Ministry of Technical
and Vocational Education

Republic of Lebanon
Office of the Minister of State for Administrative Reform
Center for Public Sector Projects and Studies
(C.P.S.P.S.)

Technical Schools - Building Specifications

DEVELOPMENT SERVICES

الخدمات الإنمائية

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الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

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BUILDING SPECIFICATIONS

development services

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CONTENT

PREFACE

This document presents the guidelines that should be observed by the architect when designing the premises of a new Technical and Vocational educational facility.

The document comprises four Chapters and five Annexes. A brief description of the content of each part of the document is given here below.

Chapter 1 is divided into 3 parts :

- ***Part 1*** presents the major principles governing the design of the educational facility and describes the main inter-related constituents of the campus.
- ***Part 2*** describes the various functional areas of the school and determines some basic standards for their calculation.
- ***Part 3*** introduces the Annexes where the electrical and mechanical building equipment are technically described.

Chapter 2 is dedicated to the various recommendations regarding the building(s) housing the classrooms. It covers their dimensioning, their surface (walls, floor and ceiling) fixtures and finishes. It also prescribes guidelines for their lighting systems, their acoustical characteristics and their electrical and HVAC systems.

Chapter 3 describes the Practical Work Areas (PWAs). These include the workshops, drawing rooms, computer rooms, scientific and universal labs. All these areas have been regrouped into five standardized types of constructions called : Class A; Class B; Class C; Class D and Class E. The constructional characteristics of each class are presented in a detailed table. Class A, Class B and Class C areas call on some specific details, which are given in 3 appendices to Chapter 3.

Chapter 4 complements the Chapters 2 and 3 in presenting methods for the calculation of the number of units for each specific functional area : classrooms and PWAs. This chapter aims principally at helping in the preparation of the "Construction Programme" for each school – the main document that governs the designers' work. However, these methods may be useful for the architect, since they point to many links between the various parts of the campus. In this respect, the designers must keep in mind that the main principle underlying the concept of standardized PWAs in five classes is to provide flexibility for the school to meet with the labour market variable demand : ***the possibility of closing a specialization and implementing another one in the same premises.*** Thus, each PWA must be seen as a polyvalent construction where a series of different educational activities can take place, depending on the installed equipment.

Finally, the **5 Annexes** describe the electrical and mechanical building components. The guidelines proposed in these Annexes should be observed, unless otherwise prescribed in the Chapters text. These Annexes are :

Annex 1 : Power distribution guidelines.

Annex 2 : Plumbing guidelines.

Annex 3 : Elevators.

Annex 4 : Heating, Ventilating and Air Conditioning.

Annex 5 : Telecommunication wiring guidelines.

School Buildings Design Considerations

Part 1 : Planning of School Buildings

1.1 Introduction

Planning a building for a particular type of training involves the difficult task of matching educational programs with specific buildings. The social change required continual need for new educational programs and consequently, school buildings, which are not difficult to alter. Thus rigid school buildings can impede the modernization of educational facilities and the introduction of reforms.

Buildings have much longer life than educational programs for which they were once intended. This fact may result in a building, which is no longer suitable. Changes that may occur involve alterations in curricula, introducing new specializations, or increasing the number of students.

These factors have two consequences for the planning of buildings :

a- *A design for a school must be carefully matched with its curriculum and goals.*
b- *Allowance for the greatest possible uses must be built in the design.*

Thus architects must come up with flexible school design. This design must be easily adaptable and alterations at later stages can be made to suit new specializations with minimum modifications on the school structure. Schools should be designed so that future additions to the building will not require major changes in the existing facilities.

1.2 Planning Adaptable Designs

Factors effecting building flexibility

Educational planners are today concerned with the idea of flexible school designs. The more adaptable the design is, the greater the possibilities for easy alteration and development at a later stage, and the more useful the building will be in the future. The harmony between educational guiding principles and spatial reality, so necessary for successful teaching, can in this way be recreated again and again.

The design considerations, which have substantial impact on the flexibility of a school building, relate greatly to the type of walls of a teaching area and to the installation layout.

1.2.1 Types of walls

Construction of buildings in Lebanon enforces two basic types of design for school buildings as follows :

- ***The skeleton principle :*** The ceiling is carried on a system of supports, mainly made of concrete. The walls can be altered enabling a variety of sizes and shapes of rooms. The process of alteration is not very easy, as it requires knocking down walls and building new boundaries. Furthermore, the intervals between supports have a structural limitation and freestanding supports will also limit the functionality of the room.
- ***The self-supporting principle :*** When large rooms are required, then the self-supporting ceiling should be considered. The space in between can be divided as required when needed. However, this last solution is very expensive.

1.2.2 Installations layout

Installations must be planned with particular care if value is placed on the possibility of altering the rooms later. For instance, it does not make much sense to lay all pipes and cables under plaster. Instead, it is advantageous to put the whole system (water, sewage, gas, electricity and communications cables) in the ceiling- in the corridors for instance- and cover it with a hanging ceiling. There are now ways of laying the whole system flexibly. In this way additions and alterations can be easily made at anytime.

1.3 General Design Criteria

1.3.1 Functional school areas

a) Inhabited areas of a school

The basic school building comprises of the following functional areas :

✳ ***The teaching area[1] :***

This Includes all teaching and learning activities in the various subject areas. Therefore this must be further classified at later stages of planning. When planning the area to be used for theoretical teaching, one must take account of the activities which will take place in the rooms- for instance "technical Drawing Room", "Foreign Language room", or "Technology". Similarly varied use will be made of the practical area : Laboratories for science and technology and workshops for the various vocations and vocational fields require individual consideration. The teaching area comparizes normally of : classrooms, laboratories, workshops.

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1) This section will be described in detail in Chapter 3.

✳ **The information area :**

Comprises of areas dealing with information and communications. From an architectural point of view, the factors involved are rather varied : an auditorium, perhaps with a small stage and slightly tiered seating, a library with a reading room and a computer room, store-room, and an area for exhibitions, which can also be used as a lounge.

✳ **The administration area :**

The School's office space belongs in the administrative area, as so do principal's room and working areas and lounges for the teaching staff. Conference rooms and teachers library and computer room is also located in this part of the building.

✳ **The catering area :**

The catering area is made up of the kitchen, rooms for preparing and storing food, a washing-up room and the dining room.

✳ **Leisure and sporting area :**

The amount of consideration given to leisure facilities and sporting area is largely determined by the site chosen, the size of the school and financial factors.

✳ **The transport area :**

A transport area must be also considered when one is planning the distribution of the area available for building. This includes garages for school's own vehicles, storage areas and enough space for parking.

b) School equipment areas

Proper sizing of mechanical and electrical equipment rooms to accommodate the building's mechanical and electrical systems and to allow maintenance personnel easy access, shall be carried out. Transformers, boilers, pumps, tanks, heat exchangers, and other large equipment must be located adequately to permit easy servicing, operation, and removal. Adequate circulation areas around equipment must be provided, including around valves and accessory piping. To the greatest extent practical, access to mechanical and electrical equipment rooms shall occur from public corridors. Accessing mechanical and electrical spaces through custodial spaces is to be avoided.

✳ **Mechanical rooms :**

Adequate circulation space shall be provided in all mechanical rooms to facilitate maintenance and repair operations on all equipment located within.

An adequate number of floor drains shall be sized and placed in each mechanical room to prevent water damage to adjacent areas in the event of a pipe or fitting leak.

Sufficient lighting for maintenance and service work shall be provided. Additionally, a telephone connected to the campus system shall be provided in each mechanical room.

Appropriate sound and vibration isolation measures shall be taken when locating a mechanical room within the facility.

* **Telecommunications rooms :**

Telecommunications rooms are also referred to as "frame rooms" or "wiring closets". There will be a telecommunications room located on each floor of the new facility. The "main" telecommunications room (MDF, Main Distribution Frame) shall be strategically located on the first level of a building. In multi-level projects, stacking these elements is recommended for economy, and when practicable, the MDF should be located close to the service entrance of the building.

Main Distribution Frame (MDF) Rooms or Closets :

Each building shall contain one main Tele/data wiring closet designated as the Main Distribution Frame (MDF), which shall be a minimum of 100 square feet in size. The MDF room shall contain the outside plant copper, fiber and cable TV entrance facilities, tie cable origination to IDF closets, and station cable origination to tele/data/TV outlets within the building specifically served by this space.

* **Intermediate distribution frame (IDF) rooms or closets :**

All other tele/data wiring rooms within the building shall be designated as Intermediate Distribution Frame (IDF) Rooms. These rooms shall be a minimum of 80 square feet in size. The typical IDF closet shall contain the termination of tie cables from the MDF and station cable origination to tele/data/TV outlets within the building specifically served by this space.

MDF and IDF Location :

The MDF and IDF locations within buildings shall be such that all tele/data station cabling distances from wiring blocks to station outlets are no greater than 90 meters (295 feet). If this distance is exceeded, multiple IDF rooms will be required for that level. The MDF and IDF closets shall be separate rooms, not shared with electrical, mechanical, storage or custodial spaces. The MDF and IDF closets shall be connected with cable trays and multiple 4-inch conduits. For buildings above one story, the frame rooms shall be stacked, and connected via multiple 4-inch conduits.

Minimum 5/8" thick plywood, painted with fire retardant, electrical gray in color, shall be installed on all walls of the tele/data frame rooms in the new building. This is to provide mounting space for tele/data/TV termination equipment. A minimum of one quad electrical outlet shall be installed on each "frame" room wall, eighteen inches above the finished floor. No carpeting is to be installed in the "frame" rooms.

c) School support facilities : Stores and store rooms

* **Store for raw material :**

Requires a space of 80-120 m^2 depending on the stored material (electrical, Mechanical..). Approach ramp is required for loading. Space for standard dimensions sheet metals and pipes must be considered.

* **General store/Distribution of tools :**

80-140 m^2 of space to store boxes of tools and general use parts. Approach Ramp is required.

* **Store of liquids :**

About 20 m^2 of space to store liquids, paints, small amounts of patrol and diesel for training uses. Room should be explosion proof with independent ventelation system and metal containers to store explosive materials.

* **Store for gases :**

Approximately 12 m^2 per store. Up to 4 stores are recommende. Materials stored are cylinders containing acetylene gas, oxygen, inert gas, propane and butane. Store rooms must be close to the area of use but have a safe distance.

* **Compression room :**

Minimum 16 m^2 for central production of compressed air.

* **Scrap metal and refuse storage room :**

About 40 m^2 of space for metal scrap and refuse. Close to workshops and buildings. Waste carts for unloading are recommended.

* **Installation work area :**

Approximately 140 m^2 of Diverse building materials for instalation works : Electrical and Mechanical.

* **Overhead line construction and cable laying :**

Where needed, approx. 200 m^2 of space for Laying of lines and lighting installations on pylons and in trenches.

* **Waste oil ditch :**

Where needed, a ditch for oils and lubricants. Special tubing will be adopted.

✳ **Solid waste collection :**

Outdoor solid waste collection sites are to be located in the major building service areas where their need is required. The sites are to be as visually inconspicuous as possible. All sites shall accommodate pick-up by a 40-foot long by 8-foot wide truck, including turn-around space. All sites are to be screened from public view with constructed elements compatible with the architectural character of adjacent buildings.

d) School support facilities : Parking

✳ **Parking areas :**

General parking areas are to be clearly defined and physically separated from roadways. Existing trees are to be preserved to the greatest extent possible. Paved lots are to be striped, delineated with curbs and gutters with appropriate drainage and proper lighting for safety after dark.

Spaces for service vehicles and vendors will be provided also. Usually, the number required will be from four to six (4-6) spaces. The service parking spaces are to be located adjacent to the building within an enclosed service yard.

✳ **Bus and auto traffic :**

All new schools should have separate entranceways and exits for bus and automobile traffic. If the configuration of the school campus does not allow for separate bus and automobile entranceways and exits, the school should have staggered arrival and dismissal times for bus and automobile traffic.

Pick up and drop off areas should be designed so that students do not walk through automobile or bus traffic to get to or from their transportation.

Visitor parking areas should be located near the designated entranceways for visitors.

1.3.2 Site design considerations

a) Project siting

Consideration should be given to the building placement as it relates to traffic and pedestrian patterns. Scale of the structure should be contextually compatible with other buildings adjacent to it. The building should not overwhelm the site. Utilization of open space within the site is critical.

* **Outdoor spaces :**

Careful design of spaces between buildings will integrate these interstitial spaces into the network of campus open spaces. Within these spaces there are opportunities to create gathering spaces or "outdoor rooms". Take care to locate these outdoor rooms where their activity will not disrupt or distract nearby classroom or similar established activities. In developing outdoor spaces, the designer should look to the existing campus for precedents of form and material as well as lighting, signage, and landscaping.

* **Ramps and steps :**

Accessibility ramps shall be placed at all roadway intersections. Individual site or project designers shall be responsible to coordinate the width of such ramps with the anticipated usage. The use of steps is to be avoided if at all possible.

Provide railings and guardrails at stairwells, steps, bridges, loading docks and ramps, as may be necessary in the interest of safety. Provide runways and ramps in all buildings where bulk supplies are handled. Ramps are to have a non-slip surface.

b) Drainage

* **Site drainage :**

The site is to be graded in such a manner that all areas slope away from buildings at a minimum gradient of ¼" per foot. Grade all terrain surrounding the building, including loading, service and parking areas in such a manner to prevent water flow into the building should storm drains servicing the area become overwhelmed. Site drainage from new construction is to be tied to the existing storm water drainage system.

* **Storm drainage :**

All storm water runoff from paved areas shall be collected in inlets and carried by underground pipe to retention areas. No open ditch runoff is allowed.

* **Roof drainage :**

Provide appropriate drainage design to accommodate roof drainage from the building or facility.

1.3.3 Superstructure

Foundations

A geotechnical engineer shall provide a thorough subsurface exploration program for all new construction projects. The engineer, shall determine the number, locations, and depth of soil borings, or other tests required to establish a reasonable estimate of the elevation of bearing strata or depth of the foundation system. The geotechnical engineer shall prepare a report indicating an estimate of the properties of underlying soils, location and characteristics of ground water, allowable soil bearing pressure and recommended type of foundation system. The design of suitable foundation system will be based on the findings of the soil exploration program and the recommendations of the geotechnical engineer.

1.3.4 Access and safety design considerations

✳ **Access :**

All new schools should be designed so that maximum visual access exists within the facility. Schools should be built on flat ground as much as possible to allow maximum visual access. Entranceways should be designed so that entry through them can be easily monitored and controlled. Access to the building through the main entrance should bring visitors directly to the office area.

Building offices should be designed so that staff are protected from unwanted entry. The front office staff have direct visual access to the front entrance of the building. If building design does not provide direct visual access to the front entrance, visual access can be accomplished through the use of a video surveillance system.

In general, video cameras may be placed in the following areas of campus :

- building entrances which are difficult to monitor or secure
- parking lots that are difficult to monitor
- cafeterias or common areas
- Stairwells or alcoves that are difficult to monitor
- other areas of campus that are difficult to monitor or secure.

✳ **Security systems :**

All school buildings should have a centralized and uniform key system. Buildings should have perimeter doors that can be locked without the use of chains. Window and door locks should be maintained in good condition.

Buildings may have a monitored burglar alarm system so that an immediate response by security is possible. The burglar alarm system should cover, as a minimum, the following areas :

- offices
- computer rooms
- media rooms
- kitchens
- entrances
- Labs and workshops.

* **Fencing :**

Schools should be set back on property to allow construction of border fences. If the school campus boundaries require fencing, the fencing should be set back a minimum of three meters from the campus boundaries and the area behind the fencing should be kept mowed or cleared.

1.3.5 Emergency and evacuation procedures

a) Fire fighting systems

All school buildings should comply with the minimum state or local fire code requirements or a well-recognized standard and should have fire alarms. Fire Alarms must be audible in all parts of the facility. Fire fighting hoses should be located in all major hazardous areas. Enough locations for small fire extinguishers must be considered in the design. First aid kits should be located and housed in easily accessible locations in the building and outside it.

b) Classroom and workplace safety measures

* **Classrooms :**

Each school classroom should have a door that can be locked from the inside and every teacher should have a key to his or her classroom door. Classroom door handles and locks should meet fire code requirements for egress in the event of emergency. Classroom door should have a small window made of clear, non-breakable material which allows visual access into the classroom.

* **Science laboratories and workshops :**

All laboratories and workshops should comply with national regulations for the receipt, storage and disposal of hazardous chemicals. All laboratories and workshops should have space to accommodate the following minimum safety equipment :

- emergency shower
- emergency eye wash stations
- first aid kit
- Chemical and fire extinguishers.

All laboratories and workshops should have space for storage of chemicals and materials.

c) *Signage*

The following signs should be addressed in the design :

The relevant state statute relating to the prohibition of weapons on school campus should be posted on all perimeter doors of the school building. All perimeter doors should have visitor signs which instruct visitors a pass is required and to go to the front office.

All classrooms should have fire evacuation procedures, a list of CPR and first-aid trained staff, CPR and first-aid procedures conspicuously posted.

All cafeteria areas, gymnasiums, teacher lounges and offices should have a list of CPR and first-aid trained staff conspicuously posted.

Directional signs to the office building should be posted on all perimeter doors and throughout the building.

d) *Lightening protection*

Lightening protection should be considered in the design. Standard lightening protection systems must be a part of the safety measures in all schools.

1.3.6 Disabled ramps

All school buildings should have minimum access requirements for disabled and handicapped.

1.3.7 Student lockers

Student lockers should be considered in the design. Locker rooms should be designed in a relation to the number of students and should be located in appropriate places such as corridors, workshops and other places. The size of lockers should follow well-established standards.

1.3.8 Design considerations : School building envelope

a) *Exterior materials*

Local brick is the predominant exterior construction material in Lebanon, and is an appropriate exterior wall material. Stone sills, copings, and story bands may be used to articulate the mass of the brick envelope.

b) *Exterior envelope design elements*

Avoid designing elements that may have a tendency to attract birds, bats or other "critters".

c) Windows

✳ **Insulated/energy conserving glass :**

Use of insulated or energy conserving glass for windows is required. However, highly reflective glass is not desired. Criteria for glass selection should include its ability to reflect harmful UV rays and heat, and transmit light. Additionally, minimum distortion of color perception when viewing from the interior to the outside.

✳ **Window maintenance :**

If possible, provide window types that can be cleaned on both sides from inside the building. If such window types are not used, consider how the window cleaning process will be accomplished in overall design.

d) Exterior doorways

✳ **Public entry doors :**

Aluminum and glass "store front" entrance doors are typically used for public entries. If additional aluminum framing and glass is used with the doors, compatibility is required.

✳ **Service doors :**

Exterior service and limited access doors and frames are typically hollow metal. Inclusion of glass lights in the doors is determined usually by the door location or function.

✳ **Overhead doors :**

Overhead or double doors shall be provided on all loading docks. The doors shall be at least 8 feet high and 8 feet wide. Larger doors may be required depending upon the function of the building. Double doors shall be designed with a removable stile.

e) Roofs

✳ **Access :**

Safe access to roof areas is required. Ladders for primary roof access are not permitted, except for single story, flat roofed buildings. A permanent stair access to all roof levels must be provided.

✳ **Roof mounted equipment :**

The utilization of roof mounted equipment shall be avoided where possible. Roof mounted heating, ventilating, and air conditioning systems are not acceptable.

Part 2 : Design of School Functional Areas

2.1 Introduction

When designing a building for a technical or vocational institute, a number of closely interconnected problems involving overall planning, educational and construction factors must be solved. This difficult task requires a solid cooperation between architects and educational planners.

In designing teaching areas, the educational planner must give some answers to the architect, answers to questions such as :

Who - That is the learners and teachers - will be working in the room ?

What - That is, what learning content - is to be taught in the room ?

In what way - That is, by means of what teaching methods and learning activities - will this take place ?

How - That is, using what media and aids - will teaching be carried out ?

The architect should also be supplied with essential basic information such as: Specializations, expected number of students per specialization, potential growth rates, other potential uses of the educational facilities, potential future alterations (change of disciplines), size of the learner groups, educational design basic criteria, and allocated budget. Having this data in hand added to other important design criteria, would help the architect in producing a successful and functional design.

2.2 Teaching Areas Design Considerations

2.2.1 Design Criteria

There are no unique design criteria for teaching areas. Some assumptions for calculating the areas of a vocational technical facility exist and can be used to produce basic calculations when starting a project. Those calculations are based on some theoretical values.

Teaching success relies to a large extent on the learner group. There is no fixed number for a learner group; the number of trainees assigned to a teacher varies according to what is being taught. For instance, in the case of a lecture on the history of technology, the learner group may be much larger than for a microscope lesson. In addition to pedagogical considerations, safety factors are also playing a role. In training involving dangerous machines and laboratory work, safety alone requires that the group size is small.

