CONTENTS

D60 Communications

This chapter addresses unclassified systems. Refer to ESM Ch. 18 for secure systems.

1.1 Definitions[1]

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

B. **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**.**

C. **Category 6A** cable is 100 ohm twisted-pair copper cable that meets or exceeds specifications in TIA-568 (*e.g., C.2*) 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 this. (alien crosstalk is an unwanted coupling of signals into a balanced twisted-pair in a given cable from one or more balanced twisted pairs external to the given cable).*

D. **Cross-connect** enables the mechanical termination and interconnection of premise cabling and backbone cabling.

E. **Entrance facility** is an entrance to a building for both public and private network service cables (including wireless) including the entrance point at the building wall and continuing to the entrance room or space.

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

G. **Information Technology (IT) Equipment Room** is a special server equipment room designed to NEC 645 and NFPA 75 (e.g., special fire and HVAC requirements). Such rooms are not addressed separately from server equipment rooms in this document.

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

I. **Server Equipment Room** is an equipment room that houses mainly computer servers. In information technology circles, the term "server equipment room" is generally used for groups of servers housed in data centers. Server equipment rooms may also house headless systems that are controlled remotely via keyboard/video/mouse (KVM) devices, Virtual Network Computing (VNC), or other terminal emulation software to the desktop.

J. **Telecommunications Server Room** houses mainly telecommunications servers.

K. **Telecommunications room** is an enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and horizontal cabling.[2]

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

---

1 Definitions adapted from the BICSI Telecommunications Glossary to suit conditions at LANL.

2 Chapter 3 in the BICSI *Telecommunications Distribution Methods Manual*, 13th Ed

1.2 General

A. All new and renovated buildings shall have wired voice networks except for remote locations where not desired by User and with agreement of LANL Telecommunications Group.

B. 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.

C. Conform to the requirements of LANL Engineering Standards, Specifications and NFPA 70 current edition.[3] Use the materials and installation methods described in LANL Master Specifications Section 27 1000, *Structured Cabling*.

1.3 ELECTRICAL SUPPORTS AND SEISMIC CONTROLS

A. LANL is in a Seismic Design Category D area (note: a change is likely in FY21).[4]

B. Telecom equipment that is in, or attached to, a building must be installed with seismic design considerations, unless the structural point of contact has deemed otherwise.

C. At time of this writing[5], the following exemptions existed:

Equipment exemptions, for equipment that is positively attached to the structure:

- Equipment that satisfies all of the following:
  - 400 pounds or less
  - has a center of gravity not more than 4 feet above the floor
  - has in importance factor equal to 1.0
- Positively attached equipment that weighs 20 pounds or less

Raceway exemptions:

- Raceways that are Trade Size 2 or less
- Raceways that are positively attached and are supported within 12 inches of the structure
  - Except for rod type hangers or trapeze systems

Other raceway considerations:

- Rod-type hangers
  - Where rod is less than or equal to 12 inches in length, a swivel must be used to provide flexibility
  - Where rod is greater than 12 inches, a seismic design is required
- Trapeze installations
  - Where trapeze, of any length, supports systems that are more than 10 pounds per foot, a seismic design is required.
  - Where trapeze, of any length, supports systems that are 10 pounds per foot or less, the trapeze is exempt from seismic considerations.

D. Clearly identify electrical components that must remain in position, must contain internal parts, or remain operable following a design seismic event.

---

[3] 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.

[4] Refer to LANL ESM Chapter 5 for latest applicable seismic design criteria; telecom is considered facility (e.g., IBC) scope.

[5] Per ASCE 7-2010, Chapter 13.

E. Refer to the following documents for additional requirements:

- LANL ESM Chapter 5, Structural
- LANL Seismic Spec-Editing Flowchart and Guides (linked from Master Specs page).
- LMS Section 26 0529, Hangers and Supports for Electrical Systems
- LMS Section 26 0548.16, Seismic Controls for Electrical Systems
- For ML-1 and ML-2 (e.g., nuclear) systems only: Follow applicable direction in ESM Chapter 7 Electrical, Section D5000, heading "Additional Requirements for Safety-Related Electrical Systems" in this document for special requirements and guidance.

D6010 Data Communications

1.1 Backbone and Entrance Pathways

A. Design Backbone and Entrance Pathways in accordance with LANL Engineering Standards Chapter 19 G50 "Site Communications"

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. (Note that this cable is not plenum-rated.)
2. Terminate the conduits in the left-rear corner of the telecommunications room and adjacent to the left wall.
    a. Design a minimum of two 4-inch backbone pathway conduits interconnecting the vertically aligned telecommunications rooms in a building.
    b. Design a minimum of one 4-inch backbone pathway conduit (or equivalent space in cable tray) interconnecting multiple telecommunications rooms on a floor.
    c. 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. 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.
    d. Specify a woven polyester pull tape (1,200-lb. test) with stamped footage markings pulled into each backbone and entrance pathway conduit and all innerduct and tied off at each end.
    e. Specify 2ea. MaxCell three cell innerducts in conduits.
    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.
    g. Specify identification of backbone and entrance pathways in accordance with 27 1000, *Structured Cabling*; generate records acceptable to the LANL Telecommunications Group.

