No. 1

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE PROVISION OF PLANETARIUM PROJECTOR
FOR
THE NATIONAL SPACE SCIENCE EDUCATION CENTRE
IN
MALAYSIA

October 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of Malaysia, the Government of Japan has decided to conduct a Basic Design Study on the Project for the Provision of Planetarium Projector for the National Space Science Education Centre and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Malaysia a survey team headed by Mr. Shoichi Ito (Planetarium Director of the Suginami Science Educational Centre) from July 23 to August 6, 1989.

The team exchanged views with the officials concerned of the Government of Malaysia and conducted a field survey in Kuala Lumpur. After the team returned to Japan, further studies were made. Then, a mission was sent to Malaysia in order to discuss the draft report and the present report has been prepared.

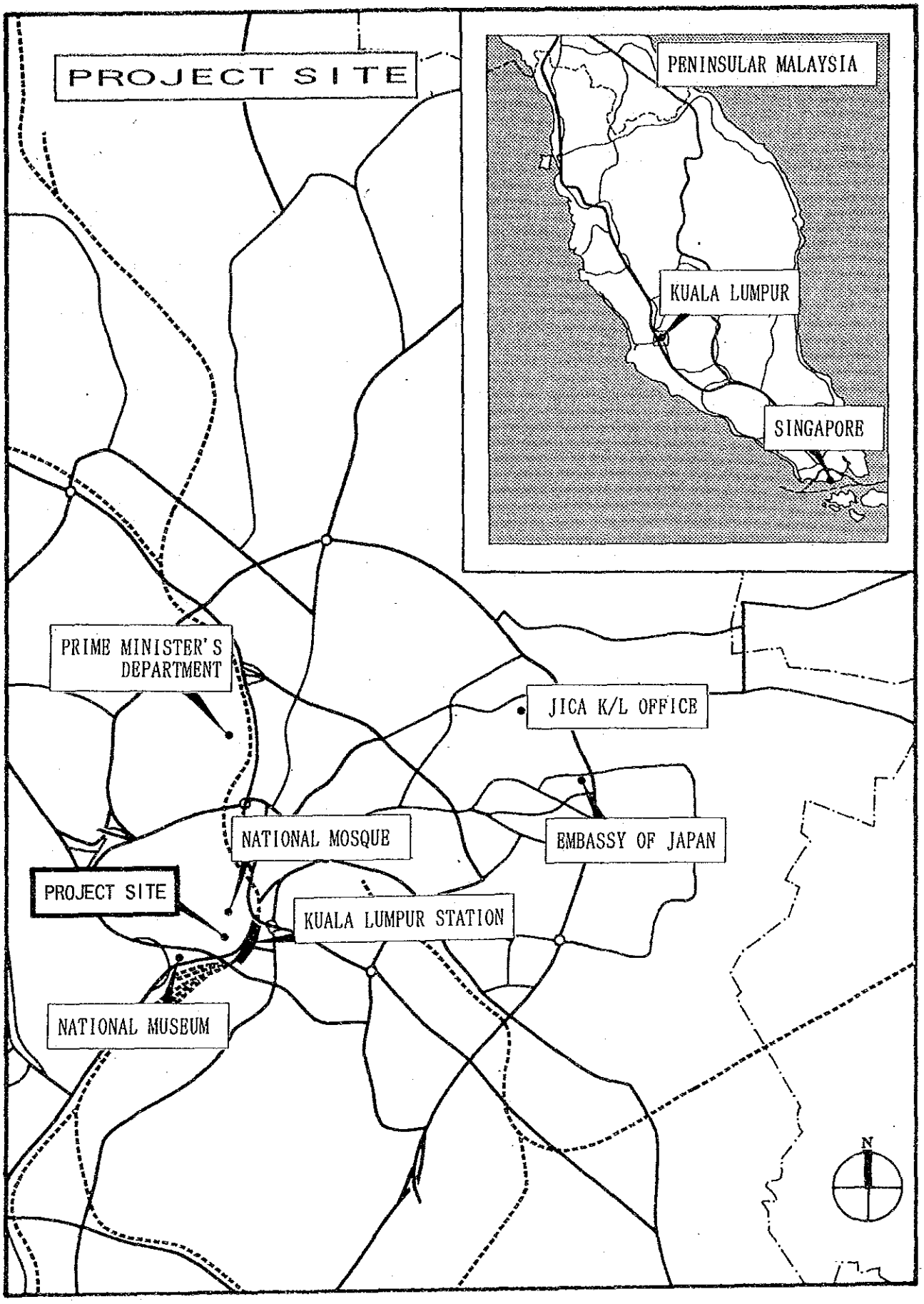
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

October, 1989

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency


PROJECT SITE
PENINSULAR MALAYSIA
KUALA LUMPUR
SINGAPORE
PRIME MINISTER'S DEPARTMENT
JICA K/L OFFICE
NATIONAL MOSQUE
EMBASSY OF JAPAN
PROJECT SITE
KUALA LUMPUR STATION
NATIONAL MUSEUM
N

SUMMARY

SUMMARY

Malaysia is in the midst of its Fifth Malaysia Plan and a new economic policy. Under this policy, the Malaysian economy has improved greatly and the industrialization has progressed rapidly, and the demand for science and technical oriented personnel in the economy and the government has increased. Though the educational sector has tried to cope with this demand by placing priority on science and technology, it has not been entirely successful. Space science education is important as the beginning of science education. However, in comparison to other fields of science in Malaysia, it is lagging behind.

The content of the curriculum in the higher forms as well as in the primary, and secondary levels is not adequate given the current conditions of space science education in Malaysia. Of the seven universities in Malaysia, only three are currently offering astronomy related courses, and though they have been long awaited by specialists in this field, the content of these courses leaves much to be desired. The main reason given for the inadequacy is the shortage of equipment necessary in the study of astronomy. Despite the fact that there is an active astronomical community in Malaysia, there are no telescopes, etc., geared for professional use; therefore the of the activities of the community have tended to remain at a rudimentary level.

Malaysia is striving to expand its science education by promoting space science. However, as practical educational institutions related to space science do not exist, the Malaysian government has been looking into the establishment of such an institution, its necessary facilities, and the provision of its equipment. As part of this effort, the Malaysian government has instituted a project to construct a "National Space Science Education Centre", which will be the focal point of space science education in the capital city of Kuala Lumpur. The Malaysian government officially requested the Japanese government for grant aid for the provision of the planetarium projectors and a portion of its special effects projectors. In response to this request, the Japanese government decided to implement a basic design study entitled "The Project for Provision of the Planetarium Projector for the National Space Science Education Centre", to study the appropriateness of the project and to ensure that an optimum plan is devised. Japan International Cooperation

Agency (JICA) dispatched a study team to Malaysia for 15 days from July 23 to August 6, 1989.

According to the study, a National Space Science Education Centre will be instituted and the Administration and Finance Division of the Prime Minister's Department will be the implementing agency. The Centre will be constructed in the Malaysian capital of Kuala Lumpur; its total floor area will be approximately 1,800 square meters; it will contain a 20 m oblique domed planetarium theater and facilities such as a lecture hall; and its objective will be to spread knowledge pertinent to space science to the general public as well as to primary, secondary students, and specialists. The equipment requested are the main projectors fitted with diverse controls and the various special effects projectors which are listed below.

1. The Main Projectors

* Projector for fixed stars
* Projector for planets
* Control console
* Computer

2. The Special Effects Projectors

* Multi-image projector
* Multi-wide projector
* Variable zoom projector
* Spinning image projector
* Projector for rising celestial objects
* Projector for multi-shooting/meteor swarms
* Flashing projector
* Projector for uni-shooting/fireballs
* Unveiling projector
* Projector for lunar and solar eclipse
* Video projector
* Cloud projector
* Projector for special lighting effects

All the requested equipment are composed of one unit or one set. They are completely necessary as a practical means of teaching space science and are therefore considered relevant to the project.

The selection in the scope of the equipment has been decided according to the scope in construction or the size of the dome. The size of the dome

is determined by estimated demand. According to the results of the basic design study, a seating capacity for about 250 people has been calculated as suitable to meet the demand.

An oblique dome with a diameter of about 20 m was concluded to be the most suitable for a seating capacity of this size when compared with other recently constructed planetariums; and hence the Malaysian plan for a 20m diameter dome is suitable and has been considered appropriate for this project. Similarly, the type and scope of the special effects projectors were also selected in correlation to this 20m diameter dome since they are closely interrelated.

After an exchange of notes has been concluded between both governments, a total of 16.5 months has been scheduled for the implementation period which includes one month for design planning, one month for tendering, 11 months for manufacturing, one month for transport, and 2.5 months for unloading, installation, adjustment, and testing.

This project will be carried out by the Administration and Finance Division of the Prime Minister's Department which is the implementing agency. The National Space Science Education Centre will be under the direction of this implementing agency and the Centre's staff will be comprised of the Centre's director and 16 other members. The staff members will be recruited and placed after a strict evaluation of their qualifications; and placement will be divided into two different phases. In order to ensure that the Centre is operating smoothly after its completion, a segment of the personnel will be placed earlier, followed by placement of the remaining staff at a later date. The management organization and the operation of the Centre after its completion has already been decided. The Centre will be established as an independent organization under the jurisdiction of its instituting agency, the Administration and Finance Division of the Prime Minister's Department. The cost of operation and maintenance of the Centre has been estimated at M$7.9 million and income generated by its activities has been estimated at M$2.5 million by the Malaysian government. The government has approved appropriations for financial assistance, as subsidy in the amount of M$5.4 million is needed annually.

The benefits of this project will be reaped by the visitors to the Centre; and though it cannot be quantitatively measured, it will make a contribution to the development of space science in Malaysia as well as to science in general. An estimated 190,000 students and pupils in compulsory

education, and many university students striving to become specialists, as well as the general public, will receive an education in space science and will be able to pursue research in space science.

Although Malaysia has developed actively in its industry and culture, it is comparatively behind other Asean countries in the field of space science. This situation must be rectified immediately. This project will practically contribute to the solution of this problem; therefore it is considered appropriate.

Construction of the Centre, which is the principal part of the project, will be carried out entirely by the Malaysian side. Consequently, coordination in the work schedules of both countries is an important factor in the efficient progress of the operation. Careful and close coordination is recommended. Moreover, it is desirable that pertinent measures be taken by the Malaysian side with regard to budgetary measures, placement of personnel, etc., so that there are no impediments to the efficient operation and management of the Centre.

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1. INTRODUCTION

1. INTRODUCTION

The Government of Malaysia is endeavoring to develop the field of space science in order to foster scientists and technicians and to upgrade the field of general science in conjunction with its social and economic development. Therefore, the feasibility of providing such a facility and its related equipment has been investigated. To achieve the aforementioned goal of the Malaysian government, the construction of a "National Space Science Education Centre" which will be the mainstay of space science education in Malaysia, has been planned in Kuala Lumpur, the capital. The purpose of this centre will be to offer general as well as specialized education in space science, and to disseminate related information.

According to this project, the Government of Malaysia will construct the building and supply all necessary equipment of the centre, with the exception of the planetarium projector and special effects projectors which will be acquired through Japanese cooperation. The Malaysian government requested grant aid from the Japanese government for the planetarium projector and the special effects projectors.