As a general rule for the ratio of teachers to students for various learning activities, the following ratios are suggested :

Table 1 : Teacher to student ratio / Educational facility

Educational Facility	Teacher to Student Ratio (TSR)
Laboratory	1:8
Language Lab	1:12
Workshop	1:12
Seminar Room	1:25
Lecture Theatre	1:100

The following tables show some of the standards used in constructing schools. In order to carry basic calculations of a school, the following design criteria for educational facilities can be used :

Table 2 : Theoretical and central areas / Student

Facility	Area per student m^2	
	Minimum	Maximum
Teaching Rooms	1.4	2
Practical Rooms	3	4
Laboratories	2.7	3.5
Single- purpose Workshops	4	5
Computer laboratories	2.5	3.2

Table 3 : Multi purpose facilities spaces / Student

Facility	Area per student m^2	
	Minimum	Maximum
Multi Purpose Workshops	7	10
Metal Work	6	9
Electricity - Electronics	5	8
Construction/woodwork	9	12
Textiles	10	13
Printing	9	15

The area values given in table 2 cannot be simply added to data given in table 3 to determine the area of a school. In specific areas, movement areas can be overlapped. On the other hand access areas must be added to the total. In addition, the curriculum should be analyzed and the total hours of use for a training place should be calculated. This curricula based calculation can be done using methods like averaging the number of hours or more precisely, per specialization.

In the planning of school buildings, it is useful to use a **grid of 1.2 m x 1.2 m as a basis. Gross room areas are the multiples of the grid unit of 1.44 m^2**. The net area of a room is the gross area minus structural area.

It is useful to design a room sheet for each group in the school. The architect must produce those sheets for all specializations. This will contain the most important planning factors.

These include :

- number of rooms
- size in m^2
- number of training places
- special structural requirements

The following diagram shows an example :

Specialization : Woodworks **N° of Rooms : 4**
Room sheet for Workshops
Sheet N°

Description of Room	Area/space	Number	Total area	Number of seats	Stacking rooms	Height of room	Natural day light	AC	Ventilation	Wall: Oil proof	Floor : Oil proof	Water supply	Compressed air	Gas	Elec: 220 V	Elec:380	Safety switches
Bench-room	150	2	300	30	no	3.5	y		y			y			y		y
Machine room																	
Sharpening room																	
Store room cut wood																	
Total																	

In order to obtain a general picture of the orders of magnitude involved in the building of training institutions, one can estimate area requirements by means of a rough measurement procedure.

For this procedure, standard area values which provide information on the total of areas which must be made available for a training place. The necessary primary use area (PUA) per place of training includes space needed for lecture theatres, classrooms, laboratories (including computers), and offices. The space requirements for central facilities are combined separately.

2.2.2 Making a Rough Estimate of Areas

In making rough estimates of a school area, the following types of area will be considered :

PUA = Primary use area.
SUA = Secondary use area.
FA = Functional area for equipment and plant.
MA = Movement area for accessibility of building.
SA = Structural area for columns, walls, etc.
GSA = Gross story area, total of all types of area.

The areas SUA, FA, MA, and SA are given as a % of the PUA.

For the calculation, the number of trainees must be known as well as the ratio of theoretical and practical hours of the courses contents. The best way to explain the method of calculation is to apply it to a hypothetical situation.

2.2.3 Case Study

It is required to calculate the area for a vocational technical school which will host 600 students. The theory - practice ratio is 1:2. **The rough measure procedure results in :**

1. Areas for theoretical training :

Assumptions :

Primary use area (PUA) per student : Includes class rooms, offices, lecture theatres, labs. = $4m^2$.

Theory / practice ratio = 1:2. This means that a Maximum of 200 students will be in the lecture halls at one time.

PUA = Number of student x PUA/student = 200 x 4

PIU= 800 m^2

TYPES OF AREA	% of PUA	AREA in m^2
PUA	100%	800
SUA	10%	80
FA	9%	72
MA	40%	320
SA	16%	128
Total		**1400**

Gross area for theoretical space = 1400 . m^2

2. ***Area of Practical Training*** :

Assumptions :

All Specializations are industrial.

Average PUA/ student = 12 m^2 */ Student.*

Theory / practice ratio = 1:2. This means that a Maximum of 400 students will be in the practice area at one time.

PUA= 400 x 12

PUA= 4800 m^2

TYPES OF AREA	% of PUA	AREA in m^2
PUA	100%	4800
SUA	10%	480
FA	20%	960
MA	45%	2160
SA	20%	960
Total		**9360**

Gross area for practical space = 9360 m^2

3. ***Central Facilities*** :

Assumptions :

PUA/ student = 2 m^2

PUA= 600 x 2

PUA=1200 m^2

TYPES OF AREA	% of PUA	AREA in m^2
PUA	100%	1200
SUA	10%	120
FA	15%	180
MA	43%	516
SA	17%	204
Total		**2220**

Gross space area for central services = 2220 m^2

The whole school area :

Type of Area	***Space area m^2***
Theoretical	*1400*
Practice	*9360*
Central Services	*2220*
Total	***12980***

The primary use are a:

Type of Area	***Space area m^2***
Theoretical	*800*
Practice	*4800*
Central Services	*1200*
Total	***6800***

In the detailed planning, a calculation must be made for each room. In order to get more reasonable results, calculations can be made per specialization so the sizes of workshops can be calculated for each discipline. This requires precise information on the curriculum and the amount of teaching hours per week.

In order to calculate the number of rooms in a school, the following data is needed:

T = Number of instruction hours per week for a specific course.
GS = Group size per class.
N = Number of students attending the course.
G = Number of groups.
W = Number of teaching hours per week.
U = Utilization factor of room.

The number of rooms (R) needed in a school can then be calculated by running individual calculations using the following equation :

$$R = \frac{T \times G}{W \times U}$$

Example :
If we wish to establish the number of classrooms required for general technology which all students attend (the previous example), and assuming the following :

T = 4, N = 200, GS = 15

Then : G=200/15 = 14

G = 14, W = 40, U = 0.8

Then : $R = \frac{T \times G}{W \times U} \Rightarrow R = \frac{4 \times 14}{40 \times 0.8} \Rightarrow$ R = 2 Rooms.

Part 3 : Electrical and Mechanical Building Equipment

In many occurrences, indications and guidelines are given in Chapter 2 and 3 for the electrical and mechanical components of the buildings. However, some other general rules, codes and specifications are applicable to the whole campus or to some parts of it. These recommendations are presented separately in five Annexes attached to the end of this document. The designer will comply with these guidelines, unless otherwise stated in the main text.

The annexes are :

Annex 1	Power Distribution Guidelines
Annex 2	Plumbing Guidelines
Annex 3	Elevators
Annex 4	Heating, Ventilating and Air Conditioning
Annex 5	Telecommunication Wiring Guidelines

Classroom Design Guidelines

2.1 General Classroom Characteristics

Designing a space for teaching and learning requires careful planning and organization. It requires close collaboration between architect, mechanical engineer, electrical engineer, lighting designer, audio-visual specialist and instructor. A well-designed space is the result of careful coordination of information gathered from architectural and engineering disciplines as well as established instructional technology principles.

a. Locating Classrooms

The learning environment, or classroom, must be located within a building with easy access for students and equipment, yet the space must be isolated from noisy gathering places. Classrooms should, whenever possible, be concentrated on the lower floors of buildings to provide an easy avenue for students, as well as provide convenient access for the disabled and support services. The use of adjacent spaces must be carefully chosen to avoid distracting noises and sounds. A classroom should not be adjacent to reception areas, dining facilities, rest rooms, bicycle parking, loading docks, mechanical equipment rooms, and other similar noise producing areas. Care must be taken in the location of the classroom in relation to the exterior environments as well as to direct air paths between rooms. For example, in classrooms that rely on the presentation of materials through audio-visual equipment, south and west facing windows require a higher degree of blackout capability than do east and north facing windows.

The success with which a student receives information from an instructor, or can effectively participate in class activities, is affected by factors of the classroom design, the shape of a classroom as well as the classroom's placement within a building. In spaces planned for extensive media use, the configuration can be one of the most significant factors contributing to the effectiveness of the display system, the student's comfort and ability to interact with the instructor and other students, and the strength and clarity with which the instructor's voice is heard.

For new facilities, consideration should be given during the site planning process for access and parking of vehicles which deliver and maintain audio-visual equipment. Items which need to be considered are ramps, level vehicle access points, and other provisions for the ease of movement of heavy or bulky equipment.

b. Classroom Entrances

The flow of students should be the major factor in determining the location of entrances. Entrances should be located to avoid student traffic passing through non-instructional areas. In addition, large numbers of students traveling in corridors and hallways can generate unwanted noise for classrooms still in use. In determining the size of classroom entrances and exits, building codes should not be the only criteria. The flow of students in and out of classrooms can have a major impact on size of entrances and exits. The design of entrances, exits, stairs, corridors, and exterior paths should take into account between-class student traffic.

For example, it is not realistic to assume that a classroom will be completely vacant when students begin arriving for the next class. If classrooms must be located on upper floors, it is necessary to consider the width of the stairs as well as the doors in and out of the stair wells.

c. Capacity and Support Space

The size of the classroom should be designed to accommodate the programmed number of occupants as well as provide for additional support space. The support space must take into consideration both the set up and use of audio-visual equipment, access for the disabled, layout of the instructor's materials, circulation space and empty floor space needed to keep students from being seated too close to a chalkboard, projection screen, or video monitor.

d. Ceiling Height

The ceiling height is another important consideration when designing a classroom space. For example, because a projection screen must be large enough to display images of adequate size, it must be placed high enough from the floor to provide unobstructed sight lines. This usually requires a ceiling height higher than 2.4 m.

e. Orientation

The orientation of a room's surfaces play a major role in how sound is reflected from the sending end of a room to the rear of a room. Careful consideration must be given to the configuration of each wall surface, ceiling plane, and floor finish. In classrooms that require fixed seating, floors should be sloped to provide good sight lines. The ceiling section over the sending end should be inclined toward the students, angled upward from the sending end, to project the instructor's voice towards the rear of the classroom.

f. Accessibility

All classrooms must be designed to provide Barrier-Free Access for Students with Disabilities.

g. Noise control

Other important factors must be considered in the design of classrooms. To avoid the noise generated by their operation and use, vending machines must be located as far away as possible from classrooms. Trash and recycling containers should be located near the vending machines. Restrooms and drinking fountains should be located near classrooms and should be designed to handle student use between classes, rather than minimum code requirements which are based solely on room occupancy load. To prevent unwanted noise transmission, classrooms and restrooms should not share common walls, floors, or ceilings.

2.2 Definitions

The classrooms are identified by size :

A.	Small (Standard) size:	Classrooms with a seating capacity of fewer than 30 seats;
B.	Medium size:	Classrooms with a seating capacity of more than 30, and fewer than 60;
C.	Large size:	Classrooms with a seating capacity of more than 60, and fewer than 100;
D.	Lecture Halls:	Classrooms with a seating capacity of 100 and more.

For the design of new classrooms, ***1.4-2 m^2*** *per seat should be used for preliminary planning purposes*. This will allow for seating, circulation, media equipment, space requirements to meet accessibility standards, and lecture space within each classroom. The shape of the room is rectangular and a basic formula :

A = W x L, where L = 1.5 W,

is used to calculate the dimensions of the room.

2.3 Classroom Surfaces and Finishes

Some sound absorption is desired in classrooms, regardless of size. The following is the basic criteria for the surface treatment for the sending ends, side walls, rear walls, ceilings, and floors of classrooms. An acoustical engineer may be required for the design of large classrooms and Lecture Halls. In addition, small specialty classrooms, such as video-conferencing rooms or similar media intensive rooms, may have special surface treatment needs which may require design and review by an acoustical engineer.

Following is a description of the required finishes and surfaces in a typical classroom, organized by location in the room.

2.3.1 Front End

1. The instructor needs to keep student's interest and attention. The area where the instructor stands should be well visible from all the seats in the room. This may be obtained by having the lecturer on a raised platform, or by banked riser seating.
2. Standard and Medium size classrooms should have the sending end hard-surfaced (gypsum board, blackboards) with no special acoustical shaping required.
3. Large size classrooms may require the sending end to be hard-surfaced, with special acoustical shaping, depending on the overall room-design and configuration.
4. Lecture Halls should incorporate some or all of the following design features as feasible (the larger the classroom the more the features are required) :
    a. Chalkboards should be divided into two or three sections. Outer sections are to be angled to help reflect sound to the rear of the classroom and to reduce the acuteness of viewing angle for viewers on the opposite end of front row seats. Typical angle is 15° - 30°. The wider a room, the more angle is required for the outer blackboards.
    b. The side walls (to the immediate left and right of the chalkboards) need to be angled to help provide useful reflection to the rear of the classroom.
    c. The surface above the chalkboard should be angled to help reflect sound to the rear of the classroom.
    d. For viewing 35 mm slides, 16 mm film and overhead transparencies, the projection screen width should be equal to 1/5 of the distance between the screen and the furthest viewer.
    e. For computer data viewing, the projection screen width should be equal to 1/4 of the distance between the screen and the furthest viewer.
    f. The minimum distance from the chalkboard and/or projection screen to the first row of seating should be at least 2 times the width of the image size.

2.3.2 Side Walls

1. Classrooms with seating capacity fewer than 100, shall have hard side wall surfaces with no special acoustical treatment required.
2. Lecture Halls shall have hard side wall surfaces designed to reflect desired sound (early reflections) and to absorb undesired sound (late reflections), as follows:
    a. The front three-quarters of each side wall should be of hard (acoustically-nonabsorbent) materials, e.g., gypsum board, masonry, or wood paneling. These hard walls can be painted or vinyl-surfaced, but should not employ fabric covering or any other acoustically-absorbent finish.
    b. Install acoustically-absorbent finish on rear one-fourth of side wall. This is to absorb useless reflections and to dampen standing waves (this reduces the room's "boominess").

2.3.3 Rear Wall

1. Small (Standard) and medium size classrooms shall have a rear wall with a hard surface, with no special acoustical treatment required.
2. In large size classrooms, the shape of the room, the orientation of the seating, and the type of seats, shall determine the acoustical treatment for the rear wall.
3. Lecture Hall rear walls shall be of an acoustically-absorbent finish.

2.3.4 Ceiling

1. In small (Standard) and medium size classrooms, ceilings may be acoustically-absorbent, although a nonabsorbent finish is preferred. Large size classrooms shall have ceiling surfaces acoustically-nonabsorbent.
2. Lecture Halls require the following measures :
   a. Ceiling should be hard, acoustically-nonabsorbent, such as painted gypsum board.
   b. Ceilings should have minimum openings and penetrations if noisy conditions exist above (avoid where possible lighting fixtures surface-mounted rather than recessed).
   c. Lighting fixtures should be designed for a minimum trapping of sound. For example, diffuser panels on fluorescent fixtures should be acoustically reflective rather than open egg crate type.
   d. Front one-third of ceiling (as viewed in longitudinal section) should be sloped to assist in projecting early sound reflections to rear seats.

2.3.5 Floor and Seating

1. Small and medium size classrooms: the ceiling may be made acoustically-absorbent, and thus the floor may be non-absorbent.

2. Flat floor large size classrooms require that one or all of the following is installed :
   a. Rear wall is surfaced with acoustically-absorbent material.
   b. Upholstered seating is installed.
   c. Ceiling is acoustically-absorbent.
   d. Carpet flooring.

3. In Lecture Halls the following requirements apply :
   a. Fixed seating is suggested. Fixed seating enables the use of a sloped floor and/or risers toward the rear of the room (as well as more seating per assignable square foot and improved sight lines).
   b. If a flat floor is dictated by physical or budgetary constraints, rear risers should be installed. If only a one-step riser is feasible, due to limited ceiling height, two or three gradations are possible within normal safety criteria, and in compliance with building code and accessibility guidelines. No more than 7 rows of seats should be allowed on a flat floor.

c. When fixed seating is used, it should be upholstered for acoustical absorption. The floor surface under the seating should have a hard finish such as sealed concrete or sheet vinyl. Side-aisles require floor carpeting (for standing-wave damping as well as reverberation control).

d. When fixed seating is used, the first row of seating is to be placed at a continuous fixed-in-place table. The location and length of this table must not impede the flow of foot traffic in and out of the room (or the Faculty Lectern, if applicable). This table provides :

- additional seating for wheelchair users by removing a chair and setting it aside;
- additional seating when used with stacking chairs;
- table support for an overhead projector or an occasional demonstration.

2.3.6 Architectural Finishes and General Guidelines

1. Architectural materials specified should be primarily chosen for durability, maintainability, and acoustical properties.
2. Whenever possible, composite vinyl flooring should be used for ease of maintenance and durability.
3. Floor carpet, if used, should be of good institutional quality. Floor carpet should be cut-pile, stain resistant, and low static.
4. Cut-pile carpet is acceptable as an acoustically-absorbent material for wall installation at lower frequency ranges. It has proven the most durable and cost-effective acoustically-absorbent wall finish in an institutional setting.
5. Each classroom must be equipped with a black (not colored) porcelain or steel chalkboard. A white chalkless board may be used in certain instances. In some cases, both may be desirable.
6. All classrooms requiring projection should have effective, easily operated, and durable closures over the windows in walls and doors allowing the room to be completely darkened.
7. Student entrances and exits should be at the back of the room, or if not possible, at the sides. The audience should not enter at the front of the room, as it interferes with the instructor. Students arriving late should not have to disrupt a class in progress in order to sit down. The use of an entry vestibule is desirable to control external noises as well as prevent daylight from spilling into the classroom and interrupting a presentation using media. Doors into the classroom should be provided with vision panels to allow students to see if the classroom is in use or that they have the right class. The vision panels should be narrow enough to reduce exterior light that may spill into the classroom or be equipped with durable shades. All doors shall have illuminated emergency exit signs, and all classrooms should have emergency lighting for safe evacuation during power failures.

8. The projection screen's lower limit stop should be set at a minimum 1200 mm (4 ft) above the finished floor.
9. The instructor should be able to control the lights, the sound levels, raise and lower the projection screen, and control the slide projector in a convenient location at the front of the room. The control panel should be positioned in a cluster at a height in compliance with accessibility standards. If the room is equipped with a projection booth, all these functions should also be clustered and duplicated in the booth.
10. Adequate storage space must be provided (in close proximity to classrooms) for audio-visual equipment.
11. Sufficient number of coat hangers should be provided close to the access doors, at the rear of the room.
12. Chair guards should be installed around the walls of classrooms with movable chairs and tables, and be wide enough to prevent furniture of different heights to damage the walls.

2.4 Classroom Fixtures and Furniture

A. All fixed furniture (platforms, tables, tablet-arm seating, etc.) should be permanently attached to the floor. All furniture should be selected for durability and be of a brand, model, and color to permit efficient repair, exchange, and replacement.

B. Predominant paint colors should be selected from the standard color tables for ease of maintenance. Accent colors and materials should be used to create a pleasant learning environment.

C. Fixed continuous tables, minimum 400 mm wide are recommended as this provides more room for students to spread out their material. Tables should be arranged in long concentric arcs, spaced at 750 to 900 mm. Use of movable chairs is recommended. Either tables or chairs should have a rack to store books and personal effects.

D. All media cabinets should be mechanically fixed to wall(s) and all hanging equipment (video projectors, speakers, televisions/monitors, etc.) should be fixed with securely fastened safety cables (designed to meet seismic requirements).

E. All fixtures, cabinets, table and counter tops, and furniture should be covered with high pressure plastic laminate unless selected surfaces must match existing materials in the room.

F. Projection screens over 2400 mm (8 ft) wide should be motorized. In most cases, the size of the projection screen is related to the Media Package specified. Sometimes it is desirable to install two or more screens for various presentation purposes. In large classrooms, a separate projection screen should be provided for use with a standard overhead projector. This screen should be located so it can be used when the main screen is also in use. There are times when faculty will want an image on the projection screen while simultaneously using the chalkboard. This requires careful design. The screen will be installed at sufficient distance in front of the chalkboard so that light fixtures illuminating the chalkboard are positioned behind the screen and aimed toward the chalkboard to avoid light spilling onto the screen.

G. All chalkboards should be equipped with chalk trays, and along the upper edge, cork strips and map hooks that cannot be removed. For classrooms which require large sliding tiered chalkboards, separate cork boards with map hooks should be provided near the front of the classroom. The following should be used when determining the minimum chalkboard size requirements for classrooms :

Classrooms size Minimum Chalkboard Size :

Small:	***3600 mm long x 1200 mm high (12 ft x 4 ft)***
Medium:	***6000 mm long x 1200 mm high (20 ft x 4 ft)***
Large:	***9000 mm long x 1200 mm high (30 ft x 4 ft) (may consider tiered type)***
Lecture Halls:	***3 sections @ 3600 mm long x 1200 mm high (3 x 12 ft x 4ft) (2 tier high each section)***

In all classrooms, chalkboard space should be provided that can be used when the projection screen is down and in use.

H. A large, easy to read battery operated electric clock is desirable. The clock should be located where it is easily seen by the presenter, and be protected by a locking clear plexiglass dome.

I. Every seating place in classrooms with fixed seats and/or tables should be numbered. The numbering system should be in the format YZ, where Y is a letter corresponding to the row (A being the first row), and Z the seat number in the row (01 being the first seat). Numbering should start with the front right seat (looking towards the front of the room). An engraved metal seat/row plate, 34 x 75 mm, should be glued or screwed to the seat or table. Font should be Helvetica narrow, 25 mm high.

2.5 Classroom Mechanical Systems

Classrooms must be designed to promote a level of comfort and effectiveness which will promote optimum conditions for study, listening, reading, and interaction.