1.2 Telecommunications Rooms

A. Design telecommunications rooms that meet the requirements of the LANL Engineering Standards Manual and NFPA 70.

B. Design to LANL Standard Drawings ST-D5030-1 and ST-D5030-3.

C. Design dedicated lockable telecommunications rooms on each floor in new and remodeled facilities.

1. *Buildings with less than 10 work area outlets may be provided with wall cabinets, or closets instead of telecommunications rooms; coordinate requirements with the LANL Telecommunications Group.*
2. *For minor work in existing facilities, telecommunications system may be extended from existing telecommunications rooms if sufficient capacity exists; coordinate with the LANL Telecommunications Group.*
3. *Design telecommunications room to accommodate a minimum of 20% future growth.*

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

1. Provide a minimum of one telecommunications room per floor.
2. Provide additional telecommunications rooms when area served exceeds 10,000 sq. ft. or horizontal cable will be more than 275 feet.
3. Locate telecommunications room(s) in the building core.
4. Locate the entrance room as close as practical to the main electrode ground bar.
5. Locate the telecommunications entrance room above grade where it will not be flooded.
6. In multi-story buildings align the telecommunications rooms vertically.
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. Telecommunications rooms shall be dedicated to the telecommunications function and related support facilities.
8. No equipment unrelated to the support of the telecommunications closet shall be installed in, above, pass through, or enter the telecommunications closet without prior approval from the LANL Telecommunications Group.
9. Servers must be installed in dedicated server rooms, not in telecommunications rooms.

E. Coordinate with the LANL Telecommunications Group 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 are as follows; room dimensions shall not be reduced without permission from the LANL Telecommunications Group:

1. Room serves less than 1000 sq. ft.: 8 ft. x 4 ft. with double doors.
2. Room serves up to 5,000 sq. ft.: 10 ft. x 8 ft.
3. Room serves up to 8,000 sq. ft.: 11 ft. x 9 ft.
4. Room serves up to 10,000 sq. ft.: 11 ft. x 10 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.*

F. Design telecommunications rooms for a minimum distributed live load of 100 lb./sq. ft. and a minimum concentrated live load rating of at least 2000 lb.

G. Design independent HVAC for telecommunications rooms larger than 20 sq. ft. for maintaining the following environmental conditions 24 hours per day, 365 days per year: Do not use the building "comfort" HVAC system as primary cooling for telecommunications rooms.

1. Temperature: 64 ºF to 75 ºF
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 6,000 BTU per equipment rack and a minimum of two racks per telecommunications room[6]; coordinate exact requirements with the LANL Telecommunications Group
7. If available in the facility, power the telecommunications room HVAC system from a power distribution system with standby power system.

H. Line two 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 on all six sides. The plywood will be placed on the right and left wall as you enter the room.

1. Control lighting with a dedicated switch for the telecommunications room. Provide a minimum illumination of 50 foot-candles 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 Telecommunications Group.
4. Provide lighting fixtures with lamp guards.

I. Locate electrical receptacles in each telecommunications room as follows:

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, receptacles (NEMA L5-20R) on the cable tray support system above each equipment rack; serve each receptacle by a separate dedicated 20-ampere circuit.[7]

J. Design a multi-outlet assembly in each room at 6′ 6″ above finished floor on the left side of the room. Verify locations with the LANL Telecommunications Group. Serve the multi-outlet assembly by two dedicated 20 ampere circuits. This multi-outlet assembly is for wall mounted equipment. 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 Grounding" heading below for additional grounding and bonding requirements in the telecommunications room.

[6] Criteria for equipment thermal loading is provided by the LANL Telecommunications Group
[7] Equipment rack power requirements updated by LANL Telecommunications Group on 8/16/06.

K. Design in each telecommunications room as described below and as shown in LANL Standard Drawing ST-D5030-1. For small buildings use Standard Drawing ST-D5030-3.[8]

1. Design cable tray system to accommodate 20% growth.
2. 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 and dimensions of cable tray and the equipment racks.
3. Extend both ends of the cable tray into the corridor ceiling space; connect to the corridor cable tray system if present.
4. Locate the cable tray with bottom at 7′-9″ above the finished floor and edge of tray a minimum of 8 inches from the backboard.[9]
5. Design wall-mounting brackets for the cable tray that do not reduce the useable area of the telecommunications board.
6. Specify not less than six cable tray dropout fittings in each telecommunications room; coordinate requirements with the LANL Telecommunications Group.
7. Specify an approved method to restore the fire rating of walls at cable tray penetrations; method must allow future installation and removal of cables.

