DOCUMENT RESUME

ED 460 577		EF 005 229

TITLE	Guidelines and Standards for the Technology Infrastructure of 21st Century Educational Facilities.
INSTITUTION	New York State Education Dept., Albany. Office of Facilities Planning.
PUB DATE	1998-00-00
NOTE	35p.
AVAILABLE FROM	State Education Department, Office of Facilities Planning, Room 1060, Education Building Annex, Albany, NY 12234. Tel: 518-474-3906; Fax: 518-486-5918. For full text: http://www.nysed.gov/fmis/facplan/home.html.
PUB TYPE	Legal/Legislative/Regulatory Materials (090)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Educational Facilities Improvement; *Educational Technology; Elementary Secondary Education; Modernization; *Standards
IDENTIFIERS	New York; *Technological Infrastructure; *Technology Implementation

ABSTRACT

New York State Regents directed that new guidelines and "standards" be developed for technology infrastructures in educational facilities in order to assist administrators and educators in planning technology integration during retrofits, renovations, or new construction of educational facilities. This document provides the first draft of these guidelines that respond primarily to the needs of rehabilitation and modernization projects, but also can be used for new construction. The guidelines are broken down into nine areas as follows: Environmental/Life Safety; Planning for Electrical Power; Lighting; Space Planning and Pathways; Structured Cable Plants; Libraries; Security; Wireless Systems; and Distance Learning Capabilities. Appendices presents information regarding asbestos regulations and resource addresses. (GR)

Available at Web site
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Guidelines and Standards for the Technology Infrastructure of 21st Century Educational Facilities

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BACKGROUND

The introduction and use of technology in schools, libraries, colleges, universities, museums, and other cultural institutions for purposes of instruction, research and skills development are moving forward at an ever increasing pace. Understanding the opportunities and challenges that this present to both educators and students alike is a major focus of the New York State Board of Regents. In response to these needs, the Department has advanced many programs to improve access to, and the use of, technology by the State's learners, teachers, and citizens.

One of the critical priorities this year will be the establishment of closer relationships between technology planning and the capital plans of institutions. Linking technology and capital planning is necessitated by two important trends affecting the quality of the learning environment and the fiscal efficiency of every educational institution. First, there is considerable pressure on educational institutions-- and new fiscal resources such as the Federal Communication Commission's telecommunications discount program -- to introduce new technologies into the learning environment. Second, coinciding with this urgency to upgrade technology are the mounting problems that many of New York State's educational facilities have with crumbling buildings, deferred maintenance, overcrowding, serious health and safety needs, and new accessibility and environmental requirements. The integration of technologies within facilities, however, is a complex and expensive endeavor in an ever-changing technological environment.

It therefore imperative that a new strategy be developed to enable institutions to integrate new and evolving technologies into facilities as they are being rehabilitated or constructed. As a first step in the development of this strategy, the Department, together with the Dormitory Authority of New York and the New York City School Construction Authority, sponsored the *Accessing Technology: Planning and Financing the Technology of Educational Facilities* conference on October 7 in New York City and October 9, 1997 in Rochester. At these conferences, participants from educational and research institutions, architectural and engineering firms, and technology and telecommunications companies discussed issues relating to the technology components of the infrastructure and the fiscal resources available for technology improvements. There was general agreement that the State lacked facilities "standards" that would assist educators and administrators when they planned for capital projects that, by necessity, should include technology as a major priority.

Based on this need, the Regents directed the Office of Technology Policy, in collaboration with the Office of Facilities Planning, Division of Library Development, and the Office of Finance and Facilities Planning in Higher Education to develop new guidelines and "standards" for the technology infrastructure of educational facilities. These guidelines would be designed to assist and inform the planning process whenever institutions contemplate new technologies or whenever they plan to modernize, retrofit or construct new facilities. It was also determined that the Regents leadership in this area was consistent with their leadership in promulgating standards for curricula, teacher training, and other aspects of educational program quality. These facilities standards would be required for all elementary, intermediate, and secondary schools and public libraries in New York State. In addition, they would be presented to all public and independent colleges, universities, libraries, museums, research institutions, and other cultural institutions in the spirit of "voluntary" compliance. The overall objective, as with other Regents technology objectives, is to build a seamless, networked learning network that takes advantage of all the State's educational resources.

The first step in the development of the guidelines has been the drafting of a "white paper" to begin the identification of the facilities issues that will need to be addressed in the guidelines. To that end, the Department has subcontracted with the architecture and engineering firm, Einhorn, Yaffee & Prescott, to develop the attached first draft of a "white paper" for public comment. In addition to being posted on the Department's web page, http://www.nysed.gov, letters will be sent to institutions, educational organizations, architectural and engineering companies and associations, and technology and telecommunications companies requesting their analysis and input. It is important to emphasize that the purpose of this first draft is to elicit technical comments from all perspectives, including users and contractors. Such a comprehensive review process should ensure that the final guidelines are of the greatest relevance and assistance to institutions. It should also be noted that the Department's approach to these standards is not static. That is, although it is hoped that the guidelines developed this year will provide some meaningful "future proofing" for facilities, there is also the understanding that the needs of institutions and technology itself are always evolving and changing. As a result, the guidelines and standards will be continuously revisited and updated.

I -- OVERVIEW

Goal

To ensure that every New York State education, research, and cultural institution has a technology infrastructure that provides users with high-speed connectivity to internal and external network-based resources.

Approach

The purpose of the *Guidelines* is to assist all institutions in creating a robust infrastructure to support the present and future addition of computers into the educational environment. These *Guidelines* would apply to all New York State schools, libraries, public and independent colleges and universities, museums, and other cultural institutions.

It is not the intent of the *Guidelines* to require institutions to install certain kinds of infrastructure, but rather to give guidance and direction on trends and related information sources. Additional references have therefore been provided to enable institutions to obtain the referenced standards and codes sited.

