2-3 Basic Design

2-3-1 Design Concept

The basic design of the facilities and equipment in the Project is based on the following design policies with due consideration of the result of the field survey, the environmental and social conditions of Indonesia, the construction and procurement conditions, the maintenance and management ability of the facility and equipment and construction schedule under Japan's Grant Aid assistance:

(1) The new facilities and equipment should be planned giving consideration to the contents and level of training according to the training and teaching method and curriculum, based on the results of the basic design study.

(2) The new facilities and equipment should be planned in smooth coordination with the PTTC. Also, regarding selection of equipment, coordination and/or cooperation with the other donors should be considered.

(3) The design of facilities, utilities and selection of equipment should be to reduce the maintenance and operation costs and should minimize cost with consideration of easy maintenance and operation system.

(4) The good design points of relevant facilities in Indonesia and Japan should become a reference for the design, while the existing problems of the building should be improved in the plan.

(5) The new facilities should be arranged to meet the functional concept of the existing facilities so as to coexist effectively as a whole and show the significance of this plan. The design of the new building must harmonize with the existing buildings and surrounding environment.

(6) The new facilities should be designed by conducting the natural condition survey such as topographical survey and geotechnical investigation and the design criteria should be established in order to avoid excessive design or shortage of strength.

(7) The new facilities should be designed giving consideration to the local weather condition (rain, sun and wind). More natural ventilation, natural lighting should be considered in order to minimize running costs of electrical lighting, air-conditioning and mechanical ventilation. Also, local custom should be considered in the design of new facilities (e.g. toilet, mandi and pray room).

(8) Local construction methods and local materials should be considered and used as much as possible. Necessary cost should also be considered not only for initial costs, but also for long-term recurrent costs.

(9) The selection of equipment should be made in accordance with the criteria and syllabi. Group experiment as the minimum quantity concept of the Indonesian side is considered possible by the study team. The said concept will be respected but the quantity of the equipment will be decided after the study and analysis of the following factors: 1) scale of facility, 2) utilization prospect, 3) situation of similar facilities and experiment method.

(10) Environmental considerations and safety conditions will have to be taken into account in the design of facilities and selection of equipment.

2-3-2 Study of the Design Criteria

(1) Basic Concept for Determination of Contents and Scale of Facilities (IKIP-Bandung)

The study of the number of rooms or the scale of each room will formulate a useful basis on which to make the design. The design concept and determination of the facilities' scale may have an important impact not only on the function for the facilities, but it will have an important effect on the future operational budget as well as on the activities of FPMIPA. The determination of the facilities scale is based on the following policies:

1) The contents of the facilities and their assumed scale is based on the contents of Minutes of Discussions signed by the Indonesian side and the Basic Study Survey Team and rational number and scale of facilities should be designed and established.

2) Detailed studies on number of occupants, experiment table layout in each laboratory and other furniture layout should be made and scaling of each facility should be established. Also detailed studies should be made with equipment and utility planners in order to formulate proper number and scale of each facility.

3) In particular, number of laboratories and classrooms which are the major facility should be formulated by studies and analysis of the curriculum and number of students. Also by studying the form of each experiment and curriculum, number and scale of each laboratory would be analyzed and laboratories which can be combined should be combined in order to rationalize the facility scale as a whole.

4) As the new building is planned for FPMIPA consisted of 4 departments, facility plan including flow line and zoning should be considered to create an integrated one faculty building not separated 4 departments buildings in order to facilitate total operation and management of FPMIPA.

(2) Study for the Number of Rooms (IKIP-Bandung)

Table of Annex-2 in the Minutes of Discussions (Items Requested by DGHE-Building) were used for this study to determine number and scale of each room in accordance with

a series of discussions. Based on the table of each facilities' number and scale, floor scheme and layout plan were prepared. Items relevant to equipment planning and utility planning were studied and coordinated based on the floor scheme and layout plan .

Also, based on the proposal submitted by IKIP-Bandung a series of discussions were made with staff of each department in order to formulate function and number of occupants in each room.

Furthermore, in order to confirm suitability of number of classrooms and laboratories as determined, total number of units (one unit is 50 minutes teaching) per week for computation of operation rates to be applied for classroom and laboratory is explained as follows:

In IKIP-Bundung teaching hours in a day consist of 9 units, from 7:00 to 17:00 (6 units in the morning, 3 units in the afternoon and 1 unit is 50 minutes) and 8 units are secured for 1 day as 1 unit is reserved for teachers preparation and changing of class. As shown in Table 2-1 below, maximum lesson hours per week would be 44 units based on 8 units per day (but 7 units on Friday and 5 units on Saturday). Since only general subjects are taught on Wednesday, each laboratory would not be operated. However, if In-service training experiments are to be conducted on Saturday and part of Pre-service experiments are to be conducted on Wednesday and Saturday afternoon, laboratories would possibly be used more effectively. Therefore number of units per week to calculate operation rate should be 42 units by adding 3 units each for Wednesday and Saturday afternoon (6 units) to 36 units. However, regarding the 2 Computer Rooms, Primary Teaching and Secondary Teaching Rooms, those rooms are planned to be used by 20 students not 40 students, therefore number of units per week to calculate operation rate should be 21 units (42 x 20/40).

Table 2-1 Classroom Lesson Units Per Week

Day of the Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
Number of Hours	8 units	8 units	8 units	8 units	7 units	5 units	44 units
Pre-service	○	○	○	○	○		5 days
In-service				○	○	○	3 days

Note: On Wednesday only general subject courses are conducted and therefore laboratories are not to be utilized.

Studies for the number of rooms and conclusions are explained as follows:

1) Laboratory

Number of occupants, experiment table and other furniture layout for each laboratory were discussed in detail and scale of each laboratory was determined. Also, detailed discussions were held with equipment planner and utility planner and scale of each laboratory was formulated. Scale of 20 m by 10 m was considered for one laboratory unit. One laboratory unit consists of experiment room, staff room,

preparation room, storage, darkroom, etc. In reviewing the number of class hours per week and type of experiment for each laboratory, laboratories which could be combined were combined and number and scale of laboratories as a whole were rationalized as follows:

① Biology Department (6 rooms → 5 rooms)

General Biology and Plant Structure laboratories were able to be combined after reviewing curriculum and type of experiment. As such, total number of laboratories in Biology Department was reduced to 5 from 6 as originally proposed.

② Physics Department (5 rooms → 5 rooms/Size reduced)

As for Intermediate Physics and Advanced Physics laboratories, the size of each laboratory was able to be reduced to 75% since both rooms could be utilized commonly. As such total number of laboratories in Physics Department remained unchanged, however size of each laboratory was able to be reduced.

③ Chemistry Department (6 rooms → 5 rooms)

Organic Chemistry and Bio & Food laboratories were able to be combined after reviewing curriculum and type of experiment. As such, total number of laboratories in Chemistry Department was reduced to 5 from 6 as originally proposed.

④ Mathematics Department / Common(6 rooms → 4 rooms)

2 Computer Rooms of 40 person capacity were originally proposed. Considering the number of computers to be provided under this project, it was discussed and determined to provide 2 Computer Rooms of 20 Persons for Mathematics Department use and Common use respectively. Also, for Secondary Teaching and Primary Teaching Laboratories, 2 rooms each with 20 person capacity were originally proposed. However, reviewing each curriculum, it was discussed and determined to provide 1 room each with 20 person capacity. As such, total number of laboratories in Mathematics Department/Common was reduced from 6 to 4.

As a result of reviewing the number of laboratories, total number of laboratories was reduced to 19 from 23 as originally proposed. In comparison with the number of laboratories in IKIP-Malang (Physics Department: 7, Chemistry Department: 6, Biology Department: 11, Mathematics Department: 8, Total 32 laboratories), number and scale of laboratories for this project were rationalized.

Based on the contents of laboratories as rationalized in each department, as shown in Table 2-2, experiment subjects and class hours per week were summarized and operation rate of each laboratory and each department were computed in accordance with the following conditions:

Operation rate of laboratories per each department vary from approximately 20 to 80 percent as shown in Table 2-2. Operation rates of each laboratory are considered to be higher than those of Japanese public and/or national universities, which is only 50%. However, if time-table and preparation system of each laboratory are rearranged by each department, number of laboratories in each department are sufficient in order to conduct every experiment for both In-service and Pre-service training as indicated on the curriculum.

Table 2-2 Number of Hours per Week for Experiment Subjects and Operational Rates at Each Laboratory

Dept.	Laboratory (Capacity)	Experiment Subject	Pre-service		In-service		Number of Hours Per Week (Operation Rate)		Operation Rate	
			Odd Semester	Even Semester	Odd Semester	Even Semester	Odd Semester	Even Semester	Odd Semester	Even Semester
Biology	①General Biology/Plant Structure(40)	General Biology	36				45 (107%)	27 (64%)	71%	51%
		Plant Morphology		9						
		Plant Anatomy		9						
		Botany Phanerogamae	9							
		Botany Cryptogamae		9						
	②Ecology(40)	Animal Ecology	9	6			24 (57%)	24 (57%)		
		Plant Ecology	9							
		Experiment Technique		18	6					
	③Physiology(40)	Plant Physiology	9				33 (79%)	9 (21%)		
		Animal Physiology	9		6					
		Biochemistry		9						
		Human Anatomy and Physiology	9							
	④Animal Structure(40)	Embryology		9			27 (64%)	24 (57%)		
		Animal Structure	9							
		Vertebreta Zoology	9							
		Invertebreta Zoology	9			6				
		Entomology		9						
	⑤Microbiology(40)	Microbiology		9		6	21 (50%)	24 (57%)		
		Genetics		9	6					
		Applied Biology	9		6					
Physics	①Basic Physics(40)	Fundamental Physics I	36				36 (86%)	36 (86%)	40%	39%
		Fundamental Physics II		36						
	②Electronics(40)	Electronics I	9				9 (21%)	9 (21%)		
		Electronics II		9						
	③Intermediate Physics(40)	Physics Laboratory I	18				18 (43%)	18 (43%)		
		Physics Laboratory II		18						
	④Advanced Physics(40)	Mechanics			6		21 (50%)	15 (36%)		
		Nuclear Physics	9		6					
		Modern Physics		9		6				
	⑤Earth & Space Science(40)	Science of the Earth & Universe		9			9 (21%)	9 (21%)		
		Primary Science	9							
Chemistry	①Basic Chemistry(40)	Basic Chemistry I	36				36 (86%)	36 (86%)	56%	57%
		Basic Chemistry II		36						
	②Organic / Bio & Food(40)	Organic Chemistry I	18				27 (64%)	33 (79%)		
		Organic Chemistry II		18						
		Biochemistry	9							
		Food Chemistry		9		6				
	③Physics & Inorganic Chemistry(40)	Physics Chemistry I	9				18 (43%)	18 (43%)		
		Physics Chemistry II		9						
		Inorganic Chemistry I	9							
		Inorganic Chemistry II		9						
	④Analytical Chemistry(40)	Analytical Chemistry I	9				15 (36%)	18 (43%)		
		Analytical Chemistry II		9						
		Environmental Chemistry		9	6					
	⑤Instrumental Analysis(40)	Analytical Instrument Chemi.	9		6		21 (50%)	15 (36%)		
		Service for Other & Reports	6	9		6				
Mathematics	①Computer Room (20) (Common)	Introduction to Computer (Chem)		12		4	16 (76%)	22 (105%)	81%	81%
		Introduction to Computer (Bio)		6						
		Computer (Physics)	12		4					
	②Computer Room(20) (Mathematics)	Computer Programming (Math)	12			8	18 (86%)	12 (57%)		
		Numerical Analysis (Math)	6			4				
Common	③Primary Teaching (20)	Teaching Method	4				4	8	19%	38%
		Primary Science		4						
		Primary Mathematics II		4						
	④Secondary Teaching(20)	Teaching and Learning Strategy	12		2		14	12	67%	57%
		Teaching Planning		12						

2) Classrooms (27 rooms → 16 rooms)

As stated in "(2) Study for Number of Rooms", 44 lesson units per week are the basis when classrooms are operated 100 % and it would not be possible to operate classrooms 100% in view of time table arrangement. In case of national or public universities in Japan, their operation rates of both classrooms and laboratories are 40 to 50 % and maximum operational rate up to 80 % would be considered possible. However, operation of classrooms at 80 % is subject to all teachers being stationed in the campus during the lesson hours from Monday through Saturday. Therefore, basis to calculate operation rate of classroom should be 33 units, 75% of 44 units, and required number of classrooms should be calculated on this basis. However, on Saturday, maximum operation rate would not exceed more than 25% because only In-service course teaching is conducted. Therefore, operational rate from Monday to Friday practically should considered to be more or less 80%.

Table 2-3 shows how many hours (units) are used for Pre-service or In-service training program in each department at 120, 80, 40 and 20 student classrooms respectively. One classroom unit is considered to be 40 students.

Table 2-3 Required Number of Classrooms (IKIP-Bandung)

Department	Program	Odd Semester				Even Semester			
		Number of Hours Per Week by Classroom Types				Number of Hours Per Week by Classroom Types			
		120 Ss	80 Ss	40 Ss	20 Ss	120 Ss	80 Ss	40 Ss	20 Ss
Biology	Pre-service	19	8	96	30	19	6	72	8
	In-service	0	0	24	12	0	0	20	0
	Sub Total	**19**	**8**	**120**	**42**	**19**	**6**	**92**	**8**
Chemistry	Pre-service	19	8	107	28	22	9	56	8
	In-service	0	0	32	12	0	0	4	8
	Sub Total	**19**	**8**	**139**	**40**	**22**	**9**	**60**	**16**
Physics	Pre-service	19	8	92	30	19	6	84	8
	In-service	0	0	30	0	0	0	20	0
	Sub Total	**19**	**8**	**122**	**30**	**19**	**6**	**104**	**8**
Mathematics	Pre-service	20	6	125	30	18	4	96	8
	In-service	0	0	26	12	0	0	38	0
	Sub Total	**20**	**0**	**151**	**42**	**18**	**4**	**134**	**8**
Primary Science & Mathematics	Pre-service	0	0	28	0	0	0	28	0
	In-service	0	0	40	0	0	0	40	0
	Sub Total	**0**	**0**	**68**	**0**	**0**	**0**	**68**	**0**
Total		**77**	**24**	**600**	**154**	**78**	**25**	**458**	**40**
Number of Classrooms Required		**3(2)**	**1**	**18**	**5**	**3(2)**	**1**	**14**	**2**

According to the above table, a larger number of classroom would be required for Odd Semester than for Even Semester for each type of classroom. As such 3 Nos., 1 No., 18 Nos. and 5 Nos. are required for Classroom (120Ss.), Classroom (80Ss.), Classroom (40Ss.) and Classroom (20Ss.) respectively. However, according to the series of discussions with IKIP-Bundung, existing classrooms in the existing Graduate School can take over 1 Classroom (120Ss.) and 10 Classrooms (40Ss.) from the above required numbers, and therefore it was determined to provide 2

Classrooms (192m^2 for 120Ss.), 1 Classroom (144m^2 for 120Ss.), 8 Classrooms (80m^2 for 40Ss.) and 5 Classrooms (64m^2 for 20Ss.).