1. Classrooms (including the projection booths) may be equipped with mechanical ventilation wherever needed. Classrooms with fixed seating may also include air conditioning.
2. Air handlers (including heating and ventilating units) serving classrooms shall be equipped with economizer cycle controls to allow for cooling with outdoor air.
3. All classroom HVAC systems shall be designed to provide outdoor air for ventilation as called out in ASHRAE Standard 62-1989; "Ventilation for Acceptable Indoor Air Quality".
4. Classroom thermostats shall be equipped with tamper proof covers.
5. Start / Stop control of classroom HVAC systems shall be provided by the campus Energy Management System controlled from Facilities Management.
6. Classroom systems shall use the following criteria as the basis of design;
   a. Indoor air temperatures; 20 °C (winter), with RH of min. 15% 25.5 °C (summer, for rooms with air conditioning), with RH of max 50%. For rooms without air conditioning (small classrooms without fixed seating), provide a ventilation rate sufficient to maintain the indoor temperature within 6 degrees of outdoor air temperature under summer design conditions.
   b. Outdoor air temperatures; -5 °C (winter), 30 °C (summer dry bulb).
7. Diffuser locations shall be selected to distribute supply air uniformly in the classroom at occupant level velocities as recommended by applicable ASHRAE design standards. Diffusers shall be selected based on design air volume and a maximum sound rating of NC-30. Supply diffusers shall be equipped with opposed blade dampers. Balancing dampers shall be provided at ductwork branch connections.
8. Projection booths shall be equipped with separate HVAC systems or zoned independently of the classroom. Projection booths shall be equipped with 2 hour manual timers to activate the HVAC system serving the booth.
9. Classroom HVAC systems shall not produce room noise in excess of NC-30 American National (Standards, Guidelines, Certificates).
10. System components (fans, ductwork and diffusers) shall be selected to meet the following sound criteria: New Classrooms: NC 20 to NC 25, Renovations: NC 25 to NC 30.
11. For small classrooms, ventilation may be enhanced by windows that open. Air movement, aided by ceiling fans as required, may be desirable to avoid the feeling of air stagnation in a completely enclosed room.
12. In areas where heat generating audio-visual equipment will be located, such as projection booths, audio-visual equipment closets, and cabinets, ventilation and/or cooling must be provided to lengthen the life of the equipment.

2.6 Classroom Lighting Systems

Classrooms require lighting that can produce enough brightness for note taking and reading. Lighting systems also require illumination on chalkboards, demonstration areas, and other work surfaces. Control of illumination is extremely important in classrooms where audio-visual equipment is used.

Lighting fixtures and lamps should be specified for minimum light intrusion onto projection screens, for energy efficiency, low heat generation, and easy maintenance. General guidelines for the selection of light fixtures would include the use of recessed lamps in sharp cutoff luminaries to provide controlled lighting with minimal light spill on projection screens and to avoid shining light directly in the audience's view. The use of incandescent lamps should be avoided in order to reduce maintenance, conserve energy, and reduce heat generation.

For large classrooms, a possible system is low-intensity PL fluorescent down-lighting for note-taking during projection screen use plus higher-intensity fluorescent fixtures for general illumination purposes. The note taking light fixtures should provide enough light for the students to read and take notes, while not bouncing light around the room or washing out the image on the projection screen.

For smaller classrooms, fixtures in the front half of the room should have the capability to be switched off. Fixtures in the rear of the room should have the capability to be switched to half level and/or every other fixture turned off.

2.6.1 Lighting Systems Guidelines

All classrooms over 30 seats should have a minimum of three lighting systems.

a. One system should control the classroom's general use of fluorescent lights. A master ceiling-mounted occupancy sensor should be installed. The light fixtures should be installed in rows parallel to the front wall. Separate switches should control the front, middle and rear rows.

b. One system should control low level lights for note taking. Special care should be taken for uniformity of lighting, and to avoid shine on the screens and reflection toward the audience.

c. One system should control board lights, to illuminate the writing surface at the front of the room. Contrast between chalkboard and background, and screen and background is the key to good lighting design. Uniformity of illumination and lack of shadows is at least as important as level. Avoid bright bands of light directly above a dark chalkboard.

d. Optionally, a fourth system could control incandescent spot lights that highlight the instructor and demonstration area.

2.6.2 Lighting Level Guidelines

Classroom lighting levels should be preset at 2, 5, 10 and 50 fc.

1. General lighting at 50 fc (+/- 10fc). This is overall illumination adequate to read, at the worst, poor photocopies. Fixture glare control should be provided to avoid annoying bright spots in the field of vision from an audience position looking toward the front.
2. 10 fc for overhead projection. Reflection off screen should be taken into consideration for the front rows of seats.
3. 5 fc for slide projection.
4. 2 fc for video data projection.

2.6.3 General Requirements

1. All light switches shall be clustered, simple to use, with clearly labeled functions on the switch plates. Light controls should be conveniently located close to the entrance doors, and duplicated at the chalkboard or lectern (front of the room, except for small classrooms), and in the projection booth (if available).
2. Aisle lights (on a separate circuit) should be provided in tiered Lecture Halls, in order to prevent late arriving students from tripping in the dark.
3. All fluorescent light fixtures shall have dimmable electronic ballasts.

2.7 Classroom Electrical Systems

All electrical equipment (including contactors, lighting fixtures, dimmers, etc.) should be of selected brands, models, and specifications to conform to safety standards.

A. All conduit should be of continuous EMT electrical metallic tubing (conduit) type material where possible.

1. Areas and situations where EMT is not possible, junction boxes or flexible conduit should be installed only by prior approval.
2. Junction boxes should not be located in hidden or inaccessible corners.
3. All conduit should be at least 3/4" inside diameter or larger. Larger conduit is generally installed to ensure space for expansion.

B. Low voltage cables (e.g. audio, video, and control cables) are all required to run in a separate conduit from any AC wiring.

C. All conduit and electrical circuits should have the same ground reference.

D. All audio, video, computer and control electrical circuits should be fed from "clean" legs from the transformer free of high inductive loads. There should be no elevator motors, compressor motors, blower motors, etc. on the side of the power transformer that feeds the media equipment.

E. All electrical control circuits (per classroom) should come to a single location.

1. This location should be large enough for the lighting contactor cabinet, and when there is control of the lights from a faculty workstation podium, a NEMA type I box (or equivalent) that contains the low voltage media control system. This NEMA box of adequate capacity must be fitted with internal threaded studs to accept the panel that the control modules are mounted on.
2. The location should be convenient for maintenance and secure from vandalism.
3. If possible this location should be isolated from the classroom to eliminate repair and contactor noise.

F. Utility AC outlets on separate circuits from the media equipment should be provided inside the classroom for overhead projectors, portable VCR's, computer terminals, etc.

1. There should be at least one duplex outlet on each wall, as well as on the front, classroom side, of the projection booth. In larger rooms which have fixed seating on risers, an outlet should be provided in the face of the first riser (centered in the room), and on the face of a riser midway back in middle of seating (centered in the room).
2. The number and locations of outlets will increase with the size of the room.

G. Whenever possible, power and audio/video outlets shall not be floor mounted to avoid the intrusion of water and debris. Outlets shall be mounted on the rear stage wall and/or the front stage wall or other vertical surfaces (such as the risers of tier seating). If this is not possible, as a last resort, the use of electrical flush-mounted outlets with threaded covers is permissible.

H. Video Projection - Provide continuous 220V A/C power to the video projector, and a conduit to the projector control station at the front of the classroom and to the projection (or control) booth. This conduit is to be used for low voltage projector control cables.

2.8 Faculty Lectern

The Faculty Lecterns for small classrooms should consist of either a small free-standing podium, or a small podium resting on the lecturer's desk.

For large classrooms and Lecture Halls, the lecterns should house controls to all lighting, audio/visual and public address systems. It should also contain the overhead projector, video cassette player, video disk player, laser pointer and audio cassette recorder, contained in a secure locking cabinet.

Medium size classrooms would only be equipped with this type of podium if so required.

As with the other standardized media packages, the objectives in designing and building the Faculty Lecterns remain :

Self-service operation.
Simple, intuitive, and easy to use interface.
Off-the-shelf technology.
Flexibility for integration of future technology.
High reliability and fast repair response.

Practical Work Areas (PWAs)

3.1 General

The workshop area must be independent of the instruction and administration areas. For heavy industrial specializations, it is preferred that single floor workshops are constructed. To ensure that as many different uses can be made of workshops, the structure of the workshops must be flexible. The structural design factors that can provide flexibility were discussed in Chapter one.

To facilitate diversity of use, specializations are grouped in 5 groups and workshops and labs. are classified into 5 classes as follows :

3.2 Grouping of Specializations and Practical Work Areas (PWAs)

Currently, the VTE system in Lebanon serves about 22 trade families distributed at 5 levels of study and cover about 76 specializations. Newly built training facilities may include existing and additional specializations. In order to create flexible training facilities, existing[1] and suggested new specializations are grouped under 5 main groups and identified as G1, G2, G3, G4 and G5 as presented in tables 3.1 and 3.2.

To further increase the flexibility of the design and to insure that future changes can take place without major civil works, the PWAs for all specializations are also classified under 5 classes and identified as A,B,C,D&E. Brief descriptions of the 5 classes are presented in table 3.3 and detailed descriptions are presented in tables 3.4 to 3.8.

While designing a school, a close cooperation between the architect and the educational designer is required for two major reasons :

1- To ensure that the building is cost effective.
2- To ensure that there is no duplication in the workshops or labs and that space is used efficiently.

The architect can not just add up the number of workshops per specialization and decide on the size of the school. The educational specialist must decide which workshops or rooms are common training facilities. As an example, if a school contains two G1 specializations, then the educational designer must look into the curricula to identify the common practical activities of the two specializations. If for instance, industrial mechanics and automobile mechanics are to be taught in one school, then one common mechanical workshop is required. This means that one less "Class A" workshops is needed in the school.

1 *Specializations listed in tables 3.1 and 3.2 are only for BT and TS levels.*

Table 3.1 **Grouping of Existing VTE Specializations**

G1	G2	G3	G4	G5
Civil Engineering *	Hotel Industry - Sales	Topography *	Nursing	Dental Care
Refrigeration & Air Conditioning *	Electricity	Architectural Drawing *	Pre-School Education *	Fine Arts
Heating & Plumber *	Electronics	Accountancy & Informatics	Social Services *	Topography *
Industrial Mechanics	Cloth Industry	Sales & Commercial Relations	Dental Care	Architectural Drawing *
Aircraft Mechanics	Industrial Chemistry	Administrative Secretariat		Pre-School Education *
Automobile Mechanics & Electricity	Civil Engineering *	Documentation		Social Services *
Metallic Construction	Refrigeration and Air Conditioning *			
Carpentry and Woodwork (Building)	Heating and Plumbry *			
Carpentry and Woodwork (Industrial Production)				
Hotel Industry – Cooking				
Hotel Industry – Pastry				

Table 3.2 Grouping of Proposed Additional Specializations

G1	G2	G3	G4	G5
Hydraulic & Pneumatic Control*	Renewable Energy	E-Commerce		Industrial Drawing
Agricultural Food Industry	Photography And Processing	E-Advertising		Commercial Art
Irrigation and Pumping	Cameramen Work	Warehouse Management		Pre-Press Design
Treatment of the Used Water	Film Editing			
Printing	Acoustics			
Heavy Machinery Maintenance	Household Equipment Maintenance			
Plastics	Medical Equipment Maintenance			
	Hydraulic & Pneumatic Controls			

(*) Asterix marked specializations may belong to more than one single group, since their respective PW may adequately take place in either of two (or more) classes of PWAs.

Table 3.3 Classification of workshops

Class	Function and number of students per session
A	This class covers heavy industrial Practical Work areas in all specializations. 18 students can work simultaneously.
B	This class is designed for workshops with medium and light equipment for a maximum of 12 students and for physics and other scientific laboratories.
C	This class covers computer rooms, communication labs, CAD, CAM rooms. 30 students can work simultaneously.
D	This class consists of a group of small rooms(6-8) with bathrooms, suitable for hotel or hospital training. About 30 students can work simultaneously.
E	This class covers drawing halls, service halls, hospital wards. 30 students can work simultaneously.

The following tables present suggested detailed specifications of PWAs classes A to E. The listed specifications should be modified when special conditions are encountered (such as geographic nature of the area of the school, or other).

Table 3.4 Specifications for Workshops Class A

Scope :	This class covers heavy industrial workshops in all specializations.
Area :	180-240 m^2 per 18 students
Height :	above 6 meters
Location :	Ground floor, no stacking
Ventilation :	Normal and forced
Capacity :	18 students working at the same time

Special Equipping of CLASS A Workshops	
Ceiling drop power supply	Yes, single-phase and 3-phase power supply, 3 x 45 Amps, are suspended from the ceiling. The connecting points are distributed on a ceiling grid of 2.4 x 2.4 m^2. At least 16 connecting points must be available in the central area of the WS
Single-phase - 220 V	Yes, an underground grid must be available for student benches. 2 sockets, 10 Amps per bench (3 students) are recommended. Points in the walls must be available, maximum distance between points is 2.4 meters.
3-phase	Points in the walls must be available, maximum distance between points is 2.4 meters
Gas/air supply	4 points of gas/air must be available in one wall at least.
Welding gases	Special consideration must given when there is a welding lab. Minimum of 6 points must be available
Hot water	One point of hot water and one cold in each wall
Forced ventilation	Yes, air circulation must be calculated according to an international standard
Heating	Yes, hot air
Air conditioning	Depending on school location and WS uses
Oil ditch	Designed per case
Rough floors	Yes
Coated floors	Yes, special coating, oil absorption resistant
Communications network	Two points for computers, one 3 points for telephone, Alarm unit
Safety equipment	Fire fighting hoses, Individual extinguishers, first aid kit, eye shower
Storage area	Yes, storage for students kits and special tools
Trainers and small lecture room	Yes
Audio visual setting	No

Class A Workshops should comply with the constructional guidelines presented in Appendix A, attached at the end of this Chapter.

Table 3.5 Specifications for Workshops Class B

Scope :	This class is designed for workshops with medium and light equipment for a maximum of 12 students and for physics and other scientific laboratories.
Area :	90-120 m^2
Height :	Normal ceiling / 3-4 meters
Location :	Ground or above
Stacking :	Yes
Ventilation :	Normal and forced
Capacity :	12 students practical

Special Equipping	
Ceiling drop power supply	Optional, 3-phase, 3 x 20 Amps.
Single-phase – 220 V	Points in the walls must be available, maximum distance between points is 2 meters, 10 Amps.
3-phase	1 points in each wall must be available
Gas/air supply	1 point of gas/air must be available in one wall at least.
Welding gases	No
Hot water	At least one point of hot water and one cold in each wall
Forced ventilation	Yes, air circulation must be calculated according to an international standard
Heating	Yes, hot air or hot water
Air conditioning	Depending on school location and WS uses
Oil ditch	No
Rough floors	No
Coated floors	Yes, special coating, oil absorption resistant or tiled
Communications network	6 points for computers, one 3 points for telephone, alarm unit
Safety equipment	Individual extinguishers, first aid kit, eye shower
Storage area	Yes, storage for students kits and special tools
Trainers and small lecture room	No
Audio visual setting	No

Since they may be used as laboratories, Class B premises should comply with the safety guidelines presented in Appendix B, attached to this Chapter.

Table 3.6 Specifications for Workshops Class C

Scope :	This class covers computer rooms, communication labs, CAD, CAM rooms.
Area :	110-130 m^2
Height :	Normal ceiling/ 3-4 meters
Location :	Ground or above
Stacking :	Yes
Ventilation :	Normal and forced
Capacity :	30 students computer lab or science lab.

Special Equipping	
Ceiling drop power supply	Optional ceiling / floor, 1 x 50 Amps..
Single-phase - 220 V	One socket per computer, 10 Amps. designed to supply all computer accessories. Standard computer design room, network design, communications included.
3-phase	-
Gas/air supply	No
Welding gases	No
Hot water	No
Forced ventilation	Yes, air circulation must be calculated according to an international standard
Heating	Yes, hot water
Air conditioning	Depending on school location and WS uses
Oil ditch	No
Rough floors	No
Coated floors	Yes,
Communications network	Fully networked
Safety equipment	Individual extinguishers
Storage area	No
Trainers and small lecture room	No
Audio visual setting	Yes

Class C Workshops Wiring System must comply with the guidelines presented in Appendix B, attached to the end of this Chapter.

Table 3.7 Specifications for Workshops Class D

Scope :	This class consists in 6 rooms for housing 2-4 students, with individual bathrooms, suitable for hotel or hospital rooms, dentistry rooms, etc.
Area :	150-180 sq. meters (total for all rooms)
Height :	Normal ceiling/ 3-4 meters
Location :	Ground or above
Stacking :	Yes
Ventilation :	Normal and forced
Capacity :	24 students.

Special Equipping

Ceiling drop power supply	No
Single-phase - 220 V	At least 2 sockets, 10 Amps. per room (hotel and hospital room arrangements are required). Total 1 x 50 Amps.
3-phase	No
Gas/air supply	Recommended
Welding gases	No
Hot water	Yes
Forced ventilation	Yes, air circulation must be calculated according to an international standard
Heating	Yes, hot water
Air conditioning	Depending on school location and WS uses
Oil ditch	No
Rough floors	No
Coated floors	Yes, tiled, carpeted
Communications network	2 phone points, 1 computer point (or 1 network point) in each room
Safety equipment	Fire alarm, small Individual extinguishers
Storage area	Yes
Trainers and small lecture room	No
Audio visual setting	No
Shower and WC	Yes, standard hotel/hospital room
Special configuration	Walls may be see-through, or virtual rooms can be designed in an open space.

Table 3.8 Specifications for Workshops Class E

Scope : This class covers drawing halls, service halls, and hospital wards.
Area : 110-130
Height : Normal ceiling/ 3-4 meters
Location : Ground or above
Stacking : Yes
Ventilation : Normal and forced
Capacity : 30 students.

Special Equipping

Ceiling drop power supply	Optional ceiling / floor / walls / etc., 1 x 50 Amps.
Single-phase - 220 V	At least 4 sockets per wall
3-phase	-
Gas/air supply	No
Welding gases	No
Hot water	No
Forced ventilation	Yes, air circulation must be calculated according to an international standard
Heating	Yes, hot water
Air conditioning	Depending on school location and WS uses
Oil ditch	No
Rough floors	No
Coated floors	Yes
Communications network	3 phone points, 3 computer points (or 3 network points)
Safety equipment	Individual extinguishers
Storage area	Yes
Trainers and small lecture room	No
Audio visual setting	No

Appendix A
To
Chapter 3

Heavy Industrial Specializations Workshop

1 – GENERAL

The workshop area must be independent of the instruction and administration areas. For heavy industrial specializations, it is preferred that single floor workshops are constructed. To ensure that as many different uses can be made of workshops, the structure of the workshops must be flexible. There are four different possibilities of supporting structure of a workshop:

1- *The Skeleton principle :* The ceiling is carried out on a system of supports. His enables to have large variety of different rooms. Free-standing supports must be taken into consideration.

2- *The self-Supporting ceiling principle :* The most elegant solution, The ceilings rest on widely spaced supports. The space in between can be divided as required. However, this variation is the most expensive.

The following characteristics must be considered in the design :

1. Structural Characteristics
2. HVAC
3. Electricity supply and Lighting
4. Energy factors

Structural characteristics

For heavy industrial specializations, the self supporting ceiling is recommended. The following standards can be followed :

Interval between beams	Normal 7.2 m
Height of WS	
Area	approx. 9 sq m per student
Floors:	Level, Fire resistant coating, non-slip and resistant to absorption. Suitable for heavy duty uses.
Maximum load	min 3.5/ ;avg 5/ ; normal 7 kn/m^2
Doors:	2 standard fire doors opposite to each other, one standard garage door for unloading.
Windows	Located in the ceiling and in the walla
Instructors room	3x4 m^2 located at the entrance. full view of the WS is possible from inside.
Storage room 8 sq m	2x4 m^2 located near the instructors room
Practical lecture room	5x7 Located near the instructors room
Locker and shower rooms	Located on top of the lecture rooms. Minimum 2 showers and 2 lavatories

2 – HEATING VENTILATION AND AIR CONDITIONING (HVAC)

All workshops will need ventilation. Two types of ventilation can be implemented :

1- Natural ventilation : Can be used in areas where there is no combustion, odors, fumes and mechanical works.
2- Forced ventilation : Must be used in workshops where combustion, fumes, mechanical works, kitchens and welding areas.

For air conditioning, some schools may need air conditioning, especially training centers, as training will continue over summer. Split unit methods are not efficient in huge workshops. Central air conditioning must be used.

For Heating, hot air heating is recommended due to the size of the workshops.

Design of HVAC installations must follow the ASHRAE standards. Annex 3 presents the regulations for design and installation of HVAC.

Heat discharged from lights, machines and equipment in a workshop must be calculated and compensated.

ENERGY FACTORS :

A- ELECTICAL SUPPLY AND LIGHTING

All workshops must be supplied with single and three phase power. power calculations must be carried out according to curricula and used equipment. however, due to flexibility requirements, the minimum design criteria is 60 kva per workshop.

AC 1-phase and 3-phase current outlets for the equipment and machines must be suspended from the ceiling. Solid housing for the wiring must be secured. A safety switch must be installed before the sockets. The distance between the suspended lines must not exceed 3 meters. Easy access to the connecting points in the ceiling must be considered in the design. Power losses must be minimized. Design standards should follow acceptable standards like EN, ISO, NF, etc. for electrical installations.

AC 1-phase and 3-phase sockets for general use must be distributed along the walls..