With regard to this request by the Malaysian government, the Japanese government has implemented the "Basic Design Study for the Provision of a Planetarium Projector for the National Space Science Education Centre" and the Japan International Cooperation Agency (JICA) carried out this study.

JICA dispatched Mr. Shoichi Ito (Planetarium Director of the Suginami Science Educational Centre) to Malaysia as the team leader of the basic design study team for 15 days, from July 23 to August 6, 1989. This study confirmed the background and the objective of the request, explained the system of Japanese grant aid and implementation system to the Malaysian authorities concerned, and reconfirmed the sphere of responsibility for each government. In addition, a survey was made on the infrastructure of the area surrounding the proposed construction site and on the current conditions of space science education in Malaysia. After returning to Japan, the basic study team studied and analyzed the data and the content of the discussions held in Malaysia; evaluated the purpose and suitability of this project; formulated an appropriate basic plan concerning the equipment; and compiled this information in a draft report.

JICA then made the final deliberations on the content of the report prepared by the basic design study team and dispatched a draft report

mission headed by Koichi Morita, Director, First Project Management Division, Grant Aid Project Management Department, JICA, from September 25 to 30, 1989 for explanation and final discussion of the contents of the draft report of the basic design study.

This report is a compilation of the basic plan for the most appropriate equipment, its implementation structure, and operation costs based on the results of the basic design survey. Members of the study team, itineraries, and the Minutes of Discussions are attached in the Appendices.

2. BACKGROUND OF THE PROJECT

2. BACKGROUND OF THE PROJECT

2.1 The Current State of Education in Malaysia

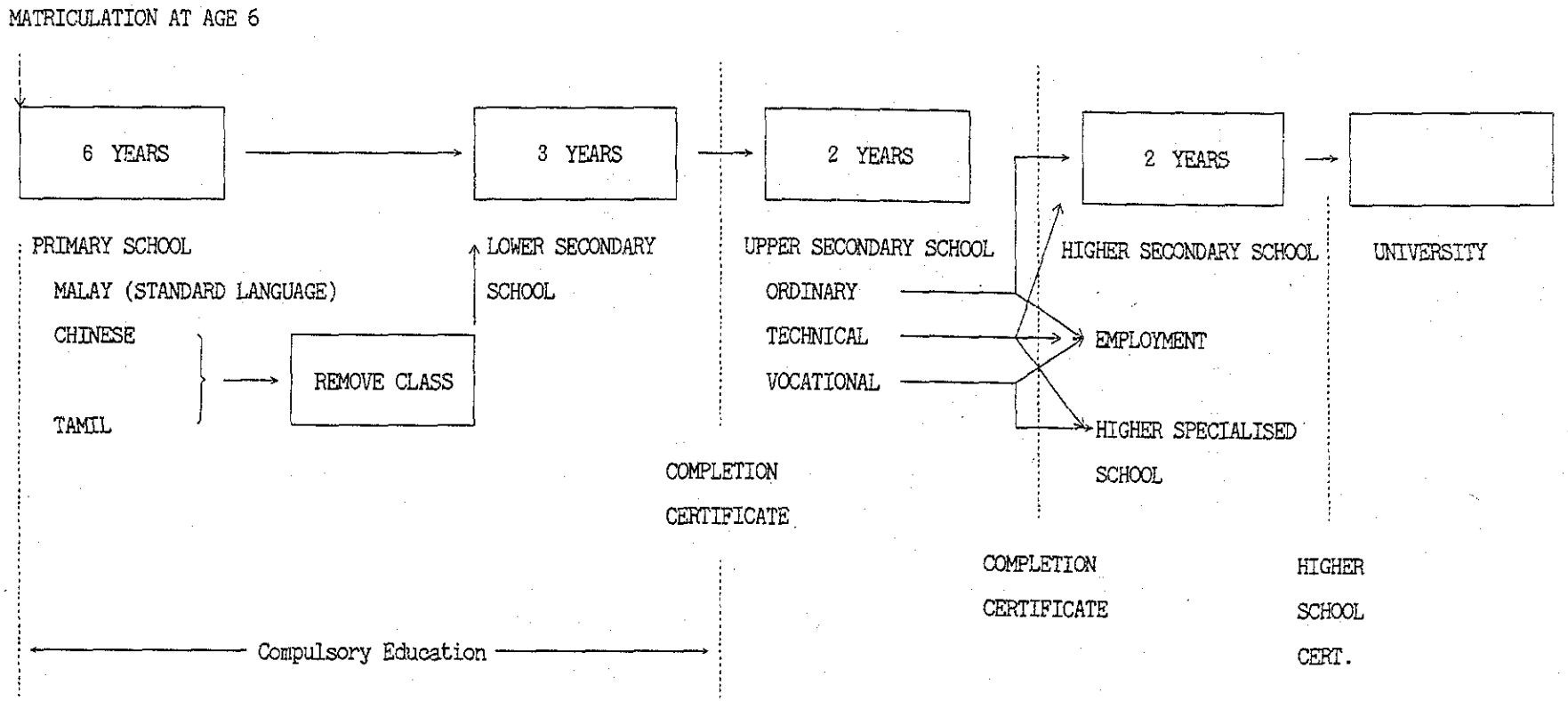
2 1.1 General Conditions

The Malaysian peninsula is located approximately 1° 20'to 6° 40' north latitude and 100° to 104° 30' east longitude. The capital city of Kuala Lumpur is located at 3° 10' north latitude and 101° 40' east longitude. The population on the peninsula is about 14 million, out of which about 920,000 people are concentrated in Kuala Lumpur.

Malaysia is currently implementing its Fifth Malaysia Plan (1986-1990) and its New Economic Policy (1971-1990). The increase in international debt, the deficit in the budget and in the international balance of payments, and the lack of economic growth during the Fourth Malaysian Plan which was in effect until 1985, have greatly improved under the Fifth Malaysia Plan. GDP has shown stable growth; international balance of payments, and domestic finances have taken a turn for the better, and the economic situation is in very good condition. Improvements have been made not only in the economic and financial sectors, but in the bureaucratic circles as well where it has become priority to foster qualified personnel. The demand in personnel with backgrounds in science and technology is growing rapidly. The importance of education in these fields is also an issue which is being reviewed within the aforementioned plan and policy. According to the Mid-Term Review of the Fifth Malaysian Plan, it has been pointed out that despite the high priority which has been given in this area, there has been minimal progress.

2.1.2 The Current Situation in Education

The educational system in Malaysia, as shown in Fig. 1, is currently comprised of six years of primary school (beginning at age 6 and known as STANDARD 1-6), followed by three years of lower secondary school (known as FORM 1-3), two years of upper secondary school (known as FORM 4, 5; the students are divided into ordinary, technical, or vocational groups), and two years of high school (university preparatory; the first year is known as LOWER FORM 6 and the second year as UPPER FORM 6). In addition to this, there is a teacher's training centre (2.5 years) or polytechnic schools (with 2,3, or 5 year courses). It is a 6-3-2-2 system with



*Pupils who have completed school in Chinese or Tamil language schools are required to undergo take a Remove Class for one year in order to study Bahasa Malaysia before they can enter lower secondary levels. As a result they are usually one year older than the average age for lower secondary school matriculation

FIG. 1 THE EDUCATIONAL SYSTEM IN MALAYSIA

options for higher education (university, etc.). In 1974 a government policy promoting Malay as the national language was instituted; and pupils of Chinese or Tamil (Indian language) primary schools are required to take a supplementary course in Malay for one year, before entering lower secondary school. Furthermore, compulsory primary school education is not strictly enforced. However, the rate of primary school attendance is high. According to the 1986 statistics, the rate is 96.9%.

Generally, there are many schools where lower and higher secondary schools have been combined to form a five year system or combined with FORM 6 to comprise a seven year system. Moreover, tuition is free until FORM 6 (university preparatory). Furthermore, there are 28 Residential Schools which are schools with a dormitory system. In these schools, a special educational program is provided for gifted children, and six schools teach Japanese as a second foreign language.

2.2 The Current State of Space Science Education in Malaysia

2.2.1 The Need for Space Science Education

Space Science is a science of systematized knowledge concerning space and the heavenly bodies. It is an ancient field of study which can be traced to the beginning of human civilization and yet concurrently, it is a leading field of study in what is known today as the space age. Until the present time, there have been many observations of the heavenly bodies from earth, observations made from the outer layer of the atmosphere by rockets and satellites, and planet surveys by space flight vehicles which constantly renew and enrich man's knowledge of the fixed stars, the solar system, the Milky Way Galaxy, and deep space.

In ancient times, the field of natural science developed from mankind's attempts to explain the various phenomena between himself and his natural environment. Particularly in the case of astronomy, mankind has earnestly pursued the observation of celestial body movements and phenomena they are closely related to the origin of humanity. It would not be an exaggeration to say that physics, mathematics, physical geography, and many other fields of natural science evolved from these observations. Therefore, these observations are the origin of astronomy and many fields of natural science or as evidenced in space science today, it has become a multi-disciplinary field which requires the knowledge of many areas of

modern science.

Though the field of modern space science contains many elements of physics and theory, its groundwork still begins with observation. Particularly in the primary and secondary school curricula, practical instruction in space science begins with the observation and understanding of various phenomena in space. Telescopes and planetariums play a crucial role in this area.

The International Astronomical Union or the IAU, which many countries are affiliated with, sponsor and hold many international conferences on space science. The problems inherent in space science education world wide, are always discussed at these conferences. At the International Conference on Space Science held in Kyoto, Japan for the Asian Pacific countries, the necessity of planetariums due to their important role in space science, as well as the requirement of telescopes were discussed.

There are currently more than 100 planetariums in Japan; and among the Asian countries, India has six; Burma has one; Indonesia has one in Jakarta; Thailand has one in Bangkok; Singapore has one; the Philippines has one in Manila; Taiwan has five; and the People's Republic of China has two planetariums. Many of the programmes shown at these planetariums are open to the general public. The planetarium in Myanmar has been built at the Youth Educational Centre and has been particularly valuable in promoting space science education among the youth. However in Malaysia, with the exception of one manually operated planetarium recently established in the state of Sarawak, there is none.

Astronomical observations which take place near the equator are exceedingly important in this field. As Malaysia is located near the equator, it is one of the countries which is geographically important to the International Astronomical Society. However, as mentioned above, there are currently no planetariums and no celestial telescopes for professional use, with the exception of the planetarium in the state of Sarawak.

2.2.2 The Present State of Space Science Education in Primary and Secondary Schools

Space Science education in Malaysia is still in its initial stage. Primary school textbooks provide only simple, basic concepts of the sun, moon, and the stars; and in order to enhance the interest of its pupils, many textbooks recently contain one or two miniature drawings of satellites.

In the science curriculum of lower secondary schools, calculations for

measuring the distance of the planets in the solar system to the sun is taught. Furthermore, sun radiation, the law of universal gravitation which determines the orbit of the planets, and the lunar phases of the moon are taught in the science courses beginning with upper secondary school.