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

1. Minimum ceiling height: 12 inches above cable tray (a finished ceiling is not required). Any fire resistive material that is applied to the structure must be sealed or covered to control dust that may contaminate electronic equipment.
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.
3. Floor finished with conductive (anti-static) vinyl composition tile (VCT) flooring.
4. Use 3/4 inch thick APA grade A-B interior plywood without voids.
5. Paint front, back, and all edges with two coats of white or light gray, intumescent latex, fire-retardant paint with a Class A fire rating.
6. Use 1/4″ aluminum backboards in buildings that will handle or store transuranic waste or other material that will require non-combustible backboards.
7. Walls and ceiling (or exposed structure) finished with white paint to enhance lighting.
8. Double 3′-0″ lockable doors that open outward into the building corridor. For telecommunications rooms smaller than 20 sq. ft. provide double doors with top and bottom louvers.
9. Signage on the doors indicating the room number and "TELECOMMUNICATIONS - AUTHORIZED PERSONNEL ONLY."

[8] Due to evolving technology, location of racks in equipment room may change from what is indicated in Standard Drawings; consult LANL Telecommunications Group for specifications.
[9] Separation from terminal board is to allow vertical conduits to pass behind the cable tray.

M. Cross connect equipment (*typically GFE)*

1. Cross connect equipment 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.

N. Specify fire stop material in telecommunications cable trays and raceways that penetrate fire-rated walls or floors.[10]

1.3 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.

1. Coordinate and refine design requirements with the server equipment owner (e.g. the LANL Telecommunications Group, the major facility User organization.
2. Each server room equipment rack requires 42" wide x 32" deep of floor space for the equipment itself in addition to 36" front and rear aisle space and 36" to the open side.

B. Design server equipment rooms to meet the requirements in NFPA 75, NFPA 70, and this Chapter.

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

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.

D. Server equipment rooms shall be dedicated to the telecommunications and computing functions and related support facilities.

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.
2. Special-use buildings (laboratory, industrial, etc.): 1 sq. ft. per work area but a minimum server equipment room area of 150 sq. ft.
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.

[10] NFPA 70 Section 300.21

- 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 at least 182 lb./sq. ft.

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

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: *Server rooms located adjacent to telephone equipment rooms may share the same HVAC system.* Do not use the building "comfort" HVAC system as primary cooling for server equipment rooms.[11]

I. For blade server racks, design for 300 w/sq. ft. (1000 BTU/h/sq. ft.) heat load removal as follows:

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 power distribution system fed by the standby supply.
7. Coordinate HVAC requirements with the server equipment owner.

J. 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.

K. 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.
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.*

[11] 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.

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. *Guidance: For increased reliability, the shut-down function should use an electro-mechanical thermostat that directly interfaces with circuit breaker shunt trip elements.*

L. Control lighting with a dedicated switch for the server equipment room.

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

M. 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.[12]

N. Information technology equipment rooms shall be designed to NFPA 75.

O. Locate one or more dedicated 208Y/120V isolated ground panelboards or power distribution units (PDUs) in the server equipment room to serve telecommunications equipment. *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. 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. Refer to the "Panelboards" heading in Section D5010 of ESM Chapter 7. *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 Chapter 7 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 Chapter 7 for detailed requirements for branch circuit wiring systems.

P. 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.

Q. 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.

R. 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:

[12] 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.

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
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.[13]

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

1. Minimum ceiling height: 12 inches above cable tray.
2. Floor finished with vinyl composition tile (VCT).
3. Walls and ceiling finished with light colors to enhance room lighting.[14]
4. Double 3'-0" lockable doors, without doorsill, that open outward into a corridor.
5. Badge reader access control.
6. Signage on the doors indicating the room number and "SERVER ROOM- AUTHORIZED PERSONNEL ONLY".

D6090 Communications Supplementary Components (Pathways, etc.)

Subsection includes: Anchorage, pathways, conduits and back boxes, cable trays, vibration and seismic controls, identification, and grounding and bonding

1.1 Server, Switch, and other Component Anchorage

A. Anchor wall-mounted enclosures per LANL Telecommunications Standard Drawings and Detail ST-F1033-3, 4 as applicable.

B. Anchor equipment racks and cabinets per LANL Telecommunications Design Detail.

C. For all other equipment, anchor per ESM Chapter 5, Structural.

1.2 Horizontal Pathways

A. Design telecommunications horizontal pathways that meet the requirements in the current NFPA-70, and this chapter of the LANL Engineering Standards Manual.