Each WS must have a control panel to disconnect power supply from individual locations. A master push button circuit breaker for the workshop with overload protection must be installed.

Lighting at a rate 500 lx, which is equivalent to 35 va/m^2 at a room height of 4 meters is recommended. Other standards for illumination as in classrooms can be followed. All light switches must have indicator lights.

B- WATER SUPPLY AND WASTE WATER DRAIN

In addition to the general sanitary installations the workshops must have separate water connections for practical uses.

Hot and cold water piping to usage places must comply with ASHRAE or other acceptable standards for piping. Floor drainage is essential.

C- GAS SUPPLY

Standard gas supply piping must be installed. Piping must be physically protected and accessible. Proper valves and protection equipment (pressure sensors) must be installed.

D- COMPRESSED AIR

Depending on the use of the WS, 3-6 connections for compressed air should be installed.

GENERAL REQUIREMENTS :

1- Stores and store Rooms :

a- Store for raw material :

Requires a space of 80-120 m^2 depending on the stored material (electrical, Mechanical..) Approach ramp is required for loading. Space for standard dimensions sheet metals and pipes must be considered.

b- General store / Distribution of tools :

80-140 m^2 of space to store boxes of tools and general use parts. Approach Ramp is required.

c- Store of liquids :

about 20 m^2 of space to store liquids, paints, small amounts of petrol and diesel for training uses. Room should be explosion proof with independent ventilation system and metal containers to store explosive materials.

d- Store for gases :

Approximately 12 m^2 per store. Up to 4 stores are recommended. Materials stored are cylinders containing acetylene gas, oxygen, inert gas, propane and butane. Store rooms must be close to the area of use but have a safe distance.

e- Compression room :

minimum 16 m^2 for central production of compressed air.

f- Scrap Metal and refuse storage room :

40 m^2 of space for metal scrap and refuse. Close to workshops and buildings. Waste carts for unloading are recommended.

g- Installation work area :

Approximately 140 m^2 of Diverse building materials for installation works: Electrical and Mechanical.

h- Overhead Line construction and cable laying :

Approx. 200 m^2 of space for Laying of lines and lighting installations on pylons and in trenches.

i- Waste oil ditch :

A ditch for oils and lubricants. Special tubing will be adopted.

Appendix B
To
Chapter 3

Laboratory (Class B)
Design Guidelines

OVERVIEW

This Guideline is provided to help architects/engineers, departmental users and others understand the safety requirements for new and remodeled School laboratories.

FIRE SAFETY & BUILDING CODES

1. All remodeling and new construction must be designed in accordance with known standards and Labs must be designed for the "low hazard" classification according to an internationally recognized code.
2. Doors :Doors opening onto exit corridors must swing with exit egress and must be self-closing and self-latching.
3. All door hardware shall meet the requirements for the physically impaired.
4. View panel: All doors opening onto the exit corridor and within interior partitions must be provided with view panels. All view panels shall be 20 x 40 cm and shall be 1/4' wire glass in steel frames. All view panels shall be placed directly above the self-latching hardware.
5. Any interior partitions more than 180 cm in height shall be extended to the floor slab above.
6. As a minimum, a 5# ABC (all-purpose) fire extinguisher shall be provided adjacent to each door giving access to an exit corridor. Additional units may be required for a particular/specialized hazard(s).
7. Interior and/or windowless laboratories shall be provided with emergency lighting.

ENGINEERING CONTROLS

8. Safety showers and eyewashes must comply with internationally recognized Guidelines, and must be installed in every laboratory.
9. Placement of "supply air" and "exhaust air" vents must be located to avoid short-circuited air movement patterns. Low velocity air diffusers will be required to avoid turbulence and noise.
10. Laboratories must be designed to pull air into laboratory from the corridor (negative pressure in relation to rest of the building).
11. Electrical outlets located within 180 cm of sinks, safety showers, or other sources of water shall be Ground Fault Circuit Interrupter (GFCI) outlets/circuits.

Laboratory Safety

Emergency Eyewash and Shower Equipment :

Where the eyes or body of any person may be exposed to injurious corrosive material, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for emergency use.

Physical Requirements for Emergency Safety Shower

Emergency safety showers shall be located in an immediately accessible area within the laboratory unit or other work areas where the user shall not have to pass through a corridor door to reach the unit.

Emergency safety showers shall be identified with a highly visible sign and a green cross located as an integral part of the floor directly under the shower.

Appendix C
To
Chapter 3

Guidelines for Computer Workshop Cabling and Electrical Wiring

1 – PURPOSE OF THE DOCUMENT

These Guidelines for Computer Data Cabling and Electrical Wiring in Schools have been developed to assist :

- school divisions
- administrators
- trustees
- technology support staff, and
- architects

in formulating plans for the functional integration of computer technologies into school instructional classrooms for both new construction and renovation of existing facilities.

At various locations within the document, the term 'must' is used. This term is used only where standards for installation, such as fire and building codes etc. are known.

2 – BACKGROUND

The use of computer technologies in today's education environment has grown significantly. Advances in technology has meant that more schools are establishing intra school networks and computer labs as well as deploying computers into individual classrooms to support instruction, learning and school administration.

The introduction of computer equipment in schools places increased demand on the electrical power, air-conditioning, ventilation, and computer network cabling infrastructures. The requirement to plan for and accommodate technology equipment in classrooms during the planning stages of new building design, or renovation of buildings is critical. To retrofit these facilities at a later date can be costly and physically prohibitive.

This document is a guideline for computer cabling and wiring and does not cover the requirements of other school needs.

3 – DESIGN & INSTALLATION GUIDELINES

Qualified personnel should complete all design, layout, installation and commissioning. Testing of computer cabling and electrical wiring should be completed in all cases.

Drawings and records of wiring and cabling layouts, as built, are required. All computer cables should be identified at both ends of the cable.

It is not acceptable to install computer cables where they lay on top of suspended ceiling "T" bars.

Sample diagrams

See Appendix A.

3-1 General

All construction and installations must conform to applicable building, fire, and electrical codes.

3-2 Instructional Spaces (Classrooms, Science labs.)

a. Two boxes with duplex jacks wired with computer network connections in each room, located at opposite ends of the room. This will provide flexibility to allow for the establishment of "pods" of computers to be moved between classrooms and be networked and to accommodate both instructor and student computers in the room.

b. Two additional "roughed in" jacks at a different location in the room, complete with conduit, boxes and pull string for future expansion.

c. All conduits used should be a minimum of ¾" in diameter or larger and allow for the inclusion of additional expansion cables.

3-3 Computer Labs

a. Computer network wiring to accommodate 30 computers.

b. Electrical power to accommodate 30 computers, 4 printers and a network server. All electrical circuits providing power to computer systems should have isolated ground systems.

c. One telephone outlet jack.

3-4 Libraries

a. Two boxes with duplex jacks, each wired computer network connections.

b. Two additional "roughed in" jacks at a different location in the library, complete with conduit, boxes and pull string for future expansion.

c. Two 15 Amp electrical circuits dedicated to the library (Large laser printers may require an additional circuit due to their electrical load).

d. All conduits used should be a minimum of ¾" in diameter or larger and allow for the inclusion of additional expansion cables.

e. Telephone outlet jack.

3-5 Other Offices (Administrative offices, staff rooms etc.)

a. All offices and staff rooms should be equipped with at least one computer/local area network connection.

b. One telephone outlet jack.

c. Electrical power for computers, printers and fax machines as appropriate.

4 – ELECTRICAL REQUIREMENTS

All work must conform to all applicable codes and standards.

Electrical outlets that provide power to computer systems in computer labs should be connected to an isolated ground system. Other rooms must also be equipped with standard electrical power plugs to accommodate non-computer devices.

Raceways should be used to allow the installation of expansion, other services etc. ¾" or larger conduit should be used in order to allow for future expansion.

5 – COMPUTER WIRING

Computer cable should be rated to CAT 5 or higher. Capable of operating at a minimum speed of 10MB (100 MB preferred). Cables must meet applicable minimum building and fire standards.

Computer wiring must be installed following accepted industry practices, avoiding routes that pass in close proximity to radiating electrical devices such as florescent lights, motors, photocopiers etc. Individual cable runs must not exceed 90 meters.

Cross-connect cables should be ordered with distinctive coloured sheaths that allow them to be easily identified from other cables.

Raceways should be used where possible to allow for the installation and expansion of computer network and other compatible services etc. ¾" or larger conduit should be used in order to allow for future expansion.

6 – WIRING CLOSETS

Wiring closets should be secure with adequate working area clearances and access.

All required safety devices must be installed in accordance with codes, etc. In particular, attention should be paid to fire detection equipment and ventilation systems in these rooms.

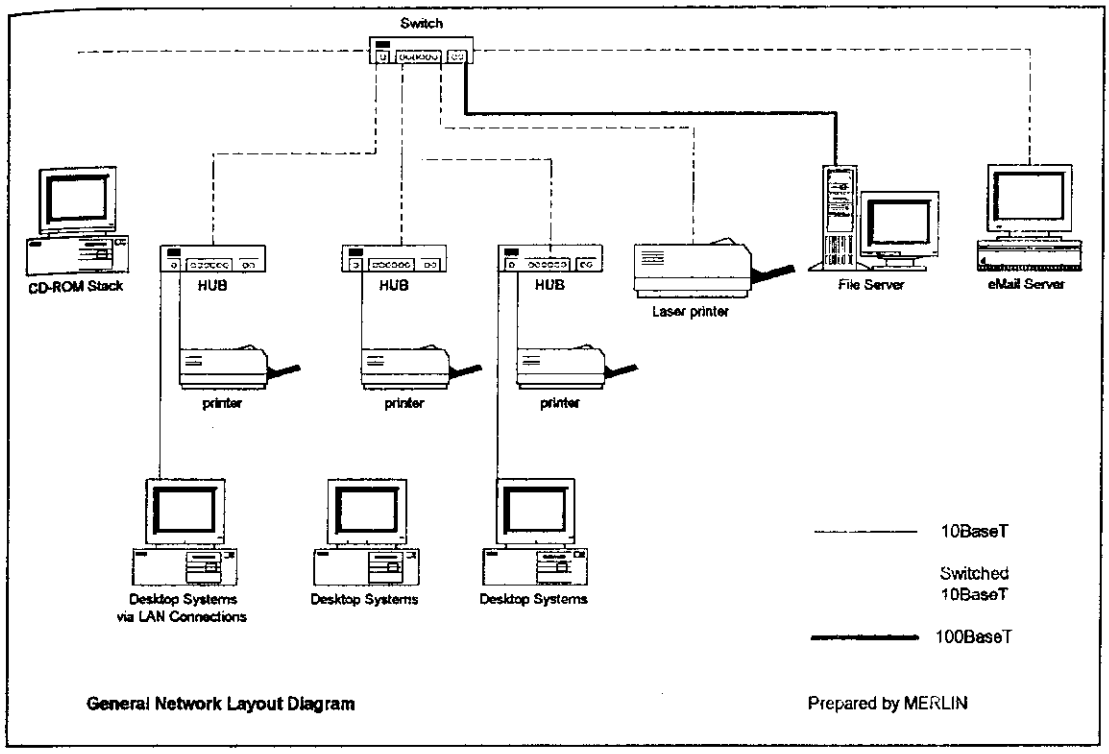
Electrical panel rooms are generally not suitable locations for wiring closets.

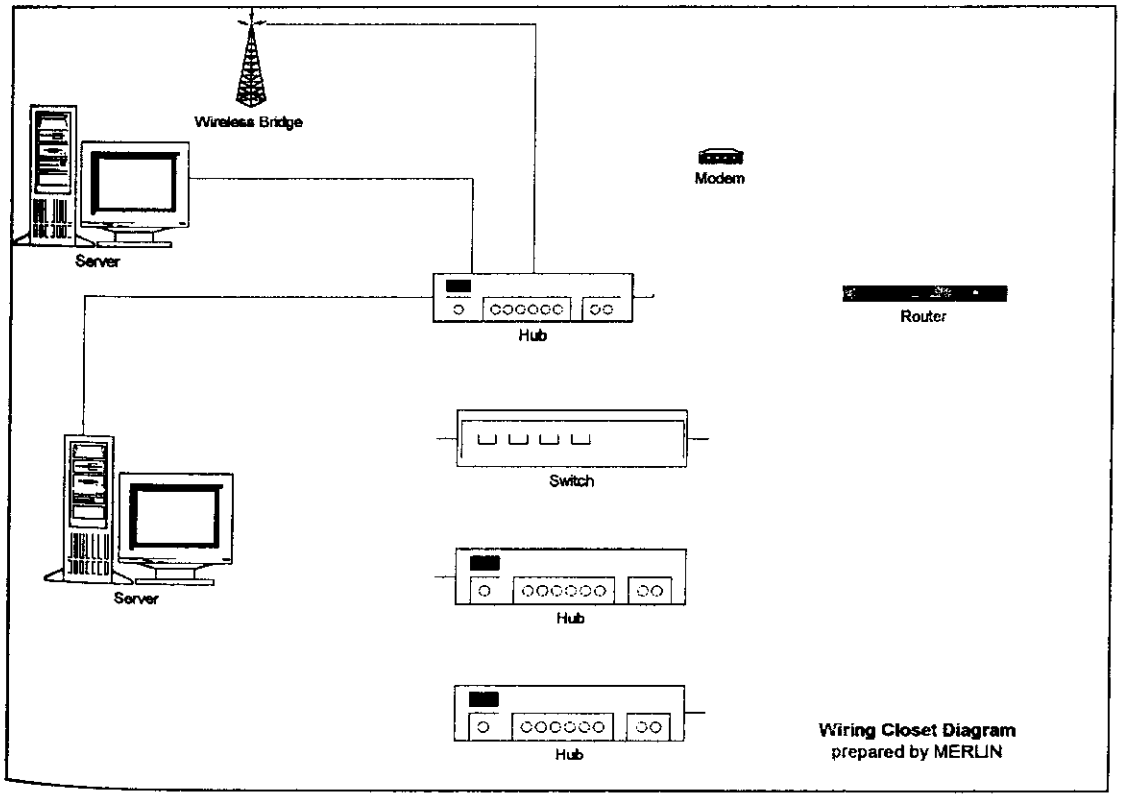
7 – HOW TO TENDER

Appendix B outlines some of the items that you should consider including in tenders for computer data cabling and electrical wiring contracts.

APPENDIX A

Sample wiring diagrams.





APPENDIX B

Computer cabling tender criteria.

1. Codes and Standards

   1.1. All construction and installation must conform to all applicable building, fire, electrical codes.

   1.2. Computer cables must meet EIA/TIA, IEEE, FCC & other applicable standards.

2. Contractor Qualification

   2.1. Only experienced Data installation Contractors will be considered for the work. Contractors must be able to provide evidence of having performed work of a similar type as specified.

   2.2. Contractors shall have tools and test equipment necessary for the installation and testing of the cabling systems.

   2.3. Contractor shall list the type and manufacturer of all test equipment to be used.

3. Materials

   3.1. Cabling Performance - Category 5 cable performance is intended for high speed Local Area Network (LAN) applications (10/100 MB). Category 5 cables must meet the electrical and corresponding distance requirements of the applicable standards for horizontal UTP cables. This specification places limits on the horizontal distances to assure minimum performance. The cable run from the wiring closet to the work area outlet is limited to 90 meters. An additional 3 meters is allowed from the outlet to the terminal and 6 meters allowance for patching on the cabinet patch panel to hub equipment.

   3.2. Wire Management Panels - These panels must be grouped and identified in such a manner as to provide the greatest degree of flexibility in the organization of network wiring. This will be achieved by the supply and installation of a standard 19" cabinet, floor mounted. All panels will be clearly labeled and identified.

   3.3. Modular Patch Cables - (Wiring Closet) Four twisted pair Category 5 type standard cables complete with RJ45 non-keyed modular plugs. Length of cable - adequate to connect. Cables are required to be equipped with strain relief sleeves over the jacks.

   3.4. Modular Line Cables - (Workstation) as detailed above for patch cables, except complete with plugs to be used in conjunction with the workstation jacks. Length required - adequate to connect from wall outlet to device.

   3.5. Modular Cross Connect Cables - An adequate number shall be provided in a colour sheath that is clearly identifiable from other cables in use.

   3.6. Connector Performance - Tested to applicable standard.

   3.7. Conduit bends to be 10 times the interior diameter of conduit.

4. Installation

4.1. Supply and install all data lines and associated terminal equipment specified.

4.2. Ensure that all plenum cabling is kept clear of all power equipment and lighting fixtures.

Installation Guidelines

• Transformers up to 5 kVA	⇒	1 M
• Power Lines (220 V systems)	⇒	300 mm
• Fluorescent Lighting	⇒	300 mm
• Electrical Motors	⇒	1 M
• Other	⇒	1 M

4.3. Bundled data cables in transition areas between conduit and trays. It is recommended that Velcro be used instead of plastic tie wraps.

4.4. Identify all cables with numbered markers at both ends. Transfer identity number onto mark-up drawings for record purposes.

4.5. Ensure that all equipment is constructed to appropriate standards. All like material shall be by a single manufacturer.

4.6. No splicing, tapping or bridging devices will be used between specified connecting hardware and outlet assemblies.

4.7. Cabling should be installed over corridor areas and/or along line parallel to building structures. Penetrations through full-height wall partitions should be made through per-established openings or sleeves.

4.8. All cable installations shall be protected from mechanical damage.

4.9. Cables should be free from tension over the entire length of each run.

4.10. Cable installation and termination methods shall be completed in a manner that will not degrade the cable specification. All terminations shall be inserted by the use of the proper tool. Use of the "dust cap" to effect insertion will not be considered adequate. Bundling, supporting, stripping of outlet jacket and retention of wiring twist will be subject to final approval. Work not meeting the above criteria will be re-done.

4.11. All fire separation penetrations shall be fire stopped in compliance with codes.

4.12. All conduit ends, including vertical stubs in wall cavities, shall be fitted with insulated grommets.

4.13. Where concealed or surface conduit must be used, a minimum box size for the data/voice termination shall be 4 x 4 x 2 ½ inches, complete with either a single gang or double gang mud ring as required by the number of drops specified.

4.14. Use of approved cable clips or hangers on 4'-0" centres to effectively support all multi-cable harnessing.

4.15. Small numbers of cable splitting off the harness to individual room drops shall be supported by either Velcro straps or combined Panduit wirewraps.

4.16. Cables dropped in a wall cavity shall have insulated bushings fitted to the top wall plate.

4.17. Where numbers warrant, centre hung cable trays shall be installed to support major harnessing, preferably over corridor areas.

4.18. Cable tray drop-off shutes shall be fitted where cables exit this tray downward.

4.19. During installation, nylon types or equivalent shall not be used to suspend data cable coils. Proper support of coils to prevent damage is essential.

4.20. One small loop of cable shall be arranged in the cable before entering the wall cavity, Excessive slack cable should be avoided as this increases run length.

5. Testing

5.1. Test for continuity, pair placement, pair reversal and incorrectly terminated cables. All testing will be performed in accordance with appropriate standards.

5.2. Test and record in tabular form the following for each outlet:

- attenuation
- crosstalk (test from both ends)
- resistive impedance

5.3. Test and record the length of all horizontal data field wiring from the wire management panel to the workstation outlet assembly.

5.4. Supply a test summary sheet and full test results on computer disk upon completion of project. Disk format should allow for the download of individual data sheets for viewing and printing.

6. Warranty

6.1. The installation contractor will warranty work for a period of one year.

Determination of Practical Work Areas (PWAs)

4.1 Introduction

In chapter 3, we have identified five types of constructions – called "classes" – where practical work can take place. These are :

Class A : - for PWs related to specializations requiring heavy industrial equipment

Class B : - for PWs related to specializations requiring light industrial equipment.
- for various labs : scientific, universal, etc.

Class C : - for PWs related to office work specializations.
- for computer-based teaching.

Class D : - for PWs related to hospitality, hotel and pre-school specializations.

Class E : - for PWs related to Fine Arts, Graphic Art Design, Commercial Art, etc.
- for teaching technical drawing.

There are several methods of assessing the number of PWAs units for a given set of specializations selected for a school. The complexity of these methods results from the fact that almost every class of PWAs is suitable for several possible uses, according to various specialization curricula.

4.2 First Method : Experience Based Selection Method

Data[1] presented in table 3.4 offers designers a quick tool of estimating the numbers and types of PWAs for a specialization or a group of specializations in a school. The method presented was based on the experience of the author in teaching and training. Verification of this data was done through :

a- applying it to existing curricula, and
b- consulting experienced teachers and trainers in the various grouped disciplines.

Table 4.1 Classification of required PWAs per group of specializations

	G1	G2	G3	G4	G5
Class A	2	1	0	0	0
Class B	2	2	0	1	1
Class C	1	2	3	1	1
Class D	0	0	0	Up to 6	0
Class E	1	1	1	2	2

1 *Data proposed in this section is based on the assumption that there is a maximum of 75 students per specialization.*

As an example to applying the data in table 4.1, let us assume that a school, which includes the following specializations, is to be designed :

1- Automotive Technology
2- Mechanical Technology
3- Electronics
4- Electricity
5- Accountancy and Information
6- Social Services
7- Architectural Drawing.

Assuming that 75 students is the maximum number per specialization.
This means that we have 2 G1, 2 G2, 1 G3, 1 G4 and 1 G5 specializations.

