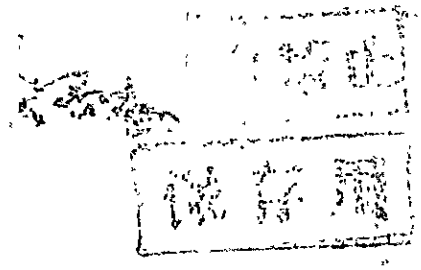

REPORT

ON

THE CONSTRUCTION

OF

NATIONAL SPORTS COMPLEX

IN

SINGAPORE

March 1971

OVERSEAS TECHNICAL COOPERATION AGENCY

JAPAN

PREFACE

In response to the request of the Government of Singapore, the Government of Japan entrusted the Overseas Technical Cooperation Agency (OTCA) to conduct a survey for the National Stadium now under the construction in the said country. The OTCA despatched a Survey Team comprising four experts headed by Mr. Hazama, a Construction Expert, Minister's Secretariat, Ministry of Construction to the country in November 1970.

The Survey Team stayed in Singapore for about a week and completed its survey activities with a success in extensive cooperation by the Government and various competent authorities concerned. Since its return to Japan, the Team has directed its efforts to the compilation and analysis of data and materials collected during the field survey, and the results are hereby submitted to the Government of Singapore,

On behalf of the OTCA, I wish to take this opportunity to express my heartiest gratitude to various agencies of the Government of Singapore and the members of the Survey Team, and also competent authorities which accorded their facilities for the despatch of the Team as well as to the Japanese Embassy in Singapore which rendered a great assistance for the field survey.

February 1971

K. Tatsuke

Keiichi Tatsuke

Director-General
Overseas Technical
Cooperation Agency

INTRODUCTION

The Survey Team has summarized its view as follows with particular study on the results of survey conducted during the period from December 1 to 8, 1970 in Singapore.

Main stadium had been already started for construction work and concrete works had been fairly advanced. Therefore, future alteration shall be naturally restricted. Though the Survey Team has scrutinized its "multipurpose utilization" as the principal object, the Team is still collecting data for study, and results of study and some recommendations shall be submitted after this Report in the future, if it is necessary.

The survey and research is rather a technical subject, and this Report shall not be the end of the study on the Project. The prime importance for both parties shall be a complete understanding with each other based upon continuous mutual cooperation.

Japnuary 30, 1971

Survey Team: I. Hazama
S. Murohashi
M. Nagata
T. Tohriyama

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CHAPTER 1. GROUND PLAN OF BUILDING

This Ground Plan shall refer to only Public Address System, Lighting and the dimensions of Stadium Main Exit.

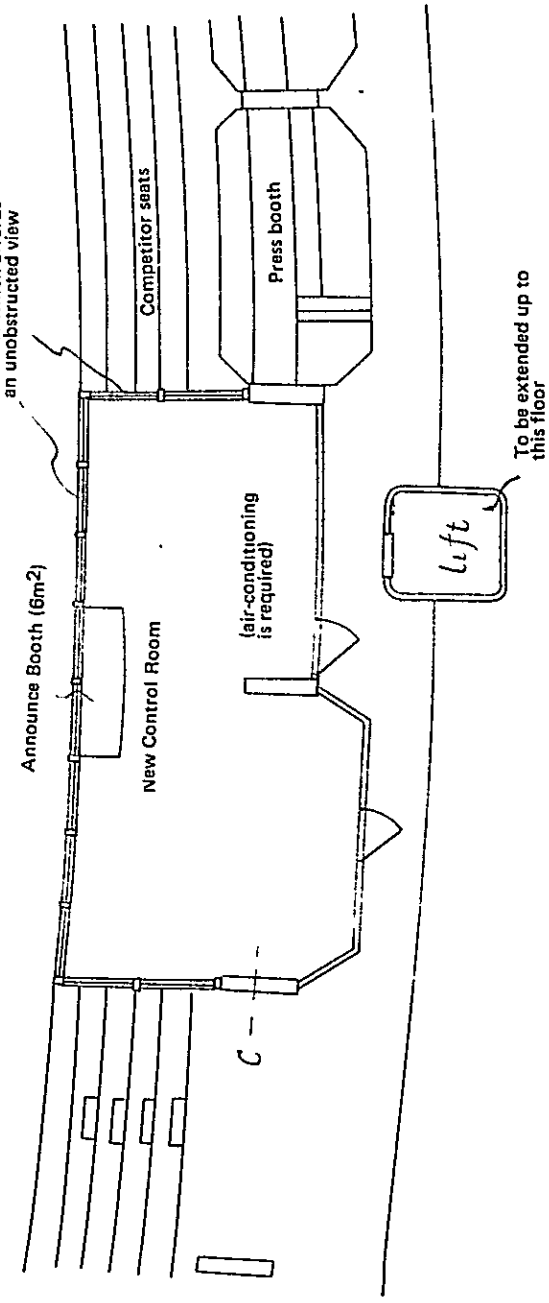
1.1 It is very meaningful to use both light and sound in an integrated representation for a certain events.

For this purpose, it is advisable to construct a Control Room including Public Address System, Lighting system and Score-board at a place from where the whole view of the Ground and the Stand can be commanded. An area of about $120m^2$ is required for the Room including the machine room. The interior of the Room must be finished with a consideration of sound absorption.

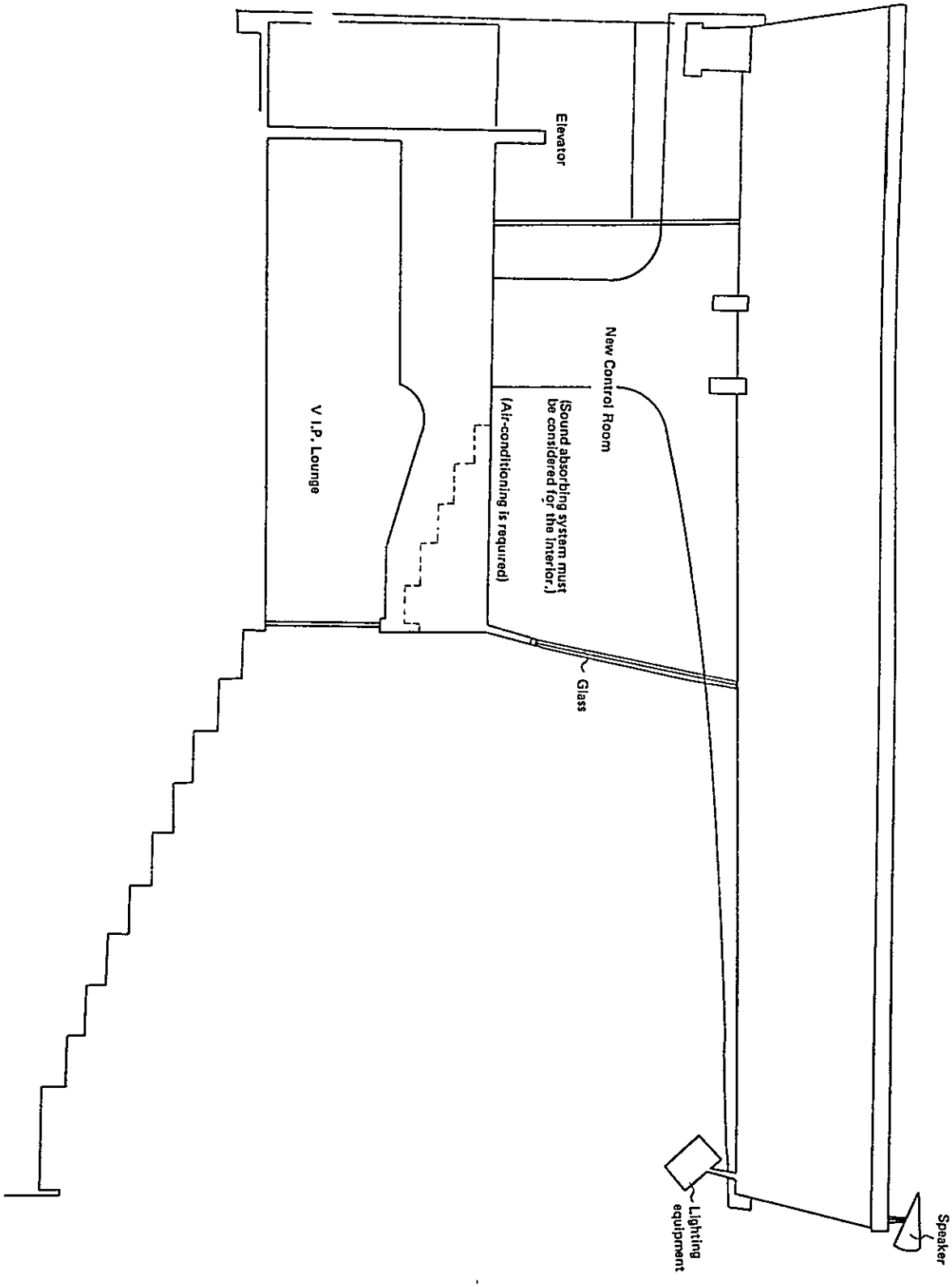
As described in the attached Figure, it is recommendable to utilize a part of Press Booth and Competitor seats under the roof of the Main Stand.

1.2 With such a control room as above, those rooms from Public address room to TV control room located at the central ground floor of the Main Stand can be maintained as they are, however, it is better to partition them as largely as possible and with movable partition walls when necessary, because those rooms are to be used for different purposes according to various types of events. When a sub-control room is installed in this section for a certain event, it may be finished just like an ordinary office, without any special consideration of sound obsorption.

It is recommendable to install a doorway for every span at the Ground side of those rooms as well as windows.


Material which affords an unobstructed view
Competitor seats
Press booth
To be extended up to this floor
Announce Booth (6m²)
New Control Room
(air-conditioning is required)
Lift
C

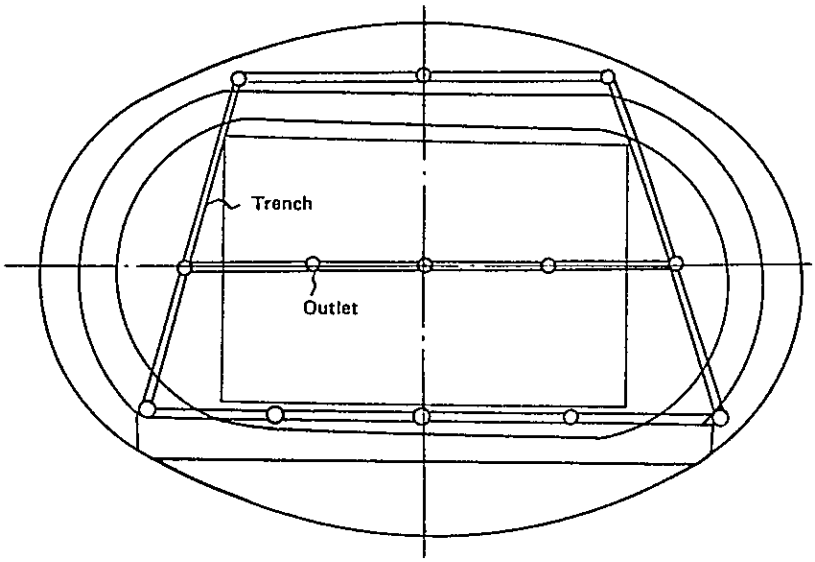
Ground Plan


Elevator
New Control Room
(Sound absorbing system must be considered for the interior.)
(Air-conditioning is required)
V.I.P. Lounge
Glass
Lighting equipment
Speaker

1.3 Connection of various kinds must be especially firmly secured between the planned Control Room and Head Office for various events. It is advisable to install, if possible, pneumatic carriers as well as telephone and interphone systems.

It is better also to extend the Elevator up to this floor because of the above-mentioned reason.

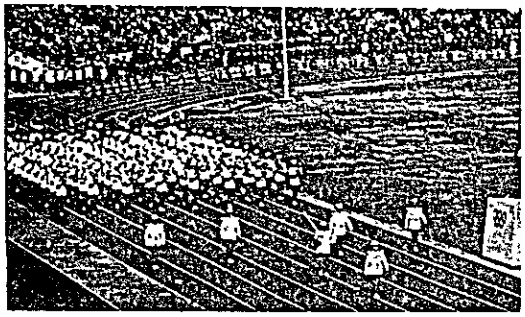
1.4 Trench and outlets shall be installed at the Ground level as mentioned hereunder for the purpose of laying various connecting circuits, microphone circuits and speaker input circuits. Although a minimum number of outlets is shown here, it shall be more convenient if more outlets be installed. It is natural that drainage system must be well arranged and lids of outlets must be so arranged that they will not spoil the function of tracks and fields.

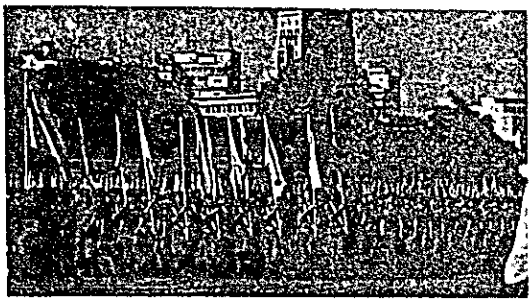


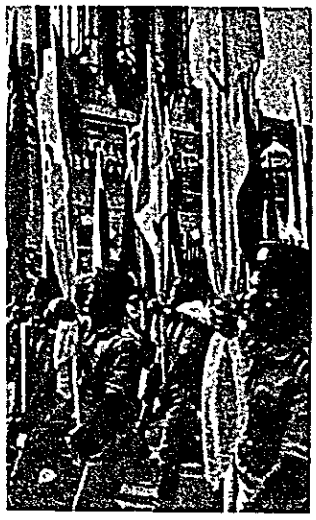
1.5 It is necessary to prepare mobile peakers of a considerable size and weight inside the Ground for the use of mass choir or stage production. And a storage must be considered so that those speakers can be smoothly housed.

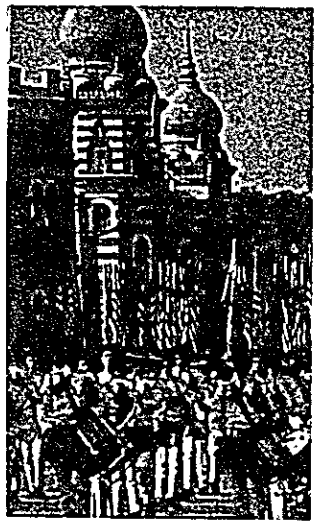
1.6 It is necessary to install speakers of a considerable dimensions on the roof. Load and catwalks for those speakers must be considered. It is recommendable to install 29 lighting fixtures at the front of the roof (canopy), because it is necessary to raise the illumination especially for the straight track section in front of the main stand. One lighting fixture will weight about 100 kg, and maintenance of these fixture must be also considered.

1.7 The Stadium Main Exit is used as shown in the attached material (the copied photograph). Though the present width will be sufficient for normal use, it is not favorable



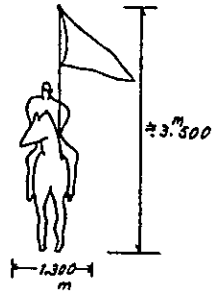






for production of events that a parade may swell out around the Exit or may become stagnant there on leaving. Therefore, the width of the Exit must be made equal at least to that of the track. Though the height of the Exit is unknown due to lack of the cross-sectional view of the Exit, the height must be made fully sufficient in consideration of such an event as the Flags Parade shown in the attached Photograph.

In the case of the stadium in Tokyo, the height of the Exit is made sufficient for a colorbearer on horseback.



1.8 It is said that the running truck of competitor's stand-by field is made of the same material of that of the track of the Ground. Though the track is very good, its length must be insufficient. Length of such a track cannot be determined, however, a longer track will be more convenient for competitors, for their exercise in rainy weather and for mass choir etc. It is better to make such a track as long as possible.

1.9 About the offices and shops at the back stand it is better to roughly classify them for multi-use.

1.10 Details of the score board to be installed at a corner of the Stand are described in other Paragraph. Its skeleton must be set up from ground level. Air-conditioning system is required for this section to dispose of the heat generated by electrical equipment.

Though secretariats of various gymnastic associations are planned to be constructed in the first floor of the back stand as shown in the ground plan, it is technically unreasonable to construct such offices, under the stand, which are not directly related to the stadium, and also such offices would cause some inconvenience to management of popular mass meetings. Therefore, it is recommended to divide the area which are at present planned to include offices and shops as largely as possible so that the area would be available for multi-use purposes.

In Japan, sports are very popular at schools. However, common people in general cannot enjoy sports and only those who hold membership of some clubs enjoy gymnastics. Especially, must housewives have no chance to enjoy sports.

As a national stadium must contribute to the elevation of the physical standards of the nationa, it must be utilized for popularization and promotion of physical upbuilding.

Examples of practical use of the space under the stand in Japan are shown hereunder.

National Stadium

In the case of the national stadium in Tokyo, besides various facility necessary for sporting events, the area under the stand is utilized as follows.

As some of the facilities were planned during construction and most of them were designed after completion of construction work to utilize the available space, the facilities are not in an ideal arrangement. However, they are available for the aimed purposes and are popularly utilized.

Prince Chichibu Memorial Sports Museum:

Prince Yasuhito Chichibu (a younger brother of the Emperor) lived his youth and prime of manhood in the same generation as the sportsman who greatly contributed to the prosperity of sports in Japan. He had understood very well the course of the athletic circles with a deep concern and his own experience in sports, and laid the foundation for today's brilliant achievements of the athletic circles.

The Prince was praised as "Prince of Sports" for his popularity and eminent virtue by the athletic circles in Japan. The memorial museum was established for condolence of his death and in commemoration of his service in athletics.

Exhibits are so displayed that the history of sports in Japan from the ancient days to the present age can be easily understood, inclusive of the Prince's articles left behind.

The exhibits include some 2,000 items as reemergence of "Kemari" (football) which is said to have been popular in 644, and the reemergence of "Yabusame" (horseback archery) at Tsurugaoka Hachiman Shrine in 1187 and also the Medal of Friendship which was shared between Mr. Nishida and Mr. Ohe at Berlin Olympics.

Annual number of visitors (April 1969 - March 1970, hereinafter the same period) 540,512

Annual income by admission fee ¥11,081,660

Swimming Pool:

This is a hot water pool in dimensions of 25m x 13m. The water temperature is kept at 29°C and the temperature inside the building is set at 30°C even in winter, to be available for swimming all the year round.

The pool is at present utilized for both private use (to be leased to members of schools, companies and circles by hour) and popular use (to be explained later).

Annual numbers of user:

Private user	42,221	¥4,231,930
Popular user	40,562	¥12,452,250

Sports Sauna:

In Japan these days the number of people who suffer such diseases as modern disease or urban disease is increasing, and it is said that such diseases are caused mostly by lack of physical training.

The sports sauna with a combination of the sauna bath and the training course brings about an effect for a double purpose of compensating the lack of physical training, relieving of fatigue and promoting health. This facility is expected to be more effective for health of middle and old aged people who are engaged in severe brain work.

The training course of this sports sauna is for composite training for the purpose of maintaining the health and physical strength of especially the middle and old aged people with about ten different training equipments and machines for physical strength test. The training method was invented and guided by Mr. Hiroshi Matsunobu of Tokyo University of Education, who is an authority in physical education, and training is conducted in the circuit system in which instructors make up training schedules suitable for trainees and carry out physical training in systematic method.

When physical training is over, trainees enjoy the sauna bath (110°C) and also cold bath.

Gymnasium:

This was constructed under the girder bridge. Its floor area is 950m^2 and it is available for gymnastics, pingpong, volley ball and basket ball.

Annual private users	40,025	¥2,161,322
Annual popular users	21,440	¥5,071,600

Auditorium, Conference Room:

The area of the conference room is 331m^2 to be available for meetings of an attendance of about 200 persons. The auditorium has 200 seats. Both are available for conference, lecture and film show for members of athletic associations.

Annual income ¥487,751

Sports Medical Counselling Office:

This office is usually available for physical check-up and various medical consultations for sportsmen, and for a first-aid clinic during athletic meeting.

Annual number of users 7,217
Annual revenue ¥2,796,990

Training Center:

The floor area is 660m^2 and equipped with 380 units of training appliance of 60 kinds. In this center, systematic training is conducted by expert instructors for three groups of male adults, female adults and children for the purposes of developing physical strength and promoting health. To be concrete, this center will bring about large effect to the following:

1) Those who want to cultivate mascular strength, power (mascular strength and speed) and staying power,

2) Those who want to cultivate beautiful, well-poised and strong bodies,

3) Those who want to have weight training and circuit training as reinforcement for their sports,

4) Those who want to increase or decrease their body-weights.