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

1. Allow at least three cable runs per telecommunications outlet unless otherwise designated by LANL Telecommunications Group.
2. Provide for at least 20% future growth.
3. Limit raceway fill as follows:

   - Less than 50 ft. between pulling points with no more than 225 degrees in bends: 40 percent fill.
   - More than 50 ft. between pulling points with no more than 225 degrees in bends 31% 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:

1. Underfloor system (underfloor duct or cellular floor system)

[13] Telecommunications equipment racks are nominally 7 ft. tall
[14] Chapter 3 in the BICSI *Telecommunications Distribution Methods Manual, 13th Ed*

2. Access floor
3. Conduit
4. Cable tray
5. Wireway
6. Perimeter raceway
7. Furniture pathways.

D. Design underfloor pathway systems (underfloor duct or cellular floor system) to meet NEC requirements.

E. Refer to Section 26 0533 for power and communications surface metal raceway (*e.g., 2.16 G-1*).

F. Specify G6000 raceway where electrical and communications comingle with a dielectric separation. Install communications channel on top of dual communication/electrical raceway.[15]

G. Design access floor pathway systems to meet NEC requirements[16] and the following requirements:

1. For general office areas, design the raised floor surface to be 8 inches high or higher.[17]
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.
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.

1.3 Conduits

A. Refer to LANL Master Specification 27 1000 (*e.g., 7.1*) for conduit sizes.

B. Place white tape on conduits at intervals not to exceed 10' where possible and in change of direction to identify unclassified interior telecommunications routes for all new and legacy installations.

C. Specify EMT or IMC conduit unless otherwise required.

D. Use conduit pathway for individual telecommunications outlets and for furniture pathway/building interfaces. Provide conduit pathway systems that meet NEC requirements, and the following requirements:

1. Specify conduit runs with no more than 100 feet between pull points.
2. Specify conduit runs with no more than 225 degrees of bends between pull points.
3. Specify a pull box at any reverse bend.
4. 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.
5. 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.

[15] G6000 is better suited than G4000 for the volume of comingled cable
[16] NFPA 70 Article 645
[17] Chapter 5 in the BICSI *Telecommunications Distribution Methods Manual, 13th Ed.*

6. Select conduit sizes on the following basis:
   - No more than 225 degrees between pulling points: 40 percent fill.
   - Minimum size: 1 inch unless specified otherwise
7. Specify individual conduits from each wall-mounted telecommunications outlet to a telecommunications cable tray or to the telecommunications room.
8. Design individual conduits from each furniture pathway/building interface to a telecommunications cable tray or to the telecommunications room. Size conduits based on 3 cables per workstation.
9. Terminate metallic telecommunications conduits using an insulated throat fitting or an insulating bushing.

1.4 Cable Tray Systems

A. Use dedicated cable tray systems to distribute horizontal cables from the telecommunications room(s) to locations near the outlets. Provide cable tray pathway systems that meet NEC requirements and the following criteria: Basket tray systems may be used for building <2000 sq. ft. with the same criteria as listed below.

1. Limit cable initial tray total fill ratio to 40%.
2. Calculate cable tray size to accommodate 20% future growth.
3. Require not less than 12 inches access headroom above and to one side of all telecommunications cable trays. *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 9 inches to reduce cable sag and the possibility of long-term cold creep insulation damage to telecommunications cables.
5. Cabling systems other than telecommunications that >50v are not allowed to comingle in cable tray system.
6. Refer to Section D5090 of ESM Chapter 7 for cable tray design requirements.
7. Use materials and installation methods described in LANL Master Specifications Section 26 0536, *Cable Trays for Electrical Systems*.

B. 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.

C. Identify horizontal pathways in accordance the LANL Telecommunications Group. Use materials and installation methods described in LANL Master Specification Section 26 0553, *Identification for Electrical Systems* and 27 1000, *Structured Cabling*.

D. Use UL listed bonding couplings in cable tray system.

E. For retrofit of pathways for horizontal cables in existing buildings use materials and installation methods that comply with the NEC and meet LANL Telecommunications Standards.

1.5 Outlet Boxes

A. Use 4-11/16 inch square, 2-1/8 inch deep outlet boxes with single gang raised device covers for telecommunications and television outlets served by 1 inch conduit for up to 4ea. CAT5E cables.

B. Use 5 inch square, 2.875 inch deep outlet boxes with single gang raised device covers for telecommunications and television outlets served by conduits 1" or larger or for ea. CAT6A cables.

C. Use 5 inch square, 2.875 inch deep outlet boxes with single gang raised device covers for telecommunications and television outlets served by conduits 1-1/4" or larger or for 6 ea. CAT6A cables.

1.6 Pull and Junction Boxes

A. Provide junction boxes with the following minimum dimensions: Three times the trade size diameter of the largest conduit in addition to the sum of the remaining conduits.

B. Label all junction boxes "Communications" with mechanically generated labels.

1.7 Terminal Boards

A. Use 3/4 inch thick, APA-grade A-B interior plywood without voids.

B. Paint front, back, and all edges with two coats of white or light gray, intumescent latex, fire-retardant paint with a Class A fire rating.

C. Use 1/4" aluminum backboards in buildings that will handle or store transuranic waste or other material that will require non-combustible backboards.

