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## D5030 COMMUNICATIONS

**RECORD OF REVISIONS**

| Rev | Date | Description | POC | RM |
|---|---|---|---|---|
| 0 | 6/28/99 | Rewritten and reformatted to support LIR 220-03-01. Superseded Facilities Engineering Standards, Volume 7, Electrical, Manual Rev 15, 6/26/98. | David W. Powell, *PM-2* | Dennis McLain, *FWO-FE* |
| 1 | 11/18/02 | General revision and addition of endnotes. Replaces Subsections: 245.7, 271, 273, 274, and 275. | David W. Powell, *FWO-SEM* | Kurt A. Beckman, *FWO-SEM* |
| 2 | 2/1/06 | Updated refs to LANL Spec Sections, NEC, telecon stds, and LANL orgs; added telecon reqts for conference rooms, copy rooms and parking structures; updated reqts for admin access control system. Updated PTS and security system requirements; when Chapter 9 – Security is published, these reqts will be superseded. Indicated that fire alarm reqts will be superseded when the material appears in a rev of Chapter 2 – Fire Protection. | David W. Powell, *ENG-DECS* | Michael S. Harris, *ENG-DO* |
| 3 | 10/27/06 | Deleted Fire Alarm Systems subsection (now in Fire Ch); deleted PTS and PSS (now in Security Chapter); changed telecommunications horizontal cable to Category 6A and adjusted pathway criteria to accept the larger cable; removed LANL Telecommunications Group support for voice paging systems; changed support for administrative access control systems to LANL Security Systems Group. Organization and contract reference updates from LANS transition. ISD number changes based on new Conduct of Engineering IMP 341. Master Spec number/title updates. Other administrative changes. | David W. Powell, *FM&E-DES* | Kirk Christensen, *CENG-OFF* |
| 4 | 9/28/09 | Revisions limited to paragraphs 1.1, 1.3, and 1.4 to address TA16-933 Server Room incident report action item #5: Added definition of "server equipment room;" expanded coordination requirement for telecommunications rooms and server equipment rooms; defined “independent HVAC;” added an HVAC load density of 1000 BTU/hr/sq ft to be used as a first approximation for server equipment rooms; updated server equipment room first approximation electrical power density to 300 VA/sq ft; added requirements for server equipment rooms to have temperature sensors, thermostats, and related components so server equipment room over-temperature will be automatically reported to the Facility Coordinator and the server equipment owner, and if the room temperature reaches a high limit, the server equipment will be automatically shut-down. IMP 341 changed to PD 342. | David W. Powell, *ES-DE* | Larry Goen, *CENG-OFF* |

# D5030 COMMUNICATIONS

## 1.0 UNCLASSIFIED TELECOMMUNICATIONS SYSTEMS

### 1.1 Definitions[1]

A. **Alien crosstalk** is undesired signal coupling from one cable to another or one channel to another most commonly affecting pairs with similar twist lays.

B. **Backbone** is a facility (e.g., pathway, cable, or conductors) between the entrance facilities, and the telecommunications rooms within buildings.

C. **Building core** is a three-dimensional space, permeating one or more floors, and is used for the extension and distribution of utility services (e.g., elevators, washrooms, stairwells, mechanical and electrical systems, and telecommunications) throughout the building.

D. **Category 6A** cable is 100 ohm twisted-pair copper cable that meets or exceeds specifications in ANSI/TIA/EIA-568-B.2 Addendum 10, and is used for transmissions up to 500 MHz. *The near-end crosstalk loss and return loss requirements are more severe than those of Category 5e or Category 6 cables. Transmission in the 500 MHz range introduces alien crosstalk concerns not associated with lower frequency transmission; refer to manufacturers' literature for detailed discussions of installation methods to reduce alien crosstalk.*

E. **Cross-connect** enables the mechanical termination and interconnection of horizontal cabling, backbone cabling, and entrance cabling

F. **Entrance facility** is an entrance to a building for both public and private network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance telecommunication room.

G. **Horizontal cable** extends from the telecommunications outlet/connector in the work area to the horizontal cross-connect in the telecommunications room.

H. **Pathway** is the vertical and horizontal route of the telecommunications cable.

I. **Server Equipment Room** houses mainly computer servers. A server is a computer system in a network that is shared by multiple users. In information technology circles, the term "server equipment room" is generally used for smaller arrangements of servers; larger groups of servers are housed in data centers (e.g. the LDCC). Server equipment rooms may also house headless computers (i.e., no monitor or keyboard) that are controlled remotely via KVM devices, Virtual Network Computing (VNC), or remote desktop.

J. **Telecommunications room** is an enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. Telecommunications rooms house the cross-connects between (1) entrance cable and backbone cable and/or (2) backbone cable and horizontal cabling.

[1] Refer to Article 2 in TIA-589-B and Chapter 3 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.

K. **Work area outlet** is a device placed at user workstation for termination of horizontal media and for connectivity of network equipment.

## 1.2 General

A. Design unclassified telecommunications (voice and data) system as described in this section and as required to meet the user's programmatic needs. Coordinate service and interior distribution requirements with the LANL Telecommunications Group.

B. Conform to the requirements of the NEC, this chapter of the LANL Engineering Manual, and latest editions of (and amendments to) the following telecommunications standards:

1. TIA/EIA-568-B series, *Commercial Building Telecommunications Cabling Standard* (ANSI): [2, 3]
   - TIA/EIA-568-B.1 — General Requirements
   - TIA/EIA-568-B.2 —100-Ohm Balanced Twisted-Pair Cabling Standard
   - TIA/EIA-568-B.3 — Optical Fiber Cabling Component Standard
2. EIA/TIA-569-A, *Commercial Building Standard for Telecommunications Pathways and Spaces* (ANSI)[2] including Addendum 1 – Surface Raceways, Addendum 2 – Furniture Pathways and Spaces, and Addendum 3 – Access Floors.
3. EIA/TIA-606-A, *Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings* (ANSI). [2]
4. ANSI-J-STD 607-A, *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications* (ANSI). [2]

C. Use the materials and installation methods described in LANL Master Specifications Section 27 1000, *Structured Cabling*.

D. Specify installation of telecommunications system in accordance with NECA/BICSI 568, *Standard for Installing Commercial Building Telecommunications Systems* (ANSI).[4]

E. *Time and funding will be necessary for the installation of unclassified telecommunications system instruments and electronics, performance testing, and field quality assurance activities by the LANL Telecommunications Group. The Project should obtain a definitive cost estimate and schedule from the LANL Telecommunications Group.*

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2 The TIA/EIA telecommunications standards provide minimum requirements for wiring, pathways and spaces, grounding, and administration of telecommunications systems in commercial buildings. These standards were invoked for all federal buildings by FIPS PUB 174, 175, and 176. These documents are quite expensive and are not commonly available to designers. For this reason, applicable requirements from the TIA/EIA telecommunications standards are restated in this part of Chapter 7.

3 The TIA/EIA-568-B series has replaced TIA/EIA-568-A dated October 6, 1995.

4 The NECA *National Electrical Installation Standards* define a minimum baseline of Quality and workmanship for installing electrical products and systems. They are intended to be referenced in contract documents for electrical construction projects.

## 1.3 Telecommunications Rooms

A. Design telecommunications rooms that meet the requirements in EIA/TIA-569-A, the NEC, and the LANL Engineering Standards Manual. The requirements of this article are also applicable to RED telecommunications rooms; refer to ESM Chapter 9, *Security* for additional requirements for RED telecommunications rooms. Coordinate RED telecommunications rooms with the LANL PTS Site Manager.

B. Design dedicated lockable telecommunications rooms on each floor in new facilities and extensively remodeled facilities.[5]

1. *Very small buildings, with less than 10 work area outlets, may be provided with wall cabinets, or small closets instead of telecommunications rooms; coordinate requirements with the LANL Telephony Group.*[6]
2. *For minor work in existing facilities, telecommunications system may be extended from existing telecommunications rooms if sufficient capacity exists; coordinate with the LANL Telephony Group.*

C. Refer to the layout for a typical telecommunications room on LANL Drawing ST-D5030-1.

D. Locate telecommunications room(s) to meet the following requirements:

1. Provide a minimum of one telecommunications room per floor.[7]
2. Provide additional telecommunications rooms when:[8]
   - Area served exceeds 10,000 sq. ft.
   - Any horizontal cable will be more than 275 feet.[9]
3. Locate telecommunications room(s) in the building core.[10]
4. Locate the entrance room as close as practical to the main electrode ground bar.[11]
5. Locate the telecommunications entrance room above grade where it will not be flooded.[12]
6. In multi-story buildings align the telecommunications rooms vertically.[13]
7. Locate telecommunications rooms away from sources of electromagnetic interference such as power transformers, large motors, generators, x-ray equipment, radio or radar transmitters, arc welders, copiers, and induction heating equipment.[14]

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5 Refer to §7.1 in TIA/EIA-569-A.
6 Refer to Annex B.3 in TIA/EIA-569-A.
7 Refer to §7.2.2.1 in TIA/EIA-569-A
8 Refer to §7.1.2.1 in TIA/EIA-569-A
9 295 ft maximum in TIA/EIA-569-A §7.2.2.1.b) is decreased to allow for outlet relocation and/or use of extra long equipment cables.
10 Refer to §7.1.2 in TIA/EIA-569-A.
11 Refer to NEC Section 800.100(A)(4).
12 Refer to §8.2.1.3 and §8.3.2.1.4 in TIA/EIA-569-A.
13 Refer to figure 2.2-1 in TIA/EIA-569-A.
14 Refer to §8.2.1.5 in TIA/EIA-569-A.

E. Telecommunications rooms shall be dedicated to the telecommunications function and related support facilities.[15]

1. No electrical equipment or installations other than those for telecommunications shall be located in telecommunications rooms.
2. No equipment not related to the support of the telecommunications closet shall be installed in, pass through, or enter the telecommunications closet.
3. Servers must be installed in dedicated server rooms, not in telecommunications rooms.