In addition to technical assistance, the *Guidelines* also recognize the important educational and fiscal implications of "future proofing." That is, careful planning of the technology infrastructure will extend the life of the investment and prevent premature obsolescence. For example, there is an ever-growing demand for bandwidth for telecommunications systems in learning environments. Typically when school districts or libraries start to use networks, the 10 to 16 Mbps range is found satisfactory for text based uses such as e-mail. Multimedia and Internet graphic files are now prevalent so the 100 Mbps range is required. Increasingly necessary, however, is full motion video which may require up to 155 Mbps, depending upon video compression technology. This upward trend in higher bandwidths will continue as computer assisted education and research become more sophisticated. Planning for future technological evolution is therefore essential and needs to be part of every institution's mission.

Finally, because most projects are renovations, the *Guidelines* have provided more detail that respond to the needs of rehabilitation and modernization. They also apply, however, to new construction projects as well.

Needs Assessment and Technology Plan

One of the key entities that needs to be in place is a team that can understand the needs of the district, how the institution wants to move forward with computer assisted education, and an understanding of the current trend that will spawn future needs. It needs to be emphasized that the most important determinant of the kind of infrastructure to be chosen are the applications. This means that in addition to administrative and technology staff, instructional and other educational staff should be part of all technology infrastructure decisions.

Design and Construction

This team should also include engineers and architects, as well as other building industry professionals, to successfully guide the district through the often difficult and disruptive construction process.

It should be emphasized that in this technically complex era, the end user needs to understand the difference between consulting services of professionals and vendors. Professional consulting services require an absence of vested interest in the sale of products. Vendors provide similar information about their respective products, but they have a vested interest in their own products. We, nevertheless, encourage institutions to consult with as many vendors as necessary to obtain the best information, products, services, and prices.

Additional Information

Please refer to the Manual for Planning Standards for School Buildings published by the State Education Department for further information on elementary, middle, and secondary schools. In addition, refer to Codes, Rules, and Regulations of the State of New York 9 Executive B for other requirements.

II -- ENVIRONMENTAL & LIFE SAFETY

Asbestos

It is vital to identify areas of the facility that may contain asbestos before any construction work on a technology upgrade begins. If an Operations & Maintenance program is not in place that identifies and maintains asbestos containing materials, a survey should be done by a qualified environmental consultant. In addition to the potential health hazards, an understanding of the potential impact pathway... construction in an asbestos containing building will also inform project schedules and costs.

There should therefore be a coordination between the consultant designing the telecommunications pathways and the environmental consultant wherever and whenever disturbance of asbestos containing materials is possible. In older buildings, it is usually part of the engineer and/or architect's role to identify concealed spaces that may be used as pathways for the anticipated telecommunications upgrade. It is important that these concealed spaces be investigated as part of the environmental consultant's scope of work.

The result of the environmental consultant's services should be a set of documents that clearly indicates the location and quantity of all asbestos containing materials in the building and the degree of friability and hazard for release each location presents.

It is also important in historic buildings to assure that decorative moldings and plaster are also investigated for possible asbestos, because these materials will most likely be disturbed and/or penetrated during a telecommunications upgrade. The plaster walls in older non-historic buildings can also contain asbestos along with floor and ceiling materials. If cutting, drilling or fastening is to occur, then the area affected must have the asbestos removed

<u>Standards</u>

New York State Department of Labor
Industrial Code Rule #56

Lead Paint

Most schools older than 1977 will most likely contain lead paint on walls, ceilings, windows, millwork, doors or all of the above. The survey for lead content in paint should be conducted by the environmental consultant in a similar manner as the asbestos survey noted above.

<u>Standards</u>

OSHA 29 CFR 1926.62
See Attachment A

Fire Stopping

A fire protection program consists of four components:

- Prevention
- Detection

- Suppression
- Containment

Fire stopping is one of the critical aspects of fire containment. It prevents the spread of smoke and fire from one fire zone to another.

Fire stopping is required whenever a cable tray, conduit, or cable assembly passes through a fire or smoke rated barrier to re-establish the barrier's integrity .

As a telecommunications construction project nears completion and cabling is installed, it is very important to assure that the contractor has properly sealed all openings in fire rated barriers with approved fire stopping materials.

This awareness of the integrity of fire rated barriers should be maintained on an ongoing basis throughout the life of the building. As additional cables are installed or conduits are installed in the future, the fire rating of all barriers should be restored. In areas where it is likely that new cables will be installed in the near future, the consultant should consider using approved reusable fire stopping materials.

Standards

Underwriter Laboratories Fire Resistance Directory
NYS Building Code

III -- PLANNING FOR ELECTRICAL POWER

Power Density

Guidelines for Classrooms

A 20 amp, 120 volt circuit should be planned for each following:

- A general circuit per classroom for task lighting, and miscellaneous other plug in devices,
- One circuit for future printers and scanners,
- One circuit for every three to four computers planned,

Note: Reference to one circuit indicates a dedicated circuit breaker in a panelboard and its connected branch circuit wiring to the receptacle(s). The above guideline for the number of circuits does not include lighting circuits.

Other Areas

The same guideline for the number of computers on a circuit applies to computers anywhere within the building. For other areas such as media centers and libraries, use this guideline of three to four computers on a circuit. In larger areas, the number of circuits available for printers, scanners, etc. should be based on number and power draw of loads. The remaining circuits should be sized for the additional support equipment within the space, such as large production copiers or groups of printers and scanners. The trend is for more intense use of electronic equipment so the future planned capacity should take this into account.

Power Quality

Surge Suppression

With the amount of capital invested in computers and other solid state devices, it is essential to create a coordinated surge suppression system to protect the investment. Power lines are typically subject to switching, lightning, and other events that cause power surges to be transmitted to a building. If these surges are not attenuated to a safe level, damage will result in the solid state devices. This damage may present itself in a catastrophic failure or the device will survive the event with some damage that will cause a failure at a later time.