However, in comparison to the textbooks of astronomy courses for students of the same age in Japan or the advanced western nations, the content is superficial and poor from a scientific point of view. Furthermore, despite the fact that much of the instruction is conducted in Malay, there were no textbooks on astronomy or space science in Malay until very recently. An introductory text entitled "Modern Astronomy" was compiled in Malay for the first time by Dr. Mazlan Othman in 1987. In summary, the groundwork to teach space science more scientifically has not been established in the curricula of primary and secondary education.

2.2.3 The Current State of Higher Education

Three out of the seven universities in Malaysia (University of Malaya, National University of Malaysia and University of Technology) offer courses in astronomy in their physics departments; and a number of students write their graduation theses in the field of astronomy each year. In addition, the University of Science in Penang and the University of Agriculture offer basic courses in astronomy.

At the University of Malaya, an introductory course on astronomy as an elective for first and second year students, a specialized astronomy course for four year students, and a graduation thesis course are offered. In addition, the theory of relativity and courses on space theory are also offered.

At the National University of Malaysia, there are a number of specialized astronomy courses offered in the physics department by the astrophysicist. They are as follows:

Astronomy I	(SF2111):	Introductory Astronomy and General Astrophysics
Astronomy II	(SF2121):	Position Astronomy, Theory of Astronomical Survey, Basic Theory on Observation
Astrophysics I	:	Basic Stellar Physics, Theory on Binary (Star), Theory on Variable Stars, Nebula, and Theory on Interstellar Space

However, though there are many students who take courses in astronomy as electives, astronomy is not offered as a major.

Generally at each university in Malaysia, the caliber of the professors and assistant professors is very high due to the practice of placing an External Examiner, who is a foreign scholar, on the national selection board for the selection and hiring of faculty members. (This is a common method of selection for universities in Europe and the United States.) A crucial factor underlying the low number of four year astronomy majors, is the fact that specialized equipment necessary in the study of astronomy is nonexistent at all universities.

Although nearly all university professors are scholars with doctoral degrees from overseas institutions in Europe, U.S.A., Japan, etc., it is an undeniable fact that because of the lack of equipment necessary for observation in astrophysics, the content of the courses taught in astronomy inevitably tend to be incomplete.

Existing practical work in the field of astronomy is in the creation of the Islamic calendar. The research department at the University of Technology undertakes the routine task of drawing up the Islamic calendar. The exact position of the sun and moon for every six days is published annually.

2.2.4 Dissemination of Space Science Information to the Public

Currently the Ministry of Education has produced a television program on information related to astronomy and space science which is broadcast within the country. However, this program is shown only once every few months and since not all schools, particularly schools in rural areas, have televisions, the program is deemed only minimally effective.

Much of the space science information is disseminated publicly by three main sources, newspapers, science magazines, and publications put out by the Astronomical Society of Malaysia. Each newspaper dedicates about half a page each month on in-depth articles related to astronomy or space science, but these newspapers are inevitably English language newspapers.

There are a number of domestic science magazines published monthly and recently they contain many astronomy and space science related articles.

The main objective of the Astronomical Society is to disseminate knowledge and information on astronomy; and since it is widely recognized as a valuable source of the latest information on astronomy, it often sends

out lecturers to astronomy clubs throughout the country. It also promotes the dissemination of information on many different fields in astronomy and encourages related activities through its publications.

2.2.5 The Present State of the Astronomical Society of Malaysia

The Astronomical Society of Malaysia, also known as ASM, was established in 1979. It is managed by 11 committee members headed by the chairman, deputy chairman, secretary, and treasurer. There are currently about 300 members. Most of the members are concentrated in Peninsular Malaysia.

As there are very few people with advanced academic degrees (PhD) in astronomy, the majority of the members are primary and secondary school science teachers (including higher form teachers), university students majoring in science, and/or science graduates.

There is a library at the society headquarters containing 100 books on astronomy and its related fields, which are lent out to members. There is also a 12.5 inch (30cm) diameter Cassegranian reflector and on clear nights members often conduct various kinds of astronomical observations. At the branch office of the society in Penang, there is an 8 inch (20cm) diameter Dobsonian telescope which is also used by society members.

Currently the main objective of the astronomical society is not to conduct specialized research, but to disseminate knowledge and publish its official newsletter. Membership requirements are not very strict.

Society activities include lectures given on the last Sunday of every month in Kuala Lumpur. Not only are lectures given by specialists of astronomy and its related fields in Malaysia, but by guest speakers from foreign countries as well. A Japanese professor and assistant professor from the University of Tokyo were invited to give lectures in December 1987 and in January 1989.

One of the main activities of the ASM is to publish its monthly "Newsletter" of three to four pages which is distributed monthly to its members. Another publication is the magazine, "The Astronomer", which is published twice a year and contains sophisticated commentaries on lectures in astronomy and synopses of the lectures given at conferences.

Furthermore, when science conferences are held within the country, the ASM will almost always be in charge of the section on space science and will cooperate by contributing lecturers from the society to the conference. In addition to this, the ASM will send out a lecturer from the

society upon request from the many Astronomy Clubs of the secondary schools and universities which have about 20 to 40 student members. In doing so, they further promote the dissemination of knowledge in astronomy.

These lectures usually last for two days (from 9 a.m. to 5 p.m. each day), the cost per student is M$15.00 and the cost of general admissions is M$30.00.

Though the ASM is very active in promoting astronomy, as delineated above, their financial source of income is strictly from membership dues and from monetary contributions from a few supporters.

2.3 Outline of the Promotion and Plan for Space Science Education

2.3.1 The Plan for Improving Space Science Education in Primary and Secondary Education

A committee composed of educators and scientists who are active in space science education, has submitted a proposal to the government describing the need to rectify the low level of space science education in Malaysia, by teaching the subject from a more scientifically oriented standpoint within the secondary school curriculum. In order to achieve this, they have proposed that a separate provision on astronomy be made in the 1991 science textbook revision of secondary schools.

According to this proposal, a curriculum containing 25 hours of astronomy instruction per one school year has been suggested. Furthermore, in order to compile an astronomy, space science related word list, a committee was formed in the beginning of 1989 for this purpose and is presently engaged in this endeavor. It is expected to be completed in the near future.

2.3.2 Plan for Improving Space Science Education in the Lower and Upper Forms

The Malaysian Physics Research Centre was requested to outline the future prospects in the development of science and technology in Malaysia during the Sixth Malaysian Plan by the Science Advisor to the Prime Minister. A report entitled "Priority Area in Physics Research" on the promotion of space science and its education was submitted in response to this request. This report compiled a list of areas in the following order of importance: astronomy, space science, computers and physics, energy alternatives, laser electro-optics and materials science, nuclear/reactor

physics, plasma fusion physics and pulse technology, radiation biophysics, and theoretical physics. Future research and the educational programmes in these fields were mentioned in the report. The following policy on fostering future specialists in these areas, provision of space science facilities in higher education, research development, and international cooperation, etc. has been outlined below:

a) To educate, train, and foster qualified personnel in practical fields of application, i.e. in remote sensing, satellite communication, geodetic astronomy, etc.

b) To establish a space science department in at least one Malaysian university as part of the plan to provide space science facilities in higher education.

c) To establish an observatory open to university students and the general public as part of the plan to strengthen research and development in space science.

d) To place Malaysia in the international space science network through international cooperation, thereby allowing space science technology to flow into Malaysia.

It is believed that reforms in space science education will be made in higher educational institutions in Malaysia according to this policy.

Presently there has been a trend among university researchers to promote space science research. An "Astronomy and Space Science Group" was formed under the auspices of the Malaysian Physics Society, spearheaded by several professional astronomers. They are also requesting the government to allocate increased funds for the science budget.

2.4 The Details and Content of the Request

2.4.1 Details of the Request

As delineated in the earlier section on "The Need for Space Science Education," the promotion of astronomy in Malaysia is not only the aspiration of the nation, but of the international community as well, since

it will play an important role in the development and promotion of astronomy internationally. Under these circumstances, the Malaysian government has planned the institution of a "National Space Science Education Centre" to promote space science among compulsory school students, university students striving to become astronomers, and the general public. It has requested the Japanese government to provide the planetarium projector which is the main equipment of the Centre, and its special effects projectors in the implementation of the project.

The plan to establish a planetarium in Malaysia was drawn up approximately 20 years ago in 1969. It began when the National Museum started to study the possibility of establishing a planetarium as part of its objective to improve its activities. The museum concretely studied the plan to construct a planetarium in 1969/1970 and drew up a proposal. However, the plan was shelved after the economic situation deteriorated in 1972. The plan for a planetarium was not taken up again until 1986. The astronomical community continued to strive to procure funds for the construction of a planetarium despite this setback. The details are outlined below.

March 1986: Exhibition Celebrating the Recurrence of Halley's Comet (held for one month at the Islamic Centre); the exhibition was highly successful in impressing upon the public the importance of space science. 2000 pamphlets which were prepared for the exhibition were sold out in a few days.

April 1986: Announcement by the Prime Minister's Department regarding the importance of establishing a planetarium; the announcement was made after Prime Minister Mahathir was impressed with the importance of space science and the success of the exhibition on his visit there.

1987: Preparation of basic design of the planetarium; a consultant company under the auspices of the Prime Minister's Department, unofficially conducted a survey of the construction site of the planetarium, its design, and its cost.

October 1988: Approval by the government for the planetarium and the selection of the executing agency; the government approved a project proposal to establish a National Space Science Centre based on the basic design drawn up on the results of the unofficial survey. It was also decided that henceforth the Prime Minister's Department would be responsible for the facility as an executing agency.

April 1989: Request for grant aid to the Japanese government for a joint project between the two governments; Prime Minister Mahathir requested Japan's cooperation in the form of grant aid for the planetarium projector during former Prime Minister Takeshita's visit to Malaysia.

2.4.2 Contents of the Request

(1) The contents of the Project requested by the Government of Malaysia as the Project of the Provision of the Planetarium Projector for the National Space Science Centre is shown below.

1. Major Equipment: Main projector (able to project 15,000 or more fixed stars, the sun, the moon, the planets, the coordinates, the constellations, the panorama, the sunrise and sunset glow, the twilight, the Milky Way, the pointers) and other projectors and attachments

2. Others: Big screen projector, a wide angle gigantic screen projector, a variable zoom type multi-image projector, a spinning image projector, and nine other types of projectors have been given priority in the request

(2) "The National Space Science Education Centre" which will be constructed relatively with the Project by the Government of Malaysia, will have the total floor area of about 1,800 m^2 and it will be the

integrated space science education centre. The details are outlined below.

1. Facilities: Planetarium theater to be used jointly as a space theater, a small hall, a space science lab, a library, a special exhibition hall, etc.

2. Main Equipment: Planetarium projector, special effects projectors, an inner dome, a sound system, a sky movie projector, telescope, cooling facility, generator, office equipment, mimeograph machine, etc.

3. Staff: 16 staff members in addition to the director (The Public Service's Commission will conduct the advertising, hiring, and placement of personnel.)

4. Location: Jalan Perdana, Kuala Lumpur (It will be located in the centre of a park, surrounded by the Lake Garden, the National Monument, the Islamic Centre, the National Mosque, the National Museum, and the Kuala Lumpur Railway station.)

5. Cost: Approximate total cost is M$20 million (about 1100 million yen)

3. CONTENTS OF THE PROJECT

3. CONTENTS OF THE PROJECT

3.1 Objective of the Project

3.1.1 Objective of the National Space Science Education Centre

The objective of the National Space Science Education Centre which is the main body of this project, is to establish a professional institution which will provide a workshop for space science education in Malaysia. The fundamental objectives are outlined below.

