AT&T

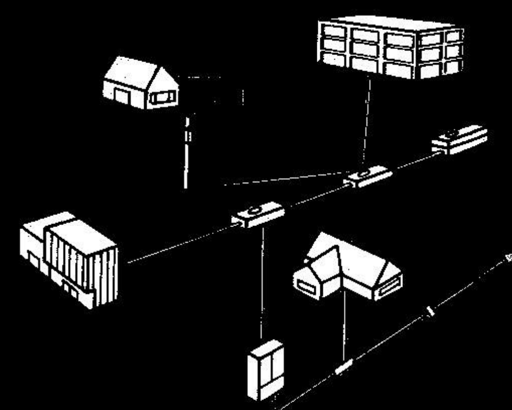
Outside Plant Engineering
Handbook

900-200-318

AT&T

Outside Plant Engineering

Handbook



TO THE OUTSIDE PLANT ENGINEER:

This handbook is designed to be used at your desk or in the field. To use it to best advantage, please take a few minutes to read the following paragraphs and then to thumb through and become familiar with its contents.

Purpose and Scope—Detailed design and construction of the Outside Plant Network are covered in the 900 through 939 (Outside Plant Engineering), 363 (Loop Transmission Systems — Pair Gain), and 620 through 649 (Outside Plant Construction) series of practices. This handbook does not replace these practices, but provides ready reference to the various practices plus information required for field use.

How to Use This Handbook—If you can identify the desired information with one of the main section titles (tabs), go to the Table of Contents at the front of that section and look for the topic of interest. If you do not know the proper section, cannot associate the topic with a main section title, or cannot find the material in the section, go to the Index (Section 19). The Index contains references to subjects listed alphabetically. The abbreviations used are explained in Section 18.

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

Updating—This handbook is intended to be updated periodically by reissue of the entire contents or selected complete sections.

Feedback—This 1990 edition is being issued to include changes in design concepts, software, and hardware products. To help in updating and to ensure that the handbook continues to meet your needs, please use the enclosed Feedback Form.

"Local" Information—This handbook contains only standard information; however, you can add Company practices and other local directives either in Section 1, which is provided for that purpose, or in the section appropriate for the topic. The page size is half the standard 8-1/2 by 11 inches. Standard pages may be folded, punched, and inserted, or pages may be reproduced locally to handbook size. It is suggested that pages produced locally for insertion in one of the sections be printed on colored paper and inserted at either the front or the back of the section.

Blank pages are provided at the end of the handbook for your personal notes. Additional pages can be made by cutting standard size paper in half.

OUTSIDE PLANT ENGINEERING HANDBOOK

JANUARY 1990

Prepared by
The AT&T Document Development Organization
Winston-Salem, North Carolina

TABLE OF CONTENTS

Section

1. Local Information
2. Planning — Integrated Methods System
3. Exchange Network Design
4. Pressurization
5. Transmission
6. Electrical Protection
7. Cable Entrance Facilities
8. Conduit
9. Buried Plant
10. Aerial Plant
11. Clearances for Aerial Plant
12. Premises Distribution Systems
13. Pair Gain Systems
14. Cable and Wire
15. Terminals and Closures
16. Loading Coils, Inductors, and Capacitors
17. Administration
18. Symbols and Abbreviations
19. Index
20. Notes

AT&T CONTACTS

TECHNICAL ASSISTANCE

Technical assistance for the subjects covered can be obtained by calling the Regional Technical Assistance Center at ***1-800-225-RTAC***. This telephone number is staffed 24 hours per day. For lightguide technical assistance, call 1-800-824-1931.

