CALABAR INTERNATIONAL CARGO AIRPORT:

ARCHITECTURAL RESPONSE TO MODERN CARGO HANDLING

BY

OGBO OBU UPE

A thesis submitted to the Postgraduate School, Ahmadu Bello University Zaria, as a partial fulfillment of the Requirements for the award of the Degree of Master of Science (M.Sc) in Architecture

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DECLARATION

I Ogbo Obu Upe of the Department of Architecture, Faculty of Environmental Design, Ahmadu Bello University hereby declare that this thesis work has been a personal academic undertaking executed under the supervision of my Supervisor Arc. Umeh Henry O.A. of the Department of Architecture, Ahmadu Bello University Zaria and that all quotations and information utilized and their sources have been duly acknowledged by way of references.

....
STUDENT'S SIGNATURE DATE

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SUPERVISOR'S SIGNATURE DATE

CERTIFICATION

This thesis titled, CALABAR INTERNATIONAL CARGO AIRPORT (An Architectural response to Modern Cargo Handling) by Ogbo Obu Upe meets the regulations governing the award of the degree of Master of Science (Architecture) of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEAN, POST-GRADUATE SCHOOL	15/09/02 DATE

HEAD, DEPT. OF ARCHITECTURE
Faculty of Environmental Design
A.B.U. Zaria - Nigeria.

DEDICATION

To my father and my mother, the committed visioners.

To Samuel, who stood by me but could not make it to the end.

And to the Almighty God, the merciful.

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For an inexperienced writer and rather young in academics, the search for an understanding of a dynamic and complex aviation industry, and how to house it with particular respect to 'Calabar International Cargo Airport Terminal, has not been without occasional doubt and anxieties, difficulties and fears.

But the search from the very beginning has never been a lonely one and different personalities have stood by me with their helping minds and hands.

To think of listing down all names would almost mean writing an entire chapter, but then I cannot resist naming a few.

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To my Dear Brother Patrick, (whom I love secretly from my childhood, great shall be thy household).

To my brother Otei (the intelligent whom I secretly respect and envy, may the Almighty guide you to realise your dream).

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ABSTRACT

Calabar's rich history and peaceful nature coupled with her good land, sea and aerial communication system Jed to the United Nations Industrial Organisation's (UNIDO) recommendation of the ancient Nigeria colonial capital for the establishment of the Nigeria premier Export Processing Zone (EPZ).

The promulgation of decree 63 of 1991 by the Federal Military Government of Nigeria, formalised the birth of the Calabar EPZ project, with the aim of diversifying the monoproduct nature of Nigeria economy (due to its sole dependence on a singular export product - oil) by the encouragement of export oriented industries in the Zone.

To facilitate the effective take-off of the scheme, ancillary infrastructures such as uninterrupted electric power supply, pipe born water, effective telecommunication, good road network, a functional rail transport system and an international cargo airport and a modern sea-port are required.

A total of 152 hactres of land has been developed and an additional 20 hactres already earmarked for future expansion as the first phase of the project. A good 10km road network and effective communication system and other facilities like banks, power station, police station, customs, fire service have been completed and the dredging of the Calabar seaport is in progress. Studies carried out indicated that the existing calabar international Airport is inadequate to cater for the magnitude of the anticipated EPZ project. This is due to the inadequacy of the existing Cargo

handling and warehousing facilities requiring expansion of runway and support facilities.

Due to the presence of air navigational obstacles such as ravines along the path of the extendable section of the runway and the Airport being situated in a densely built- up suburb, the siting of a cargo International Airport on a different site became imperative as stated by the Calabar Master plan.

An accessible and relatively flat site has been recommended at Akamkpa, 35km North of the EPZ Project location. Though the choice of a site is a step towards problem solving, it is just a chip off the ice berge considering the enormous task of designing a modern cargo airport.

The prospect of air cargo transport system is of great concern to both the will be users, airliners and the airport authorities considering the level of security, the dynamic nature of the aviation industry and the level of mechanization and automation required. Cargo terminals design requires future forecast of aviation needs, high level technology involvement in mechanization and Architectural response to this inevitable future technological changes should be accommodated uninhibited.

CHAPTER ONE

INTRODUCTION

1.0 INTRODUCTION

Advancement in Science and technology has turned the world into a global village. Scientific discoveries have produced a social and economic revolution of a dimension never before known. The effect of this industrial revolution on lives is profound and the aviation industry is one of such industries that have undergone rapid technological transformation within less than a century of its existence these changes have attained a complexity such that the construction of airports is now a multifaceted venture engaging a multitude of professionals.

This geometric progression in the aviation industry expansion is due to the reliable advantages of speed, limitless access and scheduled operation enjoyed by users over other means of transportation, this users response has two implications in the industry; firstly the need for the seperation of freight carrying from passenger carrying aircrafts and the subsequent expansion of aircrafts to carry more freight, and to cover longer distances, and secondly, the need for the expansion of landing and take-off runways and associated facilities to take care of the additional passenger and freight requirement.

The first need has been satisfied by the manufacture of wide-bodied jet transport aircrafts like Airbuses A300, A310, A330, Boeing 747 - 100, 200 and 300, 747SP, ilyushim 45 classic Mc Donnel-Douglas Series MD 11, DC-10-30 etc and Supersonic jet transport aircrafts like Aerospatiale/BAE Concord and the yet anticipated aircrafts of the future.

The second need has imposed on the airport designer, a multidimensional task of proper forecasting of aviation need for now and the protracted period. A task of evolving

an architecture that is dynamic and responsive to these anticipated changes and yet serve its principal purpose.

The need for an international cargo Airport for Calabar EPZ is a welcomed development and its construction should not be seen as a duplication of facilities, but as a boost to commerce and to open up the aboundant untaped potentials of the eastern region. Before it's acceptance, careful planning and consideration has been given to the general aviation network to justify its establishment.

Architecturally though the airport is one of the most dynamic building forms, its fundamental planning characteristics is simple though the architecture of ground to air transfer is somewhat complex, the design principles still apply regardless of size and it is the adaptation of specific local user requirements that challenge the designers skill within the restrictions of economy and time considering demands of the present without inhibiting the inevitable changes of the future.

1.1 PROBLEM STATEMENT

Within the last decade air cargo growth rate exceeded that anticipated by the aviation industry. Initially the industry met this growth largely with converted passenger aircrats, existing terminal facilities and manual handling techniques this has led to congestion, service failure and escalating pilgerage rate in airports.

The idea behind this study is therefore to come up with a design solution which may tend to effectively address these problems.

1.2 MOTIVATION AND JUSTIFICATION

The ability to effectively process the transported unit is a measure of effectiveness of the transportation system generally. Success therefore of individual components in the overall fulfilment of an airport determines its performance.

Therefore the planning and eventual control of circulation of both passengers and aviation personnel with Cargo handling in an international airport is in itself challenging.

The prospect of addressing the problem of cargo handling, security and fast freight processing which has been a limiting factor in most passenger terminals is another motivating factor.

1.3 AIM AND OBJECTIVES

This work is aimed at using design as an instrument for fast, efficient and safe cargo processing in airport design and similarly address circulation problems by the provision of the shortest working distances for passengers within the passenger terminal facility.

The objective of this work is the satisfaction of airline operators and passengers and other requirements within international civil Aviation Organisation (ICAO) standards, the objective can be achieved thus:

1.3.1 FOR CARGO

(a) The provision of convinent and efficient ramping facilities for departure cargo.

(b) The provision of automated cargo terminal with safe storage facilties and warehousing for long term storage.

(c) The provision of a versatile automated interface for variety of cargo paircrafts loading/off loading activities.

1.3.2 **FOR PASSENGERS**

(a) The provision of defined access into the airport and terminal area for both visitors, and passengers.

(b) Provision of simple and well defined parking lot and vehicle rental area.

(c) Provision of a comfortable terminal area with effective check in facilities arrangement and defined enplaning and deplaning system

(d) Design and provision of a convenient baggage handling system.

(e) Provision of comfortable airside facilities and boarding protective enough to shelter them from inclement weather and at the same time provide the shortest travelling distance to the aircraft.

1.3.3 **FOR AIRLINES**

(a) The provision of airport terminal dedicated to handling all types of air cargo.

(b) Provision of an economic, effective and efficient security for airlines operations.

(c) Accommodation of existing and future cargo airport fleets with maximum operational efficiency.

(d) Provision of facilities which will embrace the latest energy and manpower conservation.

1.4 SCOPE AND LIMITATION

As indicated by this research project title, emphasis will be primarily on the design of the airport passenger terminal and the related cargo facilities. Implicitly architectural detail will be emphatic about the terminal building and all housed within it and the ware house and its related facilities.

Other aspects of airport configuration such as runways, taxiways, aprons, as well as vehicular parking will be treated within the framework of general site planning but will be intergrated in relation to the terminal building.

Not included in the scope of this project are:

i) Welfare matters such as club houses, theatres dance halls, sport facilities etc.

ii) Staff housing scheme.

iii) Outside station or route structure

iv) Aircraft interiors supposedly meant for improving travellers comfort and cargo convinence.

The passenger terminal and the cargo warehouse are basically conceived as a means of passenger and cargo transfer in both directions between land and air transportation systems, It is therefore devoid of all activities not directly connected with cargo and passenger movement.

1.5 AIRPORT CAPACITY

The runway and the terminal capacity will be the primary determinants for this International Calabar cargo Airport terminal. The terminal which could be increased as air travel increases should be modular in nature with modest area demands.

Trends in air travel suggest intersecting runways will be sufficient for the International Airport Calabar Cargo terminal at full development industrially and sufficient for cargo needs for a city of 1.1 million. This will be adopted in the design but in the event of unforeseen air travel density subsequent needs such as increase in per-capital rate of domestic travel beyond that forecasted, emergence of unexpected general aviation activity and the development of calabar as a transfer hub for international Traffic, then the existing passenger terminal will be an alternative.

The Boeing 747, fully loaded for maximum stage length is adopted as the critical aircraft type for the purpose of design of Calabar International Cargo airport. This requires a maximum runway length of 4,000m 4km.

CHAPTER TWO

CHRONOLOGY OF FLIGHT HISTORY

2.0 CHRONOLOGY OF FLIGHT HISTORY

The annals of ancient Greek, Egyptian, Assyrian and Oriental mythology contain numerous legends of Kings, gods and herors who tried to harness the power of flight. In almost every case, the stories involved men imitating the winged flight of birds and fairies, hence historian Berthold Laufer's observation that:

"The desire to fly is as old as mankind".

2.1 HOT AIR BALLOONS

The 16th century records artists impression of crude helicopters and parachute designs as well as gliders with flapping wings. But outstanding aeronautical breakthrough was recorded in 1783 by the discovery by Joseph Michael and Jacque-Elinne Montgolfier who made small paper balloons rise swiftly carrying two passengers by filling them with hot air. In 1785, Jean-Piene -Francois Blanchard successfully crossed the English Channel in a hydrogen balloon carrying the world's first animal. By 1862, aeronants have made voyages across Europe and throughout the United States at altitudes of over eight kilometers.

Breakthroughs in the 19 century made aerial navigation possible to a greater degree with sausage - shaped lighter-

than - air dirigibles using gasoline and electric power travelling at 10 and 30 kilometers an hour.

2.2 THE ARRIVAL OF THE AIRPLANE

The Wright brothers, Orville and Wilbur Wright ushered in the era of air transportation. The Wright brothers first powered and controlled flight in December, 1903 after trials from 1901 at Kitty Hawk, North Carolina U.S.A. The machine remained airborne for nearly full minute and travelled a distance of 260 meters. Then there where no existing airports and the Wright Brothers made do with a level 220 acres (90 hectare) pastine called Huffman's Praice, a few miles outside of Day to Ochio, U.S.A. This site is generally considered the first airport with the historic flight on May 16th, 1904 with aircraft "flyer No. 2" was followed by an improved "flyer No.3" after further wind tunnel tests where conducted by the Wright Brothers

In October 1906, Santos-Dumount successfully launched a 14 bis motor powered heavier than air flight.

2.3 FIRST TRANSCONTINENTAL CROSSING

Between 1909 and 1914, the Biplane gained popularity, welled published world records for speed at 71 kilometers per hour and climb to 43 meters altitude. In 1911 the first U.S. transcontinental airplane crossing was made; the trip from New York to California took about 49 days.

2.4 IMPROVED FLIGHT AND SCHEDULED FLIGHT

1918 - 1920s. World War II saw the primary use of airplanes in military service air craft, speed was pushed from 100 kilometers per hour to over 230 killometers per hour. Attitude records soon topped 9,000 meters, until 1918, when airmail service was

began, first in the U.S. The immense war stimulus to aviation in general paved way for the development of commercial operation. Surplus war time aircraft were converted into passenger use and chattered commercial flights were recorded in the U.K, U.S. USSR and India. almost at once the idea of sustained scheduled flight operations came into being.

2.5 INTRODUCTION OF AERONAUTICAL EDUCATION AND RESEARCH

1926 - 1927, Altitude record leaped to 9,934 meters, set by major Rudolph N. Schrooder of the US Army Air Service in a Biplane. The speed record was also pushed up to 286 kilometers per hour by L.Col. Mosley of the U.S. Army with a virville packard plane. Charles A. Linkergh's May 1927 non-stop New York to Paris flight in 33 hours and 20 minutes, triggered public interest and generated interest in aeronautical education and research programmes that eventually established air transportation as the most effective means of transportation in the World.

2.6 EUROPE'S LINKAGE OF AIR TRANSPORT TO COLLONIES

1928 - 29, most European governments recognised the commercial value of air transport, so in 1928 air linkage was established in other countries and with their colonial possessions. Scheduled commercial routes were established, with air routes crossing all over Europe and most cities had adequate airports.

2.7 ESTABLISHMENT OF AIRPORTS, AIRLINE SCHEDULE AND TRANSCONTINENTAL OPERATION.

1930: The 1930s saw the inauguration of first transcontinental operations. A string of small airports and emergency fields were established at the coast. The first airline schedule were started in Conjunction with the existing railroads systems, passengers fly by day and travel in railway sleeping cars at night. Airports, were sited adjacent to railroad stations and passengers were routed between planes and trams.

2.8 INTRODUCTION OF NAVIGATIONAL AIDS

1932, ushered in the installation of light beacons and radio communication systems in airports making it possible to fly during the night. This resulted in the abandonment of the combined air and rail travel schedule reducing one-way travelling time to 33 hours including 12 to 15 stops for fueling and refreshment. Burgeoning Technical development was pushed primarily by airline market with the introduction of asphalt and concrete runways and development of precise navigation instruments and radio navigation aids. This increased the safety and reliability of airline operations.

650 yards (600 metres) was established as maximum landing and take-off distance just before World war II and additional demand for engine failure was not clearly defined. London, Paris, New York and Berlin airfields were laid down in this terms, involving an area that rarely exceeds 500 acres. At the end of 1939, air travel got on to a point that US airlines were serving nearly 3 million passengers annually. DC-3, the standard airliner of the 1930s was the major carrier, with a capacity of 21 passengers.

2.9 USE OF AIRPLANES IN MILITARY OPERATIONS

1940S: World War II saw the major use of airplanes in military operations. The following years were marked by the expansion of commercial aviation on a scale never before dreamt of. A fierce wave of technological development that pushed aircraft performance beyond all pre war predictions achieving crossing speed of about 480 kilometers per hour and a bitter battle for supremacy in nuclear airpower between the US and USSR.

2.10 EMERGENCE OF SOPHISTICATED AIRPORTS

1950s recorded the emergence of sophisticated airport layouts culminating from the developments of the 1940s. The most significant change being the British introduction of commercial turbo jet service in 1952 after which speed range and carrying capacity more than doubled.

2.11 INTRODUCTION OF LARGER AIRCRAFT

1960s passengers demand and cargo requirements greatly expanded for both domestic and international routes. Airports that where considered over elaborate for the 50s rapidly became obsolete. the Soviets introduced the grant for jet, Illyshim 62 classics designed to carry 180 passengers non stop over international distances, and then the longer Antonov AN22 which would carry more than 700 passengers.

2.12 INTRODUCTION OF INTERNATIONAL ICAO REGULATIONS

The 1970s ushered in the recommendation of regulation by the International civil Aviation Organisation (ICAO) in 1970 backed up by National Air navigation regulations of member countries and international airline agreement, had been accumulated to guide the operation of world wide air services.

A trend towards increased numbers, size and carrying capacity of aircraft was continued in the 1970s with the introduction of the "Jumbo Jet". One result was the chronic congestion, some times of crisis proportion at nearly all major world airports near large cities. Several airports were immediately constructed to curb some of the problems.

The latest significant change has been the introduction of commercial supersonic transport (SST) with speeds exceeding twice the speed of sound. Tupolev TU-144 was pioneered by the Russians in 1970 which the British (BAC) and French (Aerospatials) Cooperatively introduced the concorde in January 1976. This led to an upsurge in facility demand and procedural control requirements or major airports like London's Heathrow, charles De Gulles in North of Paris, New York cities J.f. Kennedy airport and Montreal's Mirable Airport.

1980s heralded the introduction and modifications of various versions of the old brigade that have been in service for some time. New aircrats were proposed but not modeled for production. The Boeing B-767, 747 where introduced and Airbus A340 - 300 also in 1989.

1990s: the field of avionics is trying to change the mode of air transport communications system by the proposed introduction of the Microwave Landing System (MLS) and Future Air Navigation System (FAN) a satellite based system.

2.13 HISTORY OF AIR TRANSPORTATION IN NIGERIA AND AFRICA

Over the years Nigeria and Africa have witnessed consistently, sharp growth in passenger and freight demands for air transport, despite the problem of cost that has beset most African Airlines.

The growth of commercial air transport in Nigeria is a recent development, dating from the year 1935, when imperial airways a British owned firm established airfields in Lagos, Kano and Maiduguri.

The advent of the world war II also saw to the growth of this new mode of transportation in the continent as in Europe. The british royal Airforce and the American airforce established extensive airbases in Lagos, Kano and Maiduguri for ferring of men and materials across the desert to north Africa. Also the colonial authorities came to really o air transport for the war time administration of their colonies. The end of world war II saw the provision of rudimentary infrastructural facilities for the take off of the industry. Out of the 30 airfields developed, three had tarmac runways - Kano, Lagos and Maiduguri while 15 others are seasonal airfields. Air transport were carried out by the British Royal Airforce Transport command.

In 1946, the Government of the colonies of Nigeria, Gold Coast (Ghana) Sierra Leone and Gambia formed the West African Airway Cooperation (WAAC) with its

headquarters in Lagos. It is from Lagos that administrative operations were carried out for a little over a decade, when in 1958, following Ghana's independence and when there came to be little prospect and vestiges of hope for political unification among the remaining member state, Nigeria took over WAAC and renamed it Nigeria Airways".

During the following year Nigerian government who by that time did not accomplish a capable man power to run the business, called in the partnership of British overseas Airways cooperation (BOAC) and Elder Dempster Shipping Company in 1959 to help run the Airline. On attainment of independence in 1960, Nigeria bought out BOAC and Elder Dampster Shipping company in 1961 to become the Sole owner of Nigeria Airways.

For a better part of 1960's efforts were made towards establishing a good base for the sustenance and advancement of aviation in general and commercial aviation in particular, when through the Nigerian civil Aviation Training Centre in 1964 established a civil aviation training centre.

The 70's saw an appreciable in unprecidented achievement in Air transportation with the establishment of the Nigeria Airport Authority (NAA), appropriate at the time it came (during the oil boom), by decree No. 45 of July 1977.

During this period the Nigerian Airways was the sole commercial aviation set-up in the country.

While Nigeria Airways operated scheduled services on the domestic, international and intercontinental routs, other airlines companies which came into play later operated non-scheduled services in certain parts of the country. They include, Aero Contractors

Ltd. Okada Airlines, Pan African Airlines, the Nigerian Trade Winds, Arax Airlines, and Bristow Helicopters Liberation of unscheduled services in 1983 resulted in the increasing number of airlines and charter companies making use of the airport facilities. The first to register was Kabo Air. With the indegenization of the Airline business in 1988, Okada Air, Kabo Air and Gas airlines got their license to operate schedule domestic flights.

2.14 AIRPORTS DEVELOPMENT IN NIGERIA

Airports Development in Nigeria followed the sequence of Airfields established within the World War II period, aerodromes by the colonial administrators to the recent existing airports.

There has been the conflicting use of the words airports and Airfields in some quarters. The International civil Aviation Organisation (ICAD) defines aerodrome as an area of land or water, including buildings installations and equipments, intended for use in the arrival and departure movement of aircrafts. Also within the context of the ICAO definition, an airport is used in reference to the air transport hub where facilities for handling transport aircraft, passengers and cargo exist, with full time customs facilities sometimes. An airfield is kind of small aerodrome generally without a hard runway and without facilities for handling passengers and cargo.