F. Coordinate with the LANL Telephony Group (or in the case of RED telecommunications rooms the LANL PTS Site Manager) on each project to properly locate and size the telecommunications room(s) to meet the requirements of the occupants of the building and the telecommunications equipment installers. Minimum telecommunications room dimensions[16] are as follows; room dimensions shall not be reduced without permission from the LANL Telephony Group:

1. Room serves less than 1000 sq. ft.: 6 ft X 3 ft. with double doors.
2. Room serves 1000 to 5,000 sq. ft: 10 ft X 7 ft.
3. Room serves up to 8,000 sq. ft: 10 ft X 9 ft.
4. Room serves up to 10,000 sq. ft: 10 ft X 11 ft.
5. Provide multiple closets on each floor that exceeds 10,000-sq. ft. or where the horizontal cable distance to the work area exceeds 275 ft.
6. *Entrance telecommunications rooms may need to be larger.* Coordinate with the LANL Telephony Group.
7. *RED telecommunications rooms may need to be larger.* Coordinate with the LANL PTS Site Manager.

G. Design telecommunications rooms for a minimum distributed live load of 100 lb./sq. ft. and a minimum concentrated live load rating of 182 lb/sq ft.[17]

H. Specify wire cages for sprinkler heads to prevent accidental discharge.[18]

I. Design independent HVAC for telecommunications rooms larger than 20 sq. ft. with redundancy as required for maintaining the following environmental conditions 24 hours per day, 365 days per year:[19] *Telecommunications rooms located adjacent to server equipment rooms ay share the same HVAC system.* Do not use the building "comfort" HVAC system as primary cooling for telecommunications rooms.[20]

1. Temperature: 64 ºF to 75 ºF

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15 Refer to §7.2.1 in TIA/EIA-569-A.
16 Refer to table §7.2.1 in TIA/EIA-569-A.
17 Refer to §7.12.4.1.7 in TIA -569-B.
18 Refer to §7.2.6.3 in TIA/EIA-569-A.
19 Refer to §7.2.7 and §8.2.3.6 in TIA/EIA-569-A. Relative humidity requirement relaxed based on local operating experience and manufacturers' specifications for newer computing equipment. Filtration efficiency requirement added to reflect LANL ESM Chapter 6 requirements.
20 LANL experience is that using the building "comfort" HVAC as primary cooling server equipment rooms resulted in numerous equipment failures and the uneconomical operation of large systems to cool small spaces. These same issues apply to telecommunications room HVAC.

2. Relative Humidity: Non-condensing
3. Positive pressurization with respect to adjacent spaces
4. Minimum ventilation rate of one air change per hour
5. Minimum 30 percent efficiency air filtration.
6. Heat from equipment installed in the telecommunications rooms will be approximately 4,000 BTU per equipment rack and a minimum of two racks per telecommunications room[21]; coordinate exact requirements with the LANL Telephony Group
7. If a standby generator power source is available in the facility, power the telecommunications room HVAC system from a standby power system[22]

J. Line three walls of each telecommunications room with void-free 3/4-inch plywood, 8 ft high, that has been treated with two coats of white or light gray fire-retardant paint.[23]

K. Control lighting with a dedicated switch for the telecommunications room.[24]

1. Provide a minimum illumination of 50 footcandles measured 3 ft. above the floor.
2. Locate the bottom of the lighting fixtures a minimum of 8′-6″ above the finished floor.
3. Orient lighting fixtures to optimize illumination of terminal blocks and equipment racks; coordinate with the LANL Telephony Group.
4. Provide lighting fixtures with lamp guards.

L. Locate electrical receptacles in each telecommunications room as follows:[25]

1. Locate duplex receptacles spaced at 6 ft intervals around the perimeter of the room at 6 inches above the finished floor; serve by a dedicated 120 volt, 20 ampere circuit. These receptacles are for tools and test equipment.
2. For each equipment cabinet or rack, design two 20 ampere, 120 volt, twist-lock, receptacle (NEMA L5-20R) on the cable tray support system above each equipment rack; serve each receptacle by a separate dedicated 20-ampere circuit. If available in the facility, use isolated ground circuits with isolated ground receptacles. If available in the facility, use circuits from a UPS system to power these receptacles.[26]
3. Design two 2-circuit, multi-outlet assemblies in each room at 7'-6" above finished floor; verify locations with the LANL Telecommunications Group. Serve each multi-outlet assembly by two dedicated 20 ampere circuits for a total of four circuits. These multi-outlet assemblies are for wall mounted equipment. If available in the facility, use isolated ground circuits with isolated ground receptacles. If available in the facility, use circuits from a UPS system to power these receptacles.[26]

M. Locate the telecommunications ground bar at the rear corner of the left-hand wall in each telecommunications room, 12 inches above the floor. Refer to the "Telecommunications

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21 Criteria for equipment thermal loading provided by the LANL Telecommunications Group.
22 Refer to §7.2.7 in TIA/EIA-569-A.
23 Refer to §7.2.4.1 in TIA/EIA-569-A.
24 Refer to §7.2.4.2 in TIA/EIA-569-A.
25 Refer to §7.2.4.6 in TIA/EIA-569-A.
26 Equipment rack power requirements updated by LANL Telecommunications Group on 8/16/06.

Grounding" heading below for additional grounding and bonding requirements in the telecommunications room.[27]

N. Design in each telecommunications room as described below and as shown in LANL Standard Drawing ST-D5030-1.

1. Locate cable tray around the three interior walls of the telecommunications room and spanning across the middle of the room and above the equipment racks; consult the LANL Telecommunications Group for the location of the equipment racks.[28]
2. Extend both ends of the cable tray into the corridor ceiling space; connect to the corridor cable tray system if present.
3. Locate the cable tray with bottom at 7′-9″ above the finished floor and edge of tray 8 inches from the backboard.[29]
4. Design wall-mounting brackets for the cable tray that do not reduce the useable area of the telecommunications board.
5. Specify not less than six cable tray dropout fittings in each telecommunications room; coordinate requirements with the LANL Telephony Group.
6. Specify an approved method to restore the fire rating of walls at cable tray penetrations; method must allow future installation and removal of cables.[30]

O. Design the telecommunications rooms with the following interior finish characteristics:

1. Minimum ceiling height: 12 inches above cable tray (a finished ceiling is not required).[31] Any fire resistive material that is applied to the structure must be sealed or covered to control dust that may contaminate electronic equipment.[32]
2. Design telecommunications room to exclude contaminants and enable the HVAC system to positively pressurize the room. If a ceiling is not provided, extend all walls to the bottom of the deck above and close all openings and seal all penetrations.[33]
3. Floor finished with vinyl tile.
4. Walls and ceiling (or exposed structure) finished with white paint to enhance lighting.[34]
5. Double 3′-0″ lockable doors that open outward into the building corridor.[35] For telecommunications rooms smaller than 20 sq. ft. provide double doors with top and bottom louvers.
6. Signage on the doors indicating the room number and "TELECOMMUNICATIONS - AUTHORIZED PERSONNEL ONLY."

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27 Refer to §7.2.4.7 in TIA/EIA-569-A.
28 Due to evolving technology, location of racks in equipment room may change from what is indicated in Drawing ST-D5030-1.
29 Separation from terminal board is to allow vertical conduits to pass behind the cable tray.
30 Refer to §7.2.5 in TIA/EIA-569-A.
31 Refer to §7.2.4.3 in TIA/EIA-569-A.
32 Refer to §7.2.4.5 and §8.2.3.7 in TIA/EIA-569-A.
33 Refer to §8.3.3 in TIA/EIA-569-A.
34 Refer to Chapter 7 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.
35 Refer to §7.2.6.1 in TIA/EIA-569-A.

P. *LANL will furnish and install cross connect equipment.*

1. *Cross connect for copper cables will consist of termination blocks assembled on an interlinking mounting system with provisions for identifying cables.*
2. *Cross-connect equipment for fiber-optic cables will consist of patch panel racks.*

Q. Specify fire stop material in telecommunications cable trays and raceways that penetrate fire-rated walls or floors.[36]

## 1.4 Server Equipment Rooms

A. Design dedicated lockable server equipment rooms in new or extensively remodeled office and/or laboratory facilities as required by the Users' programmatic needs.[37]

1. Coordinate and refine design requirements with the server equipment owner (e.g. the LANL Telephony Group, the major facility User organization.)
2. The requirements of this article are also applicable to RED server equipment rooms; refer to Chapter 9, Security for additional requirements for RED server equipment rooms. Coordinate design of RED server equipment rooms with the LANL PTS Site Manager.

B. Design server equipment rooms to meet the requirements in EIA/TIA-569-A, NFPA 75 (as applicable), the NEC, and the LANL Engineering Standards Manual.

C. Select server equipment room locations with the following considerations:[38]

1. Avoid locations that are restricted by building components (elevators, stairwells, core facilities, etc.) that will limit future expansion of the server equipment room.
2. Design accessibility for the delivery of large equipment.
3. Locate server equipment room(s) as close as practical to the associated telecommunications room.
4. Locate server equipment rooms above grade where they will not be flooded.
5. Locate server equipment rooms away from sources of electromagnetic interference such as power transformers, large motors, generators, x-ray equipment, radio or radar transmitters, arc welders, copiers, and induction heating equipment.[39]

D. Server equipment rooms shall be dedicated to telecommunications, server, and computing functions and related support facilities.[40]

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36 Refer to NEC Section 300.21.
37 Refer to §7.12 in TIA/EIA-569-B. *Users should strongly consider using virtual server space on existing machines to increase energy efficiency and decrease cost.*
38 Refer to §7.12.1 in TIA/EIA-569-B.
39 Refer to §7.12.2 in TIA/EIA-569-B.
40 Refer to §7.12.4.1.1.3 in TIA/EIA-569-B.

