AIR TERMINAL BUILDING
FOR KUALA LUMPUR, MALAYA.

Submitted in partial fulfillment
of the requirements
for the degree of
MASTER IN ARCHITECTURE
from
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June, 1953.

Presented by

ENG HUNG ÓNG.

Accepted by

LAWRENCE B. ANDERSON,
Head of Dept.,
Architecture & Planning,
M.I.T.
Dear sir,

In partial fulfillment of the requirements for the degree of Master in Architecture, I submit herewith my thesis report entitled, "Air Terminal Building for Kuala Lumpur, Malaya".

[Signature]

Eng Hung Ong.
ABSTRACT

TITLE: "Air Terminal Building for Kuala Lumpur, Malaya".

-- being a thesis report for the degree of Master in Architecture from Massachusetts Institute of Technology. June 1953.

Since resumption of commercial aviation in Malaya after World War II in 1947, statistics have shown an increasing popularity of air travel in Malaya. But, due to the smallness of the country and the relative inaccessibility of a great part of the country, shorter hops by helicopter service may become the dominant feature in the future. This service, however, is as yet unobtainable.

The program for this thesis has been based on requirements as projected to the year 1965, according to methods recommended by the Civil Aeronautics Administration. However, the projections and subsequent translation into design requirements have been made with a clear understanding of local conditions: physical, social and economic.

The hot-humid climate of Malaya demands special considerations in design. Design criteria consist of the effective exclusion of heat, rain and humidity from within the building, while at the same time enabling the building to be most receptive to every agent, natural or mechanical, which may help in maintaining comfort for its inhabitants within.
# Table of Contents

1) **Acknowledgements** ................................................. 1  
2) **General Background** .............................................. 1  
3) **Commercial Aviation in Malaya** ................................. 3  
4) **Kuala Lumpur Airport** ............................................ 6  
5) **Predictions for Peak-Hour Loads** ............................... 8  
6) **Assumptions in Programming** .................................... 11  
7) **Space Requirements for Terminal Building** ..................... 13  
8) **Operational Procedures & Circulation** .......................... 18  
9) **Circulation Pattern** ............................................. 22  
10) **The Site** ......................................................... 23  
11) **Special Considerations in Design** .............................. 24    
   A) **Climate Control** .................................................. 24  
   B) **General Thoughts on the Terminal Building** .................. 32  
12) **Bibliography** .....................................................  
   A) **On Airport Design** .............................................. 36  
   B) **On Design for Hot-Humid Climates** ........................... 37
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Mr. A. W. Hayes, Chief Operations Officer, Department of Civil Aviation, Federation of Malaya, for his encouraging interest, and without whose help in supplying the necessary maps and data this project would not have been possible;

Mr. Reginal L. Reed, Airport Engineer, Civil Aeronautics Administration, in Boston, who gave me the full benefit of his long experience in airport and terminal designing;

Col. Albert L. Edson, Airport Manager, Logan International Airport, Boston, for helpful advices;

and Prof. Alexander J. Bone, Civil Engineering Department, M.I.T., for helpful consultations on airport design.

For guidance in design, I am indebted to Dean Pietro Belluschi, Prof. Serge Chermayeff, Prof. Ernest N. Gelotte (for guidance in structural considerations), and Prof. August L. Hesselschwerdt, Jr., (for consultation in problems of air-conditioning).
GENERAL BACKGROUND

Kuala Lumpur lies within 25 miles of the west coast of Malaya midway down the peninsula. It is a sprawling city with a neat core of governmental and business buildings approached by broad, tree-lined avenues, but also intersected by some inadequate streets within the congested portion of the city. Located in a valley ringed by green hills, the city is beautiful in its greenery and well-kept gardens of the residential districts.

In 1874, when a British Resident was appointed for the state of Selangor, Kuala Lumpur was still a "kampung" (a small Malayan village) of tatched huts surrounded by jungle, used mainly by Chinese miners as headquarters for their activities. But now rubber and tin have made it into a bustling city of about 200,000, serving as capital of Malaya. Almost entirely a foreign creation, Kuala Lumpur is Chinese in population, with Indians as the second community, and Malays in the minority.

The present Emergency situation in Malaya has gained much world-wide publicity, but in the city, the trouble seems remote and do not constitute any restriction on most activities.

Lying about 3 degrees north of the Equator, the climate in Kuala Lumpur is intensely tropical, featuring heat, rain and humidity throughout the year, and providing
seasonal variations only in the varying degrees in the heaviness of the prolific rainfall. Nature seems only intent on exhibiting her various forces one at a time at full strength: if it is sunny, one has to squint one's eyes from the intensity of the light; if it is to rain, the sun is withdrawn in a matter of minutes and the rain is poured under a darkened sky while people grope for shelter; then in a short while, the rain is spent and the sun is immediately exposed again in all its glory. Although the sky is usually cloudy, the clouds never seem to hide the sun for long. Finally, when day is done, there is only a few minutes of twilight before night envelopes the land.

One word must be applied when describing the people—they are leisurely. Although hardworking, intelligent and ambitious in their own way, the predominant characteristic of really being able to enjoy and take leisure whenever possible has sometimes evoked the censure of being indolent and lazy. The art of bargaining for pennies by minutes is really a battle of wits. The American concept of working in haste in order to have more leisure which will be spent hurrying to nowhere in particular for a quick visit is not liable to gain much popularity in Malaya.

The standard of living in Malaya has been rated
the highest in south-east Asia. However, the economy is too closely geared to the world markets for rubber and tin to warrant any claim to assured stability. With good demand for rubber and tin, the country is happy and prosperous; with decreased demand, a depression settles immediately. There is great need for immediate diversification of the Malayan economy, not only to make the country more independent of the fluctuations of the tin and rubber markets, but also to absorb the increasing manpower available due to steady population increases.

