CHAPTER 3 CONTENTS OF THE PROJECT

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3-1 Objectives of the Project

The Government of Sri Lanka has been introducing medical equipment into its public medical institutions in order to improve the quality of health care services. Through the development of Biomedical Engineering Services (BES), which is responsible for the maintenance and management of all medical equipment, the Government has been making every effort to distribute medical equipment properly, and to keep it in good condition. The ultimate target of BES is to keep all medical equipment in the country in good working condition. However due to a shortage of technical staff, working space, repair equipment and spare parts, BES is unable to achieve its goal. The objectives of the project are to strengthen the ability of BES by constructing facilities and providing equipment which are urgently needed.

3-2 Examination of Contents of the Request

3-2-1 Examination of Appropriateness and Necessity of the Project

The Ministry of Health and Women's Affairs has estimated that country's public medical institutions own about 2,000 million rupees worth of medical equipment. There are about 150 types making up 35,000 pieces of medical equipment. However, 30 percent of this inventory is not in operating condition, as mentioned in "2-2 Present Condition of Medical Equipment in Use at Hospital". This means about 600 million rupees worth of medical equipment, or 20 percent of the Ministry's annual budget, is in some state of disrepair. This situation is a major impediment to improving technical aspects of the country's health services, and should be promptly resolved in order to achieve a more effective use of the budget.

On the other hand, most items of medical equipment are imported from foreign countries, and the costs of their maintenance and repair are higher than in the countries where they are manufactured. The public medical institution's income from diagnosis and treatment is relatively small, and having to operate within the framework of the government budget, it is impossible to ask foreign distributors and manufacturers to maintain and repair these items of medical equipment. Furthermore in terms of cost and time, it is not advantageous to ask foreign manufacturers to repair devices such as sphygmomanometers, electrocardiographs and monitors. Therefore, the programme in which BES takes charge of maintenance and management of all medical equipment at public medical institutions, is realistic and sound. The plan to improve the facilities and equipment at BES is made up of three sub-projects: 1) Improvement of Colombo Centre's functions, 2) More effective training of technical and medical staff members, and 3) Reinforcement of BES's service for regional hospitals. The necessity and relevance of each of these three sub-projects are examined as follows:

(1) Improvement of Colombo Centre's Functions

The primary functions of BES are: a) ordering/purchase, b) acquisition/inspection/storing/delivery, c) maintenance/repair, d) management of records, e) disposal of condemned equipment, and f) training of medical and technical staff. As a result of discussions between the basic design team and Sri Lankan officials it was agreed that the training function, and the administration function, should be excluded from the scope of the project; their improvement is not urgently needed. The other four functions were examined and grouped into the following three functions:

1) Procurement/Supply

In 1990, BES placed orders, purchased, acquired, and delivered 140 million rupees worth of medical equipment. This was

equivalent to nearly half of the MSD's total cost for the purchase of medical supplies for the same year. At present, BES has about 300,000 spare parts in stock with a total volume of 150m3. Handling, inventory control, and warehousing of the medical equipment and spare parts are all conducted manually. This is considered to be inefficient. If the warehousing work is automated, it will greatly increase efficiency by reducing both preparation time and dead stock.

2) Maintenance/Repair

As mentioned in "2-2 Present Condition of Medical Equipment in Use at Hospitals", all of the 502 public hospitals are classified into two sectors -- the higher level complex, which includes teaching, provincial and base hospitals, and the lower level complex, which includes district, peripheral, rural hospitals and smaller institutions. Table 3-2-1 shows the amount of medical equipment which each complex may have owned, number of breakdowns which each complex may have had, and the number of cases which were repaired at the Colombo Centre in 1990. Due to a shortage of both staff and repair equipment, plus an insufficient maintenance and management system, the Centre was unable to meet the demand for repairs by the lower level complex. However, the Centre was able to satisfy some of the demand for the higher level complex even though both complexes own a nearly equal amount of equipment.

For this reason, it is very important to improve the Centre's maintenance and repair functions. For study purposes, medical equipment repaired at the Centre was divided into: a) basic levels, b) middle levels and c) advanced levels, and an examination of each level was made.

Table 3-2-1 Number of Possessions, Breakdowns and Repairs at Each Medical Complex

Quantity \ Level of hospitals		Higher Level Complex (Teaching, Provincial, Base Hospitals)	Lower Level Complex (District, Peripheral, Rural Hospitals)	Total
Number of Hospitals		39	463	502
Number of Beds		21,525	25,095	46,620
Medical Equipment Owned	Basic Levels	11,500	14,000	25,500
	Middle Levels	7,700	2,000	9,700
	Advanced	300	0	300
Total		19,500	16,000	35,500
No. of Equipment Breakdowns	Basic Levels	4,400	4,000	8,400
	Middle Levels	3,750	550	4,300
	Advanced	-	-	
Total		8,150	4,550	12,700
No. of Repairs (1990)	Basic Levels	1,527	412	1,939
	Middle Levels	2,209	151	2,360
	Advanced	* 56		* 56
Total		3,792	563	4,355

*: includes maintenance contracted to manufacturers

a) Basic Level Equipment

There are about 25,000 pieces of basic medical equipment in Sri Lanka. The Colombo Centre repaired only 30 percent of the breakdowns which occured at the higher level complex, and only 10 percent at the lower level complex. Repair of basic medical equipment is characterised by repeated repairs of a low technical level. It is, therefore, illogical for the Colombo Centre, which has high level repair technologies, to make repeated repairs on basic level equipment. For this reason, a new workshop should be established to repair basic level medical equipment used at institutions located in and around Colombo. As for basic level equipment used at more distant locales, the Colombo Centre can not repair them all,

owing to the following two reasons: first, the large quantities of breakdowns are beyond the capacity of the Centre, and second, the locations of the institutions are scattered too far across the country.

b) Middle Level Equipment

The Colombo Centre has repaired about 60 percent of the equipment which belongs to the middle level. This relatively high repair ratio, compared with the ratio for basic level equipment, is mainly attributable to the locations of the hospitals having these types of equipment. Most of the hospitals are located in and around the Colombo Centre and broken equipment can be collected easily. Therefore, in order to cover the rest, it is important to increase the Centre's technical staff and repair equipment as well as to improve accessibility to rural hospitals.

It will be also necessary to improve the ability of the technical staff, and the quality of repair equipment in the following areas:

- Replacement of the basic X-ray control board's electrical circuitry, and the replacement of electronic components.
- Replacement of the power unit of the electrosurgery unit.
- Replacement of the electronic components of the ultrasound scanner.
- Replacement of the electrode portion of the blood gas analyser.

c) Advanced Equipment

Most items of advanced level equipment, including CT scanners, angiography units, holter monitors, color dopplers, and gamma cameras, are maintained by agreement with the distributors. BES intends to repair advanced level equipment in phases. Because repairs of this type of medical equipment (done with a state-of-the-art computer) require a wide range of sophisticated repair technologies, these equipment repairs are not included in the scope of this project.

In light of these facts, the study team has concluded that the focus of this project should be to improve the ability with which BES can repair middle level equipment.

3) Management of Records

Records kept at the Colombo Centre can be divided broadly into: a) records of medical equipment owned and its repair, and b) acquisitions of medical equipment and inventories of spare parts.

a) Records of Medical Equipment Owned and Their Repair

If the Colombo Centre had records of medical equipment owned, their operating conditions, and repairs done at the country's medical institutions, it would enable shortening of the repair time and a more effective order of spare parts. To this end, it is necessary to develop an organised system for the sorting and retrieval of repair records by medical equipment type.

b) Acquisitions of Medical Equipment and Inventories of Spare Parts

It is possible to reduce dead stock by establishing a system for the acquisitions of medical equipment and the inventory of spare parts.

(2) Training of the Technical Staff and the Medical Staff

The BES's staff members have aquired general repair technologies through on-the-job training, and will have similar training programmes after the implementation of the project. However, the staff members need to go abroad in order to aquire higher repair technologies because there is no domestic medical equipment manufacturer and training institution providing relevant technical training. Between 1981 and 1990, each member of the 20 BES's technical staff received overseas training for an average of nine weeks. Their training focused mainly on repairing radiological equipment and laboratory equipment. Such training programmes will continue to be implemented under the same arrangement.

There are few training programmes for nurses and paramedics. It is imperative to implement viable training programmes for the medical staff because of their relatively low technical know-how, and their limited knowledge about the function and operation of medical equipment. (medical equipment in normal operation condition is often mistakenly judged to be out of order). It is difficult to implement relevant training programmes under this project as BES lacks both the necessary systems and trained staff members to carry it out.

(3) Reinforcement of BES's Service for Regional Hospitals

It is difficult for the Colombo Centre to perform all medical equipment maintenance and management services for the lower level complex. As much as 90 percent of the medical equipment owned by these medical institutions consists of sphygmomanometers, instrument sterilisers, and other basic devices, which do not require sophisticated maintenance and management. Therefore, BES will be able to maintain and manage these devices on the basis of its present technical capabilities. As these basic devices are indispensable in primary care, and as BES's service of maintenance and management will

have favorable effects on the quality of the country's health care, it is essential to improve BES's medical equipment maintenance and management capabilities for regional hospitals.

3-2-2 Examination of Project Implementation and Management System

(1) Management System

There have been some discrepancies between the organisation and the actual activities of BES, thus both the Sri Lankan side, and the basic design study team, agreed that the management system of BES should be reorganised into three departments: a) Procurement/Supply, b) Maintenance/Repair, and c) Training, each of which should be managed by a senior BM engineer. Both sides also agreed that the Maintenance/Repair Department should be divided into six workshops: 1) General-Purpose, 2) Radiology, 3) Electronics, 4) Laboratory Equipment, 5) OT/Steriliser and 6) Mechanical Workshops. Fig. 3-2-1 shows the proposed organisation.

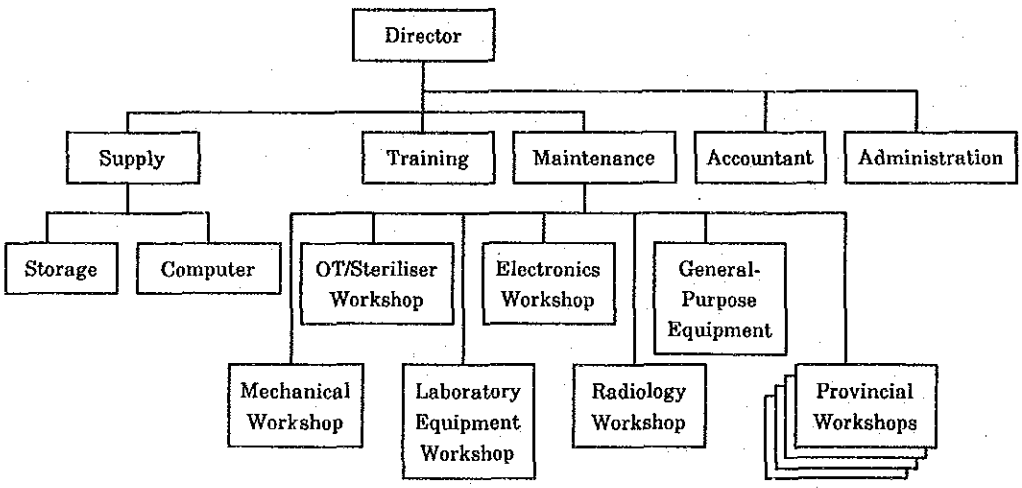


Fig. 3-2-1 The Proposed Organisation of BES

(2) Staff Plan

BES had planned to increase the total number of staff to 272 persons for the Colombo Centre, and 104 persons for the eight provincial workshops. Owing to the afore-mentioned modification of the organisation, both the Sri Lankan officials and the basic design study team agreed to revise the total number to 217 persons for the Centre, and 104 persons for the workshops. Table 3-2-2 shows the proposed staff plan.

In order to satisfy the proposed staff plan, BES must hire 142 technical staff members (18 BM engineers, 48 foremen, and 76 mechanics). However, owing to the limitation of the budget allocated by the Ministry, and the small supply of skilled workers in Sri Lanka, it is very difficult to hire these large amounts of staff at the same time. Furthermore, the training of newly hired staff can cause the deterioration of quality repair jobs. Therefore, both the Sri Lankan officials and the study team agreed to design the proposed facilities and equipment not based on 321 staff members (217 in Colombo Centre and 104 in provincial workshops), but based on the number of staff allowed by the Salaries and Cadre Commission.

Table 3-2-2(a) Proposed Staff Plan for Colombo Center, BES

	BM Engineer			Fore-man	Mecha-nic	Store-keeper	Store-man	Driver	Labour-er	Clerk/ Others	Total
	Senior	BME	Assist.								
Maintenance/Repair	1(0)										1 (0)
Radiology W.S.		1(0)	1(0)	8(4)	10(4)				1(1)		21 (9)
Electronics W.S.		1(1)	1(1)	9(2)	10(2)				2(3)		23 (9)
Laboratory Equip. W.S.		1(1)	1(0)	8(2)	10(1)						20 (4)
OT/Steriliser W.S.		1(1)	1(0)	10(6)	15(12)				3(5)		30(24)
Mechanical W.S.		1(0)	1(0)	9(0)	18(4)				3(1)		32 (5)
General Purpose Equip. W.S.		1(0)	1(1)	8(4)	12(14)				4(3)		26(22)
Procurement/Supply	1(0)										1 (0)
Storage						11(4)	12(0)				23 (4)
Records										8(0)	8 (0)
Training	1(0)										1 (0)
Accountant / Administration	1(1)							15(11)	6(6)	9(9)	31(27)
Total	4(1)	6(3)	6(2)	52(18)	75(37)	11(4)	12(0)	15(11)	19(19)	17(9)	217(104)

( ): existing number

Table 3-2-2(b) Proposed Staff Plan for Provincial Workshops

Workshops	Assistant BM Engineer	Foreman	Mechanics	Store-keeper	Labourer	Driver	Total
Central (Kandy Teaching Hospital)	1	2 (1)	5 (1)	2	2	1	13 (2)
Southern (Galle Teaching Hospital)	1	2 (1)	5 (1)	2	2	1	13 (2)
North-Central (Anradhapura Provincial Hospital)	1	2	5	2	2	1	13
Uva (Badulla Provincial Hospital)	1	2	5	2	2	1	13
North-Western (Kurunegala Provincial Hospital)	1	2	5	2	2	1	13
Sabaragamuwa (Ratnapura Provincial Hospital)	1	2	5	2	2	1	13
Eastern (Batticaloa Provincial Hospital)	1	2	5	2	2	1	13
Northern (Jaffna Teaching Hospital)	1	2	5	2	2	1	13
Total	8	16 (2)	40 (2)	16	16	8	104 (4)

( ) : existing number

(3) Budget Plan

During the past five years the annual budget of BES has fluctuated widely. It stood at about 210 million rupees in 1990. The details of the annual budget are described in "2-3 Present Condition of Biomedical Engineering Services". The current expenditures (mainly personnel and travel expenses) have remained constant at about 65 million rupees. The government of Sri Lanka has been trying to hold down the number of its new employees. However, in order to increase its personnel, it must first obtain the approval of the Salaries and Cadre Commission. Although the plan to expand the Colombo Centre's personnel has gained the commission's preliminary approval, the plan to increase the staff of the provincial workshops has not yet been approved since this plan is also related to the provincial government's budgets.

3-2-3 Examination of the Project Constituents

The project consists of three components: 1) Colombo Centre, 2) Provincial Workshops and 3) Mobile Workshops. As shown in Fig. 3-2-2, each of these components assumes responsibilty according to the type of equipment repaired and the degree of repair work.

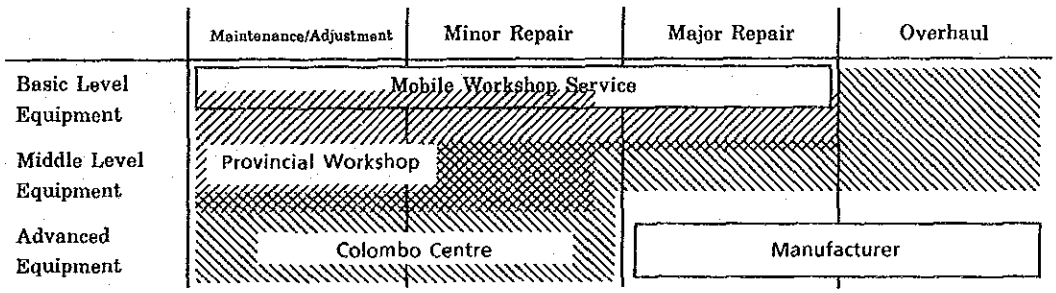


Fig. 3-2-2 Equipment Repair Diagram

As mentioned earlier, the Colombo Centre will be responsible for sophisticated repair work (mainly of middle level equipment). The Centre's General-Purpose Equipment Workshop will repair basic level

equipment in use at hospitals located in and around Colombo, while the mobile workshops will offer the same services to regional hospitals. The provincial workshops have a function which is intermediate between that of the Colombo Centre and the mobile workshops. The Sri Lankan side has worked out a plan to set up a provicial workshop in each of the country's eight provinces as a base for regional maintenance and management activities. Medical institutions to be covered by these workshops are as shown in Table 3-2-3.

The provincial workshops are not only to repair basic level equipment but also to offer maintenance service which does not require higher technical skill. These services include adjustment, trouble shooting, and minor repairs of middle level equipment. The received wisdom is that more than 80 percent of breakdowns can be repaired at a low technical level, meaning that the provincial workshops can shorten the down time of middle level equipment.

Table 3-2-3 Provincial Workshops Maintenance Coverage

Provinces	Hospital Name	The distance and time from Colombo	No. of Hospitals	No. of Beds	The Amount of Medical Equipment
Central	Kandy Teaching Hospital	144km 3hours	76	6,513	5,050
Southern	Galle Teaching Hospital	115km 3hours	51	4,425	3,400
North-Central	Anuradhapura Provincial Hopsital	203km 4hours	40	2,594	2,000
Uva	Badulla Provincial Hospital	235km 8hours	38	2,531	1,800
North-Western	Kurunegala Provincial Hospital	93km 2hours	49	4,440	3,350
Sabaragmuwa	Ratnapura Provincial Hospital	103km 2hours	36	3,901	2,900
Eastern	Batticaloa Provincial Hospital	309km 8hours	25	1,975	1,700
Northern	Jaffna Teaching Hospital	392km 10hours	35	3,176	2,600

The conclusion of the study team was that the eight provincial workshops should be improved successively one after another, and not at the same time. Since basic level equipment accounts for 90 percent of the amount owned by regional hospitals, improving all the provincial workshops at the same time would require the hire of 25 times more new employees. For this reason, a provincial workshop is to be established in one province for the purposes of measuring its effectiveness, acquiring know-how in operating this type of workshop, comparing the effects of the mobile workshops, and obtaining data on which future similar plans will be worked out. Meanwhile, basic medical equipment in use at the other provinces is to be maintained and managed through the mobile workshops.

3-2-4 Examination of the Project's Relationships (including overlap) with Other Assistance Projects

Besides Japan, countries extending health development assistance to Sri Lanka include Australia, UK, and Scandinavia. Through the project to improve the equipment of regional hospitals under the Government of Japan's grant aid cooperation (a 1985 grant aid project), medical equipment was supplied directly to individual medical institutions, and not through BES. Therefore BES has been unable to obtain data on the distribution and operation of the medical equipment installed at each recipient hospital. This situation has made it very difficult for BES to provide sufficient maintenance and management services. The Government of Finland provided medical equipment directly to Colombo General Hospital which opened in 1991, causing a similar problem. In organising similar projects in the future, it will be necessary to make them consistent with BES's operations -- in other words to designate BES as the official organisation to receive the medical equipment provided.

Presently, BES is conducting a survey of the operating status of medical equipment in the hospitals, with financial assistance from the World Bank. It is also implementing training programmes for engineers and foremen with

financial assistance from the WHO. While the main project is aimed at improving the hardware of the country's health system, these projects are aimed at improving its software. For this reason, it is necessary to link details of the technical cooperation programmes (such as the dispatch of experts) to these other projects.

3-2-5 Examination of the Project's Relationship with BES's Operational Programming for the Future

The degree to which BES's goals are being achieved is measured in three stages, as shown in Table 3-2-4.