Development of major airports over the years was accelerated by the steady increase in the traffic and by the demands of jet transport for larger runway lengths, greater pavement strength and much increased passenger and cargo handling capacity.

the arrival then of the 4 and 3 engine jets, especially the Boeing 707 and Mc Donnel Douglas DC 8 groups of Aircrafts, was one of the principal activating factors. This promoted an extensive airport building development programme in the early 70s. the facilities provided at that time formed the basis of the existing airport system in the country, but already the new generation of wide bodied jets did step up demands in airport specification and provision.

In Nigeria the responsibility of airport development and management was delegated then to the Nigerian Airports Authority (NAA) established in 1976 which later gave way to Federal Airports Authority of Nigeria (FAAN) established in 1995.

Airports in Nigeria could be classified under the following two classes:

1. Airports for long distance flights it long haul and
2. Airports for short and medium haul flights.

There are about 70 major airports, 15 of which are connected by scheduled services. Besides there are 30 other landing fields which are publicly or privately maintained for non-schedule and emergency landings.

2.14 AIRPORTS FOR LONG DISTANCE FLIGHTS

i) Murtala Mohammed Airport Lagos: Designed to handle present and future wide bodies jet transport aircraft which operate international and intercontinental routes.

ii) Port Harcourt Airport: Constructed out of the old airport, now capable of handling wide bodied aircrafts. Operates international and intercontinental routes.

iii) Kano international Airport: This is the second largest Airport in the country, next to Lagos, in terms of capacity and activity intensity. It handles both international and intercontinental flights.

iv) Abuja International Airport: This is the most recent, constructed to meet future high volume traffic demand in the Federal Capital Territory to operate both international and intercontinental flights.

v) Calabar Airport: The existing facility of the airport was upgraded in 1983. The runway was made to accommodate jet aircrafts like DC - 8 and A-310. It operates domestic as well as international flights especially to central and south Africa.

vi) Ilorin Airport: Inaugurated in May 1978 and designed to accommodate wide-bodied jet transport aircrafts. Originally commissioned as a domestic airport but operates International flights during Hajj Operations.

2.14.1 **AIRPORTS FOR SHORT AND MEDIUM HAUL FLIGHTS**

i) Maiduguri Airport: This airport is capable of handling wide-bodied jet transport aircrafts as Airbus A300 and even bigger ones due to the construction of a new runway, but it is basically a domestic airport.

ii) Kaduna Airport: It was designed to handle such aircrafts as B747 which will mainly be for Cargoing. It is for domestic purposes.

iii) Sokoto Airport: It was built at a new site early last decade, and is capable of handling wide-bodied jet transport planes like Kaduna airport, it is also for domestic purposes.

iv) Enugu Airport: This airport was modernized and upgraded in 1976, with new terminal building. the runway can accommodate large jet. Aircrafts like DC 9-30. It is a domestic airport.

v) Jos Airport: Built at a new site in Heipan Jos, accommodate medium sized jets. It generates domestic flights.

vi) Benin Airport: The airport was reconstructed and upgraded and operates only domestic flights.

vii) Imo Airport Owerri: This is one of the newly constructed airports in the country. Operation started in 1995 and handles medium size jets as Boeing 727-200 - 300 - 400 and the like.

All this and other airports not mentioned such as Katsina, Minna, Markudi airports etc and other minor airports and airfields also exist and form the spoke of domestic operation in the country.

2.15 AIR TRANSPORT ADMINISTRATION AND POLICIES IN NIGERIA

Commercial aviation like other aspects of a country's developmental contributors have always been carried out with the combined involvement of government bureaucracy and the private sector. In all administration has always been relied upon to coordinate the activities of both parties aimed at projecting and propagating air transport business as an economic and development factor.

In Nigeria the parties involved are as follows:-

(a) Federal Ministry of Aviation (FMA)

This body is vested with the overall responsibility for the development and maintenance of air transportation. To facilitate the easy performance of its statutory duties, the ministry is divided into three departments Viz:

i) Management and policy department which promulgates and enforces policies to guide the aviation industry development in the country.

ii) Civil aviation Department which supervises and regulates the activities of the Federal Airport Authority of Nigeria (NAAN), the Nigerian College of Aviation Technology Zaria and the airline operations.

iii) Meteorological Department: Provides advisory meteorological information to the air aviation transport industry in the country.

(b) Federal Airports Authority of Nigeria.

The authority was established on the 31st of August, 1995 to take over the activities of the scrapped FCAA and NAA. The activities of the authority include:

i) It is charged with the responsibility for laws regulating safety in aviation. Its duties include; Airport transport licencing and safety, air worthiness and operational safety, including the liciening of pilots and flight engineers, the National air traffic services including air traffic control and telecommunications and the well being in general of aviation.

ii) To develop and maintain all necessary services and facilities for efficient airport operation excluding navigational aids, telecommunication facilities and air traffic control services.

iii) FAAN provides accommodation and other facilities for passengers and freight handling.

iv) Provides and develops facilities for surface transportation in all the airports, and also carries out economic activities that are relevant to air transportation within the airports.

2.15.1 THE NIGERIAN COLLEGE OF AVIATION TECHNOLOGY ZARIA

The institution provides manpower development for civil aviation to ensure the safety, regularity and efficiency of the aviation industry especially commercial aviation.

2.16 EVALUATION OF AIR CARGO TRANSPORTATION

Awobi (1993) discussed the enormous opportunity offered by air-cargo in Nigeria which has not been fully exploited, a situation he attributed to lack of awareness of the prospective clients and the keen competition offered by other means of transport by land and sea.

Air cargo transport offers among others advantages such as:-

1. Fast delivery: The air transport presently offers the fastest means of transportation the world over. It has the shortest turn around time than any other means of transportation. The singular factor 'speed' has deposed the use of other means of transport in the handling and delivery of mails, newspapers, perishable goods such as flowers, vegetables, vaccines, medicines etc. Over long distances within the shortest time possible.

2. Cheaper packing: Air Cargo transport offers cheaper goods packing and handling than as obtained in ship transport. It is possible to use rubust materials, and methods of packing. In countries where customs duties are imposed by gross weight of a consignment packing, air freighting will comparably reduce.

3. Fresh delivery: The advantage of speed has enhanced the effective transportation of goods with short life span from going bad, stale or expire before reaching their destination.

4. Lower insurance premium: The greater speed of transit offered by air transportation has resulted to less goods handling, subjected to less loss in transit, damage, pilferage and greatly reduced period of storage. These reduction in risks, has attracted lower insurance premium for goods transported as air cargo.

Despite these numerous advantages offered by air transport, the choice of air transportation relative to other forms of transport depends on factors such as unit value, the overall cost and the exigency of the transported unit. The unit value is based on a comparison of the value of articles to be transported in relation to their weight and size. An article say a carton of jewelry having a gross weight of three kilograms and worth N50,000.00, when packed to be transported can be said to be a cargo of high unit value compared to a bag of sand which is worth about N20.00 with a gross weight of 50kg. This can be grouped as low unit value cargo.

Overall cost of good is the total production expense and the transportation incurred for it to get to the consumer. To make profit, the selling price must include the intended profit margin.

Assuming both consignments are flown from the same station to the same destination over the same route by air. If freight rate of all gross by air should be N5.00 per kilogram then three kilogram gross weight will be N15.00 as total freight cost. The total price of the three kilogram of jewelry will be N50,000.00 plus freight charge of N15.00 a total of N50,015.00. The freight rate of N15.00 equals 0.03 percent of the basic value of the jewelry and such an increase could be bearable. Therefore in this case air cargo transport can be a good means of transporting jewelry. But for the bag with a value N20.00 and weighing 50kg will incur a total freight of 50 x 15.00 = N750.00. In this case, the cost price will be N765.00 to get to the consumer. The freight charge of N750 represents 200% or 20 times the basic value of the bag of sand. Such increase in the cost of an article might not be reasonable under normal circumstances. Therefore air cargo will not be an adviceable method of dispatch.Therefore the jewelry is a higher unit value than the sand.

CHAPTER THREE

CASE STUDIES

3.1 DULLES INTERNATIONAL AIRPORT, USA.

ARCHITECTS:	Eero Saarinen and Associate Hamrden Connecticut, U.S.A.
SPONSOR:	Metropelitan Washington Authority.
SITUATION:	7km North-West of Chantily, Virginia, Washington D.C.
BUILT:	1958 - 1962.
AREA:	4,047 Hectres (10,000 acres)
REFERENCE	
LOCATION:	Longitude: $38^{o}\ 56^{1}\ 39^{11}$W
	Latitude: $77^{o}\ 27^{1}\ 24^{11}$N
ELEVATION:	95m above sea level
TERMINALS	Two level passenger terminal, Seperate general aviation terminal and three cargo buildings.
REF. TEMP:	30.2^{o}C
RUNWAYS:	Oil/19R 3,505 x 46m Concrete grounded
	OIR/19L 3,505 x 46m ,, ,,
	12/30 3,048 x 46m ,, ,,
PAVEIDENT	
STRENGTH:	90, 718kg, 113,398kg, 204,1164kg respectively.
AIRLINE	
OPERATORS:	14 Scheduled Carriers and 2 commuters

TRAFFIC

VOLUME:	1970	1975	1976	1977	1978
	2.2	2.6m	2.9m	3.0m	3.2m.

CARGO (TONNES) 17,000; 30,297; 31,0001; 35,000

3.1.1 **Historical Background**

The need for a second airport to serve Washington, DC. became apparent after the close of World War II. The second Washington Airport Act of September 7, 1950, as amended by the congressional Act of 11th July, 1958, approved for "the construction, protection, operation and maintenance of a public airport in or in the vicinity of the District of Columbia".

After many studies President Eisenhower in 1958 approved the Virginia site, which has beautiful farmland with adequate air space large enough to develop buffer zones with the surrounding residential community. 1.5 million trees seedling where planted to completely encircle the airport with a 1,000 foot wide tree belt.

3.1.2 **The Terminal Building**

The terminal building, designed by the late Eero Sanrinen, was selected for a first Honour Award by the American Institute of Architects in 1966.

Is a two level structure 180m long and 60m wide without fingers. It can be readily expanded to 360m in length by adding 90m extension to either end.

The public parking lot is slightly lower than the ground floor of the terminal. This permits a passenger flow that effectively seperate explaining and deplaning passengers. This fast and direct passenger flow accounts for the uncongested appearance of the terminal building.

A centrally located South concourse contains a passenger lounge area, a restaurant and an observation deck on the main floor while the lower floor contains offices.

3.1.3 **Functionality**

Enplaning passenger enter through one of the eight entrances located directly in front of the airline ticket counter and walk less than 70m to the mobile lounge. Explaining passengers leaving cars in the public parking lot (lower level) ascend to the ground via a short ramp and an escalator to the main floor level.

Deplaning passengers descend through one of the two escalators directly in front of the mobile lounge doors and land in the centre of the baggage claim area. A short ramp links the baggage claim area to the public parking lot.

3.1.4 **Structure**

The roof is supported by a row of columns 12m apart, 20m high on the approach side and 12m on the air field side. It is made of light suspension bridge cable between concrete panels of the roof deck fit. The concrete pillars are slopped outward to counteract the pull of cables.

3.1.5 **Concept**

In order to minimise tremendous distance covered to aircraft and to satisfy the increasing need for flexible interior space a transporter departure lounge was invented. the transporter departure lounge on the wheels and slits is a part of the terminal which detaches itself from the building and travels out to where the aircraft is conveniently parked or serviced.

3.1.6 **Merits**

(a) Commendable lateral expansion possibility

(b) Flexible interior space

(c) Decentralised entrance system

(d) Effective lateral seperation of enplaning and deplaning traffic

(e) Commendable departure lounge that satisfies passenger convenience requirements.

(f) Symbolic architectural expression.

3.1.7 **Demerits**

(a) Expansion possibility restrictive, possible only laterally

(b) Departure lounge operation cost is high, economical only where traffic schedule is high.

CASE STUDY II

3.2 KANSAI INTERNATIONAL AIRPORT, JAPAN

ARCHITECTS: Renzo Piano

BUILT: 1987 - 1993

AREA: 500 hactres

TERMINALS Three level passenger terminal and two Cargo terminals.

RUNWAYS: One runway.

CAPACITY: 160,000 Movements per year.

3.2.1 Historical Background

Kansai International Airport was planned in 1974 but work did not start until January 1987. It is the first virgin offshore Airport that was conceived due to the wise nuisance experienced by the neighbourhood in the inland Osaka airport that led to the imposition of flight sanctions allowing the use of airports only in the day and at nights stopping operations to allow the neighbourhood catch sleep.

This led to the proposal of an off shore island airport 5km off shore linked by a 3.75km rail and road bridge expressway.

The Island airport is planned with a double sided pier terminal over a mile long, with 2 cargo warehouses for Domestic and international cargo respectively with an oil tanker berth area.

3.2.2 **Functionality**

The terminal is vertically stacked with three passenger processing levels. Domestic passengers are processed on the middle and departing international passengers at the top, with international arrivals below reducing transfer passengers walking distances considerably. The land side incoperates a bus and train station and a good attempt has been made at improving indoor environment by the planting of trees within the terminal.

3.2.3 **Structure**

The most stricking structure is its giant snaking curved roof like enormous waves at the point of breaking supported by bow string trusses spanning 60m. It is one of the highest roofing systems ever adopted.

3.2.4 **Merits**

(a) Commendable compact planning

(b) effective seperation of domestic and international passengers.

(c) Flexible cargo terminal accessibility

(d) Commendable improvement of indoor environment by effective land scaping.

3.2.5 **Demerits**

(a) Expansion consideration possible only on the already long pier sides.

(b) Passengers walking distances are very long to the gate area at the piers.

CASE STUDY III

3.3 LONDON HEATHROW TERMINAL 4

AIRPORT CLASS: A1

LOCATION: Longitude: 51°28' 11" North

Latitude: 00°27' 08" West

SITUATION: 22KM (12 miles) off London city.

ELEVATION: 24M

AREA: 1,1477 HECTRES

RUNWAYS: 5

OWNERS: British Airport Authority

ARCHITECTS: Scott Browning and Turner Buildford.

3.3.1 Historical Background

The area now known as the Heathrow Airport was owned by the Fairey Aircraft Company, when the need arose for a London base for heavy bombers after the beginning of World War II, the area was taken over and developed to what is now know as the Heathrow Airport.

The airport was initially designed with three terminals and three runways which was later changed to five adopting the star of David formation, and operation commenced in 1950. The central terminal area, constrained by the runway pattern surrounding it, had developed steadily between 1950 and 1977 then the decision was made to build a fourth terminal outside the central area, using an area originally designated as an aircraft

maintenance area. The site was the last remaining one on the perimeter of the airport until the future release of major areas of land by the relocation of a sewage disposal plant. Even so the available site was severely constrained by the perimeter road and the retained crosswind runway.

3.3.2 **Terminal Building**

Terminal four was planned as a predominantly long-haul one, to relieve pressure on the long and medium haul terminal 3. The desired objective of parking the maximum number of wide-bodied aircraft directly at the terminal was achieved. It has 80% of its stands terminal served, in contrast to the 60% of terminal 1, 2 and 3 stands.

Furthermore the apron layout at terminal 4 provides for the advent of aircraft with maximum wingspan of 70m, length of 86m and tail height (under constraining runway side slope) of 21m.

3.3.3 **Functionality**

Innovative features of the terminal design are the vertical segregation of arrivals and departures, centralized security clearance and wide airside concourse without gate assembly enclosures. A London underground Piccadilly line railway station is under the Multi-story car park which adjoins two-level forecourt and supplemented by the terminus of the Heathrow Express direct rail link to London Paddington.

3.3.4 **Merits**

(a) Effective segregation of arrivals (Mezzamine level) and departure (ground level).

(b) Effective achievement of short walking distances.

(c) Good and effective passengers free flow through the complex.

(d) Effective achievement of close parking of aircrafts to terminal.

3.3.5 **Demerits**

(a) Expansion constrained by adjoining multi story high level parking.

CASE STUDY IV

3.4 **CALABAR INTERNATIONAL AIRPORT**

ARCHITECTS:	Adenrele Onisore Connecticut, U.S.A.
SPONSOR:	Nigerian Airport Authority
SITUATION:	2KM Off Calabar metropolis
AIRLINE OPERATORS:	Nigeria Airways, Okada Airline, Kabo Airline, A.D.C, British Airways, etc.
RUNWAYS:	2450m x 5m
ELEVATION:	211 above sea level
LOCATION:	Longitude: $08^{O}\ 20'\ 53"E$ Latitude: $04^{O}\ 58'\ 58"N$
OPENED:	1983.

3.4.1 **Functionality**

Enplaning passengers drop at the curb and enters the ticketing hall to check-in counters. After being issued a boarding pass proceeds to the departure lounge which leads to the apron through a 10m long finger structure.

Deplaning passengers enter the terminal through a similar 10m long arrival finger structure into the baggage claim area. All international and domestic lounges are laterally located on the ground floor with airline offices behind the check in counters and administrative offices on the floors above.

3.4.2 **Cargo Terminal**

The cargo terminal is accommodated in a $60m^2$ space adjoining the passenger terminal where both domestic and international cargo handly takes place.

3.4.3 **Structure**

A system of columns and beans of varying dimensions carrying a reinforced concrete (damp proofed) roof decking and at the same time carrying drain pipes to the ground. The foundation is of deep strip tupe with system of underground beams running below load bearing vertical elements. A dogleg staircase with 170mm risers and 250mm treads finished with terrazor connects the administrative floors.

3.4.4 Finishes

The facade is of cement sancrete blocks infill between columns plastered smooth with paint finish and at intervals including the cargo section infill material of aluminum cladding. Floors are finished according to functions; P.V.C tiles in offices, terrazo on check-in and concourses areas and non-slip cement finish in the cargo hall.

3.4.5 Merits

(a) Effective seperation of explaining and deplaning traffic.

(b) Oneness of connector elements

(c) Functional selection of finishes

(d) Effective achievement of natural lighting

3.4.6 Demerits

(a) Inadequate ticketing hall for peak hour traffic.

(b) Location of airline offices allow for introduction of unapproved baggage into airside.

(c) Inadequate cargo hall cannot accommodate wide-bodied cargo aircraft capacity.

CASE STUDY V

3.5 PORT HARCOURT INTERNATIONAL AIRPORT

ARCHITECTS:

KASHIM IBRAHIM LIBRARY

SPONSOR:	Nigerian Airport Authority
SITUATION:	About 10km off Porcourt Metropolis
AIRLINE OPERATORS:	Nigeria Airways, Okada Airline, Kabo Airline, British Airways, KLM, Concord, GAS, etc.
RUNWAYS:	3000 x 60m
ELEVATION:	81 above sea level
LOCATION:	Longitude: 050052N Latitude: 006 5701E

3.5.1 **Functionality**

All passenger processing functions take place on the ground floor of the terminal while the upper floors house the administrative functions.

Lateral segregation of functions is employed. Enplaning passengers disembark at the curb proceed into the check-in counter area for isuance of boarding pass and proceeds to the departure lounge through a 10m finger structure into the apron. Deplaning passengers leave the apron through a similar finger structure into the baggage claim area via the landside curb.

Domestic and international passengers follow the same process, but the internal lounge and concourse area are more elaborate.

3.5.2 Cargo terminal

Port Harcourt Airport enjoys a 50m x 20m cargo terminal with a truck dock and delivery bay of about 50m x 30m and an airside bay of similar size. The cargo terminal has a departure cargo hall of 20m x 10m at one end and arrival cargo hall of 30m x 20 at the other with administrative offices sanwitched in between, the departing and arrival hall of 20m x 10m.

Housed within the cargo halls are: a 2 x 1.2m cold room for perishable goods and a 1.2m x 1.6m safe for valuables.

3.5.3 Structure

The passenger terminal of a similar structure as calabar airport terminal.

The Cargo hall is of aluminum cladding on 'I' section Steel columns spaced at 10m centres supporting a steel space frame roof. All doors are roller track doors. The floor finish

is of a non-slip cement concrete finish, with a trailer dock of 900mm height at the land side delivery bay.

3.5.4 Merits

(a) Effective segregation of arrival and departure Cargo halls.

(b) Adequate ventilation and natural lighting in both cargo halls.

(c) Effective docking area.

3.5.5 **Demerits**

(a) The sandwitching of administrative accommodation between the two cargo halls has rubbed it of natural lighting and ventilation.

(b) Non-availability of storage racks

(c) No defined air mail cargo areas.

(d) No provision for cargo pallets storage areas.

CHAPTER FOUR

SITE AND ENVIRONMENTAL DATA FOR AIRPORT PLANNING

4.1 CRITERIA FOR AIRPORT SITE SELECTION

The selection of a suitable site for a new airport, is being guided by certain criteria which are the determining factors for its location and size. They are viz:

(a) Type of development of the surrounding area.

(b) Atmospheric conditions

(c) Availability of land for expansion

(d) Pressure of other airports on the general area.

(e) Accessibility to ground transport

(f) Surrounding Obstruction

(g) Economic consideration

(h) Availability of Utilities

(i) Proximity to aeronautical demand.