DOCUMENTATION CONTENT

If you have questions regarding the content of this document, contact:

AT&T
Document Development Organization
Attention: Publishing Services Department —
Outside Plant Group
2400 Reynolda Road
Winston-Salem, N.C. 27106
Telephone: 1-800-334-0404 or (919) 727-3167
Monday through Friday, 8:00 a.m. — 4:00 p.m. EST

ORDERING INFORMATION

To order additional copies of this document, **AT&T Entities** and **Commercial Customers** should send an order to:

AT&T
Customer Information Center
Attention: Order Entry Section
2855 N. Franklin Road
P. O. Box 19901
Indianapolis, Indiana 46219

(AT&T Entities should use Form IND 1-80.80 FA, available through the Customer Information Center.)

Section 2

CONTENTS

	Page
GENERAL	2-1
LONG RANGE OUTSIDE PLANT PLANNING (LROPP)	2-1
Purpose	2-2
Detailed Distribution Area Planning (DDAP)	2-3
Facility Analysis Plan (FAP)	2-3
Feeder Administration (FA)	2-3
Fundamental Subscriber Carrier Planning	2-3
LROPP Steps	2-4
Wire Center Selection	2-4
Assemble Data Base	2-4
Begin Administrative Route Layout Sheets	2-5
Ultimate Sectionalization	2-5
Existing Sectionalization	2-5
Prepare EAA Pair Group Displays	2-6
Create Exchange Feeder Route Analysis Program (EFRAP) Schematic	2-6
Taper Code the Network Based on Sectionalization	2-6
Spread Forecasted Growth to EFRAP Sections	2-6
Simplified Boundary Testing	2-6
Make Final EFRAP Run	2-7
Develop Long Range Digital Line Plan	2-7
Compile Long Range Outside Plant Plan Documentation	2-7
Present the Plan for Approval	2-8
Implementation	2-8

FEEDER ADMINISTRATION	2-8
Tasks	2-9
FACILITY ANALYSIS PLAN (FAP)	2-10
DETAILED DISTRIBUTION AREA PLANNING (DDAP)	2-12
FUNDAMENTAL SUBSCRIBER CARRIER PLANNING	2-13
LOOP ENGINEERING INFORMATION SYSTEM (LEIS)	2-17
Taper Coding the Network for LEIS	2-18
Engineering Responsibilities for Inputting Data in LFACS for LEIS Outputs	2-19

Section 2

PLANNING — INTEGRATED METHODS SYSTEM

GENERAL

Outside plant planning is comprised of a getting-started step and ongoing efforts as shown below.

- Getting Started
  - — Ongoing (Current Planning)
  - — Feeder Administration (FA)
- Long Range Outside Plant Planning (LROPP)
  - — Facility Analysis Plan (FAP)
  - — Detailed Distribution Area Planning (DDAP)
  - — Fundamental Subscriber Carrier Planning

These methods systems collectively are known as the Integrated Methods System (IMS).

LONG RANGE OUTSIDE PLANT PLANNING (LROPP)

Practices 901-350-200, -201

Long range outside plant planning is the process of analyzing future growth and change, and providing for them in an efficient and economical manner. It is an effective tool for intelligently managing the subscriber network. Once developed, the long range plan allows savings in engineering and outside plant costs in several ways. The plan:

- Provides a guide for efficiently designing all work—rearrangements, rehabilitation, and plant additions—toward the most economic network configuration.
- Reduces duplication of engineering effort because it produces standardized documentation.
- Assures up-to-date and accurate documentation when its maintenance and updating become an ongoing function of the feeder administration and design processes. The documents are continuously used as input to designing, administering, and monitoring the outside plant network.

Section 3

CONTENTS

	Page
FEEDER DESIGN AND ADMINISTRATION	3-1
Basic Strategies	3-1
Feeder Administration Method System	3-2
Feeder Cable Sizing — Paired Cable	3-4
Feeder Cable Sizing — Lightguide Cable	3-4
DISTRIBUTION DESIGN AND ADMINISTRATION	3-4
Distribution Design and Administration — Urban and Suburban — Paired Cable	3-4
Design Guidelines for New Distribution Plant — Urban and Suburban — Paired Cable	3-5
Administration of Cable Pairs in a Distribution Area	3-6
Distribution Design and Administration — Rural — Paired Cable	3-6
Rural Area Network Design (RAND) — Paired Cable	3-7
RAND Interface Locations	3-8
CARRIER SERVING AREA (CSA) DESIGN	3-8
Copper (Paired) Distribution Cable	3-8
Lightguide (Fiber) Distribution Cable	3-9

