NO. 04

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR PROVISION OF LABORATORY AND EDUCATIONAL EQUIPMENT

FOR

BALUCHISTAN ENGINEERING COLLEGE, KHUZDAR

IN

THE ISLAMIC REPUBLIC OF PAKISTAN

NOVEMBER 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR PROVISION OF LABORATORY AND EDUCATIONAL EQUIPMENT

FOR

BALUCHISTAN ENGINEERING COLLEGE, KHUZDAR

IN

THE ISLAMIC REPUBLIC OF PAKISTAN

NOVEMBER 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

P R E F A C E

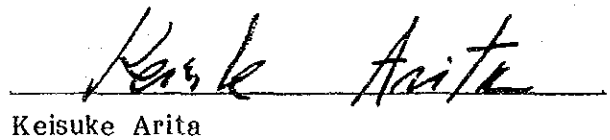
In response to the request of the Government of the Islamic Republic of Pakistan, the Government of Japan has decided to conduct a basic design study on the Project for Provision of Laboratory and Educational Equipment for Baluchistan Engineering College, Khuzdar and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Pakistan a study team headed by Dr. Susumu Yamashiro, Professor, Kitami Institute of Technology, from April 18 to May 8, 1987.

The team had discussions on the Project with the officials concerned of the Government of Pakistan and conducted a field survey in Islamabad, Karachi, Quetta and Khuzdar areas. After the team returned to Japan, further studies were made, a draft report was prepared and a mission to explain and discuss it was dispatched to Pakistan. As a result, the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the team.

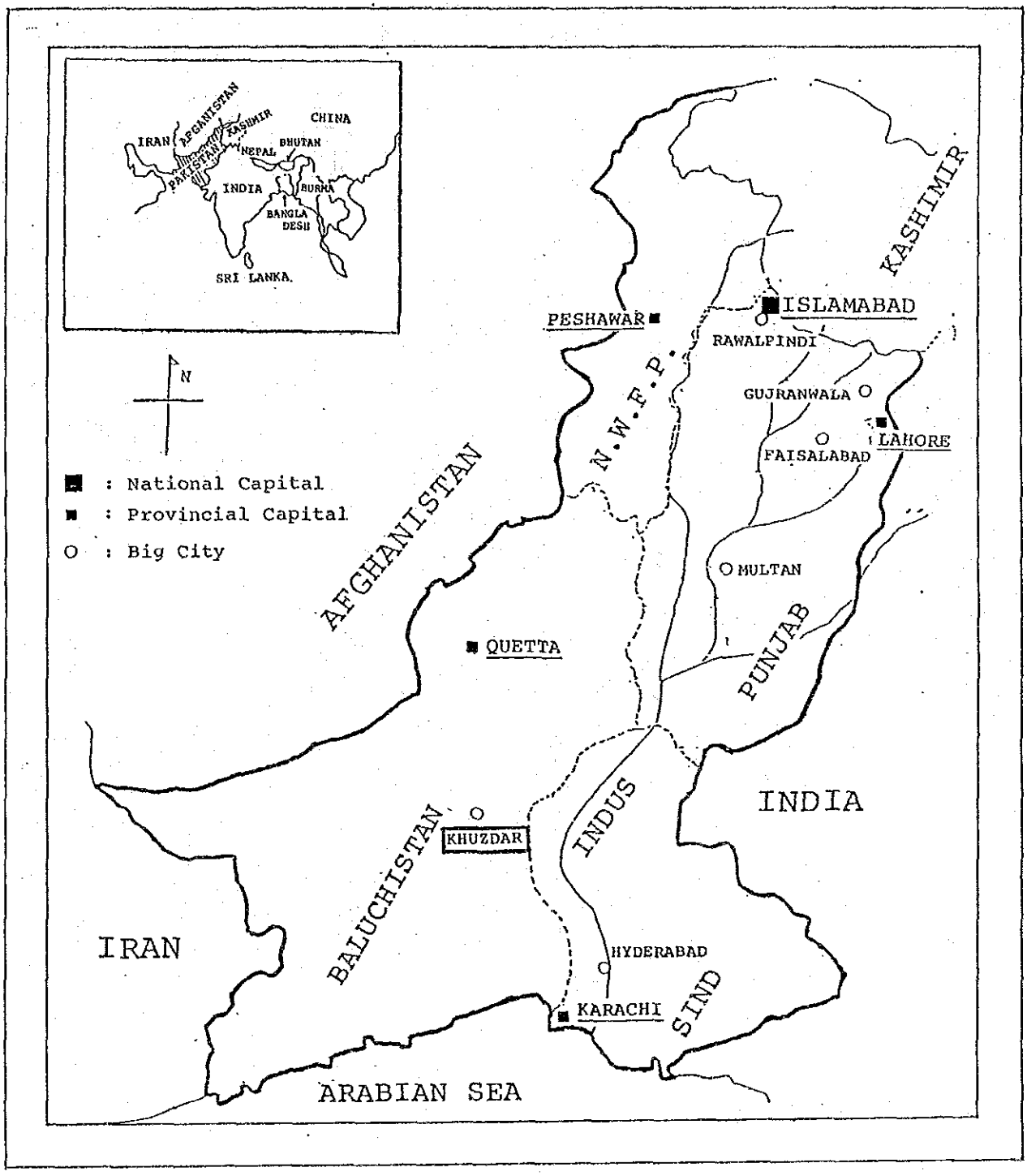
November, 1987.



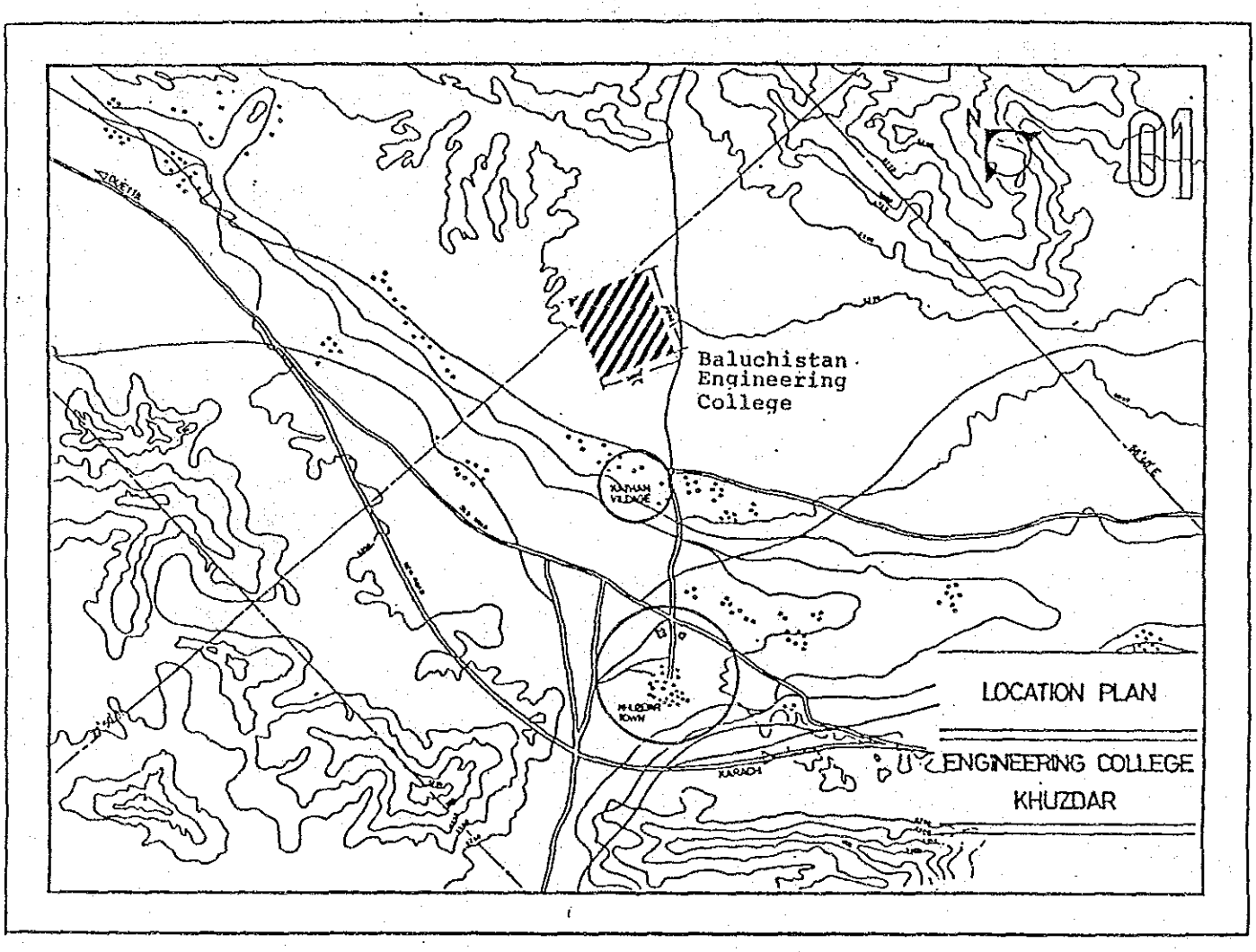
Keisuke Arita

President
Japan International Cooperation Agency

MAP OF PAKISTAN



MAP OF KHUZDAR



SUMMARY

S U M M A R Y

The Islamic Republic of Pakistan (hereafter referred to as Pakistan) has endeavored to improve and elevate the level of education in the country as part of several Five Year Development Plans. At present the country has four engineering universities and three engineering colleges (four year course), so that instruction in engineering is being provided at seven institutions of higher education. In The Sixth Five Year Development Plan (1983-1988) emphasis is placed on the improvement of scientific and technical research facilities and the expansion of educational facilities, on which basic progress is being made in expanding and improving existing engineering institutions as well as the planning of new ones.

In Baluchistan Province, which possesses considerable economic potential, a large number of development projects are being carried out in the agricultural sector and for improvement of the civil infrastructure, as part of the national development effort. Engineering and technical personnel who have received a suitable education have a particularly important role to play in the development of the province, and the need to educate such persons has increased. Baluchistan, however, does not have a college of engineering and men and women of that province who wish to study engineering must move to other provinces in order to do so.

With the foregoing situation as background, the Government of Pakistan is proceeding with a plan for construction of what will be the province's first engineering college, the Baluchistan Engineering College, Khuzdar (hereafter referred to as BEC, Khuzdar) in order to educate persons to meet the province's needs. Japan has been asked to provide grant aid for the provision of the laboratory and educational equipment which will be needed for the college.

In response to this, the Government of Japan, through the Japan International Cooperation Agency (JICA), dispatched a preliminary study team to Pakistan in October, 1986, to confirm the background and content of the request. Subsequently, faculty members of BEC, Khuzdar were appointed, the Curriculum Committee was formed, and the Government of Pakistan requested that a basic design study be made on the laboratory and educational equipment needed. JICA dispatched a team for carrying out the basic

design study work from April 18 to May 8, 1987. The team studied the courses planned, laboratory work to be performed, and the progress in planning and constructing the college.

The team also met with many persons related to the college, in Islamabad, Karachi, Quetta and Khuzdar, including officials of the Pakistani and Baluchistan Governments, and BEC, Khuzdar officials and faculty. The team visited the project site and studied matters related to it.

The outline of the findings of the study is as follows.

(1) Construction of BEC, Khuzdar is being undertaken as a federal government project, and the government has assumed responsibility for securing the budgetary funds needed for the construction. The Department of Education of Baluchistan Province is in charge of the construction work. Upon completion of construction, responsibility for management and operation of the college will be delegated to the Baluchistan Provincial Government, but day-to-day management and operation will be entrusted to BEC, Khuzdar. The executing agency for this project therefore will be BEC, Khuzdar.

(2) Construction of the college's facilities is scheduled to be completed in June, 1989. At present, construction of the Civil, Electrical and Mechanical Engineering Department classroom buildings as well as the general education classroom building and the laboratories is 95% completed. Dormitories and staff residences which would be necessary from the beginning of classes are virtually completed, being at the stage of installation of utility lines and wiring. The admission procedure has started in October, 1987 and academic session will start from February 15, 1988. Three professors, one associate professor, twenty-one lecturers and fifteen technical staff have been assigned.

(3) BEC, Khuzdar will offer four-year programmes in civil, electrical and mechanical engineering. Thirty students are to be admitted to each department every year, so at capacity enrollment will be 360.

(4) The course of studies, curriculum and experiment theme prepared by the Curriculum Committee have been studied with an existing Pakistani engineering university as a model, and are thought to be suitable.

A laboratory and educational equipment plan that will contribute to the attainment of the college's objective, namely to educate engineers capable of participating in the development plans, has been prepared on the basis of the foregoing outline. In formulating the plan, in addition to keeping in mind the scale of the college's student body and its curriculum and experiment theme, consideration was given to the fact that the college is a newly built one, and to the minimum requirements for laboratory and educational equipment which must be furnished for each laboratory.

The types of equipment required are as summarized in the following table. There are 810 items in all. Concerning the major specifications of the items, the grade was determined primarily on the basis of the laboratory and workshop activities to be performed by the students. Because the college is a new one, it is deemed that the plan for provision of equipment should conform to the annual progress of the students toward graduation, and the change in the students' course of studies based on this, and therefore the plan is proposed to be implemented in two phases.

	Number of Items		
	Phase 1	Phase 2	Total
(1) Civil Engineering Department			
.Structural and Concrete Laboratory	52	5	57
.Soil Mechanics Laboratory	-	106	106
.Road and Highway Laboratory	-	27	27
.Sanitation and Irrigation Laboratory	9	38	47
.Survey Laboratory	26	-	26
.Drawing Room	3	-	3
Sub Total	90	176	266
(2) Mechanical Engineering Department			
.Hydraulic Laboratory	17	14	31
.Material Testing Laboratory	19	-	19
.Mechanics and Measuring Laboratory	77	-	77
.Heat Engine Laboratory	-	11	11
.Air conditioning and Refrigeration Laboratory	-	10	10
.Fuel Oil and Lubrication Laboratory	-	44	44
.Workshop	49	18	67
.Drawing Room	6	-	6
Sub Total	168	97	265

	Number of Items		
	Phase 1	Phase 2	Total
(3) Electrical Engineering Department			
.Basic Electrical Engineering Laboratory	46	-	46
.Electrical Machine Laboratory	19	9	28
.Electronics Laboratory	27	11	38
.Telecommunication Laboratory	22	9	31
.Computer Laboratory	5	-	5
.Electrical Workshop	7	-	7
.Drawing Room	3	-	3
Sub Total	129	29	158
(4) General Education			
.Applied Physics Laboratory	50	-	50
.Applied Chemistry Laboratory	61	-	61
.Learning Laboratory	10	-	10
Sub Total	121	-	121
Grand Total	508	302	810

The equipment to be provided in both phases would be installed in the buildings which are almost completed. No additional buildings are presumed to be built.

The Project consists of the supply of equipment, its transportation to the college, unloading, installation, secondary wiring, test operation after installation and consulting work related to the preparation of tender documents and supervisors' tasks to be undertaken by the Japanese side. As the responsibilities of the Pakistani side, there are the furnishing of all electric power supply and lighting devices needed for operation of the equipment, the supply of utilities, such as electric power and water, drainage facilities, foundations for equipment requiring them, and the furnishing of benches, tables, shelves and other furniture for each laboratory.

Necessary expenditures for the Pakistani side directly related to the equipment are estimated at about Rs.600,000. The Project will require a period of 12 months each for Phase 1 and Phase 2, four months for the detailed design and tendering, six months for manufacturing of the equipment and transporting it to the site and two months for installation and test operations, all subsequent to the Exchange of Notes between the two governments. The implementation of Phase 2 would be taken place after accomplishing the recruitment plan for 1988.

BEC, Khuzdar will undertake the maintenance of the equipment and for that purpose the following specific measures will be required.

(1) Acquisition of operation and maintenance manuals

(2) Appointment of the persons to be responsible for maintenance

(3) Budgetary arrangements for maintenance

(4) Training of maintenance personnel

The annual budget for maintenance of the equipment is estimated at about Rs.3.2 million. It is necessary to obtain assurance that the specific requirements of annual recurring expenditures given in Amended Revised PC-1 will be met.

As effects of the Project, the following are anticipated.

(1) Human resources development in the area of science and engineering

(2) Promotion of development through engineering education

(3) Increases in study and employment opportunities

Taking the foregoing anticipated effects into consideration, it is judged that implementation of the present project is justified, and the provision of grant aid by Japan for the Project would be highly significant.

C O N T E N T S

APPENDICES

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

Through several Five Year Development Plans, Pakistan has made efforts to reform and improve the level of education in the country. Emphasis in The Sixth Five Year Development Plan is placed on the expansion and improvement of technical education in the higher education section. Moreover, in The Sixth Five Year Development Plan, policy emphasis is placed on development of the economic potential of Baluchistan, and many development projects are being realized on that basis.

Against this background, in order to train engineers in Baluchistan--which lacks a technical college--it was decided by the Government of Pakistan to construct the Baluchistan Engineering College, Khuzdar (hereafter referred to as BEC, Khuzdar), which would have three departments, namely Civil, Mechanical and Electrical Engineering. The Government of Pakistan requested the Government of Japan to provide grant aid, in the form of the provision of the laboratory and educational equipment necessary for the school's laboratories.

In response to this request, the Government of Japan carried out a preliminary study through the Japan International Cooperation Agency (JICA) in October 1986 to determine the background and confirm the nature of the request. Thereafter, the Government of Pakistan appointed faculty members of the new college, established a committee to draft the curriculum and requested the Government of Japan to conduct a basic design study. For the 21 days from April 18 to May 8, 1987, JICA sent to Pakistan the Basic Design Study Team, headed by Dr. Susumu Yamashiro, Professor, Kitami Institute of Technology, to undertake a field study, collect information, and hold discussions with officials of the federal and Baluchistan governments, faculty members of BEC, Khuzdar and members of the Curriculum Committee.

Discussions with Pakistani officials were recorded as minutes of the discussions, which were exchanged between Mr. Munir Ahmad, Joint Educational Adviser, Ministry of Education and Dr. S. Yamashiro, team leader. (Refer to Appendix-1).

The present report proposes the appropriate plan for achieving the purpose of the Project, identifies the laboratory and educational equipment needed and provides the basic plan for the Project, all on the basis of the field study, discussions, collected information, and related activities.

CHAPTER 2 BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 General Description of Pakistan

. Area, population

Pakistan borders Iran, Afghanistan, China and India, and faces the Arabian Sea to the south. The land area is 796,096 sq km, 2.2 times the area of Japan. The population during 1986 was estimated at 99 million, and is increasing by 3.1% per annum (1982 - 1986).

. Climate

Climate varies according to region. Summer is from April to October, including the monsoon season in July and August. Winter is from November to March. The annual temperature range in Khuzdar is wide, from -8°C in winter to 42°C in summer.
Khuzdar district is in a very dry region and has only 200 mm of annual precipitation. Humidity is usually between 40 - 65%.

