric LXE sheath has nonmetallic strength members parallel to the core and outside the core. The sheath jacket material is high-density polyethylene for maximum environmental protection.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
12 to 96	0.59 in. (1.50 cm)	0.12 lb/ft (0.18 kg/m)
108 to 144	0.69 in. (1.75 cm)	0.18 lb/ft (0.27 kg/m)

Tension Rating: 600 lb (2,669 N)

DIELECTRIC LXE *AccuRibbon* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3GNX-012-HXM	12	106 352 289
3GNX-024-HXM	24	106 352 297
3GNX-036-HXM	36	106 352 305
3GNX-048-HXM	48	106 352 313
3GNX-060-HXM	60	106 352 321
3GNX-072-HXM	72	106 352 339
3GNX-084-HXM	84	106 352 347
3GNX-096-HXM	96	106 352 357
3GNX-144-HXM	144	106 352 396

3GSX Metallic Armored LXE AccuRibbon Cable

3GSX is the standard Fiber Optic Express Entry (LXE) *AccuRibbon* Cable, containing 12 to 144 multimode 62.5/125-μm fibers, in increments of 12 fibers. It is designed for easy mid-sheath entry. The fibers are set side by side and held together by a matrix material to form the *AccuRibbon* Cable. The ribbons are surrounded by a core tube filled with water-blocking compound. This LXE sheath has two steel wires placed opposite one another parallel to the core and outside the core. The steel armor provides rodent protection and buried lightning protection. The sheath jacket material is high-density polyethylene for maximum environmental protection. 3GSX LXE *AccuRibbon* Cable is used in underground conduit, direct-buried, or aerial applications.

Subsystem: Campus Backbone

Physical Specifications:

Fibers	Diameter	Weight
12 to 96	0.59 in. (1.50 cm)	0.15 lb/ft (0.22 kg/m)
108 to 144	0.69 in. (1.75 cm)	0.20 lb/ft (0.30 kg/m)

Tension Rating: 600 lb (2,669 N)

METALLIC ARMORED LXE *AccuRibbon* CABLE		
Product Number	**No. of Fibers**	**Comcode**
3GSX-012-HXM	12	106 355 167
3GSX-024-HXM	24	106 355 175
3GSX-036-HXM	36	106 355 183
3GSX-048-HXM	48	106 355 191
3GSX-060-HXM	60	106 355 209
3GSX-072-HXM	72	106 355 217
3GSX-084-HXM	84	106 355 225
3GSX-096-HXM	96	106 355 233
3GSX-144-HXM	144	106 355 274

FIBER OPTIC PATCH CORDS, JUMPER CORDAGE

Detailed specifications and ordering information for Fiber Optic Patch Cords and Jumper Cordage is listed in the *SYSTIMAX Structured Cabling System (SCS) Product Guide* (3726C).

ELECTRICAL PROTECTION

The purpose of electrical protection is to minimize, as far as practical, electrical hazards to distribution system users and to reduce, as far as practical, electrical damage to the distribution system, connecting equipment, and structures.

To prevent this kind of harm, *SYSTIMAX* SCS include protector panels that hold interchangeable plug-in protector units to control the magnitude of high-voltage surges that pass through building wiring. Each protector unit contains gas-tube or solid-state protective elements.

AT&T protector units are identified by an alphanumeric code. For more information on AT&T protectors and a description of the alphanumeric code, see section 6, "ELECTRICAL PROTECTION," beginning on page 6-15.

Protection Devices

The following protectors are used at building entrances for electrical protection in buildings served by exposed cables.

Protector Panel, 110ANA1-Type Multipair

The 110ANA1-Type Multipair Protector Panel provides indoor station protection for small-pair-count applications using the 3B, 3C, 4B, or 4C Series Protector Units. The unique internal wiring design prevents protector bypass. Designed with 110-Type Connecting Blocks for input and output terminations, the 110ANA1 Multipair Protector Panel provides a modular, space-efficient package with quiet-front and simplified installation. The 110ANA1 Multipair Protector Panel comes in 6- and 25-pair sizes and can be ordered with or without the individual protector units included.

Subsystem: Campus Backbone

Physical Specifications:

Height: 6 pair, 3.5 in. (8.89 m); 25 pair, 10.0 in. (25.4 cm)
Width: 6 pair, 4.1 in. (10.4 cm); 25 pair, 3.9 in. (9.91 cm)
Depth (110ANA1-06, 110ANA1-25): 2.6 in. (6.60 cm)

110ANA1-TYPE MULTIPAIR PROTECTOR PANEL			
Product Number	**Pair Size**	**Protector Unit Type Included**	**Comcode**
110ANA1E3-06	6	3B1EW	105 736 540
110ANA1E4-06	6	4B1EW	105 736 565
110ANA1C3-06	6	3C1S	105 736 508
110ANA1C4-06	6	4C1S	105 736 524
110ANA1E3-25	25	3B1EW	105 736 557
110ANA1E4-25	25	4B1EW	105 736 573
110ANA1C3-25	25	3C1S	105 736 516
110ANA1C4-25	25	4C1S	105 736 532
110ANA1-06	6	None included	105 736 482
110ANA1-25	25	None included	105 736 490

Protector Panel, 188-Type Multipair

The 188-Type Multipair Protector Panel provides protection for communication equipment and circuits exposed to voltage surges and sneak currents. The protector panel, designed for use with the 110 Connector System, consists of a metal housing containing mountings for 3B, 3C, 4B, or 4C Series Protector Units (sold separately). Input options for the protector panel include a swivel input stub and splice chamber equipped with a 110 Wiring Block or 710 or 3M connector. Both input options allow cable to be fed from the top or bottom. The conductors in the swivel stub and splice chamber are 26 AWG and satisfy the fuse link requirements. Insertion of the protector units into the protector panel completes the circuit to the 110 Connector System termination field output. Another option of the 188 Multipair Protector Panel with splice chamber is a hinged cover for mechanical protection and security. Output is through a 110 Wiring Block. The 188 Multipair Protector Panel comes in 25-, 50-, and 100-pair sizes. Standard length of the stub is 25 feet (7.62 m).

Subsystem: Campus Backbone

Physical Specifications:

Width: 188B series, 10.75 in. (27.3 cm)
188E series, 13.75 in. (34.9 cm)

188-TYPE MULTIPAIR PROTECTOR PANEL					
Product Number	Pair Size	Input	Height in. (cm)	Depth in. (cm)	Comcode
188B1-25	25	Swivel Stub	5.38 (13.7)	4.50 (11.4)	106 087 133
188B1-50	50	Swivel Stub	5.38 (13.7)	4.50 (11.4)	103 314 969
188B1-100	100	Swivel Stub	10.75 (27.3)	4.50 (11.4)	103 314 951
188ENA1-025G	25	110 Block	5.75 (14.6)	5.57 (14.1)	106 086 788
188ENA1-050G	50	110 Block	5.75 (14.6)	5.57 (14.1)	106 086 770
188ENA1-100G	100	110 Block	10.75 (27.3)	5.57 (14.1)	106 086 762
188ECA1-025G*	25	110 Block	5.75 (14.6)	6.25 (15.9)	106 087 190
188ECA1-050G*	50	110 Block	5.75 (14.6)	6.25 (15.9)	106 086 804
188ECA1-100G*	100	110 Block	10.75 (27.3)	6.25 (15.9)	106 086 796
188ENS1-025G	25	710 Conn.	5.75 (14.6)	5.57 (14.1)	106 086 911
188ENS1-050G	50	710 Conn.	5.75 (14.6)	5.57 (14.1)	106 086 929
188ENS1-100G	100	710 Conn.	10.75 (27.3)	5.57 (14.1)	106 086 937
188ECS1-025G*	25	710 Conn.	5.75 (14.6)	6.25 (15.9)	106 086 887
188ECS1-050G*	50	710 Conn.	5.75 (14.6)	6.25 (15.9)	106 086 895
188ECS1-100G*	100	710 Conn.	10.75 (27.3)	6.25 (15.9)	106 086 903
188ENP1-025G	25	3M Conn.	5.75 (14.6)	5.57 (14.1)	106 087 166
188ENP1-050G	50	3M Conn.	5.75 (14.6)	5.57 (14.1)	106 087 174
188ENP1-100G	100	3M Conn.	10.75 (27.3)	5.57 (14.1)	106 087 182
188ECP1-025G*	25	3M Conn.	5.75 (14.6)	6.25 (15.9)	106 086 879
188ECP1-050G*	50	3M Conn.	5.75 (14.6)	6.25 (15.9)	106 087 141
188ECP1-100G*	100	3M Conn.	10.75 (27.3)	6.25 (15.9)	106 087 158
* Optional cover is available.					

Protector Panel, 190-Type Multipair

The 190-Type Multipair Protector Panel provides indoor station protection for exposed lines, where the cross-connect field is separated from the protector panels, at building entrance terminals. The protector panel consists of a metal housing containing mountings for 3B, 3C, 4B, or 4C Series Protector Units (sold separately). It also includes a 25-foot (7.62 m), 26-AWG stub cable that serves as a fusible link, a 24-AWG terminating cable, and two connectors for external ground connections. The internal wiring design prevents protector bypass and a cable pass-through feature allows for side-by-side and top-to-bottom installation. The 190 Multipair Protector Panel comes in 50- and 100-pair sizes.

Subsystem: Campus Backbone

Physical Specifications:

Height: 50-pair, 13 in. (33.0 cm)
100-pair, 24 in. (61.0 cm)
Width: 4 in. (10.2 cm)
Depth: 2.75 in. (6.99 cm)

Product Number	Comcode
190A1-50	102 995 073
190A1-100	102 995 099

Protector Panel, 195-Type Multipair

The 195-Type Multipair Protector Panel provides indoor station protection for exposed lines, where the cross-connect field is separated from the protector panels, at building entrance terminals. This 100-pair protector panel consists of a metal housing containing mountings for 3B, 3C, 4B, or 4C Series Protector Units (sold separately). It also includes a 26-AWG stub cable that serves as a fusible link, four 24-AWG, 12-inch (30.5-cm) output cables terminated with male or female connectors, and two connectors for external ground connections. The internal wiring design prevents protector bypass. Designed for large-pair-size installations, the 195 Multipair Protector Panel may be frame-mounted or wall-mounted with the wall-mounting bracket.

Subsystem: Campus Backbone

Physical Specifications:

Height: 8 in. (20.3 cm)
Width: 8 in. (20.3 cm)
Depth: with wall bracket, 9.25 in. (23.5 cm)
without wall bracket, 5 in. (12.7 cm)

195-TYPE MULTIPAIR PROTECTOR PANEL			
Product Number	**Input Stub**	**Output Connector**	**Comcode**
Wall-Mountable Units*:			
195A1-100-25	25 ft (7.62 m)	Female	105 404 776
195A1-100-25M	25 ft (7.62 m)	Male	105 564 025
195A1-100-50	50 ft (15.2 m)	Female	105 564 033
195A1-100-50M	50 ft (15.2 m)	Male	105 564 041
Frame-Mountable Units:			
195B1-100-25	25 ft (7.62 m)	Female	105 501 050
195B1-100-25M	25 ft (7.62 m)	Male	105 564 058
195B1-100-50	50 ft (15.2 m)	Female	105 564 066
195B1-100-50M	50 ft (15.2 m)	Male	105 564 074
195B1-100-100	100 ft (30.5 m)	Female	105 564 082
195B1-100-100M	100 ft (30.5 m)	Male	105 564 090
* Includes wall-mount bracket			

Individual Protector Units

Six types of individual protector units are currently included in the *SYSTIMAX* Product Guide.

- 3B1D
- 3B-EW Series
- 3C-S Series
- 4B-EW Series
- 4C-S Series
- 4C3S-75

For more information on these protectors, see the *SYSTIMAX Structured Cabling Systems (SCS) Product Guide* (3726C) and section 6, "ELECTRICAL PROTECTION" of this handbook.

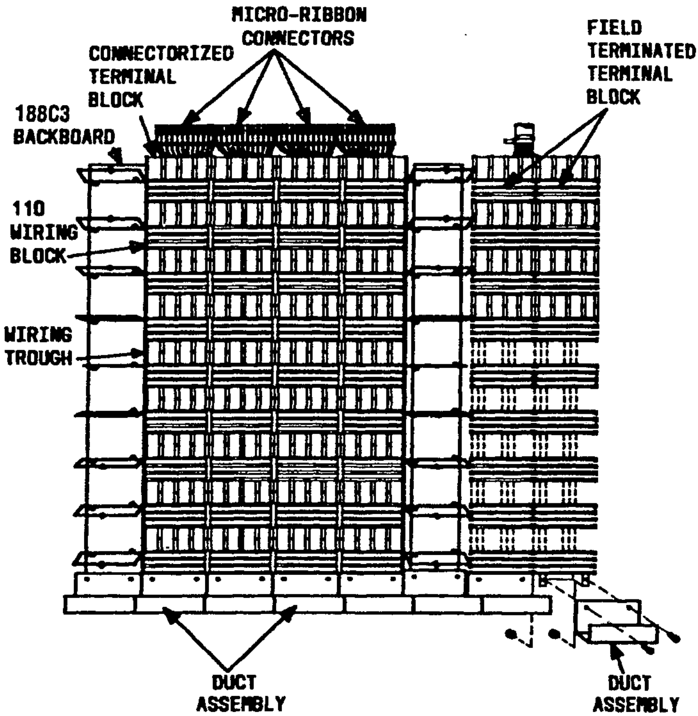
110 CONNECTOR SYSTEMS

The basic components of the 110 Connector Systems are the wiring block, the connecting block, patch cords, and label inserts. Wire cross-connect hardware is used to terminate and interconnect cables and to route circuits throughout the distribution system.

There are two basic types of 110 Connector Systems:

- 110 Cross-Connect System — typically used for low-speed data applications because it requires short lengths of jumper wire to link the cable pairs at two circuit termination points
- 110 Patch Panel System — typically used with high-speed applications because patch cords are used for circuit termination. Shown on the next page is a typical 110 Patch Panel System.

For a complete description of these and other associated AT&T products see the *SYSTIMAX Structured Cabling Systems (SCS) Product Guid* (3726C).



Typical Layout

110 Wiring Block

The 110 Wiring Block is a fire-retardant, molded plastic block with horizontal index strips, each of which secures and organizes 25 cable pairs. The index strips are marked with the five tip colors to help the installer locate pairs quickly. The blocks accommodate 22- through 26-gauge (0.6 - 0.4 mm) conductors and can be mounted directly on wall surfaces without backboards or Extra Large Building Entrance Terminal (XLBET) frames.

The 110 Wiring Block is used to terminate cable pairs and permits a neat, organized arrangement of cables behind the block. There are two types of 110 Wiring Blocks: "A" wiring blocks and "D" wiring blocks. These blocks are used in conjunction with the 110C Connecting Blocks, which are ordered separately. The 110A Wiring Block is equipped with legs to provide space behind the block; also, the space on the sides can be used as a vertical jumper trough. The 110D Wiring Block is built without legs and is used where depth is restrictive.

Subsystem: Administration

Pair Size: 100, 300

Physical Specifications:

Height: 100-pair, 3.59 in. (91 mm); 300-pair, 10.79 in. (274 mm)
Width: "A" block, 10.72 in. (272 mm); "D" block, 8.5 in. (216 mm)
Depth: "A" block, 3.25 in. (82.5 mm); "D" block, 1.4 in. (36 mm)

110 WIRING BLOCK		
Product Number	**Description**	**Comcode**
110 AW2-100	100 Pairs	107 059 891
110 AW2-300	300 Pairs	107 059 917
110 DW2-100	100 Pairs	107 059 909
110 DW2-300	300 Pairs	107 059 925

110AB2 Bridged Wiring Block

The 110AB2 Bridged Wiring Block consists of 110A Wiring Blocks vertically prewired to form common bridged termination points. These blocks may be used to provide auxiliary circuit wiring for Integrated Services Digital Network (ISDN) Basic Rate Interface (BRI) multipoint circuits, IBM Systems 36/38 or AS/400 workstation bridging, and other equipment applications requiring bridged circuit administration.

The 110AB2-25M Bridged Wiring Block consists of a 110AW2-100 Wiring Block vertically prewired across four rows. The 110AB2-50M Bridged Wiring Block consists of a 110AW2-300 Wiring Block vertically prewired across two sets of six rows each. The blocks are furnished with designation labels and holders for circuit identification.

Subsystem: Administration

Physical Specifications:

Height: 110AB2 2-25M, 3.625 in. (92 mm), 110AB2-50M, 10.75 in. (273 mm)
Width: 10.75 in. (273 mm)
Depth: 3.25 in. (82.5 mm)

Circuit Capacity:

110AB2-25M, 24 1-pair bridged circuits with four termination points each
110AB2-50M, 48 1-pair bridged circuits with six termination points each

Bridged Wire: 24-AWG solid twisted pair, CCW-F Hook-Up Wire

110AB2 BRIDGED WIRING BLOCK	
Product Number	**Comcode**
110AB2-25M	107 059 347
110AB2-50M	107 059 370

110C Connecting Block

The 3-pair (110C-3), 4-pair (110C-4), and 5-pair (110C-5) connecting blocks consist of a 1-piece, fire-retardant, molded plastic housing containing solder-plated quick clips that cut through the insulation on 22- through 26-gauge (0.6 - 0.4 mm) conductors as they are seated onto the wiring block. The front of the connecting block is color-coded, allowing rapid pair identification and termination. The connecting blocks seat on the 110 Wiring Block and provide an electrically tight connection between cable conductors terminated on the wiring block and F Cross-Connect Wire or 110 Patch Cords.

When ordering, note that all pair sizes are available only in packages of 10. Therefore, if 45 blocks are required, 5 packages must be ordered.

Subsystem: Administration

Physical Specifications:
Height: 0.25 in. (6.4 mm)
Width: 3-pair, 0.9 in. (23 mm); 4-pair, 1.2 in. (30.5 mm); 5-pair, 1.5 in. (38 mm)
Depth: 0.93 in. (23.6 mm)

110C CONNECTING BLOCK		
Product Number	**Description**	**Comcode**
110C-3	3-Pair Connecting Blocks	103 801 239
110C-4	4-Pair Connecting Blocks	103 801 247
110C-5	5-Pair Connecting Blocks	103 801 254

110 Disconnect Terminal Block

AT&T's 110 Connector System Family has been expanded to include a disconnect terminal block. Intended for those locations where network administration is required, the disconnect terminal block permits circuit isolation without removing patch cords or cross-connect wire. The "look both ways" testing capabilities allow end users to identify out-of-service lines and other circuit conditions easily.

The 110 Disconnect Block, which has the same footprint as the 110DW2 Wiring Block, includes the 110C-4 or 110C-5 Connecting Block (noted with a "B" or "A," respectively, in the code) and provides for termination of 50 pairs. In addition, the 110 Disconnect Terminal Blocks are also available prepackaged with insert labels, label holders, jumper troughs, metal backpanel, duct assembly, plastic rivets, bond assembly, screws, washers, and an instruction sheet for terminating 150 or 450 pairs. Other parts include insulators to open the circuit, covers to protect the circuit connections on the connecting block, and a 154A1 Mounting Bracket for a single disconnect block.

Subsystem: Administration

Physical Specifications:

50-Pair Terminal Block
- Height: 3.59 in. (91 mm)
- Width: 8.5 in. (216 mm)
- Depth: 1.4 in. (36 mm)

150-Pair Terminal Block Kit
- Height: 24.68 in. (627 mm)
- Width: 8.5 in. (216 mm)
- Depth: 8.05 in. (204.5 mm)

450-Pair Terminal Block Kit
- Height: 61.7 in. (1567 mm)
- Width: 8.5 in. (216 mm)
- Depth: 8.05 in. (204.5 mm)

110 DISCONNECT TERMINAL BLOCK		
Product Number	**Description**	**Comcode**
110TA1-50 Terminal Block	50 Pairs	106 274 749
110TB1-50 Terminal Block	50 Pairs	106 569 908
110TA2-150FT Terminal Block	150 Pairs	107 059 818
110TB2-150FT Terminal Block	150 Pairs	107 059 826
110TA2-450FT Terminal Block	450 Pairs	107 059 834
110TB2-450FT Terminal Block	450 Pairs	107 059 859
110W4A4	Test Cord	106 310 659
110W4M4	Monitor Cord	106 780 380
110A1 Insulator	1 Pair	106 310 618
110C1 Insulator	25 Pair	106 310 626
182A1 Cover	5-Pair White	106 310 634
182A2 Cover	5-Pair Red	106 569 916
182B1 Cover	4-Pair White	106 569 924
182B2 Cover	4-Pair Red	106 569 932
154A1 Mtg. Bracket	Metal Bracket	106 310 642

110 Cross-Connect System Terminal Blocks

The 110 Cross-Connect System Terminal Blocks are available in packages that include wiring blocks with legs (110AW2-100 and 110AW2-300), connecting blocks, and a label holder with white inserts for field termination (for example, 110AB2-100FT). The 110 Cross-Connect System Terminal Blocks are also available preterminated, connectorized, and tested from the factory (for example, 110AA1-100CT). These blocks can be wall- or frame-mounted and are applicable for small cross-connect fields as well as large fields. The 110 Cross-Connect System Terminal Blocks are used to terminate connectorized and raw-ended cable pairs.

The options available for 110 Cross-Connect System Terminal Blocks are designated by a 9-character alphanumeric code.

110 A B 2 - 300 - CTM

UNWIRED OR WIRED WITH CONNECTING BLOCKS
- CB -- Connectorized Bottom (Female)
- CBM -- Connectorized Bottom (Male)
- CT -- Connectorized Top (Female)
- CTM -- Connectorized Top (Male)
- FT -- Field Terminated

NUMBER OF PAIRS TERMINATED
- 100, 300, 600

PRODUCTION SERIES
- 2

SIZE OF CONNECTING BLOCKS
- A = 5 Pair
- B = 4 Pair
- C = 3 Pair

TYPE OF WIRING BLOCK
- A -- Wiring Block With Legs

FAMILY DESIGNATION

110 CROSS-CONNECT SYSTEM TERMINAL BLOCKS				
Field Terminated				
Product	Height	Width	Depth	Comcode
110AA2-100FT	3.6 in. (91 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 901
110AB2-100FT	3.6 in. (91 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 919
110AC2-100FT	3.6 in. (91 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 927
110AA2-300FT	10.8 in. (274 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 935
110AB2-300FT	10.8 in. (274 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 943
110AC2-300FT	10.8 in. (274 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 950
Connectorized				
Product	Height	Width	Depth	Comcode
110AA2-100CT	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 448
110AB2-100CT	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 489
110AC2-100CT	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 521
110AA2-300CT	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 562
110AB2-300CT	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 604
110AC2-300CT	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 646
110AA2-600CT	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 703
110AB2-600CT	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 745
110AC2-600CT	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 786
110AA2-100CTM	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 455
110AB2-100CTM	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 497
110AC2-100CTM	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 539
110AA2-300CTM	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 570
110AB2-300CTM	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 612
110AC2-300CTM	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 653
110AA2-600CTM	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 711
110AB2-600CTM	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 752
110AC2-600CTM	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 794

110 CROSS-CONNECT SYSTEM TERMINAL BLOCKS (Contd)				
Connectorized				
Product	Height	Width	Depth	Comcode
110AA2-100CB	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 463
110AB2-100CB	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 505
110AC2-100CB	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 547
110AA2-300CB	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 588
110AB2-300CB	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 620
110AC2-300CB	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 661
110AA2-600CB	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 687
110AB2-600CB	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 729
110AC2-600CB	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 760
110AA2-100CBM	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 471
110AB2-100CBM	13.3 in. (338 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 513
110AA2-300CBM	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 596
110AB2-300CBM	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 638
110AC2-300CBM	20.4 in. (518 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 679
110AA2-600CBM	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 695
110AB2-600CBM	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 737
110AC2-600CBM	31.2 in. (792 mm)	10.7 in. (272 mm)	3.25 in. (82 mm)	107 058 778

3A/4A Cable Terminal Sections

The 3A and 4A Cable Terminal Sections form a wall-mounted metal enclosure that provides mechanical protection and security for indoor building distribution apparatus.

The 3A Cable Terminal Sections consist of a lift-out door and top and bottom panels attached to a backboard at the factory. The backboard is made of plywood and laminated on both sides with aluminum, which acts as a fire-retardant barrier and aids grounding. Multiple 3A Sections can be mounted side-by-side to form an enclosure of any size. The 3A Cable Terminal Sections are proportioned to accommodate 110 Cross-Connect System apparatus and equipped with a ground bar for ground leads. They ***will not*** accommodate 110 Patch Panel apparatus.

The 4A Sections consist of side panels used to enclose the 3A Sections. The 4A Sections must be ordered in pairs (that is, order one 3AA1 and twc 4A1s).

The D-180992 Locking Kit of Parts provides greater security via a commercial key lock. Locking kit must be ordered separately.

3A/4A CABLE TERMINAL SECTIONS				
Product Number	**Height**	**Width**	**Depth**	**Comcode**
3AA1-19/32	32 in. (813 mm)	19.5 in. (495 mm)	6.5 in. (165 mm)	104 036 637
3AB1-19/32*	32 in. (813 mm)	19.5 in. (495 mm)	6.5 in. (165 mm)	105 679 005
3AA1-19/52	52 in. (1321 mm)	19.5 in. (495 mm)	6.5 in. (165 mm)	103 115 036
3AB1-19/52*	52 in. (1321 mm)	19.5 in. (495 mm)	6.5 in. (165 mm)	105 679 013
3AA1-19/72	72 in. (1829 mm)	19.5 in. (495 mm)	6.5 in. (165 mm)	103 115 044
3AB1-19/72*	72 in. (1829 mm)	19.5 in. (495 mm)	6.5 in. (165 mm)	105 679 021
4A1-32	32 in. (813 mm)	1.0 in. (25 mm)	6.5 in. (165 mm)	104 036 645
4A1-52	52 in. (1321 mm)	1.0 in. (25 mm)	6.5 in. (165 mm)	103 115 051
4A1-72	72 in. (1829 mm)	1.0 in. (25 mm)	6.5 in. (165 mm)	103 115 069
D-180992 Locking Kit				103 299 426

* These cable terminal sections are not equipped with a backboard, and they are designed for existing cross-connect fields.

110 Patch Panel System Terminal Blocks

The 110 Patch Panel System Terminal Blocks are made up of prewired 300- and 900-pair sizes and consist of 110 Wiring Blocks with connecting blocks and connectorized stubs and special horizontal jumper troughs for arranging patch cords. Wiring blocks and troughs are mounted on a metal backpanel equipped with an express trough at the bottom. Connecting blocks in 3-, 4-, or 5-pair sizes may be specified to match the pairs per circuit of the system in use. Transparent label holders allow you to insert circuit identification labels. Field-terminated terminal blocks, which allow direct termination of building cables, are also available. The terminal blocks are used to terminate connectorized or raw-ended cable pairs. Preconnectorized units are rated EIA/TIA Category 3 compliant.

The options available for 110 Patch Panel System Terminal Blocks are designated by a 9-character alphanumeric code system.

110 P A 2 - 900 - CBM

UNWIRED OR WIRED WITH CONNECTING BLOCKS
- CB -- Connectorized Bottom (Female)
- CBM -- Connectorized Bottom (Male)
- CT -- Connectorized Top (Female)
- CTM -- Connectorized Top (Male)
- FT -- Field Terminated

NUMBER OF PAIRS TERMINATED
- 300, 900

PRODUCTION SERIES
- 2

SIZE OF CONNECTING BLOCKS
- A = 5 Pair
- B = 4 Pair
- C = 3 Pair

TYPE OF TERMINAL BLOCKS
- P -- 110 Wiring Blocks With Connecting Blocks And Horizontal Troughs On A Backpanel

FAMILY DESIGNATION

110 PATCH PANEL SYSTEM TERMINAL BLOCKS					
Field Terminated					
Product	Height In. (mm)	Width In. (mm)	Depth In. (mm)	EIA/TIA Ctgry	Comcode
110PA2-300FT	24.7 (627)	8.5 (216)	8 (203)	5	107 058 802
110PB2-300FT	24.7 (627)	8.5 (216)	8 (203)	5	107 058 810
110PC2-300FT	24.7 (627)	8.5 (216)	8 (203)	5	107 058 828
110PA2-900FT	61.7 (1567)	8.5 (216)	8 (203)	5	107 058 851
110PB2-900FT	61.7 (1567)	8.5 (216)	8 (203)	5	107 058 869
110PC2-900FT	61.7 (1567)	8.5 (216)	8 (203)	5	107 058 877
Connectorized					
Product Number	Height	Width	Depth	EIA/TIA Ctgry	Comcode
110PA2-300CT	34.5 (876)	8.5 (216)	8 (203)	3	107 058 968
110PB2-300CT	34.5 (876)	8.5 (216)	8 (203)	3	107 059 008
110PC2-300CT	34.5 (876)	8.5 (216)	8 (203)	3	107 059 040
110PA2-900CT	79 (2007)	8.5 (216)	8 (203)	3	107 059 107
110PB2-900CT	79 (2007)	8.5 (216)	8 (203)	3	107 059 149
110PC2-900CT	79 (2007)	8.5 (216)	8 (203)	3	107 059 198
110PA2-300CTM	34.5 (876)	8.5 (216)	8 (203)	3	107 058 976
110PB2-300CTM	34.5 (876)	8.5 (216)	8 (203)	3	107 059 016
110PC2-300CTM	34.5 (876)	8.5 (216)	8 (203)	3	107 059 057
110PA2-900CTM	79 (2007)	8.5 (216)	8 (203)	3	107 059 115
110PB2-900CTM	79 (2007)	8.5 (216)	8 (203)	3	107 059 156
110PC2-900CTM	79 (2007)	8.5 (216)	8 (203)	3	107 059 206
110PA2-300CB	33.6 (853)	8.5 (216)	8 (203)	3	107 058 984
110PB2-300CB	33.6 (853)	8.5 (216)	8 (203)	3	107 059 024
110PC2-300CB	33.6 (853)	8.5 (216)	8 (203)	3	107 059 065
110PA2-900CB	113 (2870)	8.5 (216)	8 (203)	3	107 059 123
110PB2-900CB	113 (2870)	8.5 (216)	8 (203)	3	107 059 164
110PC2-900CB	113 (2870)	8.5 (216)	8 (203)	3	107 059 248
110PA2-300CBM	33.6 (853)	8.5 (216)	8 (203)	3	107 058 994
110PB2-300CBM	33.6 (853)	8.5 (216)	8 (203)	3	107 059 032
110PC2-300CBM	33.6 (853)	8.5 (216)	8 (203)	3	107 059 073
110PA2-900CBM	113 (2870)	8.5 (216)	8 (203)	3	107 059 131
110PB2-900CBM	113 (2870)	8.5 (216)	8 (203)	3	107 059 180
110PC2-900CBM	113 (2870)	8.5 (216)	8 (203)	3	107 059 255

110 Patch Panel System Backboard

The 110 Patch Panel System Backboard is a metal panel equipped with distributing rings that provide the vertical paths for running patch cords or jumpers between 110 Patch Panel System Terminal Blocks.

Also available is the 188E3 Backboard used in horizontal paths for patch cords and jumpers between 110 Patch Panel System Terminal Blocks.

Physical Specifications:

Length: See Chart
Width: 8.5 in. (216 mm)
Depth: 8 in. (203 mm)

110 PATCH PANEL SYSTEM BACKBOARD			
Product Number	**Description**	**Length In. (mm)**	**Comcode**
188C3	Used with 900-Pair Terminal Blocks	61.75 (1568)	107 151 185
188D3	Used with 300-Pair Terminal Blocks	24 (610)	107 151 193
188E3	Used for Horizontal Wiring Runs	24 (610)	107 151 201

110 Patch Panel System Frame

The original 110 Patch Panel System frame coded 1110A2 has been discontinued. The Extra Large Building Entrance Terminal (XLBET) Frame System is currently used to mount the 110 components.

The XLBET Frame System is designed to meet the needs of large entrance facilities and PBX distribution systems where wall space is at a premium. Block modules are mounted on a standard 24-inch (610 mm) with 23-inch (584 mm) center mounting, 7-foot (2.13 m) high single- or double-sided steel relay rack.

The assembled frame module includes a lightweight welded steel frame available in two different designs: single-sided (3,600-pair) or double-sided vertical (7,200-pair).

EXTRA LARGE BUILDING ENTRANCE TERMINAL (XLBET) FRAME SYSTEM			
Product Number	**Description**	**Size**	**Comcode**
XLBET 720S LA2054	Single-Sided Frame	19 in. x 7 ft. (483 mm x 2.13 m)	105 425 565
XLBET 720D LA2053	Double-Sided Frame	19 in. x 7 ft. (483 mm x 2.13 m)	105 429 641
Note: The AT&T 19-inch (483 mm) frame conforms to the EIA RS-310 standards. It is available in single- or double-sided versions. The 7-foot (2.13 m) charcoal gray frames are shipped unassembled with two packs of 50 screws for installation. Assembled frame modules, including block modules and protectors, are available. For more information, see the *SYSTIMAX Structured Cabling Systems (SCS) Product Guide* (3726C).			

110 Jack Panel System

The 110 Jack Panel System consists of 8-pin modular jacks mounted in a metallic holder and wired to a standard 110-Type Wiring Block. Jack panels are available in three sizes providing either 12, 36, or 108 8-pin modular jacks. The jack panels provide a 4-pair modular interface with the 110 Connector System, such as the direct termination of balun adapters with modular plugs that provide connectivity between coaxial and twisted copper pairs on the 110 Wiring Block. The jack panels generate savings by permitting termination of modular connectors on the 110 Cross-Connect Field, eliminating intermediate components and labor.

110 JACK PANEL SYSTEM		
Product Number	**Description**	**Comcode**
110AB2-100JP12 Jack Panel*	12 Modular Jacks on a 110AW2 100-Pair Wiring Block (with Mounting Legs)	107 059 636
110AB2-300JP36 Jack Panel*	36 Modular Jacks on a 110AW2 300-Pair Wiring Block (with Mounting Legs)	107 059 735
110PB2-300JP36 Jack Panel*	36 Modular Jacks on a 300-Pair Wiring Block	107 059 768
110PB2-900JP108 Jack Panel*	108 Modular Jacks on a 900-Pair Wiring Block	107 059 776
110AB-CAT5JP12 Jack Panel†	12 Modular Jacks on a 110AW2 100-Pair Wiring Block (with Mounting Legs)	106 952 062
110AB-CAT5JP36 Jack Panel†	36 Modular Jacks on a 110AW2 300-Pair Wiring Block (with Mounting Legs)	106 952 088
110BB-CAT5JP12FT Jack Panel†	12 Modular Jacks on a 110DW2 100-Pair Wiring Block (without Mounting Legs)	107 071 011
110PB-CAT5JP36 Jack Panel†	36 Modular Jacks on a 300-Pair Wiring Block	106 952 096
110PB-CAT5JP108 Jack Panel†	108 Modular Jacks on a 900-Pair Wiring Block	106 952 120

* These products are rated EIA/TIA Category 3.

† These products are rated EIA/TIA Category 5.

The options available for the 110 Jack Panel System are designated by a 9-character alphanumeric code.

P B 2 900 JP 108

- 108 — NUMBER OF 8-CONDUCTOR JACKS
  12, 36, 108
- JP — 110 JACK PANEL (JP)
- 900 — TOTAL QUANTITY OF PAIRS TERMINATED
- 2 — PRODUCTION SERIES
- B — SIZE OF CONNECTING BLOCKS
  B = 4 Pair
- P — TYPE OF WIRING/TERMINAL BLOCKS
  A -- 110 Wiring Blocks With Legs
  B -- 110 Wiring Blocks Without Legs
  P -- 110 Wiring Blocks and Horizontal Troughs on a Backpanel

FIBER OPTIC CONNECTING HARDWARE

SYSTIMAX Structured Cabling Systems Product Guide (3726C)

Fiber optic cross-connects, like copper wire cross-connects, provide a centralized location for circuit administration. They allow for rerouting circuits, adding new circuits, and removing old ones using fiber patch cords that are terminated with connectors on each end. Permanent cables, such as feeder cables and riser backbone cables, are terminated at the cross-connect.

Fiber Optic Interconnects are used to interconnect connectorized fibers from different cables directly, without using fiber patch cords. Interconnects are generally installed when rearrangements are not expected and the amount of optical power loss is of primary importance. Interconnects allow for a lower optical power loss than cross-connects since the optical signal passes through one connection as compared with two connections in a cross-connect.

Both cross-connect and interconnect modules are built from the same basic components:

- Fiber Optic Interconnection Units (LIUs) — cabinets that protect and organize the fibers
- Fiber Optic Cross-Connect (*LGX*®) Fiber Distribution Systems — frames that protect and organize the fibers
- Connector panels — which are used to mount connector couplings in the LIU or *LGX*
- Couplings — the hardware that joins the connectors.

LIUs are appropriate for smaller installations (under 200 fibers), and the *LGX* is ideal for larger installations.

Fiber Optic Interconnection Units (LIUs) 100A3, 200A, 200B, and 400A2

Fiber Optic Interconnection Units are designed to provide cross-connection and interconnection of fiber optic cables within buildings and currently include the 100A3, 200A, 200B2, and 400A2 types. They can be used individually, in an interconnect mode, or in a cross-connect mode.

The 100A3 Fiber Optic Interconnection Unit (LIU) terminates a maximum of 12 fibers and can accommodate splices for up to 12 fibers with *CSL LightSplice*® or rotary mechanical splices. It is a modular enclosure that provides cross-connect, interconnect, or splicing capabilities for fiber optic building cable, ribbon cables, and *Lightpack* cables in a building. Two windows are provided to mount connector panels. The 100A3 is made of an engineered polycarbonate material and has five plastic split rings for managing slack fibers within the unit and two rings for routing cables passing through the unit. Termination posts at the top and bottom secure the cables entering from overhead or below. The 100A3 LIU has inserts to enclose cable entry holes and grommets to seal around the cables. The LIU is both wall- and frame-mountable. The five retainer rings in the slack storage section are arranged in a racetrack configuration; they hold the buffered fibers so they do not exceed a 1.5-inch (3.81-cm) bend radius.

The 200A LIU has similar features to the 100A3 except it is made of aluminum and has four windows for connector panels. The 200A LIU terminates 24 fibers or accommodates splices for up to 24 fibers or a combination of 12 splices and 12 terminations.

The 200B LIU is used to terminate or splice 24 fiber outside plant cables, fiber optic building cables, or *Lightpack* cables in a National Electrical Manufacturers Association (NEMA) 4-rated cabinet. It is a modular enclosure intended to provide cross-connect and/or interconnect splicing and termination capabilities. The 200B is a steel enclosure designed for industrial applications. The right side is designed to allow rearrangement of jumpers or interconnection to building cable. It comes with a removable outer door and an inner door for securing the network section. The LIU provides split rings fiber bend limiters for routing and expressing cables.

The 200B is both wall- and frame-mountable. The LIU has three top and bottom knockouts for cable entry. It also has interior and exterior grounding studs.

The 400A2 LIU directly terminates 48 fibers or accommodates 24 splices plus 36 terminations. Eight 1000 *ST*® Connector Panels can be attached to provide terminating capability for 48 *ST* II Connectors. The 400A2 LIU can also accommodate up to four 2000 Fiber Distributed Data Interface (FDDI) Connector Panels for a total capacity of 24 FDDI, C4010 Series, MIC-to-*ST* couplings. The doors of the 400A2 LIU may be locked with separately orderable key locks for additional security.

The LIU units are designed to be mounted on backboards in equipment rooms, backbone or satellite closets, or remote locations. They may also be mounted inside the 3A/4A cable terminal sections, covered on Page 12-66.

Connector panels, couplings, splice adapters, and splices must be ordered separately.

Subsystem: Administration, Horizontal, Riser Backbone

FIBER OPTIC INTERCONNECTION UNITS (LIUs)				
Product Code	**Height in. (cm)**	**Width in. (cm)**	**Depth in. (cm)**	**Comcode**
100A3	8.75 (22.23)	7.5 (19)	3 (7.62)	106 896 947
200A	8.75 (22.23)	7.5 (19)	4 (10.16)	105 535 926
200B2	12.6 (32.0)	17 (43.18)	5.25 (13.34)	106 939 564
400A2	11 (27.94)	17 (43.18)	4 (10.16)	106 414 170
For additional components available, see the AT&T *Fiber Optic Products Catalog* (2492C) and the *SYSTIMAX Structured Cabling Systems Product Guide* (3726C).				

ASSOCIATED COMPONENTS FOR THE FIBER OPTIC INTERCONNECTION UNITS (LIU)	
Description	**Comcode**
Connector Panels for 100A3 and 200A LIUs 10A *ST* Connector Panel (Retains 6 Threaded *ST* Couplings, C2000A-2)	104 141 858
FDDI MIC Connector Panel (Retains 3 MIC-to-*ST* Couplings, C4010 Series), 1 Each	106 021 470
Blank Panel (Fills Unused LIU Windows)	105 276 570
10SC1 SC Connector Panel (Retains 6 SC Couplings, C6060A-4)	106 371 800
10SC1-DPLX Duplex SC Panel (Retains 3 Duplex SC Couplings, C6060A-4)	107 025 835
*ESCON** Panel F87AK8657 (Retains 3 *ESCON* Couplings, C6010/C6020), 1 Each	105 388 656
Connector Panels for 200B and 400A2 LIUs 1000 *ST* Connector Panel (Retains 6 Threaded *ST* Couplings, C2000A-2), 1 Each	105 392 005
1000 *ST* Connector Panel (Retains 6 Threaded *ST* Couplings, C2000A-2), Pkg. of 12	105 428 486
2000 FDDI MIC Connector Panel (Retains 6 MIC-to-*ST* Couplings, C4010 Series)	106 372 147
1000 SC Connector Panel (Retains 6 Simplex SC Couplings, C6000A-4)	106 372 121
2000 BM1 *ESCON* Panel (Retains 6 *ESCON* Couplings)	106 474 471
* Registered trademark of IBM.	

Interconnect Mode — LIU

The LIU can be used as an interconnect field without the use of jumper cables. In the interconnect configuration, the left interconnect unit should terminate the permanent cables and the right unit should terminate the movable fibers.

Cross-Connect Mode — LIU

The LIU can also be used as a cross-connect field to provide a connection point between incoming and outgoing fibers through a fiber optic cross-connect jumper cable.

The cross-connection fields could consist of a number of LIU modules. The modules can be stacked up to six high. The cross-connect field can be centered to 12 columns of six LIUs each for a total terminating capacity of 864 fibers. The wall space required to install the maximum termination configuration of 864 fibers requires a backboard 11-ft. 6-in. (3.5 m) high by 5-ft. 8-in. (1.7 m) wide.

LGX Fiber Optic Distribution Frame

The *LGX* Fiber Optic Distribution Frame (DF) has the capacity for 648 fiber terminations in a single bay and growth capability of up to 20 bays in a line-up. It is designed with ample jumper-routing capacity to allow easy administration of reassignments and to avoid congestion. The frame provides a termination and cross-connection point for fiber optic circuits. It is also designed for cable termination and grounding, ribbon or individual fiber splicing, and fiber and patch cord storage. In addition, splice-only and express-through situations are easily accommodated. The *LGX* DF is a special framework assembly for accepting Lightguide Distribution Shelves and is intended for use in applications where a large number of fibers can be terminated. The *LGX* DF design is versatile in that it accommodates all AT&T cable construction types including outside plant ribbon, stranded, *Lightpack* cable, and buffered building cables.

The *LGX* Distribution Frame provides a 23-inch (58.42 cm) wide, 7-foot (2.13 m) high frame and the associated raceways, brackets, retainers, and components for field mounting to the 7-foot (2.13 m) high frame. A Network Bay Frame is the basic framework portion of the *LGX* Frame. It uses the extended mount arrangement with the recessed wide flange side designated as the front and the flush narrow flange side as the rear. The frame is available in three sizes:

- 7-ft (2.13 m) high, 23-in. (58.42 cm) unequal flange frame (standard)
- 9-ft (2.74 m) high, 23-in. (58.42 cm) unequal flange frame
- 11.5-ft (3.5 m) high, 23-in. (58.42 cm) unequal flange frame.

LGX Distribution Frame parts provide the sheet metal ducts, brackets, retainers, and other components to be field-assembled to the Network Bay Frame to make an *LGX* Distribution Frame.

The complete *LGX* frame includes a number of components, some of which are described below.

- The 12A-Type Cable Clamps contain all the hardware necessary for securing one outside cable equipped with or without sheath-terminating hardware to the *LGX* Frame. 12A1 Clamps are used on metallic sheath cables, while 12A2 Clamps are used on nonmetallic sheath cables.
- An LST1U-072/7 Termination Shelf can terminate up to 72 connectorized fibers. The shelf is equipped with cable-mounting brackets for outside plant or building cables using 12A-Type Clamps. Up to 12 six-pack connector panels can be mounted on a shelf.
- An LST1F-072/7 Front-Access Termination Shelf can terminate up to 72 connectorized fibers. The shelf has a slide-out panel for easy front access. The shelf is equipped with cable-mounting brackets for outside plant or building cables using 12A-Type Clamps. Up to 12 six-pack connector panels can be mounted on a shelf.
- An LSC2U-024/5 Combination Shelf can be used for splicing or terminating buffered building cables or for up to four outside plant cables using 12A-Type Clamps. The shelf can accommodate up to 24 fibers and accepts one LT1A-Type splice organizer and up to four 6-pack connector panels.
- An LSS1U-216/5 Splice Shelf can splice up to 18 ribbon-to-ribbon array/splice connectors. The shelf is equipped with 2-cable clamp brackets that can accommodate up to four outside plant cables with 12A-Type Clamps.
- An LSS1U-144-7 Splice Shelf can splice up to 144 fibers. The shelf is equipped with cable-clamp brackets for up to four outside plant cables with 12A-Type Clamps that can accommodate up to six LT1A-Type splice organizers.
- An LSS1U-072/5 Splice Shelf can splice up to 72 fibers. The shelf is equipped with cable-clamp brackets for up to four outside plant cables with 12A-Type Clamps that can accommodate up to three LT1A-Typ Splice Organizers.

- An LSJ1U-072/5 LG Storage Shelf provides for jumper cable slack storage. The cables can enter from either side, the front, or rear and can be coiled in loops that are stored in the shelf's base.
- An LST1P-48ST/2.5 Termination Shelf contains two pivoting trays that will each accommodate terminations up to 24 fibers using *ST* connectors. Two bend-limiting drums are included with each shelf to prevent bending fibers less than 3 inches (7.62 cm) in diameter.
- Preterminated multimode shelves are available in 36, 72, and 144 fibers. The LST1Us are pre-loaded with *ESCON* duplex to *ST* couplings and include 6 × 6 coupling panels that accept up to 36 *ESCON* couplings each. A kit is also available with each shelf option. The kit consists of two preterminated LST1U shelves; however, one shelf does not have the *ST* connectors plugged into the back of the panel. The configuration avoids having to pull the shelf in addition to the cable during installation. All shelves are ordered using "equipped with" ___ feet of fiber and include the comcode for the cable type desired. The fiber cable can be either *Accumax* Building Cable, Fiber Optic Building Cable, or 3FLX *AccuRibbon* Riser Cable.

Subsystem: Administration, Equipment

Physical Specifications:

Height: 7 ft (2.13 m), 9 ft (2.74 m), 11.5 ft (3.50 m)
Width: 26 in. (66 cm)
Depth: 12 in. (30 cm)

The following table shows the product number and ordering comcodes for some of the *LGX* components.

LGX COMPONENTS			
Product Number	**Description**	**Height**	**Comcode**
ED6C321-50 G1	*LGX* Frame	7 ft (2.13 m)	N/A
ED8C501-50 G1* ED8C501-50 G2 ED8C501-50 G3	Network Bay Frame	7 ft (2.13 m) 9 ft (2.74 m) 11.5 ft (3.50 m)	601 019 466 601 019 474 601 019 482
ED6C321-50 G2	*LGX* Frame Parts		601 248 354
LST1U-072/7	LG Termination Shelf	7 in. (17.8 cm)	105 335 871
LPS1-L-BMST-AR-036-07 Kit, *ESCON* Trunk (36)	Preterminated Shelf 2 LPS1-L-BMST-AR-036-07 with one end of *ST* cable unplugged		106 704 455 106 704 448
LPS1-L-BMST-AR-072-07 Kit, *ESCON* Trunk (72)	Preterminated Shelf 2 LPS1-L-BMST-AT-072-07 with one end of *ST* cable unplugged		106 696 156 106 696 164
LPS1-L-BMST-AR-144-21 Kit, *ESCON* Trunk (144)	Preterminated Shelf 2 LPS1-L-BMST-AT-144-07 with one end of *ST* cable unplugged		106 696 149 106 696 172
LST1F-072/7	LG Front-Access Termination Shelf	7 in. (17.8 cm)	106 191 695
LSC2U-024/5	LG Combination Shelf	5 in. (12.7 cm)	106 455 355
LSS1U-216/5	LG Splice Shelf	5 in. (12.7 cm)	105 361 448
LSS1U-144/7	LG Splice Shelf	7 in. (17.78 cm)	105 335 772
LSS1U-072/5	LG Splice Shelf	5 in. (12.7 cm)	105 335 806
LSJ1U-072/5	LG Storage Shelf	5 in. (12.7 cm)	105 335 780
LST1LP-48ST/2.5	Shelf, 48 *ST* Termination	2.5 in. (6.35 cm)	106 587 710
* Provided as part of ED-6C321-50 G1 above.			

Listed in the table below are some associated components for the *LGX* Fiber Optic Distribution Frame.

ASSOCIATED COMPONENTS FOR *LGX* FIBER OPTIC DISTRIBUTION FRAME	
Description	**Comcode**
Connector Panels 1000 *ST* Connector Panel (Retains 6 Threaded *ST* Couplings In-Line), 1 Each	105 392 005
1000 *ST* Connector Panel (Retains 6 Threaded *ST* Couplings In-Line), Pkg. of 12	105 428 486
1000ST1-8 *LGX* Panel (Retains 8 *ST* Couplings)	107 026 130
1000SC1-8 *LGX* Panel (Retains 8 SC Simplex Couplings)	106 907 981
1000SC1 Panel (Retains 6 Simplex SC Couplings), 1 Each	106 372 121
1000BK Panel (Blank Panel for *LGX* Shelf)	106 924 483
FDDI Bulkhead Connector Panel (Retains 36 FDDI Couplings), 1 Each	106 021 488
2000 FDDI Connector Panel (Retains 6 FDDI Couplings)	106 372 147
ESCON Bulkhead Connector Panel F89AK8522 (Retains 36 *ESCON* Couplings in 6 x 6 pattern), 1 Each	105 730 717
36BM1 *ESCON* Panel (Retains 36 *ESCON* Couplings in staggered 5 and 4 patterns), 1 Each	106 483 969
2000BM1 *ESCON* (Retains 6 *ESCON* Couplings), 1 Each	106 474 471
Fanouts 3B/*ST* Fanout Module (62.5/125 µm Equipped with *ST* II Connector)	845 770 585
10B1/48/24 LG Fanout (62.5/125 µm Equipped with *ST* II Connector)	104 325 089

ASSOCIATED COMPONENTS FOR *LGX* FIBER OPTIC DISTRIBUTION FRAME (Contd)	
Description	**Comcode**
Splice Organizers LT1A-M/M Splice Organizer for Mechanical Splices	105 339 907
LT1A-F/F Splice Organizer for Fusion Splices	105 339 899
Grounding, Blocking, Buffering 12A1 Cable Clamp	104 384 490
12A2 Cable Clamp	106 230 337
D-181268 Blocking Kit for Ribbon Cable	104 223 060
D-181781 Blocking Kit for *Lightpack* Cable (Unit Splitter [6])	105 342 463
D-181683 Blocking Kit for *Lightpack* Cable (8-Finger Unit Splitter)	105 277 792
D-181755 Buffer Kit for Direct Termination	105 317 549
D-182663 Unit Splitter	106 847 25
D-181348 Unit Splitter	104 225 196
Miscellaneous 11A Door (7-in. High Metal Front Door and a Pair of Brackets)	104 436 878
145A Bracket (Pair of Brackets for Locking 5-in. High Doors and 7-in. Splice Doors)	104 436 852
JR2A Jumper Retainers	104 436 092
11A Labels for *LGX* Jumper Retainers	104 436 084
100CCL Color Code Labels	106 971 542
FDA *LGX*-1 FDDI Admin Label AA for FDDI Connector Panels (Note 1)	106 458 961
FDB *LGX*-1 FDDI Admin Label BB for FDDI Connector Panels (Note 2)	106 458 979
FSA *LGX*-1 FDDI Admin Label AA for 1000 *ST* Connector Panels (Note 1)	106 467 103
FSB *LGX*-1 FDDI Admin Label BB for 1000 *ST* Connector Panels (Note 2)	106 467 111

Notes:

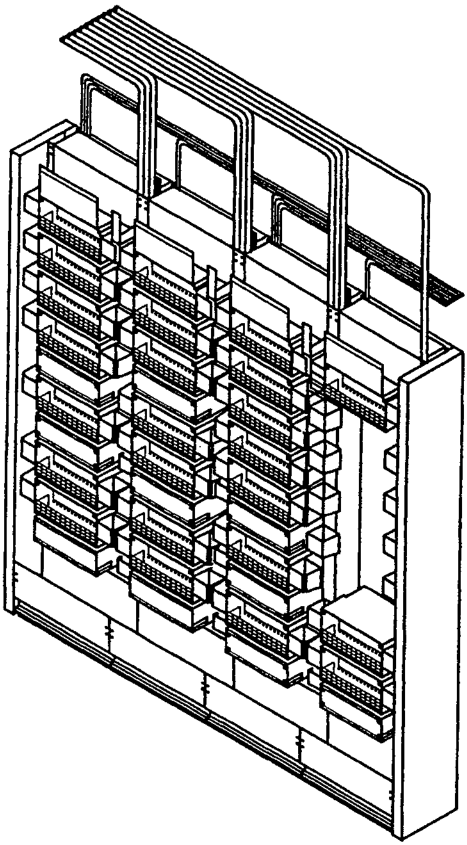
1. Administration label for use on *LGX* equipment that defines the FDDI dual-ring signal assignments listed below for the first four color-coded fibers in a building cable:

   Fiber 1 (blue) — secondary input
   Fiber 2 (orange) — primary output
   Fiber 3 (green) — primary input
   Fiber 4 (brown) — secondary output

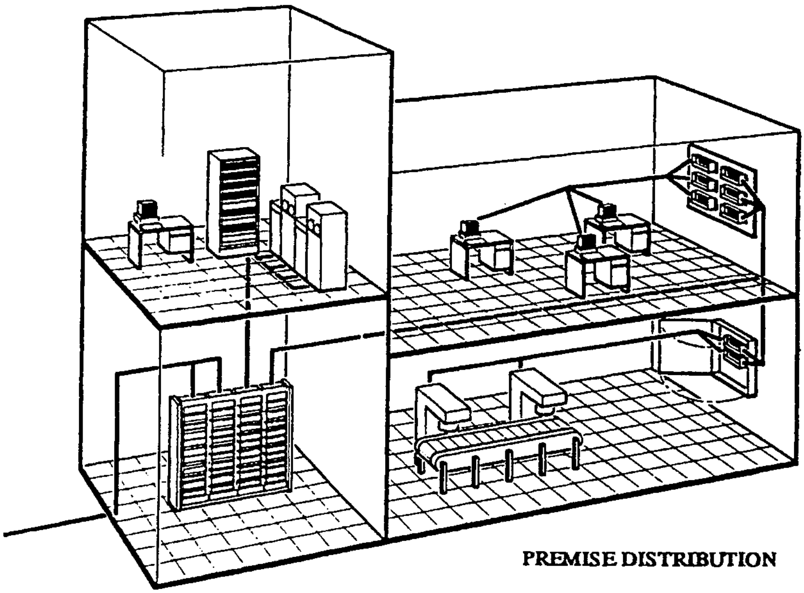
2. Administration label for use on *LGX* equipment that defines the FDDI dual-ring signal assignments listed below for the first four color-coded fibers in a building cable:

   Fiber 1 (blue) — secondary output
   Fiber 2 (orange) — primary input
   Fiber 3 (green) — primary output
   Fiber 4 (brown) — secondary input

Shown below is a typical *LGX* frame installation.



Four *LGX* Distributing Frames



LGX System Local Network Applications

FIBER OPTIC PREMISES DISTRIBUTION APPARATUS

Universal Fiber Optic Closure (UCB)

Fiber Optic Products Catalog No. 2492C, *SYSTIMAX* Structured Cabling Systems No. 3726C

The UCB1, UCB2, and UCB3 closures are sealed aluminum housings for joining and splicing fiber optic cables. They will accommodate up to four cables (two at each end) and up to 24 mechanical, 24 fusion, or any combination of mechanical and fusion splices that total 24 splices per tray. The closures will handle up to eight splice organizers for a total of 192 mechanical or fusion splices. These closures are used for splicing fiber optic cable in all applications of aerial, buried, underground, and building cables. However, when used in a corrosive environment, such as buried or underground, the closure is protected by installing it in a 51D3 outer closure.

The Extended UCB1 12-Organizer Closure Cover allows installation of up to 12 splice storage leaves (216 single-fiber mechanical splices or 288 single-fiber fusion splices). Note that the completed UCB1 closure with the optional 12-organizer cover cannot be housed in either standard outer closure.