3) Workshop (2 rooms)

2 Student Workshops and 1 Service Workshop were proposed originally. However, as a result of the study, one workshop for common use was considered. Also, as an electrical workshop separated with the above is required, one small electrical workshop is to be provided.

4) Staff Room / Lecturers Room (68 rooms)

Presently FPMIPA has 200 teaching staff. As aforementioned, each laboratory adjoins a Staff Room. Number of staff to be allocated to those Staff Rooms are summarized as follows:

① Biology Department Laboratory Staff Rooms (5 rooms)		24 staff
② Chemistry Department Laboratory Staff Rooms (5 rooms)		20
③ Biology Department Laboratory Staff Rooms (5 rooms)		25
④ Mathematics/Common Staff Rooms (3 rooms)		14
Total	① ~ ④	83 staff

In addition, numbers of staff to be allocated to each Lecturers Room (for 1 person/2 persons) for each department are as follows:

⑤ Mathematics Department (5 rooms for 1 person ea.)	5 staff
Mathematics Department (7 rooms for 2 persons ea.)	14
Sub Total	19
⑥ Physics Department (5 rooms for 1 person ea.)	5
Physics Department (7 rooms for 2 persons ea.)	14
Sub Total	19
⑦ Chemistry Department (5 rooms for 1 person ea.)	5
Chemistry department (8 rooms for 2 persons ea.)	16
Sub Total	21
⑧ Biology Department (5 rooms for 1 person ea.)	5
Biology Department (8 rooms for 2 persons ea.)	16
Sub Total	21
Total⑤ ~ ⑧	80 staff

From the above assumption, a total of 163 staff (83 + 80) would be able to use staff rooms in the new facilities. According to explanation of IKIP-Bandung, remaining 37 staff are to be allocated to the existing staff building.

5) AVA Room (1 room)

Audio visual education is normally conducted in the common classrooms using slide, OHP and video. AVA room is defined as "audio visual teaching material production room" and used for the purpose of video and personal computer editing. Since it is used commonly by every department, only one AVA Room is to be provided with a minimum size. Certain space should be considered for stocking some equipment and for experts and teachers preparation. Also, one AVA Preparation Room is to be provided adjacent to the AVA Room.

6) Dean Office/Assistant Dean Office (4 rooms)

One Dean Office and 3 Assistant Dean Offices are to be proposed. According to discussion with IKIP-Bandung, those rooms should be located in the same zone with common secretary and reception spaces.

7) Project Management Office (1 room) / JICA Experts Room (3 rooms)

As proposed, one Project Management Office and Expert Room (for 5 experts) are to be provided. Meeting spaces are to be considered which are to be used by project management staff and experts.

8) Head and Secretary of Department Office (4 rooms) / Administration Office (4 rooms) / Seminar & Meeting Room (4 rooms)

The above rooms are to be provided in each department zone.

9) Faculty Administration Office (2 rooms)

According to the proposal from IKIP-Bandung, 4 separate rooms (64m^2 each) are requested. However, as a result of the discussion with IKIP-Bandung, number of rooms was reduced to 2 with the zoning of 4 sections as follows. ①is to be located adjacent to the entrance hall considering the communication with the students, ④is to be in the separate room in view of better security.

① Academic Affairs Section
② Technical Section
③ Student Affairs Section
④ Finance and Personal Affairs Section

10) General Storage (1 room)

Storage space is considered to be important for the operation of the facility. One General Storage room is to be allocated.

11) Support Facilities

① Curriculatorium (1 room)

Curriculatorium is to be used by staff and for keeping textbooks, teaching manuals and kits by allocating bookshelves, tables and lockers. Students will use the Central Library, and no FPMIPA's library for staff and students is to be provided. Curriculatorium is to provide space for stocking of materials and reading and be provided next to AVA room.

② Auditorium (1 room)

IKIP-Malang has one auditorium to accommodate 300 persons. Also, IKIP-Yogyakarta has a large space provided in the Physics Department which can be used for an auditorium and another big room in the existing common building. In this project, it was considered that one auditorium to accommodate more than 200 persons would be necessary in FPMIPA IKIP-Bandung. Besides the auditorium itself, waiting room, storage and halls are effectively planned in order for it to function properly. According to the auditorium program, seminars are the main function. For that purpose, movable chairs are considered to be suitable.

③ Small Book Store (1 room)

One small book store is to be provided close to the Cafeteria considering the zoning and flow lines of staff and students. The small book store will sell books and stationery to the staff and students.

④ Cafeteria (1 room)

Instead of providing a large dining room, one small cafeteria is to be provided for In-service Training students (about 320 persons) and staff to take a light meals between 7:00 and 16:00 hours. Serving system should be self-service and tables and chairs for 40 persons are to be provided. In the kitchen area, storage room should be considered for storing materials such as rice and potatoes. During the B/D study, cooking menu was presented by IKIP-Bandung and necessary kitchen equipment and their space are to be planned accordingly.

(3) Computation for Scale of Each Room (IKIP-Bandung)

In accordance with the scale of the project mentioned in "(1) Basic Concept for Determination of Contents and Scale of Facilities", the floor areas are estimated based on the expected rooms and facilities required for the FPMIPA. The facility scale will be formulated based on similar facilities in Indonesia, such as the existing facilities of IKIP-Bandung and new facilities of IKIP-Yogyakarta, IKIP-Malang, other Grant Aid projects and design manual as well as the result of discussions with the Indonesian side.

1) Classrooms

According to IKIP-Bandung's proposal, 4 types of classroom, i.e. 3 class rooms for 120 persons (180m^2 each), 1 Classroom for 80 persons (120m^2), 18 Classrooms for 40 persons (60m^2 each) and 5 Classrooms for 20 persons (30m^2 each) were proposed. Normally 40 students are considered for 1 class unit, however, in reality, 40 to 50 students should be considered for 1 class unit. The above scales are computed based on 1.5 m^2 for 1 student. According to other IKIP's and similar Grant Aid projects, scale of classrooms in IKIP-Malang is 1.68m^2 for one student, in Myammer Nursing University 1.6m^2 for one student (80m^2 for 50 students). For this project, scale of classroom should be determined as a scale of ordinary classroom because laboratories are provided independently and classrooms should be used for its own use.

Therefore, 2 Nos. of Classrooms (for 120 students) with 192m^2 each, 1 No. of Classroom (for 80 students) with 144m^2, 8 Nos. of Classrooms (for 40 students) with 80m^2 and 5 Nos. of Classrooms (for 20 students) with 40m^2 are planned, based on the standard classroom accommodation being 40 students but 50 students as maximum, since currently classes are being conducted for more or less 50 students.

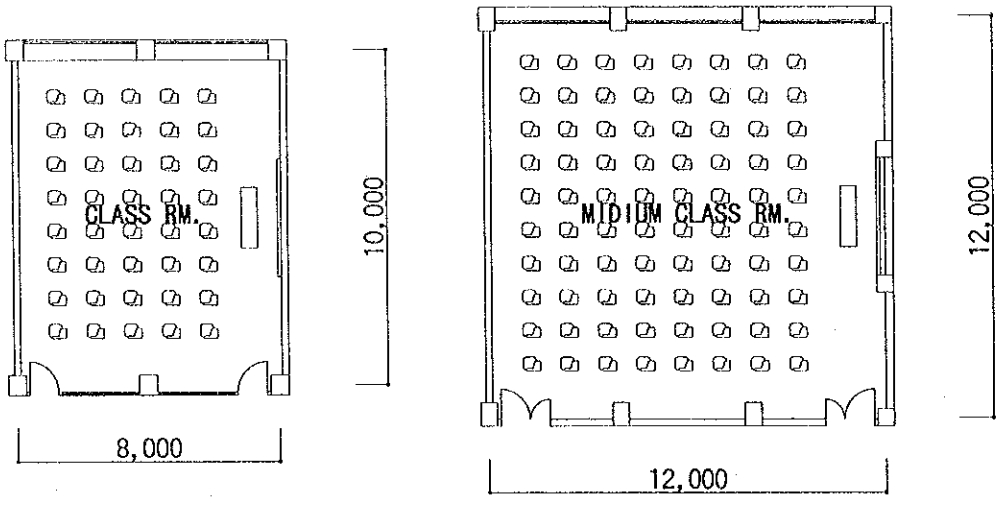

Figure 3-1 Classroom

2) Laboratory

In each laboratory, 40 students are the standard for one class lesson (however 20 students are the standard for Computer Rooms in Mathematics Department). For each laboratory, staff room, preparation room and stock room (equipment room) should be adjoined. By adjoining such rooms, communication between staff would become smooth which improves the level of education and provides better security for operation and maintenance of equipment. Number of staff, experiment table layout, other furniture layout were discussed in detail with IKIP-Bandung and scale of each laboratory was reviewed and formulated.

In addition, discussion was made with equipment and utility planners in order to confirm the scale of each laboratory.

According to the scale of other IKIP's laboratories, one laboratory is 105.84m^2 (12.6m x 8.4m) in IKIP-Malang and 2.6m^2 provided for one student, 325m^2 provided for 2 Physics laboratories and 990m^2 provided for 4 Chemistry laboratories in IKIP-Yogyakarta. According to Philippine's Science and Mathematics Training Center, one laboratory is 128m^2 (16m x 8m) and 2.5m^2 provided for 1 student. As for Myammer Nursing University, 1 laboratory is 120m^2 (10m x 12m) and 2.4m^2 provided for 1 student. As for this project, laboratory unit frame was standardized (20 m x 10 m) and 140m^2 allocated for experiment room and remaining 60m^2 allocated for staff room, preparation room and stock room (equipment room). Scale of each staff room adjoined to each experiment room was determined based on the number of staff to be accommodated. According to "(2) Study for the Number of Rooms", 4 to 7.5m^2 area is provided for one person in each staff room.

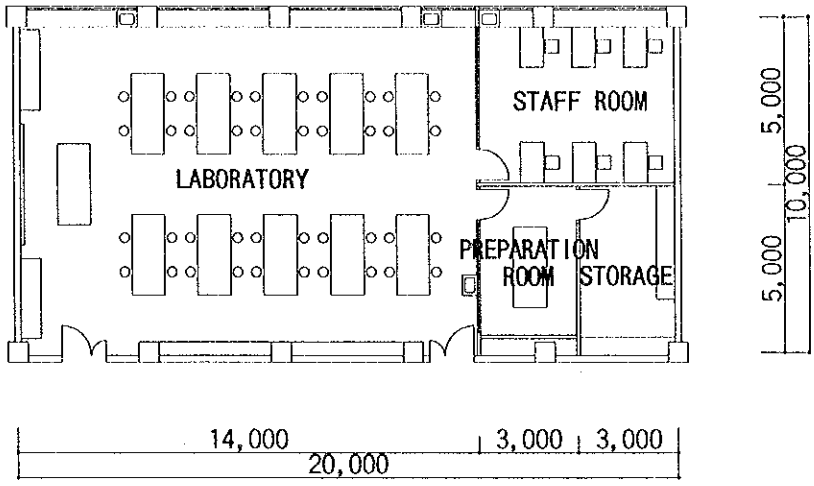

Figure 3-2 Laboratory (Physics)

3) Computer Room

According to IKIP-Bundung's proposal (July 1998), 2 Nos. of 200m^2 computer rooms (each for 40 students) were requested. As the result of discussions with IKIP-Bandung it was decided to provide 2 Nos. of computer rooms (each for 20 students). One computer room is to be provided for Mathematics Department and other for Common use. Between two computer rooms, staff room and printing room are planned for common use. Therefore scale of each computer room was determined to be 96m^2. According to other IKIPs, 144m^2 computer room is provided at IKIP-Malang and 100m^2 computer room is provided at Physics Department in IKIP-Yogyakarta.

For effective use of computer rooms, air conditioners, stabilizer and free access floor are considered to be provided.

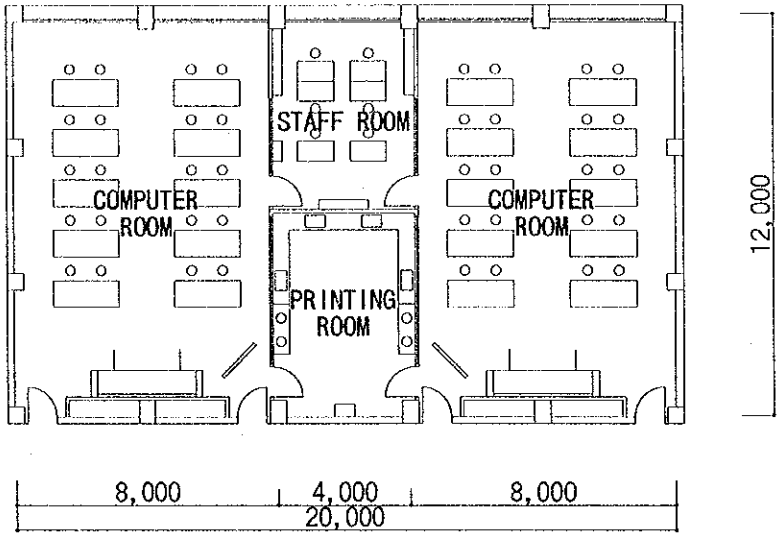

Figure 3-3 Computer Room

4) Workshop

Workshop is a major facility for learning teaching material development by making equipment, and repairing of equipment to supplement shortage. According to IKIP-Bandung's proposal, two 100m^2 student workshops and one 35m^2 service workshop were requested. However, after a series of discussions it was decided to provide one common workshop with approx. 150m^2. By arranging machines and equipment effectively in one room, machines and equipment could be zoned and running costs such as electricity would be saved. Electrical workshop, however, is to be provided independently with a minimum size of approx. 20 m^2 in response to the request.

5) Cafeteria

According to the series of discussions with IKIP-Bandung it was determined to provide a simple self-service style Cafeteria instead of a large dining room. According to IKIP-Bandung, the cafeteria is to be used by 320 In-service Training students and staff. The cafeteria is to be open from 7:00 until 16:00 and the space for taking snacks is planned for 40 persons seating capacity at one time. During B/D study period, menu for the cafeteria was submitted from IKIP-Bandung in order to plan kitchen space, equipment and space for storing foods. Therefore, the scale of the cafeteria including dining and kitchen spaces is determined to be about 160m^2.