4.1.1 Type of Development of Surrounding Area

This is an extremely important factor, since from the stand point of noise particularly, the activity of an airport is often quite objectionable to the airport's neighbours. Sites which offer the closest compatibility with airport activities should be given priority.

Proximity to residential neighbourhood should be avoided whenever possible. However, for spousely developed site, enactment of zoning statutes for the control of land adjacent to the airport should be considered to avoid future conflicts. Noise is an extremely important factor where jet aircraft operations are anticipated the adverse

community reaction to noise has increased since the introduction of jet aircrafts. It is desirable to provide a buffer zone between the runways, taxiways, aprons, etc. and the boundaries of the airport property, in order that nuisances created by activities of the airport be at least partially attenuated.

The amount of acreage within the airport's boundaries to a high degree dictate the types of land uses to be therein. For airports with limited acreage, most land uses will be aviation oriented. Considerable attention is being given these days to providing space on the airport for industrial users, especially those utilizing company aircraft or whose personnel travel extensively and whose operations are not hampered by aviation noise. Taxiway access is provided directly to the industry's door. In some instances, railroad tracks serving the industrial area, company parking lots, or low-level warehousing can be located directly under runway approaches (but free of clear zones). Care is taken, however, to eliminate from consideration industries which might produce electronic disturbances which would interfere with aircraft navigational or communications equipment or cause visibility problems due to smoke. Recreational uses such as golf courses and cricketing areas are quite suitable for airport land uses and may in effect serve as good buffer areas.

Certain agricultural uses are appropriate for airport lands but grain fields which attract birds should be avoided. Where water bodies such as lakes, rivers, streams, reservouiers exist, within boundaries, care should be taken to avoid water bodies that attract large numbers of water-fowl. Dumps, fields and tree belts which attracts birds should be avoided.

4.1.2 Atmospheric Conditions

Site selection should be free from visibility reducing conditions. Poor visibility lowers the traffic capacity of the airport. Conditions such as fog, smoke and haze impare visibility. fog generally settles in the area where the wind blowing is minimum, e.g. in a valley. Smoke and haze nuisance exist at sites nearer to the industrial area. Therefore, trends of the future development of industrial area should also be studied and the site should be selected accordingly.

4.1.3 Accessibility to Ground Transport

Consideration should be given to site accessibility during site selection. The airline passenger is more concerned with his door-to-door time rather than the actual time in air travel. The time to reach the airport, is therefore an important consideration specially for short haul operations. The time required to reach an airport in a passenger car from the business or residential centres, should normally not exceed 30 minutes. The best location is a site adjacent to the main highway. This provides a quick access and minimises the cost of an entrance road.

For Cargo airport, accessibility of cargo trucks and their free manouring into and out of the airport enhances its operation and decongests the city centre. Consideration should be given to its location close to industrial zones where its services will be highly required. Careful study should be carried out to avoid industrial trucks traffic crossing the city centre to access the airport as this will obstruct traffic. Where there is a forecast

for a busy airport, special transportation means such as railways, electric trains should be considered as a means of decongesting the airport.

4.1.4 Availability of Land for Expansion

In a field so dynamic as aviation it is necessary to acquire in advance or be able to acquire sufficient real estate in the future for expanding the airport plant. Historically, as the size of aircraft and the volume of traffic increased, runways have had to be lengthened, terminal facilities expanded, and additional support facilities provided. sufficient real estate must be available to accommodate new facilities.

4.1.5 Presence of Other Airports in the General Area

This must be given due consideration when selecting a site for a new airport. It should be selected at a considerable distance from the existing airport to avoid landing manouviring interference with the movement of aircraft at other airports. The required distance between airports depends mainly upon the volume of air traffic, the type of aircraft and the air traffic control, i.e. whether the airports are equipped with instrumental landing facilities or not. The minimum spacings have been suggested as a guide for planning viz:

i) For airports serving small general aviation aircrafts under VFR condition = 3.2km (2miles)

ii) For Airports serving bigger aircrafts, say two piston engine under VFR conditions = 6.4km (4 miles)

iii) For airports operating piston engine aircrafts under IFR conditions. 25km

iv) For airports operating jet engine aircrafts under IFR conditions = 160km (100 miles).

Where the above minimum spacing between the airports cannot be provided, then the landing and take-off of aircrafts in each airport should be properly timed to avoid accidents. This obviously reduces the capacity of each of the airport involved.

4.1.6 **Surrounding Obstructions**

In airport site selection consideration is given to approaches necessary for runway landing and take-off on the site are free of obstructions. Provision and protection of adequate approach to an airport to necessitate height restrictions in the airport turning zones in line with the runways. During the planning stage steps towards precluding the possibility of future erection of obstruction to aircrafts using the airport should be taken. Obstructions may consist of fences, trees, pole lines, buildings and other natural or man made objects. Some times the ground may naturally slope upwards from the end of runways to such an extent that it forms obstructions to aircrafts operations.

The participation of the Federal Government in the finance of a new airport or the reconstruction and expansion of an existing one requires that 'clear zones' at the ends of runways be provided by the operator. Runways clear zones and areas comprising the innermost portions of the runways approaches as defined by FAR Par 77. The dimension of the clear Zone, areas are shown in the figure below. (See diagram).

4.1.7 Economic Consideration

The cost estimate should be prepared for the entire airport construction considering both initial and ultimate stages. If there is to be alternative site, the one which is more economical to be constructed should be given priority consideration. The estimate should include land cost, clearing and grading of land, drainage, removal of hazards, paving, turfing, lighting, construction of buildings, access roads, and automobile parking areas.

4.1.8 Availability of Utilities

An airport requires reasonably longer quantities of water, national gas or oil, electric power and fuel for aircraft and surface vehicles. Disposal of sewage is a factor that must be given due consideration during site selection.

4.1.9 Proximity to Aeronautical Demand

This should be an important area to be considered when locating an airport. Ground access should be as short as possible, the advice has always been to establish regional airports at considerable distances from centres of population. Records from U.S.A. shows that about half of the passengers are local travelling not more than 820km i.e. they are short hand operations.

4.2.0 FACTORS INFLUENCING AIRPORT SIZE

There are certain determinants of the size of an airport to be constructed. These factors primarily determine the airport size and its classification by the international civil aviation organisation (ICAO). These are as follows:

4.2.1 Performance Characteristics and Size of Aircraft Expected to Use the Airport

The performance characteristics of aircrafts have a direct bearing in the length and load bearing capacities of runways. Where long haul flights and heavy traffic is expected, larger aircrafts are more economical and therefore calls for long runways. But where the anticipated traffic makes it serve the functions of a hub and spoke, short haul traffic will be much considered and both aprons and taxiways should be given such consideration in sizing.

4.2.2 Anticipated Traffic Volume

The volume and character of expected traffic have an influence in the number of runways required, the configuration of taxiways and the size of aprons area. Baggage and cargo volume forecast do greatly influence the size of an airport as consideration should be given to internal land traffic manoeuvering by service vehicles and feeder vehicles within the airport layout. A clearly defined traffic pattern is an asset to airport patronage as much time is saved and facilitates door-to-door accessibility to the units being served.

4.2.3 Meteorological Conditions

Important meteorological conditions which affect the size of an airport are wind, temperature and cloud cover. Temperature influences runway lengths. The direction of the prevailing wind indicated on a wind rose is an influencing factor of the terminal building location, which should not be against the prevailing wind. The amount of cloud cover determines visibility and the period of restricted visibility has a restrictive influence on the number of expected flights in a proposed airport. Visibility enhances landing and take-off operations in airports. Though modern jet aircrafts can rely on landing instruments, the essence of visibility cannot be ruled out therefore, much should not be left to chance.

4.2.4 Classification of Airport

The classification of the airport under consideration is an important determinant of its size. The International Civil Aviation Organisation (ICAO) classifies airports in two ways; In the first case, classification is based on basic runway length and the second, based on aircraft wheel load characteristics.

(a) Classification by runway lengths has been done by using code letters viz. A to E in which the A type of airport has the longest runway length and E type has the shortest length. See table below;

Runway Length Geometric (ICAO)

AIRPORT TYPES	BASIC RUNWAY LENGTH				RUNWAY WIDTH		MAXIMUM LONGITUDINAL GRADE
	MAXIMUM		MINIMUM		PAVEMENT		
	m	ft	m	ft	m	ft	%
A			2100	45	45	150	1.5
B	2099	6999	1500	45	45	150	1.5
C	1490	4999	900	30	30	100	1.5
D	899	2999	750	22.5	22.5	75	2.0
E	749	2499	600	18	18	60	2.0

i) Maximum effective: 1.0 percent for ABC and 2.0 grade percent for D and E types.

ii) Maximum transverse: 1.5 per cent for ABC and 2.0 grade percent for ABC and 2 percent for D and E types

iii) Rate of change of: For 30m (100ft) length of vertical Longitudinal grade curve 0.1 percent for AB, 0.2 percent for Card 0.4 per cent for D and E types.

iv) Safety area:Minimum width of 150m (500 ft) for ABC and 78m (260ft) for D and E types. It extends at least 60m beyond runway end on either side.

In the second method, classification is based on equivalent single wheel load (ESWL) and the tire pressure of the aircraft which will use the airport. This is done using numerical numbers viz. 1 to 7 as shown in table..

CODE	SINGLE ISOLATED WHEEL LOAD		TIME PRESSURE	
	Kg	1bs	Kg/cm^3	$1bs/in^2$
1	45,000	100,000	8.5	120
2	34,000	75,000	7.0	100
3	27,000	60,000	7.0	100
4	20,000	45,000	7.0	100
5	13,000	30,000	6.0	85
6	7,000	15,000	5.0	70
7	2,000	5,000	2.5	35

4.2.5 **Environmental Analysis Deduction**

Environmental factors must be carefully considered in the development of a new airport or the expansion of an existing one. Studies of the impact of airport construction and operation upon acceptable levels of air and water quality, noise levels, ecological processes, and demographic development of the region must be conducted to determine how the airport requirements can best be accomplished comfortably within the site under consideration.

Noise, which is the severest, should always be considered and proper planning of the site neighbourhood noise levels can be reduced effectively if well executed.

Air and water pollution, industrial waste and domestic sewage originating at the airport and the altering of natural environmental values. Environmental studies should

include statements on how waste problems should be solved, as it can become a restrictive factor on future expansion.

4.2.6 **Environmental Impact Studies and Analysis**

Airports as an entity of human creation, being foreign where they are sited, alters in one way or the other some balances in the immediate and surrounding environs which most times if overlooked degenerates into problems that may become almost insummontable.

This impact on the natural environment has restrictive influence on site locations acceptability since it might be incompatible with the site if restrictive and corrective measures are not considered in airport size consideration. The environmental study envisages and indicates how this problems can be alleviated.

Airport environmental impact statements guidelines by Government Agencies requires that findings should include:

i) The environmental impact of the proposed development.

ii) Any adverse effects which cannot be avoided should the development be implemented.

iii) Alternatives to the proposed development.

iv) The relationship between local short term uses of man's environment and the maintenance and enhancement of long term productivity.

v) Any irreversible environmental and irretrievable comitments of resources

vi) Growth inducing impact.

HASSUM IBRAHIM LIBRARY

vii) *Mitigation measures to minimize impact.*

The outcome of such impact assessment studies goes a long way in determining the size and acceptability of airports future expansion within the site under consideration and due alternative considerations.

CHAPTER FIVE

AIRPORT MASTER PLAN

5.1.0 DEFINITION

According to Horonjeff, 'an airport master plan is a concept of the ultimate development of an airport". The term 'development' includes the entire airport area and the land use adjacent to the airport.

The planning of an airport is a complex problem that analysis the wide range of activities which have differing and often conflicting requirement but interdependent so that a single activity may limit the capacity of the whole complex. The airport system is divided into two major components, the land side and the air side, with the terminal buildings forming the interface between the two components. The characteristics of the two components activities defines and determines its complexity and in turn its configuration and effectiveness depends on the parculiarity of the site as there are no rigid master plan rules for airport design but its design is only guided by laid down principles.

Though, the scope of this thesis is limited to terminal design, the basic elements of airport planning will be mentioned to relate their inter dependence.

5.2.0 AIRPORT CONFIGURATION

"Airport configuration is as the number and orientation of runways and the location of the terminal area in relation to the runways". This therefore includes all airside components that characterize air side activities including runways, taxiways, and aprons (as influenced by the site), meteorological factors, the airport capacity and the adjacent neighbourhood.

_____ Aircraft flow

..... Passenger flow

Source: Horenjeff (Planning and design of Airports).

5.3.0 RUNWAY DESIGN

Runways are the most significant components of airports. The landing and take-off of aircrafts take place on runways. Maximum strength of runways are required for this operation and not just a strip of tarmac. A B-747 weights 373, 500kg, including 400 passengers and 18 crew weight, touching down at 240km/h (150mph) suggests why there is more to building a runway than merely a strip of tarmac.

Runways vary in length, short ones for light aircrafts and long ones for big jets. Aircraft size and weight therefore are of vital consideration when deciding on the length of a new runway. A B-747 must have at least 1,980m to land safely, although 3,000m is a more realistic figure for an aircraft making a difficult landing and a late touchdown along a short runway.

Average width of runways for international airports are between 45-60m. Heathrow airport is possibly unique in having three 90m wide runways.

5.3.1 Runways Orientation

Runways are usually oriented in the direction of the prevailing winds. The head wind, i.e. the direction of the wind opposite to the direction of landing and take-off, provides greater lift on the wings of the aircraft when it is taking off, as such the aircraft rises above the ground much earlier and in a shorter length of runway. During landing the head wind provides a braking effect and the aircraft come to a stop in a smaller length of runway. Landing and take-off if done in the wind direction will take longer runway.

5.3.2 Cross Wind Component and Wind Coverage

Cross wind component is the wind that blows along the direction of the centre line of the runway. The cross wind component may interrupt safe landing and take-off of air-crafts. The maximum permissible cross wind component depends upon the size of aircraft and the wing configuration. The following recommendations are made by the Federal aviation authority (FAA).

Aircraft	Wind component	Speed Km/h
Small aircrafts	≥	15
Mixed traffic	≥	25
Big aircrafts	≥	35

The percentage of time in a year during which the cross wind component remains within the limits as specified above is called wind coverage. FAA stipulates that runways handling mixed air traffic should be so planned that 95 per cent of time in a year, the permissible cross wind component does not exceed 25kph and for busy airports it may increase to 98 percent to 100 percent.

For efficient traffic flow the runway and the connecting taxiways should be arranged so as to:

i) Provide shortest taxi distance possible from terminal area to the end of runway.

ii) Provide adequate seperation in the air traffic pattern.

iii) Cause the least interference and delay in landing, taxying and take-off operations and

iv) Provide adequate runway for quick exist of runway by landing aircraft and follow routes as short as possible to terminal area.

5.3.3 Runway Configurations

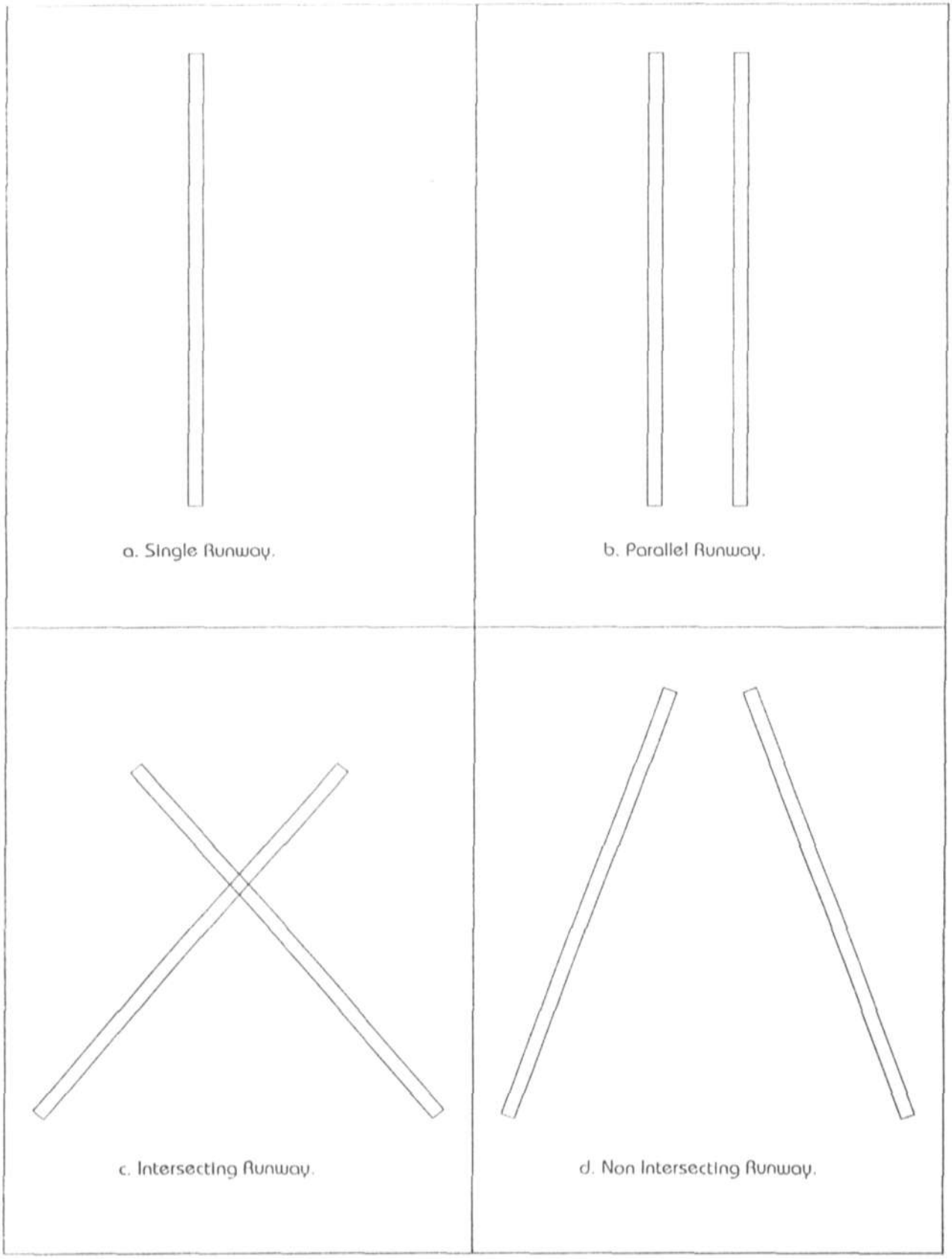
The capacity of an airport depends upon its runway configuration. The pattern of runway to be finally adopted at the site depends upon the volume of air traffic to be handled, the direction, duration and intensity of wind, availability of suitable approaches etc. The basic runway patterns are as follows:

i) **Single Runway**

This is the simplest runway pattern, and is usually dopted when the wind blows in one direction. It has an hourly capacity estimate of between 45 and 100 operations per hour in visual flight Rule (VFR) conditions and 40 and 50 operations per hour in Instrument Flight Rule (IFR). (See diagram).

ii) **Parallel Runways:**

The capacity of this pattern depends upon the lateral spacing between two runways, the weather conditions and the navigational aids available at the airport. Spacing between parallel runways varies considerably and can be classified as 'close', "intermediate" and "far". Close runway spacing varies form 213m to 1067m, intermediate runways 1067m to 1524m and 1310m and above for far runways. (See diamgram).



⊙ **Figure Showing Runway Configuration.**

iii) **Intersecting Runways:**

This is usually adopted when relatively strong winds blow from more than one direction, resulting in excessive cross winds. (See diagram)

iv) **Non Intersecting Runways:**

Here it depends on the wind condition and visibility. The two runways may be used alternatively for landing or take-off of aircrafts as the wind directive may decfate at a time. (See diagram).

5.4 TAXIWAYS

This are specially prepared tracks to provide the shortest possible access to landing aircrafts from the runway to the loading apron or service hanger and back. They should be designed for effective aircraft clearance of runway upon landing to prevent interference of other landing aircrafts.

5.4.1 Exit Taxiway

High-speed exist taxiways are designed for a higher speed exit and angles made by them with the runway are of the order of 30: The location of exit taxiway depends on great extent on:

i) the mix of aircraft

ii) the approach and touch down speeds

iii) The exist speed and

iv) The rate of deceleration which in turn depends on the pavement surface and number of exits.

Basic Taxiway elements are:

i) Structural pavement

ii) Shoulders

iii) Safety areas.

5.5 APRON DESIGN

An apron is the wide pavement that connects the terminal building to the runway, and used for aircrafts parking, for loading, off-loading and refueling operations. There are many configurations of holding aprons, but the important design criteria for aprons are:-

i) Adequate spacing of aircrafts to enhance easy maneuvering within parked aircrafts.

ii) Sufficient room for parked aircraft and servicing vehicles such as, fueling, cabin cleaning, water tanks, toilet etc.