. Economy

Of the Rs.495 billion planned total expenditures under The Sixth Five Year Development Plan which has been implemented since 1983, 60% is to be provided by the governmental sector and the rest is to be supplied by the private sector. The following are the main emphasis and targets of the plan.

(1) 6.5% annual planned GDP growth
(2) Expansion of public services
(3) Cooperation between the public and private sectors
(4) Public corporations to play a major role in capital formation
(5) Decentralization of development activities
(6) Greater role for local bodies
(7) Creation of new employment opportunities for 4 million labour force
(8) Development of rural areas
(9) Improvement of the economic and social status of women
(10) Assistance for the poor

The development of investments in various fields of the public sector of the nation is shown in Table 2-1-1. In The Sixth Plan, education and manpower are allocated a 6.5% share, representing a large increase from The Fifth Plan.

Table 2-1-1 Development of Investments in Various Fields of the Public Sector

(Unit: Million Rupees)

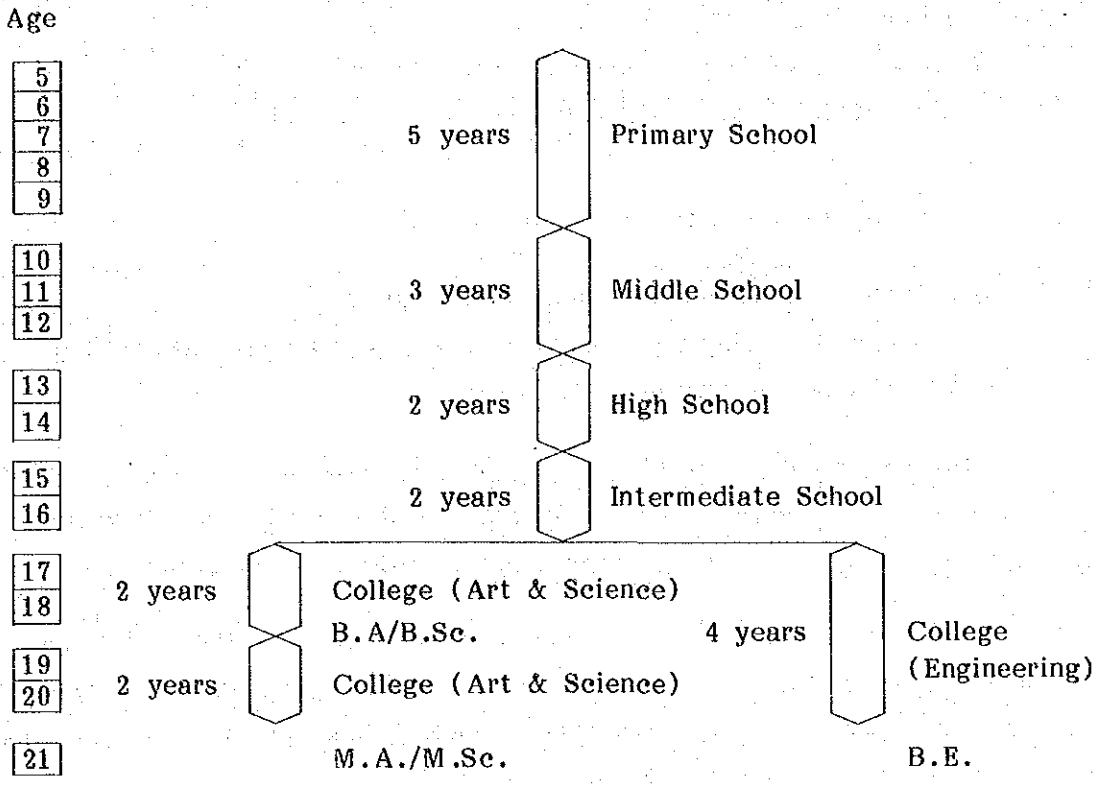
Sector	First Plan (1955-60)	Second Plan (1960-65)	Third Plan (1965-70)	Non-Plan Period (1970-78)	Fifth Plan (1978-83)	Sixth Plan (1983-88)
1. Agriculture	461	902	1,377	6,492	14,860	15,350
(a) Agriculture	461	695	822	4,141	6,060	12,350
(b) Fertilizer Subsidy	-	207	555	2,351	8,800	3,000
2. Water	969	4,597	4,513	12,810	15,770	32,100
3. Energy	607	1,293	1,760	13,841	38,830	116,500
(a) Power	575	1,165	1,571	10,880	28,119	87,400
(b) Fuels	32	128	189	2,961	10,597	27,500
(c) Renewable Energy	-	-	-	-	114	1,600
4. Industry	742	478	786	11,294	25,400	20,500
5. Minerals	124	94	271	492	400	5,750
6. Transport and Communications	1,080	1,595	2,521	15,653	35,210	57,520
7. Physical Planning and Housing	505	957	698	5,687	9,000	15,500
8. Education and Manpower	232	463	563	3,442	5,640	19,850
9. Health	76	174	281	2,381	4,580	13,000
10. Population Welfare Programme	-	9	145	820	600	2,300
11. Other/Misc. Programmes	67	44	289	2,632	2,320	6,630
Total	4,863	10,606	13,204	75,544	152,610	305,000

Source: Planning Commission

2.2 Present State of Education in Pakistan

2.2.1 Educational system and budget

The educational system in Pakistan is as follows:



In order to enter an engineering college, 12 years of lower and intermediate education are required. A total of 16 years of education is required to complete the collegiate engineering programmes.

In The Sixth Plan, provision is made for disbursement of Rs.60 billion in the sector of education, consisting of Rs.20 billion for development programmes and Rs.40 billion for meeting the recurring costs of maintaining existing and new development programmes.

Strategy related to education under the Plan broadly consists of (1) expansion of primary education, so as to improve literacy, and (2) education and training of the high-level scientific and technical personnel needed for economic development.

2.2.2 Higher technical education

Pakistan has 20 universities, one of which is in Baluchistan. Nineteen thousand students are enrolled at these schools. The four engineering universities are the following.

The University of Engineering and Technology, Lahore
Mehran University of Engineering and Technology
NWFP University of Engineering and Technology
NED University of Engineering and Technology, Karachi

In addition to these there are three engineering colleges.

Dawood College of Engineering and Technology
Mehran University College of Engineering and Technology, Nawabshah
University College of Engineering, Taxila

These institutions require completion of an intermediate college preparatory education (12 years) for admission, and award the Bachelor of Engineering degree after successful completion of four years of study.

The difference between a university and a college is that the latter has no postgraduate course; there is no difference between the two in regard to their four-year undergraduate curricula. Also, college degrees are conferred by the university which it is an affiliate of.

2.2.3 Programme for improvement of technical personnel

Training of engineers is given high importance by Pakistan in The Sixth Five Year Development Plan (1983 - 88). This is because it is understood that in order to improve the productiveness of Pakistan and implement development projects it is necessary to make effective use of many engineers possessing outstanding skills and abilities, as well as scientific knowledge.

A variety of engineer training programmes have been planned on the basis of recognition of the importance of training engineers in different fields of expertise. As part of that effort, the planning and plan implementation of improvements at existing engineering institutions as well as the construction of new ones are being carried out.

On the basis of such policies, BEC, Khuzdar is being planned as a national project, subsequent to the establishment of the NWFP University of Engineering and Technology.

2.3 Baluchistan Development Planning

Baluchistan has the largest area (347,000 sq km) of any province in Pakistan, and the smallest population (4,332,000 in 1981). The province borders on Iran to the west and Afghanistan to the north, and has a long shoreline on the Persian Gulf to the south.

Baluchistan had been the most retarded province in terms of development, but because its economic potential was recognized, a development plan emphasizing the realization of that potential, especially in the agri--cultural sector, was formulated under The Sixth Five Year Development Plan.

According to The Sixth Plan, "Baluchistan Province is blessed with large areas of virgin land and special climatic conditions, and is well suited to cultivation of high-value fruits and vegetables," and thus there are great expectations for the province as an agricultural frontier.

It is believed that in addition to emphasizing agricultural production with its related infrastructure, and development of power resources and supply systems, the need exists for expansion of social services and improvement of the lives of the residents. The Sixth Plan therefore emphasizes the following for development of Baluchistan.

(1) Development of agriculture proper and exploration of water resources.

(2) Development and improvement of transportation and communications network.

(3) Improvement of health care and development of educational programme.

(4) Improvement of the water and sewerage facility and development of housing.

(5) Exploration of mining and development of Industry

2.4 Establishment of Baluchistan Engineering College, Khuzdar

2.4.1 Background

The following are the two principal features of the background of the founding of BEC, Khuzdar.

(1) In comparison to the other provinces, Baluchistan lacks educational facilities, and possesses as institutions of higher learning only one university, eleven degree colleges, and 18 intermediate colleges. Because Baluchistan has no engineering college, students from the province aspiring to study engineering must go to other provinces.

(2) Many development plans have been formulated for Baluchistan, and require a large number of technical personnel in order to be successfully implemented. Because it is difficult to recruit such persons who have graduated from engineering college in other provinces, the importance of educating them in Baluchistan has increased.

These factors led to the Pakistani Government's decision to establish BEC, Khuzdar. The provincial government has decided that rather than further concentrate educational facilities at Quetta, for the sake of the overall development of the province, it would be suitable to build the college in Khuzdar, the province's third largest city, which is located about midway between Karachi and Quetta.

2.4.2 Plans for the college

The first planning document dealing with the founding of the college, PC-1, was approved by the Pakistani Government in January, 1977. At that time the budget provision made for it was Rs.126.9 million, including Rs.43.1 million expected as assistance from Iran in the form of foreign currency support.

The initial plan called for constructing the college, which was to have Civil, Mechanical, Electrical and Mining Engineering Departments, by March, 1981, but the start of construction was delayed until June, 1982, because of a variety of reasons.

This delay and cost overruns necessitated revision of the PC-1 document, and the result, in the form of the Amended Revised PC-1, called for postponement of establishment of a Mining Engineering Department, and retention of plans for Civil, Mechanical and Electrical Engineering Departments. This document was approved by Executive Committee for National Economic Council (ECNEC) on July 9, 1987. The Amended Revised PC-1 calls for a budget allocation of Rs.292.1 million including foreign currency assistance of Rs.105.4 million.

The college offer four-year degree courses in the following three departments.

Civil Engineering Department
Mechanical Engineering Department
Electrical Engineering Department

Each of the three departments is to accept 30 new students a year, so from the fourth year the college will have a total of up to 360 students. Admission to the college is limited to those who have completed the intermediate course and passed the examination prescribed by the college. Selection of applicants will be made by competent officials of the provincial government. The admission procedure for classes has started on October, 1987, and the academic session will start after winter vacation with effect from February 15, 1988.

2.4.3 Facilities

(1) Buildings

Construction of classroom and laboratory buildings, student dormitories, staff residences, and other structures is proceeding on a 200-acre (0.81 sq km) site in the mountainous region outside Khuzdar city, at an altitude of 1,150 m. The overall site plan is shown in Fig. 2-4-1.

Completion of construction of all facilities is scheduled for June, 1989.

Separate classroom and laboratory buildings are provided for each of the Civil Engineering Department, the Electrical Engineering Department, the Mechanical Engineering Department and the General Educational Department. Construction is about 95% complete and it is planned that the indoor wiring and all work other than flooring and finishing of freight entrances will be completed by December, 1987. One of the laboratory buildings, a workshop, will be completed by May, 1988.

Construction of the office building has been completed. Major construction work for six dormitories has been completed including interior finishing work for the two dormitories that will be required for the first entering class. Faculty housing needed for the first year is 90% complete and in the final stage of finishing work.

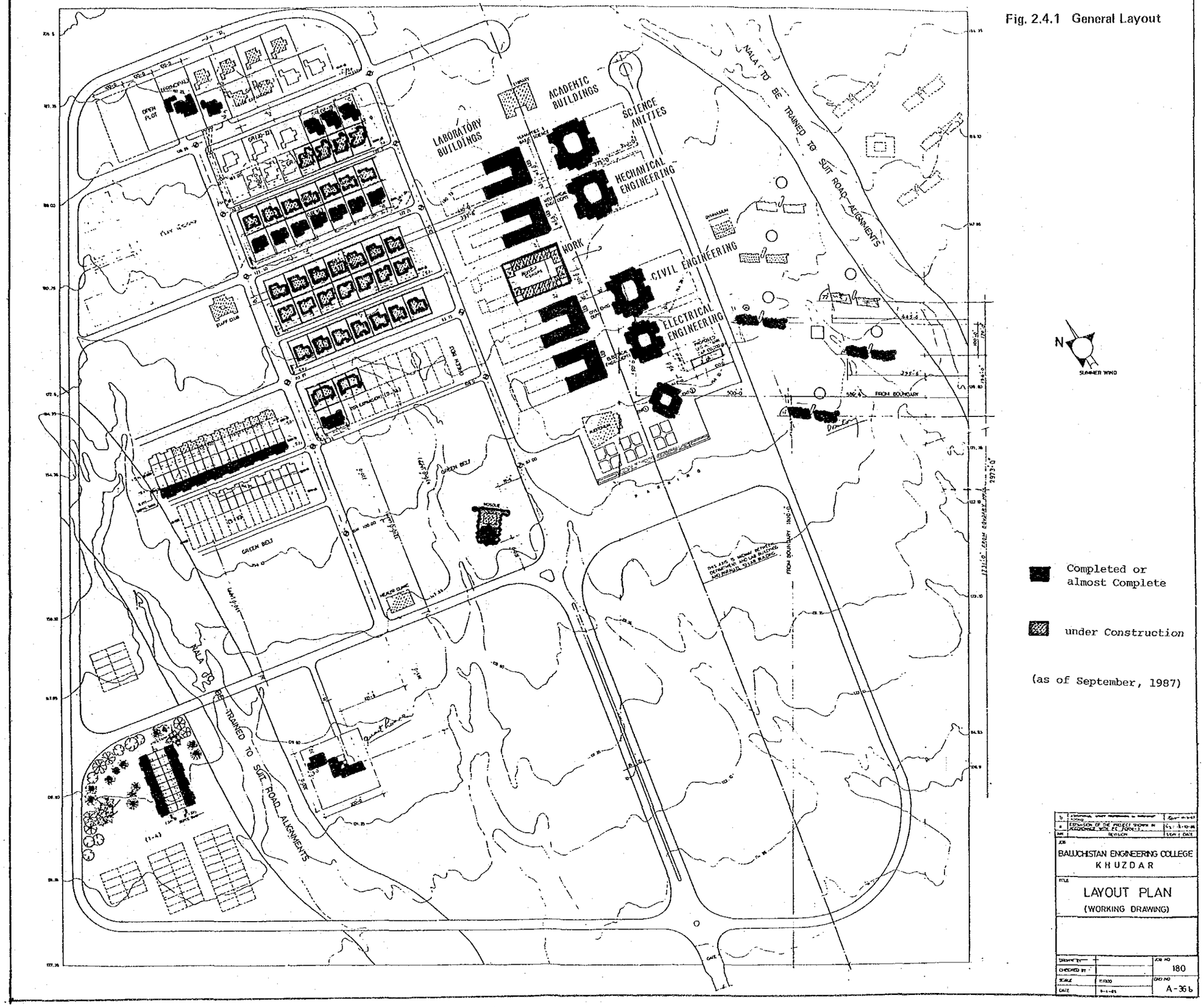
(2) Roads and utilities

Paving of intra-campus roads has been deferred until building construction is completed. Conventional access roads to the city are being planned and are scheduled to be completed in 1989.

The receiving line for the power supply (1 megawatt, 11kV) has been installed. Each building is to be supplied with 440 volt of 3-phase and 220 volt of 1-phase power supply.

Boring of two 100 m wells has been completed and a 4-inch service pipe to each building has been installed. Pump capacity is 60 tons/hour. The pH rating of the water is neutral and no difficulties are expected in regard to processing it for use.

Fig. 2.4.1 General Layout



2.4.4 Construction budget

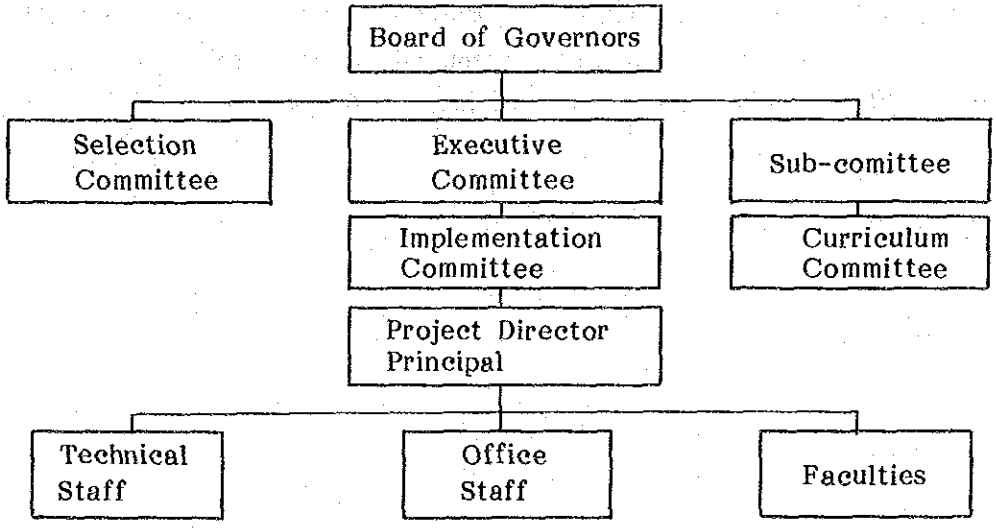
The composition of the Rs.292.135 million budget given in Amended Revised PC-1 is as follows.

(1)	Building construction	
	Academic and laboratory buildings, and dormitories	55,526,000 Rs.
	Staff residences	54,528,000 Rs.
	Common-use buildings	17,078,000 Rs.
(2)	Roads, utilities, etc.	27,362,000 Rs.
(3)	Furniture and fixtures	8,300,000 Rs.
(4)	Laboratory and educational equipment	115,431,000 Rs.
(5)	Contingency	13,910,000 Rs.
	Total	292,135,000 Rs.

The Government of Pakistan desired that the Government of Japan may provide the laboratory and educational equipment as grant aid. Laboratory desks, tables, shelves and other furnitures are to be provided by the Pakistani side [to the extent of Rs.4 million of item (3)].

2.4.5 Organization for establishment of the college

The organization set up for the establishment of the college is as follows.



The Board of Governors is headed by the Minister of Education of the federal government, and is composed of 12 members, from the federal and Baluchistan governments and universities in other provinces. It has the function of determining basic policy for creation of the college.

The Executive Committee is headed by the Minister of Education of Baluchistan Province, consists of seven members, and decides on basic policy for management of the college.

Among the sub-committees, the Curriculum Committee had the following members as of November 1986, and is in charge of planning the curriculum and preparing lists of the equipment that will be needed.