The required labs for the individual specializations are as listed in table 3.4. However, having the specializations in the same school means that there are many common PWAs. If we calculate the required PWAs individually for each specialization the following numbers and classes are required :

Class A	6
Class B	12
Class C	11
Class D	6-8 Small rooms
Class E	9

An average of 11 m^2 of PWA per student.

If we consider the common PWAs, then the results are as follow :

Class A	4
Class B	8
Class C	6
Class D	6-8
Class E	5

An average of 7 m^2 of PWA per student.

As can be seen, there is a considerable reduction in the PWA/student when common areas are considered.

4.3 Second Method : Occupation of PWAs Based Method

This method relies on analyzing the curricula of each specialization and deducing the PWA per specialization. Tables 4.2 to 4.6 present a demonstration of how this method can be applied in determining the PWAs for each specialization.

For flexibility, weekly total occupation hours per WS have been fixed to 25. This limit may be overstepped in specific cases to an upper limit of 36 hours.

Table 4.2 Determination of PWAs for G1 Specializations

	Year 1	Year 2	Year 3	WS unit capacity	WS needed occupation (hrs/week)
Total PW hours/week	14	16	18		
Students numbers	30	25	20		
Class A PW hours	8	10	10	18	56
Class B hours	4	2	4	12	24
Class C hours	2	2	2	30	10
Class D hours				30	0
Class E hours		2	2	30	6

Table 4.3 Determination of PWAs for G2 Specializations

	Year 1	Year 2	Year 3	WS unit capacity	WS needed occupation (hrs/week
Total PW hours/week	14	16	18		
Students numbers	30	25	20		
Class A PW hours	4	2	2	18	0
Class B hours	8	8	10	12	26
Class C hours	2	4	4	30	16
Class D hours				30	0
Class E hours		2	2	30	6

Table 4.4 Determination of PWAs for G3 Specializations

	Year 1	Year 2	Year 3	WS unit capacity	WS needed occupation (hrs/week)
Total PW hours/week	14	16	18		
Students numbers	30	25	20		
Class A PW hours				18	0
Class B hours	4	2	2	12	20
Class C hours	10	12	14	24	58
Class D hours				2-4	0
Class E hours		2	2	24	6

Table 4.5 Determination of PWAs for G4 Specializations

	G4			WS unit capacity	WS needed occupation (hrs/week)
	Year 1	**Year 2**	**Year 3**		
Total PW hours/week	14	16	18		
Students number	30	25	20		
Class A PW hours				18	0
Class B hours	4	2	4	12	24
Class C hours	2	2	2	24	10
Class D hours	8	10	10	2-4	46
Class E hours		2	2	24	6

Table 4.6 Determination of PWAs for G5 Specializations

	Year 1	Year 2	Year 3	WS unit capacity	WS needed occupation (hrs/week)
Total PW hours/week	14	16	18		
Students numbers	30	25	20		
Class A PW hours				18	0
Class B hours	4	2	4	12	24
Class C hours	4	4	4	24	20
Class D hours				2-4	0
Class E hours	6	10	10	24	42

As in the first method, the number of PWA units of each class must be computed, for the whole school, by taking into account the use of a same unit – at different times – by the various student groups (specializations) of the school. To illustrate some of the possible combinations, the third method herebelow presents several detailed case studies.

4.4 Third Method : Detailed Case Studies

This method proceeds from the building up of the weekly time schedule of the school. It identifies 8 types of premises usage :

- Classrooms : Specific construction, called C-R.
- Labs : Class B construction, specifically equipped, designated by Lab.
- Universal Lab : Class B construction, specifically equipped, designated by U-L.
- PW area A : Class A construction, designated by A.
- PW area B : Class B construction, designated by B.
- PW area C : Class C multi-use construction, designated by C.
- PW area D : Class D construction, designated by D.
- PW area E : Class E construction, designated by E.

The weekly time schedule covers 36 hours in five days. Thus, the school will operate for the BT level 7 hours per day, except for one day – say Wednesday – when it will operate 8 hours.

4.4.1 Selected Cases

- When attempting to determine an appropriate set of specializations for a school, one quickly finds that there are 3 major groups – G1, G2 and G3 – which must always be represented in any school.
- The available funds, if distributed over the 42 foreseen new schools, put a limitation to their respective sizes. On one hand, it makes no sense to build a school which will house less than 3 specializations. On the other hand, for financial reasons, only few schools should accommodate more than four or five specializations, although the demand may call for more.
- Yet, despite those restrictions, the number of possible combinations is very large. But, since it appears that most of the schools will comprise 3 or 4 specializations, we have decided to study the following cases :

Case	Groups among which specializations are chosen
1	G1 ; G2 ; G3 ; G4
2	G1 ; G2 ; G3 ; G5
3	G1 ; G2 ; G2 ; G3
4	G1 ; G2 ; G3 ; G3
5	G1 ; G2 ; G3

These are actually the most probable configurations.

For each case, we shall build a weekly time schedule, where we shall try to minimize the number of required premises of each type. With each time schedule, we have prepared a table showing the number of simultaneous occupation for each premises type. The time schedules are based upon the following distribution of the curricular hours over the 8 types of premises.

4.4.2 Case 1 : 1G1 + 1G2 + 1G3 + 1G4

Table 4.8 gives the curricular hours distribution for this set of specializations.

Table 4.8 **Groups G1 + G2 + G3 + G4**

Premises types	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3	G4/Y1	G4/Y2	G4/Y3
A	8	8	8	0	0	0	0	0	0	0	0	0
B	2	0	2	10	8	8	2	0	0	0	0	0
C	2	2	2	2	4	4	10	12	14	2	2	2
D	0	0	0	0	0	0	0	0	0	8	10	12
E	0	2	2	0	2	2	0	2	2	0	0	0
Lab	2	2	2	2	2	2	2	2	2	4	4	4
U-L	0	2	2	0	0	2	0	0	0	0	0	0
C-R	22	20	18	22	20	18	22	20	18	22	20	18

This configuration may be implemented by the following time schedule.

Table 4.9 **Time Schedule 1**

	Periods	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3	G4/Y1	G4/Y2	G4/Y3
Monday	1	C-R	C-R	B	C-R	C	E	Lab	C-R	C	C-R	C-R	C-R
	2	C-R	A	B	B	C	E	Lab	C-R	C	C-R	C-R	C-R
	3	C-R	A	C-R	B	C-R	C	C-R	C-R	C	Lab	C-R	C-R
	4	C-R	A	C-R	B	C-R	C	C-R	C-R	C-R	Lab	D	C
	5	C-R	C-R	A	C-R	C-R	U-L	C-R	C-R	C-R	C-R	D	C
	6	C-R	C-R	A	C-R	C-R	U-L	C	C-R	Lab	C-R	C-R	D
	7	C-R	C-R	A	C-R	C-R	C-R	C	C	Lab	C-R	C-R	D
	8												
Tuesday	1	A	C-R	Lab	B	C-R	B	C-R	C	C	C-R	C-R	D
	2	A	C-R	Lab	B	C-R	B	C-R	C	C	C-R	C-R	D
	3	A	U-L	C-R	B	C-R	C-R	C	C-R	C	Lab	D	C-R
	4	C-R	U-L	C-R	B	C-R	C-R	C	C-R	C-R	Lab	D	C-R
	5	C-R	C	A	C	B	C-R	C-R	C-R	C-R	C-R	C-R	C-R
	6	C-R	C	A	C	B	C-R	C-R	C-R	C-R	D	Lab	C-R
	7	C-R	C-R	A	C-R	B	C-R	C-R	C	C-R	D	Lab	C-R
	8												
Wednesday	1	C-R	C-R	C-R	C-R	C-R	C	C-R	C-R	C-R	C	D	Lab
	2	C-R	A	C-R	C-R	C-R	C	C-R	C-R	C-R	C	D	Lab
	3	Lab	A	C-R	C-R	C-R	C-R	B	E	C-R	C-R	C-R	D
	4	Lab	A	C-R	C-R	C-R	C-R	B	E	C-R	C-R	C-R	D
	5	C-R	E	U-L	C-R	B	Lab	C-R	C	C-R	C-R	C-R	D
	6	A	E	U-L	C-R	B	Lab	C-R	C	C	C-R	C-R	C-R
	7	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C	D	C-R	C-R
	8	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C	D	C-R	C-R
Thursday	1	A	C-R	C-R	Lab	C-R	B	C	C	C-R	C-R	D	C-R
	2	A	C-R	C-R	Lab	C-R	B	C	C	C-R	C-R	D	C-R
	3	C	A	C-R	C-R	C	B	C-R	C-R	C-R	D	C-R	Lab
	4	C	A	C-R	C-R	C	C-R	C-R	C-R	E	D	C-R	Lab
	5	C-R	Lab	A	C-R	B	C-R	C-R	C-R	C	C-R	C-R	D
	6	C-R	Lab	A	C-R	B	C-R	C	C-R	C	C-R	C-R	D
	7	C-R	C-R	C-R	C-R	B	C-R	C	C-R	C	C-R	C-R	D
	8												
Friday	1	B	C-R	E	C-R	C-R	C-R	C-R	Lab	C-R	C-R	C	D
	2	B	C-R	E	C-R	C-R	C-R	C-R	Lab	C-R	C-R	C	D
	3	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C	C	D	Lab	C-R
	4	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C	C	D	Lab	C-R
	5	C-R	C-R	C-R	B	E	B	C-R	C	C-R	C-R	C-R	C-R
	6	C-R	C-R	C-R	B	E	B	C	C	C-R	C-R	D	C-R
	7	C-R	C-R	C-R	B	C-R	B	C	C-R	E	C-R	D	C-R
	8												

Table 4.10 shows the occurrences of simultaneous use of each type of premises.

Table 4.10 Simultaneous use of premises

	A	B	C	D	E	C-R	Lab	U-L	
Monday	0	1	2	0	1	7	1	0	
	1	2	2	0	1	5	1	0	
	1	1	2	0	0	7	1	0	
	1	1	2	1	0	6	1	0	
	1	0	1	1	0	8	0	1	
	1	0	1	1	0	7	1	1	
	1	0	2	1	0	7	1	0	
Tuesday	1	2	2	1	0	5	1	0	
	1	2	2	1	0	5	1	0	
	1	1	2	1	0	5	1	1	
	0	1	1	1	0	7	1	1	
	1	1	2	0	0	8	0	0	
	1	1	2	1	0	6	1	0	
	1	1	1	1	0	7	1	0	
Wednesday	0	0	2	1	0	8	1	0	
	1	0	2	1	0	7	1	0	
	1	1	0	1	1	7	1	0	
	1	1	0	1	1	7	1	0	
	0	1	1	1	1	6	1	1	
	1	1	2	0	1	5	1	1	
	1	0	2	1	0	7	1	0	
	1	0	2	1	0	7	1	0	
Thursday	1	1	2	1	0	6	1	0	
	1	1	2	1	0	6	1	0	
	1	1	2	1	0	6	1	0	
	1	0	2	1	1	6	1	0	
	1	1	1	1	0	7	1	0	
	1	1	2	1	0	6	1	0	
	0	1	2	1	0	8	0	0	
Friday	0	1	1	1	1	7	1	0	
	0	1	1	1	1	7	1	0	
	0	0	2	1	0	8	1	0	
	0	0	2	1	0	8	1	0	
	0	2	1	0	1	8	0	0	
	0	2	2	1	1	6	0	0	
	0	2	1	1	1	7	0	0	
	1	2	2	1	1	8	1	1	<<-- Max simultaneous usage
	2	**5**	**2**	**1**	**1**	**8**	**3**	**1**	**<<-- Number of modules**
	2	5	3	2	2	10	3	1	<<-- Should be required
	24	32	58	30	12	240	30	6	<<-- Weekly occupation hours
	66.67%	44.44%	80.56%	83.33%	33.33%	83.33%	83.33%	16.67%	

The first of the bottom lines gives the highest occurrence of simultaneous use of each type of premises. It shows, therefore, the number of units needed for each type of premises, for the implementation of BT curricula. The second bottom line translates this number into constructional modules. The third states the number of modules to be constructed, so as to provide for some flexibility.

The results should now be checked against the occupational needs for carrying out the STT programmes. Wherever needed, more units should be added.

4.4.3 Case 2 : 1G1 + 1G2 + 1G3 + 1G5

Table 4.11 gives the curricular hours distribution for this set of specializations.

Table 4.11 **Groups G1 + G2 + G3 + G5**

Premises types	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3	G5/Y1	G5/Y2	G5/Y3
A	8	8	8	0	0	0	0	0	0	0	0	0
B	2	0	2	10	8	8	2	0	0	0	0	0
C	2	2	2	2	4	4	10	12	14	4	4	5
D	0	0	0	0	0	0	0	0	0	0	0	0
E	0	2	2	0	2	2	0	2	2	6	10	9
Lab	2	2	2	2	2	2	2	2	2	4	2	4
U-L	0	2	2	0	0	2	0	0	0	0	0	0
C-R	22	20	18	22	20	18	22	20	18	22	20	18

This configuration may be implemented by the following time schedule.

Table 4.12 **Time Schedule 2**

Periods	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3	G5/Y1	G5/Y2	G5/Y3
1	C-R	C-R	B	C-R	C	E	Lab	C-R	C	C-R	C-R	C-R
2	C-R	A	B	B	C	E	Lab	C-R	C	C-R	C-R	C-R
3	C-R	A	C-R	B	C-R	C	C-R	C-R	C	Lab	C-R	C-R
4	C-R	A	C-R	B	C-R	C	C-R	C-R	C-R	Lab	E	C
5	C-R	C-R	A	C-R	C-R	U-L	C-R	C-R	C-R	C-R	E	C
6	C-R	C-R	A	C-R	C-R	U-L	C	C-R	Lab	C-R	C-R	C
7	C-R	C-R	A	C-R	C-R	C-R	C	C	Lab	C-R	C-R	C-R
8												
1	A	C-R	Lab	B	C-R	B	C-R	C	C	C-R	C-R	E
2	A	C-R	Lab	B	C-R	B	C-R	C	C	C-R	C-R	E
3	A	U-L	C-R	B	C-R	C-R	C	C-R	C	Lab	E	E
4	C-R	U-L	C-R	B	C-R	C-R	C	C-R	C-R	Lab	E	C-R
5	C-R	C	A	C	B	C-R	C-R	C-R	C-R	C-R	C-R	C-R
6	C-R	C	A	C	B	C-R	C-R	C-R	C-R	E	Lab	C-R
7	C-R	C-R	A	C-R	B	C-R	C-R	C	C-R	E	Lab	C-R
8												
1	C-R	C-R	C-R	C-R	C-R	C	C-R	C-R	C-R	C	E	Lab
2	C-R	A	C-R	C-R	C-R	C	C-R	C-R	C-R	C	E	Lab
3	Lab	A	C-R	C-R	C-R	C-R	B	E	C-R	C-R	C	C
4	Lab	A	C-R	C-R	C-R	C-R	B	E	C-R	C-R	C	C
5	C-R	E	U-L	C-R	B	Lab	C-R	C	C-R	C-R	C-R	C-R
6	A	E	U-L	C-R	B	Lab	C-R	C	C	C-R	C-R	C-R
7	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C	C-R	C-R	E
8	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C	C-R	C-R	E
1	A	C-R	C-R	Lab	C-R	B	C	C	C-R	C-R	E	C-R
2	A	C-R	C-R	Lab	C-R	B	C	C	C-R	C-R	E	C-R
3	C	A	C-R	C-R	C	B	C-R	C-R	C-R	E	C-R	Lab
4	C	A	C-R	C-R	C	C-R	C-R	C-R	E	E	C-R	Lab
5	C-R	Lab	A	C-R	B	C-R	C-R	C-R	C	C-R	C-R	C-R
6	C-R	Lab	A	C-R	B	C-R	C	C-R	C	C-R	C-R	E
7	C-R	C-R	C-R	C-R	B	C-R	C	C-R	C	C-R	C-R	E
8												
1	B	C-R	E	C-R	C-R	C-R	C-R	Lab	C-R	C	C	E
2	B	C-R	E	C-R	C-R	C-R	C-R	Lab	C-R	C	C	E
3	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C	C	E	E	C-R
4	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C	C	E	E	C-R
5	C-R	C-R	C-R	B	E	B	C-R	C	C-R	C-R	C-R	C-R
6	C-R	C-R	C-R	B	E	B	C	C	C-R	C-R	C-R	C-R
7	C-R	C-R	C-R	B	C-R	B	C	C-R	E	C-R	C-R	C-R
1	C-R	C-R	B	C-R	C	E	Lab	C-R	C	C-R	C-R	C-R

Table 4.13 shows the weekly occurrences of simultaneous use of each type of premises.

Table 4.13 Simultaneous use of premises

	A	B	C	D	E	C-R	Lab	U-L	
Monday	0	1	2	0	1	7	1	0	
	1	2	2	0	1	5	1	0	
	1	1	2	0	0	7	1	0	
	1	1	2	0	1	6	1	0	
	1	0	1	0	1	8	0	1	
	1	0	2	0	0	7	1	1	
	1	0	2	0	0	8	1	0	
Tuesday	1	2	2	0	1	5	1	0	
	1	2	2	0	1	5	1	0	
	1	1	2	0	2	4	1	1	
	0	1	1	0	1	7	1	1	
	1	1	2	0	0	8	0	0	
	1	1	2	0	1	6	1	0	
	1	1	1	0	1	7	1	0	
Wednesday	0	0	2	0	1	8	1	0	
	1	0	2	0	1	7	1	0	
	1	1	2	0	1	6	1	0	
	1	1	2	0	1	6	1	0	
	0	1	1	0	1	7	1	1	
	1	1	2	0	1	5	1	1	
	1	0	2	0	1	7	1	0	
	1	0	2	0	1	7	1	0	
Thursday	1	1	2	0	1	6	1	0	
	1	1	2	0	1	6	1	0	
	1	1	2	0	1	6	1	0	
	1	0	2	0	2	6	1	0	
	1	1	1	0	0	8	1	0	
	1	1	2	0	1	6	1	0	
	0	1	2	0	1	8	0	0	
Friday	0	1	2	0	2	6	1	0	
	0	1	2	0	2	6	1	0	
	0	0	2	0	2	8	0	0	
	0	0	2	0	2	8	0	0	
	0	2	1	0	1	8	0	0	
	0	2	2	0	1	7	0	0	
	0	2	1	0	1	8	0	0	
	1	2	2	0	2	8	1	1	<<-- Max simultaneous usage
	2	**5**	**2**	**0**	**2**	**8**	**3**	**1**	**<<-- Number of modules**
	2	5	3	0	3	10	3	1	<<-- Should be required
	24	32	65	0	37	240	28	6	<<-- Weekly occupation hours
	66.67%	44.44%	90.28%		51.39%	83.33%	77.78%	16.67%	

The first of the bottom lines gives the highest occurrence of simultaneous use of each type of premises. It shows, therefore, the number of units needed for each type of premises, for the implementation of BT curricula. The second bottom line translates this number into constructional modules. The third states the number of modules to be constructed, so as to provide for some flexibility.

The results should now be checked against the occupational needs for carrying out the STT programmes. Wherever needed, more units should be added.

4.4.4 Case 3 : 1G1 + 2G2 + 1G3

Table 4.14 gives the curricular hours distribution for this set of specializations.

Table 4.14 **Groups G1 + G2 + G2 + G3**

Premises types	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3
A	8	8	8	0	0	0	0	0	0	0	0	0
B	2	0	2	10	8	8	10	8	8	2	0	0
C	2	2	2	2	4	4	2	4	4	10	12	14
D	0	0	0	0	0	0	0	0	0	0	0	0
E	0	2	2	0	2	2	0	2	2	0	2	2
Lab	2	2	2	2	2	2	2	2	2	2	2	2
U-L	0	2	2	0	0	2	0	0	2	0	0	0
C-R	22	20	18	22	20	18	22	20	18	22	20	18

This configuration may be implemented by the following time schedule.