Grommet and grip kits and fiber optic organizers must be ordered separately. One kit is required for each splice location.

Subsystem: Campus Backbone

Physical Specifications for UCB1 only:
Length: 22.5 in. (57.1 cm)
Width: 5.5 in. (13.97 cm)
Height: 5.0 in. (12.7 cm)

UCB CLOSURES		
Product Number	Description	Comcode
UCB1	UCB1 Closure	103 921 946
UCB2	UCB2 Closure	106 896 699
UCB3	UCB3 Closure	—
51D3-LG2	Outer Cover	103 921 938
—	Gasket	845 628 775

51D3-LG2 Fiber Optic Closure

The 51D3-LG2 Fiber Optic Closure is a protective cover used to safeguard the UCB Closures in buried and corrosive aerial environments.

The 51D3-LG2 Closure can be buried directly in the ground. (See description under "UCB Closure.") The 51D3-LG2 Closure is a fiberglass-reinforced, bolted, polypropylene enclosure. The complete closure includes an instruction sheet, a liner, a funnel, two blank grommets, two brackets, two cable ties, two foam tapes, B sealant, two stoppers, and a 42-inch (106.7 cm) long galvanized bar. To complete the protection of the inner closure, the 51D3-LG2 Closure should be filled with the proper encapsulant.

Subsystem: Campus Backbone

Physical Specifications:
Length: 28.0 in. (71 cm)
Inside Diameter: 7.0 in. (18 cm)

51D3-LG2 FIBER OPTIC CLOSURE		
Product Number	**Description**	**Comcode**
51D3-LG2	Closure	103 921 938
D-182121	Reentry Kit	104 228 424
54A	Hanger	103 118 865
UC-41	Grommet Kit for Cables with Outside Diameter (OD) 0.41 in. (1.04 cm)	104 145 560
UC-48	Grommet for Cables with OD 0.48 in. to 0.50 in. (1.22 cm to 1.27 cm)	104 145 537
UC-55	Grommet for Cables with OD 0.55 in. to 0.58 in. (1.40 cm to 1.47 cm)	104 146 576
UC-59	Grommet for Cables with OD 0.59 in. (1.50 cm)	105 348 080
UC-65	Grommet for Cables with OD 0.65 in. (1.65 cm)	104 145 545
UC-75	Grommet for Cables with OD 0.75 in. (1.91 cm)	104 145 552
UC-98	Grommet for Cables with OD 0.98 in. (2.49 cm)	104 146 618
UC-23/23/23	Grommet for Three Fiber Drop Dielectric Cables 0.23 in. (0.584 cm)	105 534 242
UC-32/32	Grommet for Two Fiber Drop Metallic Cables 0.32 in. (0.813 cm)	105 534 267
UX-41/41	Grommet for Two Cables with OD 0.40 in. to 0.42 in. (1.02 cm to 1.07 cm)	105 150 270
UC-48/41	Grommet for One Cable with OD 0.41 in. (1.04 cm) and one 0.48 in. to 0.50 in. (1.22 cm to 1.27 cm)	105 150 296

PAIR GAIN SYSTEMS HOUSINGS

90A and 90B Business Remote Terminal (BRT) Cabinets

The 90A and 90B Business Remote Terminal (BRT) cabinets are designed to provide an attractive and secure housing at business customer locations for equipment such as the *SLC* Series 5 Carrier Systems, DDM-1000 and DDM-2000 Multiplexers, and DDM-Plus or DS1 Extension Shelves. The cabinets can accommodate the associated apparatus including a power shelf, fan unit, and battery shelves. The DDM-2000 Multiplexer offers greater networking capabilities for the 90A and 90B cabinets. These include the ability to perform OC-3 fiber hubbing and add/drop, which allows a self-healing ring architecture to be implemented. Both of these offer users increased reliability and flexibility.

The 90A and 90B cabinets are both fully factory-assembled and tested to provide the same high quality established by the 80-type cabinet product line. The standard 90A cabinet arrangements are UL listed per UL1459 (2nd edition) as well as Electric Magnetic Compatibility (EMC) verified.

90A Business Remote Terminal

This cabinet provides the customer with the ability to quickly provision a mix of services such as plain old telephone service (POTS), special services, integrated services digital network (ISDN), and high capacity services such as DS1 and DS3. Electrical and optical extensions can also be provided using the DDM-Plus.

The cabinet can be equipped with up to two *SLC* Series 5 dual channel banks or with a DDM-1000 or DDM-2000 multiplexer and a *SLC* Series 5 dual channel bank plus optional DS1 extension shelves.

The front and rear door handles contain key locks for added security, and the cabinet side panels are removable to facilitate equipment additions and replacements.

Dimensions:

28.25 in. (718 mm) wide
73.5 in. (1867 mm) high
29.5 in. (749 mm) deep

90B Business Remote Terminal

Cabinet configurations are designed to be quickly installed and to support the rapid provisioning of DS1 and DS3 services. Business locations with initial needs for one or several DS1 signals can be economically served over fiber with the 90B cabinet equipped with the DDM-Plus. In addition, DS1 facilities can be optically or electrically extended with a DDM-Plus to upper floors or remote corners of a building where service is needed.

The cabinet can be equipped with a DDM-2000 Multiplexer and up to two DDM-Plus Extension Shelves or two DS1 Extension Shelves. The 90B cabinet equipped with a DDM-2000 or DDM-Plus can achieve increased network reliability with diverse routing. Since the DDM-2000 is Synchronous Optical NETwork (SONET) Phase II compatible, it provides increased bandwidth and improved operations.

The cabinet will fit virtually any office with no special thermal, electrical, or physical requirements. It is available with optional casters (permitting portability) or earthquake bracing (ensuring continued service during moderate to severe tremors). Key locks are provided in both the front and rear door handles for security. The side panels are removable to facilitate equipment additions or replacements.

Dimensions:

28.25 in. (718 mm) wide
48 in. (1219 mm) high (including castors)
29.5 in. (749 mm) deep

BIBLIOGRAPHY

AT&T	Title
461-115-002	Wire Installation Manual — *SYSTIMAX*® PDS
461-115-004	Fiber Installation Manual — *SYSTIMAX*® PDS
461-200-100	Inside Wire and Cable — Selection
461-604-102	Connecting Blocks — 66A-, B-, C-, and M1-Types
461-604-106	700 Series — Interface Facilities — Jack
462-265-201	Wiring at Main Building Terminals Using Quick-Connect Hardware
462-265-211	Wiring Building Riser and Distribution Terminals
620-100-011	Fire Safety Consideration Cable in Buildings
626-108-003	Fiber Optic Premises Cable Specification
626-108-103	*Lightpack*® Fiber Optic Cables
627-610-225	Placing Metallic and Fiber Optic Riser and Building Cable
627-610-230	Placing Fiber Optic Cable in Risers, Conduit, and Plenums
631-005-100	Terminating Facilities — Exchange Cable
631-050-108	66-Type Connecting Block — Description and Use
631-050-110	5A-Type Connecting Block — Description and Use
631-400-101	Building Terminals — Mechanical Protection
631-400-102	Cable and Terminal Grounding — Subscriber Buildings
631-400-105	B Cable Terminal Frame AT-8640
631-400-110	110 Patch Panel System
631-400-111	110 Product Application Guide
631-440-211	Terminal Blocks — Building Terminals

AT&T	Title
631-460-113	188-Type Protectors — Description and Use
631-460-114	189-Type Protectors — Description and Use
631-460-115	190-Type Protectors — Description and Use
631-460-116	189P-Type Protectors — Description and Use
631-460-117	189M-Type Protectors — Description and Use
631-460-118	195-Type Protectors — Description and Use
631-460-119	199E6A-Type Protectors — Description and Use
631-460-122	1500-Type Building Entrance Cable Terminal
631-460-125	1990-Type Protectors — Description and Use
631-460-201	Building Terminals — Main Terminals Using 66-Type Quick-Connect Hardware
631-460-205	110-Type Connecting Blocks — Description and Installation
631-470-201	Building Terminals — Riser and Distribution
633-501-101	Universal Fiber Optic Closure (UCB1)
636-299-102	*LGX*® (Fiber Optic Cross-Connect) Frame
636-299-103	Fiber Optic Distributing Shelves
636-299-104	*LGX*® Fiber Optic Distributing Frame
917-454-100	Building Cable — General Considerations of Building Cable Systems
917-454-100	Appendix A — Building Classifications and Typical Customer Requirements
917-454-100	Appendix B — Performance Specifications
917-454-200	Building Cable and Housing — Housing Systems
917-454-300	Building Cable — Design Illustrations
917-454-400	Building Cable — Design Data

Other Documents

AT&T	Title
555-400-601	Requirements Survey
555-400-603	Components Guidelines for Premises Distribution Systems
555-401-100	Premises Distribution Systems Administration Manual
555-401-101	Installing Wire for Premises Distribution Systems
555-401-102	Installing Fiber for Premises Distribution Systems
636-299-120	*LGX*® Distribution Systems Planning, Engineering, Installation, and Operation Reference Guide
2268C	Outside Plant Systems
2218B	Premises Distribution Components
3726C	*SYSTIMAX*® Structured Cabling Systems (SCS) Product Guide
700-020	Equipment and Supplies Catalog

Section 13

Contents

Section 13

DIGITAL LOOP CARRIER SYSTEMS

GENERAL

The increasing demand for an assortment of special services has made it necessary to condition the local loop network to support these services. It must be able to accommodate a wide range of transmission applications including voice, data, video, sensor control, and many others. Some of these services require high rates of transmission. Existing copper facilities can support some of the services. However, in many cases, expensive reconditioning of the cable plant will be necessary before service can be provided. The goal is to have the entire local loop network ultimately capable of supporting a transmission rate of 64 kb/sec. Nonloaded 26-gauge cable is capable of providing this bit rate within 12,000 feet (3657.6 m) of the serving central office. Digital subscriber carrier (pair gain) is necessary to meet that bit rate beyond 12,000 feet (3657.6 m).

Carrier Serving Area (CSA) Philosophy

The Carrier Serving Area (CSA) concept is to sectionalize the wire center area into discrete geographical areas beyond 12,000 feet (3657.6 m) of the central office. This sectionalization is done during the long-range outside plant planning (LROPP) process described in Section 2 of this handbook. Each CSA will ultimately be served via a remote terminal (RT) which houses the digital carrier equipment and divides the feeder from the distribution network. The boundaries of the CSA are based on resistance limits of 900 ohms for the distribution plant beyond the RT. These limits basically equate to 9,000 feet (2743.2 m) of 26-gauge cable and 12,000 feet (3657.6 m) of 19-, 22-, or 24-gauge cable including bridged tap. After the CSAs are established, when relief is required in a route and it is economical to deploy digital carrier, the RT sites can be activated. Digital carrier is also applicable to individual customer buildings or groups of buildings such as a campus environment, industrial areas, shopping centers, and condominium and apartment complexes.

Digital loop carrier requires multiplexing at the central office (CO) and remote terminal (RT). The transmission media between the CO and the RT may be either copper cable T1 lines or fiber optic cable. T1 lines can accommodate transmission rates up to 1.544 Mb/sec. When higher rates are required, a wideband facility such as lightwave or digital radio must be employed.

Central Office Terminal (COT)

A central office terminal is required to care for the multiplexing at the CO except for integrated *SLC*® 96 and integrated *SLC* Series 5. In those systems, a direct digital interface is made into the 5ESS® switch without requiring a COT.

Remote Terminals (RT)

Remote terminals are associated with an interface to separate the feeder and distribution network. The interface can be either housed in the same enclosure as the carrier equipment or externally, depending on the hardware used. The RT must be housed in a weather-resistant facility. Present facilities include cabinets, huts, buildings, electronic equipment enclosures (EEEs), or controlled environment vaults (CEVs).

Individual Loop Carrier Systems

Present loop carrier systems include the following:

Digital Systems

- *SLC*-2000 Access System
- *SLC*-2000 Multi-Services Distant Terminal
- Universal *SLC* Series 5 Carrier System
- Integrated *SLC* Series 5 Carrier System

- Integrated Network Access — RT (INA-RT)
- Universal *SLC* 96 Carrier System
- Integrated *SLC* 96 Carrier System
- *SLC* 120 and 240 Network Access System
- OPTIMUX Integrated Optical Line and Multiplex System

Analog Systems

- *SLC* 1.

SLC-2000 ACCESS SYSTEM

AT&T 363-208-000, -001, -003

The *SLC*-2000 Access System is AT&T's newest digital loop carrier (DLC) system. It builds upon many of the administrative and operational features of the industry standard *SLC* Series 5 Carrier System and the *SLC* 96 Carrier System. This service-ready platform provides for cost-effective deployment options and full service capability based on standard interfaces, network element commonality, and operational ease. It is compatible with existing *SLC* Series 5 Carrier System channel units (CUs) which preserves the value of the existing investment. A full array of services is supported by the *SLC*-2000 Access System. A brief description of the type of services supported is given below.

Full Service Platform

The *SLC*-2000 Access System is a modular-based system providing a full telephone service platform. It serves as one of the fundamental elements for establishing a cost-effective and service-ready infrastructure.

a. **Switched Services** — A new family of channel units, *SLCPAQ*™, is being developed for the *SLC*-2000 Access System. The services provided by these new channel units are described on the next page.

- **POTS** — This and other locally switched services are provided by *SPQ*® 400 POTS, *SPQ* 440, and *SPQ* 450 *SPOTS*® quad channel units. They are also supported by existing *SLC* Series 5 Carrier System CUs (for example, POTS, *SPOTS* CU, coin, multiparty, frequency selective ringing [FSR], etc.).
- **ISDN Basic Rate Access** — This system transports ISDN basic rate access services to remote customers of the ISDN switch. This service is provided by basic rate interface transmission extension (BRITE) channel units, which are used in the RT or Multi-Services Distant Terminal.

b. **Special Services** — Nonlocally switched and nonswitched special services (digital data services provided by DDS, 2- and 4-wire foreign exchange [FX] line/trunk, private line voice/data, 4-wire private branch exchange [PBX] tie trunk, etc.) are supported using existing *SLC* Series 5 channel units.

c. **High-Speed Services** — This system provides high-speed DS1 service at the DSX-1 level. One DS3 service or up to 28 DS1 services are supported directly from the system without using an external multiplexer. These DS1 pipes can be used in a variety of applications such as DS1 service and ISDN primary rate access service.

Integrated SONET Multiplexer and Networking

a. **Integrated SONET* Multiplexer** — This system supports an integrated Phase 2 SONET OC-3 interface, which can be upgraded through software to Phase 3 SONET. This capability allows a variety of advanced SONET-based applications to be supported such as point-to-point, taper, linear drop, and ring topologies without using an external SONET multiplexer. All of these SONET-based applications are achieved within a single common system.

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* Synchronous Optical NETwork

b. **Flexible Network Applications** — The *SLC*-2000 Access System supports a direct SONET OC-3 interface. An optional upgrade to optical carrier level 12 (OC-12) feeder is possible with an external DDM-2000 OC-12 shelf. Point-to-point, hub, taper, and ring applications are supported.

Flexible Central Office Interfaces

The *SLC*-2000 Access System currently supports universal *SLC* 96 Carrier System COTs and integrated TR-08 digital switch interfaces such as the *5ESS* switch and *DMS 100* * switch. In a *5ESS* switch office, both TR-08 interfaces to the digital carrier line unit (DCLU) and integrated digital carrier unit (IDCU) are supported.

a. **Bandwidth Management** — This system supports DS0 TR-08 Mode 2 traffic concentration in an RT. Virtual remote terminals (VRTs) are separate logical or software-defined RTs based on a physical 768-line RT. The *SLC*-2000 Access System supports VRT capability for TR-08 operation (limits RT line size to 96 lines).

Flexible Metallic and FITL Distribution Options

a. **Modular Architecture** — The *SLC*-2000 Access System architecture is highly modular, which allows economical start-up and growth configurations, thus minimizing the initial system cost. The *SLC*-2000 Access System supports up to four metallic distribution shelf (MDS) assemblies and one or two high-density optics shelves (HDOS) (one HDOS per two MDS assemblies) within a single system, which allows up to 768 lines and 28 DS1 pipes in the maximum configuration. A flexible slot architecture (any service/any physical slot) is supported, avoiding RT channel unit slot equipment restrictions for various services.

* Trademark of Northern Telcom, LTD.

b. **SONET-Only Multiplexer** — This system can be configured with no metallic distribution shelf assemblies. In this configuration, up to 28 DS1 pipes can be supported. Metallic distribution shelf assemblies can be added when DS0 based services such as POTS, ISDN BRI, and special services are required.

c. **Fiber in the Loop (FITL)** — The *SLC*-2000 Access System supports a point-to-point FITL architecture. When configured for FITL, the *SLC*-2000 RT serves as the ***host digital terminal*** (HDT) and is connected to *SLC*-2000 ***Multi-Services Distant Terminals*** (MSDTs), which serve as the ***optical network units*** (ONUs), using single-mode fiber links. The *SLC*-2000 FITL feature supports all telephony services to subscribers that are available with metallic distribution, including special services. The *SLC*-2000 MSDT is compatible with existing *SLC* Series 5 CUs, as well as the new *SLC*-2000 Access System quad POTS and POTS/*SPOTS* channel units. The FITL feature can also be combined with broadband services such as cable television (CATV).

d. **Optical and Metallic DS1 Extensions** — This system supports both metallic and optical DS1 extensions using the DDM-Plus System. For metallic applications, the DDM-Plus System can be used as a repeater shelf to support T1 extensions. The DDM-Plus System is ideal for delivery of T1 pipe services over fiber in the riser in customer premises applications, or over fiber distribution facilities from an outside plant cabinet or controlled environment vault (CEV).

Operations, Administration, Maintenance, and Provisioning (OAM&P)

a. **Local, Remote, and Centralized OAM&P Capabilities** — The *SLC*-2000 Access System, Release 2.0, supports local OAM&P capabilities, allowing craft personnel to perform tests at the RT site. Remote access to OAM&P capability is available for the SONET portion of the *SLC*-2000 Access System in Release 2.0 and for the full configuration in Release 3.0. Remote access allows craft personnel located at an RT or central office (CO) site to log into other *SLC*-2000 Access Systems on a subnetwork. Centralized access allows craft personnel located in an operations work center to access *SLC*-2000 Access Systems at different RT or CO sites.

b. **Multilevel Craft Interface** — The craft interface architecture has multiple levels of system information and controls. Level 1 consists of the user interface panel, faceplate LEDs, displays, and pushbuttons that allow craft personnel to perform most routine tasks without a craft interface terminal (CIT). Level 2 allows craft personnel to access the *SLC*-2000 Access System locally with a CIT (for example, within the RT site). Level 3 (SONET subsystem only) allows craft personnel to perform all level 2 functions remotely from a CO, RT, or from one centralized location (work center).

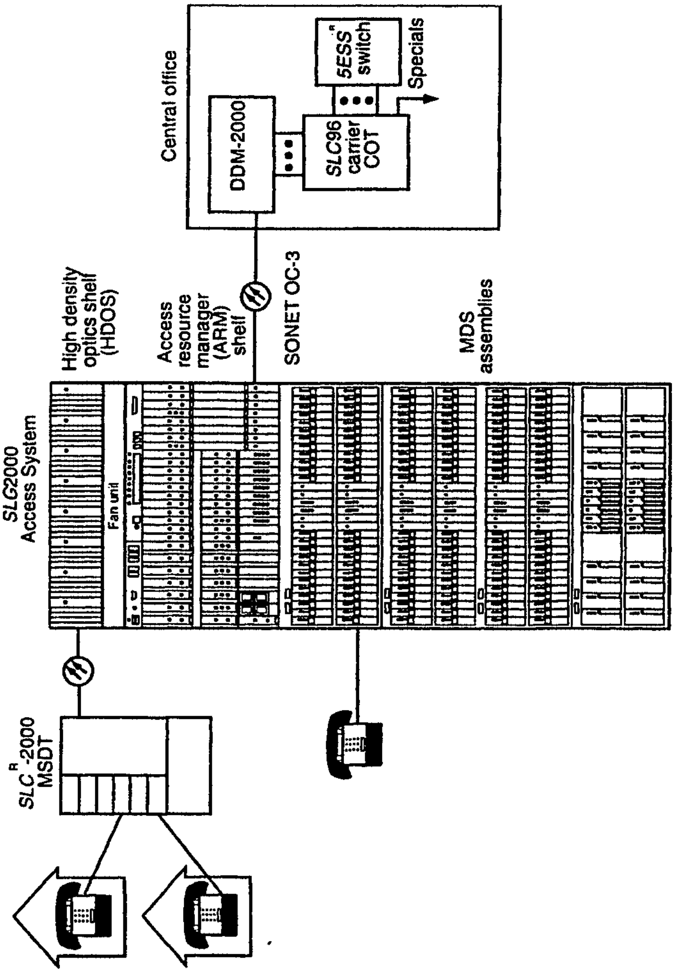
c. **User Interface Panel (UIP)** — The user interface panel (UIP) serves as the primary point for local maintenance activities and alarm summary information. The UIP provides an array of test access jacks, a number of light-emitting diode (LED) summary indicators, and a 24-character alphanumeric display that craft personnel may use for simple OAM&P activities.

d. **Craft Interface Terminal (CIT)** — To support more complex applications and maintenance, a craft interface terminal may be connected to a port on the UIP. The CIT is either an ASCII terminal or a PC running software that emulates an ASCII terminal. Menu-driven and prompt command modes are available as well as extensive help features.

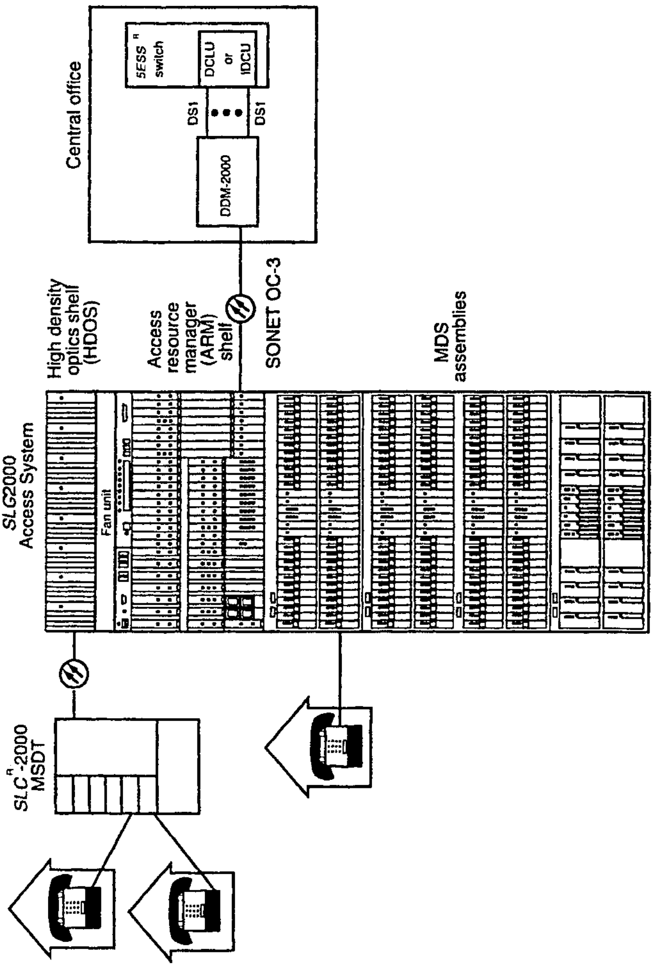
e. **Integral Test Head (ITH)** — The *SLC*-2000 Access System supports an ITH capability that eliminates the need for an external remote test unit (RTU) and metallic bypass pair.

f. **Automatic Maintenance Features** — The *SLC*-2000 continuously monitors transmission parameters and provides 1:1 high-speed (optical path, multiplexer card, synchronization/TSI core) protection and 1:7 VT1.5 and DS1 low-speed card protection.

g. **Analog Line to Integrated *SLC* Carrier at *5ESS* Switch Cut (ALIC5)** — The *SLC*-2000 Access System allows in-service transfer of circuits on a 1A *ESS*™ analog switch to an integrated DLC system on a *5ESS* switch.



SLC®-2000 Access System Universal Configuration



SLC® -2000 Integrated Configuration (Mixed Metallic and Fiber Distribution)

Remote Terminal Cabinet Arrangements

The *SLC*-2000 Access System is very compact in size and allows for flexible and economical arrangements in a variety of enclosures. The system provides twice the line density of the *SLC* Series 5 Carrier System when it is equipped with quad channel units. Configurations for serving metallic, Fiber in the Loop, and T1 or optical extensions using DDM-Plus are available with bulk powering.

The *SLC*-2000 Access System can be mounted in the 80A-type and 80D-type cabinets. Both types of cabinets look similar except the 80A-type is approximately two-thirds the size of the 80D-type. This system can also be mounted in a 7-foot (2134 mm) bay arrangement. The physical dimensions of the cabinets are shown below.

CABINET DIMENSIONS			
Cabinet	**Height in. (mm)**	**Width in. (mm)**	**Depth in. (mm)**
80A-Type	66 (1676)	52 (1321)	36 (914)
80D-Type	69 (1753)	90 (2286)	39 (991)

The cabinet line sizes are listed in the table on the next page.

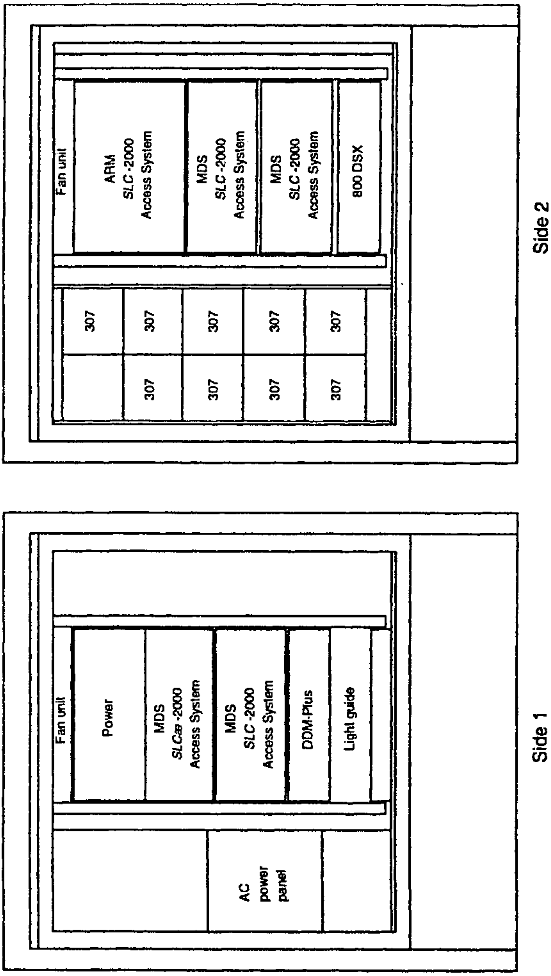
CABINET LINE SIZES		
Cabinet Type	**Combined *SLC*-2000/ *SLC* Series 5 Carrier System (Lines/DS1 Pipes) (Notes 1-3)**	***SLC* Series 5 Access System (Lines/DS1 Pipes) (Notes 1 and 4)**
80A-BP	576/20	768/28
80A-HX		768/28
80D-BP	1344/4	1536/56
80D-HX		1536/28

Notes:

1. Equipped with integrated SONET OC-3 interface.
2. This comparison assumes SONET OC-3 point-to-point topologies and variable concentration ratios.
3. The DS1 pipes from the ARM shelf assembly are used to feed the *SLC* Series 5 Carrier Systems.
4. Each ARM shelf assembly can support up to 28 DS1 pipes.

80A-Type Cabinet

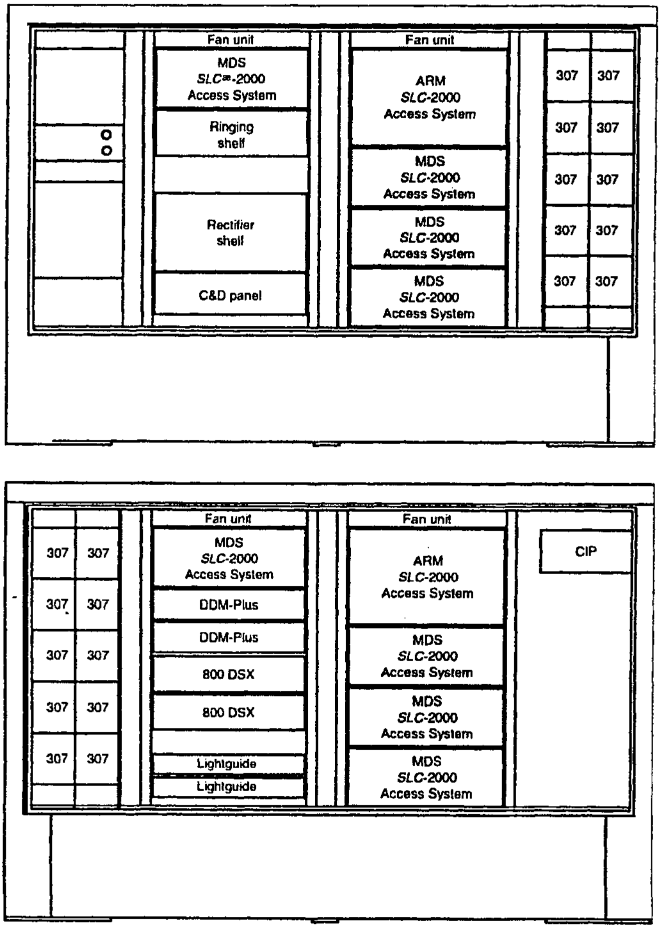
The 80A-type cabinet has bulk power (BP) and /or a center-mounted heat exchanger (HX), a separate battery compartment, a cooling system, and shelf space for the access system equipment. The cabinet provides a large splicing chamber 40 inches (1016 mm) high, 20 inches (508 mm) wide, and 11 inches (279 mm) deep with side access. Fiber optic cables are terminated in the cabinet using a fiber splice shelf. The 80A-type cabinet uses 30-amp, 120/240 single-phase AC power service. This cabinet houses the reserve power supply batteries in a skirt below the main electronics section. Depending on the way the cabinet is equipped, the batteries provide from 8 to 15 hours of reserve time using 118 ampere-hour strings. An 80A-HX cabinet configuration is shown on the next page.



80A-HX Cabinet Configuration

80D-Type Cabinet

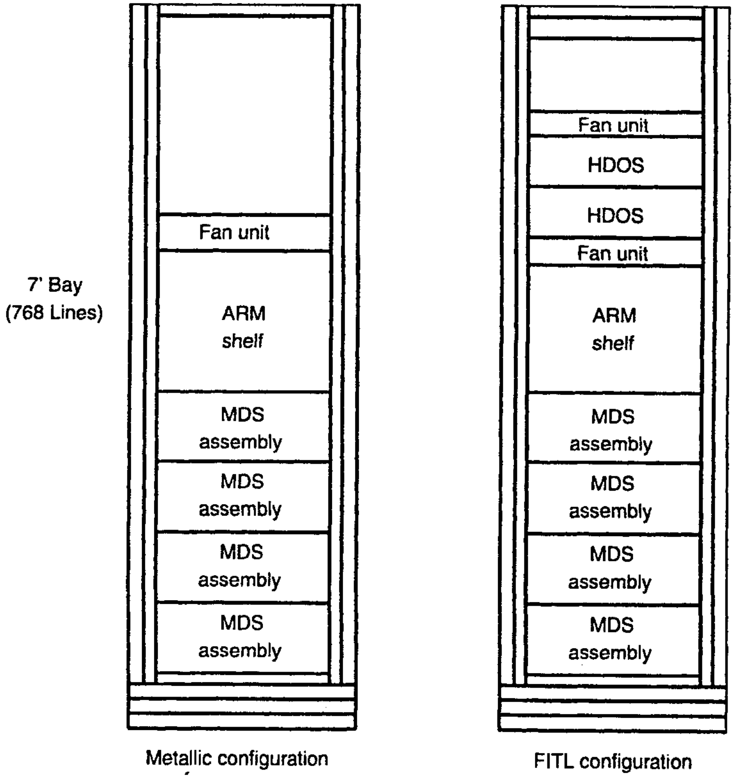
The 80D-type cabinet looks very similar to the 80A-type cabinet, but it is approximately two-thirds larger. This cabinet has bulk power (BP) and /or a heat exchanger (HX), a separate battery compartment, a cooling system, and shelf space for the access system equipment. The cabinet provides a large splicing chamber with side access and also supports a high-density fiber termination shelf. The 80D-type cabinet uses 120/240 single-phase AC power service. This cabinet houses the reserve power supply batteries (up to three strings) in a skirt below the main electronics section. The batteries provide a minimum of 8 hours of reserve time for fully equipped cabinets. An 80D-HX cabinet configuration is shown on the next page.



80D-HX Cabinet Configuration

7-Foot (2134 mm) Remote Terminal (RT) Bay

The *SLC*-2000 Access System can be mounted on a 7-foot (2134 mm) remote terminal (RT) bay. The figure below shows two 7-foot (2134 mm) bay arrangements (one with metallic distribution and the other with FITL distribution). Both arrangements can be equipped with a single ARM shelf, up to four MDS assemblies, and one or two fan shelf assemblies. The total number of lines supported is 768.



7-Foot Remote Terminal (RT) Bay

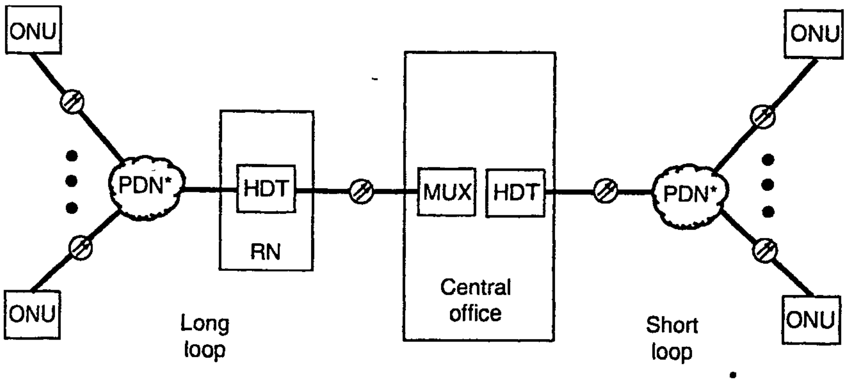
SLC-2000 MULTI-SERVICES DISTANT TERMINAL (MSDT) FEATURE

Fiber in the Loop (FITL)

AT&T 363-205-003, -004

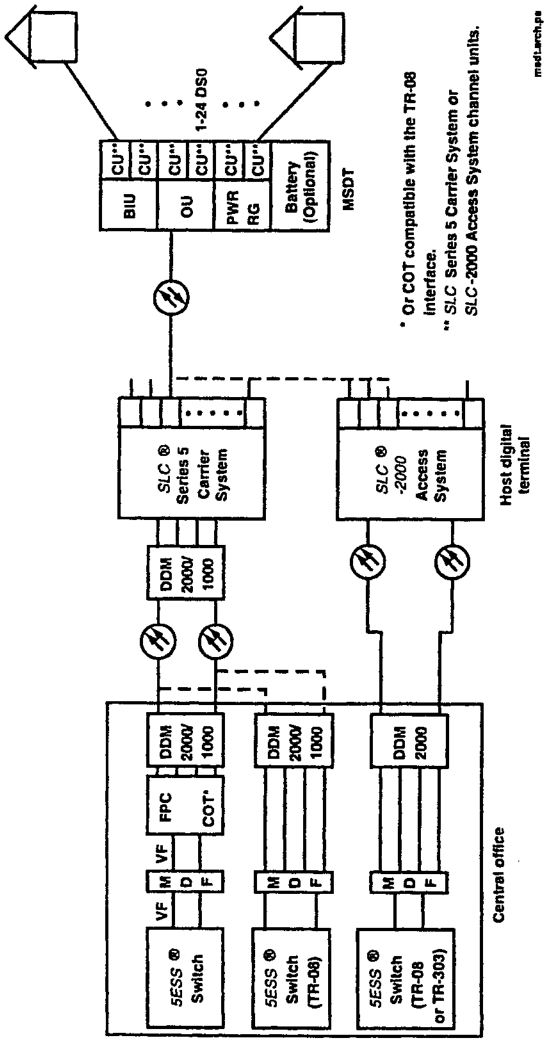
The *SLC*-2000 MSDT feature enables the cost-efficient delivery of telephony, data, and video services to subscribers over a wide range of applications. The *SLC*-2000 MSDT is a flexible distribution terminal that is designed to support both fiber in the loop (FITL) and small line size Digital Loop Carrier configurations.

Bellcore has defined the elements of a FITL System in TR909, illustrated by the diagram below. Optical network units (ONUs) are generally located to serve multiple subscribers; for example, at curbside in residential applications. These ONUs connect a host digital terminal (HDT) over a fiber optic link. The HDT then interfaces to the switch. For short loop applications, the HDT may be located in a central office building; for long loops, the HDT may be remotely located in a cabinet, hut, or controlled environment vault (CEV).

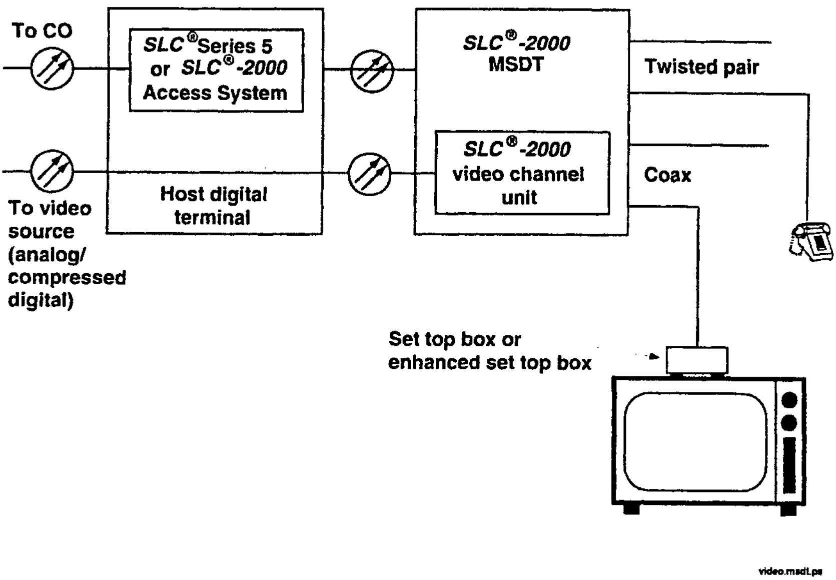


*PDN - Passive Distribution Network

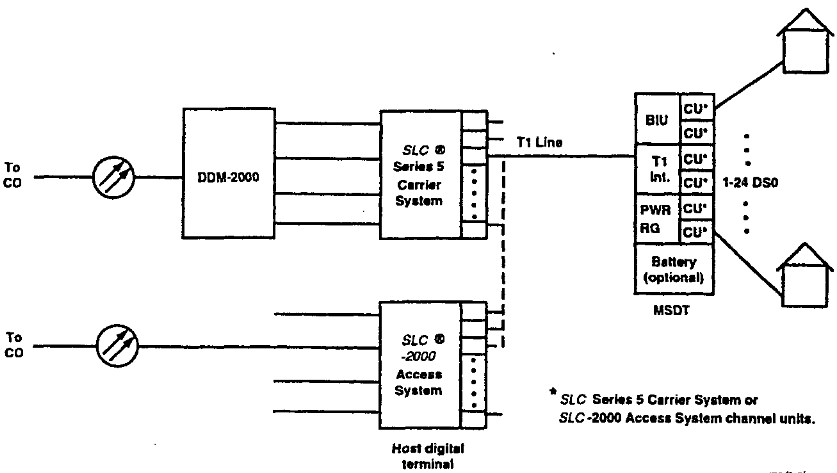
The *SLC*-2000 MSDT is AT&T's ONU product. The HDT may be either a *SLC* Series 5 or a *SLC*-2000 remote terminal. The *SLC*-2000 MSDT feature uses one single-mode fiber along with 1310-nm optical components to provide a bidirectional transmission link between each *SLC*-2000 MSDT and the HDT. Telephone and data distribution from the *SLC*-2000 MSDT to the subscriber is accomplished with standard twisted pair metallic drops. Both the *SLC* Series 5 and *SLC*-2000 remote terminals may be directly integrated into a digital switch using the Bellcore TR08 interface. For other applications, a universal configuration using either a *SLC* Series 5 Feature Package C or a *SLC*-2000 central office terminal is used. The AT&T FITL architecture is shown on the next page.


1-24 DS0
CU**
BIU
OU
PWR RG
Battery (Optional)
MSDT
* Or COT compatible with the TR-08 interface.
** SLC Series 5 Carrier System or SLC-2000 Access System channel units.
msdt.arch.ps
SLC ® Series 5 Carrier System
SLC ® -2000 Access System
Host digital terminal
DDM 2000/ 1000
DDM 2000
FPC COT*
VF
M D F
5ESS ® Switch
5ESS ® Switch (TR-08)
5ESS ® Switch (TR-08 or TR-303)
Central office

The *SLC*-2000 MSDT is a compact distribution terminal that supports the full range of narrowband services including POTS, coin, 2- and 4-wire specials, 56-kb/s data, and Integrated Services Digital Network (ISDN). The *SLC*-2000 MSDT has a channel capacity of 24 DSOs which allows the sharing of electronics over a number of customers to achieve economic deployment in a wide range of applications. The distribution of video services, including Video Dial Tone, may also be accomplished through the *SLC*-2000 MSDT with the installation of the optional *SLC*-2000 Broadband Video Channel Unit. Using a separate fiber from a video head-end, high quality analog and/or digitally compressed video signals are delivered to the *SLC*-2000 MSDT for distribution to subscribers over coax drops. This arrangement is shown below.



Beyond its applicability for conventional FITL, the *SLC*-2000 MSDT may also be deployed as a small Digital Loop Carrier System. In this arrangement, the connection between the *SLC*-2000 MSDT and the HDT may be one bidirectional optical fiber, two single direction optical fibers, a DSX-1 transport system, or a T1 line as shown below. This facility flexibility enables the installation of *SLC*-2000 MSDTs now over existing copper plant and allows a simple future upgrade to fiber when replacement of the copper is warranted. The copper distribution loops can extend to 900 ohms and beyond. The *SLC*-2000 MSDT feature is an extremely effective vehicle for increasing the service capability of the loop network.



Multi-Services Distant Terminal (MSDT) Cabinet

The multi-services distant terminal (MSDT) cabinet is required at the customer end of the fiber in the loop (FITL) network. The MSDT provides optical-to-electrical and electrical-to-optical conversion between the fiber and the customer equipment or service. The MSDT cabinet is the smallest of AT&T's electronics cabinets and can be mounted on a pole, cable strand, stake, pad, or below ground with a handhole. The MSDT cabinet is usually installed close to the customer site. MSDT cabinets may be individually mounted, or a group of them can be installed with service drops extended to the customer location.

SLC SERIES 5 CARRIER SYSTEM

AT&T 363-205-010, 640-250-246, -248, 915-710-115

The *SLC* Series 5 System operates the same as the *SLC* 96 System except it provides twice the number of channels (192) in the same equipment space at the central office terminal (COT) and remote terminal (RT). A Series 5 System requires the same digital transmission facilities between the COT and RT as *SLC* 96 Systems. The transmission facility may be metallic T1 carrier or high-capacity fiber optic cable. However, when fiber optic cable is used, multiplexers such as the DDM-1000 or DDM-2000 are required. The following sections describe the various *SLC* Series 5 configurations available.

Universal Series 5

A Universal Series 5 System is illustrated on Pages 13-25 through 13-27. It consists of a Series 5 COT and RT. The Series 5 System offers different feature packages depending on the types of services to be supported. The feature packages are described on the following pages. Feature packages A, B, and C/D are shown in the illustrations. The universal Series 5 FP-B illustrated on Page 13-27 uses the Series 5 remote terminal connected to an existing *SLC* 96 Carrier System central office terminal (COT). This TR-08 configuration can support both Mode 1 and Mode 2 with or without provisional special service channel units, depending on the choice of common equipment.

Integrated Series 5

This situation is illustrated on Page 13-28. The integrated Series 5 FP-B (TR-08) System provides a direct digital interface with the *5ESS* Switch. The Digital Carrier Line Unit (DCLU) provides the digital line interface at the central office. ***A central office terminal (COT) is not involved.*** Each T1 line terminates in a DCLU on a Subscriber Digital Facility Interface (SDFI). The system requires a DSX-1 cross-connect bay and an office repeater bay (ORB) as illustrated. The ORB provides power to the digital lines. The recently introduced Integrated Digital Carrier Unit (IDCU) may be used to provide the TR-08 interface to the switch also. The IDCU supports both the TR-08 and TR-303 interfaces.

SLC Series 5 — Feature Packages

The *SLC* Series 5 System offers the following feature packages:

Feature Package A (FP-A) — Single-Party Telephone Service, locally-switched services, and simple special services as shown below:

- Single-party message telephone service (MTS [POTS] channel units)
- Two-wire locally switched special services (*SPOTS*® and M *SPOTS* channel units)
- Coin service (coin channel units)
- Multiparty service (multiparty channel units)
- Frequency Selective Ringing (FSR) channel units
- Direct Inward Dial (DID) trunks (DID channel units).

Note: Feature Package A is compatible with Universal Series 5 only.

Feature Package A is rated Discontinued Availability (DA), but all services are available in other Series 5 feature packages as described in this section.

Enhanced Feature Package B (FP-B) — Supports FP-A services and nonswitched specials and programmable (E *SPOTS*) channel units using the DCLU, IDCU, or *SLC* 96 central office terminal (COT) at the central office end. The modes that are supported are *SLC* 96 Modes 1 and 2 (concentration) as explained on Page 13-36.

Feature Package C (FP-C) — FP-A services plus nonswitched special services with advanced circuit testing. ***Feature Package C is compatible with Universal Series 5 only.***

Feature Package C — AUTOCUT — Allows a pre-equipped Universal Series 5 FP-C remote terminal (RT) to be automatically converted to an enhanced FP-B system which provides "direct" access to a digital switch via interfaces. ***Feature Package C could later be converted to universal or integrated FP-B, providing both Mode 1 and Mode 2 capability to handle nonswitched specials and programmable (E*** *SPOTS*) channel units.

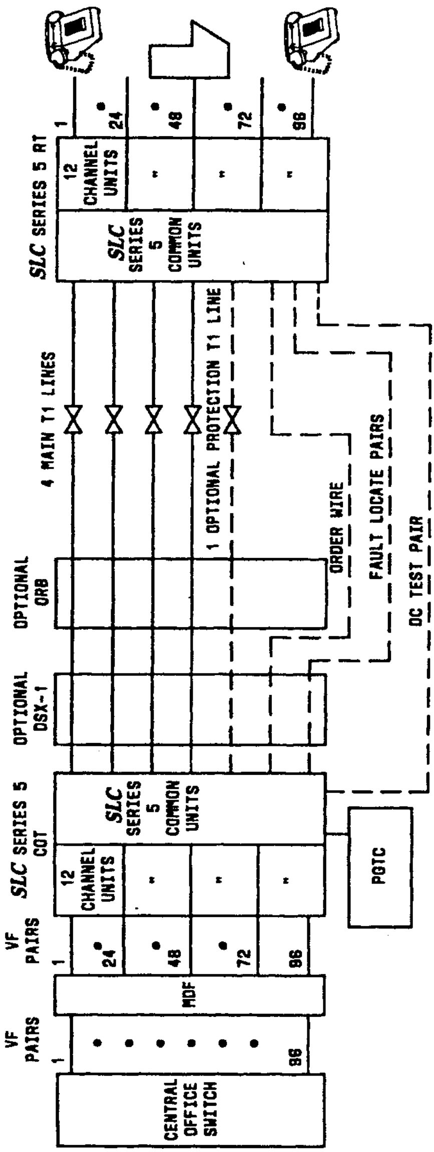
Feature Package D (FP-D) — FP-A and FP-C services using bit compression to reduce facility use. ***Feature Package D is compatible with Universal Series 5 only.***

Feature Package F (FP-F) — FP-F is used to configure a *SLC* Series 5 RT to be used as a Host Digital Terminal (HDT) to support Fiber in the Loop (FITL) applications using the *SLC*-2000 Multi-Services Distant Terminal (MSDT).

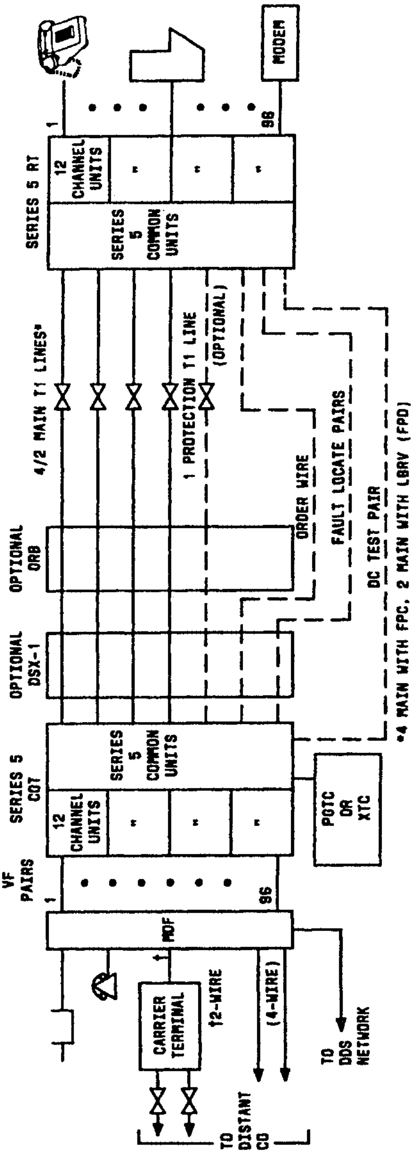
Feature Package 303 (FP303) — The FP303 remote terminal integrates into a TR-303 switch, such as the *5ESS* Switch equipped with an IDCU. With full-access time slot interchange (TSI), FP303 provides variable concentration of 96 lines on 2, 3, or 4 DS1 facilities. FP303 supports single-party, multiparty (superimposed and frequency selective ringing), coin (coin first and dial tone first), and direct inward dialing services. Two-wire locally-switched special services are supported in the CSA. In addition, it allows for a full bank (no placement restrictions) of dual-circuit U-DSL ISDN channel units by allowing dynamic assignment of B-channels to DSO time slots on a per-call basis. FP303 time-division multiplexes four 16-kb/s D-channels on a single full-time DSO.

The following list summarizes key capabilities of TR-303 implemented into FP303:

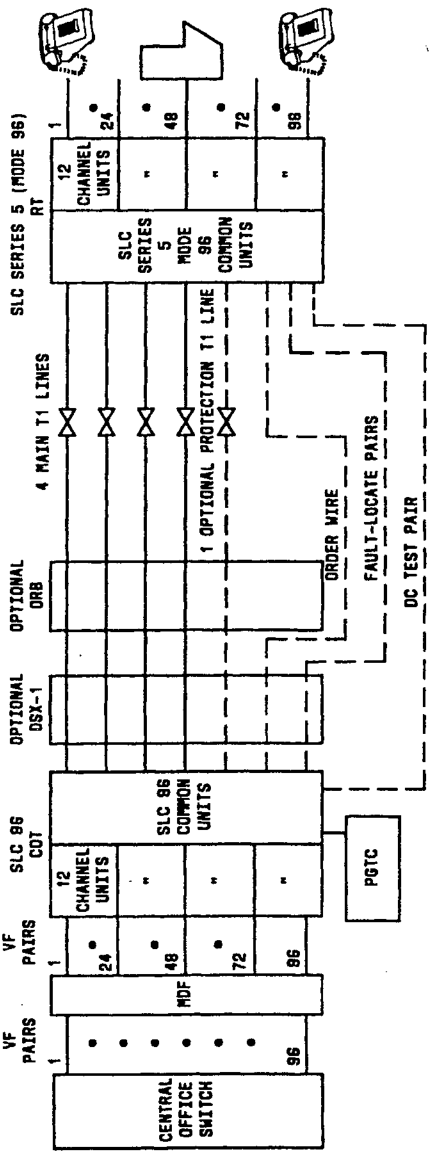
- Hybrid signaling for locally switched voice frequency (VF) circuits
- Embedded operations channel using ASN.1 messages
- Full access dynamic time-slot assignment
- TMC and EOC path switching
- 4 kbps extended superframe new data link (ESF/ndl)
- 4:1 time division multiplexing (TDM) method
- Channel testing and drop access
- Optional DS1 facility protection switching
- B8ZS clear channel capability
- Alarm and ISDN event reports
- DS1 performance monitoring
- Enhanced maintenance capability
- DS1 facility loopbacks
- DSL overhead transport
- DSL performance monitoring
- Full compliment of ISDN loopbacks.



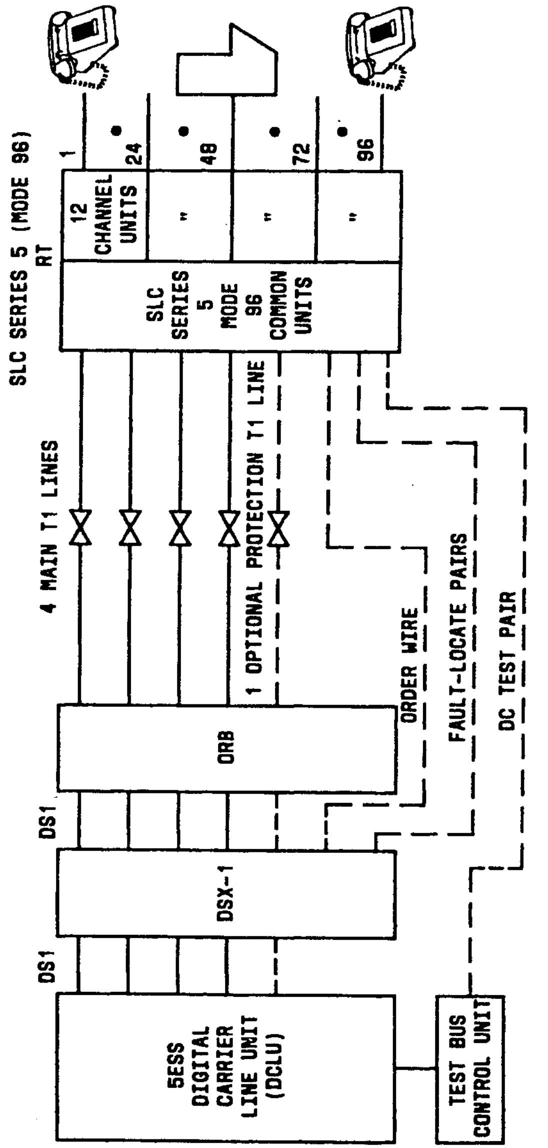
Universal Series 5 — Feature Package A



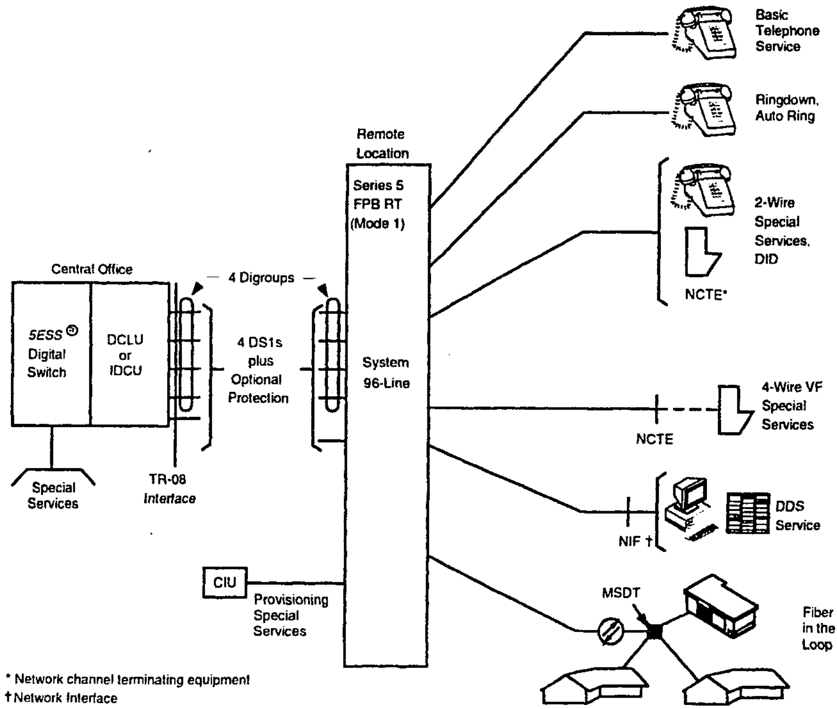
Universal Series 5 — Feature Package C/D



Universal Series 5 FP-B RT Interfacing With A SLC 96 COT



An Integrated FP-B (TR-08) RT



Feature Package 303 Applications

INTEGRATED NETWORK ACCESS — REMOTE TERMINAL (INA-RT)

AT&T 363-099-105, 363-205-104

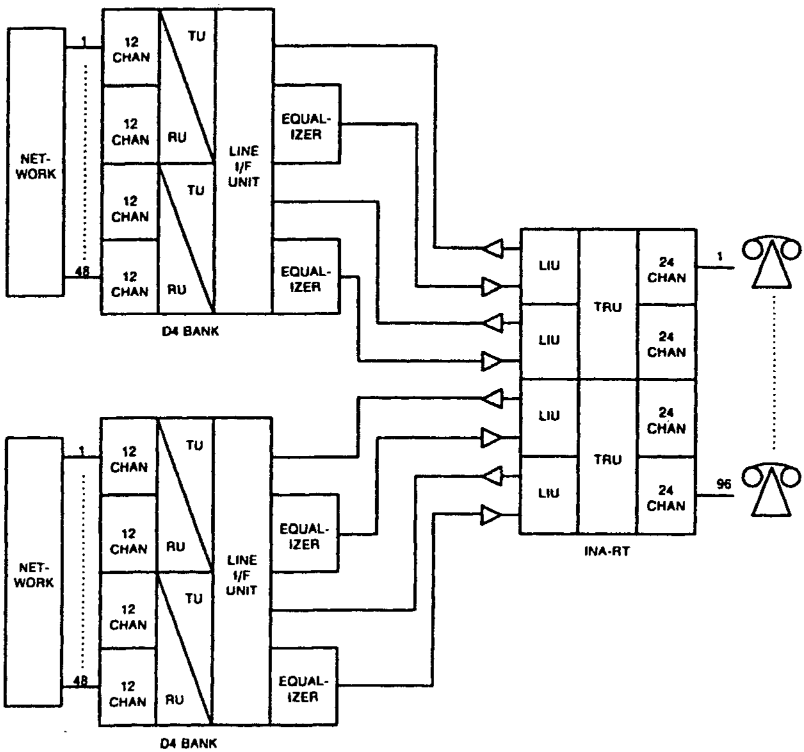
An integrated network access — remote terminal (INA-RT) is a remote channel bank that uses *SLC* Series 5 Carrier System technology to provide integrated network access based on the use of a subset of D4 channel bank features. Applications for the INA-RT include termination on a D4, D5, digital cross-connect system (DCS) such as DAS II, or on a *SLC* 96 carrier central office terminal (COT) D4 emulator at the central office.