1.8 Furniture Pathways

A. Specify separation from electric light and power conductors as required in NEC Article 800.[18]

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

1. Metallic divider bonded to ground between power and telecommunications cables to accommodate 40% fill limit.
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 Cables

A. Copper

1. Specify three horizontal cables to each telecommunications outlet. Coordinate with the LANL Telecommunications Group to determine the exact types and mix of horizontal cables that will be provided.

a. 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

[18] NEC Section 800.133(a)(2)

maximum outside diameter of 0.265 inches or Category 5E unshielded twisted pair (UTP) cable with a maximum outside diameter of 0.195 inches.

b. The installing subcontractor shall terminate all Category 5E and Category 6A horizontal cables.

c. Designate the following colors: red-fire alarm, orange wireless access points.

B. Fiber

1. Fiber optic backbone cable shall be UL listed as type OFNR, tight-buffered fiber-optic cable with a mixture of single-mode and multi-mode fibers.

2. Fiber optic horizontal cable shall be UL listed as type OFNP (plenum-rated) cable with an outside diameter of approximately 0.24 inches.

a. The installing subcontractor shall terminate all fiber optical backbone cables.

b. The installing subcontractor shall terminate the fiber optical horizontal cables.

C. Cable installers must have the following minimum qualifications:

1. Category 6A horizontal cables: BICSI Registered Installer Level 2 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.[19]

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 two previous projects.

3. Copper and fiber installers shall have Fluke copper and fiber testing certification.

D. Specify labels on cables, ports, and panels of fiber housings in racks per LMS Section 27 1000 *Structured Cabling*. Generate records acceptable to the LANL Telecommunications Group.

E. Physically provide Fluke LinkWare test results in electronic file format for each cable to the LANL Telecommunications Group for review and acceptance.

1.10 Outlets

A. Locate communication outlets per Table D6090-2.

Table D6090-2 Communication Outlet Requirements

Location	Number of 3-port Outlets	Notes
Badge reader	1	For a wall mounted telephone
Break room	1	For a wall-mounted telephone

[19] 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.

Conference room	2	One at front of room and a second centered in floor for table's telecom phone
Copier room	2	One located within 4 ft. of copier
Electrical room (main)	1	For electrical metering; locate within 4 ft. of meter.
Elevator equipment room	1	For elevator equipment
Mechanical equipment room (main)	1	For building automation system; locate within 4 ft. of BAS.
Open office workstation	1	
Parking structures	Use a 1-port outlet	Outside each entry to each stairwell
Private office	2	Locate on opposite walls. In spaces served by a protected transmission system (PTS), coordinate the location of the outlets with the PTS outlet to maintain required separations; see Chapter 18- Secure Communications

Notes:

1. Telecommunication outlets that serve BAS, elevator, wireless, badge reader, or camera installations may be designed to accommodate single- or dual-port outlets as required.
2. Provide additional work area outlets as required to meet the User's programmatic needs identified in their design input documents.

B. The outlet will consist of three RJ45 jacks on a common faceplate. Some projects will have fiber-optic connectors in place of some of the RJ45 jacks.

C. For each 1–4 port or more CAT6A wall mounted telecommunications outlet, specify a 5" square, 2.875" deep outlet box with a single gang raised device cover with 1" knockouts.

D. For each. 5 port or more CAT6A wall mounted telecommunications outlet, specify a 5" square, 2.875" deep outlet box with a single gang raised device cover with 1-1/4" knockouts.

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

1. In common areas (e.g., conference rooms), position telecommunications outlets with center 18 inches above the finished floor.[20] 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).[21] [22] Coordinate locations of outlets with modular furniture and associated hangers to assure that outlets will be accessible.

[20] 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

[21] Office spaces with special ADAAG accommodations will be provided on an as-needed basis.

[22] 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.

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

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.

G. Install a 6" x 6" x 4" box above the fire alarm control panel.

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

1.11 Pull and Junction Boxes

A. Provide junction boxes with the following minimum dimensions: Three times the trade size diameter of the largest conduit in addition to the sum of the remaining conduits.

B. Label all junction boxes "Communications" with mechanically generated labels.

1.12 Grounding

A. Design a telecommunications bonding backbone conductor that interconnects the telecommunications grounding busbar in each telecommunications room, each server equipment room, Use #4 AWG conductor with 600V insulation and connected with two-hole hydraulically compressed cable lugs.

B. Locate a telecommunications main grounding bus bar 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. Place ground equal to the main electrode ground size.

1. Use a NEMA pattern (1.25 inch x 1.25 inch), pre-drilled, electro-tin-plated copper bar that is 1/4 inch thick, 2 inches wide, minimum 10 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. Label ground bars appropriately (TMGB, TGB, or TB).
2. Bond the telecommunications main grounding bus bar to the building electrical system main electrode ground bar using a dedicated 4 AWG conductor with 600V insulation and connected with two-hole, hydraulically compressed, cable lugs.
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.