In this examination, implementation of the project is considered the first stage. The second stage is when it becomes possible for BES to carry out an information management function in addition to the education/training, and research development functions -- a result of improving the training function and the central administration organisation. If the training and central administration functions are improved during the second stage, all other functons, particulary the repair function, will be strengthened. The resulting improvement in BES's functions as a whole, will make it possible to implement the third stage of its future operational programming.

Table 3-2-4 The Progress of BES Rehabilitation

Functions		Activities/Conditions		Phase		
				1st Stage	2nd Stage	3rd Stage
Procure-ment	Order · Purchase	Evaluation of equipment to be purchased	Necessity Certification	●	○	◎
			Suitability Certification	●	○	◎
		Equipment evaluation system development		●	○	◎
		Procurement system development		●	○	◎
Supply	Inspection · Accession	Acceptance testing		○	◎	◎
		Testing/Standard development		●	◎	◎
		Acceptance		◎	◎	◎
	Delivery · Installation	Delivery	Scheduling control	○	◎	◎
		Installation	Pre-installation site chodring	●	○	◎
			Completion test/Inspection	○	◎	◎
			Installation planning	×	○	◎
Repair	Preventive Maintenance · Repair	Repair	Repair of basic equipment	△	◎	◎
			Repair of middle level equipment	◎	◎	◎
			Repair of advanced equipment	●	●	△
			Regional workshop development	●	○	◎
		Trouble-shooting	Trouble shooting by center	○	△	●
			Trouble shooting by regional workshop	●	○	◎
		Component inventory control	Proper stock contral system	●	○	◎
			Component retrieval system	○	◎	◎
Records	Record Keeping	Purchases equipment information	Acceptance testing record	◎	◎	◎
			Acceptance /Delivery record	◎	◎	◎
		Equipment inventory	Trouble/Repair record	○	◎	◎
			Clinical accident record	△	◎	◎
		Repair component information	Component procurement record	◎	◎	◎
			Performance record	◎	◎	◎
	Information Management	Repair date processing system		△	○	◎
		Component information system		○	◎	◎
		Comprehensive management system		×	×	●
Inspec-tion	Periodical Inspection	Preventive maintenance	Periodical inspection	●	○	◎
		Performance/Safety cecuring	Site calibrating	●	○	◎
			Overhaul	×	●	○
Disposal	Inspection for Discard	Disposal of the medical devices being impossible to repair		○	◎	◎
		Disposal of the medical devices being unsafe		○	◎	◎
		Disposal of the medical devices older than official services life		×	●	△
		Disposal of the medical devices being not adaptable to clinical method		×	●	△
	Condemning	Disposal ratio of used components		●	●	○
Training	Education Traiing	Training for medical device repair		○	◎	◎
		Training for medical device operation		●	◎	◎
		Education for safety and reliablity		●	◎	◎
	Survey Publicity	Survey	Clinical adaptability assessment	×	△	◎
			Reference system development	×	○	◎
			Clinical accident investigation	×	○	◎
		Public information	Publication	×	○	◎
	Research Development	Accident prevention study		×	●	△
		Technical assistance to clinical/Medical activity	Technical analysis	×	×	●
			Lab. equipment development	×	×	×
		Medical device development	Device improvement	×	●	△
			Device design	×	×	×

Accomplishment Ratio: ×=0%、0%<●≤25%≤△≤50%≤○≤75%◎≤100%

3-2-6 Examination of the Facilities and Equipment Requested

The programmes involved in the project are about the enhancement of the existing institutions, hence the study team will examine requests based on policies improving the functions which have produced significant results.

(1) Colombo Centre

The project will improve three functions: a) procurement/supply, b) maintenance/repair, and c) management of records in the Colombo Centre. The existing facilities were constructed as warehouses before World War II, and are physically beyond use and repair. Furthermore, they are in many respects, functionally inconsistent with the activities carried out. For example, the workshops are too small to repair a large quantity of equipment, and the storage warehouses are too worn out to keep equipment and spare parts in good condition. It is imperative, therefore, to reconstruct many portions of the existing facilities. Table 3-2-5 gives a summary of the results of the examination of the requests. The total floor area of 3,400m^2, which the Sri Lankan side formally requested (which excludes the area of the administration and training department) is only one and half times as large as the existing facilities, and is thus, reasonable and sound.

Table 3-2-5 Examination of the Facilities Requested

Department	Existing Area	Requested Area	Result of Examination
Repair Workshop	1,015 m^2	1,200 m^2	included
Storage	1,220 m^2	2,000 m^2	included
Records Management	0	150 m^2	not included
Garage	132 m^2	200 m^2	included partially
Administration Office	373 m^2	700 m^2	not included
Training	0	1,000 m^2	not included

(2) Provincial Workshop

The Sri Lankan side has asked for the establishment of eight 250m^2 provincial workshops at Kandy Teaching Hospital, Galle Teaching Hospital, Kurunegala Provincial Hospital, Annradhapura Provincial Hospital, Badulla Provincial Hospital, Ratnapura Provincial Hospital, Batticaloa Provincial Hospital and Jaffna Teaching Hospital. Presently, there are only two workshops (Kandy and Galle), where technical staff maintain and repair medical equipment. As stated in "3-2-1 Examination of Appropriateness and Necessity of the Project", it is very important to provide medical equipment maintenance and management services for regional hospitals. However, it is still unclear which are more effective, provincial workshops or the mobile workshops. Moreover, it will be necessary to increase the number of staff 26 times in order to establish and operate eight provincial workshops at the same time, which would require enormous increase in maintenance and management costs. For these reasons, only one provincial workshop will be established under the project, as a test case, in order to evaluate feasibility of these workshops.

The study team concluded that Galle teaching hospital would be the best place for a test case, since the existing workshop at the hospital offers high quality service, and the hospital has to construct a new workshop building in the site where the hospital has recently moved.

(3) Repair and Calibration Equipment

The Sri Lankan side asked for 100 types (550 items) of repair and calibration equipment during the basic design study. The requested equipment is indispensable to repair and maintenance activities, and currently BES has little of it. Therefore the study team considers the requests as sound, and defines equipment as follows:

1) Equipment to be Consistent with the Activity Plan

As mentioned earlier, the project focuses on improving the ability to maintain and repair basic and middle level equipment. Based on this the quality and quantity of equipment should be selected.

2) Equipment Ensuring Safety and Reliability

The project must include calibration equipment in order to check repairs, and to promise safer, more reliable repair work. It must also include proper examination equipment to check the environmental conditions of the rooms where medical equipment would be placed.

3) Equipment Easily Handled and Maintained

The project must exclude equipment which the existing staff can not handle (unless the staff receives long-team training) or equipment which BES can not easily maintain.

4) Quantity to be Consistent with Repair Activities

As for the repair equipment which is to be used frequently, it will be necessary to fix the quantity of it by examining the number of staff and the workload at each relevant workshop.

3-2-6 Excluded Repair/Calibration Equipment

Item	Request	Plan	Reason
Blood pressure monitor system analysis	2	0	Not urgently needed since examinations can be conducted with pressure gauge.
Arrhythmia ECG monitor simulator	4	0	Not urgently needed since E.C.G. Monitor simulator can be used as a substitute.
X-ray tabe exchange unit	1	0	The project should exclude the replacement of X-ray tubes from the viewpoint of precision and safety.
Voltage checker	4	0	Analog multimeter can be used as a substitute.
X-ray high voltage generator and controller	1	0	Not included.

3-2-7 Examination of the Necessity of Technical Cooperation

The BES's present operational objective is to establish a system for maintenance and management of the medical equipment used at the country's public medical institutions. For this reason, BES is planning to improve the efficiency of its functions, from purchasing to the disposal of medical equipment. The basic design study team's discussions with the Sri Lankan side, and subsequent analysis has revealed that the most important technical problems involved in the implementation of this project are the introduction to BES of comprehensive management techniques. These include the management of purchase and stock, repair records, and the improvement of medical equipment repair technologies. Furthermore, Japanese technical cooperation is indispensable to this project as these management techniques and repair technologies are not easily available in Sri Lanka. It is too difficult for BES to introduce and improve them on its own.

3-2-8 Basic Policy for Implementation of Cooperation

The feasibility and anticipated effects of the project, as well as the ability of the Sri Lankan organisation to take charge of its implementation, have been proven. It has also been confirmed that the anticipated effects of this project are consistent with the objectives of the Government of Japan's grant aid cooperation system. Therefore, the outline of this project will be reviewed, and the basic design for it will be drawn up on the assumption that this project will be implemented under Japanese grant aid cooperation. However, it is considered appropriate to change parts of the content of the Sri Lankan request.

3-3 Outline of the Project

3-3-1 Implementing Organisation and Management System

(1) Implementing Organisation

The government agency responsible for the project is the Ministry of Health and Women's Affairs. Biomedical Engineering Services, a division of the Laboratory Services, is controlled by the Planning Committee whose head is the Secretary of Health and Women's Affairs.

(2) Management System

Under a director are three senior BM engineers who are expected to control these three departments: a) Procurement/Supply, b) Maintenance/Repair and c) Training. Although training is not included in the project, BES intends to work out training programmes in order to develop a concrete method of implementation. In this case the senior BM engineer from the training department should be included in the project. Fig. 3-3-1 shows the planned organisation.

(3) Staff Plan

As stated in "3-2-2 Examination of Project Implementation and Management System", it is very difficult to hire more than 100 new technical staff members at the same time. Therefore, both the Sri Lankan officials and the study team created a plan for 1993 (the time of implementation) as shown in Table 3-3-1 to be the first step of the BES staff increase. After implementation, BES will have 170 staff members (164 in Colombo Centre, 4 in southern province workshop, and 2 in central province workshop). The Ministry of Health and Women's Affairs has ensured the recruitment of staff by issuing the formal letter to Mr. Hideo Yasuki, Resident Representative, Japan International Cooperation Agency.

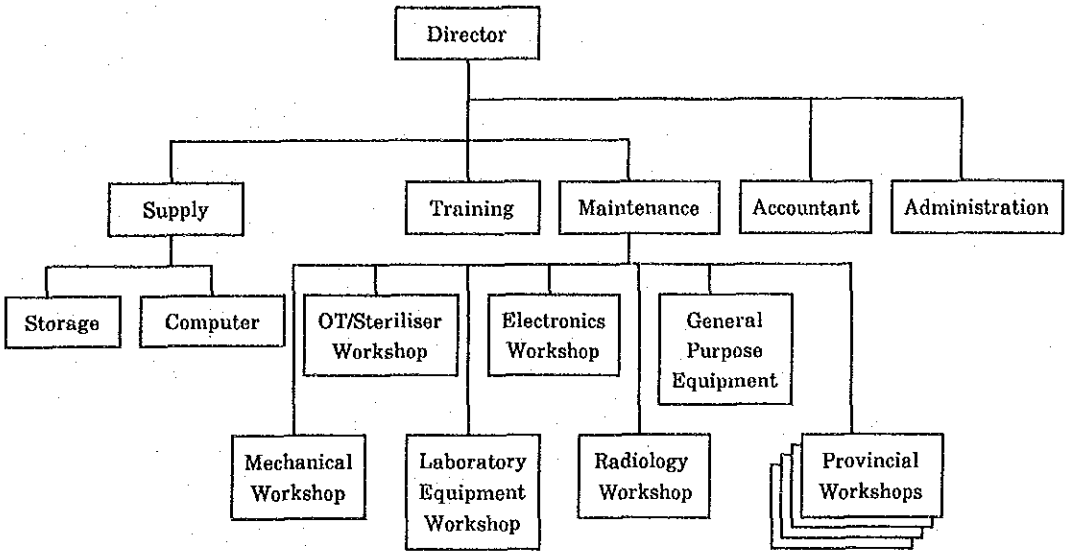


Fig. 3-3-1 The Planned Organisation of BES

Table 3-3-1(a) Examined Staff Plan for Colombo Centre

	Director	BM Engineer			Foreman	Mechanic	Store Keeper	Store-man	Driver	Labourer	Clerk/ Others	Total
		Senior	BME	Asst.								
Maintenance/Repair		1										1
Radiology W.S.			1	1	6	7				1		16
Electronics W.S.			1	1	10	6				2		20
Lab. Edquip. W.S.			1	1	4	7						13
OT/Steriliser W.S.			1		8	12				3		24
Mechanical W.S.					2	7				3		12
General-Purpose Equipment W.S.				1	8	16				4		29
Procurement/Supply		1					4	6		5		16
Training		1										1
Accountant/ Administration	1					1			15	6	9	32
Total	1	3	4	4	38	56	4	6	15	24	9	164

Table 3-3-1(b) Examined Staff Plan for the Sourthern Province Workshop

Foreman	Mechanic	Total
1	3	4

The Mechanical Workshop will support the other ones, and will not repair medical equipment directly. Hence, it will not have a full-time BM engineer. The General-Purpose Workshop will have four repair teams, each consisting of 2 foremen, 4 mechanics, and 1 labourer. An assistant BM engineer will adjust the teams. The other workshops will have 3 to 5 teams according to repair work.

The Sri Lankan side's staff plan did not take into account the staff which takes charge of maintenance of the facilities. While the maintenance and management of the electrical facilities can be contracted out to Ceylon Electricity Board (CEB), it is desirable that a full-time engineer inspects and controls the operation of the air conditioning utilities.

(4) Employment Plan

BES will employ 62 new staff members (60 for the Colombo Centre and 2 for the Southern Province Workshop) in three batches: the beginning term of 1992, the latter term of 1992, and 1993.

Table 3-3-2 Employment Plan

	Existing	Pro-motion	Beginning of 1991	Latter of 1992	1993	Total in 1993
Senior BM Engineer					3	3
BME, Assistant BME	6	2		1		9
Foreman	18+1*	▲2	7	9	6	38+1*
Mechanic	37+1*		5	4	10+2*	56+3*
Storekeeper, Storeman	4			6		10
Driver	11		4			15
Labourer	19			3	2	24
Cleark/Others	9					9
Total	104+2*		16	23	21+2*	164+4*

*: Southern Province Workshop

The BES's regulations requires a BM engineer to have a Bachelor of Science, a foreman must have NDT (National Diploma in Technology), and

a mechanic must have a degree of N.A.I.T.A. (National Apprenticeship and Industry Training Authority). Table 3-3-3 shows the number of annual graduates of each course.

Table 3-3-3 Number of Annual Graduates

	Electronics	Electrical Engineering	Mechanical Engineering	Total
B. Sc degree	60	70	80	210
NDT	35	35	40	110
NDT (Open University)	25	25	50	100
NAITA				300

Besides new graduates, qualified personnel working in private companies can also apply for BES. The employment plan, under which BES will hire 6 to 9 foremen, and 4 to 10 mechanics annually, is feasible.

(5) Staff Training Plan

Table 3-3-4 shows employment plan of Maintenance/Repair Department.

Table 3-3-4 Employment plan of Maintenance and Repair Department.

Workshop	Designation	Existing	Beginning of 1992	Latter of 1992	1993	Total of New Employees	Total in 1993
Radiology	BME. Assistant BME	1*		1		1	2
	Foreman	3	2	1		3	6
	Mechanic	4	1		2	3	7
Electronics	BME. Assistant BME	2					2
	Foreman	2	3	3	2	8	10
	Mechanic	2	2	1	1	4	6
Laboratory	BME. Assistant BME	1+1*					2
Equipment	Foreman	1		1	2	3	4
	Mechanic	1		2	4	6	7
OT/	BME	1					1
Steriliser	Foreman	6		2		2	8
	Mechanic	12					12
Mechanical	Foreman				2	2	2
	Mechanic	4			3	3	7
General-	Assistant BME	1					1
Purpose	Foreman	4	2	2		4	8
	Mechanic	14	2			2	16

*: Promotion

BES already has skilled staff who repair OT/sterilsing equipment, and thus will hire new staff members according to the increase in repair jobs. Therefore, On-the-Job training is the most appropriate way to train new employees. The General-Purpose Workshop will hire all staff members by 1993, and will accomplish the designed target in 1994.

However, BES has an insufficient number of staff for the Radiology, Electronics, and Laboratory Equipment Workshops, and will thus hire 28 new technical staff members. Training these new staff members can cause a deterioration in repair activities, making Japanese technical cooperation indispensable.

3-3-2 Activity Plan

The project activity plan has three functions: (1) procurement/supply, (2) maintenance/repair, and (3) management of records.

(1) Procurement/Supply

BES is responsible for the procurement and supply of medical equipment to public medical institutions, as well as the procurement of spare parts and consumable goods required for maintenance and management of medical equipment.

1) Purchase/Ordering

BES will send some of its staff members to the Technical Advisory Committee (TAC), which examines hospital requests for the purchase of medical equipment, and, to the Technical Specification Formulation and Evaluation Committee (TSF & EC), the organisation that prepares tender documents and technical specifications. Based on their experience in maintenance and management of medical equipment, this staff may give advice on technical aspects. For example, they can oversee the purchase of medical equipment,

assessing the records of wonership, repair, etc., to ensure its more proper introduction and distribution.

2) Acquisition/Inspection

BES will inspect large-size equipment which must be installed in hospitals, plus all other items at the Centre.

a) Quantity Examination

Confirmation of the number of pieces of medical equipment, accessories, and optional components ordered.

b) Form Examination

Confirmation of forms, types, and assigning control numbers.

c) Performance/Function Testing

Testing of medical equipment delivered to see if their performance and function are consistent with the specifications.

3) Sorting/Storage

a) Purchased Medical Equipment

BES will store delivered equipment purchased in bulk, and the equipment which is to be installed at the hospitals, until the hospitals can make the necessary preparations. Therefore, it is necessary to establish an inventory management system of sorting out medical equipment according to the department concerned, as well as the type of equipment and distribution area to ensure more prompt delivery. The maximum quantity of equipment which can be stored at BES's warehouse is about 350m^3.

b) *Spare Parts/Consumable Goods*

BES will classify and store all spare parts and consumable

goods in three sections. This system is expected to offer easier access and faster distribution. The total number of spares and goods is estimated at 1,000 types (100,000 pieces) and the total volume is estimated at 65m3 for each storing section.

4) Delivery/Installation

The supplier's contract for large-size medical equipment generally includes installation and a test run at the hospital where the equipment is installed. BES engineers should accompany the supplier and supervise the work. Following this they should instruct users on its operation and daily maintenance. BES will inspect other items of medical equipment at the Centre and deliver them to hospitals.

(2) Maintenance/Repair

1) Preventive Maintenance

Preventive maintenance is practiced by a) daily users, and b) technical staff. However it would be desirable if the daily users had sufficient knowledge of the medical equipment so that the help of technical staff would not be required so often.

a) Daily Inspection by the User

Although the project excludes training activities, BES should conduct training at one or two model hospitals as a test. This not only will provide users with knowledge of daily maintenance, but will also provide necessary data for extending the training programme. Further, the test will prepare manuals and check lists with which users can check the functions of the medical equipment.

b) Preventive Maintenance performed Technical Staff

Two mobile workshops will make rounds of designated hospitals,

twice a year, to repair breakdowns and inspect the state of basic level equipment. In addition to this, other workshops will regularly conduct preventive maintenance on some middle level equipment such as high pressure strerilisers, electrosurgery units, ventilators, and laboratory equipment. Preventive work should be conducted as soon as possible.

2) Repair

The repair target of each equipment level is:

- Basic level:
  Both the General-Purpose Workshop and mobile workshops will repair 6,000 breakdowns a year. This includes breakdowns which require major repairs and overhauls as well as minor repairs.

- Middle level:
  Each workshop is to repair almost all breakdowns of relevant medical equipment, but is to exclude breakdowns which require advanced repair techniques, or special repair equipment. Four workshops: OT/Steriliser, Laboratory Equipment, Electronics, and Radiology Workshops, are expected to repair 4,000 breakdowns in all per year.

- Advanced level:
  BES will obtain maintenance contracts from manufacturers for the maintenance of C/T scanners, gamma cameras and angiography units. As for other advanced equipment, BES will be responsible for the replacement of certain parts and troubleshooting. It will also place orders for higher outside technical repairs.

Table 3-3-5 arranges the targets according to level and area.