(1) To foster space science education in primary, secondary, and higher school curriculum

(2) To handle activities such as exhibitions on the premises which will promote the general public's interest in space science

(3) To provide training for specialists in astronomy

(4) To actively disseminate information on astronomy

(5) To foster space science education through basic activities such as lectures, presentations at the planetarium, opening the library to the general public, and distributing publications

3.1.2 The Role of the Equipment Requested in the National Space Science Education Centre

The planetarium projector and its related special effects projectors which are the nucleus of this project for the aforementioned Space Science Education Centre will be provided by Japanese grant aid. When the Centre is completed and in full operation, this project will fulfill and substantiate the objectives of the Centre to promote science through space science education, to foster scientists and technicians, and to achieve concrete results from the space science educational programme.

3.2 Evaluation of the Requested Items

The promotion of science and the need to foster scientists and technicians as mentioned above is a task which must be urgently undertaken. The field of space science is the origin of all other fields of science. Therefore, space science education is indispensable to the enrichment of science education in general. However, there are no practical space science educational facilities in Malaysia as yet. This situation has become an impediment to the enhancement of space science education; and as a result space science education is greatly lagging behind. In order to meet the demands of Malaysian society in this area, it is indispensable that space science education is promoted. Establishing practical space science facilities is crucial to promoting space science education. Practical space science facilities have a significance in coping with the nation's demands to foster technical, scientific personnel, to promote science education as well as space science. This project which will furnish the planetarium projector and the related special effects projectors for the National Space Science Education Centre, has an important role and objectives of the Centre.

The details of the investigation concerning the equipment which has been requested in the project will be given in the following chapters. However, the equipment requested by the Malaysian side will be able to simulate astronomical conditions for programmes suited to the compulsory education student and the general public to the specialist. Therefore the equipment has been judged as appropriate since they are in accordance with the objectives of the Centre.

The establishment of a National Space Science Education Centre is due to enthusiastic support for space science education in Malaysia. The centre's completion has been long awaited by Malaysian people. As can be seen from the completed basic construction plan, the centre reflects the enthusiasm of the Malaysian government. Hence the two projects "Project for the Provision of Planetarium Projector for the Space Science Centre" and the "Project to Establish a National Space Science Education Centre" must be implemented jointly with cooperation of both governments.

The following is an outline of the duties which will be carried out to promote space science education by the Centre.

1. Public Shows:	The planetarium and sky movies will be shown to the general public as well as students and specialists.
2. Lectures:	Lecturers from all research institutions will be invited to give lectures to groups involved in the study of astronomy.
3. Seminars/Symposiums:	Discourses for specialists as well as for the layman will be given by Malaysian as well as foreign visiting astronomers invited by the Centre.
4. Courses:	Courses will be held.
5. Publications:	Space science publications, pamphlets on astronomy and space science will be distributed.
6. Library:	The library will contain a collection of books on astronomy and will be available for public lending. The library will also appeal for book donations.
7. Exhibitions:	Exhibitions will be held twice a year on astronomy related topics.
8. Information Dissemination:	There will be press conferences, a public relations office, and information exchange with international astronomical organizations.

According to the "Project to Establish a National Space Science Education Centre" by the Malaysian side, a planetarium theater with a seating capacity for 250 people for the sky movies and the planetarium, a lecture hall with a seating capacity for 100 people, an exhibition hall, a library, and an observation tower equipped with telescope, are the facilities which are being planned. The planetarium projector which is the

main projector for the planetarium show, and its special effects projectors has been compiled into the Project for the Provision of the Planetarium Projector for the National Space Science Education Centre, based upon the request for Japanese grant aid cooperation. This equipment will be used to show information concerning space science, which is the main function of the centre; and it is expected to contribute to the promotion of space science in Malaysia. The conditions on the use of the planetarium have been assessed on the calculation of the number of people who will be using it and are delineated as follows:

1) The planetarium show and the sky movie will be shown four times a day. (Malaysian plan)

2) The programme will be shown six days a week. (Malaysian plan)

3) Compulsory education programmes will be shown three times on a weekday and twice on Saturdays for a total of 14 showings per week.

4) Programmes for the general public will be shown once a day, twice on Saturdays, and four times on Sundays, for a total of 10 showings per week.

5) Programmes for university astronomy majors and members of the astronomical society differ in content from the programs for the general public or students. Therefore such programmes will be shown at different times, for example after the programmes for the general public or on days when the planetarium is officially closed.

The aforementioned plan on the operation of the planetarium ensures that the equipment which will be provided by the Japanese side will be used to its fullest capacity. The planetarium will be closed once a week and it is expected that the equipment will be suitably maintained. This operation plan is considered appropriate for the Centre. The Malaysian side has placed the Administration and Finance Division of the Prime Minister's Department in charge of the centre; and they will be handling such fundamental operations as construction and installation of the equipment.

In addition, they will be in charge of operations after the centre has been completed and until the centre's operations have stabilized, at which time an organization will be appointed to operate the centre permanently. Therefore, the Prime Minister's Department will also be in charge of the operation budget. Details such as the number and qualifications of the personnel have already been decided. All that is remaining is the hiring and placement of the personnel.

By referring to and employing the expert opinion of the ASM in the planning of the planetarium show programme for the National Space Science Education Centre which will be inaugurated in the near future, the effectiveness of the centre will be enhanced.

There are plans on the Malaysian side for a committee meeting to be held on programme formulation, which will include members of the ASM. The centre is also planning to request the cooperation of the society in providing lecturers for the centre's lectures and courses, and contributions for its publications. The ASM has also indicated their desire to cooperate as much as possible with the planetarium after its completion, though they have no official ties with the government and are currently a voluntary organization.

3.3 Evaluation of the Planned Facilities and Equipment

3.3.1 The Facilities

The ground area of the National Space Science Education Centre in the Malaysian plan is approximately 3000 square meters and the total floor space (net) is 1778.87 square meters. The main facilities are given below. The overall plan of the Centre is given in Fig. 2.

(1) Main Building (Dome)

A part of the structure will be three stories high and made of reinforced concrete.

1) Planetarium theater (to be used jointly as a space theater)
2) Main hall
3) Lecture hall
4) Space science workroom
5) Special exhibition room

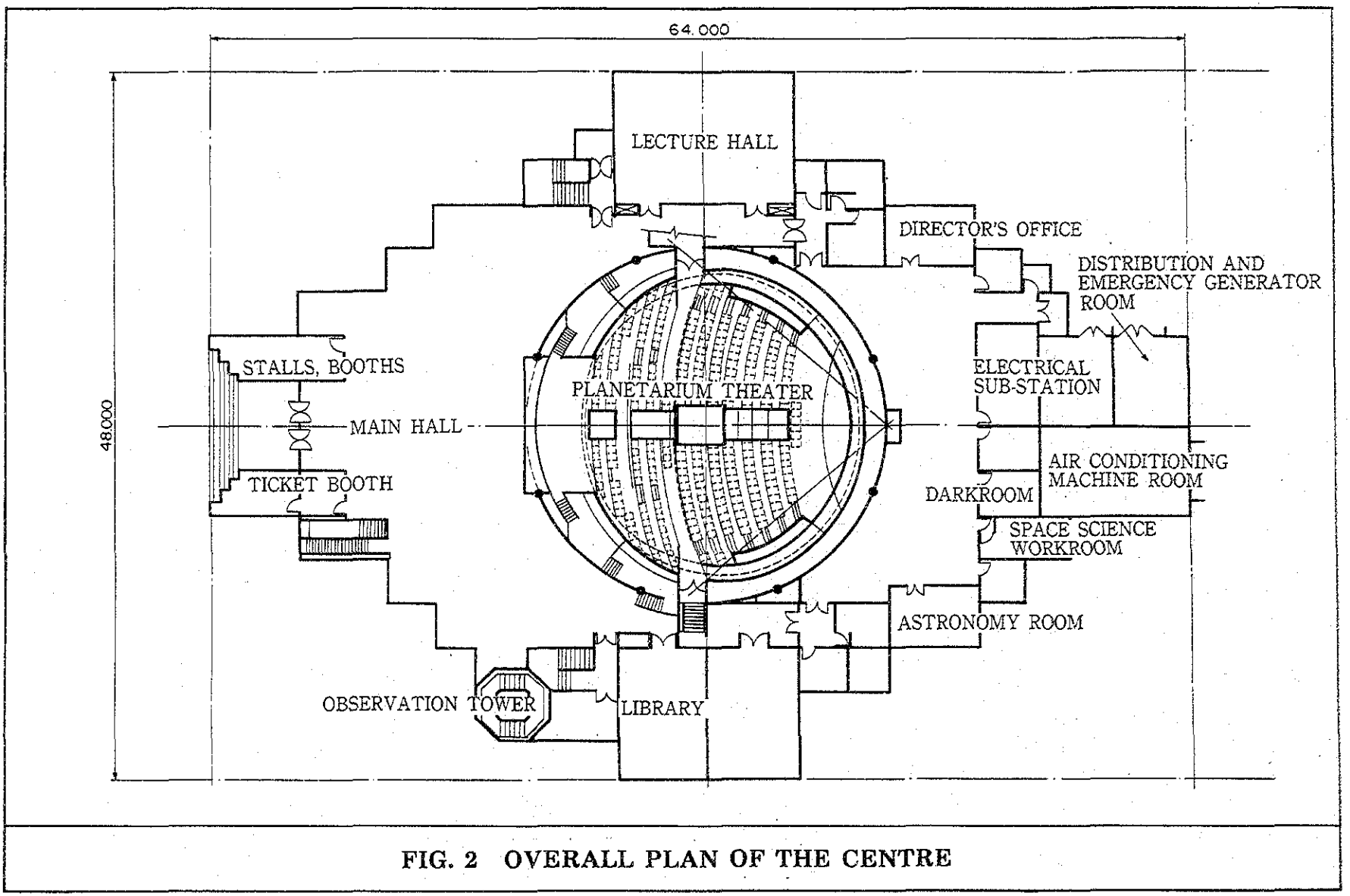


FIG. 2 OVERALL PLAN OF THE CENTRE

6) Director's office
7) Astronomy room
8) Darkroom
9) Editing room
10) Library
11) Stack room/storehouse
12) Ticket booth
13) Stalls, booths
14) Computer room
15) Space theater projector room
16) Air handling unit room
17) Elevator
18) Air conditioning machine room
19) Electrical sub-station
20) Distribution and emergency generator room
21) Pump room
22) Cooling tower, etc.
23) Fire fighting equipment
24) Others

(2) The Observation Tower

The height is about 32 m with an elevator and will be constructed of reinforced concrete.

1) Observation room with telescope
2) Observatory corridor
3) Stairway
4) Elevator
5) Elevator hall

The equipment which is requested will be installed in the planetarium theatre and the computer room.

The Malaysian government is responsible for the design, the execution, and the management of the entire building. Work has already begun under the Kumpulan Senireka Company, a local consultant company selected by the Malaysian government. The basic blueprint for construction was already completed at the time of the basic design study and a portion of the structural study was also completed.

