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INTRODUCTION

Hong Kong lies in the center of a region that has experienced, and is predicted to continue to experience, dynamic economic growth. This is manifested by doubledigit annual growth in air transportation and development of six new international airports, not including the Peoples Republic of China (PRC) (Bangkok, Hong Kong, Kansai, Kuala Lumpur, Macau, and Seoul). The PRC has another 20 to 30 new airports on the drawing board or under construction in addition to the new Shenzhen Airport, located approximately 45 miles west of Hong Kong, which opened in late 1991. One half of the world's population live within this Asia-Pacific Region, all within only five hours flying time from Hong Kong.

Seven million tourists visit Hong Kong each year spending US\$7 billion. Hong Kong is also a major center for export trade, 20 percent of which moves by air. It is essential that unconstrained and environmentally acceptable air transportation facilities continue to be provided beyond the July 1997 governmental transfer to the PRC to protect the long-term economic well being of Hong Kong..

The existing Kai Tak Airport, the world's fourth busiest international airport, has reached its design throughput capacity of 24 million annual passengers in late 1993. Because of its physical setting, Kai Tak cannot be expanded. Airline schedules are already constrained due to limited aircraft parking and a nighttime curfew.

These capacity and scheduling constraints, coupled with predictions of continued dynamic economic growth for the region, set the stage for the development of a new replacement airport at Chek Lap Kok. (Figure 1)

BACKGROUND

After a decade of airport site selection studies, a preferred site was selected in 1979 at Chek Lap Kok Island, directly north of Lantau Island and 17 miles (28 km) west of Kai Tak Airport. In 1982-83 a master plan was prepared, but its implementation was put on hold due to worldwide economic conditions. In the late 1980s detailed planning studies resumed and resulted in the Port and Airport Development Strategy (PADS). The Provisional Airport Authority (PAA) was created by the Hong Kong government in 1990 to initiate the detailed planning, design, and construction of the New Hong Kong Airport at Chek Lap Kok. In 1991, a Memorandum of Understanding was signed by the United Kingdom and the PRC to confirm support of the PADS program by both governments.

Planning Objectives

The overall objective of the 1990-1992 New Airport Master Plan was to prepare a comprehensive and environmentally acceptable scheme for the planning and development of an operationally safe and efficient New Hong Kong Airport at Chek Lap Kok, with the first runway coming into operation in 1997 and with subsequent development into a two-runway airport operating 24 hours per day.

Planning Assumptions

During the course of the master plan study, several major assumptions influenced the planning of airport facilities: major assumptions were :

• The existing Kai Tak Airport will close when the new airport opens,

• All passengers will be international,

• High priority will be given to rail in a multimodal surface transportation system,

• Surface access by road, rail, and ferry will be provided on opening day, and

• Maximum opportunities will be given for privatization of airport facilities.

Planning Approach

The 17-month master planning study was conducted in three work streams: planning, civil engineering, and environmental.

Planning established the work program, parameters, and criteria for the project which resulted in a well defined physical configuration of all facilities. This



FIGURE 1A Hong Kong area airport site location and airport core program projects.



FIGURE 1B Hong Kong area regional airport locations.

provided the essential focus for the preliminary engineering and environmental studies to proceed concurrently in close coordination as the airfield, terminal complex, and surface access elements were further developed and refined.

Civil engineering developed the detailed design and construction documents for the site reclamation, as well

as the preliminary design guidelines for all airport facilities and infrastructure.

The environmental work stream investigated impacts associated with construction activity and operation of the airport. The key considerations included noise, air and water quality, hydrodynamics, and marine and terrestrial ecology.

	Year		
Category	1997	2010	2040
Two-Way Passengers	28,500	44,700	87,300
Air Cargo (Tons)	1,130	2,300	8,900
Aircraft Movements (Two-Way)			
International			
Passenger	123	184	278
Cargo	12	22	66
Non-Revenue	4	6	11
Civil Local	7	7	7
Military	10	11	15
Total A/C Movements	154	11	376
Airport Employment	26	35	59

TABLE 1 SUMMARY OF ANNUAL FORECASTS (1000)

TABLE 2 SUMMARY OF BUSY HOUR FORECASTS (TWO-WAY)

Passengers	11,400	14,100	28,500
A/C Movements	44	53	82
Road Vehicles	2,900	3,750	7,300

The airport project interfaced with many other related PADS projects including the North Lantau development, rail service, roads and expressways, industrial and commercial relocations, utilities, business and financial planning, and other aviation- and infrastructure-related activities.