Table 3-3-5 Number of Repair Targets

Area	Western Province	Southern Province	Others	Total
No. of Breakdowns				
Basic Level	3,000	800	4,600	8,400
Middle Level	1,500	400	2,400	4,300
Advanced	–	–	–	–
Total	4,500	1,200	7,000	12,700
No. of Repairs (Target)				
Basic Level	2,700 (Colombo Centre)	800 (Provincial WS)	2,500 (Mobile WS)	6,000 (1,939)
Middle Level	4,000 (Colombo Centre)			4,000 (2,360)
Advanced	–			– (56)
Total				10,000 (4,355)

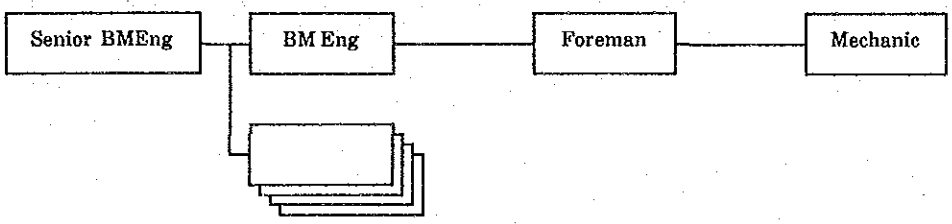


Fig. 3-3-2 Organisation of Repair Work

Each workshop consists of a BM engineer, 4 to 10 foremen, and 6 to 12 mechanics. The foremen are to repair breakdowns with the mechanics, and to train mechanics on the job. The BM engineer is to supervise all repair jobs and to produce regular reports. The senior BM engineer, as a head of the department, is to control all workshops.

a) Radiology Workshop

To be repaired medical equipment:

Basic X-ray, mibile X-ray unit, fluoroscopic I.I. unit, mobile X-ray C-arm, X-ray unit dental, film auto processor, etc.

Repair work:

① Repairs and replacement of spare parts in the power supply unit and the high-tension generators.

② Adjustment and repairs of controls (primary voltage, exposure to radiation, X-ray tube peak current, etc.) and replacement of relay electronic parts in signal circuits which are very likely to breakdown.

③ Adjustment and calibration of the voltage and current of X-ray tube units.

④ Replacement of X-ray tube units in case of filament breakdown.

⑤ Repairs of radiation shields by measuring radiation leaks.

b) Electronics Workshop

To be repaired medical equipment:
ECG recorder, ECG monitor, EEG recorder, EMG recorder, Ultrasound scanner, defibrillator monitor, infusion pump, fetal heart detector, shortwave therapy unit, ultrasonic therapy unit, tread mill, audio meter, blood gas analyser, Na/K electrolyte analyser, electronic balance, etc.

Repair work:

① Replacement of spare parts for power supply units, rectification circuits, and stabilisation circuits, particularly, the replacement of damaged spare parts in the three-terminal regulators and power transistors.

② Replacement of damaged electronic elements on electronic substrates through measuring analog electronic circuits.

③ Identification of the damaged electronic substrates through measuring digital electronic circuits. Ordering new ones.

④ Adjustment of breakdowns of sensors, probes, electrodes and oscillators, where electrical energy is converted into physical mass, and replacing of the spare parts.

c) Laboratory Equipment Workshop

To be repaired medical equipment:
Electric centrifuge, hot air steriliser, laboratory incubator, colorimeter, flame photometer, electrophoresis unit, vertical autoclave, tissue embedding unit, wax bath, infra red lamp, etc.

Repair work:

① Repairs and replacement of spare parts in power supply units, transformers, rectification circuits and stabilisation circuits.

② Identifying the damaged parts of analog circuits, oscillation circuits, receiving circuits, output circuit, amplification circuits and control circuits. In particular, identifying the damaged electronic elements on electronic substrates.

③ Replacing spare parts, damaged motors, heaters and lamps.

④ Repairs and replacement of spare parts, and greasing of precision components.

d) Operation Theatre/Steriliser Workshop

To be repaired medical equipment:
Anaesthetic unit, ventilator, operation theatre table, electrosurgery unit, nebuliser, oxygen tent, infant respirator vacuum extractor, endoscope, plaster cast cutter, high

pressure steriliser, slit lamp, ENT equipment, dental unit air rotar hand piece scale, ultra low freezer, etc.

Repair work:

① Repairs of simple breakdowns.

② Repairs of power supply units and electrical circuits.

③ Replacement of the damaged repair parts of electronic control units and substrates.

④ Adjustment and replacement of spare parts, and the overhaul of mechanical components.

⑤ Welding and reinforcing of the damaged components.

e) General-Purpose Equipment Workshop

The Colombo Centre will be responsible for repairs of medical equipment in and around the city of Colombo, while the mobile workshops will handle those outside the city.

To be repaired medical equipment:
Sphygmomanometer, instrument steriliser, OT lamp, examination lamp, photo therapy unit, water distiller, water bath, etc.

Repair work:

① Replacing spare parts and overhaul.

② Repairs of simple electrical breakdowns such as deterioration of power supply units, internal wirings, and electric leaks.

③ Cleaning and adjustment of stained or logged components.

④ Welding, riveting, painting and other processing of damaged materials.

f) Mechanical Workshop

This workshop will support the other workshop's repair activities.

① Producing and processing nuts and bolts.
② Lathe work.
③ Pressing work.
④ Welding work.
⑤ Painting work.
⑥ Rewinding motors.

Mechanical components of operation theatre tables and boilers will also be repaired at this workshop.

The targeted annual number of repairs for the Southern Province Workshop is about 800. The workshop will also be responsible for the maintenance and management of mostly basic equipment used at all hospitals within the province.

(3) Management of Records

1) Records of Medical Equipment Owned and Their Repair

At the time of delivery of the medical equipment, a control number will be attached to each piece, and their records will be managed on the basis of their control numbers. On the control sheet for each piece of equipment will be listed the control number, the name of the hospital, the name of the department, the date of the first use of the equipment, the terms of warranty, the name of the manufacturer, the name of the distributor, the name of the person in charge, and so on. When repair work is completed, details of

the breakdown, repair work done, and a list of spare parts and their respective prices will be recorded on the sheet. Thus it will be possible to obtain all the necessary data on each piece of equipment through the control sheet. Since information concerning the type of equipment, records of previous repair, and unique features of the equipment will be easily obtained by using the control sheet, the repair work itself will become more efficient. In the future, a database, storing all records of equipment breakdown and repair work, can be developed, and used to evaluate the placing of orders and purchases.

2) Inventory Control

a) Medical Equipment Purchased

Mainly an inventory control of medical equipment purchased in bulk. After collation of a hospital's requests with the list of items in stock, those items are delivered.

b) Spare Parts

A database storing information on about 300,000 spare parts will be developed. This promises a more effective control of inventory. A list of spare parts which are used most often will also be prepared. This data will be used to aid the purchase of spare parts.

3-3-3 Location and Present Condition of the Project Site

(1) Colombo Centre

1) Location of the Project Site

The site for the Colombo Centre will remain the same as that of the present Centre. It is situated in the Maradana District of the central part of Colombo. The Colombo General Hospital, the Eye Hospital, and the National Tuberculosis Research Institute are near the project site. The central warehouse of the Medical Supplies Division (constructed in 1986 under the grant aid project of the Government of Japan) and the Drug Quality Assurance Laboratory (constructed in 1988 under the aid project of the Government of Norway) are located in an adjacent area. The project site is only about 300 meters away from Colombo General Hospital, where the demand for maintenance and management of medical equipment is the highest. Its location is also convenient for communication with MSD and other related organisations. For these reasons, the site for the Colombo Centre is considered very appropriate.

2) Present Condition of the Project Site

The project site faces Deans road on the east, De Saran Place on the south, and the National Tuberculosis Research Institute on the north side. It has a total land area of 5,600m^2. However, its shape is irregular having an elbow-shaped bend near the northern boundary with the National Tuberculosis Research Institute. Therefore it is very difficult, to construct a building with a regular shape on the site. As a result of the discussion between the Sri Lankan side and the basic design study team (during the basic design study), it was concluded that the best idea would be to dismantle the existing Workshop/Storage, and the Mechanical

Workshop Buildings (combined total floor area: about 2,100m^2) and to build the proposed facilities on the site of the demolished buildings. During the construction work of the proposed facilities, a warehouse facing Francis Road, which used to serve as MSD's central warehouse, will be used temporarily as a workshop/warehouse. Table 3-3-6 shows a list of the facilities to be demolished before the start of construction of the proposed facilities.

Table 3-3-6 Existing Facilities to be Demolished

Name of Building	One-storey steel frame	Floor Area
Workshop/Storage Building	One-storey steel frame	1,134 m^2
Mechanical Workshop Building	〃	426 m^2
Purchased Equipment Warehouse	〃	348 m^2
Condemned Equipment Storage	〃	126 m^2
Garage	〃	84 m^2
Total		2,118 m^2

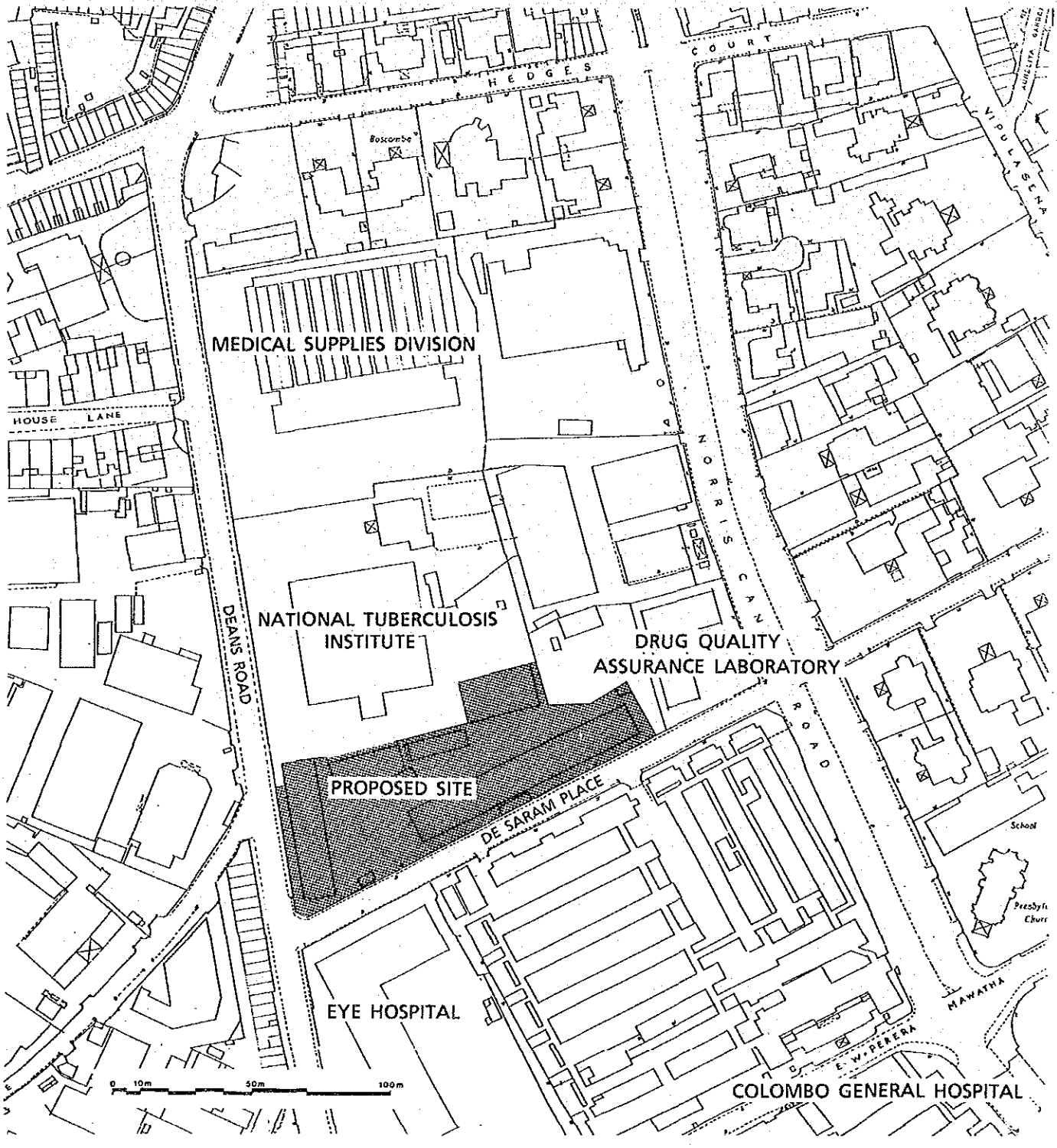


Fig. 3-3-3 Location of the Site

3) Present Condition of the Infrastructure around the Site

a) Electricity

A three-phase, three-line 11kV high-tension cable of the Ceylon Electricity Board (CEB) is laid underground near De Saram Place. As the existing facility's power receiving capacity is superannuated, a new cable is to be laid under this project. This will require the installation of a high-tension current breaker plus a substation (11kV/400V-230V 400kVA). Currently a long power failure will occur two to three times a month, and short power failures will occur frequently every day. Moreover, the voltage in not constant. The existing facilities receive electricity from a CEB substation located near the site's boundary, but the current surplus power is 80kVA, which is relatively low.

b) Telephone

There is a telephone cabinet on Deans Road, from which a PVC/SWA/PVC/telephone cable (20P×0.5mm) leads into the site. The existing facilities have a four-circuit telephone line and a direct line connecting with Colombo General Hospital.

c) Water Supply

A water main with a diameter of 32mm is laid underground near De Sarma Place. At present, city water is stored in a $3m^3$ tank, from which all the buildings on the site are supplied. The water supply pressure is low at about $0.5kg/cm^2$. The quality of the city water is not good, having a high degree of turbidiness. Also, many colon bacilli are found in the water.

d) Sewage System

Sewage from the existing facilities is discharged into a sewer with a diameter of 32.5mm which is laid underground near De

Saram Place. Rainwater is discharged into a drain ditch at the southwestern corner of the site.

e) City Gas

There is a gas main with a diameter of 200mm, laid under Deans Road and another one with a diameter of 75mm under De Sarma Place. Gas can be led into the site from either one. The supply pressure is 75mmAq, and the heat capacity is 600BTU/cut. Since the quantity of city gas consumed at the existing facilities is very limited, butane gas is used (LP gas cylinders are purchased from Colombo City Gas Corporation).

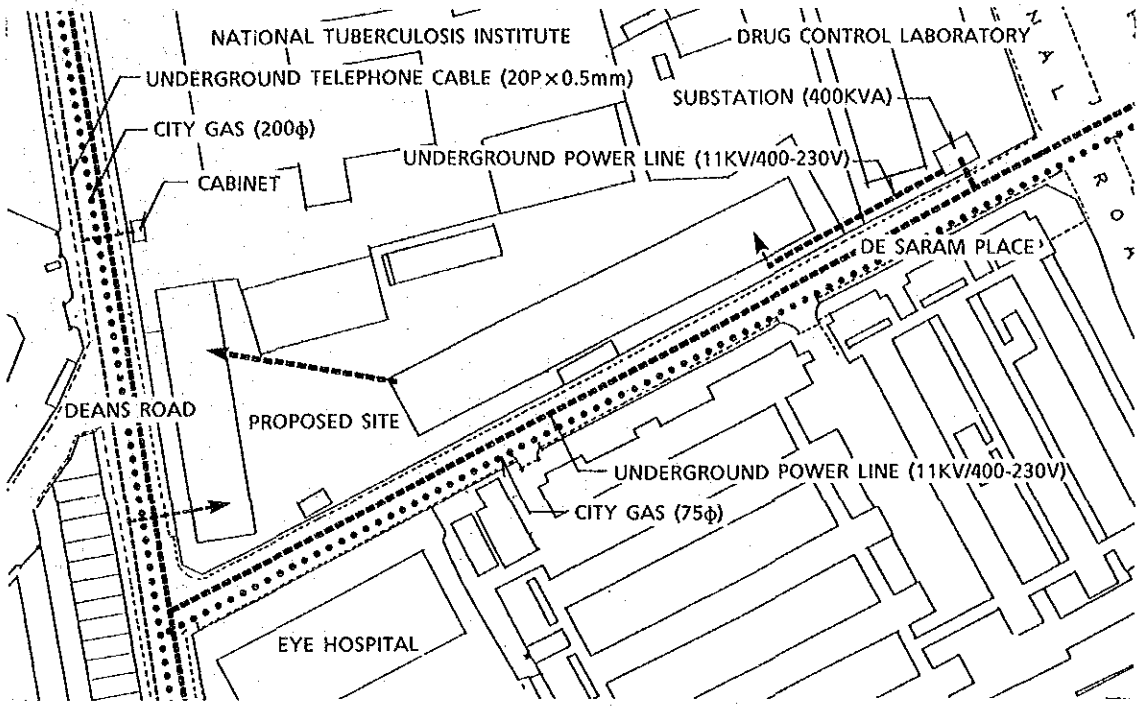


Fig. 3-3-4 (a) Condition of Electricity and Telephone

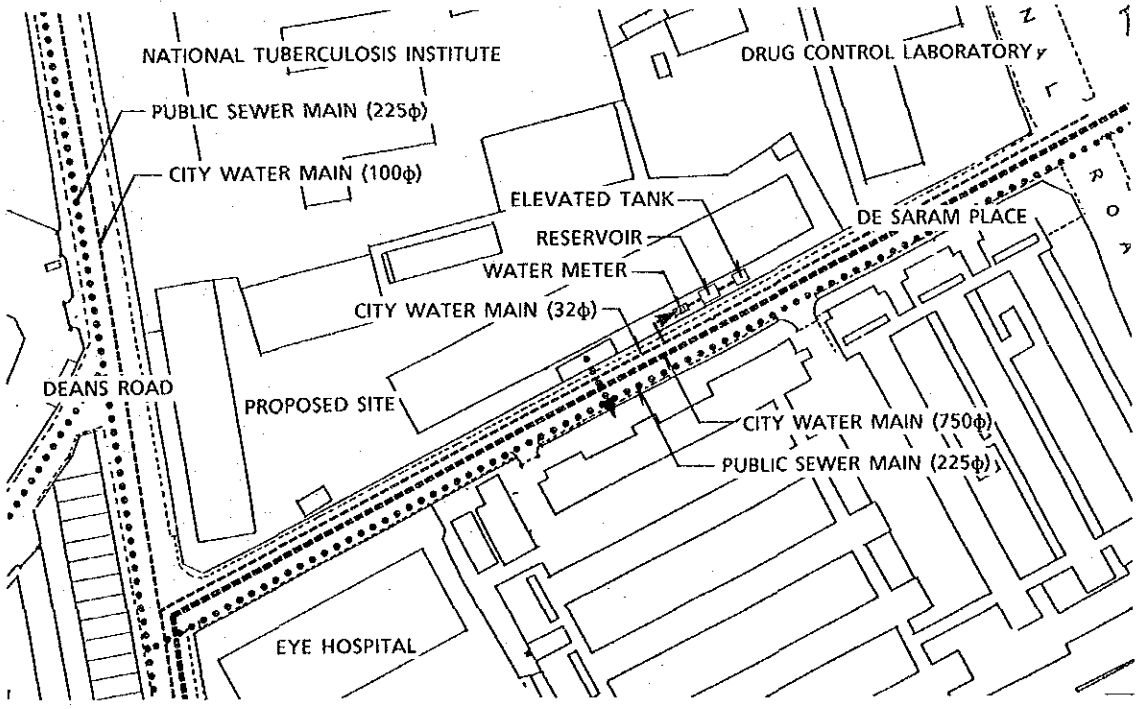


Fig. 3-3-4 (b) Condition of Water Supply and Sewage Systems

(2) Southern Province Workshop

1) Location and Present Condition of the Project Site

The site for the Southern Province Workshop is located on the premises of the Galle Teaching Hospital, in the city of Galle. The old facilities of the teaching hospital built along the coast, have been superannuated, and heavily damaged by the briny air. In 1985, the hospital moved gradually to the new site located on a hill. The new facilities became operational in March 1991. Two lots (one located on the western side of the hospital, and the other adjacent to the site of the Building and Repairs Department on the eastern side) had been proposed as the site for the new workshop, and it was concluded that the latter is best suited to the objective of this project in terms of facility expansibility and path of flow.