The following three zones of protection are recommended:

- Service Entrance - A heavy duty Category C suppressor should be located at the service entrance to attenuate the high energy surges that may enter the building via the utility line.
- Power Panel- A Category B—suppressor should be located here to attenuate medium energy surges that originate within the building as well as provide additional attenuation on the surges that have been initially acted on by the service entrance suppression device.
- Point of Use-A Category A—device should be located at the point of connect of the electronic device. Careful consideration should be given to the procurement of these point of use devices because of the abundance of very inexpensive commercially available devices that will not provide the level of protection required.

The following are issues to consider when evaluating the quality of point of use surge suppressors

- Maximum clamping voltage - this is the highest voltage that the protected device will be exposed to.
- The use of a device that will protect power, as well as telecommunications connections, housed within the same enclosure. This device is referred to as Surge Reference Equalizer. The concept is to prevent damage to components caused by grounds in various connects being a different potentials during a surge event. If all components are housed in the same enclosure, the ground reference will be the same thus avoiding potential damage due to high ground currents.
- Indicator lights or other display to verify operational readiness of the device
- UL listed under UL1339 and manufactured after February 16,1998. The units manufactured after this date meet the higher demands of the updated standard such as:

    - More severe endurance testing, and
    - Internally fused to prevent meltdown or explosion if capacity exceeded. (Note: Preference should be given to units that disconnect power from the load when internal fuse opens.

The technical characteristics and methods of application are beyond the scope of this document. A professional engineer should design an appropriate coordinated system that includes a specification for the purchase of point of use surge suppressors. This will give the institution the option to buy the appropriate devices in bulk in the future when replacement of existing -- or as additional -- protection is needed.

<u>Isolation</u>

Electrical distributions systems need to be isolated from sources of electrical noise and spikes such as:

- Elevators
- Large motors
- Large power supplies

Isolation, as used in this context, refers to the practice of dedication branch circuits, panelboards and feeders back to the main distribution centers, to a specific type of load. (i.e. computer loads)

<u>Harmonics</u>

Harmonics, in a very simplistic sense, is the presence of higher frequency power components that are multiples of the primary frequency (60 Hertz) that put additional stress on power systems. If not dealt with properly, they will overload transformers and overheat wiring.
The following are some of the sources of harmonics:

- Single mode power supplies (most common type for computers)
- Dimming systems (such as stage lighting and ballasts)
- Uninterruptible Power Systems (UPS)
- Adjustable speed drives (common in HVAC Systems)
- Electronic lighting ballasts

A system that has many computers and electronic equipment (abundance of single mode power supplies) must be able to deal with the harmonics generated. A professional engineer should be consulted to ensure safe operation of the electrical system. This is particularly important when evaluating existing systems in older buildings for technology upgrades because these older electrical systems were not designed to handle harmonics.

Some of the methods of dealing with harmonics are:

- Oversized neutral conductors in feeders and branch circuit wiring

- Special electronic panelboards that have oversized neutrals
- Harmonic filters
- Special K-rated transformers that are built to operate with a high percentage of harmonics
- Controlling the amount of harmonics by controlling the generating sources; that is, through specification of the maximum harmonic level that certain devices are allowed to generate. This is accomplished as part of procurement specifications.

Backup Power Systems

<u>Uninterruptible Power Systems (UPS)</u>

UPS systems are used to provide typically 5 to 20 minutes of backup power in the event of electrical system failure.

The need for UPS backup depends on the answers to the following questions:

- Whether multi-site distance learning events are planned that require highly reliable power at the origination end?

- Is the event time critical; that is, will it take place regardless if power is available to support transmission?

- Is there a need for extensive rebooting or reprograming of system if momentary power failure occurs?

Types of UPS systems:

- Large Central UPS installations with power distribution systems to equipment that needs protection.

- Modular small UPS systems that just back up the server or critical components that need continuous power.

Note: If it is anticipated that a UPS backup system is required, a modular approach would work best for educational and institutional needs unless there is a compelling reason to spend that additional money for a central system.

<u>Generators</u>

Generators are used for longer term back up power. They take a few seconds to start so they do not provide the continuous power that a UPS does during a power interruption.

Generators provide the long term (hours to days) of back up power needed to power systems such as:

- Life safety systems

- Air Conditioning systems

If an institution's program must function during a prolonged outage, vital equipment will need generator back up. Further, if this equipment requires ventilation and or cooling, the fans and air conditioning equipment will need to be connected to the generator. Generator sets must be specified and specifically constructed if they are to serve high density computer and other electronic (non-linear) loads. The nature of the loads served must be classified as life safety or simply standby. Separate transfer equipment or generator may be required to meet applicable codes. This is true in healthcare and other applications where generators and transfer switches are designated to serve specific purposes such as critical patient care. In these instances the sharing of generator and transfer equipment may be prohibited.

Power Distribution Issues

Planning Power Distribution Systems

The planning of the electrical distribution system should take into account the following:

- Development of a thorough understanding of the current or first use electrical needs, as well as a future projection of long term needs such as higher density computer equipment.

- Installation of sufficient capacity for current needs.

- Development of a cost-effective strategic plan for future needs.

The strategic plan for the future should be well documented by the electrical engineering consultant to ensure a thorough understanding by the institution in the event future expansion becomes necessary.

Main service entrances, feeders, and panelboards should be sized for future load, but only currently required branch circuits need to be installed as part of initial construction. A plan can be developed for installation of additional branch circuits at a later date.

Standards

National Electrical Code
IEEE 1100
IEEE 519

IV -- LIGHTING

Computer Screen Glare

Traditional lensed light fixtures cause excessive glare on computer screens. As users view their computers, they will see two images: the computer graphics and bright reflections of light fixtures. The user's eye will continuously focus between the two images, producing eye strain, fatigue and headaches.

This issue can be dealt with by using the following approaches:

- Indirect Lighting Systems

  This system employs suspended luminaires that direct light onto the ceiling surface. The ceiling then becomes a homogeneous light source that uniformly illuminates the entire room. The absence of concentrated light sources substantially reduces reflected glare on computer screens. For proper performance, indirect systems require a ceiling height greater than nine feet to be effective.