Section 3

EXCHANGE NETWORK DESIGN

FEEDER DESIGN AND ADMINISTRATION

Basic Strategies

Spare feeder facilities should be apportioned along an entire feeder route to defer cable relief as long as possible. This is accomplished by dividing the feeder route into Allocation Areas (AAs) during the Long Range Outside Plant Planning (LROPP) process, Practice 901-350-201. Spare facilities should then be allocated along the route based on the transmission limitations of each Allocation Area. Relief intervals (2 to 5 years) can then be established for various cross sections of the feeder 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 distribution plant or appears on the feeder field of a feeder-distribution interface.) These pairs should always be committed in one or more 25-pair groups (complements). The allocated spare pair groups which may remain in an AA after commitment for identified growth can then be made available for future growth as required. This is accomplished by splicing the spare groups into Reenterable In Cable Splices (RICS). The use of RICS along the route provides the flexibility of multipling these spare groups without actually introducing multiple appearances of pairs into the distribution plant. If unforeseen growth occurs, these spare pair groups are available then to be spliced to the appropriate lateral(s).

The methods of administering the feeder facilities using paired cable are as follows.

Type I — Serving Area Concept (SAC) Dedicated. Feeder pairs for primary services are permanently assigned (dedicated). All feeder pairs are committed to the interface in 25-pair groups and are multiple-free.

Type II — SAC Connect-Through (CT). In areas of low penetration, sufficient nonmultipled feeder pairs are committed (in 25-pair 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 Feeder. Where there are insufficient feeder pairs available for Types I or II administration, or where growth is subject to shifts between two contiguous serving areas, 25-pair groups may be multipled between two interfaces. The number of pairs multipled should not exceed 15 percent of the committed pairs. Also, 25-pair groups should not be multipled outside of their Allocation Area. Multipled pairs within an Allocation Area must meet the transmission criteria for the AA.

These methods are covered in Practices 917-100-101, 915-215-200, -300.

The Loop Feeder Administration System (LFAS) and the Long Range Analysis Program (LRAP) are mechanized tools which aid the engineer in determining the optimal economic solution in the feeder provisioning process. Given several solution alternatives incorporating both proposed feeder relief and potential route rearrangements, these programs are used to determine both the economic fill at relief and the proper allocation of feeder facilities so as to minimize total costs.

The introduction of lightguide (fiber) cable and subscriber carrier into the network is reducing the requirement for traditional large paired feeder cables. The ultimate goal is to have outside plant facilities capable of handling high rates of transmission throughout the network as explained in Section 2 - Planning. This can be accomplished by either utilizing paired cable, T1 application to paired cable, or lightguide cable. Although new technology will change many of our guidelines for designing feeder facilities, the strategies for administering paired cables will generally remain the same.

Feeder Administration Method System

Practices 916-100-010 to -015

The Feeder Administration Method System recommends the establishment of Feeder Administrators in each Distribution Service Planning Center (DSPC) to manage the feeder network.

Their purpose is to develop economical relief plans for each feeder route. The plan should meet the facility requirements for the route for a specific relief interval. The emphasis here is on:

(1) Looking at the entire route

(2) Looking at it for a specific relief interval.

Using the Feeder Administration Method System to look at each route systematically has these benefits:

(1) Each route is studied over a year.