3.3.2 The Equipment

The following is a list of the basic equipment which will be installed in the National Space Science Education Centre.

(1) Planetarium projector
(2) Special effects projectors
(3) Projector for sky movies
(4) Sound system
(5) The inner dome screen
(6) Chairs for the planetarium theater
(7) Softwares for the planetarium programmes
(8) Video projector
(9) Telescope
(10) Dome for the telescope
(11) Video system for the telescope
(12) Book collection for the library
(13) Space science workroom equipment (darkroom, editing room, etc.)
(14) Office equipment including mimeograph machine
(15) Other equipment

At the present stage, the basic construction design has been completed, and also the outline of the equipment necessary for the centre has been studied and finalized. Japan has been requested to provide only a portion of the necessary equipment. Therefore, it investigated the appropriateness of the request in this basic design study. However, Japan did not study the details of equipment unrelated to the project.

3.4 Outline of the Requested Equipment

3.4.1 The Planetarium Projector

There are mainly two types of planetarium projectors. They are projectors suited for planetariums with horizontal domes and planetariums with oblique domes (this type can also be used with horizontal domes). In the plan of Malaysian side, the sky movies will be shown in the planetarium and only the latter type of dome can be applied to sky movies. As exemplified in recently constructed planetarium most of the domes are

oblique type dome since the objective is to show the sky movies. greatly enhances the audience's interest, as exemplified in recently constructed planetariums; therefore the introduction of sky movies becomes important for its operations. Hence, an oblique dome becomes necessary and the planetarium projector must be the type used for oblique domes. The request made to the government of Japan was for a projector of this type. The oblique dome is not completely spherical (a part of the half dome is lacking). Thus in comparison to the horizontal dome, it is unable to project the same number of stars which can be projected on the horizontal dome. However, it has the unique characteristic of giving the observer a sense of being in the space while watching the stars.

In conjunction with the Malaysian government's plan to show sky movies, it is necessary to examine the matter of providing an oblique dome projector.

3.4.2 Investigation of Other Equipment

In addition to the planetarium projector, other equipment which has been requested for the project and delineated in the "Minutes of the Discussions", are the special effects projectors to be used in conjunction with the main planetarium projector. The details are given in later sections on the outline of the equipment. The special effects projectors are basically used to raise the effect of the projection and to help explain space science more effectively. Though the suitability of these projectors will be explained in detail in the following paragraphs, nearly all of the equipment has been judged to be appropriate in terms of projection ability and the purpose of the centre.

3.5 The Contents of the Project

3.5.1 Implementing Agency

The Project was requested by the Prime Minister's Department which will be the implementing agency. The organizational structure of the Prime Minister's Department is shown in the organization chart in Fig. 3 and within this structure, the Administration and Finance Division will be the implementing agency. The operation of the National Space Science Education Centre after its completion, will be undertaken by the newly organized centre itself. The employees of the centre will be recruited by the Public

Services Commission. The director of the centre must have a minimum of a master's degree in physics with experience in teaching astronomy. The Senior Administration Officer must be an university graduate qualified in accounting with experience in personnel management. The qualifications of other staff members have been decided in detail. It has been concluded that based on the current level of education in Malaysia, there should be no difficulties in recruiting staff members, if the qualification of experience in teaching astronomy is excluded. The budget for operation and maintenance costs has been approved by the government of Malaysia and efficient operation of the centre is expected. The details are given in Chapter 5.

3.5.2 Operation Plan

As delineated in the earlier chapter on the study of the content of the requested project, the National Space Science Education Centre will be established to promote space science education through its management and operation. The centre will achieve this objective through the various activities described in the earlier chapters. The main attraction of the centre, the planetarium theater, will utilize an oblique dome of about 25 degrees and will show sky movies in addition to its function as a planetarium. By doing so, space science education will be enhanced for primary and secondary students, university science and astronomy majors, people working in astronomy related fields, and the general public. The details of the centre's operations are described below.

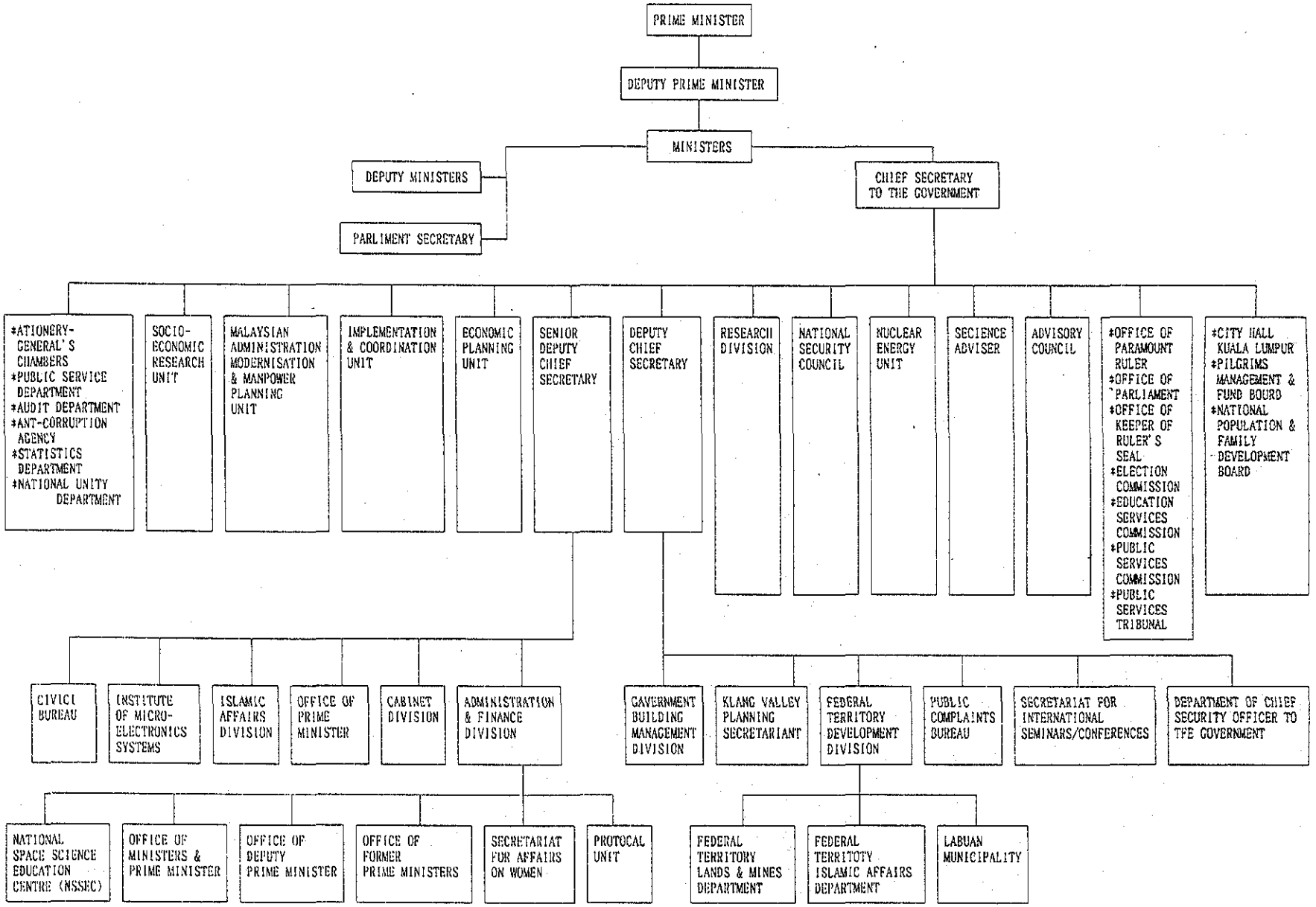


FIG. 3 ORGANIZATION OF PRIME MINISTER'S DEPARTMENT

3.5.3 Summary of the Equipment

3.5.3.1 Outline of the Equipment Requested

(1) Main Projectors

1) Projector for the fixed stars
2) Projector for the planets
3) Control console
4) Computer

(2) Special Effects Projectors

1) Multi-image projector
2) Multi-wide projector
3) Variable zoom projector
4) Spinning image projector
5) Projector for rising celestial objects
6) Projector for multi-shooting meteors
7) Flashing projector
8) Focusing projector
9) Uni-shooting/fireball projector
10) Unveiling projector
11) Projector for the lunar and solar eclipses
12) Video projector
13) Cloud projector
14) Other equipment

3.5.3.2 Outline of Equipment Not Listed in the Request

An outline of the equipment important in the operation of the National Space Science Education Centre which will be furnished by the Malaysian side, and therefore not included in the request to the Japanese government, is given below.

1) Additional special effects equipment

Equipment necessary to complement equipment provided under Japanese grant aid will be installed.

2) Sky movie projector

The projector for this type of movie, generally referred to as sky movies, is a projector for large-scale movies which give the

audience a sense of being drawn into the screen. It utilizes large size film which gives it a unique feature that ordinary movies cannot provide.

3) Sound system

The sound system equipment is closely related to the sky movies. Therefore, the Malaysian government will furnish the sound system equipment together with the sky movie projector. The equipment will have an 8 channel sound system and will be able to produce 6 channels of sound.

4) Inner dome

The inner dome, together with the main projector, is the most crucial piece of equipment in this project. The inner dome screen will not only project the images from the planetarium projector and its special effects projectors, but will project sky movies as well. An important factor is the rate of reflection from the surface of the screen. A high reflection rate is desirable for the planetarium, while a low reflection rate is desirable for sky movies. Normally for screens used for both purposes, the reflection rate is about 40%.

5) Planetarium chairs

Chairs are indispensable and reclining chairs are desirable.

6) Planetarium softwares

Softwares are mainly composed of computer softwares and ready made slides for each projector. Programs and slides which are suited to the tastes of the Malaysian audience are desirable.

7) Telescope

A telescope will be attached to the top of the observation tower which will be constructed as part of the centre. The telescope will permit direct observation of celestial bodies in the sky or will allow the play back of celestial images recorded during the night with the video system.

8) Video system for the telescope

This system will be used in conjunction with the telescope as explained above.

9) Book collection for the library

A book collection will be provided for the library at the centre.

10) Equipment for the space science work room

This equipment will be used to make programs for the planetarium shows or will include equipment necessary for official publications.

11) Office equipment

This includes general office equipment such as a mimeograph machine, etc.

12) Other equipment

In addition, there are display cases for exhibitions and other provisions needed at the centre.

3.5.4 Description of Proposed Site/Planned Site

3.5.4.1 Present Condition of Project Site Surroundings

The proposed site for the construction of the National Space Science Education Centre is located on a hill behind the Islamic Centre and the National Museum in the centre of Kuala Lumpur. The vast expanse of the city can be seen from the construction site of the dome which is the main structure of the centre. Lake Perdana which includes the Lake Garden, surrounds the entire area and is well known among the citizens of the city as a place of relaxation. The proposed construction site is easily accessible by sufficiently wide, well paved roads. Presently, there is an official residence of the state government on the proposed site of the dome. It is a reinforced concrete, two storied structure which is in disuse. It will be destroyed when construction begins. The remains will be cleared away and the necessary level ground area will be secured. There is a 120 meter stairway planned from the front entrance of the dome to the junction of the nearest existing road. Currently, it is a gentle slope completely overrun with low growing weeds. The road which will surround the centre will be widened and is a part of the construction plan. The proposed construction site for the centre belongs entirely to the federal

government.