- Direct Lighting Systems

  This system uses recessed ceiling light fixtures with parabolic louvers optically designed specifically to limit luminaire brightness for VDT environments. This type of parabolic fixture substantially reduces computer screen glare as compared to lensed troffers or other parabolic fixture styles. The fixtures produce a "cut-off" light distribution that directs light primarily downward. A drawback to this distribution is that the upper portion of the room cavity is darker and vertical surfaces are not uniformly illuminated. This direct system is more economical than an indirect system, which typically includes more expensive fixtures and higher installation costs.

Lighting Control

With computers and other high-tech teaching and research equipment becoming more dominant in classrooms and other learning environments, control of the lighting systems has become an important concern.

Adjustable light levels are required to address the variety of room functions. This can be accomplished by employing the following lighting control measures:

- Multiple Switching

  Separate control of light fixture groups.

  Separate control of the lamps in each light fixture, such as controlling a three lamp fixture's inboard lamp separately from the two outboard lamps.

- Dimming System

  Wall box dimmer switches to control light fixture groups.

  Dimming panel system with preset scene selection control.

  In lieu of providing incandescent fixtures for dimming, fluorescent dimming is an option for projects with sufficient budgets. Dimming ballasts that are capable of reducing the light output down to 1% are recommended.

- Daylight Control

  Although windows are an important classroom feature, the bright daylight is a major contributor to computer screen glare. To insure a properly illuminated space, the control of daylight is critical. This issue can be address by the following techniques:

  - Window shading -- use products such as blinds that are capable of shielding the entire window area and that include the ability to control the amount of daylight introduced.

  - Room layout -- arrange room so that the computer screens are not directed toward the windows.

<u>Standards</u>

Illuminating Engineering Society of North America (IESNA)
Recommended Practice No.1 (RP-1-93)

V -- SPACE PLANNING AND PATHWAYS

The intent of the structured pathway standard is to provide a logical plan that will accommodate future change with minimal cost and disruption. The basic premises are as follows:

- Horizontal cabling (cable from the work area to the closet) should be configured in a star topology; that is, each data outlet has a dedicated cable run directly back to the telecommunications closet on each floor.
- Horizontal cabling is expensive to reroute because it involves work about the ceiling (or under the floor) and is disruptive because the work must take place in occupied educational space.
- Horizontal cabling will be in place through several generations of networks. New network topologies are to be created in the telecommunication closets.
- New electronics (routers, hubs, switches, etc.) required to support the telecommunications needs on a specific floor/area, shall be housed in the telecommunications closet
- New backbone cabling will be added as needed through the use of spare sleeves/conduit on an as-needed basis. Because this work is not done in occupied program space, it is not required to install initially all future backbone capacity for the first use.

The main components of the pathway system are:

- Entrance Facilities
- Equipment Room
- Telecommunications Closet
- Horizontal Cabling Pathways

Entrance Facilities:

<u>Purpose</u>
Entrance facilities provide the interface and demarcation point between service providers and the cable backbone system within the buildings. It may also contain electronic components; if it does, the space should meet the requirements of an equipment room.

<u>Location</u>

Entrance spaces should not be subject to excessive moisture or major temperature variations. They should be located for close access to the vertical cable riser system up through the building.

<u>Space Sizing Guidelines</u>

For buildings up to 100,000 square feet, wall-mounted equipment may be most appropriate; typically, three to twelve feet of wall space is required depending on building size.

For larger buildings, floor-mounted racks are typically employed, which require dedicated spaces. Typical sizes would be approx. 6' by 12' for a 100,000 sq. ft. building to 12' by 16' for a 500,000 sq. ft. building.

Environmental Considerations

Because the service entrance room generally does not contain substantial amounts of active components, it does not require special consideration other than to be located in an area that will not be subject to flooding or other water hazards. Coordination of environmental requirements (and space) with the service provider is critical.

Equipment Rooms:

Purpose

The equipment room is the dedicated space for large centralized telecommunications equipment such as:

- Private Branch Exchange Systems (PBX)
- Hubs, bridges, routers, and servers
- Cross-connects to provide a means of connecting active components to horizontal and backbone cabling

In addition, the equipment room may be used for other related services such as bell, alarm, paging, energy management, and clock systems

Location

The following should be taken into account for location of the equipment room:

- Provide reliable access to the backbone cable system
- Avoid close proximity to large electrical equipment like elevators, major transformers, motors, and radio systems, etc., to limit electromagnetic interference
- Provide accessibility to HVAC distribution to meet present and future cooling and ventilation requirements
- Avoid locations adjacent to building components that may limit future expansion of the room such as elevator shafts, loading docks, bathrooms, exterior walls, etc.
- Avoid areas of excessive moisture hazards such as flooding
- Avoid areas of excessive vibration
- Facilitate close proximity to areas that may require interaction with equipment such as multimedia areas demanding acess to video origination equipment.
- Provide access for personnel that may service and/or operate equipment, as well as an access path for new equipment to be brought through the building
- Adhere to service provider requirements

Space Sizing Guidelines

Voice and Data

The guidelines for sizing equipment rooms in the EIA/TIA 569 standards use a space planning figure of .75 square ft. of equipment room allocation for every 100 square ft. of work space. This standard is based on office building type usage and needs to be modified for institutional use. This guideline would be appropriate for administration areas. For classrooms and other learning environments, a more reasonable assessment may be in the .5 square foot per computer range.

The computer count should be the maximum number anticipated in the future.

It should be noted that additional equipment may be required in the telecommunications closet to support specific high bandwidth users using switched hubs to allocate dedicated bandwidths.

Environmental Considerations

A temperature range of 64 to 75 degrees F. should be maintained within the equipment room (18 to 24 degrees C.) with a relative humidity range of 30 to 55%. Because this room often must be cooled/ventilated 24 hours a day, seven days a week, year round, it may require its own separate HVAC system that is not on a time clock seasonal cycle.

To prevent dust infiltration, positive pressure should be maintained in the area with respect to the surrounding spaces.