E. Coordinate with the server equipment owner to properly locate and size the server equipment room(s) to meet the requirements of the occupants of the building. As an initial approximation, design server equipment rooms with useable floor areas as follows:

1. General office buildings: Use as a first approximation 0.75 sq. ft per 100 sq. ft of workspace area but a minimum server equipment room area of 150 sq. ft.[41]
2. Special-use buildings (laboratory, industrial, etc): 1 sq. ft per work area but a minimum server equipment room area of 150 sq. ft.[42]
3. Provide additional floor space in server equipment rooms for the following:
   - Bookshelves for software and equipment manuals.
   - Fireproof safe for software and back-ups.
   - HVAC equipment for server equipment room.
   - Electrical panelboard(s) or power distribution units (PDUs) for server equipment.
   - Uninterruptible power supply (UPS) system for server equipment; however, any UPS larger than 100 kVA shall be in a separate room.

F. Design server equipment rooms for a minimum distributed live load of 100 lb/sq. ft. and a minimum concentrated live load rating of 182 lb/sq ft.[43]

G. Specify wire cages for sprinkler heads to prevent accidental discharge damage.[44]

H. Design independent HVAC for server rooms with redundancy as required for maintaining the following environmental conditions 24 hours per day, 365 days per year.[45] *Guidance: Server rooms located adjacent to telecommunications rooms may share the same HVAC system.* Do not use the building "comfort" HVAC system as primary cooling for server equipment rooms.[46] Refer to LANL ESM Chapter 6 Section D30HVAC for additional server equipment room HVAC requirements.

1. Temperature: 64 ºF to 75 ºF measured at 5 ft above the floor with all server and support equipment operating.
2. Relative Humidity: Non-condensing.
3. Positive pressurization with respect to adjacent spaces.
4. Minimum ventilation rate of one air change per hour.
5. Minimum 30 percent efficiency air filtration.
6. If a standby generator power source is available, connect server room HVAC to the standby supply.

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41 Refer to §7.12.4.1.1.1 in TIA/EIA-569-B.
42 Refer to §7.12.4.1.1.2 in TIA/EIA-569-B.
43 Refer to §7.12.4.1.7 in TIA/EIA-569-B.
44 Refer to §7.12.5 in TIA/EIA-569-B.
45 Refer to §7.12.4.2.2 in TIA/EIA-569-B.
46 LANL experience is that using the building "comfort" HVAC as primary cooling for server rooms resulted in numerous equipment failures and the uneconomical operation of large systems to cool small spaces.

7. As a first approximation, design for an HVAC load density of 1000 BTU/h/sq ft.[47] Coordinate HVAC requirements with the server equipment owner.

I. Specify computer room AC units for server equipment rooms.

1. Use "down-flow" units for rooms with raised floors.
2. If multiple computer room AC units are used, locate on opposite walls.
3. Racks will be configured with "hot" and "cold" aisles.
4. Locate raised floor perforated air supply tiles only in "cold" aisles.

J. In server equipment rooms provide temperature sensors, thermostats, and associated controls to perform the following functions. *[Guidance: If available, the Building Automation System (BAS) should be used for these functions; otherwise use an automatic dialing remote monitoring system or other reliable automatic notification system.]* Locate temperature sensors and thermostats 5 ft above the finished floor.

1. When the room temperature exceeds 78 °F (adjustable), send a telephone/pager/e-mail warning to the facility maintenance coordinator and the server equipment owner that the server equipment room temperature is out of design specification[48].
2. When the room temperature exceeds 85 °F (adjustable), send a telephone/pager/e-mail alarm to the facility maintenance coordinator and the server equipment owner that the server equipment room temperature is very high and that server equipment orderly shut-down should be initiated[49]. *Guidance: Some modern servers have self-initiated, soft shutdown capability on over-temperature, and this should also be utilized.*
3. When the room temperature exceeds 95 °F, shut-down the server equipment and send a telephone/pager/e-mail notification to the facility maintenance coordinator and the server equipment owner that the server equipment has been shut-down[50]. *Guidance: For increased reliability, the shut-down function should use an electro-mechanical thermostat that directly interfaces with circuit breaker shunt trip elements.*

K. Control lighting with a dedicated switch for the server equipment room.[51]

1. Design a minimum illumination of 50 footcandles measured 3 ft. above the finished floor in the middle of all aisles between equipment.
2. Do not supply lighting from the same panelboard that supplies the server equipment.

L. Locate general-purpose duplex receptacle outlets for tools and test equipment so no point measured horizontally on any wall space is more than 6 ft from a general-purpose receptacle outlet[52]; serve by dedicated 120-volt, 20-ampere general power circuit(s).

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47 Each server room equipment rack requires about 36 sq ft of floor space for the equipment itself plus front and rear aisle space, plus space for HVAC and electrical equipment. Blade server racks range from 8 to 12 kW per rack. This translates to approximately 220 W to 330 W per sq ft. 300 w/sq ft (1000 BTU/h/sq ft) is chosen as an appropriate first approximation.

48 75 °F is the upper limit of the design temperature range for server rooms in ESM Chapter 7 Section D5030; 78 °F provides some "overshoot" margin to avoid unnecessary call-outs.

49 95 °F is the upper limit of the ambient operating temperature range for typical server equipment; when the temperature at the wall-mounted sensor reaches 85 °F, the ambient temperature at equipment in the middle of the room will likely be approaching 95 °F.

50 At an ambient temperature above 105 °F server equipment will start to be damaged; when the temperature at the wall-mounted sensor reaches 95 °F, the ambient temperature at equipment in the middle of the room will likely be approaching 105 °F and the temperature at the ceiling of the room will be approaching 135 °F - the lower end of the temperature range for ordinary hazard fire sprinklers.

51 Refer to §7.13.4.1.7 in TIA/EIA-569-B.

M. If the room is designed to NFPA 75, locate a pushbutton at each of the exit door(s) from the room; connect pushbutton(s) to the electrical panelboard(s), UPS equipment, and HVAC equipment to disconnect power from electronic equipment and HVAC equipment.

N. Locate one or more dedicated 208Y/120V isolated ground panelboards (or power distribution units (PDUs)) in the server equipment room.[53] *Guidance: Modern servers typically have "dual-cord" automatic throw-over power supplies.*

1. As a first approximation, design for a power density of 300 VA per sq. ft.[47] Coordinate power requirements with the server equipment owner.
2. Design power to each panelboard from an isolated ground power system separately derived through a shielded, k-rated transformer.[54] Refer to the "Panelboards" heading in Section D5010 of this Chapter. *Guidance: PDUs include a k-rated transformer.*
3. Equip each panelboard or PDU with a surge protection device. Refer to the "Surge Protection" heading in Section D5010 of this Chapter for detailed requirements.
4. Equip each panelboard or PDU with a shunt trip connected to the power disconnect pushbutton(s) described above and to a thermostat in the server room as described below.
5. Design isolated ground branch circuit wiring system to power server equipment; coordinate requirements with the server equipment owner. Refer to Section D5020 of this Chapter for detailed requirements for branch circuit wiring systems.

O. If warranted by programmatic or operation need, select UPS system(s) to support server equipment through momentary power anomalies and to an orderly programmed shutdown in case of an extended power interruption. Refer to Section D5090 for UPS requirements.

P. Locate a telecommunications ground bar adjacent to the electrical panelboard(s) in each server equipment room, 12 inches above the floor. Refer to the "Telecommunications Grounding" heading below for additional grounding and bonding requirements.[55]

Q. Design pathway(s) for power and data cables from the server racks to the panelboards or PDUs and the corridor cable tray system and/or the associated telecommunications room. Use either or a combination of the following:

1. Access floor system as described under the heading Telecommunications Horizontal Pathways. Provide minimum 12" raised floor to assure adequate cable routing space. If the server room exceeds 1000 sq. ft., provide minimum 18" raised floor. Provide additional clear space as required for cooling air distribution.
2. Cable tray system, as described under the heading Telecommunications Horizontal Pathways, above equipment racks with bottom of tray at 7′-9″ above the finished floor.[56]

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52 Receptacle spacing based on the 6-ft cords supplied with most power hand tools and test equipment. Adequate accessible receptacle outlets will reduce or eliminate the need for extension cords.

53 Refer to §7.12.4.3 in TIA/EIA-569-B. Relative humidity requirement relaxed based on local operating experience and manufacturers' specifications for newer computing equipment. Filtration efficiency requirement added to reflect LANL ESM Chapter 6 requirements.

54 Recommended practice in IEEE Std. 1100-1999. Refer to §8.5.3.2 for a detailed description of the isolated ground power system as a means to reduce common-mode noise that may interfere with electronic telecommunications equipment.

55 Refer to §7.12.4.4 in TIA/EIA-569-B.

56 Telecommunications equipment racks are nominally 7 ft tall.

3. *Some server equipment room designs use the raised floor for power wiring and cooling air distribution, and use cable trays located above the equipment racks for (mostly fiber optic) data cable distribution.*

R. Design server equipment rooms with the following interior finish characteristics:

1. Minimum ceiling height: 12 inches above cable tray.
2. Floor finished with vinyl tile.
3. Walls and ceiling finished with light colors to enhance room lighting.[57]
4. Double 3′-0″ lockable doors, without doorsill, that open outward into a corridor.[58]
5. Badge reader access control.
6. Signage on the doors indicating the room number and "SERVER ROOM-AUTHORIZED PERSONNEL ONLY."

## 1.5 Telecommunications Grounding

A. Design telecommunications grounding to comply with TIA/EIA-607[59], *Commercial Building Grounding and Bonding Requirements for Telecommunications,* and the NEC.