Registered members . . . 3,500
Total number of users . . 90,039
Revenue ¥23,548,500

Sports Library:

Books and materials related to sports are collected and arranged for public persual.

Number of books . . . . 10,000 volumes
Annual number of users . 1,429

Golf Practice Ground:

This is not situated under the stand, but arranged from the stand to the ground in winter which is out of season. Though there is not such a large-scale practice ground in central Tokyo, this is largely utilized. However, it is not recommendable to plan such a facility like this, because track and field are considerably spoiled.

Annual number of users . . .	43,802
Revenue	¥33,395,840

Popular Use:

Utilization of the National Stadium is roughly classified into three, those are reserved use, membership use and open use.

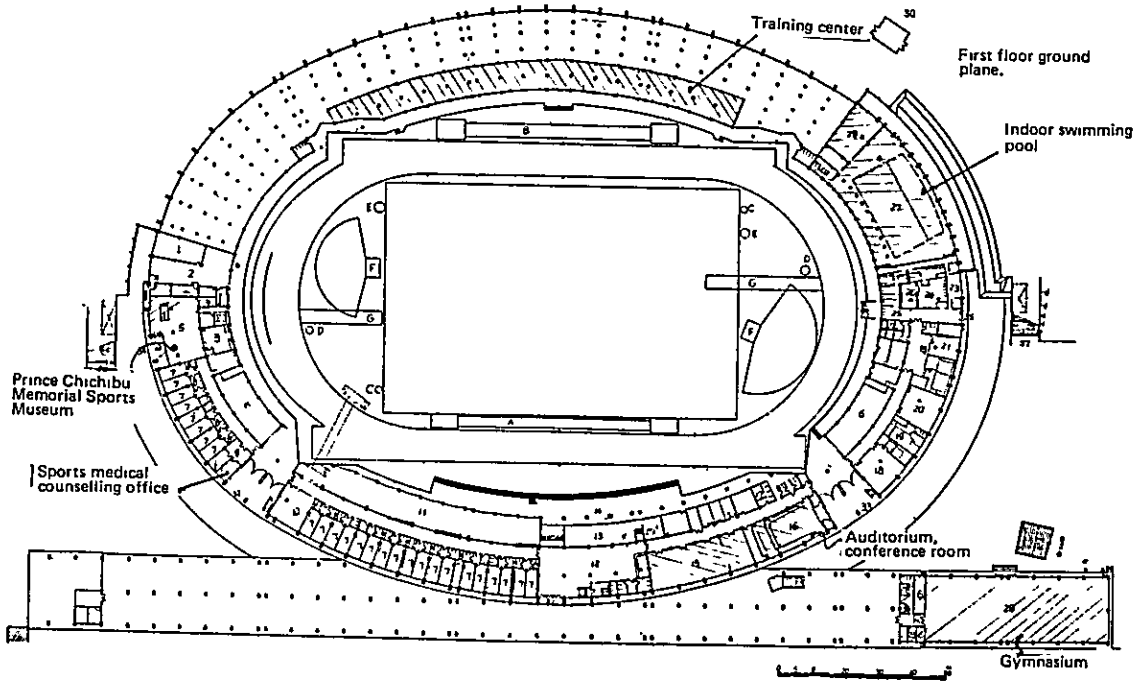
Reserved use is to lease the whole stadium or a part of it for international tournaments, Japanese championship tournaments, athletic festival or athletic meetings of universities or companies.

Open use is to open golf practice ground, sports sauna and etc. to the public for free use during the open period.

Membership use is one of the features of the National Stadium. This is sports classroom with expert instructors by means of effective use of the aforesaid facilities for the purpose of promoting physical training of the public persons who are likely to lack physical training. The capacity of accommodation is still limited and only a part of the total application is accepted at present. Therefore, it is desirable to organize more classroom at various places.

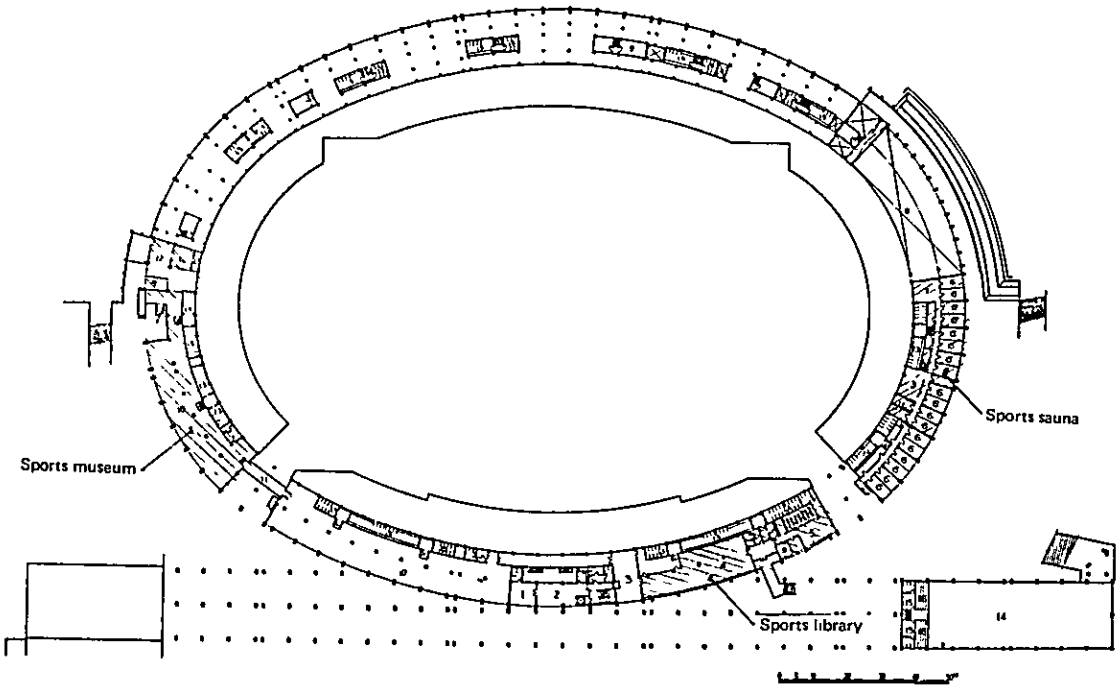
The following table shows sports classrooms by means of the facilities of the National Stadium (field and track):

Item / Classroom	Object	Capacity	Open day	Hour	Unit period	Facility
Swimming Classroom for women (Wednesday)	Housewife	80	Every Wednesday	10:00 – 12:00	3 months, can be continued	Swimming pool
Swimming Classroom for women (Friday)	Housewife	80	Every Friday	10:00 – 12:00	3 months, can be continued	Swimming pool
Swimming Classroom for beginners in general	Adult over senior high school boy and girl	Male 40 Female 40	Mondays, Thursdays	18:30 – 20:00	3 months	Swimming pool
Swimming Classroom for advanced swimmers in general	Adult over senior high school boy and girl	Male 40 Female 40	Wednesdays, Saturdays	18:30 – 20:00	3 months, can be continued	Swimming pool
Swimming Classroom for synchronized swimming	Women over junior high school girl	30	Mondays, Thursdays	18:30 – 20:00	3 months, can be continued	Swimming pool
Swimming Classroom for beginner children	Primary school children	Boy 80 girl 80	Saturdays, Sundays	Girls – 14:00 – 15:10. Boys – 15:30 – 17:00.	3 months	Swimming pool
Swimming Classroom for boy children	Primary achool boy, 2 – 6th grade boy	60	Mondays, Thursdays, 2nd, 3rd & 4th Sundays of the month	17:00 – 19:30 on Mon. & Thurs 11:30 – 13:00 on Sundays	Whole year	Swimming pool
Swimming Classroom for girl children	Primary school girl, 2 – 6th grade	60	Wednesdays, Saturdays and 2nd, 3rd and 4th Sundays	17:00 – 18:30 on Wed. and Sat. 11:30 – 13:00.	Whole year	Swimming pool
Gymnastics Classroom for women	Housewife	80	Mondays and Thursdays	10:00 – 11:30	Whole year	Gymnasium
Gymnastics Classroom for children	From 4 years old to 3rd grade children	80	Mondays and Thursdays	17:00 – 18:30	Whole year	Gymnasium
Gymnastics Classroom for adults	Adults in general	80	Mondays and Thursdays	18:30 – 20:00	Whole year	Gymnasium
Children sports school	Primary school 4 – 6th grade children	90	Wednesdays and Fridays	17:00 – 18:30	Whole year	Gymnasium, swimming pool, field and track
Field & track classroom	Adults in general	Free participation	Mondays and Thursdays	18:00 – 20:00	Whole year	Sub-track and etc.

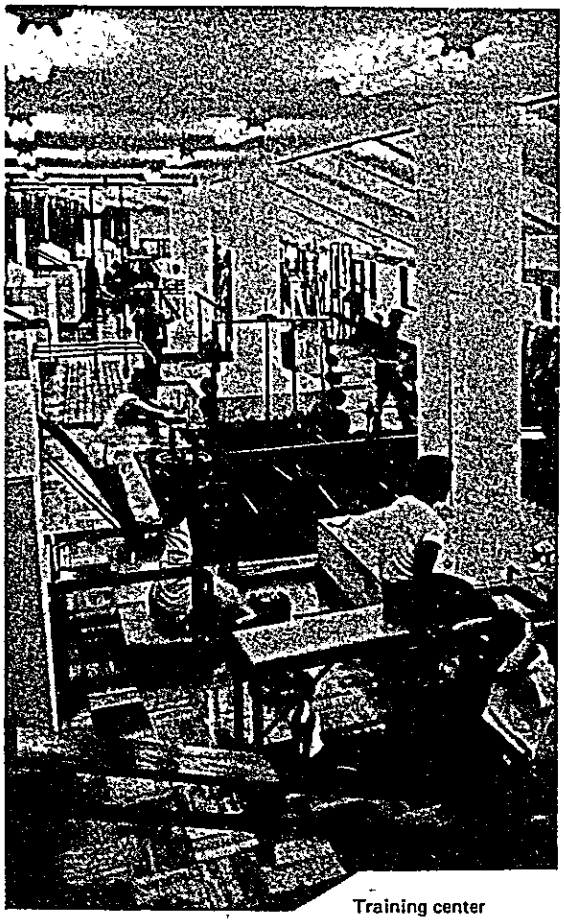


Utilization of the space under the stand of the National Stadium

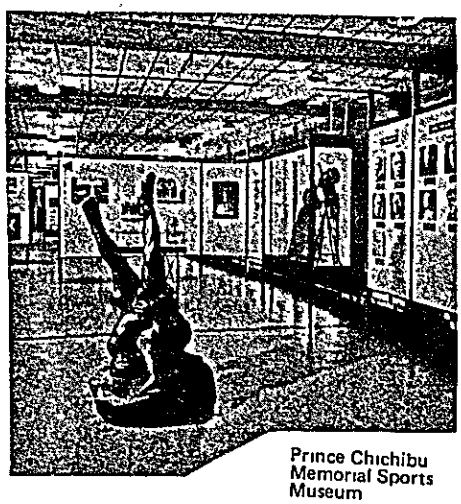
2nd floor ground plane



Various Facilities of the National Stadium

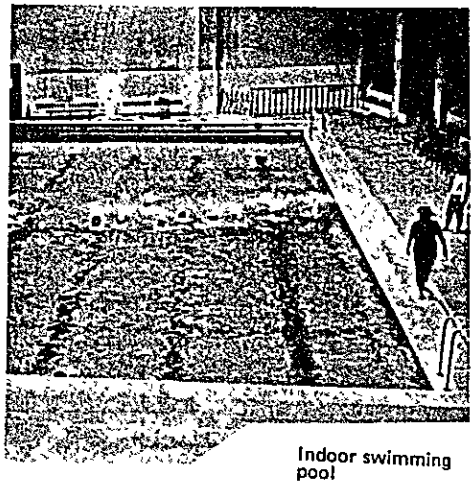


Training center



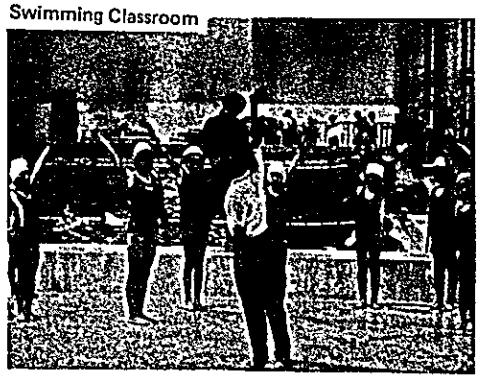
Prince Chichibu Memorial Sports Museum

Women's sports classroom



Indoor swimming pool

Swimming Classroom



Osaka Municipal Nagai Stadium

This stadium is situated in Nagai General Park which is 30 minutes from Osaka Station by means of subway.

Its main and back stand are constructed with ferro-concrete, and it is not equipped with corner. It accommodates an audience of about 30,000.

The main stand includes various facilities necessary for a stadium. The back stand is two-storied; the first floor is for training center and the second floor is for youth hostel. The training center occupies the half of the first floor of the back stand. Training is conducted as follows under appropriate guidance according to users' aims, ages and sex distinction.

1)	General course	for citizens in general.
2)	Children group	for children over 10 years old in primary and junior high schools.
3)	Men's group	for young men, middle and old men.
4)	Women's group	for women of young, middle and old aged.
5)	Housewives' group	housewives in general.
6)	Sportsmen course	for players of various kinds of sports.

Annua number of users 24,848
Revenue ¥4,702,140

Youth Hostel:

This hostel was established by Osaka Municipality to be managed as a municipal facility. This accommodates any young man or woman, regardless of nationality and sex distinction.

Youth hostel is an inexpensive lodging facility for the purpose of making young men and women enjoy wholesome and pleasant jorneys. Unlike inns and hotels in general, boarders must observe regulations of the hostel.

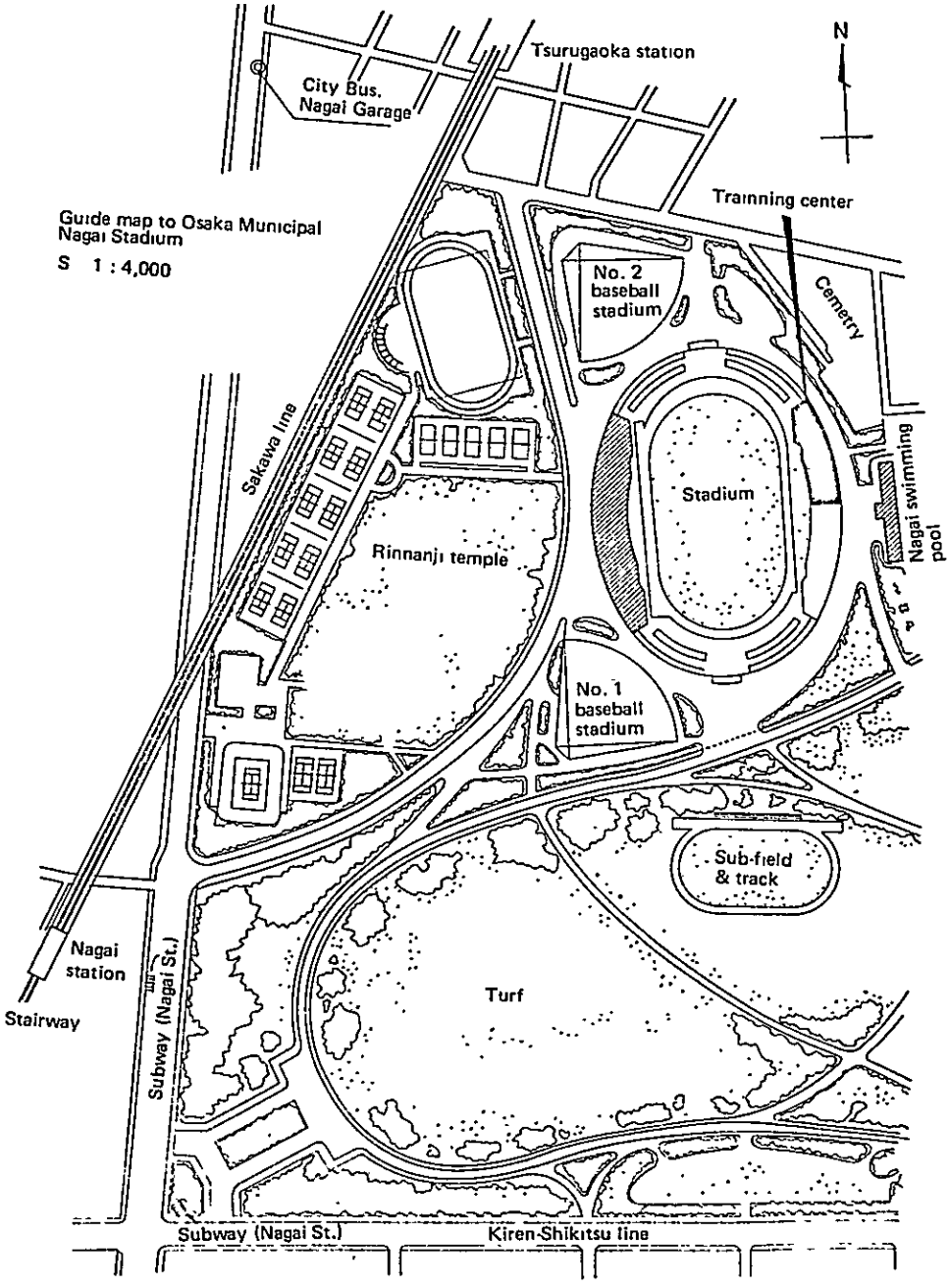
Osaka Municipal Nagai Youth Hostel:

Nagai Stadium, Back Stand 2nd floor

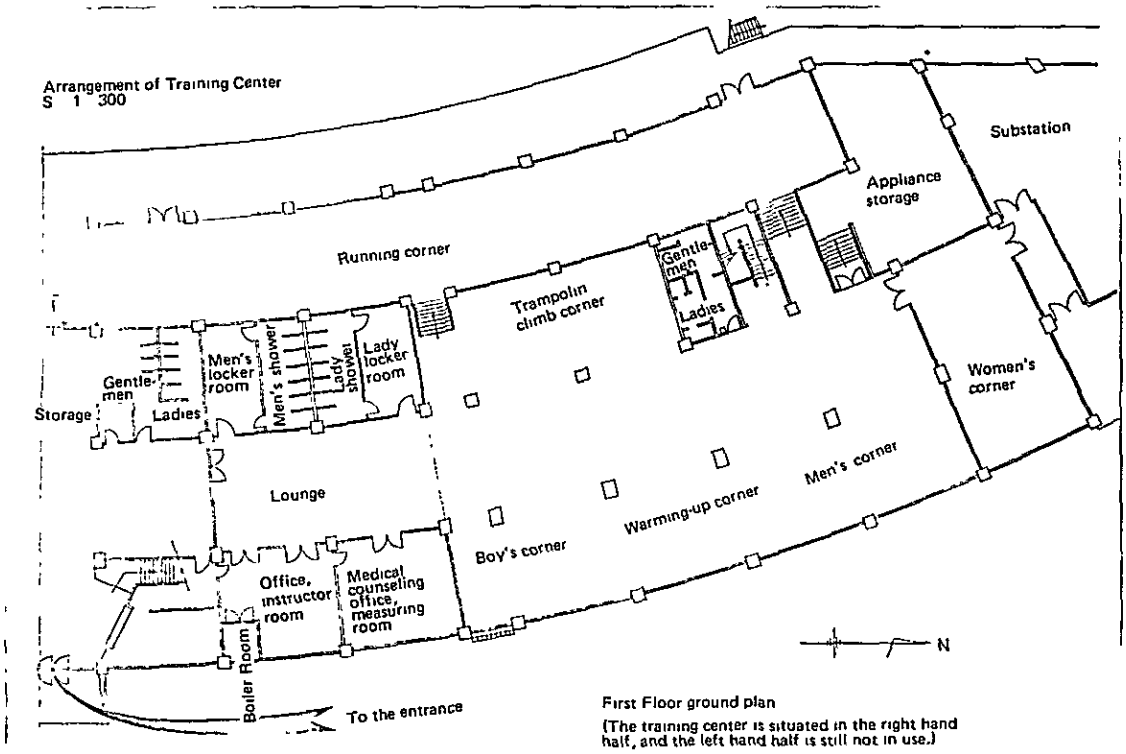
Lodging room:	6-bed room	14
	16-bed room	1
	20-bed room	1

Capacity:	120 beds
Lodging charge:	¥250 per capita per night
Meal charge:	Breakfast . . . . . ¥120 Supper ¥180
Charge for sheets:	¥70 per capita per stay
Self-cooking charge:	¥20 per capital per meal