Considering the amount of capital invested in equipment in this room, prudent measures should be taken to protect the components such as wire guards on the sprinkler heads within the room.

This room should not be used to store fuels, chemicals, cleaning agents, or copier supplies. This should be a dedicated environment for active components.

Telecommunication Closets:

Purpose

The purpose of the telecommunication closet is to provide a transition point between the backbone cable system and the horizontal distribution for each floor or area served. The telecommunications closet may also be used to house additional active components that support users in the area served by the telecommunications closet. Further, as the transition point between the horizontal and backbone cable systems, the reconfiguration of network topologies, relocations, and other wiring changes will take place within the closet.

As a special purpose area, the telecommunications closet should not support other electrical equipment that is not related to telecommunications nor should it be used for other services such as janitors sinks or storage.

Location

The location for a telecommunications closet should provide the following:

- Easy access from a hallway or other common area
- A maximum cabling distance of 90 meters from the furthest network access point
- Easy access to the backbone cabling system

- A minimum of one telecommunications closet per floor

Space Sizing Guidelines

Voice and Data

The guidelines for sizing equipment rooms in the EIA/TIA 569 standard use a space planning figure of 1.4 to 1.1 square ft. of equipment room allocation for every 100 square ft. of work space. This standard is based on office building type usage and needs to be modified for K-12 use. It would, however, be appropriate for administration areas. For classrooms, a more reasonable assessment may be in the 1.25 square ft. per computer range.

The computer count should be the maximum number anticipated in the future.
It should be noted that additional equipment may be required in the telecommunications closet to support specific high bandwidth users utilizing switched hubs to allocate dedicated bandwidth.

All active components supporting activities on the specific floor area served should be located in the telecommunication closet.

A minimum clearance height of 8 feet should available with the room. Closets of this type should be at least 4.5 ft. by 4.5 ft.

In smaller buildings or building renovations where it is difficult to find suitable space for a telecommunications closet, shallow closets may be used. Typically, closets of this type are at least 2 ft. deep by 8.5 ft. wide.

In difficult renovations, where even shallow closets are difficult to site, it may be appropriate to use fiber optic cable back to a main telecommunications closet. Fiber optic cable is not subject to the maximum 90 meter distance in terms of system performance (although the standards limit the distance to 90 meters regardless of type of cable used).

Other Systems

The above figure only takes into account voice and data. It most likely will be desirable to configure other cabling needs such as PA and other special systems back to the telecommunications closet in a star configuration (unless they have already been integrated into the structured cabling system). Additional space must be allocated for this wiring.

Environmental Considerations

If the telecommunications closet is used to house active components, a temperature range of 64 to 75 degrees F. should be maintained the (18 to 24 degrees C.) with a relative humidity range of 30 to 55 percent If the space does not contain active components, a temperature of 50 degrees F. to 95 degrees F. should be maintained (10 degrees C. to 35 degrees C.) with a maximum relative humidity of 85 percent.

Because this room often must be cooled/ventilated 24 hours a day, seven days a week, it may require its own separate HVAC system that is not on a time clock seasonal cycle.

To prevent dust infiltration, positive pressure should be maintained in the area with respect to the surrounding spaces.

Wire guards on the sprinkler heads should be used within the room.

VCT tile should be used in lieu of carpet to minimize static discharge potential.

This room should not be used to store fuels, chemicals, cleaning agents, or copier supplies; it should be a dedicated environment for active components.

Horizontal Cabling Pathways

Suspended Ceiling Systems

Newer buildings often have suspended ceiling tile systems. This allows for an above ceiling distribution system to be installed. Although most systems use lay-in acoustical tile, some systems such as concealed spline are very difficult to remove and replace without significant damage. For older schools with high floor-to-floor heights and plaster ceilings without easy access, a possible solution for horizontal pathways is to install a suspended ceiling in conjunction with the cable pathway system installation.

The area above a suspended ceiling can be classified as plenum or non-plenum. This refers to whether or not the area above the ceiling is utilized as the return air plenum for the HVAC system. In spaces used as air handling plenums, special, more expensive, plenum rated cable must be used unless the horizontal cabling above the ceiling is completely enclosed in conduit or wireway.

Non-Suspended Ceilings

When a convenient space such as the area above a suspended ceiling is not available for horizontal cabling, the building should have a thorough architectural evaluation to determine potential routing. This is typical in older buildings. The following are potential options to consider in this situation:

- Creating a space for cable distribution by installing a new drop ceiling
- Pursuing areas above a plaster or sheet rock ceiling. If this space exists, access points and staging areas for cable installation and maintenance may be created.
- Creating an architectural soffit system to distribute cabling in corridors. This can be designed to complement the architectural nature of the building.

Under-floor Distribution

Under-floor distribution methods are most appropriate for new construction; however, they can be applied, in a limited manner, to buildings undergoing a renovation. Typically, under-floor distribution methods combine both power and telecommunications wiring in the same installation method.

- Under-floor Ducts

  Systems consist of wire ducts that are embedded into the concrete slab. Inserts provide the access to the ducts for network connections.

- Conduit

  Can be run in the slab to each potential computer location. This system is not flexible.

- Cellular Floors

  This method used in new construction incorporates buried wireway into the structure of the building. The system, typically, has much more capacity than a duct floor system.

- Access Floors

  Often called raised floors, they provide a very flexible pathways for horizontal wiring. This method is appropriate for building areas that expect very intense computer use and frequent relocation of computers.

<u>Support Methods</u>

Cables cannot be laid on the top surface of the ceiling tiles or suspended by the ceiling system.

The following methods are commonly used for above suspended ceiling cable installations:

Cable Tray

This is typically the most flexible as well as the most expensive method. This continuous support system allows greater accessibility and is easiest to manage because cables are laid in a trough and typically not bundled as in a J-hook installation as described below. This method allows the installation of additional cables while leaving the existing cables in place. Because the cables are not bundled with the new cables on top and old cabling on the bottom, obsolete cabling can easily be removed at a later date. If funding and space are available, this is usually the method of choice.