The INA-RT uses two operating modes to optimize physical space and transmission bandwidth.

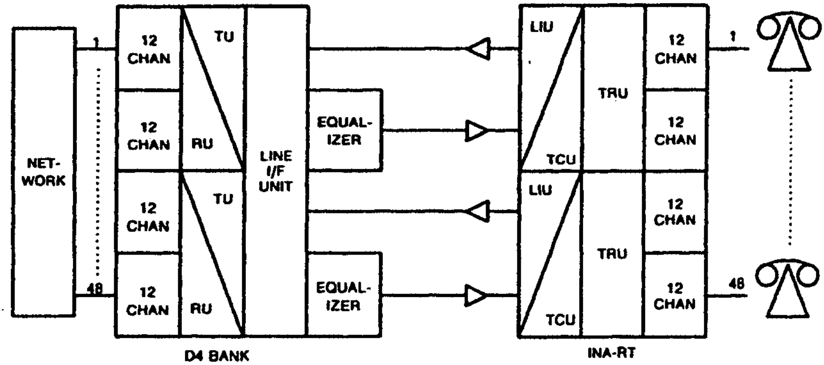
MODE I — Four line interface units (LIUs) are used to access up to 96 subscriber circuits. MODE I is shown on Page 13-31.

MODE III — Two LIUs and two transcoder units (TCUs) are used to provide facility savings for a 48-line system. Mode III is shown on Page 13-32.

A SLC Series 5 dual channel bank can support up to 192 lines in MODE I and 96 lines in MODE III. The advantage of INA-RT is to provide an inexpensive loop transmission media for groomed special services.



Mode I INA-RT Application



Mode III INA-RT Application

SLC Series 5 Remote Terminal Enclosures

The remote terminal closures used for *SLC* Series 5 Systems (except for Fiber in the Loop) and their capacities with distributed or bulk power arrangements are shown on the next page. The capacities for the *SLC* Series 5 Fiber in the Loop (FITL) feature are covered in the text that describes the *SLC*-2000 Multi-Services Distant Terminal (MSDT) feature, beginning on Page 13-16.

The present hardware for housing the remote terminal equipment is the 24-foot (7.3 m) controlled environment vault (CEV) or the 80E-type aboveground cabinet. The Fiber to the Home (FTTH) feature requires optical interconnection within the remote terminal. The 24-foot (7.3 m) CEV is equipped with either the fiber optic interconnect (*LGX*®) frames or the preferred high-density fiber interconnect frame.

The *LGX* frame will accommodate 288 fiber jumpers on the optical unit side. In the FITL application, a maximum of five *LGX* frames are permitted in a 24-foot (7.3 m) CEV. Therefore, a maximum of 1440 residential customers (at two lines per customer) can be served from the RT using *LGX* frames.

The high-density fiber interconnect frame (HDIC) is designed for a maximum of 1152 fiber jumpers on the optical side of the frame. It is recommended that a maximum of three of these frames be allowed in a 24-foot (7.3 m) CEV under the FITL feature, or a total of 3456 jumpers. ***However, in this situation the 24-foot (7.3 m) CEV will accommodate only ten SLC Series 5 equipment bays with a capacity of 192 channels per bay. Therefore, customer service from a 24-foot (7.3 m) CEV using high-density fiber interconnect frames is limited to 1920 customers (maximum of two lines per customer) or 3840 lines.*** If some of the customers desire more than two lines, the maximum number of customers that could be served would be reduced accordingly.

SERIES 5 RT ENCLOSURE CAPACITIES WITH DISTRIBUTED OR BULK POWER						
	Metallic T1 (Note)			Lightguide (Note)		
Type of Enclosure	Dual Channel Banks	Systems	Lines	Dual Channel Banks	Systems	Lines
51-Type Cabinet	1	2	192	—	—	—
80A-BP* Cabinet	3	6	576	2	4	384
80D-DP Cabinet	4 —	8 —	768 —	3 1†	6 2†	576 192†
80D-BP* Cabinet	(6)	(12)	(1152)	(5)	(10)	(960)
80E-DP Cabinet	6	12	1152	5	10	960
80E-BP Cabinet	(8)	(16)	(1536)	(7)	(14)	(1344)
90A Cabinet	2 —	4 —	384 —	1 2	2 4	192 384
Concrete Hut	16 (18)	32 (36)	3072 (3456)	14 (15)	28 (30)	2688 (2880)
Controlled Environment Vault (CEV) 16-foot	20 (22)	40 (44)	3840 (4224)	18 (21)	36 (42)	3456 (4032)
Controlled Environment Vault (CEV) 24-foot	30 (39)	60 (78)	5760 (7488)	28 (34)	56 (68)	5376 (6528)
Electronic Equipment Enclosure (EEE)	36 (39)	72 (78)	6912 (7488)	36 (39)	72 (78)	6912 (7488)

Note: The system capacity listed is the maximum number of Series 5 96-line systems for the enclosure. Numbers in parentheses reflect capacity using bulk power.

* Also available with heat exchanger (HX).

† Capacity of an 80D-DP cabinet equipped with a DDM-2000 lightwave multiplexer. Other configurations with additional dual channel banks are available.

Other Enclosures

When Series 5 is placed on customer premises, the capacity of the system is limited only to the amount of floor space that is allocated for the equipment bays.

In some situations of clusters of individual customers such as industrial areas, shopping malls, office complexes, etc., the telephone company may elect to lease space in a customer building for housing carrier equipment or they may elect to erect a separate building.

SLC 96 CARRIER SYSTEMS

Universal SLC 96

AT&T 363-202-010, 363-202-100, -200,

915-710-110, -111

The universal *SLC* 96 Carrier System is a digital subscriber carrier system that provides for up to 96 subscriber channels, when fully equipped, between a central office terminal (COT) and a remote terminal (RT). The subscriber channels are pulse-code modulated and then time-division multiplexed into DS1 (1.544 Mb/s) type signals. The DS1 signals are then processed for transmission over T1 digital lines or other digital transmission facilities such as fiber optic cable. In addition to single and multiparty message telephone service (MTS), the system can provide coin service, voice-frequency (VF) special services, digital dataport service, and voice-data circuit switched digital capabilities.

The initial deployment of the *SLC* 96 Carrier System consisted of a COT and RT using T1-type digital lines for the transmission facility. Enhancements to the *SLC* 96 Carrier System provide for variation of the system configuration.

The most recent *SLC* 96 configuration uses fiber optic cable for the transmission facility in the loop plant. The lightwave applications of the *SLC* 96 Carrier System are described in AT&T 915-710-111.

Universal SLC 96 Served by T1 Digital Lines (Copper)

The *SLC* 96 Carrier System served by T1 digital lines may be operated in three modes, depending on the class of customer services involved. The three operating modes are:

- **MODE 1** — Provides 96 carrier channels and dedicates one channel to each subscriber line. This configuration requires four T1 lines as a transmission media and one protection T1 line per system. Mode 1 is intended to be the general purpose mode of operation. It can handle single-party, multiparty, coin, and most special services. It is used for subscriber lines with very high traffic.
- **MODE 2** — Concentrates shelf groups of 48 lines onto 24 carrier channels per group. This configuration requires three T1 lines (two main and one protection) per system. This increased T1 line capacity is achieved by the time assignment switching unit (TAU). Mode 2 is intended to provide single-party and multiparty service. Mode 2 also offers up to 16 special service channels. Full access, 2 to 1 concentration ratio (48 subscriber channels concentrated onto 24 carrier channels) is a very conservative design with regard to traffic handling capability. However, it only requires two main T1 lines rather than four.
- **MODE 3** — Provides 48 nonsubscriber (special service, coin, or dataport) channels per system. A single working T1 line is required per shelf group and is achieved by a multiplex unit (MXU), a digital multiplex- demultiplex unit that combines nonsubscriber channel unit digital streams from the two shelves which make up a shelf group. Mode 3 is intended to provide service to areas where a large demand for special services is anticipated.

Modes 1 and 3 can also run on Integrated Services Digital Network (ISDN) with capabilities of handling voice and data at the same time.

Note: A T1 line can accommodate 24 channels. Each T1 line consists of 2 cable pairs (one transmit and one receive). The T1 line used for protection is optional. It is automatically switched in by the line switch unit if a working line fails.

T1 lines require repeaters between the central office (CO) and the remote terminal (RT) to regenerate the digital signals. The repeaters are generally spaced at 6000-foot (1828.8 m) intervals with a nominal central office end section of 3000 feet (914.4 m).

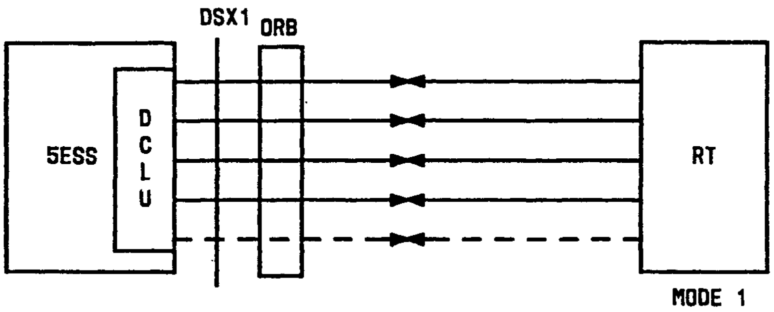
Integrated SLC 96

AT&T 363-200-010

The ***integrated*** *SLC* 96 Carrier System is similar in many respects to the universal *SLC* 96 Carrier System: both have remote terminals and digital lines. However, the integrated *SLC* 96 Carrier System provides a direct digital interface into the *5ESS* Switch without requiring a central office terminal (COT).

The DS1 digital carrier lines from the *SLC* 96 Carrier System remote terminals (RTs) connect directly through the main distribution frame (MDF), office repeater bay (ORB), and digital signal cross-connect (DSX) bay to terminate on a *5ESS* switch peripheral unit on a switching module called the digital carrier line unit (DCLU). See the figure below for this configuration.

Within a DCLU, each DS1 line terminates on a subscriber digital facility interface (SDFI). The function of the SDFI in the DCLU is comparable to that performed by the line interface unit (LIU) in a COT for the universal *SLC* 96 Carrier System. However, the SDFI cannot power a digital line; powering for a digital line is provided by the office repeater bay.



Integrated *SLC* 96 Carrier System

The integrated *SLC* 96 Carrier System can be used to provide facilities for locally switched (LS) services, including:

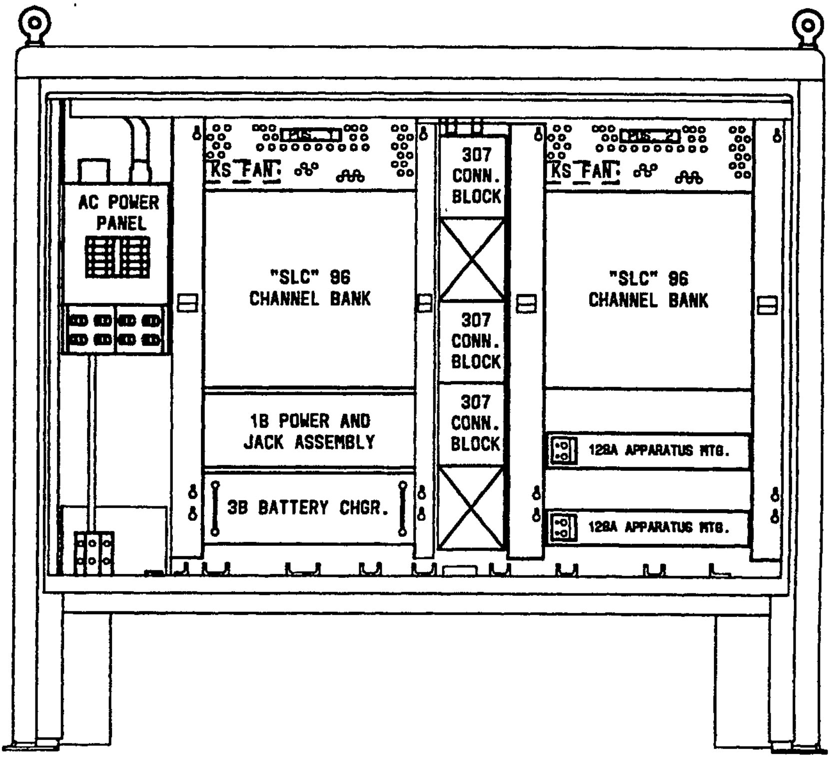
- Single-Party
- Multiparty
- Frequency Selective Ringing
- Coin
- Special Services.

SLC 96 Remote Terminal Equipment

The remote terminal (RT) equipment consists of channel banks. The latest channel banks are compatible with both T1 metallic transmission facilities and fiber optic cable arrangements. Electrical protection must be provided for metallic T1 lines, either by the use of protector blocks associated with channel bank or bulk protection as in a controlled environment vault (CEV) or 80D-type cabinet where 190- or 307-type protectors are used. *SLC* 96 RT equipment consists of channel bank(s), protection devices, a battery charger, and a power and jack panel. When numerous *SLC* 96 systems are required, a 7-foot (2134 mm) remote terminal frame is available. These are used in CEVs, electronic equipment enclosures (EEEs), huts, and on customer premises. A standard frame consists of two connectorized *SLC* 96 banks, plug-in circuit packs, a connectorized power and jack panel, a connectorized battery charger, and battery shelves and packs. The frame is powered from commercial 120-volt AC at 60 Hz.

The 80D-type cabinet can accommodate up to four *SLC* 96 systems. The 80D cabinet is shown on Page 13-39.

The remote terminal enclosures for *SLC* 96 and their system capacities are listed on Pages 13-40 and 13-41.



80D Cabinet Remote Terminal Equipped With Four *SLC* 96 Systems

The 80D is a double-sided cabinet. Two *SLC* 96 channel banks are mounted on each side in this grouping.

SLC 96 Remote Terminal Enclosures

Distributed Power Arrangement

The following remote terminal enclosures are used for *SLC* 96 applications with metallic T1 lines or fiber optic cable and distributed power arrangements.

SLC 96 DISTRIBUTED POWER ARRANGEMENT				
Remote Terminal Description (Note 1)	**Metallic T1**		**Fiber Optic (Note 2)**	
	System Capacity	**Line Capacity**	**System Capacity**	**Line Capacity**
36-Type Cabinet	1	96	—	—
80D-Type Cabinet†	4	384	3	288
AT-8910C Mini-Hut	10	960	9	864
Concrete Hut ED-7C285-30	16	1536	14	1344
Controlled Environment‡ Vault (CEV) 16-foot	20	1920	18	1728
Controlled Environment§ Vault (CEV) 24-foot	30	2880	28	2688
Electronic Equipment Enclosure (EEE)	40	3840	35	3360

Notes:

1. The practices describing the above RT enclosures are listed in the Bibliography at the end of this section.
2. The reason the system capacity is less for lightguide cable applications is because space must be provided for lightguide terminating and lightwave multiplexing equipment.

† The 80E cabinet is not arranged for *SLC* 96 Carrier Systems on a standard basis at this time.

‡ Equipped with B or C equipment platform.

§ Equipped with 24-foot equipment platform.

Bulk Powering Arrangement

Bulk powering is available for *SLC* 96 systems. The bulk powering equipment reduces the number of bays available for mounting channel banks. However, three channel banks can be mounted on a 7-foot frame rather than two with distributed power. Therefore, the overall system capacity is increased in the enclosures. System capacities for *SLC* 96 using bulk powering are listed below.

SLC 96 BULK POWERING ARRANGEMENT				
Remote Terminal (RT) Description (Note)	Metallic T1		Fiber Optic	
	System Capacity	Line Capacity	System Capacity	Line Capacity
Concrete Hut ED-7C285-30	18	1728	15	1440
Controlled Environment Vault (CEV) 16-foot	24	2304	21	2016
Controlled Environment Vault (CEV) 24-foot	39	3744	36	3456
Electronics Equipment Enclosure (EEE)	39	3744	39	3744

Note: The practices describing the above RT enclosures are listed in the Bibliography at the end of this section.

Other Enclosures

When the *SLC* 96 Carrier System is placed on customer premises, the capacity of the system is limited only to the amount of floor space that is allocated for equipment bays.

In some situations of clusters of individual customers such as industrial areas, shopping malls, office complexes, etc., the telephone company may elect to lease space in a customer building for housing carrier equipment or they may elect to erect a separate building.

Copper Distribution Facilities Beyond Remote Terminal (RT)

Standard copper cable plant is used as the voice frequency (VF) facility from the RT to the customer location. Open, multiple, rural wire, and unshielded cable should never be used beyond the RT due to inductive interference problems and high rates of trouble normally found with this type of facility. The recommended resistance limits of the cable facilities beyond the RT for planning purposes is 900 ohms as explained on Page 13-1. However, the resistance limits can be extended to 1500 ohms (1800 ohms including the station) by using extended range RT plug-in units.

DDM-2000 OC-12 MULTIPLEXER

The DDM-2000 OC-12 Multiplexer is designed for loop, interoffice, and customer location applications. This multiplexer starts with many of the proven features of AT&T's DDM-1000 and DDM-2000 OC-3 Multiplexers and extends into the future with the flexibility of the SONET standard. This single-shelf, digital multiplexer supports a mix of digital signal 3 (DS3) and optical carrier level 3 (OC-3) signals and multiplexes them into a SONET standard 622-Mb/s optical carrier level 12 (OC-12) rate. The shelf can be equipped to serve many diverse network applications and supports a variety of operations interfaces for current and evolving network operations needs.

The DDM-2000 OC-12 Multiplexer has a phased release plan. Release 1 supports DS3, interconnect signal level 3 (IS-3), and OC-3 interfaces. Applications include OC-12 point-to-point, OC-12 hubbing, and optical interworking with the DDM-2000 OC-3 Multiplexer. Release 2 supports OC3/OC-12 open systems interconnections (OSI) interworking, an OC-3c (STS-3c) interface using the 21G optical line interface unit (OLIU), synchronization messaging, and 1550-nm operation using the 21H OLIU. Future releases will support electrical carrier signal level 1 EC-1 (STS-1) interfaces, drop, add/drop, and rings.

DDM-2000 OC-3 MULTIPLEXER

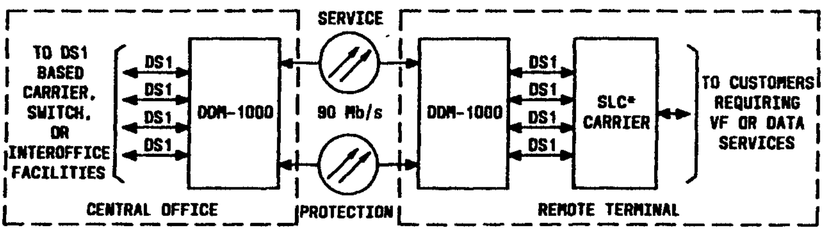
AT&T 363-206-200

The DDM-2000 OC-3 multiplexer supports DS1 and DS3 low-speed interfaces and an OC-3 high-speed interface. The DS1 and DS3 interfaces accept any DSX-1 or DSX-3 compatible signal (clear channel interfaces) and can be mixed on a per-STS-1 basis. This multiplexer is a single-shelf assembly equipped with circuit packs that fits in a standard 23-inch (584 mm) wide bay. Each shelf is a stand-alone entity with its own fiber cabling, DSX-1, and office power interfaces. The default configuration provides rear access cabling, although front access (through dangler cables) is also available. The basic shelf consists of 36 circuit pack slots and a user panel: twenty-six 4-inch (102 mm) slots and ten 8-inch (204 mm) slots. Two 4-inch (102 mm) slots are reserved for service and protection synchronous timing generator (TGS) circuit packs.

DDM-1000 MULTIPLEXER

AT&T 363-205-100

The DDM 1000 Multiplexer is suitable for *SLC* 96 or Series 5 application in the local loop network. The multiplexer is capable of accepting up to 56 DS1 signals at 90-M/bs lightwave transmission to a remote terminal. This means that four fibers can accommodate 14 *SLC* 96 or Series 5 Systems. The DDM-1000 serving a remote terminal is shown as follows (only four DS1 signals are shown).



The DDM-1000 also provides 180-Mb/s operation. Two shelves can be connected together to provide up to four equivalent DS3 muldems. Any of the four DS3 muldems can be fully or partially equipped, providing added flexibility should unexpected growth occur. If only one or two DS3s are needed initially, the DDM-1000 can operate at 90 Mb/s and be upgraded in service to 180 Mb/s when required. The two DDM-1000 assemblies are connected together with two cables on the backplane.

DDM-PLUS

AT&T 363-206-150

The DDM-Plus is available in two housing configurations, an extension shelf and a wall distant terminal. The DDM-Plus extension shelf is the largest capacity housing for the optical line interface unit (OLIU) circuit packs. It is used primarily in central offices, controlled environment vaults (CEVs), and medium-to-large capacity cabinets. It mounts in a standard 23-inch (584 mm) equipment rack and has a total capacity of 28 DS1s. It provides the flexibility of carrying 28 DS1s either on copper using the AT&T T1 Carrier System or on fiber using either the 25A OLIU or 25F OLIU. The DDM-Plus wall distant terminal (DT) housing is designed for use at a customer location. It has the capacity for one DDM-Plus system (four DS1s) and is attractively packaged. The DT housing can be mounted on a wall or placed on a table or desk. The wall DT contains one or two standard OLIU circuit packs and provides transport for four DS1s. The DDM-Plus wall DT can be used only to transport four DS1s on fiber. Therefore, the AEK-type T1 repeaters cannot be used in the wall DT.

SLC 1 CARRIER SYSTEM

AT&T 363-400-100, 902-219-100

The *SLC* 1 is a solid-state analog carrier system that derives an additional line from an existing voice frequency (VF) physical line. Bidirectional transmission is achieved by using a different carrier frequency for each direction of transmission. The *SLC* 1 System is used as an expedient to provide customer service where cable pairs are not immediately available, either by line and station transfers (LSTs) or defective pair recovery. ***The system can be used only for single-party service.*** The basic system is illustrated on Page 13-47. It consists of the following components:

a. **Central Office Unit (COU) NS1 Circuit Pack** — provides the interface between the physical and the derived central office line equipment and the cable pair

b. ***SLC* 1 Main Frame Terminal Block** — provides a termination field for the physical and derived line equipment and the cable pair

c. **119A Isolation Filter** — provides isolation of carrier frequencies from the subset of the subscriber served by the physical pair

d. **Subscriber Unit NT1, NT2, or NT12B Circuit Pack** — provides the interface between the derived customer subset and the cable pair.

Notes:

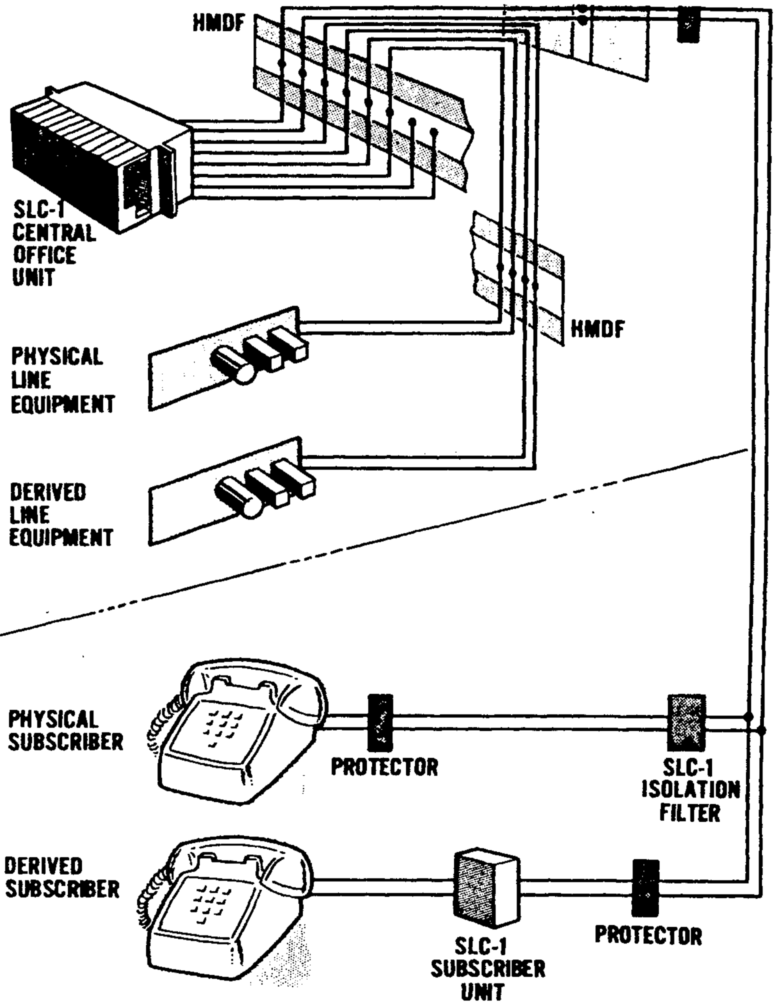
1. The NT1 subscriber unit is not compatible with *ESS*™ central offices.
2. The NT2 or NT12B will operate with *ESS* offices.
3. The NT1 and NT2 units must be installed indoors. The NT12B is for outdoor use.

The SLC 1 system range is limited to nonloaded resistance design loops of less than 1300 ohms and without bridged tap. This limit is generally to subscribers less than 18,000 feet (5486.4 m) from the central office.

The central office unit grouping consists of a rack-mounted shelf on a standard 23-inch (584 mm) equipment rack. Each shelf accepts up to 12 NS1 circuit packs. Each derived channel terminates in the *SLC* 1 terminal block at the horizontal main distributing frame (HMDF) to provide access for service connections.

The subscriber unit is installed by mounting the unit at the customer premises and connecting it to the subscriber loop. The associated 1119A isolation filter is installed in series with the physical line service drop.

Once the shelves have been installed in the central office, subscriber units can be used anywhere in the outside plant network within the restrictions of generally 18,000 feet (5486.4 m) from the central office.



SLC 1 Carrier System

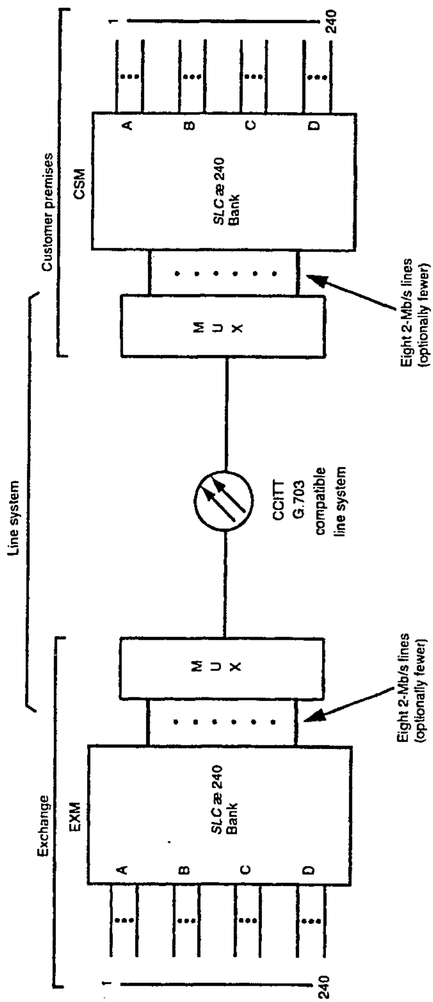
DIGITAL LOOP CARRIER FOR INTERNATIONAL APPLICATIONS

AT&T offers two main product lines for use in international markets. They are the *SLC* 120 and *SLC* 240 Network Access Systems (NAS) and the OPTIMUX Integrated Optical Line and Multiplex System. Both product lines conform to the 30-channel recommendations set forth by the International Telegraph and Telephone Consultative Committee (CCITT) and European Conference of Posts and Telecommunications (CEPT). They are the outgrowth of extensive experience in designing, manufacturing, installing, and servicing digital loop carrier (DLC) systems since 1971.

SLC 240 NETWORK ACCESS SYSTEM

AT&T 363-207-011

The *SLC* 240 Network Access System (NAS) is an extension of the *SLC* domestic product line designed to serve the world markets. It is built upon the previous *SLC* 120 NAS technology which provides 120 carrier channels. The *SLC* 240 NAS provides 240 carrier channels and dedicates one channel to each subscriber line. Both systems introduce digital technology into the subscriber loop quickly, reliably, and economically. The *SLC* 240 NAS is an advanced, flexible, modular network access system arranged in four 60-channel groups in a channel bank with distributed and duplicated common equipment shared across these groups to ensure high reliability. The same channel bank is used at both ends of the system, with its function determined by the installed plug-ins. A typical *SLC* 240 System configuration is shown on the next page.



SLC [R] **240 System Configuration**

System Architecture

Architecture for the *SLC* 240 NAS is classified into the following four categories:

1. **Customer Interface** — This channel unit (CU) is the first circuit pack that the customer's signal interfaces with, and it determines the type of service provided to the customer. The following four categories include all of the types of service provided by the *SLC* 240 NAS CUs.
   - Plain old telephone service (POTS)
   - *SPOTS* service channel units
   - Transmission only
   - Digital data channel units.
2. **Line Interface** — Two types of units provide an interface between the channel units and the line system: the transmit/receive unit (TRU) and line interface unit (LIU). The TRU polls the channel units for pulse code modulation (PCM) words. The TRU time division multiplexes the PCM words into a unipolar bit stream and sends the bit stream to the LIU. The LIU converts the unipolar bit stream from the TRU and inserts data link information into the bipolar 2 Mb/s.
3. **Common Equipment** — Circuit packs used in the *SLC* 240 NAS that are common for the EXM and CSM bulk-powered bays can be placed into the following categories: power shelf, battery shelf, and channel bank.
4. **Testing** — The *SLC* 240 Universal System tests include installation tests, customer line and channel unit testing, and 2-Mb/s facility testing. The system architecture provides remote testing capability for testing the EXM and CSM CUs with the Status, Inventory, Test, and Alarm (SITA) System. With the integrated SITA System, a dial-up modem provides system access.

Features of the SLC 240 NAS

The *SLC* 240 NAS offers the following types of service features:

- Single-party direct exchange lines
- Public/coin
- Private automatic branch exchange (PABX) direct inward dialing (DID)
- PABX outdoor extensions
- PABX exchange and trunk lines
- Switched voice frequency (VF) data services
- 64-kb/s digital data service
- 12- and 16-kHz subscriber pulse metering (SPM)
- 2- and 4-wire leased line VF data service
- Future Integrated Services Digital Network (ISDN) offering.

The *SLC* 240 NAS has the following features to ensure reliable performance in a wide variety of applications:

- Built-in diagnostics with automatic fault reporting and isolation
- Single-ended maintenance philosophy, with communications assisted by a time slot 0 data link
- Subscriber line testing with a remote or integrated test-head
- Communication channels for internode transmission of control and maintenance information using a 4-kb/s data link
- Detection and filtering of operational alarm conditions that are displayed locally and reported to the opposite end with eventual reporting to a maintenance center
- Performance monitoring of incoming 2-Mb/s lines from the network
- Pick-up points for external alarms of various security and safety functions

- Diagnostics of internal circuitry to identify failed or degraded circuit packs
- Automatic fault reporting and fault isolation to simplify operational procedures
- Status, Inventory, Test, and Alarm (SITA) System to provide dial-up system access for remote operation, administration, and maintenance (OA&M).

OPTIMUX — INTEGRATED OPTICAL LINE AND MULTIPLEX SYSTEM

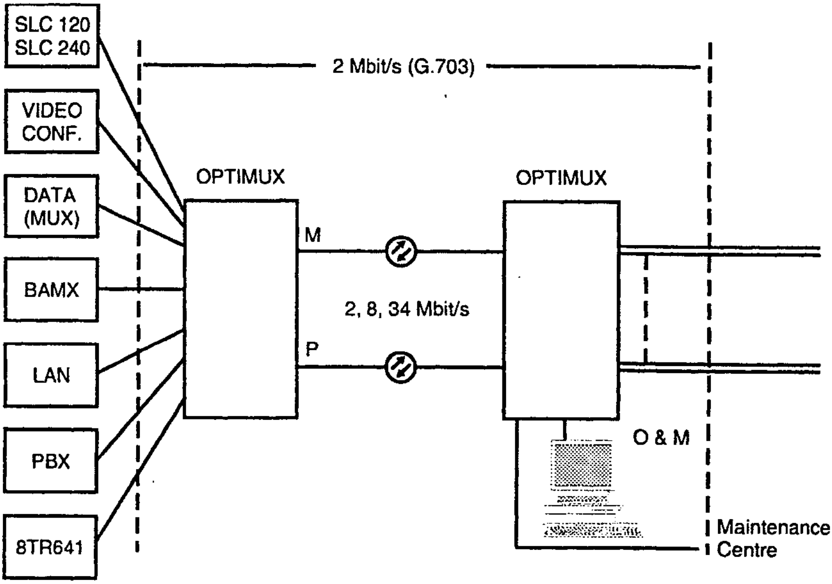
OPTIMUX Application and Planning Guide

The OPTIMUX System is designed to suit most short- and medium-haul applications, in both public and private networks, where 2-Mbit/s signals containing various types of traffic must be transported over optical fibers. The 2-Mbit/s signals can contain 30 digitized speech signals originating from a PCM multiplexer (such as AT&T's 8TR635 and 8TR641), a network access system (such as *SLC*-120 or *SLC*-240), data from digital PBXs, remote switching units, video conferencing systems, and other digital sources. OPTIMUX can also be a very economical system for private networks as a feeder system for base stations of cellular networks. OPTIMUX conforms with the relevant CCITT recommendations and ETSI standards.

The OPTIMUX System is a combined optical line and multiplex system of the plesiochronous digital hierarchy (PDH) product family. In one subbay, both multiplex units and optical line units in various configurations can be housed. The system provides the multiplexing of four 2-Mbit/s signals to one 8-Mbit/s signal, of four 8-Mbit/s signals to one 34-Mbit/s signal, and the demultiplexing of these signals. It is a combined multiplex and optical system for transmission speeds of 2048, 8448, and 34,368 kbit/s. The system is suitable for operating at a wavelength of 1300 nm on single-mode fiber and includes all facilities for multiplexing, demultiplexing, and transmission of signals at the three mentioned bit rates conforming with CCITT Rec. G.703. The OLTUs are fully transparent and may be used for transmission of digitally encoded signals such as voice, data, television, music, or a mixture of these signals.

Applications

Some basic applications for the OPTIMUX System are shown in the diagram below.



Other OPTIMUX System applications are listed below:

- **Junction and Rural Networks** — The OPTIMUX System is primarily intended to be applied in the junction network where distances are not long; however, the system can also be used in rural networks where density of traffic decreases with the distance from the central office.
- **Point-to-Point Link** — The system can be deployed as a low-capacity line system. Transmission at bit rates of 2, 8, or 34 Mbit/s is possible. Together with the relevant multiplexer units, this provides transmission of one, four, or sixteen 2-Mbit/s signals.
- **Multi-star Configuration Using Hubs** — One 34-Mbit/s received optical signal can be split into four 8-Mbit/s signals and transmitted in four independent directions. These 8-Mbit/s signals can be split furthermore into four 2-Mbit/s signals.
- **Linear Link with Drop and Insert** — In this kind of network, the optical signal may be 34 Mbit/s while drop and insert can be realized at 8 Mbit/s or 2 Mbit/s.
- **Ring-Shaped Network with Drop and Insert** — In a ring network, transmission can be provided in two directions. The system can be configured so that in case of a cable rupture, transmission is continued via the remaining link. Drop and insert of all or part of the tributaries is possible.
- **Access Network** — The system can be applied in the access network with or without line protection. Signals from subscriber lines can be combined at a remote point from the exchange with the help of a Network Access System. Transport of the signal obtained in this manner can be performed by the OPTIMUX System.

Interfaces and Services

The OPTIMUX System can interface with the following to perform the services listed:

- Main traffic interfaces
- Auxiliary channels
  - Service bit channels
  - Engineering order wire channels
  - Additional channels
- Supervision interfaces
  - Maintenance bus
  - Supervision sharing interface
  - Station interface
  - LED indicators
- Management interface
- Monitor points
- Power interfaces.

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363-202-010	DCLU — Integrated *SLC* 96 Carrier System
363-202-100	*SLC* 96 Carrier System — General Description
363-202-602	Bulk Protected Remote Terminals — *SLC* Series 5 and *SLC* 96 Carrier Systems
363-205-003	*SLC*-2000 Multi-Services Distant Terminal (MSDT) Features, Applications, Planning, and Ordering Guide
363-205-010	*SLC* Series 5 Carrier System — General Description
363-205-104	Integrated Network Access — Remote Terminal, User's Guide
363-206-100	DDM-1000 Multiplexer
363-208-000	*SLC*-2000 Access System; Applications, Planning, and Ordering Guide
363-400-100	Subscriber Loop Carrier *SLC* 1 System — General Description
622-506-050	16-Foot Controlled Environment Vault (CEV) — Description
622-506-051	24-Foot Controlled Environment Vault (CEV) — Description
622-506-226	16-Foot Controlled Environment Vault (CEV) — Operation and Maintenance
622-506-227	24-Foot Controlled Environment Vault (CEV) — Installation

AT&T	Title
622-506-228	24-Foot Controlled Environment Vault (CEV) — Operation and Maintenance
622-506-235	Concrete Hut ED-7C285-30 — Description and Installation
626-500-105	80-Type Cabinet — Coding Scheme
626-500-125	40-Type Cabinets — Hardware
631-600-228	40-Type Cabinet — Description and Placing
631-600-240	80-Type Cabinet — Installation
631-600-244	80E-BP (Bulk Power) Cabinet Installation
631-604-210	PC-Type Cable Closures — Description and Installation
640-250-216	Subscriber Loop Carrier *SLC* 40 — Digital Line Construction
640-250-217	*SLC* 96 Mini Hut — Installation of Frames and Hardware
640-250-220	36-Type Remote Terminal Cabinet — *SLC* 96 Systems
640-250-222	B Equipment Platform *SLC* 96 (Metallic and Fiber) Systems — Description
640-250-223	80-Type Cabinet Remote Terminal — Installation and Splicing *SLC* 96
640-250-224	Precabled Structures Using Bulk Protection — Remote Terminal Splicing — *SLC* 96 Systems
640-250-237	51-Type Remote Terminal Cabinet — Placement — *SLC* Series 5 Carrier System

AT&T	Title
640-250-246	EEE, CEV, and Mini-Hut Expanding Outcounts Using *SLC* 5 Carrier Systems
640-250-247	*SLC* Series 5 Dual Channel Banks (Metallic) Field Installation Into 80-Type Cabinets Precabled for *SLC* Series 5
640-250-248	Precabled Structures Using Bulk Protection Remote Terminal Splicing (Metallic) — *SLC* Series 5 Carrier System
640-250-250	Precabled Structures Using Bulk Power and Protection — Splicing and Cabling Arrangements (Metallic and Fiber) — *SLC* Series 5 Carrier Systems
640-250-251	24-Foot Platform — Arranged for *SLC* Series 5 Carrier System
640-250-252	80D Cabinet (Fiber) — Group 80 — *SLC* Series 5
640-250-253	AT-9049 Type Protector and Cable Enclosure — Description and Installation — *SLC* Carrier Systems
640-250-254	80E Cabinet (Fiber) — Group 88 — *SLC* Series 5
640-250-255	80D Cabinet (Fiber) — Group 90 — *SLC* Series 5
640-250-256	80E Cabinet (Fiber) — Groups 70, 71, 78, 90, and 91 — *SLC* Series 5
640-250-260	80D Cabinet (Metallic) — Description and Splicing
640-250-275	35-Type Remote Terminal Cabinet — Description and Installation — Loop Switching Systems

AT&T	Title
640-250-325	80D Cabinet Remote Terminal — Description, Installation, and Splicing — *SLC* Series 5 Carrier System (Metallic)
640-250-326	80D Cabinet — Description and Splicing
640-250-327	80E Cabinet (Metallic) — Description and Splicing — *SLC* Series 5
640-252-220	80-Type Cabinet — Description, Installation, and Splicing Fiber — *SLC* 96 Carrier System
640-252-310	Concrete Hut (ED-7C285-30) — Splicing (Metallic and Fiber) Combined *SLC* 96 and *SLC* Series 5 Carrier Systems
640-252-311	C Equipment Platform ED-97973-31 — Splicing (Metallic and Fiber) Combined *SLC* 96 and *SLC* Series 5 Carrier Systems
640-252-312	80-Type Cabinet — Description, Installation, and Splicing Combined *SLC* 96 and *SLC* Series 5 Carrier Systems
902-219-100	*SLC* 1 Subscriber Loop Carrier System — Engineering Design
915-710-110	*SLC* 96 Subscriber Loop Carrier System — Application Engineering
915-710-111	Fiber *SLC* Carrier Systems — Application Engineering
915-710-115	*SLC* Series 5 Carrier System — Application Engineering
915-774-110	Loop Switching System (LSS) — Engineering and Implementation
916-100-102	Designing Digital Loop Carrier Systems

Manuals

363-205-002	*SLC* Series 5 Carrier System — Fiber to the Home Feature
363-205-004	*SLC*-2000 Multi-Services Distant Terminal (MSDT) Features, User/Service Manual (USM)
363-205-104	*SLC* Series 5 Carrier System — Network Access Remote Terminal (INA-RT) — Users Manual
363-208-001	*SLC*-2000 Access System User/Service Manual
363-208-003	*SLC*-2000 Access System Command and Message Manual

Section 14

Contents

Section 14

CABLE AND WIRE

METALLIC CABLE

Metallic cables are cables having copper or aluminum conductors.

Metallic Cable Identification Code (Bell Design)

AT&T 626-020-006, 626-020-011

Metallic exchange cables are identified with a 4-letter code to simplify their designation in ordering, manufacturing, and on records.

B K T A UM 0100

- 0100 — PAIR SIZE
- UM — OUTER PROTECTION
- A — SHEATH DESIGNATION
  - A -- Alpeth
  - H -- Bonded Pasp
  - M -- Alvyn (Riser)
  - P -- Reinforced Self-Support
  - S -- Self-Support
  - W -- ASP
  - Y -- Bonded ASP
  - Z -- Bonded Stalpeth
- T — GAUGE OF CONDUCTOR
  - B = 19 AWG (0.9 mm)
  - A = 22 AWG (0.6 mm)
  - M = 24 AWG (0.5 mm)
  - T = 26 AWG (0.4 mm)
- K — CONDUCTOR INSULATION
  - C - Dual Expanded Polyolefin*
  - F - Dual Expanded Polyolefin* Core With FLEXGEL Filling Compound
  - G - Solid Polyolefin - Core Filled With FLEXGEL Filling Compound
  - H & K - Solid Polyolefin - Air Core
  - R - XPE/PVC (Expanded Polyethylene Polyvinyl Chloride)
- B — CABLE DESIGN
  - A - PIC Riser
  - B - PIC Air Core
  - D - DUCTPIC Cables
  - G - PIC Filled
  - K - Screened Core
  - N - Noncolor-Coded

* Polyethylene or Polypropylene

Sheath Types

AT&T 626-020-020, 626-759-020

The following are the types of available sheaths for protecting the conductors. Their uses are explained in a following table.

SHEATH	MAJOR COMPONENTS FROM INSIDE OUT
Alpeth	Aluminum, Polyethylene
PASP	Polyethylene, Aluminum, Steel, Polyethylene
ASP	Aluminum, Steel, Polyethylene
Stalpeth	Aluminum, Steel, Polyethylene
Plain Lead	Lead
Polyjacketed Lead	Lead, Polyethylene
Alvyn	Aluminum, Polyvinyl Chloride (PVC)
Steampeth	Aluminum, Steel, Polyethylene, Polybutylene

Many of these sheaths are available where the outer polyethylene jacket is adhesively bonded to the underlying metal layer by a copolymer coating. In this case the term is preceded by the word BONDED.

For example: BONDED ASP.

Outer Protection

AT&T 626-759-025, -030

The following are types of outer protection available to protect the cables under various conditions.

OUTER PROTECTION AVAILABLE			
Type	**Code**	**Makeup From Inside Out**	**Uses**
Unsoldered Mechanical Protection	UM	Unsoldered steel, polyethylene	Replacement for MP on some types of cable
Light Wire Armor	LA	Jute, galv. wire, jute	Mechanical protection under small streams and across gullies
Single Wire Armor	SA	Same as LA, but with heavier wire	Under navigable lakes, streams, and coastal waterways
Double Wire Armor	DA	Jute, galv. steel wire, jute, galv. steel wire, jute	Under navigable lakes, streams, and coastal waterways when conditions are severe, such as a rocky bottom or a strong current

Many of these types of outer protection have been discontinued. However, there are older cables in use with these designations. Therefore, code designation is shown here.

Sheath Types and Uses

SHEATH TYPES AND USES — PIC CABLES					
Sheath Type	Fourth Letter Code	Available On	Principal Use	Comments	Outer Protection Available
Alpeth	A	Air-Core Copper	Aerial	—	UM BT
Self-supporting Alpeth	S	Air-Core Copper	Aerial	Cheaper to install than lashed Alpeth	None
Self-supporting Reinforced	P	Air-Core Copper	Aerial	Rodent-resistant	None
PASP, Bonded PASP	H	Air-Core Copper	Buried	Alternative to PAP when some mechanical protection is required	UM, BT
Steampeth	V	PIC	Underground	For use in high temperature areas, steam tunnels, etc. 626-101-030	None
ASP	W	Filled Copper and Aluminum	Buried Underground	Offers greater mechanical and lightning protection than filled Alpeth	UM
Alvyn	M	PE-PVC	Used for terminating cables in buildings		None
Bonded ASP	Y	Filled	Buried Underground	626-200-400	None
Bonded Stalpeth	Z	Air-Core Copper	Underground	—	None
Stalpeth	C	Air-Core Copper	Underground	—	None

The sheath types shown here only represent the types that are presently available.

Sheath Markings

AT&T 626-020-020

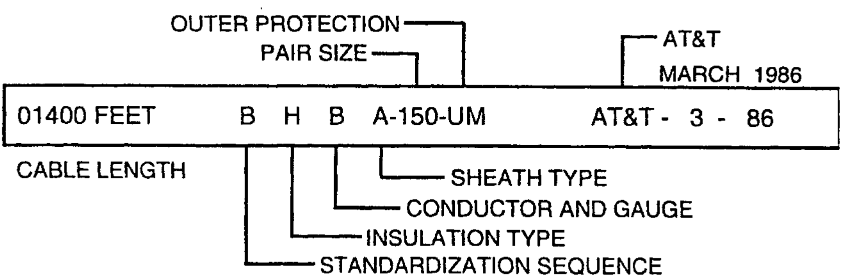
All plastic-insulated conductor (PIC) cables are identified by a series of factory-applied markings repeated at 2-foot intervals on the outer jacket. The markings indicate the following:

(a) Cable length

(b) Cable code

(c) Date of manufacture.

Example:



PLASTIC INSULATED COPPER CONDUCTOR (PIC) CABLE

Plastic insulated conductor (PIC) cable is designed for ease in cable pair identification. It is made up of 25-pair, color-coded binder groups. The pairs within each binder group are color coded as shown in the color code table on next page. Each 25-pair binder group is identified by a color-coded binder wrapping. PIC cables are available in sizes ranging from 6 to 4200 pairs. They are manufactured in various designs for aerial, buried, underground, and building cable applications. The following pages describe the PIC cables that are available from AT&T. For more information, consult your AT&T account representative.

Reel Lengths—PIC Cables

PIC cable length is defined as standard length on the 420 reel. Fiber optic cable lengths are defined as maximum length for a given reel or container. Greater lengths can be obtained in some cable sizes. Reel codes, diameters, widths, and weights are shown on Page 14-86.

INDIVIDUAL PAIR COLOR CODE FOR PIC CABLE				
25-Pair Color Code			Binder Group Standard	
Pair Number Sequence	Color Code Tip	Color Code Ring	12-13 Pair Units	25 Pair Unit
1	White	Blue	12	25
2	White	Orange		
3	White	Green		
4	White	Brown		
5	White	Slate		
6	Red	Blue		
7	Red	Orange		
8	Red	Green		
9	Red	Brown		
10	Red	Slate		
11	Black	Blue		
12	Black	Orange		
13	Black	Green	13	
14	Black	Brown		
15	Black	Slate		
16	Yellow	Blue		
17	Yellow	Orange		
18	Yellow	Green		
19	Yellow	Brown		
20	Yellow	Slate		
21	Violet	Blue		
22	Violet	Orange		
23	Violet	Green		
24	Violet	Brown		
25	Violet	Slate		

PIC CABLE DIAMETERS, WEIGHTS, AND REEL LENGTHS

Plastic insulated conductor (PIC) cables which are presently available are shown on Pages 14-10 through 14-32.

The description and use of PIC cables are covered in the following documents:

AT&T	TITLE
626-020-010	Feeder and Distribution Cable Selection
626-101-005	Air-Core Nonscreened and Screened PIC Cables
626-101-010	Filled Nonscreened and Screened PIC Cables
626-107-005	PE-PVC Insulated Terminating Cables
626-107-006	AR-Series Riser Cables
626-200-400	Filled Bonded ASP Cable
626-800-095	Screened, Air-Core, and Filled Nonstandard/Limited Availability PIC Cables

10-Pair Unit PIC Cables

Many international telephone companies use 10-pair core construction as their standard. AT&T offers 10-pair copper cables in the same sheath types, same gauge, and pair size ranges as the 25-pair products listed in this section with the addition of the following pair sizes:

- 10-pair
- 20-pair
- 30-pair
- 70-pair.

Please contact the Product Consulting Organization for copper cable and wire at the AT&T Phoenix Works (602) 233-5700 Voice, (602) 233-5634 Fax, for specific ordering information and prices.

Flat Bonded Aluminum Cables

Many telephone companies specifications require this type armor for copper cables rather than corrugated armor. AT&T offers cables with flat polymer coated aluminum armor in filled or aircore versions. The polymer coating not only bonds to the cable jacket but also bonds to itself at the overlap to produce a complete moisture barrier. The following flat aluminum 25-pair unit constructions are available in the gauges shown.

FLAT BONDED ALUMINUM CABLE				
Pair Size	Gauge			
	19	22	24	26
6	x	x	x	
12	x	x	x	
25	x	x	x	x
50	x	x	x	x
75		x	x	
100	x	x	x	x
150		x	x	
200	x	x	x	x
300		x	x	x
400		x	x	x
600		x	x	x
900		x	x	x
1200		x	x	x
1500			x	x
1800			x	x
2100			x	x
2400				x
2700				x
3000				x

Please contact the Product Consulting Organization for copper cable and wire at the AT&T Phoenix Works (602) 233-5700 Voice, (602) 233-5634 Fax, for specific ordering information and prices.

25-Pair Unit PIC Cables

DUCTPIC® (Air Core) Bonded Stalpeth

AT&T 626-101-005, 626-WIP-004

DUCTPIC is color-coded PIC cable used where large paired cable is required in the underground system.

DUCTPIC (AIR CORE) BONDED STALPETH								
Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
DCAZ	0900	22	NS	1320(403)	2.55(65)	4.40	6548	106389836
	1200	22	NS	1000(305)	2.88(73)	5.79	8616	105486146
DCMZ	0600	24	NS	2500(763)	1.74(44)	1.95	2902	106202609
	0900	24	NS	2000(610)	2.11(54)	2.80	4167	106202625
	1200	24	NS	1660(506)	2.33(59)	3.74	5566	104246749
	1500	24	NS	1320(403)	2.55(65)	4.61	6860	103716692
	1800	24	NS	1100(336)	2.84(72)	5.49	8170	103716700
	2100	24	NS	880(269)	3.02(77)	6.37	9479	103716718
	2400	24	NS	820(250)	3.23(82)	7.24	10774	103716726
DCTZ	0600	26	NS	3500(1067)	1.41(36)	1.30	1935	106201437
	0900	26	NS	2800(854)	1.65(42)	1.86	2768	106202633
	1200	26	NS	2310(705)	1.88(48)	2.41	3586	103175147
	1500	26	NS	1980(604)	2.10(53)	2.98	4435	105485866
	1800	26	NS	1730(528)	2.28(58)	3.52	5238	103175154
	2100	26	NS	1390(424)	2.44(62)	4.10	6101	105485874
	2400	26	NS	1390(424)	2.55(65)	4.64	6905	103175162
	2700	26	NS	1150(351)	2.78(71)	5.19	7723	103733242
	3000	26	NS	1070(327)	2.92(74)	5.75	8557	103175170
	3300	26	NS	1070(327)	3.01(76)	6.32	9405	105485890
	3600	26	NS	860(263)	3.10(79)	6.86	10209	103175188
	3900	26	NS	860(263)	3.25(83)	7.42	11042	105485916
	4200	26	NS	810(247)	3.35(85)	7.98	11875	103175196

Notes:

1. AWG metric equivalent: 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eye available on all pair sizes.
3. Longer lengths are available: contact an AT&T Sales Representative.

Self-Supporting Cable (Air Core)

AT&T 626-101-005

These self-supporting cables feature a 6.6M galvanized steel support strand and are for aerial use in exchange plant.

SELF-SUPPORTING CABLE (AIR CORE)									
Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)		Nominal Weight		Comcode
					Major	Minor	Lbs./Ft.	Gr./m	
BHBS	0025	19	S	4860(1482)	1.37(35)	0.91(23)	0.47	699	100022979
	0050*	19	S	4860(1482)	1.63(41)	1.17(30)	0.74	1101	101452068
BHAS	0025	22	S	9810(2991)	1.17(30)	0.71(18)	0.33	491	100022045
	0050	22	S	6540(1994)	1.37(45)	0.91(23)	0.46	685	100022052
	0100*	22	S	4900(1494)	1.63(41)	1.17(30)	0.74	1101	101452084
BKMS	0025	24	S	11340(3457)	1.05(27)	0.59(15)	0.28	417	100023944
	0050	24	S	8500(2591)	1.23(31)	0.77(20)	0.37	551	100023951
	0100*	24	S	6800(2073)	1.45(37)	0.99(25)	0.56	833	101452100
	0200*	24	S	4250(1296)	1.69(43)	1.23(31)	0.88	1310	101452126
BKTS	0025	26	S	10580(3225)	0.97(25)	0.51(13)	0.26	387	101452134
	0050	26	S	10580(3225)	1.13(29)	0.67(17)	0.31	461	100024926
	0100	26	S	8820(2689)	1.27(32)	0.81(21)	0.42	625	100024934
	0200*	26	S	5870(1790)	1.49(38)	1.03(26)	0.64	952	101452167
	0300*	26	S	4800(1464)	1.63(41)	1.17(30)	0.83	1235	101452175
	0600	26	NS	1865(569)	2.33(59)	1.87(47)	1.41	2098	106638158

*Bonded aluminum shield.

Notes:

1. AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eyes are not available.
3. Longer lengths are available: contact an AT&T Sales Representative.

Self-Supporting Cable (Air Core) Reinforced Sheath

This cable contains a reinforced sheath for protection against wildlife damage. It is designed for aerial exchange plant.