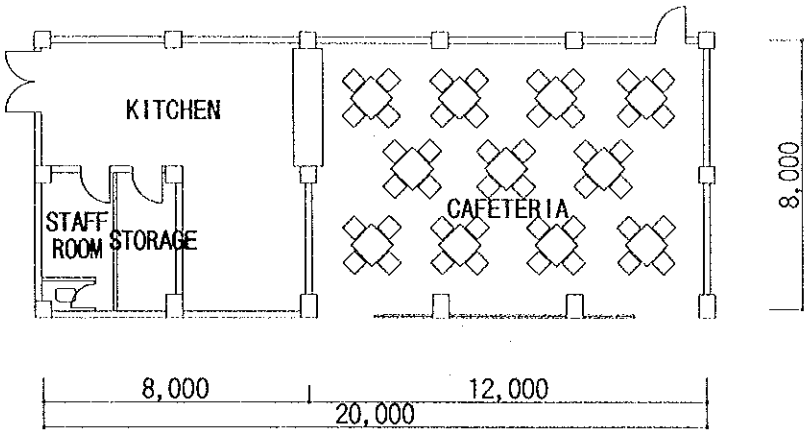

Figure 3-4 Cafeteria

6) Curriculatorium

Curriculatorium is provided to keep text books, teaching manuals and other information to be used by FPMIPA staff. According to IKIP-Bandung's proposal, 40 m^2 of curriculatorium was originally requested. However, as a result of a series of discussions with IKIP-Bandung, spaces for shelves, lockers, tables etc. as well as reading space are required and total area is considered to be about 120m^2. Consideration is also given to the location of the curriculatorium which should be close to the AVA Room. According to IKIP-Bandung, students should use the Central Library which is commonly used by all students and staff in IKIP-Bandung.

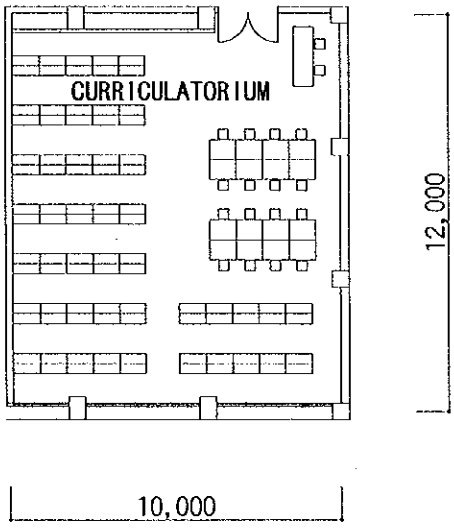

Figure 3-5 Curriculatorium

7) AVA Room

AVA room is defined as "audio visual teaching material production room" and used for the purpose of video and personal computer editing. Audio visual education is normally conducted in the common classrooms by using slide, OHP and video . Since AVA Room is used commonly by every department, only one AVA Room is to be provided with an approximate scale of 40 m^2 considering minimum spaces for storing of some equipment, experts and staff's working space. Also, AVA Preparation Room is to be provided adjacent to the AVA Room.

8) Auditorium

According to IKIP-Bandung's proposal, 400m^2 of Auditorium for 200 persons was requested. Purpose of the auditorium is mainly for seminars and conferences. Considering such purposes, movable type chairs are to be planned. Also, considerations are given to the function of the auditorium by providing adjoining waiting room, storage and small halls to the corridor side. Total area including such adjoined facilities is to be approx. 700m^2 at least. According to the scale of auditoriums in other IKIPs and relevant facilities, IKIP-Malang is 300m^2 for seating area and 1.5m^2 provided for one person, Philippine's Science and Mathematics Training Center (for 250 persons) is 480m^2 and 1.92m^2 provided for one person. Based on such data and if an area of 1.7 to 2m^2 for one person is considered for total capacity of 200 to 250 persons, scale of seating area itself is to be 320 to 350m^2.

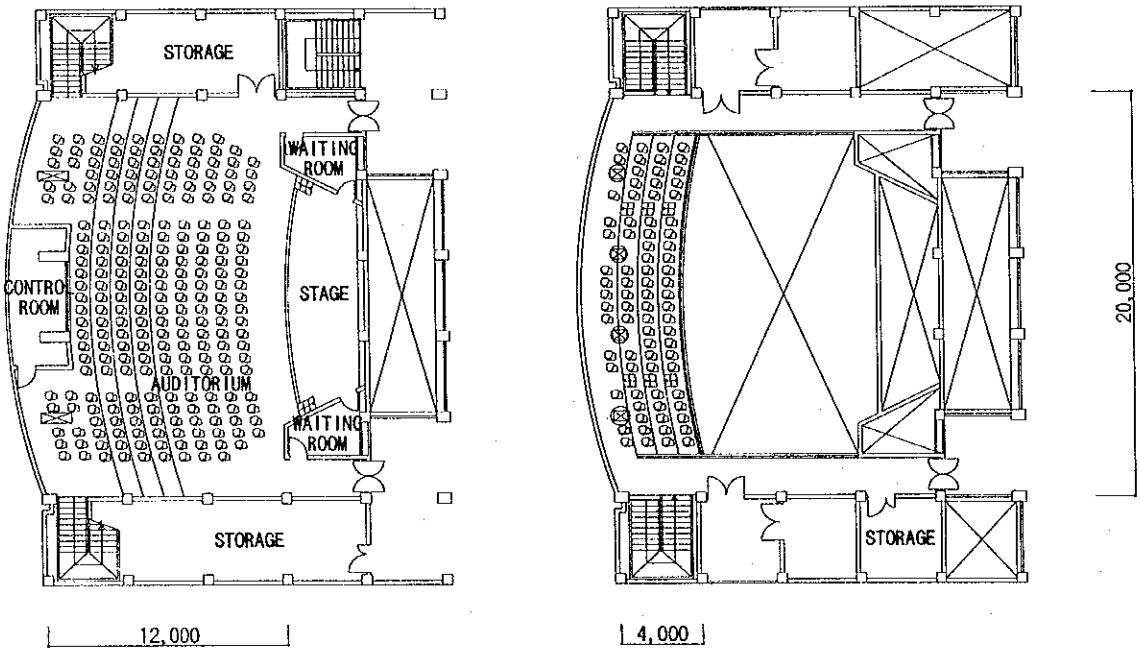

Figure 3-6 Auditorium

9) Administrative Rooms

Administrative rooms consist of Dean and Assistant Deans Offices, Project Management Office, Experts Room, Faculty Administration Office, Department Administration Offices, Seminar and Meeting Rooms and storage etc. Areas for Dean and Assistant Deans are planned to be $45m^2$ and area for Faculty Administration Office is planned to be $270m^2$ referring to the data of other similar projects. Area of Seminar and Meeting Rooms which are provided for each department is planned to be approx. $60m^2$ ($1.5m^2$ for 1 person). Experts Room and Project Management Office are to be adjoined for better communication and the areas to be provided are $45m^2$ and $90m^2$ respectively.

10) Other Facilities

As for other facilities, rooms such as Room for Praying, Small Book Store, Electric and Mechanical Rooms are to be provided based on IKIP-Bandung's proposal. According to the series of discussions with IKIP-Bandung, the Room for Praying should be planned to provide space for 5 men and 5 women with a leader in the middle are able to pray westward. Washing rooms for men and women independently are to be provided for washing hands and feet in front of the pray room . As the result of discussions, total area for the Room for Praying including washing rooms is planned to be $50m^2$. As for the Small Book Store, which is to be located adjacent to the cafeteria, the area is planned to be approximately $50m^2$ as IKIP-Bandung requested. Electrical and Mechanical Rooms consist of electrical room, generator room, mechanical room and gas cylinder room. Scale of each room should be studied and determined based on the layout of equipment. Currently, a total area of $250m^2$ is planned to be provided for Electrical and Mechanical Rooms.

(4) Facilities Required and Area of Each Facility

Based on the result of discussions with the Indonesian side during the B/D study period, scale of each facility were computed and the results are summarized in Table 2-4. According to this assumption, total area including public space such as corridors and stairs is approx. $12,500m^2$.

Table 2-4 Facilities Required and Area of Each Facility (IKIP-Bandung)

Division Name		IKIP Bandung Proposal July, 1998			Result of Study (Nov, 1998)		
		Facilities	No. of Rooms	Area	Facilities	No. of Rooms	Area
LABORATORY	Mathematics Laboratory	Computer Room(40)	2	400	Computer Room	1	240
		Teaching Secondary(20)	2	200	Teaching Secondary/Primary	1	240
		Teaching Primary(20)	2	200			
		Total		800	Total		480
	Physics Laboratory	Basic Physics (40)	1	200	Basic Physics Lab.	1	200
		Electronics (40)	1	200	Electronics Lab.	1	200
		Intermediate Physics (40)	1	200	Intermediate/Advance Physics Lab.	1	280
		Advanced Physics (40)	1	200	Earth & Space Science	1	200
		Earth & Space Science	1	200			
		Total		1,000	Total		880
	Chemistry Laboratory	Basic Chemistry (40)	1	200	Basic Chemistry Lab.	1	200
		Organic Chemistry (40)	1	200	Organic / Bio & Food Lab.	1	200
		Physical & Inorganic (40)	1	200	Physical / Inorganic Lab.	1	200
		Analytical Chemistry (40)	1	200	Analysis Lab.	1	200
		Instrumental Analysis (40)	1	200	Instrumental Lab.	1	200
		Bio & Food (40)	1	200			
		Total		1,200	Total		1,000
	Biology Laboratory	General Biology (40)	1	200	General / Plant Structure Lab.	1	200
		Ecology Lab.(40)	1	200	Ecology Lab.	1	200
		Physiology (40)	1	200	Physiology Lab.	1	200
		Animal Structure (40)	1	200	Animal Structure Lab.	1	200
		Plant Structure (40)	1	200	Microbiology Lab.	1	200
		Microbiology (40)	1	200			
		Total		1,200	Total		1,000
	General and Common Classrooms etc.	Large Classroom (120)	3	540	Large Classroom (120)	2	384
		Midium Classroom (80)	1	120	Midium Classroom (80)	1	144
		Classroom (40)	18	1,080	Classroom (40)	8	640
		Small Classroom (20)	5	150	Small Classroom (20)	5	200
		AVA Room (40)	1	100	AVA Room	1	40
		Auditorium	1	400	Auditorium	1	622
		Cafeteria	1	100	Cafeteria	1	160
		Curricuratorium	1	100	Curricuratorium	1	120
		Small Book Store	1	40	Small Book Store	1	48
		Room for Praying	5	45	Room for Praying	1	64
		Storages	9	205	Storages	LS	85
		Workshop (Student)	1	200	Workshop	1	164
		Workshop (Service)	1	35	Printing Room	1	20
		Machine Rooms	3	120	Computer Room	1	40
					Machine Rooms	LS	304
		Total		3,235	Total		3,035
	Administration Division etc.	Dean Office	1	36	Dean Office	1	40
		Assist. Dean Office	3	48	Assist. Dean Office	3	80
		Project Management Office	1	40	Project Management Office	1	40
		Experts Room	5	80	Experts Room	3	80
		Head & Secretary of Dept. Office	4	64	Head & Secretary of Dept. Office	4	84
		Lecturers Room (1)	30	480	Lecturers Room (1)	20	310
		Lecturers Room (2)	50	1,250	Lecturers Room (2)	30	610
		Faculty Administration Office	4	256	Faculty Administration Office	4	240
		Dept. Administration Office	4	256	Dept. Administration Office	4	84
		Seminor & Meeting Room	4	240	Seminor & Meeting Room	4	208
		Rest Rooms & Janitor Rooms	LS	200	Other Rooms (Labatories etc.)	LS	513
		Teachers Quarters	LS	2,500	Corridors, Staires etc <31%>	LS	3,930
		Total		5,450	Total		6,218
		Grand Total		12,885	Grand Total		12,613

①Grand Total of IKIP-Bandung Proposal of July 1998 does not include general areas such as corridors.
②Figures in () indicate capacity.
③Figures in <> indicate the ratio of general areas such as corridors to the total floor area.
④Each laboratory area includes the Staff Room and Preparation Room areas.

(5) Design of Equipment

The project does not only include the provision of experiment equipment but the procurement of audiovisual editing and workshop equipment for the development and creation of teaching materials and teaching aids. The development of equipment for teaching aids and materials is expected to contribute to the improvement of the quality of education and the implementation of the PTTC. It must be duly noted that the Indonesian side maintains high expectations on the Project's impact. The design criteria in each FPMIPA are as follows:

1) IKIP-Bandung

For effective coordination and cooperation with the PTTC, most of the equipment excluding several items will be installed in the existing facilities which can adequately provide sufficient space, except the department of Physics and Mathematics education. Main equipment such as personal computers and other related equipment for the department will be procured and installed in the new building after its completion. Experiment tables, draft chambers for the department of chemical education and consumables will be housed in the new building and thus will have to be procured after its construction.

Water to be used in experiments will be treated by a portable type wastewater treatment equipment to avoid adverse environmental effects. The wastewater from drainage facilities will have to be addressed by the engineering plans for the facility.

2) IKIP-Yogyakarta

The construction of a new building for the department of chemical education is scheduled to restart, thus equipment planning for said department will have to be for the new building. The air-conditioners, exhaust fans and black curtains involving installation works have been included. However, those needing major installation works were excluded. Personal computers for the department of Mathematics education were excluded because of the existing large number of computers including PGSM project procurement. The equipment procured in 1997 by the PGSM Project are included in the existing equipment but equipment in 1998 under PGSM Project will have to be adjusted in terms of quantity upon confirmation with the Indonesian side. Space for installation is not a problem for the said equipment. The portable type wastewater equipment will be included.

3) IKIP-Malang

All departments have transferred to the new building thus there is no problem for the installation of equipment. The concept of the equipment necessary for installation work, the equipment procured by PGSM Project and the portable type

wastewater treatment equipment will be the same as that adopted for IKIP-Yogyakarta. The department of Mathematics education has enough personal computers, but have some problems in practice due to the absence of hard disk. Through the study for improvement, it was found out that some repairing or up-grading of the existing computers would be necessary. However the department of Mathematics education is scheduled to introduce 19 units of new personal computers under the PGSM Project, therefore the procurement of personal computers is suspended in this project. Three laboratories at the third floor of the department of chemical education building are currently used as general lecturing rooms due to lack of experiment tables. It should be noted that the necessary experiment tables are scheduled to be procured by IKIP-Malang from its own budget.

2-3-3 Basic Design

(1) Site Layout Plan (IKIP-Bandung)

The site layout plan of this project was planned focused on the following points which give full consideration to site conditions (environmental and natural conditions, site conditions and conditions around the site) in order to review and analyze total composition of the facility and improve the previously mentioned subjects. The site layout was planned based on the following policies.

1) Basic Policy

① It is important to consider the flow lines of the whole IKIP campus and relations with existing facilities in the site layout plan and approach in order that people and articles can move smoothly and a good relation with other faculties can be kept.

② Consideration should be given to the most effective land use and better natural lighting and ventilation in the site layout plan. Options of inner court type, linear type and intensive type were compared and reviewed and inner court type was considered to be the most appropriate plan.

③ It is important to consider scenery and harmonization with the surrounding buildings in the site layout plan. As the limit for buildings is 8 stories and the site is excavated and filled land sloping from north to south, the view should be open to the city of Bundung toward the south.