J-Hooks

Another, less expensive, method is use of J-hooks. This support system utilizes individual hook-like devices to support cables, typically placed on 4-foot to 5-foot centers. Interior telecommunications cables are not self supporting and care must be taken not to overload a J-hook installation because this may have an adverse effect on cable performance. Manufactures ratings and installation instructions must be rigidly followed.

Conduit

If less expensive non-plenum rated cable is used in environmental air-handling spaces, a conduit system must be used to enclose the cable. This is a less flexible method because it is difficult to install new cabling without removing the existing cables. In addition, if more cables are needed, it is also difficult to pull new cables into occupied conduits. If spare conduits are used to deal with this issue, extra expense will be incurred.

Clearances

It is necessary to maintain proper clearances above the ceiling for:

- Access to cable trays and J-hook installations for future cable installations and modifications

- Required clearance from heat and electromagnetic producing devices about the ceiling such as lighting ballasts

Pathways at the Point of Use

The final connection to computers in such open areas as classrooms, libraries, or open offices can be one of the more difficult problems in telecommunications and power wiring. The following are methods commonly used:

<u>Poke-Through Devices</u>

This method involves core drilling a hole and feeding up from the floor below. Although commonly used, this method has many drawbacks:

- High cost of drilled holes
- Negative structural and fire rating impact on slab
- Every relocation of user requires a new hole to be made

<u>Cellular Floor and Duct Systems</u>

- Cellular systems are flexible and meet the need for open area access but can only be installed during new construction.
- Duct systems are a similar application; however, they can be installed in existing slabs, though it requires trenching the slab. Another solution is to lay out duct on existing concrete slabs and add lightweight concrete to encase ducts. This method involves dealing with the resulting change in floor elevations in relation to corridors, etc.

<u>Perimeter Wireways</u>

This is a common application for both new and renovation work, as well as technology upgrades, because it has the least impact on the building. Wireways, mounted on perimeter walls, can be surface or flush mounted.

Wireways typically are of a suitable metal multi-channel construction to provide a shield around telecommunications cabling, thereby, allow power wiring to be located in the adjacent channel.

Data and power outlets are mounted in the wireway at convenient locations. Additional outlets can be inserted in knockouts as required.

This type of distribution requires computers to be located close enough to the perimeter walls to connect to the appropriate outlets.

<u>Modular or Custom Furniture</u>

Another approach is to use the furniture system as a means of final distribution within the classroom or other open areas. This method involves using internal wireways to distribute the cables to data and power outlets mounted in the furniture itself. Furniture is then arranged in the area to have contact with a perimeter wall or column to allow cabling to enter the furniture system.

Power Poles

Power poles are usually not a desirable solution because of site line issues in classrooms. If used, they should be of the heavy duty type to stand up in the educational environment.

Under-carpet Cable Systems

Under-carpet systems are typically not appropriate for a heavy use educational environment. These flat cables installed under carpets can be susceptible to damage from foot traffic and furniture moves.

Standards

EIA/TIA-569
Commercial Building Standard for Telecommunications Pathways and Spaces

VI -- STRUCTURED CABLE PLANTS

The intent of the standard for structured cable systems, TIA/EIA 568A , Commercial Building Telecommunications Standard, is to provide a multi-product, multi-vendor environment. This means that the cable system, if installed per this standard, will be able to support many different vendors as well as network topologies. The cable system is intended to have a useful life of at least ten to fifteen years. This system will support voice, data as well as video. Before the standards were available, cabling was often vendor specific, which meant when equipment vendors were changed, it was often necessary to replace the entire cabling system. This is very expensive, disruptive and wasteful.

Further, it should be emphasized that standards are constantly being updated to reflect technological advances in cable technology. Planners, as a matter of policy, should therefore always obtain the most recent addition.

Cable systems are categorized as backbone or horizontal.

Backbone systems connect service entrance, equipment room and telecommunications closets. The backbone cable system is typically fiber but can be copper based as well.

Recognized Cable Types

The following types of cable are recognized by standard 568A:

- Four-Pair 100 ohm Unshielded Twisted Pair (UTP)
- Two-Pair 150 ohm Shielded Twisted Pair (STP)
- Two-Fiber 62.5/125 ohm Optical Fiber

At present, 50 ohm coaxial cable is recognized but not recommended for new installations. It will likely be removed from future editions of this standard. The systems that are now supported by this type of cable will use the three cable types listed above.

Unshielded twisted pair (UTP) has become the most commonly used cable based on cost effective criteria. If a high level of electromagnetic interference (EMI) is present, more costly shielded twisted pair may be required to attain the same level of performance.

One of the considerations when selecting cable types is the diameter of the cable. If a larger diameter cable (such as STP) is selected, conduit sizes will have to be larger for all pathways to get the same flexibility.

<u>UTP</u>

Since UTP is the most commonly used cable, the following provides additional data on this cable type. Note: Lengths of cable are limited to 100 meters including drop lengths to attain the following performance levels:

Category 3- Supports applications through 10 Mbps (Mega ***bits*** per second)

Category 4- Supports applications through 16 Mbps

Category 5- Supports applications through 100 Mbps

It should be noted that each category represents a minimum standard of performance. All category 5 cables, for example, meet category 5 performance standards, but each may exceed them to various degrees. All category 5 cables are not equal.

Additional categories of cable, such as enhanced category 5 as well as category 6 and 7, have been developed by cable manufactures. These higher performance components have not yet been recognized by the standards. This is one of the inherent problems of standards in a rapidly developing industry. Standards will lag behind innovation. To be able to use this higher performing cable, performance based, as opposed to standards based, specifications must be used.

The State Education Department recommends that a minimum of category 5 or fiber be used in most, if not all, renovations and new construction projects.

Fiber Optic Cabling

Traditionally, there is a choice to be made between using fiber optic cabling vs. copper cable. In the past, fiber cable has been the more expensive option because of the cost of the electric interfaces involved (electrical signal to optical signal, and then back to electrical within the computer). However, recent reductions in the interface electronics have made fiber more competitive as a horizontal cabling media to the desktop.