Malaya is made prolific in growth by its bountiful rain and warm humid climate. This makes for an excitingly vitalizing environment where energetic growth surrounds Man. Yet, the climate itself has proved enervating for Man, and under its atmosphere, Man is not conditioned to enjoy and benefit by this otherwise stimulating environment. Were Man to be housed comfortably and healthfully here, such a panorama of perpetual growth will surely prove invigorating and he will be living under conditions more beneficial to him than are available in other more barren temperate parts of the world.

COMMERCIAL AVIATION IN MALAYA

Between 1933 when Imperial Airways inaugurated their service between Singapore and London, and the Japanese invasion of 1941, unusual progress was made throughout Malaya in both civil and commercial aviation. Numerous
airports and emergency landing fields were constructed, meteorological service was brought to a high pitch of efficiency, and complete aviation maps of Malaya were prepared. Either directly or indirectly, Singapore was connected by airways with all the major countries of the world.

**Malayan Airways Ltd.**

Major operations resumed after World War II with the formation of the Malayan Airways Ltd. in 1947, with three 5-seat Airspeed Consul aircrafts operating from Singapore to the rest of Malaya. Dakota aircraft were introduced in the same year and service routes to Medan (in Sumatra), Djakarta, and Saigon opened.

By 1951, the company reported a fleet of 10 Douglas DC-3's and 1 Airspeed Consul. Services now have been extended to Sarawak, North Borneo, Indonesia, Burma, Thailand, and Indo-China, with a complete network covering the Federation of Malaya and connecting to Singapore.

In November 1951, the company began operation of 3 local services on subsidiary routes radiating from Kuala Lumpur to connect the smaller and more remote cities with the main trunk routes. An additional fleet of 6-passenger De Havilland Beavers were reserved for government officials only.

Table I gives some pertinent data showing the very rapid increase in demand on commercial flying.
TABLE I*

<table>
<thead>
<tr>
<th></th>
<th>1948</th>
<th>1949</th>
<th>1950</th>
<th>1951</th>
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</thead>
<tbody>
<tr>
<td>Cities served:</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Metropolitan</td>
<td>5,000,000</td>
<td>5,000,000</td>
<td>5,000,000</td>
<td>---</td>
</tr>
<tr>
<td>population:</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Route miles</td>
<td>250</td>
<td>316</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per station:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily scheduled</td>
<td>3232</td>
<td>3964</td>
<td></td>
<td>5720</td>
</tr>
<tr>
<td>miles:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total revenue</td>
<td>55,228</td>
<td>65,531</td>
<td>84,968</td>
<td>119,740</td>
</tr>
<tr>
<td>passengers:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flown:</td>
<td>1,621,000</td>
<td>2,023,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily flight time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per aircraft:</td>
<td>4:08 hr.</td>
<td>4:20 hr.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note that the number of passengers more than doubled in 3 years i.e. from 1948 to 1951, with only a corresponding increase of 1-1/2 in scheduled miles served.

Federation Air Service:

The Federation Air Service began scheduled flights in February 1952, radiating from Kuala Lumpur and connecting the smaller and more remote cities in Malaya to the main trunk route. It also features chartered flights in De Havilland Beavers with seating capacity of 5 or 6 passengers.

Future Activities:

Figure I shows the airways network as covered at present by the Malayan Airways Ltd. and the Federation Air Service.

Although it is inevitable that the future use of airlines in Malaya will be greatly increased, yet it is doubtful if many more new airlines will be formed to handle this increase in traffic.

The geographic relation of Kuala Lumpur to the rest of Malaya and its neighbouring countries seem to support the conviction that even future operations to and from Kuala Lumpur will be limited within Malaya itself. Considering the smallness of this country, it will be feasible to assume that the present 2 airlines will be able to handle any traffic with the foreseeable future.
FIGURE I
MAP SHOWING NETWORK OF SCHEDULED FLIGHTS BY:
MALAYAN AIRWAYS LTD.
FEDERATION AIR SERVICE.

THAILAND

TO BANGKOK (THAILAND)

TO SAIGON (INDO-CHINA)

PENANG

ALOR STAR

KOTA BHARU

K. TRENGGANU

TO MEDAN (SUMATRA)

SITIAWAU

TAIPING

IPOH

BENGALESE

UPELE

BINTAN

LAMIKHIAN

KUALA LUMPUR

KUANTAN

LABIS

MALACCA

BINTAN

DATU PARAT

JOHORE BHARU

SINGAPORE

SUMATRA

TO BORNEO

TO SARAWAK & N. BORNEO

TO PALEMBANG (SUMATRA)

0 25 50 75 100 miles
KUALA LUMPUR AIRPORT

Data

a) Kuala Lumpur Airport is located at 03°07' N, 101°42' E, being 2-1/4 miles from the Government Offices of Kuala Lumpur.

b) Hours of Aircraft Traffic Control and aerodrome availability from 20 minutes before sunrise to sunset, not open at night except in emergency.

c) Operations possible under both visual and instrument.

d) Runway 6000ft. x 120 ft. widening to 150 ft. for 600 ft. at each end. Tarmac.

e) Runway suitable for

- De Havilland Comet
- Lockheed Constellation 749A (up to 6 movements a week).
- Douglas DC6
- Handley Page Hermes 5
- Canadian DC4M
- Douglas DC4
- Avro York
- Airspeed Ambassador
- Vickers Viscount

Activities

Activities at Kuala Lumpur Airport over the past

From Information Circular Number 1 of 1952, Department of Civil Aviation, Malaya.
few years show enormous increases in traffic, as shown in Table II.

It will be noted that here, within 4 years, the number of passengers increased with a factor of 2.4. However, this factor of 2.4 is rather deceptive, for it may be derived mainly from the newness of the airlines. It is believed that the levelling off of passenger totals between 1951 and 1952 indicates the end of the novelty attraction and the establishment of more reasonable influence from economic and social causes on the passenger totals. The monthly totals for 1952 as shown in Table III bears out this view: note the lack of any appreciable variation of passenger totals from month to month.