④ Consideration should be given to the orientation of the building (east-west axis is better) in view of getting better shading of sunlight and scenery. Also, it is important to consider consistency with the layout and characteristics of surrounding buildings.

⑤ It is important to consider distances between buildings and their orientation in order to secure good natural ventilation and lighting without mechanical devices throughout the year with consideration of the climate in Bandung.

⑥ Safety, easy approaches for access and security check points should be considered in order to make a proper site layout plan. Approach from the south road is considered to be the most appropriate because of level difference at north, east and west boundaries and considering the new road plan at south and east sides of the site.

⑦ Since FPMIPA serves a large number of people, consideration should be given to the flow lines of students, staff, teachers, guests and services in planning of the site layout so that there will be no confusion of such flow lines.

(2) Architectural Design (IKIP-Bandung)

1) Floor Plan

In terms of floor planning, the calculated areas and the layout plan as aforementioned were used and each facility was planned on the basis of the following criteria.

① The floor plan should be coordinated considering the relation between each facility. Contents and function of each facility shall be considered in the floor plan so that the facility can be integrated effectively.

② The facility floor plan takes basic frontage and depth spans of 4m and 10m and standard laboratory unit's frontage and depth spans are planned to be 20 m and 10 m.

③ Areas for administration, education/experiment, auditorium and public areas should be zoned clearly and location and method of connection among each zone shall smoothly be coordinated so that flow lines between those sections would not be confused.

④ Zoning of laboratories in each department and grouping of laboratories shall be effectively integrated within each department zone. As for ordinary classrooms which are to be used commonly, the numbers and scale should be rationalized.

⑤ It is important to integrate required rooms and equipment effectively so as to correspond to flexibility of planning. Grid span should be in a standard module, in particular for laboratory and classroom units. Building should be planned

with most economical and effective module used in Indonesia considering layout plans of equipment, furniture etc. for economical construction.

⑥ In floor planning, the regional nature and climate shall be considered in order to have sufficient natural lighting and ventilation and reduction of building running cost. Therefore, minimum number of air conditioners should be considered.

⑦ The size and layout of equipment and furniture in each room shall be considered in the floor planning.

⑧ The functional relationship between each classroom and laboratory shall be considered based on curriculum and timetable of training.

⑨ Clear zoning of laboratories, classrooms, auditorium and administration offices shall be made with an understanding of syllabus and curriculum in floor planning and considering flow lines of students and staff.

⑩ The type of corridor enclosing the inner court as shown in Figure 2-7 shall be planned in order to address disadvantages of the one side corridor and central corridor types.

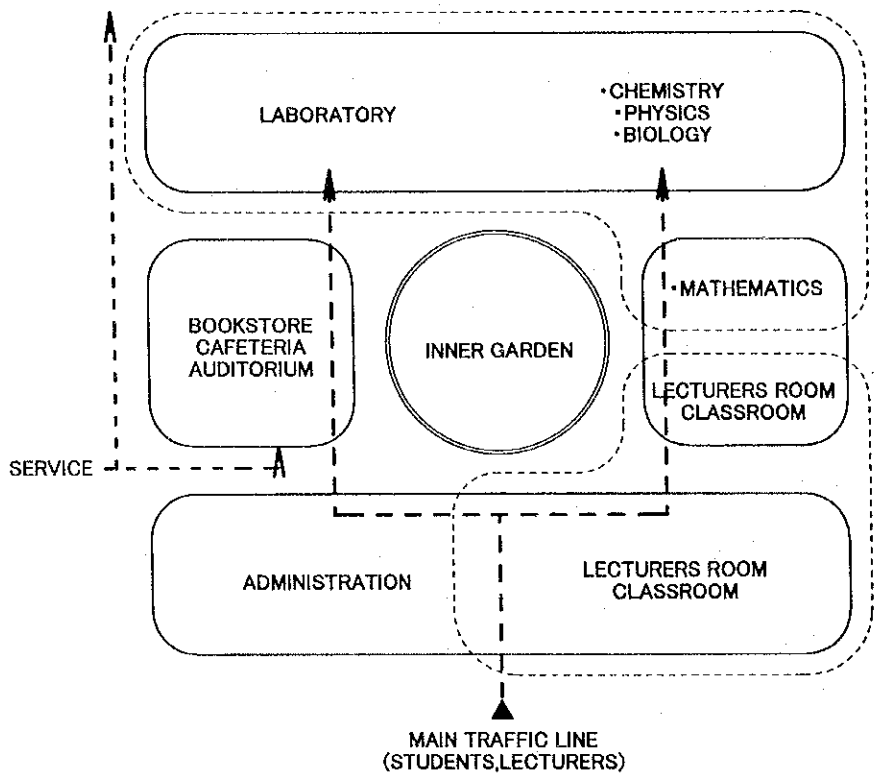

Figure 2-7 Zoning Plan

2) Elevation and Cross-Section Plan

For planning of elevation and cross-section of the building, local building styles, local construction methods and the existing building styles should be considered for references on the basis of the following policies:

① Building height should be arranged giving consideration to the zoning of stories of 3 to 5 from south to north considering its harmonization with the surroundings, view from the surrounding area and nature of land as the site is located on a slope from north to south.

② The roof should be sloped in order to quickly discharge rain water.

③ The depth of eaves and louvers should be designed giving consideration to protect rooms from direct sunlight and rainfall.

④ Walls should have sufficient openings to enhance room ventilation and provide a balanced intake so that the building running cost could be minimized.

⑤ Elevation and facade of building should be designed giving consideration to harmonization with the existing buildings and style suitable for Indonesian nature and climate.

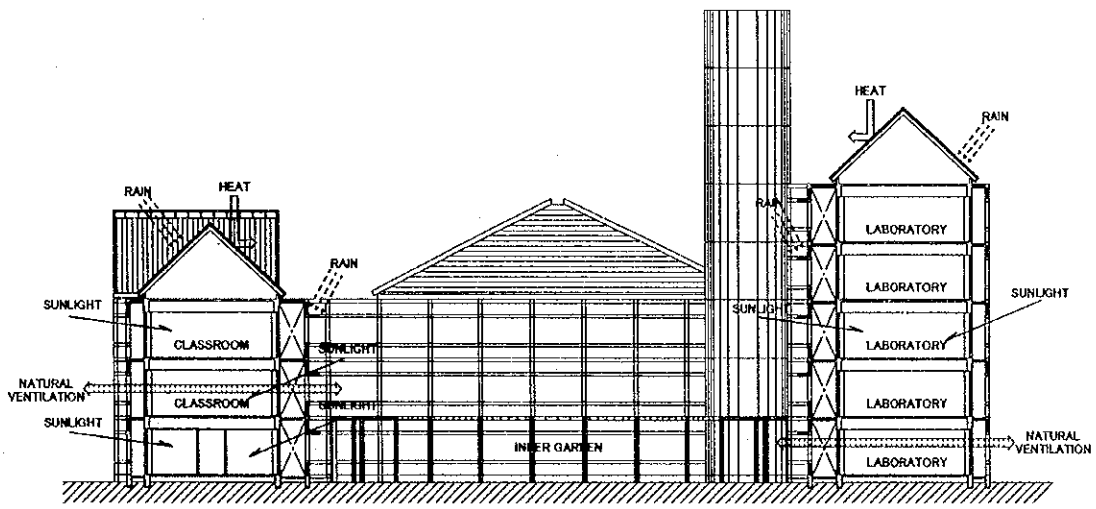

Figure 2-8 Cross-Section Plan

3) Cost Reduction Measures on Architectural Planning

The various factors for cost reduction which have to be considered in the course of design works of a building are as follows. The cost performance and the maintenance cost must be taken into account for building design.

① The standardization of space is necessary to give flexibility in design of the building. The basic module is to be studied carefully giving consideration to combinations of the basic module. Through extensive investigation, the economical module span and standard module of Indonesia has been successfully determined for incorporation into the Basic Design.

② Building should be planned effectively giving consideration to consistency with the existing buildings and its cost performance.

③ The overall size of the facility is rationalized so as to enhance the utilization rate of the rooms and to promote the effective use of rooms, utilities and equipment.

④ Local construction materials of Indonesia should be effectively used so as to reduce the cost for construction and maintenance. Also, in the long-term view of the project, together with the consideration of the maintenance costs of the facilities, the finishing materials will be selected considering their long life and maintenance characteristics.

⑤Consideration is given to the introduction of energy efficient equipment and insulation materials in order to reduce operation expenses.

⑥ In principle, natural ventilation and lighting is to be applied as much as possible and mechanical ventilation and artificial lighting is to be minimized in order to reduce maintenance costs. However, some of the rooms will need mechanical systems. In this case, local and individual systems will be used in place of a central system.

⑦ As mentioned above, cost reduction measures are considered in the course of design work. However, the reduction of initial cost shall be considered carefully so as not to cause any cost increase in operation and maintenance and deterioration in quality.

4) Architectural Design

Architectural design should be studied after floor planning, sectional planning, and cost planning etc. have been well considered as well as after building's function and durability have been considered. It would be necessary to consider how much Indonesian local building style can be reflected in the design and the building can be harmonized with the surrounding buildings. For example, as for the style of roof, Indonesian style was suggested by IKIP-Bandung. However, roof design would be reflected by total architectural design concept of the facility and the roof should be designed in the course of Basic Design. Therefore, the roof shall be designed carefully in the course of total architectural design. Consideration should be given to

the fact that the Project is under Japan's Grant Aid, and the building design should not be too luxurious.

(3) Structural Plan (IKIP-Bandung)

1) Basic Policy

The structural plan for the project should be formulated after a full review of the existing site conditions.

The structure shall be designed to prevent serious defects such as deflection, settlement, etc. In addition, the building shall have sufficient safety and durability against earthquakes, strong winds, etc. Consideration should also be given to local construction and maintenance conditions.

2) Standard for Structural Design

Structural design shall basically conform to the relevant codes, regulations and standards of Indonesia. However, other relevant codes and or standards such as ACI (American Concrete Institute), AISC (American Institute of Steel Construction) and AIJ (Architectural Institute of Japan) are to be referred to secure safety and rationality in structural design.

3) Method and Material

The superstructure is to be made by reinforced concrete and the walls are to be made by brick which are economical and widely used materials in Indonesia. A steel structure frame is to be provided in some portions of the building, such as roof trusses, to achieve the required strength. Reinforcing steel bars, concrete and structural steel are locally available, however appropriate quality control management while in the factory and the site should be made.

Concrete: Design Strength (Fc) =210 kg/cm^2
(28 days compressive strength of cylinder test piece)

As for the design of the roof structure, wooden or steel frames can be considered. However, consideration is given to the most economical and efficient steel truss (frame) proportion in view of the span being more than 10 m and advantages in durability.

4) Soil Condition and Foundation

The foundation design should be formulated after accurate soil data and topographic data have been obtained and studied. Such investigations and survey were carried out by the local consultant entrusted with a natural conditions survey . Since the site

area is limited to approx. 100 m x 100 m and as a result of site layout plan, northern part of the facilities (laboratories wing) should be 5 stories and piled foundation were found to be necessary considering the foundation of existing buildings such as Central Library and Gymnasium, the foundation of which were piled. The boring data originally submitted from Indonesian side was only for two locations. Therefore, further survey and investigation were required in order to formulate the actual site conditions (site area is excavated and graded and southern area is filled) and topographic survey and soil investigation were carried out. Consideration was given to the latest site layout plan and boring was carried out at 4 locations. As the result of soil investigation, N-value of more than 50 has been obtained at the level of more than 13 to 18m below ground level. Furthermore, as the result of sampling, top soil was observed to be clayey silt and as the layers become deeper the soil becomes harder with sandy silt, tuffaceous sand and gravely sand. According to such results, the foundations are to be designed as piled foundations (PC pile).

5) Design Load

① Wind Load: The wind load is calculated in accordance with the Architectural Standards of Indonesia. Heavy winds which cause significant impact on the building are not recorded around the project site.

② Seismic Load: Indonesia is located in an active volcanic zone of the Pacific Ocean where earthquakes occur frequently. According to the Indonesian zoning map of seismic scales, the project site lies in the area of fourth degree on the seismic scale. Pedoman Perencanan Pembebanan untuk Rumah dan Gedung is to be referred.

③Dead Load: The structural member and finish materials can be calculated for dead load.

④Live Load: Indonesian Standard of Pedoman Perencanan Pembebanan untuk Rumah dan Gedung is to be referred. Load conditions are to be determined considering the equipment layout and use. Location should be considered for rooms such as Workshop, Mechanical Room and Electrical Room where live loads are to be relatively higher, to be at first floor level for more economical slab design.

(4) Utility and Building Facility Plan (IKIP-Bandung)

As for basic concepts of the Utility and Building Facility Plan, it should firstly be taken into consideration that the Project facility is for the faculty of science and mathematics education (FPMIPA). Then, coordination with facility planning and equipment planning should be made so that each facility, such as the laboratories, can be operated effectively. Then, consideration should be given to the surrounding conditions and infrastructure (electric power, telephone, water supply and drainage etc.) and furthermore, operation and maintenance system and costs.

1) Basic Concept

① The following items are concepts considered for the utility and building facility plan required for FPMIPA:

a) An appropriate utility and building facility should be planned giving consideration to the number of persons utilizing the facility based on the educational curriculum. Furthermore, energy supply plan should be considered effectively for planning of laboratories where the equipment is possibly to be renewed so that any experiments can be done without any disturbance. Furthermore, it is important to review the experiment subject curriculum in conjunction with facility and equipment planning for effective use of facilities.

b) In the process of conducting experiments, no particular dangerous waste is produced. However, an appropriate waste disposal system is an important factor in the plan since safety in facility will improve environmental protection .

c) As there will be a lot of equipment, consideration should be given to the consistency and/or interface with facility and equipment plans and problems on piping and electric distribution.

② In order to clarify the boundary of the work to be borne by the Japanese and Indonesian sides, the facility plan should be made so that existing facilities in the Project site are not affected. New facilities for the project should be independent from the existing ones. In addition, the function of existing facilities and new facilities to be built by the Project should be clarified and new facilities should function together with existing facilities. For example, the telephone system for the new facility should be established in

order to interface with the existing PABX so that internal calls within the campus can be made through PABX.

③ From the view point of easy procurement of spare parts, easy facility maintenance and repair, and easy facility operation and management, equipment and materials for the Project should be locally standardized products.

④ The codes and standards should basically be relevant Indonesian codes and standards. If there are no applicable codes and standards in Indonesia, other relevant codes and standards should be referred.

⑤ In Bandung city, no air conditioners are found to be necessary because of the regional climate conditions. However, minimum numbers of air conditioners should be provided in computer room and analytical equipment room in order to maintain the room temperature as required.

⑥ As low utility costs are very important for facility maintenance and operation, the facility plan should be made by taking into consideration energy saving measures.