Fiber Optic cabling has the following advantages:

- Fiber has the largest bandwidth of any media.
- Fiber can extend 20 times farther then copper cable.
- A fiber system may not need telecommunications closets on each floor since they may be extended all the way back to a central location in the building in a star configuration.
- Fiber is not subject to EMI.
- Because of the almost unlimited bandwidth of fiber (fiber's bandwidth is limited only by the electronics at this point, which will continue to improve), it may have a longer useful life then a copper cabling system, as bandwidth demands become greater.

Placement Issues

The proper installation and protection of cabling is critically important. Fiber must be installed with attention to minimum bend radius and mechanical protection

High performance Category 5 cabling must be installed properly to be able to attain the performance levels this cable is capable of delivering.

Some poor practices that can compromise Category 5 cable performance are:

- Violating minimum bend radius

- Violating minimum distance between supports
- Installing too close to EMI or heat sources
- Excessive untwisting of cable at terminations

Management

Cable plant management has also been standardized to insure long term success of installation. Cable management is critically important to the long term success of a cable plant installation. The lack of proper management will erode cable performance over time and lose control of the quality of the installation. Trouble shooting an existing cable plant to determine where problems exist is expensive and disruptive. It is best to follow good cable management practices to assure continuous performance.

An investment needs to be made in the personnel that will be assigned to manage the installation. A poorly managed cable plant typically needs an additional investment in electronic components or additional cabling because the capacity of the cabling installation has apparently been reached (prematurely)

NOTE: Although this paper will address some telecommunications issues, the SED will also develop a companion discussion paper that will focus more exclusively on standards for hardware, software, and networking as opposed to facilities infrastructure.

Standards

TIA/EIA 568A Commercial Building Telecommunications Cabling Standard

TIA/EIA 606 Administration Standard For The Telecommunications Infrastructure of Commercial Buildings

VII -- LIBRARIES*

New demands are being placed on libraries to not only be centers for accessing printed material but to be an access point for digital material as well. The new demands also include the need to use multimedia equipped computers to edit and manipulate audio as well as video based materials. Further, library workstations are increasingly be used by many members of the public to access the Internet and other databases.

These new activities have a profound effect on the infrastructure required for libraries. One important difference exists between the approach to infrastructure of a classroom environment and that of a library. It is expected that the large open spaces of a typical library will require many moves and reconfigurations as technology evolves over time. Likewise, libraries will have to contend with significant structures that currenly occupy so much space such as stacks and reading rooms. These concerns, and many more, will require a more flexible plan to accommodate changes than would be expected in a classroom, for example.

The following are approaches that can be implemented during new designs and major renovations to make the library infrastructure more suitable for the transition to high density computer use.

Electrical and Telecommunications Pathways

- Provide access floor or underfloor duct system for power and telecommunications wiring or other method to provide cabling pathway to all areas.

- Where possible, provide areas presently allotted for stack areas with the same pathway support systems as areas intended for high density computer use.

- When sizing electrical systems, give main components enough extra capacity to support high density computer use throughout the library spaces.

Lighting Issues

Install only lighting systems that provide low glare environment for computer use.

Develop a plan to deal with the large amount of natural light that enters many libraries, such as hanging banner systems or window treatments. This is necessary to reduce high luminance (brightness) sources which can be projected onto FDT screens.

**Enhancements to this section are currently being developed.*

VIII -- SECURITY

Access Control

Security for computers can be broken down into two categories:

Computers Located In Secure Areas

This method of computer security controls the space where computers are located. There are several systems that can accomplish this:

Access Control Systems

This system allows access to area by card, keypad or other door peripheral. This access can be provided 24 hours a day or just off hours (after normal school hours).
It will restrict access to the area to the individuals that have the appropriate cardand will provide a record of the cards used to access an area as well as a time log of use.

Intrusion Control Systems

This system involves security devices to protect areas where computers are located. The devices typically employed to provide this mode of security are:

- Cameras and recording equipment
- Motion Detectors
- Door contacts

Machine Security Attachments

Another approach is to protect the computer itself, in addition to or instead of, protecting an area. The most effective application of this method is a system that protects not only the computer case (enclosure) from being removed, but also protects against entry into the computer's internals to remove or tamper with memory or other internal components. Various specialty manufacturers have made available devices that are specifically fabricated for this computer security application. They typically require an electrical cable to be cut in order to remove or open the computer component. This cable is supervised by the security system and alarms when cut. Mouse and keyboard can also be protected in a similar fashion.

IX -- WIRELESS SYSTEMS

Wireless technology is changing rapidly, thereby creating opportunities for the deployment of this technology in the educational and research environments. There are limitations to this technology, however. With a maximum speed of approximately 10 to 24 Mbps it works well for data but is not ideal for full motion video. It could very well prove to be a bottleneck in high bandwidth multimedia applications.

The following categories present some of the applications for wireless technologies for institutions.

Extension of Wired LANs Within Buildings

As laptop computers become more and more common for teachers and students, the ability to connect to the network without physical connectors is very desirable.. The traditional 120 volt receptacle and plug configuration is constructed to withstand numerous cycles of attachment and removal. Telecommunications connections are not commonly constructed to provide the same durability.

The ability to connect to wired LANs via a wireless connection is made possible by two technologies: infrared and radio frequency (RF) technology.

This technology can also be used to connect students in auditoriums or other large public areas to the network.

Another application of this technology may be for a remote user who cannot be easily connected to the wired LAN.

Historic buildings in which a wired network cannot be installed without compromising the historic fabric of the building is another application.

Wireless connections and networks come with their own disadvantages that are addressed in the next section.

Wireless Networks Within Buildings

The obvious advantage of a totally wireless network is not having to run telecommunications wiring throughout the building.

Totally wireless networks within buildings do have, however, the following disadvantages:

- Relatively low transmission rate of 10Mbps
- More expensive on a per user basis then wired networks
- Network security issues such as emissions from remote unauthorized sources

Wireless Networks To Access Remote Sources/LANs

This section addresses building to building or building to Internet access issues.