Table 4.15 **Time Schedule 3**

	Periods	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3
Monday	1	C-R	C-R	B	C-R	C	E	C-R	C-R	C-R	C-R	C-R	C
	2	C-R	A	B	B	C	E	C-R	C-R	C-R	C-R	C-R	C
	3	C-R	A	C-R	B	C-R	C	C-R	C-R	B	C-R	C-R	C
	4	C-R	A	C-R	B	C-R	C	C-R	C-R	B	C-R	C-R	C-R
	5	C-R	C-R	A	C-R	C-R	U-L	B	B	C-R	C	C	C-R
	6	C-R	C-R	A	C-R	C-R	U-L	B	B	C	C	C-R	C-R
	7	C-R	C-R	A	C-R	C-R	C-R	B	B	C	C-R	C-R	C-R
	8												
Tuesday	1	A	C-R	Lab	B	C-R	B	C	C-R	C-R	C	C-R	C-R
	2	A	C-R	Lab	B	C-R	B	C	C-R	C-R	C	C-R	C-R
	3	A	U-L	C-R	B	C-R	C-R	B	C-R	Lab	C	C-R	C
	4	C-R	U-L	C-R	B	C-R	C-R	B	C-R	Lab	C	C-R	C
	5	C-R	C	A	C	B	C-R	B	C-R	C-R	C-R	C-R	C-R
	6	C-R	C	A	C	B	C-R	B	C-R	U-L	C-R	C-R	Lab
	7	C-R	C-R	A	C-R	B	C-R	C-R	C-R	U-L	C-R	C-R	Lab
	8												
Wednesday	1	C-R	C-R	C-R	C-R	C-R	C	B	C-R	C-R	Lab	C	C-R
	2	C-R	A	C-R	C-R	C-R	C	B	C-R	C-R	Lab	C	C-R
	3	Lab	A	C-R	C-R	C-R	C-R	B	C	C-R	C	C-R	E
	4	Lab	A	C-R	C-R	C-R	C-R	C-R	C	C-R	C	C-R	C-R
	5	C-R	E	U-L	C-R	B	Lab	C-R	B	C-R	C	C-R	C
	6	A	E	U-L	C-R	B	Lab	C-R	B	C-R	C	C-R	C
	7	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C	C-R	E	C-R
	8	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C	C-R	E	C-R
Thursday	1	A	C-R	C-R	Lab	C-R	B	C-R	C-R	B	C-R	C	C
	2	A	C-R	C-R	Lab	C-R	B	C-R	C-R	B	C-R	C	C
	3	C	A	C-R	C-R	C	B	C-R	E	B	C-R	Lab	C-R
	4	C	A	C-R	C-R	C	C-R	C-R	E	C-R	C-R	Lab	C-R
	5	C-R	Lab	A	C-R	B	C-R	C-R	B	C-R	C-R	C	C
	6	C-R	Lab	A	C-R	B	C-R	C-R	B	E	C-R	C	C
	7	C-R	C-R	C-R	C-R	B	C-R	C-R	B	E	C-R	C	C-R
	8												
Friday	1	B	C-R	E	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C	C
	2	B	C-R	E	C-R	C-R	C-R	C-R	C-R	B	C-R	C	C
	3	C-R	C-R	C-R	C-R	C-R	C-R	C-R	Lab	B	B	C-R	C
	4	C-R	C-R	C-R	C-R	C-R	C-R	C-R	Lab	B	B	C-R	E
	5	C-R	C-R	C-R	B	E	B	C-R	C-R	C-R	C-R	C	C-R
	6	C-R	C-R	C-R	B	E	B	Lab	C	C-R	C-R	C	C-R
	7	C-R	C-R	C-R	B	C-R	B	Lab	C	C-R	C-R	C-R	C-R
	8												

Table 4.16 shows the weekly occurrences of simultaneous use of each type of premises.

Table 4.16 Simultaneous use of premises

	A	B	C	D	E	C-R	Lab	U-L	
Monday	0	1	2	0	1	8	0	0	
	1	2	2	0	1	6	0	0	
	1	2	2	0	0	7	0	0	
	1	2	1	0	0	8	0	0	
	1	2	2	0	0	6	0	1	
	1	2	2	0	0	6	0	1	
	1	2	1	0	0	8	0	0	
Tuesday	1	2	2	0	0	6	1	0	
	1	2	2	0	0	6	1	0	
	1	2	2	0	0	5	1	1	
	0	2	2	0	0	6	1	1	
	1	2	2	0	0	7	0	0	
	1	2	2	0	0	5	1	1	
	1	1	0	0	0	8	1	1	
Wednesday	0	1	2	0	0	8	1	0	
	1	1	2	0	0	7	1	0	
	1	1	2	0	1	6	1	0	
	1	0	2	0	0	8	1	0	
	0	2	2	0	1	5	1	1	
	1	2	2	0	1	4	1	1	
	1	0	2	0	1	7	1	0	
	1	0	2	0	1	7	1	0	
	1	2	2	0	0	6	1	0	
	1	2	2	0	0	6	1	0	
	1	2	2	0	1	5	1	0	
	1	0	2	0	1	7	1	0	
	1	2	2	0	0	6	1	0	
	1	2	2	0	1	5	1	0	
	0	2	1	0	1	8	0	0	
	0	1	2	0	1	8	0	0	
	0	2	2	0	1	7	0	0	
	0	2	1	0	0	8	1	0	
	0	2	0	0	1	8	1	0	
	0	2	1	0	1	8	0	0	
	0	2	2	0	1	6	1	0	
	0	2	1	0	0	8	1	0	
	1	2	2	0	1	8	1	1	**<<-- Max simultaneous usage**
	2	**5**	**2**	**0**	**1**	**8**	**3**	**1**	**<<-- Number of modules**
	2	5	3	0	2	10	3	1	**<<-- Should be required**
	24	58	62	0	16	240	24	8	**<<-- Weekly occupation hours**
	66.67%	80.56%	86.11%		44.44%	83.33%	66.67%	22.22%	

The first of the bottom lines gives the highest occurrence of simultaneous use of each type of premises. It shows, therefore, the number of units needed for each type of premises, for the implementation of BT curricula. The second bottom line translates this number into constructional modules. The third states the number of modules to be constructed, so as to provide for some flexibility.

The results should now be checked against the occupational needs for carrying out the STT programmes. Wherever needed, more units should be added.

4.4.5 Case 4 : 1G1 + 1G2 + 2G3

Table 4.17 gives the curricular hours distribution for this set of specializations.

Table 4.17 **Groups G1 + G2 + G3 + G3**

Premises types	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3	G3/Y1	G3/Y2	G3/Y3
A	8	8	8	0	0	0	0	0	0	0	0	0
B	2	0	2	10	8	8	2	0	0	2	0	0
C	2	2	2	2	4	4	10	12	14	10	12	14
D	0	0	0	0	0	0	0	0	0	0	0	0
E	0	2	2	0	2	2	0	2	2	0	2	2
Lab	2	2	2	2	2	2	2	2	2	2	2	2
U-L	0	2	2	0	0	2	0	0	0	0	0	0
C-R	22	20	18	22	20	18	22	20	18	22	20	18

This configuration may be implemented by the following time schedule.

Table 4.18 **Time Schedule 4**

	Periods	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3	G3/Y1	G3/Y2	G3/Y3
Monday	1	C-R	C-R	B	C-R	C	E	Lab	C-R	C	C-R	C-R	C
	2	C-R	A	B	B	C	E	Lab	C-R	C	C-R	C-R	C
	3	C-R	A	C-R	B	C-R	C	C-R	C-R	C	C-R	C-R	C
	4	C-R	A	C-R	B	C-R	C	C-R	C-R	C-R	C-R	C-R	Lab
	5	C-R	C-R	A	C-R	C-R	U-L	C-R	C-R	C-R	C	C	Lab
	6	C-R	C-R	A	C-R	C-R	U-L	C	C-R	Lab	C	C-R	C-R
	7	C-R	C-R	A	C-R	C-R	C-R	C	C	Lab	C-R	C-R	C-R
	8												
Tuesday	1	A	C-R	Lab	B	C-R	B	C-R	C	C	C-R	C-R	C-R
	2	A	C-R	Lab	B	C-R	B	C-R	C	C	C-R	C-R	C-R
	3	A	U-L	C-R	B	C-R	C-R	C	C-R	C	C	C-R	C-R
	4	C-R	U-L	C-R	B	C-R	C-R	C	C-R	C-R	C	C-R	C-R
	5	C-R	C	A	C	B	C-R	C-R	C-R	C-R	Lab	C	C-R
	6	C-R	C	A	C	B	C-R	C-R	C-R	C-R	Lab	C	C-R
	7	C-R	C-R	A	C-R	B	C-R	C-R	C	C-R	C-R	C	C-R
	8												
Wednesday	1	C-R	C-R	C-R	C-R	C-R	C	C-R	C-R	C-R	C	C	E
	2	C-R	A	C-R	C-R	C-R	C	C-R	C-R	C-R	C	C	C-R
	3	Lab	A	C-R	C-R	C-R	C-R	B	E	C-R	C	C-R	C
	4	Lab	A	C-R	C-R	C-R	C-R	B	E	C-R	C	C-R	C
	5	C-R	E	U-L	C-R	B	Lab	C-R	C	C-R	C-R	C-R	C
	6	A	E	U-L	C-R	B	Lab	C-R	C	C	C-R	C-R	C
	7	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C	C-R	E	C
	8	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C	C-R	E	C
Thursday	1	A	C-R	C-R	Lab	C-R	B	C	C	C-R	C-R	C	C-R
	2	A	C-R	C-R	Lab	C-R	B	C	C	C-R	C-R	C	C-R
	3	C	A	C-R	C-R	C	B	C-R	C-R	C-R	C	C-R	C-R
	4	C	A	C-R	C-R	C	C-R	C-R	C-R	E	C	C-R	C-R
	5	C-R	Lab	A	C-R	B	C-R	C-R	C-R	C	C-R	C-R	C
	6	C-R	Lab	A	C-R	B	C-R	C	C-R	C	C-R	C-R	C
	7	C-R	C-R	C-R	C-R	B	C-R	C	C-R	C	C-R	C-R	C
	8												
Friday	1	B	C-R	E	C-R	C-R	C-R	C-R	Lab	C-R	C-R	C	C
	2	B	C-R	E	C-R	C-R	C-R	C-R	Lab	C-R	C-R	C	C
	3	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C	C	B	C	E
	4	C-R	C-R	C-R	C-R	C-R	C-R	C-R	C	C	B	C	C-R
	5	C-R	C-R	C-R	B	E	B	C-R	C	C-R	C-R	Lab	C-R
	6	C-R	C-R	C-R	B	E	B	C	C	C-R	C-R	Lab	C-R
	7	C-R	C-R	C-R	B	C-R	B	C	C-R	E	C-R	C-R	C-R
	8												

Table 4.19 shows the weekly occurrences of simultaneous use of each type of premises.

Table 4.19 Simultaneous use of premises

	A	B	C	D	E	C-R	Lab	U-L	
Monday	0	1	3	0	1	6	1	0	
	1	2	3	0	1	4	1	0	
	1	1	3	0	0	7	0	0	
	1	1	1	0	0	8	1	0	
	1	0	2	0	0	7	1	1	
	1	0	2	0	0	7	1	1	
	1	0	2	0	0	8	1	0	
Tuesday	1	2	2	0	0	6	1	0	
	1	2	2	0	0	6	1	0	
	1	1	3	0	0	6	0	1	
	0	1	2	0	0	8	0	1	
	1	1	3	0	0	6	1	0	
	1	1	3	0	0	6	1	0	
	1	1	2	0	0	8	0	0	
Wednesday	0	0	3	0	1	8	0	0	
	1	0	3	0	0	8	0	0	
	1	1	2	0	1	6	1	0	
	1	1	2	0	1	6	1	0	
	0	1	2	0	1	6	1	1	
	1	1	3	0	1	4	1	1	
	1	0	3	0	1	6	1	0	
	1	0	3	0	1	6	1	0	
Thursday	1	1	3	0	0	6	1	0	
	1	1	3	0	0	6	1	0	
	1	1	3	0	0	7	0	0	
	1	0	3	0	1	7	0	0	
	1	1	2	0	0	7	1	0	
	1	1	3	0	0	6	1	0	
	0	1	3	0	0	8	0	0	
Friday	0	1	2	0	1	7	1	0	
	0	1	2	0	1	7	1	0	
	0	1	3	0	1	7	0	0	
	0	1	3	0	0	8	0	0	
	0	2	1	0	1	7	1	0	
	0	2	2	0	1	6	1	0	
	0	2	1	0	1	8	0	0	
	1	2	3	0	1	8	1	1	<<-- Max simultaneous usage
	2	**5**	**3**	**0**	**1**	**8**	**3**	**1**	**<<-- Number of modules**
	2	5	4	0	2	10	3	1	<<-- Should be required
	24	34	88	0	16	240	24	6	<<-- Weekly occupation hours
	66.67%	47.22%	81.48%		44.44%	83.33%	66.67%	16.67%	

The first of the bottom lines gives the highest occurrence of simultaneous use of each type of premises. It shows, therefore, the number of units needed for each type of premises, for the implementation of BT curricula. The second bottom line translates this number into constructional modules. The third states the number of modules to be constructed, so as to provide for some flexibility.

The results should now be checked against the occupational needs for carrying out the STT programmes. Wherever needed, more units should be added.

4.4.6 Case 5 : 1G1 + 1G2 + 1G3

Table 4.20 gives the curricular hours distribution for this set of specializations.

Table 4.20 **Groups G1 + G2 + G3**

Premises types	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3
A	8	8	8	0	0	0	0	0	0
B	2	0	2	10	8	8	2	0	0
C	2	2	2	2	4	4	10	12	14
D	0	0	0	0	0	0	0	0	0
E	0	2	2	0	2	2	0	2	2
Lab	2	2	2	2	2	2	2	2	2
U-L	0	2	2	0	0	2	0	0	0
C-R	22	20	18	22	20	18	22	20	18

This configuration may be implemented by the following time schedule.

Table 4.21 **Time Schedule 5**

	Periods	G1/Y1	G1/Y2	G1/Y3	G2/Y1	G2/Y2	G2/Y3	G3/Y1	G3/Y2	G3/Y3
Monday	1	C-R	C-R	B	C-R	C	E	C-R	C-R	C
	2	C-R	A	B	C-R	C	E	C-R	C-R	C
	3	B	A	C-R	C-R	C-R	C	C-R	C-R	C
	4	B	A	C-R	C-R	C-R	C	C-R	C-R	C-R
	5	C-R	C-R	A	B	C-R	U-L	C-R	C-R	C-R
	6	C-R	C-R	A	B	C-R	U-L	C	C-R	Lab
	7	C-R	C-R	A	B	C-R	C-R	C	C	Lab
	8									
Tuesday	1	A	C-R	Lab	B	C-R	C-R	C-R	C	C
	2	A	C-R	Lab	B	C-R	C-R	C-R	C	C
	3	A	U-L	C-R	B	C-R	C-R	C	C-R	C
	4	C-R	U-L	C-R	B	C-R	C-R	C	C-R	C-R
	5	C-R	C	A	C	B	C-R	C-R	C-R	C-R
	6	C-R	C	A	C	B	C-R	C-R	C-R	C-R
	7	C-R	C-R	A	C-R	B	C-R	C-R	C	C-R
	8									
Wednesday	1	C-R	C-R	U-L	C-R	C-R	B	C-R	C	C-R
	2	C-R	A	U-L	C-R	C-R	B	C-R	C	C-R
	3	Lab	A	C-R	C-R	C-R	C	B	E	C-R
	4	Lab	A	C-R	C-R	C-R	C	B	E	C-R
	5	C-R	E	C-R	C-R	B	Lab	C-R	C-R	C-R
	6	A	E	C-R	C-R	B	Lab	C-R	C-R	C
	7	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C
	8	A	C-R	C	C-R	Lab	C-R	C-R	C-R	C
Thursday	1	A	C-R	C-R	Lab	C-R	B	C	C	C-R
	2	A	C-R	C-R	Lab	C-R	B	C	C	C-R
	3	C	A	C-R	C-R	C	B	C-R	C-R	C-R
	4	C	A	C-R	C-R	C	C-R	C-R	C-R	E
	5	C-R	Lab	A	C-R	B	C-R	C-R	C-R	C
	6	C-R	Lab	A	C-R	B	C-R	C	C-R	C
	7	C-R	C-R	C-R	C-R	B	C-R	C	C-R	C
	8									
Friday	1	C-R	C-R	E	B	C-R	C-R	C-R	Lab	C-R
	2	C-R	C-R	E	B	C-R	C-R	C-R	Lab	C-R
	3	C-R	C-R	C-R	B	C-R	C-R	C-R	C	C
	4	C-R	C-R	C-R	C-R	C-R	C-R	Lab	C	C
	5	C-R	C-R	C-R	C-R	E	B	Lab	C	C-R
	6	C-R	C-R	C-R	C-R	E	B	C	C	C-R
	7	C-R	C-R	C-R	C-R	C-R	B	C	C-R	E
	8									

Table 4.22 shows the weekly occurrences of simultaneous use of each type of premises.

Table 4.22 Simultaneous use of premises

	A	B	C	D	E	C-R	Lab	U-L	
Monday	0	1	2	0	1	5	0	0	
	1	1	2	0	1	4	0	0	
	1	1	2	0	0	5	0	0	
	1	1	1	0	0	6	0	0	
	1	1	0	0	0	6	0	1	
	1	1	1	0	0	4	1	1	
	1	1	2	0	0	4	1	0	
Tuesday	1	1	2	0	0	4	1	0	
	1	1	2	0	0	4	1	0	
	1	1	2	0	0	4	0	1	
	0	1	1	0	0	6	0	1	
	1	1	2	0	0	5	0	0	
	1	1	2	0	0	5	0	0	
	1	1	1	0	0	6	0	0	
Wednesday	0	1	1	0	0	6	0	1	
	1	1	1	0	0	5	0	1	
	1	1	1	0	1	4	1	0	
	1	1	1	0	1	4	1	0	
	0	1	0	0	1	6	1	0	
	1	1	1	0	1	4	1	0	
	1	0	2	0	0	5	1	0	
	1	0	2	0	0	5	1	0	
Thursday	1	1	2	0	0	4	1	0	
	1	1	2	0	0	4	1	0	
	1	1	2	0	0	5	0	0	
	1	0	2	0	1	5	0	0	
	1	1	1	0	0	5	1	0	
	1	1	2	0	0	4	1	0	
	0	1	2	0	0	6	0	0	
Friday	0	1	0	0	1	6	1	0	
	0	1	0	0	1	6	1	0	
	0	1	2	0	0	6	0	0	
	0	0	2	0	0	6	1	0	
	0	1	1	0	1	5	1	0	
	0	1	2	0	1	5	0	0	
	0	1	1	0	1	6	0	0	
	1	1	2	0	1	6	1	1	<<-- Max simultaneous usage
	2	3	2	0	1	8	2	1	<<-- Number of modules
	2	3	3	0	2	8	2	1	<<-- Should be required
	24	32	52	0	12	180	18	6	<<-- Weekly occupation hours
	66.67%	88.89%	72.22%		33.33%	83.33%	50.00%	16.67%	

The first of the bottom lines gives the highest occurrence of simultaneous use of each type of premises. It shows, therefore, the number of units needed for each type of premises, for the implementation of BT curricula. The second bottom line translates this number into constructional modules. The third states the number of modules to be constructed, so as to provide for some flexibility.

The results should now be checked against the occupational needs for carrying out the STT programmes. Wherever needed, more units should be added.

ANNEX 1

POWER DISTRIBUTION GUIDELINES

(Unless otherwise specified in the main document, the following Standards can be used)

Campus Primary Electric Distribution System

The primary campus distribution system must be properly rated, grounded neutral, and installed in an underground conduit system with above ground transformers and switches. The electrical designer shall make the arrangements with the Electrité du Liban regarding availability of service, location of nearest transformer, and available KVA.

The design of the electrical system for the project should begin at the manhole designated by the Electrité du Liban. The incoming service (but not transformer size) shall be designed to have sufficient capacity for full design connected load plus 25% additional capacity for future growth.

Transformers

Transformers should be sized based on diversified KW demand. Pad mounted transformers are preferred to transformers located in vaults of any kind. Building surge protection should be a design consideration.

Locate pad mounted transformers at a suitable point outside the building, accessible to maintenance personnel and to truck-mounted crane. Provide a minimum of 2.50 m clearance in front of the transformer to permit hot-stick operation in the primary section. No other equipment or structures may be installed above or adjacent to the transformer, which may impede its installation or removal. Where possible, locate transformers at least 25 m from the nearest building. Any transformer that must be located nearer to the building shall be insulated with a "listed less flammable" material, such as silicone fluid or Rtemp oil.

Where the use of a pad mounted transformer is not feasible, underground vaults are discouraged. Every effort should be made to provide adequate space for a vault in the building, located where it is readily accessible and where there is no danger of flooding. The vault should not be located under or opposite the building entrance. In addition to the necessary maintenance access requirements, provisions should be made for possible removal of equipment from the vault. Doors, window openings, or removable panels in walls should be considered so that large equipment can be removed without structural, piping, or lighting changes. Water, steam, vent, or drain pipes of any kind are not permitted in the transformer vault, switch-gear, or switch-board room. Switch-gear should be located in a separate room so that it is not subject to the high ventilation rates in vaults.

Computer Room Power

Electrical service for areas to be used for computers should have :

a. Dedicated circuits for computer use only, eventually through UPSs.
b. Isolated ground receptacle and wiring to be used in conjunction with dedicated circuits.

Emergency Generators

Wherever possible, emergency generators should be located in weather-protected space contiguous with the buildings which the generator serves. Generator exhaust should be ducted to discharge above the roof and remote from any air intake for the buildings.

When sizing a generator system for a project, consideration should be given to providing emergency power to adjacent buildings requiring an emergency power supply.

Receptacles

A. Maintenance Needs

For use with housekeeping floor maintenance equipment, provide a 20 amp, 120 volt electrical receptacle every 10 m in corridors, on each stairway landing, and close to each exterior door. To the maximum extent possible, circuit these receptacles so that more than one piece of high amperage floor maintenance equipment may be operated simultaneously in each corridor.

B. General Needs

Generally all rooms will have a receptacle placed on each wall so that no receptacle will be more than 6 m from another receptacle. Floor plans must be provided with outlets marked on them for evaluation before the final set of plans is issued.

Lighting (Interior)

A. General Considerations

Fluorescent lighting should be used in most indoor building applications, especially where dimming is not required. Because of its poor efficiency and poor lamp life, incandescent lighting should only be used where other more efficient sources are unsuitable. In these cases, use improved efficiency sources such as halogen and reflectorized lamps. Avoid the use of chandeliers. Lighting should not exceed an average of 2 watts per gross square foot with a goal of 1.5.