Chairman : . Vice Chancellor, NED University of Engineering and Technology, Karachi

Members : . Principal, Dawood College of Engineering and Technology
. Joint Secretary, Higher Education Department, Ministry of Education;
. Project Director and (concurrently) Principal, BEC, Khuzdar

In addition to these four, specialists in civil engineering (from BEC, Khuzdar) and electrical and mechanical engineering (NED University) participate in the committee.

It is planned that the employees of BEC, Khuzdar shall be comprised of 41 teachers (professors, associate professors, assistant professors, lecturers), a 35 member laboratory technical staff, and clerical, administrative and other workers for a total of nearly 160 persons.

Three professors, one associate professor, 21 lecturers and 15 technical staff has been assigned by the end of October, 1987. Further recruitment plan of teaching and technical staff is as follows.

	Target in 1989	1987		1988	1989
		as of Oct.	End of Dec.	Target	Target
Professor, associate professor, assistant professor	21	4	-	+9	+8
Lecturer	20	16*	+1	+3	-
Technical staff	35	15	+20	-	-
Total	76	35	+21	+12	+8

Note: * Although 16 lectures has been hired as full time job, additional 5 lectures has been kept as leave reserve.

2.4.6 Operating budget

Construction of the college is being undertaken by the federal government as a national project, but after construction the college is to be operated by the Baluchistan Government. According to Amended Revised PC-1 the annual recurring expenditures of the college are to be as follows.

Personnel costs (Pay and allowances)	Rs.5.60 million
Operation and maintenance	Rs.4.50 million
Local maintenance cost (buildings, utilities etc.)	
Equipment maintenance cost in foreign exchange	Rs.3.40 million
Total	Rs.13.50 million

CHAPTER 3 CONTENTS OF THE PROJECT

CHAPTER 3 CONTENTS OF THE PROJECT

3.1 Purpose of the Project

In the Sixth Five Year Development Plan (1983 - 1988) the Pakistani Government emphasizes development plans for Baluchistan Province. It is necessary to prepare a large number of engineers in order to implement those plans.

The Pakistani Government, moreover, is promoting the expansion and improvement of educational institutions specializing in engineering, in order to carry out the social and economic development work of the nation, and on the basis of a programme for engineering education, the Government is creating more engineering universities and colleges, and improving such existing departments.

On the basis of these national plans the Pakistani Government decided to establish BEC, Khuzdar, as the first engineering college in Baluchistan, to thereby improve the opportunities for Baluchistan residents to obtain a higher engineering education, and supply the technically-qualified personnel required for implementation of the province's development plans.

Construction of the college's buildings was begun in June, 1982, on a site outside Khuzdar city, on the basis of the PC-1 approved by the Pakistani Government in 1976. Delays and cost overruns required revision of initial plans, and Amended Revised PC-1 was approved by ECNEC in July, 1987.

The revised plan calls for creating three engineering departments, Civil, Electrical and Mechanical, and in November, 1985, the Government of Japan was requested to provide assistance in the form of grant aid of laboratory and educational equipment for these three departments.

The objective of the present project is to provide the necessary laboratory and educational equipment so that the college can accomplish its purpose.

3.2 Contents of the Request

At the time of the preliminary study in October, 1986, Pakistan provided a list of about 700 items that were to be requested, but at that time the curriculum had not yet been determined.

Thereafter, the Curriculum Committee, chaired by the vice chancellor of NED University, was formed and compiled three volumes of the course contents and curriculum planned for the college including an equipment list, and these have been submitted to the study team.

The course outlines for each department, as submitted to the team at the time when the basic design study was made in May 1987, are provided as Appendix-5 of this report. The experiments themes to be conducted in each laboratory or workshop are as shown in Appendix-6. A comparison of the outline of the equipment list provided by the Pakistani side and the items identified as being requested at the time of the preliminary study is provided as Appendix-7.

The course outlines and curriculum of each of the three departments are examined on the basis of those of NED University.

Basic information on NED university is as follows.

a. Location: Karachi, adjacent to Karachi University (100 acres)

b. Founded: 1922;
Relocated to the present site in 1975,
Elevated to university status in 1977

c. Departments: Civil Engineering
Mechanical Engineering
Electrical and Computer Engineering

d. Faculty: 11 professors
21 associate professors
22 assistant professors
36 lecturers

e. Student body: New admissions for the first semester, 1987 academic year, as follows:

Civil Engineering	208
Mechanical Engineering	207
Electrical Engineering	138
Computer Engineering	70
	623

Total enrollment is more than 3,000, including 200 postgraduate students.

Whereas NED University is an institution offering postgraduate courses of study as well as a graduate course and having more than 600 students enrolled in each of the four years, BEC, Khuzdar is a school in the process of being established, and will have only 90 students in the first year instruction is offered. Consequently, even though its three departments are also to be found at NED University, it would be preferable for the experiment themes performed at BEC, Khuzdar to be fewer than at NED University, and it is thought that the scale and contents of experiment themes as delineated in the submitted documents are generally suitable.

Construction of classroom and laboratory buildings at Khuzdar is proceeding more rapidly than that of other buildings and completion of laboratory and workshop buildings where the laboratory and educational equipment will be installed is scheduled by May, 1988.

3.3 Contents of the Project

3.3.1 Executing agency

BEC, Khuzdar is being constructed as a federal government project, and responsibility for formulation of basic policy for establishment of the college, and securing the budget for its construction, lies with the Ministry of Education. Actual construction is being undertaken by the Baluchistan Province Department of Education. Operation and management of the college after the initiation of instruction will be by the Baluchistan Government, which will make the appropriate budgetary allocations. The provincial government will delegate operation and management to the college's officials. The executing agency with regard to the present project for the provision of equipment therefore will be BEC, Khuzdar.

3.3.2 Curriculum

The course of study in the three departments as planned by the Curriculum Committee, is as follows.

Civil Engineering Department

First Year

1) Applied Physics
2) Mathematics-I
3) Engineering Drawing-I
4) Workshop Practice
5) Islamic Studies-I
6) Engineering Mechanics
7) Mathematics-II
8) Surveying-I
9) Applied Chemistry
10) Thermodynamics
11) English

Second Year

1) Surveying-II
2) Electrical Technology
3) Strength of Materials-I
4) Mathematics-II
5) Engineering Materials
6) Mathematics-IV
7) Engineering Drawing-II
8) Fluid Mechanics-I
9) Concrete Technology
10) Theory of Structures-I
11) Islamic Studies-II

Third Year

1) Mathematics-V
2) Strength of Materials-II
3) Transportation Engineering-I

4) Engineering Construction
5) Reinforced Concrete-I
6) Engineering Economics
7) Soil Mechanics-I
8) Engineering Geology
9) Quantity Surveying & Costing
10) Theory of Structure-II
11) Reinforced Concrete-II
12) Islamic Studies-III

Fourth Year

1) Steel Structures
2) Structural Design
3) Soil Mechanics-II
4) Sanitary Engineering-I
5) Fluid Mechanics-II
6) Civil Engineering Project
7) Construction Management
8) Transportation Engineering-II
9) Water Resources Engineering
10) Architecture & Town Planning
11) Sanitary Engineering-II
12) Civil Engineering Project

Mechanical Engineering Department

First Year

1) Engineering Mechanics-I
2) Surveying-I
3) Calculus-I
4) Chemistry
5) English
6) Engineering Mechanics-II
7) Engineering Drawing
8) Workshop Practice
9) Calculus-II
10) Physics
11) Pakistan Studies-I

Second Year

1) Thermodynamics
2) Solid Mechanics-I
3) Production Engineering-I
4) Electrical Technology-I
5) Differential Equations
6) Fluid Mechanics-I
7) Elements of Machine Dynamics & Design
8) Electronics
9) Mathematical Methods
10) Islamic Studies-I (for Muslims) or
Pakistan Studies-II (for Non-Muslims)

Third Year

1) Internal Combustion Engines
2) Steam Generation and Steam Turbines
3) Solid Mechanics-II
4) Metallurgy
5) Numerical Analysis
6) Engineering Economics
7) Fluid Mechanics-II
8) Machine Design
9) Mechanical Vibrations
10) Heat Transfer-I
11) Production Engineering-II
12) Probability and Statistics
13) Islamic Studies-II (for Muslims) or
Ethical Behaviour (for Muslims)

Fourth Year

1) Stress Analysis
2) Gas Dynamics
3) Heat Transfer-II
4) Refrigeration & Air Conditioning
5) Advanced Mathematical Techniques
6) Gas Turbines

7) Nuclear Power
8) Lubrication
9) Industrial Engineering
10) Mechanical Engineering Design Project

Electrical Engineering Department

First Year

1) Basic Electrical Engineering
2) Engineering Mechanics-I
3) Mathematics-I
4) Physics
5) English
6) Islamic Studies-I or Pakistan Studies-I
7) Basic Circuit Theory
8) Basic Electronics
9) Engineering Drawing
10) Workshop Practice
11) Mathematics-II
12) Chemistry

Second Year

1) Electrical Measuring Instruments
2) Electronics-I
3) Basic Electrical Machines
4) Engineering Mechanics-II
5) Mathematics-III
6) Islamic Studies-II or Pakistan Studies-II
7) Electrical Measurements
8) Electronics-II
9) Electrical Machines-I
10) Thermodynamics
11) Fortran-IV Programming
12) Mathematics-IV

Third Year

1) Network Theory
2) Power Electronics
3) Electrical Machines-II
4) Electrical Power Systems-I
5) Mathematics-V
6) Engineering Economics
7) Industrial Electronics
8) Electrical Machine Design & Drawing
9) Linear Control Systems-I
10) Logic Design & Switching Theory
11) Electromagnetic Field-I
12) Pakistan Studies-I or
    Ethical Behaviour

Fourth Year

1) Generalized Electrical Machines Theory
2) Electrical Power Systems-II
3) Analog & Digital Techniques
4) Energy Conversion
5) Telecommunications-I
6) Electrical Engineering Project
7) Electrical Power Systems-III (Analysis Protection)
8) Computer Architecture & Organization
9) Linear Control Systems-II
10) Electromagnetic Fields-II
11) Telecommunications-II

Classroom hours are planned to be as follows:

(Unit: Instruction hours/week)

	Civil Eng. Dept.		Mech. Eng. Dept.		Elect. Eng. Dept.	
	Theory	Practice	Theory	Practice	Theory	Practice
First year						
1st semester	18	16	19	11	20	5
2nd semester	20	12	18	18	20	10
Second year						
1st semester	20	14	20	16	22	8
2nd semester	20	12	18	12	24	10
Third year						
1st semester	24	6	23	16	24	8
2nd semester	22	12	24	20	22	8
Fourth year						
1st semester	20	12	18	16	20	8
2nd semester	18	20	16	22	20	18

3.3.3 Laboratory and educational equipment plan

A plan for provision of the laboratory and educational equipment, described below, has been prepared on the basis of the foregoing information on the curriculum and review of the planned experiment themes.

The basis and procedures of the planning are as follows.

1. Selection of equipment, and related plans, are based on the emphasis to be given to acquisition of basic knowledge and technical skills, in view of the objective of the college as stated above.

2. Selection is to be made assuming 30 students in each department, and 90 students in each of the four years.

3. Selection and planning are to be made on the basis of the planned curriculum and experiment themes for the three departments.

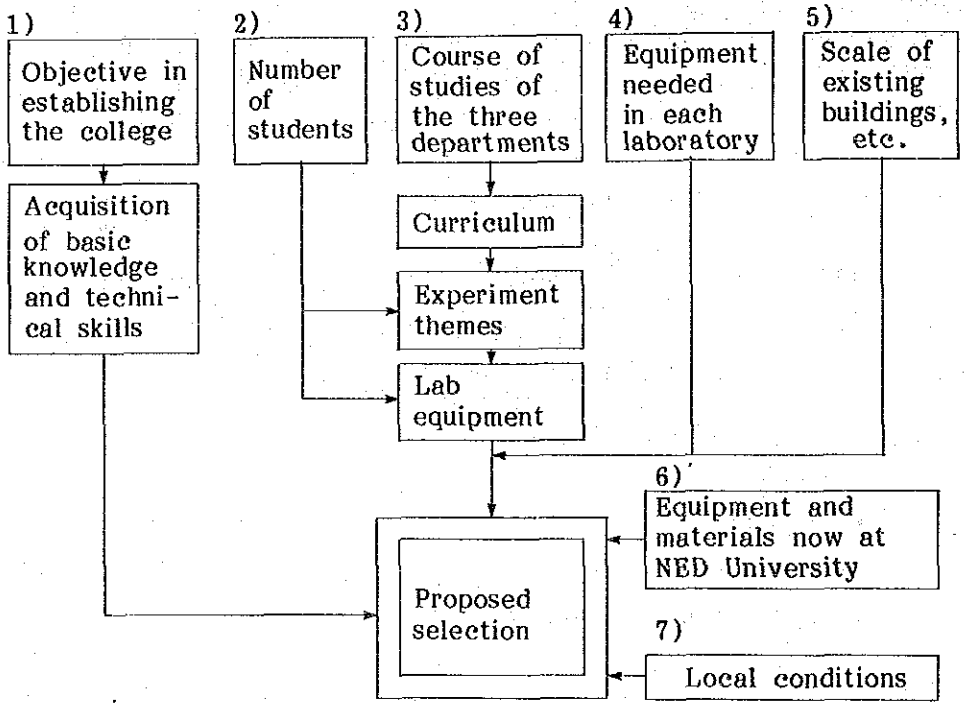
4. Because this is an entirely new college it now has no laboratory and educational equipment, and therefore provision is to be made for the supply of basic devices, tools and so on as would be required in each laboratory in view of course of study and the curriculum planned.

5. Selection and planning are to be done so as to provide laboratory and educational equipment such as may be installed and furnished in the laboratories that have been virtually completed.

6. Planning is to take into account the equipment presently in use at NED University.

7. Selection and planning are to be done so as to facilitate maintenance of the equipment in view of local conditions, especially in Khuzdar.

The method of study for selection and planning is schematically shown below.



(1) Civil Engineering Department

Tests, experiments and lab and workshop practice will be emphasized in the Civil Engineering Department, where education will be provided in the following laboratories.

Structural and concrete laboratory

Basic experiments are to be conducted on the properties of materials used in civil engineering in order to become familiar with testing equipment and methods of measurement. Equipment to be supplied shall be the necessary items for the measurement of the specific gravity, fineness, screening, apparent specific gravity, particle size and other properties of cement and aggregate, as well as for performance of tests on the composition, density and compression of concrete.

These items are the following:

Specific gravity test set
Sieve testing set
Universal testing machine
Compression testing machine
Water bath for concrete curing

Soil mechanics laboratory

Basic experiments for the measurement of the properties of soil are to be performed. The necessary equipment will be for mechanical tests and tests of soil properties, notably tests of physical properties such as water content, specific gravity, liquid limit, plastic limit, grain size and permeability. Mechanical tests will include such as consolidation, shearing, compression, compaction and CBR tests. The required items are as follows.

Tri-axial compression machine
Soil penetrometer
CBR test apparatus

Road and highway laboratory

Basic tests are to be performed for measurement of the properties of asphalt, such as penetration number, softness, softening point, flash point and specific gravity.

Sanitary engineering and irrigation laboratory

Basic hydraulic experiments such as are closely related to civil engineering are to be performed. The required equipment is to be for measurement of flow rate, wear and distribution of flow of water channels; measurement by orifices, venturimeter and friction loss in pipes; and measurement of the specific gravity, viscosity and pressure of water. For sanitary engineering experiments, equipment will be required for measurement of alkalinity, acidity, residual chlorine, sulfates, iron content and hardness of sample water. The major items required are as follows:

Tilting universal modular flow channel
Wave generator
Eddy current generating apparatus

Surveying laboratory

Equipment will be necessary for the practice of basic field surveying methods, such as distance surveying, traverse surveying, angle surveying, plane table surveying and leveling. The main items required are as follows:

Theodolites
Sextant
Levels

(2) Mechanical Engineering Department

Experiments and practice in the Mechanical Engineering Department may be divided into mechanical engineering experiments and practice in the workshop. The experiments and equipment required in each laboratory are as follows.

Hydraulic laboratory

Equipment will be required for experiments on the properties of fluids and gases, hydrokinetics, flow through channels, pipes and ducts, resistance and lift of wing, hydraulic machines, and friction in pipes. Major items required are as follows:

Horizontal shaft francis turbine
Hydraulic press
Blower and ventilator test bench

In addition to these, pumps, fans and other devices, orifices, nozzles and measuring equipment will be needed.

Material testing laboratory (Including metallurgy)

The subjects of basic experiments on the properties of metals and on metallurgical subjects will be testing of tensility, compressibility, fatigue, impact and the like; hardness of materials, elasticity of springs; and microscopic examination of metallic structure. The major items required are as follows:

Universal testing machine
Fatigue tester
Creep tester
Spring tester
Metallurgical microscope

In addition, it will be necessary to have equipment for preparation and production of test pieces.

Mechanics and measuring laboratory

Experiments are to be performed to aid in learning the principles and laws basic to the motion, oscillation and so on of matters which are fundamental to mechanical engineering. The most important subjects of the experiments are concerned with rotational movement, mass, moment of inertia, coefficient of friction, Newton's law of motion, oscillation, pendulum, and dynamic balancing test, as well as the use of the micrometer, dial gauge and other measuring instruments. There are no unusual or very large pieces of equipment but the number of pieces of equipment is high, including simple devices.

Heat engine laboratory

Experiments are to be performed with internal combustion engines and steam engines, as part of the studies in the area of thermodynamics and its applications. The major experiments will be concerned with the laws of thermodynamics, the principle of the internal combustion engine, and the operation of the gasoline engine, diesel engine, steam boiler and other equipment. The major equipment required is as follows:

Gasoline engine test stand
Diesel engine test stand
Steam boilers, turbines and related equipment

In addition, certain lab devices, measuring instruments, and models for use in explaining principles are required.

Air conditioning and refrigeration laboratory

The following equipment is necessary for facilitating the students' understanding of heat transmission through conduction, convection and radiation, and their application in the functioning of air conditioning and refrigeration systems.

Thermal conductivity apparatus
Convection apparatus
Cooling unit

Lubrication and fuel laboratory

Experiements are to be performed to obtain knowledge about fuels used in internal combustion engines, and about lubricants. Equipment and materials are required for study of the properties of fuels, measurement of the viscosity of lubricants, and other subjects. Fuel testing equipment and special, small analytic equipment are needed.

Workshop

Equipment is necessary for obtaining both knowledge of the basics of machinery use and skills in such use through actual practice. The following are the major pieces of equipment. In addition to these, devices, attachments, tools and measuring equipment are needed.

Forging shop	Forging furnace
	Normalizing furnace
Fabricating shop	Shearing machine
Sheetmetal shop	Press brakes
	Bending machine
	Rotary shear
Welding shop	Welding equipment (gas, arc)
Machinery shop	Lathe
	Universal miller
	Radial drilling machine
	Surface grinder
Carpentry	Saw bench
	Thicknesser
Auto repair shop	Cylinder boring machine

The equipment installed in the workshop can also be used to prepare test and experiment materials for use elsewhere in other college courses as well as to produce parts for equipment.