B. Design a telecommunications bonding backbone conductor that interconnects the telecommunications grounding busbar in each telecommunications room, each server equipment room, and each telecommunications equipment rack not located in a telecommunications room.[60] Use 4/0 AWG conductor with 600V insulation and connected with two-hole hydraulically compressed cable lugs.[61]

C. Locate a telecommunications main grounding busbar in the entrance telecommunications room, each "satellite" telecommunications room, each server equipment room, and at each telecommunications equipment rack not located in a dedicated room.[62]

1. Use a NEMA pattern (1.25 inch x 1.25 inch) pre-drilled electrotin-plated copper bar that is 1/4 inch thick, 4 inches wide, minimum 12 inches long plus additional length as required to land the required cables plus at least 20% future growth. Mount busbar on 2-inch standoff insulators.
2. Bond the telecommunications main grounding busbar to the building electrical system main electrode ground bar using a dedicated 4/0 AWG conductor with 600V insulation and connected with two-hole hydraulically compressed cable lugs.[63]
3. Terminate the ground cable in telecommunications duct bank(s) to the ground bar in the entrance telecommunications room(s) using hydraulically compressed cable lugs.

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57 Refer to Chapter 7 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.
58 Refer to §7.13.4.1.8 in TIA/EIA-569-B.
59 ANSI-J-STD 607-A is the telecommunications standard that addresses grounding and bonding from a functional perspective. It is used in concert with ANSI/EIA/TIA-568 and ANSI/EIA/TIA-569.
60 Refer to §5.3 in ANSI-J-STD 607-A.
61 This is the same grounding conductor size and connection method used for electrical power systems at LANL. Used on telecommunications systems to simplify tooling and inspections.
62 Refer to §5.4 and §5.5 in ANSI-J-STD 607-A.
63 Refer to §5.2 in ANSI-J-STD 607-A.

4. If the building has a metal frame, also bond the busbar to the nearest structural steel using a 6 AWG conductor with crimp-on cable lugs.

D. Do not place grounding or bonding conductors in ferrous metallic conduit.[64]

E. Label, identify, and green color code each bonding and grounding conductor.[65]

F. Effectively ground and bond all metallic telecommunications raceways and cable trays.[66]

1. Bond the telecommunications cable tray to each telecommunications ground bar with minimum 6 AWG using crimp-on lugs.
2. Install a 6 AWG equipment grounding conductor in each cable tray and bond to every section using NRTL listed cable tray bonding clamps.[67]
3. Bond metal raceways entering the telecommunications room and containing telecommunications cables to the telecommunications ground bar.
   - Use 12 AWG conductor for individual conduits 1" and smaller.
   - Use 6 AWG conductor for multiple conduits or individual conduits larger than 1".
4. Connect metallic conduits to cable tray with approved cable tray to conduit clamps.
5. Isolated sections of metallic raceway or cable tray will be considered effectively grounded when clamped or bonded to the metal building structure.
6. In buildings without metal structure, install a minimum 12 AWG green insulated ground wire with the telecommunications cables to bond isolated sections of metallic raceway.

G. Use materials and installation methods described in LANL Master Specification Section 26 0526, *Grounding and Bonding for Electrical Systems*.

## 1.6 Work Area Outlets

A. Locate work area outlets as follows: [68]

1. Two 4-port outlets in each private office, located on opposite walls. In spaces served by a protected transmission system (PTS), coordinate the location of the 4-port outlets with the PTS outlet to maintain required separations; refer to the Protected Transmission System heading in ESM Chapter 9 - Security.
2. Each open office workstation: one 4-port outlet.
3. Elevator equipment room for connection to elevator equipment: one 4-port outlet.
4. Main mechanical equipment room for building automation system: one 4-port outlet.
5. Main electrical room for electrical metering: one 4-port outlet within 4 ft of meter.
6. Each break room for a wall mounted telephone: one 4-port outlet.
7. Each badge reader for a wall mounted telephone: one 4-port outlet.

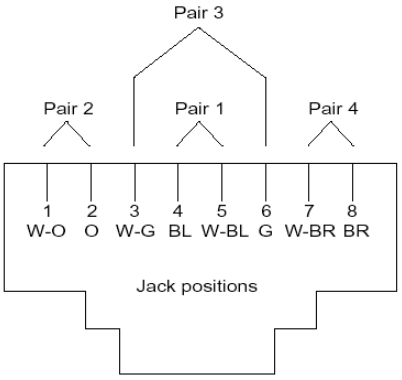
64 Refer to §5.1.4 in ANSI-J-STD 607-A.
65 Refer to §5.1.5 in ANSI-J-STD 607-A.
66 Refer to NEC Section 250.96.
67 Recommended practice in §8.4 of IEEE 1100-1999.
68 Refer to §6.2.2 in TIA/EIA-569-A.

8. Each copy machine room: two 4-port outlets.
9. Each conference room: one 4-port outlet at the front of the room, one 4-port outlet in the floor centered in the room for teleconferencing.
10. Parking structures: one 1-port outlet outside each entry to each stairwell.
11. Provide additional work area outlets as required to meet the User's programmatic needs as identified in either design criteria or functions and requirements documents.

B. The LANL Telecommunications Group will provide the telecommunications outlet jacks. *The GFE outlet will typically consist of four RJ45 jacks on a common faceplate. Some projects will have fiber-optic connectors in place of some of the RJ45 jacks.*

C. Configure RJ45 jacks as T568B[69] per TIA/EIA-568-B; refer to Figure D5030-1.

**Figure D5030-1: T568B Pin/Pair Assignments (front view of connector)**




D. For each wall-mounted telecommunications outlet, specify 4-inch square, 2-1/8-inch[70] deep outlet box with single-device raised cover.

E. Coordinate telecommunications outlet locations with furniture and equipment layout so outlets will be accessible.[71]

1. In common areas (e.g. conference rooms), position telecommunications outlets with center 18 inches above the finished floor.[72] Locate outlets to comply with Americans with Disabilities Act Accessibility Guidelines (ADAAG), 28 CFR Part 36, Appendix A.
2. Locate wall mounted and telecommunications outlets in hard wall-enclosed offices with center 7 inches above the finished floor (immediately above the cove base).[73, 74] Coordinate locations of outlets with modular furniture and associated hangers to assure that outlets will be accessible.[75]

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69 Pin/pair assignment with designation T868B is configuration used at LANL.
70 Refer to §4.4.4 in TIA/EIA-569-A.
71 Refer to §6.2.3 in TIA/EIA-569-A.
72 Height complies with *ADA Accessibility Guidelines for Buildings and Facilities* (ADAAG), (28CFR, Ch 1, Part 36, App A) available at http://www.access-board.gov/adaag/html/adaag.htm.
73 Office spaces with special ADAAG accommodations will be provided on an as-needed basis.
74 The 7" center mounting height will allow the outlet device plate to be completely above a 4" cove base and below furniture "modesty panels" that are typically 9-1/4" AFF.
75 Lesson learned form LANL construction projects.

3. Coordinate mounting height of outlets at lab benches and counters with architectural details. The maximum height to meet ADAAG requirements is 44 inches. [72]

F. Locate each telecommunications outlet within 3 ft of a suitable electrical power outlet; group and align power and communications outlets so a symmetrical appearance results.[76]

G. At the fire alarm control panel install a 6" x 6" x 4" box.

1. Extend a ¾-inch conduit to the nearby telecommunications room.
2. Extend a ¾-inch conduit to the fire alarm control panel.

## 1.7 Telecommunications Horizontal Pathways

A. Design telecommunications horizontal pathways meet the requirements in EIA/TIA-569-A, the NEC, and this Chapter of the LANL ESM.

B. Design telecommunications horizontal pathways to have the following characteristics:[77]

1. Suitable for all telecommunications media recognized in TIA/EIA-568-B.[78]
2. Allow at least four cable runs per telecommunications outlet.
3. Accommodate cabling changes.
4. Minimize occupant disruption when horizontal pathways are accessed.
5. Facilitate ongoing maintenance of horizontal cabling.
6. Accommodate future additions to and changes in cabling, equipment, and services
7. Provide for at least 20% future growth.
8. Limit raceway fill as follows[79]:

- Less than 50 ft between pulling points and only one bend: 40 percent fill.
- More than 50 ft between pulling points or two 90-degree bends: 31 percent fill.

C. Use one or more of the following horizontal pathways to provide a telecommunications distribution system that is appropriate for the building use and strikes an acceptable balance between greatest flexibility and lowest life-cycle cost:[80]

1. Underfloor system (underfloor duct or cellular floor system)
2. Access floor
3. Conduit
4. Cable tray
5. Wireway
6. Perimeter raceway

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76 Refer to §6.2.3 in TIA/EIA-569-A.
77 Refer to Chapter 4 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.
78 Refer to §4.1.4 in TIA/EIA-569-A.
79 Refer to table 4.4-1 in TIA/EIA-569-A.
80 Refer to §4.1 in TIA/EIA-569-A.

7. Furniture pathways.

D. Design underfloor pathway systems (underfloor duct or cellular floor system) to meet NEC requirements[81] and the design guidance in EIA/TIA-569-A.[82]

E. Design access floor pathway systems to meet NEC requirements,[83] the design guidance in EIA/TIA-569-A,[84] and the following requirements:

1. For general office areas, design the raised floor surface to be 8 inches high or higher.[85]
2. For computer or control room environments where the plenum is used for HVAC, design the finished floor to be 12 inches high or higher.[77]
3. Use cable trays, wireways, and dedicated routes so telecommunications cables in an access floor pathway can be placed in a manner that provides sufficient space for service personnel to stand on the structural floor without risk of damaging cable.[77]
4. Require the following minimum clearances above and below cable trays and wireways[77]:
   - 2 inches of free space between the top of the wireway or the cable tray side rails and the underside of the stringers.
   - 1 inch of free space between the bottom of the wireway or the cable tray side rails and the structural floor for power conduits.

F. Use conduit pathway for individual telecommunications outlets and for furniture pathway/building interfaces. Provide conduit pathway systems that meet NEC requirements, the design guidance in EIA/TIA-569-A,[86] and the following requirements:

1. Install conduit runs with no more than 100 feet between pull points.[87]
2. Install conduit runs with no more than 180 degrees of bends between pull points. Install a pull box at any reverse bend.[88]
3. For conduits 2 inches and smaller the inside radius of conduit bends must not be less than 6 times the internal diameter of the conduit.[89] For conduits larger than 2 inches the inside radius of conduit bends must not be less than 10 times the internal diameter of the conduit. Do not use conduit bodies in any conduit pathway system.[77]
4. Select conduit sizes on the following basis:
   - Less than 50 ft between pulling points and only one bend: 40 percent fill.
   - More than 50 ft between pulling points or two 90-degree bends: 31 percent fill[90].