B. Lighting Fixture Types

For general offices and classrooms where dimming is not required, and all other indoor building applications not mentioned below, use "general use" lay-in fluorescent fixtures.

For electronic offices, and similar applications where the occupants will use CRT screens, use "electronic office" lay-in fluorescent fixtures. These are 2 x 4 or 2 x 2 fixtures.

Lighting Level Guidelines

Unless safety and security requirements dictate greater illumination or specific visual tasks require either more or less illumination, lighting designs shall conform to the following guidelines :

a. Offices and classrooms, general use - 50 foot candles.
b. Offices and classrooms, special use - 60 to 75 foot candles.
c. Laboratories, drafting rooms, libraries, and similar close-task areas - 75 to 100 foot candles.
d. Corridors and stairs - 10 foot candles.
e. Shop areas - 30 foot candles, with task lighting as required. Do not use florescent lights over saws or other high speed blades that may be strobed to look like they are not moving.
f. Lobbies and lounges - 20 to 30 foot candles.
g. Emergency lighting - 2 foot candles.
h. Specialized areas - in accordance with recommendations of our internationally accepted code.
i. Conference tables - 30 foot candles with background lighting - 12 foot candles.
j. Exterior pedestrian plazas and walkway - 1.5 foot candles.

Lighting of Large Interior Areas

High Intensity Discharge (HID) lighting should be used for all warehouse, gymnasium and similar applications.

For gymnasiums and similar areas, use metal halide HID luminaries.

Design for illumination levels as follows :

- 50 foot candles for general recreation.
- 75 foot candles for High School/College Competition.
- 100 foot candles for televised athletic events.
- For multiple usage facilities, provide 3 stage switching.

For warehouses and similar areas use metal halide or color corrected high pressure sodium with a temperature rating of not less than 2500 Kelvin and a Color Rendering Index (CRI) of not less than 82. Design for an illumination level of 30 foot candles with special allowances for specific tasks.

Lighting of Mechanical Equipment Rooms

Mechanical equipment rooms shall be illuminated by either fluorescent or High Intensity Discharge (HID) lamps at 30 foot candles. Electrical and pneumatic control panels shall have task lighting designed at 50 foot candles.

Locate switches for mechanical room lighting fixtures inside the room and beside the door; large mechanical rooms with more than one door shall have 3-way switches to provide control at each entrance. Place mechanical room lights on emergency circuits from the emergency generator.

Lighting Control

Provide individual switching to control lighting in all areas. For areas over 20 square meter, provide either dimming or multiple switching to reduce the lighting. Use three tube fluorescent fixtures, with Master / satellite configuration where possible, to achieve three light level capability without dimming. Other areas may be so equipped if feasible.

Maintenance Considerations

The lighting design must address accessibility for relamping, cleaning and other maintenance procedures. The following guidelines are provided :

a. Do not locate fixtures directly over hazardous chemicals, mechanical equipment and/or laboratory benches. Install fixtures on the perimeter of such equipment as directed.

b. The Designer should make special provisions for solving the maintenance problems associated with lamps located in high ceiling areas. Any special instructions or equipment shall be provided to the Ministry as a part of the design.

c. Stairwell fixtures should be mounted so that maintenance personnel can reach them safely from an 2.40 mor shorter ladder.

Lighting (Exterior)

All outside lighting shall be of the High Pressure Sodium type.

1. Run 1" schedule 40 PVC from the appropriate size lighting circuit breakers to each base in series. Stub the conduit up 60 cm above grade at each location. Center the conduits in the concrete base.

2. Install a concrete base of appropriate dimensions below grade. Install galvanized anchor bolts in base to fit the Lantern base.

ANNEX 2

PLUMBING GUIDELINES

(Unless otherwise specified in the main document, the following Standards can be used)

TECHNICAL REQUIREMENTS

Hot domestic water temperature : +55 °C. All line sizing for potable water, sewage and drain systems shall be in accordance with ASHRAE standards, or another acceptable codes. The hot and cold water consumption shall be calculated from the ASHRAE or other acceptable codes, and actual figures for main consumers such as kitchen and laundry equipment. The redundancy requirement for hot water supply shall be calculated. Anticipated domestic water pressure on top floor of high rise buildings shall be stated.

The code prescribes that service water-heating system design loads shall be calculated following the procedures described in Chapter 44 of the ASHRAE HVAC Applications Handbook (1991). The designer may also use procedures developed by equipment manufacturers.

The handbook presents a number of calculation methods. The appropriate approach depends both on the application and the type of system (storage heater or instantaneous).

In addition to load calculations, Chapter 44 of the ASHRAE HVAC Applications Handbook (1991) also provides useful information on other aspects of service water-heating systems. These include: the sizing of distribution piping; special considerations in piping; problems of water quality and protection from corrosion and scale; design of dual temperature systems; health and sanitation concerns; and numerous references providing water usage and utilization temperatures for a range of building and system types.

Detailed plans for all plumbing systems must be provided (Electronic and hard copies).

DESIGN GUIDELINES

A. Planning

The hydraulic design and planning shall be determined after consideration is given to :

1. Accessibility for maintenance purposes.
2. Reliability of supply ring mains.
3. Service riser grid both horizontally and vertical.
4. Drainage and surcharge protection.
5. Standardization of repetitive components.
6. Balance flow control/pressure zones.

Quality Assurance :
The Hydraulic Services shall conform to the requirements of a recognized standard.

Design Criteria :
The works shall comply with a relevant design Standard.

The following criteria can be followed :

Hot & Cold water/Pipeline velocity	1.5 metres/second
Operating pressure	250-500 kPa minimum/maximum
Sanitary plumbing and drainage system	Modified vented system for combined soil and wastes
Domestic Hot Water	55°C Bathrooms and amenities 65°C Kitchens
Environment Pollution	Compliance with acceptable regulations.

The following minimum flow rates shall be provided to fixtures and equipment to the fixture values complete with flow rate scheduled below at the faucet outlet.

WC Cistern -	5.0 L/min full flush.
Basins -	6.0 L/min
Showers -	9.0 L/min
Sinks -	9.0 L/min
Baths -	9.0 L/min
Hose taps -	18.0 L/min
Cleaners Sinks -	12.0 L/min
Tubs -	9.0 L/min
WC for the Disabled -	84.0 L/min (flush valves)

. Drawings

repare design manufacturing, coordination and installation drawings covering the ervices installed. Site work shall not proceed until drawings have been approved y the client.

rawings shall be submitted in accordance with the procedures established by the rchitects to comply with the construction program.

ll workshop drawings shall be produced by CAD drafting system compatible with iat of the Architect's plans.

uring construction, maintain an up-to-date set of working drawings on the job. his set shall be used for marking-up and signing off by the relevant Authorities as sting proceeds and to maintain an accurate record of the work.

C. Maintenance Manual

Prepare three [3] copies of an instruction manual prior to the issue of Certificate of Practical Completion which shall include the following sections :

a. A complete description of the day by day operation of all equipment
b. A detailed maintenance schedule listing daily, weekly, monthly and yearly requirements
c. Manufacturer's brochures and service information of all equipment installed, listing the name, address and telephone numbers of all supply and service organizations if equipment requires regular maintenance
d. A set of 'work as executed' drawings covering the complete installation of the particular equipment and including electrical wiring diagrams The manuals shall be A4 size and each page of the manual shall be heavy quality paper. The hard cover shall secure each page at a minimum of four points.

D. Installation Guidelines

1. Pipe Layout

Except where specifically shown otherwise, all services shall be free of each other and easily replaceable for their full length. Pipes shall be so arranged with inspection openings, valves, and similar items of equipment placed to be accessible through inspection doors.

Wherever possible, pipes shall be run parallel with walls and slabs and with each other, minimize crossovers and unsightly groupings. All pipes shall be accurately set out and fully coordinated prior to commencing fabrication and installation. Pipes shall not be installed or designed for installation over electrical switch gear, motor control centers, transformers, nor in elevator shafts, and, during construction, leave all unfinished work in a safe condition, protecting the works against damage or loss through any cause whatsoever, seal off open ends of pipes in such a manner as to prevent the entry of foreign matter into the lines, until the works have been handed over on completion.

2. Valves

All valves shall be suitable for the particular service and the working parts shall be appropriately lubricated. All valves shall be thoroughly blown out before installation. In all cases, valves shall be of back-seating type so that gland packing may be replaced without draining the pipework.

Gate valves and stop valves shall be used for isolating purposes. Valves shall be provided for the isolation of all plant and equipment, Globe valves shall be used for system balancing and throttling.

a. Gate Valves - Shall be bronze suitable for a working pressure of not less than 2000 kPa.
b. Regulating Valves (throttling) - For use on all hot water return lines and regulating locations.
c. Pressure Limiting Valves - Shall be bronze. Provide pressure gauges upstream and downstream of valves.
d. All Check Valves and Strainers - Shall be suitable for a working pressure of not less than 2000 KPa.
e. Stop Valves - Shall be of approved manufacture with tested brass body and loose valve. Stop valves located in walls in exposed locations shall be chrome plated recess cocks, designated hot and cold.
f. Automatic Air Release Valves - Shall be approved suitable for a working pressure of not less than 1000 KPa, and located at the top of all hot water flows and in-line circulators. Bleed off to drain to adjacent floor drains.
g. Mini Stop Valves - At each wall connection for both hot and cold water to all basins and sinks, supply and install a 15mm right angled, screw driver operated mini stop valve. Valves shall be all CP, complete with wall dome and domed, screwed cover to conceal operating head.

Gauges

Gauges other than draft gauges shall be 4-1/2 inches diameter single spring type with recalibration adjustment in the dialface and with gate valve shut-off. Tailor the range to the application. Gauges shall not be positioned over 1.8 m above the floor; install remote sensing gauges as required to conform with this restriction.
Other piped systems: Locate vacuum or pressure gauges as required to properly identify pressure within each system.

Thermometers

Thermometers shall be red-reading-in-glass type with 9-inch magnified column, Centigrade scale, recalibration feature, adjustable head and brass separable socket. Tailor the range to the application. Thermometers shall not be positioned over 6-feet above the floor; install remote head type of thermometers as required to conform with this restriction.

Piped systems and storage tanks: Locate thermometers as required on all systems or tanks where temperature should be identifiable for operation and maintenance.

Access Panels

Adequately sized access panels shall be provided to pipe chases and to valves above ceilings or otherwise concealed.

Laminated plastic identification signs should be installed on the wall immediately below or adjacent to any concealed valve unless its location is obvious (such as immediately above or behind fixture). The sign shall identify type of service (hot water, cold water, etc.) and indicate the location by arrow or legend. Fire protection valves shall be prominently identified at each valve location.

Back-flow Preventers

Fixture valve outlets with hose attachments, hose bibs, and lawn hydrants shall be protected by an approved back-siphonage back-flow preventer or vacuum breaker on the discharge side of the valve. It is suggested that each building have a back flow preventer on the water main.

Compression Tanks

All compression tanks shall be specified to meet ASME Code Construction, or equivalent, and shall be so stamped. This applies to compressed air tanks, sewage ejector tanks, and well water tanks.

Cutoff Valves and Unions

All main lines and all hot water lines, especially those serving group toilet rooms, shall have shut off valves for isolation purposes and valves shall be accessible. Accessible water supply cutoff valves shall be furnished where each piece of equipment is to be connected. Unions shall be installed to facilitate removal of traps, valves, strainers, etc.

Floor Drains

Floor drains shall be provided in all equipment rooms, custodial closets, rest-rooms, and locker rooms with floors sloped to drains. Floor drains shall empty into the sanitary sewer. Infrequently used floor drains shall have traps resealed by trap primer from clear water fixtures. Drains of exterior stairwells shall be a drain well with grate type cover.

Clean-outs

Clean-outs shall be provided in all drain lines for maintenance, especially where sinks are placed back to back or side by side, and spaced at intervals that would allow access to any pipe that could become clogged.

Hot Water Tanks

All domestic hot water tanks shall be lined with "pre-krete" or other similar material suitable for potable water. Where appropriate the hot water should circulate continuously to all users.

Hot water Radiators

Standard cast iron cells type or better are required. Radiators must be manufactured in accordance with recognized standards and certified (ISO or other).

Penetrations and Sleeves

Set out all work and be responsible for accurate positioning and installation of all penetrations, core holes, waterstop flanges and sleeves in conjunction with the fixing of formwork and/or placing of brickwork and concrete.

To prevent weakening of the building structure, all penetrations shall be approved by the Structural Engineer prior to the scheduled placing of concrete.

Generally all major penetrations in pipe ducts and shafts shall be purpose made to the required size and accurately positioned and supported during the pouring of concrete. All other Core Hole shall be 'Slabseal' plastic waterstop assemblies accurately positioned and symmetrically provided for all pipes passing through floors.

Waterstop flanges shall be provided to all pipes, plant room sumps, roof outlets, floor wastes and pipes passing through floors and walls or wherever the possibility exists for water leakage. Each waterstop flange shall be of the same material as the pipe served with an external diameter twice the diameter of the pipe. The flange shall be integral to the casting or welded, brazed, silver soldered or sealed as applicable to the riser.

Sleeves shall be fitted to all pipes passing through walls, floors and beams. Construct sleeves from 1.2 mm thick copper, 25mm diameter larger than the outside diameter of the pipe being served and project 50mm above finished floor level in ducts and 10mm from walls. The space between pipes and sleeves shall be caulked and sealed with an approved fire rated material.

Expansion Joints

Expansion joints shall be provided at intervals to comply with manufacturers requirements and in positions to prevent stress in pipe work. Provide expansion joints between fixed points more than 2m apart and at a minimum of 6m centers where there are not fixed points.

Inspection Opening and Gates

Inspection openings shall be provided and built in so that each section of pipe work is accessible in at least one direction. Additional test gates shall be provided at each floor.

Sanitary Fixtures

Generally all sanitary fixtures and fittings shall be white vitreous china incorporating integral traps vandal proof and selected for performance and long term reliability with consideration to maintenance.

Special consideration shall be given to access ducts, service risers and false ceiling access zones.
All plumbing fittings shall be of proven design and quality with high grade materials and components. All cisterns shall be concealed to enable maintenance and high cleaning standards. Access to these facilities shall be properly designed and easily removable.

Toilet pans shall be floor mounted with exposed cistern.

Wall urinals shall be ceramic wall mounted with infrared or similar movement detector activation of solenoid valves to concealed cistern. For water conservation floor urinals shall be 316 stainless steel with hinged grating and waterfall spurge flush.

Hand basins shall be wall mounted with a mixing type spray tap by a manufacturer. Exposed floor wastes shall be chrome plated brass.

Bracketing and Supports

All service pipes shall be positioned in locations as approved before installation or fabrication commences. All pipework shall be free to move without causing stresses in the pipework or in the pipe joints. The works shall be entirely free of system noises and water hammer.

Clamp supports shall not be oversized. All clamp supports shall be galvanised mild steel split hanger type.

No pipe shall be supported from or to an adjacent pipe. Horizontal runs shall allow for complete adjustment to suit pipe grade and shall be positioned with a minimum of 40mm clearance, including insulation from adjacent services, floors and walls.

Special care shall be taken to avoid contact of dissimilar metals likely to cause electrolytic corrosion. Separate all pipes from dissimilar metals with 3mm thick rubber strip or similar approved material. Adhesive tape will not be accepted.

For spigot and socketed pipes such as cast iron, there shall be at least one fixing behind each pipe collar including fittings.

Painting and Identification

Except where otherwise specified or directed, all internal exposed piping throughout, adjacent to plumbing fixtures including traps and fittings shall be chromium plated. Where exposed pipes pass through a finished wall, floor or ceiling they shall be fitted with approved chromium plate. All other piping, except as otherwise directed or specified below, shall be cleaned free of cement droppings, etc, primed and painted to approval with the exception of concealed pipes in ducts, false ceilings and other concealed positions.

Concealed pipes in ducts, false ceilings and other concealed positions which shall be provided with 450 mm long color identification band. Color identification bands shall be at a maximum of 3000 mm centers.
Valves are to be labeled with a circular plate of trifoliate material engraved with their respective function and mounted in an approved manner on top of valve spindles with brass ring.

Excavation

The ground shall be excavated in the form of trenches to enable the various pipelines to be constructed in the locations shown on the drawings.

Trenches shall be excavated at uniform grades in straight lines.

Other buried services may also cross the route of the proposed systems and every precaution is to be taken to ensure their safety. Be responsible for the repair of all damaged services.

Backfill

Unless otherwise specified, all trenches shall be backfilled to the bulk excavation level with cement stabilized sand.

Restoration of Surfaces

The Contractor shall be entirely responsible for the restoration of any concrete, bitumen or natural surface removed or damaged as a result of the work. Any road, path etc so affected shall be restored with materials of the same nature and of equal quality as those contained in the original construction and to the same depth.

At the end of the maintenance period all restored surfaces shall at least equal in all respects those existing before the commencement of the works.

Surplus Spoil

Surplus spoil shall mean such excavated material which is not required for the purpose of the works and shall be removed from the site.

Flushing of Pipelines - Water Services

On completion of the installation of all pressure systems, allow to flush out all piping installations to remove foreign matter from the system.

Prior to flushing operation, disconnect all filters, screens, ball float valve inlets and other appliances which may be subjected to damage due to foreign materials. Ensure that the final installation is totally clear of any foreign matter and that all valves, filters, screens and outlets are not affected by such material. Replace any and all damaged items of equipment, make all necessary reconnections. Provide Ministry staff with a minimum of 48 hours notice prior to inspection and flushing procedures.

In general, all sanitary piping shall be pressure tested and function tested after installation. The test shall be performed prior to application of any thermal insulation.

Sanitary Systems : Atmospheric system : Sufficient blinding of the sanitary equipment shall be completed prior to the test. The sewage system shall be pressure tested with a pressure of 0.5 bar for a period of 30 minutes without any pressure decrease or leakage.

Potable water : The domestic water system, including the domestic water heaters, shall be pressure tested for a period of 24 hours without any pressure decrease or leakage. Test pressure to be 150% of the design pressure.

Schedule of Preferred Fittings and Equipment (All pipes and fittings shall comply with internationally recognized standards, ASME, BS or other acceptable to the client)

SERVICE	MATERIALS	COMMENTS
Stormwater Dainage	VC Pipe and fittings	
	RC Pipe	
	PVC Pipe and Fittings	
	Cast Iron Pipe and Fittings	
Sub – Soil Drainage	Slotted PVC Pipe and Fittings	
	VCP Perferated	
Storm Water Plumbing	PVC Pipe & Fittings	
	Cast Iron	
Basement Drainage	RCP	
	PVC pipe & Fittings	
Downpipes	UPVC/Galvanised	
Rising Mains	Copper	
Cold Water Reticulation	Copper	
Cold Water Mains Supply	Copper	
Hot Water Reticulation	Copper	
Pipe Fittings	Capillary	
Pipe Fittings	CTS	
	Screwed Brass/Flanges	
Plumbing Assessories	Brackets/Sealants/Gaskets	
Galvanised Pipe		
Pipe Fittings Galvanised	Screwed	
	Roll Groove	
VALVES	Globe/Gate/Ball	
	Loose Jumper style	
	FH Landing Valves	
Faucets & Taps	Enware	
PVC Pressure	Relative Pressure Pipes	
	Relative Fittings	
EQUIPMENT		
Booster Pumps	Multistage	
Circulation Pumps	Stainless Steel	
Sump Pumps	Submergible	
Water Heaters	(stainless steel)	
Electric Motors	As per acceptable Standards	
Flow/Water Meters	Reliable and easy to calibrate	
Storage Tanks	Safety and health standards compliant	
Sound & Vibration	BP Engineering	
Safety Equipment	Showers/Signs/Labels	

INSULATION

All insulation shall have a system fire and smoke hazard rating. The system rating shall be based on insulation, jacket, adhesives, coatings, fittings, and cements. Any treatment of jackets or facings to impede flame and/or smoke shall be permanent. The use of water soluble treatments is prohibited. ***ASBESTOS IS PROHIBITED***.

Required Insulation

The following piping shall be insulated :
Domestic and hot water lines
Fuel oil lines, where necessary or exposed to low temperatures

Specifications

Maximum temperature limit of the insulation must be above the maximum operating temperature of piping. Surface temperature of insulation for heated piping in still ambient air at 25 degrees C shall not be above 35 degrees C at the pipe operating temperature below 100 degrees C. The minimum thickness of insulation shall be one inch. Thickness of insulation for cold piping shall be selected to prevent condensation on the surface of insulation. Insulation shall be continuous unbroken and unpunctured. Insulation shall meet or exceed ASHRAE Standard 90A-1980 for energy conservation or selected in accordance with BS 5422 and BS 5970, or other acceptable standards.

Fittings, flanges, unions, and valves, except valves in hot water lines, shall be insulated. Insulation covers shall be either prefabricated or fabricated of pipe insulation. Insulation efficiency shall not be less than that of the adjoining piping. Specify that insulation vapor barrier be installed continuous and unbroken.

Hangers, supports, anchors, secured directly to cold surfaces, must be adequately insulated and vapor sealed to prevent condensation.

Controls

On multiple boiler plants, the controls shall be of the modulating selector type so that individual boilers can be made to lead or lag. These controls shall be located in view of the boilers themselves so that personnel can see the boilers as controls are being adjusted.

Float chambers of level control devices shall have gate valve drains with pipes extended to discharge over a floor drain.