2) Infrastructure Situation

① Power Supply

Overhead power supply lines (3 stage, 3 wire 20kv, 50Hz) are installed PT PLN along the road (Jl. Setia Budhi) in front of the campus. From there, lines are extended to PLN Room located in the campus. Power is supplied to the existing facilities from the electrical room adjacent to the PLN Room and power supply to the new FPMIPA facility is considered to be possible from the existing PLN Room.

② Telephone

Like the power supply line, TELKOM's main telephone lines are installed along the road (Jl. Setia Budhi) in front of the campus and 32 lines are supplied to the existing MDF. However, among those 32 lines, 6 lines are connected to the existing PABX, 5 lines are used for direct line (Rector:1 line, Assist. Rectors: 4 lines), therefore, 21 lines remain. Among these 21 lines, 5 lines are secured for direct lines used by new FPMIPA facility, and the remaining 16 lines can be used through the new PABX. If such remaining lines could be used, IKIP-Bandung side would not have to extend lines from

the Main Feeder again and cost incurred for the Indonesian side would be the fee for Permanent Consumer (Langganan Tetap) only.

③ Water Supply

PDAM's water treatment plant is located adjacent to the north boundary of the campus and from there, the main water supply line of 200mmϕ crosses the road to the campus. Since it is located near to the site, it was confirmed by PDAM that water could be distributed from this pipe. The distribution pipe to the new facility should be about 2 inches diameter (needs further study). According to PDAM, water supply quantity during the rainy season (December to February) is sufficient but in the dry season, quantity is reduced to 1/5 of the rainy season, which is considered to be fairly small.

Owing to the location of PDAM water treatment plant close to the campus, sufficient quantity and pressure of water can be supplied in the dry season. As such, boring of a deep well is not considered under the Grant Aid Project.

As to securing of sufficient water supply during the dry season, it is understood from IKIP-Bandung that if they request PDAM for a better water supply, a reasonable quantity of water may be supplied. It was advised by IKIP-Bandung that the current water quantity and pressure were not enough. As a result of an investigation of the existing facility, it was found that the water was supplied through direct connection and insufficient level of elevated tank which caused insufficiency of water pressure. In this project, such problems should be taken into account in order that a constant water supply can be made.

④ Drainage Facility

As the result of site investigations and discussions, no public sewage lines were found around the campus. Sewage water is currently disposed to a septic tank and absorbed into the ground. In the rainy season, it is found that the capacity of ground absorption becomes lower due to rising of the ground water level and thus pollution of the ground surface is possible. Therefore, for environmental protection, a septic tank should be provided and the water therefrom should be disposed into the river.

A 60 cm wide and 80 cm deep canal is located at the east boundary of the site. However, this canal is to be relocated. However, it was found that a drainage connection to the western canal was appropriate and planned

accordingly in view of its sufficient drainage capacity and water flow from the site.

⑤ Effects on Environment

As no public sewage lines are provided around the campus, sewage water currently is disposed to a septic tank and absorbed into the ground. In the rainy season, it is anticipated that the capacity of ground absorption becomes lower due to rising of the ground water level and therefore, pollution of the ground surface is possible.

As for environmental effects, pollution in well water and soil is possible due to direct sewage and waste disposal.

a) Sanitary Sewage and Waste Disposal

In view of environmental protection, a septic tank should be planned in order to dispose of water to the canals nearby which are connected to the river.

According to the Indonesian and Japanese regulations for allowable level of disposed water and considering the Indonesian regulation being more strict, the septic tank is planned to be of the combined treatment system and output should be less than BOD 20 ppm.

b) Garbage and Chemical Waste Disposal

The garbage is collected from the campus twice a week regularly by "City Disposal Dept.(Dinas Kebersihan Kotamadya)" truck from Bandung city. The cost of collecting the garbage twice a month is about Rp. 75,000.- . There is an existing incinerator which is broken and of no use. Such problems should be considered in the planning of the collection and disposal system.

As mentioned above, since garbage is collected by the city on a regular basis, a new incinerator for the facility is not necessary. Therefore, a room for temporary garbage stocking should be planned in the facility.

As for treatment of chemical waste water from the laboratory, consideration should be given to the following:

Waste water containing heavy metal, acid and alkaline, and organic solvent containing harmful are temporarily stocked in large bottles.

However, such solvents, when the bottles became full, are normally discharged into the ground. It has been advised and understood that such concepts are not desirable for environmental reasons, and are just temporary measures, and will have adverse consequences in the future. However, due to budgetary problems, it was found to be difficult to respond to such problems correctly.

Chemical waste water includes waste water after experiment, water used to wash equipment and cooling water. As for heavy waste water and waste water after experiments using acid, alkaline and organic solvent, these should be treated first by a waste water treatment system (supplied under the equipment plan), and after that it will be added to second stage wash water, and lead to the neutralization tank (tank structure by facility construction and neutralization system by mechanical works), and the treated water will be discharged to the external canal. Such a system is to be studied. A first stage waste water treatment system is planned to be located in each laboratory as required, and treated heavy waste water (preliminary treatment) is to be stored in the attached tank. Such waste water should ideally be collected by a collection company. However, without such a company, the waste water in the tank should be stored in the waste water storage room temporarily.

As mentioned above, it is necessary to establish a total operation system in order to achieve environmental protection by a proper trash disposal system as well as waste water disposal system. Besides, in planning of facilities and utilities, it is also important to correspond to the environmental protection system required in the future in Indonesia.

c) Correspondence During New Facility Construction

It is necessary to consider minimizing noise and vibration during construction, as the existing facilities would be under operation. Also, it is necessary to prevent the spread of dirt and dust during the construction period. Appropriate measures for traffic control are also required as the roads to the site within the campus are narrow.

3) Electrical Works

① Power and Transformer Facilities

As for the power source for the new facility, medium voltage line (3stage, 3 wires, 20kv, 50Hz) located along the road (Ji. Setia Budhi) is currently

extended to the existing PLN Room with medium voltage (3stage, 3 wires, 20kv, 50Hz). According to the series of discussions with PT. PLN (at Bandung), lines can be extended to the transformer in the new facility by rehabilitation and expansion of H.T. Receiving Panel in the PLN Room. It has been explained and confirmed that such rehabilitation and expansion of H.T. Receiving Panel in the PLN Room and distribution and extension works as stated in "(6) Undertakings required of the Government of the Recipient Country" in the Inception Report should be carried out by the Indonesian side by the middle of 2000 . The new electrical room should be next to the new facility in order to avoid unnecessary cabling and to allow easy access from campus roads.

Owing to the recent power station project, power supply condition in Indonesia should have been improved. However, according to IKIP-Bandung, the power supply condition has not yet improved, sometimes black-outs occur and the voltage fluctuates. Since there are no factories around the site causing fluctuation of electrical voltage , supply voltage being 20 KV, less concern as to power supply is considered. In order to correspond to the regional gap, transformer equipped with tap switch should be considered. Besides, stabilizers are to be provided for the computer room under the equipment plan.

Specification for the transformer, based on the data received, is to be as follows. Transformer should be selected with easy maintenance and oil injection type (oil available in Indonesia) considering the current operation and maintenance system of IKIP-Bandung.

Lighting, Electrical Outlets and Power installations

Laboratories, classrooms related : approx. 6,800 m^2 x 100W/m^2	= 680KW
Administrative and other rooms : approx. 5,200 m^2 x 60W/m^2	= 312KW
Total:	992KW

As such, if demand rate for lighting, outlets and power installations to be 0.7, power rate to be 0.85,

992KW x 0.7 x 1 / 0.85 = 817KVA.

Therefore, transformer can be selected from a degree of 1000KVA listed in the brochure availed locally in order to meet the requirement of more than 817KVA.

② Generator and Main Feed Wiring

As for power supply, no black-outs were experienced during the B/D Survey period and according to IKIP-Bandung, black-outs occur occasionally during the rainy season. However, no problems were encountered since the existing generator operated. As such an emergency generator should be provided for the new facility to correspond to long time black-out and consideration should be given to maintain minimum loading for operation of building utilities required for security. Operational hours of generator are considered to be 10 hours.

Outline of the emergency generator is as follows. According to general statistics of 20 KVA/m^2, the capacity of the generator is planned to be 240 KVA (20VA/m^2 x approx. 12,000 m^2= 240 KVA). Type of engine should be diesel, considering its economical benefit, and easily maintained and reliable equipment should be selected. Therefore, as per the locally available brochure, standard output type of 255 KVA level can be selected in order to meet the requirement of 240 KVA capacity.

Main feed wiring system should be distributed from the distribution board with 3 stage, 4 wire 220 - 380 V 50 Hz, and systematized giving consideration to loading and classification of facility rationally in order to feed power to each facility through each distribution board. Main feed wiring capacity should meet the capacity of each equipment to be connected in order to disperse risks and considering easy installation. Wiring method should be basically cable truck system in shafts and for other locations wiring should be piping system.

③ Lighting Fixtures and Outlets

According to the survey of existing facilities, each facility has rather large openings and almost no lighting was required for classroom lesson in the daytime. However, lighting level was found to be relatively low (215 lux according to answers to the questionnaire) and such conditions are not ideal. Furthermore, during the rainy season, each room is so dark that minimum lighting level should be maintained in order not to affect education.

Therefore, the lighting level for each room is to be established as follows, based on the mean lighting level of JIS standard taking the condition of existing facilities and IKIP's requirements into consideration. In particular

for laboratories, lighting layout should be diversified effectively with local switch circuits in order that the electrical running cost can be reduced.

Rooms	IKIP-Bundung Proposed Lighting Level	Design Standard (Lighting level) lx
Classroom	300	300
Meeting Room	300	300
Laboratory	300	500
Computer Room	400	500
Library	300	300
Workshop	300	300
Cafeteria	300	200
Auditorium	300	300
Toilet		100
Corridor	-	100
Storage	-	50

IKIP-Bandung requested to consider certain security measures by lighting, since expensive equipment is installed in the new facility. In this regard, planning of facility, equipment and utility should be integrated and incorporated into each design accordingly. As for lighting fixtures, mercury lights are to be provided at the entrance and around the building for a security measure.

In Indonesia, sunrise and sunset times are constant throughout the year, no automatic switches for the lighting should be required but timer switch is required.

As for layout of outlets, a series of discussions were held with IKIP-Bandung staff based on the detailed layout of each laboratory. Outlet in the laboratory is to be 16 A.

④ Telephone System

As main telephone lines are installed along Jl.Setia Budhi in front of the campus, connections can be made at any time upon request without any problem on capacity.

As for scope of works by Indonesian side, Cabling works/Wiring and Piping works from existing PABX/MDF to Point Distribution at the site should be the undertaking of the Indonesian side by the middle of 2000.
Supply and installation of new PABX/IDF, Cabling works/Wiring and Piping works from Point Distribution to new PABX should be the scope of the Japan side.

The existing telephone circuit system in IKIP is very complicated. Each department contracts with TELKOM independently and has their own circuits. As such, total number of circuits is not known even by Utility Dept. staff in IKIP-Bandung.

a) Existing PABX

-Location :B1 of Rector Building (PARTERE)
-Specification :Model "Alcatel 300"
Capacity of 230 lines
Analog card 20 pcs. for INTERCOM
Trunk Card 5 pcs. for TELKOM

By connecting between new PABX and existing PABX, mutual communication between existing facilities and new facility through internal lines could be made. If internal lines are used through existing and new PABX, and external lines are not used, this would be a factor for cost saving of the new facility.

For internal communication line, it is required to install "Independent Line Trunk" (function to enable internal communication between 2 PABXs) and it was considered to be more appropriate that such works should be undertaken by the Japan side. With the provisions of "Independent Line Trunk", extension line calls could be made by extension number from each telephone to the existing facilities.

External call can be requested through the operator and connected with designated number(e.g. 0). As for the internal call system, system is to be studied to enable calls to the existing facilities to be made with an initial number (e.g. 8) followed by extension numbers and calls to the new facility can be made by only dialing the extension numbers. As requested by IKIP-Bandung, telephones for rooms stated in item c) should be planned to enable direct external calls with an initial number (e.g. 9). Initial number designation can be settled freely based on IKIP's operational plan.

b) Existing MDF

The existing MDF is very outdated and its manufacturer is unknown. To this existing MDF, 32 lines are extended from TELKOM main feeder located at Jl. Setia Budhi. However, among these 32 lines, 6 lines are currently connected to the existing PABX, 5 lines are used for direct line

(Rector:1 line, Assist. Rectors: 4 lines), therefore, 21 lines remain. Among these 21 lines, 5 lines are secured for direct lines used by new FPMIPA facility, and the remaining 16 lines are expected to be used through the new PABX. If such remaining lines could be used, IKIP-Bandung side would not have to extend lines from the Main Feeder again and cost incurred by Indonesian side would be the fee for Permanent Consumer (Langganan Tetap) only.

In Indonesia, the cost per one circuit is quite high and in order to utilize a small number of circuits and to minimize the maintenance, the introduction of PABX should be provided for the most appropriate telephone system. Proposed number of telephone circuits and the rooms where telephones are to be installed are as follows:

c) Telephone Lines Connected to PABX

Rooms and No. of Telephones to be Installed

1F	Faculty Administration Office (2) Security Guard Table (1) Cafeteria Kitchen (1) Electrical Room (1) Head & Secretary of Dept. Office - Bio. (1) Biology Labo. (total:3, 1 for each Staff Room) Department Administration Office - Bio. (1) AVA Room (1) Workshop (1)	
		Sub total: 12
2F	Dean Office (1) Assistant Dean Office (3) Secretary Room (1) Project Management Office (1) Experts Room (5) Control Room of Auditorium (1) Biology Labo. (total:2, 1 for each staff room) Physics Labo. (1 for staff room) Head & Secretary of Dept Office-Physics (1) Head & Secretary of Dept Office-Math. (1) Dept. Administration Office-Physics (1) Dept. Administration Office-Math. (1)	
		Sub total: 19
3F	Physics Labo. (total:4, 1 for each staff room) Computer Staff Room (total:2, but 1 for internet) Teaching Primary / Secondary Labo. (1)	
		Sub total: 7
4F	Chemistry Labo. (total:2, 1 for each staff room) Head & Secretary of Dept. Office-Chem. (1) Dept. Administration Office-Chem. (1)	
		Sub total: 4

5F Chemistry Labo. (total:3, 1 for each staff room)

Sub total: 3

Total: 45 (circuits)

Among the above 45 telephone lines, telephones of the following locations should be able to make and receive external calls as well as internal calls. Remaining telephones should be set for internal call use only and these telephones which are designated by FPMIPA should be able to make external call only through the operator.

-Dean Office (1)
-Assistant Dean Office (1 of 3)
-Secretary Room (1)
-Project Management Office (1)
-Experts Room (1 of 5)
-Computer Staff Room (2, 1 for internet)

Public telephones are to be provided for the following locations:

-Auditorium Lobby (total:2, 1 No. Coin Type, 1 No. Card Type)
-Entrance Hall (total:2, 1 No. Coin Type, 1 No. Card Type)

⑤ Public Announcement System

Public Address system is to be provided for communication of staff and call of staff and teachers. In the auditorium, speakers (wall and/or ceiling mounted types), amplifier and microphone systems are to be provided for seminar and lecturing purposes.