Arrangement of Osaka Municipal Nagai Stadium



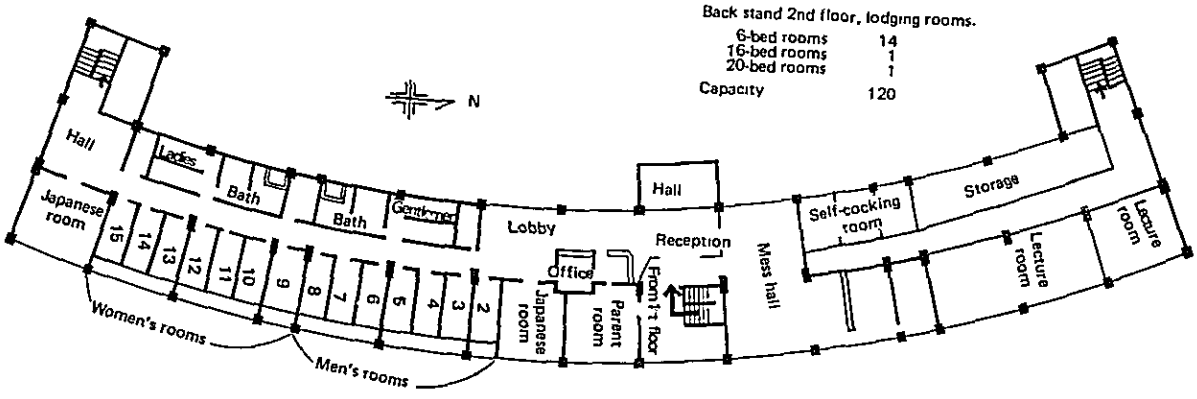
Ground Plane of Back Stand of Osaka Municipal Nagai Stadium



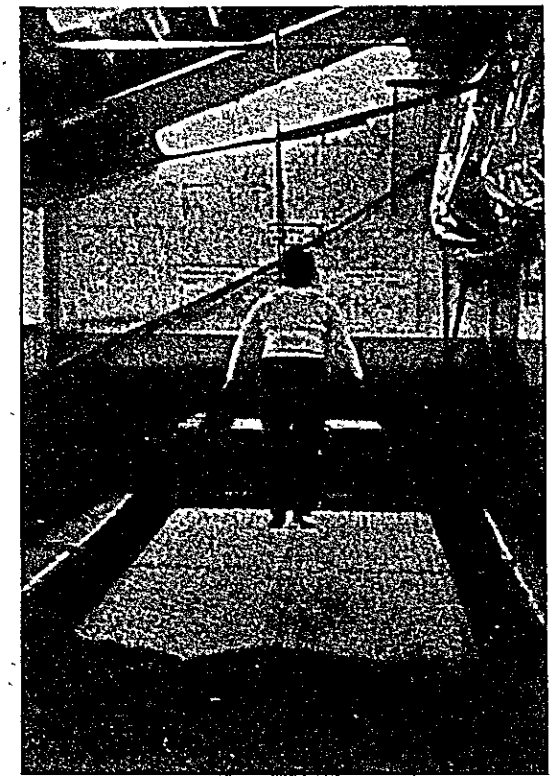
First Floor ground plan
(The training center is situated in the right hand half, and the left hand half is still not in use.)

Nagai Stadium
Back stand 2nd floor, lodging rooms.

6-bed rooms	14
16-bed rooms	1
20-bed rooms	1
Capacity	120



2nd floor ground plane
(Used as youth hostel)



Trampolin corner:

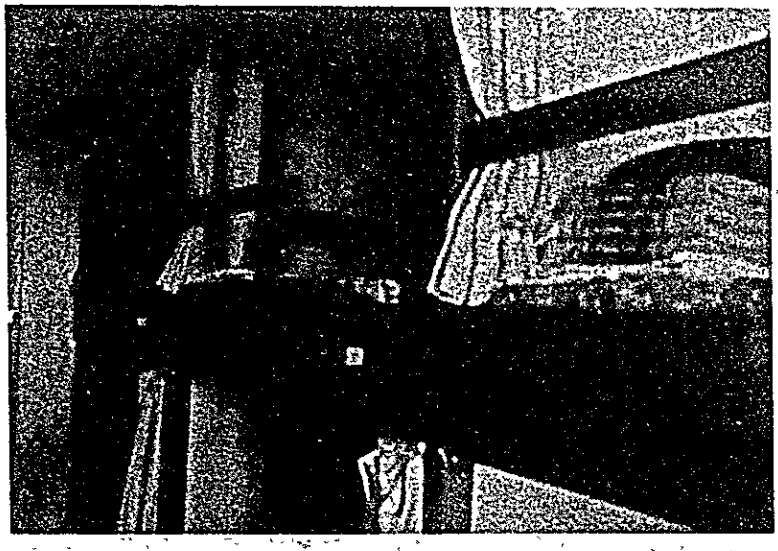
Scaffolding and seat are for construction work.
Sponge mattress is arranged around the trampolin for prevention of danger.

Running corner

Both upper and lower photographs
show the training center.

The ceiling is under construction

Lobby of youth hostel at 2nd floor



Beds in 6-bed room in youth hostel
(2-stair bed)

CHAPTER 2. RESULTS OF NOISE MEASUREMENT

2.1 Date and time of the measurement:

4th December 1970
7.30 – 11.00 a.m.

2.2 Measuring points:

Point 1: Located just front of the working office which is at the south side of the sports studium

Point 2: On the platform of the main entrance

2.3 Measured Noise:

Aircraft noise and traffic noise from Nicoll Highway

2.4 Measuring apparatus

a. Noise Meter: B & K Type 2203 Precision Sound Level Meter

b. Tape Recorder: TEAC A-21 Cassette Tape Recorder

c. Microphone: SONY F-96 Moving Coil Microphon
Afterwords octave band analysis were carried out at the NHK Technical Research Laboratories with following apparatus.

d. Reproducer: Philips EL-3312A Casette Tape Recorder

e. Octave Band-Pass Filter: Rion Type SA-55

f. Level Recorder: Rion Type LR-OID

2.5 Results of the Measurements

(1) During the measurements seven planes were observed, which were Boeing 737, DC-8, Friendship and others. Beside these planes several take-off and landing noise were heard from the oposite side of the air-port and circuitous flying far from the site were also observed. The noises from these flight were too small compared to the back ground noise. Only for 7 planes which flew over the site the noise measurements were carried out. In table 2-1 type of the planes, flying modes and the peak value of the sound pressure level D B C and noise level d B A (phone value) are shown. The higher level were observed for Boeing-737 (take off) and DC-8 (landing). The peak value of these planes are 80

d B A (phon) and 76 d B A (phon) respectively. The back ground noise level were about 59 – 58 d B A (phon).

(2) For B-737 and DC-8 the octave band spectrum were obtained from the recorded signal. The results is shown in Fig. 2-1. They have flat and wide spectrum from the 63 Hz to the 4 kHz. This is the typical jet noise spectrum.

(3) The back ground noise at the site was also measured at the point 1 and point 2. The histogram and cumulative frequency are shown in Fig. 2-2 and its octave band spectrum are also show in Fig. 2-1. Background nosie at the site is mainly due to the traffic noise from the Nicoll Highway. The center value of the noise level is about 56 – 58 phon.

2.6 Discussion and Conclusions.

The disturbance due to the aircraft noise at the site is not so easily concluded from these simple and short time observations. But from the following considerations, unless the flight density and other flight conditions are widely changed, the aircraft noise at the site seems to be not serious against the performances held in the sports studium.

(1) According to the flight schedule of the Singapore International Airport every day about one hundred planes are taking off and landing. These are concentrated mainly into the morning and the evening. During the measurements, fifteen planes should been taking off and landing according to the information from the Airport. But as shown in Table 2-1, only 7 planes were observed. Moreover, the planes to be mentioned were only two, one was the middle sized two engine plane and the other was realy the large 4 engine plane.

The measured noise level was 85 phon. This value is not so remarkable as for the aircraft noise. From these facts show that at the Singapore Airport take off and landing are conducted not only to the site directions but also to the opposite directions. Another feature of the flight conditions related to the noise problems is that at Singapore Airport the middle sized jet planes flight is very often compared to the large sized planes.

(2) Disturbance due to the aircraft noise at the sports stadium seems to depend not only to its sound level and duration time, but to the back ground noise level, especially in the case of full audience, sound pressure level from the laud speakers, art of the performances.

The stadium noise with full audience is estimated at least 50 – 60 phons and when the spectators are excited, the noise level would reach about 70 – 75 phon is reported.

The speech level at the microphone position is normally more 90 phon. As the

recorded signal at the measurements show as in Fig. 2-3, the announce level is about 5 dB higher than the aircraft noise. As the results if the sound level area from the laud speakers would reach 80 phon at the seating the aircraft noise seem to be not remarkable and the aeroplanes fly over the site would not disturb the performances.

(3) The traffic noise from the Nicoll Highway was even at the morning rush hours below 60 phon. No attention is needed at all. In future when the sport complex would been completed and become to use, the vehicles noise at the site would become serious, for example when a performance in a stadium is finished but at the another stadium is finished but at the another stadiums the another performances is conducted.

(4) During the measurements, take-off of the large jet planes were not observed. If it would flown just over the site, the noise level would reach about 95 phon. In this case, the announcements from the loud speakers can not be heared only in few seconds. But as it previously discribed, these occasion seem to be in very seldom. For these high level outdoor noise at the open field stadium, no countermeasure is recommended. By the very important ceremonies, and performances flight at the opposite direction or time shift of the flight schedule would be recommended.

Table 2-1 Observed Aeroplanes and their Noise Level

No.	Time	Type of the plane	Flying mode	Measured level (peak)	
				dB A	dB C
1	8.21	B-737	Take-off	80	85
2	8.25	(Propeller plane)	Pass	–	76
3	8.44	DC-8	Landing	76	80
4	8.49	(Propeller plane)	Take-off	70	83
5	9.24	Helicopter	Pass		
6	9.25	B-737	Landing	68	79
7	10.51	Friendship	Landing	62	76
	Back Ground Noise			54 – 58	70 – 74

No.	Measuring Point	events	A	B	C	
(1)	point 1	B-737 take off	80		85	
(2)	point 1	DC-8 landing	76		80	
(3)	point 1	Back Ground Noise				at 9.17
(4)	point 2	Back Ground Noise				

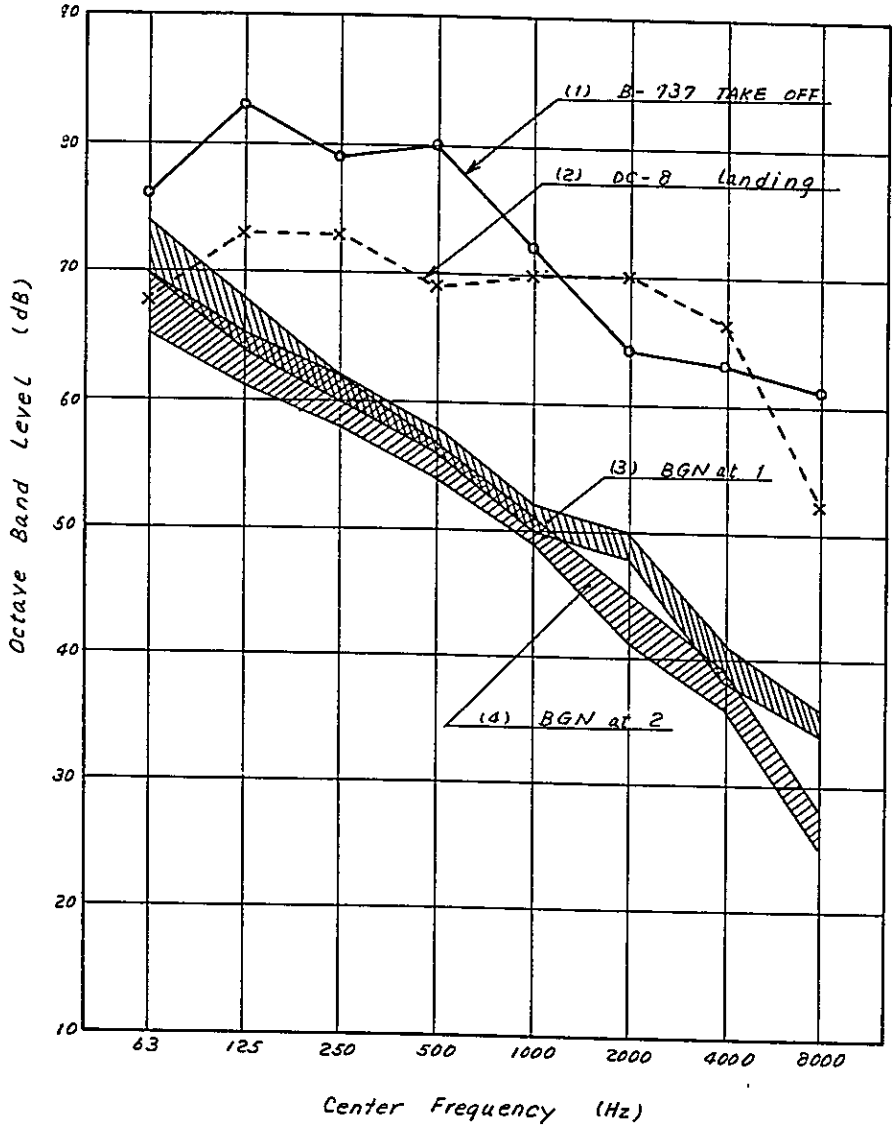


Fig. 2-1 Octave Band Noise Level at the Site

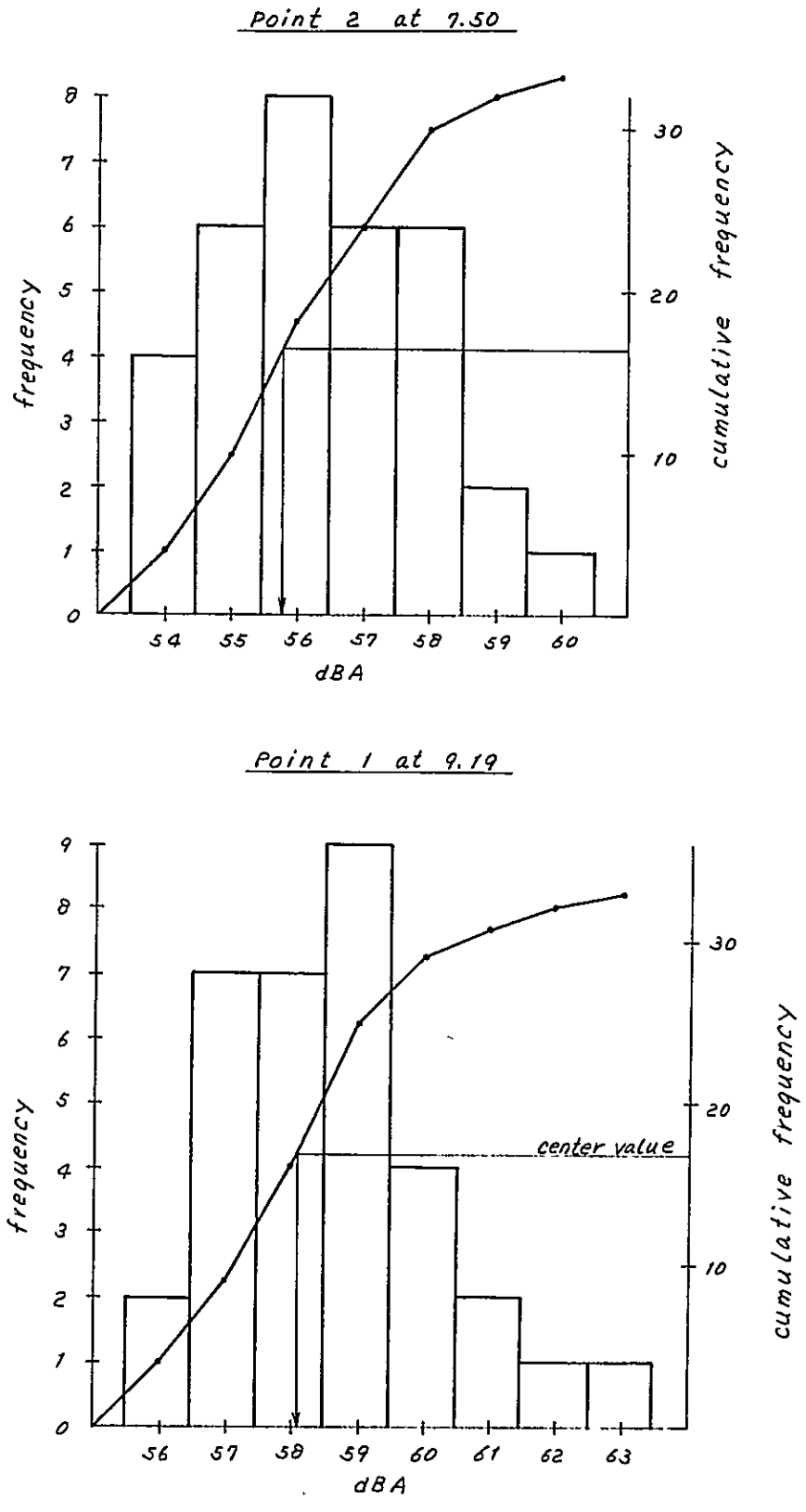


Fig. 2-2 Distribution of the Noise Level measured at the Site of the Sports Stadium

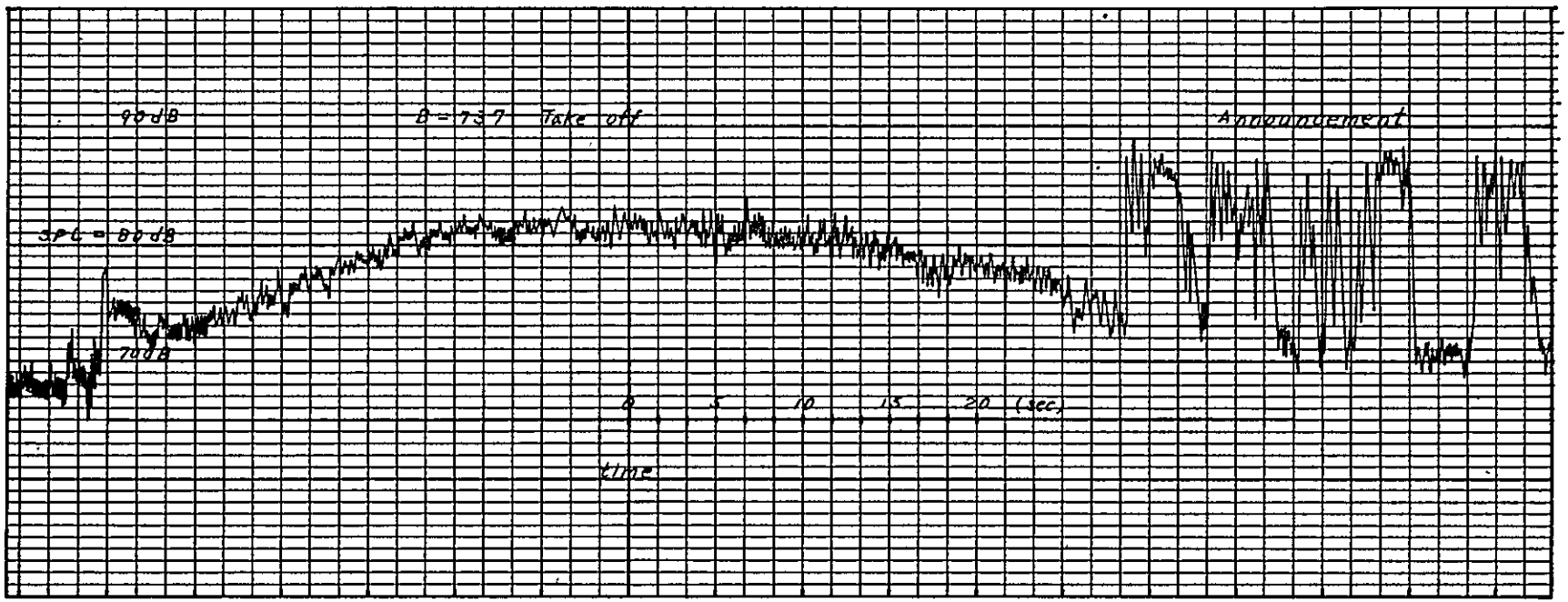


Fig. 2-3 Recorded Level of the Aeroplane Noise and Announce

CHAPTER 3. BASIC PLAN OF ELECTRO-ACOUSTIC SYSTEM

Various performances held in the stadium and facilities needed are well organized by the Singapore Government as Table 3-1. According to these intentions the following layout is made.