Safety Valves : On hot water, relief valves shall be installed and so vented that they may be blown down without danger to personnel. Design will require adequately sized vent lines with appropriate drains to prevent steam and hot water from blowing back into the boiler room or other areas where they can endanger personnel.

Cut-offs : Boilers shall have a low water cut-off on the burner.

BOILER FEEDWATER EQUIPMENT

Water Softener

Each boiler room shall be provided with a water softener for boiler feedwater makeup.

Thermal Shock Prevention

Each steam boiler plant shall have a factory assembled de-aerating feedwater heater with automatic controls. The heater shall be located at an elevation to provide net positive suction head for the boiler feedwater pumps. Hot water boilers shall have system piping and cold water makeup arranged to prevent cold water from entering a hot boiler.

Fuel Handling Equipment

Fuel handling equipment and fuel burning equipment on boilers shall comply with recognized safety recommendations.

ANNEX 3

ELEVATORS

(Unless otherwise specified in the main document, the following Standards can be used)

General

All passengers' elevators should be designed to meet the handicapped code. Except in unusual situations, elevators should not be designed to be used exclusively as freight elevators. Electrical traction elevators are preferred for buildings higher than 3 floors. Schools elevators must comply with latest elevator codes and standards.

Elevators and elevator machine room equipment shall be designed to provide smooth and quiet operation. Sounds and vibrations shall be isolated from the building structure.

Elevator Equipment Rooms

Elevator equipment rooms shall not be used for access to roof or other parts of the building. Access to elevator equipment rooms shall not be through housekeeping or other such space.

Each elevator pit shall be provided with either a drain or sump pump as necessary to remain clear and dry. If sump pump is provided, it shall be controlled by a float switch. Each elevator pit shall have a work ladder and a light installed with the switch easily accessible from the door. The elevator pit shall be acid etched and finished with one coat thinner 50/50 and then one un-thinned coat of gray porch and deck synthetic enamel.

Elevator equipment rooms shall have sufficient ventilation or cooling to limit the maximum temperature in the space to 30 °C. If exterior supply air is provided, the intake shall be filtered. Ventilation fans should be sidewall mounted if possible. If necessary to install roof mounted fan, a permanent ladder for access shall be installed.

The elevator mechanical equipment room shall have fluorescent fixtures mounted above, in front of, and behind all control circuit panels. Adequate lighting for the hoist machine shall be provided.

If the elevator mechanical equipment room for a traction elevator is located on the bottom floor, fluorescent lighting shall be provided at the top of the hoist-way with a work platform, a light switch, and adequate access.

A safe accessible ladder and platform shall be provided for any mechanical equipment room above roof level.

The Penthouse, where necessary, shall have a minimum 2.40 m ceiling and shall have sufficient ventilation or cooling to limit the maximum temperature in the space to 30 °C. If exterior supply air is provided, the intake shall be filtered.

Schools, which rise for 3 floors or above, must have elevators installed. The building designer must determine the number and size.

ANNEX 4

GUIDELINES FOR HEATING, VENTILATION AND AIR CONDITIONING

(Unless otherwise specified in the main document, the following Standards can be used)

1 – SCOPE

This standard identifies the basic requirements for the design of heating, ventilation and air conditioning systems.

2 – TECHNICAL REQUIREMENTS

2-1 General

The ventilation systems shall be designed to :

- Maintain acceptable working environment for students and staff and non-destructive conditions for equipment.
- Prevent entry of hydrocarbons into closed non-hazardous areas.
- Prevent smoke spreading and keep enclosed escape ways free of smoke in case of fire.

The design shall take into account both normal and emergency operation requirements.

The HVAC design and choice of equipment should be chosen to benefit the overall Life Cycle Cost (LCC). The method of calculation is described in ASHRAE.

As guidance, the calculation for the purposed guarantee period should at least cover the following :

- Capital costs including construction, installation and commissioning
- Operational costs including preventive maintenance, critical failures and energy consumption

A plan, demonstrating how to verify compliance with the specified functional requirements described in this standard, shall be provided at the start of the design process, currently updated and used in the commissioning phase.

2-2 Design temperatures

For design of the HVAC systems, the designer shall investigate for the ambient temperature shall be defined in the school zone, for both winter and summer.

For internal room temperatures, reference is made to ASHRAE.

For occupied areas, the minimum and maximum temperatures shall be suitable for the actual areas/rooms (ASHRAE).

2-3 Natural ventilation

Minimum requirements for natural ventilation shall be secured. Ventilation openings shall be optimised with respect to sizes, shapes and positions and give the necessary level of weather protection to improve the working environment. Potential stagnant zones shall be evaluated.

3 – LAYOUT AND ARRANGEMENT

3-1 General

The main air-handling units should be located in designated HVAC areas.

Ductwork shall be located to enable simple maintenance work.

3-2 Clearance and accessibility

All equipment and ducting shall be arranged to provide required headroom and clearances for installations, operation, inspection, maintenance and dismantling with the minimum interference or removal of ducting and equipment. Accessible inspection and maintenance doors shall be installed in ductwork.

3-3 Air intakes and outlets

The air intakes shall, where possible, be located in a clear area. Consideration shall be taken to possible contamination sources such as :

- Ventilation extract outlets.
- Turbine and diesel engine exhaust outlets.
- Burning smoke.
- Gas leakage from hazardous areas.

The air intakes shall, where possible, be upstream of the prevailing wind. The wind influence on the air intake must be studied and documented.
Outlets from hazardous areas should be located at high level.

3-4 Air extract

From hazardous areas (i.e. Class A and Class B WS) extract shall be arranged at both high and low level in order to take care of both light and heavy gases.

Spot extract shall be used wherever suitable to avoid spreading of dust, fumes, heat etc. and to reduce the amount of general ventilation.

3-5 Ducting

Special attention shall be paid to ductwork connections to fan inlets and outlets in order to maximize the fan performance.

Flexible ducting shall be kept to a minimum and be used only for vibration damping or thermal expansion purposes.

3-6 Inspection doors/access

Doors shall be provided in all ductwork for inspection and cleaning. The size and location of doors for inspection, cleaning and access shall be in accordance with applicable codes.

The extract ducts from areas exposed to pollution, such as kitchen hood, shall be fitted with inspection doors, suitable for complete clean out of the ducting.

4 – FABRICATION

4-1 General

All duct elements shall be of aerodynamic design. Furthermore it shall be suitable for direct connection to equipment such as fans, air handling units, heaters, coolers, dampers and air terminal units, standard for fittings as documented by ASHRAE.

4-2 Duct classes

Ductwork is classified with respect to operational conditions.

Table 1 - Duct classes

Class	Material	Thickness	Operating Conditions
A	Stainless steel UNS S31603	3 mm	High strength ductwork. Ductwork exposed to weather and saliferious atmosphere Fire rated ductwork
B	Stainless steel UNS S31600	Supplier standard (Light Gauge)	Internal ductwork in corrosive environments, such as laboratories, battery rooms, etc.
C	Stainless steel UNS S31600 UNS S31603		Internal ductwork in production and utility Areas. External ductwork protected from mechanical strain.
D	Carbon steel painted or hot dipped galvanized. (Note 2)	4 mm	High strength ductwork Fire rated ductwork
E	Pre-galvanized sheet Steel	Supplier standard (Light Gauge)	Internal ductwork in controlled environments

Notes :
1. For rectangular ductwork the referenced size is the longest side.
2. Galvanising to be in accordance with ISO 1461 Metallic coatings.
3. Alternative duct class or duct material shall be qualified.

4-3 Ductwork design

The ductwork shall be true in section and not twisted or distorted.

All ducts shall be designed for actual velocities and max. operating pressures considering possibilities of fans running against closed dampers.

All ducts shall be made in suitable lengths, to suit surface protection, installation, maintenance and replacement.

4-4 Welding

All welding shall be carried out in accordance with a WPS established in accordance with EN 288 or equivalent.

The throat thickness of the weld shall be defined on WPS, drawing or equivalent. All welds shall be visually examined and show evidence of good workmanship.

5 - INSTALLATION

5-1 Ductwork erection

Different materials shall be isolated to prevent galvanic corrosion where applicable.

All relevant details regarding ductwork erection shall be in accordance with ASHRE standards.

Ductwork with limited access after installation should preferably be welded and/or all connections specially secured.

Duct penetrations through sound-rated walls (partitions) to noise-sensitive areas, shall have elastic caulking.

5-2 Joints

The jointing system shall be of a well-recommended system with a certified pressure class. For stainless steel flanges, bolts shall be stainless steel.

5-3 Hangers and supports

Ductwork supports shall be arranged to prevent any movement and shall be adequately sized for mechanical loads, wind loads. Supports shall not be welded to the ductwork unless specified on the drawings.

Supports, which are welded directly to the ductwork and/or equipment, shall be attached during the fabrication of the duct/equipment and shall be subject to the same inspection as the duct/equipment.

When being erected, duct runs shall not be forced into place to suit the installed support and thereby introduce undue stresses into the ductwork.

Surfaces of supports, which will be inaccessible after erection, shall receive the protective coating before assembly.

Where ducts are conveying conditioned air, packing blocks shall be installed between duct and support when externally insulated. The blocks shall be of sufficient insulating value to prevent condensation.

Ductwork in and close to noise-sensitive areas shall have a resilient support to prevent structural noise.

The addition of insulation to ducts should generally not affect the method of support, providing a vapour barrier is not required.

5-4 Ductwork insulation

For ductwork insulation, the following table 2 shall be used as a guideline.

Table 2 - Ductwork Insulation

Insulation Service	Insulation		Jacketing Note 5, 6, 7			Purpose
	Material	Thickness	Material	Thickness		
Heat conservation, hot	Mineral Wool or other suitable material	External ductwork. Min. thickness 50 mm. One layer. Internal ductwork. Min. thickness 50 mm. One layer.	Stainless steel	0,5	0,7	To reduce heat losses
			Aluminium alloy	0,7	0,9	
Cold conservation, cold	Cellular glass or other suitable material Mineral wool w/ vapour barrier	Temperature difference to surroundings. Max. 10 °C, thickness 25 mm. Above 10 °C, thickness 50 mm	Stainless steel	0,5	0,7	To maintain low temperature
			Aluminium alloy	0,7	0,9	
Fire Proofing A60	Mineral wool of "Rock" type, 110 kg/m3	75 mm.	Stainless steel	0,5	0,7	To prevent accident escalation due to rupture of ducts during fire
			Aluminium alloy	0,7	0,9	
Fire Proofing H0	Ceramic fibre, 128 kg/m^3	2 x 25 mm	Stainless steel	0,5	0,7	To prevent accident escalation due to rupture of ducts during fire
Fire Proofing H60	Ceramic fibre, 128 kg/m^3	2 x 38 mm	Stainless steel	0,5	0,7	To prevent accident escalation due to rupture of ducts during fire
External condensation, cold	Cellular foam, Cellular glass or other suitable material. Mineral wool w/ vapour barrier	Temperature difference to surroundings. Max. 10 °C, thickness 25 mm. Above 10 °C, thickness 50 mm	Stainless steel	0,5	0,7	To prevent external condensation on ductwork
			Aluminium alloy	0,7	0,9	
Acoustic insulation, ductwork internal	Mineral Wool	Design according to noise reduction requirements	Galvanised, perforated (30%) carbon steel sheet (Inside duct towards air flow	0,5		To reduce noise

Notes:

1. The thermal conductivity shall be max. 0,040 W/mK at 20 ° C,
2. If alternative materials are proposed, the insulation capability shall be equivalent to or better than the capability for the specified material and thickness
3. The vapour barrier shall have a maximum vapour transmission ratio of 1,75 PERM (= ng/s x Pa –1 x m –2). The barrier shall be a fire retardant, non toxic, factory applied cover reinforced by glass-fibre threaded tissue.
4. No insulation shall have an "open" surface allowing fibres to break off and pollute the surroundings. Factory applied cover shall be preferred to seal the insulation
5. Stainless steel jacketing shall be type UNS S31600, 2B finish or equivlent.
6. Aluminium alloy jacketing shall be type AlMn1 (AA3103) or equivalent.
7. Alternatives shall be qualified.
8. All fire insulation and installation method shall be certified.
9. For heat conservation and cold conservation standard pre-insulated ductwork may be used.
10. For installation ref. is made to BS 5970.

5-5 Identification of ductwork

The ductwork shall be adequately marked.

The identification symbols shall be placed on :

- Ducting in ceiling behind access points.
- Either side of major components (fans etc.).
- All ducting in HVAC plant rooms.
- Ducting in shafts behind access doors and panels.
- Ducting entering and leaving modules.
- Ducting entering or leaving local equipment/control rooms in open modules/areas.
- Both sides of fire walls where the duct penetrates.
- Each leg of a branch ducts where the destination is not immediately obvious.

5-6 HVAC equipment

Equipment shall be installed in accordance with the supplier's installation instruction and/or as specified on contract drawings and/or documents.

Grilles, diffusers and louvers shall be installed so as to fit neatly in the ceiling or wall in which they are installed.

Ductwork supports shall be located such that the equipment can be removed from the system without major dismantling of ductwork.

5-7 Cleaning and protection

All ductwork, fittings and equipment shall be cleaned before erection. All protective covers on equipment shall be left in place as long as possible during erection. Equipment shall be adequately protected against damage during construction.

All duct elements shall be supplied with dustblinds immediately after fabrication. Dustblinds shall remain in place until the duct elements are actually required for installation. Ductwork terminated for later hook-up shall be equipped with a blind on the open end immediately after installation.

When the duct system is finally installed and ready for mechanical completion, the system shall be internally clean along the complete run.

Stainless steel ductwork and equipment shall be kept externally covered to avoid contamination from other sources.

5-8 Pressure testing

5-8-1 General requirements

The ductwork inclusive equipment shall be pressure tested after installation. All materials such as duct, stiffeners, gaskets, bolting etc., intended as part of the final installation, which are damaged during testing, shall be replaced.

5-8-2 Preparation for pressure test

The section of the ductwork to be tested shall be prepared by blanking off duct outlets etc.

All dampers in the tested ductwork shall be left in open position. Testing shall be satisfactory completed before insulation or enclosure of the ductwork and before terminal units are fitted.

6 - COMMISSIONING

6-1 General

Commissioning codes series A with appendixes shall generally be applied as a guideline for the commissioning.

Acceptance of the HVAC-plant shall not take place until satisfactory commissioning has been completed. The commissioning shall take place after mechanical completion of the plant.

6-2 Preliminary checks

The purpose of this check is to ensure that the plant is in a satisfactory and safe condition before starting up.

6-3 Air flow adjustments

The balancing of system(s) shall be carried out in accordance with the proportional method as described in CIBSE Commissioning codes, series A, section A 2.7.

The balancing shall be carried out with the following tolerances :

The main airflow, and airflow into each room shall be within +/-10% of the specified value including errors of measurements. All measurements and settings shall be documented.

ANNEX 5

TELECOMMUNICATION WIRING GUIDELINES

(Unless otherwise specified in the main document, the following Standards can be used)

1 – PATHWAYS

1-1 Building pathways

Horizontal building pathways are facilities for the installation of telecommunications cable from the telecommunications closet to the work-area telecommunications outlet. Pathways can be underfloor; accessfloor; conduit (protective tubing that encases cable or wire); tray (holds the cable); and wireway, ceiling, and perimeter facilities. In most cases, underfloor and accessfloor distribution is costly and impractical for school buildings. Generally, horizontal pathways in school buildings utilize conduit, tray, and wireway and/or ceiling facilities. But please remember when examining ceiling facilities for horizontal pathways, suspended ceiling supports should not be used to hold wiring, and wiring should not lie directly on the ceiling tile.

For ceiling distribution systems, use cable-tray systems (rigid, prefabricated structures that support telecommunications cables and wiring), conduit, and/or cable rings. Open ventilated cable trays are recommended for ceiling distribution systems, even though they are the most costly option. Trays should be installed as close as practicable above the ceiling tile and have adequate support to withstand the stress of pulling the cables. A minimum of 30 cm should be maintained above the cable tray for access. The most practical solution for a school's wiring infrastructure usually involves using a mix of cable tray, cable ring suspension, and conduit. Whatever choice is used, the solution should be installed to meet the applicable code requirements.

1-2 Inter-building pathways

Inter-building pathways link multiple buildings for local area or campus telecommunications. If utility tunnels exist between buildings, they provide the preferred route for inter-building telecommunications pathways. Underground conduits may also be used for interbuilding pathways. In a campus environment, conduit should extend from the building entrance facility through the exterior for interbuilding connectivity. A conduit is considered full when 40 percent of the inside diameter is utilized.

2 – MEDIA STANDARDS

Unshielded twisted pair. The minimum standard for horizontal distribution wiring is six cables of Category 5 four-pair, 24-gauge unshielded twisted pair (UTP) wiring terminated in each classroom. The standard specifies 100-ohms impedance at one megahertz, satisfying Integrated Services Digital Network (ISDN) and Institute of Electrical and Electronics Engineers (IEEE) 802.3 10BaseT requirements.

3 – TELECOMMUNICATIONS CLOSETS

A telecommunications closet, also known as an MDF (main distribution frame) and also called a wiring closet, is a local communications equipment room. This should be dedicated space providing a secure environment for the installation and termination of cable, network electronics, and other telecommunications equipment.

The MDF, the point where the backbone and horizontal distribution facilities intersect, should be located near the center of the area served, preferably in the building core area. Every effort should be made to secure as large an area as possible. When one MDF is insufficient to cover a building, additional wiring closets, called IDFs (intermediate distribution frames), must be established. The same parameters apply for both MDFs and IDFs. A telephone should be installed in each location, and each door should have a lock..

Locate telecommunications closets away from any sources of electromagnetic interference, such as electrical power-supply transformers, motors, and generators. There should be no water sources in this area.

Locate one telecommunications closet for each 1000 m^2 or less. The minimum closet size for that area, is 10 by 3 m. The recommended minimum ceiling height is 2,50 m. Closets should be designed with adequate conduit or openings through beams and other obstructions into the accessible ceiling space.

Do not install false ceilings.

Power needs for the closet(s) vary, but you should plan for at least two dedicated 20-amp power circuits per closet.

The MDF contains wiring terminations and communications equipment to serve a floor. This equipment may include modular fiber distribution panels, wiring termination panels, telephone systems, concentrators/hubs that connect communications lines, routers that connect users on different networks, CATV (cable television) equipment, and equipment racks.

ENVIRONMENT. Telecommunications closets require continuous climate control.

Carpet should not be installed in closets. Tile or sealed concrete floors will protect equipment from static electricity and dust.

The major components of the building electrical system should not be co-located in the telecommunications closet. Closet space should be dedicated to serving telecommunications needs only. Electrical installations supporting telecommunications functions only should be located in the closet.

4 – TELECOMMUNICATIONS CLOSET TERMINATIONS

Each closet should contain at least one universal self-supporting 48 cm data rack. Each rack should be securely mounted to the floor and braced to the wall using a section of cable tray. Racks must be grounded in accordance with Code requirements.

If fiber optic cable is to be terminated in the closet, attach a fiber optic patch panel to the uppermost part of the data rack. Terminate the fiber optic cable with ST or SC connectors. The maximum optical attenuation for each mated connector pair must not exceed the connector manufacturer's specifications.

Terminate Category 5 cable on Category 5 RJ45 patch panels in all closet locations. All incoming cables should be routed on the tray and neatly dressed down to the patch panels. A cable management panel should be installed directly above and below each patch panel.

5 – BUILDING WIRING

Here are some tips for properly wiring workstations for students and teachers.

5-1 Student workstation wiring

Each classroom should have at least two student workstation outlets. A duplex power outlet with ground should be in close proximity to the student workstation outlet. Run two cables of Category 5 four-pair, unshielded twisted pair from the outlet to the wiring patch panel located in the telecommunications closet. The cables must be a continuous run and not spliced. The maximum cable length must not exceed 100 m. Each outlet should consist of either flush-mounted or surface-mounted, high-quality Category 5 RJ45 modular jacks with Krone IDC-style or 110-style wire T568A or B terminations. Consistency must be maintained throughout the installation. Jacks must meet EIA/TIA TSB40 recommendations for Category 5 connecting hardware.

Each outlet must be terminated with two individual cables. One outlet allows for voice and the remaining outlet allows for data. The color stripes on each cable must correspond with the color stripes on the edge connector. Faceplates must match the manufacturer for RJ45 outlets at all locations.

The designer should take into consideration that in each Class C WS, 30 student workstations and 2 reacher workstations will be installed.

5-2 Teacher workstation wiring

Each classroom should have one teacher information outlet. A duplex power outlet with ground should be in close proximity to the information outlet.

Run two cables of Category 5 four-pair, unshielded twisted pair from the outlet to the wiring patch panel located in the telecommunications closet. The cables must be a continuous run and not spliced. The maximum cable length must not exceed 10 m. The outlet must consist of either flush-mounted or surface-mounted, high-quality Category 5 RJ45 modular jacks with Krone IDC-style or 110-style wire T568A or B terminations. Consistency must be maintained throughout the installation. Jacks shall meet EIA/TIA TSB40 recommendations for Category 5 connecting hardware.

Each outlet must be terminated with two individual cables. One outlet allows for voice and the remaining outlet allows for data. The color stripes on each cable must correspond with the color stripes on the edge connector. Faceplates must match the manufacturer for RJ45 outlets at all locations

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