C. Do not place grounding or bonding conductors in ferrous metallic conduit.

D. Effectively ground and bond all metallic telecommunications raceways and cable trays.[23]

Bond the telecommunications cable tray to telecommunications ground bar with minimum 6 AWG using crimp-on lugs.

1. 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 conductors for multiple conduits or individual conduits larger than 1".

[23] NEC Section 250.96

Record of Revisions (D60)

Rev	Date	Description	POC	RM
0	2/23/15	Initial issue superseding D5030 rev. 4. Changes for server equipment rooms and to reflect Cat6A cabling requirements, j-box, and conduit size. New wireless section. Updates for NEC, BICSI, and TIA standards. General reorganization.	Pete Lowe, *NIE-TS*	Mel Burnett, *ES-FE*
1	9/01/20	Improved coordination with 27 1000. Conduit requirements revised for vertical pathways within the building between comm. rooms to account for fiber taking the place of a majority of the copper count formerly needed. Horizontal pathways allowable bends increased from 180 degrees to 225 degrees between pull points. Added G6000 for labs or where electrical and communications are installed in the same raceway. Added use of white tape for identification. Outlet box sizes modified to specify sizes required dependent on type of cabling and number of cables per outlet box. Grounding conductor sizes reduced due to a lesser need for grounding resulting from fiber replacing copper entrance cables. Alignment to evolving industry standards; eliminated others more restrictive than needed (e.g., some BICSI). Public address system (voice paging) revised. Deleted D6060.40 "Uncleared Personal Warning Light System" and Appendix A "Administrative Access Control System" (Apollo), now in Chapter 9.	Pete Lowe, *NIE-TS*	Jason Apperson, *ES-DO*

Record of Revisions (as D5030)

Rev	Date	Description	POC	RM
0	6/28/99	Rewritten and reformatted to support LIR 220-03-01. Superseded Facilities Engineering Standards, Vol. 7, Electrical, Manual Rev 15, 6/26/98.	David W. Powell, *PM-2*	Dennis McLain, *FWO-FE*
1	11/18/02	General revision; 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	Added telecom reqts for conference rooms, copy rooms and parking structures; updated reqts for admin access control system. Updated PTS and security system req'ts; when Ch. 9 Security was published later, these reqts were superseded. Fire alarm reqts were superseded when the material appeared later in Ch. 2.	David W. Powell, *ENG-DECS*	Michael S. Harris, *ENG-DO*

3	10/27/06	Deleted Fire Alarm subsection (now in Fire Ch); deleted PTS and PSS (now in Security Ch); changed horizontal cable to Category 6A and adjusted pathway criteria to accept the larger cable; removed LANL Tel Group support for voice paging systems; changed support for admin access control systems to Security. Org and contract reference updates from LANS transition. Became an ISD. Master Spec number/title updates. Other admin changes.	David W. Powell, *FM&E-DES*	Kirk Christensen, *CENG-OFF*
4	8/27/09	Revisions limited to paragraphs 1.1/1.4 to address TA-16-933 Server Room incident report action item #5: Added def'n of "server equipment room;" expanded coordination req't to include the server equip owner; defined "indep HVAC;" added an HVAC load density; updated server room power density; added reqt's to have temperature sensors, thermostats, and related components so server room over-temp will be reported to the Facility Coord and the server equipment owner, and if the room temp reaches a high limit, the server equipment will be shut down.	David W. Powell, *ES-DE*	Gary Read, *CENG-OFF*

Appendix A IEEE 802.11 Wireless Systems[24] (D6010.10)

*The overwhelming majority of new and renovated buildings will have wired networks ("landlines") as noted earlier in this document. Wireless networks are not a replacement for a wired network; they offer an alternative type of service from wired service with respect to portability. Wireless service, indoor and outdoor, is an extension of the wired network for general-purpose network needs. It enables applications that require the mobility offered by wireless, but which are not necessarily equivalent in bandwidth, reliability, or security versus wired connecti*on.

1.1 Definitions

A. Access point: A device that is a RF transmitter and receiver to facilitate wireless communications.

B. Cell: The area in which the wireless access point can be located.

C. Coverage zone: The area in which the wireless access point provides a signal that is strong enough to support communications.

D. dBm.: Decibel in relation to milliwatts of power

E. Fade Margin: the level of desired signal above what is required

F. Fresnel zone: a 3-dimensional shape of concentric ellipsoids that surround the visual line of sight between two antennas

G. Link budget: the calculation of Received Power (dBm) = Transmitted Power (dBm) + Gains (dBm) – Losses (dBm)

H. Signal-to-Noise Ratio: Signal level minus the noise level measured in dbm

1.2 Acronyms

A. AP - Access point

B. HD – High density

C. LANL – Los Alamos National Laboratory

D. PoE – Power over Ethernet

E. RF – Radio frequency

F. SAR - Specific absorption rate

G. SNR - Signal-to-noise ratio

H. TO – Telecommunications outlet

I. WLAN – Wireless local area network

1.3 General

A. Wireless Network(s) shall meet all applicable regulatory agency standards and shall be installed to minimize radio frequency interference.