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81 Refer to NEC Articles 800.110.
82 Refer to §4.2 in TIA/EIA-569-A.
83 Refer to NEC Article 645.
84 Refer to §4.3 in TIA/EIA-569-A.
85 Refer to Chapter 4 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition. Although ANSI/TIA/EIA-569-A specifies 6 in as the minimum finished height for standard-height access floors, at least 8 in is necessary to provide sufficient space for cable trays and other means of cable management.
86 Refer to §4.4 in TIA/EIA-569-A.
87 Refer to §4.4.2.2 in TIA/EIA-569-A.
88 Refer to §4.4.2.3.1 in TIA/EIA-569-A.
89 Refer to §4.4.2.3.2 in TIA/EIA-569-A.
90 Telecommunications cables are much more fragile than standard building wire. FPN No, 1 to Table 1 in Chapter 9 of the NEC states that for certain conditions a lesser conduit fill should be considered. Note 2 to Table 4.4-1 in TIA/EIA-569-A

- Minimum size: 1-1/4 inch unless specified otherwise

5. Specify an individual 1-1/4 inch[91] conduit from each wall-mounted telecommunications outlet to a telecommunications cable tray or to the telecommunications room.
6. Design individual conduits from each furniture pathway/building interface to a telecommunications cable tray or to the telecommunications room. Size conduits based on 4 cables per workstation.
7. Terminate metallic telecommunications conduits using an insulated throat fitting or an insulating bushing.[92]
8. Use materials and installation methods described in LANL Master Specifications Section 26 0533, *Raceways and Boxes for Electrical Systems*.

G. Use dedicated cable tray systems to distribute horizontal cables from the telecommunications room(s) to locations near the outlets.[93] Provide cable tray pathway systems that meet NEC requirements, the design guidance in EIA/TIA-569-A,[94] and the following criteria:

1. For general office buildings, size cable tray based on 1 sq. in. of cable tray per 100 sq. ft. of useable floor area served.[95]
2. Limit cable initial tray fill ratio to 41.6%.[96]
3. Require not less than 12 inches access headroom above and to one side of all telecommunications cable trays.[97] *Careful design and installation coordination with the building structure, HVAC ductwork, sprinkler piping, and luminaires is required to maintain the required 12-inch clearance. Consider developing "plan and profile" type drawings for each cable tray to assure meeting this requirement.*
4. Use cable tray with a maximum rung spacing of 6 inches to reduce cable sag and the possibility of long-term cold creep insulation damage to telecommunications cables.
5. Do not allow any wiring system other than telecommunications and LABNET CATV in any telecommunications cable tray.[77]
6. Refer to Section D5090 of this chapter for cable tray design requirements.
7. Use materials and installation methods described in LANL Master Specifications Section 26 0536, *Cable Trays for Electrical Systems*.

H. Route horizontal pathways away from sources of electromagnetic interference such as electrical power wiring, radio frequency sources, power transformers, large motors and generators, induction heaters, arc welders, fluorescent and HID luminaires, etc.[98]

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states that the number of cables that can be installed in a conduit is limited by the allowed maximum pulling tension of the cables.

91 Refer to table 4.4-1 in TIA/EIA-569-A. A 1-1/4 inch conduit provides capacity for up to six Category 6A 4-pair UTP plenum-rated cables having an 0.354 inch outside diameter.

92 Refer to §4.4.3.1 in TIA/EIA-569-A.

93 A cable tray concealed above corridor lift-out ceilings provides an economical and flexible way to accommodate evolving communications needs.

94 Refer to §4.5 in TIA/EIA-569-A.

95 Refer to §4.5.3 in TIA/EIA-569-A.

96 §4.5.3 in TIA/EIA-569-A sets an absolute maximum cable tray fill ratio of 50%. Limiting the initial fill ratio to 41.6% provides for 20% future growth.

97 Refer to §4.5.6 in TIA/EIA-569-A.

98 Refer to §10.3 in TIA/EIA-569-A.

I. Identify horizontal pathways in accordance with EIA/TIA-606; generate records acceptable to the LANL Telecommunications Group.[99] Use materials and installation methods described in LANL Master Specification Section 26 0553, *Identification for Electrical Systems.*

J. For retrofit of pathways for horizontal cables in existing buildings use materials and installation methods that comply with the NEC and meet TIA/EIA requirements.

## 1.8 Furniture Pathways

A. Comply with TIA/EIA-569-A Addendum 2 for furniture pathways.[100]

B. Comply with TIA/EIA-569-A section 10.3 "Separation from EMI Sources."

C. Specify separation from electric light and power conductors as required in NEC Article 800[101].

D. Use one of the two following options to obtain the required separation:

1. Metallic divider bonded to ground between power and telecommunications cables.
2. Dedicated separate pathway for telecommunications cables. *Guidance: Some furniture system manufacturers offer panel systems with a telecommunications pathway on top of the panels.*
3. Power conductors enclosed in grounded metallic raceway or cable sheath.

## 1.9 Backbone and Entrance Pathways

A. Design a minimum of four 4-inch backbone pathway conduits interconnecting the vertically aligned telecommunications rooms in a building.[102]

B. Design a minimum of one 4-inch backbone pathway conduit (or equivalent space in cable tray) interconnecting multiple telecommunications rooms on a floor.[103]

C. Design a minimum of two telecommunications[104] entrance conduits (plus security[105] service entrance conduits as described under the heading "Physical Security System" in Chapter 9 - Security) from the entrance telecommunications room to the point of connection to the network; coordinate design for each project with the LANL Telecommunications Group. *Point of connection to the network will be either a maintenance hole (MH) or a telephone pedestal.*

1. Design the number and size of entrance conduits based on the anticipated number and type of telecommunications circuits required in the building. *In office buildings, this*

99 Refer to Chapter 5 in TIA/EIA-606.
100 TIA/EIA-569-A Addendum 2 addresses furniture pathway planning, fill factors, capacity, access, bend radius, and power/telecommunications separation requirements.
101 Refer to NEC Section 800.133(a)(2).
102 Refer to §5.2.2.2 in TIA/EIA-569-A.
103 Refer to §7.2.2.2 in TIA/EIA-569-A.
104 Refer to §9.4.2.2 in TIA/EIA-569-A.
105 Argus security system requirement.

*anticipated number is often calculated as one entrance pair per 100 ft$^2$ of usable office space.* Coordinate with the LANL Telecommunications Group.

2. Table D5030-1 provides data for determining the quantity and size of underground entrance conduits.
3. Terminate the conduits in the left rear corner of the telecommunications room and adjacent to the left wall.[106]

**Table D5030-1: Underground Entrance Conduits[107]**

| Telephone Entrance Pairs | Require |
|---|---|
| 1-99 | One 2-inch conduit plus 1 spare. |
| 100-2000 | Two 4-inch conduits plus 1 spare. |
| 2001-3000 | Three 4-inch conduits plus 1 spare. |
| 3001-5000 | Four 4-inch conduits plus 1 spare. |
| 5001-7000 | Five 4-inch conduits plus 1 spare. |
| 7001-9000 | Six 4-inch conduits plus 1 spare. |

D. Route backbone and entrance pathways away from sources of electromagnetic interference such as electrical power wiring, radio frequency sources, power transformers, large motors and generators, induction heaters, arc welders, etc.[108] If pathways must be installed in close proximity (less than 24 inches) and parallel to potential sources of significant electromagnetic interference, use galvanized rigid steel conduit, intermediate metallic conduit (IMC) or similar raceway that will provide effective shielding.

E. Specify a woven polyester pull tape (1200-lb test) with stamped footage markings pulled into each backbone and entrance pathway conduit and all innerducts and tied off at each end.[109]

F. Require sealing the building end of each entrance pathway to prevent rodents, water, or gases from entering the building or MH. Use rubber conduit plugs or duct sealer, depending upon the conditions. Reseal conduits after cable is placed in them.[110]

G. Specify identification of backbone and entrance pathways in accordance with EIA/TIA-606; generate records acceptable to the LANL Telecommunications Group.[99] Use materials and installation methods described in LANL Master Specification Section 26 0553, *Identification for Electrical Systems.*

106 Refer to LANL Standard Drawing ST-D5030-1.
107 Refer to Table 9.2 in Chapter 9 of the *BICSI Telecommunications Distribution Methods Manual*, 9th Edition.
108 Refer to §10.3 in TIA/EIA-569-A.
109 Footage markers facilitate ordering the correct length cable.
110 Refer to §5.1.1.2.8 in TIA/EIA-758.

## 1.10 Telecommunications Cables

A. Specify four LANL-furnished horizontal cables[111] to each telecommunications outlet. Coordinate with the LANL Telecommunications Group to determine the exact types and mix of horizontal cables that will be provided.

1. *Copper horizontal cable will be UL listed as type CMP (plenum-rated), 4-pair, 23-gauge, Category 6A, unshielded twisted pair (UTP) cable with a maximum outside diameter of 0.354 inches.*[112]
2. *Fiber optic horizontal cable will be UL listed as type OFNP (plenum-rated) cable with an outside diameter of approximately 0.24 inches.*[112]
3. The installing contractor shall terminate all Category 6A horizontal cables.
4. *LANL will terminate the fiber optic horizontal cables.*

B. Specify LANL-furnished backbone cables to interconnect the telecommunications rooms and server equipment rooms. Coordinate with the LANL Telecommunications Group to determine the sizes, types, and mix of backbone cables that will be provided.