SELF-SUPPORTING CABLE (AIR CORE) REINFORCED SHEATH									
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)		Nominal Weight		Comcode
					Major	Minor	Lbs./Ft.	Gr./m	
BHAP	0025	22	NS	6540(1994)	1.39(35)	0.93(24)	0.47	699	102857133
	0050	22	NS	4900(1494)	1.60(41)	1.14(29)	0.65	967	102857141
	0100*	22	NS	3270(997)	1.83(46)	1.37(35)	0.95	1414	102857166
BHBP	0025	19	NS	4810(1466)	1.68(43)	1.20(31)	0.71	1057	102857109
	0050	19	NS	3200(975)	1.94(49)	1.46(37)	1.03	1533	102857117
BKMP	0025	24	S	8500(2591)	1.31(33)	0.85(22)	0.42	625	102857174
	0050	24	S	6800(2073)	1.43(36)	0.97(25)	0.53	789	102857182
	0100*	24	S	4250(1296)	1.65(42)	1.19(30)	0.75	1116	102857208
	0200*	24	S	3390(1034)	1.91(49)	1.45(37)	1.12	1667	102857224
	0300*	24	NS	2530(771)	2.25(57)	1.73(44)	1.49	2217	107215527
BKTP	0025	26	S	8820(2689)	1.24(31)	0.78(20)	0.39	580	102857232
	0050	26	S	7560(2305)	1.35(34)	0.89(23)	0.46	685	102857240
	0100	26	S	5880(1793)	1.47(37)	1.01(26)	0.58	863	102857257
	0200*	26	S	4060(1238)	1.71(43)	1.25(32)	0.84	1250	102857273
	0300*	26	S	3770(1150)	1.83(46)	1.37(35)	1.06	1577	102857281

*Bonded aluminum shield.

Notes:

1. AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eyes are not available.
3. Longer lengths are available: contact an AT&T Sales Representative.

Alpeth Sheath (Air Core)

These cables are primarily designed for aerial use. ***They should not be used for buried installation.*** If the environment where they are being installed is subject to sheath damage due to wildlife, etc., the Alpeth-UM design shown on Page 14-16 should be used.

ALPETH SHEATH (AIR CORE)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight Lbs./Ft.	Nominal Weight Gr./m	Comcode
BHBA	0025	19	S	9720(2963)	0.82(21)	0.33	491	100022151
	0050	19	NS	4860(1482)	1.09(28)	0.59	878	100022185
	0100	19	NS	3240(988)	1.48(38)	1.12	1667	100022243
	0200	19	NS	2400(732)	1.97(50)	2.18	3244	100022300
	0300	19	NS	1590(485)	2.36(60)	3.21	4777	100022334
BHAA	0025	22	S	9810(2991)	0.62(16)	0.19	283	100021146
	0050	22	S	9810(2991)	0.80(20)	0.33	491	100021179
	0100	22	S	4900(1494)	1.09(28)	0.60	893	100021237
	0200	22	S	3920(1195)	1.45(37)	1.13	1682	100021294
	0300	22	S	3270(997)	1.68(43)	1.67	2485	100021328
	0400	22	S	2170(662)	1.93(49)	2.18	3244	100021351
	0600	22	S	1360(415)	2.28(58)	3.21	4777	100021385
	0900	22	S	1190(363)	2.82(72)	4.75	7069	103711339
BKMA	025	24	S	11340(3457)	0.58(15)	0.13	193	100023043
	0050	24	S	10200(3109)	0.70(18)	0.22	327	100023076
	0100	24	S	8500(2591)	0.88(22)	0.39	580	100023134
	0200	24	S	5430(1656)	1.18(30)	0.72	1071	100023191
	0300	24	S	4240(1293)	1.38(35)	1.05	1563	100023225
	0400	24	S	3770(1150)	1.53(39)	1.39	2069	100023258
	0600	24	S	2390(729)	1.87(47)	2.03	3021	100023282
	0900	24	S	1670(510)	2.31(59)	2.97	4420	100023316
	1200	24	S	1360(415)	2.53(64)	4.00	5953	103711313
	1500	24	S	1020(311)	2.86(73)	4.95	7366	103711305
	1800	24	S	910(278)	3.04(77)	5.92	8810	103711297

ALPETH SHEATH (AIR CORE) (Contd)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
BKTA	0025	26	NS	10580(3225)	0.52(13)	0.10	149	100024025
	0050	26	S	10580(3225)	0.58(15)	0.16	238	100024058
	0100	26	S	10580(3225)	0.70(18)	0.27	402	100024116
	0200	26	S	8820(2689)	0.94(24)	0.48	714	100024173
	0300	26	S	7500(2287)	1.09(28)	0.70	1042	100024207
	0400	26	S	5240(1598)	1.29(33)	0.91	1354	100024231
	0600	26	S	3720(1134)	1.54(39)	1.33	1979	100024264
	0900	26	S	2610(796)	1.81(46)	1.94	2887	100024298
	1200	26	S	2140(653)	2.01(51)	2.54	3780	103711248
	1500	26	S	1430(436)	2.28(58)	3.15	4688	103711255
	1800	26	S	1430(436)	2.42(61)	3.75	5581	103711412
	2100	26	NS	1160(354)	2.61(66)	4.35	6473	103711404
	2700	26	NS	910(278)	2.90(74)	5.56	8274	103711396

Notes:

1. AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eye available on all pair sizes.
3. Longer lengths are available: contact an AT&T Sales Representative.

Alpeth Sheath (Air Core) — UM Protection

These cables are used primarily in aerial application. ***They should not be used for buried installations.*** Use where additional sheath protection is required due to wildlife, etc.

ALPETH SHEATH (AIR CORE) — UM PROTECTION								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
BHBA-UM	0025	19	NS	4860(1482)	1.01(26)	0.48	714	102314374
	0050	19	NS	4860(1482)	1.31(33)	0.83	1235	102314382
	0100	19	NS	2400(732)	1.68(43)	1.45	2158	102614518
	0200	19	NS	1920(586)	2.22(56)	2.66	3958	102614534
	0300	19	NS	1070(327)	2.63(67)	3.73	5551	102614542
BHAA-UM	0025	22	NS	9810(2991)	0.81(21)	0.32	476	102314259
	0050	22	NS	9810(2991)	1.01(26)	0.50	744	102314267
	0100	22	NS	4540(1384)	1.27(32)	0.81	1205	102314283
	0200	22	NS	3030(924)	1.68(43)	1.40	2083	102614385
	0300	22	NS	2170(662)	1.91(49)	2.04	3036	102614393
	0400	22	NS	1770(540)	2.28(58)	2.61	3884	102614401
	0600	22	NS	1190(363)	2.54(65)	3.73	5551	102614419
BKMA-UM	0025	24	NS	11340(3457)	0.77(20)	0.24	357	102314440
	0050	24	NS	9050(2759)	0.86(22)	0.37	551	102314457
	0100	24	NS	6800(2073	1.07(27)	0.57	848	102314473
	0200	24	NS	4550(1387)	1.40(36)	0.98	1458	102612546
	0300	24	NS	3400(1037)	1.61(41)	1.35	2009	102613478
	0400	24	NS	2730(833)	1.77(45)	1.72	2560	102613486
	0600	24	NS	1940(592)	2.11(54)	2.44	3631	102612553
	0900	24	NS	1360(415)	2.57(65)	3.52	5238	102612561

ALPETH SHEATH (AIR CORE) — UM PROTECTION (Contd)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
BKTA-UM	0025	26	NS	10580(6831)	0.70(18)	0.19	283	102314515
	0050	26	NS	10580(3225)	0.77(20)	0.27	402	102314523
	0100	26	NS	10580(3225)	0.89(23)	0.40	595	102314531
	0200	26	NS	6600(2012)	1.14(29)	0.69	1027	102314556
	0300	26	NS	5250(1601)	1.30(33)	0.93	1384	102612819
	0400	26	NS	3740(1140)	1.50(38)	1.14	1696	102314564
	0600	26	NS	2720(830)	1.78(45)	1.64	2441	102612827
	0900	26	NS	2010(613)	2.05(52)	2.42	3601	102612835

Notes:

1. AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eyes available on all pair sizes.
3. Longer lengths are available: contact an AT&T Sales Representative.

Bonded PASP Sheath (Air Core)

Bonded PASP sheath is for buried use in rural or suburban areas where protection against lightning and mechanical damage is critical. Where moisture is a problem, DEPIC filled cable should be used (see Pages 14-22 and 14-23).

BONDED PASP SHEATH (AIR CORE)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
BHBH	0025	19	NS	9630(2936)	1.05(27)	0.45	670	100022821
	0050	19	NS	4810(1467)	1.27(32)	0.78	1161	100022847
	0100	19	NS	3240(988)	1.61(41)	1.38	2054	100022888
	0200	19	NS	1925(587)	2.16(55)	2.56	3810	100022920
	0300	19	NS	1190(363)	2.54(65)	3.68	5476	100022946
BHAH	0025	22	NS	9810(2991)	0.89(23)	0.29	432	100021856
	0050	22	NS	10050(3063)	1.05(27)	0.45	670	100021872
	0100	22	NS	4900(1494)	1.27(32)	0.78	1161	100021914
	0200	22	NS	3280(1000)	1.61(41)	1.38	2054	100021955
	0300	22	NS	2170(662)	1.90(48)	1.99	2961	100021971
	0400	22	NS	1950(595)	2.09(53)	2.56	3810	100021997
	0600	22	NS	1190(363)	2.55(65)	3.68	5476	100022011
	0900	22	NS	870(266)	3.01(76)	5.33	7932	103711321
BKMH	0025	24	NS	15050(4587)	0.85(22)	0.22	327	100023746
	0050	24	S	10000(3048)	0.93(24)	0.33	491	100023761
	0100	24	S	6800(2073)	1.11(28)	0.53	789	100023803
	0200	24	S	6020(1835)	1.35(34)	0.94	1399	100023845
	0300	24	S	3400(1037)	1.57(40)	1.31	1949	100023860
	0400	24	S	2830(863)	1.70(43)	1.70	2530	100023886
	0600	24	S	1990(607)	2.03(52)	2.42	3601	100023902
	0900	24	S	1390(424)	2.48(63)	3.47	5164	100023928
	1200	24	S	1170(357)	2.76(70)	4.51	6712	103711289
	1500	24	S	910(278)	3.07(78)	5.53	8229	103711271
	1800	24	S	820(250)	3.28(83)	6.55	9747	103711263

BONDED PASP SHEATH (AIR CORE) (Contd)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
BKTH	0025	26	NS	10580(3225)	0.85(22)	0.18	268	100024728
	0050	26	NS	10580(3225)	0.89(23)	0.25	372	100024744
	0100	26	NS	10560(3219)	0.93(24)	0.38	565	100024785
	0200	26	NS	6600(2012)	1.15(29)	0.65	967	100024827
	0300	26	NS	5280(1610)	1.35(34)	0.89	1324	100024843
	0400	26	NS	4400(1342)	1.43(36)	1.12	1667	100024868
	0600	26	S	2900(884)	1.70(43)	1.57	2336	100024884
	0900	26	S	2100(640)	1.99(51)	2.27	3378	100024900
	1200	26	NS	1830(558)	2.24(57)	2.94	4375	103711388
	1500	26	NS	1430(436)	2.48(63)	3.59	5342	103711370
	1800	26	NS	1170(357)	2.67(68)	4.24	6310	103711347
	2100	26	NS	1070(327)	2.84(72)	4.89	7277	103711354
	2700	26	NS	800(244)	3.13(80)	6.16	9167	103711362

Notes:

1. AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eye available on all pair sizes.
3. Longer lengths are available: contact an AT&T Sales Representative.

Bonded Stalpeth Sheath (Air Core)

Cables with bonded Stalpeth sheath are designed for use in ducts. A bonded Stalpeth sheath is used where lightning exposure is at a minimum. The sheath consists of a corrugated aluminum, a corrugated steel, and a polyethylene jacket that is bonded to the steel by a copolymer coating on the steel. This sheath is applied over a core wrap that covers the pulp core of plastic insulated conductors. See the table below.

BONDED STALPETH SHEATH (AIR CORE)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
BHAZ	0011	22	NS	9180(2799)	0.53(13)	0.15	223	105448146
	0016	22	NS	9180(2799)	0.59(15)	0.18	268	105447130
	0025	22	NS	9090(2771)	0.70(18)	0.24	357	105447148
	0050	22	NS	9090(2771)	0.86(22)	0.40	595	105447155
	0100	22	NS	6060(1848)	1.11(28)	0.68	1012	105447171
	0200	22	NS	4540(1384)	1.48(38)	1.21	1801	105447197
	0300	22	NS	2580(787)	1.78(45)	1.75	2604	105447205
	0400	22	NS	2270(692)	2.02(51)	2.28	3393	105447213
	0600	22	NS	1540(470)	2.44(62)	3.34	4970	105447221
	0900	22	NS	1130(345)	2.93(74)	4.89	7277	105447239
BKMZ	0025	24	NS	11700(3567)	0.62(16)	0.18	268	105447346
	0050	24	NS	11700(3567)	0.72(18)	0.28	417	105447353
	0100	24	NS	9060(2762)	0.91(23)	0.48	714	105447379
	0200	24	NS	5430(1656)	1.25(32)	0.82	1220	105447395
	0300	24	NS	3880(1183)	1.46(37)	1.16	1726	105447403
	0400	24	NS	3400(1037)	1.65(42)	1.50	2232	105447411
	0600	24	NS	2270(692)	1.95(50)	2.18	3244	105447429
	0900	24	NS	1360(415)	2.30(58)	3.17	4717	105447437
	1200	24	NS	1130(345)	2.65(67)	4.17	6206	105447445
	1500	24	NS	1010(308)	2.98(76)	5.15	7664	105447452
	1800	24	NS	900(275)	3.10(79)	6.13	9122	105447460

BONDED STALPETH SHEATH (AIR CORE) (Contd)								
Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
BKTZ	0025*	26	NS	11200(3414)	0.51(13)	0.14	208	105447478
	0050	26	NS	11200(3414)	0.62(16)	0.21	313	105447486
	0100	26	NS	11200(3414)	0.77(20)	0.33	491	105447494
	0200	26	NS	9020(2750)	1.00(25)	0.55	818	105447510
	0300	26	NS	6020(1835)	1.21(31)	0.78	1161	105447528
	0400	26	NS	5410(1649)	1.31(33)	0.99	1473	105447536
	0600	26	NS	3380(1031)	1.60(41)	1.42	2113	105447544
	0900	26	NS	2700(823)	1.88(48)	2.04	3036	105447551
	1200	26	NS	1940(592)	2.10(53)	2.66	3958	105447569
	1500	26	NS	1690(516)	2.30(58)	3.28	4881	105447577
	1800	26	NS	1350(412)	2.56(65)	3.90	5804	105447585
	2100	26	NS	1130(345)	2.78(71)	4.51	6712	105447593
	2700	26	NS	900(275)	3.06(78)	5.75	8557	105447601

* Pulling eye not available on these pair sizes.

Notes:

1. AWG metric equivalent: 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Longer lengths are available: contact an AT&T Sales Representative.

Noncolor-Coded Bonded Stalpeth Sheath (Air Core)

Cables with bonded Stalpeth sheath are designed for use in ducts. A bonded Stalpeth sheath is used where lightning exposure is at a minimum.

NONCOLOR-CODED BONDED STALPETH SHEATH (AIR CORE)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
NKMZ	0200	24	NS	5850(1784)	1.25(31)	0.82	1220	103712758
	0300	24	NS	3920(1195)	1.46(37)	1.16	1726	103877098
	0400	24	NS	3340(1019)	1.65(42)	1.50	2232	103712766
	0600	24	NS	2260(689)	1.95(50)	2.15	3200	105448237
	0900	24	NS	1670(510)	2.30(58)	3.15	4688	105448245
	1200	24	NS	1130(345)	2.74(70)	4.14	6161	105448252
	1500	24	NS	1080(329)	2.98(76)	5.11	7604	105448260
	1800	24	NS	870(266)	3.10(79)	6.12	9107	106248602
	2100	24	NS	800(244)	3.37(86)	7.08	10536	106248594
NKTZ	1200	26	NS	2250(686)	2.10(53)	2.65	3944	104256763
	1500	26	NS	1800(549)	2.30(58)	3.26	4851	104256755
	1800	26	NS	1450(442)	2.56(65)	3.89	5789	104256771
	2100	26	NS	1180(360)	2.78(71)	4.50	6697	104227962
	2400	26	NS	1000(305)	2.90(74)	5.15	7664	104227970
	2700	26	NS	900(275)	3.06(78)	5.75	8557	104227988
	3000	26	NS	820(250)	3.21(82)	6.65	9896	104227996
	3600	26	NS	820(250)	3.35(85)	7.53	11206	105448229

Notes:

1. AWG metric equivalent: 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eye available on all pair sizes.
3. Longer lengths are available: contact an AT&T Sales Representative.

GF-Type ASP Sheath (Filled) DEPIC Nonscreened

AT&T 626-101-010

Filled Cable is designed to minimize moisture penetration in buried PVC cable. This cable features DEPIC (foam/skin) insulation and an ASP Sheath, the preferred sheath for mechanical protection. UM-type protection is available over ASP sheath when additional mechanical protection is necessary. See Pages 14-25 and 14-26.

GF-TYPE ASP SHEATH (FILLED) DEPIC NONSCREENED								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
GFBW	0006	19	S	9720(2963)	0.59(15)	0.18	268	107019341
	0011	19	S	9720(2963)	0.67(17)	0.23	342	107019358
	0025	19	S	9720(2963)	0.91(23)	0.46	685	106578768
	0050	19	NS	4810(1467)	1.17(30)	0.79	1176	106578776
	0075	19	NS	4810(1467)	1.35(34)	1.23	1830	106578792
	0100	19	NS	3200(976)	1.51(38)	1.55	2307	106578800
	0150	19	NS	2400(732)	1.72(44)	1.96	2917	106578826
	0200	19	NS	1930(589)	2.05(52)	2.93	4360	106578925
	0300	19	NS	1370(418)	2.45(62)	4.25	6325	106578933
GFAW	0011	22	S	20150(6142)	0.59(15)	0.17	253	107019374
	0016	22	NS	20150(6142)	0.61(15)	0.21	313	107019382
	0025	22	S	20150(6142)	0.71(18)	0.27	402	106579055
	0050	22	S	10100(3078)	0.91(23)	0.44	655	106579063
	0075	22	NS	6930(2112)	1.03(26)	0.61	908	107063067
	0100	22	S	5000(1524)	1.13(29)	0.79	1176	106579089
	0150	22	NS	4540(1384)	1.33(34)	1.12	1667	106579097
	0200	22	S	4040(1231)	1.49(38)	1.43	2128	106579105
	0300	22	S	2885(879)	1.83(46)	2.18	3244	106579113
	0400	22	S	2525(770)	2.02(51)	2.82	4197	106579121
	0600	22	S	1680(512)	2.52(64)	3.96	5893	106579139
	0900	22	S	1120(341)	2.92(74)	5.81	8646	106579147
	1200	22	S	760(232)	3.34(85)	7.56	11250	106579154

GF-TYPE ASP SHEATH (FILLED) DEPIC NONSCREENED (Contd)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
GFMW	0025	24	S	15050(4587)	0.61(15)	0.21	313	106583909
	0050	24	S	15050(4587)	0.77(20)	0.33	491	106583917
	0100	24	S	10000(3048)	0.99(25)	0.55	818	106583933
	0200	24	S	6040(1841)	1.29(33)	0.97	1443	106583958
	0300	24	S	3780(1152)	1.48(38)	1.38	2054	106583966
	0400	24	S	3775(1151)	1.65(42)	1.75	2604	106583974
	0600	24	S	2260(689)	2.01(51)	2.59	3854	106583982
	0900	24	S	1675(511)	2.41(61)	3.80	5655	106584154
	1200	24	S	1255(383)	2.93(74)	4.97	7396	106584162
	1500	24	S	1005(306)	3.02(77)	6.18	9197	106584170
	1800	24	S	820(250)	3.30(84)	7.24	10774	106584188
GFTW	0025	26	S	30050(9159)	0.59(15)	0.17	253	106584709
	0050	26	S	15050(4587)	0.68(17)	0.24	357	106584717
	0100	26	S	15050(4587)	0.83(21)	0.37	551	106584733
	0200	26	S	9500(2896)	1.07(27)	0.66	992	106584758
	0300	26	S	6690(2039)	1.19(30)	0.94	1399	106584766
	0400	26	S	5470(1667)	1.37(35)	1.15	1711	106584774
	0600	26	S	3340(1018)	1.63(41)	1.73	2574	106584782
	0900	26	S	2510(765)	1.93(49)	2.47	3676	106584790
	1200	26	NS	1641(500)	2.11(54)	3.29	4896	106584808

GF-TYPE ASP SHEATH (FILLED) DEPIC NONSCREENED (Contd)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
GFTW	1500	26	NS	1670(509)	2.34(59)	3.93	5848	106584816
(Contd)	1800	26	NS	1505(459)	2.55(65)	4.63	6890	106584824
	2100	26	NS	1160(354)	2.80(71)	5.32	7917	106584832
	2400	26	NS	910(278)	2.92(74)	6.01	8944	106584840
	2700	26	NS	840(257)	3.13(80)	6.77	10074	106584857
	3000	26	NS	840(257)	3.24(82)	7.39	10997	106584865

Notes:
1. AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eye available on all pair sizes.
3. Longer lengths are available: contact an AT&T Sales Representative.

GF-TYPE ASP SHEATH (FILLED) DEPIC NONSCREENED — UM PROTECTION								
Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
GFBW-UM	0006	19	NS	9720(2963)	0.78(20)	0.32	476	107015893
	0011	19	NS	9720(2963)	0.86(22)	0.42	625	107015901
	0016	19	NS	4860(1482)	1.03(26)	0.52	774	107015919
	0025	19	NS	4860(1482)	1.11(28)	0.69	1027	107015927
	0050	19	NS	3240(988)	1.38(35)	1.12	1667	107015935
	0075	19	NS	3210(784)	1.57(40)	1.52	2262	107015943
	0100	19	NS	2410(735)	1.74(44)	1.89	2813	107015950
	0150	19	NS	1930(589)	1.96(50)	2.67	3973	107015968
	0200	19	NS	13709(418)	2.30(58)	3.39	5045	107015976
	0300	19	NS	1070(327)	2.75(70)	4.82	7173	107015984
GFAW-UM	0011	22	NS	9090(2771)	0.69(18)	0.29	432	107015992
	0016	22	NS	9090(2771)	0.71(18)	0.33	491	107016008
	0025	22	NS	9090(5542)	0.80(20)	0.40	595	107016016
	0050	22	NS	6060(2771)	0.99(25)	0.63	938	107016032
	0075	22	NS	6060(2113)	1.15(29)	0.82	1220	107014896
	0100	22	NS	4540(1525)	1.36(35)	1.01	1503	107016040
	0150	22	NS	3630(1384)	1.50(39)	1.39	2069	107016057
	0200	22	NS	2590(1232)	1.76(45)	1.74	2589	107016065
	0300	22	NS	2270(880)	2.06(52)	2.45	3646	107016073
	0400	22	NS	1810(770)	2.22(56)	3.11	4628	107016081
	0600	22	NS	1130(513)	2.64(67)	4.44	6607	107016099
	0900	22	NS	860(342)	3.21(82)	6.63	9866	107016107

GF-TYPE ASP SHEATH (FILLED) DEPIC NONSCREENED — UM PROTECTION (Contd)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
GFMW-UM	0025	24	NS	9050(2759)	0.75(19)	0.33	491	107016115
	0050	24	NS	9050(2759)	0.90(23)	0.48	714	107016131
	0100	24	NS	6790(2070)	1.10(28)	0.74	1101	107016149
	0200	24	NS	3880(1183)	1.45(37)	1.22	1816	107016156
	0300	24	NS	3010(918)	1.65(42)	1.68	2500	107016172
	0400	24	NS	2710(827)	1.95(50)	2.17	3229	107016198
	0600	24	NS	1700(519)	2.26(57)	3.02	4494	107016206
	0900	24	NS	1130(345)	2.70(69)	4.31	6414	107016222
	1200	24	NS	900(275)	3.07(78)	5.69	8468	107016248
	1500	24	NS	810(247)	3.24(82)	6.85	10194	107016271
GFTW-UM	0025	26	NS	8960(4351)	0.82(21)	0.28	417	107016297
	0050	26	NS	8960(3937)	0.87(22)	0.38	565	107016313
	0100	26	NS	8960(4588)	0.96(24)	0.55	818	107016339
	0200	26	NS	6020(2896)	1.23(31)	0.86	1280	107016354
	0300	26	NS	4400(2040)	1.40(36)	1.23	1830	107016370
	0400	26	NS	3520(1668)	1.59(40)	1.52	2262	107016396
	0600	26	NS	2370(1019)	1.85(47)	2.09	3110	107016404
	0900	26	NS	1860(766)	2.18(55)	2.93	4360	107016420
	1200	26	NS	1430(436)	2.36(60)	3.70	5506	107016446
	1500	26	NS	1160(354)	2.61(66)	4.45	6622	107016453
	1800	26	NS	1080(330)	2.83(72)	5.20	7738	107016487
	2100	26	NS	800(244)	3.09(78)	6.04	8988	107016506
	2400	26	NS	800(244)	3.21(82)	6.80	10119	107016511
	2700	26	NS	600(183)	3.44(87)	7.25	10789	103911202

Notes:

1. AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eyes available on all pair sizes.
3. Longer lengths are available: contact an AT&T Sales Representative.

GF-Type Bonded ASP (Filled) DEPIC Nonscreened

AT&T 626-200-400

GF-TYPE BONDED ASP (FILLED) DEPIC NONSCREENED								
Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
GFAY	0600	22	NS	1375(419)	2.38(60)	4.00	5953	105714844
	0900	22	NS	860(263)	2.90(74)	5.81	8646	105714851
	1200	22	NS	780(238)	3.24(82)	7.40	11012	105714869
GFMY	0600	24	NS	1880(573)	1.91(49)	2.59	3854	105714877
	0900	24	NS	1390(424)	2.30(58)	3.76	5595	105714885
	1200	24	NS	1175(358)	2.59(66)	4.95	7366	105715387
	1500	24	NS	910(278)	2.90(74)	6.18	9197	105715379
	1800	24	NS	820(250)	3.13(80)	7.27	10819	105715361
GFTY	0600	26	NS	3340(1018)	1.57(40)	1.73	2574	105715346
	0900	26	NS	2370(723)	1.89(48)	2.47	3676	105715338
	1200	26	NS	1850(564)	2.09(53)	3.29	4896	105715312
	1500	26	NS	1430(436)	2.30(58)	3.93	5848	105715304
	1800	26	NS	1280(391)	2.51(64)	4.63	6890	105715296
	2100	26	NS	1160(354)	2.74(70)	5.44	8095	105715593
	2400	26	NS	910(278)	2.88(73)	6.23	9271	105715601
	2700	26	NS	900(275)	3.07(78)	6.91	10283	105715619
	3000	26	NS	830(253)	3.23(82)	7.39	10997	105714471

Notes:

1. AWG metric equivalent: 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Pulling eyes available on all pair sizes.
3. Longer lengths are available: contact an AT&T Sales Representative.

AR Series Riser Cable

AT&T 626-107-006

The AR series riser cables have expanded polyethylene-polyvinyl chloride (XPE-PVC) insulated conductors and have bonded Alvyn sheath.

The AR series riser cables are intended for use in commercial and telephone company buildings. The National Electrical Code (NEC) requires that cables used in buildings covered by the code have a fire-resistant covering capable of preventing the carrying of fire from floor to floor. The AR series cables meet the code requirements.

AR SERIES RISER CABLE								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
ARAM	0025	22	NS	7740(2360)	0.61(15)	0.21	313	105509541
	0050	22	NS	7740(2360)	0.78(20)	0.34	506	105509558
	0100	22	NS	7740(2360)	0.97(25)	0.61	908	105509574
	0200	22	NS	3870(1180)	1.30(33)	1.11	1652	103562559
	0300	22	NS	2580(787)	1.55(39)	1.61	2396	103562567
	0400	22	NS	2580(787)	1.80(46)	2.12	3155	103562575
	0600	22	NS	1710(522)	2.18(55)	3.13	4658	103562583
	0900	22	NS	1190(363)	2.70(69)	4.62	6875	103562591
ARMM	0025	24	NS	11340(3457)	0.53(13)	0.14	208	105462287
	0050	24	NS	11340(3457)	0.65(17)	0.23	342	105462295
	0100	24	NS	11340(3457)	0.87(22)	0.43	640	103562609
	0150	24	NS	7560(2305)	0.96(24)	0.59	878	103562617
	0200	24	NS	7560(2305)	1.09(28)	0.75	1116	103562625
	0300	24	NS	4530(1381)	1.30(33)	1.09	1622	103562633
	0400	24	NS	3780(1153)	1.48(38)	1.43	2128	103562641
	0600	24	NS	2830(863)	1.80(46)	2.10	3125	103562658
	0900	24	NS	1890(577)	2.15(55)	3.07	4569	103562666
	1200	24	NS	1510(461)	2.42(61)	4.05	6027	103562674
	1500	24	NS	1080(330)	2.75(70)	5.03	7485	103730198
	1800	24	NS	1080(330)	2.94(75)	5.96	8869	103562682

AR SERIES RISER CABLE (Contd)								
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
ARTM	0050	26	NS	11200(3414)	0.60(15)	0.18	268	105509582
	0100	26	NS	11200(3414)	0.75(19)	0.30	446	105509590
	0200	26	NS	8970(2735)	0.94(24)	0.52	774	105509608
	0300	26	NS	6400(1951)	1.10(28)	0.73	1086	103562690
	0400	26	NS	6400(1951)	1.20(30)	0.95	1414	103562708
	0600	26	NS	4480(1366)	1.44(37)	1.40	2083	103562716
	0900	26	NS	2800(854)	1.80(46)	2.04	3036	103562724
	1200	26	NS	2130(650)	2.02(51)	2.67	3973	103562732
	1800	26	NS	1490(455)	2.42(61)	3.89	5789	103562740
	2400	26	NS	1140(348)	2.78(71)	5.13	7634	103562757
	2700	26	NS	1060(324)	2.92(74)	5.75	8557	103562765
	3000	26	NS	870(266)	3.05(77)	6.35	9450	103562773
	3600	26	NS	820(250)	3.29(84)	7.60	11310	103562781

Note:

1. AWG metric equivalent: 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.
2. Longer lengths available: Contact an AT&T Sales Representative.

SCREENED BONDED PASP SHEATH

Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
KHAH	0028	22	S	6540(1994)	0.97(25)	0.35	521	103268645
	0054	22	S	6540(1994)	1.11(28)	0.53	789	103268686
	0106	22	S	3920(1195)	1.35(34)	0.87	1295	103268728
	0158	22	NS	3240(988)	1.57(40)	1.21	1801	103268769
	0210	22	S	2770(844)	1.70(43)	1.52	2262	103268801
	0314	22	NS	1940(591)	2.03(52)	2.15	3200	103268843
	0418	22	NS	1760(537)	2.24(57)	2.68	3988	103268884
	0616	22	S	1180(360)	2.65(67)	3.96	5893	103268926

Notes:

1. AWG metric equivalent: 22 Ga = 0.6 mm
2. Pulling eye available on all pair sizes.
3. Longer lengths are available: Contact an AT&T Sales Representative.
4. Codes less than 100-pair 22-gauge are T1 compatible; remaining codes are T1C compatible.

SCREENED DEPIC ASP SHEATH

Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight Lbs./Ft.	Nominal Weight Gr./m	Comcode
KFAW	0054	22	S	9090(2771)	0.93(24)	0.50	744	103342184
	0106	22	S	6050(1844)	1.24(31)	0.90	1339	103342192
	0158	22	NS	4540(1384)	1.41(36)	1.23	1830	103342200
	0210	22	S	3020(921)	1.63(41)	1.57	2336	103342218
	0314	22	NS	2270(692)	1.94(49)	2.26	3363	103342226
	0418	22	NS	1810(552)	2.22(56)	2.87	4271	103342234
	0616	22	NS	1290(393)	2.55(65)	4.09	6086	103342242

Notes:

1. AWG metric equivalent: 22 Ga = 0.6 mm
2. Pulling eyes available on all pair sizes.
3. Longer lengths are available: Contact an AT&T Sales Representative.
4. KFAW-54 is T1 compatible; remaining codes are T1C compatible.

SCREENED DEPIC ASP SHEATH (FILLED) — UM PROTECTION

Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight Lbs./Ft.	Nominal Weight Gr./m	Comcode
KFAW-UM	0054	22	NS	6050(1845)	1.13(29)	0.71	1057	103603189
	0106	22	NS	3630(1107)	1.45(37)	1.16	1726	103603197
	0158	22	NS	3020(921)	1.64(42)	1.55	2307	103603205
	0210	22	NS	2580(787)	1.87(48)	1.94	2887	103603213
	0314	22	NS	1810(552)	2.20(56)	2.70	4018	103603221
	0418	22	NS	1390(424)	2.50(64)	3.38	5030	103603239
	0616	22	NS	1130(345)	2.85(72)	4.69	6979	103603247

Notes:

1. AWG metric equivalent: 22 Ga = 0.6 mm
2. Pulling eyes available on all pair sizes.
3. Longer lengths are available: Contact an AT&T Sales Representative.
4. KFAW-54 is T1 compatible; remaining codes are T1C compatible.

SCREENED SOLID ASP SHEATH

Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
KGAW	0028	22	S	6840(2085)	0.89(23)	0.34	506	103343299
	0054	22	S	6840(1525)	1.07(27)	0.62	923	103343281
	0106	22	NS	4550(1387)	1.41(36)	1.10	1637	103343315
	0210	22	NS	2730(833)	1.83(46)	1.98	2947	103343331

Notes:

1. AWG metric equivalent: 22 Ga = 0.6 mm
2. Pulling eyes available on all pair sizes.
3. Longer lengths are available: Contact an AT&T Sales Representative.
4. Codes less than 100-pair 22-gauge are T1 compatible; remaining codes are T1C compatible.

SCREENED SOLID ASP SHEATH (FILLED) — UM PROTECTION

Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode
						Lbs./Ft.	Gr./m	
KGAW-UM	0028	22	NS	6840(2085)	1.09(28)	0.49	729	103359303
	0054	22	NS	4550(1387)	1.28(33)	0.84	1250	103603254
	0106	22	NS	3420(1042)	1.64(42)	1.42	2113	103603262
	0210	22	NS	1710(522)	2.09(53)	2.42	3601	103603288

Notes:

1. AWG metric equivalent: 22 Ga = 0.6 mm
2. Pulling eyes available on all pair sizes.
3. Longer lengths are available: Contact an AT&T Sales Representative.
4. Codes less than 100-pair 22-gauge are T1 compatible; remaining codes are T1C compatible.

Plenum Cables

AT&T 461-200-100

Plenum cables are used within buildings through air handling spaces including air returns, space between a suspended ceiling and the floor above, or space between a false floor and the floor below. Since these cables are installed without conduit, they are constructed to possess fire-resistant and low smoke producing qualities. They are UL Listed Type CMP meeting National Electric Code (NEC) 800 and are available in 22 and 24 gauge. Plenum cables are listed below.

PLENUM CABLES			
Type Of Cable		Pair Size	Gauge
Plenum Cable (CMP)	C Plenum Cable	2,3,4,6 and 25	24
	ECTFE/ ECTFE	2-100	22 24
	ECTFE/ PVDF-CP	2-100	22 24
	"TEFLON*"/ ECTFE	4,25,50, 75,100	24
* Registered trademark of E.I. du Pont de Nemours and Co., Inc.			

CABLE STUBS

1A1 and 1B1 Terminal Stubs

AT&T 631-240-21

These terminal stubs are used to extend cable pairs from pulp-insulate cable or large PIC cables into a 105-type aerial terminal. They are gastigh 50-pair, 24-gauge PIC cable stubs.

The 1A1 terminal stub has a PVC sheath and is intended to be spliced t the main cable using a splice case or a closure. They are available in 9-foc lengths only.

The 1B1 terminal stub has a lead sheath and is intended for use with lead sleeve. They are available in 9-, 15-, and 25-foot lengths.

10A1, 10B1, 10C1, and 12B1 Cable Stubs

AT&T 631-020-10

These stubs contain an air plug and are used between pressurized an nonpressurized cable to keep the cables separated pneumatically.

Stub	Pair Sizes	Standard Lengths Ft. (m)
10A1	50, 100, 200, 300, 400 600, 900 in 24 gauge	20(6.1), 30(9.1), 40(12.2), 50(15.2) 30(9.1)
10B1	50, 100, 200, 300, 400 600, 900 in 24 gauge; 1200, 1500, 1800 in 26 gauge	20(6.1), 30(9.1), 40(12.2), 50(15.2) 30(9.1) 30(9.1)
10C1	27, 52, 104 in 22 gauge	20(6.1), 30(9.1), 40(12.2), 50(15.2)
12B1	300, 600, 900 in 24 gauge; 1200, 1500, 1800 in 26 gauge	30(9.1) 30(9.1)

RURAL ELECTRIFICATION ADMINISTRATION (REA) LISTED CABLE

REA Listed Cable Identification Code

AT&T 626-020-001

REA listed cables are identified with a 5-letter code to simplify their designation in ordering, manufacturing, and on records.

W B 9 A R 0100

PAIR SIZE

CABLE TYPE
R - REA Listed

TYPE OF SHEATH
A -- Coated Alpeth (CAP)
C -- 5-mil Copper
J -- Copper Alloy 194
W -- Coated Aluminum And Steel (CACSP)

GAUGE OF CONDUCTORS
2 = 22 AWG (0.6 mm)
4 = 24 AWG (0.5 mm)
6 = 26 AWG (0.4 mm)
9 = 19 AWG (0.9 mm)

CORE TYPE AND CONDUCTOR INSULATION
A - FLEXGEL® Filled Foam Skin (DEPIC)
B - Air Core Solid
G - FLEXGEL Filled Solid

CABLE DESIGN
K - Screened Cable
W - Standard Exchange Cable

PE-22 REA Listed Air Core Cable With Coated Alpeth Sheath

This cable meets the requirements of REA Specification PE-22 for aerial service. The design features solid polyethylene insulation with full color-coding, a core wrap for electrical protection, coated aluminum for electromagnetic shielding, and a tough/flexible outer jacket. The aluminum is corrugated for mechanical flexibility.

Air core cable is available in an ALPETH sheath design with multiple pair sizes and standard gauge in both screened and nonscreened designs.

PE-22 REA LISTED AIR CORE CABLE WITH COATED ALPETH SHEATH									
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
WB9AR	0006	19	S	5000(1524)	0.53(13)	0.12	179	105183784	3A4
	0012	19	S	5000(1524)	0.60(15)	0.20	298	105183800	3A5
	0025	19	NS	5000(1524)	0.81(21)	0.35	521	105183834	3E6
	0050	19	S	2500(763)	1.08(27)	0.64	952	105183842	3E6
WB2AR	0006*	22	S	5000(1524)	0.43(11)	0.09	134	105184899	3A4
	0012	22	S	5000(1524)	0.53(13)	0.13	193	105184972	3A4
	0025	22	S	5000(1524)	0.70(18)	0.20	298	105185003	3A5
	0050	22	S	5000(1524)	0.85(22)	0.35	521	105185037	3E6.5
	0100	22	S	5000(1524)	1.07(27)	0.62	923	105188486	3E0
	0200	22	S	5000(1524)	1.48(38)	1.16	1726	105188437	3E0
	0300	22	NS	2000(610)	1.75(44)	1.69	2515	105188429	3E0
	0400	22	NS	2000(610)	1.96(50)	2.19	3259	105188403	3E0
	0600	22	NS	1000(305)	2.44(62)	3.23	4807	105188387	3E0
	0900	22	NS	1000(305)	2.88(73)	4.76	7084	105188379	3E0
	1200	22	NS	750(229)	3.29(84)	6.26	9316	105188296	3E0

PE-22 REA LISTED AIR CORE CABLE WITH COATED ALPETH SHEATH (Contd)

Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
WB4AR	0006*	24	S	10000(3049)	0.41(10)	0.07	104	105182406	3A4
	0012*	24	S	10000(3048)	0.46(12)	0.09	134	105182422	3A5
	0025	24	S	10000(3048)	0.55(14)	0.15	223	105182463	3E6
	0050	24	S	5000(1524)	0.66(17)	0.24	357	105182927	3A5
	0100	24	S	5000(1524)	0.87(22)	0.42	625	105182497	3E6.5
	0200	24	S	5000(1524)	1.18(30)	0.76	1131	105182539	3E0
	0300	24	S	2500(763)	1.38(35)	1.11	1652	105182703	3E6.5
	0400	24	S	2500(763)	1.53(39)	1.43	2128	105182711	3E0
	0600	24	S	2500(763)	1.85(47)	2.10	3125	105182745	3E0
	0900	24	S	1500(457)	2.31(59)	3.08	4583	105182752	3E0
	1200	24	S	1000(305)	2.69(68)	4.05	6027	105182760	3E0
	1500	24	NS	1000(305)	2.92(74)	4.99	7426	105182778	3E0
	1800	24	NS	750(229)	3.01(76)	5.93	8825	105182794	3E0
	2100	24	NS	500(153)	3.39(86)	6.93	10313	105186357	3E0
WB6AR	0025*	26	NS	10000(3048)	0.49(12)	0.11	164	105182919	3A5
	0050	26	NS	10000(3048)	0.57(14)	0.17	253	105182935	3E6
	0100	26	NS	10000(3048)	0.71(18)	0.29	432	105182968	3E6.5
	0200	26	NS	5000(1524)	0.97(25)	0.50	744	105182976	3E6.5
	0300	26	NS	5000(1524)	1.14(29)	0.72	1071	105182984	3E0
	0400	26	NS	5000(1524)	1.30(33)	0.92	1369	105183008	3E0
	0600	26	NS	2500(762)	1.54(39)	1.35	2009	105183016	3E0
	0900	26	NS	2500(762)	1.88(48)	1.97	2932	105183024	3E0
	1200	26	NS	1500(457)	2.10(53)	2.59	3854	105191456	3E0
	1500	26	NS	1500(457)	2.32(59)	3.18	4732	105183032	3E0
	1800	26	NS	1000(305)	2.48(63)	3.80	5655	105183040	3E0
	2100	26	NS	1000(305)	2.68(68)	4.39	6533	105183057	3E0
	2400	26	NS	1000(305)	2.90(74)	4.97	7396	105183065	3E0
	2700	26	NS	1000(305)	3.03(77)	5.55	8259	105183107	3E0
	3000	26	NS	750(229)	3.20(81)	6.14	9137	105183115	3E0

* Pulling eyes not available in these pair sizes.
Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.

Filled Self-Supported Cable

This self-supported filled ALPETH cable, also referred to as "figure-8 cable, is designed specifically for pole-to-pole installations, but can also b used for pole-to-building applications. Both the cable core and the galvanize steel support strand are enclosed within a common sheath, eliminating th problem of strand corrosion. This filled ALPETH cable consists of du expanded polyolefin insulated copper conductors, a ***FLEXGEL*** filled, full color-coded core, a core wrap and corrugated aluminum shield, a plastic we which holds the cable and strand together, and an extruded polyethylen jacket. The aluminum shield is bonded to the polyethylene jacket by copolymer coating.

The ***FLEXGEL*** filling compound makes filled cable virtually maintenanc free and gives the greatest possible protection for all filled cable application This cable is available in both screened and nonscreened designs.

FILLED SELF-SUPPORTED CABLE								
Cable Code	No. Of Pairs	AWG	Standard Length #420 Reel Ft.(m)*	Nominal Outside Dia. In.(mm)		Nominal Weight		Comcode
				Major	Minor	Lbs./Ft.	Gr./m	
WG2SR	0006	22	9930(3027)	0.96(24)	0.49(12)	0.24	357	106835192
WG2SR	0012	22	9930(3027)	1.00(25)	0.53(13)	0.27	402	106835200
WG2SR	0025	22	9810(2990)	1.16(29)	0.69(18)	0.36	536	106835218
WG2SR	0050	22	6540(1993)	1.34(34)	0.87(22)	0.52	774	106835226
WG4SR	0006	24	11340(3456)	0.88(22)	0.41(10)	0.22	327	106835234
WG4SR	0012	24	11340(3456)	0.96(24)	0.49(12)	0.24	357	106835242
WG4SR	0025	24	11340(3456)	1.02(26)	0.55(14)	0.29	432	106835259
WG4SR	0050	24	11340(3456)	1.18(30)	0.71(18)	0.40	595	106835267
WG6SR	0050	26	13320(4060)	1.08(27)	0.61(15)	0.32	476	106835275
WG6SR	0100	26	8820(2688)	1.26(32)	0.79(20)	0.45	670	106835283

* Longer lengths are available — please contact an AT&T Sales Representative or authorized distributor.
AWG metric equivalent: 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.

PE-89 REA Listed Filled Cable With Coated Alpeth Sheath

This cable meets the requirements of REA Specification PE-89 for direct burial cable, underground, and aerial applications. The design features foam-skin polyethylene insulation with full color-coding, a core wrap for electrical protection, coated aluminum for electromagnetic shielding, and a tough/flexible outer jacket. The aluminum is corrugated for mechanical flexibility. ***FLEXGEL*** filling compound fills the spaces between conductors, and flooding compound seals the sheath interfaces for resistance to water entry.

PE-89 REA LISTED FILLED CABLE WITH COATED ALPETH SHEATH

Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
WA9AR	0006	19	S	5000(1525)	0.52(13)	0.14	208	105185573	3A4
	0012	19	NS	5000(1525)	0.62(16)	0.23	342	105185565	3A5
	0025	19	S	5000(1525)	0.86(22)	0.41	610	105183859	3E6
	0050	19	S	5000(1525)	1.12(28)	0.76	1131	105183909	3E0
	0100	19	NS	2500(763)	1.51(38)	1.45	2158	105184071	3E0
	0200	19	NS	1500(458)	2.04(52)	2.65	3944	105184097	3E0
WA2AR	0006*	22	S	5000(1525)	0.48(12)	0.10	149	105183214	3A4
	0012	22	S	5000(1525)	0.52(13)	0.14	208	105183222	3A4
	0025	22	S	5000(1525)	0.66(17)	0.23	342	105183263	3A5
	0050	22	S	5000(1525)	0.86(22)	0.39	580	105183271	3E6
	0075	22	NS	5000(1525)	0.96(24)	0.54	804	105183289	3E6.5
	0100	22	S	5000(1525)	1.10(28)	0.71	1057	105183305	3E0
	0150	22	NS	5000(1525)	1.32(34)	1.03	1533	105183339	3E0
	0200	22	S	2500(763)	1.49(38)	1.32	1964	105183362	3E0
	0300	22	S	2000(610)	1.72(44)	1.91	2842	105183404	3E0
	0400	22	S	2000(610)	1.96(50)	2.52	3750	105183412	3E0
	0600	22	NS	1000(305)	2.40(61)	3.71	5521	105188098	3E0
	0900	22	NS	1000(305)	2.90(74)	5.44	8095	105183438	3E0
	1200	22	NS	750(229)	3.28(83)	7.40	11012	105183446	3E0

PE-89 REA LISTED FILLED CABLE WITH COATED ALPETH SHEATH (Contd)									
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
WA4AR	0006*	24	S	10000(3048)	0.44(11)	0.09	134	105185052	3A5
	0012*	24	S	10000(3048)	0.48(12)	0.11	164	105185078	3A5
	0025	24	S	10000(3048)	0.58(15)	0.16	238	105185110	3E6
	0050	24	S	10000(3048)	0.70(18)	0.27	402	105185144	3E6.5
	0075	24	NS	5000(1525)	0.86(22)	0.48	714	105185169	3E6
	0100	24	S	5000(1525)	0.94(24)	0.48	714	105185268	3E6.5
	0150	24	NS	5000(1525)	1.06(27)	0.70	1042	105185276	3E0
	0200	24	S	5000(1525)	1.20(30)	0.88	1310	105185284	3E0
	0300	24	S	2500(1278)	1.45(37)	1.27	1890	105185292	3E6.5
	0400	24	S	2000(610)	1.59(40)	1.66	2470	105185300	3E6.5
	0600	24	S	2000(610)	1.92(49)	2.39	3557	105185318	3E0
	0900	24	S	1000(305)	2.32(59)	3.28	4881	105185326	3E0
	1200	24	S	1000(305)	2.68(68)	4.70	6994	105185334	3E0
	1500	24	NS	1000(305)	2.92(74)	5.80	8631	105185375	3E0
	1800	24	NS	750(229)	3.20(81)	7.14	10625	105185383	3E0
	2100	24	NS	600(183)	3.44(87)	7.27	10819	105423321	3E0
WA6AR	0025	26	NS	10000(3048)	0.52(13)	0.13	193	105187207	3A5
	0050	26	NS	10000(3048)	0.58(15)	0.19	283	105187264	3E60
	0100	26	NS	10000(3048)	0.78(20)	0.33	491	105187330	3E0
	0200	26	NS	5000(1525)	1.02(26)	0.60	893	105187405	3E6.5
	0300	26	NS	5000(1525)	1.18(30)	0.85	1265	105187439	3E0
	0400	26	NS	5000(1525)	1.33(34)	1.10	1637	105187454	3E0
	0600	26	NS	2500(763)	1.59(40)	1.58	2351	105187488	3E0
	0900	26	NS	2000(610)	1.92(49)	2.27	3378	105187538	3E0
	1200	26	NS	1500(458)	2.10(53)	3.29	4896	105187579	3E0
	1500	26	NS	1000(305)	2.34(59)	3.93	5848	105187595	3E0
	1800	26	NS	1000(305)	2.60(66)	4.63	6890	105187637	3E0
	2100	26	NS	1000(305)	2.78(71)	5.11	7604	105187660	3E0
	2400	26	NS	1000(305)	2.92(74)	6.01	8944	105188122	3E0
	2700	26	NS	750(229)	3.14(80)	6.77	10075	105188148	3E0
	3000	26	NS	750(229)	3.24(82)	7.20	10715	105188155	3E0

* Pulling eyes not available in these pair sizes.
Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.

PE-89 REA Listed Filled Screened Cable With Coated Alpeth Sheath

This cable meets the requirements of REA Specification PE-89 for direct burial cable, underground, and aerial applications. The design features foam-skin polyethylene insulation with full color-coding, a core wrap for electrical protection, coated aluminum for electromagnetic shielding, and a tough/flexible outer jacket. The aluminum is corrugated for mechanical flexibility. ***FLEXGEL*** filling compound fills the spaces between conductors, and flooding compound seals the sheath interfaces for resistance to water entry. The core consists of the normal complement of pairs and additional service pairs. The core is bisected with an insulated aluminum screen.

PE-89 REA LISTED FILLED SCREENED CABLE WITH COATED ALPETH SHEATH

Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
KA2AR	0028	22	NS	5000(1525)	0.70(18)	0.27	402	105643530	3A5
	0054	22	NS	5000(1525)	0.86(22)	0.39	580	105643548	3E6
	0106	22	NS	5000(1525)	1.18(30)	0.80	1191	105643555	3E0
	0210	22	NS	2500(763)	1.57(40)	1.52	2262	105486898	3E0
	0314	22	NS	2000(610)	1.88(48)	2.00	2976	105643571	3E0
	0418	22	NS	2000(610)	2.18(55)	2.50	3720	105643589	3E0
	0616	22	NS	1500(457)	2.60(66)	3.60	5357	105643597	3E0
KA4AR	0054	24	NS	10000(3049)	0.82(21)	0.42	625	105643605	3E0
	0106	24	NS	5000(1525)	0.98(25)	0.69	1027	105643613	3E6.5
	0210	24	NS	5000(1525)	1.30(33)	1.00	1488	105643639	3E0

Pulling eyes available in all pair sizes.
Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 22 Ga = 0.6 mm, 24 Ga = 0.5 mm,

PE-89 REA Listed Filled Cable With CACSP Sheath

This cable meets the requirements of REA Specification PE-89 fo gopher-resistant, direct burial cable, underground, and aerial applications Coated aluminum is used for electromagnetic shielding and coated steel fo mechanical protection; both metals are corrugated for mechanical flexibility The design features foam-skin polyethylene insulation with full color-coding, ε core wrap for electrical protection, and a tough/flexible outer jacket ***FLEXGEL*** filling compound fills the spaces between conductors, and floodinç compound seals the sheath interfaces for resistance to water entry.

PE-89 REA LISTED FILLED CABLE WITH CACSP SHEATH									
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
WA9WR	0006	19	NS	5000(1525)	0.58(15)	0.19	283	105184477	3A4
	0012	19	NS	5000(1525)	0.66(17)	0.28	417	105184485	3A5
	0025	19	S	5000(1525)	0.90(23)	0.48	714	105184519	3E6.5
	0050	19	NS	2500(763)	1.18(30)	0.85	1265	105184527	3E6
WA2WR	0006	22	S	5000(1525)	0.54(14)	0.15	223	105184204	3A4
	0012	22	S	5000(1525)	0.58(15)	0.18	268	105184261	3A4
	0025	22	S	5000(1525)	0.70(18)	0.29	432	105184212	3A5
	0050	22	S	5000(1525)	0.90(23)	0.47	699	105184923	3E6.5
	0100	22	S	5000(1525)	1.14(29)	0.81	1205	105184352	3E0
	0200	22	NS	2500(763)	1.51(38)	1.44	2143	105184725	3E0
	0300	22	NS	2000(610)	1.76(45)	2.08	3095	105184766	3E0
	0400	22	NS	2000(610)	2.00(51)	2.87	4271	105184782	3E0
	0600	22	NS	1000(305)	2.46(63)	3.88	5774	105184816	3E0
	0900	22	NS	1000(305)	2.94(75)	5.74	8542	105184840	3E0
	1200	22	NS	750(229)	3.28(83)	7.40	11012	105184873	3E0

PE-89 REA LISTED FILLED CABLE WITH CACSP SHEATH (Contd)									
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
WA4WR	0006*	24	S	10000(3049)	0.50(13)	0.11	164	105185847	3A5
	0012	24	S	10000(3049)	0.54(14)	0.13	193	105185896	3E6
	0025	24	S	10000(3049)	0.58(15)	0.21	313	105185961	3E6
	0050	24	S	10000(3049)	0.74(19)	0.33	491	105185987	3E6.5
	0100	24	S	5000(1525)	0.98(25)	0.57	848	105186035	3E6.5
	0200	24	S	5000(1525)	1.26(32)	1.00	1488	105186084	3E0
	0300	24	NS	2500(763)	1.49(12)	1.39	2069	105186118	3E0
	0400	24	NS	2000(610)	1.63(41)	1.79	2664	105186126	3E0
	0600	24	NS	2000(610)	1.96(50)	2.57	3825	105186159	3E0
	0900	24	S	1000(305)	2.36(60)	3.73	5551	105186183	3E0
	1200	24	NS	1000(305)	2.68(68)	4.97	7396	105186258	3E0
	1500	24	NS	1000(305)	2.94(75)	6.08	9048	105186282	3E0
	1800	24	NS	750(229)	3.22(82)	7.29	10849	105186324	3E0
WA6WR	0025	26	NS	10000(3049)	0.58(15)	0.18	268	105184964	3E6
	0050	26	NS	10000(3049)	0.66(17)	0.25	372	105184956	3E6.5
	0100	26	NS	10000(3049)	0.82(21)	0.40	595	105184915	3E0
	0200	26	NS	5000(1525)	1.08(27)	0.68	1012	105185011	3E0
	0300	26	NS	5000(1525)	1.22(31)	0.94	1399	105185045	3E0
	0400	26	NS	5000(1525)	1.38(35)	1.20	1786	105185060	3E0
	0600	26	NS	2500(763)	1.63(41)	1.70	2530	105185086	3E0
	0900	26	NS	2000(610)	1.92(49)	2.44	3631	105183321	3E0
	1200	26	NS	1500(458)	2.11(54)	2.58	3839	105183388	3E0
	1500	26	NS	1000(305)	2.36(60)	3.93	5848	105183420	3E0
	1800	26	NS	1000(305)	2.62(67)	4.70	6994	105183453	3E0
	2100	26	NS	1000(305)	2.78(70)	5.40	8036	105183461	3E0
	2400	26	NS	1000(305)	2.94(75)	6.10	9078	105183537	3E0
	2700	26	NS	750(229)	3.18(81)	6.76	10060	105183610	3E0
	3000	26	NS	750(229)	3.26(83)	7.51	11176	105183826	3E0

* Pulling eyes not available in these pair sizes.
Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.

PE-89 REA Listed Filled Screened Cable With CACSP Sheath

This cable meets the requirements of REA Specification PE-89 fo gopher-resistant, direct burial cable, underground, and aerial applications Coated aluminum is used for electromagnetic shielding and coated steel fo mechanical protection; both metals are corrugated for mechanical flexibility The design features foam-skin polyethylene insulation with full color-coding, a core wrap for electrical protection, and a tough/flexible outer jacket ***FLEXGEL*** filling compound fills the spaces between conductors, and flooding compound seals the sheath interfaces for resistance to water entry. The core consists of the normal complement of pairs and additional service pairs. The core is bisected with an insulated aluminum screen.