Speakers are to be of wall or ceiling mounted type and are to be provided in each room. Considering emergency cases, public announcement systems are provided with battery and battery charger (30 minutes assured).

⑥ Clock System

Electric Clock would be provided on the external wall of the building. The clock should be assured against power failures. Operation board will be installed at the security guards room.

⑦ Fire Alarm System

According to Indonesian regulations (Panduan Pemasangan Sistem Deteksi Dan Alarm Kebakaran Untuk Pencegahan Bahaya Kebakaran Pada Bangunan

Rumah Dan Gedung), fire alarm system of either automatic or manual type should be installed for a school of more than 4 stories. Fire hydrant box equipped with bells, red lights and buttons should be installed at each floor and each warning area. Boards (with bell, light and buttons) should be installed at the locations where a fire hydrant box is not installed. The fire alarm board (receiver) should be installed in the security guards room.

Fire alarm board should be operational during power failure, equipped with battery and battery charger (30 minutes assured).

⑧ Lightning Protection System

It was requested by IKIP-Bandung that lightning rod should be provided to protect the whole building, because there would be many lightning strikes during the rainy season. According to the Ministry of Works regulations, the grounding resistance at each grounding rod should not exceed 5 ohms. A grounding indication panel having a test connection should be provided.

4) Water Supply and Sewerage System

① Water Supply Systems

Elevated water tank is to be provided in order that sufficient water pressure can be maintained in any location of the facility. As this system has a minimum number of machines, it would be easy for maintenance.

As for scope of works for water supply system, it was explained and confirmed that connections from main PDAM pipe (located at the western side of the site) to a water supply meter at the site boundary should be the undertaking of PDAM(Indonesian side) and piping from water meter to the new water reservoir and further piping and connections should be carried out by the Japan side. As for works undertaken by the Indonesian side, it was explained and requested to the Indonesian side that such works should be completed by the middle of 2000 (preconditions).

Water reservoir tank should be above ground type, considering hygienic conditions. Both the water reservoir tank and elevated water tank should be of the 2-tank type. Piping materials should be V.P. which is strong, low cost and easy for installation.

a) Water Consumption

Based on number of persons and each room's operational rate as stated in 2-3-2, number of persons using the facility is calculated as follows:

Laboratories (390 persons/day), Classrooms (555 persons/day), Staff (169 persons/day), Administration (79 persons/day) : Total 1,193 persons/day

As such, 1193 persons/day x 60 ltr/day person = 71,580 ltr./day
Tap for experiment : 80 locations x 100 ltr./day location = 8,000 ltr./day
Sprinkler water for garden: 5,000 ltr/day
Total: 84,580 ltr./day → 85 m^3/day

b) Capacity of Water Reservoir

Daily Water Consumption : 85 m^3/day
Storing 70% of Daily Water Consumption : 85 m^3 x 0.7 = 59.3 m^3→60 m^3 (3m x 10m x 3m H, FRP made with partition)
Fire Fighting Tank : 30m^3 for internal fire fighting hose+30m^3 for external fire fighting hose+60m^3 for SP Total: 120m^3 (underground concrete water reservoir)

c) Elevated Water Tank

Elevated water tank should have a capacity of 15% of daily water consumption.
85 m^3 x 0.15 = 12.75 m^3 → 13 m^3 (3m x 3m x 2m H, FRP made with partition)

d) Pump

If running time per day is 10 hours,
Average water supply quantity per hour: 85m^3 / 10 hrs = 8.5m^3 /hr
Maximum water supply quantity per hour: 8.5m^3 x 2 = 17m^3/hr
Momentary maximum water supply quantity: 8.5m^3/hr x 3 = 25.5m^3/hr → 425 ltr/min
Capacity of pump: 450 ltr/min (automatic alternate operation)

Based on the series of discussions with staff of each department in IKIP-Bandung, water supply plan should be made considering type of experiment and layout of equipment.

② Fire Fighting Facility (including fire extinguishers)

Based on Indonesian Law of fire fighting "Dinas Pemadam Kebakaran", internal fire hydrant, external fire hydrant, sprinkler and fire extinguisher systems are to be provided.

③ Sewerage System

As no public sewage lines are provided around the campus, sewage water currently is disposed to a septic tank and absorbed in the ground. In the rainy season, it is anticipated that the capacity of ground absorption becomes lower due to rising of the ground water level and pollution of the ground surface is possible. Therefore, a septic tank should be planned and the water therefrom should be disposed of into the river considering environmental effects to the surrounding area. As Indonesian regulations are becoming more strict, the septic tank is planned to be of a combined treatment system and output should be less than BOD 20 ppm because water is finally discharged to the river.

As for treatment of experiment waste water, please see "(4) 2) ⑤Effects on Environment in 2-3-3".

④ Sanitary Equipment

As for water closets in the existing facilities, it was found that Asian types are mainly used. According to the request by IKIP-Bandung, water closets should be a combination of local and western types considering Indonesian lifestyle and hygienic view points.

According to IKIP-Bandung, it was proposed that no washing showers were required in each booth due to maintenance problems. As for type of urinals, Muslim type was proposed. Since sanitary equipment is locally available, maintenance including procurement of spare parts would be easy.

⑤ Kitchen Equipment

As described in 2-3-2 (2) 5), the cafeteria is a self service style restaurant providing snacks for students (In-service Training 320 persons) and staff (50 persons), a total of 370 persons. Opening hours are from 7:00 to 16:00 and considering an operational rate of 80%, the daily number of persons is expected to be 296 (370 x 80%). As for kitchen equipment, a menu was provided by IKIP-Bandung and on this basis equipment to be supplied is to

be studied while rice cooker, medium size refrigerator, freezer and sink etc. were requested. In addition, kitchen stock rooms were requested to keep rice, potatoes etc.

Serving system : Self service
Opening Hours: 7:00 to 16:00
Seating Capacity: for 40 persons (for In-service students and staff)

⑥ Propane Gas System

Number of gas cylinders in each department as a result of the survey is as follows:

-Chemistry Department : 3 Nos. of 50kg cylinder
-Biology Department : 3 Nos. of 50kg cylinder

The above cylinders are kept in the store adjacent to the Biology Department building and gas is supplied to each laboratory by a central supply system. The gas is filled about once a month. As for the Physics laboratory, one 12kg cylinder is provided in the laboratory and the pipes are connected to the Bunsen burners on the side tables.

Therefore, the gas supply should be a central supply system. 50kg cylinders, which are easily available, should be selected and located in the gas cylinder room where such cylinders can be changed easily.

Another gas cylinder room is considered for the Cafeteria besides the above, as LPG is required for cooking. As the cafeteria should be operated independently by another party, the two gas cylinder rooms should be separate, each with it's own entrance.

5) Air Conditioning and Ventilation System

According to IKIP-Bandung, air conditioners are not necessary in Bandung city, as it is located in a highland area and its temperature and humidity are not so high. Apart from the computer room, no existing facilities have air conditioner. As such, air conditioners are to be provided only for the rooms where personal computers are to be provided under the Project and PGSM project, in order to maintain the room and delicate equipment in proper conditions. The rooms where air conditioners are to be provided are as follows:

1F AVA Room, AVA Preparation Room (however, ceiling fan only for Cafeteria)

2F Expert Room, Auditorium (including the Control Room)
3F Computer Room
5F Analytical Equipment Room

As for the ventilation system, basic policy should be natural ventilation. However, a mechanical ventilation system is considered for Laboratories and laboratory annexe rooms, Common Workshop, Printing Room, Garbage Room, Waste Chemical Keeping Room, Cafeteria Kitchen, Electrical Rooms, Diesel Generator Room, Pump Room, Elevator Machine Room, Toilets and Mandi.

(5) Building Material Plan (IKIP-Bandung)

1) Basic Policy

The building material plan shall be formulated based on local climate conditions, location of the site, local construction situation, construction period, construction cost and maintenance and operation costs. The following items are the basic policy considering the contents as stated in "(2) Architectural Designs 3) Cost Reduction Measures on Architectural Planning".

① Local procurement of construction materials should be considered in order to reduce construction cost and shorten the construction period.

② The operation and maintenance costs shall be reduced by using materials conforming to the local climate, resistance against weather and of easy maintenance.

③ It is important to note that the selection of materials should be made satisfying the essential functions required for the facility of science and mathematics education in conjunction with equipment and utility plans.

④ Selection and determination of the building materials shall be based on the studies of local procurement or application of local construction methods.

⑤ Based on the above policy, building material will be planned. However, ensuring quality is the most important item to be noted for facility planning.

According to past Grant Aid projects and other similar projects in Indonesia, most of the building materials are locally available and considered to be acceptable in quality and supply. Therefore, use of local building materials is preconditions for cost reduction and easy maintenance. As such, locally procured materials are planned to be used for this project as much as possible. However, ensuring and improving quality are the most important items to be noted.

For the existing facilities, standard materials were used, such as paint on plaster for external and internal walls, paint on slate or direct paint for ceilings, and clay tiles on roof. It is considered that such materials were selected because the materials are available locally, can be installed by local construction methods and allow easy maintenance. Among the 3 IKIPs, facilities in IKIP-Bandung were found to be very old (more than 40 years old). However, buildings and

equipment were maintained properly. In Malang, the FPMIPA facilities were constructed between 1992 and 1996, using standard materials. However, large cracks on the wall and leakage from the roof were observed. Such defects were considered to be caused due to poor quality control during construction. Therefore, materials should be carefully selected considering easy construction and maintenance and construction should be executed under appropriate quality control.

Considering the above-mentioned policies, required functions, local construction, construction period, construction and maintenance costs, planning of building materials should be established as follows:

① Structural Materials

Reinforced concrete is basically used for the substructure and super structure, in combination with brick used for walls, which is commonly used and similar to the existing facilities. No problems are found for procurement of cement, aggregates, and brick. However, as for roof truss materials, steel and/or light gauge steel must be considered.

As for the Central Library and Gymnasium, the foundations of these were piled with cast in-situ piles and PC piles respectively. The boring data originally submitted from the Indonesian side was only for two locations. Therefore, further survey and investigation were required in order to formulate the actual site conditions and a topographic survey and soil investigation were carried out. Consideration was given to the latest site layout plan and boring was carried out at 4 locations. As the result of soil investigation, N-value of more than 50 has been obtained at the level of more than 13 to 18m below ground level. Furthermore, as the result of sampling, top soil was observed to be clayey silt and as the layers become deeper the soil becomes harder with sandy silt, tuffaceous sand and gravely sand. According to such results, the foundation are to be designed as pile of foundations (PC pile).

② External Finishing Materials

a) External Wall

External walls should be finished with paint which is weather resistant, suitable for the local climate and easy for maintenance. Selection of materials to maintain durability of the building itself is an important factor. Furthermore, as for plastering which would be the base for

painting, sufficient curing time should be considered in order to avoid cracks and peeling of paint. As such quality of plaster works and paint works shall be controlled together.

b) Roofs

Roofs of the 2 IKIPs and existing facilities in IKIP-Bandung are covered by locally made clay tile. Clay roof tiles are laid directly onto the wooden purlin without any waterproofing layers, and therefore rain leakage would occur when the tiles are damaged. During the survey period, repair of the roof by opening the ceiling was observed.

In order to improve such situations, the shape of roof should be designed appropriately considering harmonization with the surroundings, weather resistance, water tightness and the detail of the roofing should be considered with waterproofing sheets under the clay tile roofing.

c) External Doors and Windows

In the existing facility of IKIP-Bandung, steel frames are used for external windows. In IKIP-Yogyakarta and IKIP-Malang, aluminum frames are used for windows because the facilities were constructed recently. In this regard, aluminum windows are to be used for the new facility considering its advantages of durability, water and air tightness. In addition to aluminum windows, security grilles are necessary against theft and provision of such grilles is to be considered.

d) Floors

In the existing facilities, cement slate tiles or ceramic tiles are used for floor finish. For this project, ceramic tiles are to be considered for floor finish. External floors will be wet when it rains and non slip type tiles are to be considered.

③ Internal Finishing Materials

a) Floors

In the existing facilities, cement tiles or ceramic tiles are used for floor finish. For the new facility, basically ceramic tiles are to be used for floor finish. For the floor in the Auditorium, flooring materials should be considered for flexibility of use and function.

b) Walls

For internal wall finish, paint is also to be used on the plastered walls since the walls in the existing facilities are standard paint finish. Particular attention should be paid to quality of plastering which would be the base for painting. As for walls in the auditorium, its sound properties should be studied and considered.

c) Ceilings

In the existing facilities, cement boards are mainly used for ceilings. For the new facility, plaster boards (false ceiling), which is locally available, should be considered. As for the ceiling of the auditorium, the material should be selected considering its sound properties.

2) Main Materials Proposed

The criteria for building materials were studied in 2-3-3 (5) and on this basis, main materials proposed are shown Table 2-4 below:

Table 2-4 Main Materials Proposed (IKIP-Bandung)

Structure	Reinforced Concrete, partially steel structure					
Floor Height	4,500 mm					
External Finish						
Roof	Clay Tile, paint water proofing for flat roof					
Eaves	Paint on Cement Board					
External Wall	Paint on Plastered Wall / Paint on Louver					
Doors & Windows 1) Windows 2) Doors	 Aluminum Aluminum					
External Floor	Non-Slip Ceramic Tile on mortar base					
External Corridor Ceiling	Non-Slip Ceramic Tile on mortar base					
Internal Finish						
	General Facilities	Laboratory (Chem. Bio.)	Computer Room	Auditorium	Corridors	Staircase
Floor	Ceramic Tile on Mortar Base	Ceramic Tile (Anti-chemical) on Mortar Base	Free-access Floor & PVC Tile	Parket Flooring	Ceramic Tile on Mortar Base	Ceramic Tile on Mortar Base
Skirting	Ceramic Tile	Ceramic Tile	PVC	Hard Wood	Ceramic Tile	Ceramic Tile
Wall	Paint on Plastered Wall	Paint on Plastered Wall	Paint on Plastered Wall	Paint on Plastered Wall/Wooden Wall	Paint on Plastered Wall	Paint on Plastered Wall/Glass Block
Ceiling	Plaster Board (False ceiling)	Rockwool Board	Rockwool Board	Rockwool Board/ Wooden Wall	Plaster Board with EP	Plaster Board with EP
Toilet Floor Wall Ceiling	 Ceramic Tile Ceramic Tile on Plastered Wall (VP) Plaster Board (VP)					

(6) Equipment Plan (IKIP-Bandung, IKIP-Yogyakarta, IKIP-Malang)

The equipment planning was based on the requested equipment list with the order of priority confirmed through the site survey under the following concept:

1) Priority

On the selection of equipment, the policy of the Indonesian side is that every experiment curriculum has to be implemented to limit the latitude of discretion by each teacher, hence the adjustment of quantity has higher priority than the kind of equipment. A-priority means it should not be deleted, B and C mean the rank when the number deleted must be limited. A-priority equipment should not be automatically accepted and the balance in type and quantity among the 3 IKIPs should be considered. Regarding the type of equipment, when the request for some equipment comes from only one school or is rather small in quantity, its necessity must be well considered and the items evaluated as low priority will have to be deleted. As to the equipment which can not be procured in Japan and must be procured from a third country, only the indispensable equipment were included. Through these analyses, the common equipment list among the 3 IKIPs was made. Each experiment equipment is designed with the necessary apparatus and related equipment so that it can be used without any trouble as much as possible. Therefore there is no problem on the execution of experiments requested by the Indonesian side and it is in compliance with this proposal.