These figures for passenger totals were carried only by the scheduled flights. Figure II shows the schedules of these flights for the week. A few observations are pertinent here:

a) Flying activities are only scheduled for the daylight hours. There is no reason to assume that this practice will be violated to any extent in the future, considering that the longest flight from Kuala Lumpur is only of about 2 hours' duration (to Singapore or Penang).

b) At present, flight schedules are concentrated between the hours of 8:30 A.M. to 10:30 A.M. and 4:00 P.M. to 6:00 P.M. These are obviously cal-
### TABLE II*

**ACTIVITIES AT KUALA LUMPUR AIRPORT**

<table>
<thead>
<tr>
<th></th>
<th>1948</th>
<th>1949</th>
<th>1950</th>
<th>1951</th>
<th>1952</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movements:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Airlines</td>
<td>3174</td>
<td>3602</td>
<td>4116</td>
<td>5382</td>
<td>7769</td>
</tr>
<tr>
<td>Others</td>
<td>470</td>
<td>1181</td>
<td>10,751</td>
<td>12,325</td>
<td>12,654</td>
</tr>
<tr>
<td>Passengers:</td>
<td>31,368</td>
<td>39,805</td>
<td>51,211</td>
<td>68,278</td>
<td>75,332</td>
</tr>
<tr>
<td>Freight (kilos)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>616,980</td>
</tr>
<tr>
<td>Mail (kilos)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>187,953</td>
</tr>
</tbody>
</table>

*Figures supplied through courtesy of Mr. A. W. Hayes, Chief Operations Officer, Department of Civil Aviation, MALAYA.

Note: the figures given are all for 2-way traffic.
TABLE III*

1952 MONTHLY PASSENGER TOTALS AT KUALA LUMPUR AIRPORT

<table>
<thead>
<tr>
<th>MONTH</th>
<th>MALAYAN AIRWAYS LTD.</th>
<th>FEDERATION AIR SERVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENPLANED</td>
<td>DEPLANED</td>
</tr>
<tr>
<td>January</td>
<td>2,677</td>
<td>2,740</td>
</tr>
<tr>
<td>February</td>
<td>2,600</td>
<td>2,519</td>
</tr>
<tr>
<td>March</td>
<td>2,754</td>
<td>2,766</td>
</tr>
<tr>
<td>April</td>
<td>2,898</td>
<td>2,791</td>
</tr>
<tr>
<td>May</td>
<td>2,737</td>
<td>2,619</td>
</tr>
<tr>
<td>June</td>
<td>2,491</td>
<td>2,612</td>
</tr>
<tr>
<td>July</td>
<td>2,541</td>
<td>2,616</td>
</tr>
<tr>
<td>August</td>
<td>2,762</td>
<td>2,792</td>
</tr>
<tr>
<td>September</td>
<td>2,527</td>
<td>2,589</td>
</tr>
<tr>
<td>October</td>
<td>2,440</td>
<td>2,715</td>
</tr>
<tr>
<td>November</td>
<td>2,509</td>
<td>2,464</td>
</tr>
<tr>
<td>December</td>
<td>2,595</td>
<td>2,749</td>
</tr>
</tbody>
</table>

Totals 31,531 31,972 1,650 1,489

* Supplied through courtesy of Malayan Airways Ltd., Singapore, MALAYA.
FIGURE II

SCHEDULED ACTIVITIES AT KUALA LUMPUR AIRPORT DURING ONE WEEK.

Hours of day
6  7  8  9  10 11 12 13 14 15 16 17 18

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<tbody>
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<td>FAS</td>
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<tr>
<td>FAS</td>
<td>Saturday</td>
<td>MA</td>
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<tr>
<td>FAS</td>
<td>Sunday</td>
<td>MA</td>
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</tbody>
</table>

FAS -- Federation Air Service
MA -- Malayan Airways Ltd.

* -- Arrival of plane
• -- Departure of plane
culated to exploit the cooler hours of the day. With improved comfort conditions inside the terminal building, it may be assumed that there will be no objections to spreading the schedule over the entire 12 hours of daylight. Thus, any abnormal increases of traffic in the future may easily be accommodated by simply dispersing the overloads.

PREDICTIONS FOR PEAK-HOUR LOADS.

The following are based on information presented on Table III and Figure II, using only the figures for passengers enplaning from Kuala Lumpur and assuming that all were carried by scheduled flights.

1952:

a) Passengers.

Malayan Airways Ltd.:

Maximum of 2898 passengers per month.
283 scheduled departures per month.
Therefore, average passengers per departure is 10.25 passengers per departure.

Federation Air Service:

Maximum of 216 passengers per month.
64 scheduled departures per month.
Therefore, average passengers per departure is 3.4 passengers per departure.
**Unscheduled Airlines:**

According to Table II -- 12,654 movements in 1952.

i.e. 6,327 departures per year, say 18 departures per day. (This high figure is probably due to restriction of ground travel caused by the "Emergency" situation in Malaya.)

Therefore, assume an average of 2 departures/hour.

Assuming DeHavilland Beavers, average passengers per departure is 3.4.

**Average Passengers per hour:**

On examination of schedules (see Fig. II), the maximum number of scheduled departures per hour occur between 9:15 am. and 10:15 a.m., as follows:

- 3 for Malayan Airways -- 30.75 passengers
- 2 for Fed. Air Service -- 6.8 passengers
- 2 unscheduled flights -- 6.8 passengers.

**Average Total**

44.35 passengers.

**Total People in Terminal per Peak Hour:**

Passengers per peak hour is 44.35 x 1.5*

i.e. 67 passengers.

Total people in terminal per peak hour, (including those deplaning and visitors), is 67 x 4.5*

i.e. 302 people.