PE-89 REA LISTED FILLED SCREENED CABLE WITH CACSP SHEATH

Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight Lbs./Ft.	Nominal Weight Gr./m	Comcode	Std. Reel Size
KA2WR	0028	22	NS	5000(1525)	0.74(19)	0.30	446	105648844	3E6
	0054	22	NS	5000(1525)	0.94(24)	0.50	744	105648851	3E6.5
	0106	22	NS	5000(1525)	1.22(31)	0.80	1191	105648869	3E0
	0210	22	NS	2500(763)	1.59(40)	1.50	2232	105648885	3E0
	0314	22	NS	2000(610)	1.92(49)	2.10	3125	105648893	3E0
	0418	22	NS	2000(610)	2.22(56)	2.82	4197	105648901	3E0
	0616	22	NS	1000(305)	2.62(67)	4.23	6295	105648919	3E0
KA4WR	0054	24	NS	10000(3049)	0.86(22)	0.42	625	105648927	3E0
	0106	24	NS	5000(1525)	1.02(26)	0.69	1027	105648935	3E6.5
	0210	24	NS	5000(1525)	1.34(34)	1.10	1637	105648950	3E0

Pulling eyes available on all pair sizes.
Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 22 Ga = 0.6 mm, 24 Ga = 0.5 mm

PE-39 REA Listed Filled Cable With Coated Alpeth Sheath

This cable meets the requirements of REA Specification PE-39 for direct burial cable and underground applications. The design features solid polyethylene insulation with full color-coding, a core wrap for electrical protection, coated aluminum for electromagnetic shielding, and a tough/flexible outer jacket. The aluminum is corrugated for mechanical flexibility. ***FLEXGEL*** filling compound fills the spaces between conductors, and flooding compound seals the sheath interfaces for resistance to water entry.

PE-39 REA LISTED FILLED CABLE WITH COATED ALPETH SHEATH

Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
WG9AR	0006	19	S	5000(1525)	0.60(15)	0.17	253	105191530	3A5
	0012	19	S	5000(1525)	0.78(20)	0.28	417	105187769	3E6
	0025	19	S	5000(1525)	1.01(26)	0.50	744	105187785	3E6.5
	0050	19	S	2500(763)	1.34(34)	0.91	1354	105187793	3E6.5
	0100	19	NS	2500(763)	1.86(47)	1.67	2485	105187819	3E0
	0200	19	NS	1000(305)	2.37(60)	3.16	4703	105183073	3E0
WG2AR	0006*	22	S	5000(1525)	0.51(13)	0.11	164	105183669	3A4
	0012	22	S	5000(1525)	0.60(15)	0.17	253	105183693	3A5
	0025	22	S	5000(1525)	0.78(20)	0.28	417	105183743	3E6
	0050	22	S	5000(1525)	1.00(25)	0.48	714	105184006	3E6.5
	0075	22	NS	5000(1525)	1.14(29)	0.70	1042	105184022	3E0
	0100	22	S	5000(1525)	1.32(34)	0.89	1324	105184030	3E0
	0150	22	NS	2500(763)	1.60(41)	1.25	1860	105184063	3E0
	0200	22	S	2500(763)	1.76(45)	1.64	2441	105184113	3E0
	0300	22	S	2000(610)	2.08(53)	2.35	3497	105184295	3E0
	0400	22	S	1500(458)	2.42(61)	3.08	4583	105184303	3E0
	0600	22	S	1000(305)	2.94(75)	4.59	6831	105184329	3E0
	0900	22	NS	500(153)	3.58(91)	7.91	11771	105288070	3E0

PE-39 REA LISTED FILLED CABLE WITH COATED ALPETH SHEATH (Contd)

Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight Lbs./Ft.	Nominal Weight Gr./m	Comcode	Std. Reel Size
WG4AR	0006*	24	S	5000(1525)	0.49(12)	0.09	134	105186076	3A4
	0012	24	S	5000(1525)	0.56(14)	0.13	193	105186100	3A4
	0025	24	S	5000(1525)	0.67(17)	0.20	298	105186175	3A5
	0050	24	S	5000(1525)	0.83(21)	0.33	491	105186209	3E6
	0075	24	NS	5000(1525)	0.96(24)	0.46	685	105186233	3E6.5
	0100	24	S	2500(763)	1.10(28)	0.60	893	105186274	3E6
	0150	24	NS	2500(763)	1.31(33)	0.85	1265	105186290	3E6.5
	0200	24	S	2500(763)	1.45(37)	1.07	1592	105186340	3E6.5
	0300	24	S	2500(763)	1.76(45)	1.54	2292	105186365	3E0
	0400	24	S	2500(763)	1.95(50)	2.01	2991	105186381	3E0
	0600	24	S	1500(458)	2.34(60)	2.98	4435	105186423	3E0
	0900	24	S	1000(305)	2.83(72)	4.26	6339	105186613	3E0
	1200	24	S	750(229)	3.21(82)	5.47	8140	105290787	3E0
	1500	24	NS	500(153)	3.57(91)	6.90	10268	105512669	3E0
WG6AR	0025	26	NS	10000(3049)	0.57(14)	0.15	223	105314538	3E6
	0050	26	NS	10000(3049)	0.69(18)	0.25	372	105187728	3E6.5
	0100	26	NS	10000(3049)	0.86(22)	0.42	625	105187991	3E0
	0200	26	NS	5000(1525)	1.16(29)	0.76	1131	105188072	3E0
	0300	26	NS	5000(1525)	1.34(34)	1.08	1607	105188171	3E0
	0400	26	NS	2500(763)	1.61(41)	1.38	2054	105188189	3E0
	0600	26	NS	2500(763)	1.86(47)	2.00	2976	105188197	3E0
	0900	26	NS	1500(458)	2.27(58)	2.92	4345	105188205	3E0
	1200	26	NS	1000(305)	2.62(67)	3.85	5729	105188213	3E0
	1500	26	NS	1000(305)	2.88(73)	4.71	7009	105188221	3E0
	1800	26	NS	750(229)	3.13(80)	5.61	8348	105512685	3E0
	2100	26	NS	750(229)	3.30(84)	6.51	9688	105512701	3E0

* Pulling eyes not available in these pair sizes.
Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.

PE-39 REA Listed Filled Cable With CACSP Sheath

This cable meets the requirements of REA Specification PE-39 for gopher-resistant, direct burial cable and underground applications. Coated aluminum is used for electromagnetic shielding and coated steel for mechanical protection; both metals are corrugated for mechanical flexibility. The design features solid polyethylene insulation with full color-coding, a core wrap for electrical protection, and a tough/flexible outer jacket. ***FLEXGEL*** filling compound fills the spaces between conductors, and flooding compound seals the sheath interfaces for resistance to water entry.

PE-39 REA LISTED FILLED CABLE WITH CACSP SHEATH									
Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight		Comcode	Std. Reel Size
						Lbs./Ft.	Gr./m		
WG9WR	0006	19	S	5000(1525)	0.63(16)	0.21	313	105187850	3A5
	0012	19	S	5000(1525)	0.80(20)	0.33	491	105187868	3E6
	0025	19	S	5000(1525)	1.03(26)	0.56	833	105187884	3E6.5
	0050	19	S	2500(763)	1.42(36)	0.99	1473	105187892	3E6.5
WG2WR	0006	22	S	5000(1525)	0.52(13)	0.15	223	105182349	3A4
	0012	22	S	5000(1525)	0.64(16)	0.21	313	105182356	3A5
	0025	22	S	5000(1525)	0.80(20)	0.33	491	105185771	3E6
	0050	22	S	5000(1525)	1.02(26)	0.55	818	105185805	3E6.5
	0100	22	S	5000(1525)	1.35(34)	0.98	1458	105185854	3E0
	0200	22	NS	2500(763)	1.78(45)	1.80	2679	105185938	3E0
	0300	22	S	2000(610)	2.11(54)	2.62	3899	105185979	3E0
	0400	22	S	1500(458)	2.44(62)	3.24	4822	105186001	3E0
	0600	22	NS	1000(305)	2.94(75)	4.88	7262	105186043	3E0
	0900	22	S	500(153)	3.60(91)	7.08	10536	105428767	3E0
WG4WR	0006	24	NS	5000(1525)	0.50(13)	0.12	179	105187322	3A4
	0012	24	S	5000(1525)	0.58(15)	0.16	238	105187421	3A4
	0025	24	S	5000(1525)	0.71(18)	0.25	372	105187462	3A5
	0050	24	S	5000(1525)	0.88(22)	0.40	595	105187504	3E6.5
	0100	24	S	5000(1525)	1.12(28)	0.67	997	105187587	3E0
	0200	24	NS	2500(763)	1.48(38)	1.17	1741	105187645	3E6.5
	0300	24	NS	2500(763)	1.78(45)	1.67	2485	105187652	3E0
	0400	24	NS	2500(763)	1.97(50)	2.14	3185	105187678	3E0
	0600	24	NS	1500(458)	2.36(60)	3.14	4673	105187686	3E0
	0900	24	NS	1000(305)	2.85(72)	4.55	6771	105187702	3E0
	1200	24	NS	750(229)	3.24(82)	5.78	8601	105290746	3E0
WG6WR	0025	26	NS	10000(3049)	0.60(15)	0.19	283	105188577	3E6
	0050	26	NS	10000(3049)	0.73(19)	0.30	446	105188585	3E6.5
	0100	26	NS	10000(3049)	0.88(22)	0.48	714	105188601	3E0
	0200	26	NS	5000(1525)	1.16(29)	0.85	1265	105188627	3E0
	0300	26	NS	5000(1525)	1.39(35)	1.19	1771	105188312	3E0
	0400	26	NS	2500(763)	1.63(41)	1.51	2247	105188163	3E0
	0600	26	NS	2500(763)	1.90(48)	2.14	3185	105187694	3E0
	0900	26	NS	1500(458)	2.30(58)	3.08	4583	105187710	3E0
	1200	26	NS	1000(305)	2.63(67)	4.12	6131	105187744	3E0
	1500	26	NS	1000(305)	2.80(71)	5.01	7456	105187751	3E0

Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.

PE-39 REA Listed Filled Cable With Copper Alloy 194 Sheath

This cable meets the requirements of REA Specification PE-39 for gopher-resistant, direct burial cable and underground applications. The copper alloy 194 is used for electromagnetic shielding and mechanical protection and is corrugated for mechanical flexibility. The design features solid polyethylene insulation with full color-coding, a core wrap for electrical protection, and a tough/flexible outer jacket. ***FLEXGEL*** filling compound fills the spaces between conductors, and flooding compound seals the sheath interfaces for resistance to water entry.

PE-39 REA LISTED FILLED CABLE WITH COPPER ALLOY 194 SHEATH

Cable Code	No. Of Pairs	AWG	Avail-ability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight Lbs./Ft.	Nominal Weight Gr./m	Comcode	Std. Reel Size
WG9JR	0006	19	NS	5000(1525)	0.60(15)	0.20	298	105183123	3A5
	0012	19	NS	5000(1525)	0.78(20)	0.31	461	105183131	3E6
	0025	19	NS	5000(1525)	1.01(26)	0.52	774	105183149	3E6.5
	0050	19	NS	2500(763)	1.34(34)	0.96	1429	105188759	3E6.5
WG2JR	0006*	22	NS	5000(1525)	0.51(13)	0.14	208	105184758	3A4
	0012	22	NS	5000(1525)	0.60(15)	0.20	298	105184857	3A5
	0025	22	NS	5000(1525)	0.78(20)	0.31	461	105184881	3E6
	0050	22	NS	5000(1525)	1.00(25)	0.51	759	105183164	3E6.5
	0100	22	NS	5000(1525)	1.32(34)	0.95	1414	105184931	3E0
	0200	22	NS	2500(763)	1.76(45)	1.71	2545	105182331	3E0
	0300	22	NS	2000(610)	2.08(53)	2.43	3616	105184998	3E0
	0400	22	NS	1500(458)	2.42(61)	3.18	4732	105185748	3E0
	0600	22	NS	1000(305)	2.84(72)	4.72	7024	105185755	3E0
WG4JR	0006*	24	NS	5000(1525)	0.49(12)	0.11	164	105186639	3A4
	0012	24	NS	5000(1525)	0.56(14)	0.15	223	105186654	3A4
	0025	24	NS	5000(1525)	0.67(17)	0.22	327	105186845	3A5
	0050	24	NS	5000(1525)	0.83(21)	0.37	551	105186910	3E6
	0100	24	NS	5000(1525)	1.10(28)	0.64	952	105187116	3E0
	0200	24	NS	2500(763)	1.45(37)	1.14	1696	105186951	3E6.5
	0300	24	NS	2500(763)	1.76(45)	1.61	2396	105186977	3E0
	0400	24	NS	2500(763)	1.95(50)	2.09	3110	105187173	3E0
	0600	24	NS	1500(458)	2.28(58)	3.09	4598	105187249	3E0
	0900	24	NS	1000(305)	2.83(72)	4.40	6548	105187280	3E0
	1200	24	NS	750(229)	3.21(82)	5.65	8408	105290779	3E0

* Pulling eyes not available in these pair sizes.
Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.

PE-39 REA Listed Filled Cable With 5-Mil Copper Sheath

This cable meets the requirements of REA Specification PE-39 for direct burial cable and underground applications. The 5-mil copper provides superior electromagnetic shielding and is corrugated for mechanical flexibility. The design features solid polyethylene insulation with full color-coding, a core wrap for electrical protection, and a tough/flexible outer jacket. ***FLEXGEL*** filling compound fills the spaces between conductors, and flooding compound seals the sheath interfaces for resistance to water entry.

PE-39 REA LISTED FILLED CABLE WITH 5-MIL COPPER SHEATH

Cable Code	No. Of Pairs	AWG	Availability	Standard Length #420 Reel Ft.(m)	Nominal Outside Dia. In.(mm)	Nominal Weight Lbs./Ft.	Nominal Weight Gr./m	Comcode	Std. Reel Size
WG9CR	0006	19	NS	5000(1525)	0.60(15)	0.19	283	105451249	3A5
	0012	19	NS	5000(1525)	0.78(20)	0.30	446	105452999	3E6
	0025	19	NS	5000(1525)	1.01(26)	0.52	774	105453013	3E6.5
	0050	19	NS	2500(763)	1.32(34)	0.95	1414	105453021	3E6.5
WG2CR	0006*	22	NS	5000(1525)	0.51(13)	0.12	179	105453088	3A4
	0012	22	NS	5000(1525)	0.60(15)	0.19	283	105453096	3A5
	0025	22	NS	5000(1525)	0.78(20)	0.30	446	105453112	3E6
	0050	22	NS	5000(1525)	1.00(25)	0.50	744	105451231	3E6.5
	0100	22	NS	5000(1525)	1.32(34)	0.92	1369	105451272	3E0
	0200	22	NS	2500(763)	1.71(43)	1.69	2515	105452197	3E0
	0300	22	NS	2000(610)	2.06(52)	2.41	3586	105452502	3E0
	0400	22	NS	1500(458)	2.37(60)	3.15	4688	105452536	3E0
	0600	22	NS	1000(305)	2.84(72)	4.68	6964	105452544	3E0
WG4CR	0006*	24	NS	5000(1525)	0.49(12)	0.10	149	105452569	3A4
	0012	24	NS	5000(1525)	0.56(14)	0.14	208	105452577	3A4
	0025	24	NS	5000(1525)	0.67(17)	0.22	327	105452866	3A5
	0050	24	NS	5000(1525)	0.83(21)	0.36	536	105453120	3E6
	0100	24	NS	5000(1525)	1.10(28)	0.63	938	105453286	3E0
	0200	24	NS	2500(763)	1.45(37)	1.11	1652	105453484	3E6.5
	0300	24	NS	2500(763)	1.76(45)	1.59	2366	105453518	3E0
	0400	24	NS	2500(763)	1.95(50)	2.06	3066	105453542	3E0
	0600	24	NS	1500(458)	2.34(59)	3.05	4539	105453716	3E0
	0900	24	NS	1000(305)	2.73(69)	4.35	6473	105453732	3E0
	1200	24	NS	750(229)	3.21(82)	5.57	8289	105492417	3E0

* Pulling eyes not available in these pair sizes.
Longer lengths are available: contact an AT&T Sales Representative.
AWG metric equivalent: 19 Ga = 0.9 mm, 22 Ga = 0.6 mm, 24 Ga = 0.5 mm, 26 Ga = 0.4 mm.

WIRE

Buried Wire

AT&T 626-300-100

The designation of buried wire types are listed below. In the first group of letters, BSW indicates buried service wire and BDW indicates buried distribution wire. The second group of numbers indicates the number of pairs and their gauge. The third group can consist of up to three letters, on optional 1- or 2-letter feature followed by a letter that indicates the design generation. For example, GRE is gopher-resistant wire, generation E.

BURIED WIRE DESIGNATIONS	
Description	**Designation**
Buried Service Wire (2 pairs and 5 pairs)	BSW-2/22-C BSW-5/22-C
Buried Service Wire (2, 3, 4, 5, and 6 pairs)	BSW-2/22-GRF BSW-3/22-GRF BSW-4/22-GRF BSW-5/22-GRF BSW-6/22-GRF
Buried Distribution Wire (1 pair)	BDW-1/19-GRE
Buried Distribution Wire (2 and 3 pairs)	BDW-2/19-GRF BDW-3/19-GRF
Buried Distribution Wire (2, 3, 4, 5, and 6 pairs)	BDW-2/22-GRF BDW-3/22-GRF BDW-4/22-GRF BDW-5/22-GRF BDW-6/22-GRF

The physical characteristics and guidelines for selection are shown on the following pages.

BURIED SERVICE WIRE
PHYSICAL CHARACTERISTICS AND GUIDELINES FOR SELECTION

WIRE TYPE	RATING	NO. PAIRS	GAUGE (AWG)	FILLED	RODENT PROTECTION	WEIGHT LB/1000 FT	BREAKING STRENGTH (POUNDS)	RECOMMENDED INSTALLATION LENGTH	COMMENTS
BSW-2/22-C (C Service Wire—2 Pair)	Std	2	22	Yes*	No	53	200	700 (Max. Ft)†	Service drop from any cable. Provides improved impact and corrosion protection. Flame resistant.
BSW-5/22-C (C Service Wire—5 Pair)	Std	5	22	Yes*	No	89	275	700 (Max. Ft)†	Service drop from any cable. Provides improved impact and corrosion protection. Flame resistant.
BSW-2/22-GRF	Std	2	22	Yes*	Yes	42	200	700 (Max. Ft)†	Replaces BSW-2/22 - GRE armored wire. Service drop from any cable. Flame resistant.
BSW-3/22-GRF	Std	3	22	Yes*	Yes	51	200	700 (Max. Ft)†	
BSW-4/22-GRF	Std	4	22	Yes*	Yes	60	200	700 (Max. Ft)†	
BSW-5/22-GRF	Std	5	22	Yes*	Yes	68	200	700 (Max. Ft)†	
BSW-6/22-GRF	Std	6	22	Yes*	Yes	75	200	700 (Max. Ft)†	

* Flame-resistant FLEXGEL® filling compound-type material.

† Due to transmission limitations, the wire should not be used normally in runs exceeding 700 feet in length. When runs in excess of 700 feet are unavoidable, care should be taken that the service wire does not cause total loop loss to exceed "Resistance Design" objectives.

BURIED DISTRIBUTION WIRE
PHYSICAL CHARACTERISTICS AND GUIDELINES FOR SELECTION

WIRE TYPE	RATING	NO. PAIRS	GAUGE (AWG)	FILLED	RODENT PROTECTION	WEIGHT LB/1000 FT	BREAKING STRENGTH (POUNDS)	RECOMMENDED INSTALLATION LENGTH	COMMENTS
BDW-1/19-GRE	Std	1	19	No	Yes	56	200	14 miles †	Used for rural distribution. Also, service drop from any cable.
BDW-2/19-GRF	Std	2	19	Yes*	Yes	98	200	14 miles †	Used for rural distribution. Also, service drop from any cable. Flame resistant.
BDW-3/19-GRF	Std	3	19	Yes*	Yes	113	200	14 miles †	
BDW-2/22-GRF	Std	2	22	Yes*	Yes	67	200	7 miles †	Buried Distribution wire. Flame resistance.
BDW-3/22-GRF	Std	3	22	Yes*	Yes	80	200	7 miles †	
BDW-4/22-GRF	Std	4	22	Yes*	Yes	92	200	7 miles †	
BDW-5/22-GRF	Std	5	22	Yes*	Yes	103	200	7 miles †	
BDW-6/22-GRF	Std	6	22	Yes*	Yes	111	200	7 miles †	

* Flame-resistant FLEXGEL® filling compound-type material.

† May require loading on longer run.

Aerial Service Wire

AT&T 626-300-126

AERIAL SERVICE WIRE PHYSICAL CHARACTERISTICS AND SELECTIONS							
WIRE TYPE	NO. PAIRS	GAUGE (AWG)	CONDUCTOR MATERIAL	WEIGHT (LB PER 1000 FT)	BREAKING STRENGTH (LBS)	RECOMMENDED INSTALLATION LENGTH (MAX FT) (NOTE 1)	COMMENTS
ASW-1/18½-F	1	18.5	Copper Covered Steel	33	450	500	Replaces C Drop Wire
ASW-1/22-A	1	22	Copper	29	450	700	—
ASW-2/22-A	2	22	Copper	35	450	700	—
ASW-2/22-F	2	22	Copper	65	850	700	—
ASW-5/22-F	5	22	Copper	86	850	700	—
ASW-6/22-F	6	22	Copper	92	850	700	Replaces E Multiple Drop Wire

Note 1: The wire should not be used in runs exceeding the recommended length. If the recommended length must be exceeded, the resistance of the wire must be included in the conductor loop resistance calculations to assure that total loop loss does not exceed "Resistance Design Limit."

Aerial Line Wire

AT&T 919-370-100

Aerial line wire is seldom installed. However, there still may be some in service. Therefore, it is being covered in this handbook.

AERIAL LINE WIRE			
Type	Diameter (Mils)	Weight (Lb/Mile)	Resistance (Ohms/Loop Mile)
Copper	080	102	17.5
	104	173	10.3
	128	262	6.8
	165	435	4.1
Copper-steel (40% conductivity)	080	93	42
	104	158	25
	128	240	16
Galvanized Steel (H = high strength) (F = extra high strength)	083	99	113
	083-H	99	130
	109	170	67
	109-H	170	75
	109-F	170	91
	134	258	45
	134-H	258	50

FIBER OPTIC OUTSIDE PLANT CABLE

AT&T 626-108-101, 626-108-103, 627-610-230

Inside plant cable or fiber optic building cable for use inside the customers' premises is described in Section 12, "PREMISES NETWORKS".

Outside Plant Cable

The high-fiber density of AT&T's outside plant cables provide for small lightweight fiber optic cables. The cables contain various fiber counts in either the ***AccuRibbon***® or ***Lightpack***® core designs and are available in a variety of sheath and oversheath designs to meet the specific requirements of any outside plant installation. Installation can be aerial, underground in conduit, or buried directly in the ground. When used in outside plant applications, both types of cores contain a water-blocking compound to prevent moisture penetration. Fiber optic outside plant cable is available with single-mode fibers (8.3 μm core/125 μm cladding) or multimode fibers (62.5 μm core/125 μm cladding).

Outside plant cables can be used as building entrance cables or as interbuilding cables. **Fiber optic cables do not require electrical protection devices at the building entrance. However, they do require bonding and grounding.** Outside plant cables within the domain of a telephone company or common carrier are almost always of a singlemode design (1310-nm or 1550-nm attenuation). However, recent applications for large premises private networks or Local Area Networks (LANs) have incorporated singlemode cables instead of the standard multimode cables used in most of the current premises applications. Although multimode cable is used in most premises applications, singlemode is used where extra long distances on outside plant or building riser runs are required.

Note: Outside plant fiber optic cables are not fire-resistant and are not to be used inside a building beyond 50 feet (15.25 m) of the building entrance.

The "general purpose" outside plant cables come with three different sheath options. All contain a waterblocking tape over the core tube.

- **Metallic Sheath**—A high-density polyethylene (HDPE) jacket with two steel wires running parallel to the core of the cable as strength members. The outer jacket covers a steel armor jacket which provides for protection from lightning damage.
- **Rodent/Lightning Sheath**—A stainless steel shielded jacket is inside the HDPE outer jacket and provides protection from both lightning and rodent-induced cable damage.
- **Dielectric Sheath**—The HDPE outer jacket covers the two dielectric strength members.

The following table contains information on the application of fiber optic cable in the outside plant environment.

RECOMMENDED CABLE SHEATHS AND APPLICATIONS		
Application	**Environmental Hazards**	**Recommended Sheath/ Oversheath Type**
Underground Plant and Buried PVC Pipe	None	**Lightguide Express Entry** — (LXE-ME) consists of two steel strength members running longitudinally along a coated carbon steel armor. An economical cable that is excellent for mid-span entry.
Buried PVC Pipe	Rodent and/or lightning	**Lightguide Express Entry** — (LXE-DE) consists of two groups of glass strength members which are longitudinally applied, diametrically opposite each other, over the cable core, along with two ripcords. The two ripcords, nestled along the strength members, provide easy sheath entry.
Direct Buried, Trenched, or Plowed	Lightning	**Lightguide Express Entry** — See (LXE-ME) above.
	Rodent and/or lightning	**Rodent/Lightning - Protected** — Consists of a tape laminated to stainless steel, followed by a single layer of helically applied steel reinforcing wires and a polyethylene outer jacket. **Lightguide Express Entry** — (LXE-RL) consists of an adhesive-coated 0.13 mm (5 mil) stainless steel armor that envelopes the core tube and has a ripcord under it to ease its removal. The steel armor is coated to inhibit corrosion and to bond to the outer jacket. Two steel wire strength members run longitudinally along the armor, diametrically opposite each other. A ripcord is located next to each steel wire for ease of sheath removal.
See note at end of table.		

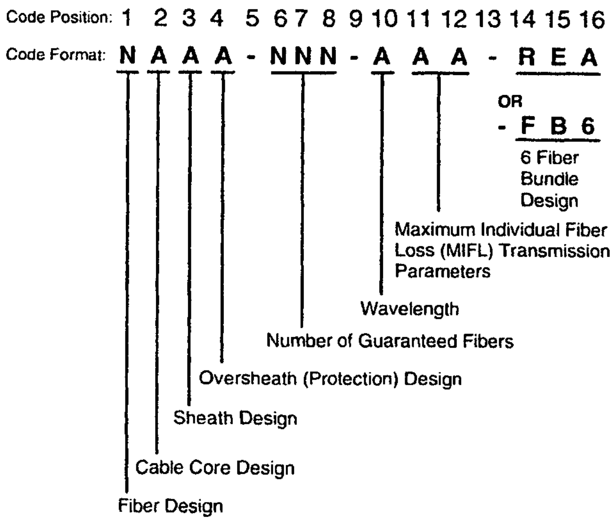
RECOMMENDED CABLE SHEATHS AND APPLICATIONS (Contd)		
Application	**Environmental Hazards**	**Recommended Sheath/ Oversheath Type**
Lake/River Crossings	None	**B-Oversheath** — consists of a corrugated copper layer and a corrugated stainless steel layer, followed by a single layer of helically applied steel reinforming wires and a polyethylene outer jacket.
	Bottom currents, snagging	**Wire Armored Oversheath** — consists of from 1 to 3 helically applied layers of steel laid in a tight package over the cable sheath with a twine bedding and wrapping, and flooded with an asphalt compound.
Indoor	Fire	**PVC Riser** — Offers a flame-retardant PVC jacket for building riser applications.
Aerial	None	LXE-ME lashed or self-support cables.
	Lightning	LXE-ME or self-support cables.
	Rodent and/or lightning	LXE-RL or RL self-support cables.

Note: All AT&T outside plant cables may be used for aerial, buried, or underground applications.

For more information and detailed descriptions of fiber optic cable, see the Fiber Optic Products Catalog (2492C).

Cable Identification Codes

Outside plant fiber optic cable is ordered using a 12-character code to specify fiber design, core design, sheath design, fiber count, cable length, etc. Four more characters are added when an REA-listed or 6-fiber bundle configuration is requested. The general format and description of the code are as follows:



N = NUMERIC VALUE
A = ALPHA VALUE

The following table provides a description of each code position and the available code options.

OUTSIDE PLANT FIBER OPTIC CABLE CODE DESCRIPTION			
Code Position	Description	Cable Code Options	
		Designator	Description
1	Fiber Design	1	Multimode with 50-Micron Core
		3	Multimode with 62.5-Micron Core
		4	Singlemode
		6	Singlemode, Dispersion-Shifted
2	Cable Core Design	A	Ribbon, Air Core
		B	Ribbon, Filled Core (50-μm only)
		D	*Lightpack*, Filled Core
		F	*AccuRibbon*, Air Core
		G	*AccuRibbon*, Filled Core
3	Sheath Design	A	Crossply, Metallic
		F	Crossply, Dielectric
		G	Armored Figure-8 Self-Support
		H	Primary RL
		K	RL Figure-8 Self-Support
		L	PVC Crossply (Riser)
		M	Primary Armor (Required REA Designator in 14-16 position)
		N	LXE-DE
		P	Dielectric Circular Self-Support
		R	LXE-RL
		S	LXE-ME
		U	LXE-LW
4	Oversheath Design	B	B-Oversheath
		X	No Oversheath
		Y	Figure-8 Self-Support Oversheath (Required for Figure-8 Sheath Designs)

OUTSIDE PLANT FIBER OPTIC CABLE CODE DESCRIPTION (Contd)			
Code Position	Description	Cable Code Options	
		Designator	Description
6-8	Number of Guaranteed Fibers		
	-*Lightpack* Core	4-96	Fiber Count in Multiples of 2
	-*AccuRibbon* Core, SM	12-216	Fiber Count in Multiples of 12
	-*AccuRibbon* Core, 62.5-µm MM	12-144	Fiber Count in Multiples of 12
	-Ribbon, 50-µm MM	12-136	Fiber Count in Multiples of 2
10	Wavelength	B	Singlemode, 1310/1550 nm
		C	Singlemode Dispersion-Shifted, 1550 nm
		G	Multimode, 825 nm, 850 nm, 870 nm
		H	Multimode, 825 nm, 850 nm, 870/1300 nm
		J	Multimode, 1300 nm
11-12	MIFL Transmission Parameters		
	-Singlemode	XC*	0.35-0.39 dB/km at 1310 nm 0.23-0.29 dB/km at 1550 nm
		XD†	0.40-0.49 dB/km at 1310 nm 0.25-0.39 dB/km, at 1550 nm
	-Singlemode	**	

OUTSIDE PLANT FIBER OPTIC CABLE CODE DESCRIPTION (Contd)			
Code Position	Description	Cable Code Options	
		Designator	Description
	Dispersion-Shifted	XB	0.5 dB/km at 1310 nm 0.25 dB/km at 1550 nm
		XC	0.25 dB/km at 1550 nm
	-50-µm Multimode	XH	4.33 dB/km, 500 MHz km at 825 nm 4.0 dB/km, 500 MHz km at 850 nm 3.72 dB/km, 500 MHz km at 870 nm 1.0 dB/km, 500 MHz km at 1300 nm
	-62.5-µm Multimode	XM	4.13 dB/km, 160 MHz km at 825 nm 3.75 dB/km, 160 MHz km at 850 nm 3.42 dB/km, 160 MHz km at 870 nm 1.0 dB/km, 500 MHz km at 1300 nm
		XN	4.68 dB/km, 160 MHz km at 825 nm 4.3 dB/km, 160 MHz km at 850 nm 3.97 dB/km, 160 MHz km at 870 nm
		**	2.0 dB/km, 400 MHz km at 1300 nm

OUTSIDE PLANT FIBER OPTIC CABLE CODE DESCRIPTION (Contd)			
Code Position	**Description**	**Cable Code Options**	
		Designator	**Description**
14-16	REA	REA	Rural Electrification Administration Listed
	6-Fiber Bundles	FB6	6-Fiber Bundles in *Lightpack* Core

* A loss value between the indicated limits must be specified when ordering.

† If no value is specified when ordering, the default is: XD - 0.4/0.3 dB/km.

** Additional Transmission Parameters are available upon request.

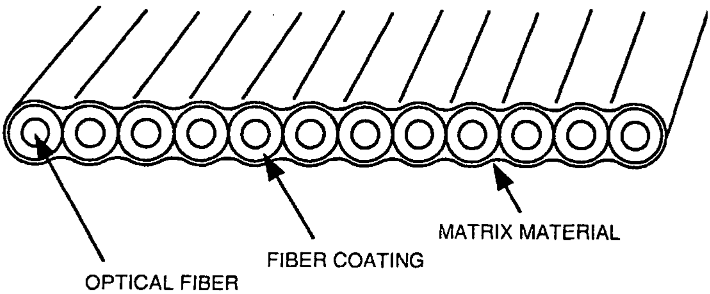
Fiber Identification

Fiber identification for both core types, ***AccuRibbon*** and ***Lightpack***, is provided by color-coding the individual fibers. AT&T uses the following colors to distinguish fibers.

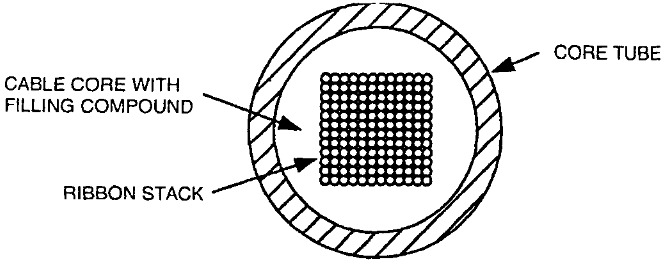
1. — Blue
2. — Orange
3. — Green
4. — Brown
5. — Slate
6. — White
7. — Red
8. — Black
9. — Yellow
10. — Violet
11. — Rose
12. — Aqua

AccuRibbon® Cable

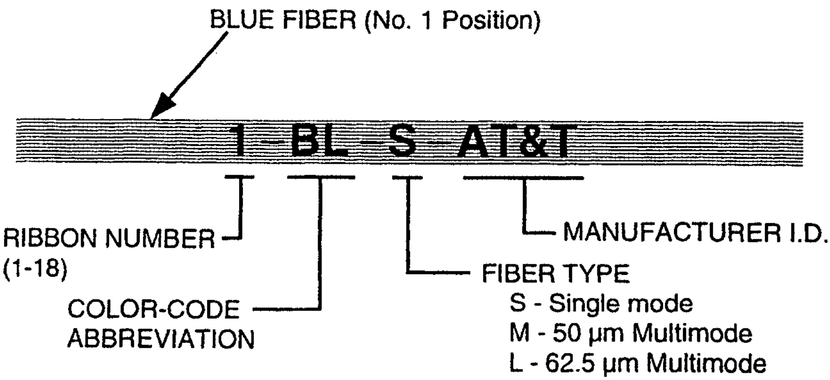
AccuRibbon cable is for applications where a large fiber count is required (more than 12 fibers). The ribbon design consists of 12 fibers bonded side by side with a UV-curable matrix material as shown below. Up to 12 fibers can be spliced simultaneously and ribbon cable may be ordered with factory-installed array splices.



Fiber counts are available from 12 to 216 fibers for singlemode and 12 to 144 fibers for multimode (in increments of 12 fibers). Each fiber position is guaranteed. The ribbon stack is housed in an extruded plastic tube. The plastic tube's outer diameter is nominally 0.31 inch (7.9 mm) for fiber counts up to 96 and 0.41 inch (10.4 mm) for fiber counts from 108 to 216. Up to 18 ribbons can be contained in the core tube.



Each ribbon, in an ***AccuRibbon*** cable, has identifying marks consisting of a number (1-18) and a 2-letter color abbreviation (for example BL=blue) printed along its length every 6 inches (150 mm). The markings are printed directly on the ribbon structure and may be used for mid-span or end-entry identification.



AccuRibbon UNIT IDENTIFICATION CODE			
AccuRibbon Number	*AccuRibbon* Identification		
	Singlemode	DS Singlemode	62.5-µm Multimode*
1	1-BL-S-AT&T	1-BL-DS-AT&T	1-BL-62.5-AT&T
2	2-OR-S-AT&T	2-OR-DS-AT&T	2-OR-62.5-AT&T
3	3-GR-S-AT&T	3-GR-DS-AT&T	3-GR-62.5-AT&T
4	4-BR-S-AT&T	4-BR-DS-AT&T	4-BR-62.5-AT&T
5	5-SL-S-AT&T	5-SL-DS-AT&T	5-SL-62.5-AT&T
6	6-WH-S-AT&T	6-WH-DS-AT&T	6-WH-6.25-AT&T
7	7-RD-S-AT&T	7-RD-DS-AT&T	7-RD-62.5-AT&T
8	8-BK-S-AT&T	8-BK-DS-AT&T	8-BK-62.5-AT&T
9	9-YL-S-AT&T	9-YL-DS-AT&T	9-YL-62.5-AT&T
10	10-VI-S-AT&T	10-VI-DS-AT&T	10-VI-62.5-AT&T
11	11-RS-S-AT&T	11-RS-DS-AT&T	11-RS-62.5-AT&T
12	12-AQ-S-AT&T	12-AQ-DS-AT&T	12-AQ-62.5-AT&T
13	13-DBL-S-AT&T	13-DBL-DS-AT&T	
14	14-DOR-S-AT&T	14-DOR-DS-AT&T	
15	15-DGR-S-AT&T	15-DGR-DS-AT&T	
16	16-DBR-S-AT&T	16-DBR-DS-AT&T	
17	17-DSL-S-AT&T	17-DSL-DS-AT&T	
18	18-DWH-S-AT&T	18-DWH-DS-AT&T	

* The 62.5-µm Multimode ***AccuRibbon*** cables are available with up to 12 ***AccuRibbon*** units (144 fibers).

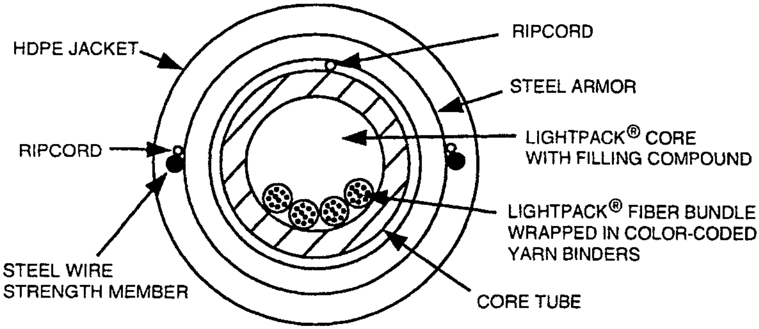
The physical characteristics of ***AccuRibbon*** fiber optic cables are show below.

AccuRibbon CABLE						
Sheath Type	12-96 Fibers			108-216 Fibers		
	Diameter In.(mm)	Weight		Diameter In.(mm)	Weight	
		Lbs/Ft	Gr/m		Lbs/Ft	Gr/m
Crossply Metallic	.49(12.4)	.09	134	.59(15)	.13	193
Crossply Dielectric	.49(12.4)	.09	134	.59(15)	.13	193
Rodent Lightning	.49(12.4)	.11	164	.59(15)	.15	223
Oversheath	.74(18.8)	.23	342	.84(21.3)	.29	432
LXE ME	.59(15)	.15	223	.69(17.5)	.20	298
LXE DE	.59(15)	.12	179	.69(17.5)	.18	268
LXE RL	.59(15)	.15	223	.69(17.5)	.20	298

Note:
Maximum pulling tension for ***AccuRibbon*** cables is 600 lbs.

Lightpack Cables

The ***Lightpack*** cable core consists of up to 8 bundles, each bundle containing up to 12 individual fibers. The bundles are held together with two spirally wrapped color-coded yarn binders. The bundles are contained in an extruded plastic core tube. The core tube's outer diameter is nominally 0.24 inches (6.1 mm) for up to 48 fibers and 0.31 inches (7.9 mm) above 48 fibers. A typical ***Lightpack*** cable core with an LXE metallic sheath (6DSX) is shown below.



The ***Lightpack*** cable bundle identification is made possible by the application of 2 spirally wrapped color-coded yarn binders around each bundle. The following colors are used to identify bundles.

1. — Blue
2. — Orange
3. — Green
4. — Brown
5. — Slate
6. — White
7. — Red
8. — Black

Fiber counts are available from 4 to 96 fibers in increments of 2 fibers. As an alternative, cables with up to 36 fibers can be ordered with no more than 6 fibers to a bundle. The following table lists the standard fiber counts and the fiber allocation within each color-coded bundle.

Lightpack CABLE: STANDARD FIBER COUNTS									
Guaranteed Cable Fiber Count	No. of Bundles	Number of Fibers per Bundle							
		Blue	Orange	Green	Brown	Slate	White	Red	Black
4	1	4							
6	1	6							
8	1	8							
12	1	12							
16	2	8	8						
20	2	12	8						
24	2	12	12						
36	3	12	12	12					
48	4	12	12	12	12				
60	5	12	12	12	12	12			
72	6	12	12	12	12	12	12		
84	7	12	12	12	12	12	12	12	
96	8	12	12	12	12	12	12	12	12
Cables with more than 48 fibers may contain a spare fiber colored Dash Green (DGR) in the blue and orange bundles.									

Lightpack CABLES WITH 6 FIBER BUNDLES							
Guaranteed Cable Fiber Count	No. of Bundles	Number of Fibers per Bundle					
		Blue	Orange	Green	Brown	Slate	White
6*	1	6					
8	2	6	2				
10	2	6	4				
12*	2	6	6				
14	3	6	6	2			
16	3	6	6	4			
18*	3	6	6	6			
20	4	6	6	6	2		
22	4	6	6	6	4		
24*	4	6	6	6	6		
26	5	6	6	6	6	2	
28	5	6	6	6	6	4	
30*	5	6	6	6	6	6	
32	6	6	6	6	6	6	2
34	6	6	6	6	6	6	4
36*	6	6	6	6	6	6	6
* Standard Fiber Counts							

The physical characteristics of ***Lightpack*** fiber optic cables are showr below.

Lightpack CABLE						
Sheath Type	4-48 Fibers			50-96 Fibers		
	Diameter In.(mm)	Weight		Diameter In.(mm)	Weight	
		Lbs/Ft	Gr/m		Lbs/Ft	Gr/m
Crossply Metallic	.42(10.7)	.07	104	.49(12.4)	.09	134
Crossply Dielectric	.43(10.9)	.07	104	.49(12.4)	.09	134
Rodent Lightning	.42(10.7)	.09	134	.49(12.4)	.11	164
Oversheath	.70(17.8)	.21	313	.74(18.8)	.23	342
LXE ME	.49(12.4)	.11	164	.59(15)	.15	223
LXE DE	.49(12.4)	.09	134	.59(15)	.11	164
LXE RL	.49(12.4)	.11	164	.59(15)	.15	223

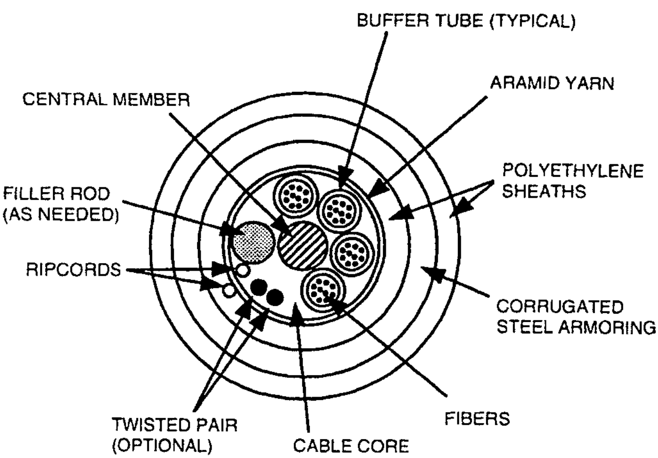
Note:
Maximum pulling tension for ***Lightpack*** cables is 600 lbs. ***Lightpack*** cable is available in a Figure-8 self-support design with either an armored or rodent/lightning sheath. See Fiber Optics Products Catalog (Select Code 2492C) for more information.

AT&T Fitel Fiber Optic Cable

Loose Tube Cable

AT&T Fitel loose tube cable is available in fiber counts from 2 to 216 in singlemode and multimode design. The design options available make this loose tube cable adaptable to almost any buried, duct, or aerial applications.

AT&T Fitel utilizes the highly reliable loose buffer tube design in its fiber optic cable. Multiple fibers are contained within a buffer tube several times larger in diameter than the fibers. This isolates the fibers from the effects of tension and temperature felt by the cable. The buffer tubes are gel filled to cushion the fibers and to prevent water penetration. Both the buffer tubes and fibers are color-coded for easy identification.



The cable core consists of a number of buffer tubes, each containing from 1 to 12 fibers, surrounding the central member. The central member can be a dielectric epoxied glass rod or a steel rod with polyethylene buildup. High density polyethylene filler rods are installed as required to maintain the integrity of the cable core. A filling compound is applied to prevent water penetration and dual binder threads are used to secure the core.

An aramid yarn strength member is stranded around the cable core to provide strength during installation and operation and also serves as the pulling member in the AT&T Fitel design. A medium density polyethylene jacket is extruded over the strength elements to complete the basic high-strength cable structure. A ripcord is placed under the cable jacket to permit easy sheath removal. Several standard jacketing options are available.

The following code is used to order and identify AT&T Fitel cable.

Code Positions: 1 2F 3 4 5 6 789

Code Formats: FG - 3 4 1 N 2 L 6 - 024

- 3 — TRANSMISSION PERFORMANCE
- 4 — ATTENUATION (1310 nm)
- 1 — FIBER TYPE (SINGLE-MODE)
- N — CENTRAL MEMBER DESIGNATION SHEATH TYPE
- 2 — TENSILE LOAD
- L — CABLE UNIT TYPE
- 6 — UNIT SIZE
- 024 — NUMBER OF FIBERS

The following table provides a description of each code position and the available code options.

AT&T Fitel CABLE CODE DESCRIPTION			
Code Position	Description	Cable Code Options	
		Designator	Description
1	Transmission Performance	1	1310 nm performance only
		2	1310/1550 nm attenuation equal
		3	1550 nm attenuation 0.1 db/km less than 1310 nm
		4	1550 nm performance only
2	Attenuation 1310 nm)	B	0.35 db/km (max. attenuation)
		4	0.40 db/km (max. attenuation)
		5	0.50 db/km (max. attenuation)
F	Fiber Type (singlemode)	0	AT&T D-LUX®-100
		1	Corning SMF-28
		2	Corning TITAN™ SMF
3	Central Member Designation, Sheath Type*		DIELECTRIC CENTRAL MEMBER
		1	P or D, P (all dielectric)
		N	D, P, S, P (single armor)
		R	D, P, S, P, S, P (double armor)
		W	P, D, P, D, P (PowerGuide™)
			NO CENTRAL MEMBER
		Q	S, SW, P (single armor)
			METALLIC CENTRAL MEMBER
		D	P or D, P (dielectric jacket)
		K	D, P, S, P (single armor)
		L	D, P, S, P, S, P (double armor)

AT&T Fitel CABLE CODE DESCRIPTION (Contd)			
Code Position	Description	Cable Code Options	
		Designator	Description
4	Tensile Load	2	600 lbs.
		C	600 lbs., 1 twisted pair (22 AWG)
		D	600 lbs., 2 twisted pair (22 AWG)
		M	Figure 8
		7	PowerGuide™
5	Cable Unit Type	L	Loose tube
		B	Fiber bundle
6	Unit Size	1	1 fiber per unit
		2	2 fibers per unit
		4	4 fibers per unit
		6	6 fibers per unit
		8	8 fibers per unit
		N	10 fibers per unit
		T	12 fibers per unit
7,8,9	Number of Fibers	002-216	Number of fibers

* Sheath options
P = polyethylene
D = dielectric strength member
S = corrugated steel armor
SW = steel wire strength elements

The physical characteristics of AT&T Fitel fiber optic cables are shown below:

PHYSICAL CHARACTERISTICS OF AT&T Fitel CABLE			
Fiber Count *	**Nominal Outside Dia. In. (mm)**	**Nominal Weight lb/kft. (kg/km)**	**Maximum Pulling Tension (lbs)**
Single Jacket			
2-36	0.45 (11.5)	76 (113)	600
38-72	0.51 (12.9)	98 (146)	600
74-96	0.59 (14.9)	131 (195)	600
98-120	0.67 (16.9)	168 (250)	600
122-144	0.75 (19.0)	211 (314)	600
Single Armor, Double Jacket			
2-36	0.59 (15.1)	160 (238)	600
38-72	0.65 (16.5)	189 (282)	600
74-96	0.73 (18.5)	235 (349)	600
98-120	0.81 (20.5)	284 (423)	600
122-144	0.89 (22.6)	339 (505)	600
Double Armor, Triple Jacket			
2-36	0.77 (19.5)	282 (420)	600
38-72	0.82 (20.9)	323 (481)	600
74-96	0.90 (22.9)	382 (569)	600
98-120	0.98 (24.9)	446 (664)	600
122-144	1.06 (27.0)	515 (767)	600

* Information on higher fiber counts (146-216) is available upon request.

Note:

All physical dimensions refer to dielectric central member.
Multimode fibers also available.

Figure-8 Cable

AT&T Fitel figure-8 fiber optic cable incorporates the loose tube design and can accommodate up to 144 singlemode or multimode fibers. Figure-8 cable is a cost effective choice for aerial networks since it is a self-supporting loose tube cable suitable for spans of up to 500 feet (153 m). The cable uses conventional pole attachment hardware such as 3-bolt clamps and dead-end supports. It meets NESC rule 250 for light, medium, and heavy loading conditions and also meets or exceeds all Bellcore TR-20 specifications.

The following code is used to order and identify AT&T Fitel figure-8 self-supporting cable.

FG - 3 4 1 1 M L 6 - 024

NUMBER OF FIBERS

UNIT SIZE (PER TUBE)
1 = 1 Fiber
2 = 2 Fibers
3 = 3 Fibers
4 = 4 Fibers
6 = 6 Fibers
8 = 8 Fibers
N = 10 Fibers
T = 12 Fibers

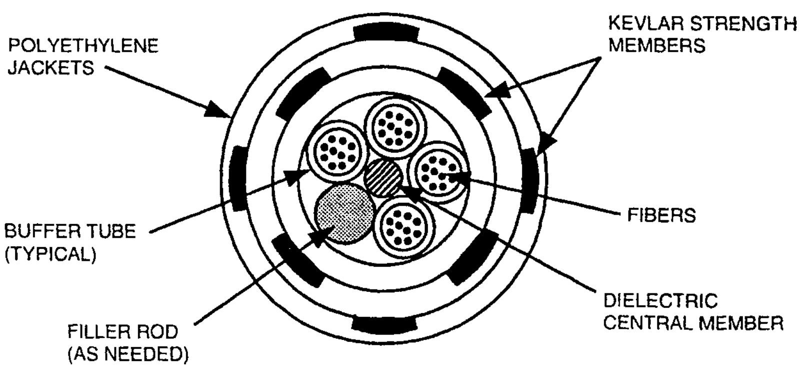
FIBER TYPE (SM)
0 = AT&T D-LUX-100
1 = CORNING SMF-28
2 = CORNING TITAN SMF

ATTENUATION (1310 nm)
B = 0.35 dB/km (max)
4 = 0.40 dB/km (max)
5 = 0.50 dB/km (max)

TRANSMISSION PERFORMANCE
1 = 1310 nm only
2 = 1310/1550 nm attenuation equal
3 = 1550 nm attenuation
0.10 dB/km less than 1310 nm
4 = 1550 nm only

AT&T Fitel PowerGuide® Cable

AT&T Fitel's ***PowerGuide*** is an all dielectric, self-supporting, loose tube fiber optic cable which can accommodate from 2 to 144 singlemode or multimode fibers. The ***PowerGuide*** cable features a 6000 pound minimum breaking strength. This cable's high strength allows it to withstand rigorous handling during installation and heavy storm loading during operation. ***PowerGuide*** cable incorporates an exclusive Kevlar® reinforced triple polyethylene jacket. This triple jacket design, which includes two layers of Kevlar, provides the necessary strength to eliminate a pre-installed messenger as required in traditional figure-8 self-supporting cable. The resulting small, round cross section of ***PowerGuide*** minimizes the effects of wind loading, ice accumulation, and aeolian vibration. This cable meets or exceeds the NESC requirements for light to heavy storm loading conditions.



The physical characteristics of ***PowerGuide*** fiber optic cables are showr below:

PowerGuide PHYSICAL DATA			
Fiber Count*	**Nominal Outside Dia. In. (mm)**	**Nominal Weight lbs/1000 ft. (kg/304.8 m)**	**Max. Stringing Tension (lb).**
1-30	0.67 (17)	150 (68.0)	1200
31-36	0.70 (18)	167 (75.8)	1200
37-48	0.78 (20)	206 (93.4)	1200
49-60	0.86 (22)	251 (113.9)	1200
61-72	0.93 (24)	297 (134.7)	1200

* Data for higher fiber count is available upon request.
Shipping lengths: singlemode-1, 2, 3, 4, 5, or 6 km
multimode-1, 2 km

Fiber Optic Interconnect Cables

Fiber Optic Products Catalog (2492C)

Pigtails

Pigtails are interconnect cables equipped with a connector on one enc and are primarily spliced to outside plant cables entering a central office oı customer premise. This allows the outside plant cable's metallic strengtr members to be bonded and grounded away from sensitive transmissior electronics. The pigtail interconnect cables are equipped with eithei singlemode or multimode connectors and permit connection to a wide variety of termination equipment. The following table lists some of the current pigtails available.

PIGTAILS						
Product Code	**Comcode**	**Ft. (m)**	**Fiber Type**	**Cable Type**	**Cable Color**	**Availability**
Singlemode — Biconic (Standard)						
1B-5	105 167 563	5 (1.5)	8.3/125	SBJ*	Yellow	Stock
1B-7	105 168 108	7 (2.1)	8.3/125	SBJ*	Yellow	Non-stock
1B-10	106 715 683	10 (3.1)	8.3/125	SBJ*	Yellow	Non-stock
1B-17	105 165 518	17 (5.2)	8.3/125	SBJ*	Yellow	Non-stock
1B-35	105 165 500	35 (10.7)	8.3/125	SBJ*	Yellow	Non-stock
S1A-25	104 246 806	25 (7.6)	8.3/125	2000A	Yellow	Non-stock
S1A-40	104 246 814	40 (12.2)	8.3/125	2000A	Yellow	Non-stock
Singlemode — *ST*® Lightguide Cable Connectors						
1STA-1	105 380 695	1 (0.3)	8.3/125	SBJ*	Yellow	Non-stock
1STA-5	105 380 703	5 (1.5)	8.3/125	SBJ*	Yellow	Non-stock
1STA-7	106 271 653	7 (2.1)	8.3/125	SBJ*	Yellow	Non-stock
1STA-10	106 298 235	10 (3.1)	8.3/125	SBJ*	Yellow	Non-stock
1STA-20	105 380 711	20 (6.1)	8.3/125	SBJ*	Yellow	Non-stock
1STA-35	105 380 729	35 (10.7)	8.3/125	SBJ*	Yellow	Non-stock
Singlemode — Biconic (Keyed)						
1B-5K	105 265 573	5 (1.5)	8.3/125	SBJ*	Yellow	Non-stock
1B-7K	105 265 581	7 (2.1)	8.3/125	SBJ*	Yellow	Non-stock
1B-17K	105 265 599	17 (5.2)	8.3/125	SBJ*	Yellow	Non-stock
1B-35K	105 265 607	35 (10.7)	8.3/125	SBJ*	Yellow	Non-stock

* Strengthened Buffer Fiber Jacket — This jacket is created by placing aramid yarns directly over the coated fiber just prior to the extrusion of the PVC buffer jacket.

PIGTAILS (Contd)						
Product Code	Comcode	Ft. (m)	Fiber Type	Cable Type	Cable Color	Availability
Multimode — Biconic						
2B-5	105 165 443	5 (1.5)	50/125	SBJ*	Orange	Non-stock
2B-7	105 165 419	7 (2.1)	50/125	SBJ*	Orange	Non-stock
2B-17	105 165 385	17 (5.2)	50/125	SBJ*	Orange	Non-stock
2B-35	105 165 328	35 (10.7)	50/125	SBJ*	Orange	Non-stock
A1A-25	104 246 764	25 (7.6)	50/125	1800A	Orange	Non-stock
A1A-40	104 246 772	40 (12.2)	50/125	1800A	Orange	Non-stock
3B-5	105 165 302	5 (1.5)	62.5/125	SBJ*	Slate	Non-stock
3B-7	105 165 286	7 (2.1)	62.5/125	SBJ*	Slate	Non-stock
3B-17	105 165 252	17 (5.2)	62.5/125	SBJ*	Slate	Non-stock
3B-35	105 165 229	35 (10.7)	62.5/125	SBJ*	Slate	Non-stock
L1A-25	104 246 780	25 (7.6)	62.5/125	1860A	Slate	Non-stock
L1A-40	104 246 798	40 (12.2)	62.5/125	1860A	Slate	Non-stock
Multimode — *ST* Lightguide Cable Connectors						
2STA-1	105 380 737	1 (0.3)	50/125	SBJ*	Orange	Non-stock
2STA-5	105 380 745	5 (1.5)	50/125	SBJ*	Orange	Non-stock
2STA-20	105 380 752	20 (6.1)	50/125	SBJ*	Orange	Non-stock
2STA-35	105 380 760	35 (10.7)	50/125	SBJ*	Orange	Non-stock
3STA-1	105 380 778	1 (0.3)	62.5/125	SBJ*	Slate	Non-stock
3STA-5	105 380 786	5 (1.5)	62.5/125	SBJ*	Slate	Non-stock
3STA-20	105 380 802	20 (6.1)	62.5/125	SBJ*	Slate	Non-stock
3STA-35	105 380 810	35 (10.7)	62.5/125	SBJ*	Slate	Non-stock

* Strengthened Buffer Fiber Jacket — This jacket is created by placing aramid yarns directly over the coated fiber just prior to the extrusion of the PVC buffer jacket.