5.5.1 Parking on Aprons.

It is worthy of note, to consider passengers protection from adverse effect of jet blasts, noise and weather, when designing aprons.

The two methods of aircraft parking on aprons involve the push out operation (assisted) and the power-out operation (unassisted).

i) **The push-out operation** involves the use of expensive tractors and personnel to tow the aircraft out of the aircraft gate position before it is powered away from the apron, after loading. (See diagram).

ii) The power-out operation involves, the aircraft powering itself from the gate area unassisted after loading. The operation requires large apron area, and terminal protection from blasts from the aircraft. (See diagram).

However, to achieve either of the above mentioned operations, the determining factor for a successful opron layout is the aircraft parking angle. The four basic parking angles are viz:

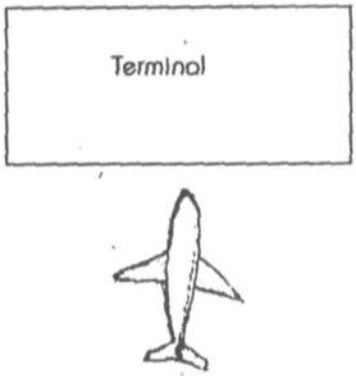
(a) **Nose in parking**: Aircrafts are parked perpendicular to the terminal building line. The operation here involves power-in and push-out.

(b) **Angle nose-in parking**: Aircrafts are parked at other angles to the building line with their nose pointing towards the terminal building. The operation involves power-in and power-out by its own engine (unassisted).

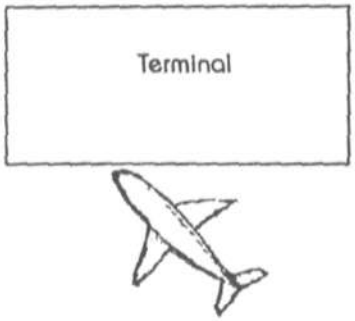
iii) **Angle nose-out**: Aircrafts are parked with their nose pointing say from the terminal building at angle. The operation calls for power-in and power-out. (See diagram).

iv) **Parallel Parking**: Aircrafts are parked parallel to the terminal building line, the operation requires more parking area and has the advantage of passengers loading at both forward and rear aircraft doors at the same time. (See diagram).

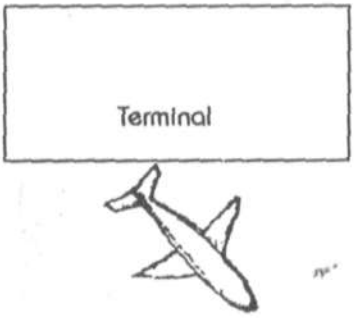
Other operations that take place on the apron include fueling, fire fighting, toilets discharge, catering vans services, etc.



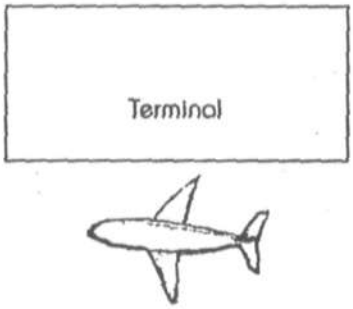
None In parking



Angle nose-In parking



Angle nose-out parking



Parallel parking

Basic Aircraft Parking Angles

5.5.2 **Aircraft Fueling:**

Aircrafts fuelling operations take place on the apron and there are three methods of aircrafts fueling or a combination of this methods in airports.

i) **Fuel Trucks**. This entails the use of fuel trucks which can fuel the aircraft flexibly any where on the apron. This method though has the disadvantage of apron congestion, particularly for aircrafts with a short gate period requiring all services operations at the same time. But it is economical.

ii) **Fuel pits**: In this system fuel is piped from a central fuel storage area to a connecting point consisting of a pit adjacent to the aircraft stand. It is then pumped by a mobile unit into the aircraft. The process though avoids the risk of fire, requires duplication of pit materials at strategic aircraft gate areas and requires replacement when aircrafts sizes change.

iii) **Fuel hydrant**: This involves the pumping of the fuel direct from the storage area by pressure to the hydrant valve adjacent to the aircraft stand and then metered by a mobile unit into the aircraft. It is more popular, but vehicles are not entirely removed from the apron though hydrant dispensers are smaller.

5.5.3 **Fire Fighting**

Fire precaution and rescue fire fighting operations is an important part of airports services, which should be considered in airport design. At present there is a whole range

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of purpose-built fire fighting equipment available ranging from small, rapid intervention (RIVs) to very large multi-wheel appliances. The size of fire fighting facilities provided at an airport depends on:

i) The size of the Airport.

ii) The number and type of aircraft expected in use at the airport.

The location of fire fighting facilities should be such that there is:

i) Unobstructed view and access to all airport areas.

ii) All weather response - 3 minutes to crash site any where on the airport.

iii) Space for expansion as the airport system grows.

It is important for fire fighting personnels to be accommodated close to the vehicles and staff amenities such as changing rooms provided and facilities for maintenance and repair work on fire apparatus provided.

CHAPTER SIX

AIRCARGO TERMINAL DESIGN

6.1 INTRODUCTION

This chapter is designed to guide and direct the planning, design and construction of future air cargo terminals or the modification or expansion of existing terminals.

The initiators of the project should generate policy objective establishing the need for the, source of funding and the period during which the project can be completed. It should also ensure that all possible alternatives are investigated prior to determining the imidiate course of action.

6.2 ESTABLISHMENT OF AIR CARGO REQUIREMENTS

Within the last decade, aircargo growth rate exceeded that anticipated by the industry. What has now forced the industry to react initaterally to seek solutions is congestion, service failures and escalating pilferage rates.

Other problems that plague metropolitan airports include

(a) Ground handling link between the consignor, the airborne segment and the consignee..

(b) The air cargo terminal siting, design and operation equipments in use is a prime contributor to total air cargo costs.

In the planning of new cargo terminals, emphases must be placed on the following:

(a) Efficient and speedy handling of all types of cargo shipments.

(b) New or improved handling equipment and procedures must be developed

(c) *Terminal buildings and aprons must be able to handle the maximum unit or total volumes of weights of air cargo shipments which may be carried on both current* and future generations of aircrafts.

Within the past five to ten years, individuals airlines in company with an ever-increasing number of materials handling manufacturers have developed parallel concepts of air cargo terminal design and associated materials handling equipment, techniques and systems. The aim being the reduction

of door-to-door section times on either side of air borne portion of cargo journey.

Though I.A.T.A., A.T.A, various government and industry committees for a seminars, the industry has participated in the development of standardised unit load modules (containers, pallets, igloos etc).

The state of - the art in the design and manufacture of mechanised equipment and systems which readily lend themselves to computer commands and ultimately to extensive automation, is well advanced. A degree of standardation is evolving between airlines and equipment manufacturers. The end objective is to handle a greater volume of air cargo in less time.

An important consideration to be given by designs of equipment and systems is the increasing use of standard cargo containers and pallets. The planners must make particular allowance for the extreme in container and pallets sizes, and the special techniques which are necessary to ensure safe handling.

It is virtually impossible to arrive at a basic air cargo terminal design that will meet requirement of any given operator or location when the following options are considered.

- An international carrier without domestic routes needs bonded facilities.
- Relatively large hold and storage areas and customs oriented documentation procedures. High speed movement of air cargo through the terminal building is characteristic of an international operator.
- A domestic carrier needs far less than mere loose space, for a comparable volume of carriage, a small bonded area and relatively simple documentation procedures.

6.2.1 Basic Requirements for Cargo Terminal Design Planning

As in the case with passenger terminals a single design concept cannot meet the varying needs of all carriers or all geographical areas. There are however common guidelines that a cargo terminal planner shall follow. These are:

(a) Collect all possible information related to past, present and future cargo traffic forecasts from airlines sources.

(b) Determine the impact of cargo, mail and company stores upon the facility.

(c) Determine the desired materials handling system based upon the nature and volume of the forecast traffic and the operating method best suited to the particular locality.

(d) Design the terminal to accommodate the desired materials handling system and with the ability to be progressively expanded within the confines of the building site.

(e) Ensure that the site area will accommodate required gate positions, truck ramp areas and customer/employee parking area/access and will allow for future expansion.

(f) Site the terminal with due consideration of the type of operation(all cargo or combination) and to provide the shortest possible time for the movement of on-time interlane and in-bond cargo.

(g) Incoperate within the basic terminal confines, sufficient space to accommodate engineering and maintenance, fixed or installed equipment, parking and refuelling of ground powered equipment.

(h) Maximize internal overhead dimensions, (head rooms), as well as clear floor space to allow optimum utilisation of available cubic capacity and to accommodate multi-level unit load handling and storage.

(i) Limit the amount of administrative area occupying warehouse floor space to the absolute minimum and consider second level administrative accommodations wherever possible.

(j) Consider means of preventing the unauthorised removal of air cargo and equipments.

(k) Provide adjustable or flexible interfaces at air-side and land-side to accommodate fixed loading bridges, mobile ramp equipment and variable delivery/collecting vehicle heights.

(l) Provide terminal building by-pass means to transfer unitised loads or large single pieces between air-side and land-side.

(m) Make adequate provision for holding or stacking areas for unitised loads, including cargo containers and lower deck containers both of which have specialised handling requirements. In the case of lower deck containers, particular attention should be paid to the necessity for ensuring that such facilities will enable the containers to be handled expediously at all times, including periods of unavoidable multi-operations, as it is essential to keep aircrafts ground times to a minimum.

6.2.2 **Planning Forecast**

Accurate detailed forecasting with intelligent and logical anticipation are essential for a realistic and expandable future terminal, therefore cargo traffic forecast form the base reference plan for planning forecast.

6.2.3 **Data Collection**

A proposed cargo terminal scope determines the amount of required data and included are:

- Distribution of consignments/packages by weight dimensions and volume. And distribution of packages per consignment.
- Rations of transfer or transhipment cargo.
- Percentage of containers or pallestised cargo.
- Percentage of bulk and heavy piece cargo.

- Nature of cargo, etc e.g. air cargo, express cargo perishable cargo or air mail, company store, etc.
- Storage times applicable to particular types of cargo
- Variations in volume of time of day, day of week, etc.
- Destination distributions of export, imports and transhipment traffic.
- Arrival pattern of trucks delivery, and collection from the terminal.

6.2.4 **Analysis of Collected Data**

This involves the provision of complete statistical descriptions of the total operation within the terminal to give knowledge of cargo-handling systems appropriate to the study, as they relate to cargo flow rate to meet commercial and aircraft operation demands and establish storage requirements.

6.3.0 **PRODUCTION OF FORECASTS**

For terminal future demands forecasts consideration should be given to the collected data as they relate to the following:

(a) Effects on future operations of observed trends on increase in size or weight of the average consignment or package.

(b) Projected flight schedules and future availability and utilization of aircraft cargo capacity, with consideration of new aircraft types.

(c) Traffic growth projections for both the interim and the period under review.

6.3.1 Service Standards

It is essential that standards of service are established for the guidance of planers. Such standard may be connected with customers services, e.g. waiting time for boarding or unloading of vehicles, or the operational needs, e.g. aircraft loading and unloading times. Particular consideration should be given to ensuring that cargo when carried on passenger aircraft, does not adversely effect accepted passenger standards.

6.3.2 Space Requirements

It could be mis-leading to present a general formular for converting forcasting cargo traffic vehicles into physical space requirements because of large variations in local conditions such as delivery patterns, storage times in terminals, use of pallets and containers, use of all cargo aircraft, ration between domestic to international traffic, and different handling system used. Local consultation with airlines will assist an Airport Authority in obtaining this information. Nevertheless, it is extremely important for planners to get the best possible indication of total space requirements, at the earliest possible stage. Therefore, a formular should be developed based on daily, and/or hourly peace volumes of air cargo, for each particular location where new cargo terminal facilities are being considered. Formular preparation should be jointly carried out with the concerned airlines.

6.4.0 GENERAL DESIGN: CARGO TERMINAL CONCEPT PLANNING

The need for a new or extended cargo facility may originate from two sources:

(a) Basic planning criteria and statistical analysis of projected volumes of cargo traffic will normally indicate when a new cargo facility is required.

(b) Also it is recognised that the erection of a new cargo terminal facility is as a result of a unilateral decision by Airport Authorities generally when cargo activities in and around passenger terminal becomes a serious problem or when new industrial and political policies indicate the need for a new terminal facility to handle expected increase of cargo volume. Calabar International Cargo Airport, fits in this category.

Cargo terminals follow three basic concepts:

1. **Passenger terminal cargo facility**

Where Airport authority persist, cargo is processed and stored in the passenger terminals by airlines moving very low volumes on a low flight frequency.

2. **Multiple occupancy cargo terminal**

Normally recognised as modular construction Cargo sheds (or warehouses) seperate from the passenger terminal area, and shared by a number of airlines.

3. **Single occupancy cargo terminal**

Where an individual airline plans, designs and constructs a cargo terminal for its own exclusive use. This often occurs at extreme high volume points where multiple occupancy cargo terminals are too restrictive and do not readily lend themselves to expansion, or are not functionally adaptable to the individual needs of the carriers.

The choice of the most practical concept is contingent upon an airlines short and long range objectives. hence creation of basic planning criteria should be founded upon these objectives. When they have been established, written information of the project can be prepared and circulated for consideration by personnel who are directly or indirectly involved.

6.4.1 **Preliminary Schedule**

A preliminary schedule should be prepared incorporating:

- Required date of occupancy.
- Number of years facility is expected to run before expansion is required.
- Deadline date for completion of planning.
- Estimated length of time for creation of terminal design drawings.
- Construction period.

6.4.2 **Sitting of Terminal**

The following factors should be taken into consideration when choosing sites for cargo terminals.

- The site should be in accord with the long range master plan and should be reviewed at periodic intervals with expansion consideration in mind.
- Considerable land should be provided to meet requirements and expansion for the future.

- The site should be adequate to accommodate future needs such as, automation, clear accessibility, short aircrafts taxing routes, good ground link between passenger and cargo terminal, prevailing winds consideration in terminal orientation and the non-infringement of flight operation in apron position with non-interfered electronic equipments or navigation.

6.4.3 By-Pass System for containers Traffic

Thought should be given to container by-pass system access to the apron to facilitate direct flow of cargo received can containers from shippers which due to size and volume cannot be handled automatically. Provision should therefore be made for a direct access to the airside of terminal, though the system is disadvantaged from the security point of view, but necessary during emergency.

6.4.4 Cargo Apron

For effective cargo handling the cargo apron should be designed as a continuation of the cargo terminal. All load and unloading processing should be carried out on the apron and its design should allow its expansion flexibility which should be synonymous to terminal expansion. Aprons layout should accommodate all ramp and service vehicles without interference with aircraft parking. Provision should be made for fixed ramp equipments such as multi-level container and pallets handling facilities including conveyors (where in use).

6.4.5 Cargo Terminal

The cargo terminal should be considered as a flow system during its design. A system that starts from the cargo ramp or apron through the terminal on to the truck docks and ending with the road system or vise versa. Though security is an area of concern and consideration in design, speedy flow of cargo should be of equal concern. Therefore functional cargo terminal is one that resolves the problem of security and at the same time speed of materials movement, therefore both should not be compromised.

6.4.6 Design Guideline

The design of Cargo terminal should first of all consider the level of automation required and provision should be made

for future expansion of such facilities or their modification to meet aviation needs.

6.4.7 Operating Levels

In the past, cargo terminals where designed around single operation level. But modern systems employ vertical storage for cargo, thereby requiring higher structures and headroom for operation machines. This system holds particular interest where vertical expansion of the terminal is most economical.

6.4.8 Government Controls

Government requirements must be given consideration in cargo terminal planning. Excessive control can drastically effect the effective functioning of cargo terminals.

Compatible controls would yield more effective results with the flow pattern established by airlines.

6.4.9 Cargo Flow Principles

Design and layout principles of cargo terminals should satisfy the following principles:

(a) Cargo aircraft should be loaded and unloaded at the cargo terminal.

(b) The flow of cargo to and from aircraft and of transfer cargo between aircraft should be smooth and uncomplicated.

(c) Distance between the various points in the flow sequence should be as short as possible.

(d) Direct access between passenger aircraft apron and cargo terminal is a necessity.

(e) Access to the cargo terminal from the apron (air side) and the road (land side) should be direct, convenient and under cover.

(f) Physical barrier between handling areas for the import and export of air cargo should be avoided where possible, to permit maximum flexibility in utilising available space in the cargo terminal, particicularly in storage areas.

(g) Adequate provision should be made for containers and pallets handling between trucks, terminals and aircrafts.

6.5.0 CARGO HANDLING AND DATA PROCESSING SYSTEM

Prior to determining the actual design and construction of the cargo terminal, the system to be selected for the handling and processing of cargo and relevant data in a facility should be established.

Important consideration in a chance of a system are economy, speed in handling, operating liability and capability of providing the necessary traffic handling data and on accurate inventory control. These factors requires careful analysis in relation to the effect on the degree of automation and mechanisation to be adopted and the extent to which maximum utilisation of the terminal capacities can be achieved.

Systems employing horizontal or vertical movement of shipments or both are now available. The types of equipments presently in use include belt rollers and roller conveyors, heavy duty elevators, automatically controlled travelling carts, vertical stanking units for "storage, pallets and containers, automatic weigh bridges, and a wide veriety of mobile equipment. There is also increasing large volume containers requiring considerable study and analysis to find the most suitable materials handling systems, their interphasing and control.

6.5.1 Space Requirements

Two principal factors govern actual space requirements in cargo terminals space layout.

One is the rate of flow which depends on the handling system employed and the cargo carrying capability of passengers and all cargo aircraft including frequency of

services. The other relates to the future storage requirements in the cargo terminal which is a feature depending heavily upon the procedures used by airlines in preparing goods for shipment and delivery, and the implementation of new procedures as the volume of air cargo increases.

The planning of space requirement in cargo terminals is a complex matter which calls for careful study. For example, although rapid and continuous movements of air cargo is a desirable objective, certain interning waiting period may be clearly foreseen and appropriate holding space provided, as necessary.

Thought should be given to vertical storage containers and bulk cargo. Vertical storage greatly improve space utilisation and may increase handling costs in the long

6.6.0 **HANDLING OF UNITISED LOADS**

- Unitised load is a term that relates to the system of industrial aircraft containers or pallets that provides for rapid aircraft turn around times. The containers or pallets to which reference is made in this section are those having a flat base and conforming to the characteristics of an IATA standard container or pallet.

Unitised Load

For the purpose of cargo terminal design, unitised loads fall into two major categories:-

(i) **Shipper Unitised Loads**

These are complete shipments ready to board the aircraft, (ready for lock-down) normally requiring no other handling than storage and transportation to the aircraft. These loads are generally from shipper door to consignee door.

(ii) **Airline Unitised Load**

These are shipments that only require handling from airport terminal to another airport terminal, which may be either a transfer airport of a destination airport. The airline unitised load may be comprised or individual shipments or some form of smaller prepacked container (i.e. various IATA standard size containers).

The main differences between the two definitions is that the shipper unitised loads will be one that allows for mechanised handling from truck to storage to the aircraft with no need to top-off net or re-arrange the load.

It must be assumed that proper and adequate programmes for training shippers to comply with standard loading practices (Shoring, dunages, weight distribution, airline and government regulations) will be established and enforced. If the shipment is not unitised in accordance with these requirements, it must be considered and handled as an airline containerised load and terminal space must be provided to handle such volume. The load must also have the capability of being handled within the carrier's close-out time.

6.6.1 Size and Shape of Unitised Loads

The cargo facility planner should be aware that cargo terminal system may have to be designed to handle several sizes of unitised loads such as-

- B747 All-cargo (Main Deck) 10 FT/20 (3m/6m)
- B747 All-cargo (Main Deck) 30ft/40ft (9m/12m).
- DC-8/B707 All-cargo (Main Deck, Pallet and Igloo.
- B747 Belly containers - (Half-size containers, full-size containers, belly pallets).

There may be other units that are part of the individual carrier's fleet, which the planner should take into consideration.

Initially, it is anticipated that the B747 all-cargo aircraft will handle containers that are 10/20ft (3/6 meters) long and that longer containers will be a part of the advanced marketing programme. The B747 10/20ft (3/6 metres) containers will therefore be the largest units considered at this time.

However, the impact of the 30/40ft (9/12 metres) containers should not be dismissed if the terminal is to be planned for more than the foreseable future. Long range planning provision should be made for the special handling and logistic problems created by the 30/40 ft (9/12 metres) containers. Consideration should be given to mechanical handling systems as well as airline loading, unloading and storage of the large containers. Long range plans should be established for the possible positioning of these large containers employed

6.6.4. Handling Characteristics of the Containers

All the containers have these handling characteristics which are:-

- They have flat bases
- They are not adaptable to being placed one on top of the other (except when empty).
- They are not adaptable to handling by fork-lift using conventional fork-lift lines.
- They are not adaptable to crahe hosting, except the 3m/6m and 9m/12m containers.