1. *Copper backbone cable will be ARMM (24 AWG) cable, UL listed as type CMR.*[112] *(Note that this cable is not plenum rated.)*
2. *Fiber optic backbone cable will be UL listed as type OFNR, tight-buffered fiber-optic cable with a mixture of single-mode and multi-mode fibers.*[112]
3. *LANL will terminate all backbone cables.*

C. Cable installers must have the following minimum qualifications:

1. Category 6A horizontal cables: BICSI Registered Installer Level 1 or equivalent certification plus successful completion of Systimax Installer Training that includes installation and termination of Category 6A cable; experience installing and terminating Category 6A cables on at least 2 previous projects.[113]
2. Fiber optic horizontal cables, all backbone cables: BICSI Registered Installer Level 2 or equivalent certification; experience installing backbone and fiber optic cables on at least 2 previous projects. [113]

D. Specify identification of backbone cables, horizontal cables, and telecommunications outlets in accordance with EIA/TIA-606-A; generate records acceptable to the LANL Telecommunications Group.

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111 The four ports on the work area outlet are for telephone, computer network interface, printer network interface, and spare.

112 Cable information from the LANL Telecommunications Group.

113 BICSI, a not-for-profit telecommunications association, is a worldwide resource for technical publications, training, conferences, and registration programs for low-voltage cabling distribution design and installation. BICSI is the only nationally recognized organization that offers a vendor independent comprehensive testing and registration program for both installers and designers. Installer registration is available at three levels: Installer Level 1 (minimum of six months experience), Installer Level 2 (minimum of two years experience) and Installer Technician Level (minimum of five years experience). Written and hands-on examinations must be successfully completed. Registration exams are offered at all levels. The required minimum work experience is necessary to sit for each exam. Successful completion of these exams reinforces and documents that BICSI registered installers have the background, knowledge, and skills needed to work effectively.

E. Specify testing of the installed and terminated Category 6A horizontal cables in accordance with TIA/EIA-568-B; provide test results for each cable to the LANL Telecommunications Group. The LANL Telecommunications Group may spot-check test results.

## 2.0 VOICE PAGING SYSTEMS

### 2.1 General

A. Design an overhead voice paging system throughout each facility as required to meet the User's programmatic needs.[114]

B. Locate speakers in all occupied spaces including corridors, offices, laboratories, shops, warehouses, conference rooms, copy rooms, file rooms, break rooms, restrooms, mechanical rooms, electrical rooms, and telecommunications rooms.[115]

C. Conform to the requirements of the NEC[116], and the LANL Engineering Standards Manual.

D. Voice paging systems shall include the following components:

1. Speakers
2. Speaker wiring.
3. Terminal box(es).
4. Zone paging amplifier(s).
5. Page controller(s).

E. Life safety[117], noise masking[118], and sound reinforcement[119] are beyond the scope of this heading. *Voice evacuation systems (such systems will meet the requirements of NFPA 72 or 29CFR 1910.165, "Employee Alarm Systems" and will use equipment that is NRTL-listed to UL Standard 864) may be used as the basis for the paging system described in this section.*

F. Design an overhead voice paging system that is accessible from telephones in the building by dialing an access code, either for a particular zone or for "all-call."[120]

G. Zone the system by floor, by function, or by organization; refer to Figure D5030-2. Provide one or more amplifiers for each zone; wire speakers in each zone to a specific amplifier. [120]

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114 Overhead voice paging systems facilitate locating personnel, alerting occupants to changes in operating status, etc. The system provides the users with the capability to use their telephone to access the voice-paging speakers that are typically mounted in the ceiling. In large buildings, zones can be individually accessed or dialing the "all zones" code can access the entire building.

115 The intent is to provide full coverage of the building, including service spaces.

116 Refer to NEC Articles 640 and 725.

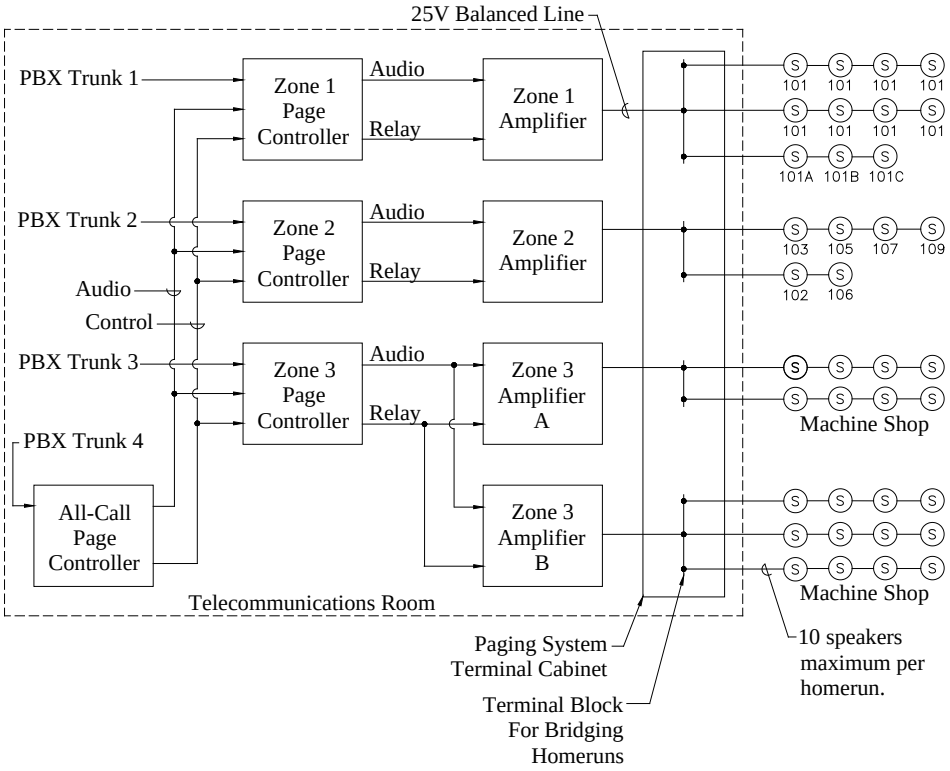
117 The purpose of a "life safety" system is to announce to one or more zones that there is a potential life safety concern. The most common use of this system is to announce to the building occupants that they should evacuate the building due to a fire or other dangerous situation. The design and installation of life safety systems must conform to ANSI/NFPA 72, *National Fire Alarm Code.*

118 Noise masking systems are often used in open office applications and generate "white noise" to create an artificial sound barrier.

119 Sound reinforcement systems are typically used in auditoriums and theaters to increase the loudness of the person speaking or to play pre-recorded music.

120 Refer to Chapter 23 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.

**Figure D5030-2: Typical Zoned Paging System**




H. Provide separate zones with separate conduits, cables, and amplifiers for secure areas.

I. Refer to LANL Master Specification Section 27 3000, *Voice Communications* for materials and installation requirements.

## 2.2 Design Parameters

A. Design a distributed speaker system that gives even coverage for each space at the lowest sound power level (SPL) possible but at least 6 dB above the ambient noise level.[121]

B. In order to plan the type, number, and placement of speakers, determine the ambient noise level of each area under consideration.

1. In a new facility where only blueprints are available, use Table D5030-2 to estimate ambient noise levels.

[121] Refer to Chapter 23 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition. Keep the level of the reproduced direct sound level as low as possible so that the reverberant sound is not audible. Direct sound is sound that travels directly from a speaker to the listener. Reverberant sound is sound that is reflected from a surface such as a wall or floor to the listener. A high level of reverberant sound could cause the direct sound to be unintelligible.

**Table D5030-2**[122]

| Typical Ambient Noise Levels | |
|---|---|
| **Location** | **dB** |
| Machine Shop | 90 |
| Mechanical Room | 85 |
| Assembly line | 75 |
| Lab or noisy office | 70 |
| Public corridor | 65 |
| Office (quiet) | 55 |

2. In an existing facility, perform on-site testing with a sound level meter. Measure ambient noise levels at peak periods using the "A" weighting scale on the sound level meter.[123]

C. In office and laboratory environments, design ceiling recessed speakers distributed in corridors, offices, conference rooms, laboratories, copy rooms, file rooms, break rooms, restrooms, equipment rooms and similar spaces. [120]

D. In high noise areas, specify horn speakers to direct the sound toward the listener and away from areas, such as walls, that may cause reverberant sound to occur. [120]

## 2.3 Speaker Placement

A. Locate speakers to provide uniform coverage of each area. [120]

1. *For cone-type ceiling-mounted speakers the two most common speaker distribution patterns are a "hexagonal pattern" and a "square pattern." A "hexagonal pattern" is preferred because it provides the most uniform coverage.*

2. *For horn-type speakers the preferred placement is a "diamond pattern" with all horns pointing the same direction.*

B. In areas with less than 70-dB noise level, locate 8-inch ceiling-mounted speakers so the distance between speakers is approximately twice the ceiling height. Use Table 5030-3 to determine speaker density. Design the distribution system based on 0.5 watt per speaker in quiet areas (less than 65 dB) and 1 watt per speaker in noisy areas (up to 70 dB). [120]

[122] Based on Table 23.1 in Chapter 23 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.
[123] The "A" weighting scale is designed to correspond to the sensitivity of the human ear at various frequencies; refer to ASA S1.1 for a more detailed definition.

**Table 5030-3**[124]

| Ceiling Speaker Coverage (Maximum 70-dB Noise Level) | | | | |
|---|---|---|---|---|
| **Quantity of Speakers** | **8 ft Ceiling Height** | **9 ft Ceiling Height** | **10 ft Ceiling Height** | **12 ft Ceiling Height** |
| 1 | 250 | 325 | 400 | 574 |
| 2 | 500 | 650 | 800 | 1148 |
| 3 | 750 | 975 | 1200 | 1722 |
| 4 | 1000 | 1300 | 1600 | 2296 |
| 5 | 1250 | 1625 | 2000 | 2870 |
| 6 | 1500 | 1950 | 2400 | 3444 |
| 7 | 1750 | 2275 | 2800 | 4018 |
| 8 | 2000 | 2600 | 3200 | 4592 |
| 9 | 2250 | 2925 | 3600 | 5166 |
| 10 | 2500 | 3250 | 4000 | 5740 |

Decrease the distance between speakers in areas with a noise level greater than 70 dB.