Fiber Optic Patch Cords, Jumper Cordage

Patch cords are interconnect cables equipped with connectors on both ends and used to link cross-connect or interconnect modules with optical/electronic equipment or to link cross-connect modules.

Jumper cordage are interconnect cables without connectors on the ends. The cables are purchased in bulk lengths which are cut to required lengths and connectorized in the field.

For more information on patch cords and jumper cordage, see the Fiber Optic Products Catalog (2492C).

CABLE REELS (METALLIC AND FIBER OPTIC CABLE)

AT&T 626-030-005

The following information describes cable reels for shipping metallic and fiber optic cables. The length of cable that can be placed on various reels is covered in this section and in the 626-XXX-XXX series of practices.

The dimensions and weights of cable reels are shown in the following tables.

STANDARD SHIPPING REEL DIMENSIONS						
Reel Size	Diameter In.(mm)			Width In.(mm)		Empty Reel Mass lbm(kg)
	Overall	Drum	Arbor Hole	Overall	Between Heads	
Metal						
413	48(1220)	30(760)	2-11/16(68)	24(610)	18(457)	216(980)
414	50(1270)	30(760)	2-1/16(52)	31-3/8(797)	25-3/8(645)	250(1130)
415	56(1420)	30(760)	2-11/16(68)	31-3/8(797)	25-3/8(645)	288(1310)
416	66(1680)	36(910)	2-11/16(68)	32-3/8(822)	25-3/8(645)	360(1630)
417	78(1980)	42(1070)	2-11/16(68)	32-3/8(822)	25-3/8(645)	550(2490)
420	83(2110)	42(1070)	3-5/8(92)	46-3/4(1187)	39-3/4(1010)	795(3610)
Wood						
3E5	56(1420)	30(7600)	3/1/2(89)	32(813)	26(660)	380(1720)
3E7	78(1980)	36(910)	3-1/2(89)	32(813)	26(660)	694(3150)
3E0	83(2110)	42(1070)	3-1/2(89)	45(1143)	38(965)	870(3950)
For L Type Reels: Add 13 lbm (5.9 kg) to 413, 414, 415, and 3E5 Reel Mass. Add 16 lbm (7.3 kg) to 416, 417, 420, 3E7, and 3E0 Reel Mass.						

Fiber Optic Cable Shipping Reel Capacities

The order entry system will automatically specify the smallest reel available for your order. If you require a specific size and weight reel, specify when ordering. Wooden reels are available, but subject to additional charges. The tables below lists the maximum standard cable lengths for each sheath type.

METAL REEL CAPACITIES FOR FIBER OPTIC CABLES*

Reel Size	Cable Diameter In.(mm)						
	0.42(11)	0.45(11)	0.49(12)	0.52(13)	0.59(15)	0.7(18)	0.74(19)
	Cable Length Ft.(m)						
413	6854(21)	5970(18)	5035(15)	4471(14)	3473(11)	2467(8)	2208(8)
414	11290(34)	9835(30)	8295(25)	7365(22)	5721(17)	4064(12)	3637(11)
415	16603(51)	14463(44)	12198(37)	10831(33)	8413(26)	5977(18)	5348(16)
416	23347(71)	20337(62)	17153(52)	15230(46)	11831(36)	8405(26)	7521(23)
417	33865(103)	29500(90)	24880(76)	22092(67)	17161(52)	12191(37)	10909(33)
419	40037(122)	34877(106)	29415(90)	26119(80)	20289(62)	14413(44)	12897(39)
420	52009(159)	45306(138)	38211(116)	33929(103)	26356(80)	18723(57)	16754(51)
487	91053(278)	79318(242)	66896(204)	59400(181)	46141(141)	32779(100)	29331(89)
413L	5283(16)	4602(14)	3881(12)	3447(11)	2677(82)	1902(6)	1702(5)
414L	9454(29)	8236(25)	6946(21)	6168(19)	4791(15)	3404(10)	3046(9)
415L	13904(42)	12112(37)	10215(31)	9070(28)	7046(21)	5005(15)	4479(14)
416L	19551(60)	17031(52)	14364(44)	12755(39)	9908(30)	7038(21)	6298(19)
417L	27025(82)	23542(72)	19855(61)	17630(54)	13695(42)	9729(30)	8706(27)
419L	33198(101)	28919(88)	24390(74)	21657(66)	16823(51)	11951(36)	10694(33)
420L	45303(138)	39465(120)	33284(101)	29555(90)	22958(70)	16309(50)	14594(44)

*The reel capacities shown here do not include figure-8, self-supported cable.

WOOD REEL CAPACITIES FOR FIBER OPTIC CABLES*

Reel Size	Cable Diameter In.(mm)						
	0.42(11)	0.45(11)	0.49(12)	0.52(13)	0.59(15)	0.7(18)	0.74(19)
	Cable Length Ft.(m)						
3E5	15589(48)	13580(41)	11453(35)	10170(31)	7900(24)	5612(17)	5022(15)
3E7	32671(100)	28460(87)	24003(73)	21314(65)	16556(50)	11762(36)	10525(32)
3E0	61544(188)	53612(163)	45216(138)	40149(122)	31187(95)	22156(68)	19825(60)
3E5L	13116(40)	11425(35)	9636(29)	8556(26)	6646(20)	4722(14)	4225(13)
3E7L	26231(80)	22850(70)	19272(59)	17112(52)	13293(41)	9443(29)	8450(26)
3E0L	53456(163)	46566(142)	39274(120)	34873(106)	27089(83)	19244(59)	17220(52)

*The,reel capacities shown here do not include figure-8, self-supported cable.

ACCEPTANCE TESTING, EQUIPMENT REQUIREMENTS

This equipment is used for final acceptance testing and measurement of newly installed copper cable and fiber optic cable. Field testing and measurement shall be carried out in two phases to insure the integrity of the newly installed plant; construction testing (splice verification) and completion testing. The associated equipment requirements for the above testing procedures are listed here.

The following equipment is required for testing copper cables:

- CTC Model 9955E Splicer's Test Set
- Wilcom Model T-124 Shield Continuity Tester
- Micro-Computer Systems Model 575 Portable Verification Unit
- Associated Research Model 293 Vibroground Tester
- Associated Research 36962 Carrying Case with Test Rods and Cords
- CTC Model 9925XB Subscriber Loop Test Set *
- Fluke Model 87 Digital Multimeter
- Fluke Model 80T-150U Temperature Probe
- Wilcom Model T-207 Longitudinal Balance Set
- Aines 140A/MC Tone Test Set
- Aines 150SP Test Probe
- Miscellaneous Test Items—Handset, Terminations, Cords, and Spare Batteries.

* This test set also used in maintenance testing.

The following equipment is required for testing fiber optic cables:

FIBER OPTIC TEST EQUIPMENT		
Description	**Quantity (Note)**	**Application sm - Singlemode mm - Multimode**
TEKTRONIX * KS-22732 Multimode OTDR	1	mm
ANRITSU† MW98A (F-61933) Singlemode OTDR	1	sm
AT&T 941 A1 Optical Talk Set	2	sm, mm
AT&T 736A Transmitter	2	sm
AT&T 736C Transmitter	2	sm
AT&T 938A Optical Loss Set	2	sm, mm
AT&T LS1T-N-06 Cable	2	sm
AT&T LA1T-N-06 Cable	2	sm, mm
AT&T LA1T-T-06 Cable	2	sm, mm
AT&T 1012A Coupling	2	sm
AT&T 1002A Coupling	2	mm

Note:

Quantities listed are minimum for one work crew. Multiple work crews may require additional equipment.

In addition to the above listed equipment, any cables requiring that splices be re-made or connectors applied at the testing ends will require that splicing and connectorization supplies be available. These include tool kits, splices, connectors, and consumables.

* Registered trademark of Tektronix. Inc.

† Registered trademark of Anritsu Electric Co., LTD.

BIBLIOGRAPHY

AT&T	Title
461-200-100	Plenum Cable — Copper
626-020-006	Cable Conductors
626-020-007	Metallic Shields and Sheaths Resistance
626-020-010	Feeder and Distribution Cable — Selection
626-020-011	Designations for Cable Conductors, Conductor Insulations, Sheaths, and Protective Coverings
626-020-020	Standard Plastic Sheaths
626-030-005	Cable Shipping Reels
626-100-006	CD Series of Multiunit Pulp (MUP) Cable (DA)
626-101-005	Air-Core PIC Cables
626-101-010	Filled PIC Cables
626-101-015	CGAW Filled High Dielectric Strength Cable (DA)
626-101-030	PIC and Pulp Steampeth Cables (DA)
626-105-008	ICOT T1/T1C Carrier Cable (DA)
626-107-005	PE-PVC Terminating Cables
626-107-006	AR Series Riser Cable
626-108-101	Ribbon-Type Fiber Optic Cable
626-108-102	Stranded-Type Fiber Optic Cable (DA)
626-108-103	***Lightpack*** Fiber Optic Cable
626-108-110	Single-Mode Fiber Optic Cable
626-200-400	Filled Cable — Bonded ASP Sheath

626-300-100	Buried Wire
626-300-126	Aerial Service Wire
626-500-101	CONECS Cable Splicing System (DA)
626-759-020	Lead Sheaths
626-759-025	Outer Protection
626-759-030	Wire Armor Protection
626-800-090	AD Series Pulp-Insulated Cable (DA)
626-800-095	PIC Cable — Nonstandard/Limited Availability
627-610-225	Placing Metallic Riser and Building Cable
627-610-230	Placing Fiber Optic Cables in Buildings
644-202-202	Fiber Optic Cable Restoration
919-370-100	Line Wire

For further information on AT&T copper cable and wire contact:

AT&T Copper Cable and Wire
Product Consulting Organization
505 N. 51st Ave.
Phoenix, AZ 85043

Damijan Baricevic
(602)233-5700 voice
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!dbaricevic E-mail

To obtain copies of AT&T copper cable specifications contact:

AT&T Customer Information Center
2855 N. Franklin Road
P.O. Box 19901
Indianapolis, IN 46219-1999

Call:
800-432-6600 from USA
800-255-1242 from Canada
317-322-6416 from the Far East
317-322-6646 from Europe

Facsimile:
317-322-6699 or 6484

For availability of Spanish translations for Outside Plant documentation contact:

AT&T Network Systems Customer Education and Training
Outside Plant Group
2400 Reynolda Rd.
Winston-Salem, NC 24106

Terry Smith
(910)727-3474 voice
(910)727-3831 facsimile

Section 15

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Section 15

TERMINALS, CLOSURES, AND CONNECTORS

FEEDER-DISTRIBUTION INTERFACES

40-Type Cabinets

AT&T 631-600-230

The 40-type cabinet is a single-sided feeder-distribution interface offered in a pedestal or aerial (pole or wall mounted) configuration. The 40-type cabinet family consists of seven cabinet sizes. The cabinet sizes are identified by their respective letter designations A, B, C, D, E, F, and H.

40-TYPE CABINET DESIGNATIONS	
Size	**Mounting**
A	Pedestal or Aerial
B	Aerial
C	Enhanced Pedestal or Aerial
D	Aerial
E	Enhanced Pedestal
F	Enhanced Pedestal
H	Aerial

The 40-type **pedestal** cabinet has been redesigned and named the *Enhanced* 40-type cabinet. Except for the 40 "A" size cabinet, which remains unchanged, all 40-type pedestal cabinets have been replaced by the enhanced cabinet design. The enhanced cabinet codes available are:

P4—a low profile design with a 6-inch (152 mm) base

P5—a standard height design with a 13-inch (330 mm) base

P6—a high profile base design with a 30-inch (762 mm) base.

The P4, P5, and P6 enhanced pedestal cabinets are available in sizes C, E, and F.

Dimensions

The following dimensions are for enhanced pedestal, standard pedestal and aerial 40-type cabinets.

40-TYPE CABINET DIMENSIONS			
Enhanced Pedestal			
Cabinet	**Dimensions**		
	Width In. (mm)	**Height In. (mm)**	**Depth In. (mm)**
40CEP4	40 (1016)	36.5 (927)	12 (305)
40EEP4	40 (1016)	47.3 (1201)	12 (305)
40FEP4	40 (1016)	63.5 (1613)	12 (305)
40CEP5	40 (1016)	43.3 (1100)	12 (305)
40EEP5	40 (1016)	54.1 (1374)	12 (305)
40FEP5	40 (1016)	70.3 (1786)	12 (305)
40CEP6	40 (1016)	59.5 (1511)	12 (305)
40EEP6	40 (1016)	70.5 (1791)	12 (305)
40FEP6	40 (1016)	86.5 (2197)	12 (305)
Notes: P4 cabinet dimensions include a 6-inch (152 mm) base. P5 cabinet dimensions include a 13-inch (330 mm) base. P6 cabinet dimensions include a 30-inch (762 mm) base.			
Standard Pedestal			
Cabinet	**Dimensions**		
	Width In. (mm)	**Height In. (mm)**	**Depth In. (mm)**
40AP1	15 (381)	43 (1092)	12 (305)
Note: P1 cabinet dimensions include a 13-inch (330 mm) base.			
Aerial			
Cabinet	**Dimensions**		
	Width In. (mm)	**Height In. (mm)**	**Depth In. (mm)**
40AA1	15 (381)	30 (762)	12 (305)
40CA1	33 (838)	30 (762)	12 (305)
40DA1	33 (838)	41 (1041)	12 (305)
40HA1	33 (838)	57 (1448)	12 (305)

Cabinet Coding

The 40-type cabinets use the following codes to specify the cabinet size, base size, terminal block type, pair count, etc.

40 C E P 4 - 76 S / 12 CF SA 3 25

BASIC CABINET DESIGN
- 40 = SINGLE SIDED

CABINET SIZE

PAD SIZE (OMIT ON ISSUE 1 & AERIAL)

CABINET MOUNTING
- A = AERIAL
- P = PEDESTAL

DESIGN ISSUE
- 1 = 13 INCH (330 mm) BASE - STANDARD PEDESTAL
- 4 = 6 INCH (152 mm) BASE - ENHANCED
- 5 = 13 INCH (330 mm) BASE - ENHANCED
- 6 = 30 INCH (762 mm) BASE - ENHANCED

TERMINAL BLOCK TYPE
- J1 = SPLICING CABINET
- 76 = 76-TYPE BINDING POST
- 99 = 99-TYPE SNAP CAP
- 108 = 108-TYPE CONNECTOR BLOCKS

CONNECTOR OPTION
- S = STANDARD (FEEDER OR DISTRIBUTION)

PAIR COUNT
- 12 OR 1200 = 1200 PAIR

STUB CABLE END CONFIGURATION
- CF = HARNESSED, 710 CAPLESS FEMALE
- EA = ENCAPSULATED WITH FILLED CABLE STUB
- FE = FIELD ENCAPSULATED
- HA = RAW ENDED, HARNESSED
- KT = KIT OF LOOSE CONNECTOR PARTS (108 ONLY)
- CM = HARNESS WITH 710 MALE CONNECTOR MODULES

CABLE STUB IDENTIFIER
- SA = AFMY FILLED CABLE
- SB = BKMZ AIRCORE CABLE
- SP = BKMZ AIRCORE CABLE WITH MOISTURE PLUG
- SG1 = 1 BKMZ AIRCORE STUB CABLE WITH GAS TYPE PRESSURE PLUG
- SG2 = 2 BKMZ AIRCORE STUB CABLES WITH GAS TYPE PRESSURE PLUG

CABLE STUB QUANTITY

CABLE STUB LENGTH IN FT. (SEE NOTE)

NOTE: STUB LENGTHS ARE AVAILABLE IN 20- TO 100-FOOT LENGTHS IN 10-FOOT INCREMENTS TO BE SPECIFIED ON ORDER AS E/W XX FT. STUB.

Pair Capacities

The 40-type cabinets are available with 76- and 99-type terminal blocks 108-type connectors, or unequipped. The cabinets are available with capacities up to 2700 pairs using 76- and 99-type terminal blocks and up to 3600 pairs using 108-type connectors. These cabinets come in 100-pair increments starting at 100 pair up to the maximum pair capacities as shown in the table below. For cabinets requiring over 2700 pairs, refer to the 42-type cabinets. The empty 40-type cabinet may also be used for splicing.

40-TYPE CABINET PAIR CAPACITIES			
Size	Mounting	Capacities (Pairs)	
		76/99-Type Block	108-Type Connector
40A	Pedestal	400	600
40A	Aerial	400	600
40B	Aerial	—	1200
40C	Pedestal	1200	1800
40C	Aerial	800	1800
40D	Aerial	1200	2700
40E	Pedestal	1800	2700
40F	Pedestal	2700	3600
40H	Aerial	1800	—

Mounting

The specifications on the 40-type pedestal cabinet call for the cabinet to be mounted on a pad foundation. The foundation pad drawing number is ED-1T223-01 and is available from AT&T. A cabinet mounting pad bracket must be ordered in advance of pad construction to locate mounting inserts and cable duct entrance opening(s). The new enhanced 40-type pedestal cabinet has been designed to mount on the standard foundation pad without the need for adapters. This change has resulted in several cabinet sizes being eliminated and replaced by a standard width pedestal cabinet that fits on the standard size pad. The table below shows the pad size and bracket type used for each cabinet.

40-TYPE PEDESTAL CABINET MOUNTING		
Size	**Foundation Pad Size In. (mm)**	**Bracket Reqd.**
40A	36 (914) W x 48 (1219) L x 5 (127) D	130A
40C	58 (1473) W x 48 (1219) L x 5 (127) D	130G
40E	58 (1473) W x 48 (1219) L x 5 (127) D	130G
40F	48 (1219) W x 48 (1219) L x 5 (127) D	130G

Notes: Foundation pad shown on drawing No. ED-1T223-01. Aerial type cabinets do not require an additional bracket for mounting.

Terminal Block Codes

Individual terminal blocks for 40-type cabinets are coded as follows:

76 S 1 - 600 HA

TERMINAL BLOCK TYPE
- 76-TYPE
- 99-TYPE
  - SB - SEALED BRIDGABLE
  - SC - SEALED CLOSED
  - SD - SEALED DRY
  - DC - DRY CLOSED
- 108-TYPE

CONNECTOR OPTION
- S = STANDARD (FEEDER OR DISTRIBUTION)

DESIGN ISSUE
- 76-TYPE (1)
- 99-TYPE (2)
- 108-TYPE (1)

NUMBER OF PAIRS
(100-PAIR INCREMENTS)

TERMINATION METHOD
- CF = HARNESS WITH 710 CAPLESS FEMALE CONNECTOR MODULES
- EA = ENCAPSULATED
- F = HARNESS WITH 710 FEMALE CONNECTORS (CAPS PRESSED IN PLACE)
- HA = RAW ENDED HARNESS
- KT = KIT OF LOOSE CONNECTOR PARTS (108 ONLY)
- CM = HARNESS WITH 710 MALE CONNECTOR MODULES

NOTE: STUB LENGTHS ARE AVAILABLE IN 20- TO 100-FOOT LENGTHS IN 10-FOOT INCREMENTS TO BE SPECIFIED ON ORDER AS E/W XX FT. STUB. ALL TERMINAL BLOCK WIRING, HARNESSING, AND CABLE IS 24 AWG (0.5 MM).

Terminal Block Cabinet Codes

The size of the 40-type cabinets is determined by the letter designation. Due to the large numbers of 76-type terminal blocks available, the ordering numbers are not shown here. Ordering information for the 76-type blocks are available in AT&T 631-600-230. Ordering codes for the 99-type terminal blocks and 108-type connectors available for the 40-type cabinets are shown below.

99-TYPE TERMINAL BLOCKS FOR 40-TYPE CABINETS

Description	Comcode Number	
	710 Conn.	Raw Harness
40CEP4-99SB/100 CF	106509870	—
40CEP4-99SB/100 HA	—	106509839
40CEP4-99SB/200 CF	106509979	—
40CEP4-99SB/200 HA	—	106509938
40CEP4-99SB/300 CF	106510118	—
40CEP4-99SB/300 HA	—	106510076
40CEP4-99SB/400 CF	106510217	—
40CEP4-99SB/400 HA	—	106510175
40CEP4-99SB/600 CF	106510316	—
40CEP4-99SB/600 HA	—	106510274
40CEP4-99SB/900 HA	—	106756117
40CEP4-99SB/1000 CF	106510415	—
40CEP4-99SB/1000 HA	—	106510373
40CEP4-99SB/1200 CF	106510514	—
40CEP4-99SB/1200 HA	—	106510472
40EEP4-99SB/1500 CF	106510613	—
40EEP4-99SB/1500 HA	—	106510571
40EEP4-99SB/1800 CF	106510829	—
40EEP4-99SB/1800 HA	—	106510787

99-TYPE TERMINAL BLOCKS FOR 40-TYPE CABINETS (Contd)		
Description	Comcode Number	
	710 Conn.	Raw Harness
40FEP4-99SB/2100 HA	—	106757719
40FEP4-99SB/2200 CF	106510936	—
40FEP4-99SB/2200 HA	—	106510886
40FEP4-99SB/2400 HA	—	106757727
40FEP4-99SB/2700 CF	106511041	—
40FEP4-99SB/2700 HA	—	106511009
40CEP5-99SB/100 CF	106769292	—
40CEP5-99SB/100 HA	—	106769326
40CEP5-99SB/200 CF	106769557	—
40CEP5-99SB/200 HA	—	106769631
40CEP5-99SB/300 CF	106770084	—
40CEP5-99SB/300 HA	—	106770118
40CEP5-99SB/400 CF	106770381	—
40CEP5-99SB/400 HA	—	106770431
40CEP5-99SB/600 CF	106770597	—
40CEP5-99SB/600 HA	—	106770605
40CEP5-99SB/900 HA	—	106771272
40CEP5-99SB/1000 CF	106771322	—
40CEP5-99SB/1000 HA	—	106771330
40CEP5-99SB/1200 CF	106772585	—
40CEP5-99SB/1200 HA	—	106772593
40EEP5-99SB/1500 CF	106773047	—
40EEP5-99SB/1500 HA	—	106773054
40EEP5-99SB/1800 CF	106773179	—
40EEP5-99SB/1800 HA	—	106773187

99-TYPE TERMINAL BLOCKS FOR 40-TYPE CABINETS (Contd)		
Description	Comcode Number	
	710 Conn.	Raw Harness
40FEP5-99SB/2100 HA	—	106773476
40FEP5-99SB/2200 CF	106773765	—
40FEP5-99SB/2200 HA	—	106773773
40FEP5-99SB/2400 HA	—	106773781
40FEP5-99SB/2700 CF	106773799	—
40FEP5-99SB/2700 HA	—	106773807
40AA1-99SB/100 CF	106562150	—
40AA1-99SB/300 CF	106562168	—
40AA1-99SB/300 HA	—	106824337
40CA1-99SB/600 CF	106562176	—
40CA1-99SB/600 HA	—	106824360
40DA1-99SB/1200 CF	106562184	—
40DA1-99SB/1200 HA	—	106824386
40HA1-99SB/1800 HA	—	106824402

99-TYPE TERMINAL BLOCKS FOR 40-TYPE CABINETS (Contd)			
Description	No. of Stubs	Stub Length ft. (m)	Comcode Number
			Encapsulated Panels
40EEP4-99SB/12* EA 30'	1	30 (9.1)	106756430
40EEP4-99SB/18* EA 30'	1	30 (9.1)	106756448
40FEP4-99SB/27† EA 30'	1	30 (9.1)	106757743
40EEP5-99SB/12* EA 30'	1	30 (9.1)	106772924
40EEP5-99SB/18* EA 30'	1	30 (9.1)	106773195
40FEP5-99SB/27† EA 30'	1	30 (9.1)	106773815

* Numbers 12 and 18 designate 1200 and 1800 pairs.

† Number 27 designates 2700 pairs.

108-TYPE CONNECTORS FOR 40-TYPE CABINETS			
Description	Comcode Number		
	710 Conn.	Raw Harness	Kit Not Wired
40AP1-108S/300 HA	—	106824303	—
40AP1-108S/600 CF	103081360	—	—
40AP1-108S/600 HA	—	103081378	—
40AP1-108S/600 KT	—	—	103243218
40CEP4-108S/900 CF	106755358	—	—
40CEP4-108S/900 HA	—	106755366	—
40CEP4-108S/900 KT	—	—	106755382
40CEP4-108S/1200 CF	106755234	—	—
40CEP4-108S/1200 HA	—	106755259	—
40CEP4-108S/1200 KT	—	—	106755275
40CEP4-108S/1500 CF	106755291	—	—
40CEP4-108S/1500 HA	—	106755309	—
40CEP4-108S/1500 KT	—	—	106755317
40CEP4-108S/1800 CF	106643224	—	—
40CEP4-108S/1800 HA	—	106755333	—
40CEP4-108S/1800 KT	—	—	106755341
40EEP4-108S/2100 CF	106755432	—	—
40EEP4-108S/2100 HA	—	106755457	—
40EEP4-108S/2100 KT	—	—	106755473
40EEP4-108S/2400 CF	106755481	—	—
40EEP4-108S/2400 HA	—	106755499	—
40EEP4-108S/2400 KT	—	—	106755507
40EEP4-108S/2700 CF	106643232	—	—
40EEP4-108S/2700 HA	—	106755564	—
40EEP4-108S/2700 KT	—	—	106755598
40FEP4-108S/3600CF	106756521	—	—
40FEP4-108S/3600 HA	—	106756539	—
40FEP4-108S/3600 KT	—	—	106756570

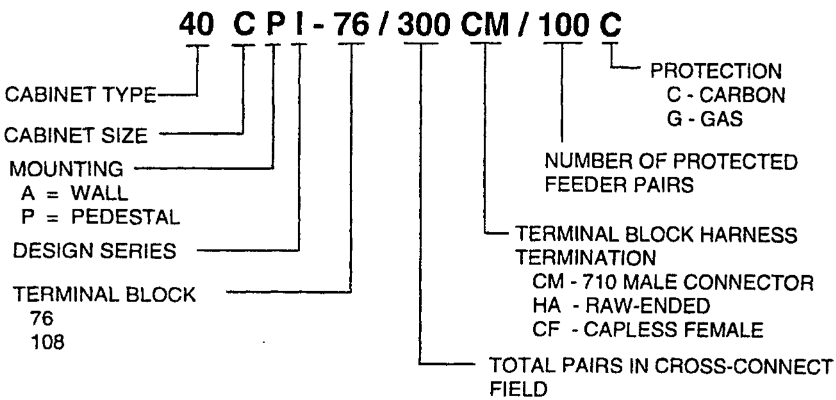
108-TYPE CONNECTORS FOR 40-TYPE CABINETS (Contd)			
Description	Comcode Number		
	710 Conn.	Raw Harness	Kit Not Wired
40CEP5-108S/900 CF	106770670	—	—
40CEP5-108S/900 HA	—	106770688	—
40CEP5-108S/900 KT	—	—	106770704
40CEP5-108S/1200 CF	106771348	—	—
40CEP5-108S/1200 HA	—	106771363	—
40CEP5-108S/1200 KT	—	—	106771371
40CEP5-108S/1500 CF	106772767	—	—
40CEP5-108S/1500 HA	—	106772775	—
40CEP5-108S/1500 KT	—	—	106772783
40CEP5-108S/1800 CF	106756133	—	—
40CEP5-108S/1800 HA	—	106756141	—
40CEP5-108S/1800 KT	—	—	106772809
40EEP5-108S/2100 CF	106773203	—	—
40EEP5-108S/2100 HA	—	106773211	—
40EEP5-108S/2100 KT	—	—	106773229
40EEP5-108S/2400 CF	106773237	—	—
40EEP5-108S/2400 HA	—	106773252	—
40EEP5-108S/2400 KT	—	—	106773278
40EEP5-108S/2700 CF	106756505	—	—
40EEP5-108S/2700 HA	—	106756513	—
40EEP5-108S/2700 KT	—	—	106773302
40FEP5-108S/3600 CF	106773690	—	—
40FEP5-108S/3600 HA	—	106773716	—
40FEP5-108S/3600 KT	—	—	106773732

108-TYPE CONNECTORS FOR 40-TYPE CABINETS (Contd)			
Description	Comcode Number		
	710 Conn.	Raw Harness	Kit Not Wired
40AA1-108S/200 HA	—	104437165	—
40AA1-108S/300 HA	—	104437280	—
40AA1-108S/600 CF	103081329	—	—
40AA1-108S/600 HA	—	103081337	—
40AA1-108S/600 KT	—	—	103243200
40BA1-108S/1200 CF	103081410	—	—
40BA1-108S/1200 HA	—	103081428	—
40BA1-108S/1200 KT	—	—	103243226
40CA1-108S/1200 CF	103081501	—	—
40CA1-108S/1200 HA	—	103081519	—
40CA1-108S/1200 KT	—	—	103243242
40CA1-108S/1800 CF	103081535	—	—
40CA1-108S/1800 HA	—	103081543	—
40CA1-108S/1800 KT	—	—	103243259
40DA1-108S/2700 CF	103081642	—	—
40DA1-108S/2700 HA	—	103081659	—
40DA1-108S/2700 KT	—	—	103144432

40-Type Cabinet With Protectors

AT&T 631-600-232

The 40-type cabinet equipped with 134-type protectors is intended to provide station protection at garden apartments, shopping centers, and small commercial buildings. They provide for 100, 200, and 300 protected feeder pairs with a feeder-to-distribution ratio of 1 to 2. The coding for these cabinets is shown below.



40-Type Cabinet — Wiring

The wiring of 40-type cabinets is covered in AT&T 462-250-107.

42-Type Cabinet

AT&T 631-600-236, -237

The 42-type cabinet is a double-sided, feeder-distribution interface tha serves as an extension of the 40-type cabinet family. This **pedestal only** cabinet is available in two sizes and is identified by the letter designations E and F. It has a 3-column terminal block panel on each side and is designed to permit feeder-to-distribution ratios of 1 to 2 for SAC application or 1 to 1 fo multiple plant application.

Two new cabinet configurations have been added, both with the same pair capacity as the other cabinets.

- **42-Type Low Profile**—This is a low profile cabinet designated 42LP The 42ELP cabinet has the same capacity as the conventional 42E cabinet, but has been reduced in height by 9 inches (229 mm) for a tota height of 48 inches (1.22 m), including the 4-inch (102 mm) pedesta base, making it the lowest profile double-sided cabinet in the interface market. The 42FLP cabinet has been reduced to a height of 64 inches (1.6 m) and also has the same pair capacity as the standard 42F cabinet.
- **42-Type High Profile**—This is a high profile cabinet designated 42HP that was specially developed for use in high water areas and areas prone to flooding. The 42EHP cabinet has the same capacity as the conventional 42E cabinet, but has been increased in height by 30 inches (762 mm) for a total height of 74 inches (1.88 m), including the 30-inch (762 mm) pedestal base. This high profile cabinet is no available in the 42F size.

42-TYPE CABINET DESIGNATIONS		
Size	**Version**	**Mounting**
E	Standard	Pedestal
F	Standard	Pedestal
EL	Low Profile	Pedestal
FL	Low Profile	Pedestal
EH	High Profile	Pedestal

Dimensions

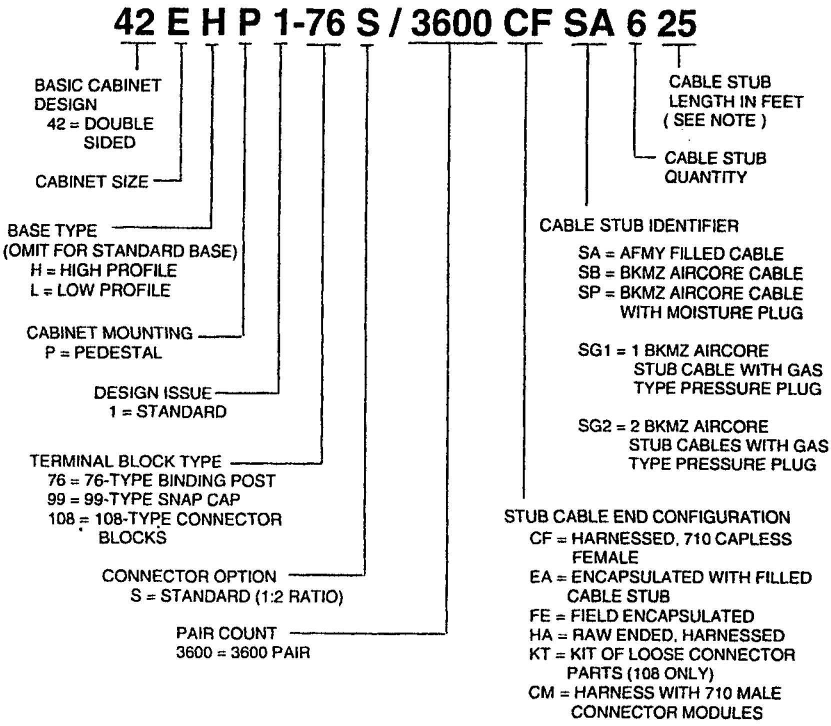
The 42-type cabinets are available in two sizes and three heights as shown below. Empty cabinets are also available for rehabilitation.

42-TYPE CABINET DIMENSIONS			
Cabinet	**Dimensions**		
	Width In. (mm)	**Height In. (mm)**	**Depth In. (mm)**
42E Standard	40 (1016)	57 (1448)	22 (559)
42F Standard	40 (1016)	73 (1854)	22 (559)
42EL Low Profile	40 (1016)	48 (1219)	22 (559)
42FL Low Profile	40 (1016)	64 (1626)	22 (559)
42EH High Profile	40 (1016)	74 (1880)	22 (559)

Notes: 42-type standard cabinet dimensions include a 13-inch (330 mm) base.
42-type Low Profile version cabinet dimensions include a 4-inch (102 mm) base.
42-type High Profile version cabinet dimensions include a 30-inch (762 mm) base.

Cabinet Coding

The 42-type cabinets use the following codes to specify the cabinet size, base size, terminal block type, pair count, etc.



NOTE: STUB LENGTHS ARE AVAILABLE IN 20- TO 100-FOOT LENGTHS IN 10-FOOT INCREMENTS TO BE SPECIFIED ON ORDER AS E/W XX FT. STUB.

Pair Capacities

The maximum capacity with 76- or 99-type terminal blocks is 3600 pairs for the E type cabinet and 5400 pairs for the F type cabinet. The maximum capacity with 108-type terminal blocks is 5400 pairs for the E type cabinet and 7200 pairs for the F type cabinet. These cabinets come in 100-pair increments starting at 100 pair, up to the maximum pair capacities as shown in the table below.

42-TYPE CABINET PAIR CAPACITIES			
Size	Mounting	Capacities (Pairs)	
		76/99-Type Block	108-Type Connector
42E	Pedestal	3600	5400
42F	Pedestal	5400	7200
42EL	Pedestal	3600	5400
42FL	Pedestal	5400	7200
42EH	Pedestal	3600	5400

Mounting

The specifications on the 42-type cabinet call for one standard pad foundation 58 inches (1473 mm) wide by 79 inches (2007 mm) long by 5 inches (127 mm) deep. The foundation drawing number is ED-1T280-01 and is available from AT&T. The cabinet mounting pad bracket (130H) must be ordered in advance of pad construction to locate mounting inserts and cable duct entrance opening(s).

Terminal Block Codes

Individual terminal blocks for the 42-type cabinets are the same as the codes shown for the 40-type cabinets.

Terminal Block Cabinet Codes

The size of the 42-type cabinets is determined by the letter designation Due to the large number of 76-type terminal blocks available, ordering code: are not shown here. Ordering information for the 76-type blocks are availabl in AT&T 631-600-230. Ordering codes for the 99-type terminal blocks an 108-type connectors available for the 42-type cabinets are shown below.

99-TERMINAL BLOCKS FOR 42-TYPE CABINETS		
Description	Comcode Number	
	710 Conn.	Raw Harness
42EP1-99SB/3600 HA	—	106824667
42FP1B-99SB/5400 CF	106646433	—
42FP1T-99SB/5400 CF	106646540	—
42FP1B-99SB/5400 HA	—	106646383
42FP1T-99SB/5400 HA	—	106646474
42FLP1B-99SB/5400 CF	106646623	—
42FLP1T-99SB/5400 CF	106646706	—
42FLP1B-99SB/5400 HA	—	106646581
42FLP1T-99SB/5400 HA	—	106646664

99-TERMINAL BLOCKS FOR 42-TYPE CABINETS			
Description	No. of Stubs	Stub Length ft. (m)	Comcode Number
			Encapsulated Panels
42EP1-99SB/3600 EA 30'	1	30 (9.1)	106562143

108-TYPE CONNECTORS FOR 42-TYPE CABINETS		
Description	Comcode Number	
	710 Conn.	Raw Harness
42EP1-108S/2700 CF	104194097	—
42EP1-108S/2700 HA	—	104194113
42EP1-108S/3600 CF	104194121	—
42EP1-108S/3600 HA	—	104194147
42EP1-108S/5400 CF	104045208	—
42EP1-108S/5400 HA	—	104045216
42ELP1-108S/2700 CF	104431613	—
42ELP1-108S/2700 HA	—	104431622
42ELP1-108S/3600 CF	104431804	—
42ELP1-108S/3600 HA	—	104431812
42ELP1-108S/5400 CF	104431820	—
42ELP1-108S/5400 HA	—	104431838

80-Type Cabinets

The 80-type cabinets are double-sided and designed for use as either an interface, a remote terminal, or a combination of both. The 80-type cabinets are designed to house the following apparatus:

- The 80B and 80C cabinets have been rated Discontinued Availability (DA).
- The 80D cabinets are available in various combinations of Feeder Distribution Interfaces (FDI) only, FDI and SLC®-96 Carrier Systems, or FDI and *SLC* Series 5 Carrier Systems, and also Digital Data Multiplexers.
- The 80E cabinets are available and designed in various combinations of FDI and *SLC* Series 5 carrier systems, and FDI and *SLC* Series 5 — Fiber in the Loop (FITL) feature.
- The 81C cabinet is designed to house a wide range of equipment including the *SLC*-2000 Access System, *SLC* Series 5 Carrier System, *SLC* 240 Network Access System, OLC-2000, Hardened Remote Integrated Services Line Unit 2 (HRISLU2) switching equipment, and FDI.

The greater density of electronics housed in enclosures, and customer requests for additional battery reserves, has led to the development of bulk-powered cabinets. Additional enhancements to the remote terminal cabinet product family have also been incorporated into the bulk-powered cabinet designs. The introduction of the 80E-BP, 80A-BP, and 80D-BP enclosures further expanded the possible choices in size, capacity, and powering options that are available.

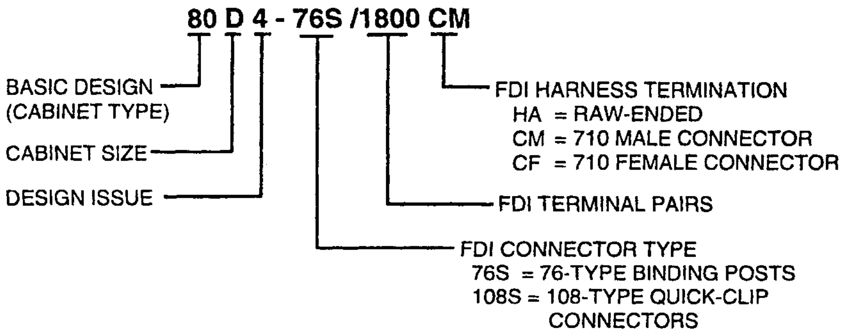
The dimensions of the 80-type distributed power cabinets are shown below.

80-TYPE DISTRIBUTED POWER CABINET DIMENSIONS			
Cabinet Code	Overall Dimensions Inches (mm)		
	Height	Width	Depth
80D	66 (1676)	84 (2134)	27 (686)
80E	74 (1880)	106 (2692)	33 (838)

The dimensions of the 80-type bulk powered cabinets are shown below.

80-TYPE BULK POWERED CABINET DIMENSIONS			
Cabinet Code	Overall Dimensions Inches (mm)		
	Height	Width	Depth
80A-BP/HX	66 (1676)	52 (1321)	36 (914)
80D-BP/HX	69 (1753)	90 (2286)	38 (965)
80E-BP/HX	75 (1905)	106 (2692)	33 (838)
81C	62 (1575)	106 (2692)	18 (457)

The 80-type cabinet code is as follows:



These cabinets are available with associated hardware factory-installed, depending on their use. They are ordered by group configuration numbers depending on the equipment required. For group numbers refer to the following practices:

80A-BP	631-600-247
80D-BP	631-600-249
80E-BP	631-600-243
80A-HX	631-600-251
80D-HX	631-600-254
81C	631-600-253

Feeder Distribution Interface (FDI)

The 80D cabinet is the only one presently used strictly as an FDI and has the following terminating capacities:

4800 pairs — Equipped with 76-type terminal blocks with binding posts
7200 pairs — Equipped with 108-type connecting blocks.

80-Type Cabinet — Wiring

Wiring of 80-type cabinets with 76-type binding posts and 108 connectors is described in AT&T 462-250-110.

80-Type Cabinets Housing Pair Gain Systems

The 80D cabinets are also used for housing ***SLC***-96 and ***SLC*** Series 5 Pair Gain Systems. There are various combinations available. Some can be ordered with a combination of carrier equipment and an FDI in the same cabinet. Others may be ordered with strictly carrier equipment. In those situations, an FDI may be required in a separate housing.

The 80E cabinets are designed for housing strictly carrier equipment alone or with an FDI. ***They are not designed strictly as an FDI at the present time.***

The various equipment combinations are ordered by group numbers for both cabinets. The group numbers for ordering the equipped cabinets plus illustrations of the various combinations are shown in AT&T 631-600-243 for the 80E-BP and in AT&T 631-600-249 for the 80D-BP..

The practices involved with these cabinets are too numerous to describe here They are shown in the Bibliography at the end of this section.

51A Remote Terminal Cabinet

AT&T 640-250-237

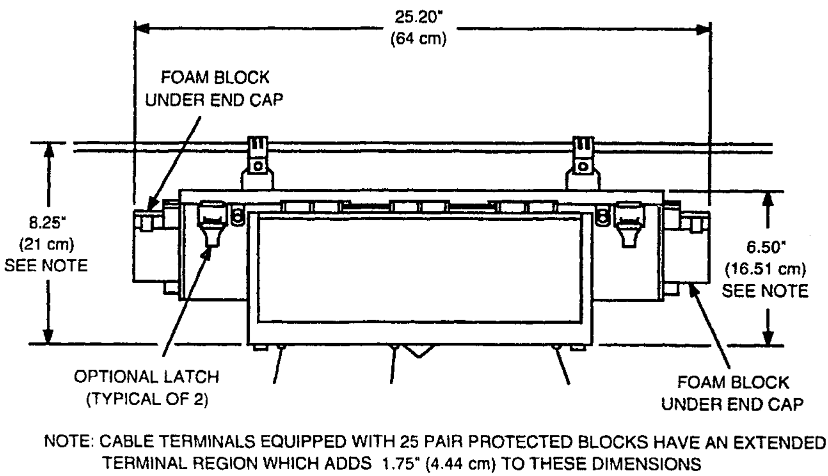
The 51A cabinet houses one ***SLC*** Series 5 dual channel bank and associated equipment with a capacity of serving 192 subscriber lines. The cabinet is factory-assembled, completely prewired, and may be pole- or wall mounted. A multiple arrangement of three cabinets on an H fixture may also be mounted on stub poles. There is a separate FDI associated with the cabinet. The 51-type cabinet is available housing various configurations of electronic equipment including a single ***SLC*** Series 5 and a DDM-PLUS or a 2000 Series Digital Data Multiplexer (DDM-2000) and digital cross-connect.

STRAND-, POLE-, OR WALL-MOUNTED DISTRIBUTION TERMINALS AND CLOSURES

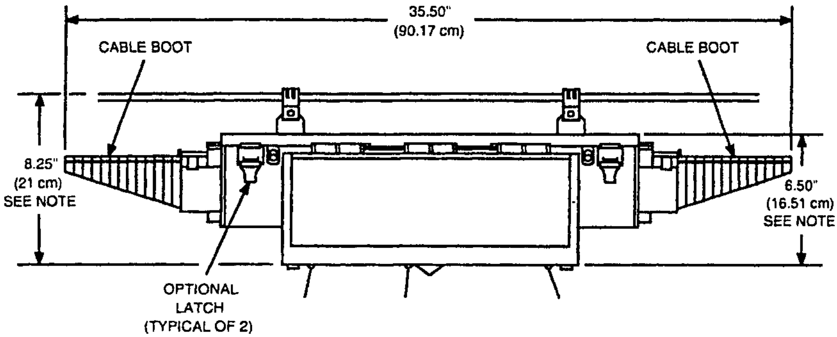
AT&T Flexterm® 5000 Aerial Cable Distribution Terminal

AT&T 631-250-210

The AT&T ***Flexterm*** 5000 cable terminal is a strand mounted unit for use on nonpressurized PIC cables. This cable terminal is recommended for use where in-line splicing and distribution service wire termination is required. The housing and endcaps are molded from high impact plastic specially formulated to resist the hazards of aerial applications. The cable terminal is available with two types of endcaps, a free-breathing, rodent resistant design utilizing cable boots and drip collars, or a sealed design utilizing high density, closed cell foam blocks.



Assembled Cable Terminal Equipped With Foam Blocks



NOTE: CABLE TERMINALS EQUIPPED WITH 25 PAIR PROTECTED BLOCKS HAVE AN EXTENDED TERMINAL REGION WHICH ADDS 1.75" (4.44 cm) TO THESE DIMENSIONS

Assembled Cable Terminal Equipped With Cable Boots

An optional D-182493 Extension Kit is available for mounting the cable terminal on oversized sheath openings (as in rehabilitation applications). Also available is an optional 51B wall bracket for mounting the cable terminal to a wall. The options available on the cable terminal are listed on the next page.

AAAABC- DDEF- GHIJKLMNOP

P-G = WIRE GUIDES
O-T = TEST PROBE
N-R = RIGID SHEATH RETENTION
M-C = BINDING POST CAPS
L-S = SECURITY SCREW IN DOOR (REQUIRES KS WRENCH)
H = HEX HEAD (216 TOOL)
K-B = BOND BAR
J-E = EYELET BOND STRAP
D = D-BOND CLAMP ON BOND STRAP
X = REA
I-W = EXTERNAL WIRE SLITTER
H-A = AIRTIGHT GASKET SEALS
G-L = LATCHES

F-1 = FIRST GENERATION
E-J = J-SERIES IDC BLOCK
K = K-SERIES IDC BLOCK
B = BINDING POST BLOCK
D-# = PAIR SIZE

C-S = SELF SEAL FOAM BLOCK END PLATES
D = DRIP COLLAR BOOTS
B-E = GAS TUBE PROTECTION
F = NO PROTECTION
V = PROTECTED BLKS - NO PROTECTOR (EMPTY WELLS, 5-PAIR K-SERIES ONLY)
A-# = PRODUCT SERIES (5000)

The table below lists the cable terminals and comcode numbers.

FLEXTERM 5000 CABLE TERMINAL			
Product Code	**Comcode**	**Product Code**	**Comcode**
5000ED-10B1-WEB	106 396 567	5000ED-25K1-EB	106 415 128
5000ED-10K1-WEB	106 396 203	5000ES-5K1-EB	106 475 718
5000ED-25B1-WEB	106 397 201	5000ES-10B1-EB	106 415 102
5000ED-25K1-WEB	106 396 781	5000ES-10K1-EB	106 415 060
5000ES-10B1-WEB	106 396 583	5000ES-25B1-EB	106 415 185
5000ES-10K1-WEB	106 396 542	5000ES-25K1-EB	106 415 144
5000ES-25B1-WEB	106 397 235	5000FD-5K1-EB	106 475 726
5000ES-25K1-WEB	106 396 831	5000FD-10B1-EB	106 415 078
5000FD-10B1-WEB	106 396 559	5000FD-10K1-EB	106 415 037
5000FD-10K1-WEB	106 396 161	5000FD-12K1-EB	106 415 193
5000FD-12K1-WEB	106 396 591	5000FD-25B1-EB	106 415 151
5000FD-25B1-WEB	106 396 880	5000FD-25K1-EB	106 415 110
5000FD-25K1-WEB	106 396 724	5000FS-5K1-EB	106 475 734
5000FS-10B1-WEB	106 396 575	5000FS-10B1-EB	106 415 094
5000FS-10K1-WEB	106 396 237	5000FS-10K1-EB	106 415 052
5000FS-12K1-WEB	106 396 641	5000FS-12K1-EB	106 415 219
5000FS-25B1-WEB	106 397 219	5000FS-25B1-EB	106 415 177
5000FS-25K1-WEB	106 396 815	5000FS-25K1-EB	106 415 136
5000ED-5K1-EB	106 475 700	D-182493 —	846 684 611
5000ED-10B1-EB	106 415 086	Extension Kit of Parts*	
5000ED-10K1-EB	106 415 045	FK Test Probe	106 487 820
5000ED-25B1-EB	106 415 169		

* Contains one 10.87 in. (276 mm) extension, bond strap extension, one screw, one nut.

This cable terminal accommodates the newly designed J-series insulatio displacement contact (IDC) blocks, the K-series IDC blocks, or binding po: blocks. It will accommodate up to 25-pair of protected or unprotected ID(blocks or binding post blocks. A 6-pair unprotected only K-series bloc configuration is available, permitting the assembly of an 18-pair cabl terminal.

Note: See Pages 15-33 through 15-35 for descriptions of the J- and K series IDC blocks.

AT&T Flexterm 6000 Aerial Cable Distribution Terminal

AT&T 631-250-215

The AT&T ***Flexterm*** 6000 cable terminal is a stubbed terminal designed for pole, wall, or strand mounting. They are recommended for terminating distribution service wires external to a splice closure. All the cable terminals are molded from high impact plastic specially formulated to resist the hazards of outdoor applications. The 6000 cable terminals are available in 10-, 20-, 25-, and 50-pair sizes. The 10-pair cable terminal can be strand mounted or with the optional 45A bracket, pole or wall mounted. The 20-, 25-, and 50-pair cable terminal can be pole or wall mounted only and include the mounting bracket.

The stub cable comes in three standard lengths and is available in aircore alpeth, filled alpeth, and REA cable designs. All stub cables are equipped with an airtight pressure plug. The standard lengths available are:

- 6 feet (1.83 m) — available on 10-pair only
- 12 feet (3.66 m) — available on 10-, 20-, 25-, and 50-pair
- 25 feet (7.62 m) — available on 10-, 20-, 25-, and 50-pair.

Stub cables can also be special ordered in other cable designs, with alternate color codes, and in nonstandard lengths.

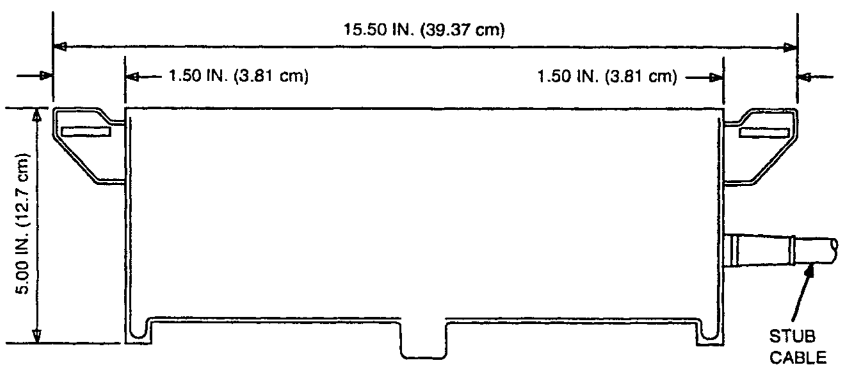
These cable terminals accommodate the newly designed J-series insulation displacement contact (IDC) terminal blocks, the K-series IDC terminal blocks, or binding post blocks.

See Pages 15-33 through 15-35 for descriptions of the J- and K-series IDC terminal blocks.

The 10-pair cable terminal is a one piece unit with a top-hinged fron cover and with the service wire entry grommets located on the bottom. Three distribution rings are provided on the back to organize the service wire loops A ground connection is furnished on the back if the cable terminal is protected The housing will accommodate:

- an unprotected binding post block (with or without caps)
- a protected binding post block (with or without caps)
- an unprotected IDC block (J-series or K-series)
- a protected IDC block (J-series or K-series*).

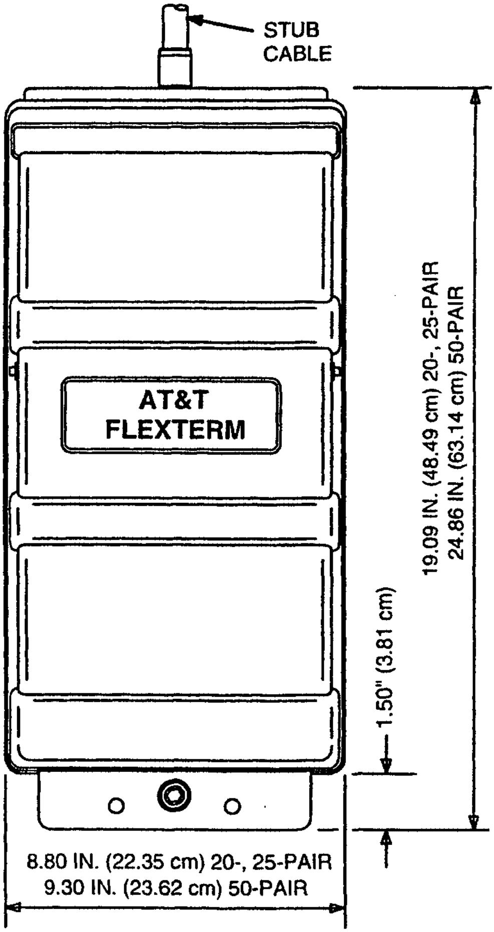
* Available late 1994



10-Pair Strand Mounted Cable Terminal
(Can be Pole or Wall Mounted Using Optional Bracket)

The 20-, 25-, and 50-pair cable terminals have a fold down front cover allowing easy access to the service wire entry grommets. The cover is secured using a captive hex head bolt, but a special security screw may be ordered. The cover is also equipped to accommodate a customer-supplied padlock. A ground connection is furnished on the back if the cable terminal is protected. A noncorrosive mounting bracket is included with each cable terminal. The housings will accommodate:

- a 20-pair unprotected IDC block (J-series or K-series)
- a 20-pair protected IDC block (J-series only)
- a 25-pair unprotected binding post block (with or without caps)
- a 25-pair protected binding post block (with or without caps)
- a 25-pair unprotected IDC block (J-series or K-series)
- a 25-pair protected IDC block (J-series or K-series)
- a 50-pair unprotected binding post block (with or without caps)
- a 50-pair unprotected IDC block (J-series or K-series)
- a 50-pair protected IDC block (J-series only).



20-, 25-, and 50-Pair Pole or Wall Mounted Cable Terminal

The 10-, 20-, 25-, and 50-pair cable terminals can be ordered using the following code.

AAAA B - CC D E F - G H I J K L

- L - O = WIRE GUIDES
- K - # = STUB LENGTH
- J - T = TEST PROBE
- I - C = BINDING POST CAPS
- H - S = SECURITY SCREW IN DOOR (NOT AVAILABLE ON 10-PAIR)
- G - W = EXTERNAL WIRE SLITTER
- F - 1 = 1ST GENERATION
- E - A = ALPETH STUB
  - W = FILLED ALPETH STUB
  - R = REA PE22 STUB
- D - J = J-SERIES IDC BLOCK
  - K = K-SERIES IDC BLOCK
  - B = BINDING POST BLOCK
- C - # = PAIR SIZE
- B - E = GAS TUBE PROTECTION*
  - F = NO PROTECTION
  - V = PROTECTED BLOCK - NO PROTECTORS (EMPTY WELLS, K-SERIES ONLY)
- A - # = PRODUCT SERIES (6000)

* AVAILABLE WITH 10-PAIR BP, 25-PAIR K-SERIES IDC BLOCK, AND ALL PAIR SIZES IN J-SERIES IDC BLOCK

The table below lists the cable terminals and comcode numbers.