---

* This factor is adjusted from data in "Airport Terminal Activities & Space Utilization". U.S. Dept. of Commerce, CAA, Washington, D.C. July 1950.
b) **Freight.**

Load carried in 1952 is 1,053,159 kilos.

Average load per day is 2,900 kilos or 6,380 lb.

Peak load per day is 2,900 kilos \(\times 1.5\)

i.e. 4,350 kilos or 9,570 lb.

c) **Mail.**

Load carried in 1952 is 208,604 kilos.

Average load per day is 572 kilos or 1,260 lb.

Peak load per day is 572 kilos \(\times 1.5\)

i.e. 858 kilos or 1,890 lb.

1965:

For this 12-year period, the CAA recommends a projection factor of about 2.8* for passengers, 1.8** for mail, and 7.2*** for freight.

However, due to the possibility of dispersing the peak hour loads over a longer period during the daylight hours (as explained in page 8), a design projection factor for passengers of 2.0 instead of 2.8 is not unreasonable.

---


Therefore passengers per peak hour is 134.
Total people in terminal per peak hour is 604.
Mail per peak day is 1,545 kilos or 3,400 lb.
Freight per peak day is 31,300 kilos or 68,800 lb.

**Runway Load:**

Maximum departures per hour in 1952 is 7.
Using a projection factor of 2.0 for 1965, (assuming no increase in carrying-capacity of aircraft), maximum departures per hour in 1965 is 14.
i.e. maximum movements per hour is 28, which can be very easily accommodated by the one runway.
(CAA recommends a safe figure of 40 movements per hour as maximum capacity for one runway under instrument landing conditions.)

**ASSUMPTIONS IN PROGRAMMING**

Community Needs:

No attempt has been made to assess the airline traffic potential of Kuala Lumpur from a study of its air travel needs. The CAA has worked out a very complete method for such an assessment based on data on the economic and social character of any city. Such data being unobtainable, the more immediate approach of projecting present traffic into a 12-year future has been used. This method is also recommended by the CAA and has been found
effective. However, in translating these needs into design, intuitive discretion will be used to adjust requirements to suit local conditions.

**Concessions:**

Successful concessions have proved to be big revenue producers in air terminals. However, their planning must be carefully related to passenger traffic and local conditions.

At the Kuala Lumpur terminal, a combination of various facts indicate that, except for a news-magazine-candy counter, any other sales concessions will probably prove unprofitable. The facts are as follows:

a) The level of income of the majority of the potential customers will not be sufficiently high to permit indulgence in impulse buying.

b) Oriental love for bargaining will be frustrated unless competitive stores are also located within the terminal.

c) The allowable baggage for local flights is only 33 lb. for Malayan Airways and 17.6 lb. for Federation Air Service. This permits little leeway for additional purchases.

d) The flow of people through the terminal is relatively small, and remembering that only a very small percentage of passengers may be in any mood
to shop, coupled with the reasons given above, an actual buying customer may be a rarity -- at least for the present.

It has therefore been assumed that rental space for retail stores will not be necessary in the immediate future. However, in these times of "Emergency", an exhibition space will be very desirable, both for propaganda and educational purposes. With gradual increase in potential concession customers (coinciding with a diminishing "Emergency"), this space may be adapted in the future for either product advertisement or actual retail sales counters.

Restaurant and Soda Fountain:

A warm climate and a leisurely people will generate a tremendous flow of customers for a tall cool drink and a tempting menu. Under good management, the terminal may well build itself a reputation for pleasant eating and refreshing, and "lunch or afternoon tea at the airport" may become a popular innovation.

SPACE REQUIREMENTS FOR TERMINAL BUILDING

The project for this thesis is to design a building for the terminal and related activities at the Kuala Lumpur airport, such that the building will adequately handle the passenger volume (as predicted to 1965), and be able to supply effectively the services and concessions
which such a passenger volume may be able to maintain.

The computations presented in this section are based largely on CAA experiences and requirements, but modified to suit local conditions in Kuala Lumpur.

PUBLIC SPACES

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Lobby</td>
<td>3000</td>
<td></td>
<td>To handle main traffic flow and acting as main circulation for ticketing, baggaging, and other services.</td>
</tr>
<tr>
<td>Waiting Area &amp; Display</td>
<td>4000</td>
<td>2</td>
<td>Provide seating for 70 people or more. Must have adequate free circulation for display.</td>
</tr>
<tr>
<td>Soda Fountain</td>
<td>600</td>
<td>2</td>
<td>Counter seating for about 20.</td>
</tr>
<tr>
<td>Lounge</td>
<td>2000</td>
<td></td>
<td>Quiet area for usual patrons; and also useful for any community functions at airport.</td>
</tr>
<tr>
<td>Toilets</td>
<td>800</td>
<td></td>
<td>Provide rest lounge for women.</td>
</tr>
<tr>
<td>Restaurant</td>
<td>3000</td>
<td>12</td>
<td>Seating for about 200. Say 15 sq. ft. per person.</td>
</tr>
<tr>
<td>Private Dining</td>
<td>400</td>
<td>2</td>
<td>About 4 or 5 private dining rooms -- able to be opened up for larger parties.</td>
</tr>
</tbody>
</table>

RESTAURANT SERVICE AREAS

<table>
<thead>
<tr>
<th></th>
<th>Approx. sq. ft.</th>
<th>Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen &amp; Storage</td>
<td>1600</td>
<td>12</td>
</tr>
<tr>
<td>Kitchen Office</td>
<td>150</td>
<td>2</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------</td>
<td>------------</td>
</tr>
<tr>
<td>Employees' Lounge</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Employees' Locker Rooms &amp; Toilets</td>
<td>600</td>
<td></td>
</tr>
</tbody>
</table>