2) Experiment curricula and method

The standard equipment list used in the preparation of the requested equipment list was prepared along with the experiment curricula of IKIP-Bandung. The experiment method among the three IKIP's is not completely the same, however the utilization of equipment appears to be similar.

Therefore the requested equipment list will comply with the experiment curricula.

3) Operation, management and maintenance system of equipment

Equipment with low operation cost and easy maintenance and management requirement should be selected. The equipment with locally available repair and after sales service should be very high priority.

4) Advice by the task team in domestic committee and technical supporting committee meeting in the Project type Technical Cooperation

It is proposed that high priority should be given to equipment produced in Japan and the procurement of equipment from a third country should be limited to items where

the educational effectiveness will be affected. The details in each subject are as follows.

① Biology Education

It is proposed that the quantity should be adjusted depending on necessity. For example, the quantity of insect nets should be kept equal to the number of students, but the quantity of plankton nets will be kept to a minimum. Though there was a question on the kind and quantity of microscopes, this was finally resolved based on the fact that these will be divided among several laboratories where the maximum quantity per laboratory will be kept at 20 sets of one type. The monitoring system using microscope camera and monitor (available for microscope and stereo microscope) is recommended due to it's expected positive effect on education. It is recommended to share equipment equally among the 3 IKIPs. 1 set of water distillation is added due to the low capacity of existing distillation in Yogyakarta.

② Chemistry Education

The introduction of some analytical equipment with low cost and high performance is recommended by several members of the task team because analytical equipment has been introduced even in high schools in Japan. In this connection, analytical equipment such as UV/VIS Spectrophotometer, FT/IR Spectrophotometer, Computer Balance System and Nuclear Magnetic Resonance System for education are recommended, but some items such as Atomic Absorption Analytical System and Flame Photometer are declined due to the problem of operation cost, etc., though some members of the task team have recommended them. For the quantity of several items such as Melting Point Experiment Apparatus, Magnetic Stirrer, Conductivity Meter and etc., it is extremely recommended to make the quantity same as the number of experimental group. For the pH meter, it is recommended to include the electrode instead of the meter itself, and for the rotary evaporator to introduce a device to protect contamination into the water pipe.

As for the type and quantity of equipment, it is felt that the 3 IKIPs should receive the same allocation. The experimental table for 2 laboratories are added as there are several laboratories in Malang chemistry building.

③ Physics Education

In the curricula in Indonesia, earth science is excluded, but it is within the territory of technical cooperation. Therefore, it is recommended to include astronomy and a telescope for each IKIP.

Some equipment necessary for a dark room are included, therefore the preparation of dark curtains is suggested by some members of the task team. In the new building in Bandung, dark rooms are already included, and black curtains for Yogyakarta and Malang will be introduced.

It is proposed that the electricity voltage should be 220V, because a 100V transformer will only cause frequent breakdowns. Therefore, all equipment should have a 220V plug and equipment with separate transformer should not be accepted. The specifications and quantity of Gyroscope, Kater's Reversible Pendulum Set, Stopwatch, Galvanometer, Coaxial Cable, Amplifier, Function Generator, Spectrum Analyzer, Ultra Low Frequency Generator, etc., were requested by the members of the task team. According to these suggestions, some deletion, specification change and quantity adjustment have been done.

The spectrometer and spectroscope are essential for the visible light spectroscopic experiment and were then included in the list of equipment to be provided.

④ Mathematics Education

The reinforcement of teaching aids for teachers is very important. From this point of view, blackboard aids and video software are recommended. At the same time the importance of computer projectors and audiovisual equipment are also noted. The modems requested by Bandung were deleted as they are supplied by PGSM project.

⑤ Teaching Material Production

For the purpose of teaching material production by Japanese experts dispatched through technical cooperation as well as technical transfer to the Indonesian side, the provision of equipment for teaching material production is recommended. In particular, personal computers and the memory devices such as magnetic optical disk drive, CD Rom writer, etc., used for visual processing are recommended.

5) Quantity of Equipment

① The minimum quantity required by the Indonesian side is equal to the number of experiment groups.

Therefore the number which would enable group experiment was settled by each department. In chemistry and biology, the experiment equipment is eight (8) which is the number of experiment tables in many laboratories, the general purpose equipment is two (2) or four (4) and the corresponding number of experiment tables. In physics the experiment equipment is six (6) so that 6 or 7 students may associate in one group for experiment, and the specific electronics equipment necessary for the wide space is two (2) or four (4). In mathematics, twenty (20) or forty (40), which will be one set for one or two students instead of group experiment, will be applied. From these basic quantities, the quantities of existing equipment are offset. The final quantity will comply with the quantity necessary for group experiment which is requested by the Indonesian side.

② The equipment procured in 1998/1999 by PGSM was confirmed. Then, the number of procured equipment was subtracted from the planned number of the equipment in this grant aid project.

6) Equipment Plan

The purpose of use of the main items are as follows:

Biology Education

Equipment	Purpose of Use
Dissecting Set	Dissecting utensil for study of structure of small animals.
pH Meter	Measuring of pH in the liquid
DO Meter	Measuring of dissolving oxygen volume in the water and study of influence to living animals and plants
Barometer	Measuring of atmospheric pressure
Insect Net, 2kinds	Catching net for creation of insect specimen
Salinity Conductivity Meter	Measuring of salinity density in the water using refractive index
Gas Analyzer	Measuring of harmful or explosive gas density in the atmosphere
Polari-saccharimeter	Measuring of sugar density in the water using refractive index
Water Bath	Water tank to keep sample at the constant temperature
Kimograph	Recording device of the contraction of muscle and the beat of heart
Pneumograph	Amplifying and indicating device of respiratory wave of animal
Refrigerator	Preservation of sample and test sample
Electrocardiograph	Recording device of heart activity using electric signal
Dry Oven	Drying oven for sample
Analytical Balance	Measuring by mg unit of sample and chemical
Magnetic Stirrer with Hot Plate	Heating and stirring for liquid sample
Warburg Bath and Manometer	Measuring respiration or fermentation of microbe, plant and animal tissue, oxygen solution and etc.,
Sterilizer/Autoclave	Stelizing device of sample by high pressure and high temperature steam
Microscope for Student	Low power observation of biological sample for student
Stereo Microscope	Low power binocular microscope of magnified observation of substance without any slice of section
Binocular Microscope	High power observation of biological sample
Microscope TV Camera Set	Observation by monitor of microscope and magnified substance using CCD(charge-coupled devices/ imaging devices)
Microscope Stereo Trinocular	High power binocular microscope with adapter for TV camera
Colony Counter	Counting device of bacterial colony grew up on the surface of solid culture medium
Incubator	Constant temperature container for sample
Shaker	Vibrating platform for stirring liquid sample in flask and test tube
Wet Specimen of Vertebrate	Real skeleton specimen in formalin
DNA Electrophoresis App.,	DNA extracting device using gel electrophoresis apparatus
Mitosis Model	Model for explanation of solid mitosis
Meiosis Model	Model for explanation of solid meiosis
Human Torso	Model of human body
Clean Bench	Experimental device with sterilized condition
Homogenizer	Emulsifying device for sample
Vortex Mixer(Touch Mixer)	Stirring apparatus using stirring screw for liquid sample
Reciprotating Bath Shaker	Stirring of liquid sample in the constant temperature container
Experimental Table for Student	Table for experiment by student

Water Treatment System	Removing system of acids, alkalies and heavy metals from harmful liquid drained from laboratory
Air-conditioner	Keeping electronic and analytical equip., in reasonable working condition
Water Distillation Apparatus	Removing device of impurities in the water used for experiment

Chemistry Education

Equipment	Purpose of Use
Analytical Balance	Measuring by mg unit of sample and chemical
Drying Oven for Glass wares	Quick and clean drying of experimental glass wares
Mantle Heater	Heating of liquid sample in flask or beaker
Manometer	Measuring air pressure from the atmospheric pressure and saturation point of liquid
Electronic Precision Balance	Precise measuring of sample and chemical
Thermostatic Circular Bath	Supplying constant temperature's water
Electric Furnace	High temperature furnace for solid sample
Magnetic Stirrer	Stirring device of liquid sample using magnet
Du Noi Surface Tensiometer	Measuring Surface tension of oil, alcohol and etc.,
Potentiometer	Measuring electric potential difference and electro motive force between two points of electric circuit
Centrifuge	Separating ingredients by the difference of specific gravity of sample using centrifugal power
Mechanical Stirrer	Stirring device by rotating screw of liquid sample
BOD Meter	Measuring biochemical oxygen demand volume of microbe in the water
COD Meter	Measuring chemical oxygen demand volume
Fraction Collector	Automatic dropping device of same chemical volume into the sample the fifty to hundred test tubes
Autoclave/Sterilizer	Sterilizing device of sample and glass wares by high pressure steam
Magnetic Stirrer with Hot Plate	Heating and stirring by magnet of liquid sample
Microscope	Magnified observation of crystal etc.,
Refrigerator	Preservation of samples and chemicals
Rotary Evaporator	Concentration of liquid sample
Water Bath with Shaker	Stirring water bath with constant temperature liquid sample
Automatic Titrator	Measuring of equivalent point mainly from the added volume of titration chemical on volumetric analysis
Balance with Computer	Measuring weight up to mol level and accumulating the data in the computer for analysis
Draft Chamber	Experimental table with exhaust fan to protect the harmful or explosive gas in the experiment
Freeze Dryer	Freezer and dryer to reduce the liquid sample to powder
FT/IR Spectrophotometer	Analyzing using infrared light and Fourier-transforming data
UV/VS Spectrophotometer	Measuring reflectivity rate or transmissivity by the ultraviolet and visible light
Nuclear Magnetic Resonance for Education	Analyzing by the resonance when the nuclear in the magnet-static field received the radio wave in the specific frequency.
Ultrasonic Cleaner	Washing device by the ultrasonic waves of 400MHz approx., of samples and containers in the water tank
Experimental Table for Student	Table for experiment by student
Water Distillation Apparatus	Removing device of impurities in the water used for experiment

Physics Education

Equipment	Purpose of Use
Airtable for Dynamics	Experimental device for the law of parabolic movement
Dynamic Cart with Track	Experimental device for the law of accelerative movement
Electric Turntable Set	Disk-shaped and revolving table at constant speed for the experiment of centripetal force and turning force
Electronic Precision Balance	Precise measuring used for sample weighting
Experimental App., of Second Law of Motion	Device for experiment of acceleration
Experimental App., of First Law of Motion	Device for experiment of inertia and falling article
Free Fall Experimental App.,	Experimental device for equal falling speed of articles
Gyroscope with stand base	One kind of top which revolving axis is set up to tend toward some direction in the space
Pulley Set	Experimental set of pulley
Stop Clock	Measuring clock for precision by 1/100 second unit
Stroboscope	Intermittent lighting device for article
Optical Bench Set	Combined set of lighting source, lenses, slit plate and bench
Du Noy Surface Tension Meter	Measuring Surface tension of oil, alcohol and etc.,
E/m Experimental Apparatus	Measuring electron movement of electron using helmholtz coil
Elasticity of Flexure Apparatus	Measuring flexure of metal(Young's modulus)
Electromagnetic Force Demonstrator	Quantitative measuring of force against electric current in the magnetic field using current balance
Electronic Digital Counter	Counting device by outside electric signal
Eudiometer	Composing device of water from hydrogen and oxygen by electric spark
Experimental App., of Boyle-Charles' Law	Experimental device for relation of volume, pressure and temperature of gaseous body
Faraday's Effect Apparatus	Experimental device; for that the plane of polarization revolves when the polarized light pass through the material toward the direction of magnetic field
Light Velocity Measuring App.,	Measuring light velocity
Linear Expansion Apparatus	Measuring of linear expansion rate by heating of metals
Magnetic Circuit Training App.,	Observing the characteristic magnetization of magnetic coil by hall device teslameter
Michelson Interferometer	Interferometer which light angle of incidence into semitransparent reflective plate is at 45℃
Polari-Sacchari Meter Set	Measuring sugar density in the water using refractive index
Polarizing Plate	Disk for experiment for light polarization
Revolving Magnetic Field App.,	Explanatory device for the principle of induction motor and over-current
Viscosity Measuring Equipment	Measuring of viscosity of liquid
XY Recorder	Recording device for every physical experiment
Amplifier	Amplifiable device of minute signal
Analog Auto Measuring App.,	Automatic measuring of character of transistor and diode divices
Basic Logic Circuit Trainer	Practical device of action of digital IC in the logic circuit
Circuit Trainer	Practical device for assembling circuit of each kind of electronic element

Condenser Circuit Experimental App.,	Practical device for condenser circuit
Counter Circuit Trainer	Basic practice device of counter circuit such as accumulating counter, frequency counter, time counter and cycle
Digital Circuit Tester	Tester for digital circuit
Electronic Circuit Experimental App.,	Practical device for constant circuit, amplifiable circuit, oscillation circuit and semi-conductor circuit
Electrostatic Fields Apparatus Set	Experimental device for static electricity
Equipotential Experimental Set	Drawing equipotential curves in electric field and detecting potential difference
Experimental App., for Coulomb's Law	Experimental device for gravitation and repulsion among two electric charges
Experimental App., of Parallel Plate Capacitor	Experimental device on the relation with capacity and facing area of pole plate, relation between capacity and distance of pole plate, relative permittivity of dielectric substance between pole plates and many other applications
Experimental App., of Ohm's Law	Experimental device the law that the current in the electric circuit is proportional to the voltage
Frank-Hertz Apparatus	Measuring energy lost by electrons colliding with gas atoms
Function Generator	Signal generator in wide range waves such as sine wave, triangular wave and square wave
Hall Effect Experimental Set	Experimental device for phenomenon of potential difference generated at right angle against current and magnetic field by giving magnetic field at right angle against current on conductor or semi-conductor with current
High Frequency Circuit Trainer	Practical device for radio receiver
Logic Circuit Experimental App.,	Practical device from basic logic circuit to applied circuit
Low Frequency Oscillator	Generating device of low frequency wave of every wave form
Main Voltage Wave Observing App.,	Measuring voltage and currency of AC and observing device by oscilloscope of noise wave form
Milikan's Elementary Charge App.,	Measuring electric charge of electron
Oscillation Circuit Experimental App.,	Practical device for principle and action of oscillation circuit
Storage Oscilloscope	Measuring wave form, voltage of AC and DC, cycle and frequency
Photoelectric Effect Demonstrator	Experimental device for light telephone using photoelectric phenomenon
Potentiometer	Measuring potential difference and electro motive force among two points in electric ciruit
Semiconductor Element Experimental App.,	Practical device for movement of active element of diode, transistor, diac, triac and thyristor etc.,
Thermo Electromotive Force Measuring App.,	Measuring heat electro motive force of every kind of thermocouple
Wheaston Bridge	Bridge type circuit for measuring value of unknown resistance by comparison with value of standard resistance
Astronomical Telescope	Observation of constellation
Experimental table for student	Table for experiment by student
Air-conditioner	Keeping the working condition/environment for electronic equipment