C. Specify increased speaker density in corridors to reduce reverberation.

1. For typical enclosed corridors, locate ceiling-mounted cone-type speakers along the center of the corridor at approximately 8-ft intervals. Place the first speaker approximately 6-ft from the end of the corridor and work toward the other end. Place a ceiling speaker at each corridor junction. Design the distribution system based on 0.5 watts per speaker. [120]

2. Where ceiling speakers cannot be used, use wall-mounted bi-directional cone-type speakers placed at intervals of approximately 25 ft on alternating sides of the corridor. Place the first bi-directional speaker 20 feet from the end of the corridor and work toward the other end. Design the distribution system based on 1 watt per speaker. [120]

D. Use horn speakers having a directional projection pattern in industrial environments with more than 70-dB ambient noise, outdoors, or where each speaker must cover a large area. [120] Use Table 5030-4 to determine the area coverage for one 15 W horn mounted 16 ft above the floor and adjusted to a 60-degree angle of projection under given ambient noise levels.

**Table 5030-4**[125]

| Coverage for 15W Horn Speaker | |
|---|---|
| **SPL of Ambient Noise** | **Area** |
| Up to 74 dB | 4000 sq. ft. |
| 75 to 89 dB | 2500 sq. ft. |
| 90 dB and above | 1200 sq. ft. |

E. Coordinate speaker locations with luminaires, HVAC, sprinklers, and architectural finishes.

F. To protect against feedback, do not locate ceiling speakers directly above telephone sets or external microphones. [120]

[124] Based on Table 23.2 in Chapter 23 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.
[125] Based on Table 23.3 in Chapter 23 in the BICSI *Telecommunications Distribution Methods Manual*.

## 2.4 Speaker Wiring

A. Use a 25-volt constant voltage system to distribute audio signals to paging speakers.[126]

B. Size distribution system conductors to limit line loss to 10% based on the total wattage of all speakers on the line [120] plus an allowance for 20% future system growth. Use Table D5030-5 to select conductor sizes based on line length and signal strength.

**Table D5030-5: 25V Speaker Line Loss**[127]

| 25V Audio Line 0.5dB (10%) Loss | | Wire Gauge > | | | 18 AWG | 16 AWG | 14 AWG | 12 AWG | 10 AWG |
|---|---|---|---|---|---|---|---|---|---|
| | | Max Current (A) > | | | 10 | 13 | 15 | 20 | 30 |
| | | Resistance (ohms/kFT)> | | | 7.95 | 4.99 | 3.14 | 1.98 | 1.24 |
| Load Power (W) | Input Power (W) | Line Loss (W) | Line Current (A) | Line Res. (ohms) | Maximum Distance (ft) | | | | |
| 250 | 277.8 | 27.78 | 11.11 | 0.23 | --- | 23 | 36 | 57 | 91 |
| 200 | 222.2 | 22.22 | 8.89 | 0.28 | 18 | 28 | 45 | 71 | 113 |
| 150 | 166.7 | 16.67 | 6.67 | 0.38 | 24 | 38 | 60 | 95 | 151 |
| 100 | 111.1 | 11.11 | 4.44 | 0.56 | 35 | 56 | 90 | 142 | 227 |
| 75 | 83.3 | 8.33 | 3.33 | 0.75 | 47 | 75 | 119 | 189 | 302 |
| 60 | 66.7 | 6.67 | 2.67 | 0.94 | 59 | 94 | 149 | 237 | 378 |
| 50 | 55.6 | 5.56 | 2.22 | 1.13 | 71 | 113 | 179 | 284 | 454 |
| 40 | 44.4 | 4.44 | 1.78 | 1.41 | 88 | 141 | 224 | 355 | 567 |
| 25 | 27.8 | 2.78 | 1.11 | 2.25 | 142 | 225 | 358 | 568 | 907 |
| 20 | 22.2 | 2.22 | 0.89 | 2.81 | 177 | 282 | 448 | 710 | 1134 |
| 15 | 16.7 | 1.67 | 0.67 | 3.75 | 236 | 376 | 597 | 947 | 1512 |
| 10 | 11.1 | 1.11 | 0.44 | 5.63 | 354 | 564 | 896 | 1420 | 2268 |
| 7.5 | 8.3 | 0.83 | 0.33 | 7.50 | 472 | 752 | 1194 | 1894 | 3024 |
| 5 | 5.6 | 0.56 | 0.22 | 11.25 | 708 | 1127 | 1791 | 2841 | 4536 |
| 4 | 4.4 | 0.44 | 0.18 | 14.06 | 884 | 1409 | 2239 | 3551 | 5670 |
| 2.5 | 2.8 | 0.28 | 0.11 | 22.50 | 1415 | 2255 | 3583 | 5682 | 9073 |
| 2 | 2.2 | 0.22 | 0.09 | 28.13 | 1769 | 2818 | 4479 | 7102 | 11341 |
| 1 | 1.1 | 0.11 | 0.04 | 56.25 | 3538 | 5636 | 8957 | 14205 | 22681 |

C. Use twisted-pair speaker cables configured as balanced lines.[128] Refer to LANL Master Specification Section 27 3000, *Voice Communications* for materials and installation requirements.

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[126] The direct current (dc) resistance of the pair of wires that feed each speaker can consume a high percentage of the power from the amplifier. To avoid this power loss a larger gauge of wire could be used. This does add more cost to the project. A more efficient way to overcome the effects of the wire's dc resistance is to operate the system at a raised voltage and a reduced current. This type of system is called a constant voltage system because the amplifier delivers an almost constant voltage to the distribution lines regardless of the number of speakers connected to the line. With this system, speakers can be added or removed from the system with no noticeable change in system loudness. There are two systems in general use: 70-volt and 25-volt. 25-volt systems are used at LANL so communications technicians can work on the systems and comply with P 101-13, *Electrical Safety Program.*

[127] Based on Figure 23.3 in Chapter 23 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition, converted from 70.7v to 25v and changed into a table.

[128] Balanced lines are recommended for installations where speaker lines and other lines that carry electric current (e.g., telephone, radio frequency [RF], alternating current [ac] power) run parallel and close to each other. In these installations, the signals in one set of lines may be picked up by another line, causing hum, noise, or crosstalk. Balanced lines help

D. Use multi-tap impedance-matching transformers to convert the 25-volt line signal to the 8-ohm speaker impedance. [120]

E. Specify the identification of each end of each speaker cable.[129] Use materials and installation methods described in LANL Master Specification Section 26 0553, *Identification for Electrical Systems*.

## 2.5 Speaker Raceways and Enclosures

A. For new construction design speaker cables in raceway systems dedicated to speaker cables.[130]

1. Use flexible metal conduit to connect to speakers mounted in accessible ceilings.
2. Use methods and materials described in LANL Master Specification Section 27 3000, *Voice Communications* for materials and installation requirements.
3. Make paging system raceways electrically continuous. Bond all paging system raceways to the telecommunications ground bar.

B. For retrofit of paging systems in existing facilities use materials and installation methods that comply with NEC and TIA/EIA requirements. Avoid placing speaker wiring in close proximity to telecommunications horizontal cables.

C. Design a wall-mounted 24” x 24” x 6” hinged cover terminal cabinet below the cable tray and near the paging system equipment rack(s) in the telecommunications closet(s). Coordinate cabinet location with the LANL Telecommunications Group. Terminate the speaker conduits into the cabinet. Install terminal blocks in the cabinet for connecting and bridging speaker cables.

D. Specify ceiling-mounted cone-type speakers in metal backboxes with round perforated face metal baffles.

## 2.6 Paging Amplifiers

A. Base the power rating of each paging zone amplifier on: [120]

1. The total sum of the tap watts of each impedance matching transformer on each speaker.
2. The total sum of the power lost in the speaker distribution cabling.
3. Power reserved for 20 percent future growth.
4. Add to this number an additional 25 percent so that the amplifier will normally be operating at about 75 percent of its rated output.

B. Locate paging equipment in one or more of the telecommunications rooms. Design suitable equipment rack(s) to house amplifiers and page controllers.

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eliminate or reduce induced noise because induced signals have the same polarity in both lines (e.g., the noise currents flow in the same direction in both lines). If these signals arrive at the load in opposition to each other and at equal amplitude, they will cancel each other out.

129 Adequate identification and records of cables will facilitate set-up, troubleshooting, and additions to the paging system.

130 Raceway systems provide support and protection for the paging system cables.

### 2.7 Acceptance Testing

A. Specify acceptance testing using the following procedure: [120]

1. Adjust the amplifier to 75 percent of the rated power.
2. Select an area to measure and use a sound level meter to measure the ambient noise level.
3. Broadcast a message over the system that is representative of a normal voice page.
4. Measure the SPL of the voice page. The SPL of the voice page must be at least 6 dB higher than the ambient noise.
5. Measure the SPL in all areas within the system.
6. Adjust individual speakers by changing taps on the impedance matching transformers.

## 3.0 CATV (LABNET) SYSTEMS

### 3.1 General

A. Design cable television (LABNET) distribution system to meet the Users' functional and operational requirements. Coordinate service and interior distribution requirements with the LANL Telecommunications Group.

B. Conform to the requirements of the NEC and this chapter of the LANL Engineering Manual.

C. The LANL Telecommunications Group will furnish internal coaxial cable, connectors, directional couplers (splitters), taps, and outlets as GFE.

D. Entrance coaxial or optical fiber cable, and CATV head-end electronics will be furnished and installed in the entrance telecommunications room by the LANL Telecommunications Group.