**AIRLINES & RELATED ACTIVITIES**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket Offices</td>
<td>1000</td>
<td>7</td>
<td>Consisting of ticket counters, scales, and ticket sales offices. Baggage handling too.</td>
</tr>
<tr>
<td>Baggage Rm. (enplaning)</td>
<td>800</td>
<td>8</td>
<td>Mainly for hand-truck maneuvering and storage.</td>
</tr>
<tr>
<td>Baggage Claim Rm. (deplaning)</td>
<td>600</td>
<td>8</td>
<td>Space for temporary storage of baggage. Counter space needed.</td>
</tr>
<tr>
<td>Air Mail</td>
<td>300</td>
<td>2</td>
<td>Storage for incoming and outgoing mail. With increased activity here, this function will be transferred closer to the freight activities.</td>
</tr>
<tr>
<td>General Storage</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truckers' Lounge</td>
<td>500</td>
<td></td>
<td>Including showers, toilets, and lounging. (All men).</td>
</tr>
<tr>
<td>Hand Trucks' Storage &amp; Maintenance</td>
<td>350</td>
<td></td>
<td>For about 16 hand trucks.</td>
</tr>
<tr>
<td>Customs</td>
<td>500</td>
<td>3</td>
<td>Examination room for deplaning baggage only.</td>
</tr>
<tr>
<td>Govt. Agencies' Offices</td>
<td>400</td>
<td>4</td>
<td>Customs and Health Offices -- only for deplaning traffic.</td>
</tr>
<tr>
<td>Area</td>
<td>Approx. sq. ft.</td>
<td>Personnel</td>
<td>Comments</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------</td>
<td>-----------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Waiting Lounge</td>
<td>300</td>
<td></td>
<td>Mainly for waiting to government agencies.</td>
</tr>
<tr>
<td>Toilets</td>
<td>250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airlines Business Offices</td>
<td>2000</td>
<td>14</td>
<td>Business offices for Malayan Airways Ltd. and Federation Air Service.</td>
</tr>
</tbody>
</table>

**AIRPORT & CONTROL ACTIVITIES**

<table>
<thead>
<tr>
<th>Dept. of Civil Aviation</th>
<th>600</th>
<th>6</th>
<th>Planning and administrative offices.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport Management</td>
<td>400</td>
<td>4</td>
<td>Administration of airport and terminal.</td>
</tr>
<tr>
<td>Weather Bureau</td>
<td>600</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Traffic Office</td>
<td>400</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Radar Operating Room</td>
<td>400</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Radar Equipment Room</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communications Equipment</td>
<td>400</td>
<td></td>
<td>Mainly radio equipment -- controlled from control cab.</td>
</tr>
<tr>
<td>Telco Equipment Office</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Technicians' Workshop</td>
<td>400</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>Approx. sq. ft.</td>
<td>Personnel</td>
<td>Comments</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------</td>
<td>-----------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Maintenance Storage</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Cab</td>
<td>400</td>
<td>7</td>
<td>A 360-degree view of the sky is needed here, with ground view of both approaches to the runway. Junction space immediately below for wiring etc.</td>
</tr>
<tr>
<td>Chief's Office</td>
<td>150</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Toilets</td>
<td>250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Lighting Control</td>
<td>150</td>
<td></td>
<td>Will contain control panels and charts.</td>
</tr>
<tr>
<td>Emergency Generator</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lounge</td>
<td>400</td>
<td></td>
<td>For flying personnel and airport officials. Equipped with kitchen, locker rooms, showers and toilets.</td>
</tr>
</tbody>
</table>

**AIRPORT MAINTENANCE**

<table>
<thead>
<tr>
<th>Area</th>
<th>Approx. sq. ft.</th>
<th>Personnel</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance &amp; Storage</td>
<td>500</td>
<td>4</td>
<td>For building maintenance</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>3</td>
<td>For building area grounds maintenance.</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>2</td>
<td>For airport grounds (using mechanized equipment).</td>
</tr>
<tr>
<td>Refrigerated Garbage Storage</td>
<td>50</td>
<td></td>
<td>Mainly for restaurant garbage.</td>
</tr>
<tr>
<td>Air Conditioning Equipment</td>
<td>500</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
VEHICLES USED IN AIRPORT

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Fighting</td>
<td>2 fire trucks.</td>
</tr>
<tr>
<td>Freight</td>
<td>2 tow-wagons with detachable trains.</td>
</tr>
<tr>
<td>Aircraft Service</td>
<td>1 gas truck.</td>
</tr>
<tr>
<td></td>
<td>1 aircraft starter for each airline.</td>
</tr>
<tr>
<td></td>
<td>1 belt conveyor (mounted on Jeep) for each airline.</td>
</tr>
<tr>
<td>For Grounds Maintenance</td>
<td>1 sickle-bar mower.</td>
</tr>
<tr>
<td></td>
<td>1 pick-up truck.</td>
</tr>
<tr>
<td></td>
<td>1 light dump truck.</td>
</tr>
<tr>
<td>For Airport Management</td>
<td>1 Jeep.</td>
</tr>
</tbody>
</table>

OPERATIONAL PROCEDURES & CIRCULATION

Aircraft:

An incoming aircraft, on approaching the airport, will contact the control tower and request permission to land. On permission being granted, the aircraft arrives at the runway and taxis to a loading station on the apron in front of the terminal building. Scheduled airlines have their own assigned loading stations. At this station, the aircraft is serviced and loaded. On taking off, it taxis to position on the airstrip and proceeds down the runway. Its only other maneuver might be to taxi to an
off-apron position for inspection, servicing, or garaging.

Unscheduled airlines (for chartered flights in this case), will park their aircrafts in a parking area. When chartered, such an aircraft will be brought to a loading station for the customer.