Mathematics

Equipment	Purpose of Use
Programmable Calculator	Functional pocket calculator enable programming
Color Graph Calculator	Electronic calculator converting the result of functional calculation into graph and indicating in color
OHP Graph Calculator	Device projecting the picture of graph calculator to the screen

Computer Room

Equipment	Purpose of Use
Personal Computer	Practice for computer in Mathematics and common subject
Dot Matrix type Printer	Printing computer data
Laser Printer	Printing computer data
Computer	Used for mathematics computer software
Computer Projector	Device projecting computer picture to the screen
UPS/VR for Teaching Room	Protecting the electronic equipment from voltage fluctuation and power cut
UPS/VR	Protecting the electronic equipment from voltage fluctuation and power cut
Air-conditioner	Keeping working condition/environment of electronic equipment

Audio Visual

Equipment	Purpose of Use
OHP	Projecting device of transparent plastic sheet to the screen
Slide Projector	Projecting device of cut film and round film to the screen
Screen	Screen for OHP and slide projector
Video Deck	Recording and playing back of VHS software
Color Monitor	Playback equipment of picture by TV tube
Air-conditioner	Keeping working condition/environment of electronic equipment

Teaching Material Production

Equipment	Purpose of Use
Video Camera Set	Movie camera for teaching material
Digital Camera for Computer	Digital camera taking picture into the computer
VHS Deck	Recording and playing back of VHS software
VHS Editing System	Editing device of VHS picture using sound and subtitles etc.,
Video Dubbing System	Dubbing device of VHS software
Personal Computer for picture processing	Personal computer for editing of movie

Printing

Equipment	Purpose of Use
Photocopy Machine	Duplicator of documents
Printing Machine	Printing documents
Typewriter	Printing alphabetical letters by hitting keys

Workshop

Equipment	Purpose of Use
Electric Saw	For wooden work
Electric Round Saw	For wooden work
Electric Sander	For wooden work
Electric Drill	For wooden work

Electric Lathe Machine	For wooden work
Electric Planer	For wooden work
Formed Plastic Cutter	Cutter for formed plastic
Metal Turning Lathe Machine	For metal work
Electric Drill	For metal work
Electric Band Saw	For metal work
Electric Grinder	For metal work
Welder	Jointing device of metal
Metal Sheet Bender	Device for manual bending of metal sheet
Set for Glass Processing	Gas burner for glass working
Electric Drill	Drill for electrical work
Oscilloscope	Cathode-ray oscillograph

7) Specification

Biology Education

Equipment	Specification
Dissecting Set	Set of 10 pcs.,
pH Meter	Glass electrode type, analog, pH10～14, 220V/Battery
DO Meter	Battery
Barometer	Portable, aneroid type
Insect Net、2kinds	Nylon/silk net, glass rod handle
Salinity Conductivity Meter	0-10%, minimum 0.1%
Gas Analyzer	Quantitative analysis of CO2, CO2, O2, CnHm
Polari-saccharimeter	0-90%, 3 ranges
Water Bath	17 litre, 10-80℃, pump stirring type
Kimograph	Electric, drum recording system
Pneumograph	Recordable to Kimograph
Refrigerator	More than 400 litre
Electrocardiograph	1 channel, digital, thermal printer
Dry Oven	40℃～250℃, hot wind type
Analytical Balance	0-300g, 0.01g graduation
Magnetic Stirrer with Hot Plate	100-1500rpm, 0-300℃
Warburg Bath and Manometer	15 manometer, 40 litre bath
Sterilizer/Autoclave	110-250℃, dry heating type
Microscope for Student	40x～600x, with light
Stereo Microscope	For stereoscopic and dissecting, 20x、40x, with light
Binocular Microscope	40x～1500x, with light
Microscope TV Camera Set	Camera for microscope with color monitor 25"to 29"
Microscope Stereo Trinocular	40～1500x
Colony Counter	With tally counter
Incubator	150 litre,5-50℃
Shaker	Reciprocating and rotary type for flask and test tube
Wet Specimen of Vertebrate	4 kinds of respiratory organ, 5 kinds of skeleton and 4kinds of muscle/joint
DNA Electrophoresis App.,	Agarose gel submarine electrophoresis type
Mitosis Model	6 steps
Meiosis Model	8 steps
Human Torso	Male and female

Clean Bench	UV lamp, W:1000mm
Homogenizer	5000-25000rpm
Vortex Mixer(Touch Mixer)	2500rpm, for test tube
Reciprotating Bath Shaker	50～75℃, 50mm flask x 10
Experimental Table for Student	2.4x0.6x0.7m, with sink and gas cock
Water Treatment System	For waste water of heavy metal, cyanide, cyanogen, chromium, mercury, organic, acids and alkalies, batch processing, reagent injection system, full automatic
Air-conditioner	2.5HP
Water Distillation Apparatus	1.8 litre per hour

Chemistry Education

Equipment	Specifications
Analytical Balance	0-300g, 1mg graduation
Drying Oven for Glass wares	72L, 40-260℃, analog type
Mantle Heater	450℃ for flask
Manometer	Mercury type, 0 to 180mmHg
Electronic Precision Balance	3000g, 0.1g graduation
Thermostatic Circular Bath	5 to 70℃, pump system, for test tube
Electric Furnace	1000℃, analog setting, kanthal heater
Magnetic Stirrer	100-1800rpm, stainless
Du Noi Surface Tensiometer	Range:0～180dyn
Potentiometer	0 to 1.6V, 10mA, ±0.1%
Centrifuge	Desktop type, 5000rpm
Mechanical Stirrer	100-1200rpm
BOD Meter	0-35, 0-350mg/L
COD Meter	0～500mg/L
Fraction Collector	120 test tubes, max 99minutes 59 seconds
Autoclave/Sterilizer	40-250℃, dry heating type
Magnetic Stirrer with Hot Plate	100-1500rpm, 0-300℃
Microscope	40x ～1500x, with light
Refrigerator	400 litre
Rotary Evaporator	20-180rpm, for 50-2000ml flask, with 1000ml flask
Water Bath with Shaker	Horizontal shaking, 15 times/min, 15 litre, 100 test tubes
Automatic Titrator	Portable auto burette, 10ml
Balance with Computer	Electronic balance(400g), interface、personal computer set(moe than128M Ram), and printer
Draft Chamber	W150cm with scrubber
Freeze Dryer	100ml flask x4, vacuum pump, preparatory freezing tank
FT/IR Spectrophotometer	7800cm-1～350cm-1, single beam type
UV/VS Spectrophotometer	Photometric, 200-1100mm
Nuclear Magnetic Resonance for Education	Pulse system, single coil, 8-12 MHz, magnetic field strength 35-350mT
Ultrasonic Cleaner	40kHz, 4.5 litre
Experimental Table for Student	2.4x0.6x0.85m, wih electric plug, gas cock and water sink
Water Distillation Apparatus	For waste water of heavy metal, cyanide, cyanogen, chromium, mercury, organic, acids and alkalies, batch processing, reagent injection system, full automatic

Physics Education

Equipment	Specifications
Airtable for Dynamics	500x600mm, rectangle, with blewer
Dynamic Cart with Track	2 carts, weight adjustment, angle adjustment
Electric Turntable Set	5-50rpm, with 3 kinds of experimental adopters
Electronic Precision Balance	3000g, 0.01g graduation
Experimental App., of Second Law of Motion	With cart, support and ball, weight spring type
Experimental App., of First Law of Motion	Full set with ball
Free Fall Experimental App.,	Full set with ball
Gyroscope with stand base	D:70mm, metal
Pulley Set	Double pulleys and single pulleys set
Stop Clock	LED, available for 1 min., to 60 min.,
Stroboscope	Xenon flash-tube type
Optical Bench Set	Measuring Length:2000mm, light source, variety of lens, mirrors and support
Du Noy Surface Tension Meter	Range:0~180dyn, 0.1dyn/cm, plustic ring, D:13mm
E/m Experimental Apparatus	Holmheltz coil, valve dia: 30mm, applied voltage:0~800V
Elasticity of Flexure Apparatus	Ewing's, Testing sample of copper, iron, and brass
Electromagnetic Force Demonstrator	Solenoid coil without core, current balance et.,
Electronic Digital Counter	LED, 2 sets of reflective type sensor
Eudiometer	D:20mm, L:300mm
Experimental App., of Boyle-Charles' Law	Glass tube with graduation, injector of mercury etc.,
Faraday's Effect Apparatus	With polarizing filter, angle graduated plate, coil(250 turns) etc.,
Light Velocity Measuring App.,	Revolving mirror, optical bench, power source, etc.,
Linear Expansion Apparatus	Metal bar of iron, copper and aluminum
Magnetic Circuit Training App.,	2000 turns coil, power source for coil, magnetic flux measuring, probe(In-Sn hall element)
Michelson Interferometer	Reflex mirror D:40mm, angle adjustment, half mirror, v. chamber
Polari-Sacchari Meter Set	Portable, Brix 0~50%
Polarizing Plate	With angle graduation, 2 pcs., in set
Revolving Magnetic Field App.,	Manual type revolving U shaped magnetic
Viscosity Measuring Equip.,	Redwood type
XY Recorder	A4
Amplifier	AC/DC 30w
Analog Auto Measuring App.,	SP interface, I/O, personal computer, with transistor/diode and operational amplifier circuits
Basic Logic Circuit Trainer	With experimental panel, circuit design, terminal for element
Circuit Trainer	Block type, resistance, transistor, condenser, switch and volume etc.,
Condenser Circuit Experimental App.,	For parallel and direct connecting of Condenser
Counter Circuit Trainer	15Hz~1MHz, internal generated signal, available input from outside
Digital Circuit Tester	AC/DC current and voltage, resistance, portable type
Electronic Circuit	Digital IC, emission diode, transistor resistance, photo-transistor

Experimental App.,	etc.,
Electrostatic Fields Apparatus Set	With 5 kinds of electrode plate, static electricity generator
Equipotential Experimental Set	1kHz, 5W
Experimental App., for Coulomb's Law	With charged balls
Experimental App., of Parallel Plate Capacitor	250x250mm, 3 kinds of induced article
Experimental App., of Ohm's Law	Fixed rheostat10Ω x10, variable rheostat100Ω x 1
Frank-Hertz Apparatus	Neon tube, with accelerate voltage switch and selectable from Ne, He and Ar tube
Function Generator	0.02～2MHz(7 ranges)
Hall Effect Experimental Set	Silicon semi-conductor, 0.5～1.5mA
High Frequency Circuit Trainer	Radio frequency, narrow band area FM
Logic Circuit Experimental App.,	More than 400 block elements
Low Frequency Oscillator	10Hz～1MHz(5 ranges)
Main Voltage Wave Observing App.,	Low tension transformer, built-in load resistance, current transformer
Milikan's Elementary Charge App.,	Input voltage 100 to 500V, eyepiece 50x, with latex and lamp
Oscillation Circuit Experimental App.,	Wien bridge oscillation circuit, function generator circuit, CR phase oscillation circuit
Storage Oscilloscope	40MHz, 2 channel
Photoelectric Effect Demonstrator	2.5V lamp, photoelectric tube
Potentiometer	0.0005V～1.6V
Semiconductor Element Experimental App.,	5 kinds of circuit, power source, voltmeter, ammeter
Thermo Electromotive Force Measuring App.,	3 pcs., of thermocouple, 300℃
Wheaston Bridge	0-100cm adjustable, 10～1.11MΩ, box type
Astronomical Telescope	Eye piece and connector for camera, refractive type
Experimental table for student	2.4x1.0x0.8m, with electric plug
Air-conditioner	2.5HP

Mathematics

Equipment	Specifications
Programmable Calculator	More than128 functions,10 digits, with solving function
Color Graph Calculator	More than 475 functions, more than 28Kbyte, 10 digits, color
OHP Graph Calculator	With infared remote control device, more than 448 functions, permeable type

Computer Room

Equipment	Specifications
Personal Computer	Multi-medida type, FDD, CD Rom drive, monitor, 40MB Ram, 4GHD, 200MHz, Microsoft OS, Office & Power Point
Dot Matrix type Printer	Printing area:A3
Laser Printer	Printing area:B4
Computer	Multi-media type, FDD, CD Rom drive, monitor, 128MB Ram,

	4GHD, 200MHz、Microsoft OS, Office & Power Point
Computer Projector	TFT LCD Panel type
UPS/VR for Teaching Room	10kw
UPS/VR	1kw
Air-conditioner	2.5HP

Audio Visual

Equipment	Specifications
OHP	F=280～320mm, halogen lamp 650W
Slide Projector	Both for 35mm cut and roll film, halogen lamp 300W
Screen	180x180cm
Video Deck	PAL/NST
Color Monitor	29"
Air-conditioner	3HP

Teaching Material Production

Equipment	Specifications
Video Camera Set	8mm or popular tape type
Digital Camera for Computer	1 million elemental area, with interface, 2 focus sytem
VHS Deck	PAL/NST
VHS Editing System	VHS
Video Dubbing System	VHS
Personal Computer for picture processing	Multi-media type, with modem(56k), 15" monitor, CD Rom drive, FDD, DVD drive, with video play-back software, 64M Ram, 13.6GHD, 400MHz, Microsoft OS

Printing

Equipment	Specifications
Photocopy Machine	25 pcs., per minute
Printing Machine	Duplicating machine
Typewriter	B4

Workshop

Equipment	Specifications
Electric Saw	For wooden work, portable type
Electric Round Saw	For wooden work, portable type
Electric Sander	For wooden work, portable type
Electric Drill	For wooden work, portable type, with stand
Electric Lathe Machine	For wooden work, desk-top type
Electric Planer	For wooden work, portable type
Formed Plastic Cutter	For formed plastic
Metal Turning Lathe Machine	For metal work, portable type
Electric Drill	For metal work, desk-top type
Electric Band Saw	For metal work, portable type
Electric Grinder	For metal work, portable type
Welder	Portable type
Metal Sheet Bender	Manual type
Set for Glass Processing	LPG, with stand, burner adjustment, gas adjustment cock
Electric Drill	For electric work, portable, with stand
Oscilloscope	20MHz, 2 channel