B. Use TIA Telecommunications Systems Bulletin TSB-162 (and amendments to), "Telecommunications Cabling Guidelines for Wireless Access Points", as a guideline for installation methods.

[24] Adapted from IEEE 802.11 Wireless Design and BISCI Wireless Design Reference Manual, 3rd Ed 2008

C. Access Points and all associated components shall be installed per manufacturer's specifications.

D. Access point and antenna selection shall utilize manufacturer's "AP and Antenna Selection Decision Tree" or similar guidance for best practice based on each wireless design.

E. Follow U.S. SAR regulations which state a minimum of 6-inch clearance between WLAN antennas and the human body must be maintained.

F. *Wireless coverage areas are impacted by a number of factors such as:*

- *Building materials (concrete, sheetrock, wood, steel, etc.)*
- *Building configuration (closed, semi-closed, or open space)*
- *Building furnishings (cabinets, partitions, furniture, etc.)*
- *Existing radio frequencies operating in the same frequency spectrum (microwave ovens, cordless telephones, RF generating lab equipment, etc.)*
- *Occupant density (conference rooms, lecture halls, lobby area, etc.)*
- *In the case of outdoor wireless: distance, Fresnel zone size, topography, terrain, path obstacles such as trees, buildings and water as well as environmental effects can also be factors.*

G. *The LANL Telecommunications Group will document the WLAN configuration which will assist the network managers in tracking use of the radio spectrum.*

1.4 Wireless Design Input

An RF site survey and design or simulation must be made to ensure adequate coverage and capacity for both indoor and outdoor environments. Perform the following with each wireless design:

A. Manual site survey

B. Predictive site survey

C. Spectrum analysis

1.5 Wireless Design

A. Capacity design goals will be defined with customer input. Goals will include total number of devices and minimum bandwidth per device.

B. Coordinate service and interior distribution requirements with the LANL Telecommunications Group.

C. Coverage and capacity zones will be designed with a minimum of -70dbm received signal strength and a -25dbm minimum SNR.

D. The antenna mounting locations are to have no obstructions between the front of the antennas and the intended wireless clients.

E. Designs must show antennas mounted with built-in down-tilt flat against the ceiling or floor so that the beam is vertical.

F. Designs must not mix mounting strategies in a room. When designing adjacent HD WLANs, the same strategy, overhead, side, or picocell must be used throughout the same room.

G. When designing for side coverage strategy, design must reference manufacture spacing requirements for APs with integrated antennas and for AP spacing in a closet with antennas remotely located.

H. If external antennas are used, mount AP as close to their antennas as possible. Use coaxial cable that meets manufacturer specifications to connect to remote antenna to AP when they must be a distance away (per manufacturer specifications) from each other.

I. Perform a link budget analysis for each point-to-point and point-to-multi-point outdoor link to determine that the final received signal amplitude is above the receiver sensitivity threshold of the receiver radio.

J. Each link budget analysis must include a fade margin within the range of 20db to 30db for minimum link reliability.

K. Fresnel zone obstructions shall not exceed more than 20% into the 1st zone for all outdoor links.

1.6 Wireless Installation and Testing

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

B. The LANL Telecommunications Group will furnish access points and antennas as GFE.

C. CAT6A, or optical fiber cables, and head-end switching to provide power and Ethernet to the access points may be furnished and installed in the entrance telecommunications room by the LANL Telecommunications Group.

D. Run horizontal cable from each access point /air monitor outlet to the telecommunications room. All wireless horizontal cabling will be orange as well as cross-connects from the horizontal to the telecommunication room equipment patch cords.

E. Terminate wireless horizontal cabling on a two-port, surface-mount outlet box mounted above the drop ceiling or in general ceiling area. The patch cords and horizontal cabling connected to the access point shall not exceed 100 meters.

F. Patch cords shall connect the outlet port to a designated RJ-45 port located on the access point or air monitor and not exceed 6 feet in length.

G. *Guidance: AP placement should not exceed 14 feet above finished floor when installing access point/air monitor with built-in antennas.*

H. *In general, cell coverage zones should be 60 feet or less in diameter and placed with overlapping coverage.*

I. *Antenna adjustment on the access point/air monitor may be necessary for proper operation. Refer to manufacturer's specifications.*

J. Perform a "channel link test" on all ports made active for use by an access point or air monitor.

K. APs shall connect to PoE switches for power and network connectivity. If PoE is not available to AP location, an external power source can be used.

L. Outdoor antenna connectors must be weatherproofed.

M. External antennas must be grounded. Ground connection must be complete before connecting power. Grounding must meet LANL electrical codes.