Passengers:

The enplaning passenger arrives by some ground vehicle. He goes directly to the ticket counter and purchases his ticket, unless he has done so before arrival. His baggage is weighed and taken from him. He waits, loiters, or eats and refreshes himself until the announcement of his flight. He then arrives at the apron gate, is permitted entry on to the apron, and boards the plane.

At times when flights are fully booked in advance, some hopeful prospective passengers may wait at the apron gate until the last moment to take advantage of any cancellations.

The circulation of the deplaning passenger is simpler. Unless there are complications of customs and immigration, he leaves the plane, crosses the apron, enters the terminal building, (may be met by relatives and friends, in which case they may loiter awhile), picks up his baggage, and leaves to find ground transportation.

The passenger in transit is more liable to spend his intermission of 15 minutes or longer in the terminal
building, away from the warm atmosphere enjoying cool drinks and snacks at the restaurant or fountain.

Passengers requiring customs and health examination will be conducted off the apron immediately into a lounge to await their turn with the officials, after which they will participate in examination of their baggage.

**Baggage:**

Enplaning baggage is brought to the ticket counters by the passengers, weighed in, and slid through an opening into the baggage room. Here the baggage is stacked on hand-trucks, differentiated according to flight and pushed out to the apron when the designated aircraft arrives.

Deplaning baggage is brought in by hand-trucks to the baggage-claim room to await pick-up by passengers. Baggage for customs inspection will be transported direct to the examination room to await their owners who are meanwhile being examined by government officials.

Basic criteria for handling baggage include:

a) Passengers should handle baggage as little as possible, i.e. ticket counters and baggage-claim must be as near to passenger ground transportation as possible.

b) Baggage should be kept under cover as much as possible.
c) Baggage circulation and passenger circulation should be distinctly separated.

d) Baggage should be handled carefully.

Visitors:

The general pattern of circulation for a visitor is a meandering and loitering one. However, he usually ends up patronizing the restaurant or fountain before stepping out to the observation deck, or vice versa.

No attempt will be made to tax the public for the simple privilege of watching aircraft activities from any part of the terminal building.

Freight:

Freight is brought to the freight sheds by commercial trucks and unloaded. The freight is then sorted onto tow-wagons according to destination. Trains of these wagons will be towed out to the aircraft for loading and unloading of freight.

At present, passenger planes carry large volumes of freight too. However, the trend indicates that in the very near future, the major portion of freight will be carried by exclusively cargo planes. It will therefore be more practical to locate the freight activities away from passenger activities. The longer tow necessary at present is no major disadvantage since the commercial-truck-to-tow-wagon operation is necessary to prevent confusion on the apron.
CIRCULATION PATTERN

The main circulation pattern within the terminal building may be shown diagrammatically as follows:

APRON
(AIRCRAFT PARKING)

MAIL

BAGGAGE CLAIM

CUSTOMS & HEALTH

WAITING & CONCESSIONS

RESTAURANT

TICKETS

GROUNDT RANSPORTATION

--- passengers

--- baggage

--- visitors

--- mail

truck servicing
THE SITE

Figure III shows a diagram of the main features of the property around the airport.

The present terminal activities are housed in some temporary building north-west of the runway. There are 2 severe objections against this site for the new terminal building.

a) The present entry from Kuala Lumpur is through 2 miles along the Flying Club Road, which is a poorly paved, narrow road which may be considered to reach its "dead end" after passing the airport. As opposed to this, Sungei Besi Road is a major thoroughfare, neat, well-paved, and wide enough to serve increased traffic efficiently. This road connects Kuala Lumpur to and through one of its industrial suburbs, Sungei Besi.

b) The depth of land between the runway and the Flying Club Road will allow the development of only a very narrow apron, thereby preventing any future expansion or adjustment to future requirements.

The Department of Civil Aviation in Malaya is at present engaged in working on plans for a terminal building to be situated south-east of the runway. A large portion of the area between the runway and Sungei Besi Road used to be covered intermittently by shallow ponds. However, for this thesis, it will be assumed that the site is now well filled with clean suitable
material, and that the area is now well-drained.

The site chosen (as shown in Figure III) invalidates the objections as given above for the previous site. A careful analysis indicates that, except for the filled-in character of the land, no major disadvantages can be found for this site.

SPECIAL CONSIDERATIONS IN DESIGN

A) CLIMATE CONTROL.

The climate of Malaya\(^1\) may be classified under the hot-humid category with characteristic features of uniform temperature, high humidity and copious rainfall. These arise mainly from the maritime exposure of Malaya. There is no serious temperature variation throughout the year; but the daily range is large, being usually from 15\(^\circ\)F to 20\(^\circ\)F in Kuala Lumpur. (See Table IV). The excessive temperature of continental tropical areas are never experienced, and air temperature of 100\(^\circ\)F has very rarely been recorded in Malaya under standard conditions.

The most important feature in the seasonal division of the year is the variation in rainfall, which are distinguished according to the periodic changes in

---

\(^1\) The description following is adapted from a narrative report on the climate of Malaya in Summary of Observations, Malayan Meteorological Service, Government Printing Office, Singapore, 1941.
TABLE IV
WEATHER STATISTICS FOR 1939, 1940 & 1941 TAKEN AT KUALA LUMPUR AIRPORT.

<table>
<thead>
<tr>
<th></th>
<th>TEMPERATURE</th>
<th>% REL. HUMIDITY</th>
<th>RAINFALL</th>
<th>WIND</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>07 hour</td>
<td>13 hour</td>
<td>19 hour</td>
<td>whole year</td>
</tr>
<tr>
<td>FOR 1939:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td>74.2</td>
<td>90.1</td>
<td>81.2</td>
<td>97</td>
</tr>
<tr>
<td>MIN</td>
<td>71.5</td>
<td>85.0</td>
<td>77.9</td>
<td>66</td>
</tr>
<tr>
<td>FOR 1940:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td>76.2</td>
<td>91.3</td>
<td>80.9</td>
<td>96</td>
</tr>
<tr>
<td>MIN</td>
<td>72.3</td>
<td>85.6</td>
<td>77.4</td>
<td>66</td>
</tr>
<tr>
<td>FOR 1941:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td>76.8</td>
<td>91.2</td>
<td>82.4</td>
<td>97</td>
</tr>
<tr>
<td>MIN</td>
<td>73.2</td>
<td>86.9</td>
<td>78.2</td>
<td>68</td>
</tr>
</tbody>
</table>

the wind. There are 4 seasons, namely the S-W Monsoon, the N-E Monsoon, and 2 shorter seasons between these monsoons.