3.5.4.2 The Infrastructure of the Vicinity

(1) Electricity

Electricity in Malaysia is under the jurisdiction and management of the Lembaga Letrik Negara (LLN). Electricity supply in Kuala Lumpur is reliable. At the proposed construction site of the centre, there is only a low voltage electric cable connected to structures presently existing there. There is no high capacity electricity supply since large buildings do not exist in the area. According to the Malaysian side, the electricity capacity which will be required by the centre has been estimated at approximately 900KVA and the installation of a high voltage electric cable (11KV) has been assessed as indispensable.

(2) The Water Supply and the Drainage System

In addition to the electricity, it is necessary to provide a water supply and install a drainage system. It is also necessary to replace or expand the existing drainage facilities for rain water.

(3) Roads

The roads which will surround the centre and roads which will have access to the centre are roads currently in existence which will be expanded and improved. This work is included as part of the construction work. Furthermore, an overhead pedestrian bridge is planned which will allow direct entrance to the centre and will straddle the arterial road (Jalan Damansara) which runs near the proposed construction site.

4. BASIC DESIGN

4. BASIC DESIGN

4.1 Basic Design Principles

The principles pertaining to the basic design of this project are given below.

(1) The scope of the equipment which will be provided for this project was calculated on the number of estimated people such as students (primary, secondary, and upper form levels) in space science related curricula who will be using the centre's facilities, and the number of people who utilize similar institutions such as the National Zoo or the National Museum.

(2) The type of equipment which will be provided for the centre was selected to ensure the success of the project in fully contributing to space science education in Malaysia and to guarantee maximum efficacy of the grant aid.

(3) The equipment which will be provided is precision optical instruments which require careful maintenance. Therefore they have been selected on the basis of such maintenance considerations. Furthermore, difficulties in obtaining spare parts locally for such special optical instruments were also weighed, and a sufficient amount of spare parts was also included.

(4) As the main planetarium projector and its special effects projectors are closely interrelated, this interrelation was analyzed carefully in the selection of the equipment.

(5) The equipment which will be furnished in the project will be installed in the buildings which will be constructed by the Malaysian government. As it is impossible to decide where the equipment will be installed without considering the design of the building, it is important that the basic design be worked out in close collaboration with the construction side of the project.

4.2 Evaluation of Basic Design Conditions

4.2.1 Coordination between Equipment Installation Plan and Architectural Plan

The equipment to be provided will be installed in the buildings constructed by the Malaysian side as explained earlier. The construction and the installation work must be effectively coordinated in terms of standard, design, work schedule, division of work, and in contract bidding. Problems which may arise in these areas are outlined below.

(1) As the dimensions of the installation areas, the layout of the reclining seats, the installation area and dimensions of the special effects projectors will all differ, the equipment type must be decided in order for detailed construction design to proceed and for contract bidding to commence. In order to solve these problems, a detailed survey of the products of the two Japanese planetarium projector manufacturers must be made. The coordination between the work schedule, installation, tendering, and design must be carefully worked out; and the conditions of the basic plan must ensure that whichever equipment is selected in the tendering, there is only minimal adjustment during installation.

(2) The requested equipment will be finalized after results of a detailed study of the equipment in Japan have been undertaken. All the equipment requested may not necessarily be appropriate equipment for this project. Consequently, after the results of the study have been examined, equipment which will be excluded from the project must be provided by the Malaysian side according to the need.

(3) The construction standards will be based on to the Malaysian Uniform Building By-laws, which are based on international construction standards. The equipment which will be provided has been manufactured according to Japanese standards and the differences in the two standards must be coordinated.

(4) The Project shall be completed within the designated implementation schedule since the disbursement of the budget of both governments for the Project has a time limit. Therefore an implementation schedule efficiently coordinating the tendering period with the

construction schedule and the schedule for equipment which will be provided by the Malaysian side will be drawn up.

4.2.2 Equipment Selection Conditions

The scope of the construction is an important factor in equipment selection. According to the Malaysian government, the core of the construction plan for the present project is the oblique dome with a 20m diameter for the space theater.

In order to decide the scope of the equipment in this study, the following investigation on the scope of construction and its execution has been conducted.

A factor in the selection of equipment is to provide maximum efficacy at minimum cost, keeping the purpose of the basic design in mind.

As explained earlier in the section on Basic Design Conditions, the scope of the equipment was decided basically by the scope of the construction, which was determined by studying the conditions of similar facilities in Malaysia, and planetarium theatres in neighboring countries, and in Japan. The number of people estimated to use the planetarium was calculated on the basis of the population on the Malaysian peninsula, its pupils, students, the number of members in the astronomy association, the degree of frequency in the facilities' use, and the number of scheduled screenings. A suitable size for the dome was calculated on this figure of estimated visitors; and the final decision on the scope of the equipment was made after studying the suitability of the basic construction design formulated by the Malaysian side.

4.2.3 Equipment Plan

The scope and the type of equipment will be decided after the scale and type of the dome has been selected.

4.2.3.1 Selection of Dome

There are two types of planetarium domes, the obliques and the horizontal dome as mentioned earlier. A comparison of the advantages and disadvantages of both the horizontal and oblique domes are given below.

The Advantages of a Horizontal Dome

- The projection distance is relatively short because supplementary projectors can be installed around the dome. Therefore it does not require high image clarity or powerful illumination by the projector.

- The heavens can be projected from horizon to horizon and the stars of the entire universe can be observed without moving the image.

- The star studded skies can be observed in a state very similar to natural conditions.

- The azimuth light will project the four directions (north, south, east, west) on the screen.

The Advantages of an Oblique Dome

- Sky movies can be shown on an oblique dome.

- The planetarium projector itself will not hinder the view of the audience's line of vision.

- Nearly the entire audience will be able to see the horizon below their line of vision and have a sense of floating in space, of being present at various distances from the stars.

- The image has a powerful impact since the audience sits in proximity to the domed screen and is made to feel the largeness of the screen.

- The audience is able to maintain a natural sitting posture without having to look up at the screen in an uncomfortable position.

The Disadvantages of a Horizontal Dome

- The planetarium projector itself will obstruct the audience's line of vision.

- As the audience's line of vision is far below the horizon on the image, there is no sense of perspective or three dimensionalism when viewing the screen.

- It is not easy to produce the panorama since it must be projected throughout the entire dome.

- The height of the panorama must be kept low. Therefore it is difficult to produce a sense of perspective.

- The image may sometimes appear up side down depending on the seating arrangement.

- At times the sense of direction of the commentator and the audience may not be the same.

- There is no feeling of floating in space.

- Sky movies cannot be shown on a horizontal screen dome.

The Disadvantages of An Oblique Dome

- Nearly all the auxiliary projectors are placed in the back of the planetarium and therefore powerful projector illumination and image clarity is needed.

- The back of the dome can only be utilized for projecting the image of the stars.

- As the audience sitting in the front are seated too close to the screen, the roughness of the image can be seen.

- When members of the audience sitting in the front, attempt to view behind the vertex, the neck position is uncomfortably cramped.

- As the entire audience sees the horizon on the screen below their line of vision, they are unable to observe the star filled skies close to natural conditions.

- When the projector has been set at the northern latitude of around 35 degrees with the front facing south, the north polar star cannot be projected.

- All the stars of the entire sky cannot be projected at one time since the dome is not completely spherical.

In conclusion, the oblique dome in comparison to the horizontal dome is more capable of fulfilling and carrying out the objectives of space science education, though there are a few disadvantages in its actual operation. However, when the importance of the contribution of the sky movies to the operation of the planetarium is taken into consideration, as in the case of other recently built planetariums, the oblique dome planetarium planned by the Malaysian government is appropriate.

Generally, many oblique domes have an angle of inclination of 20 to 30 degrees. The seating capacity of the planetarium decreases when the angle of inclination rises and the area of level projection surface is reduced. But when the angle of inclination rises, the planetarium projections and the sky movies heighten the audience's sense of being drawn into the screen. The greater the angle of inclination, the more powerful is the impact of the presentation on the audience and therefore more advantageous. The angle of inclination of the planetarium dome planned by the Malaysian government is about 25 degrees. This angle of inclination is stable and most suited to the planetarium's seating capacity and projection impact.

4.2.3.2 Size of the Dome

The size of the dome is based on such factors as programme screening schedule, conditions surrounding the utilization of similar institutions in Malaysia and of planetariums in neighboring countries, the estimated demand within the country, etc. They are outlined below.

(1) Programme screening schedule

The screening schedule of the planetarium programmes is an important factor. The estimated number of visitors has been calculated on the screening given earlier in this report.

(2) Conditions under which similar institutions within Malaysia and other neighboring countries are utilized.

1) The National Museum

The number of visitors who visit the National Museum is 2.5 to 3 million people per year. This figure is equivalent to 15 to 17% of the total population of 17 million. One out of approximately every 6 to 7 people visit the museum annually and indicates a large demand for the facility in fulfilling the populace's intellectual interest.

Admission is free, but a fee of M$2.00 for adults and M$1.00 for children is charged when special exhibitions are held. This fee is applied toward a portion of the M$3.5 million annual operating cost of the museum.

2) The National Zoo

The number of visitors in 1988 was about 1.10 million people. This figure is equivalent to 6.4% of the national population or a ratio of one out of every 15 people. The admission fee is M$4.00 for adults and M$1.00 for children. The fee for bringing in a camera is M$1.00 and for a video camera, M$10.00. Groups of more than 20 people or students receive a discount of 10 to 20%.

The annual operating costs were M$3.10 million in 1988 and expenses incurred for each visitor were M$2.80. The income from admissions cover the cost of these expenses.

3) Utilization of the planetarium in Sarawak in East Malaysia

In March 1989, a Zeis planetarium with a horizontal dome of 15M in diameter was constructed for the first time in Malaysia in the state of Sarawak. It is a manually operated planetarium in the traditional style. At the time of this study, an estimated 3200 visitors were visiting the facility monthly, though it had been in operation for only six months and its activities had not stabilized. If programmes are held twice daily in the afternoons, 7 days a week

(with no holidays), the estimated number of visitors per month would be 9000. Therefore at present, the average admissions rate is about 36%. For a state with a population of 1.236 million, approximately 3.1% of the population [(3,200 x 12) divided by 1.236 million] is utilizing the facility. This is comparatively high. The programmes are still in their infancy due to the fact the planetarium is manually operated and the facility has only recently opened. There are no separate programmes for the general public and the students.

4) Utilization of the planetarium in Singapore

The oblique 23 m diameter dome planetarium in Singapore opened in December 1987 and receives 12,000 visitors per month. The number of visitors annually is equivalent to 5.5% of the national population of 2.6 million people or a ratio of one out of every 18 people.

The planetarium programme is shown four times a day, Tuesdays through Fridays, and twice a day on Saturdays and Sundays. (The planetarium is closed on Mondays.) There are approximately 140 guests at each showing.

The admission fee is S$4 for adults and S$3 for children under 12. There is a discount rate available for groups of more than 30 people.