6.6.5 Number of Container Storage Positions

In preparation to determine the number of unitised load storage position required at the cargo terminal, the planner should refresh his thoughts by reviewing the recommendations described by the IATA.

He should pay particular attention to the percentages of containerised or palletised cargo and develop a methodology to convert these percentages into a number of positions. In developing the storage requirement, the following factors should be considered.

6.6.2 Layout for Handling Systems

1. Ideally, the cargo terminal layout and specific dimensions should be designed around the handling, storage and processing systems which have been developed to accommodate the projected flow of traffic.

2. The projected volumes of cargo to be handled and the flow intensities will normally dictate the scope of the system to be employed.

3. In many instances, small to medium, volume terminals can improve handling and reduce cost by employing relatively uncomplicated handling aids such as two-wheeled warehouses trucks, tug bars, non-powered roller conveyor sections, etc.

In larger terminals, however, there is now a very high degree of mechanisation and the control systems employed frequently use computers both in connection with the physical movement of the cargo as well as with the movement of documents.

6.6.3 **Engineering Parameters**

In designing the layout for cargo handling systems it is essential to ensure compatibility between selected systems and the user's mechanical engineering standards. Example of possible parameters are:-

- The layout should provide the maximum utilisation of necessary manpower with minimal initial capital cost and yearly operating costs.
- The layout should be economical in its requirement for accommodation space.

6.6.6 **Standardisatin of Components**

Standarisation within the terminal and between terminal operators of the components making up the handling systems offers the following advantages:-

- Enables the negotiation of larger contracts, hence the possibility of price reductions for larger quantities involved.
- Holds down the capital investment in maintenance spares.
- Reduces overall training of operational and maintenance staff.
- Facilitate the negotiation for the supply of spares to be maintained by the manufacturers for the life of the equipment.

6.7.0 MAINTENANCE REQUIREMENTS

The importance of plan maintenance is increasingly high-lighted with each successive development of cargo terminal mechanisation. The following list which is not exhaustive, indicates a number of maintenance subjects that should be considered at various times during a project:

- The maintenance facilities should be provided within the cargo terminal if possible or in adjacent facilities if the scope of the mechanical systems justifies this.
- An efficient system of communication between the operating and maintenance staff is essential to ensure the safety and continuing operation of the equipment to the optimum standard.
- Planned maintenance systems to include all oiling, greasing, cleaning adjusting and similar routines.
- The interface of the operational and maintenance functions (by hours of the day and days of the week) should be designed to obtain optimum operational use of

the system whilst securing regular scheduled maintenance times.

- Maintenance manuals to be provided by manufacturers. These must be provided prior to acceptance of the equipment and should contain all detail of component parts making up the plant together with the mainufacturers' recommended spares holding for the initial stock of spares.
- Plant number should be allocated to all items of equipment requiring maintenance of ease identification in the planned maintenance system.
- Technical training to be provided for the users maintenance staff prior to hand-over.
- Maintenance staff should be trained in the operation of the equipment in conjunction with the operational personnel.
- Manufacturers skilled staff should remain on-sites for a period during the initial operational phase to under take identification and elimination of faults. During this period the user's maintenance staff should work in close liaison with the manufacture staff.

6.7.1 **Reliability Standards**

In view of the continuous operating patterns of the large cargo terminals, at the earliest possible design stage the detailed reliability standards should be considered in addition to operating performance requirements.

6.7.2 Fall-Back and Recovery Routines

In designing a cargo handling system involving mechanised/and or automated equipment, it is of the utmost importance also to design a substitute system which can be operated during scheduled or unscheduled stoppages or breakdowns. It is also essential to consider the means whereby a smooth transfer may be effected from the substitute system back to the original mechanised or automated system. The following four points should be considered in particular:-

In the event of failure of any item of a mechanised system, an alarm indication at the operational control position should show the location of the fault.

Alternative mechanised routes should be provided to by-pass faults if possible. The provision of alternative equipment required to provide an effective substitute system, e.g. fork lift trucks, must be considered when planning.

Equipment should be provided which may convert any system from an automatic to manual control. Such procedures should be carefully and rigidly controlled to ensure that damage to equipment or danger to staff does not occur.

One example of this type of procedure is that where only selected staff holding the necessary written authorisation and processing keys which control access to the alternative system, are able to initiate the operation of such a system.

6.7.3 Safety Requirements

There is a need to consider such requirements during control negotiation and in the detailed design stages. It may well be necessary to secure official approvals before

designing a mechanical system. The following points are listed to illustrate items which should be considered:-

- All equipments should comply with the relevant mandatory regulations, industrial agreements, local agreement, etc, also with the users and safety regulations.
- All equipment must be insured against third party risk; i.e. injury to personnel, after fabrication and before test take place.
- It may be necessary to delineate areas within the terminal for the access of maintenance personnel only, except in the case of fire or other emergency.
- Work carried out by maintenance staff on electro-mechanically driven systems should be strictly monitored both from the safety ponit of view as well as in connection with essential functional requirements.

6.7.4 Control Systems

In any mechanical handling system, particular care should be taken to ensure that the means of operating and controlling the system are taken into account. Two aspects of control must be considered according to IATA standards (a) Operations (b) mechanical.

(a) Operational controls

Mechancanised handling systems function in accordance with instructions given by operators who are themselves guided by the data they received and by laid-down procedures. The operators give instructions by the manipulation of control mechanisms,

e.g. push buttons, punched-card readers. These, operations cause the machinery to function in accordance with the instructions given.

The location and layout of control points and work-stations where routing and similar operational control tasks are carried out are vital parts of the overall system design. In planning the detailed design of these areas, the following points may be considered:-

If the operator responsible for a particular system does not have direct and comprehensive vision over that system, he should be provided with a display or other means, e.g. data processing point-at, to inform him of the condition of the system.

Visual display panels should be designed to the integral with an operator's control panel or mechanisms.

Visual display panels should be linked to a main panel to facilitate the back-indication of mechanical faults, and to show the overall condition of the total system.

A mimic diagram illustrating the system, or part of a systems for which an operator is responsible is recommended as an efficient visual display method.

Control points must be considered in relation to their specific location and functional requirements of the operator.

As control points represent bottlenecks in a mechanism system, maximum utilisation of staff may be retained at all times including peaks. This may duplicate controls so that an additional operators may be used during peak handling periods.

The procedures whereby an operator starts up and closes down the system, or part system, for which he is responsible must be clearly tabulated.

With regard to truly automated systems, instructions are originated within a computer which causes the machinery to function by the direct transmission of electrical impulse. In such cases particular attention must be paid to providing means whereby the computer is aware that there is no mechanical or physical impediment to the completion of the instruction.

(b) **Mechanical Controls**

The correct functioning of a mechanical handling system is directly related to the mechanical efficiencies of the controls within the system. Hence, special attention should be paid to the design and provision of these controls. The following is an exhaustive list and indicates some of the considerations which may be studied:-

(i) **Limit switches and trips**

- Should be operated by contact mechanisms which are designed so as to allow travel beyond the operating positions, this avoiding damages to the switches or trips due to over-run.

- Should have robust, cases, preferably but not of sheet metal.
- Should be of a tupe with a positive movement and should not operate through complicated linkage mechanisms.
- Should be adequately sealed and protected against dust and moisture.
- Should have terminals accessible from the front of the switch.

(ii) **"Crowding" devices**

However there is a possibility of cargo becoming over-crowded or jammed within a mechanised system, e.g. on a conveyor or elevator, suitable crowding devices should be incorporated to stop the part of the system which is causing the over-crowding, and the input to that section.

(iii) **Sequences interlocks**

If a mechanised system requires any separately pondered item of equipment to be started in a set-sequence so that each item is operating before the succeeding item starts to operate, a sequence interlock should be provided on the starting equipment.

(iv) **Control consoles**

- Should incorporate all necessary control switches, instruments, relays and associated apparatus, duly connected to each other by internal wiring and to the switches by external control cables.
- Should have front-mounted switches and flush-type instruments and indicating displays.
- Additional apparatus such as 'fuses, resistance boxes, transformers, alarms, etc should be mounted inside the console.
- Consoles should be painted internally and fitted with interior lighting.
- Consoles should be lockable and fitted with lift-off type hinged doors.

- Engraved circuits diagrams should be fitted in the consoles, preferably in the door, but readily available.
- The internal wiring of control panels and consoles should be arranged so that access to the connecting stems to be relays and other apparatus is not impeded.
- Fuses and links should be provided to enable all circuits in a panel or console except the lighting circuits to be isolated from the bus wires which should be fully insolated.

Communication System

Provisions of good communication system within the cargo terminals and related airport facilities are essential features to ensure efficient operations. It is therefore important in the early stages of planning to estimate as accurately as possible the type and volumes of communication facilities that will be required. Due consideration should also be given to various type of new communications equipment that have special installation requirements as far as ducting, conduits, etc. are concerned.

In addition to the more common communications systems such as telephone and public address systems there may be a requirement for one or more of the following:

- Pneumatic tubes.
- Message conveyors,
- Teletype machines,
- Close circuit television
- Ground radio, such as "walkie-talkie".

6.8.0 GENERAL

The importance of staff training cannot be over-emphasised and the degree of training or re-training necessary in connection with a cargo terminal project will be proportional to the amount of change in existing systems and procedures which is planned. The first outline training plans should seek answers to general question, such as:

- Which personnel require training?
- What subject matter is to be taught?
- Who will undertake the instructional duties?
- Where and when will training take place?
- What time is required to train personnel in each subject?

6.9.0 CARGO TERMINAL BUILDING: DETAILED DESIGN STAGE

The cargo terminal should be designed to ensure maximum operational efficiency, and such consideration as appearance should always be subordinate to the functional requirements. The design should be in a form that permits internal modification or overall expansion with relative ease, and provisions should be made in the planning stage for future expansion requirements, either horizontally or vertically, depending upon local conditions such as land availability and building height restrictions. Fundamentally, the building should be considered as a shell to protect the cargo handling system.

The design and construction of cargo terminals should be of a nature that will permit future expansion of both ends of the building. Ideally, no more than two carriers should operate their own individual handling systems, in a particular cargo terminal this

facilitating expansion capability at either end. Obviously, this is not always practical for economic reasons in short term planning. The planning of multiple occupancy terminals should take into account maximum flexibility in regard to the requirements of the individual carriers. The later plant is important in view of the charges in tenancy, which might well involve a different use of door ways and internal arrangements within the cargo terminal. For example, the partitions between carrier's areas should not be load-bearing and should be capable of being relocated. All fixed locations, such as strongrooms and toilets, should be positioned in such a way that they will not interfere with the expansion and flexible adjustment of the building.

To provide for requirements of this nature, it is recommended that cargo terminals should be constructed on the units principles and, in order to allow for the addition of units for progressive expansion, the end walls should be of a non-structural nature. Entrances to the cargo terminal should also be sufficient in number, location and size to ensure compatibility with the type of mechanical handling system used. Gangways should be provided at the side of these entrances to allow for personnel movement and manual handling.

In the cargo of a cargo terminal with a raised floor, for the handling of air cargo which, due to its size or nature, cannot be moved through the normal process, provisions should be made both for seperate entrances o the land-side and for vehicles to proceed to the ground floor level of the building by means of included road, (with gradient not exceeding 1 in 10) on both sides of the building. Where space for these is not available, elevating platforms capable of lifting the vehicles and their loads should be provided.

6.9.1 Constructional Details

While it is not intended to provide detailed advice on design and construction, the following design characteristics are considered important.

6.9.2 Dimensions

The shape, height, width and length of the cargo terminal should be subject to detailed study according to the local circumstances, but should take account of at least the following factors:-

- The flow routes or channels for the movement of air cargo should be as short as possible.
- Structural design should allow for the possibility of providing a further flow level for offices.
- The height and overall design of the cargo terminal should allow for the maximum possible use of mechanical handling system and their extensions as the volume of air cargo handled develops.
- The width (depth) of the cargo terminal should be dependent upon the volume of air cargo handled and the capacity of the aircraft.

6.9.3 Canopy

The canopy should be designed to afford maximum protection from rain and snow during loading and unloading operations. The vertical clearance of the canopy should be no less than 0.3/0.5 metres over the maximum truck height. The projection of the canopy in relation to this height must be determined by local weather conditions. The canopy

drainage should be designed to avoid water being shed on parked trucks.

6.9.4 **Doors**

The cargo terminal design should provide for a maximum number of door positions on both land-side and air-sides. The following points should be considered:

- On the land-side, each door should be of sufficient height and width to accommodate the largest trucks which will be receiving and delivering air cargo at the facility.
- On the air-side, each door should be of sufficient height and width to accommodate the large cargo-handling equipment including unitised cargo loading systems.
- In a terminal designed for a long range plan, it is probable that more doors will exist than will be required during the period of initial occupancy. Economic factors together with future operational requirements must be taken into consideration when reaching a decision as to installing all the doors (including electrical service) at the outset, or repairing them temporarily with removable sections, etc.
- Consideration should be given to a "service indicator light" system or alternatively, a simple removable sign system to identify those doors which are available for service. Depending upon the number of doors involved, such system can result in more efficient utilisation of manpower and reduce or eliminate costly communications equipment.

- If light indicators are employed, it's important to remember that their operation should be linked directly to the door control system.
- Even when the terminal is approaching maximum utilisation, there will be certain periods of the day and/or night men staffing is available for only some of the total doors available. In such instances, the indicator light system has decided advantages over the sign system, again depending upon the number of doors with which the facility is provided.
- When electrically operated doors are selected, operating control should be paid to the location of such controls, with particular reference to questions of access, servicing and security.
- Every type of door should have a manual override which will permit the door to be operated in the event of electrical or mechanical failure in the motors.
- When overhead doors are selected, each door should also be equipped with a safety device which will stop its movement in demanded travel, if a obstruction is in the door's path.
- The type of door to be used is dependent upon a number of local factors and shall be the subject of consultation locally with the operators concerned. Consideration should be given to providing small built-in personnel doors in the those case where there is insufficient space to accommodate a personnel door otherwise. Consideration should be given to the possibility of covering door positions with "air curtains' or similar equipment, such as over head blowers, in order to maintain an acceptable temperature within the cargo terminal.

6.9.5 Clearance height

The clearance height inside the cargo terminal will be determined by the handling and storage systems or requirements of the users. The clearance height is the height which should be maintained below heaters, ducts, pipes, lighting fixtures, etc.

6.9.6 Floors

The relationship between the ground floor level of the cargo terminal and the pavement level for trucks on the lands side should be obtained by topographical conditions or by grading, but in no case by the use of wells. There may also be provisions for built-up ramps or lift devices, such as "dock levellers" to facilitate the accommodation of lowed vehicles. On the air-side of the building the level of the floor should be determined in consultation with the operators in the light of local circumstances, taking into consideration at least the following points:-

- The method of movement of air cargo between cargo terminal and the aircraft.
- The movement of air cargo between airlines area (interline traffic).
- The growing use of unitised load systems, requiring the minimum of handling operations and changes of level. In particular cases where a difference of level is required for use of special equipment, a straight-in access to the cargo terminal should be maintained for carts and trucks, by way of a ramp whose slope should not exceed 5%. In general, there shall be no platform installed between the cargo terminal doors and the edge of the dock. However, where sufficient doors are not available, platforms may be necessary to facilitate loading and unloading of

trucks.

Each floor should be capable of supporting regularly the maximum weights of cargo foreseen in the cargo terminal and shall take into account the highly concentrated floor bearing loads associated with mechanical operations. The floor should be level and free of any raised projection, e.g. door tracks should be recessed. Floors should be a smooth travelled finish with an application of a surface hardener. Where necessary, floor drains should be provided to facilitate washdown and drainage. Users must determine the requirements for slab depressions to accommodate scales, materials handling systems, etc. It may be desirable to enclose such depressions with knock-out panels. the expansion points in the floor should run diagonally and not parallel to the floor of traffic.

6.9.7 **Illumination**

The level of illumination in all working areas must be adequate for reading necessary documents, marks and labels on packages, and there should be lighting externally at each door way and along the docks. For day time working, the fullest use should be made of natural light. Adequate illumination is also essential for the adjacent apron and roadways. Generally, standard of lighting for various functions fall within the following ranges:-

- Office areas.
- Warehouse handling areas.
- Roadways
- Aprons.

6.9.8 Access

Steel ladder should be provided between doors or bays to provide easy access from truck apron level to terminal floor level, and they should not project beyond the face of the door bumpers, personnel and customer entrances should be provided with steps which should be of prefabricated steel type in order to facilitate a move in case it is desirable to relocate them.

Weighing facilities (and floor openings to accommodate, if appropriate) should be provided with capacities capable of handling up to the largest and heaviest unit load module anticipated during the life expectancy of the facility. The position of the weighing units will be determined by the handling system and floor pattern used.

6.9.9 Office and staff facilities

Where work is carried out in shifts, planning requirements should be based on the largest number of personnel on duty, at any one time. Also due consideration must be given to future expansion of these facilities. The expansion may be vertical in order to safe guard the warehouse handling area from encroachment. Anticipated processing simplification and streamlining can have an effect on the location, size and expendability of operational and administrative offices. It is particularly important to allow for communication requirements, including document conveyors where applicable. Also the power supply, floor-loading and environmental requirements of data processing equipment should be borne in mind.

6.10.0 STAFF FACILITIES

Adequate office, lavatory, rest-room, canteen, clothing/locked room and wash room facilities should be readily available.

Space on the land and air-side should be adequate to

CHAPTER SEVEN

PASSENGER TERMINAL

7.1.0 INTRODUCTION

The terminal area is the major interface between the landside and the airside activities in an airport. It serves as the screening funnel for departing passengers, from the landside, relatives friends and site seers and the arriving passengers from the air side.

In commercial airports; building categories are terminal and operational. The terminal category refers to building used for passengers, airlines and administration facilities. Its layout is such that it offers enplaning passengers convience and direct access from the vehicular platform side (land side) of the building through the booking, waiting rooms to the aircraft gate position on the apron. Deplaning passengers are also provided with a direct route form the aircraft to the baggage claim in the terminal to the vehicle platform.

The operational category includes control tower weather bureau and other government services related to aviation. In many cases the terminal building performs the functions of the operational building too.

According to J. BLow (1991), density traffic security, commerce, airline traffic patterns and government controls are the five factors which tax a designer's ingenuity in passenger terminals design.

(i) Security:

Blow expanded that, terrorists activities have demonstrated the need to beef up security for dangerous in luggage and check in procedures have allowed for X-ray of baggage and the use of neutron analyses.

Therefore, passengers and low baggage segregation are presently of utmost importance. Seperation of departing and arriving passengers on the landside of terminal by the designing of on-ground level arrivals forecourts and educated departure forecourts and the advent of airside concourses structures for departures and arrivals to enhance centralised security controls are design measures to enhance security in terminals.

(ii) **Density traffic:**

Density in terminal floors now justify one-way passenger flows to achieve efficiency in use of space by operators. The use of wide concourses for high circulation pattern and the incoperation of disabled facilities and ramps for larger flows.

(iii) **Commerce**

The inclusion of shopping complexes and large scale public facilities are now incoperated in terminals and should be adaptive and responsive to changes. Flexibility in storage

spaces and planning to accommodate innovations and demand trends of utilities and merchandise.

(iv) **Airline traffic patterns**

Designs can cater for variability and diversity in traffic by being able to serve both large and small aircrafts by way of linear parking, finger pier system and apron adjustable or drive loading bridges. This enhances flexibility and traffic control in transfer, arrival and departure traffic.

(v) **Government Controls**

The politics of domestic and international travel service poses once of the severest test of dual facilities provision and test the robustness and flexibility of such designs.

7.1.1 **Principal Consideration in Terminal Planning.**

The planning of the terminal system, revolves around three components within which terminal activities are centred; namely the access interface, processing and the flight interface.

(a) **Access interface**

This is the passenger curb area and include passenger embarkment and disembarkment, vehicular circulation and parking areas. These covers the vehicular ramp, curbside loading and unloading of passenger and baggage prior to processing in the terminal. Planning consideration include:

i) Proximity of land transport access and accommodation location in relation to terminal position.

ii) Arrival and departure curbs for loading and unloading passengers using automobile.

iii) Facilities for loading and unloading passengers using collective airport access modes such as bus stations, limousines and rapid transit train stations.

iv) Convenient connection of movement modes i.e. automobile parking, shuttle buses, walkways or automated conveyors.

(b) **Processing**

This stage prepares the passenger for a trip or processing an arriving passenger for the curbside or landside transport mode. Processing activities cover ticketing, check-in (passenger and baggage) operation and baggage claim, health and security controls. Facilities of consideration include:

(i) Minimum delay in processing of passenger and baggage.

(ii) See to early seperation of the passengers from their baggage.

(iii) Create short walking distances for passengers from check-in to aircraft access when from the aircraft to baggage claim when leaving the terminal.

(iv) Protect passengers from aircraft blasts.