2) Present Condition of the Infrastructure

a) Electricity

Galle Teaching Hospital has two electricity receiving facilities -- one (630kVA transformer) near the site of the Central Material department, and the other (250kVA transformer) on the site for the new provincial workshop. Both have a sufficient capacity to meet the current demand for electricity. However, the latter's capacity is to be increased to 500kVA in anticipation of a growing future demand. Since the proposed provincial workshop is designed for a maximum electric capacity of 50kVA, either of the two transformers will be sufficient for this project.

b) Water Supply

An elevated water tank, with a capacity of 20 tons, is situated on a hill within the hospital premises, and supplies

all the facilities. There seems to be no problem with the quantity of water or the water pressure.

c) Sewage System

A sewage treatment plant, located on the western side of the project site, is used for final sewage treatment. There is also a primary septic tank installed near the toilet in each building. Sewage goes in the treatment plant after passing through these primary septic tanks. Similar primary septic tanks should be installed under this project. Rainwater is discharged into the river through drain ditches.

3-3-4 Outline of the Facilities and Equipment

The facilities and equipment which the project includes as a result of examination described in "3-2-6 Examination of the Facilities and Equipment Requested" are as follows:

(1) Facilities

1) Maintenance/Repair Department (Requested Floor Area: 1,200m^2)

The department will have the following six workshops:

- Radiology workshop
- Electronics workshop
- Laboratory equipment workshop
- Operation theatre/sterilising equipment workshop
- Mechanical workshop
- General-purpose equipment workshop

As these workshops differ from each other in terms of room function, maximum permissible noise/vibration levels, and indoor temperature/ humidity conditions, each workshop will be provided with an independent room. In addition, there will be rooms where

the engineers and foremen can carry out desk work, and a room to store expensive repair and medical equipment.

2) Procurement/Supply Department (Requested Floor Area: 2,000m^2)

The medical equipment purchased and spare parts will be stored in separate warehouses so that both types of equipment may be sorted and stored efficiently. The spare parts storage will be divided into three sections: "general-purpose/operating theatre, steriliser" section, "electronics/laboratory equipment" section, and "radiology/mechanical engineering" section, for rational inventory control and warehousing. There will also be an office room for use in inventory control-related desk work, and an inspection testing room.

3) Garage (Requested Floor Area: 200m^2)

Although the total floor area of 3,400m^2 (excluding the floor area of the administration building and the training centre) shown in the Government of Sri Lanka's written request is suitable for the scale of this project, it is a net floor area which does not include area for the corridors and a machine room. For this reason, the actual total floor area will include area for the corridors, the machine room, and toilets.

(2) Equipment

1) Maintenance/Repair

a) Radiology Workshop

- Radiological equipment repair/adjustment equipment.
- Radiological equipment calibration/examination equipment.
- Radiation leak measurement equipment.
- Equipment installation equipment.

b) Electronics Workshop

- Electronic equipment repair/adjustment equipment.
- Electronic equipment calibration/examination equipment.
- Measuring instrument examination equipment.
- Use conditions measurement equipment.

c) Laboratory Equipment Workshop

- Laboratory equipment repair/adjustment equipment.
- Laboratory equipment calibration/laboratory equipment.
- Physical therapy equipment repair/adjustment equipment.
- Physical therapy equipment calibration/laboratory equipment.
- Use conditions measurement equipment.

d) Operation Theatre/Steriliser Workshop

- Operation theatre equipment repair/adjustment equipment.
- Operation theatre equipment calibration/examination equipment.
- Sterilising equipment repair/adjustment equipment.
- Sterilising calibration/examination equipment.
- Dental equipment repair/adjustment equipment.
- Power supply environment measurement equipment.
- Equipment installation equipment.

e) General-Purpose Equipment Workshop

- Mobile Workshops.
- General-purpose equipment repair/adjustment equipment.
- General-purpose equipment calibration/examination equipment.
- General-purpose equipment processing equipment.

f) Mechanical Workshop

- Material processing equipment.
- Material painting equipment.

- Large-size medical equipment repair equipment.
- Motor vehicles.

g) Transportation

- Motor vehicles.

2) Procurement/Supply Department

- Medical equipment transportation equipment.
- Medical equipment sorting out/storing equipment.
- Components sorting out/storing equipment.
- Components management equipment.
- Expendable storing equipment.
- Large-size medical equipment transportation equipment.

3) Management of Records

- Personal computer for use in inventory control.

3-3-5 Maintenance and Management Plan

(1) Staffing and Budget

In Sri Lanka, the salaries of government employees are stipulated in a salary scale adopted by the Salaries and Cadre Commission. As mentioned in "3-3-1 Implementing Organisation and Management System", the planned total number of staff members at the time of implementation of the project is 164. However, staff salaries are broken down into basic salaries and periodical pay increases, which are determined according to educational background and job performance. At present, BES's senior BM engineer's salaries are kept lower than their counterparts working in other government agencies. In this project, their salaries will be raised to the same level as

their counterparts. Table 3-3-7 shows a listing of job-classified basic salaries.

Table 3-3-7 Personnel Allocation Plan

Designation	Salary scale	Salary (Rs/man·year)			No. of Persons
		Minimum	Raise/a year	Ceiling	
Director	R10-5	96,000	6,000	144,000	1
Senior Engineer	R10-3	55,200	2,400	72,000	3
Engineer	R10-2	42,000	1,800	54,000	4
Assistant Engineer	R5-1	36,000	1,200	54,000	4
Foreman	R3-4	25,200	900	33,900	18
Foreman	R3-1	19,440	600	28,800	20
Mechanic	R2-2	19,680	480	28,800	49
Painter · Welder	R2-2	19,680	480	28,800	7
Storekeeper	R2-5	22,560	600	33,000	1
Storekeeper	R2-1	16,800	480	27,600	3
Storeman	R1-1	15,000	360	22,200	6
Accountant	R5-1	36,000	1,200	54,000	1
Administrative Officer	R3-6	28,800	900	39,300	1
Clerk	R2-5	22,560	600	33,000	1
Clerk	R2-2	19,680	480	28,800	4
Stenographer	R2-5	22,560	600	33,000	2
Driver	R2-1	16,800	480	27,600	11
Driver	R1-4	16,560	480	27,600	4
Labourer	R1-1	15,000	360	22,000	24
Total					164

(2) Maintenance and Management of the Facilities

Maintenance and management of the facilities is divided into: 1) operation of the facilities, 2) maintenance of the facilities, and 3) repair of the facilities. The following points should be noted so

that more efficient maintenance and management may be carried out within the framework of limited budgetary appropriations.

1) Operation of the Facilities

Only those rooms in which air conditioning is indispensable will be air-conditioned. Moreover, a partial on/off control system will be adopted so that each room's air conditioning may be controlled optimally according to its load. Other measures such as natural lighting will also be used in order to minimise energy costs.

2) Maintenance of the Facilities

Maintenance activities such as cleaning, routine inspection, and safety measures will maximise the facilities functions and safety, and will lead longer, useful lives. For this reason, it is necessary to establish an efficient maintenance system as well as creating proper and effective inspection/maintenance standards. It is desirable that supervision of the operation and inspection of the air conditioners should be carried out by the mechanic in charge. Maintenance of the elevators, which do not require frequent inspection, should be contracted out to an elevator maintenance service company.

3) Repairs

Repair work can be divided into: Repair of damaged or defective portions of the equipment, and Remodeling of the facilities. Regarding the repair and remodeling, right after completion of the building, it will be possible to commission the Central Engineering Consulting Board to do design and supervision of the repair/remodeling work.

(3) Maintenance and Management of the Equipment

Maintenance of the equipment is divided into: 1) cleaning of the equipment, 2) inspection/tuning of the equipment, 3) replacement of equipment, and 4) repairs. The equipment to be used at these workshops is basic repair/examination equipment. Since BES's senior BM engineers are those specialising in repair technologies, most items of equipment can be repaired by the users themselves.

(4) Tentative Calculation of Maintenance and Management Costs

Tentative calculation of the costs for maintenance and management of the proposed facilities was carried out by the Sri Lankan side.

1) Personnel Expenses: 5,605,000 Rs/year

① Basic Salaries

Table 3-3-8 shows a breakdown by salary scales of the total number of employees.

Table 3-3-8 Total of Basic Salaries

Salary scale	Annual Salary (Rs)	No. of Person	Total (Rs/year)
R10-5	96,000	1	96,000
R10-3	55,200	3	165,600
R10-2	42,000	4	168,000
R5-1	36,000	5	180,000
R3-6	28,800	1	28,800
R3-4	25,200	18	453,600
R3-1	19,440	20	388,800
R2-5	22,560	4	90,240
R2-2	19,680	60	1,180,800
R2-1	16,800	14	235,200
R1-4	16,560	4	66,240
R1-1	15,000	30	450,000
Total (Annual salary)		164	3,503,280

② Special Salaries

Special salaries include travel allowance and other allowances. On the basis of the individual employee's past achievement, special salaries equivalent to about 60 percent of the amount of salaries are paid.

On the basis of ① and ② above, the annual personnel expenses were calculated as follows:

3,503,280(Rs/year) × 1.6 ≒ 5,605,000 Rs/year

2) Cost for Operation of the Facilities: 1,390,900 Rs/year

Table 3-3-9 shows an itemised breakdown of the total cost of maintenance and management of the facilities.

Table 3-3-9 Facilities Operation Cost

Items	Expenses (Rs/year)
Electricity charges	1,096,000
Telephone charges	122,000
LP gas charges	2,800
Fuel expenses (Generator)	18,000
Water charges	152,100
Total	1,390,900

The means for the calculation of charges and expenses as shown in the above table are as follows:

① Electricity Charges

Calculation of electricity charges was done on the assumption that about 40 percent (204kW) of the total load capacity of the equipment (about 510kW) will be the maximum power consumption.

Table 3-3-10 Power Consumption

Items	Load (Kw)	Power consumption	
Lighting	50	50kW×0.2×8h/day ×260days/year=	20,800 kW Wh/year
Air-conditioning/ Ventilation	170	170kW×0.4×8h/day ×260days/year=	141,440kW Wh/year
Sanitary	10	10kW×0.2×24h/day ×365days/year=	17,520kW Wh/year
Equipment	250	250kW×0.1×8h/day ×260days/year=	52,000kW Wh/year
Others	30	30kW×0.1×8h/day ×260days/year=	6,240kW Wh/year
Total	510		238,000kW Wh/year

- Calculation of electricity charges

  Base rates (demand rates):

  204kVA×150Rs/kW·12M/Y= 367,200 Rs/Y

  Fixed rates:

  240 Rs/M×12M/Y= 2,880 Rs/Y

  Unit rates:

  238,000kW/Y×3.05Rs/kWh= 725,900 Rs/Y

  Total: 1,095,980 Rs/Y ≒ 1,096,000 Rs/Y

② Telephone charges

Calculation of the annual telephone charges was carried out as follows:

- A total number of calls (20,000) was chosen as the standard number based on the assumption that the average number of calls (less than 3 minutes) per repair work is 2 and the target total number of repairs is 10,000.

Calculation of telephone charges

- Base rates: 400 Rs/line·M×10×12M/Y= 48,000 Rs
- Charges: 3.7Rs×2/1×10,000/Y 74,000 Rs

  Total: 122,000 Rs/Y

③ LP Gas Charge

Calculation of LP gas charges was conducted based on LP gas consumption at the pantries.

- Gas heaters 2 units LP gas consumption: 4,000 kcal/kg

- Rate of demand: 8 hours/day, 10 percent for burners.
  LP gas calorific value: 11,670 kcal/kg
  unit price per 40kg (cylinder): 774 Rs/40kg

- 2 units×4,000kcal/h unit×0.1×8h/D×260D/Y= 1,664,000 kcal/Y
  (1,664,000kcal/Y ÷ 11,670kcal/kg)×(774Rs/40kg)≒ 2,800Rs/Y

④ Fuel Expenses

Calculation of fuel expenses was carried out on the assumption that the generator will be operated for four hours per month.

150kVA×1.2Ps/kVA×0.165kg/Ps·h×(1/0.87kcal/ℓ)×4 h/month ×
12months/Y× 11Rs/ℓ= 18,025 Rs/Y ≒ 18,000 Rs/Y

⑤ Water Charges

Daily water consumption:
200 persons×150ℓ/person day = 30,000ℓ/day

Calculation of water charge:
30,000ℓ/day×260days×19,5Rs/1,000ℓ≒ 152,100Rs/Y

3) Maintenance Expenses: 1,331,500 Rs/year

① Facility Maintenance Expenses
Calculation of facility maintenance expenses is conducted on the assumption that the average annual maintenance expense per

unit floor area for 20 years is 40Rs/m^2, although actual expenses differ widely from one year to the next.

40Rs/m^2×4,000m^2=160,000Rs/Y

② Utility Maintenance Expenses

Electrical equipment, water supply/drainage equipment, and air conditioning equipment require component replacement and repairs. Calculation of equipment maintenance expense is conducted on the assumption that the average annual equipment expense per unit floor area for 20 years is 60Rs/m^2.

60 Rs/m^2×4,000m^2=240,000Rs/Y

③ Elevator Maintenance Expenses

Maintenance of the elevator will be contracted out to its agency. Annual maintenance contract charges: 50,000Rs/Y

④ Repair Equipment Maintenance Expenses

- Dry cells for use with measuring equipment: 42,500Rs/Y
- Consumable supplies for measuring equipment: 140,000Rs/Y
- Consumable supplies for mechanical engineering: 200,000Rs/Y

Total: 382,500Rs/Y

⑥ Vehicle Maintenance Expenses

Average annual distance covered:

Mobile Workshop	:	10,000km × 2cars =	20,000 km
Diesel Engine	:	20,000km × 10 cars =	200,000 km
Gasoline Engine	:	16,000km × 1car =	16,000 km

- Maintenance Costs

A 1,500Rs maintenance will be conducted with every 2,000km.

Mobile workshop	:	1,500Rs×5times×2cars =	15,000 Rs
Diesel Engine	:	1,500Rs×10times×10cars =	150,000 Rs
Gasoline Engine	:	1,500Rs×8times×1car =	12,000 Rs
			177,000 Rs

- Fuel Costs

Fuel : Diesel : 11Rs/ℓ, Gasoline : 25Rs/ℓ

Mileage : Diesesl : 10km/ℓ, Gasoline : 6km/ℓ

Mobile workshop(Diesel):	11Rs×1,000ℓ×2cars =	22,000 Rs
Diesel Engine :	11Rs×2,000ℓ×10cars =	220,000 Rs
Gasoline Engine :	25Rs×3,200ℓ×1car =	80,000 Rs
		322,000 Rs

Total : 177,000+322,000 = 499,000 Rs/Y

Thus, the total maintenance expenses are:

Personnel expenses	5,605,000 Rs
Operating expenses	1,390,900 Rs
Maintenance expenses	1,331,500 Rs
Total	8,327,400 Rs

3-4 Technical Cooperation

As the most important problem likely to be faced in implementing this project is the difficulty in locally procuring comprehensive administration technologies and equipment repair technologies (both of which are indispensable in attaining the objective of this project), it is considered reasonable to implement technical cooperation in the above-mentioned two areas. The Government of Sri Lanka is fully aware of the necessity and importance of such technical cooperation, and has already made a request for part of such technical cooperation to the Government of Japan. Details of the implementation of such technical cooperation are to be decided by both governments after submission of a request by the Government of Sri Lanka. In light of the contents of this basic design study and the proposed schedule for the implementation of this project, the following technical cooperation projects are considered very important:

Table 3-1-1 Proposed Technical Cooperation Schedule

Technical Field	Term	No. of Person
1. Expert Dispatch Programme		
1) Management		
• Management system	1 month at opening	1
• Management control	1 year from opening	1
2) Maintenance/Repair (Management)	2 years from 6 month before opening	1
3) Repair (Technology)		
• X-ray equipment	4 months	1
• OT & ICU equipment, (Electrosurgery unit, Ventilator, Nebuliser etc.)	1 month	1
• Lab. equipment (Flame photometer, Spectorphotometer)	1 month	1
• Microscoep & Slit lamp	1 month	1
• Electronics	3 months	1
2. Trainee Acceptance Programme *		
• OT & ICU equipment	1 month	1
• Lab. equiment	1 month	1
• Microscope	1 month	1
• Electronics	1 month	1
• Dental equipment	1 month	1
• Ultra low freezer	1 month	1

* Items of the programme are listed in order of priority.

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Design Policy

The main objective of this project is to improve the quality of services provided by Biomedical Engineering Services (BES) -- the country's sole organisation responsible for supply and maintenance of medical equipment, and whose target is to keep all medical equipment in good condition. Programmes regarded as most urgent are made up of three functions: a) procurement/supply, b) maintenance/repair, and c) management of records. These are transformed into facilities based on the following policies:

(1) Land Use to Cope with the Programme

Both an existing building, which contains administration and training functions, and the proposed facilities, which will contain the above mentioned three functions, play mutual roles and will be used in a singular body. Therefore the proposed facilities should be designed to ensure a smooth flow of persons and materials between the two buildings, and easy monitoring of visitors. The proposed facilities must also have the structural strength and the architectural configuration which will allow vertical expansion. It will contain an administration block and training centre, and will be constructed when the existing building is demolished due to the widening of Deans Road.

(2) Natural and Climatic Conditions

The project site is located in the city of Colombo, at Lat. 6°54'N and Long. 79°53'E. The average annual temperature in and around the site is 27°C, while the average annual humidity is 77.1 percent, and the average annual rainfall is 2,588mm. Although the project site is situated in an environment of high temperature and high humidity, it will be possible to make the proposed facilities comfortable, and to

reduce facility maintenance and management costs, by designing the proposed facilities in a manner consistent with natural conditions in and around the site. In designing the facilities, special attention should be paid to the following points:

1) Temperature and Humidity

The city of Colombo is located in the southwest regions of Sri Lanka's main island which is in the tropical monsoon zone. The temperature does not vary widely in Colombo, with the average annual temperature being about 27°C. However, it often exceeds 36°C between January and April, during which time the average monthly maximum temperature exceeds 30°C. For this reason, it will be necessary to air-condition the workshops in order to ensure their high efficiency. The average monthly humidity is relatively high, ranging from 71 percent to 81 percent, with the average annual humidity being 75 percent. Thus it will also be necessary to air-condition the equipment warehouse, and the parts storage.

2) Rainfall

In and around the city of Colombo, there are two rainy seasons per year. The southwestern monsoon season lasts from April to September while the The northeastern monsoon season lasts from October to March. The average annual precipitation exceeds 2,500mm. There are also many sudden showers. The highest daily rainfall in the history of the city is 260mm. It will be necessary, therefore, to take into account the generally high rainfall when designing the rooves, the elevation of the ground floor, and the openings in the walls.