THE AIRPORT PLAN

The plan commenced with the development of aviationrelated forecasts on which to base subsequent facilities requirements. Key issues that were addressed included the separation of runways, the terminal concept, and location of major support facilities such as air cargo, aircraft maintenance, and other support functions that optimized a sound business plan. Major elements of the Plan are summarized below.

Demand Forecasts

Aviation activity forecasts assumed continued resilience against periodic world economic recessions. They also assumed continued strong growth as the territory consolidates its financial, industrial, and commercial position within the region and its continued attraction as a tourist destination. New airports at Macau and Shenzhen were also considered in the forecasts, but due to the specific role played by each, they were not considered to have a major influence on the Hong Kong forecasts. (Tables 1 and 2)

Airport Description

Key components of the airport master plan are shown graphically and itemized on the airport layout plan. (Figure 2)



FIGURE 2 New Hong Kong airport layout plan.

Airport Description

Key components of the airport master plan are shown graphically and itemized on the Airport Layout Plan. (Figure 2)

Data included in the Master Plan:

- Airport site, 1,248 hectares;
 - one quarter existing islands,
 - three quarters reclaimed.
- Planned to satisfy forecast demand in 2040;
 - 87.3 million passengers,
 - 8.9 million tonnes of air cargo,
 - 375,500 aircraft movements.
- Two parallel runways;
 - 3,800m length,
 - 300m clearways,
 - 60m width,
 - 1,525m separation.

• Five parallel taxiways and four crossfield taxiways provided.

- Midfield passenger terminal complex.
- Centralized terminal processing buildings.
- One attached and one satellite terminal concourse.
- 120 aircraft parking positions.

• Road, rail, and ferry access along eastern site boundary.

- Three road bridges to the site.
- · Midfield aircraft maintenance facility.

• A majority of support and ancillary facilities located south of the southern runway.

CIVIL ENGINEERING

The existing islands of Chek Lap Kok and Lam Chau are being blasted and cut to 18 feet (6 m) above sea level to form one quarter of the 3082-acre (1248-hectare) airport island area and yielding 160 million cubic yards (121 million cubic meters), or two thirds of the suitable fill material to form the airport reclamation. (Figure 3) However, this is only part of the total site reclamation picture. The removal of unsuitable mud from the airport site prior to placement of suitable fill material and similar dredging of unsuitable mud from marine borrow sites prior to dredging the suitable marine fill material make this the world's largest marine dredging project. Total dredging will account for about two thirds of the 480 million cubic yards (367 million cubic meters) of material moved for the entire reclamation project, all in a 41 month schedule. (Figure 4)

Nine miles of seawall will be constructed to resist severe storm wave forces and overtopping. Storm



FIGURE 3 Airport land reclamation.

drainage of critical areas will have a capacity to discharge a 200-year storm. (Figure 5)

All runways, taxiways and aprons are designed to meet or exceed ICAO Code F (future) and/or FAA Airplane Design Group 6 standards. Infrastructure systems including roads, tunnels, railways, utilities, and support buildings and systems will meet the Hong Kong government and international design standards. (Figure 6)

TERMINAL COMPLEX

The terminal complex received much attention during the master planning process as it is the most visible aspect of the new airport. The series of planning objectives and performance criteria used as guidelines during its development are summarized below.

Objectives

• Provide expansion and operating flexibility.

• Give high priority to rail access integral to terminal, separate platforms for arrivals and departures.

• Facilitate efficient and cost-effective movement of passengers and baggage.

- Provide facilities and services for the disabled.
- Maximize opportunities for concessionaires.
- Optimize energy conservation.

• Accommodate the next generation of large, highcapacity aircraft.



FIGURE 4 Marine borrow pits and dump sites.

Performance Criteria

• Departing passenger and baggage close-out time shall be 30 minutes.

• Arriving passenger and baggage processing time shall be 20 minutes.

• Space allocation for departure and arrival processing functions must be efficient, economical, and flexible to accommodate future processing procedures and systems.