N. On external installations, the need for lightning protection must be determined (ref. NFPA 780).

O. All cables are to be tested and test results documented.

P. Throughput testing shall be performed using LANL Telecommunications Group approved software and testing method.

Q. Perform a "channel link test" on all ports made active for use by an access point or air monitor.

Appendix B Public Address (Voice Paging) System (D6060.10)

1.1 General

A. Design an overhead voice paging system throughout each facility as required to meet the User's programmatic needs.[25]

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[26] per LANL Telecommunications Design.

C. Conform to the requirements of the NEC[27] and the LANL Engineering Standards Manual.

D. Voice paging systems shall include the following components:

1. Network-based speakers (e.g., Algo 8180)
2. CAT-X wiring (current standard)
3. Terminal box(es)
4. End Office Switch Access

E. Life safety,[28] noise masking,[29] and sound reinforcement[30] 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."[31]

G. Network Systems are traditionally not zoned, due to network restrictions. The Network devices are individually addressable. Zones can be created in the management system (Broadsoft), but will require unique phone numbers per zone.

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.

J. Zone the system by floor, by function, or by organization; refer to Figure D6060-1. Provide one or more amplifiers for each zone; wire speakers in each zone to a specific amplifier. **Error! Bookmark not defined.**

---

25 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.

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

27 NEC Articles 640 and 725

28 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*

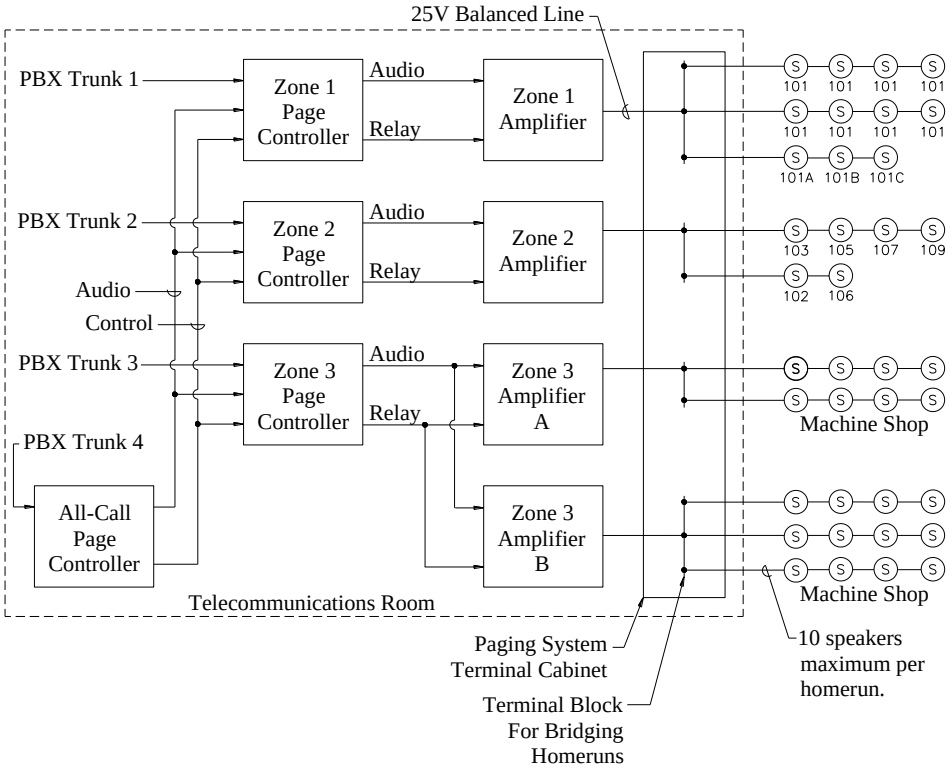
29 Noise masking systems are often used in open office applications and generate "white noise" to create an artificial sound barrier.

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

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

Appendix B Public Address (Voice Paging) System (D6060.10)

Figure D6060-1: Typical Zoned Paging System



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

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

1.2 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.[32]

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 D6060-1 to estimate ambient noise levels.

[32] 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 D6060-1 [33]

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.[34]

1.3 Speaker Placement

A. Locate speakers to provide uniform coverage of each area.

1. *Units will be placed at an 8' height in a "square pattern" for optimal coverage.*
2. *Place the speakers 20' apart in areas less than 70dB.*
3. *Decrease the distance between speakers in areas with a noise level greater than 70 dB.*

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

C. For typical enclosed corridors, Place the first speaker approximately 6 feet from the end of the corridor and work toward the other end.

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

1.4 Speaker Wiring

A. Use the current standard of Category cable (i.e. CAT-5e / CAT-6 etc…), the length of the cable not to exceed 100m from the end switch.

1.5 Acceptance Testing

A. Specify acceptance testing using the following procedure:

1. Adjust the Volume level to match the desired dB level for the stated area.
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.

[33] Based on Table 23.1 in Chapter 23 in the BICSI *Telecommunications Distribution Methods Manual*, Ninth Ed

[34] 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.