NEW EQUIPMENT-BUILDING SYSTEM (NEBS)
SPACE PLANNING

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1. GENERAL

1.01 This section introduces the Bell System Practices that provide standards and guidelines for NEBS space planning of central office, radio relay, and transmission station buildings. These sections are provided for use in the design of new buildings or building additions or the refurbishing of existing buildings that are intended to house telephone equipment that meets the requirements of the "New Equipment-Building System (NEBS), General Equipment Requirements," Section 800-610-164, and Technical Reference PUB 51001.

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

1.03 This section supersedes the Preface and Introduction of Specification X-74300, "NEBS Building Engineering Standards (BES), Part I, Building and Equipment Layout." The availability of individual sections may be determined by reference to the Numerical Index, Section 760-000-000.

1.04 An Equipment-Building Task Force, representing equipment and design areas of Bell Laboratories, studied equipment-building interrelationships and developed the NEBS standards for central office equipment design. General Equipment Requirements are available for the guidance of Bell Laboratories physical designers, providing spatial and environmental performance requirements for all new systems of central office equipment. These equipment design standards are available for Bell System information in Section 800-610-164, "New Equipment-Building System (NEBS), General Equipment Requirements," and for the General Trade in Technical Reference PUB 51001. This later document can be obtained from Director—Purchased Products, AT&T Company, Basking Ridge, New Jersey 07920.

1.05 Just as the equipment designer must consider the interdependence of equipment and buildings during the equipment design stage, so must the building space planner consider these same equipment-building interrelationships during the building planning stage. The NEBS Space Planning Practices are introduced to: facilitate the planning function; promote efficient space and equipment utilization; enhance orderly growth; and ensure economical, safe, and reliable equipment-building systems. These practices are fully coordinated with the General Equipment Requirements and should be employed in the planning and design of all new electronic local switching offices, electronic toll centers, and transmission stations.

1.06 In addition to standards for equipment and buildings, NEBS documents providing information on equipment codes and floor plan data are also available. These five document packages, listed in Table A, represent a complete guide for equipment physical designers, equipment planners, building engineers, and architects in the development and design of the NEBS.

1.07 To obtain the benefits in building construction and usage that are forecast for NEBS, information contained in the sections listed in Table B should be employed in the planning and design of new buildings and building additions and refurbished space in existing buildings.

TABLE A

USER	DOCUMENT
Bell Laboratories	New Equipment-Building System, General Equipment Requirements (Section 800-610-164)
General Trade	Bell System Technical Reference PUB 51001, New Equipment-Building System (NEBS) — General Equipment Requirements
Western Electric and Operating Company Equipment Planners	New Equipment-Building System (NEBS) Catalog; Floor Plan and Power Data Sheets
Operating Company Equipment Planners, Building Engineers, and Architects; AT&T	NEBS Space Planning and Design Criteria Practices (760-100-XXX and -200-XXX series)

2. EVOLUTION OF NEW STANDARDS

2.01 The design standards for communication buildings were originally set to accommodate electromechanical switching equipment. With the advent of miniaturized equipment through the use of large-scale integration of solid-state electronics, new values for equipment size, weight, temperature, and cable density have appeared. Bell Laboratories made a preliminary study of the spatial requirements of the different types of equipment and buildings with a goal toward more effective and economical design. The group concluded that substantial benefits could be achieved by setting up new, more unified standards of design for communications equipment and the buildings that house modern electronic systems.

2.02 As a result of the preliminary study, a Task Force was formed to review existing central office equipment and building standards in terms of existing and anticipated service and equipment requirements and to recommend appropriate design changes. The Task Force was composed of representatives from the areas of exchange and toll transmission, electromechanical and electronic switching, power, building development, and standards engineering.

2.03 The Task Force reviewed Bell System equipment and building costs, its building construction program, and the anticipated equipment-space requirements. Existing design trends in all aspects of central office equipment and power systems were determined and were basic elements in the study. The equipment-building interrelationships shown in Table C were examined.