3.1 Fundamental point of view for the layout

(1) As shown in Table 3-1 the performances which would be held in the stadium show much variety as compared with the ordinary stadium. For examples in addition to the sports performances celebrations in various styles, parades, music concerts are expected. In accordance with each performance the location of the sound source is changed from main stand to the center of the field or to the opposite side of the main stand. Therefore the electro-acoustic system designed for ordinary sports stadium would be insufficient and the new system with high grade characteristics and wide functions is required.

(2) On the design of the electro-acoustic system covering these wide area, one of the principal problems is to get the uniform sound pressure distribution over the field and the seating area and the other is to reduce the long pass echoes. In general two different types of electro-acoustic systems are put in practice, one is the concentrated laud speaker system, or multi-speaker system, and the other one is the distributed laud speaker system. The concentrated system has a merit of easy to get the uniform sound distribution, the other hand distributed system has a merit of to be able to avoid the long pass echoes. The distributed system is very popular only for the economical reasons. The multi-laud-speakers distributed along the back edge of the seating area are shown in many stadiums. But as the multi-speaker system is bound to generate long pass echoes, so that as shown in Yoyogi Stadium in Tokyo, the concentrated speaker system had to been installed for the opening ceremony at Olympic games. The concentrated system however requires high out-put in laud speaker systems and has one defect of level fluctuation due to the wind at the long distance points from the laud speakers.

(3) As the fundamental layout of the electro-acoustic system of this stadium, the laud speakers should be located at least three different point, namely at the main stand, the center of the field and the seating area just opposite to the main stand.

3.2 Basic layout

(1) The facilities needed for each performances.

About these problems the fundamental plan is already given and arranged as shown in Table 3-1. But as the results of the investigations, the following facilities as shown

in Table 3-2 would be recommended. These modification is made based on the consideration upon the information service to the performers group, spectators group and officers group.

(2) Requisite characteristics of the electro-acoustic system.

a. Sound pressure level over the seating area.

The noise level in the studium would reach even at the quite conditions to 60 dB. In general it would reach more than 70 dB. Besides these conditions the sound level fluctuation about a few dB due to the wind should be considered. As these reasons the design of the laud speaker systems should be made to get the following sound pressure level over the seating area.

For announcements of speech	80 dB
For music reproduction	85 dB

b. The frequency characteristics

For speech	300 – 500 Hz ±5 dB (apart from 10m from the front of the laud-speaker)
For music	50 – 8000 Hz ±5 dB

c. Operating conditions

Operating level;	6 dB lower level from the howl back condition
Temperature:	15°C – 40°C

(3) Master plan of the electro-acoustic system

From Table 3-2 the following systems as shown in Fig. 3-1 is arranged.

(4) Microphone and laud speaker system microphone system is shown in Table 3-3 and the speaker system is shown in Table 3-4.

The arrangements of the microphones and laud speakers are shown in Fig. 3-2.

(5) Annex rooms and installed devices

The specification of the annex rooms and devices in which should be installed are shown in Table 3-5.

(6) Common ducts in the field

Common ducts should be set in the field in order to build in the microphon, speaker cables and Ac source lines. The position of the ducts is shown in Fig. 3-2 For these ducts considerations the water exaust considerations should be paid.

3.3 Problems for further discussion

(1) These layout shows only the key plan of the electro-acoustic system which were made according to the discussions at the meeting held in December of the last year. So that another opportunity of further discussions should be required about the functions of the system, the method operations, and the relation to construction works. The main subjects seem to as follows;

a. Arrangements of the control room, announce booth broadcasting operation room, paging room and records room and so on and the communication device between the above mentioned rooms.

b. The sorts and scale of the open field concerts held in the center of the field and the back stand and the facilities needed.

c. Mode and style of the relay broadcasting.

(2) After discussions above fundamental plan from various points, the basic plan presented would be modified and then an entorcement design should be started.

The discussions for the entorcement design is also required and then general tender should be put in. Design and work should be devided.

Table 3-1

*Facilities Required	Purpose	Areas where for this purpose microphones are located	**Areas where sound from the microphones are required to be distributed at most times	Remarks
1.	Announcements	Control Room	a) Field b) Stands c) Dining + Restaurant d) Official areas e) Reserved areas f) Stadium entrances + Concourse g) Public toilets h) Practice tracks	
2.	Paging	Control Room	a) Dining b) Official areas c) Reserved areas d) Practice tracks	
3.	Speeches	a) VIP Grandstand Position 1 b) VIP Grandstand Position 2 c) Area on the field immediately below the VIP Grandstand	a) Field b) Stands c) Restaurant d) Official areas e) Reserved areas f) Practice tracks	A radio or wireless microphone is also to be provided for use in area (c) in column 3.
4.	Stage Productions	Centre of the field	a) Field b) Stands c) Restaurant d) Reserved areas	
5.	Mass Choir & Band (2,000 persons)	Stands immediately opposite to VIP Grandstands	a) Field b) Stands c) Restaurant d) Reserved areas	

*Facilities Required	Purpose	Areas where for this purpose microphones are located	**Areas where sound from the microphones are required to be distributed at most times	Remarks
6.	Mass Choir & Band (200 persons)	Area on the field immediately below the VIP Grandstands	a) Field b) Stands c) Restaurant d) Reserved areas	
7.	Tape and Disc Reproductions		a) Field b) Stands c) Dining + restaurant d) Official areas e) Reserved areas f) Standium entrances + Concourse g) Public toilets h) Practice tracks	The tape and disc reproducers are located in the Control Room. The distribution of sound to the field should be such that all parts of the field received the reproduced music simultaneously as this is essential in mass drill displays.
8.	Sound effects pick-up for broadcasting	4 Different areas in the stands		The feed will be taken from the control room.
9.	Additional high-quality feeds for broadcasting			Such feeds may be taken from the spare outputs of the above microphone pre-amplifiers.

NOTES:

* (a) More than one facilities may be required in any function.

** (b) Generally, the sound in any facility is required to be distributed throughout all or any of the following areas in the Stadium Complex:

i) Field
ii) Stands
iii) Dining + restaurant
iv) Official areas
v) Reserved areas
vi) Stadium entrances + concourse
vii) Public toilets
viii) Practice tracks

Column 4 indicates only the areas where the sound distribution is needed at most times.

Table 3-2 Facilities required in the sound system for each performance

		Announce-ment in general	Announce-ment for paging	Speach (VIP stand)	Speach at the ceremony	Choir and band	Stage produc-tions	Mass choir and band	Tape and disc re-productions	For broad-casting
Microphon positions	Announce booth	o	o							o
	Control room	o	o							o
	Paging room	o	o							o
	VIP grandstand			o						o
	Area on the field below the VIP stand				o	o				o
	Center of the field						o			
	Stand opposite to VIP stand							o		
	4 different areas in the stand									o
	Different areas in the field									o
Service area	Field	o		o	o	o	o	o	o	
	Stand	o		o	o	o	o	o	o	
	Dinning room	o	o						o	
	Restaurant	o		o	o	o	o	o	o	
	Official areas	o	o	o	o	o	o	o	o	
	Reserved areas	o	o	o	o	o	o	o	o	
	Stadium entrance concourse	o		o	o				o	

	Announcement in general	Announcement for paging	Speach (VIP stand)	Speach at the ceremony	Choir and band	Stage productions	Mass choir and band	Tape and disc reproductions	For broadcasting
Public toilets	o				o				
Locker and shower room	o	o			o				
Practice tracks	o	o	o	o	o				
Player and team entrance	o	o	o	o	o				

Table 3-3 Microphon System

Name		Purpose	Type	Postion of input connector
Announcement MIC	M0 – 1	Announcement of general information, paging	Moving coil uni-directional	Mixing console
"	M0 – 2		"	Announce booth
"	M0 – 3		"	Paging room
VIP MIC	M1 – 0	VIP speach f. broadcasting	"	VIP stand pos. 1
	M1 – 1	VIP speach	"	" " 1
	M1 – 2	" (stand-by)	"	" " 1
	M1 – 3	Task of proceeding	"	" pos. 2
Ceremony MIC for speech	M2 – 1	Speech for ceremony	"	Field just below the VIP stand
	M2 – 2	"	"	"
Ceremony MIC for music	M3 – 1 ~ M3 – 20	Music for ceremony	"	Field just below the VIP stand
		"	"	
Field stage MIC	M4 – 1 ~ M4 – 20	Stage performances at the center of the field	"	Center of the field
			"	
Back stand stage MIC	M5 – 1 ~ M5 – 20	Stage performances at the back stage	"	Back stand opposite of the VIP stand
			"	
Wireless MIC	M6 – 1 ~ M6 – 4	Pick up at the field	Wire less MIC	Mainly on the field
Stand MIC C	M7 – 1 ~ M7 – 10	Field pick up for announcement and broadcasting	Moving coil uni-directional	Center stand
Stand MIC R	M8 – 1 ~ M8 – 10	"	"	Right stand
Stand MIC L	M9 – 1 ~ M9 – 10	"	"	Left stand
Stand MIC B	M10 – 1 ~ M10 – 2	"	"	Back stand
Field MIC R	M11 – 1 ~ M11 – 10	"	"	Right field
Field MIC L	M12 – 1 ~ M12 – 10	"	"	Left field

* 1) For out door use wind screen should be attached.

Table 3-4 Loud Speaker System

Name		Purpose	Type	Position of input connector
Main speaker	S1 – 1 ∫ S1 – 6	Public address of speech and announcement towards stand and field	Horn speaker with multicellar 130 dB/m.W	Lighting pole or roof of the canopy
Canopy speaker	S 2 – 1 ∫ S2 – 20	Public address towards VIP stand	Horn speaker with multicellar 100 dB/m.W	Front edge of the canopy
Canopy back speaker	S3 – 1 ∫ S3 – 20	Public address towards the rear part of VIP stand	Corn speaker 20cm 95 dB/m.W	Rear part of the canopy ceiling
Main stand speaker	S4 – 1 ∫ S4 – 20	Public address towards the front part of VIP stand	Column speaker 100 dB/m.w	Front edge of the VIP stand
Side stand speaker	S5 – 1 ∫ S5 – 2	Public address towards the side of the VIP stand	Column speaker 110 dB/m.w	Side of the canopy
Field speaker	S6 – 1 ∫ S6 – 20	Music reproduction for mass game in the field	Combined column speaker wire-less operation	Distributed in the field
Stage speaker	S7 – 1 ∫ S7 – 4	Music reproduction for concert	Horn speaker with woofer movable	Distributed in the field
Entrance speaker	S8	Music reproduction for players at the entrance	Column speaker 100 dB/m.w.	Players entrance
Office room	S9 – 1 ∫ S9 – i	Public address music reproduction	Corn speaker 20cm	Office room
Reserved area	S10 – 1 ∫ S10 – j	Public address music reproduction	Corn speaker 20cm	Researved area
Dinning room	S11	”	Column speaker	Dinning room
Restaurant	S12 – 1 ∫ S12 – k	”	Column speaker	Restaurant
Public toilet	S13 – 1 ∫ S13 – 1	”		Toilet
Locker and shower room	S14 – 1 ∫ S14 – m	”	Horn speaker	Locker and shower room
Practice track	S15 – 1 ∫ S15 – n	”	Horn speaker with multi-cellar	Practice track
Start sign speaker for running	S16 – 1 ∫ S16 – 10	Starting sign for 400, 800m running race	Corn speaker 20cm	Running tracks

* 1) For out door speaker system water-proof consideration should be required.

2) For main speaker system high out put level is required.

In Fig. 3-3 example of the out put level of the commercial speakers are presented.

Table 3-5 Detail of the Rooms for Electro-Acoustic System

Name	Floor Area	Place recommended	Devices installed	Other specifications
Control Room for Public Address	> 30 m^2	Place from which the whole stand view is available. At the back of the VIP lounge is recommended.	1) Mixing consol 2) Input and output terminal board 3) Input and output display board 4) Amplifier rack 5) Disc player, tape recorder, radio receiver 6) Receiver of wireless microphons 7) Transmitter of wireless speakers 8) Locker of microphones and other accessories 9) Laud speakers for monitorning 10) Terminal board for paging room and broadcasting control room	1) Three side glass windors 2) Acoustical finishing $\alpha = 0.3 - 0.4$ (wall and ceiling) 3) Air conditioning 4) Space for store 5) Sound proof wall and ceiling construction
Announce Booth	> 6 m^2	Between P.A. control room and broadcasting control room	1) Microphon table 2) Talk back speaker	1) Glass windors for field side and control room side 2) Acoustical finishing $\alpha = 0.3 - 0.4$ (wall and ceiling) 3) Sound insulation to neighboring rooms D should be > 50 dB 4) Air conditioning
Control Room for Broadcasting	> 30 m^2	At the back of VIP lounge. Side of the announce both	1) Terminal board 2) Desk	1) Three side glass window 2) Acoustical finishing $\alpha = 0.3 - 0.4$ 3) Sound insulation to neighboring rooms. 4) Air conditioning

Name	Floor Area	Place recommended	Devices installed	Other specifications
Power Amplifier room	> 50 m^2	No restriction	1) Amplifier racks 2) Input output board 3) Cooling unit	Cooling unit should be installed considering the heat radiation of the amplifier
Store room for stage and field speakers	> 70 m^2	Grand floor	Speakers and cables used in the fields	Speaker transportation to the field should be considered