Section 4

CONTENTS

	Page
APPLICATION	4-1
RULES FOR JOINING PRESSURIZED AND NONPRESSURIZED CABLES	4-1
SYSTEM DESIGN	4-2
DESIGN AND MAINTENANCE STANDARDS	4-6
GAS SOURCES	4-6
Commercial Air Dryers	4-6
Nitrogen Cylinders	4-7
Liquid Nitrogen	4-7
PRESSURE TRANSDUCERS AND CONTACTORS	4-8

Section 4

PRESSURIZATION

APPLICATION

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

- All underground cable
- Buried pulp and air-core lightguide 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 Practice 930-200-010 for specific recommendations as to the proper upkeep system to be employed.

RULES FOR JOINING PRESSURIZED AND NONPRESSURIZED CABLES

Practice 632-410-200

(1) If filled PIC is to be connected to pressurized cable, use a 10- or 12-type stub (see Practice 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 Practice 631-020-101).

Section 5

CONTENTS

	Page
RESISTANCE DESIGN	5-1
Loading Rules	5-3
Cable Gauge Selection	5-3
LONG ROUTE DESIGN	5-7
Resistance Zones	5-7
LRD Devices	5-7
Loading Rules for LRD	5-8
COIN LINES	5-9
Transmission	5-9
Coin Control:	5-9
Supervision and Signaling:	5-10
TRANSMISSION IMPROVEMENT AND RANGE EXTENSION DEVICES	5-11
CONCENTRATED RANGE EXTENSION WITH GAIN (CREG) DESIGN	5-13
Design Rules	5-13
Cable Gauge Selection	5-13
Loading Rules	5-14
ELECTRICAL CHARACTERISTICS OF CABLES (METALLIC)	5-15
Loop Resistance	5-15
Attenuation	5-15
Sheath and Shield Resistance	5-17
NOISE	5-18
Shielding	5-18

TRANSMISSION ON PAIR GAIN SYSTEMS	5-19
SLC® 1 Carrier System	5-19
SLC 8 Carrier System	5-20
SLC 24 Carrier System	5-22
SLC 40 Carrier System	5-25
SLC 96 Carrier System	5-25
SLC Series 5 Carrier System	5-27
SLC Series 5 Carrier System — Fiber-to-the-Home	5-29

Section 5

TRANSMISSION

RESISTANCE DESIGN

Practices 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 T1 carrier with repeaters or lightguide 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 24 kilofeet 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 kilofeet, which includes bridged tap.

(3) Limit bridged tap on nonloaded loops to 6 kilofeet or less.

(4) Limit end section plus bridged tap on loaded loops to 12 kilofeet or less. Business loop end sections are limited to 9 kilofeet with no bridged tap.

(5) Design load spacing deviations normally within ±120 feet.

(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 Page 5-2.

Section 6

CONTENTS

	Page
GENERAL	6-1
Determining Exposure to Foreign Potentials	6-2
Exposure to Lightning	6-2
Power Contacts	6-2
Power Induction	6-2
Ground Potential Rise	6-3
Unexposed Plant	6-3
Electrical Protection Devices	6-4
CENTRAL OFFICE PROTECTION	6-5
Fuse Cables	6-5
Connectors, Protector Blocks, and Heat Coils	6-6
307-Type Connectors	6-9
Protector Units	6-10
Bonding and Grounding	6-15
Bonding and Grounding — Special Situations	6-16
CABLE PROTECTION	6-16
Aerial Plant Bonding Requirements for Exposed Aerial Plant (Copper Conductor Cable)	6-17
Aerial Plant Bonding Requirements — Joint Crossing Pole	6-17
Aerial-Underground Junctions	6-17
Aerial Plant — Joint Use	6-18
Bonding Requirements for Aerial Lightguide Cable	6-19
Buried Plant Bonding Requirements	6-19

Types of Sheaths Required for High Lightning Areas — Aerial or Buried	6-20
Underground	6-20
AERIAL WIRE PROTECTION	6-21
STATION PROTECTION	6-22
Fusing Requirements	6-22
Fused Protectors	6-22
Fuseless Protectors	6-23
Sneak Current Protection	6-24
Bonding and Grounding for Station Protection	6-24
Buildings Served by Exposed Cable —	6-24
Buildings Served by Drop or Buried Wires —	6-25
Ground Wire	6-25
High-Rise Buildings Containing Electronic Equipment —	6-26
Selection of Approved Grounds	6-27

Section 6

ELECTRICAL PROTECTION

GENERAL

Electrical protection refers to methods and devices used to control or mitigate potentials and currents of magnitude 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 AT&T Customer Information Center (under select code 350-060).