The winds of these monsoons, as experienced in Malaya, are very mild at the ground. Those of the S-W Monsoon, especially, are usually almost completely lost in stronger local circulations. At the Kuala Lumpur Airport, records over a few years have shown only a slight predominance of breezes in the north-south direction. Most of the time, it is calm, with intermittent breezes in all directions.

In general, the nights are reasonably cool and comfortable everywhere.

The Sun:

In a climate which is already overheated, sunlight being liable to add heat thereby contributing to Man's discomfort, is tolerated only as a necessary evil, to be avoided when comfort is desired. Not only is the heat objectionable, but the brightness creates a psychological effect of heat, and one looks to the shadows as a haven of comfort.

Direct sunlight therefore, has to be controlled uncompromisingly to its complete exclusion from within the building, especially at the times when the air temperatures are higher than the accepted maximum comfortable temperature (i.e. about 86°F). This corresponds to the
period approximately between 10:30 a.m. and 4:00 p.m.
when the temperatures are above 86°F. A band of cool
shadows surrounding the building, provided either through
vegetation or through construction, contributes much to
the comfort within the building.

Sun control, either through orientation, or sha-
ding devices are therefore necessary.

Kuala Lumpur Airport is 3° 07' N latitude. Thus
to all intents and purposes, it may be said that there
is 12 hours of daylight and 12 hours of night throughout
the year. However, the inclination of the noonday sun
varies as the sun migrates from solstice to solstice,
having maximums of 26-1/2° south of the zenith during
December 22nd, and 20-1/2° north of the zenith during
June 21st.

With these data, depending on the orientation,
sunshades or overhangs can be designed to exclude the sun
from the building during the hours of definite discomfort.

Re-radiated Heat. The sun brings unwelcome heat
into a building not only through its direct rays, but also
through re-radiation from a wall, roof or floor warmed by
direct sunlight.

1 This critical temperature is according to "Physiological
Study No. 2", by J. W. Drysdale. Climate & Design of
Buildings, Duplicated Document No. 32, Dept. of Works &
Housing, Commonwealth Experimental Building Station,
Sydney, Australia. March 1950.
In a hot-humid climate such as Malaya's, where the temperatures during the evenings are just within comfort conditions, (see Fig. IV in page 30a), it is important that the heat during the day is not retained, but enabled to dissipate quickly. For this, light thin construction with little thermal capacity is more suitable than thick heavy materials. However, some insulating properties may be necessary to prevent excessive heat penetration from the outside during the day. To further prevent such heat penetration, the outside surfaces may be shaded from direct sunlight wherever possible. A shade over the roof or wall, with a well-ventilated space between, results in a cooler roof or wall, thereby reducing heat re-radiation inside the building. However, the shades must be thin to prevent heat retention.

For roofs and walls where shades or a ventilated air sandwich are not practicable, it will be best to prevent absorption of solar heat by reflection, and depend on insulation to further prevent any absorbed heat from being effective within the building. Thus a surfacing of metallic aluminum, or a white reflective paint may prove effective, and has been reported as entirely satisfactory. A water spray to keep the roof cool by evaporation and reflection is workable in principle, but may be undesirable since it serves to increase the humidity of an already humid atmosphere.
Re-radiation from floors may be reduced to negligible proportions by keeping masonry floors in the shade at all times. Exposed slabs (such as the apron in this case) should be sufficiently separated from the building such that the heat re-radiated from these slabs will not be effective in causing discomfort to occupants in the building. The separating area may be covered with low planting to further reduce re-radiation.

Summarizing, the criteria for design against solar heat may be as follows:

a) Prevent solar heat from being absorbed by the building fabric;

b) Use insulation to make the interior more comfortable;

c) Exclude the sun from within the building;

d) Resort to air-conditioning if possible, to assure comfort.

The Rain:

Rainfall is heavy in Malaya. In Kuala Lumpur, the statistics for 1939 to 1941 showed totals of 77 inches to 116 inches per year with maximums per month of from 12 inches to 20 inches. Generally, rainfalls are of short durations, coming on as intermissions between the bright sunshine, and lasting probably only about 20 minutes or less during one downpour. With little strong wind to de-
reflect the rain to any appreciable angle, a wide overhang is sufficient to exclude the rain from the building, if more solid enclosures are not desired. This method has the additional merit of allowing necessary ventilation even during heavy rains.

The spray from the ground, however, may be projected a little distance, either through spattering or carried by a breeze. This can be excluded from the building by a low barrier, preferably in the form of a low louver to permit ventilation. The planting belt around the building will further help reduce the spray nuisance.

Another important problem arising from the heavy rainfall is the necessity of good drainage around the building. This careful drainage, together with a sufficiently deep fill of clean gravel beneath the floor slab, should be effective in preventing capillary action up to the slab and thus help maintain a dry comfortable floor in the building.

**The Humidity:**

The humidity in Kuala Lumpur ranges daily from about 60% to about 95%. The day to day pattern is seldom varied appreciably. It is fortunate that the daylight hours of high temperatures are also the hours of lowest humidity, thereby making conditions more bearable.