(3) Electrical Engineering Department

Basic electrical engineering laboratory

Experiments are to be performed in subjects basic to electrical engineering, such as electromagnetics and electric circuit theory. The most important experiments will be concerned with passive elements, such as resistance, inductance, capacitance; Thevenin's theorem, network conversion and other subjects. For these necessary equipment is as follows:

RLC circuit experiment apparatus
Wheatstone bridge
Oscilloscope
DC potentiometer

In addition, power supply equipment, meters, circuit elements and other items will be required.

Electrical machine laboratory

Experiments are to be performed relating to rotating machinery such as DC motors, generators and induction motors, as well as transformers, as these are basic to electrical engineering. Major subjects for experiements include characteristic tests for DC motors, generators, induction motors and transformers. Major equipment required is as follows:

DC motor
DC generator
Transformer
Induction motor

In addition to these, meters (voltmeters, ammeters, etc.) and measuring instruments of various types are needed.

Electronics laboratory

Experiments shall be performed for transistors, diodes and amplifiers which are of basic importance to electronic circuits, and for logic circuits. The main subjects are to be the properties of transistors, zener diodes, input and output characteristics of DTL gate circuits and the like. Major equipment required is as follows:

Transistor trainer
Operational amplifier circuit trainer
Oscillator
Stabilizing power supply

In addition, semiconductor elements, meters and other equipment for measurement will be required.

Telecommunications laboratory

Experiments are to be performed relating to transmission, sonics, microwaves and measuring methods. Major subjects for experiments are analysis of distorted waves, resistance measurement using a double bridge, transmission characteristics of filters and the like. Major equipment required is as follows:

Universal bridge
Q meter
Microwave experiment equipment
Audio amplifier and speaker

In addition, oscilloscopes and other instruments for measurement, and power supply equipment are required.

Computer laboratory

Computers are widely used in many fields of society, and it is necessary for students to master practical operation as well as to acquire knowledge of the computer. In order to undertake elementary-level computer use, personal computers are provided under the Project. On the assumption that 10 to 12 students are to be engaged in practice at one time and one set is used by two students, 6 sets of computers are to be installed. Software (Basic and Fortran) is to be provided. One printer is to be installed for each two computer sets. Software for English word processing is to be included, because the word processing operation is one of the important applications of the computer.

(4) General educational equipment

Applied physics laboratory

Experiments are to be performed to aid in understanding physical phenomena like properties of matter, heat, waves and electromagnetism, which are fundamental to engineering. Equipment is required for study of heat conduction, heat quantity, characteristic coefficients of matter, surface tension, the tuning fork and geomagnetism. As physics is fundamental to engineering, installation of basic and general equipment is to be planned.

Applied chemistry laboratory

Chemistry is fundamental to engineering, and experiments are to be performed for quantitative and qualitative analysis and the like. Equipment is required for measuring alkalinity, acidity, hardness, concentration of chlorine, viscosity and surface tension of water and solutions. These include glassware, pH meters, spectrophotometers and other simple equipment for measuring.

Language laboratory

For students to learn languages, a language laboratory is provided. Taking the assumption that language courses are included in the curriculum of each class of each department, the laboratory is planned for 30 to 32 students at one time.

3.3.4 Operation and maintenance training for the equipment

Proper training of the technical staff of the college in the operation and maintenance of the equipment supplied will be required. It is suitable to perform general training for the handling of laboratory and educational equipment including laboratory work and preparation of experiments at NED University or another engineering school in Pakistan. However, there will be some equipment supplied from Japan that is not familiar in Pakistan, and it will be necessary to train technicians of the college in the operation and maintenance of such main equipment at the site, together with installation work and testing operations.

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4.1 Policy of the Basic Design

The basic design of the equipment has been carried out in accordance with the following guidelines:

(1) Attainment of educational objectives

The objective of the education with the equipment to be provided is to educate engineers who will become capable of working in the area of the social and economic development of Pakistan.

(2) Compliance with the curriculum

Laboratory and educational equipment is needed to increase the effectiveness of education through experiments and practice in order to carry out the curriculum of the college.

The curriculum planned for the college is based on the one used at NED University, and is judged suitable in view of the conditions in Pakistan and the objective of the college. The equipment is to be selected in accordance with this curriculum and experiment themes and to be planned to educate capable engineers to work in society by giving basic knowledge and applicable technology to the students.

(3) Location for the equipment

The equipment is to be installed in the laboratory buildings almost completed. No expansion or modification work of the architecture and structure should be required in order to install the equipment. The equipment will be placed in each laboratory, so that preparation and implementation of experiments and maintenance of the equipment are properly performed.

(4) Maintenance over the long term

Selection of equipment reflects the objective of achieving use over a long period of time, on the strength of proper maintenance and use.

(5) Applicable standards

Laboratory and educational equipment does not have any rules applicable to it, but in the case of pressure vessels the Japanese High Pressure Gas Regulation is adopted. The materials and parts shall comply with JIS materials. For the materials used in electrical work, JEM and JEC standards shall be used.

Notes: JIS Japanese Industrial Standard
JEM Standards of the Japan Electrical Manufacturer's Association
JEC Standards of the Japanese Electrotechnical Committee

(6) Spare parts and expendable items

In view of the distance from Karachi, provision is to be made for a suitable stock of spare parts and expendable supplies to be available at the college.

(7) Phased implementation

Because the college is new, it will take three years to reach capacity as an educational institution and some courses are not taught until the third or fourth year of study. The provision of equipment and other work therefore is separated into two phases, the first to cover all that is needed in the first two years and the second phase for the remainder.

4.2 Study of Design Conditions

Winter temperatures in Khuzdar are as low as -8°C and in summer they can reach 42°C. Humidity is low, at 40-65%, and the climate is dry. Therefore air conditioning and dust control equipment are needed for the computer room and language lab, for use in summer.

Electricity required for equipment will be brought in by 3-phase, 440 volt and single phase, 220 volt, 50 Hz.

Bearing pressure is well on the safe side for the equipment, but special consideration should be given to the foundation on which heavy equipment which may generate vibration is installed.

Casting floor concrete and finishing of the floor will take place after the equipment layout is fixed and wall openings for equipment entrance will be closed after the equipment is brought inside. Construction work as mentioned above will be undertaken by the Pakistani side.

4.3 Basic Design

The selection of major pieces of equipment and their major specifications are in accordance with 3.3.3, Laboratory and educational equipment plan.

4.3.1 Selection of equipment

Major specifications are to be determined on the basis of the following.

(1) Grade shall be suitable for use by students for experimentation and practice. That is, the grade need not be as high as needed for industrial production or sophisticated research work.

(2) Planning shall reflect the specific experiments and lab work to be performed.

(3) For those pieces of equipment for which there are universally accepted standards, there shall be conformity to such standards.

(4) Self-contained experiment sets available from scientific equipment suppliers for commonly performed lab work or demonstrations shall be used where appropriate.

(5) Where possible, multi-purpose equipment is to be used.

(6) All other devices, measuring equipment, tools and so forth needed for instruction and lab work are to be provided.

(7) The grade of equipment shall conform to that which is most widely adopted at present.

4.3.2 List of educational and laboratory equipment

The following table shows the number of items selected for Phase I and Phase 2 in regard to laboratories.

	Number of Items		
	Phase 1	Phase 2	Total
(1) Civil Engineering Department			
.Structural and Concrete Laboratory	52	5	57
.Soil Mechanics Laboratory	-	106	106
.Road and Highway Laboratory	-	27	27
.Sanitary Engineering and Irrigation Laboratory	9	38	47
.Survey Laboratory	26	-	26
.Drawing Room	3	-	3
Sub Total	90	176	266
(2) Mechanical Engineering Department			
.Hydraulic Laboratory	17	14	31
.Material Testing Laboratory	19	-	19
.Mechanics and Measuring Laboratory	77	-	77
.Heat Engine Laboratory	-	11	11
.Air conditioning and Refrigeration Laboratory	-	10	10
.Fuel Oil and Lubrication Laboratory	-	44	44
.Workshop	49	18	67
.Drawing Room	6	-	6
Sub Total	168	97	265
(3) Electrical Engineering Department			
.Basic Electrical Engineering Laboratory	46	-	46
.Electrical Machine Laboratory	19	9	28
.Electronics Laboratory	27	11	38
.Telecommunications Laboratory	22	9	31
.Computer Laboratory	5	-	5
.Electrical Workshop	7	-	7
.Drawing Room	3	-	3
Sub Total	129	29	158
(4) General Education			
.Applied Physics Laboratory	50	-	50
.Applied Chemistry Laboratory	61	-	61
.Learning Laboratory	10	-	10
Sub Total	121	-	121
Grand Total	508	302	810

Equipment selected, quantities and phase in which it is to be supplied are as follows.

1. Civil Engineering Department

1) Structural and Concrete Laboraty

(a) Testing of materials section

No.	Equipment	Qts.	Phase
1	Universal Testing Machine 200 ton	1	1
2	Compression Testing Machine 100 ton	1	1
3	Los Angeles Abrasion Machine	1	1
4	Vicat Apparatus	1	1
5	Slump Test Apparatus	2	1
6	Concrete Flow Table	1	1
7	Conc. Cylinder Moulds w/base (15c.dia x 30c.H)	10	1
8	Concrete Cube Moulds (15cm x 15cm x 15cm)	2	1
9	Grillmore Needle	1	1
10	Electric Mortar Flexure Tester	1	1
11	Proctor Needle for Mortar	2	1
12	Mortar Permeability Apparatus	2	1
13	Autoclave with Pressure Regulator	1	1
14	Mortar Length Comparator	1	1
15	Mortar Bleeding Apparatus	1	1
16	Poisson Ratio Measuring Apparatus	1	1
17	Berry's Strain Gauge	2	1
18	2" Cube Mould with Tamper	5	1
19	Briquette Mould	2	1
20	Mortar Prism Mould with Tamper	2	1
21	3-Gang mould for mortar length comparator	2	1
22	Straight Edge	5	1
23	High Speed Finishing Machine for concrete specimen	1	1
24	Internal Vibrator 25mm dia	1	1
25	Concrete Beam Mould	4	1
26	Concrete Specimen Grips	4	1
27	Cutting Machine for Concrete Specimen	1	1
28	Rake Drum Type Concrete Mixer	1	1
29	Sample Splitter	1	1
30	Mechanical Convection Oven	1	1
31	Constant Temperature Electric Drying Oven	1	1
32	Electronic Balance	2	1
33	Trip Scale	1	1
34	Table Platform Scale	1	1
35	RO-Tap Sieve Shaker	1	1
36	Sand Absorption Cone with Rod	1	1
37	Le Chatelier Pycnomoter	8	1
38	Unit Weight Measures	2	1

39	Specific Gravity Test Set	2	1
40	Stone Meter	10	1
41	Stone Hardness Tester	2	1
42	Aggregate Impact Testing Machine	1	1
43	Aggregate Crushing Test Set	1	1
44	Improved Washington Type Air Meter	1	1
45	Menzel Type Air Meter	1	1
46	Mortar Mixer	1	1
47	Table Vibrator	1	1
48	Concrete Permeability Apparatus	1	1
49	Concrete Test Hammer	1	1
50	ASTM and BS Standard Sieves	4	1
51	Concrete Creep Test Apparatus	1	1
52	Impact Strength Testing Machine	1	1

(b) Concrete Section

No.	Equipment	Qts.	Phase
1	Consistency of Cement Test Vicat's Apparatus	1	2
2	Core Driller	1	2
3	Thermostat for Concrete Testing	1	2
4	Adiabolic Calorimeter	1	2
5	Environmental Cabinets for Cement Concrete Setting	1	2

2) Soil Mechanics Laboratory

(a) Geological Engineering Section

No.	Equipment	Qts.	Phase
1	Geological Hammers	50	2
2	Rock Chisels	50	2
3	Graticule Slides	12	2
4	Diamond or Abrasive Wheel Cutoff Machine	1	2
5	Vice for Gripping Regular Specimens	1	2
6	Large Specimen Cutoff Machine for Rocks	1	2
7	Oven Forced Draft	1	2
8	Dishes, Polyethylene, with cover	40	2
9	Filter Paper (Assorted)	24	2
10	Magnifiers, Folding Pocket	10	2
11	Student Stereoscope	2	2
12	Stereo Microscope	2	2
13	Field Pocket Compass	10	2
14	Mineral Collection Set	1	2

15	Elementary Rock and Mineral Collection	1	2
16	Economy Rock and Mineral Collection	1	2
17	Common Igneous Rock Collection	1	2
18	Common Sedimentary Rock' Collection	1	2
19	Common Metamorphic Rock Collection	1	2
20	Composition of Rocks Collection	1	2
21	Nature of Minerals Collection	1	2
22	Ores of Common Details Collection	1	2
23	Crystal Type Collection	1	2
24	Scale of Hardness Mineral Collection	1	2
25	Student Rock Identification Set	1	2
26	Furnace, Muffle	1	2
27	Geiger Counter	2	2
28	Forceps (Goose Neck)	12	2
29	Wash Bottles	40	2
30	Funnels	8	2
31	Watch Glasses	10	2
32	Hot Plate	1	2
33	Ultraviolet Lamp, Short Wave	1	2
34	Fossil Specimens	1	2
35	Seismograph Model	1	2
36	Relief Globe	2	2
37	Map Measurers	1	2
38	Rock Splitting and Crushing Machine	1	2
39	High Speed Diamond Wheel Grinding Machine	1	2
40	Single Spindle Lapping Machine	1	2

(b) Soil Mechanics Section

No.	Equipment	Qts.	Phase
1	Soil Microspliters	1	2
2	Proctor Penetration Resistance Apparatus	1	2
3	Rapid Density Sampler	2	2
4	Moisture, Density & Compaction Apparatus for Soil	1	2
5	Dial Indicating Soil Penetrometer	1	2
6	Laboratory Sifter	1	2
7	Sample Extruder	1	2
8	Speedy Moisture Tester (AASHO-T-217)	1	2
9	Dutch Cone Penetrometer	1	2
10	Soil Sampling Rig	10	2
11	Pressure Membrane Apparatus	1	2
12	Filter Funnel Apparatus	1	2
13	Vane Shear Apparatus	1	2
14	Consolidometer	1	2
15	Analytical Balance	1	2
16	Liquid Limit Device	1	2
17	Square Plates of Glass for Plastic Limit	3	2
18	Shrinkage Limit Set	2	2

19	Bottle Specific Gravity	4	2
20	Sieves B.S. Standard	1	2
21	Sieves U.S. Standard ASTM AASHO	1	2
22	Compactor	2	2
23	Unconfined Compression Device	1	2
24	Shear Machine (Constant Strain Manual)	1	2
25	Triaxial Machine (Universal)	1	2
26	Permeameter (Combination)	1	2
27	Penetrometer (Small Spring Type)	1	2
28	Auger, Post Hole, (Iwan Type)	1	2
29	Glass Dessicator	2	2
30	Flexible Blade Spatula	12	2
31	Centrigrade Glass Thermometer	3	2
32	Plastic Funnel	12	2
33	Funnel Support Stand	12	2
34	Burette Support Stands and Clamp	12	2
35	Plain Iron Tripod	8	2
36	Galvanized Iron Wire	8	2
37	Evaporating Dishes	12	2
38	Extra Heavy Wall Rubber Tubing	100	2
39	Analytical Weights 1 mg. to 450 grams	2	2
40	Forced Draft Double Wall Ovens	1	2
41	Rectangular Pan (Stainless Steel)	8	2
42	Round Pan (Stainless Steel)	6	2
43	Aluminium Box	2	2
44	Boxes Moisture Aluminium	52	2
45	Soil Mixer for Mechanical Analysis ASTM D422 AASH T88	1	2
46	Giessler Burettes	1	2
47	Consolidation Set (Medium Capacity)	1	2
48	CBR Lab Apparatus	1	2
49	Pipettes	12	2
50	Soil Thermometers	10	2
51	Wash Bottles	10	2
52	Cylinders, Graduated	24	2
53	Conical Flasks	30	2
54	Flind Glass Watch Glasses	30	2
55	Crucible Tongs	10	2
56	Glass Rods	10	2
57	H-base Bunsen Burner	8	2
58	Safety Gloves	10	2
59	Single Scale Double Pan Balance with Weights	2	2
60	Cylindrical Oven	1	2
61	Soil pH Tester with Test Paper 10 Refills	4	2
62	Soil Tester	2	2
63	Scoops and Scopula	12	2
64	Soil Suspension Hydrometer	1	2
65	Soil Sieve Set	1	2
66	Apparatus for Atterberg Limit of Soil Sample	1	2

3) Road and Highway Laboratory

(a) Roads Section

No.	Equipment	Qts.	Phase
1	Asphalt Penetrometer, Field Type	1	2
2	Ductility Testing Machine	1	2
3	Analytical Balance with Weights	1	2
4	Extractor, Land Type with Extractor Bowls	1	2
5	Thermometers, Asphalt (Assorted)	1	2
6	Pairs of Gloves	10	2
7	Spatula	12	2
8	Bitumen Mixers	2	2
9	Standard Bitumen Compactor	1	2
10	Specimen Extractor	3	2
11	Bitumenometers	1	2
12	Cleveland Flash Point Tester	1	2
13	Ring and Ball Set	2	2
14	Water Content Determination Apparatus	1	2
15	Pocket Stopwatch	5	2
16	Constant Temperature Water Bath	1	2
17	Distillation Apparatus	2	2
18	Single Wall Oven	1	2
19	Specific Gravity Bottles	5	2
20	Laboratory Tongs	2	2
21	Ring Burner	1	2
22	Marshal Test Apparatus	1	2
23	CBR Test Apparatus	1	2
24	Hubbard Stability Test Apparatus	1	2
25	Viscosimeter According to IP-72	1	2
26	Benkle Men's Beam Tester	1	2
27	Ride Meter for Study of Pavement Surfaces	1	2

4) Sanitary Engineering and Irrigation Laboratory

(a) Fluid Mechanics Section

No.	Equipment	Qts.	Phase
1	Universal Hydrometer	2	1
2	Hydrometric Jars	10	1
3	Mercury Barometer	2	1
4	Hand Pumps	2	1
5	Beakers	100	1
6	Stop Watch	5	1
7	Parallel Plate Capillary Apparatus	2	1