(v) Achieve optimum occupancy level.

(vi) Make the terminal compatible with aircraft type.

(vii) Create direct and simple routing fore passengers movement with minimal directional and level changes.

(viii) Reliable and accessible baggage handling systems with adequate airside handling areas.

(ix) Provision of passengers amenities to certify varying needs in appropriate locations as well as contribute to airport avenue.

(x) Ability to expand facilities and capacity by incremental stages without disruption.

(xi) Resolve conflict of mix use to meet all users requirements.

(C) **Flight Interface**

The passenger transfers from the processing component to the aircraft. Assembly passenger and baggage conveyance and loading to and from the aircraft are the major activities in this phase. Design consideration should at this stage include:

(i) Space for assembly of passengers adjacent to aircraft gates. The use of gate lounges or apron busess.

(ii) Conveyance facilities, side walks, buses or mobile lounges depending on the facility in use.

(iii) Loading facilities including jetways, nose bridges, stairs or escalators.

(iv) Conveyance of transfer passengers; corridors, waiting spaces etc.

7.2.0 BASIC TERMINAL CONFIGURATION

The terminal is the area between aircraft gate position and vehicular kerb. It serves as the funnel for the screening of departure passengers from the sea of escorts and site seers; and baggage.

There are four basic terminal concepts:

i) Transfer terminals with mobile lounge

ii) Linear terminals

iii) Piers

iv) Satellites

v) Hybrides: Combinations of forms.

(i) **Transfer terminals with mobile lounge**

These are terminal forms that are improvements of remote aircraft systems, chryster-built vehicles which raise and lower themselves by hydraulic ramps to match the height of the terminal building floor or the aircraft door sill. Most airports use buses for this purpose with ladders at aircraft doors. The system has the disadvantage of vehicular hazard in aprons.

Crysler-built vehicles are used in Washington Dulles and Mirabel Montreal terminals.

ii) **Linear terminals**

These are as the name implies linear terminals with aircrafts dock directly against the building providing short travel distances.

Examples are London heathrow terminal 4, Calabar International Airport terminal, Port Harcourt International Airport terminal. It is a simple and economical system. But its use is limited only to small airports requiring few gates positions.

iii) **Piers (single or multiple)**

These is a terminal planning system whereby passengers and baggage processing is done within the terminal area while facilities required for passengers entering or leaving the aircraft involves extensions of the terminal building. The pier or finger arrangement might be single or multiple, Y-shaped or T-shaped and has the following advantages.

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(a) Protects passengers adequately from weather and aircraft blasts.

(b) It enhances easier future terminal expansion.

(c) Brings all aircrafts close to the terminal building allowing for easy noise in parking.

(d) The system is suitable for large scale merations. Examples are Lagos international airport, and Zurish Kloten terminals A and B.

iv) **Satellite system**

These are small island buildings located at the apron connected to the main terminal building by underground tunnels. Aircrafts are parked around the satellite and less turning is required to manoeuvre the aircraft out of the gate position. It has the disadvantage of large construction cost, several level changes by passengers before boarding aircraft and apron congestion when no underground tunnels are in use. Example are Tampa and Orlando in Florida, USA.

v) **Hybrids (combination of forms)**

This is a combination of the various forms already discussed. Example is Chicago, O'ttane United Airlines Terminal, U.S.A.

In addition to these main terminal concepts, there are three basic terminal planning types: Namely, centralized decentralized and unit terminal.

(a) **Centralized**

Where all passenger routes coverge or divulge from a centralized passenger processing and amenities facility.

(b) **Decentralized**

Where passenger routes pass through a number of seperate processing amenity facilities, therefore, generally more applicable to domestic operations.

(c) **Unit terminal**

Where centralized or decentralized terminal types are provided separately for some specific functions such as for individual airlines, international only or domestic only.

In all forms of terminals, there are four basic components with the arrival and departure functions, namely:

i) Landside access systems

ii) Landside activities within terminal

iii) Airside activities within terminal

iv) Airside access system.

7.3.0 PASSENGER FLOW SYSTEM IN TERMINALS

The terminal acts as the screening funnel between the land and air sections of the airport system. The passenger flow system is a reflection of activities connecting the

airport access and the aircraft and operates as follows:

1) To interface with the passengers mode of airport access.

2) To process the passenger for starting or ending air trip.

3) To convey passengers to and from the aircraft

7.3.1 Access Interface

Here the passenger transfers from the access mode to the passenger processing component. Circulation, parking, and curbside loading and unloading of passengers are the activities that take place in this component.

7.3.2 Processing

The passenger in preparation for starting or ending an air trip. The primary activities in this phase include ticketing, baggage check-in, baggage claim and control.

7.3.3 Flight Interface

The passenger transfers from the processing component in this stage to the aircraft proper for starting a trip or disembarking from the aircraft to the processing component for ending a trip. Activities include assembly, conveyance to and from aircraft and aircraft loading and unloading.

There are two main sections of the passenger flow system;p the arriving flow and the departing flow pattern. The following are the two rules in flow planning.

i) Seperation must be completely secure between airside and landside activities (airport staff operate pass systems: the combination of airside/landside catering preparation facilities requires approval).

ii) Departure and Arrival flow systems must be seperated within the terminal. the communal use of planning and aircraft access systems is an exception, when all passengers are international. Departure and arrival concourses do not require physical seperation.

The following should also be noted:

(a) It is advisable to place principal amenities and administrative office above or below, the passenger flow system; this usually produces a more economical layout and facilities subsequent expansion.

(b) The planning of both departure and arrival functions on the same level is usually associated with smaller terminals because of the resulting limitation of Kerbside access to this one level. Though this can be hardled if both are accommodated on two levels with alternating functions at the various levels, side-by-side arrivals and departures with two level terminal.

7.4.0 SPACE DISPENSATION IN PASSENGER TERMINAL

Space requirements for passengers is strongly determined and influenced by the level of service. However guidelines that give general orders of magnitude of figures that

are subject to change depending on the requirements of specific designs can be defined.

The following steps should be followed in determining terminal facilities and space requirements.

1. Identification of passenger type and volume; Passenger volumes can be obtained from forecasts. Two measures of volumes are used;

   (a) Annual passenger volume, which is used for preliminary sizing of the terminal building and can be based on 5, 10 or 20 years projection.

   (b) 'Typical peak-hour passenger' which is a hourly design volume for passenger terminal design. The figure is a design index and is usually in the range of 0.03 to 0.05 percent of annual volume.

7.5.0 BAGGAGE HANDLING SYSTEM

This is one of the most vital requirement in a terminal design and requires thorough examination from the onset.

There are three baggage sorting methods in application in airports.

(a) Manual: in which staffs read labels and lift items into place.

(b) Semi-aritomatic; in which staffs read labels and direct automatically to flight loading positions.

(c) Fully-automatic; with electronic reading of labels and direction to flight loading positions.

Irrespective of the type of system, the following standards apply to baggage conveyor befts;

Width: 900mm

Gradient: 32% maximum

Clearance above for obstacles: 1200mm

Inner radius for turns: 900mm

LD3 trailer size with container: 3.5m long,

1.75m wide, 2.4 high with flap up.

LD4 trailer size with container: 4.5m long.

1.75m wide, 2.4m high with flap-up.

7.5.1 **Baggage Area Consideration**

Enplaning baggage: There are two type of check-in desks for enplaning baggage.

i) Counter or central check:- Here baggage is allocated by airline attendants, weighed and passed to the conveyor belt via, the central baggage make-up space.

ii) Gate check-in:- In small quantities, bags are received at the gates prior to enplaning. The activity needed to process outgoing baggage include

(a) Conveyance from baggage check-in points to central sorting area

(b) sorting of baggage according to aircraft on which it departs

(c) Conveyance of the sorted baggage to the appropriate aircraft gate position, and

(d) Loading of baggage onto the aircraft.

Deplaning Baggage: Taken care of by claim system. Activity involves:

(a) Unloading baggage from Aircraft

(b) Conveyance from aircraft gate position to central sorting area

(c) Sorting to identify transfer baggage

(d) Conveyance of arrival baggage to baggage claim area.

In planning for baggage claim area sufficient space need to be provided to facilitate easy claim while passengers assemble and wait for their baggage. An understanding of operating airlines operation and the relationship of all airlines is required in providing space for baggage landing system.

7.6.0 **SECURITY**

Strict security measures were enforced in airports since the first recorded aerial hijack in 1948. The alarming rate of hijacks between 1969 and 1978 (not fewer than 400) involving 75,000 passengers attracted ICAO interest.

Terminal security has been achieved by a combination of body-searching of baggage travelling in the aircraft baggage space. However no amount of baggage searching has succeeded in keeping undesirable objects and persons off aircrafts if it is not supported by a functional and effective building layout and policing.

The primary security control point for personnel searches is at the entry to the sterile airside concourse area and this is essential for all entries to that area. Additional or alternative secondary search position may be at the entry to the aircraft landing position or the aircraft itself. Though for security to be thorough and worthwhile it is

labour-intensive and costly, it is best carried out in the greatest practicable volume. Total checking of check-in baggage should be carried out using X-ray unit screener, electronic devices or manual search of passenger and baggage.

7.7.0 ADMINISTRATIVE FACILITIES

Administrative facilities, are those support facilities that accommodate management, personnel and operational staffs within the terminal and airport generally.

Administrative facilities can be divided into:

1. Airport administration facilities.
2. Airlines operations facilities
3. General terminal support facilities.

It should be noted that all airport administrative facilities need not be located within the terminal building itself: an office block can be located within the airport site, as in the case of Port Harcourt and Kano international airports.

1. Airport Administration facilities:
   - Mechanical Department
   - Electrical Department
   - Fire Service
   - Operations Department
   - Commercial Department
   - Accounts Department
   - Security Department

- Personnel Department
- Electronics Department
- Transport Department
- Federal Aviation Authority of Nigeria Dept.
- Signal Room
- Principal communications Offices
- Meteorological Offices
- Telecommunication Centre
- A.I.S Flight Planning Briefing room
- Chief of Facility Office.

2. Airlines Operation facilities:

- Airlines offices
- Ticketing facilities
- Amenities area
- Number of gate lounge

  Size and type of baggage claim
- Size and type of operational facilities

3. General terminal support facilities:

KASHIM IBRAHIM LIBRARY

- Rest rooms
- Stores
- Changing rooms and lockers for cleaners Kitchen staffs, Porters etc.

Catering

This facility is not to be made a large scale affair since the main aim of airport planning and management is to get passengers through a terminal as quickly as possible. The use of limited menu grills has become increasing dominant. Restaurants, in the main, are used by non passengers.

The main users of catering facilities are passengers friends, visitors and staff. From records arriving or deplaning passengers don't very much use this facility and it has been found that about 75% of the total passengers make use of the facility.

The three categories of catering area:

1. Buffer/bar ($1.3m^2$/P)
2. Grill 25%
3. Restaurant 10%

Visitors facilities viewing galleries and lounges with catering facilities should be provided. Care should be taken that such facilities have revenue generating potential.

7.7.1 Aircrew Flow

The following principles should govern the flow process of aircrew in the terminal.

- The locations where airlines require crew members to report before or after flight should be in logical sequence and close together, preferably at ground level on the airside of the building and readily accessible from the apron.

- Aircrew brief and filling of flight plan facilities should be easily accessible to the aircraft stand. Communication links with meteorological or Air traffic stops should be available for aircrew when required, but members should not be required to report personally.
- Government control clearance section for aircrew (if required) should be arranged to permit rapid processing of crew through controls and should not interfere with passenger clearance.

7.7.3 **Passenger Convenience Facilities**

To ensure that the airport terminal complex affords the best possible services to passengers and provides for efficiency in the handling of cargo, baggage, and mail, a considerable amount of space should be allocated for the following:-

i) A central waiting area for passengers relaxation while waiting for flights or baggage claim within arrival and departure sections of the terminal.

ii) Facilities for dispensing food, drinks beverages etc.

iii) Toilet facilities

iv) Telephone and communication facilities

v) Magazines and newstands.

vi) Car rental services

vii Public address systems and electronic information boards.

viii Storage rooms

ix) Medical facilities

x) Conference room

7.8.0 AIR TRAFFIC CONTROL AND COMMUNICATION SYSTEMS

There are two basic types of flight rules for air traffic control. These are known as visual flight rules (VFR) and instrument flight Rule (IFR). In general VFR conots clear weather conditions enabling aircrafts seperation by visual means. While IFR conditions prevail when visibility or the ceiling falls below those prescribed under visual flight rules.

7.8.1 The Control Tower

The control tower accommodates the radar room, the control cabin, and the visual control room.

i) The radar room equipped with rador surveillance, controls Aircraft approaching or leaving airport within 10-30 miles area. It is located below the control cabin.

ii) The control cabin. this is more like a general space for the Air Traffic controllers. It accommodates the basic control requirement e.g. the derodrome control equipment.

iii) The visual control room takes care of aircrafts approaching or leaving the airport and the use of runaways.

7.8.2 Approach Control

The control of air traffic in the airport is effected by an approach control office, landing control centre and runway control centre which also doubles as weather station (in the lading area).

7.8.3 Air Route Control

For air traffic monitoring and control in the terminal area, use is largely made of radar systems located at points which offer the best views of the airspace within the limits determined by the purpose of a particular radar.

7.8.4 Navigational Aids

The object of the navigation (Radio) systems are:-

- to automatically determine the bearing of and the distance to be travelled by, an aircraft and to transmit same data to the aircrew.
- To facilitate instrument landing.
- To effect air-traffic control from the ground by means of a controller or computer.
- to establish quick two-way communication between the pilot and the At controller.
- To automatically transmit data about the position, speed, altitude and course of an aircraft from that aircraft to the ground.

Radio navigation aid may be installed on board aircraft (i.e. airbone RN

equipment) or on the ground (ground RN equipment). The former consisting transceivers and several indicators, the later consists of transceivers and antenna systems.

Some of the equipments include non-directional beacons NDB locator beacons, Distance measuring equipment (DME), VHF Omnidirectional Radio-range (VOR), Primary surveillance radar (RSR), instrument landing system (ILS), etc.

7.8.5 Meteorological and Aeronautical Information Services

i. The meteorological section notifies the flight crew and the crew nautical information of the weather at the point of departure, destination and along flight route.

ii) The Aeronautical Information Service (AIS) dishes out navigational warnings statutory requirements, political situations, military (airforce) exercises, airfield data, runway conditions and accidents.

AIS also offer flight clearance services; These include flight control, relaying data to the control tower. Meteorological AIS and flight clearance must be located together. It should if possible have direct apron-level aircrew access. Access through landside required for staff and airlines. The amenities should be appropriate for 24 hours occupation. All thress services should have counters for common access from crew concourse.

In the room space, there is need for high level of illumination, insulation from external sound because vocal contact is the essence of operation. Air condition system desirable.

7.9.0 ACOUSTICS

It is reasonable siting noise attenuation activities at a distance from the terminal. Aircraft noise is more easily tolerated at the terminal where it is anticipated. The sound of aircrafts enhances the expected thrill of air travel for passengers. The opportunity of viewing departing and arriving aircrafts calls for extensive area glazing. Noise transfer is reduced to reasonble level by double or triple glazing. Indices of 22-62 for frequencies ranging from 63HZ to 8KHZ depending upon particular location is a typical requirement to British standard 2700:1980 part 3.

Higher level attenuation are necessary in highly staffed areas where interviews and security activities may take place. A minimum attenuation of 40dBA is desirable for staffs occupied areas for 6 hours or more Hard surfaces are acceptable in concourses, carpets in airside spaces provides quicker starting and finishing mood for travel.

7.9.1 Lighting

Daylighting is welcome particularly when accompanied with aircraft view in terminals but artificial light control determines comfort and ambience. Good lighting is reasonable as it brings reflective surfaces to light and stimulate imput of commercial enterprises present there.

7.9.2 Finishes

Airport terminals are test-beds for all materials. Consideration of primary activities taking place in each location, time spent there and level of usage are factors

that determine the level of finishes required. Their durability and stainlessness should be considered.

7.9.3 Floors

Concourses require durable hard surfaces to withstand the effect of feet and froley traffic. Close laid terrazzo or granite are recommendable. The airside concourse exposed to only foot traffic can be carpeted for a softer, quieter ambience of the airside.

7.9.4 Walls

In selecting walling materials the criteria goes beyond aesthetics, future growth changes, pressure and rationales of particular construction methods and ease of maintenance and replacement play a great part.

The rationalizing of walls into modular panels, dimensional co-ordination of different elements of the building finishes are essential design and construction control mechanisms.

Baggage trolleys and cleaning machines damage walls and floors. The use of 45^{o} splayed skirting is a recommendable way of defending walls. Materials of the adjacent floors say terrazzo or carpet can be used.

7.9.5 Fire criteria

Passenger safety in the event of fire is a major concern in terminal planning. The location of travel distances along defined escape routes are crucial in deep planning.

Acceptable design standards are defined by the following factors in case of fire in terminals:

- Fire containment by compartmentalization
- The load in the compartment
- Determination of high/medium/low risk areas.
- Establishment of smoke patterns and ventilation.
- Alarm and detection systems
- Occupancy assumptions
- Compliance with statutory authorities
- Fire brigade response times.

CHAPTER EIGHT

CALABAR INTERNATIONAL CARGO AIRPORT DESIGN REPORT

Map showing location of Cross River State

8.1 CROSS RIVER STATE

It is pertinent at this point to discuss the physical and political properties of the region for which this project is meant.

Cross River State, formerly the south Eastern State at the creation of the 12 States in 1967 was part of the old eastern region, and later recarved in 1987 to create Akwa Ibom State. The state derived its name from the Cross River which rises from the Cameroun mountains and flows through the whole length of the State.

Cross River State is bounded on the North by Benue State, on the west by Abia and Imo States, on the South-west by Akwa Ibom State, and by the Republic of Cameroun on the east.

Three major ethnic groups are easily identifiable in the State; these are the Efik group, located to the south, the Ejagham group spreads over north, but divided into two sectors by an intermediary group called the Ekoi. The Southern sector of Ejagham comprises the Quas in Calabar and the neighbouring people of Akamkpa, while the northern sector is made up of Etung. The State is divided into 16 local Government Areas.

The State is blessed with abundant natural resources and fertile soil for agriculture and losts of mineral deposits such as Uranium, Barite, Marble, limestone, caoline, granite etc. with several game reserves including abundant cattle ranches, forest reserves and numerous palm, rubber and gmelina estates. These rich resources coupled with the international Airport and a modern seaport influenced the location of the Nigerian premier export processing zone in the State.

Map showing location of Akamkpa Local Government Area

8.1.2 **Calabar**

Calabar is an ancient historic city, having served as the capital of the then souther protectorate of Nigeria before the amalgamation of the Northern protectorate in 1914, and presently the capital of Cross River State.

Geographically Calabar is located in latitude $4^{O}58'$ North, Longitude $8^{O}17'$ East, and lies on a Pennisula between Calabar and Great Kwa rivers. The city situated on the eastern bank of Calabar river on sandy terraces of 60m height above sea level. Having been limited by the mangrove swamps to the south, the city can only grow in the north and east directions, hence the location of the new Calabar International Cargo Airport in Akamkpa.

Calabar relief is composed of dense vegetation, among which are raffia palms and mangrove sticks. It has a good road links with other parts of Nigeria and transversed by the Trans-African Highway linking Cameroun and the Central countries of Central Africa. With a modern seaport and an international Airport, it is highly accessible.

8.1.3 **Akamkpa**

Akamkpa town is the headquarters of Akamkpa Local Government Area, situated 35 km north of Calabar, is the location of the proposed calabar International Cargo Airport. Akamkpa Local Government is bounded by Yakur, Ikom and Erung local government areas to the north, Biase local government to the west, Odukpani and Akpabuyo local governments to the south and the Republic of Cameroun to the East.

Akampka's proximity to Calabar and her fairly table and sparsely populated land made it the best choice for the proposed Airport.