Section 8

CONTENTS

	Page
PLANNING AND DESIGN GUIDELINES	8-1
SIZING	8-2
SECTION LENGTHS	8-5
Factors Affecting Section Lengths of Conduit	8-5
PULLING TENSION	8-6
Copper and Aluminum Conductor Cable	8-7
Lightguide Cable	8-11
CURVE DESIGN	8-13
Subsidiary Conduit	8-13
Single-Bore Conduit	8-14
Curve Radius 40 Feet or More	8-14
Curve Radius Less Than 40 Feet	8-14
CONDUIT AND PIPE	8-16
Factors to Consider in Selecting Type of Conduit	8-16
Advantages of Single-Bore Conduit:	8-16
Advantages of Multiple-Bore Conduit:	8-16
Single-Bore Conduit	8-17
Steel Pipe	8-19
PLACEMENT	8-20
Duct Arrangements	8-20
Separation From Other Structures	8-20
Spacing and Backfill Requirements	8-21
Subsidiary Conduit	8-25

Conduit Casings	8-25
Bridge Crossings	8-28
TRENCH WORK	8-29
MANHOLES	8-32
Planning and Design Considerations	8-32
Sizes and Types of Manholes	8-32
Basic Manholes	8-32
Sizes	8-33
Center Rack Manholes	8-34
Precast Manhole	8-35
Separation From Other Structures	8-37
FRAMES, COVERS, AND COLLARS	8-38
Manhole Extension Rings	8-39
DUCT ASSIGNMENT AND CABLE RACKING	8-40
CONTROLLED ENVIRONMENT VAULT (CEV)	8-43

Section 8

CONDUIT

PLANNING AND DESIGN GUIDELINES

Practices 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:
  - The Long Range Outside Plant Plan (LROPP)
  - Future requirements for reinforcement
  - 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, liquid and gas storage facilities
  - Safety and convenience of workers and general public.

Size conduit structure on present worth of annual charges (PWAC) basis. (See "Sizing" on Page 8-2.)

- 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.

Section 9

CONTENTS

	Page
PLANNING AND DESIGN GUIDELINES	9-1
Selecting Placing Locations	9-1
Urban and Suburban Residential Areas	9-1
Low-Density (Rural) Areas	9-2
Mobile Home Parks	9-2
Cable and Sheath Selection — Copper	9-2
CABLE SIZING	9-3
Distribution Cables — Copper	9-3
Urban and Suburban Areas	9-3
Low Density (Rural Areas)	9-3
Distribution Cables — Lightguide (Fiber)	9-4
Feeder Cables — Copper	9-4
Urban and Suburban Areas	9-4
Low Density (Rural Areas)	9-4
Feeder Cables — Lightguide (Fiber)	9-4
JOINT CONSTRUCTION	9-5
Random Separation Between Power and Telephone Facilities	9-6
CABLE PLACING	9-7
Placing PIC Cable — Copper	9-7
Placing Lightguide Cable	9-9
BURIED SERVICE WIRES	9-10
Preterminated Buried Wire	9-11

Section 9

BURIED PLANT

PLANNING AND DESIGN GUIDELINES

Practice 917-356-001

Buried plant is recommended as the first choice of providing outside plant facilities beyond the underground network. Total out of sight plant (no pedestals) in urban areas has proven to have the lowest first cost, trouble rates, and total cost. It also has greater public acceptance due to aesthetics.

Selecting Placing Locations

- Select a permanent location for all buried plant, considering such factors as right-of-way limitations, soil type, natural obstacles (i.e., 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

Practice 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.