8	Measuring Cylinder	10	1
9	Thermometers	5	1

(b) Hydraulics Section

No.	Equipment	Qts.	Phase
1	Tilting Universal Modular Flow Channel	1	2

(c) Sanitary Engineering Section

No.	Equipment	Qts.	Phase
1	Crucible Porcelain Gooch	3	2
2	Imhaff Cones	2	2
3	Micro Torque Balance	1	2
4	Still Water Portable Electric	1	2
5	Conical Flask, Boiling, Flat Bottom	6	2
6	Furnace, Muffle	1	2
7	Fermentation Tube	20	2
8	Secchi Disk for Visibility Measurement	2	2
9	Water Pollution Analysis Kit	1	2
10	Magnetic Stirrer	2	2
11	Single Wall Oven	1	2
12	Hot Plate, Variable Control	2	2
13	Grating Spectroscope	1	2
14	Messler Tube Set	1	2
15	Thermometer	4	2
16	Portable Autoclave	1	2
17	Microscope	1	2
18	BOD Bottle (150 ml)	24	2
19	BOD Bottle (300 ml)	24	2
20	Sewage Sampler	1	2
21	Water Funnel	2	2
22	Water Hardness Test Set	2	2
23	Water High Phosphate Comparator	1	2
24	Waste Water Tester	1	2
25	Turbidimeter	1	2
26	pH Meter	1	2
27	Tongs, Assorted	2	2
28	Dissolved Oxygen Meter	1	2
29	Cooling Incubator for BOD	1	2
30	Multiple Filter Kit	3	2
31	Air Sampler	1	2
32	Hydrogen Oxygen CO2 Cylinder	1	2
33	Glass Dishes for Culture	1	2
34	Determination of Biochemical Oxygen	1	2
35	Radiation Detector	1	2

36	Titration Apparatus	1	2
37	N2 Determination Apparatus	1	2

5) Surveying Laboratory

(a) Surveying Section

No.	Equipment	Qts.	Phase
1	Vernier Transit Theodolite	2	1
2	Micrometer Theodolite	2	1
3	Engineer's Dumpy Level	2	1
4	Pendant Clinometer and Livel	2	1
5	Abney Level	2	1
6	Prismatic Compass with Tripod	12	1
7	Mirror Optical Square	4	1
8	Planimeter	2	1
9	Combined Box-Sextant	2	1
10	Levelling Staff	12	1
11	Plumbing Fork	6	1
12	Spirit Level	10	1
13	Ranging rod	10	1
14	Measuring Tape, Fabric	6	1
15	Measuring Tape, Steel	6	1
16	Bruton Pocket Transit	2	1
17	Aneroid Barometer	2	1
18	Astronomical Refracting Telescope	1	1
19	Altimeter	3	1
20	High Power Binoculars	2	1
21	Surveyor's Odometer	2	1
22	Stereoscope	1	1
23	Meterological Instrument	1	1
24	Electronic Pantograph	1	1
25	Cowley Automatic Level with Stand	1	1
26	Geodetic Theodolite	1	1

6) Drawing Room

(a) Drawing Equipment

No.	Equipment	Qts.	Phase
1	Cone with Spheres	2	1
2	Three Sided Prism	2	1
3	Regular Polyhedra Model	2	1

2. Mechanical Engineering Department

1) Hydraulic Laboratory

(a) Fluid Mechanics Section

No.	Equipment	Qts.	Phase
1	Horizontal Shaft Francis Spiral Turbine	1	1
2	Oil Pressure Speed Governor	1	1
3	DC Generator	1	1
4	Flowmeter Point Tube	2	1
5	Liquid Manometer Demonstrator	2	1
6	Gas Volume Point Tube, Portable	1	1
7	Hydraulic Press	1	1
8	Venturi Meter	1	1
9	Water Meter	1	1
10	Level Indicators	1	1
11	Rota Meters	1	1
12	Metacentre	1	1
13	Reynolds Apparatus	1	1
14	Oil Power Hydraulic Unit	1	1
15	Viscous Flow Air Meters	1	1
16	Centrifugal Pump Test Bench for Instruction and Research	1	1
17	Bernoulli's Principle Apparatus	1	1

(b) Gas Dynamics Section

No.	Equipment	Qts.	Phase
1	Universal Blower or Ventilator Test Bench	1	2
2	Flowmeter	1	2
3	Projection Wind Tunnel	1	2
4	Bernoulli's Principle Apparatus	1	2
5	Portable Blower and Vacuum Unit	1	2
6	Gas Laws Apparatus, Piston Form	1	2
7	Combination Pressure and Vacuum Gauge	2	2
8	Biramis Anemometer	2	2
9	Glass Manometer	1	2
10	Anemometer, Pocket Type	2	2
11	Student Air Track	1	2
12	Flowmeter, Pyrex	1	2
13	Gas Volume Pivot Tube	1	2
14	Elapsed Timer	2	2

2) Material Testing Laboratory

(a) Metallurgy, Metallography and Material Testing Section

No.	Equipment	Qts.	Phase
1	Mineral Ore Grinding & Polishing Machine	1	1
2	Automatic Polishing Machine, Phase Difference Type	1	1
3	Gas Analyzer	1	1
4	Hardness Testing Machine	1	1
5	Portable Dynamic Hardness Tester	1	1
6	Non-Destruction Tester	1	1
7	Metallurgical Mano-Binocular Dynamic Microscope	2	1
8	Pyrometer, Hand Type	2	1
9	Pyrometer, Optical Triple Range Pyrometer	1	1
10	Universal Testing Machine	1	1
11	Hardness Testers, Precision Type	1	1
12	Creep and Rupture Test Machine	1	1
13	Dilatometer for Deflection of Isothermal Phase	1	1
14	Fatigue Test Apparatus	1	1
15	Balancing Machine	1	1
16	Spring Testing Machine	1	1
17	Polariscope	1	1
18	Vibration Test Rig	1	1
19	Tool Maker Microscope	1	1

3) Mechanics and Measuring Laboratory

(a) Mechanics Section

No.	Equipment	Qts.	Phase
1	Centripetal Force Demonstrator	1	1
2	Ballistic Pendulum	1	1
3	Second Law of Motion Apparatus	1	1
4	Hand Rotator	1	1
5	Gyroscopic Wheel with Handles	1	1
6	Precision Track	1	1
7	Torsion Apparatus	1	1
8	Ball Bearing Rotating Support Mass	1	1
9	Differential Chain Hoist Pulley	1	1
10	Horsepower Apparatus & Windlass Model	1	1
11	Geared Wheels	1	1
12	Moments Apparatus	1	1

13	Coefficient of Restitution Demonstration	1	1
14	Projection of Uniform Circular Motion Demonstration	1	1
15	Ball Bearing Aluminum Pulley	1	1
16	Motor-Driven Variable Speed Rotator	1	1
17	Circular Wave Generator	1	1
18	Kinetic Theory Projection Device	1	1
19	Simple Harmonic Demonstrator	1	1
20	Free Fall Apparatus	1	1
21	Inertia Balance	1	1
22	Laboratory Jack	2	1
23	Xenon Stroboscope	1	1
24	Stopwatch	1	1
25	Pulley	1	1
26	Overhead Projector	1	1
27	Vernier Caliper	1	1
28	Weight Hanger	1	1
29	Carpenter's Level	1	1
30	Simple Form Collision Ball Apparatus	1	1
31	Ballistic Car	1	1
32	C-Clamp	1	1
33	Pulley Assembly	1	1
34	Rods	4	1
35	Clamp	4	1
36	Rheostat	1	1
37	Spring Dynamometer	1	1
38	Free Force Vibration Apparatus	1	1

(b) Precision Measuring

No.	Equipment	Qts.	Phase
1	Tool Microscope	5	1
2	Surface Roughness Tester	2	1
3	Height Master	1	1
4	Screw Thread Comparator	1	1
5	Gauge Block	2	1
6	Pocket Comparator	5	1
7	Square Master	1	1
8	Combination Square Set	5	1
9	Steel Rule	5	1
10	Screw Pitch Gauge	5	1
11	Morse Taper Gauge	1	1
12	Angle Gauge	5	1
13	Radius Gauge	5	1
14	Thickness Gauge	5	1
15	Universal Bevel Protractor	3	1
16	Cylinder Bore Gauge	2	1
17	Dial Indicator	5	1
18	Dial Gauge Stand	6	1
19	Precision Surface Plate	2	1
20	Vernier Height Gauge	2	1

21	Depth Gauge	3	1
22	Vernier Caliper	5	1
23	Optical Parallel	2	1
24	External Micrometer Set	5	1
25	Inside Micrometer Set	5	1
26	Caliper Type Inside Micrometer	3	1
27	Depth Micrometer	3	1
28	Screw thread Micrometer	3	1
29	Straight Edge	3	1
30	Cylinder Square	2	1
31	Flat Type Square	10	1
32	V-block	10	1
33	Precision Square Level	2	1
34	Flat Type Precision Level	2	1
35	Sine Bar with Center	2	1
36	Surface Gauge	10	1
37	Tool Kit	5	1
38	Mini Microscope	5	1
39	Micrometer Stand	2	1

4) Heat Engine Laboratory

(a) Internal Combustion Section

No.	Equipment	Qts.	Phase
1	Engine Test Stand with Collecting Exhausts Silencer	2	2
2	Gas Calorimeter, Automatic ASTM with Thermometers	1	2
3	Electric Compressor	1	2
4	Small Tools	1	2
5	Engine Generator	1	2
6	Technometer	2	2
7	Heat Exchange Unit	1	2
8	Gas Meter	1	2

(b) Steam Section

No.	Equipment	Qts.	Phase
1	Educational Steam Boiler	1	2
2	Experimental Laggig Efficiency Unit	1	2
3	Orsat Gas Analyzer	1	2

5) Air conditioning and Refrigeration Laboratory

(a) Air conditioning and Refrigeration Section

No.	Equipment	Qts.	Phase
1	Cooling Unit for Demonstration and Test Purposes	1	2
2	Thermal Conductivity Apparatus	2	2
3	Convection Apparatus Gas	1	2
4	Convection Apparatus Liquids	1	2
5	Crooks Radiometer	1	2
6	Seamless Copper Steam Generator	1	2
7	Galvanometer	1	2
8	Rapid to Thermal Conductivity of Insulating Materials	1	2
9	Specific Heat Calorimeter	1	2
10	Boiling Heat Transfer Apparatus	1	2

6) Lubrication and Fuel Laboratory

(a) Fuel Combustion Section

No.	Equipment	Qts.	Phase
1	Carbon Residue Apparatus	1	2
2	Spectrophotometer	1	2
3	Refractometer, Dipping	1	2
4	Smoke Point Tester	1	2
5	Flash Point Tester	1	2
6	Colorimeter	1	2
7	Cleveland Flashpoint Tester	1	2
8	Stirrers, Motor Driven	1	2
9	Aniline Point Determination of Petroleum Products	1	2
10	Pour Point and Cloud Point Tester	1	2
11	Copper Corrosion Tester	1	2
12	Distilling Apparatus	1	2
13	Flash Point Tester	1	2
14	Gum Determination Apparatus	1	2
15	Calorimeter, Adiabatic	1	2
16	Tank Samplers	2	2
17	Sediment Test Extractor Fuel Oil, ASTM	4	2
18	Sulphur Determination Apparatus	1	2
19	Corrosion Test Bomb, for Liquids, Fuels and Gases	1	2
20	Vapor Pressure Bombs	1	2
21	Rotating Cylinder Viscosimeter	1	2
22	Constant Temperature Bath	1	2
23	Sample Containers of Petroleum Product	1	2

24	Saybolt Colorimeter (Test for Colour of Petroleum Products)	1	2
25	Automatic Distillation Apparatus	1	2
26	Automatic Breaking Point Apparatus	1	2
27	Automatic Distillation Tester	1	2
28	Automatic Softening Point According to Ring & Ball	1	2
29	Handness Tester for Waxes	1	2

(b) Lubrication Section

No.	Equipment	Qts.	Phase
1	Corrosion Test Strips, Copper, ASTM	2	2
2	Grease Stability Bath with Accessories	1	2
3	Steam Turbine Oil Oxidation Test Bath	1	2
4	Distillation Apparatus	1	2
5	High Temperature Bath, ASTM	1	2
6	Melting Point Apparatus Petrolation, ASTM	1	2
7	Penetrometer (for Lubricating Grease)	1	2
8	Viscosimeter-Saybolt Universal Single Tube	1	2
9	Redwood viscosimeter	1	2
10	Engler viscosimeter	1	2
11	Dropping Point Tester for Lubricating Grease	1	2
12	Apparatus for Determining the Oxidation Characteristics	1	2
13	Analytical Balance	2	2
14	Metric Weight Sets	2	2
15	Digital Balance	2	2

7) Workshop

(a) Machine shop

No.	Equipment	Qts.	Phase
1	Universal Miller	2	1
2	Shaper	1	1
3	Metal Saw	1	1
4	Gas Cutting Equipment	1	1
5	Miscellaneous Tools for Workshop	1	1
6	Pedestal Grinder	2	1
7	Horizontal Surface Grinder	1	1
8	Radial Drilling, Boring and Tapping Machine	2	1
9	Pedestal Drilling Machine	1	1

10	Bench Drilling Machine	2	1
11	Tool & Cutter Grinding Machine	1	1
12	Filing and Sawing Machine	1	1
13	Automatic Screw Machines	1	1
14	Measuring Tool	1	1
15	Cutting Tool	1	1
16	Electric Lathe	10	1
17	Meddings England	1	1
18	Trill Tool Grinders	1	1
19	Power Hacksaw	1	1

(b) Sheet Metalshop

No.	Equipment	Qts.	Phase
1	Press Brake	1	1
2	Bending Machine	1	1
3	Rotary Shears	1	1
4	Grooving Machine	1	1
5	Circle Cutting Machine	1	1
6	Light Spot Welder for Sheet Metal Work	1	1

(c) Welding shop

No.	Equipment	Qts.	Phase
1	3-Phase Electronic Controller's Spot Welder	3	1
2	Continuous Arc Welding Machine	5	1
3	Reperation Gas Cutting Machine	5	1
4	Spot Welder for Sheet Metal	2	1
5	Soldering Irons and Pencils	10	1
6	Other Gas Welding Equipment	5	1

(d) Forging shop

No.	Equipment	Qts.	Phase
1	Normalizing Furnace	1	2
2	Forging Furnace	1	2
3	Carbonizing Furnace	1	2
4	Salt Bath Furnace	1	2

(e) Carpentry shop

No.	Equipment	Qts.	Phase
1	Tilting Arbor Saw Bench	2	1
2	Belt Sanding Machine	1	1
3	Thicknesser	1	1
4	Single Ended Tenon and Scribing Machine	1	1
5	Universal Router	1	1
6	Universal Wood Worker	1	1
7	Chain Mortizer	1	1
8	Drilling Machine	1	1
9	Planer or Jointer	1	1
10	Power Tools	1	1
11	Compressor	1	1
12	Dust collector	2	1
13	Wooden Tools	1	1

(f) Fabrication shop

No.	Equipment	Qts.	Phase
1	Power Hacksaw	1	1
2	Gillotine Shearing Machine	1	1
3	Welding Transformers	1	1
4	Gas Welding Equipment	1	1
5	Hand Tools	1	1

(g) Automotive Workshop

No.	Equipment	Qts.	Phase
1	Cylinder Boring Machine	1	2
2	Wheel Balancer (on Car)	1	2
3	Wheel Balancer (off Car)	1	2
4	Hand Chain Hoist	1	2
5	Battery/Starter Tester	5	2
6	Two Circuit Battery Charger	2	2
7	Battery Hydrometer	2	2
8	Valve Seat Grinding Stone	2	2
9	Vacuum Pressure Tester	2	2
10	Steel Cleaner	1	2
11	Nozzle Plug Tester	2	2
12	Floor Stands	1	2
13	Air Compressor, Single Stage	1	2
14	Trolly Jack	2	2

8) Drawing Room

(a) Drawing Equipment

No.	Equipment	Qts.	Phase
1	Drafting Table	3	1
2	Drafting Machine	3	1
3	Drawing Board, Magnetic	3	1
4	Tracing Table	5	1
5	Drafting Instruments	30	1
6	Copying Machine	1	1

3. Electrical Engineering Department

1) Basic Electrical Engineering Laboratory

(a) Basic Electrical Engineering Section

No.	Equipment	Qts.	Phase
1	D.C. Voltmeter (Digital)	3	1
2	Moving Iron Ammeter, Portable	6	1
3	Moving Iron Voltmeter, Portable	6	1
4	Moving Coil Ammeter, Portable	6	1
5	Moving Coil Voltmeters	6	1
6	Portable Wattmeter	4	1
7	Single Phase Energy Meter	6	1
8	Frequency Meter	10	1
9	Ohmmeter	2	1
10	Cable Fault Locator and Finder (Portable)	1	1
11	Flux Meter with Search Coils	2	1
12	Stabilized Power Supply	1	1
13	Sine/Square Wave Oscillator, 10Hz to 1MHz	4	1
14	Unit Oscillator 80-470MHz	2	1
15	Modular Signal Generator	1	1
16	SHF & UHF Signal Generator	1	1
17	H.F. & V.H.F. Signal Generator	1	1
18	Counter/Timer (Digital)	1	1
19	Logic Instructional Kit	1	1
20	Decade Resistance Box	5	1
21	3-Decade Capacitance Box	1	1
22	Portable Wheatstone Bridge	2	1
23	Decade Inductance	2	1
24	DC Potentiometer	2	1
25	AC Potentiometer	2	1
26	Power Factor Meter	3	1
27	D.C. Amplifier	1	1
28	Carbon Resistors	8	1
29	Stopwatches	10	1
30	Transistor Tester	1	1
31	Impedance Bridge	5	1
32	Single Phase Voltage Regulator	3	1
33	Three Phase Voltage Regulator	3	1
34	Illuminator	1	1
35	Resistance Substitution Box	2	1
36	Capacitance Substitution Box	2	1
37	Battery Charger	2	1
38	Tool Set	1	1
39	SCR Demonstrator	1	1
40	Auto-Transformer	1	1
41	Laboratory Tool Kit	4	1
42	Oscilloscope Camera	1	1
43	Diode, etc.	3	1
44	Stroboscope	2	1

45	Single Tracer	1	1
46	TV Trainer (Colour)	1	1

2) Electrical Machine Laboratory

(a) Electrical Machine Section

No.	Equipment	Qts.	Phase
1	AC/DC Generator Set with Control Panel	1	1
2	AC/DC Generator Set	1	1
3	3-Phase Induction Motor Generator DC	1	1
4	3-Phase Induction Motor	1	1
5	Alternator	1	1
6	DC Motor	1	1
7	Wattmeters	4	1
8	Voltmeter, Ammeter AC, DC	12	1
9	Connecting Cord Assortment	2	1
10	Cord Component Assortment	2	1
11	3-Phase Induction Regulator	2	1
12	Eddy Current Breaker	1	1
13	Phase Sequence Indicator	4	1
14	Hand Tachometer	3	1
15	Photo Tachometer	3	1
16	Neon Stroboscope	3	1
17	Electric Supply Model	1	1
18	D.C. Rectifier	1	1
19	Protective Relay	1	1