• Passenger flow routes will be simple and direct with minimal level or directional changes and with provision for ramps and vertical assist systems.

• Walking distances (unassisted) shall be no more than 980 feet (300 m).

The optimal location for the terminal was determined to be between the two runway systems with surface access from the east. Many alternative terminal configurations were evaluated resulting in two final options, centralized versus decentralized. Consequences of the two options were measured and compared using detailed performance criteria, cost estimates, and operational factors. The preferred concept was a centralized passenger processing terminal.

The terminal concept selected will be organized into two pairs of centralized processing terminals, an attached concourse and a satellite concourse. Initial development will provide for Terminals 1 and 2 with their attached concourse. Ultimate development will include Terminals 3 and 4 and the satellite concourse. Fast and convenient connections between the processing terminals and the concourse will be provided by an underground people mover system located in the central spine. (Figure 7)

Aircraft parking positions will surround the concourses as well as located at remote parking positions. Surface transportation will access the terminal at two levels via road (expressway), rail and ferry connector in an integrated intermodal concept.

SUPPORT AND ANCILLARY FACILITIES

All the essential airport support and ancillary facilities are provided to allow the airport to function efficiently as a complete usable entity. These functions and facilities are shown on the Airport Layout Plan and include the following.

Terminal Facilities:

- · Airline Passengers,
- Aviation Fuel Storage
- Air Cargo
- Aircraft Maintenance
- In-flight Catering
- Ground Support Equipment Maintenance
- Air Mail Center

Airport Operations and Maintenance Facilities:

- Air Traffic Control Complex
- District Police Station
- Airport Maintenance
- Fire Training
- Rescue, Firefighting, and Sea Rescue
- Isolated Aircraft Parking



FIGURE 5 Typical seawall section.



FIGURE 6 Runways and taxiways.

- Apron Control
- Meteorological

Commercial and Noncommercial Facilities:

- General Aviation
- Cargo Village

- Heliport
- Industrial Park
- Government Flying Service Department
- Business Park

AIRSPACE AND AIR TRAFFIC CONTROL

The new airport master plan provided for a complete airspace management and air traffic control plan. The plan included arrival and departure flight tracks conforming to ICAO and UK CAA criteria and supported by a land-based navigation system. Some airspace restrictions are required due to the mountainous terrain in and around the Hong Kong and on Lantau Island. The plan also provides for dual and simultaneous precision instrument arrivals and departures to and from the parallel runways 7R-25L and 7L-25R. (Figure 8) Terminal doppler weather radar facilities are planned to enhance operational safety.

ENVIRONMENTAL IMPACT ASSESSMENT

A complete comprehensive assessment of the environmental impacts of airport construction and



FIGURE 7 Passenger terminal complex, Year 2040.



FIGURE 8 Arrivals and departures flight tracks.

airport operational impacts were conducted for the new airport master plan. Mitigation measures and monitoring programs have been planned and designed to ensure acceptable impact levels and are being implemented by the PAA and government's Environmental Protection Department. (Figure 9)

CURRENT DESIGN/CONSTRUCTION PROGRESS

Final design of all major facilities and systems are currently under contract and proposed franchise agreements for privatized facilities such as air cargo, aircraft maintenance, and others are being evaluated for award.

The site preparation (reclamation) construction contract, which started in early 1993, has completed over one third of the new land formation. This massive project (US\$1.16 billion) is moving 520,000 cubic yards (400,000 cubic meters) each day with 100 tons of explosives and the world's largest dredging fleet (22) for a single project. Other facts regarding the site preparation which will form a land area 4.3 times larger than existing Kai Tak Airport, or roughly equivalent to the entire Kowloon peninsula, include:

• Construction equipment will consume US\$128 million worth of fuel.

• 56,000 tons of explosives will be detonated to blast 90 million cubic yards (70 cubic meters) of rock.

• Dredges will move an equivalent volume of 320 Empire State Buildings.

By March, 1994, the terminal foundation contract is expected to begin. The target date for airport opening remains at 1997.







FIGURE 9 Airport noise contours.

PROGRAM BUDGET (ESTIMATED)

PAA Share	US\$6.2 billion
Hong Kong Government Share	US\$0.6 billion
Privatization Share	US\$1.9 billion

Total Budget

US\$8.7 billion