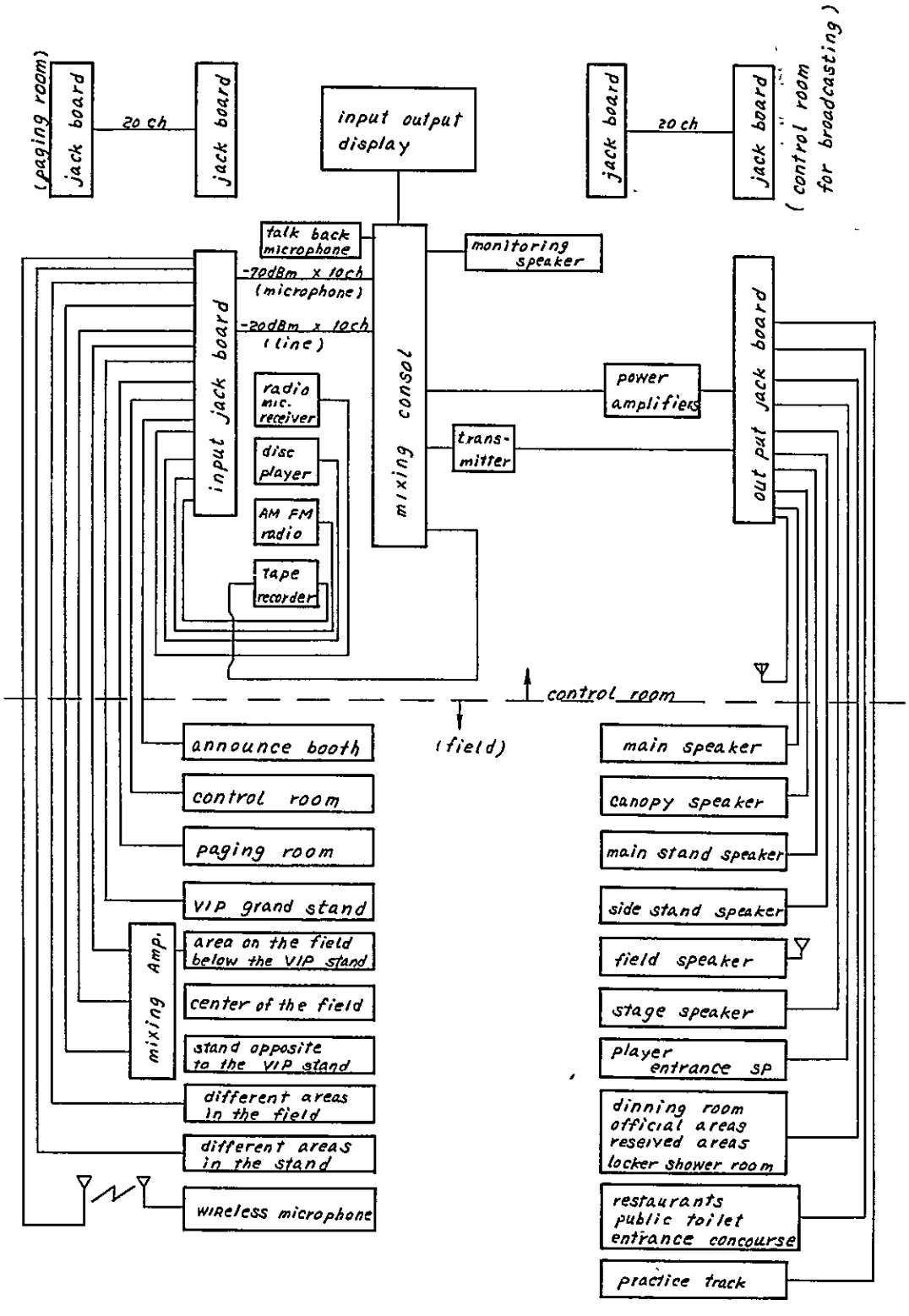


Fig. 3–1. Master Plan of the Electro-Acoustic System

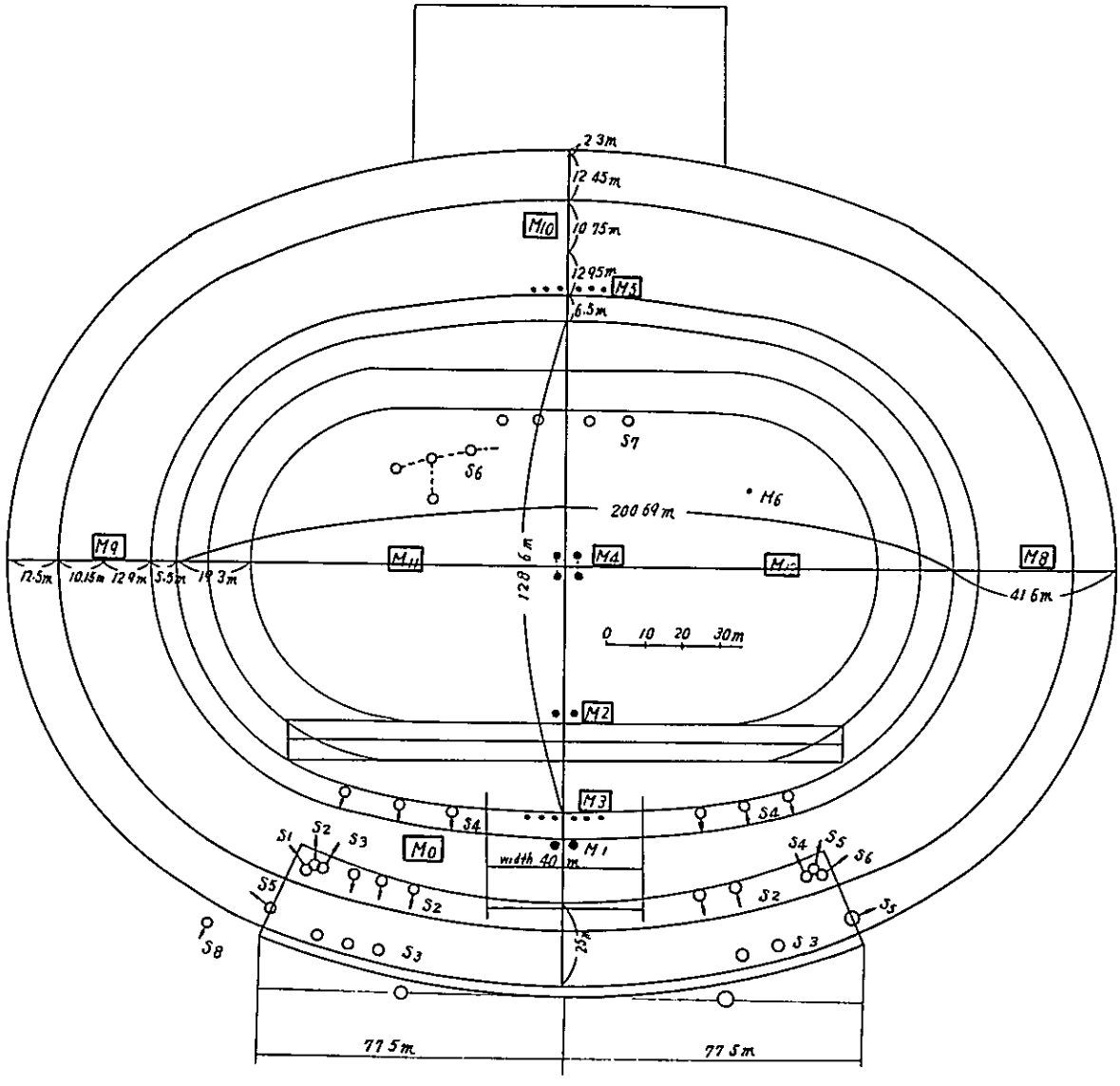


Fig. 3-2 Location of the speakers and microphones

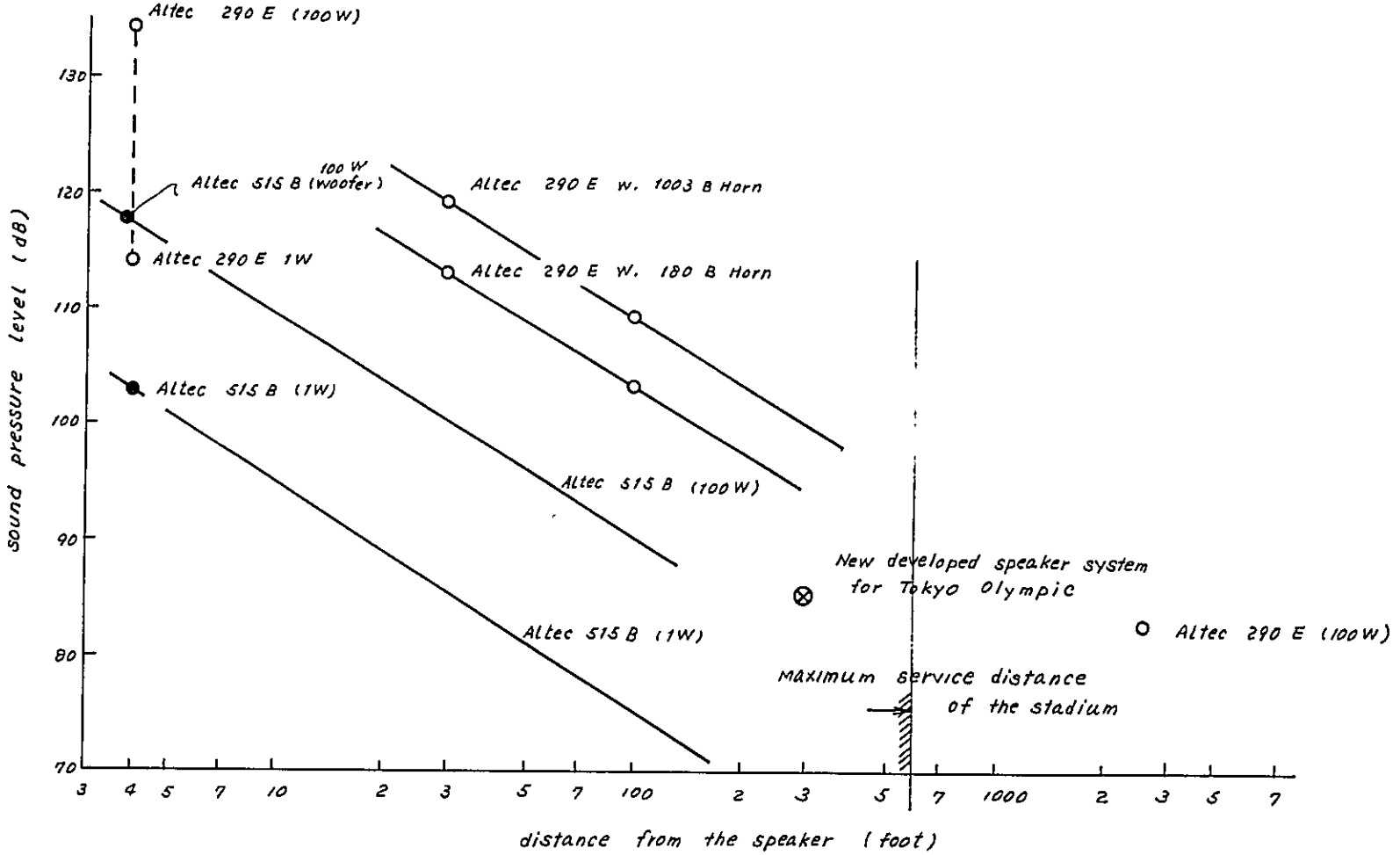


Fig. 3-3 Example of the Out-Put Level of the Commercial Laudspeakers

CHAPTER 4. BASIC PLAN OF LIGHTING

4.1 Overall Plan

(1) Basic principles

Following basic principles were adopted for lighting plan of National Stadium.

a. Sections for which lighting is required and Illumination shall be as follows:

Racing track	600 lx.
Racing track (home stretch)	1,000 lx.
Field	500 lx.

(Follow spotlight and partial lighting for VIP Stand and Back Stand shall be described later.)

b. Floodlights shall be installed at the Tower and the lower end of the roof of Canopy. (As for installation of lights to Canopy, refer to Fig. 10.)

c. Six towers shall be installed. (4 towers are planned in the present plan.)

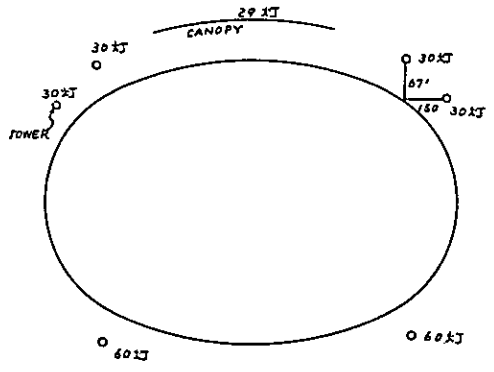
d. Lamp to be applied for floodlight shall be 2000W Halide lamp.

e. Beam angle of floodlight shall be 19°, and beam efficiency shall be 20%.

f. Maintenance factor shall be 0.7.

(2) Number of Floodlights and Arrangement

Number of floodlights and arrangement is as mentioned herewith. Number of lamps shall be 269 in total and total power shall be 661.74 kVA.



(3) Illumination Distribution

Figures 1 to 9 show Illumination Distribution Diagrams calculated with an computer.

Fig. 1	Horizontal Illumination by lighting all lamps at the 6 towers and the Canopy.
Fig. 2	Horizontal Illumination by lighting the floodlights of 6 towers.
Fig. 3 – Fig. 6	Vertical Illumination at the space imaginary phase by lighting the floodlights of 6 towers.
Fig. 7	Horizontal Illumination by lighting all floodlights of 4 towers and the Canopy. (Reference value).
Fig. 8	Horizontal Illumination by lighting the floodlights of 4 towers. (Reference value).
Fig. 9	Vertical Illumination at the space imaginary phase by lighting the floodlights of 4 towers. (Reference value).

The above-mentioned Illumination Distribution was calculated with a rough consideration of the number of floodlights, arrangement and the aiming angle, and the average Illumination level is almost satisfactory. Distribution, however, is not always satisfactory, and it is necessary to further review the aiming angle.

Because the pattern of each event is not well identified, the lighting pattern for each event is not discussed herewith, and the pattern and scale of each event is required for further study.

As described in Fig. 9, the vertical illumination is not satisfactory in the case of 4 towers. This can be well understood by comparing with the case of 6 towers in Fig. 5.

(4) Lamp, lighting fitting and ballast required

Lamp	2,000W Halide lamp	269 units
Lighting fitting	Narrow beam type	269 units
Ballast		269 units

As for detailed specifications, reference should be made to Paragraphs 4.2-lamp, 4.3 lighting fitting and 4.4-ballast.

In order to secure a higher effect of production of events, it is recommendable to install follow spotlights at the Main Stand and others. Those spotlights shall be used for the production at the Ground, and also for chorus at the Back stand. Specifications are as follows:

Nomenclature	Xenon Pin Spotlight Lamp shall be 3.6kW Xenon lamp, and power supply shall be 3ϕ – 400V.
Optical character	Intensity of illumination shall be more than 2000 lx. in the spot of a diameter of 3 feet at a distance of 150 feet. (Illumination shall be 500 lx. in the spot of a diameter of 6 feet at a distance of 300 feet.)
Number required	About 3 units

(5) Study on the Quality of Lighting

In this Paper, it is recommended to adopt 2000W Halide lamp as the light source, and this was determined from the power capacity. In short, in view of the quality of lighting it is advisable to apply Halide lamp mixed with Tungsten halogen lamp (or incandescent lamp); however, as the efficiency of Tungsten halogen lamp is lower (about 20 lm/W), it will be over 700 kVA (about 980 kVA) with full load to secure the said illumination level. If possible, it is better to draft a plan for mixed lighting with a larger power capacity.

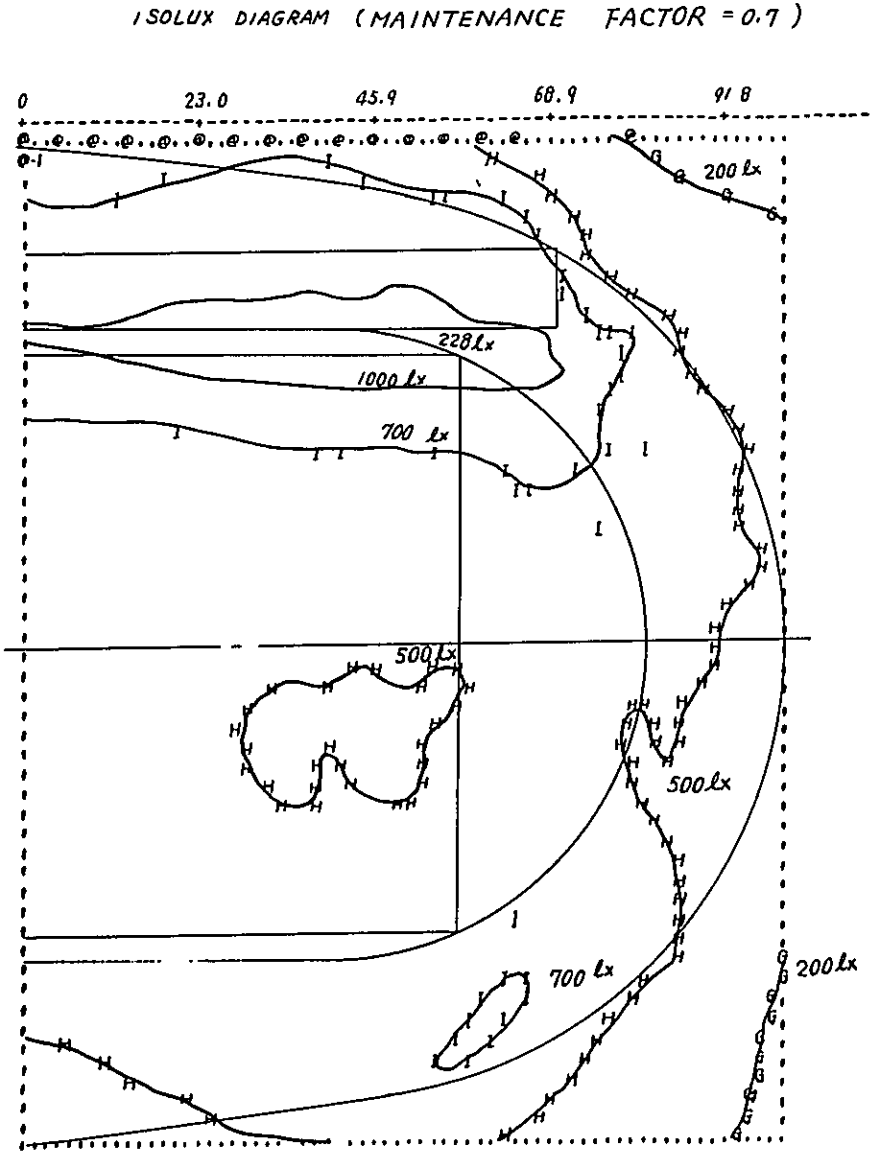
a. Color rendition

Gen eral color rendering index of the facility with only Halide lamp lighting shall be about 63. This value is a little lower than the value of cool white fluorescent lamp. Particularly the color shift of reddish objects shall be too large.

Though only Halide lamps can be also adopted, it is advisable to improve the color rendition with a mixed lighting with Tungsten halogen lamps, if possible.

b. Flicker

Flicker of lamps shall be inconvenient for players in the case of swift action and the received picture in the case of television. (Flicker is generated at 100Hz with a power supply of 50Hz.) Percentage flicker of Halide lamp is about 38%; this is rather lower among discharge lamps, and yet this value must be problematic. There are 2 ways to reduce the unfavorable effect by flicker as follows: one is to mix with Tungsten halogen lamps which have less flicker, and the other is to make the power supply three phase with only Halide lamps. If the power supply is made 3-phase, percentage flicker shall be about 16%; this is not any serious problem.



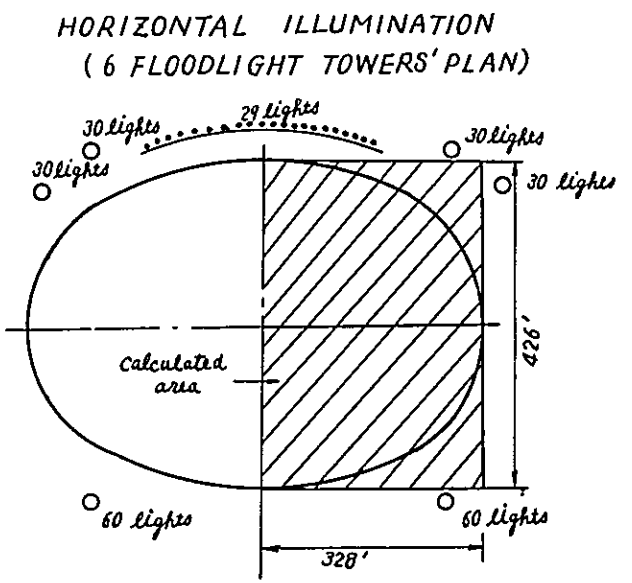
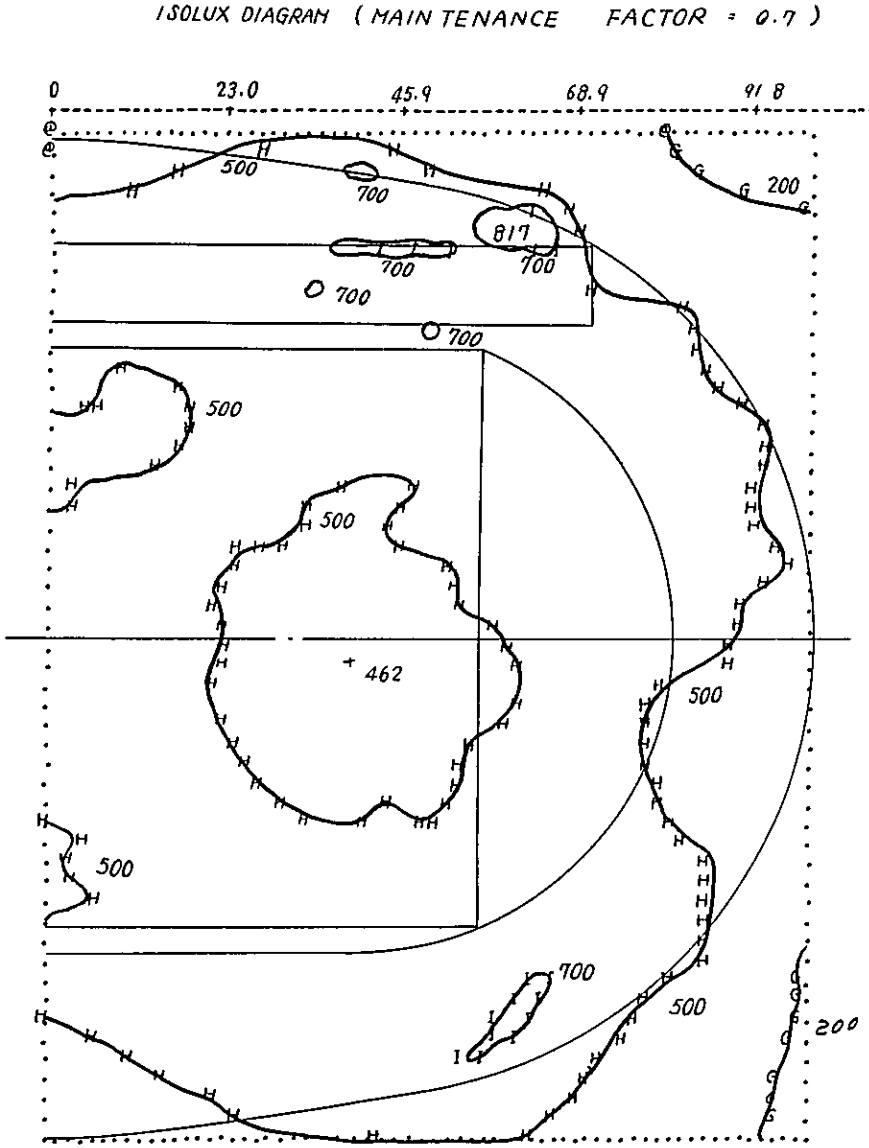


Fig. 1 Isolux Curve (1)



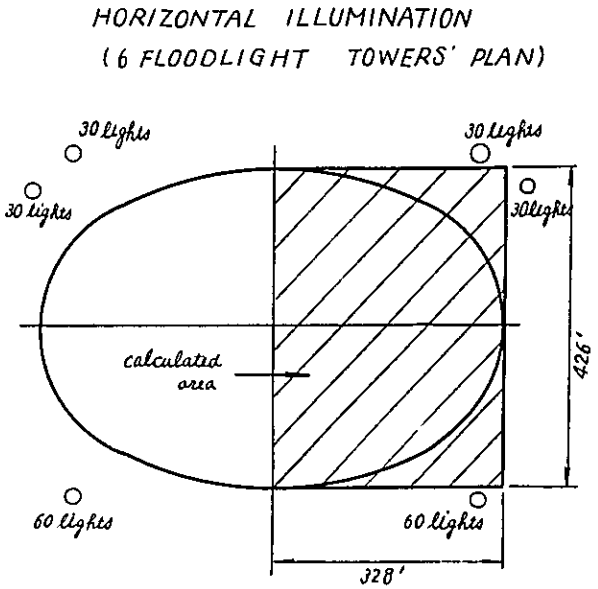


Fig. 2 Isolux Curve (2)

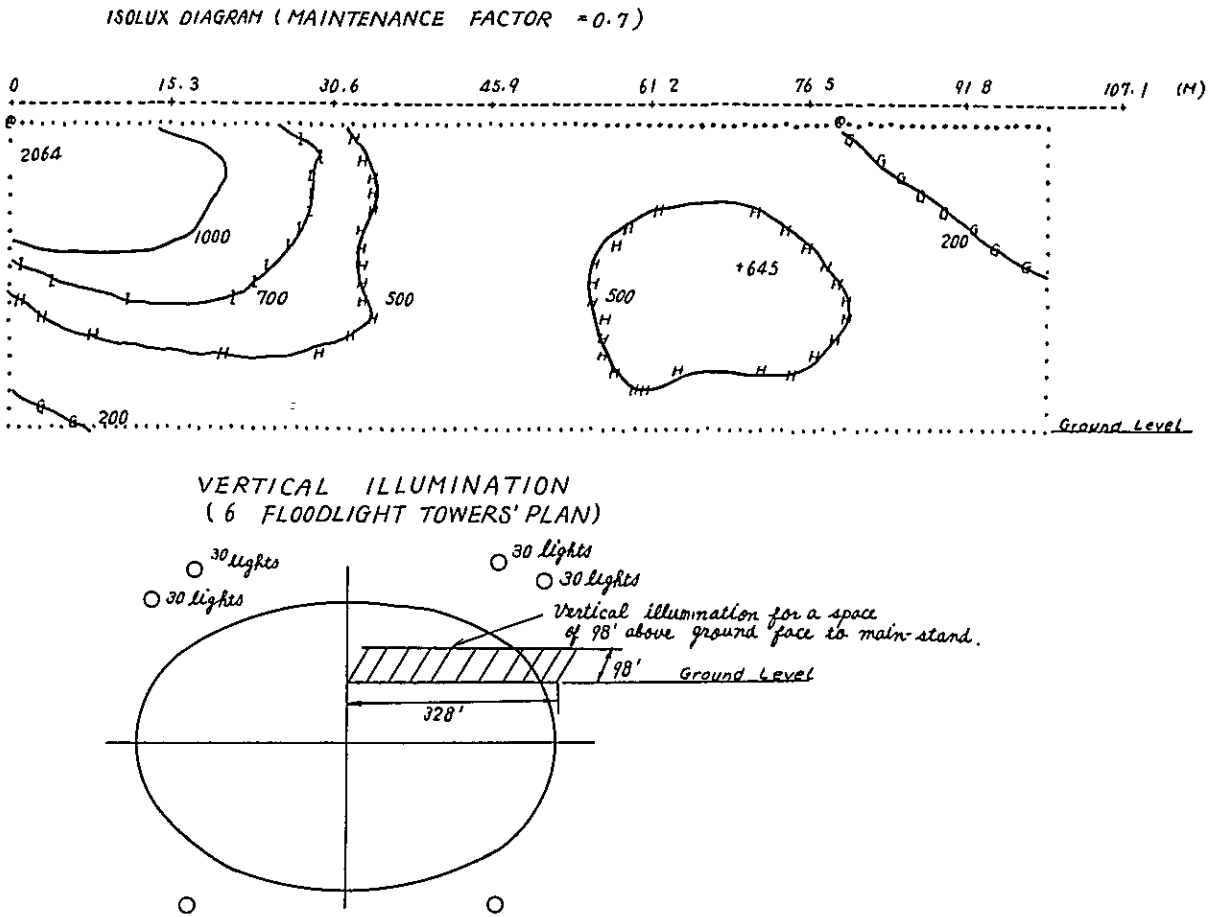
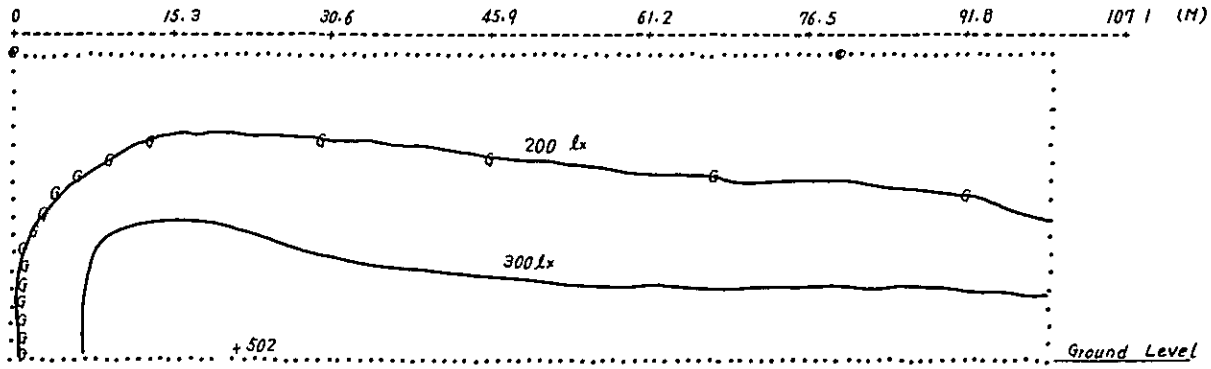