Section 10

CONTENTS

	Page
PLANNING AND DESIGN GUIDELINES	10-1
POLES	10-2
Pole Classes	10-2
Markings on Poles and Stubs	10-2
POLE LINE DESIGN	10-5
Pole Line Classification	10-5
Storm Loading Areas	10-6
Pole Loading	10-7
Transverse Storm Loading	10-7
Storm Loads for Telephone Cables	10-10
Equivalent Storm Load of Attachments	10-11
Pole Class Based on Transverse Storm Loading	10-12
Example of Pole Class Based on Transverse Storm Loading	10-14
Eccentric Loads	10-15
Vertical Loading	10-16
Depth of Setting Poles	10-18
Unguyed Corner and Dead-End Poles	10-19
Determining Pole Class	10-19
Depth of Setting Unguyed Corner and Dead-End Poles	10-23
Slack Span Design	10-23
Push Braces	10-24
POLE LINE GUYING	10-25
Guying Cable Lines	10-27

Suspension Strand Diminishing Points	10-27
Guying Insulated Wires	10-28
Sidewalk Anchor Guys	10-29
Guy Rods and Anchors	10-31
B Rock Anchor	10-31
C Guy Anchors	10-32
Grounding or Insulating Guys	10-32
CABLE — SAGS AND TENSIONS — COPPER.	10-33
Suspension Strand	10-33
Stringing Tension for Strand	10-34
Cable Sags — Copper	10-35
CABLE — MAXIMUM SPAN LENGTHS	10-41
Copper Conductor Cables	10-41
Lightguide Cables	10-45
Special Long-Span Design	10-48
WIRE	10-48

Section 10

AERIAL PLANT

PLANNING AND DESIGN GUIDELINES

Practice 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.

Section 11

CLEARANCES FOR AERIAL PLANT

GENERAL

The requirements in this section are based on the 1987 Edition of the National Electric Safety Code (NESC), Section 23, except where company requirements are more stringent. They are taken from Practice 918-117-090, Issue 4, and Addendum Issue 1. References to rules refer to the NESC.

Telephone Conductors From Power Wires on Different Pole Lines

The following clearances apply in any direction. Generally, they exceed the NESC requirements, except that the NESC (Rule 233B) requires a ***5-foot minimum horizontal*** clearance. Sag is specified at 60°F with no wind.

Voltage	Clearance (Ft)
Up to 750	The sag of the conductor having the greater sag, but not less than 4 feet.
750 to 15,000	The sag of the conductor having the greater sag, plus 1 foot, but not less than 9 feet.
Over 15,000	One additional foot for each additional 30 kV.

Note: Joint use is usually preferable to nonjoint parallel pole lines at the clearances specified above.

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).

Section 11

CONTENTS

	Page
GENERAL	11-1
Telephone Conductors From Power Wires on Different Pole Lines	11-1
Telephone Conductors From Power Poles	11-1
Telephone Poles and Stubs From Power Conductors and Other Objects	11-2
BASIC VERTICAL CLEARANCES	11-5
Basic Vertical Clearances Above Ground, Rails, Roofs, Water, Etc.	11-5
Swimming Areas	11-7
Reduced Ground Clearance When Crossing Is Not at Midspan	11-8
Midspan Vertical Clearances — Joint Use Pole Line	11-9
Power Line Crossings — Vertical Clearances	11-11
CLEARANCES FROM OTHER OBJECTS	11-13
Community Antenna Television (CATV) Distribution Systems	11-13
Police and Fire Alarm Facilities	11-13
Signs, Chimneys, Tanks, and Other Installations	11-14
MAXIMUM SPAN LENGTHS FOR BASIC CLEARANCES	11-14
Guys	11-14
Cables	11-14
Wires	11-18
CLIMBING SPACE ON JOINTLY USED POLES	11-19