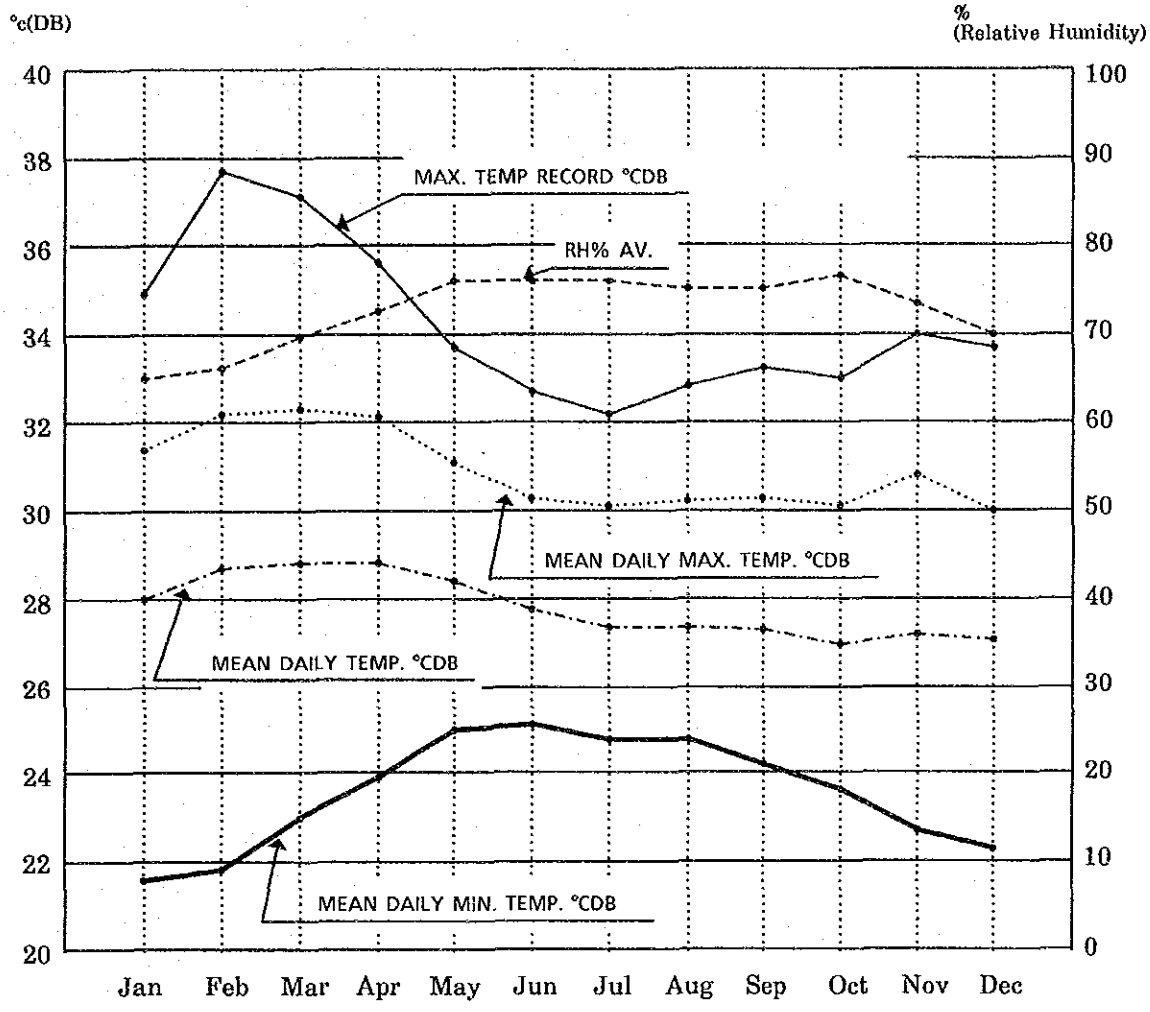


Fig. 4-1-1(a) Monthly Temperature and Humidity

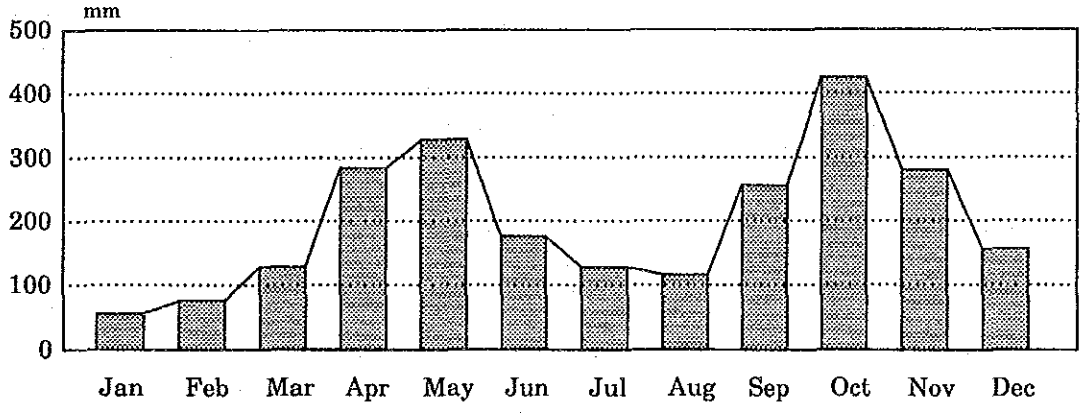


Fig. 4-1-1(b) Monthly Rainfall

3) Ventilation and Damage from the Window

In and around the city of Colombo, the direction of the wind is reversed owing to the monsoon. During the southwestern monsoon season, the wind blows from the southwest, and during the northeastern monsoon season, it blows from the northeast. Generally speaking, the wind is mild, with the average annual wind velocity at about 3.5 meters/second. Thus there is no need to consider preventative measures against strong winds. Unfortunately as there are many 2 to 4 storey buildings around the project site, it will be impossible to get sufficient natural ventilation for the proposed facilities.

4) Sunlight

As the city of Colombo is located at 6°54'N, sunlight is strong and the sun is high. It will be necessary, therefore, to attach heat insulating material to the rooves and to protect the openings in the wall from sunlight (through the design of eaves, balconies etc.).

5) Lightning

During the rainy season, many buildings are damaged by lightning. As the proposed facilities are intended for storing expensive medical equipment, it is essential to install a lightning protection system.

6) Earthquakes

Sri Lanka is not in an earthquake zone, and no serious earthquake damage has been reported. Thus there is no need to make the proposed facilities quake-proof.

(3) Social Conditions

In Sri Lanka, social status differs widely from one designation to another. Generally, there are different offices, toilets and locker rooms for use by different designations. Thus separate rooms are designed for a senior engineer, an engineer, and a foreman. As the Eye Teaching Hospital, National Tuberculosis Research Institute and many other medical institutions are located around the site, it will be necessary to minimise noise and vibrations generated from the proposed facilities. The roadside building should be lower than other buildings so as not to oppress the passers-by.

(4) Present State of the Local Building Laws and Regulations

Colombo Municipal Council requires builders to apply for official approval of proposed construction work. BES must also apply to construct the proposed facilities. The Colombo Development Plan worked out by the Urban Development Authority (UDA) is equivalent to the Urban Development Act and the Building Standards Act of Japan. CMC's Town Planning Division reviews applications for official approval of construction works in accordance with this law. The outline of this law is given below:

1) Floor Area Ratio: 200 percent

2) Maximum Lot Coverage Ratio: 80 percent

3) Height of Building: up to 15 meters (in cases where it is not a high-rise building)

4) Parking Lot: a 2.4m×4.8m parking lot per 200m^2 area (a truck parking lot for warehouses)

5) Height of Ceiling: 2.7 meters or more (ordinary rooms), 2.4 meters or more (air-conditioned rooms)

(5) Utilisation of Local Contractors and Locally Available Materials

The Sri Lankan construction market is relatively small in scale. There are few large-scale construction projects. The technological level of construction and the ability of construction work management differs from one contractor to another. It will be necessary, therefore, to scrutinise each candidate's capability when selecting sub-contractors. Aggregate, bricks, concrete blocks and stones are locally available while all the other building materials are imported from abroad. Almost all construction machines, including pile drivers and cranes, are locally available.

(6) Maintenance and Management Capabilities

In Sri Lanka, there are many cases of theft reported. There are also many cases of organised robbery. Since the project's facilities intend to store expensive medical equipment and spare parts, it is desirable that the proposed facilities should be made burglar-proof, and that each storage unit should be divided into several smaller sections. Building materials which are highly durable, and which are not costly to maintain should be selected.

4-2 Examination of the Design Conditions

4-2-1 Configuration of the Facilities

The Colombo Centre is made up of three departments: 1) Administration, 2) Maintenance/Repair, and 3) Procurement/Supply. The configuration of the proposed facilities and relationships of persons and materials between them are shown in Fig. 4-2-1.

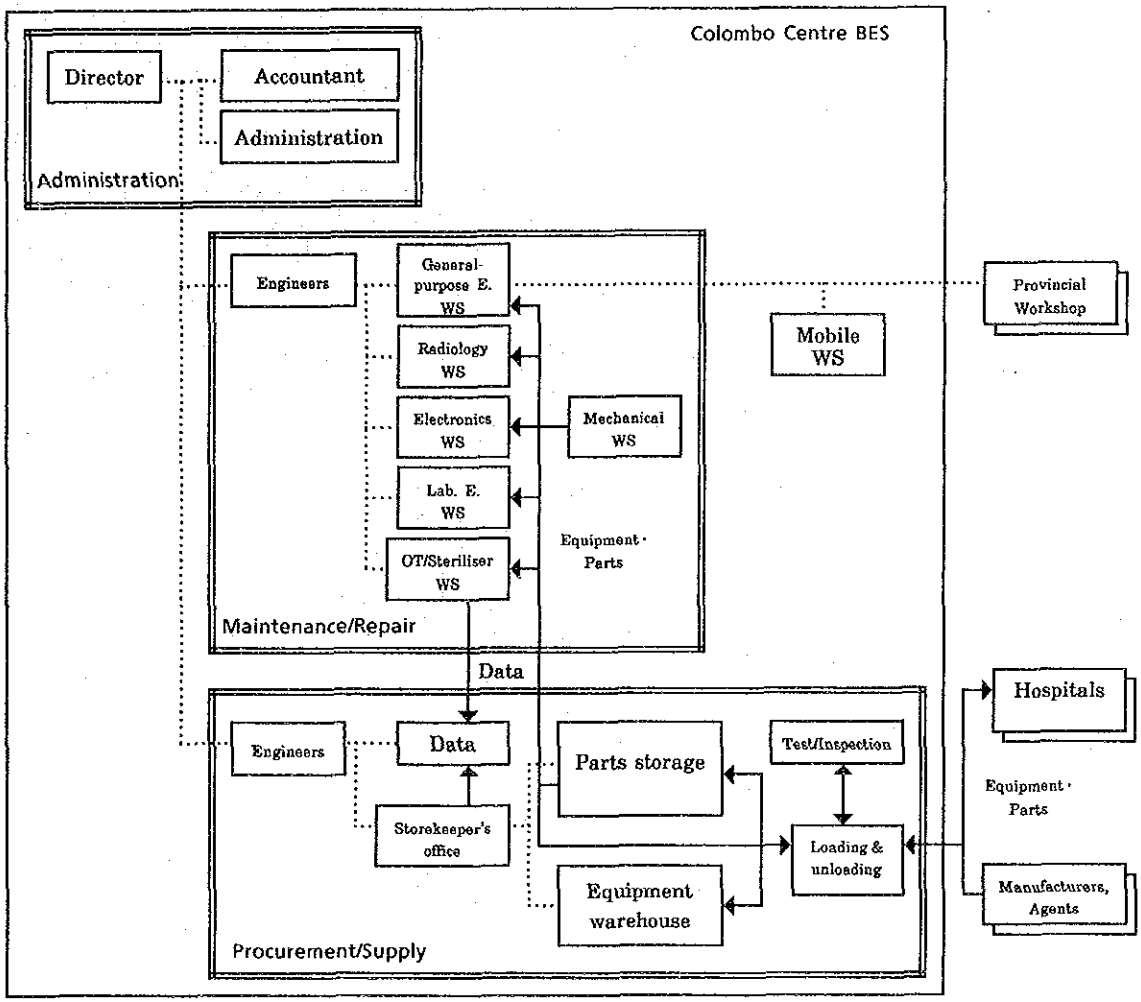


Fig. 4-2-1 Configuration of Colombo Centre

As mentioned in "3-3-1 Implementing Organisation and Management System", both the Procurement/Supply Department and the Maintenance/Repair Department are managed by a senior BM engineer. For this reason, the senior engineer's room should be combined with other rooms of the same department. The Administration Department will continue to use the

existing Administration Building since it is still in relatively good condition.

4-2-2 Size and Area of the Proposed Facilities

Size and area of each room will be determined based on "3-3-2 Activity Plan".

(1) Repair Workshop

The size and the area of each repair workshop should be determined based on the layout of the repair equipment, owing to the difference in activities and functions. Each repair workshop will have a staff of 15 to 30 persons (a BM engineer, an assistant BM engineer, foremen, and mechanics). It will require a space where all technical staff can work at the same time. The distance between two work tables should be 1.5 to 1.8 meters to make it easier to walk between occupied tables.

(2) BM Engineer's Room, Foreman's Room

It will be necessary to secure rooms where the BM engineers and foremen can do desk work (sorting out records of repairs, writing daily reports, and so on). To conform with Sri Lankan customs, separate rooms should be designed for the BM engineers and the foremen. The standard area for each designation was determined based on the Ministry of Construction of Japan's standards-namely, $20m^2$ for each senior BM engineer, $10m^2$ for each BM engineer, and $5m^2$ for each foreman.

(3) Warehouse and Storage

The ratios that result from dividing the value of actual storage volume by the total volume of shelves are called the "filling efficiency ratios". These ratios are used as indicators in designing storage. Table 4-2-1 shows the average ratios for typical storages.

Table 4-2-1 Filling Efficiency Ratios

Storage	Efficiency ratio = $\frac{\text{Actual volume}}{\text{Volume of shelves}}$
Parts	0.49
Materials	0.20
Equipment	0.41
General	0.39

The relatively low filling efficiencies (0.39 to 0.49) are attributable mainly to the distance between goods and shelves. The total volume of shelves is calculated by setting the filling efficiency ratios at 0.41 for equipment warehouses, and 0.49 for spare parts storage. Table 4-2-2 shows the value of actual storage volume and total volume of shelves of each storage.

Table 4-2-2 Planned Volume of Storages

	Actual Store Volume	Total Volume of Shelves
Equipment Warehouse	335 m^3	815 m^3
Spare Parts Storage	190 m^3	390 m^3

The standard distance between shelves is 2 to 3 meters for the main aisle and 1.5 meters for the supplementary aisle. In the proposed facilities, the distance between shelves should be calculated taking into account the types of fork-lifts and carriers. Shelves should be arranged along the main aisles on the basis of a 2.4 meter width (the minimum permissible width for unloading by a 1.5 ton-fork-lift). Shelves along the supplementary aisles should be arranged on the basis of a 1.6 meter width (the minimum permissible width which allows two carriers to pass each other).

(4) Southern Province Workshop

The Southern Province Workshop will contain almost the same functions as the General-Purpose Workshop in the Colombo Centre. Thus the Southern Province Workshop should have the same sizes repair workshop

as the General-Purpose Workshop, and other ancillary rooms such as a foreman's room and a toilet.

Table 4-2-3 Area Table

Maintenance/Repair Department

Room Name	Staff	Area Determining Factor	Area (m^2)
Radiology workshop			
Workshop		Layout of equipment	108
Foreman's room	6	6persons×5m^2=30m^2	36
Electronics workshop			
Workshop		Layout of equipment	108
Foreman's room	10	10persons×5m^2=50m^2	50
Laboratory equipment workshop			
Workshop		Layout of equipment	54
Foreman's room	4	4persons×5m^2=20m^2	22
OT/Steriliser workshop			
Workshop		Layout of equipment	162
Foreman's room	8	8persons×5m^2=40m^2	36
Mechanical workshop			
Workshop		Layout of equipment	162
Painting room		Layout of equipment	20
Foreman's room	2	2persons×5m^2=10m^2+Filing cabinets	20
General-purpose equipment Workshop			
Workshop		Layout of equipment	108
Preparation room		Layout of equipment	20
Foreman's room	8	8persons×5m^2=40m^2+Counter	54
Senior engineer's room	2*	2persons×20m^2=40m^2+PABX	60
Engineer's room	4	4persons×10m^2=40m^2	36
Assistant engineer's room	4	4persons×10m^2=40m^2	36
Locker room	101**	Mechanics(56+6+15+24)×0.5m^2=50m^2	50
First-aid room			15
Others			54
Sub-total			1,211

* : includes a senior engineer of supply department

** : include storemen, drivers , and labourers

Procurement/Supply Department

Room Name	Staff	Area Determining Factor	Area (m^2)
Equipment warehouse		(Total volume of shelves: 815m^2)	432
Parts storage		(Total volume of shelves: 390m^2)	648
Loading/unloading space			324
Test/inspection room		Layout of equipment	54
Storekeeper's room	4	4persons×10m^2=40m^2	54
Others			72
Sub-total			1,584

Others

Room Name	Staff	Area Determining Factor	Area (m^2)
Garage		Two mobile workshops and a truck	68
Machine room			95
Guard room	6	6persons×2m^2=12m^2	12
Sub-total			175

Colombo Centre BES

NET Floor area			2,970
Others			990
Sub-total			3,960

Southern Province Workshop

Room Name	Staff	Area Determining Factor	Area (m^2)
Workshop		layout of equipment	108
Foreman's room	1	1person×5m^2=5m^2+Filing cabinets	18
Utility · Corridor			80
Total	4		206

Colombo Centre	3,960
Southern Province Workshop	206
Grand total	4,166

4-3 Basic Design

4-3-1 Site Plan

The proposed facilities are to be placed in the eastern part of the site where there exists a Workshop Building and a warehouse. The site has many difficulties such as its small area (considering the size of the proposed facilities), its awkward shape, and the intended conservation of an old Administration Building. These problems can be solved by making the proposed facilities multistoreyed which enables a more effective use of the site. Multistorey buildings also lend themselves comfortably to the policy of the Colombo Municipal Council, which seeks a more effective utilisation of the central area of Colombo city.

(1) Gates for the Site

Gates for the site will be placed along De Saram Place, where there is less traffic than Deans road. There should be two gates -- the western gate through which staff and visitors can pass, and the eastern gate through which trucks carrying medical equipment and spare parts can drive.

(2) Relationship with the Existing Building

The proposed facilities should be situated to permit a close relationship with the existing building, which is to be used by the Administration and the Accounting Department. An open space should be created between them in order to ensure a better environment and a larger parking space.

(3) Future Plan

The proposed facilities should lend themselves to the expansion plan, which is to contain administration and training functions, and will be

conducted when the existing building is demolished along with the widening of Deans Road.

(4) Harmonisation with the Surrounding Environment

De Saram Place and the northern boundary line of the site meets at an angle of 15°. The roadside building will be thus placed parallel to the street, whereas the Main Building will be placed parallel to the boundary line in order to harmonise with the rows of houses around the site.

4-3-2 Architectural Plan

(1) Plan

The basic element of the proposed facilities is made up of four blocks: 1) Storage, 2) Repair Workshop, 3) Mechanical Workshop, and 4) Common Blocks.

1) Storage Block

This block should be placed on the ground floor of the Main Building to facilitate smooth handlings of large quantities of medical equipment and spare parts. There will be a platform in the front of the block, where trucks can load and unload easily, and a truck yard where a 10-ton truck can turn in front of the block.

2) Repair Block

This block should be placed on the first floor of the Main Building in order to minimise lot coverage area of the site. There will be an elevator to lift large and heavy pieces of medical equipment. A central corridor will be straddled by repair workshops on one side and foreman's and engineer's rooms on the

other. This configuration will keep these rooms in desirable close proximity.

3) Mechanical Workshop

The Mechanical Workshop should be detached from the Main Building, which contains other workshops, in order to minimise disturbances caused by noise and vibrations generated in the workshop.

4) Common Block

Common facilities, such as the locker room, toilets, and mechanical rooms, will be placed on the southern side of the Main Building.

(2) Utilisation of the Existing Facilities

The existing Administration Building, whose total floor area is 550m^2, contains 395m^2 of accountant and administration offices, a 110m^2 medical equipment warehouse, and a 45m^2 laboratory equipment workshop. After the warehouse and workshop are moved to the proposed facilities, the remaining rooms will be used to store condemned equipment. The existing BM engineer's room will serve as the senior BM engineer's room of the Training Department. Nine administration staff members will use the existing office.

(3) Section

Ceiling heights will vary from 3.0m to 6.0 due to functional differences. The storey height of the Main Building will be 4.5m and the ceiling height of the repair workshop will be 3.5m. Rooms which require higher ceilings should be detached from the Main Building in order to minimise construction costs. Table 4-3-1 shows the storey height and the ceiling height of the rooms.

Table 4-3-1 Heights of Storey and Ceiling

Rooms	Storey height	Ceiling height
Equipment Warehouse	6.0 m	5.5 m (up to bottom of beam)
Parts Storage	4.5 m	4.0 m (up to bottom of beam)
Repair Workshop	4.5 m	3.5 m
Mechanical Workshop	6.5 m	6.0 m (up to bottom of beam)

4-3-3 Structural Plan

(1) Outline of Structure

The proposed facilities will be used as workshops for maintenance and repair of medical equipment, as well as spare parts storage. Buildings will include a 2-storeyed building with a basic span of 6.0m×9.0m (with an exception of a 6.0m×4.5m span due to different occupancy), and a single-storeyed building with a basic span of 6.0m×7.5m. The 2-storeyed Main Building has 2 typical storey heights: 4.5m for workshops and 3.5m for common rooms. A single-storeyed storage is planned with a storey height of 6.0m.

(2) Structural System

The structural system adopted for the project will be a reinforced concrete rigid frame structure considering the scale of the building, economic efficiency, natural conditions, and present state of the construction industry in Sri Lanka.

According to the soil investigation report, which was obtained from the Sri Lankan side, 5 boreholes were started at the site. These were terminated after encountering a hard stratum of weathered rock at

depths varying from 16.5m to 23.0m. Sandy subsoils predominate as far as the termination depths. However, peaty soils and clay layers with SPT N-values of 0~9 are generally found at depths ranging from 6.5m to 11.5m. The SPT N-value of the upper sand layers are quite high with values ranigng from 15 to more than 50.