Fig. 3 Isolux Curve (3)

ISOLUX DIAGRAM (MAINTENANCE FACTOR = 0.7)



VERTICAL ILLUMINANCE
(6 FLOODLIGHT TOWERS' PLAN)

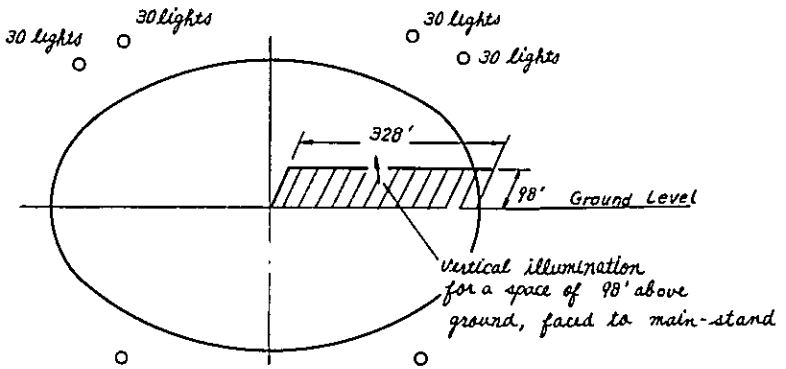
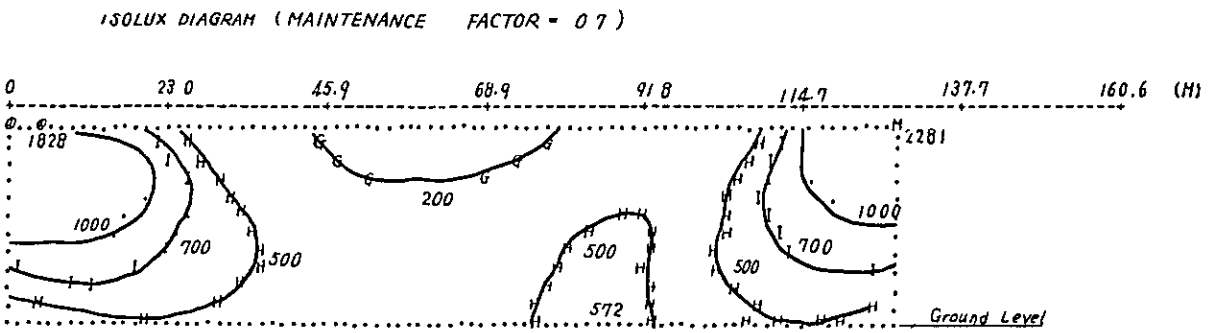


Fig. 4 Isolux Curve (4)



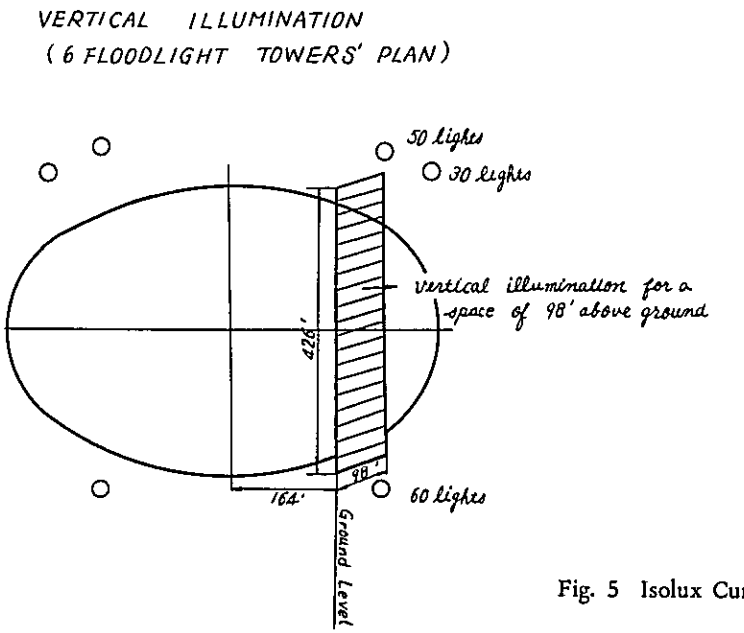


Fig. 5 Isolux Curve (5)

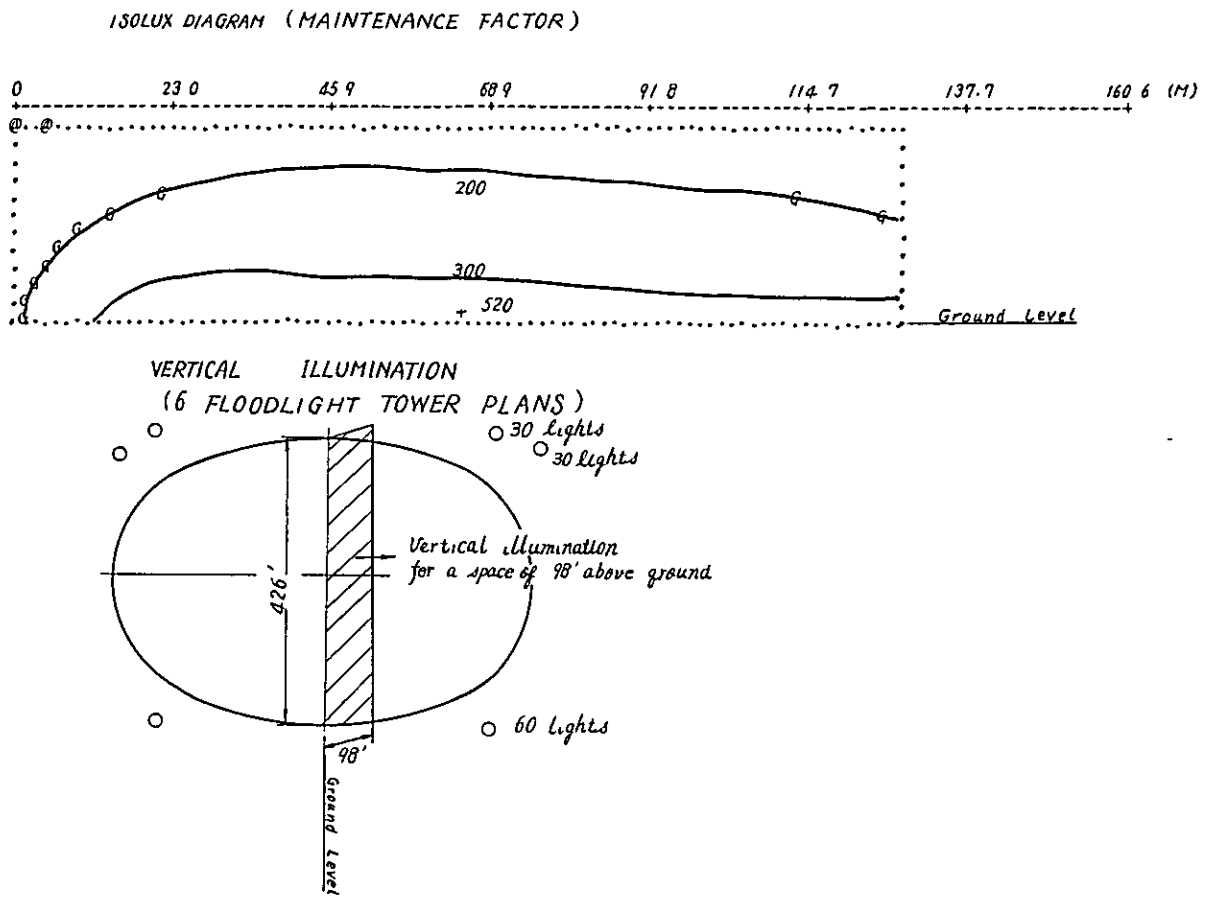


Fig. 6 Isolux Curve (6)

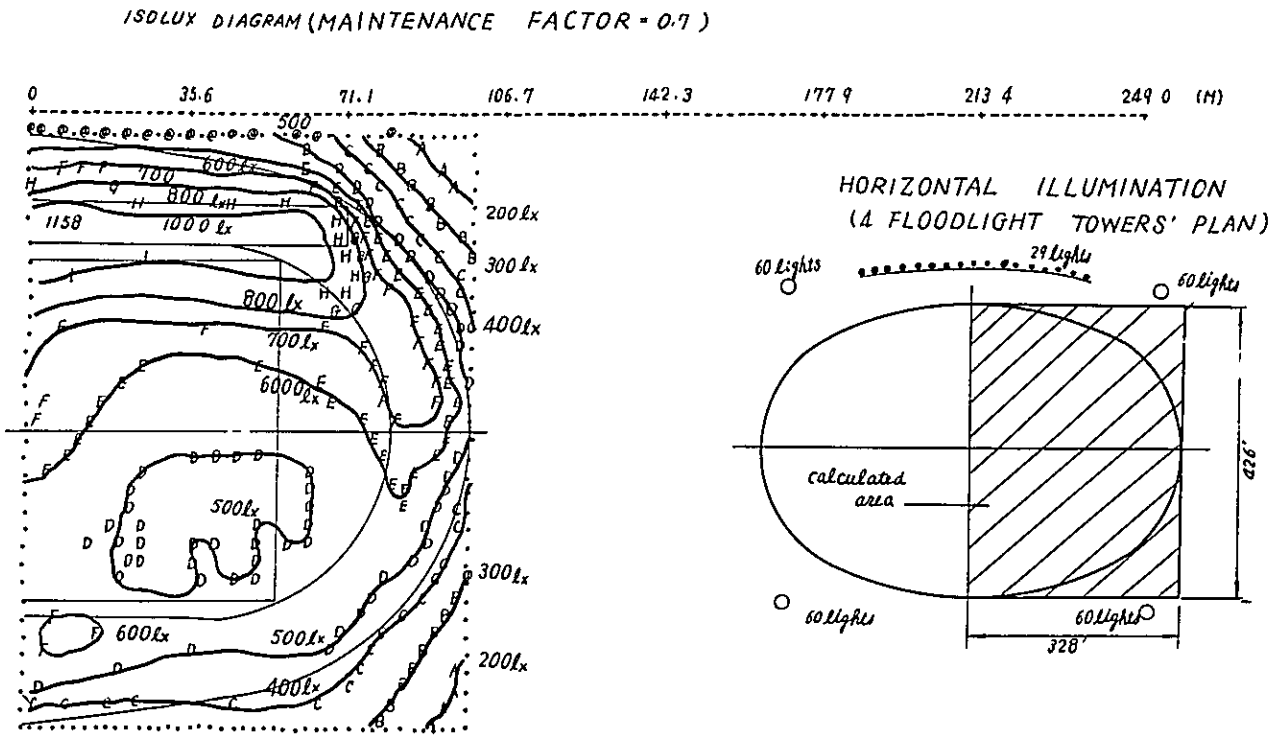


Fig. 7 Isolux Curve (7)

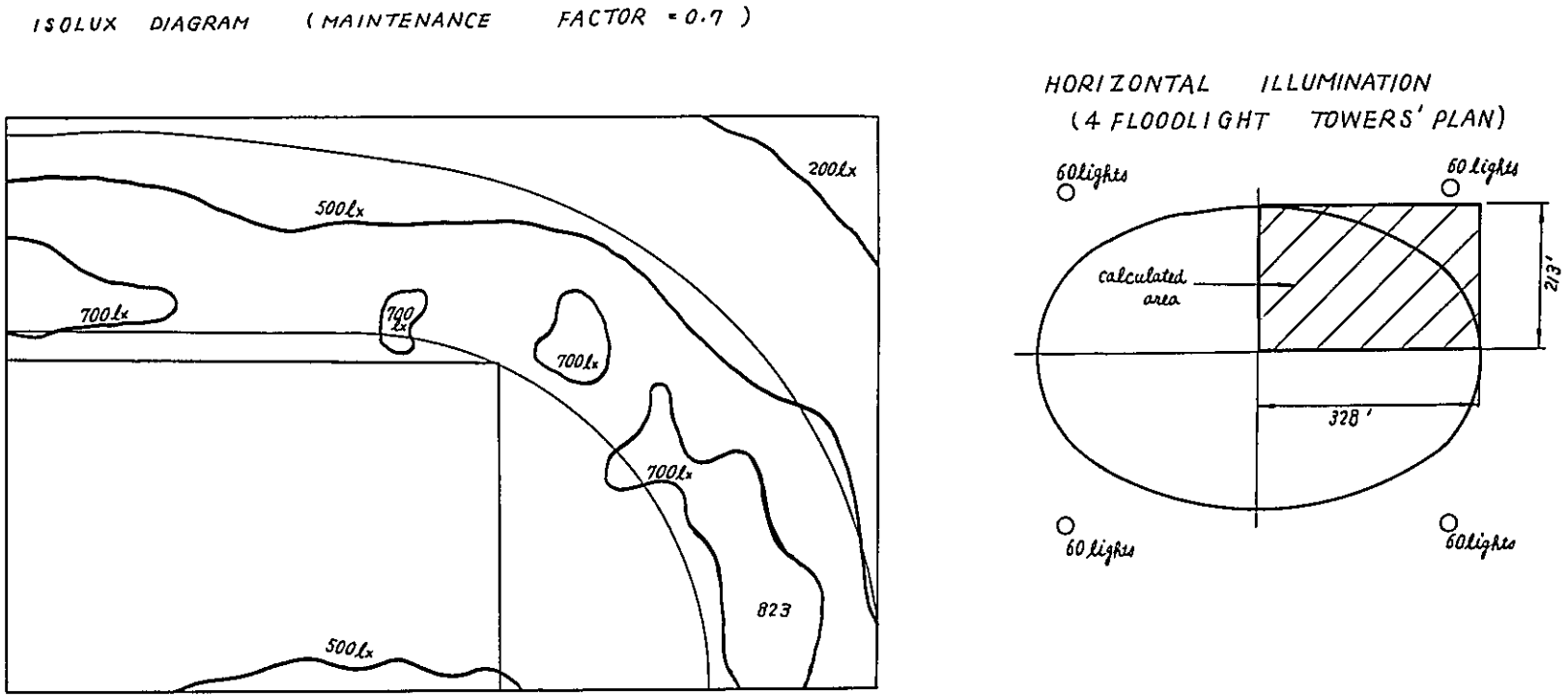


Fig. 8 Isolux Curve (8)