8.2.0 CLIMATE

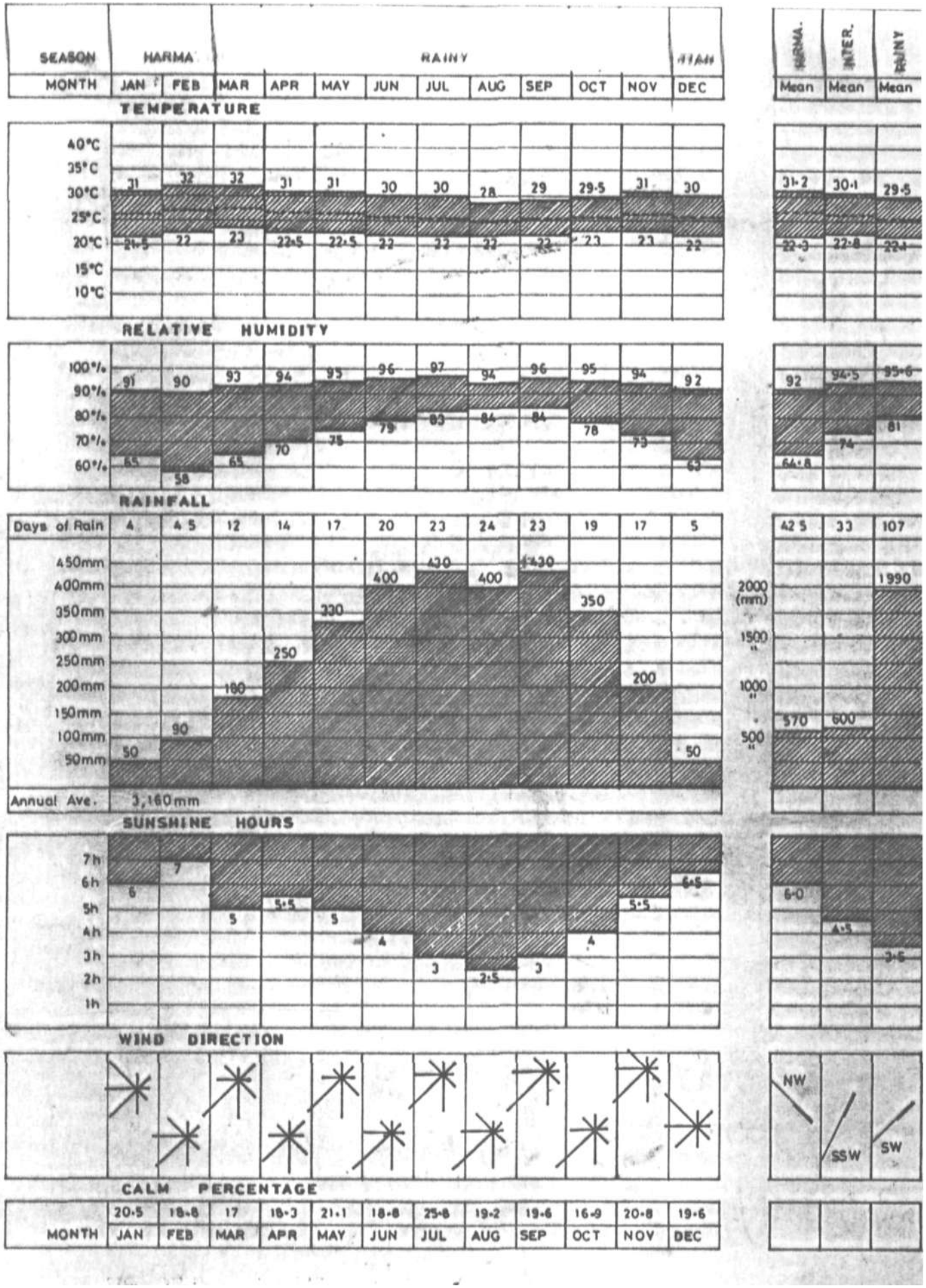
Detailed climatic information is not yet available. The most relevant climatic data is that of Calabar.

Located within the geographical rain forest region, Cross River State experiences very high rainfall. Calabar has a mean annual rainfall of about 3,066 millimeters. Monthly distribution indicates (figure ...) 3/4 of the rainfall occur within the months of May - October, a phenomena caused by conventional rains and winds when the South/West Mousoon is dominant , which originates from the Atlantic Ocean.

Calabar has an annual temperature of about 79.0^{O}F (26.1^{O} cecius). The highest temperature readings are recorded in February and March, while the coolest are August and September.

The South, South-West winds prevail in Calabar from the months of February - November bringing the influence of maritime air movement. Tropical continental air masses from the Sahara prevail within December and January west, north-west wind.

The sun shines from March to September from the north, while it shines the remaining months from the South. Day and night are almost equal throughout. The sky is always cloudy most of the time since the atmosphere has high water content, thus direct solar radiation is relatively rare.


SEASON
HARMA
RAINY
MONTH
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
HARMA. Mean
INTER. Mean
RAINY Mean
TEMPERATURE
40°C
35°C
30°C
25°C
20°C
15°C
10°C
31 32 32 31 31 30 30 28 29 29·5 31 30
21·5 22 23 22·5 22·5 22 22 22 22 23 23 22
31·2 30·1 29·5
22·3 22·8 22·4
RELATIVE HUMIDITY
100%
90%
80%
70%
60%
91 90 93 94 95 96 97 94 96 95 94 92
65 58 65 70 75 79 83 84 84 78 73 63
92 94·5 95·6
64·8 74 81
RAINFALL
Days of Rain
4 4·5 12 14 17 20 23 24 23 19 17 5
42·5 33 107
450mm
400mm
350mm
300mm
250mm
200mm
150mm
100mm
50mm
50 90 180 250 330 400 430 400 430 350 200 50
2000 (mm)
1500 "
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500 "
570 600 1990
Annual Ave. 3,160mm
SUNSHINE HOURS
7h
6h
5h
4h
3h
2h
1h
6 7 5 5·5 5 4 3 2·5 3 4 5·5 6·5
6·0 4·5 3·5
WIND DIRECTION
NW
SSW
SW
CALM PERCENTAGE
MONTH
20·5 18·8 17 18·3 21·1 18·8 25·8 19·2 19·6 16·9 20·8 19·6
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Yearly mean figure of sunshine is only 4.47 hours per day, hence 35% of the daylight time has direct sun rays not shielded by clouds.

8.3.0 **THE SITE**

In identifying airport locations, precision - instruments (ILS), clear zone and approach surface, are criteria influencing site choice.

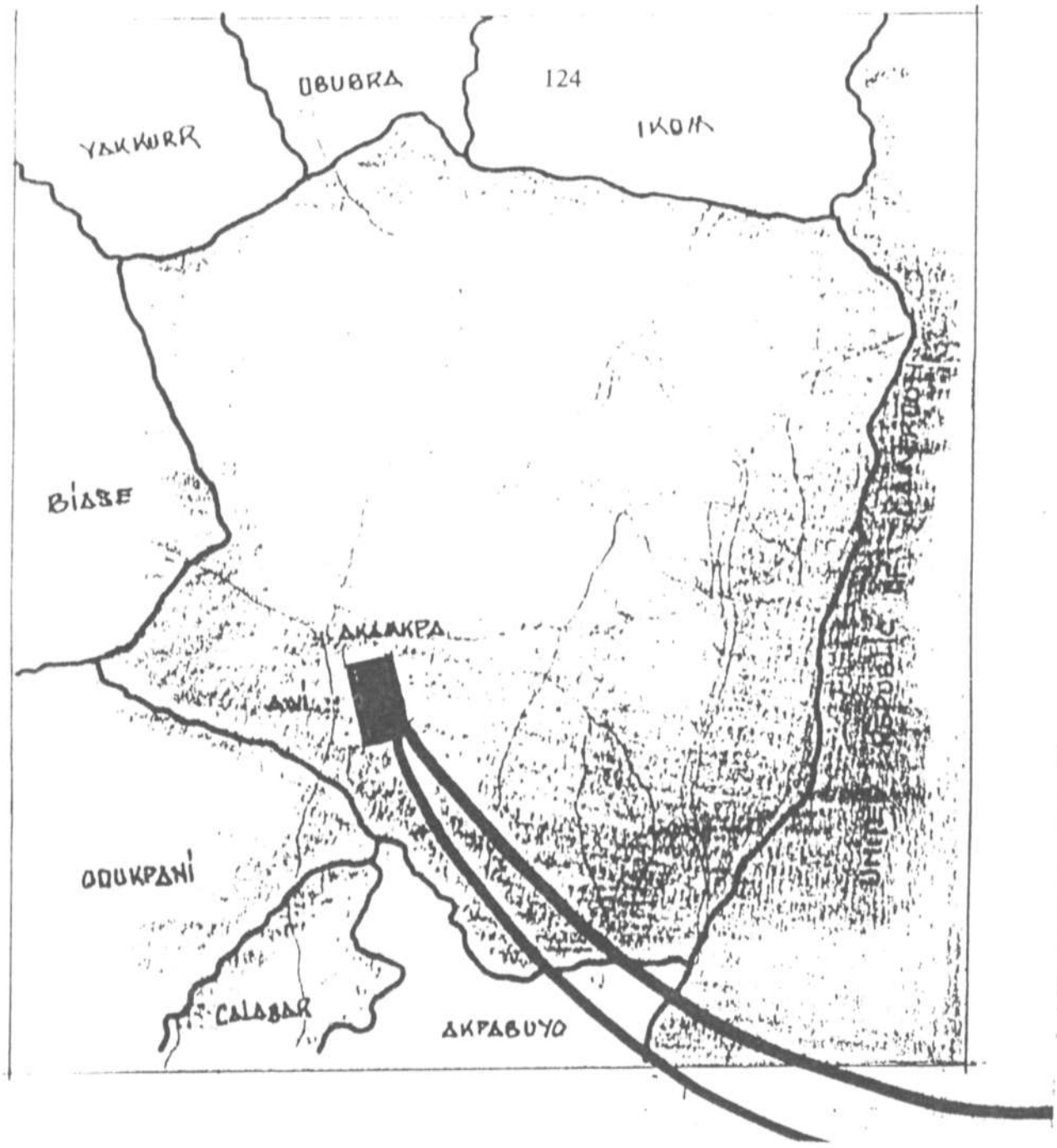
A slope of 50:1 for 3,100 metres from runway end and 40:1 slope for the next 12,000 metres, of approach surfaces clear of all abstructions.

Approach surfaces width is 300 metres at the ground end widening to 4,900 metres at the outer end. Longitudinal grades on runway should not exceed 1.0 percent or, for 4,000 metre runway, 40 metres.

On the basis of available data, the existing Calabar International Airport cannot be expanded due to its situation in a built-up suburb and the deep ravine along the extendable axis of the runway. Therefore according to the Calabar city site plan, two sites meet this requirement.

8.3.1 **Site One**

This site is located 12.87 Kilometers east of the city centre, on the Ikang - Calabar road. But has long been allocated as the permanent site for the University of Calabar.



Map showing site location

8.3.2 Site Two

This site is located 35 kilometers north of the city centre (Akamkpa Local Government Area) and 4 kilometers east of Awi village on the Calabar - Obubra Road.

Airport site two in Akamkpa local government is recommended as the location for the Cargo International Airport.

8.4 THE INTERPLAY OF FORM AND FUNCTION

There is not one airport terminal in the world that resembles the other, but all serve the same circulation function which is identifical world over. Therefore function takes precedence over everything else in Airport terminals design. This means therefore that form is not derived from function, and this one dimensional approach is the result of functional planning ideology.

Form and function are components of equal value, which in part are independent of each other, and in part combine to provide a building with its characteristics and appearance. Not only is function conditional partly upon form; form is also contingent upon function. Function will at the very least be influenced by form in the same degree as the form is derived from the functional requirements.

In the same way that the functional requirements, as an airport for example, cannot be realised where there is too much concentration on abstract theory without reference to practical and constructional principles, a successful building form cannot be conceived unless the associated functions are taken into account at the time of conception.

8.4.1 Function of an Airport

Airport functions can be classified into;

The Apron

The terminal and

The Kerb-side end parking areas.

(i) Apron

It is crucial how aircrafts are positioned in relation to the terminal. to reduce cargo handling distance and passenger walking distance aircrafts should be parked as close as possible to the terminal building and attempts should be made at decongesting the apron of service vehicles as much as possible by the use of fast and efficiently portable servicing techniques.

(ii) Terminal

Departure, Arrival, Transfer of cargo, passenger and baggage.

Check-in

In Cargo terminals, involves check-in with airlines, delivery of palletized and unitized cargo and then loading into waiting aircrafts.

In passenger terminals, it involves common check-in a central check-in area and subsequently seperation to flight check-in areas on check-in desks for decentralization and Gate check-in at the gate close to aircraft stands.

(iii) **Kerb-side and parking area**

The landside play an important role as the airside and is characterized by conflicting claims of private and public transport. This can be decentralized by the use of private cars or taxis in the passenger terminals while regulated and defined delivery and pick-up docks are necessary in cargo terminals.

Builk transport can be handled by train terminus in both cargo and passenger terminals.

8.4.2 Simplicity as a Functional Maxim

Lack of simplicity is the cause of the functional disarrangement, lack of control and site chaos found in majority of large airports, and not for the fact of faster than anticipated expansion.

Therefore my guiding principles for Calabar international Cargo Airport design are woven around simplicity and clarity, extra functional design elements and geometry as the catalyst between form and function.

8.4.3 Simplicity and Clarity

Simplicity of planning, orientation and relating the various functional elements. Clarity and conformity with the regulations above all in the structural design.

8.4.4 Extra Functional Design Elements

It has been seen how function alone produces no particular related form, but can be achieved by variety of architectural solutions.

The airport by reason of its size alone can be treated as an individual project outside the scope of conventional planning. Hence, conventional forms of international standard should be a recommendation. A simplicity that embellishes its complex function but within the limits of the virturian trinity of Firmitas (form/structure), utilitias (function) and venustas (aesthetics).

8.4.5 Geometry as a Catalyst Between Form and Function

Geometry has been applied to act as a catalyst between form and function. The square module has been used to establish the structural, constructional and services grid to reflect the five principles of modern architecture (Economy, use of materials, space appropriation, repetitiveness, and standardization).

Geometry has proved very suitable for regulating the functional requirement which would have otherwise been left to arrange themselves in an unco-ordinated manner.

8.5.0 CALABAR INTERNATIONAL CARGO AIRPORT DESIGN BRIEF

The Nigerian Export Processing Zone established in Calabar is the bed rock of industrial development in nigeria for locally manufactured goods and as a gateway for export in Nigeria.

Then, for full commercial activities to effectively take-off in the zone, there is need for the movement of people and goods along international boarders.

The Federal Government through the Aviation Ministry has now a plan for the design and construction of a Cargo International Airport in Calabar to accommodate long haul cargo and passenger aircrafts.

Therefore a proposal for a design for long haul transport aircrafts using Boeing 747 as the design capacity aircraft for runway and terminal design.

For effective loading and off-loading of cargo an automated terminal system is called for to ease, and conserve manpower, time and theft at the terminals, and allowance for an unassisted take-off of aircraft when fully loaded.

8.5.1 **Brief Development**

According to the International Civil Aviation Organisation (ICAO), an International Airport is that designated by the contracting State in whose territory it is situated as an airport of entry or departure for International traffic, where formalities incident to customs, immigrations, public health, animals and health quarantine and similar procedures are carried out.

This airport will serve as a relieve airport for Port Harcourt and Enugu provided essential facilities for technical competency are provided as intended for an International Airport of this magnitude.

The airport will run scheduled international flights and locally diverted flights in times of bad weather in neighbouring airports.

The terminals facilities will be grouped in two wings, to house cargo facilities in the main wing and the passenger terminal in the other.

8.5.2 The Calabar International Cargo Airport

The implementation of this project has been conceived in two sections and phases, in which the two terminals will be provided at the same time and would be expanded in the next phase following anticipated increase of use.

8.5.3 Site Concept

The general site concept layout is defined by two intersecting runways, to check cross wind components and the apron located between the widening glide path of the two runways. The cargo wing located directly facing the point of runway intersection (East) and the passenger wing pulled out of the main apron on the right and facing south.

The concept behind the layout is to achieve a decentralised access and parking arrangement defining cargo and passenger terminals ingress and egress, and a similarly decentralized apron.

8.5.4 Terminal Concept

(a) Cargo Terminal

An attempt has been made for effective security by providing an enclosed cargo handling operation activity area in an enclosed courtyard with visitors and unauthorised

callers stop at the peripheral parking area with the administrative building forming the interface between the two.

The cargo terminal building is conceived as an envelope structure encasing four activity bays with an underground railway system for cargo conveyance.

The structure is of insitu reinforced concrete columns supporting interlocking triangular folded concrete roof plates with triagular light concrete panel cladding walls with glass in-fill openings at intervals for interior lighting and ventilation. The floor system is designed to act independent of the roof structure to accommodate machine vibrations.

(b) **Passengers: terminal**

The passenger terminal is conceived with an elevation concept at the landside approach of a B747 parked in an apron viewed from the nose with wings spread eagle-out.

The terminal has a decentralised car park at the landside with a longterm parking semi-basement. Departing passengers approach the terminal via a ramp to an elevated kerb with a discentralized entrance. Check-in and baggage claims take place on the ground level while departure and arrival lounges are on the first floor connected via lifts, stairs and escalators. Aircrafts are brought close to passenger via a corridor finger pier through flexible apron corridors as aircraft interface.

The administrative offices are housed on the two floor and the control tower towering above the whole complex located at the air side of the terminal conceptually forming the terminal of the aircraft from the landside approach elevation.

8.6.0 **SCHEDULE OF ACCOMMODATION**

8.6.1 **Airport Terminal Space Facility:**

(A) CARGO TERMINAL SPACE FACILITY

	NAME OF SPACE	CAPACITY NO.	NO. REQ.	UNIT AREA	TOTAL AREA
	Trailers Park Visitors car park Staff car park Maintenance park **ADMINISTRATION BLOCK** Entrance drop-off porch Waiting and reception area Bill of ladding office Accouints office Accountants Office Receptions/Secretary General office Director oif Personel Secretary/Receiption Airlines Offices Manager's Office Secretary Public toilets Terminal Manager'Office Secretary W.C. Assistant Terminal Manager Contorller of customs Office Chief Security Officer State Security Service Office Staffs toilets **WORKERS FACILITIES** Restaurant area Kitchen Severy Store Workers Rest Room Changing Room Showers Toilets Clock-in Area Office				

	CARGO TERMINAL ARRIVAL Receiving Bay Cargo Store Containers Cargo Bay Palletised cargo Bay LD3 containers Bay Loose Pallets Bay Air Mail Bay **GROUND FLOOR** General concourse Departure concourse Arrival concourse Check-in Desk sapce Reception/Information area Airlines Offices Store Room Shops Post Office Bank public Toilets Baggage sorting Area Transfer Baggage way Baggage store Maintenance Strong Room Customs Check Area Baggage claim area Transfer Baggage store Unclaimed Baggage store Strong Room Staffs Rest Room Toilets **FIRST FLOOR** Coffee Bar Kitchenette Departure Lounge Customs check area Duty free shop C.I.P. Lounge Public toilets Restaurant Snaks bar Kitchen Staff toilets				

	Servery Rest Rooms Toilets Arrival Lounge Immigration Check area Immigartion Offices Rest Rooms Toilets Shops and Supermarkets **ADMINISTRATION FLOORS** FAAN Offices Airport Manager's Office Assistant Airport Manager General Office Accounts Office Accountant Secretary Personnel Office Director of Personel Secretary Manager Operations Secretary Civil Engineering Dept. Military Liaison Office Immigration Liaison Office Customs Liaison Office Conference Hall Security General commercial office **TERMINAL SERVICES** Equipment Room Signals/Battery Room Material Store Radio Room A.I.S. Office Met. Office Sate Security Service Airlines Offices Staff Lounge/bar Restaurant Kitchen Pantry Store Airline catering (delay)				

8.7.0 SUMMARY AND CONCLUSION

The study and the investigation carried out has been highlighted by the problem definition, the aims and objective of the Research within the limits set by the scope and limitation, defining the area of study.

Chapter two traced the chronology of flighrt history in Europe to its transfer to Africa, Nigeria, and the establishment of airports and their administration.

Chapter three dwells on existing case studies highlighting various airport design concepts, their expansion process, therefore preparing our minds for the Airports of the future.

The following chapters discussed conditions for airports establishment and various functions and requirements of airport components, while the last chapter brings us to the Calabar International Cargo Airport design.

The research is an attempt at arriving at a design solution that is functional and responsible to modern automated requirements of Cargo handling techniques. the concept is an Architecture that is simple, flexible and at the asme time responsive to futre changes eminent in dynamic nature of Aviation industry.

I can now hopefully conclude this write-up praying that I have brought forward a new concept responsive to modern cargo handling techniques.