Considering the structural system chosen, scale of the proposed buildings, and the subsoil conditions at the site, it is recommended to support the building on a pad foundation located at 2.0m below the present ground level.

(3) Dead Load and Live Load

1) Dead Load

The dead load shall be calculated in conformity with the actual weights of materials used in the design.

2) Live Load

The live load shall be in conformity with the Building Standard Law of Japan and its Enforcement Order.

The live load for each occupancy is as tabulated in Table 4-3-2.

Table 4-3-2 Live Load for Each Occupancy

(Unit: kg/cm²)

Occupancy	Slab/Beam	Frame
Office	300	180
Workshop	400	200
Storage	800	600
Toilet	180	130
Garage	550	400

(4) Materials

Concrete	:	Fc=210kg/cm^2 (4 week compression strength)
Reinforcing bar	:	Under 16mm SD30A, Ft=3,000kg/cm^2 Over 19mm SD35, Ft=3,500kg/cm^2
Structural steel	:	SS41, Ft=2,400kg/cm^2

4-3-4 Utility Plan

(1) Electrical Facility Plan

1) Substation

A substation will be constructed on the project site through which electric power from a three-phase 11kV high-tension underground power line will be sent to the proposed facilities. A transformer will be installed in the substation to reduce the voltage from 11kV to 400V/230V. The transformer's capacity will be 400kVA. As voltage fluctuates widely, and power failures occur frequently in and around the project site, it will also be necessary to install an automatic voltage regulator and a generator. The generator's capacity will be approximately 150kVA.

2) Power Supply System

The outline of the supply of electric power from the low-tension panel board of the substation to the local distribution boards and the motor control boards is as shown below:

- Motor 3-phase, 3-wire 400V
- Lighting and socket outlet 3-phase, 4-wire 400V/230V

3) Lighting and Socket Outlet

- Lighting fixtures

  The main light sources will be fluorescent lights, but mercury

lamps will be used in the mechanical workshop, which has a high ceiling. In general, the lighting fixtures will be mounted directly on the ceiling or else hung from the ceiling. The average luminous intensity for each of the main rooms is as shown in Table 4-3-3.

Table 4-3-3 Target Illumination Level

Rooms	Light Sources	Illumination Level
Foreman's room	Fluorescent lamp 40W×2	300lux
Engineer's room	Fluorescent lamp 40W×2	300lux
Workshop	Fluorescent lamp 40W×2	300lux
Mechanical workshop	Mercury lamp 200W	200lux
Equipment warehouse, parts storage	Fluorescent lamp 40W×2	100lux
Loading/unloading room	Fluorescent lamp 40W×2	100lux

- Socket outlet

  The socket outlet should meet BS standard requirements. A panel board will be installed in each of the workshops as well as automatic voltage regulator which will cope with fluctuations in voltage. The special socket outlet for use with the generator should be easily identifiable.

4) Telephone System

The telephone trunk line (central office line) will be led into the site from Deans Road. The number of trunk lines, including those for telephones and facsimile machines, will be 8. An electronic telephone exchange with a capacity of 10 trunk lines and about 75 extensions will be installed in the senior engineer's room.

5) Public Address System

A PA system will be installed in the senior engineer's room and a remote microphone will be installed in the guard room. The capacity of PA system will be about 240W.

6) Fire Alarm System

An alarm receiving board will be installed in the senior engineer's room. A red indicator lamp, a bell, and a transmitter will be mounted on the top of the case of each hydrant, and the hydrant's pump actuating switch will be housed in each hydrant case. Fire detectors will also be installed.

(2) Air-Conditioning and Ventilating Plan

1) Design Conditions

a) Designed Outdoor Temperature and Humidity

Dry bulb temperature 34°C D.B.

Wet bulb temperature 27°C W.B.

b) Designed Indoor Temperature and Humidity

Rooms with the air-conditioning system will be planned to control the temperature, excluding the relative humidity.

Dry Bulb Temperature: 26°C D.B.

However, the humidity should be kept at less than 65% R.H. as an aimed value in the equipment warehouse and parts storage, in order to keep medical equipment and spare parts in good condition.

2) Air-Conditioning System

Air-cooled package-type air conditioners and separate-type air conditioners will be used due to their easy maintenance and management.

3) Ventilating System

In rooms which are not air-conditioned, ceiling fans will be installed. Ventilating equipment to remove odours will also be installed in rooms where such smells are generated.

(3) Water Supply and Sanitary Plan

1) Water Supply System

The city water supply pipe, connected to the site's boundary, will be led to an underground water tank installed beneath the pump room. Water stored in this tank will be pumped into an elevated water tank from which water will be supplied to the facilities by gravity. The city water contains coliform bacilli and other bacteria, and it will thus be necessary to chlorinate the city water.

2) Drainage System

Sewage from the buildings will be discharged into the sewer main (diameter: 225mm) laid under De Saram Place. A combined system of soil and waste water both indoors and outdoors will be applied, and the stack ventilating method will be used. Rainwater will be discharged into the existing drain ditches.

3) Sanitary System

Sanitary fixtures suited to local customs will be installed. A water tap will be installed in each water closet.

4) LP Gas System

The pantry will be provided with LP gas from an LP gas cylinder.

5) Fire Extinguishing System

Indoor fire hydrants and fire extinguishers will be installed. Some of the fire hydrants should be accompanied by an outlet connection of 65mm dia. for use by firemen.

4-3-5 Construction Material Plan

(1) Structural Materials

The main structural material will be reinforced concrete, the most common in Sri Lanka and the most reasonable for the proposed facilities. In Sri Lanka, pillars, beams and floor slabs are generally made of reinforced concrete. Walls are made of either concrete blocks or bricks. However, the exterior walls of the proposed facilities should be made of reinforced concrete in order to ensure good, waterproof performance.

(2) Exterior Finishing Materials

1) Rooves

In Sri Lanka, the most common roofing material is roofing tile on pitched rooves. However, locally-made roofing tiles, which are uneven in quality, are very likely to leak and become moldy. Pitched rooves, which would have large volumes of attic due to the long depth of the proposed facilities, are not economical. Therefore the rooves should be flat reinforced concrete with steel sheet.

2) Exterior Walls

Exterior walls will be sprayed with synthetic resin emulsion double-layer pattern tiles, more durable and weatherproof than ordinary paint or sprayed resin paint, and economical in that it does not require repair or repainting.

3) Doors and Windows

Windows should be aluminum sash, which are airtight and watertight. Doors should be steel for the same reasons.

(3) Interior Finishing Materials

The following table shows interior finishing materials selected in consideration of the various functions required.

Table 4-3-4 Finishing Schedule

Rooms	Floor	Wall	Ceiling
Warehouse & Storage	Concrete	Exposed concrete	Sprayed mortar
Workshop	Vinyl sheet	Paint on mortar	Mineral acoustic tile
Foreman's room	Vinyl tile	Paint on mortar	Sprayed tile
Senior Engineer's room Engineer's room	Vinyl tile	Paint on mortar	Mineral acoustic tile
Corridors	Vinyl sheet	Paint on mortar	Exposed concrete
Corridors (exterior)	Marble tile	Paint on mortar	Decorative gypsum board
Toilet, Shower room	Ceramic tile	Ceramic tile	Decorative gypsum board

4-3-6 Repair/Calibration Equipment Plan

The following criteria are considered in determining the types, specifications, and grade of repair/calibration equipment for the project:

(1) Equipment to be Consistent with the Designed Target

The repair target of each equipment level is:

1) Basic level: All breakdowns, requiring from minor repairs to overhauls, should be repaired.

2) Middle level: Almost all breakdowns should be repaired.

3) Advanced level: BES is responsible for the replacement of limited parts and troubleshooting.

The quantity and quality of repair/calibration equipment should be sufficient for the afore-mentioned target.

(2) Equipment Easily Handled and Maintained

The project must exclude equipment which the existing staff can not handle (unless the staff receives long-term training) or equipment which BES can not easily maintain.

(3) Equipment Checking the Environmental Conditions

The project must have examination equipment to check the environmental conditions of the rooms where medical equipment would be placed. These checks will include the electric supply status at hospitals as well as the thermal and humidity conditions of rooms.

(4) Quantity to be Consistent with Repair Activities

The quantity of repair equipment should be fixed according to how often it is used.

The outline of the equipment proposed for each department is as follows:

1) Maintenance/Repair

a) Radiology Workshop

Equipment to check, repair, and calibrate X-ray apparatus. Equipment to measure radiation leakage in X-ray apparatus.

- High Voltage, Ampere meter:
  Measurement of voltage and current exposure in X-ray tube units.

- Digital time counter:
  Counting of exposure time.

- X-ray survey meter:
  Measurement of radiation.

- AC, DC Voltage recorder:
  Check of power supply units.

b) Electronics Workshop

Equipment to check, repair, and calibrate electronic equipment and parts. Equipment to check power supply.

- Digital storage oscilloscope:
  Measurement of digital control signal.

- Function generator:
  Electric signal generator to check the function of electronic circuit substrates.

- Defibrillator analyser:
  Measurement of power in defibrillators to check function and safety.

- Power line memory:
  Check of power supply units and noise levels.

c) Laboratory Equipment Workshop

Equipment to check, repair, and calibrate clinical laboratory equipment and physiotherapy equipment.

- Digital frequency counter:
  Counting of frequency of signal on circuit substrates.

- Electrical safety analyser:
  Safety check of electric leaks.

- Temp, humidity barometer racorder:
  Measurement of temperature, humidity, and atmospheric pressure.

d) Operation Theatre/Steriliser Workshop

Equipment to check, repair, and calibrate operation theatre equipment, dental equipment, and sterilising equipment. Equipment to process materials.

- Electrosurgery analyser:
  Measurement of output power and noise of electrosurgical units.

- Ventilator tester:
  Check of ventilator functions.

- AC Arc welder unit:
  Process and welding of mechanical parts or materials.

- Pipe threading machine:
  Repair and process of materials.

e) General-Purpose Equipment Workshop

Equipment to repair basic level medical equipment. Equipment to process materials.

- Mobile workshop:
  Travelling repair services.

- Phototherapy radiometer:
  Measurement of Light power in phototherapy units.

- Portable spot welder:
  Process and welding of metallic materials.

- Field electric test pack:
  General check of power supply.

- Fume hood:
  Exhaust of fumes.

f) Mechanical Workshop

Equipment to produce and process materials, and to repair mechanical parts.

- Precision lathe machine, electric bender, shearing machine, universal milling machine:
  Produce and process metallic parts.

- Painting kit (compressor):
  Painting of materials.

g) Southern Province Workshop

Equipment to check, repair, and calibrate medical equipment. Equipment to process materials.

- Analog multimeter:
  Check of electric parts.

- Electric drill, handy type:
  Process of materials.

- Wagon type vehicle:
  Transportation of equipment.

h) Transportation

Vehicles to transport equipment and technical staff.

- Delivery van type vehicle:
  Transportation of medical equipment, repair equipment and spare parts.

2) Purchase/Delivery

Equipment to store and to load/unload medical equipment, spare parts, and consumables. Equipment to deliver medical equipment.

- Fork lift:
  Loading/unloading of equipment.

- Low temperature storage:
  Storage of electronics parts and reagents.

- Truck, 3t:
  Delivery transportation of large-size and heavy equipment.

- Pick-up type vehicles:
  Transportation of installation materials and medical gas.

3) Management of Records

Equipment to gather and arrange inventory records of spare parts.

- Personal computer:
  Inventory of spare parts and consumable goods

4-3-7 Basic Design Drawing

(1) Area Table

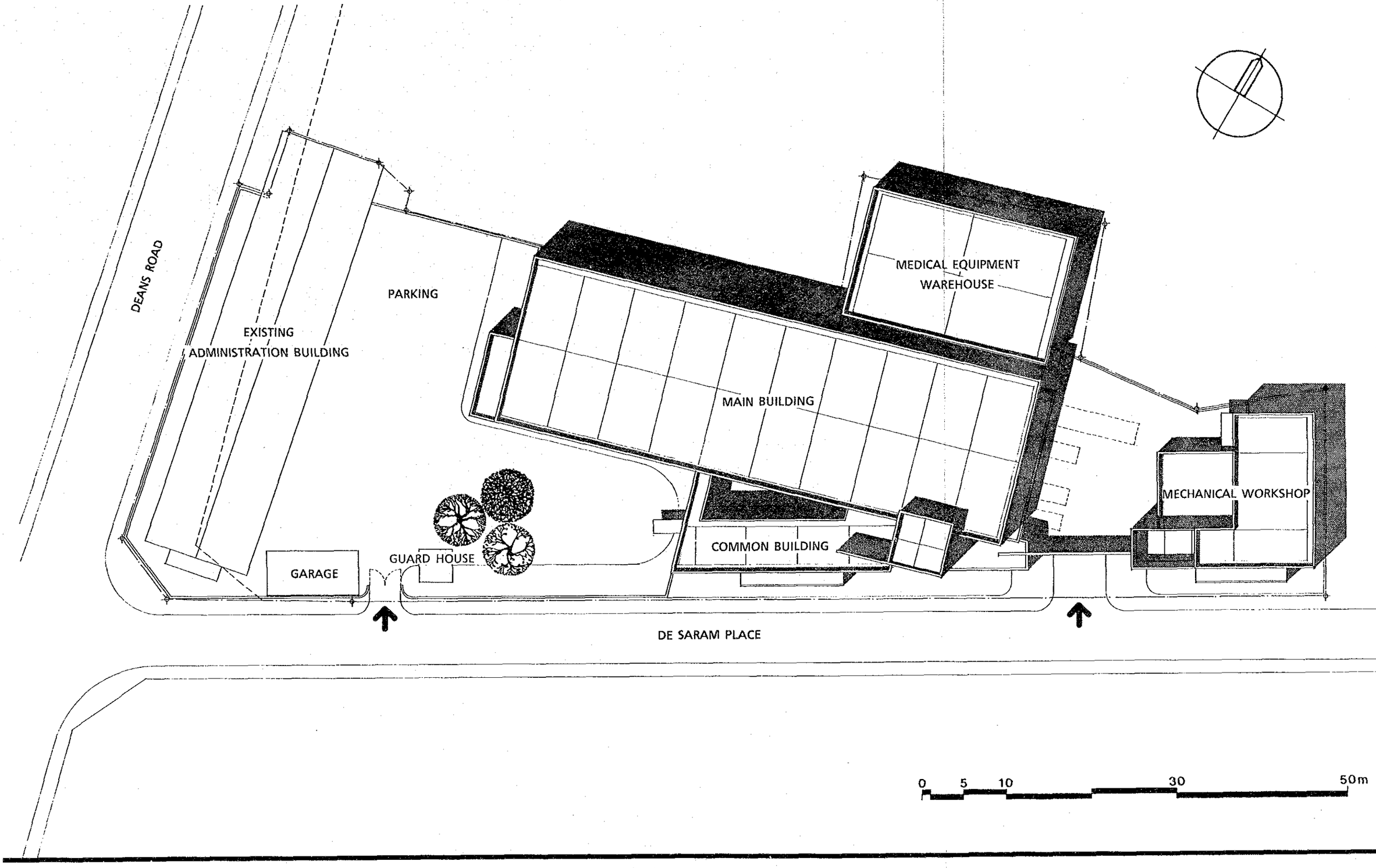
1) Colombo Centre

Penthouse	120m^2
First Floor	1,558m^2
Ground Floor	2,282m^2
Total	3,960m^2

2) Southern Province Workshop 206m^2

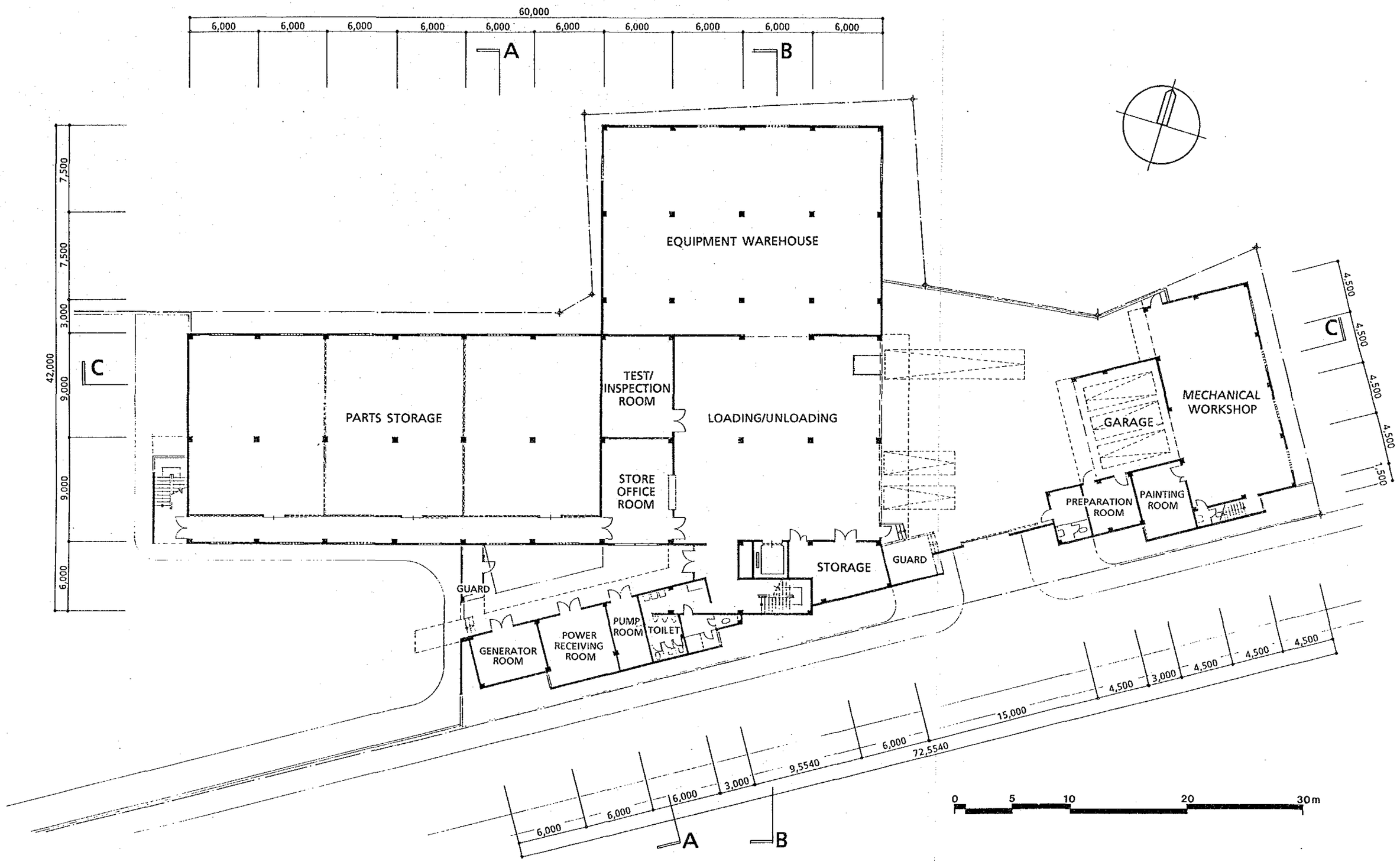
(2) Basic Design Drawings

1) Site Plan
2) Ground Floor Plan
3) First Floor Plan
4) Elevation
5) Section
6) Plan, Elevation, and Section (Southern Province Workshop)