FLEXTERM 6000 CABLE TERMINALS*											
Product Code	Length		Width		Depth†		Stub Length		Weight		Comcode
	in.	cm	in.	cm	in.	cm	ft.	m	lbs.	kg	
6000E-10BA1-6	15.49	39.3	5.00	12.7	3.29	8.4	6.0	1.83	4.1	1.86	106 396 823
6000E-10BA1-12	15.49	39.3	5.00	12.7	3.29	8.4	12.0	3.6	4.4	2.00	106 396 849
6000E-10BA1-25	15.49	39.3	5.00	12.7	3.29	8.4	25.0	7.6	5.0	2.27	106 396 856
6000F-10BA1-6	15.49	39.3	5.00	12.7	3.29	8.4	6.0	1.83	2.4	1.09	106 396 773
6000F-10BA1-12	15.49	39.3	5.00	12.7	3.29	8.4	12.0	3.6	2.7	1.23	106 396 799
6000F-10BA1-25	15.49	39.3	5.00	12.7	3.29	8.4	25.0	7.6	3.4	1.54	106 396 807
6000F-10KA1-6	15.49	39.3	5.00	12.7	3.29	8.4	6.0	1.83	2.3	1.04	106 396 625
6000F-10KA1-12	15.49	39.3	5.00	12.7	3.29	8.4	12.0	3.6	2.6	1.18	106 396 633
6000F-10KA1-25	15.49	39.3	5.00	12.7	3.29	8.4	25.0	7.6	3.3	1.50	106 396 658
6000F-25BA1-12	19.09	48.49	8.80	22.34	3.71	9.42	12.0	3.6	8.5	3.86	106 396 914
6000F-25BA1-25	19.09	48.49	8.80	22.34	3.71	9.42	25.0	7.6	10.2	4.62	106 396 922
6000F-25KA1-12	19.09	48.49	8.80	22.34	3.71	9.42	12.0	3.6	8.5	3.86	106 396 864
6000F-25KA1-25	19.09	48.49	8.80	22.34	3.71	9.42	25.0	7.6	10.2	4.62	106 396 872
6000E-25BW1-S25	19.09	48.49	8.80	22.34	3.71	9.42	25.0	7.6	11.0	4.99	106 507 999
6000E-25BA1-12	19.09	48.49	8.80	22.34	3.71	9.42	12.0	3.6	9.3	4.22	106 396 930
6000E-25BA1-25	19.09	48.49	8.80	22.34	3.71	9.42	25.0	7.6	11.0	4.99	106 396 948
6000E-25KW1-S25	19.09	48.49	8.80	22.34	3.71	9.42	25.0	7.6	11.0	4.99	106 508 054
6000F-25KR1-S12	19.09	48.49	8.80	22.34	3.71	9.42	12.0	3.6	8.5	3.86	106 572 936
6000E-25KA1-12	19.09	48.49	8.80	22.34	3.71	9.42	12.0	3.6	9.3	4.22	106 396 898
6000E-25KA1-25	19.09	48.49	8.80	22.34	3.71	9.42	25.0	7.6	11.0	4.99	106 396 906
6000F-50BA1-12	24.86	63.11	9.30	23.62	4.45	11.30	12.0	3.6	10.9	4.94	106 396 997
6000F-50BA1-25	24.86	63.11	9.30	23.62	4.45	11.30	25.0	7.6	13.7	6.21	106 397 037
6000F-50KA1-12	24.86	63.11	9.30	23.62	4.45	11.30	12.0	3.6	10.9	4.94	106 396 955
6000F-50KA1-25	24.86	63.11	9.30	23.62	4.45	11.30	25.0	7.6	13.7	6.21	106 396 963
45A Bracket	—	—	—	—	—	—	—	—	—	—	100 013 655

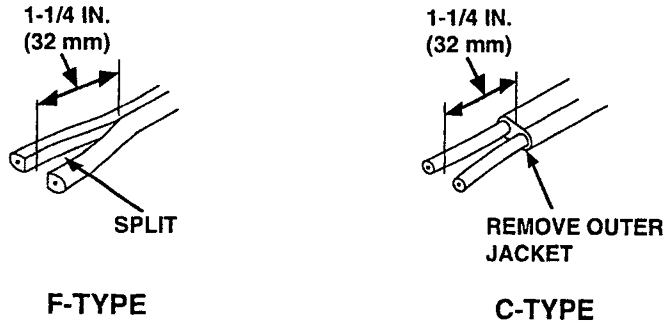
* Contact your AT&T Sales Representative for ordering information on configurations not listed.

† Add 0.83-inch (2.11 cm) to overall depth when using the 45A Bracket.

J-Series and K-Series Insulation Displacement Contact (IDC) Blocks

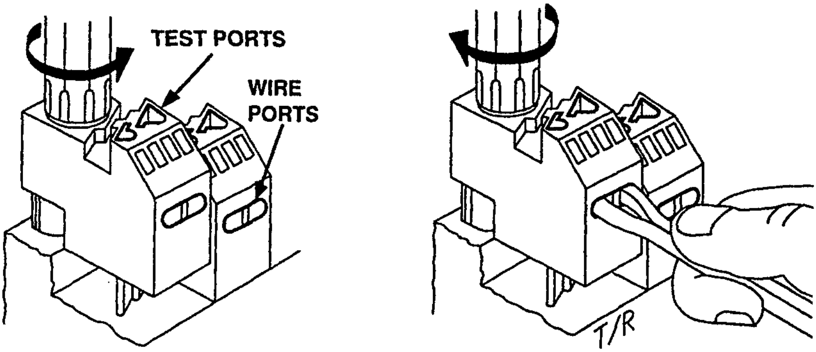
The IDC blocks are available in two configurations, the newer J-series type or the standard K-series type. Both blocks are the sealed type and are filled with a gel that protects against environmental entry. The blocks are described below:

J-Series Block—The J-series IDC block will accommodate 18.5 gauge (0.9 mm) copper clad steel wire, 22 gauge (0.6 mm) or 24 gauge (0.5 mm) copper drop wire and includes a built-in strain relief to protect F-type drop wire against pull-out. The termination area is filled with a water barrier compound to provide environmental protection. **All wire types are inserted into the same wire ports.** Before inserting wires into block, prepare F- and C-type drop wire as below. Prepare multipair and E-block drop wire by separating conductors.



Drop Wire Preparation for J-Series IDC Block

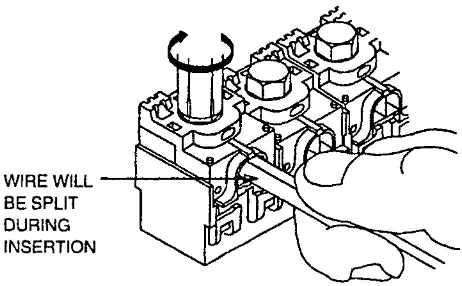
To insert drop wire, unscrew hex head bolt 3-1/4 turns until terminal cap is in the fully open position. Upon reaching the open position, an audible "click" will be heard. Orient "TIP and RING (T/R)," then insert drop wire into the wire ports until they stop, about 3/4 inch (19 mm). Hold the wires in position and tighten the hex head bolt until cap is fully seated.



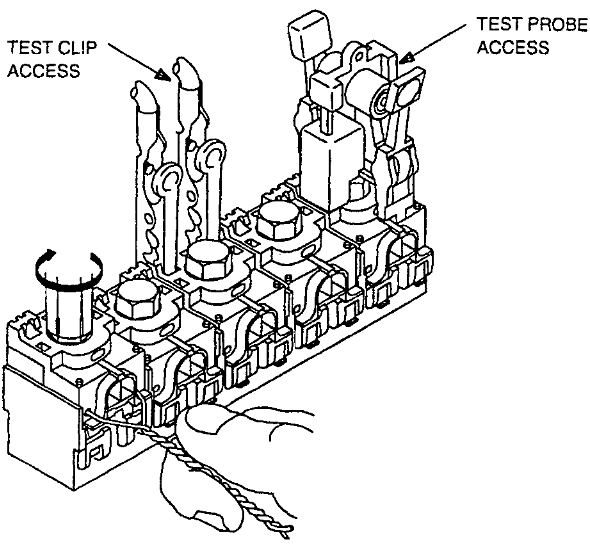
Drop Wire Insertion for J-Series IDC Block

K-Series Block—The K-series IDC block will accommodate 18.5 gauge (0 mm) copper clad steel wire, 22 gauge (0.6 mm) or 24 gauge (0.5 mm) copp drop wire and includes a built-in strain relief to protect against pull-out. **The are separate ports for the insertion of 22 or 24 gauge (0.6-0.5 mm) dr(wire.** The 18.5 gauge (0.9 mm) port of each block is equipped with a built- wire slitter, which allows wire insertion without splitting or stripping the wi pair. The two sets of ports for each pair permit a drop wire bridge connectio The termination area is filled with a water barrier compound to provi(environmental protection.

To insert drop wire, unscrew hex head bolt until the top of terminal blo(is in the fully open position. Orient "TIP and RING (T/R)", then insert dr(wire into the appropriate opening(s) in the terminal block until they stop, abo 3/4 inch (19 mm). Hold the wires in position and tighten the hex head b(until top of terminal block is fully seated as shown on next page.



K-Series IDC Block With 18.5 Gauge (0.9 mm) Wire Inserted



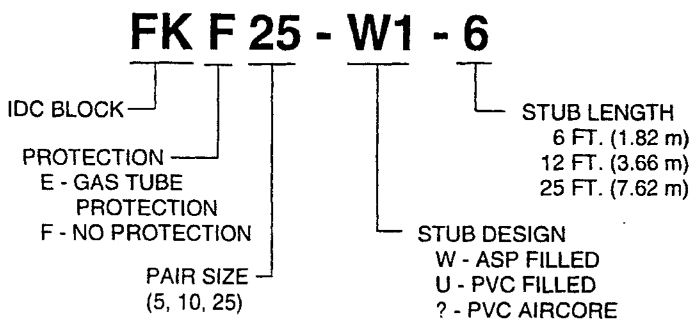
K-Series IDC Block With 22-Gauge (0.6 mm) or 24 Gauge (0.5 mm) Wire Inserted

AT&T Flexterm 9000 Buried Cable Distribution Terminal Block

The AT&T ***Flexterm*** 9000 is designed for use in outside plant applications where aerial drop wires or buried service wires are to be terminated in a pedestal. The ***Flexterm*** 9000 block is available in multiple pair sizes in protected and unprotected configurations. Standard stub cable lengths are 6-, 12-, and 25-foot and are available in ASP filled, PVC filled, or PVC aircore designs. Special nonstandard lengths or cable designs can also be provided. The ***Flexterm*** 9000 blocks can be mounted in most currently available pedestals. The primary feature of the block is the use of the IDC terminal block technology. The 9000 block accommodates the K-series insulation displacement contact (IDC) terminal blocks.

See page 15-34 for a description of the K-series IDC terminal blocks.

The ordering matrix is shown below.



A list of the blocks and comcode numbers are shown below.

FLEXTERM 9000 TERMINAL BLOCK	
Product Code*	**Comcode**
FKF25-W1-12	106 629 777
FKF25-W1-25	106 629 785
FKF25-U1-6	106 629 793
FKF25-1-6	106 629 801
FKE10-W1-25	106 629 884
FKE10-W1-12	106 629 876
FKE10-U1-6	106 629 892
FKE10-1-6	106 629 900
FKF10-W1-25	106 629 850
FKF10-W1-12	106 629 843
FKF10-U1-6	106 629 819
FKF10-1-6	106 629 827
FKE5-U1-6	106 629 934
FKE5-1-6	106 629 942
FKF5-U1-6	106 629 918
FKF5-1-6	106 629 926
FK1000 Test Probe	106 487 820
Special Circuit Caps	106 654 981

* The codes listed above are typical block configurations installed in pedestals. Please contact your AT&T Sales Representative for ordering information on configurations not listed.

105-Type Cable Terminals

AT&T 631-250-100

The 105-type cable terminals are fixed-count terminals, basically to be strand mounted for use on nonpressurized PIC cables. The available codes are listed on the next page.

105-TYPE CABLE TERMINALS (NOTE)				
Cable Terminal Code	Protection	Max. Cable Dia. (Inches)	No. Of Pairs	Comments
105A2B-10	Carbon Block (2A1B)	1.8	10	
105A2B-10E	Carbon Block (2A1B)	1.8	10	Bond Strap w/Eyelet
105A2B-10HB	Carbon Block (2A1B)	1.8	10	Hard Boots
105A2B-10HBE	Carbon Block (2A12B)	1.8	10	Hard Boots Bond Strap w/Eyelet
105A2-12	—	1.8	12	
105A2-12E	—	1.8	12	Bond Strap w/Eyelet
105A2-12HB	—	1.8	12	Hard Boots
105A2-12HBE	—	1.8	12	Hard Boots Bond Strap w/Eyelet
105A2-25	—	1.8	25	
105A2-25C	—	1.8	25	W/Binding Post Caps
105A2-25E	—	1.8	25	Bond Strap w/Eyelet
105A2-25HB	—	1.8	25	Hard Boots
105A2-25HBE	—	1.8	25	Hard Boots Bond Strap w/Eyelet
105B1-10	—	1.3	10	
105B1-10C	—	1.3	10	W/Binding Post Caps
105B1-10E	—	1.3	10	Bond Strap w/Eyelet
105B1B-10	Carbon Block (2A1B)	1.3	10	
105B1B-10C	Carbon Block (2A1B)	1.3	10	W/Binding Post Caps

105-TYPE CABLE TERMINALS (NOTE) (Contd)				
Cable Terminal Code	Protection	Max. Cable Dia. (Inches)	No. Of Pairs	Comments
105B1B-10E	Carbon Block (2A1B)	1.3	10	Bond Strap w/Eyelet
105A2E-10HB	Gas 11A2AW	1.8	10	Hard Boots
105A2E-10HBE	Gas 11A2AW	1.8	10	Hard Boots Bond Strap w/Eyelet
105B1E-10	Gas 11A2AW	1.8	10	
105B1E-10E	Gas 11A2AW	1.8	10	Bond Strap w/Eyelet

Note: When these terminals are to be used with cables larger than the maximum OD, 1A1 or 1B1 terminal stubs must be used in conjunction with the terminal as covered in AT&T 631-240-211. These terminals can also be mounted on a wall using a 51B bracket (AT&T 631-020-200).

N-Type Cable Terminals

AT&T 631-210-101, -10

The N-type cable terminals are fixed-count terminals used mostly with aerial plant. They may be pole, strand, or wall mounted. They are also available with cable protection. The N-type cable terminals are shown on the following page. The N-type cable terminal coding scheme is as follows.

N C P - 10 A 1 C - 12

- **12** — STUB LENGTH
  - 6 = 6' (1.8 m)
  - 12 = 12' (3.7 m)
  - 25 = 25' (7.6 m)
- **C** — FACTORY EQUIPPED WITH BINDING POST CAPS
- **1** — GENERATION OR ISSUE
- **A** — TYPE OF CABLE STUB
  - A = ALPETH SHEATH
- **10** — PAIR COUNT
  - 10 OR 25
- **P** — TYPE OF HOUSING
  - P - PLASTIC
  - A - ALUMINUM
- **C** — TYPE OF PROTECTION
  - C - CABLE
  - F - NONE
  - H - STATION
  - E - STATION
- **N** — TYPE OF CABLE TERMINAL
  - N

N-TYPE CABLE TERMINALS (NOTES 1 AND 2)

Terminal Code	Pair Size	Stub Type	Std. Stub Length (feet)	Housing	Corrosion Resistant	Type Protector	Mounting		
							Strand	Pole	Wall
NCA-10A1	10	Alpeth	6, 12, 25	Aluminum	No	2A1B	X	•	•
NCP-10A1*	10	Alpeth	6, 12, 25	Plastic	Yes	2A1B	X	•	•
NCP-10A1C†*	10	Alpeth	12	Plastic	Yes	2A1B	X	•	•
NFA-10A1	10	Alpeth	6, 12, 25	Aluminum	No	None	X	•	•
NFP-10A1*	10	Alpeth	6, 12, 25	Plastic	Yes	None	X	•	•
NFP-25A1	25	Alpeth	12, 25	Plastic	Yes	None	X	•	•
NFP-25W1‡	25	ASP	12, 25	Plastic	Yes	None	X	•	•
NFP-101C†*	10	Alpeth	12	Plastic	Yes	None	X	•	•
NCA-25A1	25	Alpeth	12, 25	Aluminum	Yes	2A1B	—	X	X
NCA-25A1C†	25	Alpeth	25	Aluminum	Yes	2A1B	—	X	X
NFA-25A1§	25	Alpeth	12, 25	Aluminum	Yes	None	—	X	X
NFA-25A1C†	26	Alpeth	25	Aluminum	Yes	None	—	X	X
NC-16P	16	Alpeth	6, 12, 25	Aluminum	No	2A1B	X	•	•
NF-16P	25	Alpeth	6, 12, 25	Aluminum	No	None	X	•	•
NH-16**	16	Lead	12, 25	Aluminum	No	2A1A	X	•	•
NH-25**	25	Lead	12, 25	Aluminum	No	2A1A	—	X	X
NEP-10A1* **	10	Alpeth	6, 12, 25	Plastic	Yes	11A2AW	X	•	•
NEA-25A1**	25	Alpeth	12, 25	Aluminum	Yes	11A2AW	—	X	X
NHE-25**	25	Lead	12, 25	Aluminum	Yes	11A2AW	—	X	X
NHE-25A1**	25	Alpeth	12, 25	Aluminum	Yes	11A2AW	—	X	X

Notes:

1. Codes with filled stubs, and lead sheath stubs are also available.
2. Codes with housings of die-cast aluminum not recommended for high corrosion areas.

* These terminals may be adapted for mounting on poles or walls using a 45A bracket.
† These terminals are factory-equipped with black C binding post caps.
‡ Nonstandard.
§ Not pressure-tight stubs.
** UL listed.

53-Type Cable Terminals

AT&T 631-210-101

The 53-type cable terminals are 50-pair protected or unprotected fixed count terminals designed for pole or wall mounting. The terminals are intended for use in areas where there is a heavy concentration of drop o block wires.

53-TYPE CABLE TERMINALS					
Product Code	**Housing Finish**	**Protection**	**No. of Pairs**	**Type of Stub Sheath**	**Stub Length ft. (m)**
53A4-50-12	Powder Paint	None	50	Lead	12 (3.7)
53A4-50-25	Powder Paint	None	50	Lead	25 (7.6)
53A4-50P-12	Powder Paint	None	50	Plastic	12 (3.7)
53A4-50P-25	Powder Paint	None	50	Plastic	25 (7.6)
53A4A-50-12*	Powder Paint	500-Volt Carbon	50	Lead	12 (3.7)
53A4A-50-25*	Powder Paint	500-Volt Carbon	50	Lead	25 (7.6)
53A4E-50-12*	Powder Paint	500-Volt Gas	50	Lead	12 (3.7)
53A4E-50-25*	Powder Paint	500-Volt Gas	50	Lead	25 (7.6)
* UL listed					

49-Type Cable Terminals

AT&T 631-240-10(

The 49-type cable terminals are ready access terminals that utilize separately ordered 3-type terminal blocks. Rehabilitation kits are available fo converting the 49-type terminals to fixed count. See AT&T 644-203-101.

Rehabilitation of Aerial Terminals

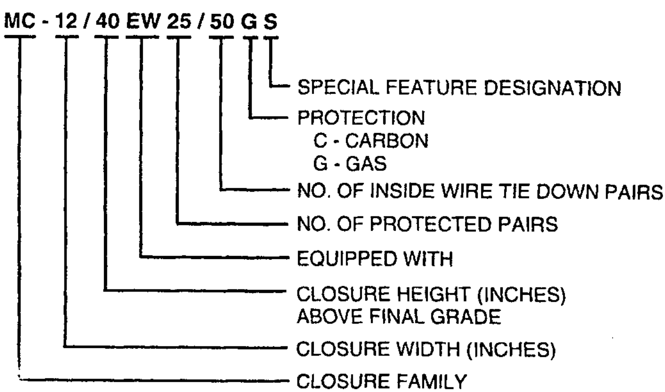
AT&T 644-203-101

Aerial ready access 49-type terminals and some fixed count and preferred count 105 terminals have problems of sheath pullout, sheath cutback, tab breakage, and inability to close covers. Many ready access terminals require conversion to fix count using the 8A-type terminal block. AT&T 644-203-101 covers the materials and methods for rehabilitation, conversion, and replacement.

MC-12/40 Closure

AT&T 631-470-205

The MC-12/40 closure provides a station-protected, outdoor termination facility with cross-connection flexibility for garden apartments, condominiums, and small businesses. The closure may be wall-, pole-, or pedestal-mounted using anchor posts. The empty closure may also be used as a aboveground splicing chamber with a capacity of 1800 pairs. The MC-12/40 coding scheme is shown below.



The various closures are shown below.

MC-12/40 CLOSURES				
Closure Code (Note)	**Equivalent Apparatus Panel Code Of Mounted Assembly**	**Apparatus Equipped With**		**Closure Comcode**
		CO Side	**Station Side**	
MC-12/40EW25G	199E1A25U	1-9E1A-25U	—	104178462
MC-12/40EW50C	199A1A150	2-9A1A25U	—	104173398
MC-12/40EW50G	199E1A50	2-9E1A25U	—	104173406
MC-12/40EW10/25G	199E1A10-25	1-9E1A-10U	1-119A1-25	104197249
MC-12/40EW25/25C	199A1A25-25	1-9A1A25U	1-119A1-25	104173331
MC-12/40EW25/25G	199E1A25-25	1-9E1A-25U	1-119A1-25	104173349
MC-12/40EW25/50C	199A4A25-50	1-9A1A-25U	1-76 Connecting Block	104173356
MC-12/40EW25/50G	199E4A25-50	1-9E1A-25U	1-76 Connecting Block	104173364
MC-12/40EW50/50GS	199E1A50-50	1-134E1A-50 1-76 Connecting Block	2-76 Connecting Blocks Multipled Together	104197256
MC-12/40EW50/100C	199A1A50-100	1-134A1A-50	2-76 Connecting Blocks	104173372
MC-12/40EW50/100G	199E1A50-100	1-134E1A-50 1-76 Connecting Block	2-76 Connecting Blocks	104173380
MC-12/40	None Furnished	None	None	104174222

Note: Closure codes with no 2nd digit denoting number of service wire tie-down pairs use the protected pairs for house wire.

MC-10/48 Cable Closure

AT&T 631-470-204

The MC-10/48 closure is a fixed-count terminal for outside wall mounting on garden apartments and small commercial buildings. It is designed to provide station protection between buried distribution cable and station wiring. The closure is divided into a top and bottom chamber. The bottom chamber is for splicing to the protector. The top chamber contains the 199-type protector and 119-type connecting blocks for connecting the protector to the station wiring. The buried cable enters from the bottom of the closure. Station wires are brought in from the back. The closure capacities are as follows:

Terminating —
199A1A10-25 10 — protected pairs
25 — station wires
199A1A25-50 25 — protected pairs
50 — station wires

Splicing — 200-pair straight and 100-pair bridge

Cable size (looped) — 400-pair or 2.1-inch diameter

Dimensions: 48 in. H by 10 in. W by 4 in. D.

MC-12/25NP and MC-12/50NP Closures

AT&T 631-470-206

The MC-12/25NP and MC-12/50NP closures are designed as network interfaces on the outside wall of garden apartments and small commercial buildings. They are equipped for station protection and Network Interface Devices (NIDs) that connect to the RJ-11 jack which is the network interface between telephone company and customer-owned equipment.

The closures contain two factory-assembled connected panel assemblies. One panel is a protector backboard. The other is a panel containing network interface devices. The protector backboard includes a 134-type protector and two 76-type connecting blocks. One 76-type block is factory-wired to the protector for the appearance of feeder pairs. The other 76-type block is factory-wired to a 9-type connecting block on the NID panel. The NID panel contains the 9-type connecting block(s) and the NIDs. The NIDs are factory-wired to the 9-type connecting blocks.

The back portion of the closure is a splicing chamber for splicing the 134-type protector stub to the outside plant cable. When a customer calls for service, a jumper is run from the feeder to the distribution 76 blocks and the pair automatically appears at the NID.

The closures have a capacity of 25 and 50 outside plant pair terminations.

BURIED DISTRIBUTION CLOSURES

85-Type Closure

AT&T 631-604-215

The 85-type closure is designed to provide fixed-count terminating facilities for buried service wires. It can be pedestal-, pole-, or wall-mounted. It can be equipped with a 174B flood cover. The types of 85-type closures and capacities are shown below.

CLOSURE CAPACITY (MAXIMUM PAIRS) USING 710 CONNECTOR WITH BACKBOARD IN PLACE (NOTE)

Closure	Straight Splice			Cable Loop (Not Cut)		
	In	Out	Total Pairs	In	Out	Total Pairs
85C6B 85C6FB*	400 24/26 ga	400 24/26 ga	800 plus stub§ cable pairs from fixed count block(s)	400 24/26 ga	400 24/26 ga	800 plus stub§ cable pairs from fixed count block(s)
85C6C† 85C6FC‡	300 22/19	300 22/19				

Note: Maximum pairs listed are 24/26 gauge; larger gauges (22 and 19) will be relative to cable diameter that will fit in closure.

* Equipped with flood cover.
† Equipped with moisture barrier.
‡ Equipped with moisture barrier and flood cover.
§ Applies to top 2 closures only.

The 85-type closure uses the 9-type terminal block for terminating buried service wires. The 9-type blocks are covered on Pages 15-48 and 15-49.

PC-Type Closure (Copper)

AT&T 631-604-21C

The PC-type closure is also designed to provide fixed-count terminating facilities for buried or aerial service wires. The types of PC closures and their capacities are shown below.

PC-TYPE CLOSURES						
Closure Code	Dimensions			Closure Capacities		
	Width In. (mm)	Overall Height In. (mm)	Depth In. (mm)	Cables	Terminating Service Wire	Loading Cables Using 710-Type Coil Cases
PC6/48	6 (152)	48 (1219)	6 152)	3-1.6" (41 mm) or 2-2.2" (56 mm) Max. Dia.	12-2 pr. 10-5 pr.	25 prs.
PC12/55	12 (305)	55 (1397)	10 (254)	3-600 pr. or 2-900 pr. Max.	24-2 pr. 20-5 pr.	100 prs.
B Svc. Wire Clos.	4 (102)	36 (914)	4 (102)	For temporary storage of service wires		AT&T 629-020-009

9-Type Terminal Blocks

AT&T 462-260-207

The 9-type terminal blocks are designed to provide fixed count termination in pedestal closures. They are available as protected or unprotected with either 500- or 800-volt carbon or gas tube protectors. They are also available with either air-core, ASP, or unshielded filled PVC stubs of varying lengths. The 85-, MC-, and PC-type closures use the 9-type terminal blocks listed on the following page for terminating service wires.

9-TYPE TERMINAL BLOCKS							
Product Code	Capacity In Pairs	Length (In.)	Depth (In.)	Width (In.)	Type Of Protection	Protector Unit & Voltage Rating	Stub Cable Length (Ft/Type*)
9A1-5	5	4	1.35	1.38	None	None	4A
9A1-10	10	6.87	1.53	1.38	None	None	4A
9A1-10W	10	6.87	1.53	1.38	None	None	12W, 25W
9A1-25	25	16.25	1.53	1.38	None	None	4A
9A1-5U	5	4	1.35	1.38	None	None	4U, 12U
9A1-10U	10	6.87	1.53	1.38	None	None	4U, 12U
9A1-25U	25	16.25	1.53	1.38	None	None	4U, 12U
9A1-25W	25	16.25	1.53	1.38	None	None	12W, 25W
9A1A-5	5	4	1.66	2.96	Carbon/Station	2A1A 500V	4A
9A1A-10	10	7.50	1.66	2.96	Carbon/Station	2A1A 500V	4A
9A1A-25	25	16.87	1.66	2.96	Carbon/Station	2A1A 500V	4A
9A1A-5U	5	4	1.66	2.96	Carbon/Station	2A1A 500V	4U
9A1A-10U	10	7.50	1.66	2.96	Carbon/Station	2A1A 500V	4U, 12U
9A1A-10W	10	7.50	1.66	2.96	Carbon/Station	2A1A 500V	12W, 25W
9A1A-25U	25	16.87	1.66	2.96	Carbon/Station	2A1A 500V	4U, 12U
9A1A-25W	25	16.87	1.66	2.96	Carbon/Station	2A1A 500V	12W, 25W
9A1B-5	5	4	1.66	2.96	Carbon/Cable	2A1B 800V	4A
9A1B-10	10	7.25	1.7	3.00	Carbon/Cable	2A1B 800V	4A
9A1B-25	25	16.87	1.7	3.00	Carbon/Cable	2A1B 800V	4A
9A1B-5U	5	4	1.66	2.96	Carbon/Cable	2A1B 800V	4U
9A1B-10U	10	7.25	1.7	3.00	Carbon/Cable	2A1B 800V	4U
9A1B-10W	10	7.25	1.7	3.00	Carbon/Cable	2A1B 800V	12W
9A1B-25U	25	16.87	1.7	3.00	Carbon/Cable	2A1B 800V	4U
9A1B-25W	25	16.87	1.7	3.00	Carbon/Cable	2A1B 800V	25W
9E1A-5	5	4	1.66	2.96	Gas/Station	11A2A 500V	4A
9E1A-10	10	7.50	1.66	2.96	Gas/Station	11A2A 500V	4A
9E1A-25	25	16.87	1.66	2.96	Gas/Station	11A2A 500V	4A
9E1A-5U	5	4	1.66	2.96	Gas/Station	11A2A 500V	4U
9E1A-10U	10	7.50	1.66	2.96	Gas/Station	11A2A 500V	4U, 12U
9E1A-10W	10	7.50	1.66	2.96	Gas/Station	11A2A 500V	12W
9E1A-25U	25	16.87	1.66	2.96	Gas/Station	11A2A 500V	4U, 12U
9E1A-25W	25	16.87	1.66	2.96	Gas/Station	11A2A 500V	12W

*Stub Code:
A = PVC Aircore Stub
U = Filled Unshielded Stub
W = Filled Shielded ASP Stub

WIRE TERMINALS

AT&T 462-240-120, 462-525-150, 629-720-21

Various wire terminals, along with their dimensions and applications, ar shown below.

WIRE TERMINALS							
Code	Dimensions (In.)			Type Of Plant	Type Of Wire	Mounting	Capacity
	L	W	D				
101B2	2.2	1.6	1.3	Aerial	Block or other	Pole, wall, crossarm	1-pair terminals, 4 wires per terminal
101C	5.5	3.0	3.5				
104B3-6	9.3	2.6	6.1		Multiple Line		6 pair
107A2	2.3	2.2	1.7		C Rural	Wire	1 pair
108A1-16	18.7	5.0	3.6		Multiple Line	Pole, wall, crossarm	16 pair
108A1B-16	18.7	5.0	3.6				
D Buried Wire Terminal	72.0	3.3	4.5	Buried	Buried	Pedestal, pole, or wall	Two 2-pair connecting blocks and one 179A1 coil case, or one connecting block and two coil cases
E Buried Wire Terminal	13.0	3.3	4.5			Pole or wall	

SPLICE CLOSURES

Splice closures are used for inline and branch splices. Splice closures are not intended for use as terminals. The current AT&T splice closures are as follows.

50- and 51-Type Closures

AT&T 633-506-205, -206

The 50- and 51-type closures are designed for aerial and underground applications on pressurized and nonpressurized cables up to 3.0 inches in diameter. The pressurized closures are intended for underground applications on pressurized cable and for aerial use on nonpressurized PIC cable.

A 35-inch sheath opening capacity stretch version is available in the nonpressurized version. Applications, lengths, cable sizes, sheath openings, and splice diameters for the 50- and 51-type closures are as follows.

50- AND 51-TYPE CLOSURES					
Code	Application	Length (In.)	Cable Size (In.)	Sheath Opening (In.)	Splice Dia. (In.)
50AA3	Inline	21.5	0.4—1.0	13.0	2.0
50B3	Inline	28.5	1.0—1.6	19.0	3.0
50C3	Inline	28.5	1.6—2.2	19.0	4.5
50D3	Inline	28.5	2.2—3.0	19.0	6.2
51AA3	Branch	21.5	0.4—1.0	13.0	3.0
51B3	Branch	28.5	1.0—1.6	19.0	5.0
51D3	Branch	28.5	1.6—3.0	19.0	7.0

1900 Series Closures

AT&T 633-500-108

The 1900 series closures are used to close sheath openings in nonpressurized aerial cables at branch or inline splices. The closure is available with or without bond clamps. A retrofit kit allows conversion of an existing 18-type closure to a 1900 series closure without disturbing the splice. The closure can also be wall-mounted on a 51B bracket. A stretch version is available for large sheath openings.

1900 SERIES CLOSURE							
Code (Note)	**Application**	**Length (In.)**	**Height (In.)**	**Cable Size (In.)**	**Sheath Opening (In.)**	**Splice Dia. (In.)**	**Nozzle Design**
1900 WE-AIS	Inline	26.0	4.5	0.0—1.2	19	2.4	Flexible
1900 WE-BIS	Inline	26.0	6.8	1.0—1.8	19	4.5	Flexible
1900 WE-CIS	Inline	26.0	8.8	1.5—2.5	19	6.4	Flexible
1900 WE-AIB	Branch	26.0	6.8	0.0—1.2	19	4.5	Flexible
1900 WE-BIB	Branch	26.0	8.8	1.0—2.2	19	6.4	Flexible
1900 WE-CIB	Branch	26.0	11.4	2.0—3.0	19	8.0	Flexible
1900 WE-A2B	Branch	26.0	6.8	0.0—1.2	19	4.5	Hard
1900 WE-A2B-E	Branch	26.0	6.8	0.0—1.2	19	4.5	Hard
1900 WE-A2B-S	Branch	44.0	6.8	0.0—1.2	36	4.5	Hard
1900 WE-A2B-SE	Branch	44.0	6.8	0.0—1.2	36	4.5	Hard
1900 WE-B2B	Branch	26.0	8.8	1.0—2.2	19	6.4	Hard
1900 WE-B2B-E	Branch	26.0	8.8	1.0—2.2	19	6.4	Hard
1900 WE-B2B-S	Branch	44.0	8.8	1.0—2.2	36	6.4	Hard
1900 WE-B2B-SE	Branch	44.0	8.8	1.0—2.2	36	6.4	Hard
1900 WE-C2B	Branch	26.0	11.4	2.0—3.0	19	8.0	Hard
1900 WE-C2B-E	Branch	26.0	11.4	2.0—3.0	19	8.0	Hard
1900 WE-A1S-S	Branch	44.0	4.5	0.0—1.2	36	2.4	Flexible

Note: An "E" suffix after the code indicates that the closure is equipped with eyelet bond straps (no bond clamps). Without the "E" suffix, the closure is equipped with captivated D-type bond clamps. An "S" suffix indicates the stretch version.

2000FR Series Closures

AT&T 633-506-210

The 2000FR series closure is intended for use on new or existing installations in building or vault applications. It is constructed of fire-resistant materials and will resist the spread of flames when mounted in either a horizontal or vertical position. It is available with end plates and cover halves which are separate items. Available covers are shown below. End plate assemblies are shown on the following page.

2000FR SERIES CLOSURES — FIRE-RETARDANT COVERS			
Code (Cover)	**Length (In.)**	**Sheath Opening (In.)**	**Diameter (In.)**
2000FR 5/20	29.5	20	5.5
2000FR 7/20	29.5	20	7.0
2000FR 8/20	29.5	20	8.5
2000FR 10/20	29.5	20	10.0
2000FR 12/20	29.5	20	12.0
2000FR 5/28	37.5	28	5.5
2000FR 7/28	37.5	28	7.0
2000FR 8/28	37.5	28	8.5
2000FR 10/28	37.5	28	10.0
2000FR 8/36	45.5	36	8.5
2000FR 10/36	45.5	36	10.0
2000FR 12/40	50.0	40	12.0

2000FR SERIES CLOSURES — FIRE-RETARDANT END PLATE ASSEMBLIES						
Code	Diameter	Openings	Std Or Split (Note 1)	Cable Dia. (In.)	Washer Sealing Series	No. Of Blank Plugs (Note 2)
2000FR 5-1E	5.5	1	—	2.2	H	—
2000FR 5-2E	5.5	2	—	1.6	G	—
2000FR 5-9G	5.5	9	Std	1.06	—	6
2000FR 5-9GS	5.5	9	Split	1.06	—	6
2000FR 7-1E	7.0	1	—	3.0	J	—
2000FR 7-2E	7.0	2	—	2.2	H	—
2000FR 7-12G	7.0	12	Std	1.06	—	6
2000FR 7-12GS	7.0	12	Split	1.06	—	6
2000FR 8-1E	8.5	1	—	3.5	K	—
2000FR 8-2E	8.5	2	—	3.0	J	—
2000FR 8-3E	8.5	3	—	(1)3.0 (2)1.6	J G	—
2000FR 8-18G	8.5	18	Std	1.06	—	6
2000FR 8-18GS	8.5	18	Split	1.06	—	6
2000FR 10-1E	10.0	1	—	3.5	K	—
2000FR 10-2E	10.0	2	—	3.5	K	—
2000FR 10-3E	10.0	3	—	(1)3.5 (2)2.2	K H	—
2000FR 10-18G	10.0	18	Std	1.06	—	6
2000FR 10-18GS	10.0	18	Split	1.06	—	6
2000FR 10-27G	10.0	27	Std	1.06	—	6
2000FR 10-27GS	10.0	27	Split	1.06	—	6
2000FR 10-36G	10.0	36	Std	1.06	—	6
2000FR 12-3E	12.0	3	—	3.5	K	—
2000FR 12-36GS	12.0	36	Split	1.06	—	6
2000FR 12-42G	12.0	42	Std	1.06	—	6

Notes:

1. Tip cable end plates only, (G = standard end plate, GS = split for retrofit).
2. Additional plugs can be ordered separately.

2199 Series Closures

AT&T 633-500-114-XX

The 2199 series closures are used for splicing aerial, buried, or underground PIC cables. They can accommodate cable sizes from 0.5 to 3.4 inches as shown below.

2199 SERIES CLOSURE SIZE SELECTION			
2199 Series Closure	**Sheath Opening**	**Cable Diameter Range**	**Maximum Splice Diameter**
3/9	9 in.	0.5 — 1.6 in.	2.3 in.
3/12	12 in.	0.5 — 1.6 in.	2.3 in.
3/20	20 in.	0.5 — 1.6 in.	2.3 in.
4/12	12 in.	0.8 — 2.6 in.	3.3 in.
4/20	20 in.	0.8 — 2.6 in.	3.3 in.
4/36	36 in.	0.8 — 2.6 in.	3.3 in.
6/12	12 in.	1.2 — 3.0 in.	5.3 in.
6/20	20 in.	1.2 — 3.0 in.	5.3 in.
6/36	36 in.	1.2 — 3.4 in.	5.3 in.

METALLIC CABLE CONNECTORS

700-Type Connector

AT&T 632-205-21

The 700-type connectors join aluminum, copper, or copper-ste conductors without stripping the insulation. The conductors can be of mo standard telephone wire gauge or combination of gauge and insulated wi pulp, paper, or plastic. The 700-type connectors join any combination of 1 AWG (0.91 mm) through 26 AWG (0.40 mm) copper or copper-ste conductors. The 700-3B and -3BT are specifically designed to join 17 AW (1.14 mm) and 20 AWG (0.81 mm) aluminum conductors.

700-TYPE CONNECTOR			
Connector	**Splice Type**	**Cable Type**	**Gauge**
700-3B 700-3BT 700-3BR 700-3BRT	Up to 3 wires	CU, AL CU	17-26 19-26
701-2B 701-2BT 701-2AR 701-2ART	Straight	CU	19-26
702-2B 702-2BT 702-2AR 702-2ART	Half-Tap	CU	19-26
T = Taped for use with connector presser. R = Flame retardant; for buildings and vaults.			

709-Type Connectors (QuickSnap®)

AT&T 632-205-216

The 709-type (QuickSnap) connectors provide a convenient pair-at-a-time, in-line splicing function while maintaining pair identity. The connectors are available filled with a moisture-resistant compound that protects in outside plant environments, or a dry, flame retardant code used in buildings. The 709 connector is engineered for a variety of applications:

- Straight splicing of small pair count cables where larger modular connectors are inconvenient. This connector can be used to splice 22 AWG (0.64 mm) to 26 AWG (0.40 mm) copper conductors in any pair size.
- Half-tapping by joining terminal blocks to distribution cable pairs or making service wire splices. (Half-taps ordered separately)
- Dead ending cable pairs at cable ends or taper points.

The 709SCT and 709SDT connectors are packaged in cartridges for use in a 1709A tool.

709-TYPE CONNECTORS						
Connector Code	**Connector Type**	**Color**	**Encap-sulated**	**Copper Wire Gauge**	**Type Insulation**	**Packaged**
709SC	In-line pair splice	Clear	Yes	22-26	PIC	Loose
709SCT	In-line pair splice	Clear	Yes	22-26	PIC	Cartridges of 25
709SD	In-line pair splice	Yellow	No	22-26	All	Loose
709SDT	In-line pair splice	Yellow	No	22-26	All	Cartridges of 25
709CD	Half-tap adapter. Use with 709 SC, SCT, or 709 SD, SDC connectors	White	*	22-26	All	Chains of 8

* The half-tap adapter is used with both the filled and unfilled version.

710-Type Connectors

AT&T 201-200-050, 632-205-220

The 710-type connectors are used to make modular splices in any combination of 19- through 26-gauge copper conductors. They will accommodate straight, bridge, or half-tap splicing on any combination of pulp, paper, or plastic insulated conductors. The 710 connector consists of an index strip, a connector module, and a cap. For bridging applications, the connector consists of a bridge module and cap. The 710 connector can be used on 19 AWG (0.91 mm) through 26 AWG (0.40 mm) copper conductors in either a fold-back or in-line configuration. The 5- and 10-pair modules are capable of splicing 17 AWG (1.14 mm) to 26 AWG (0.40 mm) copper or aluminum cable. The connectors are available filled (for moisture protection and use with PIC cable) or dry (for all pulp or paper insulated copper conductor cable and encapsulated splices). They are available in 5-pair, 10-pair, and 25-pair sizes as shown on the following pages.

710-TYPE CONNECTOR SPECIFICATIONS							
Product Code	**Application**	**Contact Plating/ Filled**	**Qty Per Box**	**Insulation**	**Connector**	**No. Of Pairs**	**Color**
COPPER OR ALUMINUM 17-24 AWG							
710-SAL-5	Splice	Indium Plated	25	PIC*	Encapsulated	5	Green w/blue index strip
710-TAL-5	Half-Tap	Indium Plated	25	PIC*	Encapsulated	5	Green w/blue index strip
710-BAL-5	Bridge§	Indium Plated	25	PIC*	Encapsulated	5	Green
COPPER 22-26 AWG							
710-SC1-5	Splice	Solder Plated	25	PIC*	Encapsulated	5	Green
710-TC1-5	Half-Tap	Solder Plated	25	PIC*	Encapsulated	5	Green
710-BC1-5	Bridge§	Solder Plated	25	PIC*	Encapsulated	5	Green
710-SD1-5	Splice Half-Tap	Solder Plated	25	Pulp† PVC‡	Dry	5	Gray
710-BD1-5	Bridge§	Solder Plated	25	Pulp† PVC	Dry	5	Gray
710-SB1-10	Splice Half-Tap	Solder Plated	25	Pulp	Dry	10	Green
710-BB1-10	Bridge	Solder Plated	25	Pulp	Dry	10	Green
710-SC1-10	Splice	Solder Plated	25	PIC	Encapsulated	10	Green
710-BC1-10	Bridge§	Solder Plated	25	PIC	Encapsulated	10	Green
710-SD1-10	Splice Half-Tap	Solder Plated	25	Pulp PVC	Dry	10	Gray
710-BD1-10	Bridge	Solder Plated	25	Pulp PVC	Dry	10	Gray
710-TC1-10	Half-Tap	Solder Plated	25	PIC	Encapsulated	10	Green
See footnotes at end of table.							

710-TYPE CONNECTOR SPECIFICATIONS (Contd)							
Product Code	Application	Contact Plating/ Filled	Qty Per Box	Insulation	Connector	No. Of Pairs	Color
COPPER 19-24 AWG							
710-SBL-10	Splice or Half-Tap	Solder Plated	25	Pulp	Dry	10	Green
710-SCL-10	Splice	Solder Plated	25	PIC	Encapsulated	10	Green
710-TCL-10	Half-Tap	Solder Plated	25	PIC	Encapsulated	10	Green
710-SCL-25	Splice	Solder Plated	24	PIC*	Encapsulated	25	Green w/blue index strip
710-TCL-25	Half-Tap	Solder Plated	24	PIC*	Encapsulated	25	Green w/blue index strip
710-BC1-25	Bridge§	Solder Plated	24	PIC*	Encapsulated	25	Green
COPPER 22-26 AWG							
710-SC1-25	Splice	Solder Plated	24	PIC*	Encapsulated	25	Green
710-TC1-25	Half-Tap	Solder Plated	24	PIC*	Encapsulated	25	Green
710-BC1-25	Bridge§	Solder Plated	24	PIC*	Encapsulated	25	Green
710-SB1-25	Splice Half-Tap	Solder Plated	24	Pulp†	Dry	25	Green
710-BB1-25	Bridge§	Solder Plated	24	Pulp†	Dry	25	Green
710-SD1-25	Splice Half-Tap	Solder Plated	24	PVC‡	Dry	25	Gray
710-BD1-25	Bridge§	Solder Plated	24	PVC‡	Dry	25	Gray

See footnotes at end of table.

710-TYPE CONNECTOR SPECIFICATIONS (Contd)							
Product Code	Application	Contact Plating/ Filled	Qty Per Box	Insulation	Connector	No. Of Pairs	Color
COPPER 22-28 AWG							
710-SCF-25	Splice	Solder Plated	24	PIC*	Encapsulated	25	Yellow
710-SDF-25	Splice Half-Tap	Solder Plated	24	PVC‡	Dry	25	Yellow
710-BCF-25	Bridge	Solder Plated	25	PIC	Encapsulated	25	Yellow
710-BDF-25	Bridge	Solder Plated	25	PVC	Dry	25	Yellow
710-TCF-25	Half-Tap	Solder Plated	25	PIC	Encapsulated	25	Yellow

* 19-gauge water-resistant DEPIC and air-core high-density polyethylene insulated conductors are acceptable with the 710 Connector System.
  19-gauge water-resistant cable with solid polypropylene or high-density polyethylene insulated conductors is not recommended for use with the 710 Connector System.

† An F Spec code is available on a nonstock basis for 19-gauge pulp application.

‡ PVC, a flame-retardant insulating material, is used in buildings and central offices.

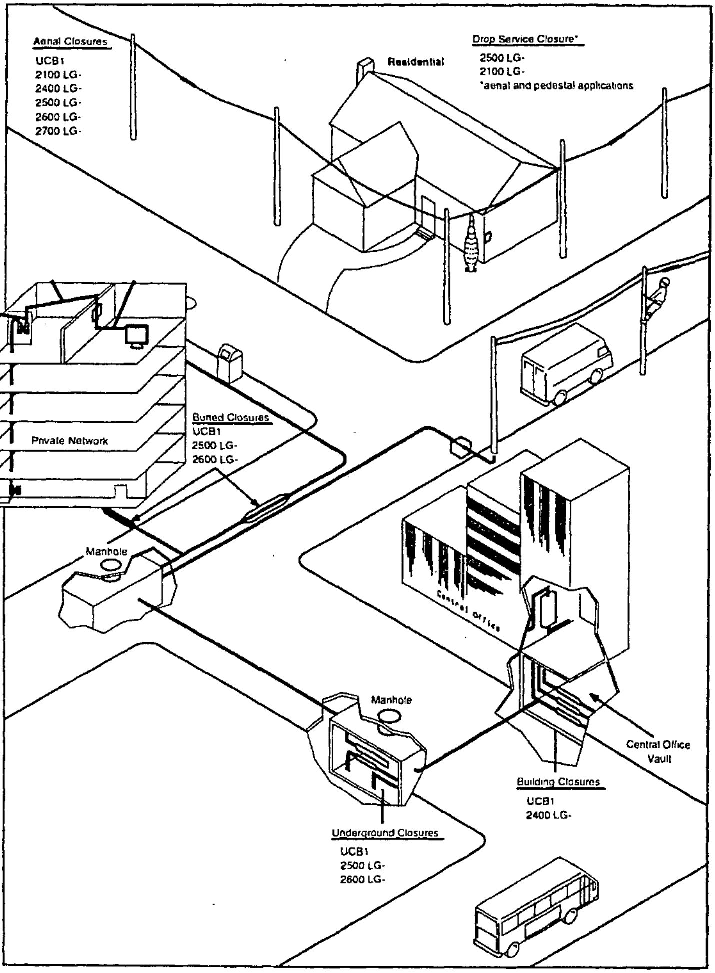
§ Bridge connectors can accommodate 17- through 24-gauge aluminum conductors and 19- through 26-gauge copper conductors.

FIBER OPTIC CLOSURES

Fiber Optic Products Catalog (Select Code 2492C)

AT&T has a wide selection of fiber optic closures to fit any outside plant application, whether it is aerial, underground, or buried. These closures are designed to seal, bond, anchor, and protect different types of cable and splices. **For a complete listing of AT&T fiber optic products, see the AT&T Fiber Optic Products Catalog.**

Below is a drawing showing typical applications of the specific AT&T closures.



Universal Fiber Optic Closure (UCB)

AT&T's universal fiber optic closure system (UCB) has been engineered to provide the highest level of environmental protection for optical cable splices. The UCB is the basis for AT&T's optical closure line and is suitable for both "butt" and "through" types of cable entry applications and can be used in aerial, buried, and underground cable configurations. This closure is used alone in cable vaults and noncorrosive aerial applications. For buried and underground applications, the closure is protected by installing it in an outer closure and filling the closure with encapsulant. The UCB system is divided into five component parts as listed below.

UCB1 Closure UCB2 Closure UCB3 Closure	This is the base closure kit. The UCB1, UCB2, and UCB3 are sealed closures designed for splicing applications. This closure is normally enclosed in an outer closure (discussed below) but may stand alone in a noncorrosive environment. One closure should be ordered for each splice point.
Organizers	The Universal Closure is designed to handle mechanical, array or fusion-type splices. Appropriate organizers must be ordered to accommodate the particular splicing method used. These organizers are installed inside the UCB1, UCB2, and UCB3.
Grommet and Grip Kits	These kits include cable grommets and a grip assembly to seal, bond, and anchor cables in the UCB1, UCB2, and UCB3 Closure. Kits are sized by cable diameter. One kit per cable entry port should be ordered. The closure has four entry ports (two at each end).
Outer Closures	Outer closures are plastic closures that are installed around the UCB1, UCB2, and UCB3 and encapsulated for additional protection in buried plant, underground plant, or corrosive aerial installations. One outer closure should be ordered per splice point. EZ Entry Encapsulant is recommended for encapsulating the outer closure.
Grommet Kits	These kits contain grommets for the outer closures. They are not to be confused with the Grommet and Grip Kits for the UCB1, UCB2, or UCB3 Inner Closure.

UCB1, UCB2, and UCB3 Closure

The UCB2 and UCB3 are the second generation of the UCB1 closure. The UCB1, UCB2, and UCB3 is a sealed aluminum housing for joining and splicing fiber optic cables. It is designed to accommodate four cables and includes grip blocks that accept cables from 0.40 inches (10.2 mm) to 0.96 inches (24.4 mm) outside diameter. It contains splice organizers that will store either 24 mechanical, 24 fusion, or any combination of mechanical and fusion splices that total 24 splices per tray. The standard closure will accommodate 8 splice organizers for a total of 192 mechanical or fusion splices.

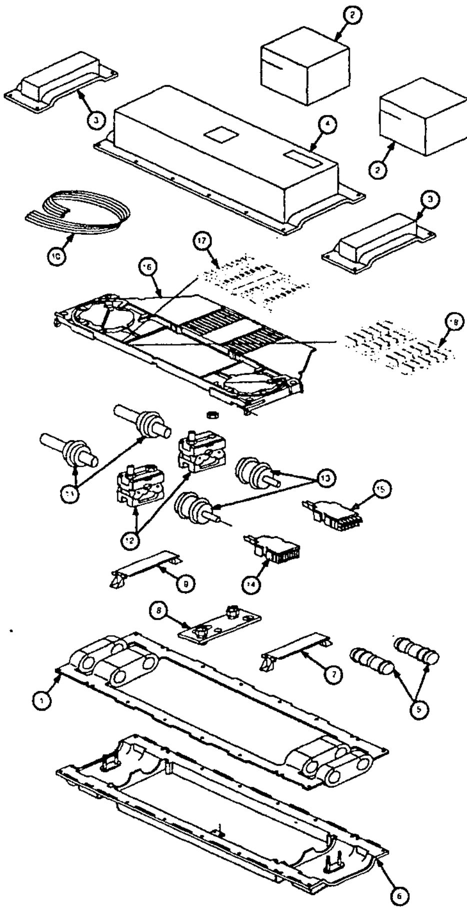
Note: Extended covers are available for the UCB1, UCB2, and UCB3 closures that allow them to accommodate 12 and 18 splice storage organizers (324 single-fiber mechanical splices or 432 single-fiber fusion splices), but the completed closure with 18-splice storage organizers cannot be housed in a standard outer closure.

The UCB2 and UCB3 contain insert grommets and encapsulant to seal all types of fiber optic cables, except cables equipped with factory-installed sheath termination hardware.

AT&T offers three outer closures to install over the UCB1, UCB2, and UCB3 to protect them from corrosive environments.

- **2-Part Outer Cover**-is a molded plastic cover that is fastened together using easily installed side clamps which slide over the flanges to seal it for encapsulation.
- **2000LG-7/20-U**-is a latchable closure which has no bolts along its flange, but uses a quick-connect spring latch to seal it and allow for encapsulation.
- **51D3-LG2**-is a bolted plastic 51-type closure. The closure is in a 4-way, in-line splice case and includes a 42-inch mounting bar.

The UCB2 closure consists of the items shown below.



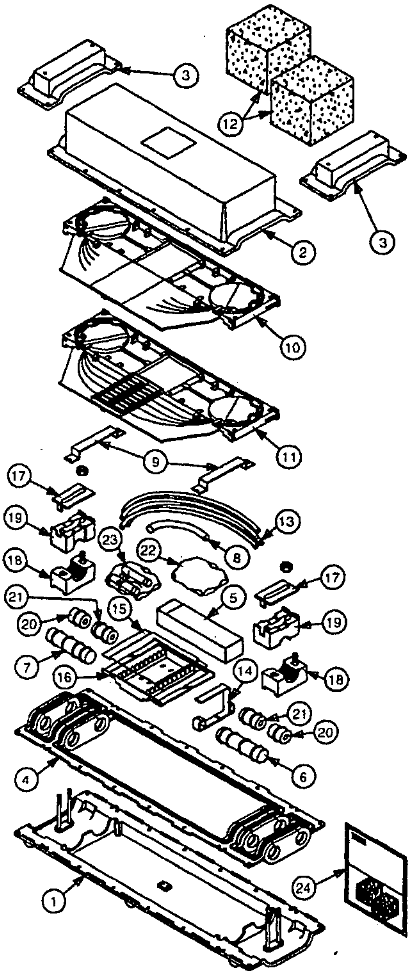
Universal Closure Parts

Exploded View of Universal Closure Parts

1. Universal Grommet
2. Foam Block
3. Clamp
4. Cover
5. Grommet Plug
6. Base
7. Storage Leaf Adapter
8. CSM Grip Plate
9. Storage Leaf Adapter
10. Tube Kit
11. Outer Grommet
12. Universal Range Grip
13. Inner Grommet
14. 20-1 Splitter
15. 24-1 Splitter
16. Fiber Storage Lid and Base
17. Rotary
18. 24 Fusion/Mechanical

Note: The UCB3 closure is the same as the UCB2 closure except it is not provided with components for sealing tubes of a loose tube cable. It is provided with the fusion organizer instead of the organizer provided with the UCB2 closure.

The UCB1 closure consists of the items shown below.



Universal Closure Parts

Exploded View of Universal Closure Parts (for array splicing)

1. Base
2. Cover
3. End Clamps
4. Gasket
5. B-Sealant
6. Grommet Blank Insert
7. Grommet Blank Insert
8. Gel Blocking Tube
9. Organizer Support
10. Fiber Organizer Assembly (Fusion Splice)
11. Fiber Organizer Assembly (Rotary Splice)
12. Foam Block
13. Extruded Vinyl Tubing (Fiber)
14. Platform Mounting Bracket (Array)
15. Platform Cover (Array)
16. Array Splice Platform
17. Bonding Plate
18. Lower Grip Subassembly
19. Upper Grip
20. Grommet Insert - Outer
21. Grommet Insert - Inner
22. Package of Bolts and Washers
23. Blocking Grommet Kit (Ribbon)
24. Instruction Sheet

Following are the differences between the UCB1 and UCB2 Closures:

Sheath Opening	UCB1	60 inches (1524 mm).
	UCB2	66 inches (1676 mm).
Grommets	UCB1	Use grommets from grip and grommet kit.
	UCB2	Measure diameter of cable sheath and core tube and then select grommets. Determine if inboard seal should be poured.
Inboard Grommet	UCB1	Dull end of grommet towards grip block for all three core tubes.
	UCB2	Dull end of grommet away from grip block for 0.41-inch (10.4 mm) diameter core tube; towards grip block for 0.24 and 0.32 inch (6.1 and 8.1 mm) diameter core tubes.
CSM Inboard Seal	UCB1	Loose tubes placed in an inboard grommet.
	UCB2	Pour inboard seal for loose tube cables.
Grounding Hardware	UCB1	Use hardware provided in grip and grommet kit.
	UCB2	Select hardware. All hardware provided in UCB2 Closure.
LXE Bonding Clip	UCB1	Curled tab down, wires cut 5/8 inch (15.9 mm) from bond clip.
	UCB2	Curled tab up, wires wrapped around grip block bolt and secured with a nut.
Grip Block	UCB1	Grip block sized to a specific cable diameter.
	UCB2	Grip block accepts cable diameters from 0.40 to 0.96 inches (10.2 to 24.4 mm).