(b) Advanced Electrical Machine Section

No.	Equipment	Qts.	Phase
1	DC Generator 5 kVA	1	2
2	AC Generator Set	1	2
3	Variable Transformer	1	2
4	Current Transformer, Multiratio	2	2
5	Current Transformer, Single Ratio	2	2
6	Flux Meter with Search Coil	3	2
7	Photon Meter	1	2
8	Elevator Model for Teaching	1	2
9	Thyristor Control Speed Drive for DC	1	2

3) Electronics Laboratory

(a) Electronics and Control Section

No.	Equipment	Qts.	Phase
1	Oscilloscope	3	1
2	Power Supplies	8	1
3	Frequency Generator	2	1
4	Sweep Generator	1	1
5	Basic Universal Bridge	4	1
6	Oscilloscope Camera	1	1
7	Laboratory Amplifier	1	1
8	Standard Single Phase Wattmeter	1	1
9	Resistance Box	1	1
10	Digital Ohm-Voltmeter	1	1
11	Insulating Oil Tester	1	1
12	Substandard Voltmeters AC Voltmeter	2	1
13	Substandard Voltmeters DC Voltmeter	2	1
14	Substandard DC Ammeter with Shunts	1	1
15	DC Microammeter	2	1
16	AC Microammeter	2	1
17	AC/DC Voltmeter	3	1
18	AC/DC Ammeter	3	1
19	AC&DC Potentiometer	1	1
20	Pulse Amplifier	1	1
21	AC/DC Milli-voltmeter	4	1
22	Transistor Trainer	1	1
23	Electronics Trainer Kit	1	1
24	Function Generator	1	1
25	DC Stabilizing Power Supply Circuit	1	1
26	Audio-video Monitor	1	1
27	Sound and Vibration Analyzer	1	1

(b) Electronics Section

No.	Equipment	Qts.	Phase
1	High Voltage Power Supply	1	2
2	Variable Capacitor	1	2
3	Decade Resistance Box	2	2
4	High Precision Standard Resistors	1	2
5	Strain Gauge Bridge	1	2
6	Electronic Electrometer DC Low Sensitivity	1	2
7	Electrometer	2	2
8	Chart Recorder (XY)	3	2
9	X-Y Recorder	1	2
10	Servo Mechanism Trainer	1	2
11	Wave Analyzer	2	2

4) Telecommunications Laboratory

(a) Measurements Section

No.	Equipment	Qts.	Phase
1	Oscilloscopes	2	1
2	Function Generators	2	1
3	Power Supplies	6	1
4	Multimeters	6	1
5	Decade Resistance Box	4	1
6	R.C.L. Bridge	3	1
7	Micrometer	2	1
8	Vernier Calipers	2	1
9	Wire Gauge	8	1
10	Platinum Resistance Thermometer	1	1
11	Bridge Thermometer	1	1
12	Thermocouple Thermometer	2	1
13	R.F. Milliammeter 150 mA	1	1
14	R.F. Milliammeter 250 mA	1	1
15	DC Milliammeter Multirange	3	1
16	DC Micrometer Multirange	3	1
17	Universal Bridge	1	1
18	AC Potentiometer, Educational Type	3	1
19	Single Phase Energy Meter	6	1
20	Flux Meter with Search Coils	2	1
21	Electrical Ground Resistance Tester with Testing Kit	1	1
22	Carona Testing Equipment	1	1

(b) Telecommunications Section

No.	Equipment	Qts.	Phase
1	Universal Filter	1	2
2	Audio Amplifier and Speaker	1	2
3	Operational Amplifier Ciucuit Tainer	1	2
4	Distortion Analyzer	1	2
5	Microwave Experimental Equipment	1	2
6	High Pass-Low Pass Filters	2	2
7	Radio Demonstration Outfit	1	2
8	Audio Output Power Meter	2	2
9	Q-Meter	1	2

5) Computer Laboratory

(a) Computer Section

No.	Equipment	Qts.	Phase
1	Personal Computers, 16 Bit with Dual Disc Drives, Monitors and Printers	6	1
2	Compilers for Basic Languages	6	1
3	Software for Word Processing and other Applications	6	1
4	Air Conditioning Unit	2	1
5	Stabilizer	1	1

6) Workshop

(a) Electric Workshop

No.	Equipment	Qts.	Phase
1	Lathe Machine	1	1
2	Electric Drill Machine	1	1
3	Compressor	1	1
4	Grinder	1	1
5	Tools	1	1
6	Grinder Pedestal	1	1
7	Bench Drilling Machine	2	1

7) Drawing Room

(a) Drawing Room Equipment

No.	Equipment	Qts.	Phase
1	Cone with Spheres	2	1
2	Three Sided Prism	2	1
3	Regular Polyhedra Model	2	1

4. Basic Science Department

1) Applied Physics Laboratory

(a) Physics Section

No.	Equipment	Qts.	Phase
1	Electric Calorimeter	5	1
2	Photocell Gate Unit & Photocell Light Source	1	1
3	Microscope	6	1
4	Calorimeter Outfit Set	5	1
5	Electromagnetism Apparatus	5	1
6	Minor Magnetic Induction and Hysteresis Apparatus	1	1
7	DC Voltmeter	10	1
8	DC Millivoltmeter	10	1
9	DC Ammeter	10	1
10	Microammeter	10	1
11	Tablet Rehostate	10	1
12	Precision Galvanometer	10	1
13	Turning Fork, of Different Frequencies	5	1
14	Kundt's Apparatus	5	1
15	Spectrum Chart	1	1
16	Atomic Model	1	1
17	Electromagnetic Laboratory Model	1	1
18	Electromagnetic (Horse Shoe)	1	1
19	Electromagentic Demonstration	1	1
20	Doppler Effect Demonstrator	1	1
21	Demonstration Stroboscope	1	1
22	The Chemical Elements Chart	1	1
23	Aneroid Barometer	1	1
24	Vacuum Phototube	1	1
25	Optical Lenses	12	1
26	Prisms	12	1
27	Magnifiers	12	1
28	Double Pan Balance	3	1
29	Heavy Duty Spring Balance	2	1
30	Newton's Ring Apparatus	1	1
31	Vernier Microscope	3	1
32	Polarimeter	3	1
33	Steam Generator	15	1
34	Stopwatch	10	1
35	Thermometers 0-110o	6	1
36	Thermometers 0-250o	6	1
37	Analytical Balance	3	1
38	Sonometer	15	1
39	Potentiometer	2	1
40	Double Walled Calorimeter	5	1
41	Regulated Power Supply	5	1
42	Induction Coil	5	1
43	Zeleny Electroscope	5	1
44	Millikan Apparatus	2	1
45	Crookes Tube	3	1

46	Battery Charger	1	1
47	Diffraction Grating	2	1
48	Oscilloscope	10	1
49	Optical Bench	2	1
50	Darkroom Equipment	1	1

2) Applied Chemistry Laboratory

(a) Chemistry Section

No.	Equipment	Qts.	Phase
1	Crucible	90	1
2	Blow Pipe	3	1
3	Rotary Cork Press	2	1
4	Double Burette, Clamp	3	1
5	Double Burette, Spring Actuated	40	1
6	Standard Test Tube Clamp	40	1
7	Reagent Bottle	100	1
8	Beaker	40	1
9	Cylinder, Graduated	20	1
10	Condenser	10	1
11	Desiccator	15	1
12	Crystalizing Dishes	30	1
13	Flask Filtering	40	1
14	Funnels	100	1
15	Pipettes	40	1
16	Bottle Dropping	50	1
17	Specific Gravity Bottle	40	1
18	Tongs, Crucible	20	1
19	Evaporating Dishes	100	1
20	Cork Assortment 0-11	1	1
21	Thermometer 0-110°	40	1
22	Thermometer 0-250°	40	1
23	Cork Sheet	40	1
24	Flask	1	1
25	Burette	40	1
26	Gloves Rubber	40	1
27	Distillation Plant for Laboratory	2	1
28	Hot Air Dryer	2	1
29	Incubator	1	1
30	Melting Point Apparatus	2	1
31	Mixer	3	1
32	Spatula	50	1
33	Stirrer, Air Driven	2	1
34	Furnace, Muffle	2	1
35	Crystal Model Set	1	1
36	Periodic Table Chart	1	1
37	Molecular Models	1	1
38	Molecular Models for Organic Material	1	1
39	pH Colour Disks	2	1
40	pH Tester, Dual Short Range	5	1
41	pH Meter	5	1

42	pH Tester	10	1
43	Absorption Pipette	10	1
44	Diminizer	2	1
45	Polarimeter	2	1
46	Analytical Balance, Single Pan	3	1
47	Analytical Balance, Double Pan	15	1
48	Tripot Balance	5	1
49	Electronic Balance (digital)	2	1
50	Electronic Centrifuge Machine	2	1
51	Spectrophotometer	1	1
52	Refrigerator, Portable Compressor	2	1
53	Water Bath	10	1
54	Moisture Meter	1	1
55	Hydrometer Specific Gravity Set	1	1
56	Water Hardness Test Set	1	1
57	Electric Drying Oven (Vacuum)	1	1
58	Electric Drying Oven	5	1
59	Burettes Stand	40	1
60	Stopwatch	10	1
61	Ostwald's Viscometer	40	1

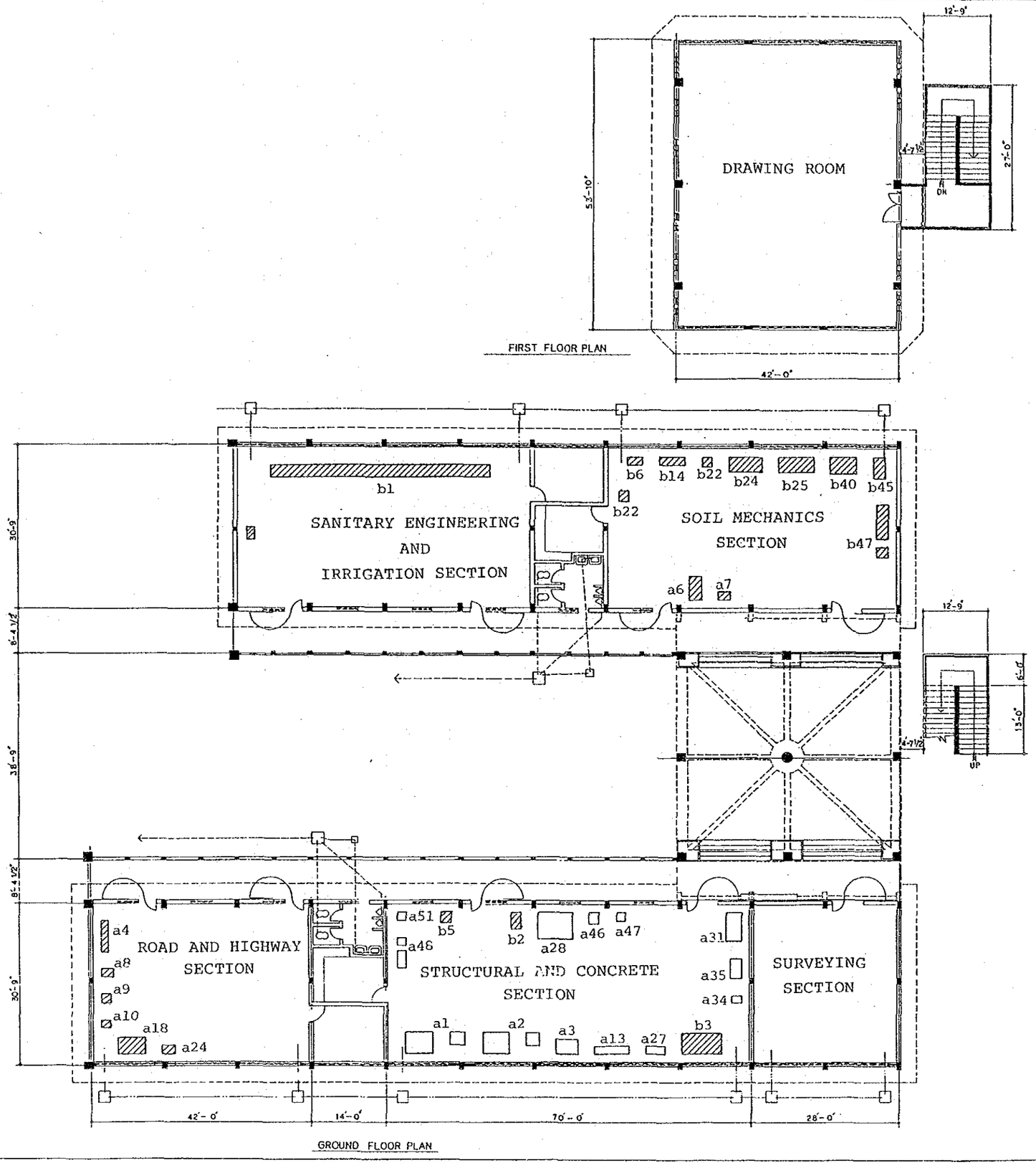
3) Language Laboratory

(a) Language Laboratory Equipment

No.	Equipment	Qts.	Phase
1	Master Console	1	1
2	Master Tape Recorder	2	1
3	Booth Console	16	1
4	Booth Tape Recorder	32	1
5	Head Set	32	1
6	Room Speaker	2	1
7	Connection Cable and Tools	1	1
8	Teacher's Chair	1	1
9	Chairs for Students	32	1
10	Window Type Room Air Conditioner	3	1

4.4 Arrangement Plan of Equipment

Equipment shown in Figures 4.4.1 - 4.4.5 represents that which requires a foundation or is of a large size. Other equipment, instruments for measurements and tools used on the working desk will be stored either on a shelf or in a storeroom.



Equipment

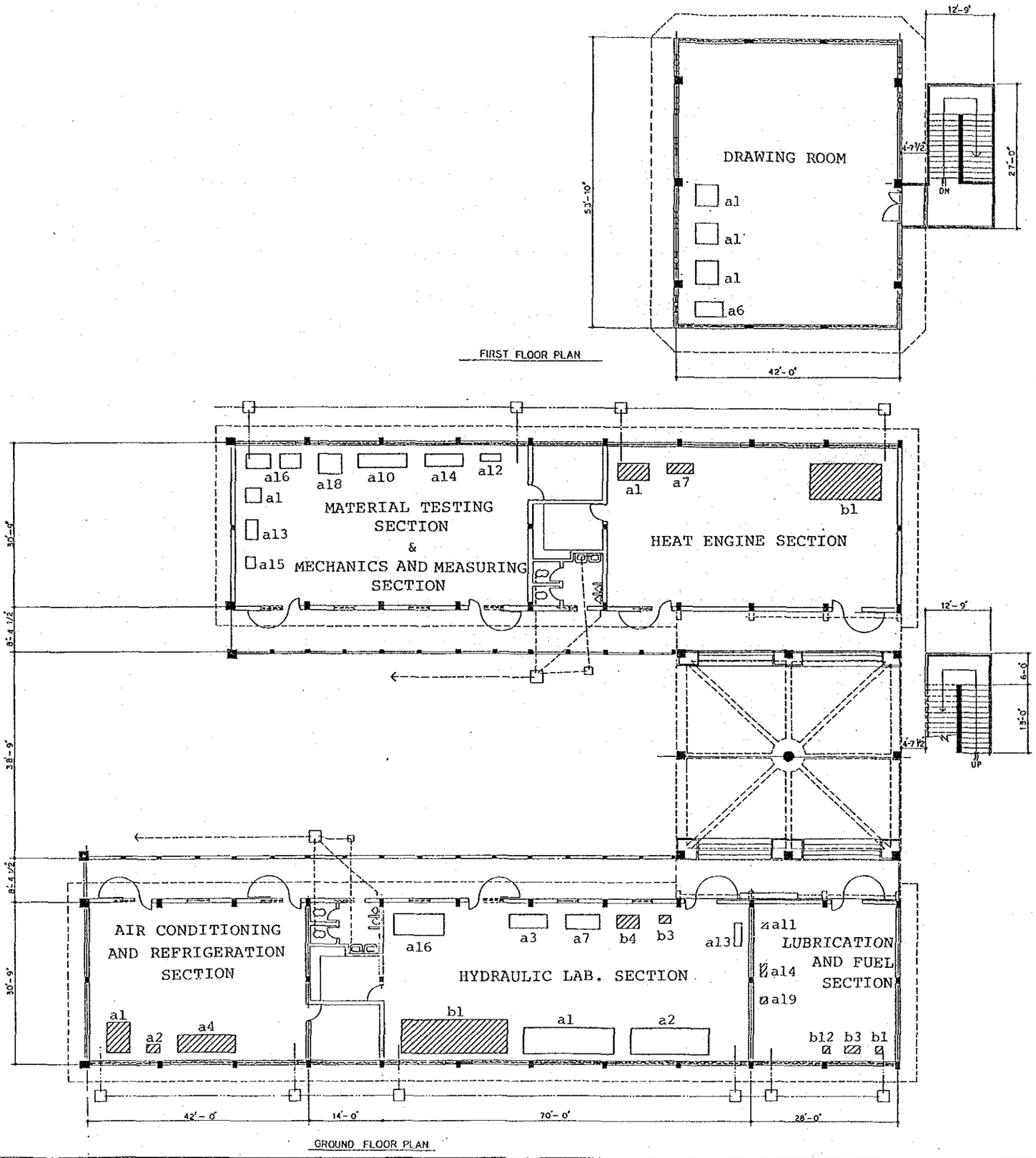
1. Structural and Concrete Section
   - (a) Testing of Material Lab.
     - a1 Universal Testing Machine 200 tons with Accessories
     - a2 Compression Testing Machine 100 tons
     - a3 Los Angeles Abrasion Machine
     - a13 Autoclave with Pressure Regulator
     - a27 Cutting Machine for Concrete Specimens
     - a28 Rake Drum Type Concrete Mixer
     - a31 Constant Temperature Electric Drying Oven
     - a34 Table Platform Scale
     - a35 RO-Tap Sieve Shaker
     - a46 Mortar Mixer
     - a47 Table Vibrator
     - a48 Concrete Permeability Apparatus
     - a51 Concrete Creep Test Apparatus
   - (b) Concrete Lab.
     - b2 Core Driller
     - b3 Thermostat for Concrete Testing (Water Bath)
     - b5 Environmental Cabinets for Cement Concrete Setting, etc.
2. Soil Mechanics Section
   - (a) Geological Engineering Lab.
     - a6 Large Specimen Cutoff Machine for Rocks
     - a7 Oven, Forced Draft 180°c
   - (b) Soil Mechanics Lab.
     - b6 Laboratory Sifter
     - b14 Consolidometer
     - b22 Compactor
     - b24 Shear Machine (Constant Strain Manual)
     - b25 Triaxial Machine (Universal)
     - b40 Forced Draft Double Wall Ovens
     - b45 Soil Mixer Mechanical Analysis ASTM D422 AASHO T88
     - b47 Consolidation Set (Medium Capacity)
3. Road and Highway Section
   - (a) Road Lab.
     - a4 Extractor Land Type with Extractor Bowls
     - a8 Bitumin Mixers
     - a9 Standard Bitumin Compactor
     - a10 Specimen Extractor
     - a18 Single Wall Oven
     - a24 Hubbard Stability Test Apparatus
4. Sanitary Engineering and Irrigation Section
   - (a) Fluid Mechanics
   - (b) Hydraulic Lab.
     - b1 Tilting Universal Modular Flow Channel
   - (c) Sanitary Engineering
     - c16 Portable Autoclave

Phase-1
Phase-2

0 5 10 15 20 25 30 (FT)
SCALE

JOB	KHUZDAR ENGINEERING COLLEGE (CIVIL ENGINEERING DEPARTMENT)
TITLE	PLAN – 1 (LABORATOR BLOCK)
	EQUIPMENT LAYOUT PLAN

Fig. 4.4.2 Mechanical Eng'g Dept.