Section 12

CONTENTS

	Page
GENERAL	12-1
RESPONSIBILITIES	12-1
Premises Distribution Administration Responsibilities	12-2
NETWORK INTERFACE	12-2
COLOR CODING	12-5
BUILDING ENTRANCE AREA	12-6
PREMISES DISTRIBUTION SYSTEMS (PDS) ARRANGEMENTS	12-8
GUIDELINES FOR DESIGNING AND SIZING PREMISES DISTRIBUTION SYSTEMS (PDS)	12-10
PREMISES DISTRIBUTION CONSULTANTS	12-11
PREMISES DISTRIBUTION SYSTEMS PRODUCTS — GENERAL	12-12
CABLE	12-12
Fire Safety Considerations	12-12
Premises Distribution Systems Cable (Copper)	12-12
PROTECTION DEVICES	12-13
188-Type Modular Protectors	12-13
189-Type Modular Protectors	12-14
190-Type Protector	12-19
134-Type Protectors	12-21
195-Type Protectors	12-22
199E6A-Type Protectors	12-23
1990-Type Protector	12-23
300-Type Building Entrance Terminals	12-24

1-Type Terminal Blocks	12-25
NETWORK INTERFACES	12-26
700-Type Jacks	12-26
CONNECTING BLOCKS	12-27
66-Type Connecting Blocks	12-27
110-Type Connecting Blocks	12-29
110 PATCH PANEL SYSTEM	12-29
Other Connecting Facilities	12-33
TERMINAL BLOCKS	12-34
5A-Type Terminal Blocks	12-34
MECHANICAL PROTECTION — BUILDING TERMINALS	12-35
GA- and GC-Type Cable Terminal Boxes	12-35
1A1 and 2A1 Cable Terminal Sections	12-35
3AA1 and 4A1 Cable Terminal Sections	12-36
H and J Cable Terminal Sections	12-37
115-Type Apparatus Box	12-37
LIGHTGUIDE PREMISES DISTRIBUTION SYSTEMS	12-38
Lightguide Cable Types	12-40
Lightguide Building Cables	12-40
Riser Cables	12-40
Design Guidelines (Lightguide Cables)	12-44
Lightguide Premises Distribution Apparatus	12-45
Universal Lightguide Closure (UCB1)	12-45
Lightguide Interconnection Units (LIUs)	12-45
Interconnect Mode — LIU	12-46
Cross-Connect Mode — LIU	12-47
LGX™ Lightguide Distribution System	12-49
PAIR GAIN SYSTEMS HOUSINGS	12-52

Section 13

CONTENTS

	Page
GENERAL	13-1
Carrier Serving Area (CSA) Philosophy	13-1
Central Office Terminal (COT)	13-2
Remote Terminals (RT)	13-2
Individual Pair Gain Systems	13-2
"SLC"® 96 CARRIER SYSTEMS	13-3
Universal SLC 96	13-3
Universal SLC 96 Served by T1 Digital Lines (Copper)	13-3
Integrated SLC 96	13-6
Fiber SLC 96	13-8
DS2 Fiber SLC Configuration	13-8
DS3 Fiber SLC Configuration	13-8
Hub Arrangement	13-10
SLC 96 Remote Terminal Equipment	13-12
SLC 96 Remote Terminal Enclosures	13-15
SLC 96 Distributed Power Arrangement	13-15
SLC 96 Bulk Powering Arrangement	13-16
Other Enclosures	13-16
Distribution Facilities Beyond Remote Terminal (RT)	13-16
"SLC" SERIES 5	13-17
Universal Series 5	13-18
Universal Series 5 Mode 96	13-18
Integrated Series 5 Mode 96	13-18
Feature Packages	13-18