E. *Time and funding will be necessary for the installation of CATV electronics, performance testing, and field quality assurance activities by the LANL Telecommunications Group. The Project should obtain a definitive cost estimate and schedule from the LANL Telecommunications Group.*

F. Use the materials and installation methods described in LANL Master Specifications Section 27 1000, *Structured Cabling*.

### 3.2 System Topology[131]

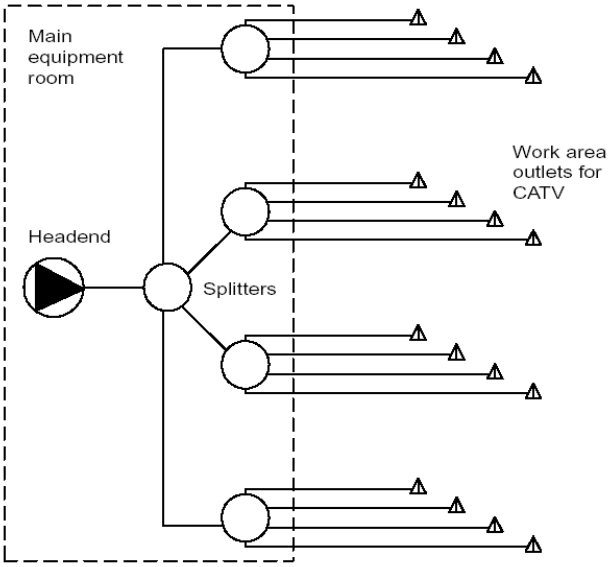
A. For small buildings use a "home run design" or star topology as shown in Figure D5030-3.

1. Provide a homerun drop cable run from each work area outlet to the entrance telecommunications room.
2. LANL will connect the telecommunications room to an entrance trunk cable from the LABNET headend.
3. LANL will provide an amplifier to boost the signal if needed.

[131] Refer to Chapter 22 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.

4. The system will include a network of directional couplers (splitters) or taps to distribute the signal to the homerun drop cables.

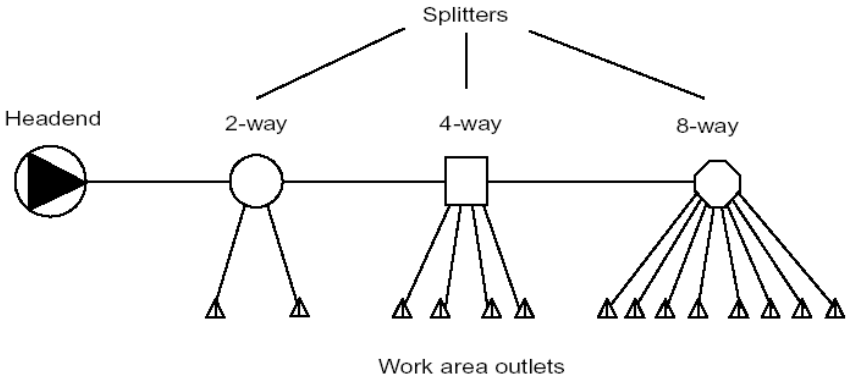
**Figure D5030-3: CATV Homerun Design**[132]




B. For large buildings use a "loop-thru" design as shown in Figure D5030-4.

1. Provide a trunk cable run through the building, typically in the telecommunications cable tray, with GFE taps installed wherever they are needed.
2. Provide drop cables run from the directional couplers (splitters) to the work area outlets.
3. LANL will connect the telecommunications room to an entrance trunk cable from the LABNET headend.
4. LANL will provide an amplifier to boost the signal if needed.

**Figure D5030-4: CATV Loop-Thru Design**[133]




[132] Refer to Figure 22.1 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.
[133] Refer to Figure 22.2 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Edition.

C. Coordinate system topology with the LANL Telecommunications Group.

## 3.3 Work Area Outlets/Connectors

A. Design work area television outlets at the following locations:

1. Conference rooms
2. Training rooms
3. Division director offices
4. Group leader offices
5. Other locations to meet the Users' functional and operational requirements.

B. Locate a duplex convenience receptacle outlet adjacent to each television outlet. Coordinate outlet locations with location of television sets.

C. Outlet will consist of a plastic faceplate with one type "F" self-terminating coaxial cable connector that automatically puts 75 ohm load on cable run when cable is disconnected.

D. Coordinate outlet locations with furniture arrangements.

E. Specify installation of GFE crimp-on-type coaxial cable connectors.

## 3.4 Television System Raceways

A. Design raceway systems for television system coaxial cables to meet the requirements for telecommunications cables.

B. Television coaxial cables may be installed in telecommunications cable trays.

## 3.5 Coaxial Cable (GFE)[134]

A. Coaxial cable is UL listed as type CATVP for use in ducts, plenums, and air handling spaces.

B. Trunk cable: Type RG-11, 500 series, or 750 series cable, diameters are approximately 0.45, 0.50 or 0.75 inches accordingly.

C. Drop cable: [131] Type RG-6; cable diameter is approximately 0.25 inches.

[134] Cable information based on data from the LANL Telecommunications Group.

# 4.0 UNCLEARED PERSONNEL WARNING LIGHT SYSTEM

## 4.1 General

A. Design a warning light system in corridors of the secure parts of LANL facilities to alert and remind building occupants of the presence of un-cleared or inadequately cleared visitors under escort in the area.[135]

B. Programmatic requirements may necessitate warning lights in additional spaces such as large computer rooms or large laboratory spaces that are not associated with corridors.

C. Refer to LANL Master Specification Section 28 1355, *Uncleared Personnel Warning Light System* for materials and installation requirements (section in development at time of writing).

## 4.2 System Design

A. Locate warning lights so they will be visible from all parts of every corridor in the secure parts of facilities; place warning lights not more than 15 ft from the end of the corridor with a separation not greater than 100 ft between lights. If there is an interruption of the concentrated viewing path, such as a fire door, an elevation change, or any other obstruction, treat the area as a separate corridor.[136]

B. Use NRTL-listed synchronized[137] xenon strobe lights with blue lens.

C. Require labeled system control switches with indicator lamps at locations such as group offices or reception desks.

# 5.0 ADMINISTRATIVE ACCESS CONTROL SYSTEM

## 5.1 General

A. Design administrative access control (badge reader) system as described in this section and as required by the Users' programmatic needs. Coordinate requirements with the LANL Security Systems Group.

B. Design an administrative access control system described under this heading in any of the following situations:[138]

1. The building or system exterior is located in a "public domain" and the interior is classified as a "property protection area." *(Guidance: A "property protection area" is intended to protect against damage, destruction, or theft of Government property. A "property protection area" is defined as one in which personnel are not required to have*

[135] Uncleared personnel warning light systems are effectively used in many LANL facilities for the purposes indicated.

[136] Same spacing criteria used for uncleared personnel warning lights as for fire alarm visible alarm appliances in NFPA 72 4-4.4.2.2.

[137] Testing has shown that high flash rates of high intensity strobe lights can pose a potential risk of seizure to people with photosensitive epilepsy. To reduce this risk, more than two visible appliances are not permitted in any field of view unless they are separated by at least 55 ft or unless their flashes are synchronized.

[138] Criteria provided by the LANL Security Systems Group.

*a clearance or be escorted but must pass through a guard or access control point. A "public domain" is an area where uncleared persons have unescorted access and uncontrolled access. This applies even if it is on Government property.)*

2. The building or system exterior located in a "limited area" or above, and the interior is classified as a "limited area" or above. *(Guidance: A "limited area" is defined as one in which personnel access is limited to persons possessing a final, Government-issued security clearance or are under escort by an individual possessing final, Government-issued security clearance. A "limited area", through physical barriers and controlled access, is intended to protect classified material or Category III SNM.)*
3. The User requires automatic entrance and exit control and logging for a room or area.
4. *Doors controlled by administrative access control systems typically include:*
   - *Each exterior door or set of doors except at vestibules install the access controls on the interior door or set of doors.*
   - *Electrical room doors.*
   - *Mechanical room doors.*
   - *Telecommunications room doors.*
   - *Server room doors.*

C. The LANL Security Systems Group will furnish and install badge readers, power supplies, and control equipment.

D. Raceways, boxes, cables, and electric strikes or panic bars will be furnished and installed by the construction subcontractor; refer to Section 28 1321, *Administrative Access Control System Rough-In*.

E. The system controller will be furnished and installed by the LANL Security Systems Group. Wiring from the controller to the terminal box in the telecommunications room will be furnished and installed by the LANL Security Systems Group.

F. Specify electric door strikes and electric crash bars that will be compatible with the administrative access control system.

1. Operating voltage: 24 VDC.
2. Door strike current: 0.3 amperes maximum.
3. Crash bar current: 0.5 amperes maximum.

G. *Time and funding will be necessary for the installation of access control system controller, performance testing, and field quality assurance activities by the LANL Security Systems Group. The Project should obtain a definitive cost estimate and schedule from the LANL Security Systems Group.*

## 5.2 System Design

A. Specify a suitably sized wireway in the entrance telecommunications room.

B. Specify a 3-inch conduit from the wireway to the access control system equipment rack.

C. Distribute and terminate 12 and/or 24 VDC power and data cables from the wireway in the telecommunications room to each badge reader, electric strike, and door switch. Refer to Figure D5030-5 for typical locations and connections of badge reader system components.

D. Distribute and terminate 12 and/or 24 VDC power and data cables from the wireway in the telecommunications room to each badge reader, electric strike, and door switch. Refer to Figure D5030-5 for typical locations and connections of badge reader system components.

1. Install power and data cables from the wireway in the telecommunications room to a badge reader junction box at each controlled-access door.
2. From the badge reader junction box install power cables to the badge reader outlet box and the door electric strike.
3. From the badge reader junction box install data cables to the badge reader outlet box and the door contacts.

E. Design raceway systems for access control system cables that meet the requirements for telecommunications cables. Provide an individual 1" conduit from each badge reader junction box to the wireway in the telecommunications room; refer to Figure D5030-5.

**Figure D5030-5 Typical Administrative Badge Reader System**