5) Utilization of the planetarium in Jakarta, Indonesia

The planetarium in Jakarta has a 23 meter horizontal dome and is built by the German manufacturer Zeis and is the universal type. Its seating capacity of 500 is quite large for a planetarium with a 23m dome. Programmes are shown 6 days a week, 1000 times annually, with about 215,000 visitors annually, which is an admission rate of about 43%. It is not very high for a dome of this size and seating capacity.

6) Utilization of the planetarium in Manila, the Philippines

Manila has a planetarium with a 16m horizontal dome and a seating capacity of 210 people. It was built with cooperative grant aid from Japan. The programmes are shown 6 days a week, four times a day. There is a full house at each screening and the rate of admissions is estimated to be about 100%. The admission fee is a nominal 5.0 pesos for adults and 3.0 pesos for children.

(3) Estimation of planetarium demand

The project for the planetarium has not been undertaken solely for the benefit of astronomers or space science specialists, but also for higher form level science or engineering students, compulsory and secondary level students, for the purpose of enhancing a segment of their science education.

1) The demand in compulsory education curriculum

The population of primary and secondary level students for 1990 in Malaysia has been estimated at 2,449,579 pupils and 974,069 students, respectively, for a total of 3,423,648. According to the population census of 1988, the population on the peninsula was 83% (14,024,000) of the total population (17,150,100). Based on this ratio, the compulsory school population has been estimated at 2,841,600.

Extracurricular activities in the form of overnight excursions are generally permitted in the compulsory school curriculum. A trip to the planetarium will undoubtedly become a part of these extracurricular activities, and as a result, will become more meaningful as a part of their natural science education.

A planetarium currently exists in the Malaysian state of Sarawak. Therefore the current project will establish a planetarium mainly for the population on the peninsula.

For example, in the case of Suginami Ward in Japan, though it has a population of 530,000 in comparison to the population of 1.5 million in Kuala Lumpur and its adjacent areas, the compulsory level student in Suginami visit the Science Education Center at least once a year and utilize its planetarium. At the very least, the compulsory school students of Kuala Lumpur and its adjacent areas and students who live in areas where over- night excursions are possible (approximately 60% of the students in the peninsula's compulsory school system fit into this category if transport is provided) will visit the planetarium once as part of the compulsory school curriculum. Therefore, more than 189,000 students are expected to visit the centre. If these students were to view the planetarium programme and the sky movies under the conditions mentioned earlier, a demand of 260 people can be estimated for each

show. This figure is based on the following calculation.

189,000 people/year divided by 14 shows/week
= 260 people/show

2). The demand in general admission visitors

The demand for leisure activities that satisfy the intellectual curiosity of the populace indicates that one out of every four to five people in Malaysia visit the National Museum or the National Zoo annually.

In the neighboring country of Singapore, 5.5% of the total population visit the planetarium annually and it is expected that a large number of the population in peninsular Malaysia will also visit the planetarium in this project. If the ratio of visitors in Malaysia were to equal the 5.5% ratio of Singapore, the citizens of Kuala Lumpur and its neighboring areas (978,326 in Kuala Lumpur and 1,517,504 from Selangor state for a total of 2,495,830 people) would comprise about 137,000 visitors to the centre annually. Therefore, there would be an estimated demand of 263 people each time. This has been based on the following calculation.

2,495,830 people x 5.5% divided by 52 weeks/year divided by 10 shows/week = 263 people/show

Moreover several people from the other area will be expected to visit the Centre.

3) The demand among specialists and higher education students

There were 154,243 higher school, university science, and technical students in 1988. Special programmes geared to their needs, separate from the programmes for primary school pupils and the general public are desirable.

In order for them to see the special program at the planetarium 2.5 times during their seven years of schooling (high school, vocational students would see the program one to two times, and university students one time), there would be a demand of about 265 people per show, 4 times/week on weekdays only, after general admission hours (including official planetarium holidays).

154,243 people x 2.5 times/7 years divided by 52 weeks/year divided by 4 times/week = 265 people

In addition, specialists will be able to utilize the planetarium after general admission hours for special programmes as in the case of higher school students. If 80% of the 300 members of the Astronomical Society were to participate in the use of the planetarium, there would be sufficient capacity to accommodate 250 people.

Based on the aforementioned facts, though the compulsory school students and general admission visitors will be separated, there will be adequate seating capacity to accommodate an estimated 250 to 270 people for each group. Moreover, as programmes for specialists will differ in content from general admission and student programmes, the seating capacity should be considered separately from the aforementioned two groups. The seating capacity for science students is approximately 265 while the seating capacity for members of the Astronomical Society is about 250.

Therefore with these factors in mind, the scale of construction for the project should have a seating capacity of 250 to 270 to accommodate the compulsory school students and general admission visitors, i.e. more than 250 seats. This capacity will also satisfactorily accommodate the number of university majors, astronomical society members, and specialists who are expected to utilize the facility.

4.2.3.3 Design Scale and Selection of Equipment

The following is an outline of the most appropriate equipment for the size of a dome described in the preceding sections.

(1) The planetarium

Although there are advantages and disadvantages to both the oblique and horizontal domes, the presentation of sky movies at the National Space Science Educational Centre is indispensable according to the Malaysian side. There are some disadvantages to the oblique dome in the study of astronomy, but they are not serious and are only somewhat inconvenient. Generally, the oblique dome is considered difficult to operate manually, because many of the planetariums are equipped with computer systems which tend to give them the impression of being difficult to operate manually. However, the advantages to computerization outweigh its disadvantages. In conclusion, the oblique dome which is proposed in the "Project to Establish

a National Space Science Education Centre" is appropriate in terms of the Malaysian government's plan to show sky movies; the fact that it poses no problems for space science education; and the fact that the majority of planetariums constructed today are of the oblique dome type.

(2) Establishing the scale of the planetarium

The seating capacity of the planetarium must be able to accommodate more than 250 people as explained in the earlier sections. The diameter of the dome for a planetarium with a seating capacity of this size has been given in the following examples of planetariums in the United States and in Japan.

(U.S.A.)

1)	St. Paul	23.0 m	330 seats
2)	Richmond	20.6 m	164 seats
3)	Cleveland	19.8 m	230 seats
4)	Alabama	20.4 m	277 seats
5)	Detroit	29.3 m	250 seats

(JAPAN)

1)	Yokohama Children's Science Building	23.0 m	300 seats
2)	The space Theater of Omiya	23.0 m	300 seats
3)	Urawa Youth Science Building	23.0 m	260 seats
4)	The Hamamatsu Science Museum	20.0 m	246 seats
5)	Fujisawa Shonan Cultural Theater	20.0 m	200 seats
6)	Hachioji Children's Science Centre	21.0 m	255 seats

There is no set standard in the number of seats and the scale of the dome. However, in order to accommodate a seating capacity of 250 seats, the dome must have a 20 to 23 m diameter. The factors in determining the number of seats according to the scale of the dome are given below.

1) A large dome with a small seating capacity is preferable.
2) The seating capacity will differ according to whether seats have been arranged in an arc or rectilinearly.

There is a tendency for factor #1 to be considered most important in recently constructed planetariums.

Furthermore, the efficiency of a 20 m or 23 m dome is found in its

borders. A halogen lamp is sufficient for the projector of a 20 m dome. But in the case of a 23m dome, there is a shortage in the volume of illumination unless a xenon lamp is used. There are problems in the use of a xenon lamp in terms of projection efficiency, doubled consumption in electricity, and an increase in operating costs.

In conclusion, the Malaysian plan to construct a 20 m diameter dome with equipment of equivalent scope, is appropriate in consideration of seating capacity, equipment efficacy, and operating costs. Furthermore, a dome on the scale of 20 m is the maximum in terms of the construction cost allotted by the Malaysian side.

As the scope of the equipment is determined by the scale of the structure, the equipment will be selected to coordinate with a 20 m oblique dome which has been concluded to be appropriate for the project.

(3) Justification of equipment selection

1) Main projector

The objective of the planetarium in this project is to project fixed stars and planets. The main piece of equipment is the projector; and as outlined in the earlier sections on the study of content request, includes the planetarium projector, the projector for the planets, the control console, and the computer. The special effects projectors as well as the main projector are indispensable to this project and their provision is appropriate. Their specifications are given in the summary below.

a) The fixed star projector and the planet projector

The fixed star projector or the main projector was originally a two-ball type of projector attached to the body of the planetarium. However, recently it is no longer attached to the body of the planetarium due to computerization; in addition a one-ball type of projector has been developed. Both the one-ball and the two-ball type of projector are in use in Japan, but their function is to project about 15,000 or more fixed stars, their coordinates, constellations, the nebulas, the Milky Way, etc.

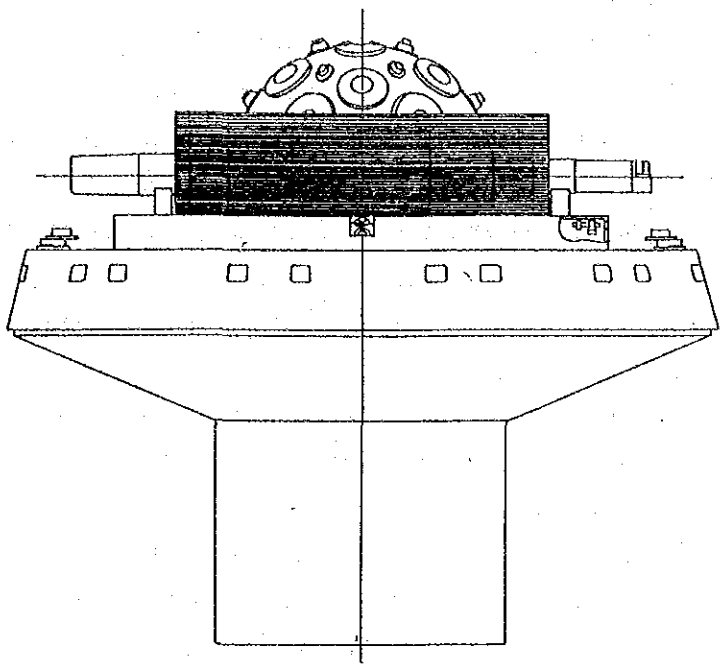
The fixed star projector was attached as part of the main body of the planetarium and it was made to synchronize with the movement of the planetarium with a gear wheel in the past.

Recently, due to computerization, the demand for speedy operation has grown. It has become common to detach the fixed star projector and install it independent of the planetarium; and through the medium of a computer, it is operated to synchronize with the planetarium. Since the detached projector is operated through a computer, the estimated date and hour skip operation can be done very swiftly. However, it is inconvenient when manually projecting the changes which take place with the passing of time.