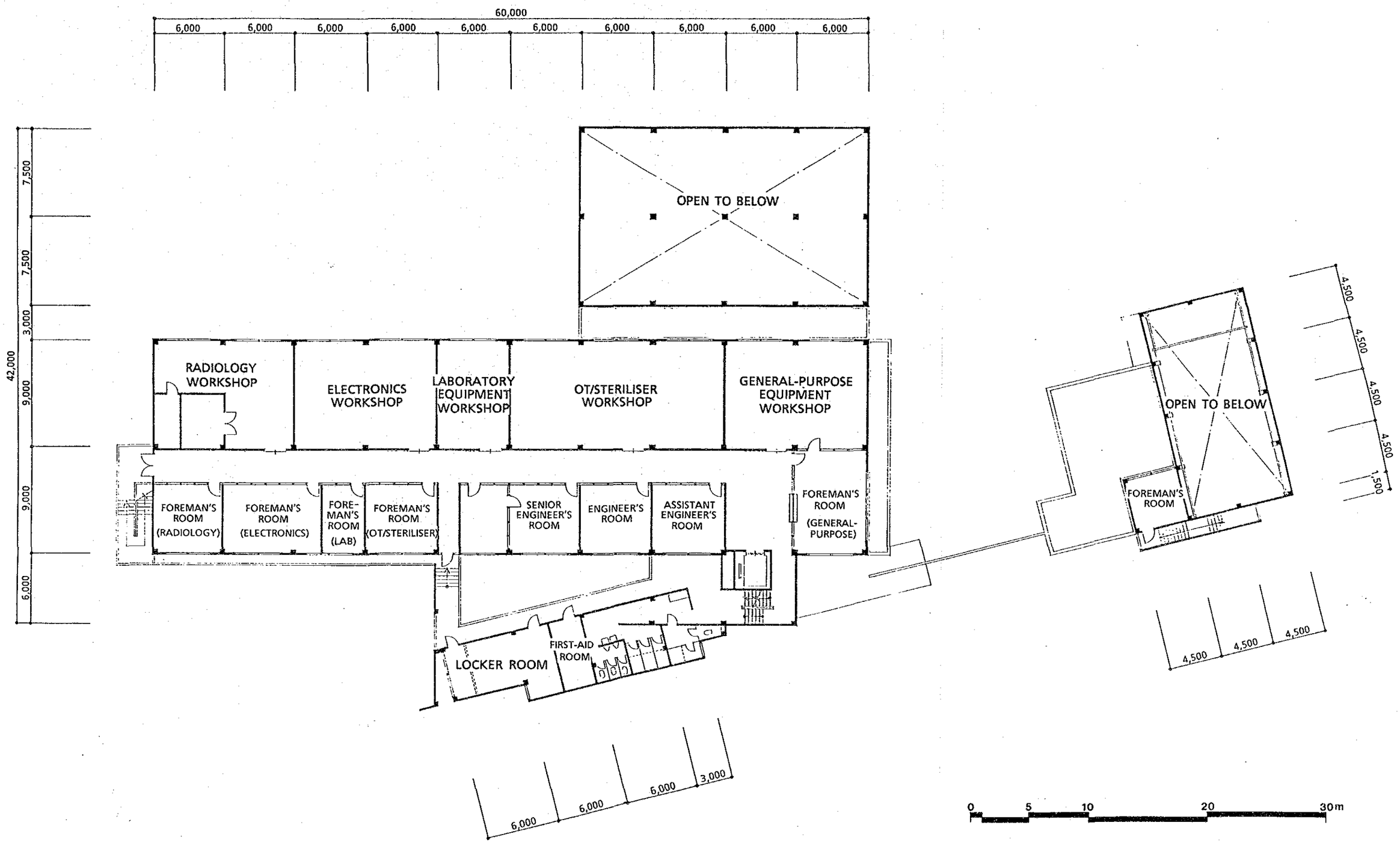
BASIC DESIGN STUDY ON THE PROJECT FOR REHABILITATION OF BIOMEDICAL ENGINEERING SERVICES

SITE PLAN



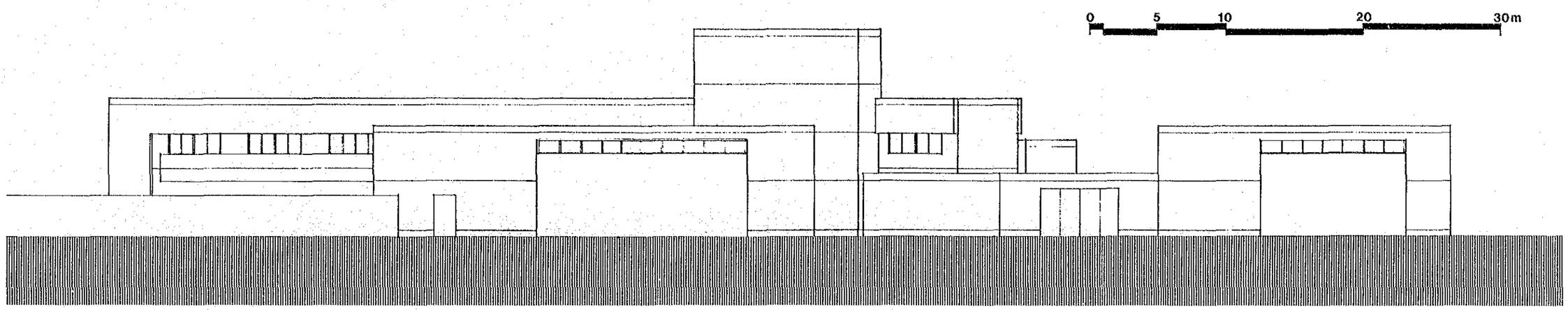
BASIC DESIGN STUDY ON THE PROJECT FOR REHABILITATION OF BIOMEDICAL ENGINEERING SERVICES

GROUND FLOOR PLAN

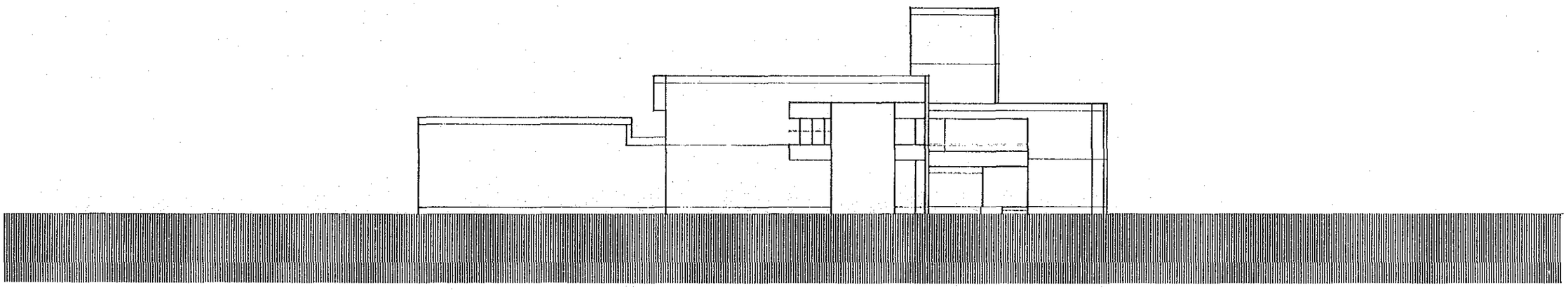


BASIC DESIGN STUDY ON THE PROJECT FOR REHABILITATION OF BIOMEDICAL ENGINEERING SERVICES

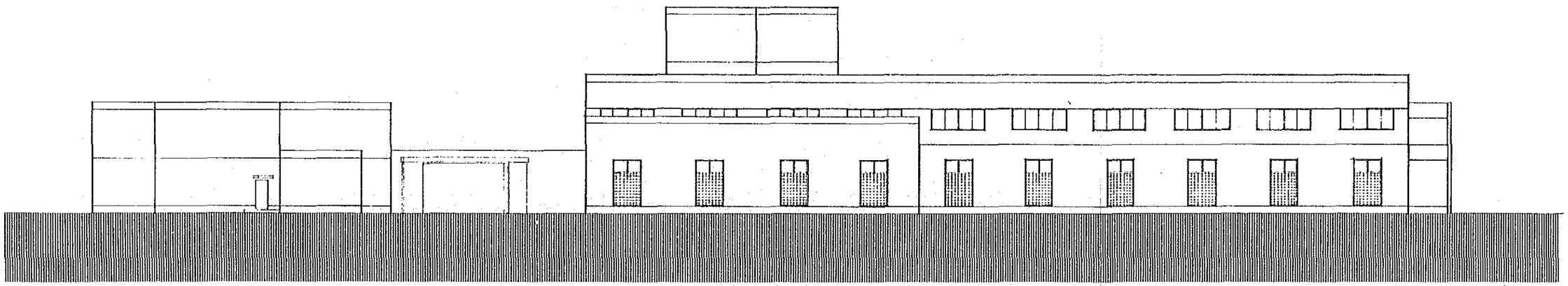
FIRST FLOOR PLAN



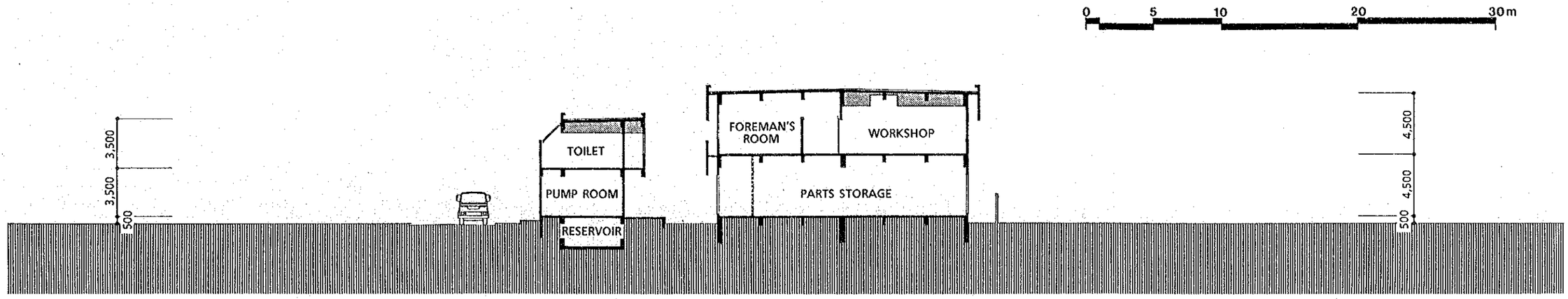
SOUTH ELEVATION



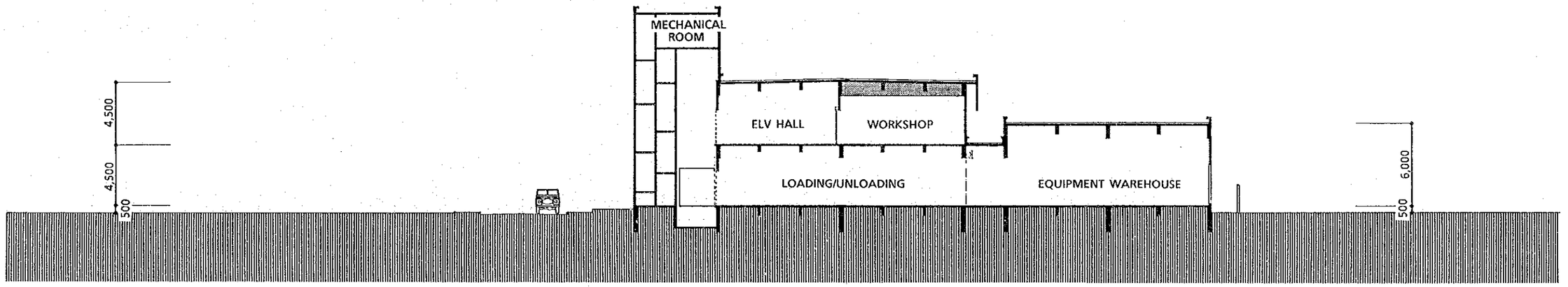
WEST ELEVATION



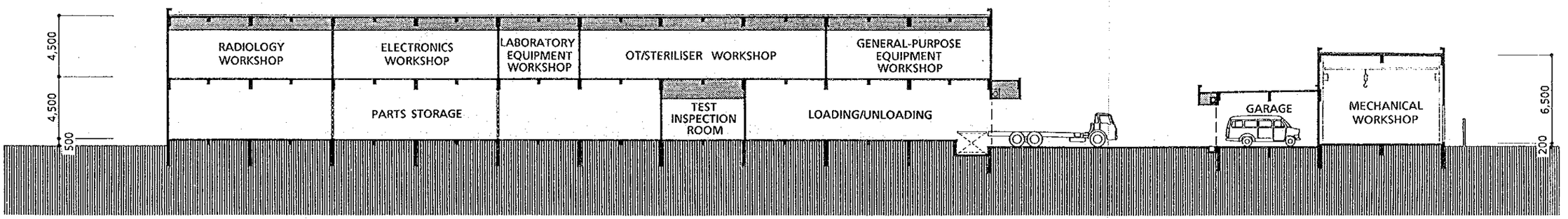
NORTH ELEVATION



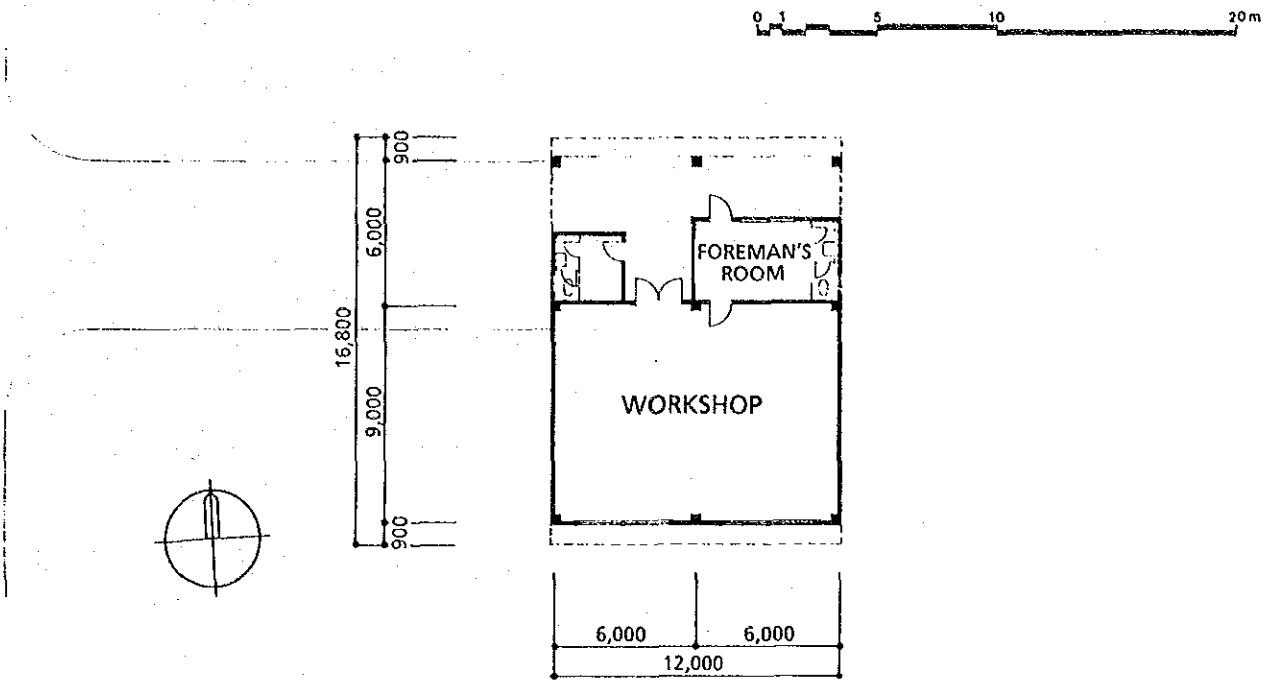
A-A SECTION



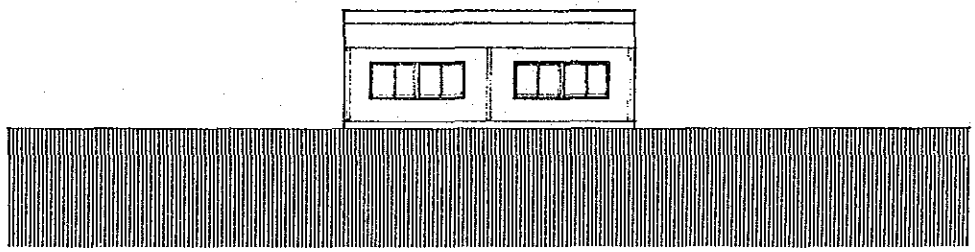
B-B SECTION



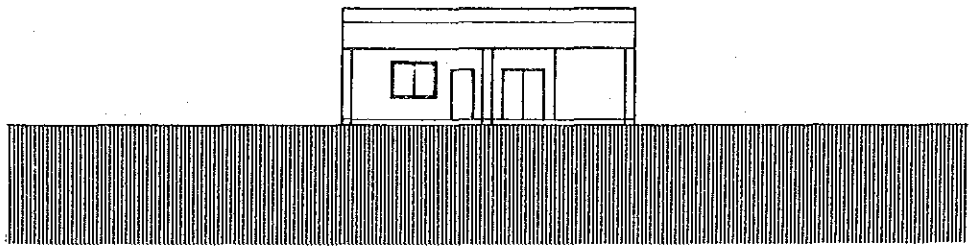
C-C SECTION



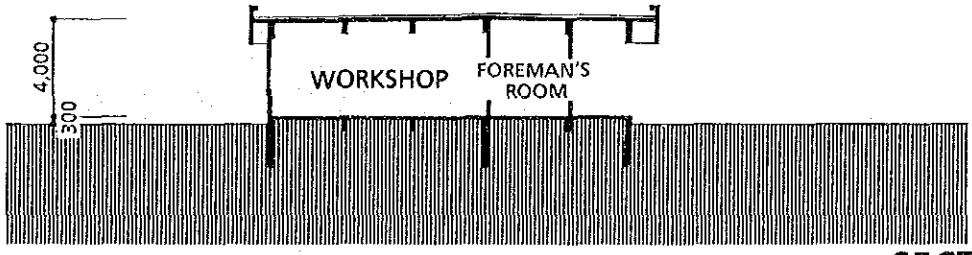
GROUND FLOOR PLAN



SOUTH ELEVATION



NORTH ELEVATION



SECTION

4-4 Construction Plan

4-4-1 Construction Work Criteria

(1) Project Implementation System

This project will be implemented under the direction of the Ministry of Health and Women's Affairs (MOH & WA). The Sri Lankan government agency responsible for the actual implementation of this project will be the Division of Biomedical Engineering Services under the Laboratory Services of MOH & WA. All the work to be carried out by the Sri Lankan side for this project will be controlled by the Construction Work Implementation Committee chaired by the Secretary of the Ministry of Health and Women's Affairs. The commission will be responsible for ensuring the smooth implementation of this project through consultations and adjustments. The Secretary of the Ministry of Health and Women's Affairs will be a party to the consultant agreement, the construction contract, and the bank arrangement concerning the construction of the planned facilities.

On the other hand, the Department of External Resources, under the control of the Ministry of Finance and Planning, will be responsible for all matters related to grant aid from the Government of Japan. It will arrange for financial cooperation between the two Governments. The Division of Biomedical Engineering Services will provide the site for the project, dismantle the existing buildings, and conduct the reclamation work. The public organisations to take charge of infrastructure will be the Ceylon Electricity Board and the Department of Post and Telecommunications.

(2) Consultant for the Project

Immediately after the conclusion of the Exchange of Notes (E/N) on the implementation of the project between the Government of Japan and the Government of Sri Lanka, the Ministry of Health and Women's Affairs

will be required to conclude an agreement with a Japanese consultant firm and obtain verification from the Government of Japan. After the conclusion of the agreement, the consultant will prepare detailed design documents based on the basic design study report. After consultation with the Division of Biomedical Engineering Services, the consultant will carry out necessary tender and construction supervision work.

(3) Contractors

Judging from the total project cost of the buildings and equipment, it would be best if the building construction work and the equipment procurement/installation work be contracted out separately. The contractors for both works will be selected from among qualified firms through an open tender. The Ministry of Health and Women's Affairs will conclude a construction contract and an equipment procurement/ installation contract with the lowest tenderer in each category, and then obtain verification from the Government of Japan. The selected contractors will be required to complete their respective work and deliver the facilities and equipment to the Government of Sri Lanka by the date specified in the contract.

4-4-2 Situation of the Construction Industry in Sri Lanka and Points to note in Construction

(1) Situation of the Construction Industry in Sri Lanka

1) Local Consultants

In Sri Lanka, particularly in the city of Colombo, there are a number of consultant firms with a staff of 10 to 20 persons. Many of these staff members were educated in Great Britain or in Australia, and therefore excel in working out detailed design drawings and supervising construction work. They also have experience in taking charge of the preparation of detailed design drawings under financial aid programmes by foreign countries other

than Japan. However, they are not judged so reliable in terms of the ability to control the actual process of construction. It will be difficult, therefore, to ask them to work out detailed design drawings for a project which does not allow ample time for design work.