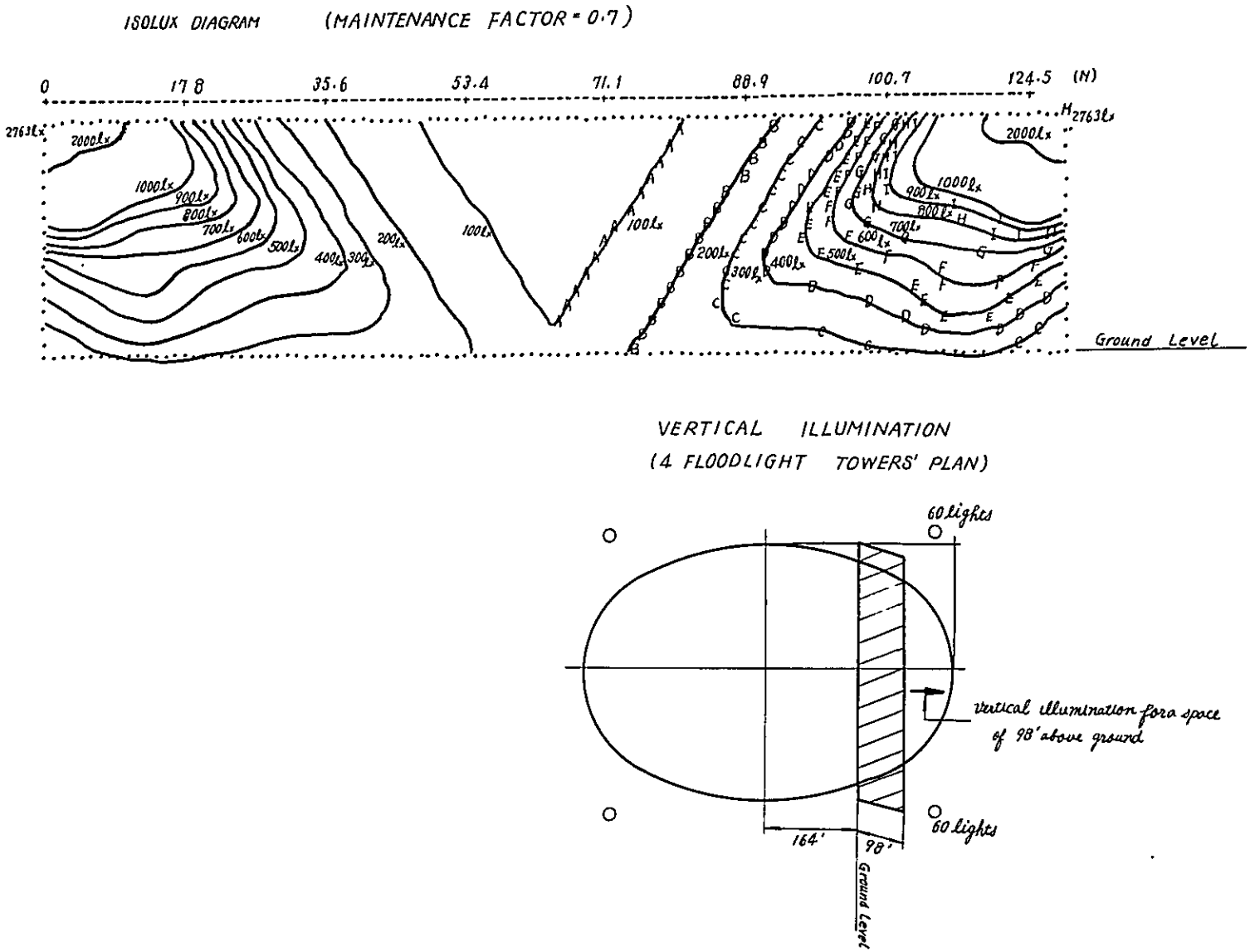


Fig. 9 Isolux Curve

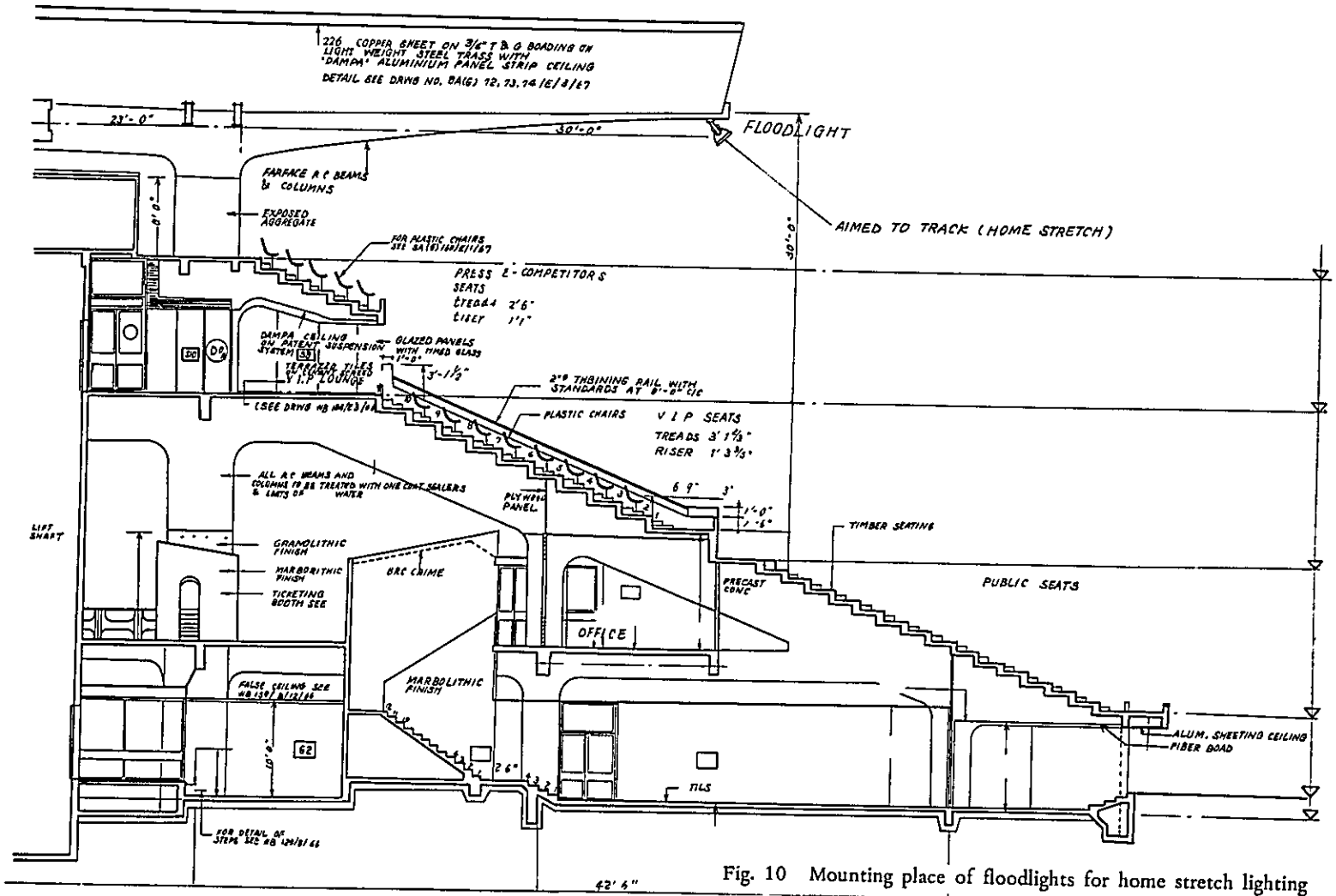


Fig. 10 Mounting place of floodlights for home stretch lighting

4.2 Lamp

Lamp to be used for floodlight shall be 2000W Halide lamp. (The terminology "Halide lamp" is quoted from the International Lighting Vocabulary of International Commission on Illumination, and this is also called Metal halide lamp or Multi-vapor lamp.)

(1) General construction

Construction is shown in Fig. 11. Dimensions, however, are indicated in rough values and the shape is of a representative example.

(2) Capacity

a. Electric characteristics

*Lamp wattage	2,000W
*Rated voltage	460V
*Lamp voltage	265V
*Lamp current	8 Amp.

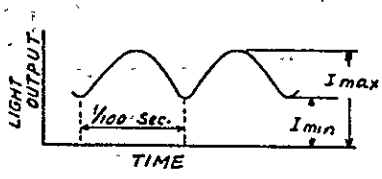
b. Optical characteristics

*Total luminous flux	190,000 lm. in average (Vertical)
	170,000 lm. in average (Horizontal)
*Efficiency	95 lm./W in average (Vertical)
	85 lm./W in average (Horizontal)

*General color rendering index over 60
(Evaluation of color rendering index was made in the method recommended by International Commission on Illumination.)

* Percentage flicker Under 40%
(Percentage flicker is calculated by the following formula, based upon the Figure hereunder:

$$\frac{I\ max - I\ min}{I\ max + I\ min} \times 100(\%)$$



*Color temperature 5,000°KC

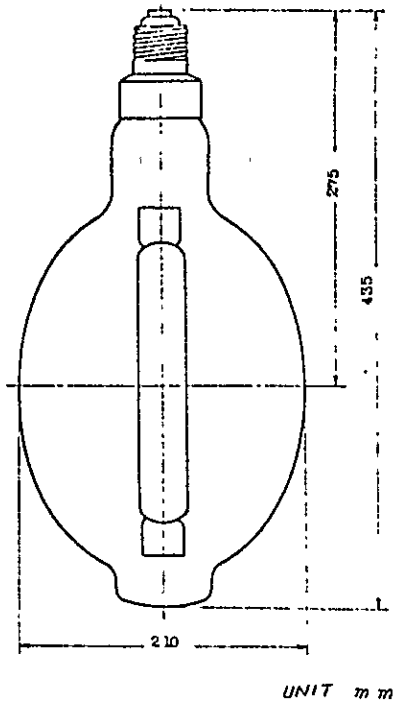
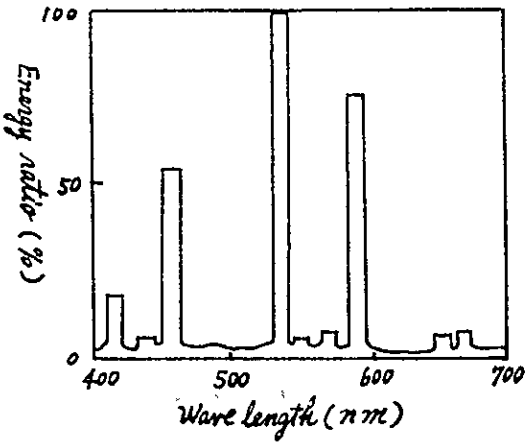


Fig. 11 2,000W halide lamp

(3) Spectral distribution curve (Example)



4.3 Lighting fitting

(1) General construction

a. Lighting fitting shall consist of the main body, front glass, reflector, socket and mounting stand. (Refer to Fig. 12)

b. Lighting fitting shall be of such a construction as that it will not be damaged by stormy weather and salinity and will withstand wind pressure of 30m/sec (about 90 ft./sec).

c. It shall be free from rain water and dusts.

d. Lighting fitting shall be fixed firmly to mounting stand or others. Horizontal and vertical angle adjustment the mounting stand shall be smoothly carried out, and it shall be provided with a device to fix it to an optional angle and a scale to indicate the angle.

e. The front glass shall be tempered glass of a thickness of 6 mm, shall be free from bubble, crack, distortion or flaw etc.

f. Reflector shall be of such a construction that aluminum plate is formed flat and smoothe, the inner surface is polished by electrolysis and coated with a film by positive treatment. Purity of aluminum must be over 99.8%.

g. Socket shall be screw type.

h. Connection wire inside lighting fitting shall be more $2mm^2$ of the cross section of the conductor with heat resistance, and it must be firmly connected.

i. Length of the lead wire shall be more than 1.5m (about 5 feet); it shall be of such a construction that direct force cannot be given to the connected section inside when tensile force is given from outside.

(2) Capacity

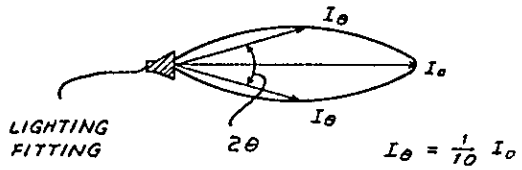
a. Suitable lamp 2,000W Halide lamp

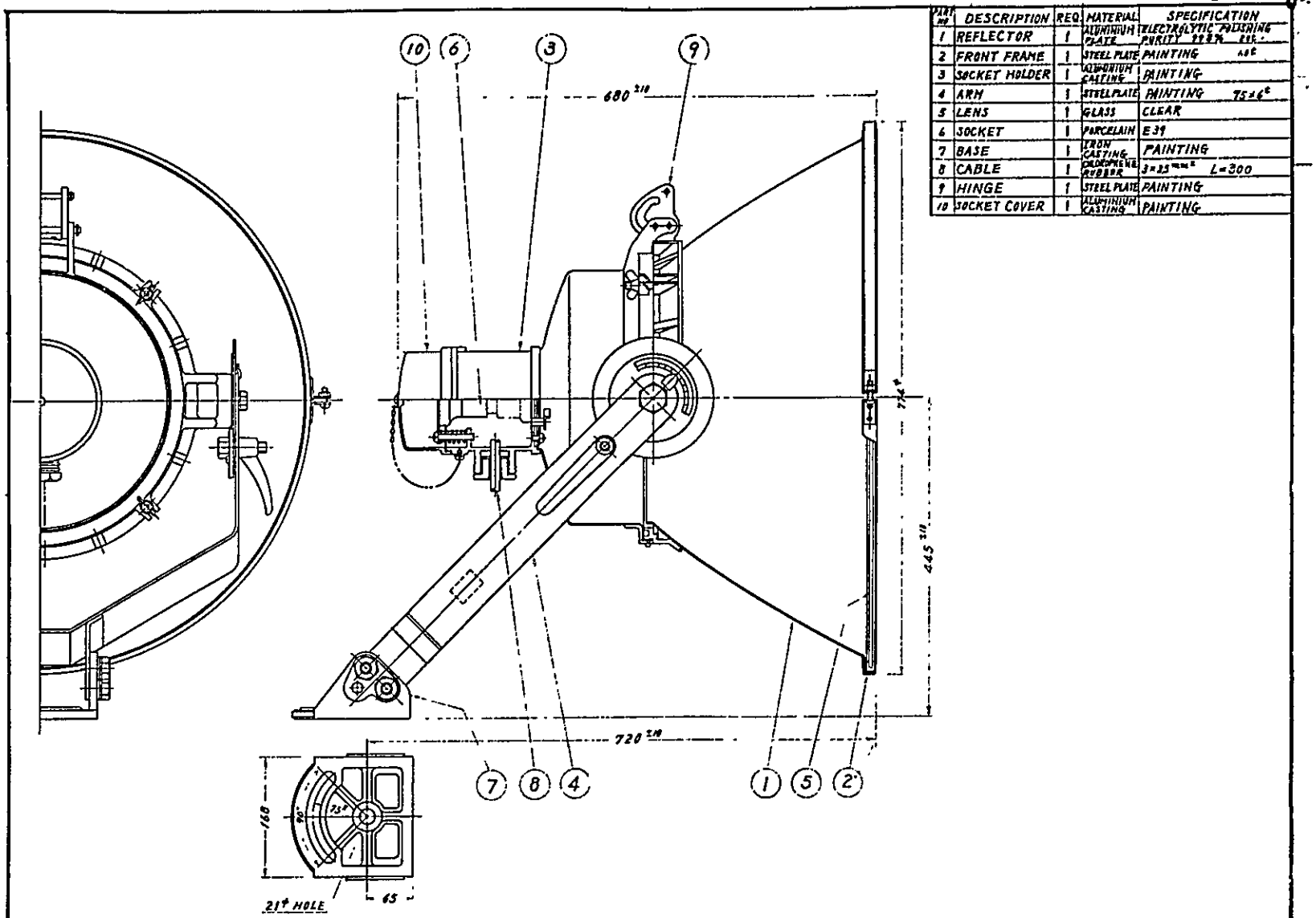
b. Beam angle $18^{\circ} - 20^{\circ}$

c. Beam efficiency Over 20%

(Beam angle shall be 2θ as shown in the Figure hereunder, if luminous intesity to the axis is Io and luminous intensity equivalent to 1/10 of Io is $I\theta$.)

(Beam efficiency is the ratio (%) of luminous flux to the total luminous flux of bare lamps included in beam angle.)





PART NO	DESCRIPTION	REQ.	MATERIAL	SPECIFICATION
1	REFLECTOR	1	ALUMINIUM PLATE	ELECTROLYTIC POLISHING PURITY 99.9% t=0.5
2	FRONT FRAME	1	STEEL PLATE	PAINTING ABE
3	SOCKET HOLDER	1	ALUMINIUM CASTING	PAINTING
4	ARM	1	STEEL PLATE	PAINTING 75×6
5	LENS	1	GLASS	CLEAR
6	SOCKET	1	PORCELAIN	E39
7	BASE	1	IRON CASTING	PAINTING
8	CABLE	1	POLYPROPYLENE RUBBER	3×2.5 sq mm L=300
9	HINGE	1	STEEL PLATE	PAINTING
10	SOCKET COVER	1	ALUMINIUM CASTING	PAINTING

Fig.12 LIGHTING FITTING

Unit : mm

4.4 Ballast

(1) General construction

a. Insulation (class) shall be Class A specified by BS2757.

b. Ballast shall be stored in a metallic box, and shall be free from salinity and water.

c. Thickness of metallic box must be nominally over 1.6mm.

d. Packing material to be used for waterproof shall have a sufficient resistance against salinity.

e. Transformer for ballast shall be leakage reactance type with insulation.

f. Lead wire shall be strand of PVC insulation; primary must be over 5.5mm^2 withstanding 250V and over, and secondary must be over 5.5mm^2 withstanding 600V and over. Length of the lead wire must be more than 150mm outside the box.

As for the lead wire, the portion connected inside the ballast shall be free from direct force and be fixed, without cutting, so that it can withstand independently a tensile strength of 2 kg gradually applied to the lead side.

g. Terminal shall be in comformity to BS3707.

h. Construction of ballast is shown in Fig. 12.

(2) Capacity

a.	Working voltage	230V	
	Frequency	50Hz	
b.	Suitable lamp	2000W Halide lamp	
		(Starting voltage	Under 400V
		Lamp current	8 Amp.
		Lamp voltage	265V
		Lamp wattage	2000W)

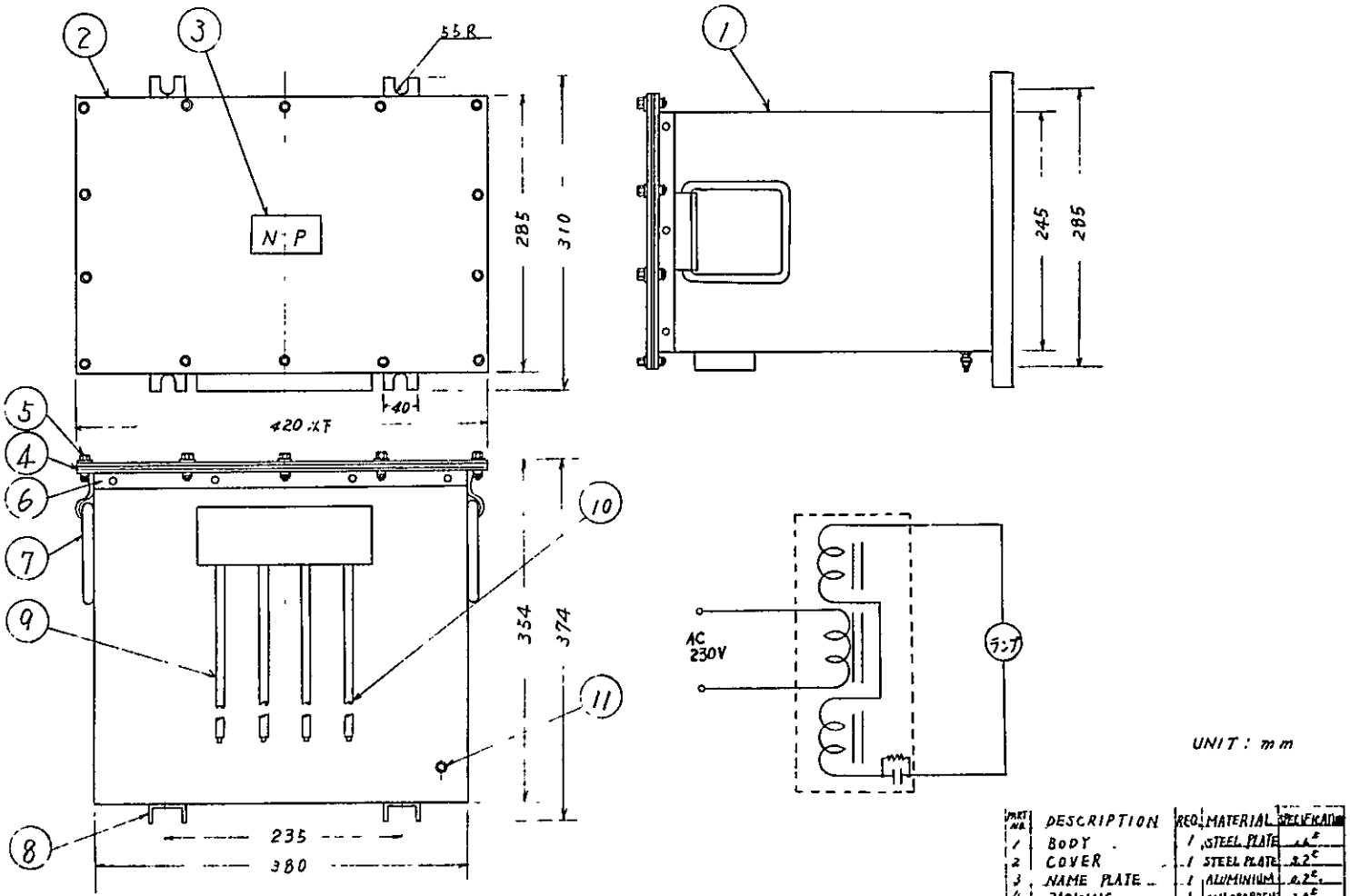
c. Electric characteristics

* Stabilized input current 10 ±1 amp.

* Stabilized input wattage	2,210 ±221W
* Stabilized power factor	Over 90%
* Stabilized lamp current	8 ±0.8 Amp.
* Stabilized lamp wattage	2000 ±150W
* Secondary (no load) voltage	460 ±46V
* Secondary short current	Under 11 + 1.65 Amp.
* Starting input current	Under 10 Amp.
* Regulation of output	Within 7%

(When power voltage fluctuates by ±10% of rated voltage, the regulation of output must be within 93% – 107% to the output value with the rated voltage applied.)

(NOTE): Secondary (no load) voltage shall be over the starting voltage (400V) of the suitable lamp, when power voltage fluctuates ±10% of the rated voltage.



UNIT : mm

PART No.	DESCRIPTION	REQ.	MATERIAL	SPECIFICATION
1	BODY	1	STEEL PLATE	t1.6
2	COVER	1	STEEL PLATE	t2.2
3	NAME PLATE	1	ALUMINIUM	t0.2
4	PACKING	1	CHLOROPRENE	t3.0
5	BOLT	14	BRASS	M6×20
6	SUPPORT	4	STEEL PLATE	L20×20×t3
7	HANGER	2	STEEL BAR	t6
8	MOUNTING LAG	2	STEEL PLATE	60×20-t3
9	SECONDARY WIRE	2	600V P.V.C.	2.5 mm²
10	PRIMARY WIRE	2	600V P.V.C.	2.5 mm²
11	EARTHING TERMINAL	1	BRASS	M5×20

Fig. 13 Ballast for 2,000W halide lamp

CHAPTER 5. ELECTRONIC DISPLAY BOARD

5.1 Object

This equipment is to be used for visual transmission of information of various kinds to the audience by means of the Central Proccessor & Sender to be installed in the Operation Room over the Main Stand and also display boards to be installed at two places behind the Stand.

5.2 Outline of the System

This equipment is composed of the devices shown in the schematic diagram (Fig. 1) with the Central processor & sender mainly consisting of electronic computer and the Display boards with incandescent lamps as sign elements.

5.3 Function

(1) Information to be displayed shall be Chinese characters, English characters, numerical figures, some marks, combination of those items, pattern and animated shadow pictures.

In the case of combination of Chinese characters and English characters, however, the board will be divided into the upper half and the lower half to display the two different characters.

Auxiliary display board shall be installed at the right hand side of the main display board for the purpose of displaying the time remained and the lap time. Time display shall be automatically made by the interlocking system with the master clock.