The human body is continually losing moisture through
evaporation. High humidity permits the air around the human body to be easily saturated from this evaporation, and, by retarding evaporation and causing perspiration, brings discomfort to the subject. There are 3 ways of relieving discomfort under such conditions:

a) Lower the temperature such that the effective temperature is lowered to within comfort ranges.
b) Reduce the relative humidity and thus lower the effective temperature.
c) Produce wind movement so that the immediate envelope of air around the human body is continually being changed.

It is evident that all 3 ways for relief call for mechanical aids in air conditioning and ventilation.

Air-Conditioning:

Fig. IV shows the comfort conditions for warm humid climates as applicable to a person acclimatized to and dressed suitably for such a climate. On the graphs showing the comfort zones for various conditions of air movements, the weather characteristics for a typical day in Kuala Lumpur is superimposed. It will be noted that between the hours of 6:30 p.m. and 9:00 a.m., comfortable conditions are obtained even in still air. However, during the daylight hours of approximately 9:00 a.m. to 12:00

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1 Such a typical day for Kuala Lumpur may be taken as representative, since the day to day variation throughout the year is very slight, if at all noticeable.
FIGURE IV

Graph showing the conditions of a typical day in Kuala Lumpur, superimposed on various comfort conditions applicable to a person (at rest) acclimatized to and suitably dressed for a hot-humid climate.

comfort conditions in still air.

comfort conditions in air moving at 60 cm per sec. or 118 ft per min.

comfort conditions in air moving at 120 cm per sec. or 236 ft per min.

conditions of a typical day in Kuala Lumpur (the figures give the hours of the day).

noon and 2:30 p.m. to 6:30 p.m., air movement is necessary for comfort, while the hours of 12:30 p.m. to 2:30 p.m. are uncomfortable even with reasonable air movement.

It appears therefore, that some means of mechanical regulation will be necessary for comfort during most of the daylight hours.

Good air-conditioning practice recommends that a low temperature differential between the inside air temperature and outside air temperature be employed. In the past, a large temperature differential has often resulted in complaints of discomfort due to the "thermal shock" on passing from one environment to the other. In fact, damage to health has been reported, such as causing respiratory ailments to acclimatized people in the hot-humid climates.¹

A careful study of the graph in Fig. IV will suggest that a best probable solution will be to depress the temperature to about 78°F to 80°F throughout the day while maintaining a humidity of about 50% to 60%.² These conditions have the advantages of requiring a low differential between inside and outside temperature and humidity, thus requiring less mechanical equipment and insulation.

² Note that these conditions, while comfortable for an acclimatized person, suitably lightly dressed for this climate, are markedly different from those required for the temperate regions.
It is proposed that all parts of the building be so air-conditioned, excepting areas for storage and the main lobby, where the constant flow of people in and out of the building makes any close control impracticable. However, the main lobby may be served by exhausting from the other areas into it, thereby receiving a partial air-conditioning treatment.

B) GENERAL THOUGHTS ON THE TERMINAL BUILDING.

Aside from its purely functional requirements, an air terminal building is obligated socially in at least 2 respects: it automatically becomes an "ambassador" of the city it serves; it should reflect the concepts of technology, efficiency and progress inherent in air travel.

To a stranger approaching the city, the terminal building and its functionings set his prejudice on the city and colors his subsequent impressions of the city proper. A well-designed, efficient and pleasant building, extending courteous service by its personnel, ushers the visitor into the city muttering enthusiasm, and immediately prejudiced in favor of the city. Or vice versa, it can soften the harsh criticisms of the departing visitor whose visit has been a disappointment. Whatever the merits of the city, this "ambassador" will have the last word to the visitor.

The notion of air travel immediately projects
into one's mind a series of concepts embracing highly advanced technology, efficiency, speed through streamlined simplicity, progress and a satisfaction in Man's prowess over Nature. It will be most appropriate to reflect these concepts in the air terminal, through design, materials, and building technology.

Remembering that patrons of the terminal are liable to be complete strangers to the building, (as different from users of other types of buildings), it will be important to keep circulation and design as simple and straightforward as possible. Spaces should be obvious and easily accessible to prevent confusion. Especially since the level of literacy is relatively low in the country, making written directories less effective, it may be best to keep different spaces easily visible, keeping opaque partitions to a minimum, and having separating mediums only where necessary for purposes of space identification, air-conditioning control and acoustic treatment.

The future of air travel can only be a matter of conjecture. One growing trend however, aside from faster and bigger aircraft of either propeller or jet propulsion, is an increasing use of helicopters especially for short hauls. No figures have been made available here of the extent of present use of helicopters, and indications are that it has not come into general use as yet. But it is
suspected that the smaller investment of cleared area required and the otherwise relative inaccessibility of many parts of Malaya will make this mode of transportation exceedingly popular if it can be brought within reach of travellers on competitive terms with conventional air travel. In this project, no special provision is made for helicopter service, (being non-existent at present), although any such requirements in the future will be easily accommodated through the design.

Considerations for flexibility and expandability should be of prime importance in air terminal design. In this project however, certain characteristics peculiar to the region may demand considerations different from those encountered in the U.S.A. Malaya is a peninsula approximately 500 miles long by 200 miles wide at its widest part. (See Fig. I in page 5a). The geographic position of Kuala Lumpur assures that the traffic for its airport will always be local in character, i.e. limited within Malaya. The territory and the maximum potential passengers will therefore be also limited, unless drastic changes occur to affect the standard of living and travel habits of the people. However, as explained in the previous paragraph, the Malayan terrain should make helicopter service exceedingly popular in the near future. Helicopter service, therefore may dominate the short hops,
leaving the longer flights to conventional airlines. It may therefore be assumed that future expansion will be more in the form of additions to accommodate such a specialized service, with requirements different enough from conventional service to warrant expansion through addition of more specialized building blocks, rather than mere expansion of the original area. Maximum flexibility will be incorporated to accommodate such service until an addition becomes imperative.
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