Integrated Network Access — Remote Terminal (INA-RT)	13-24
SLC Series 5 Remote Terminal Enclosures	13-27
Other Enclosures	13-27
SLC Series 5 Fiber-to-the-Home (FTTH)	13-28
Lightguide (Fiber) Distribution Cables	13-28
Remote Terminal (RT)	13-29
Distant Terminal (DT)	13-29
DDM-1000 MULTIPLEXER	13-30
"SLC" 40 CARRIER SYSTEM	13-31
Cabinet Mounted RT	13-31
Frame Mounted RT	13-31
T1 Span Line Powering — Distances	13-32
Interface With Higher Order M1 (Type) Multiplexer	13-32
"SLC" 24 CARRIER SYSTEMS	13-34
SLC 24 Using T1 Digital Lines	13-34
SLC 24 With Fiber	13-37
"SLC" 8 CARRIER SYSTEMS	13-39
SLC 8 System Design	13-40
"SLC" 1 CARRIER SYSTEMS	13-42
LOOP SWITCHING SYSTEMS (LSS)	13-45

Section 13

PAIR GAIN 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 kft of the serving central office. Digital subscriber carrier (pair gain) will be necessary to meet that bit rate beyond 12 kft. With the introduction of the latest technology of a complete fiber network from the central office (CO) to the customer, it may be economical to install digital subscriber carrier in loops less than 12 kft. The first phase of this is the SLC® Series 5 — Fiber-to-the-Home (FTTH) feature explained in this section.

Carrier Serving Area (CSA) Philosophy

The Carrier Serving Area (CSA) concept is to sectionalize the wire center area into discrete geographical areas beyond 12 kft 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 kft of 26-gauge cable and 12 kft 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 campus environment, industrial areas, shopping centers, and condominium and apartment complexes.

Digital subscriber carrier requires multiplexing at the central office (CO) and remote terminal (RT). The transmission media between the CO and the

Section 14

CONTENTS

	Page
METALLIC CABLE	14-1
Metallic Cable Identification Code	14-1
Sheath Types	14-3
Outer Protection	14-4
Sheath Types and Uses	14-5
Sheath Markings	14-7
PLASTIC INSULATED COPPER CONDUCTOR (PIC) CABLE	14-8
Reel Lengths—PIC Cables	14-8
PIC CABLE DIAMETERS, WEIGHTS, AND REEL LENGTHS	14-10
DUCTPIC® (Air Core) Bonded Stalpeth	14-11
Self-Supporting Cable (Air Core)	14-12
Self-Supporting Cable (Air Core) Reinforced Sheath	14-13
Alpeth Sheath (Air Core)	14-14
Alpeth Sheath (Air Core) — UM Protection	14-16
Bonded PASP Sheath (Air Core)	14-17
Bonded Stalpeth Sheath (Air Core)	14-18
Noncolor-Coded Bonded Stalpeth Sheath (Air Core)	14-20
AF-Type ASP Sheath (Filled) DEPIC Nonscreened	14-21
AF-Type ASP Sheath (Filled) DEPIC Nonscreened — UM Protection	14-23
AF-Type Bonded ASP (Filled) DEPIC Nonscreened	14-25
AR-Series Riser Cable	14-26
PASP Sheath (Air Core) Screened	14-27

ASP Sheath (Filled) DEPIC Screened	14-28
ASP Sheath (Filled) DEPIC Screened	14-29
Plenum Cables	14-30
LIGHTGUIDE CABLE	14-31
Ribbon Design.	14-31
LIGHTPACK Design	14-32
Lightguide Cable — Sheaths and Applications	14-34
Lightguide Outside Plant Cable Identification Code	14-35
Lightguide Cable — 12 Bundle Fibers	14-36
Lightguide Cable — Physical Characteristics	14-37
Lightguide Cable Reel Lengths	14-38
LIGHTGUIDE BUILDING CABLES	14-40
Lightguide Riser Cables	14-40
Lightguide Building Cables (LGBC)	14-41
Lightguide Building Cable (LGBC) Identification Code	14-41
LGBC Riser Cables	14-42
LGBC Plenum Cables	14-43
CABLE REELS	14-44
WIRE	14-46
Buried Wire	14-46
Aerial Service Wire	14-49
Aerial Line Wire	14-50