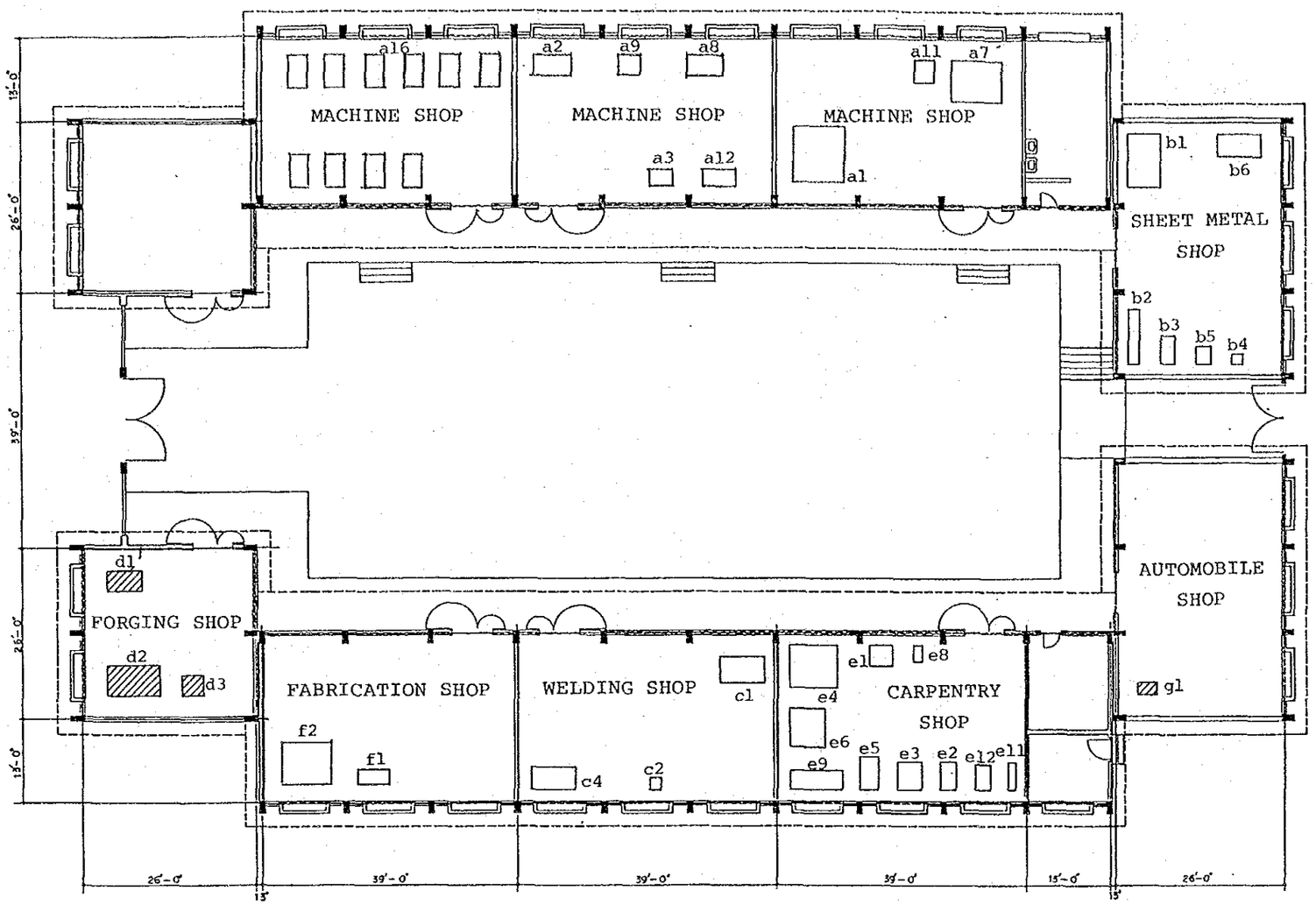
Equipment

1. Hydraulic Lab. Section
   - (a) Fluid Mechanics Lab.
     - a1 Horizontal Shaft Francis Spiral Turbine
     - a2 Oil Pressure Speed Governor
     - a3 DC Generator
     - a7 Hydraulic Press
     - a13 Reynolds Apparatus
     - a16 Centrifugal Pump Test Bench for Instruction and Research
   - (b) Gas Dynamics Lab.
     - b1 *Universal Blower or Ventilator Test Bench*
     - b3 Projection Wind Tunnel
     - b4 Bernoullis Principal Apparatus
2. Material Testing Section
   - (a) Metallurgy, Metallography
     - a1 Mineral Ore Grinding & Polishing Machine
     - a10 Universal Testing Machine
     - a12 Creep and Rupture Test Machine
     - a13 Dilatometer for Deflection of Isothermal Phase
     - a14 Fatigue Test Apparatus
     - a15 Balancing Machine
     - a16 Spring Testing Machine
     - a18 Vibration Test Rig.
3. Mechanics and Measuring Section
4. Heat Engine Section
   - *(a) Internal Combustion Lab.*
     - a1 Engine Test Stand with Collecting Exhausts Silencer
     - a7 Heat Exchange Unit
   - (b) Steam Lab.
     - b1 Educational Steam Boiler-Natural Gas Fired-Generator Type
5. Air Conditioning and Refrigeration Section
   - (a) Heat Transfer Lab.
     - a1 Cooling Unit for Demonstration and Test Purpose
     - a2 Thermal Conductivity Apparatus
     - a4 Convection Apparatus Liquids
6. Lubrication and Fuel Section
   - (a) Fuel Combustion Lab.
     - a11 Copper Corrosion Tester
     - a14 Gum Determination Apparatus
     - *a19 Corrosion Test Bomb, for Liquids, Fuels and Gases*
   - (b) Lubrication Lab.
     - b1 Corrosion Test Strips, Copper, ASTM
     - b3 Steam Turbine Oil Oxidation Test Bath
     - b12 Apparatus for Determining the Oxidation Characteristics
7. Drawing Room
   - (a) Mechanical Engineering Section
     - a1 Drafting Table
     - a6 Copying Machine (950mm)

Phase-1
Phase-2

0 5 10 15 20 25 30 (FT)
SCALE

MK	SIGN / DATE
JOB	BALUCHISTAN ENGINEERING COLLEGE KHUZDAR (MECHANICAL ENGINEERING DEPTT.)
TITLE	PLAN – 1 (LABORATOR BLOCK)
	EQUIPMENT LAYOUT PLAN



GROUND FLOOR PLAN

Equipment

7. Workshop
   - (a) Machine Shop
     - a1 Universal Miller
     - a2 Planner
     - a3 Metal Saw
     - a7 Horizontal Surface Grinder
     - a8 Radial Drilling, Boring and Tapping Machine
     - a9 Pedestal Drilling Machine
     - a11 Tool & Cutter Grinding Machine
     - a12 Filing and Sewing Machine
     - a16 Electric Lathe
   - (b) Sheet Metal Shop
     - b1 Press Brakes
     - b2 Bending Machine
     - b3 Rotary Shears
     - b4 Grooving Machine
     - b5 Circle Cutting Machine
     - b6 Light Spot Welder for Sheet Metal Work
   - (c) Welding Shop
     - c1 3-Phase Electronic Controller's Spot Welder
     - c2 Continuous Arc Welding Machine
     - c4 Spot Welder for Sheel Metal
   - (d) Forging Shop
     - d1 Normalizing Furnace
     - d2 Forging Furnace
     - d3 Carbonising Furnace
   - (e) Carpentry Shop
     - e1 Tilting Arbor Saw Bench
     - e2 Belt Sanding Machine
     - e3 Thicknesser
     - e4 Single Ended Tenon and Scribing Machine
     - e5 Universal Router
     - e6 Universal Wood Worker
     - e8 Drilling Machine
     - e9 Planer or Jointer
     - e11 Compressor
     - e12 Dust Collector
   - (f) Fabrication Shop
     - f1 Power Hacksaw
     - f2 Gillotine Shearing Machine
   - (g) Automobile Shop
     - g1 Cylinder Boring Machine

Phase-1
Phase-2

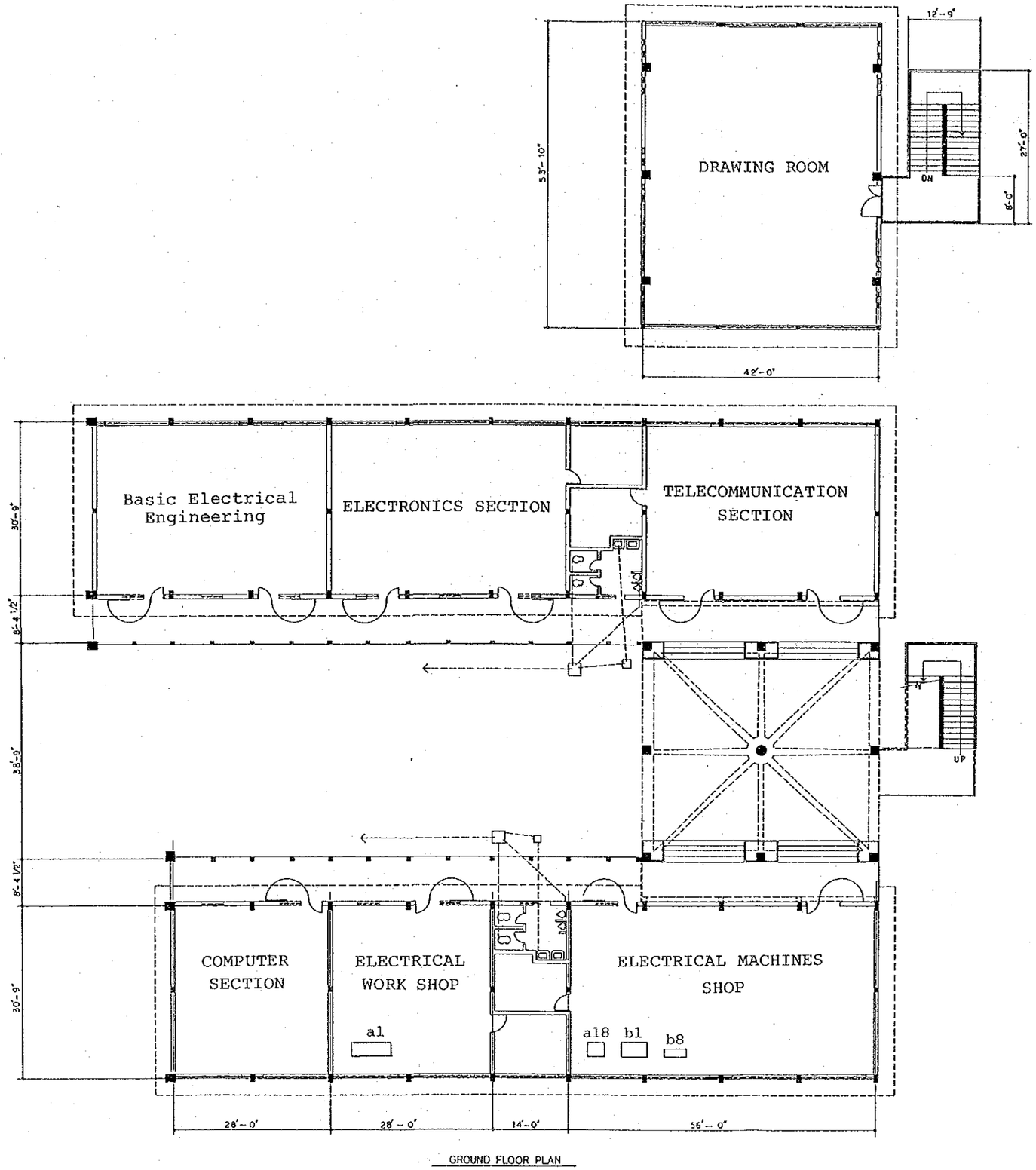
0 5 10 15 20 25 30 (FT)
SCALE

JOB: BALUCHISTAN ENGG. COLLEGE KHUZDAR (WORKSHOPS)

TITLE: GROUND FLOOR PLAN - 1

EQUIPMENT LAYOUT PLAN

Fig. 4.4.4 Electrical Eng'g Dept



GROUND FLOOR PLAN

Equipment

1. Elementary Electricity Section
2. Electrical Machine Shop
   (a) Electrical Machine Lab.
       a18 DC Rectifier 5kW, 3kW
   (b) Advance Elect. Machine Lab.
       b1 DC Generator 5kVA One
       b8 Educational Elevator Model
3. Electronics Section
4. Telecommunications Section
5. Computer Section
6. Electrical Work Shop
       a1 Lathe Machine
7. Drawing Room

Phase-1
Phase-2

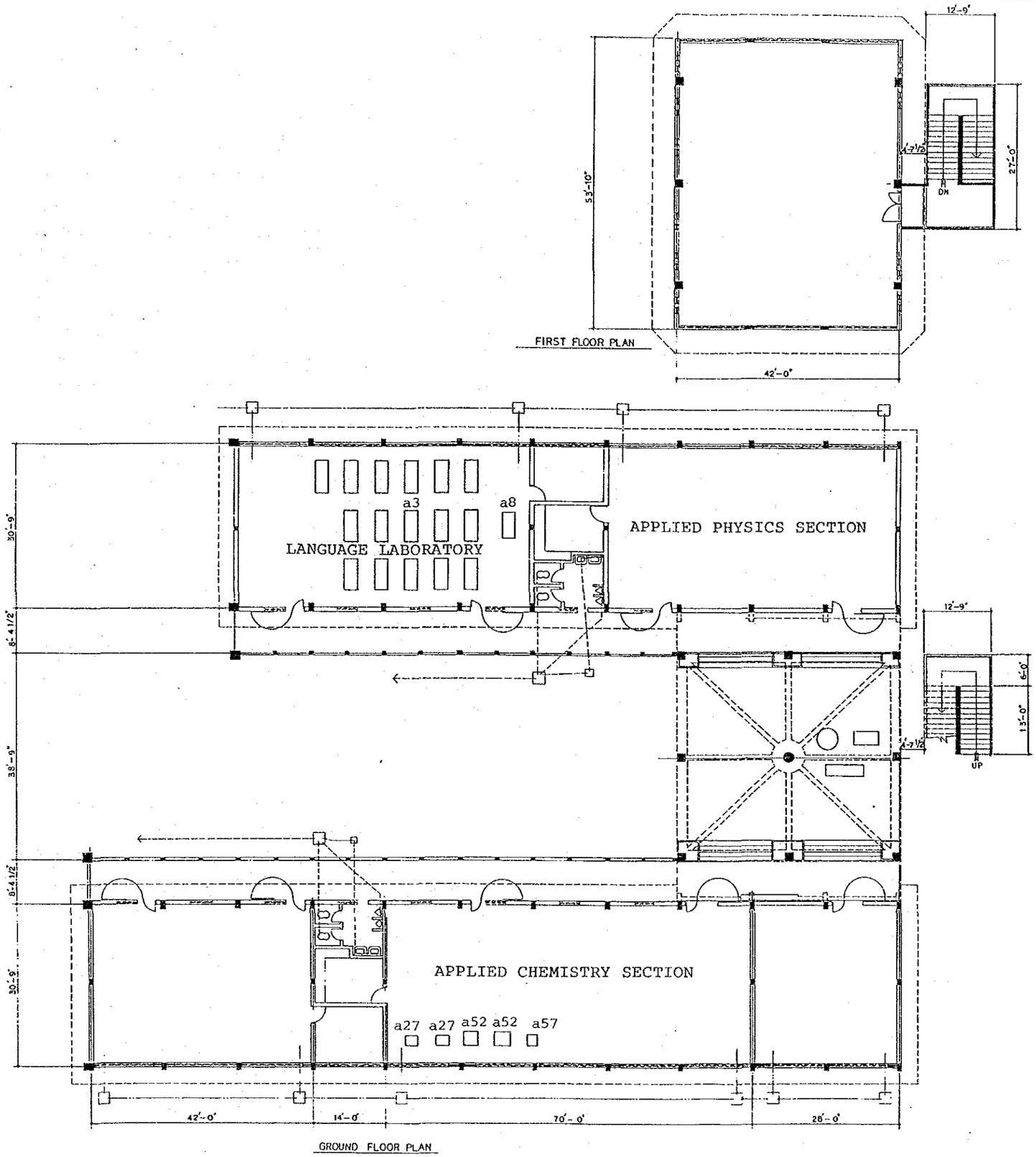
0 5 10 15 20 25 30 (FT)
SCALE

JOB
KHUZDAR ENGINEERING COLLEGE
(ELECTRICAL ENGINEERING DEPARTMENT)

TITLE
PLAN – 1
(LABORATORY BLOCK)

EQUIPMENT LAYOUT PLAN

Fig. 4.4.5 Basic Science Dept.



Equipment

1. Applied Physics Section
2. Applied Chemistry Section
   (a) Chemistry Lab.
   - a27 Distillation Plant for Laboratory
   - a52 Refrigerator, Portable Compressor
   - a57 Electric Drying Oven (Vacuum)
3. Language Lab.
   (a) Language Lab.
   - a3 Booth Console
   - a8 Teacher's Chair

Phase-1
Phase-2

0 5 10 15 20 25 30 (FT)
SCALE

	SIGN	DATE
JOB	BALUCHISTAN ENGINEERING COLLEGE KHUZDAR (BASIC SCIENCE DEPTT.)	
TITLE	PLAN – 1 (LABORATOR BLOCK)	
	EQUIPMENT LAYOUT PLAN	

4.5 Project Implementation Programme

4.5.1 Installation plan

After an Exchange of Notes on the decision to implement the Project, it will be necessary for discussions to be held by BEC, Khuzdar and the Japanese consultant firm engaged for project-related services, regarding the programme for implementing the Project; details of the design, tender invitation, tender, contracts, equipment procurement procedures and installation at the college in keeping with the Basic Design.

It will be necessary for the consultant and the college to study and agree on the suitable procedures and schedule for the following in connection with installation:

(1) The scope of installation work each country is to be responsible for, and the timing of the start of work

(2) Transportation of the equipment to the college, and installation work there

(3) Presence of college representatives at trial operation

Scheduling must provide for a suitable duration of the dispatch of technical personnel for installation, trial operation and other tasks, and for smooth completion of work on schedule.