One of the most straight forward solutions is special high speed access lines from the local provider. This cost varies by locality and soon may be subject to discounts.

Several of the alternatives to this approach are:

<u>Microwave and Satellite</u>

Both these technologies can be very expensive and can involve FCC regulations and line of sight restrictions, as well as limited capacity due to high incremental

<u>Low Power Radio</u>

The FCC has released bandwidth for unlicensed operation low power operation (.1 Watt). This technology will allow building to building access at a very low cost. It also can be used to share a high speed access line to the Internet that is connected to one school building with other sites. This avoids the high monthly cost of each building leasing its own high speed Internet access line.

X -- DISTANCE LEARNING CAPABILITIES

The following define some of the important issues for a successful distance learning classroom. If is important to decide the use and goals of the room before a design is developed.

Planning/Programming In Conjunction With Design Team

Establish Goals

- Technology must be driven by academic curriculum goals
- Goals should be established by instructional staff before the technology is selected.
- Design team should then be charged with creating an environment and the appropriate technology to achieve goals

Identify Instructor Capabilities

The present and future capabilities of the instructors must be taken into account in order to design properly a distance learning facility. This is important because if the decision has been made to provide technical assistance to instructors using additional personnel, the facility will be configured differently. Facilities to be completely operated by instructors will have all media controls in a podium or other enclosures located in a high profile location in the front of the room.

- Determine level of expertise of instructors
- Determine how much assistance will need to be provided (a control room, who operates equipment)
- Identify type of equipment needed

Flexibility vs. Tailored For a Specific Use

- Determine whether the classroom will be physically reconfigured to meet a variety of needs or set in a specific long term configuration
- Ultimate flexibility may not always be appropriate

Determine Room Population

- Actual population
- Virtual population

Determine Level of Remote Participation

- One way or two way
- Who controls transmission

Room Design Issues

Layout and Size Considerations

- Proper height to mount and service ceiling mounted devices
- Proper room configuration for good viewing angles
- Balance of room size and monitor size to assure optimal viewing
- Storage capacity for equipment and furniture needed to support program
- Slab and wall structural characteristics that attenuate outside sources of noise

Acoustics

Criteria

- Criteria is much more stringent in a distance learning classroom than in typical classroom
- Acoustics will have a large impact on the quality of the program because poor audio is much less tolerable than poor video when evaluated for its impact on program effectiveness.

Source Control

- Avoid street noise by selecting windowless room
- Provide carpet and wall treatments to prevent echoes
- HVAC system design for low noise

HVAC System Design Issues

- Locate HVAC equipment a reasonable distance away from room
- Provide long runs of duct before system enters room to reduce noise
- Utilize lined ductwork and silencers to reduce noise
- Mount Variable Air Volume distribution boxes as high as possible in ceiling cavity
- Air diffusers should be selected on their published noise generation data
- Air velocity should be very low where air is transported near, or introduced into the room to reduce noise
- Air volume balancing dampers should be located five to ten diameters of ductwork upstream of air outlet or outside room completely
- Design ductwork to minimize turbulence

Lighting

The control of the lighting system in a distance learning room is critical. The following issues need to be addressed:

- Lighting levels must support note taking
- The instructor must be properly illuminated during transmission
- Lighting cannot wash out projected images
- Lighting must not produce glare for instructor when facing class/cameras

Approaches to be considered:

Adjustable spot lights with shields for illuminating instructor

Dimmable electronic ballasts for control of fluorescent lights

Attachment A

Asbestos Regulations

I. Federal Regulations
   A. USEPA
      1. Asbestos-Containing Materials in Schools
         Section 40—Code of Federal Regulations (CFR) Federal Register
      2. Guidance for Controlling Asbestos-Containing Materials in Buildings (Purple Books) EPA 560/5-83-002
      3. NESHAPS—National Emission Standards for Hazardous Air Pollutants
      4. AHERA—Asbestos Hazard Emergency Response Act Federal Register—October 30, 1987
         a) Regulations for all public and private schools K-12
         b) Inspect for ACBM's and submit Management Plan to State Governors by October 12, 1988
         c) July 1989—Implementation of the Management Plan
   B) Department of Labor
      1. OSHA—Occupational Safety and Health Administration
         a) Asbestos Standards for Construction Industry Section 29 CFR 1910.1001 & 1926.1101 and 1910.20
         b) Objective: Reduce occupational worker exposure
II. New York State Regulations
   A. Article 30 of the New York State Labor Law
      1. Part 56 of Title 12 of the Official Compilation of Codes, Rules and Regulations of the State of NY, cited as Industrial Code Rule 56.
         a) Asbestos Work Practices
         b) Licensing of Asbestos Contractors
         c) Certification of Asbestos Handlers/Supervisors
   B. New York Department of Environmental Conservation (NYDEC)
      1. Regulations regarding Waste Transport and Disposal
   C. University of the State of New York State Education Department Manual of Planning Standards for School Buildings
   D. Code Rules and Regulations of the State of New York 9 Executive (B)

III. New York City
      1. NYC Department of Environmental Protection
         a) Local Laws 70 and 76
         b) Asbestos Work Practices and complying with DOL Article 30
      2. NYC Department of Sanitation
         a) Regulation of Landfills and Waste Transportation

Attachment B

Resource Addresses

ANSI - American National Standards Institute
430 Broadway
New York, NY 10018

EIA - Electronic Industries Association
2500 Wilson Boulevard
Arlington, VA 22201-3834

TIA - Telecommunications Industries Association
2500 Wilson Boulevard, Suite 300
Arlington, VA 22201-3834

NFPA - National Fire Protection Association
1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269

IEEE - Institute of Electrical and Electronic Engineers
IEEE Service Center
445 Hoes Lane, P.O. Box 1331
Piscataway, NJ 08855-1331

IESNA - Illuminating Engineering Society of North America
120 Wall Street
New York, NY 10005-4001

OSHA - Occupational Safety and Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

UL - Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062