2) Local Contractors

The Central Engineering Consultancy Bureau (CECB), and the building departments of the ministries concerned, usually design and construct large-scale construction works contracted out by the Government of Sri Lanka. On the other hand, many of the private contractors, being relatively small, participate in public construction work or work contracted out by foreign-affiliated companies, merely as subcontractors responsible for recruiting local construction workers. Consequently, local private contractors are unable to handle an entire construction job of this scale. Moreover, due to the shortage of technicians and skilled workers, these contractors lack the ability to control quality, progress and materials. When utilising the services of local private contractors under this project, the Japanese contractor will be required to place orders with a number of local contractors, according to the type and size of the work concerned, and at the same time dispatch Japanese engineers to take charge of quality control in Sri Lanka as occasion demands.

3) Locally Available Construction Materials

In Sri Lanka, general construction materials are either manufactured locally or imported. Although it is possible to procure them locally, some are of poor quality, and supplies are limited. It should also be noted that there are limited types, patterns, and colors for certain products. For this project, which requires prompt delivery of the necessary quantities of high-quality products, it will be essential to procure some

construction materials from Japan, or another country as occasion demands.

(2) Points to Note in Construction

Judging from the conditions of the project site and the local construction industry, the Japanese contractor should note the following points:

1) Since part of the site of BES's existing facilities is to be used, sufficient space will not be available for the construction administration office, or the temporary workshop for processing reinforcing bars and preparing provisional frames. A temporary facility plan will have to be worked out very carefully.

2) As the northern end of the project site faces the National Tuberculosis Research Institute, and the southern end faces the Eye Hospital from across a road, it will be necessary to minimise noise and dust.

3) There is a shortage of technicians and skilled workers, as well as tools, in Sri Lanka. For this reason, it will be essential to dispatch Japanese experts to give technical guidance to the local construction workers as occasion demands.

4) The Government of Sri Lanka, in conformity with the Exchange of Notes (E/N), will be required to promptly follow the procedures for bearing customs duties, internal taxes, and other fiscal levies which may be imposed in Sri Lanka with respect to the supply of the products and services necessary. The Government must also ensure the prompt unloading and customs clearance of products purchased under the project.

4-4-3 Construction Supervision Plan

(1) Contents of Services

In accordance with the procedures of Japanese grant aid programs, the Japanese consultant firm will conclude a consultant agreement with the implementation organisation of Sri Lanka. After the conclusion of such an agreement, the Japanese consultant firm will work out detailed design documents and supervise the construction work. Construction supervision is aimed at ensuring that the construction work is being carried out in accordance with the design documents. Direction, technical advice, and coordination will also be provided throughout the term of services. This is to ensure the proper implementation and quality of the construction work. The construction supervision services include the following:

1) Cooperation in Tendering/Conclusion of a Construction Work Contract

The consultant shall prepare the documents necessary for tendering the construction, and equipment procurement/installation work. The consultant shall also assist the client in carrying out tasks related to the public announcement of invitation to tender, acceptance of applications, prequalification, distribution of documents to the tenderers, acceptance of tender, evaluation of the tender result, and awarding the contract to the successful tenderer. The consultant shall further assist the client in concluding a construction work contract with the contractor.

2) Direction, Advice, and Coordination with the Contractor

The consultant shall examine the progress and scheme of construction, the construction machinery/material procurement plan, the equipment procurement/installation plan, and give the contractor direction, advice and coordination.

3) Examination and Approval of Working and Production Drawings

The consultant shall examine and approve the working drawings, production drawings, and other relevant documents submitted by the contractor.

4) Confirmation and Approval of the Construction Materials/Equipment

The consultant shall confirm the consistency of the construction machinery/materials and equipment between those which the contractor proposes to procure, and those in the contract documents, and approve their adoption.

5) Plant Inspection

The consultant shall be present at plant inspections of the building components and equipment to ensure their quality and performance.

6) Reporting on the Progress of the Construction Work

The consultant shall inspect the actual conditions of the construction site and the progress of the construction work, and report to both Governments.

7) Completion Inspection and Test Operations

The consultant shall inspect the facilities constructed and the equipment installed and make a test run of each piece of equipment in order to ascertain that all the facilities and equipment are in compliance with the provision of the contract documents, and shall submit an inspection certificate to the Government of Sri Lanka.

8) Training in Operation of the Installed Equipment

Some of the incidental facilities and repair equipment to be procured under this project will require operating skills as well as knowledge of their maintenance and management. For this reason, it will be necessary to train the local engineers and technicians in the operation, troubleshooting, and repairing of equipment during the installation period, while adjusting and

making test runs of this equipment. The consultant shall also give guidance and advice on such training.

(2) Construction Supervision System

Judging from the scale of the project, it is advisable that in carrying out the aforementioned tasks, the consultant dispatch an engineer to Sri Lanka throughout the term of work. The consultant shall also dispatch to the site the number of engineers needed for inspection, direction, and coordination. At the same time, communication and backup systems shall be established in Japan, and managed by the engineer in charge. The engineer in charge of such a system shall report to the Japanese government officials in charge of work progress, payment procedures, completion of the construction of the facilities, installation of the equipment, and any other relevant matters.

Fig. 4-4-1 gives an outline of the proposed construction supervision system and the departments to be involved.

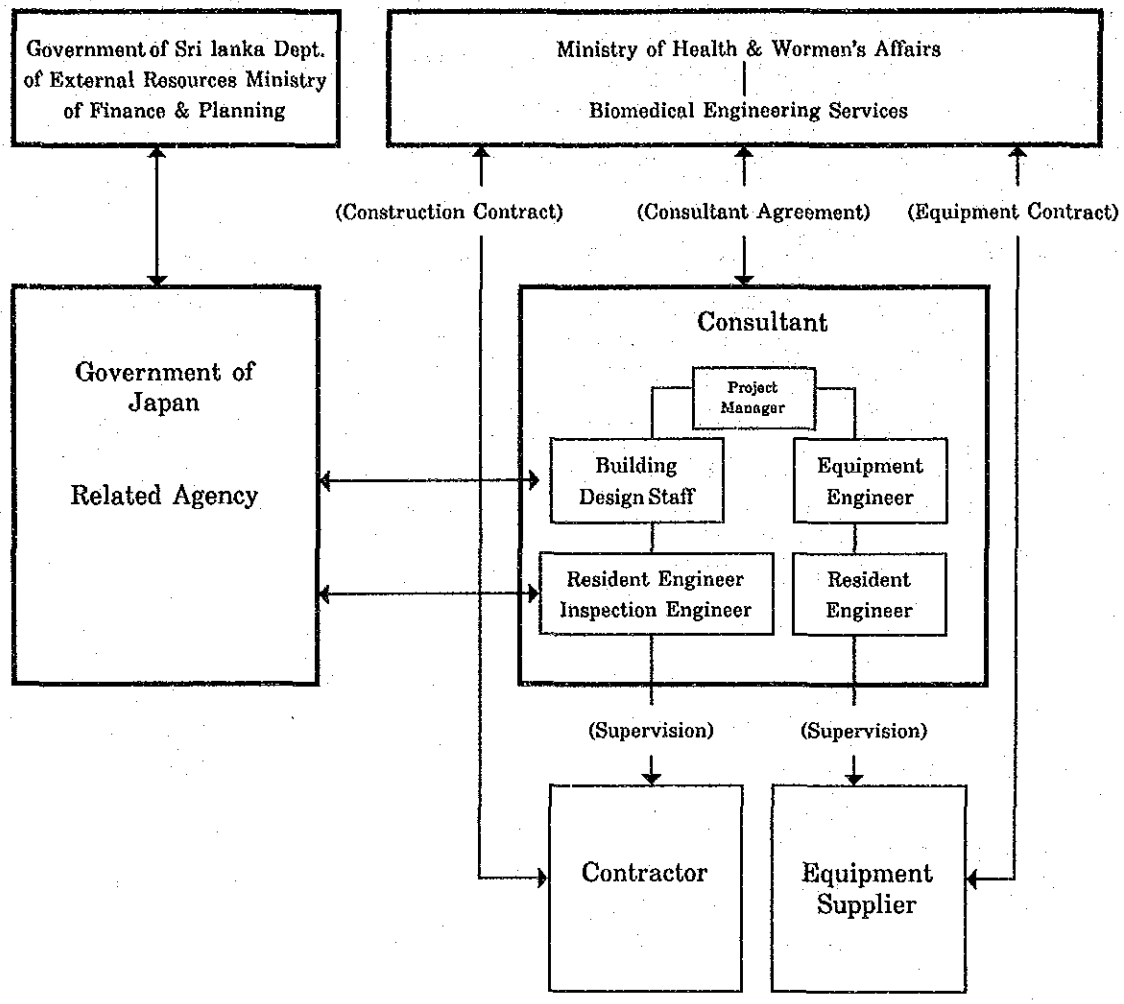


Fig. 4-4-1 Construction Supervision System

4-4-4 Appliance/Material Procurement Plan

(1) Appliance/Material Procurement Criteria

When procuring the appliances and materials for use in the construction of the facilities, the contractor should note the following points:

1) Local Procurement

To facilitate repair and management work after completion of the facilities, the appliances and materials used for the construction of the facilities should be procured locally whenever possible. In this case, orders for each appliance or material should be

placed only after confirming its availability. This will avoid delaying construction work due to supply shortages.

2) Imported Appliances and Materials

Those appliances and materials which are considered poor in quality, or in short supply, should be imported from Japan or a third country. In this case, the contractor will be required to keep close contact with the officials of the Sri Lankan implementation organisation concerning their importation and customs clearance, and ensure that all the necessary procedures are followed without delay.

3) Unit Prices of Appliances and Materials

The unit prices for the importation of an appliance or material (including the packing, transportation and insurance costs) should be compared with that for its local procurement. When the unit price for its local procurement is judged to be lower than or nearly equal to that for its importation, local procurement shall be given priority.

(2) Appliance/Material Procurement Plan

The main places for procurement of the appliances and materials for use in the construction work are all listed in Table 4-4-1.

Table 4-4-1 Materials Procurement

Works	Appliance/Material	Procurement			Remarks
		Local	Japan	Others	
Architectural Work	Cement	○			Unstable in supply but including imported cement, possible to procure locally.
	Sand	○			River sand available
	Gravel	○			Crushed stones available
	Reinforcing bar		○		Imported Re-bar available, but expensive.
	Form (Plywood)			○	Not produced locally
	Brick	○			For partition wall
	Concrete block	○			For partition wall
	Terrazzo tile	○			For floor finishing, not many varieties
	Ceramic tile	○			Produced locally, not many varieties
	Glass	○			Produced locally
	Roof tile	○			Commonly used for roof material, also poor in quality
	Timber			○	Short supply, also poor in quality
	Calcium silicated board		○		Not produced locally
	Doors & Windows (Metal)		○		Not produced locally
	Doors & Windows (Wood)			○	Bad quality
	Hardware		○		Not produced locally
	Paint	○			Easy maintenance
Mechanical Work	Pump		○		Bad quality
	Fan		○		Not produced locally
	Air-conditioner		○		Not produced locally
	Apparatus for septic and neutrilization tank		○		Not produced locally
	Water treatment apparatus		○		Not produced locally
	Sanitary fittings		○		Not produced locally, imported ones available but expensive
	PVC pipe		○		No joints available, also poor quality
	Galvanized steel pipe		○		Imported ones available but hard to find its joints.
Electrical Work	Distribution panel		○		Not produced locally
	Lighting fixtures		○		Bad quality, small variety
	Telephone exchange		○		Not produced locally
	Paging system		○		Not produced locally
	Fire alarm system		○		Not produced locally
	Electric wire/cable		○		Bad quality, small quantity
	Wiring pipe		○		No joints available, also poor quality

(3) Repair Equipment

In principle, repair equipment shall be imported solely from Japan, and not from a third country. It is desirable, however, that copiers and personal computers be procured locally.

As repair equipment and other items are likely to be damaged from shocks, humidity, and high temperature, it will be necessary to pay

close attention to their packing and transportation. In particular, those items of equipment which require careful handling should be packed in a manner that make them resistant to humidity so that they may be transported safely in a tropical environment.

4-4-5 Project Implementation Schedule

When the Exchange of Notes concerning the implementation of the project is concluded between the Government of Japan and the Government of Sri Lanka, the construction and equipment procurement/installation work will be implemented through the following procedures:

(1) Detail Design

After the conclusion of the consultant agreement, the consultant shall prepare design documents, such as detail design drawings, technical specifications, and tender documents, based on the contents of the basic design study report. The consultant shall also obtain approval on the above-mentioned documents from the Sri Lankan side. The time required to complete the procedure is estimated to be three months.

(2) Tendering

The contractors responsible for the construction work and the equipment procurement/installation work will be selected separately by tender. The tender work includes tender announcement, prequalification, reception of tenders, evaluation of the tenders, designation of the contractors and conclusion of the contracts. The time required to complete this procedure is estimated to be about two months.

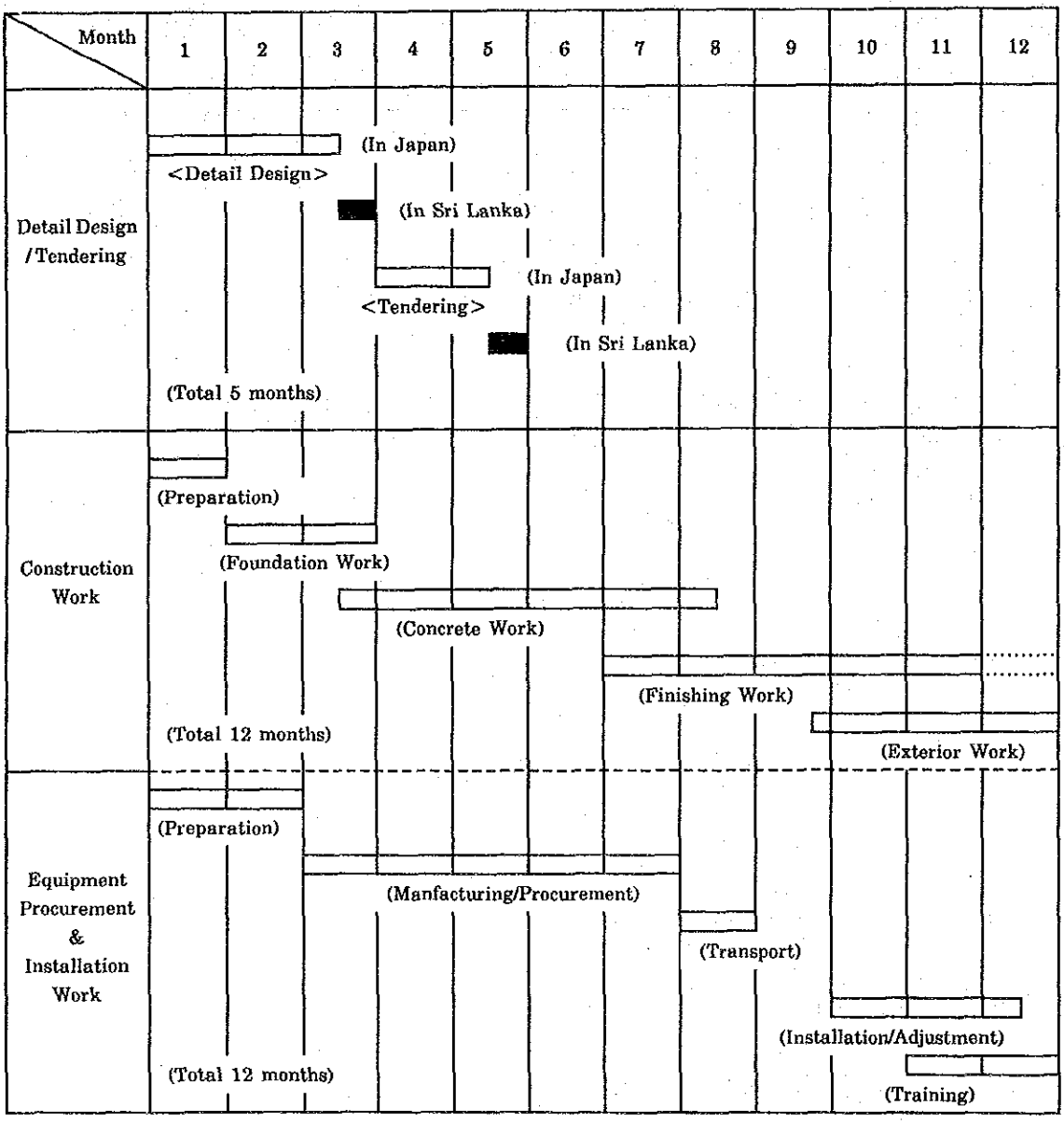
(3) Construction Work and Equipment Procurement/Installment Work

Judging from the contents and scale of the work, and the current state of the local construction industry, it will take 12 months to complete the entire project. This includes the equipment procurement/

installation work, provided the procurement of building appliances and materials and the customs clearance of imported articles proceed smoothly.

In consideration of the above factors, the overall implementation schedule from the conclusion of the Exchange of Notes to the completion of the project is shown in Table 4-4-2.

Table 4-4-2 Implementation Schedule



4-4-6 Estimated Project Costs

(1) Scope of Work

This project is to be implemented through close cooperation between the Government of Japan and the Government of Sri Lanka within the framework of grant aid from the Government of Japan. It is reasonable for the Governments of the two countries to share the project between them as follows:

1) The Work to be Done by the Government of Japan

a) Facilities
- Construction of the buildings described in this basic design study report.
- Electrical, mechanical, and sanitary installation.

b) Equipment
- Equipment procurement work.
- Equipment installation work.

c) Infrastructure
- Substation.
- Water supply and drainage work within the premises.
- Telephone exchange system.

d) Outdoor Structures
- Roads and parking lots within the premises.
- Septic tanks.
- Outdoor lighting.

e) Other Related to the above Work.
- Transportation of equipment, appliances and materials from Japan to Sri Lanka.

- Inland transportation of imported equipment, appliances and materials from port of disembarkation to the project site.

2) The Work to be Done by the Government of Sri Lanka.

a) Site and outdoor structures
- Securing the site for the project.
- Removing the existing structures, trees and so on from the project site.
- Reclaiming the site.
- Cleaning and repair of the drainage ditches around the project site.
- Planting and construction of outdoor structures.

b) Infrastructure
- Supply of electricity to the site.
- Installation of telephone lines to the telephone exchange.

c) Preparatory work
- Installation of temporary electricity supply and telephones.

d) Fixtures and furniture
- Fixtures and furniture other than those supplied by the Government of Japan.

e) Procedural work and expenses borne by the Sri Lankan side
- Banking arrangement expenses.
- Tax exemption procedure expenses.
- Prompt action related to customs clearance and inland transportation.
- Necessary measures for exemption of Japanese nationals involved in the implementation of the project from customs,

duties, domestic taxes, and other fiscal levies in accordance with the verified agreement.

- Arrangements to expedite the acquisition of visas, customs clearance, and any other formalities that may be necessary for the entry of Japanese nationals involved in the implementation of the project.
- Maintenance and management expenses for ensuring that the facilities constructed and the equipment installed are operated properly and effectively.
- Expenses for construction work-related procedures.

(2) Estimated Costs to be Borne by the Government of Sri Lanka

1.	Site preparation work	
	- Work to remove the existing facilities	250,000 Rs
	- Land reclamation and site preparation work	50,000 Rs
2.	Infrastructure	
	- Installation of electricity supply for the site	1,110,000 Rs
	- Installation of telephone lines to the PBX	60,000 Rs
	- Water supply	120,000 Rs
3.	Outdoor structure construction work	
	- Planting	80,000 Rs
	- Fences	420,000 Rs
4.	Furniture and fittings	
	- Curtains	100,000 Rs
5.	Temporary work	
	- Temporary workshop preparation work	250,000 Rs
		2,440,000 Rs

It will be necessary to include in the above total the following as part of the expenses to cover fees and taxes:

- Banking arrangement fee — 0.025 percent of the amount set forth in the E/N
- Import duties — 5 to 50 percent of CIF prices

It is desirable that the Government of Sri Lanka prepare the budget for this project and conduct the construction work on schedule so that the entire project may be implemented smoothly, and the facilities constructed may be utilised effectively.