TABLE B

SECTION	TITLE	
760-100-001	Building Planning — General Consideration	(Supersedes Section 760-220-150)
-010	Building and Equipment Space Planning — The Process	(Supersedes Section 760-220-151 and BES Section 1.1)
-015	NEBS Standards — Building Engineering Standards — Space Planning	(Supersedes BES Preface and Introduction)
-020	Selection of Building Sites for Central Offices	(Supersedes Section 760-230-150)
-021	Land Survey Information	(Supersedes Section 760-230-151)
-030	NEBS in New Buildings	(Supersedes BES Section 4.1)
-032	NEBS in Existing Buildings	(Supersedes BES Section 4.2)
-040	Telephone Office Planning and Engineering System (TOPES)	(New — To Be Issued)
-041	TOPES — Operating Guide	(New — To Be Issued)
-045	Floor Plan and Power Data Sheets	(New — To Be Issued)
-046	Floor Space Estimating for NEBS Offices	(New — To Be Issued)
-050	Space Planning for Single and Multientity Switching Offices (No. 1 ESS)	(New — To Be Issued)
-055	Space Planning for Medium Sized Switching Offices (No. 2B ESS)	(Supersedes BES Section 2.2)
-060	Space Planning for Small Switching Offices (No. 3 ESS)	(New — To Be Issued)
-065	Space Planning for Toll Centers (No. 4 ESS)	(Supersedes BES Section 2.4)
-070	Long Haul Radio Relay Station	(Supersedes BES Section 3.1)
-071	Small Radio Relay Station	(Supersedes BES Section 3.2)
-080	Analog Carrier Terminal Offices	(Supersedes BES Section 3.7)
-085	Digital Carrier Terminal Offices	(Supersedes BES Section 3.6)
-090	Space Planning for Distribution Frames	(New — To Be Issued)
-095	Space Planning for Via Cabling	(New — To Be Issued)
-120-160	Project Planning Service Operations Centers	(Supersedes Section 760-220-160)
-150-150	Building Planning for Electronic Data Processing Systems	(Supersedes Section 760-250-150)
-155	Planning for Operations Support Systems Computers	(New)
-160	Planning for Solar Energy Systems	(New)
-160-100	Fire Protection Planning	(Supersedes BES Section 8.1)

TABLE C

EQUIPMENT VARIABLES	BUILDING VARIABLES
Height, width, depth, and weight	Floor live load and ceiling height
Office layout	Column space and room area
Cabling	Racks, holes and risers, and the cable entrance facility
Heat dissipation	Heating, ventilating, and cooling
Operation and maintenance	Aisles and service areas

3. NEW STANDARDS

3.01 As a result of these optimization studies, new methods were proposed to effectively integrate equipment and building design for electronic local and toll switching offices and transmission stations. The NEBS plan approved by AT&T for adoption throughout the Bell System is based on the following design characteristics:

Equipment frame height	7 feet
Clear ceiling height	10 feet
Top of floor slab to bottom of lowest structural member	12-1/2 feet
Equipment and Power Systems floor live load (including transient load)	150 psf
Building bay module size	20 X 20 feet

3.02 Requirements for NEBS equipment (Section 800-610-164 and Technical Reference PUB 51001) cover spatial and environmental requirements for equipment frames, distributing frames, power equipment, operations support, and cabling systems. The availability of equipment designed to the new specification will permit construction of more functional and economical buildings and will simplify the planning for installation of electronic exchanges, toll centers, and stations.

4. STRUCTURAL DESIGN PARAMETERS

4.01 The design of an equipment building shell requires decisions regarding ceiling height, floor live load, and column spacing which, in turn, are influenced by equipment size, weight, and layout. It is clear that the floor-to-floor height of the building is controlled by the frame height of communication and power equipment, the space required for cabling, light fixtures, air distribution, and the floor plan; also, the design live load for the floor and column spacing is determined by equipment design and arrangement on the floor.

4.02 For a 10-story building, variation in ceiling height influences total construction cost by approximately 4.5 percent per foot of height. Costs change by approximately 6 percent if the live load is increased from 150 to 300 pounds per square foot. For a 2-story building, construction cost increases approximately 3 percent as a result of going from 150- to 300-pound-per-square-foot floors.

4.03 The size and spacing of structural columns influence slab costs and equipment layout. To obtain maximum floor area utilization, column spacing perpendicular to the lineup must be a multiple of frame depth and aisle width. Building core costs are minimal, with column spacing between 15 and 22 feet for typical floor loadings and types of construction. Area usage studies show efficient layouts with columns on 20-foot centers. This building bay module results in overall optimization and permits adopting the American National Standards modular dimensioning for buildings.