4.5.2 Scope of work

The portion of this project that Japan is responsible for comprises the provision of laboratory and educational equipment as specified in 4.3 as well as its transportation to the college, unloading, installation, interior wiring, trial operation after installation, and consulting work related to the preparation of tender documents, management of the tendering process and accomplishment of the contractor's responsibilities for supply, installation, etc. The Pakistani side is to perform the following preparation and construction work.

(1) Furnishing of all electric power facilities and equipment and lighting fixtures necessary for the laboratory and educational equipment being supplied, as well as water, fuel and other utilities.

(2) Furnishing of foundations for the installation of such equipment as requires a foundation.

(3) Furnishing of all benches and other furniture required, and as indicated in the location plan.

4.5.3 Supervisory plan

It is necessary for the consultant, in accordance with Japan's Grant Aid Programme, to organize a capable project team to undertake the design and supervisory work as required by the basic plan for the Project, so as to assure smooth accomplishment of said project.

It will be required of the consultant, at the stage of installation supervision, to confirm that the manufacture of the equipment has been properly, completely done, to be present at tests upon completion of the installation when so required, to dispatch competent technical personnel for such periods as required for installation at the college, and to insure in other ways necessary that the contractor's work is properly performed.

4.5.4 Implementation schedule

The Project is to be implemented in two phases as described in section 4.1. However the implementation of the second phase would be taken place after accomplishing the recruitment plan for 1988 (refer to 2.4.5). For each phase of the Project, steps to be taken, following an Exchange of Notes, are to be broadly as follows:

(1) Detail design and tender documents
Preparation of tender documents on the basis of the Basic Design Report, and securing of approvals by the agencies concerned.

(2) The tender

The call for bids, screening of contractor qualifications, evaluating the bids and signing of contracts with the successful bidder.

(3) Performance of work under the contract

The supplier is to submit through the consultant the necessary technical drawings, facilitate witnessing by the consultant of manufacture of the equipment and shipment of the equipment to Pakistan. The contractor shall then be responsible for the shipment, its transportation to the college and unloading, installation and trial operation, on a full turnkey basis.

(4) Completion of work

Upon completion of installation, the consultant and responsible representative of the college shall attend tests, inspections and operation of the supplied equipment, confirm that they conform to the specifications, and declare the Project to be completed.

The schedule of the foregoing is shown in Figs. 4.5.1 and 4.5.2.

PROJECT: THE PROJECT FOR PROVISION OF LABORATORY AND EDUCATIONAL EQUIPMENT FOR BALUCHISTAN ENGINEERING COLLEGE, KHUZDAR (1ST PHASE)

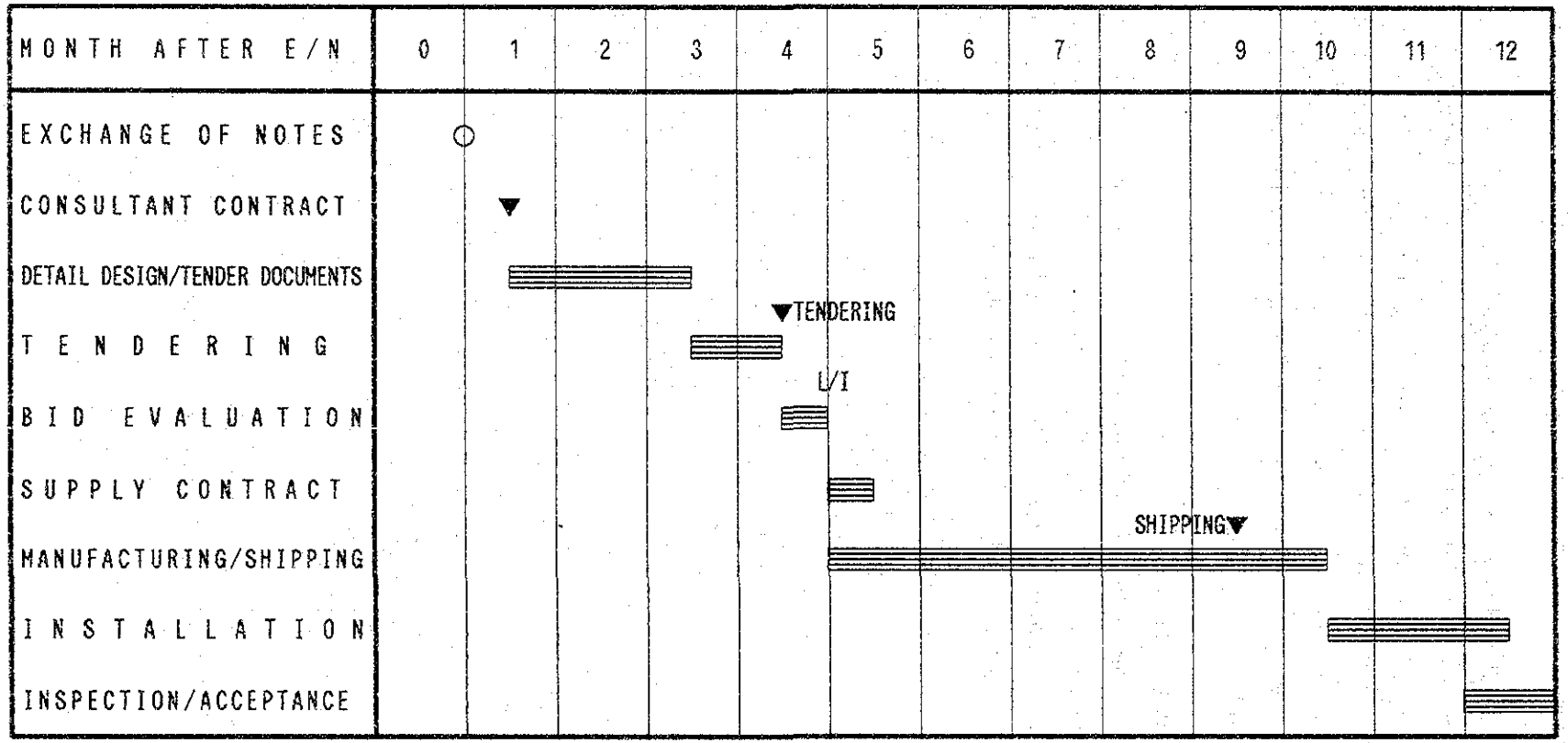


Fig. 4.5.1 Schedule (1)

PROJECT: THE PROJECT FOR PROVISION OF LABORATORY AND EDUCATIONAL EQUIPMENT FOR BALUCHISTAN ENGINEERING COLLEGE, KHUZDAR (2ND PHASE)

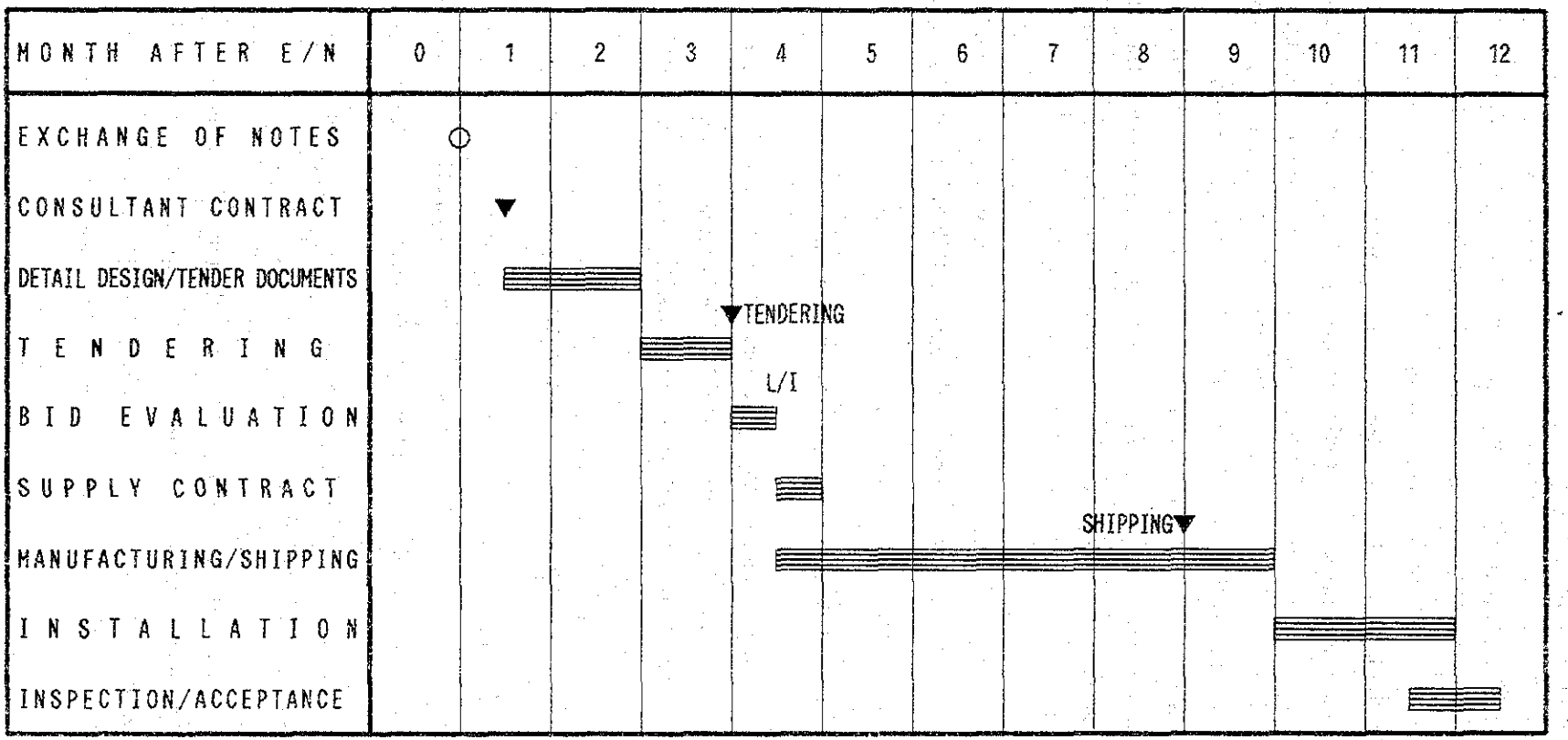


Fig. 4.5.2 Schedule (2)

4.6 Maintenance Programme

4.6.1 Maintenance programme

The maintenance programme has the objective of assuring that after the laboratory and educational equipment is supplied to the college that they will be capable of effectively functioning or being used to enhance the education provided at the college. The maintenance of the laboratory and educational equipment requires thorough preparation and strong efforts.

It is planned that the college is to have 41 professors and lecturers and a technical support staff of 35 persons for the performance of experiments and laboratory or workshop assignments. These are satisfactory numbers for the maintenance to be required, but it is necessary for the responsible faculty members and support staff to possess adequate technical experience relevant to the maintenance work to be performed.

The specific measures required in order to maintain the equipment in good working order over a long period of time so that it can be effectively used are as follows.

(1) Acquisition of operating and maintenance manuals

Instructional manuals for operation and maintenance of the equipment should be acquired from the equipment manufacturers, and the contents of those manuals should be understandable by the people who will use them.

(2) Delegation of responsibility for maintenance

The maintenance of the equipment is best made the responsibility of the persons who are in charge of the preparation for use of the equipment and supervision of student experiments in the labs.

The following are recommended as items the persons with responsibility for maintenance should be expected to do.

(a) In accordance with the maintenance manuals, determine what regularly-scheduled checks and inspections are to be made, prepare checklists and conduct regular inspections and tests on the basis of them, record all abnormalities and corrective measures

taken, monitor the quantities of spare parts and insure that the required stock levels are maintained.

(b) Ascertain on the basis of the experiments to be performed the quantities of materials and expendable supplies needed keep an adequate inventory and control the discharge of them from storage.

(c) Maintain control over the storage of spare parts, materials and expendable supplies. Maintain inventory by allowing for delivery time from Karachi.

(3) Maintenance budget

Budgetary proposals to cover the cost of spare parts, expendable supplies, materials and other budgetable costs are to be prepared. See 4.6.2 for details.

(4) Technical training for maintenance personnel

It is necessary for the personnel in charge of lab work in each department to be adequately experienced in the operation and maintenance of the equipment.

Because this is the first engineering college in Baluchistan, while technical personnel must be dispatched to NED and other universities in Pakistan for training in maintenance work, they also must be trained in how to prepare for and supervise student work in the labs. They should be present when the equipment is installed and undergoes test operation so that they can better become familiar with the handling of the equipment. Because of these reasons, it is necessary to swiftly appoint these persons and give them opportunities to acquire experience.

4.6.2 Expenditures for maintenance

On the assumption that the college has a student body of 360, maintenance costs are estimated roughly under the following conditions.

(1) Annual electric power consumption

On the basis of the hours of education given in 3.3.2, it is assumed that equipment use would be 13 hours a week and 40 weeks a year, whereby it is estimated that annual hours of use would be 420. The average load of equipment is assumed to be about 108 kW; calculation of the load is shown in Appendix-8.

(2) Spare parts and expendable supplies

Spare and replacement parts, and expendable supplies needed for normal operation like lubricants, record paper, inked ribbon, recorder pens, would cost 2.5 to 3.0 percent of the total cost of the equipment.

(3) Materials and chemicals

Concrete, steel, fuel, chemicals and the like are estimated to cost Rs.1,500 per year per student.

1) Electric power expense

108 kW x 420 hr/year = 45,360 kWH/year
45,360 kWH/year x Rs.1.5/kWH = Rs.68,040/year
Say 70,000 Rupees per year

2) Spare parts and expendable supplies

Estimated to be about 2,600,000 Rupees per year, calculated as 2.5 to 3.0% of the total cost of equipment.

3) Materials and chemicals

Rs.1,500/year x 360 students = Rs.540,000/year

Total annual expenditures for maintenance are thereby calculated to be 3.21 million Rupees. Annual recurring expenditures for maintenance of equipment are estimated at 3.4 million Rupees in Amended Revised PC-1, as shown in 2.4.6. It is necessary to ensure this maintenance cost.

4.6.3 Project costs

Project costs directly relating to the equipment to be borne by Pakistani side are estimated as follows:

Foundation work of equipment	Rs.360,000
Interior work and other preparation work	Rs.240,000
Total	Rs.600,000

This work should be prepared by the Pakistani side, in addition to wall and floor finishing, wiring up to the wall in each laboratory, and preparation of laboratory desks, shelfs and cabinets in the rooms.

CHAPTER 5 PROJECT EVALUATION

CHAPTER 5 PROJECT EVALUATION

On the basis of a programme for development of technical manpower, the Government of Pakistan is proceeding with construction of new colleges of engineering and expansion of existing ones. As part of that effort, BEC, Khuzdar is being constructed in Baluchistan Province. The present project, whereby laboratory and educational equipment is to be provided to the college, is expected to have the following effects in the perspective of engineering education in accord with the basic objective of the college itself.

5.1 Improvement of Human Resources in Science and Technology

In recent years Pakistan has constructed new colleges of engineering and expanded and modernized existing ones. The nation now has seven engineering universities and colleges. By means of providing equipment to BEC, Khuzdar which is newly constructed in Baluchistan, a contribution will be made to the improvement of the human resources not only in Baluchistan Province but in the nation as a whole, through the college's modern facilities and equipment and their use to enhance the learning process.

5.2 Promotion of Development through Training of Technical Personnel

Baluchistan Province is promoting a large number of development projects under The Fifth and The Sixth Five Year Plans, and there is a strong need for technical personnel in connection with those projects. By constructing BEC, Khuzdar and providing the equipment under the Project, it will become possible to train technical personnel within Baluchistan Province and to increase the number of technical persons from Baluchistan every year, and thereby provide technical personnel for participation in development projects in the province.

5.3 Creation of Learning and Employment Opportunities

By implementation of this project, opportunities to acquire higher education within Baluchistan, which have been relatively limited, will be increased. This will increase the number and improve the average capability of students aspiring to obtain an engineering education and contribute to improving the overall technical work force of the nation. Moreover, a considerable number of technicians will be required for operation of the equipment and conducting laboratory work. Thus, directly and indirectly, employment opportunities will be created in Baluchistan, a province hitherto lagging in development, and through this and the increase in opportunities for technical training a contribution will be made to the nation's economy.

In consideration of the above, it is judged that the validity of this project is fully justified.

CHAPTER 6 CONCLUSION AND RECOMMENDATIONS

CHAPTER 6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

As stated in the body of this report, the Pakistani nation is proceeding with the training and education of scientific and technical manpower on the basis of national development planning for the promotion of economic and social development. Colleges of engineering have already been established in every province other than Baluchistan, and are engaged in the education of engineers. Through the establishment of BEC, Khuzdar in Baluchistan Province, where development planning is proceeding at a rapid pace, opportunities for Baluchistan natives to obtain a higher education in the province will be increased, and it will become possible to get an engineering education without leaving the province. This will increase the supply of qualified personnel for work in development projects in the province.

Therefore, Japan's grant aid cooperation for the provision of laboratory and educational equipment for this new college is highly significant.

6.2 Recommendations

It is certain that this project for the provision of laboratory and educational equipment will contribute to engineering education in Pakistan, and high expectations are held for it. It is indispensable, however, for Pakistan to make the following efforts to insure that the Project achieves maximum effects.

(1) Construction to be undertaken by Pakistan

Construction of the buildings in which the equipment is to be installed is almost entirely complete, but in addition to expediting completion of construction, it is necessary to swiftly take measures, both through budgetary provisions and making arrangements for implementation, to insure full installation and furnishing of desks, benches, shelves and the like as required in each room, and the installation of wiring, water pipes and so forth, as well as connections to a source of power, in accordance with the construction schedule.

(2) Installation of equipment and test operation

The transportation of the equipment to the college, unloading, installation and test operation are all to be performed by the Japanese supplier. It is necessary for those Japanese engaged in work related to landing shipments in Karachi and subsequent transfer of the equipment to Khuzdar to be assured safe passage within Pakistan, that lodgings be provided at the college, and that their general well-being be assured.

(3) Budget for maintenance

In order to achieve the fundamental objective of this project it is necessary to make budgetary provisions for equipment maintenance on a continuing, steady basis. The college must insure that this is done.

(4) Personnel

It is necessary for the college to assign technical personnel to be in charge of the equipment in each department, under the supervision of faculty members. These personnel are to be integrated into a sound programme for control of the operation and maintenance of the equipment. In addition to acquiring the equipment, the college must acquire qualified personnel.

(5) Training of personnel

The personnel who are to operate and routinely maintain the equipment must have experience in this. In addition to dispatching newly hired personnel to other Pakistani colleges to obtain training and experience, it is necessary to insure that they be present when the equipment is installed and undergoes test operation.

(6) Maintaining an inventory of spare parts and expendable supplies

Khuzdar is some distance from Karachi, and this creates a need to be certain that stock levels of spare parts and expendable supplies are kept adequate. Provision must be made for reordering and emergencies.