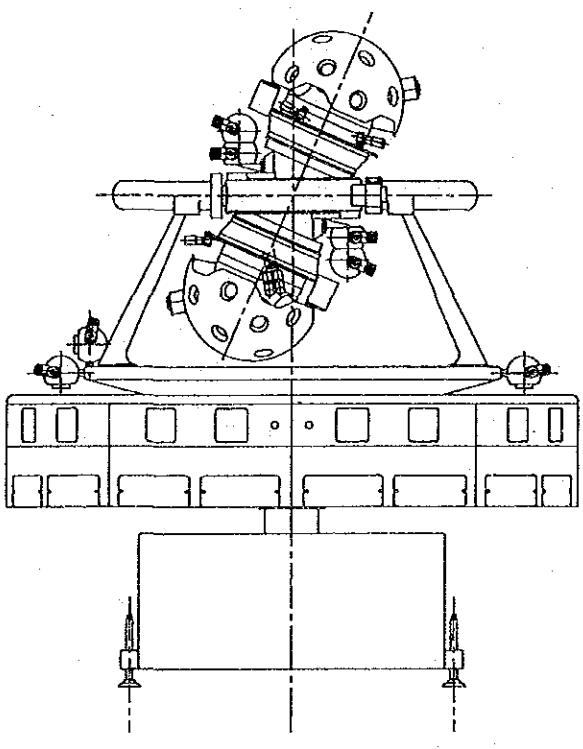
According to the main project, sky movies will be shown. The planets projector which is attached to the planetarium is an obstruction during the screening of sky movies. Therefore it is necessary to put the projector away under the floor, which greatly increases the cost. Consequently the projector which has been selected for this project is the detached type which is not necessary to put away under the floor and the elevator necessary for this purpose has not been included. If the projector is the detached type, it doe not matter whether it is a one-ball or a two-ball type of projector since it will not interfere in the screening of sky movies. Therefore a projector with specifications for either the one-ball or the two-ball type has been selected as shown in Fig. 4.

b) The computer and the control console

The computer and the control console must interrelate with the fixed star projector and the planet projector into a uniform specification. The computer will control all the functions of the projectors through programme calculations, programme search, memory of projection time and duration, and transmitting control signals. The Japanese manufacturers employ a personal or mini computer with the control console. In many cases, the control console is used to project programmed shows. However, in this project it has been requested that the projectors are able to be manually controlled. Both types of computer allow manual control, but as the fixed star projector is controlled by the computer as explained earlier, it can be only be manually controlled through the computer. The control console is a control board used to give commands to the computer for both



ONE-BALL TYPE PLANETARIUM



TWO-BALL TYPE PLANETARIUM

FIG. 4 TYPE OF PLANETARIUM

manual and automatic operation. There are two types of control consoles, the touch-screen type and the keyboard type. The touch-screen type of control console is easy to operate and is closely interconnected to the fixed star and planet projectors and their specifications. Though the touch-screen type of control console is superior, it use cannot be anticipated at this time.

2) Special effects projectors

The function of these special effects projectors is to project objects in space which cannot be shown by the planetarium projector and whose explanations are necessary in order to enhance the understanding of the audience. The special effects projectors requested in this project are all indispensable in this aspect; therefore their provision has been judged to be appropriate. A study of each of these special effects projectors are given below.

i) Multi-image projector

This projector is used to explain the birth, structure, and progress of various celestial bodies which cannot be shown by the planetarium projector alone, by using a large slide separate from the projector projection. This projector is the most important of the special effects projectors and its provision is judged to be appropriate.

ii) Multi-wide projector

The function of this projector is similar to the aforementioned projector. However, a wide angle big screen image can be projected; and it differs from the multi-image projector in this respect. It is able to project wide angle three dimensional images and is necessary from this standpoint. This projector is used in nearly all of the planetariums now in existence.

iii) Variable zoom projector

This projector is able to change the size of the image on the wide screen while projecting various other images. It is useful in increasing the impact of the projection by heightening the audience's sense of being drawn into the screen and by projecting

the flight of celestial bodies and space ships. Many planetariums are using several of these units to raise the effect of their presentations.

iv) Spinning image projector

Nearly all celestial bodies show rotating movement and this projector zooms in on this rotation. It is effective in helping the audience to understand the movement of the planets more easily. Many existing planetariums are using this projector.

v) Projector for the rising of celestial objects

This projector projects celestial objects rising from the horizon to the sky. It projects Saturn and Earth rising or setting into the horizon of the moons and satellites of Saturn. It is important to understand the planets and satellites other than the Earth to understand space; and this projector is effective in achieving this easily. It is also successful in promoting the interest of the general audience in the planetarium programmes.

vi) Projector for multi-shooting/meteor swarm

This projector mainly projects the approach and distance of shooting stars and meteors. It is effective in teaching how to observe shooting stars easily.

vii) Flashing projector

This projector is mainly used to show lightning. It is indispensable in programmes where lightning and thunder are deeply connected in portraying the birth of humanity and living organisms.

viii) Focusing projector

The effect of traveling in space and encountering objects far away that gradually draw nearer and become clearer, or of nearby objects that move away to become gradually blurred are shown with this projector. It is effective in portraying conditions out in space.

ix) Uni-shooting/fireball projector

This projector will project fireballs and shooting stars that

fly through space leaving a trail behind them. This is an important phenomenon to be understood in space science and this projector is most effective for this purpose.

x) Unveiling projector

This instrument projects images sequentially which makes explanations easier to understand.

xi) Lunar and solar eclipse projector

This projector is extremely useful in enhancing the understanding of conditions which surround the lunar and solar eclipse. It is necessary for space science education.

xii) Video projector

Recently there is a software which has recorded celestial phenomena on video tapes and optical discs. The use of such software is a very effective means of teaching space science. This projector utilizes a computer to quickly search and select the necessary scene from a list of many scenes. Therefore it is important that it is carefully interconnected to the computer of the main projector.

xiii) Cloud projector

This projector is employed to project the various movements of clouds on the inner dome. It is necessary to heighten the effect of the planetarium programme. It is used in many existing planetariums.

xiv) Other instruments

It is recommended that a special lighting effects projector be included in this category. It is effective in maintaining the attention of the learner on the projection screen. It is highly recommended among the equipment included in this category.

xv) Spare parts

The spare parts are mainly the lamps for the main and special effects projectors. About two years use of lamps will be provided, since the projectors are special types of equipment for which spare

parts such as lamps may be difficult to obtain in Malaysia. In the case of the computer, it is not very practical to keep spare parts since computers are generally trouble free for three to four years. However two years use of a minimal quantity of consumable spare parts will be provided.

(4) A summary of the specifications of each instrument

1) The Main Projector

a) Projector for the fixed stars — 1 set

Two ball or one ball type; projects 15,000 or more fixed stars; utilizes a total light source of approximately 4KW

b) Projector for the planets — 1 set

The sun, the moon, Mercury, Venus, Earth, Mars, Jupiter, and Saturn can be projected. Simulation of the movements of Uranus, Neptune, and Pluto should be possible. Each utilizes a light source of about 50W; consists of 7-8 units with zoom lens and one projector can be utilized to show the earth and the moon simultaneously; not only able to project planets but used to show change in the order of fixed stars

c) Control console — 1 set

Touch-screen system or a control board with a keyboard system, able to control projectors by complete manual operation. In addition to projecting the programmed shows, it will be possible to interrupt the show for a short time to allow explanations or commentaries by using the appropriate manual control or to show completely and manually controlled programmes.

d) Computer — 1 set

Able to input commands from control console; memorizes programme calculations; then gives operation commands to each projector and

synchronizes them, and can be utilized to control the video projector. By programming the calculations for the program, it is possible to project the program or to select the desired program through manual operation by signaling each projector. The computer should have the capability to demonstrate the close approach of planets and the constellations.

2) Special effects projectors

The special effects projectors are all equipped with interfaces, computers, and operate closely with the main projector.

a) Multi-image projector — 1 set

Consists of at least 9 units in 3 groups, each uses a light source of more than 250W; has zoom lens

b) Multi-wide projector — 1 set

With a wide angle lens of about 50MM or equivalent; uses a light source of more than 250W

c) Variable zoom projector — 1 unit

Mechanism to freely move the image horizontally or vertically, loaded on the projector stand; consists of 2 projectors per set of which one projector has a spin mechanism

d) Spinning image projector — 1 unit

Uses a light source of more than 650W; has more than 4 spinning slides

e) Projector for rising celestial objects — 1 unit

Uses a light source of more than 650W; able to use slides larger than 6 x 6 slides

f) Projector for multi-shooting/meteor swarms 1 unit
Uses a light source of more than 650W; attached with more than 3 types of negatives

g) Flashing projector 1 unit
Uses a light source of more than 80W; attached with more than 8 scene negatives

h) Focusing projector 1 unit
Uses a light source of more than 650W; attached with more than 4 types of negatives

i) Projector for uni-shooting/fireballs 1 unit
Uses a light source of more than 50W; attached with 2 types of negatives

j) Unveiling projector 1 unit
Uses a light source of more than 650W; uses 6 x 6 slides

k) Projector for lunar and solar eclipse 1 set
Uses a light source of more than 50W; attached with special metal negative

l) Video Projector 1 set
Three-tube type; approximately 250 inch in size; has optical disc player and video tape player

m) Cloud projector 1 unit
Uses a light source of more than 550W; attached with special metal negative

n) Projector for special effects lighting 1 set
Uses a light source of more than total 2.4KW; equipped with red, green, blue, white lights; light volume control attached

(5) Electric power consumption of each type of equipment

Name of Equipment	Quantity	Minimum Power Consumption (W)
(1) Main Projectors		
- Projector for fixed stars	1 set	13,320
- Projector for the planets	1 set	800
- control console	1 set	960
- Computer	1 set	4,000
(2) Special effects projectors		
- Multi-image projector	1 set	2,970
- Multi-wide projector	1 set	660
- Variable zoom projector	1 unit	750
- Spinning image projector	1 unit	730
- Projector for rising celestial objects	1 unit	730
- Projector for multi-shooting/meteor swarms	1 unit	730
- Flashing projector	1 unit	80
- Focusing projector	1 unit	730
- Projector for uni-shooting/fireballs	1 unit	500
- Unveiling projector	1 unit	730
- Projector for lunar and solar eclipse	1 set	310
- Video projector	1 set	200
- Cloud projector	1 unit	630
- Projector for special effects lighting	1 set	8,800

4.2.4 Facilities Plan

The facilities most directly related to this project are the facilities for the supply of electricity. The following sections describe the basic policy in the plan on electricity facilities.

(1) Electricity Supply Facilities

The electrical power for the entire centre will be provided via the electrical distribution room from the sub-station. Electrical power for the planetarium equipment, the planetarium theater, and the computer room will be supplied by the electrical board in each room.

(2) Electrical capacity

The electrical capacity which is necessary to supply the projectors is about 20 to 25 KVA (input) and the electrical load for

illumination is about 25KVA. Therefore the electrical capacity necessary for the equipment which will be provided in this project, is about 50KVA. However, the electrical load for the equipment which will be installed by the Malaysian side is also 50 KVA, so the total electrical capacity is calculated at about 100 KVA.

(3) Electrical specifications

Dual voltage of AC200/100V will be required with 3/single phase. It is necessary to step down the electrical voltage with a transformer since the standard in Malaysia is a single phase electrical voltage of 240V. Hence transformers will be provided with the equipment.

(4) Electrical distribution and wiring

Electricity for the central computer, planetarium projector, the console, etc. will be distributed from the distribution board installed near each piece equipment through a cable pit. Supplementary equipment for special lighting, etc., will be conjet wiring.

The control circuit wiring which will connect the machines together will be concealed in the walls, under the floor, or will be exposed. This wiring system will be separated from the general wiring since care has to be taken to protect these precision instruments from accidents. The single line diagram is shown in Fig. 5.