5. EQUIPMENT COST FACTORS

5.01 If equipment weight, cooling, cabling, and maintenance were not controlling factors, installing equipment on high frames would permit reduced floor areas; this, in turn, would lower construction costs, because it is cheaper per cubic foot of building area to increase ceiling height rather than to expand horizontally. However, a study of equipment design trends reveals that the newer generations of telephone equipment have denser configurations, higher heat dissipation, and more critical cable connections per frame than older equipment. Furthermore, the required clear ceiling height is basically the same for electronic switching equipment, a large portion of the toll terminal equipment, all power equipment (including batteries), and nonequipment space. However, if high-frame equipment continues to be used in the carrier- and voice-frequency areas and for distributing frames, this factor would determine ceiling heights for the entire building. With the use of lower frames for these types of equipment and present floor plans, the cost of additional floor areas required can be offset by savings resulting from the use of lower ceilings over the entire building.

5.02 To assess the effect of revising the maximum equipment frame height standard on the cost of the overall equipment-building system, a model of Bell System gross requirements for central office space was developed. By assuming that space will be provided in new buildings for equipment designed to the old electromechanical standards for the period 1980 to 1985 and estimating the additional nonequipment space required to support the telephone plant, the proportions of space were determined.

5.03 The equipment space included associated aisles and distributing frames. The study period 1980 to 1985 was selected to eliminate the effect of electromechanical toll and exchange switching systems since it is expected that all machines installed in equipment buildings during this period will be electronic.

5.04 In the study period, high ceilings are actually required for only approximately 21 percent of the building space. Lower ceiling heights are permissible in the remainder of the equipment space because the equipment can be installed on lower frames and high ceilings are not required in nonequipment areas. Adoption of a lower maximum frame height standard permits construction of a lower building that is cheaper on a per-gross-square-foot basis. The floor area of the building is adjusted to allow for the increased number of lower frames required to house the equivalent amount of equipment.

5.05 Normalized costs have been determined for revisions in the standards for maximum frame height, vertical space provided for cabling, and building floor-to-floor height. Central office costs are affected by building construction, cable racks, auxiliary framing, lighting facilities, air ducts, and house service expenses. Building construction costs account for approximately 45 percent of the whole. Constant cost is assumed for the communication and power equipment. An evaluation of equipment design trends indicates that a 150-pound-per-square-foot load for equipment, cable, and transient effects is adequate for the entire building. Costs that change for various equipment-building systems were normalized to the previous standard maximum frame height of 11 feet 6 inches and 2 feet of overhead space for cabling, even though many buildings have been constructed with extra space for cabling.

5.06 A 7-foot equipment frame height permits the adoption of compact floor plans for approximately two-thirds of the transmission equipment that are similar to the floor plans for the electronic switching equipment. The auxiliary framing and rolling ladders can be omitted. Utilization of reclaimed space made available through modernization programs will be facilitated, especially where clear ceiling heights are inadequate for the required cabling and air ducts over high-heat equipment frames.

5.07 Cost factors (shown in Fig. 1) determined for these new floor plans indicate 4 to 12 percent savings for the range of overhead cable space considered. The equipment-building system, composed of 7-foot equipment frames, 3-foot overhead cable space, and a 12-foot 6-inch height from top of floor slab to bottom of lowest structural member, will produce approximately 8 percent savings in cost.

5.08 The use of lower frames will alleviate equipment cooling problems as shown in Fig. 2. Reducing the equipment unit heat load for a given floor plan layout will permit more economical air distribution and reduce space required for ducts, thus avoiding the need for extremely wide aisles in areas of high-heat dissipation.

5.09 While it is expected that some reduction in maintenance costs and improvement in the quality of service will result from the general use of 7-foot frames, no savings were assigned in the cost study. At the very least, however, the elimination of rolling ladders will save approximately $1.00 per square foot of floor area and will eliminate the hazards involved in working from ladders.