Grip Block Torque	UCB1	75 in-lbs., grip block bottoms out.
	UCB2	50 in-lbs., hand tight with 216C Tool or 7/16 in. nut driver and then 1/4 turn with wrench. Grip block does not bottom out; do not over tighten. Evenly tighten and release both nuts holding grip.
CSM Grip Plate	UCB1	CSM grip block not provided by AT&T.
	UCB2	CSM grip plate provided with UCB2 Closure.
Splitter	UCB1	6-1 Splitter for 0.24 inch (6.1 mm) core tube and 8-1 Splitter for 0.32 inch (8.1 mm) core tube provided in separate kits.
	UCB2	24-1 Fiber Splitter for 0.24, 0.32, and 0.41-inch (6.1 mm, 8.1 mm, and 10.4 mm) core tubes and 20-1 ***AccuRibbon***® Splitter for 0.24, 0.32, and 0.41-inch (6.1 mm, 8.1 mm, and 10.4 mm) core tubes provided with UCB2 Closure.
Length of Fiber	UCB1	Length of fiber from white PVC Tubes - 32 inches (812.8 mm).
	UCB2	Length of fiber from white PVC Tubes - 40 inches (1016 mm).
Splice Organizer	UCB1	Splice Organizer is provided ready to use.
	UCB2	Splice Organizer is assembled with either the Fusion/Mechanical Insert or the Rotary Insert.

Note: The UCB3 closure is the same as the UCB2 closure except a CSM onboard seal and a CSM grip plate are not provided; a fusion splice organizer is provided ready to use.

2100LG/BT6 Fiber Optic Buried Terminal

The 2100LG/BT6 buried terminal is designed to seal, bond, anchor, and protect fiber optic drop cable connections in the direct buried or handhole environment.

Two different configurations of the 2100LG/BT6 buried terminal are available:

- **2100LG/BT6-00** — environmentally sealed terminal box which can accommodate one stub cable and up to six 2-fiber drop cables. Cables and ST® connectors are not included and must be ordered separately for the desired configuration.
- **F90AK8512** — identical to 2100LG/BT6-00 except can accommodate two stub cables.

2400LG Fiber Optic Grounding Closure

AT&T 633-020-029

The 2400LG fiber optic grounding closures are used for bonding and grounding the metallic sheath members of fiber optic cables. They are designed to be used at nonsplice points in aerial plant, cable entrance vaults, regenerator sites, and building entrance locations where a fire-resistant closure is required. The closures allow the two separated ends of the fiber optic cables' metallic sheath to be connected to two different (isolated) grounds if desired. They are coded as follows:

- 2400LG/41FA
- 2400LG/48FA
- 2400LG/00FA

The 2400LG/41FA and 2400LG/48FA closures include all the items needed for a complete installation. The 2400LG/00FA closure is not equipped with grommet and grip kits. If installing this closure, order "D" kit of parts which contains the necessary grip assemblies, grommets, and hardware to match the specific cable requirements.

2418LG Drop/Distribution Closure

This closure was specifically designed to serve the growing CATV industry and to use with the Fiber-in-the-Loop (FITL) technology. It can be used in an aerial application or as a pedestal closure. It has a maximum capacity of 18 splices (fusion only) and is designed to work with mini-LXE cable (maximum diameter of 0.36 inches). It is 13 inches long and 3-1/4 inches in diameter and includes everything needed for a completed closure.

2500LG Fiber Optic Closure

AT&T 633-502-100

There are four versions of the 2500LG closure. This closure can be ordered as 2500LG/SC for general splicing or as 2500LG/DC for drop cable splicing. The major difference in these two codes is the end plate. The 2500LG/SC has provisions for adding up to two branch cables using a D-182598 Kit of Parts for each branch cable. The 2500LG/DC has provisions for adding up to four metallic or dielectric drop cables using the appropriate D-Kit of Parts for the particular drop cable. The closures will accommodate fiber optic distribution cables from 0.40 inch (10.2 mm) to 0.85 inch (21.6 mm) outside diameter. The 2500LG closure can be used in buried, underground, aerial, handhole, or pedestal applications. The closures can accommodate ***ST*** connectors, 24 fusion splices, 24 rotary splices, or 24 nonpolished mechanical splices (***CSL LightSplice***).

The closure is furnished with all the necessary materials, except encapsulant, required for assembly. Separately ordered D-Kits of Parts are required for a branch cable, splicing of drop cable, external grounding, or use of ***ST*** connectors. The 2500LG closure is comprised of a thermoplastic stand-alone envelope with corrosion-resistant hardware.

Two additional codes, the 2500LG/SC48 and the 2500LG/DC48, provide higher splice capacities. Each will accommodate 54 individual fusion and non-polished mechanical (***CSL LightSplice***) type splices.

2500LG CLOSURE — ORDERING INFORMATION		
Item	**Description**	**Comcode**
2500LG/DC	Drop Closure, 24-splice capacity	106606262
2500LG/DC48	Drop Closure, 54-splice capacity	107094013
2500LG/SC	Splice Closure, 24-splice capacity	106606270
2500LG/SC48	Splice Closure, 54-splice capacity	107094005

2600LG/SC Fiber Optic Closure

AT&T 633-502-101

The 2600LG/SC fiber optic closure is designed for high fiber count splicing of fiber optic cables. The closure is not designed to handle service drops. It is intended for underground, aerial, or direct buried applications and is comprised of a cylindrical plastic stand-alone envelope with corrosion resistant metal hardware. The closure is extremely robust and highly reliable, yet can be easily re-entered by removing one bolt. The closure can be used in a corrosive environment without additional protection. The 2600LG/SC closure and associated accessory kits are listed on the next page.

2600LG Closure	This is the base closure kit. The 2600LG is a sealed, butt-configured closure designed for splicing applications. One closure should be ordered for each splice point.
Splice Organizers	The 2600LG Closure is designed to handle mechanical, array, or fusion-type splices and ***ST*** connectors. Appropriate organizers must be ordered to accommodate the particular splicing method used.
Grommet and Grip Kits	These kits include cable grommets and a grip assembly to seal, bond, and anchor cables in the 2600LG Closure. Kits are sized by cable outside diameter. The 2600LG has 3 ports, and each port (2 cables maximum) requires 1 kit (if the port has cables placed in it). The table below summarizes the kits described on the following pages.
Bonding and Grounding Kits	These kits are designed to ground the metallic cable members. One per metallic cable or bond is required.
Encapsulant	The 2600LG requires 1900 grams of encapsulant. See Encapsulant, EZ Entry.

The closure is designed to accommodate six fiber optic cables from 0.40 inches (10.2 mm) to 0.85 inches (21.6 mm) in diameter in a butt configuration. It has a capacity of 216 individual splices and will accept a maximum of six splice trays. If mass fusion or ribbon array splices are used, it can accommodate up to 432 fiber splices. Most standard fiber optic splices and connectors can be accommodated. Five different organizer/splice trays can be ordered depending on the type of splice or connector to be used. The 2600LG/SC closure is available as a base closure or equipped with splice trays, grommet and grip kits, and bonding and grounding kits.

2600LG CLOSURE — ORDERING INFORMATION		
Item	**Description**	**Comcode**
2600LG/SC1 Closure	Closure assembly	105578595
2600LG/SC2 Closure Kit	Closure assembly with 0.4-0.5-inch (10-13 mm) Grommet & Grip Kit, (2) D-182212 Bonding & Grounding Kits, (2) 24 Splice Trays, and Spare Parts Kit	106266554
2600LG/SC3 Closure Kit	Closure assembly with 0.4-0.5-inch (10-13 mm) Grommet & Grip Kit, (2) D-182212 Bonding & Grounding Kits, (2) 36 Splice Trays, and a Spare Parts Kit	106508690

2700LG/DC1 Fiber Optic Closure

AT&T 633-502-102

The 2700LG/DC1 (F92AK8541) fiber optic closure is a drop closure used in the fiber optic distribution plant. Up to 12 fiber optic service drops may be spliced to the main distribution cable to provide customer service. Four distribution cable entrances are provided to allow branch splicing. The closure is intended to be used in aerial applications and can accommodate up to 48 single fiber splices. This closure can also be used in sheath repair applications.

2800LG Fiber Optic Submarine Splice Closure

The 2800LG (F92AK8549) closure is designed to seal, bond, anchor, and protect fiber optic cable splices underwater. It is used to cover a splice or repairs in wire-armor fiber optic cable for underwater applications up to 300 meters deep in both fresh water and saltwater. The closure is designed to be used in conjunction with an outer submarine splice case. It has a capacity of 108 rotary mechanical splices or 144 single-fiber fusion splices. This product is available by special order only.

FIBER OPTIC CONNECTORS AND SPLICES

Fiber Optic Products Catalog (Code 2492C

Biconic Connector

Note: For information on fiber optic couplings and receptacles, see the Fiber Optic Products Catalog (Code 2492C).

The 2016, 2016K, 1006, and 1005 biconic connector families are field mountable connectors used for cable-to-cable or cable-to-equipment single fiber connections. These connectors can also be installed on interconnec cable and buffered or unbuffered fiber. Each connector is compatible with a variety of couplings and is stamped with the appropriate code for eas identification. These reliable connectors yield fractional dB losses through th latest in precision-molding techniques. Keyed versions of this connector ar also available.

2016 SINGLEMODE STANDARD BICONIC CONNECTOR (FIELD-MOUNTABLE)				
Product Code	Comcode	Diameter Acceptance		Availability
		Cable (mm)	Nominal Fiber (μm)	
2016A	104 300 249	2.4	125	Stock
2016A1	104 310 040	2.4	127	Stock
2016C	104 310 032	3.0	125	Stock
2016C1	104 310 057	3.0	127	Stock
Compatible Couplings (Standard) — 1011A, 1011D, 1012A, 1013D, or a 1000-type buildout block and appropriate 601, 701, or 801 buildout. Standard singlemode connectors have a yellow housing.				

2016 SINGLEMODE KEYED BICONIC CONNECTOR (FIELD-MOUNTABLE)				
Product Code	Comcode	Diameter Acceptance		Availability
		Cable (mm)	Nominal Fiber (μm)	
2016AK	105 265 789	2.4	125	Stock
2016AK1	105 265 797	2.4	127	Non-stock
2016CK	105 265 805	3.0	125	Stock
2016CK1	105 265 813	3.0	127	Non-stock
Compatible Couplings — 1012AK, 1013DK, or a 1000-type buildout block, and the SK1 buildout. Keyed singlemode connectors have a green housing. **Note:** The keyed biconic is compatible with the standard biconic.				

1006 MULTIMODE BICONIC CONNECTOR (FIELD-MOUNTABLE)				
Product Code	Comcode	Diameter Acceptance		Availability
		Cable (mm)	Nominal Fiber (μm)	
1006A	104 233 168	2.4	127	Stock
1006A-140	105 159 438	2.4	145	Non-stock
1006C	104 310 024	3.0	127	Stock
1006C-140	105 159 453	3.0	145	Non-stock
Compatible Couplings — 1000A, 1001A, 1001D, 1002A, 1003A, 1003D, or a 1000-type buildout block and the appropriate 401 or 501 buildout. Standard multimode connectors have a black housing.				

1005 MULTIMODE BICONIC CONNECTOR (FIELD-MOUNTABLE)				
Product Code	Comcode	Diameter Acceptance		Availability
		Cable (mm)	Nominal Fiber (μm)	
1005B	104 233 150	2.4	127	Stock
Compatible Coupling — 1007A standard 1005B connector has a white housing.				

ST and ST II Connectors

The ***ST*** and ***ST II*** connectors are rugged, compact connectors for use ir high-activity applications. They are ideal for interoffice and fiber-in-the-loop applications within the telephone companies, head-end connections anc backbone routes within cable television (CATV) companies, and in Ethernet Token Ring, and other premise data networks within local area networks (LANs). They are ceramic tip connectors that use a bayonet-type "twist-lock' mounting arrangement and will accept 125-μm outer diameter (OD) fibei unless otherwise specified. The original connector design can be field-mounted using the 1032A tool kit and the D-181338 consumable kit. The enhanced connector can be field-mounted using the 1032B tool kit, or a 1032A tool kit and a D-181610 kit of parts plus the D-182038 multimode or D-182037 singlemode consumable kit when using epoxy. For quick connections the multimode connector can be mounted using the 1032F and EZ consumables.

The coding scheme for the *ST* connectors is shown below:

P 20 20 C - C - 125

PLUG

CABLE
- 20 MM
- 30 SM
- 50 Backplane
- 71 DECconnect™

HARDWARE
- 20 Zinc - 2.4 and 3 mm
- 21 Zinc - black boot connector
- 22 Zinc - nonoptical disconnect
- 23 Zinc - red boot connector
- 24 Plastic - 2.4 and 3 mm
- 26 Zinc - 3 red boot plus 3 black boot connectors
- 30 Zinc - 3 mm
- 36 Zinc - 3.6 mm
- 50 Stainless - Military
- 52 Stainless nonoptical disconnect - Military
- 60 Zinc - angled
- 64 Plastic - angled

DESIGN
- A - 1st
- C - 3rd

TIP
- C - Ceramic Alumina
- Z - Ceramic Zirconia

FIBER O. D.
- 125 μm
- 127 μm
- 140 μm
- 240 μm

MULTIMODE *ST II* CONNECTOR (ENHANCED HARDWARE)				
Product Code	**Comcode**	**Diameter Acceptance**		**Availability**
		Cable (mm)	**Nominal Fiber (μm)**	
P2020C-C-125	105 143 911	2.4, 3.0	125	Stock
P2022A-C-125	105 218 341	2.4, 3.0	125	Non-stock
P2036C-C-125	106 034 812	2.4, 3.0	125	Non-stock
P2050A-C-125	105 753 669	2.4, 3.0	125	Non-stock
P2050A-C-140	105 777 338	2.4, 3.0	140	Stock
P2050A-C-240	105 777 312	2.4, 3.0	240	Non-stock
P2052A-C-125	105 753 677	2.4, 3.0	125	Non-stock
P2052A-C-140	105 777 320	2.4, 3.0	140	Non-stock
P2052A-C-240	105 777 304	2.4, 3.0	240	Non-stock
P7121A-C-125	106 038 573	2.4, 3.0	125	Non-stock
P7123A-C-125	106 038 581	2.4, 3.0	125	Non-stock
P7126A-C-125	106 042 674	2.4, 3.0	125	Non-stock
P2020C-Z-125	106 812 274	2.4, 3.0	125	Non-stock
Compatible Couplings — C2000A or A2000 series.				
Note: Military parts meet Mil-C-83522/12.				

SINGLEMODE *ST* CONNECTOR (ENHANCED HARDWARE)				
Product Code	Comcode	Diameter Acceptance		Availability
		Cable (mm)	Nominal Fiber (μm)	
P3020A-C-125	105 271 118	2.4, 3.0	125	Stock
P3020A-C-127	105 388 649	2.4, 3.0	127	Non-stock
P3022A-C-125	105 395 313	2.4, 3.0	125	Non-stock
P3022A-C-127	105 395 305	2.4, 3.0	127	Non-stock
P3024A-C-125	105 514 053	2.4, 3.0	125	Non-stock
P3024A-C-127	105 514 079	2.4, 3.0	127	Non-stock
P3050A-C-125	105 777 379	2.4, 3.0	125	Stock
P3050A-C-127	105 777 361	2.4, 3.0	127	Non-stock
P3052A-C-125	105 777 353	2.4, 3.0	125	Non-stock
P3052A-C-127	105 777 346	2.4, 3.0	127	Non-stock
P3060A-C-125	106 013 766	2.4, 3.0	125	Non-stock
P3064A-C-125	106 013 782	2.4, 3.0	125	Non-stock
P5000A-C-125	105 497 122	NA	125	Non-stock
P3020A-Z-125	106 812 258	2.4, 3.0	125	Non-stock
Compatible Couplings — C3000A, C5000, or A3000 series.				

SC Connector

The SC connector features a rugged ceramic plug and a precision sleev for proper fiber alignment. It uses a "push-pull" coupling design to allow fc easy insertion and removal in connector applications. The SC connector ca be used in both the telco and premise markets in applications similar to the ***S*** connector. It consists of a predomed ceramic tip. The mounting arrangemer will accept 125-µm OD fiber unless otherwise specified. The connector i designed to mount on 3.0-mm cordage and is easy to field-mount.

SC CONNECTOR PLUGS					
Product Code	**Comcode**	**Diameter Acceptance**		**Nominal Fiber µm)**	**Availability**
		Description	**Cable (mm)**		
P6000A-Z-125	106 917 438	SM Connector	3.0	126	Non-stock
P6000A-Z-127	106 917 446	SM Connector	3.0	127	Non-stock
P6001A-Z-125	106 917 586	SM Connector	0.9	126	Non-stock
P6001A-Z-127	106 917 594	SM Connector	0.9	127	Non-stock
P6200A-Z-126	106 917 776	MM Connector	3.0	126	Non-stock
P6200A-Z-128	106 917 792	MM Connector	3.0	128	Non-stock
P6201A-Z-126	106 917 800	MM Connector	0.9	126	Non-stock
P6201A-Z-128	106 917 826	MM Connector	0.9	128	Non-stock
SM = Singlemode MM = Multimode Compatible Couplings — C6000 and C6060.					

CSL LightSplice

The ***CSL LightSplice*** is designed to be compatible with singlemode or multimode 250 μm coated or 900 μm buffered fibers with an average splice loss of less than 0.20 dB and an average reflectance (return loss) of less than -50 dB. The polishing of fiber ends or the use of adhesives is not required for assembly. Once installed, the splice is environmentally stable from -40°F to 185°F. The splice consists of a clear plastic housing with a lens molded into it to allow observation of fibers during splicing, a pyrex glass capillary prefilled with an index matching gel, and a metal spring clip that locks the fibers into place. The ***CSL LightSplice*** is a permanent splice and may be used in any outside plant or premise distribution environment. The splice can be reentered by using a 1046B tool to reposition the metal spring clip to the open position.

A 1041A or 1041B workstation is required to assemble the ***CSL LightSplice***. The 1048A tool kit (Comcode 106 186 687) or 1048B tool kit (Comcode 106 630 833) includes a workstation and other tools and supplies needed to assemble the ***CSL LightSplice***. The workstations are also available individually. The splices come packaged in quantities of six and include condensed instructions for assembly (Comcode 106 189 442).

Rotary Mechanical Splice

The rotary mechanical splice is a tunable splice used for joining individual singlemode or multimode fibers. The splice can be tuned using the passive alignment process or the active alignment process. Mated glass ferrules are installed on each end of the fibers to be spliced. The ferrules are secured using an adhesive, then polished and inserted into an alignment sleeve. In the passive alignment process, the ferrules are rotated so the tabs line up with each other, which provides minimum loss. If extremely low loss is required, the splice can be actively aligned (tuned) for average singlemode splice losses of less than 0.05 dB. Local detection and either local or remote injection are used for active alignment. The signal source for joining singlemode fibers is provided by a 944A or 944B test set. Singlemode splice losses range from 0.20 dB using passive alignment down to 0.05 dB using active alignment. Multimode splice losses range from 0.25 dB using passive alignment down to 0.10 dB using active alignment.

The 1040A tool kit (Comcode 104 186 150) or 1040B tool kit (Comcode 104 440 615) contain tools and supplies required to assemble the rotary mechanical splices. The D-181617 kit of parts provides ferrule assemblies and enough consumable materials to make 12 splices.

BUILDOUTS AND ATTENUATORS

Fiber Optic Products Catalog (Select Code 2492C)

Cable Buildouts

Cable buildouts are used for the interconnection and attenuation of optical signals at 825-, 875-, or 1300-nm wavelengths for multimode applications and 1300- or 1550-nm wavelengths for singlemode to multimode applications.

The 400, 500, and 600 Series cable buildouts consist of a short LA1A-A jumper of 8 to 16 inches (20.3 to 40.6 cm) permanently fastened to a special fiber optic connector that is similar to the 1002A. This connector contains a Biconic sleeve attenuator consisting of a carbon-coated *Mylar** filter. For easy identification, the connector housing is colored white and is stamped with the appropriate code designation.

Cable buildouts are usually inserted into circuits at system interfaces, such as interconnection equipment.

Barrel Buildouts

Barrel buildouts are used for the interconnection and attenuation of optical signals at 825-, 875-, or 1300-nm wavelengths for multimode applications and at 1300 and 1550 nm for singlemode applications.

The 401, 501, 601, 701, and 801 Series buildouts consist of a Biconic sleeve, with or without attenuation, housed in a plastic barrel that snaps into a 1000C, 1001C, 1001E, or 1003E Buildout Block or the appropriate coupling panel. Each buildout is stamped with the appropriate code designation and

* Registered trademark of E.I. Dupont DeNemours and Company.

accepts either the 1006-Type Connector for multimode applications or the 2016-Type Connector for singlemode applications.

Note: Loss data pertaining to the cable and barrel buildouts can be found in the "Appendix — Specifications" section of the Fiber Optic Products Catalog.

Buildout Blocks

Buildout blocks are molded plastic adapters that accept any 401, 501, 601, 701, or 801 barrel buildout for multimode and singlemode applications. They are equipped with either dual or round flanges for panel mounting.

Standard threaded or electronic equipment plug-in connection styles are available. Split "6-pack" buildout blocks for mounting six buildouts are also available.

Buildouts must be ordered separately.

Coupling Panels

The 10A and 11A Coupling Panels are plastic adapters that accept six ***ST*** fiber optic connector couplings and 1007A couplings for the 1005B Connector, respectively. The 12A Connector Panel accepts six of the 401, 501, 601, or 701 Series buildouts. The 10A, 11A, and 12A Coupling Panels are accommodated by the 100A, 200B, and 400 Lightguide Interconnection Units (LIUs).

Adapter plates are necessary in the mounting of 1000C Buildout blocks for *ST* fiber optic connector couplings into ***LGX***® Fiber Optic Distribution Frame shelves.

Coupling Attenuator

The A2000 and A3000 Series can be mounted in any of the ***ST*** Coupling Panels. The attenuators are used for interconnection and attenuation of optical signals at 1300-nm and 1550-nm wavelengths.

Buildout Attenuator

The ***ST*** buildout series can be mounted in any of the ***ST*** Coupling Panels. The attenuators are used for interconnection and attenuation of optical signals at 1300-nm and 1500-nm wavelengths. The buildout snaps into the buildout block that is mounted onto the panel.

Note: For more information on buildouts and attenuators, see the Fiber Optic Products Catalog.

LGX FIBER OPTIC DISTRIBUTION FRAME

For information on the ***LGX*** Fiber Optic Distribution Frames and fiber optic shelves, see Section 12 "Premises Distribution".

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462-250-110	80-Type Cabinet — Cross-Connect Methods
462-260-207	Buried Service Wire Terminations
462-525-150	"C" Rural Wire — 107 Wire Terminal
626-500-125	40-Type Cabinets Hardware
629-020-009	B Service Wire Closure
629-720-215	D and E Buried Wire Terminals
631-020-101	10- and 12-Type Cable Stubs
631-020-200	Brackets, 51B and 38Y-3913
631-210-101	N- and 53-Type Distribution Cable Terminals
631-210-102	N-Type Cable Terminals
631-215-300	6-Type Closure
631-240-100	49-Type Terminals
631-240-211	1A1 and 1B1 Terminal Stubs
631-250-100	105-Type Cable Terminals
631-300-100	B-Type Cross-Connecting Terminals
631-470-204	MC10/48 Cable Closure
631-470-205	MC12/40 Cable Closure

631-470-206	MC-12/25 and MC-12/50 Closures
631-600-214	16AA2 Below Ground Closure
631-600-228	40-Type Cabinets — Installation
631-600-229	40-Type Cabinet Installation of 76 Blocks
631-600-231	40-Type Cabinet Installation of 108 Blocks
631-600-232	40-Type Cabinet With Protectors
631-600-233	40-Type Cabinet — Rural Area Interface (RAI)
631-600-236	42-Type Cabinet — Installation
631-600-237	42-Type Cabinet — Splicing and Wiring
631-600-240	80-Type Cabinet — Installation
631-600-241	80B, C, and D Cabinet FDI — Splicing
631-600-244	80E-BP (Bulk Power) Cabinet — Installation
631-604-210	PC6/48 and PC12/55 Cable Closures
631-604-215	85-Type Closure — Installation
631-650-200	UG-16 Underground Cable Terminal
632-205-215	700-, 701-, 702-Type Connectors
632-205-216	709-Type Connector
632-205-220	Wire Joining — 710 Splicing System
632-205-235	Modular Splicing System
633-020-029	2400 Fiber Optic Grounding Closure
633-500-102	18-Type Closure
633-500-108	1900 Series Closures
633-500-110	23-Type Closure

633-500-112	2200 Series Closure
633-500-114	2199 Series Closures
633-501-101	UCB1 Universal Fiber Optic Closure
633-501-102	UCB1-STH/P Fiber Optic Closure
633-502-100	2500 LG/DC4 Fiber Optic Drop Closure
633-502-101	2600 LG/SC1 Fiber Optic Closure
633-502-102	2700 LG/DC1 Fiber Optic Closure
633-506-205	50- and 51-Type Closures
633-506-206	50- and 51-Type Closures
633-506-210	2000 Series Closures
640-250-212	40-Type Cabinet — ***SLC*** 8
640-250-223	80-Type Cabinet — ***SLC*** 96
640-250-237	51A Remote Terminal Cabinet
640-250-247	Field Installation — ***SLC*** Series 5 Dual Channel Bank Into 80-Type Cabinet
640-250-252	80D Cabinet (Fiber) — Group 80 — ***SLC*** Series 5
640-250-254	80E Cabinet (Fiber) — Group 88 — ***SLC*** Series 5
640-250-255	80D Cabinet (Fiber) — Groups 90, 91, and 92 — ***SLC*** Series 5
640-250-256	80E Cabinet (Fiber) — Groups 70, 71, 90, and 91 — ***SLC*** Series 5
640-250-260	80D Cabinet (Metallic) — Description and Splicing
640-250-325	80-Type Cabinet — ***SLC*** Series 5 — Remote Terminal
640-250-326	80D Cabinet — Description and Splicing

640-250-327	80E Cabinet (Metallic) — Description and Splicing — ***SLC*** Series 5
640-252-220	80-Type Cabinet (Fiber) — ***SLC*** Series 5
640-252-312	80-Type Cabinet — ***SLC*** 96 and ***SLC*** Series 5
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OTHERS

201-200-050	Distributing Frame Systems — Manual

Section 16

Contents

Section 16

LOADING COILS, INDUCTORS, AND CAPACITORS

COIL CASES

AT&T 643-200-101

Standard coil cases for exchange-type loading coils and inductors are described herein. For other types of cases and for superseded cases, see the documents listed in the bibliography.

Note: This data is shown only for information on types of cases in the field. AT&T has discontinued the availability of many of these cases. Contact your AT&T representative for more information.

TERMINAL, IN-SPLICE, AND POLE-MOUNTED COIL CASES						
Case Code	Number of Coils*	Dimensions In. (mm)				Notes
		L	W	H	Diam.	
137A	1	1.44(37)	1.44(37)	1.04(26)		Has punched terminals for mounting in aboveground terminal in buried cable systems, or in 177A coil cases.
172B	1			1.5(38)	1.69(43)	172B for in-splice use. 172C has stud for mounting in 49-type terminal.
172C	1			4.0(102)	1.75(45)	
178A1	1		5.5(140)	2.25(57)	3.50(89)	Pole-mounted; equipped with 2A1B protector units. For use with C rural wire.
179A1	1			3.25(83)	1.82(46)	Has stud for mounting in D or E buried wire terminal. For use with buried distribution wire. Equipped with 1574-type inductor or load coil.
181A1 171C 171D 174C	1 6 11 11					For program loading
186A	16	12.75(324)			1.43(36)	Equipped with 662, 668, or 669 coils. For loading submarine cable.

* Coil code must be specified. All except 179A1 and 186A may be equipped with 1574-type inductor or 662, 668, or 669 load coil.

See Note on Page 16-1.

LOADING COIL CASES FOR T1 CARRIER					
Case Code	**Number of Coils***	**Dimensions In. (mm)**			**Notes**
		L	**W**	**H**	
180A2	2	7.19(183)	4.19(106)	1.12(29)	Plug-in unit for 466- and 468-type apparatus case†
182A1	2	5.4(137)	1.62(41)	1.0(25)	Wire-in unit for 466- and 468-type apparatus case†
184C1	2	5.00(127)	2.50(64)	0.68(17)	Plug-in unit for 475-type apparatus case
184D1	2	6.40(163)	2.50(64)	0.68(17)	

* 662, 668, or 669 loading coil must be specified.

† These apparatus cases are rated Discontinued Availability. See Note on Page 16-1.

COIL CASES FOR CENTRAL OFFICE USE					
Case Code	Number of Coils*	Dimensions In. (mm)			Available With
		L	W	H	
175A	12	10.31 (262)	1.62 (41)	1.50 (38)	662, 668, or 669 loading coils
600A1	10	8.00 (203)	2.90 (74)	2.56 (65)	1574-type inductors
601A1 601B1	2 1	1.69 (43)	1.19 (30)	4.6 (117)	641, 642, 643, 662, 668, or 669 loading coils or 1574-type inductors
* Coil must be specified. See Note on Page 16-1.					

BUILD-OUT CAPACITORS AND CASES

In loaded cable where a load section is too short, additional length can be simulated by bridging a build-out capacitor across each pair. If only a few pairs in a cable require building out or if different pairs require different values of capacitance, building out may be accomplished in a splice, using individual C capacitors. Where a large number of cable pairs require the same build-out the AT-8740 build-out case may be used (see Page 16-5).

C Capacitors

AT&T 643-700-210

The C capacitor (AT-8080) is a mylar wrapped tubular capacitor with 22-gauge (0.6 mm) PE-PVC insulated leads. It is available in values from 1.0 to 100.0 nanofarads in increments of 0.1 nanofarad. The dimensions range from 0.4 (10 mm) to 0.6 (15 mm) inch in diameter and 1.2 (31 mm) to 1.9 (48 mm) inches in length, depending upon the capacitance value.

AT-8740 Build-Out Cases

AT&T 643-400-105

The AT-8740 List 720 contains capacitors for building out capacitance only, and the List 730 contains lattice networks for building out both resistance and capacitance. Only one value of build-out unit (capacitor or network) may be ordered per case. Specified values of capacitance (or resistance and capacitance) include the stub cable. AT-8740 build-out cases are shown as follows.

AT-8740 BUILD-OUT CASES			
Number of Units (Capacitors or Networks)		List 720	List 730
		50,100,200,300, 400,600,900 1200,1500,1800	25,50,100,150, 200,300,450, 600,750,900
Capacitance values		1 to 100 nanofarads	1 to 100 nanofarads
Resistance values		—	1 to 200 ohms
Stub Data	Sheath	PASP or PASP-MP	
	Length	10 ft (3.05 m) standard; 15 to 30 ft (4.6 to 9.1 m) available in 5-ft (1.5 m) increments	
	Gauge	50 to 608 pairs: 24 gauge (0.5 mm) 908 to 1810 pairs: 26 gauge (0.4 mm)	
	Insulation	Polyethylene	

INDUCTORS (BRIDGE LIFTERS)

AT&T 902-815-150, -151, -153, 201-200-050

Bridge lifters reduce transmission losses on bridged cable pairs. They permit the bridging of cable pairs at the central office for customers having party line service to maintain a high party-line fill. In this situation mini- bridge lifters are used on the main distribution frame (MDF). They contain a miniaturized bridge lifter switch, two carbon protector blocks or gas tubes, and two heat coils. They are listed below.

MINI-BRIDGE LIFTER CARBON BLOCK PROTECTOR UNIT										
CODE	HOUSING COLOR	CONNECTOR APPLICATION								
		302	303	305	307	308	309	310	310M	311
4B11F	Orange	x	x	x		x		x	x	x
4C11F	Orange				x		x			
Current and Voltage Protection: 500 V DC Breakdown Voltage; 700 V DC Mean Impulse (Surge) Breakdown Voltage.										

1574-Type Inductors

The application of bridge lifters to central office cutover or area transfers is the practical method of eliminating bridged tap during the conversion period. In these situations customers are temporarily served from two central offices. The bridge lifter can be placed at the cutover or area transfer location until the transfers are complete. When they are used, it is not necessary to add or remove the bridged tap immediately before or after the actual cutover or transfer. They are generally housed in coil cases.

Two types of inductors are available:

- 1574C — standard
- 1574D — has 5600-ohm resistor shunted across each winding to reduce distortion of audible ring caused by 60-Hz induction.

416-Type Apparatus Cases for 1574-Type Inductors

AT&T 643-300-101, -105

The 416-type apparatus cases listed below are intended for mounting in central office cable entrance facility. They are equipped with 1574-type inductors and a factory-wired stub.

416-TYPE APPARATUS CASES FOR 1574-TYPE INDUCTORS						
Case Code	Number of Coils	Dimensions In. (mm)		Approximate Shipping Weight Lb. (Kg)		
		L	Diam.	50-Ft* Stub	75-Ft Stub	100-Ft Stub
416A	100	38(965)	12(305)	345(157)	385(175)	420(191)
416B	200	38(965)	12(305)	410(186)	475(216)	535(243)
416C	300	46(1168)	12(305)	470(213)	560(254)	650(295)
* Standard length						

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Section 17

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Section 17

ADMINISTRATION

ADMINISTRATIVE PROCEDURES

Field Engineering

AT&T 935-111-414

Tools

Recommended tools for field work are:

- Personal computer
- Briefcase
- Clipboard
- Applicable maps
- Measuring tape
- Pull finder
- Guy rule
- Safety glasses and hard hat
- Outside Plant Engineering Handbook
- Flashlight
- Stakes and hammer
- Vertical measuring device
- Measuring wheel
- First aid kit

- Marking paint and flagging
- Hand level
- Transit and level rod.

Note: Above items that are used infrequently may be rented rather than purchased.

Measuring Devices

Some common measuring devices are:

DEVICES FOR MEASURING GROUND DISTANCES			
Device	**Length of Range ft. (m)**	**Typical Accuracy ft./1000 ft. (m/305 m)**	**AT&T Ref. Document**
Measuring Wheel	—	1 to 100 (0.3 to 30.5)	935-111-414
Linen Tape	50, 100 (15.2, 30.5) 150 (45.7)	5 to 20 (1.5 to 6.1)	081-220-100
Steel Tape	200, 300 (61, 91.4)	—	935-111-414
Vehicle Odometer	—	20 to 100 (6.1 to 30.5)	935-111-414
Range Finder	100 (30.5)	1 ft (0.3) per measurement	081-220-104
Distance Measuring Unit †	—	1 to 100 (0.3 to 30.5)	—
Highway Station Marking *	—		935-111-414

* Stations are marked as follows. The beginning of a line is marked 0 + 00. A point 1234.5 feet from the beginning of a line would be marked 12 + 34.5.

† A sensor is mounted opposite a pair of magnets attached to the vehicle drive shaft. As the drive shaft rotates, the magnets pass in front of the sensor and create pulses. The pulses are fed through wiring into a dash mounted terminal which indicates measurement.

DEVICES FOR MEASURING HEIGHTS AND CLEARANCES		
Device	**Maximum Measurement ft. (m)**	**AT&T Ref. Document**
Clinometer	Depends on base line measurement	935-111-414
Range Finder	100 (30.5)	081-220-104 935-111-414
B Clearance Rule*	25 (7.6)	081-220-104

* The B Clearance Rule is a calibrated, telescoping fiberglass rod and is the only instrument that may be used to measure clearances from power lines by physical contact. ***Caution: It should not be used in wet weather or when the rule itself is wet.***

Note: Pole length for wood poles is shown on its marking, which is located 10 feet (3 m) from the butt, except on very long poles. Pole step spacing is 3 feet (0.9 m).

Field Notes

The AT&T Outside Plant Systems Engineering Procedure Checklist OS-C-EC-02 provides a detailed listing of the design elements and other appropriate data that should be considered when writing field notes and work orders.

Preparation of Work Prints

Computer generated drawings are recommended. The content of outside plant construction work prints are covered in the following AT&T documentation:

928-411-510 Preparation of Work Prints — General

928-411-511 Preparation of Work Prints — Underground Conduit

928-411-512	Preparation of Work Prints — Underground Cable
928-411-513	Preparation of Work Prints — Buried Cable
928-411-514	Preparation of Work Prints — Aerial Cable
928-411-515	Preparation of Work Prints — Buried Wire
928-411-516	Preparation of Work Prints — Aerial Wire
928-411-517	Preparation of Work Prints — Poles
928-411-518	Preparation of Work Prints — Building Cable
928-411-519	Preparation of Work Prints — Cable Pressurization
928-411-520	Preparation of Work Prints — Trunk and Carrier
928-411-523	Revision to Work Prints.

Accounting

Refer to the customer's Comptrollers Accounting Classification Group foı information on:

- Classification of plant and accounting codes
- Accounting code division points
- Cable measurements
- Work operations
- Retirement units.

QUALITY ASSURANCE

OS-C-EC-01

It is the intention of AT&T to be recognized as the leader in providing high quality telecommunications, information services, and products in the markets we choose to serve. Quality inspections are the tools used to evaluate quality throughout the Outside Plant (OSP) engineering process.

The quality inspections are defined as follows:

- **OSP Engineering Self-Verification Inspection**—performed by each OSP field engineer as each engineering task is completed.
- **OSP Engineering In-Process Inspection**—performed by the OSP field engineering supervisor to assure the overall quality of each phase of the OSP engineering work.
- **OSP Quality Organization Final Inspection**—performed by the OSP Quality Organization, which is external to the OSP engineering field work. The Quality Organization will inspect completed OSP engineering work as well as assure that both self-verification and in-process inspection instructions are being followed.
- **OSP Quality Organization Reinspection**—performed by the OSP Quality Organization and the OSP engineering supervisor to insure that quality deficiencies identified during final inspections are satisfactorily corrected.

The AT&T Network Systems Customer Support and Operations Outside Plant Engineering Quality Assurance Handbook (OS-C-EC-01) describes the quality assurance inspection procedures and documentation requirements.

PROJECT MANAGEMENT/SCHEDULING TOOLS

Here is a sample of some project management software tools that are currently available in the marketplace. The following products are shown only as examples of available software tools. This is not an all inclusive list and there is no implied endorsement or recommendation for the products shown.

Primavera Project Planner * 5.1

This very comprehensive software tracks resources, monitors costs, and produces graphics and reports using the following six modes: forms, tables, graphics, import, interface with other products, and batch input (for very large jobs).

* Registered trademark of Primavera Systems, Inc.

This software package is available from:

Primavera
Two Bala Plaza
Bala Cynwyd, PA 19804

Microsoft * Project for Windows† 3.0

This software provides tools to schedule tasks, manage resources, monitor costs, and generate reports for analysis and presentations. It contains interactive graphics and can be customized to specific scheduling needs. This software package is available from:

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Job Management Operation System

AT&T 935-111-460 through -464, 928-411-505

The Job Management Operation System (JMOS) is a mechanized system used by some domestic local exchange carriers and is designed to assist in the administration and control of work orders.

The JMOS job administration process is divided into ten basic steps:

1. Project preparation
2. Detailed design (see note)
3. Work print processing
4. Job scheduling

---

* Registered trademark of Microsoft Corporation

† Trademark of Microsoft Corporation

5. Material ordering
6. Construction planning
7. Job construction
8. Daily work reporting
9. Job tracking
10. Job completion reporting.

Note: Detailed design is the conversion of the engineer's concept of the proposed work into a set of work prints specifying the exact material items to be used, construction tasks to be performed, due dates, and priority for each order. The resulting work prints are the vehicle from which the JMOS encoding and scheduling data is derived.

The basic data required on work prints to properly administer the JMOS program is shown in AT&T 928-411-505.

The administration of the JMOS program is described in AT&T 935-111-460 through -464.

JOINT AGREEMENTS

Buried Plant

For information on agreements with power companies regarding joint buried plant, see AT&T 937-217-150.

Pole Lines

For information on joint-use pole lines, see the following AT&T documentation:

937-217-125 Agreements with Power Companies

937-217-126	Division of Cost Methods
937-217-130	Joint Use with REA
937-217-136	Power Line Carrier.

OUTSIDE PLANT LOCATION RECORDS

Outside plant location records are described in the AT&T's 928-1XX-XXX document division.

TRAINING

The following Outside Plant training is available from AT&T at the time of this printing:

OE1800	Basic Outside Plant Engineering
OE1801	Engineering Economy
OE1901	Outside Plant Distribution Area Planning
OE1902	Trunk Traffic Engineering
OE1908	Fiber Optic Design Engineering
OP1806	Cable Fault Location
OP1812	Subscriber Loop Acceptance Testing
OP1819	Underground Conduit and Manhole Familiarization
OP1821	Underground and Buried Copper Cable Placing
OP1908	Conduit Inspection
OP1823	Station Installation and Maintenance
OP2655	OSP Copper Cable Splicing.

Many of the AT&T courses can be held at the customer's premises (suitcased in), if there are a sufficient number of students enrolled and the equipment required for the course is on-site. For more information, contact a "suitcase" coordinator on 614-764-5542 or 614-764-5735. The AT&T training center also provides technical assistance and on-site consultation services.

For the most current training courses, call the AT&T training center at 1-800-TRAINER or dial into our COMputerized CATalog, COMCAT. To access COMCATS, dial 1-800-662-0662 and login by typing ***comcats***, then enter the password ***at&tcat***. If you need assistance, call the COMCATS Helpline on 614-764-5664.

To enroll in a course call toll free at 1-800-TRAINER and select option 2 both times. If calling from Canada, dial 1-800-221-1647. If calling from outside the United States, dial 1-614-764-5274 (International Access).

Unless other arrangements are made in advance, payment is due upon registration. Please make checks or money orders payable to AT&T. American Express®, VISA®, and MasterCard® are accepted. Fees, schedules, and courses are subject to change without notice. A refund is made for cancellations received 15 days before the start date of the course. Tuition is not refunded if you cancel or reschedule *without a substitute* within 15 days of the start date of the course. Substitutions are accepted at any time.

Training center locations include:

5151 Blazer Memorial Parkway
Dublin, Ohio 43017

1195 Summerhill Drive
Lisle, Illinois 60532 (near Chicago)

2000 Northeast Expressway
Norcross, Georgia 30071

AT&T Singapore Pte Ltd.
150 Beach Road
No. 36-00 Gateway West
Singapore 0718

AT&T NS-NL
N. E. Larenseweg 50
1200 B. D. Hilversum (P.O. Box 1168)
The Netherlands

CONVERSION FACTORS AND UNITS

Conversion Factors

To Convert	Into	Multiply by	Conversely, Multiply by
Acres	square feet	43,560	.00002296
	square meters	4,047	.0002471
	square miles	.001562	640
Atmospheres	mm of mercury	760	.001316
	ft of water	33.9	.0295
	in. of mercury	29.92	.03342
	kg per sq meter	10,330	.00009678
	lbs per sq in.	14.7	.06804
Circular mils	sq centimeters	5.067×10^{-6}	197300
	sq mils	.7854	1.273
Degrees (angle)	radians	.01745	57.3
Feet	centimeters	30.48	.03281
	meters	.3048	3.281
	miles (statute)	.0001894	5280
	miles (nautical)	.0001645	6080.2
Gallons (U.S.)	cubic feet	.1337	7.481
	gallons (Imp.)	.8327	1.201
	liters	3.785	.2642
Inches	centimeters	2.54	.3937
	miles (statute)	.00001578	63,360
	mils	1000	.001
Kilograms	pounds	2.205	.4536

To Convert	Into	Multiply by	Conversely, Multiply by
Liters	cubic centimeters	1000	.001
	cubic inches	61.02	.01639
	quarts (U.S.)	1.056	.9464
Meters	yards	1.094	.9144
	miles (statute)	.0006214	1609
Miles (statute)	miles (nautical)	.8684	1.1516
	kilometers	1.609	.6214
Watts	horsepower	.001341	745.7

International System of Units (SI)

The following is a partial list of units in the metric system known as "The International System of Units (SI)."

Quantity	Unit	Abbreviation
Area	square meter	m^2
Capacitance	farad	F
Conductance	siemens	S
Electric current	ampere	A
Electric field strength	volt per meter	V/m
Electric resistance	ohm	Ω
Electrical potential	volt	V
Frequency	hertz	Hz
Inductance	henry	H
Length	meter	m
Mass	kilogram	kg
Time	second	s

Multiples and Submultiples

Factor	Prefix	Symbol
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

BIBLIOGRAPHY

AT&T	Title
081-220-100	Measuring Tapes
081-220-104	Height and Distance Estimation Devices
620-040-XXX	Outside Plant Symbols and Abbreviations
928-1XX-XXX	Outside Plant Location Records
928-411-510	Preparation of Work Prints — General
928-411-511	Preparation of Work Prints — Underground Conduit
928-411-512	Preparation of Work Prints — Underground Cable
928-411-513	Preparation of Work Prints — Buried Cable
928-411-514	Preparation of Work Prints — Aerial Cable
928-411-515	Preparation of Work Prints — Buried Wire
928-411-516	Preparation of Work Prints — Aerial Wire
928-411-517	Preparation of Work Prints — Poles
928-411-518	Preparation of Work Prints — Building Cable
928-411-519	Preparation of Work Prints — Cable Pressurization
928-411-520	Preparation of Work Prints — Trunk and Carrier
928-411-523	Revision to Work Prints
935-100-102	Distribution Service Design Center (DSDC) — Center Description
935-100-106	Distribution Service Design Center (DSDC) — Center Training Description
935-100-108	Distribution Service Design Center (DSDC) — Information Resources Index
935-111-414	Field Engineering
935-111-430	Preparation of Specific Estimate Authorization
935-111-440	Outside Plant Job Scheduling — Manual

BIBLIOGRAPHY

AT&T	Title
935-111-460	Job Management — Operations — System (JMOS) — Administrative Guide — Overview
935-111-461	Job Management — Operations — System (JMOS) — Administrative Guide — Distribution Service Design Center (DSDC) — Design Engineer
935-111-462	Job Management — Operations — System (JMOS) — Administrative Guide — Distribution Service Design Center (DSDC) — Scheduling Engineer
935-111-463	Job Management — Operation — System (JMOS) — Administrative Guide — Construction Management Center (CMC) — CMC Supervisor
935-111-464	Job Management — Operation — System (JMOS) — Administrative Guide — Construction Field Supervisor
937-114-001	The Liaison Program
937-217-125	Joint Use of Wood Poles — General Arrangements With Power Companies
937-217-126	Division of Cost Methods in Formulating Joint Use Agreements
937-217-130	Joint-Use of Wood Poles — REA
937-217-136	Use of Power Line Carrier on REA Lines
937-217-150	Joint Agreement With Power Companies — Random Buried Installations

Section 18

Contents

Section 18

SYMBOLS

OUTSIDE PLANT SYMBOLS

Outside plant symbols for use on construction work prints, plant location records, map, etc., are explained in the following documents:

AT&T	Title
620-040-011	Outside Plant Symbols — General
620-040-012	Outside Plant Symbols — Poles and Associated Equipment
620-040-013	Outside Plant Symbols — Wire
620-040-014	Outside Plant Symbols — Underground Conduit and Manholes — Building Conduit and Housings
620-040-015	Outside Plant Codes and Symbols — Use and Application — Cable, Cable Terminals, Closures, and Interfaces
620-040-016	Outside Plant Symbols and Abbreviations — Loading Coil Cases, Capacitors, Building-Out Networks and Inductors
620-040-017	Outside Plant Symbols and Abbreviations — Carrier Systems
620-040-018	Outside Plant Symbols — Cable Pressurization Systems
620-040-019	Outside Plant Symbols — Closed Circuit TV Systems
620-040-020	Outside Plant Abbreviations — General

The symbols shown on the next pages are those most frequently used on construction work prints. For other symbols see the above documents.

SYMBOLS FOR WORK PRINTS

General

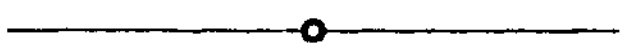
AT&T 620-040-011

	EXISTING
	PROPOSED
	FUTURE
X X X	TO BE REMOVED
	AERIAL, BUILDING, OR UNDERGROUND CABLE
B	BURIED CABLE
BJ	BURIED IN JOINT TRENCH
	UNDERGROUND CONDUIT OR CABLE IN MANHOLES
SUBM	SUBMARINE CABLE
ALTW - 50	GAUGE, TYPE, AND SIZE OF CABLE
3BAX - 144 - M	FIBER OPTIC CABLE
	FIBER OPTIC CABLE

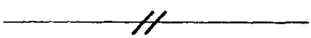
Cable Work Operations

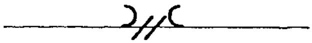
AT&T 620-040-015

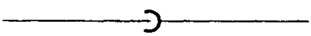
—ALMW – 3 →← ALMW – 2 — ARROWS INDICATE CHANGE IN CABLE SIZE, GAUGE, COUNT, TYPE, OR CLASSIFICATION

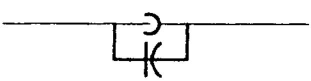

EXISTING STRAIGHT SPLICE


PROPOSED STRAIGHT SPLICE


PAIRS CUT AND ENDS CLEARED IN SPLICE CLOSURE


CABLE CUT, ENDS CLEARED AND CAPPED


INSULATING JOINT (ISOLATION GAP)


INSULATING JOINT AND CAPACITOR

— ADMC-9 —
(12, 1-900)
43, 1-900

ENTIRE COUNT OF CABLE BEING TRANSFERRED FROM 12, 1-900 TO 43, 1-900. PARENTHESIS INDICATES COUNT TO BE CHANGED.

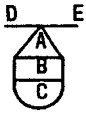
— ADMC-18 —

15, 1-600	NC
(15,601-900)	18, 1-300
17, 1-600	NC
(17, 601-900)	18, 301-300 BY SPL 5

PORTIONS OF THE COUNT OF CABLE BEING TRANSFERRED. NC - INDICATES NO CHANGE.

CHANGE IS TAKING PLACE AT SPLICE NUMBER 5.

Splicing Work Location

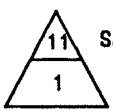


A = WORK LOCATION NUMBER
B = NUMBER OF REGULAR PAIRS TRANSFERRED
C = NUMBER OF SPECIAL SERVICE PAIRS TRANSFERRED
D = PAIRS JOINED IN SPLICE (TOTAL)
E = PIC PAIRS JOINED

Line Work Operation

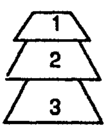
TRAPEZOID IDENTIFIES LINE WORK OPERATIONS SUCH AS PLACING AND REMOVING MATERIAL. 1 INDICATES JOB STEP NUMBER.

Combined Line and Splicing Work Operation



SPLICING 11 – INDICATES SPLICE NUMBER
LINE 1 – INDICATES JOB STEP NUMBER

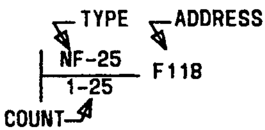
Line Work Location With Two or More Work Operations (Job Steps) Involved



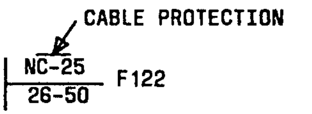
JOB STEP 1: PLACE THE POLE
JOB STEP 2: PLACE THE ANCHOR
JOB STEP 3: PLACE THE GUY

Cable, Terminals, Closures, Coil Cases

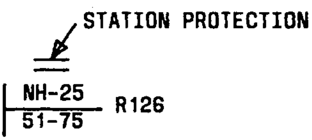
AT&T 620-040-015



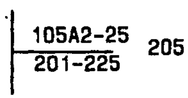
FIXED-COUNT TERMINAL



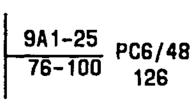
FIXED-COUNT TERMINAL WITH CABLE PROTECTION



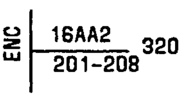
FIXED-COUNT TERMINAL WITH STATION PROTECTION



FIXED-COUNT 105-TYPE AERIAL TERMINAL (25 PAIR)



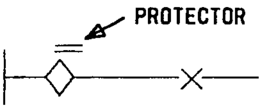
FIXED-COUNT, 25-PAIR, BURIED CABLE DISTRIBUTION TERMINAL USING THE PC 6/48 CLOSURE EQUIPPED WITH 1-9A1-25 TERMINAL BLOCK, COUNT 76 THROUGH 100



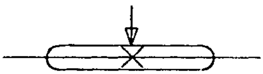
BELOW GROUND ENCAPSULATED CLOSURE WITH FOUR 2 PAIR BURIED SERVICE WIRES CONNECTED TO PAIRS 201 TO 208

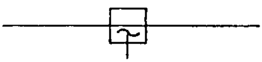
Cable, Terminals, Closures, Coil Cases (Contd)

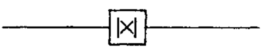

CROSS-CONNECTING TERMINAL WITH IN AND OUT PAIRS IN SAME STUB



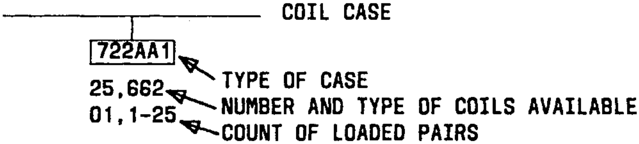
PROTECTED CROSS-CONNECTING TERMINAL WITH SEPARATE IN AND OUT STUBS


CONTROL POINT


ACCESS POINT

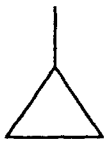

INTERFACE

COIL CASE



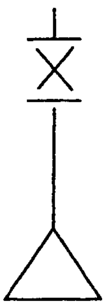
Carrier Systems

AT&T 620-040-015



SLC 96

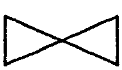
REMOTE TERMINAL (RT) HOUSING A SLC 96 CARRIER SYSTEM



SLC 96

80D CABINET

REMOTE TERMINAL (RT) WITH ASSOCIATED INTERFACE, WHEN INSTALLED IN THE SAME CABINET WITH CARRIER EQUIPMENT. 80D-TYPE CABINET ILLUSTRATED.

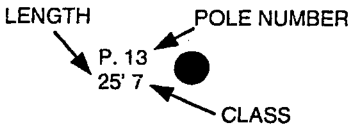


TWO WAY REPEATERS

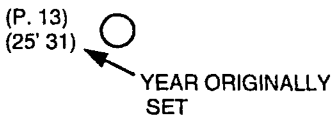
Pole Lines

AT&T 620-040-012

EXISTING TELCO POLE



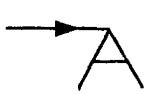
PROPOSED TELCO POLE



TELCO POLE TO BE REMOVED

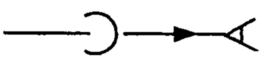
BOND

GROUNDING PLANT TO POWER MULTIGROUNDED NEUTRAL VERTICAL GROUND WIRE



SIDEWALK ANCHOR AND GUY

ANCHOR AND GUY WHOLLY OWNED BY ANOTHER COMPANY



ANCHOR AND INSULATED GUY

Wire

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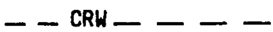
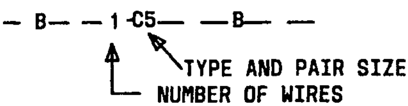


C RURAL WIRE

BLOCK OR DROP WIRE



BURIED WIRE

Underground Conduit and Manholes

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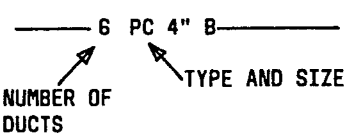

CONDUIT

PC – B	= B PLASTIC	STD	= SINGLE TILE
FD	= FIBER	SP	= SEWER PIPE
CEM	= FIBER-CEMENT	STL	= STEEL
MCD	= MULTIPLE CONCRETE	CWD	= CREOSOTED WOOD
MTD	= MULTIPLE TILE		

Underground Conduit and Manholes (Contd)

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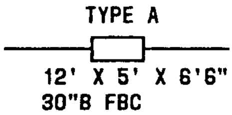
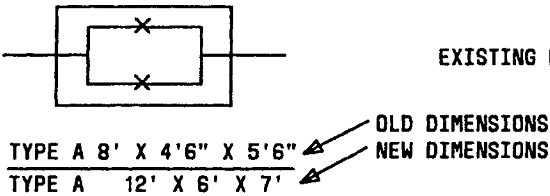
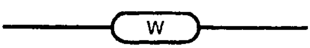


PROPOSED MANHOLE. TYPE, LENGTH, WIDTH, HEADROOM, AND TYPE OF FRAME AND COVER INDICATED.



EXISTING MANHOLE TO BE REBUILT.



NONTELCO UNDERGROUND FACILITY

CATV = CABLE TV
E = ELECTRIC
G = GAS
M = MUNICIPALITY OWNED
P = PIPELINE
PO = PRIVATELY OWNED
S = SEWER
W = WATER

Underground Conduit and Manholes (Contd)

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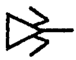
	LINE EXTENDER AMPLIFIER
	TRUNK AMPLIFIER (NO BRIDGE AMPLIFIER)
	TRUNK AMPLIFIER E/W 2 BRIDGER AMPLIFIERS - TERMINATED MAIN TRUNK
	TRUNK AMPLIFIER E/W 2 BRIDGER AMPLIFIERS AND MAIN TRUNK AMPLIFIER
	2-WAY SPLITTER
	3-WAY SPLITTER
	CABLE TERMINATION

Other Symbols

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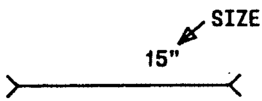
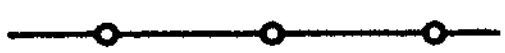
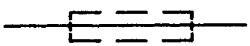


CULVERT

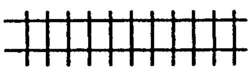


FENCE

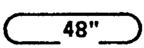
TREE



PUSH AND REMOVE PIPE, TUNNEL, AUGER, OR PLACE CASING



RAILROAD



DEPTH OF COVER

Section 19

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