(2) Maximum number of characters to be displayed

In the case of only Chinese characters . . . . 11 x 6 lines = 66 characters
In the case of only English characters . . . . . 25 x 10 lines = 250 characters.
This will be the case of the score boards.

In the case of combination of Chinese characters and English characters:

Chinese characters .. . . . . 11 x 3 lines = 33 characters
English characters . . . . . 25 x 5 lines = 125 characters

(3) Number of sign elements per character:

	Occupied number of sign elements (vertical)	(horizontal)	Actual number of sign elements (vertical)	(horizontal)
English characters and numerical figures	10 x 6		7 x 5	
Chinese characters and numerical figures	15 x 13		12 x 12	

(4) Total number of sign elements:

The total number shall be 15,000, with 100 on vertical lines and 150 on horizontal lines.

This total number shall be used for display of pattern and animated shadow picture.

(5) Sign elements:

110V, 40W reflector type sign lamps.

(6) Legible distance:

Signs on the display boards shall be legible from a distance of 300m, both night and day.

(7) Power required:

Central processor & sender	1 ϕ	2W	100V ±10%	10kVA
Display boards . . . . . (per unit)	3 ϕ	3W	100V ±10%	600kVA

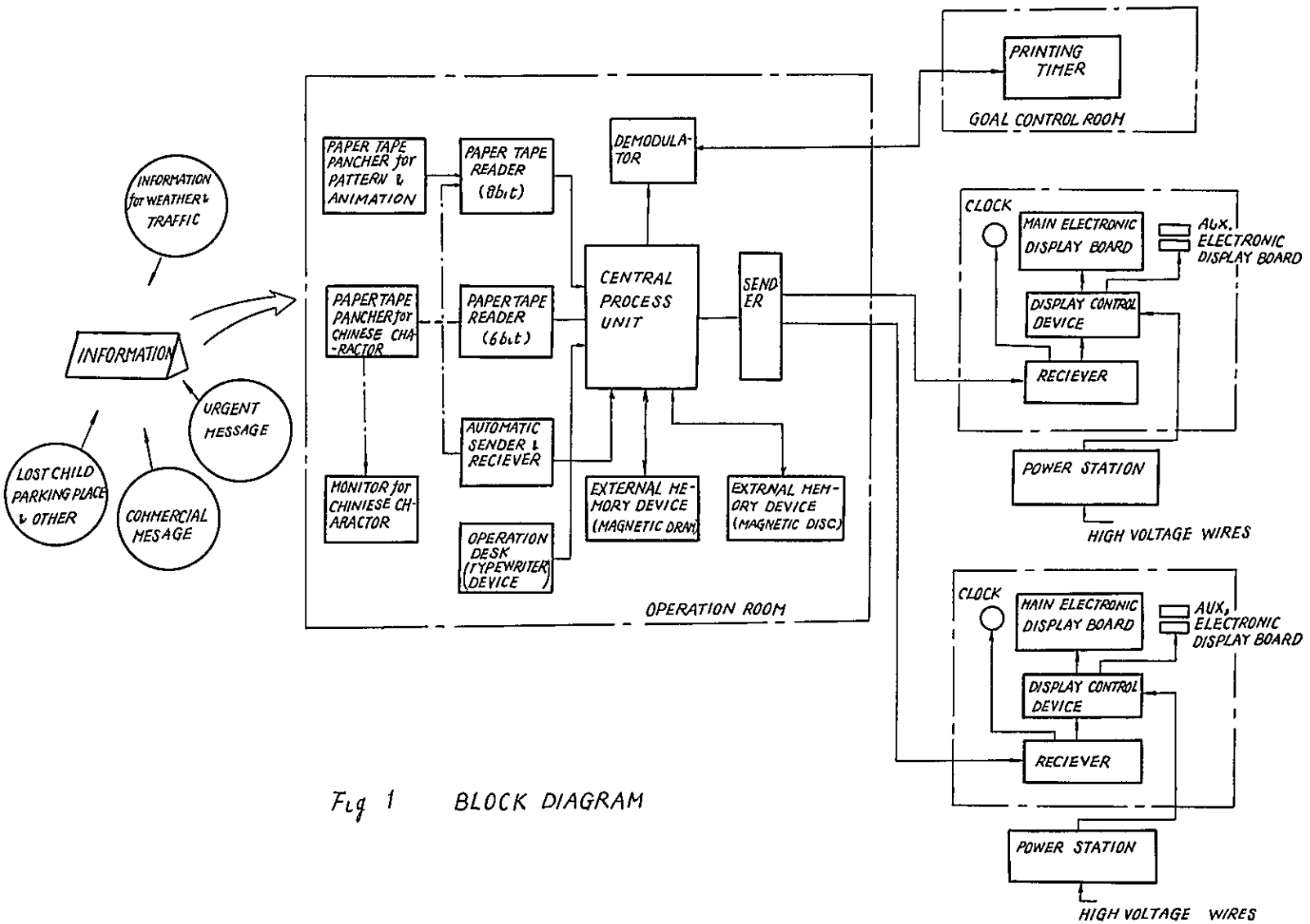


Fig 1 BLOCK DIAGRAM

The flag-poles are omitted.

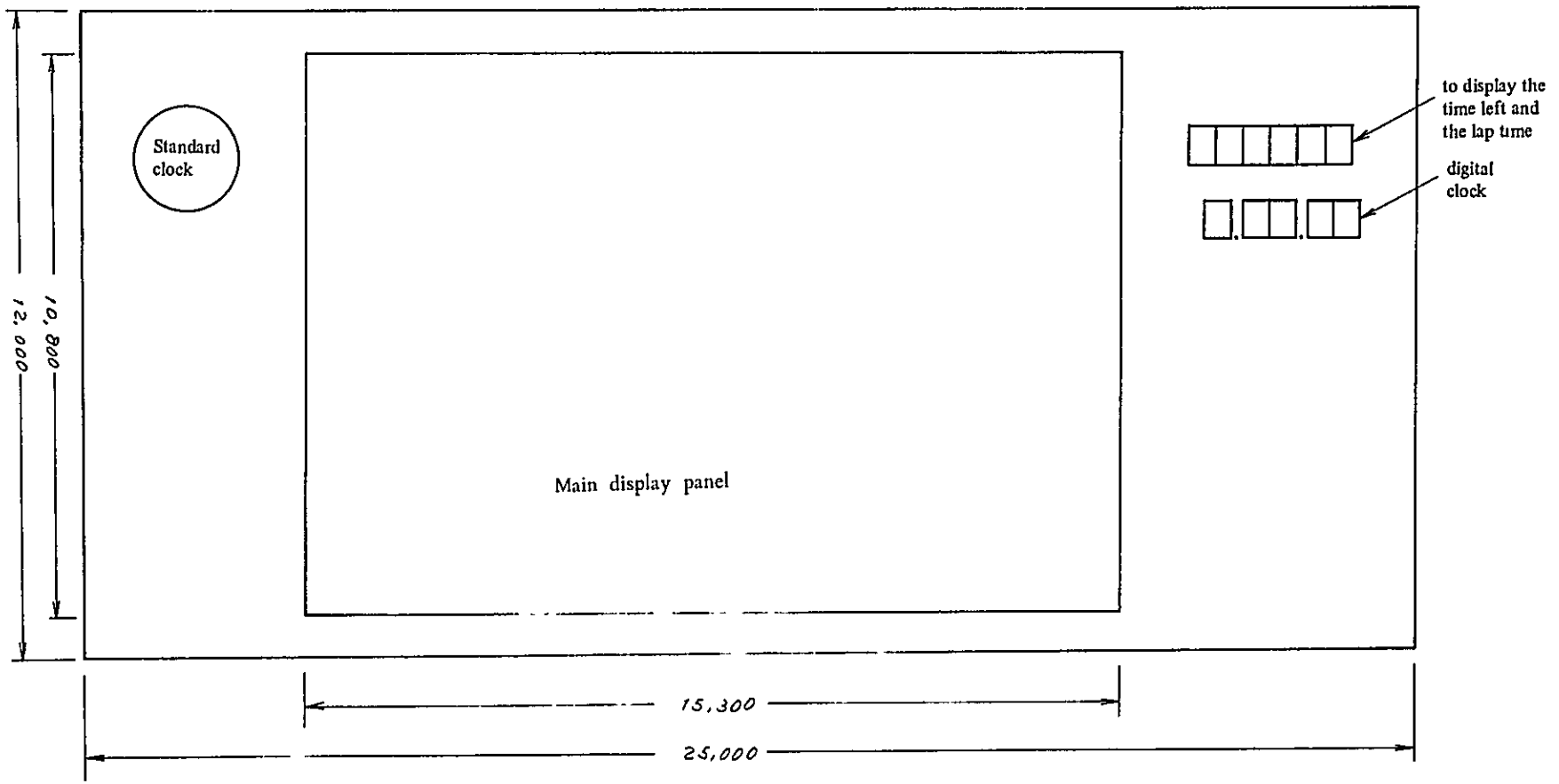


Fig. 2 Display Panel

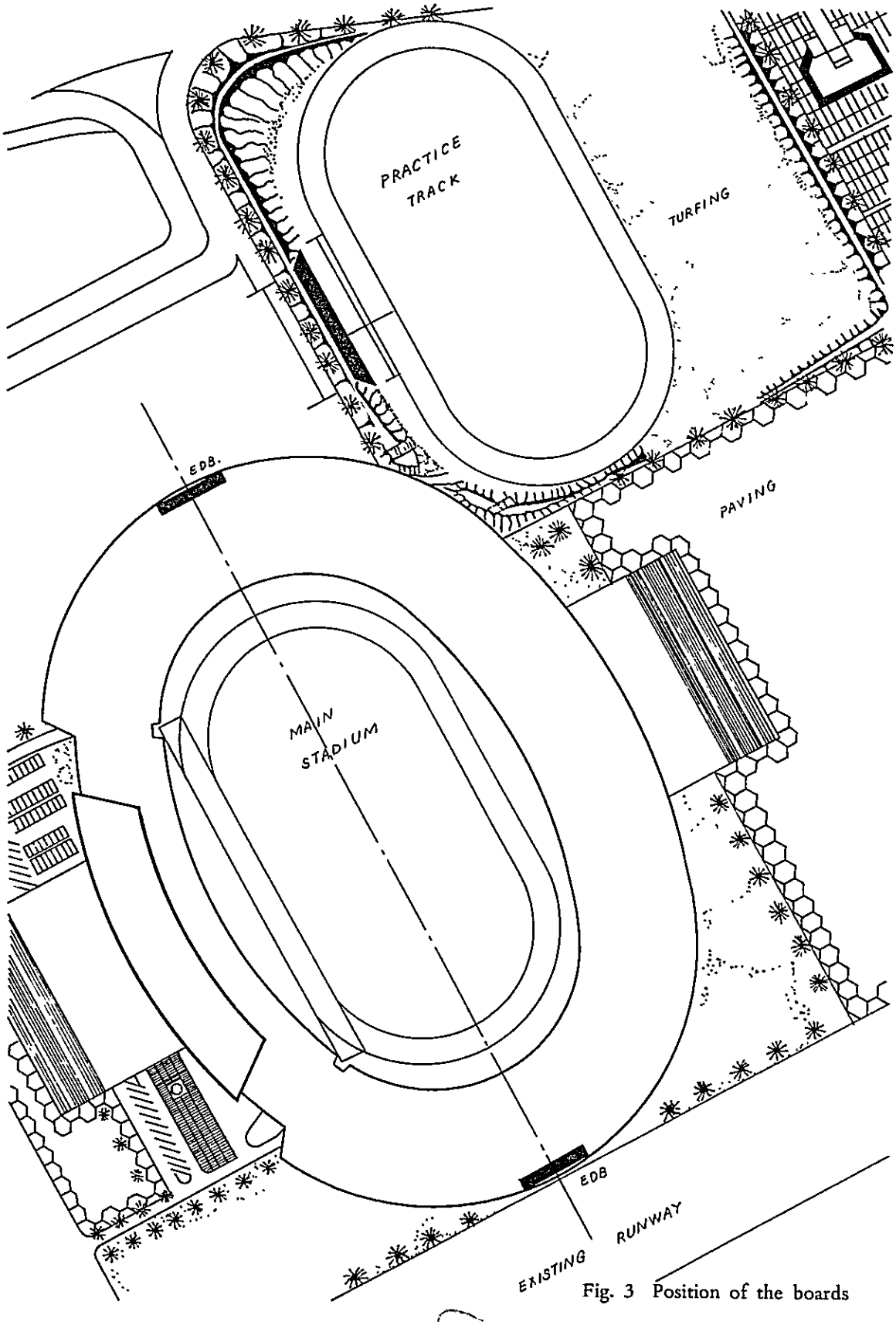


Fig. 3 Position of the boards

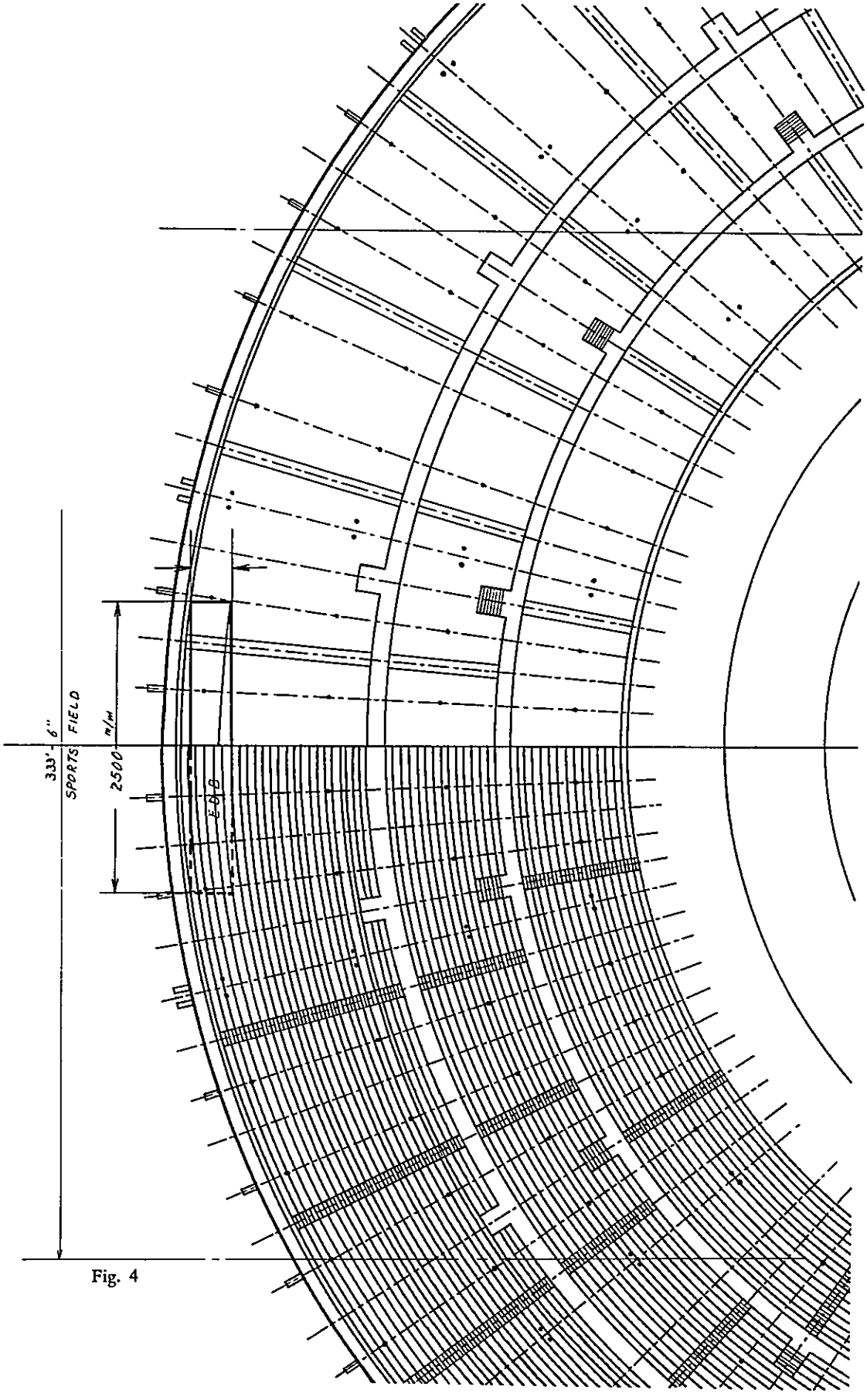


Fig. 4

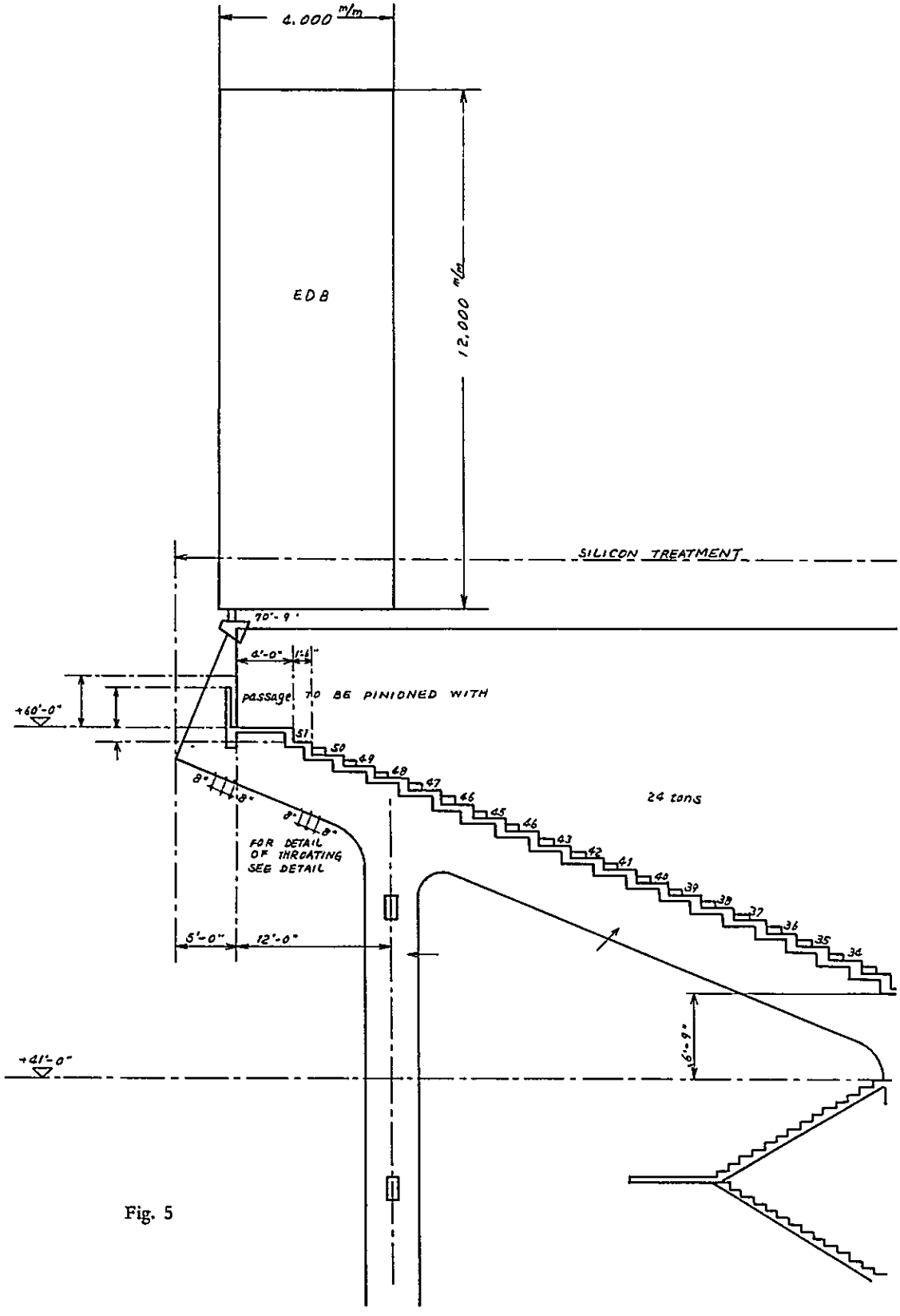

4.000 m/m
EDB
12.000 m/m
SILICON TREATMENT
70'-9"
4'-0"
1'-6"
passage TO BE PINIONED WITH
+60'-0"
51
50
49
48
47
46
45
44
43
42
41
40
39
38
37
36
35
34
24 tons
8"
8"
8"
8"
FOR DETAIL OF THROATING SEE DETAIL
5'-0"
12'-0"
6'-9"
+41'-0"

Fig. 5