5.10 Use of 7-foot frames will decrease cabling and reduce congestion by permitting cable

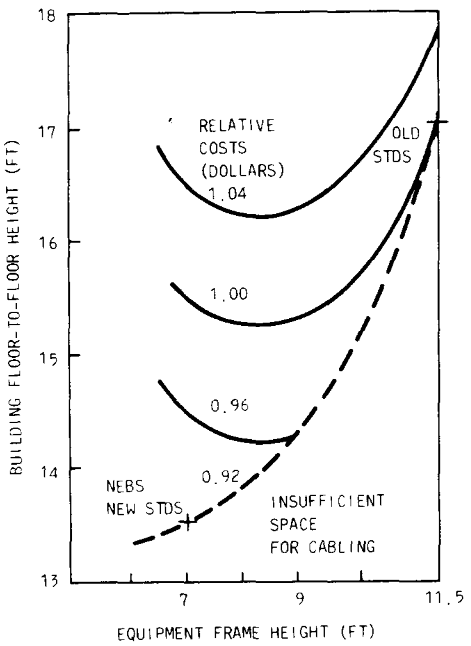

Fig. 1—Relative Costs for Equipment-Building Systems

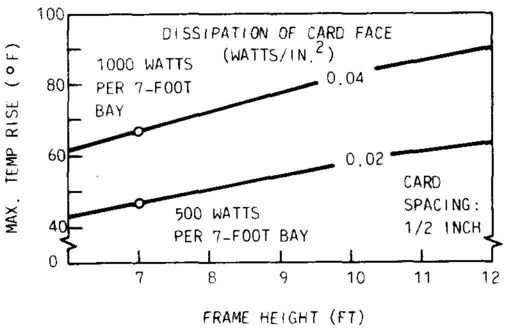

Fig. 2—Temperature Rise in Free Convection for Equipment of Different Height

to be spread in the overhead racks. The expanded floor area for transmission equipment would lengthen intrasystem cabling and thereby increase cabling costs; but this is offset by the use of more compact floor plans, additional cross-aisle racks, and savings in cable engineering and installation costs due to less congestion in the racks.

6. SPACE CONCEPT AND FLOOR PLANS

NEW BUILDINGS

6.01 In the equipment area, a height of 7 feet above the floor is allocated for the equipment frame and 3 feet between the top of the frame and all structural elements and air ducts is allocated for racks, cabling, bus bars, and lights. In the mainframe area, the height of frames plus associated cable and racks is limited to 9 feet to permit passage of via cable. Power equipment, including all overhead cable and supports, may extend to 10 feet. The 150-pound-per-square-foot floor live load is proportioned 140 pounds for equipment, racks, and cabling and 10 pounds for transient loads, such as personnel and rolling equipment. Where the Modular Cooling System (MCS) is used, a portion (10 pounds per square foot) of the 150-pound-per-square-foot limit will be required for the raised deck or floor.

6.02 To facilitate building planning and equipment engineering, all bus bars, cables, and racks are expected to be supported by the equipment frames except in zone 4 earthquake areas. Over areas lacking frame lineups, via or power cabling weighing up to 5 pounds per square foot may be supported by floor-mounted stanchions or from the ceiling. Ceiling anchors will be required to support auxiliary framing, air ducts, conduits, and suspended ceilings.

6.03 Basic standard floor plans are recommended for all types of equipment. The principle plan consists of 12-inch deep frames with 2-foot 6-inch maintenance aisles and 2-foot wiring aisles. These standards achieve three distinct advantages:

(1) While meeting all the present standard floor plan data sheet rules for minimum aisles for electronic systems, the net effective aisle space available to the craftsperson and for cooling air circulation is increased.

(2) The standard floor plan layout for 12-inch deep equipment frames repeats every building bay. This modularity is maintained for columns up to 28 inches deep before alternative arrangements must be made.

(3) The new standards will accommodate 18-inch deep process coolers (used with the MCS) in column lineups of standard layouts.

6.04 Standard layouts also exist for large 140-volt power plants. By arranging the plant to locate heavier batteries in the same building bays with the lighter distributing boards and charging equipment, an average loading of less than 140 pounds per square foot is achieved, which permits power areas to be located anywhere in the building.

EXISTING BUILDINGS

6.05 In the refurbishing of existing building space for new equipment, the application of NEBS equipment and space concepts has been anticipated. The use of modern electronic equipment on 11-foot 6-inch high frameworks is not recommended as it will lead to cable congestion and equipment cooling problems. The need for increased cabling space to handle the higher cable densities brought on by circuit compression is in direct conflict with the need for more space to provide higher capacity in the equipment cooling systems originally designed for low electromechanical heat loads. The NEBS concept will eliminate these problems in existing buildings by integrating the equipment cabling and cooling arrangements within 12 feet 6 inches of vertical height. This becomes especially valuable in older electromechanical offices where 13-foot clear ceiling heights were frequently constructed. With the necessary modifications to existing building bay dimensions, cable hole locations, and ceiling insert patterns, the use of NEBS standards becomes completely applicable and, in most cases, essential to the reuse of existing building space.