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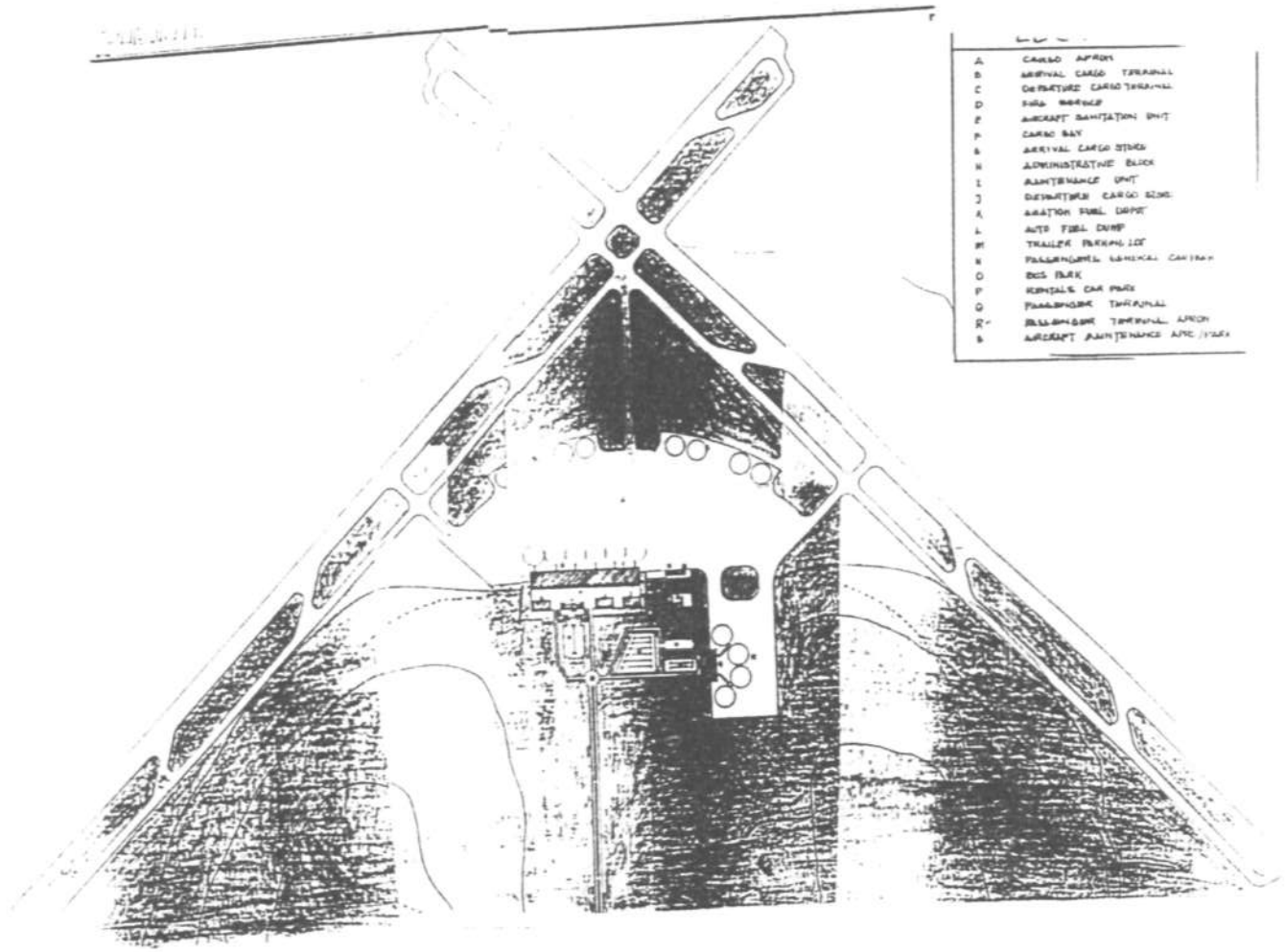
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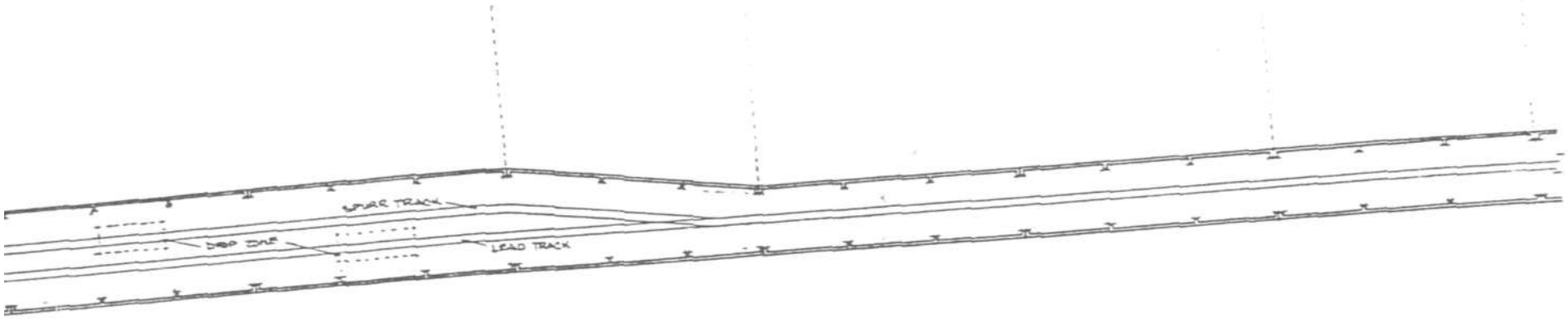
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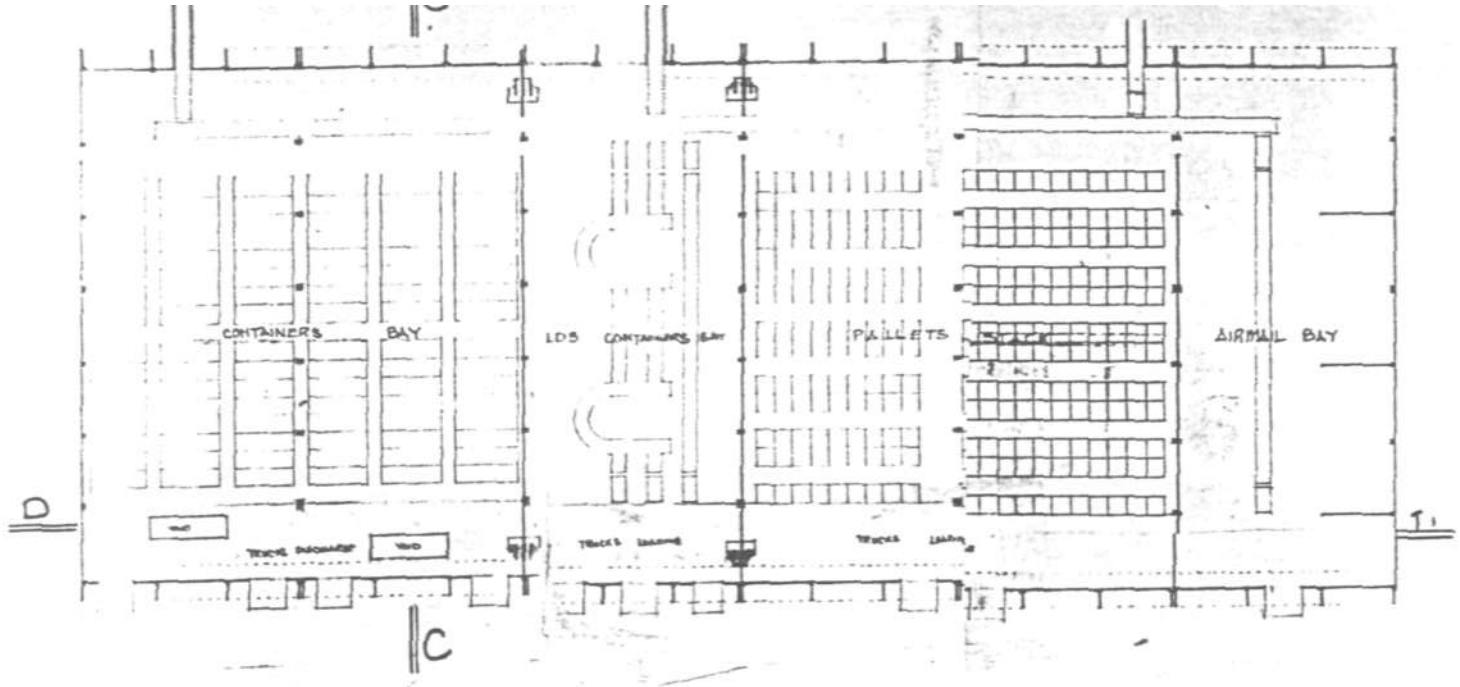
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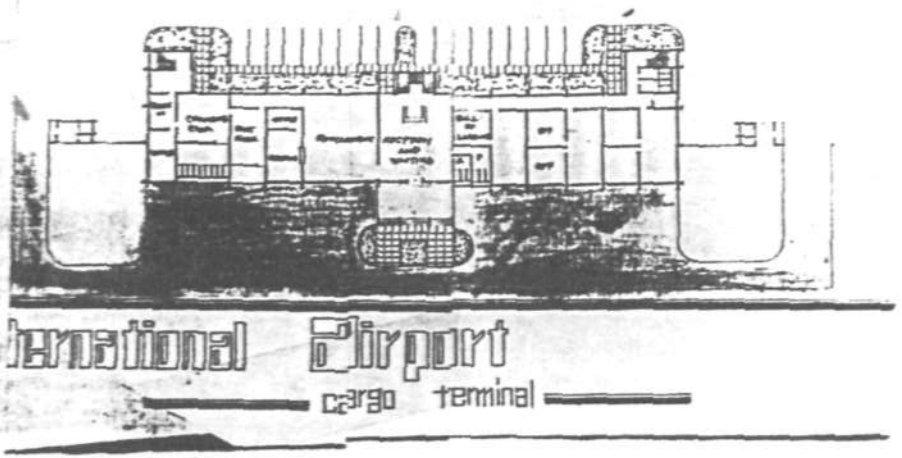
Calab

ternational Airport


UPPER TRACK
DROP DOWN
LEAD TRACK





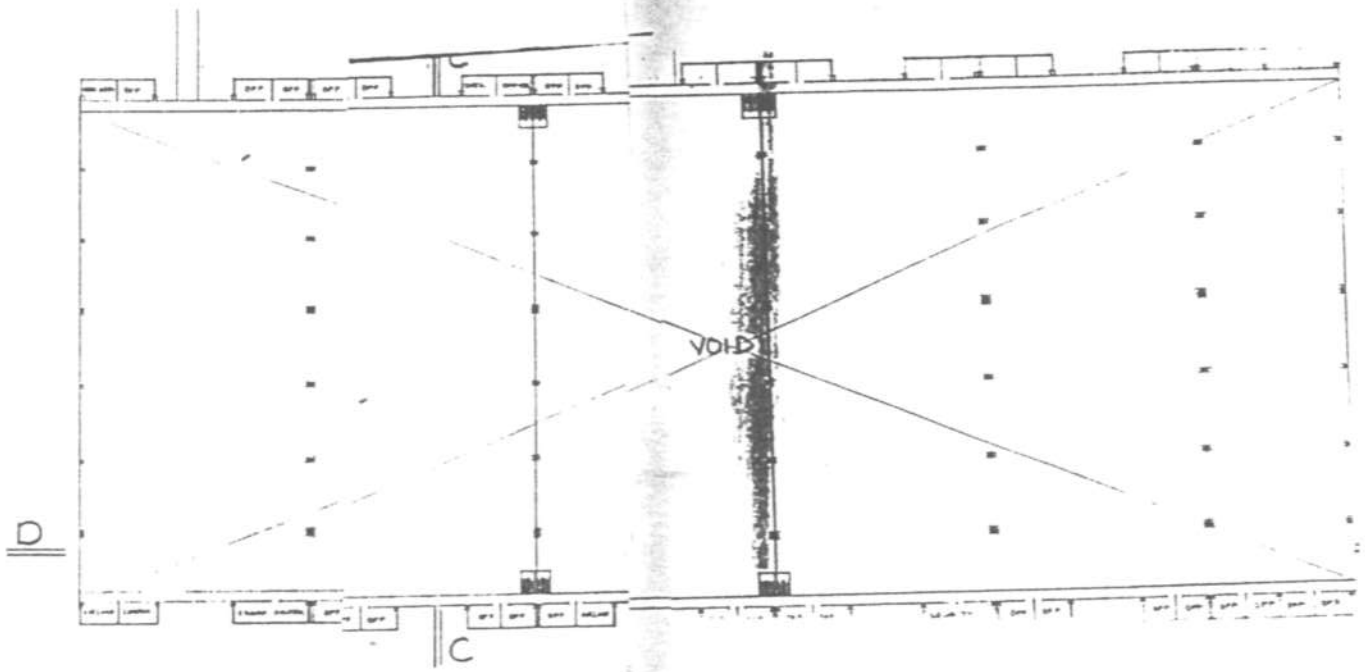


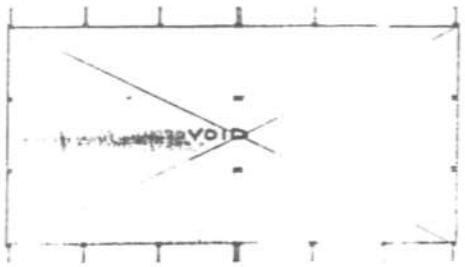
Calaba

ternational Airport

cargo terminal

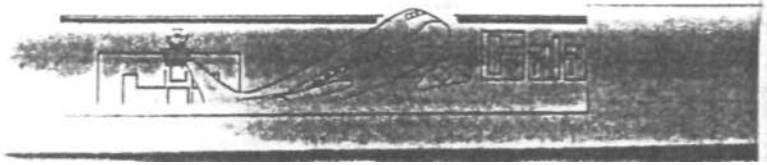
PODIUM FLOOR





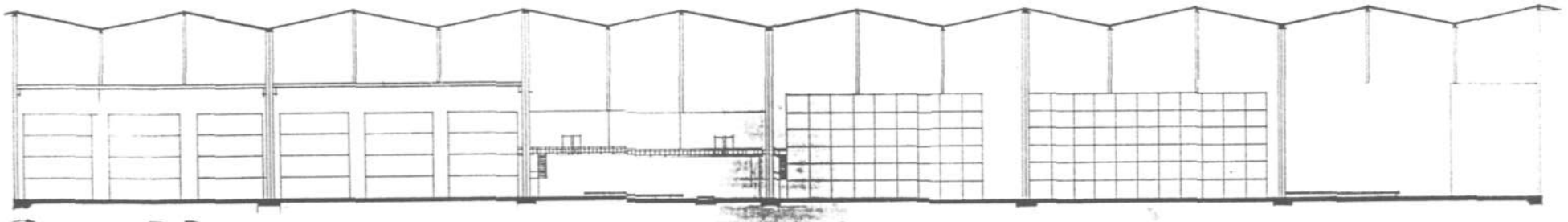


FIRST FLOOR PLAN

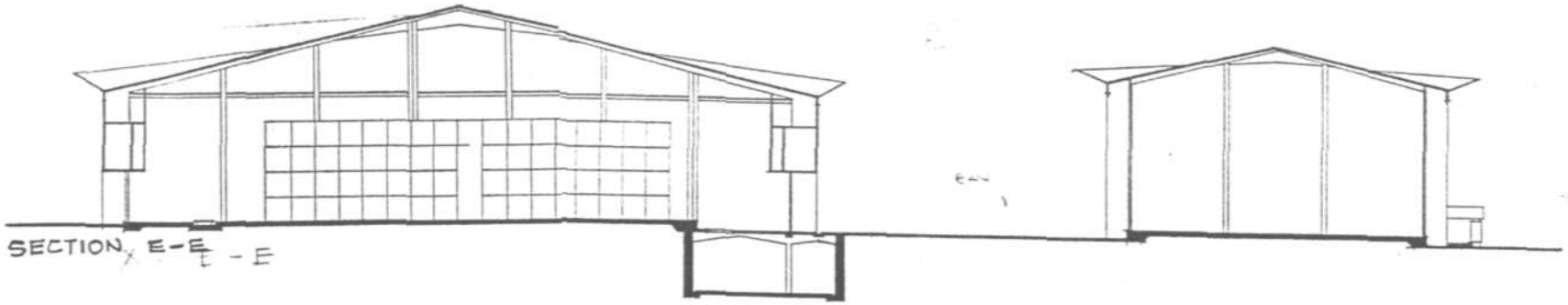


national airport

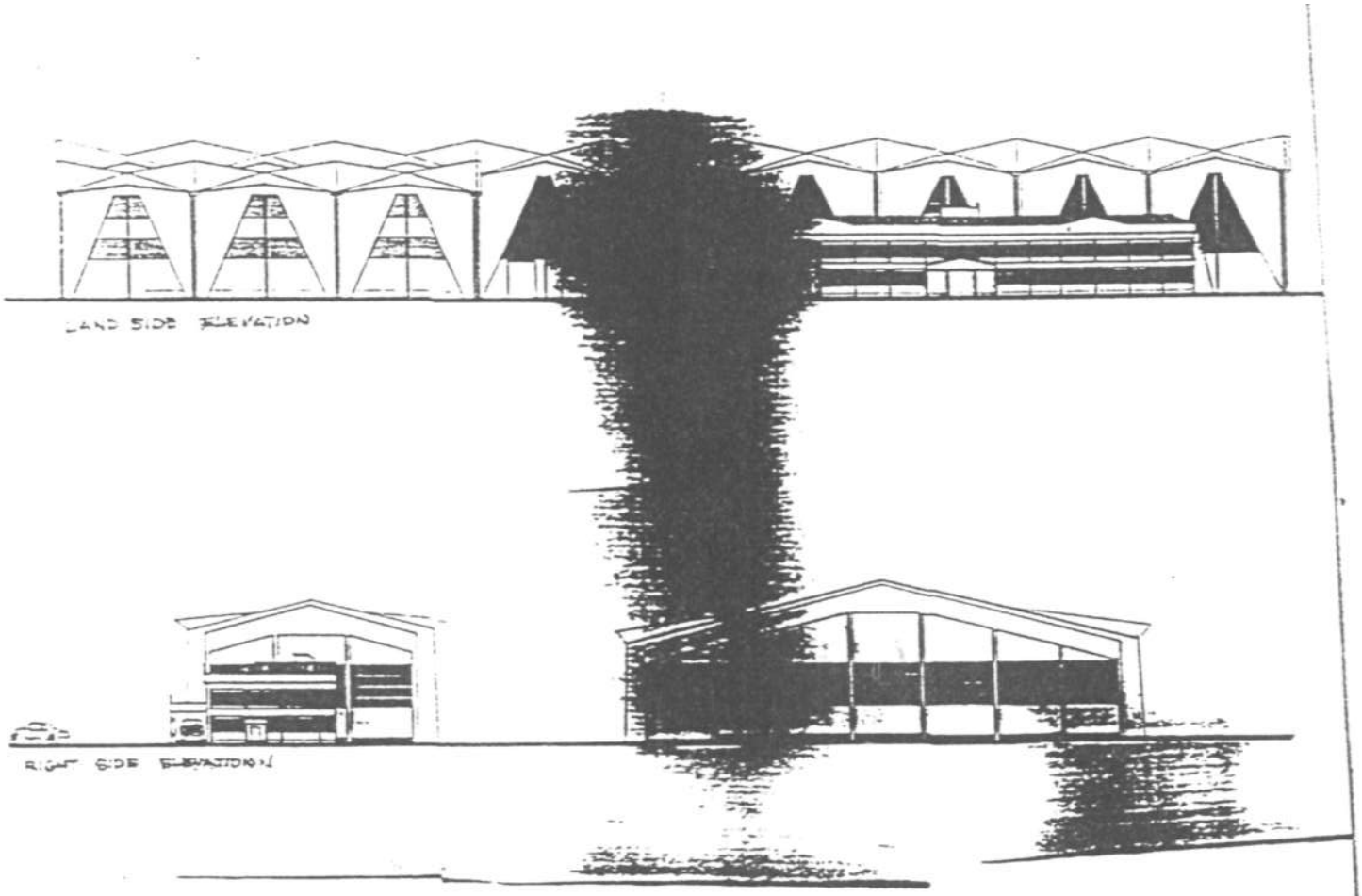
garden terminal



SECTION D-D

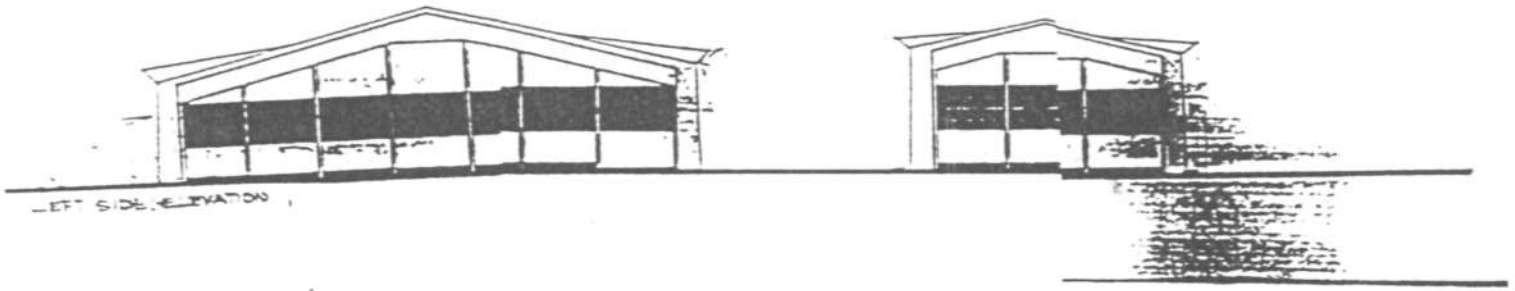


SECTION E-E

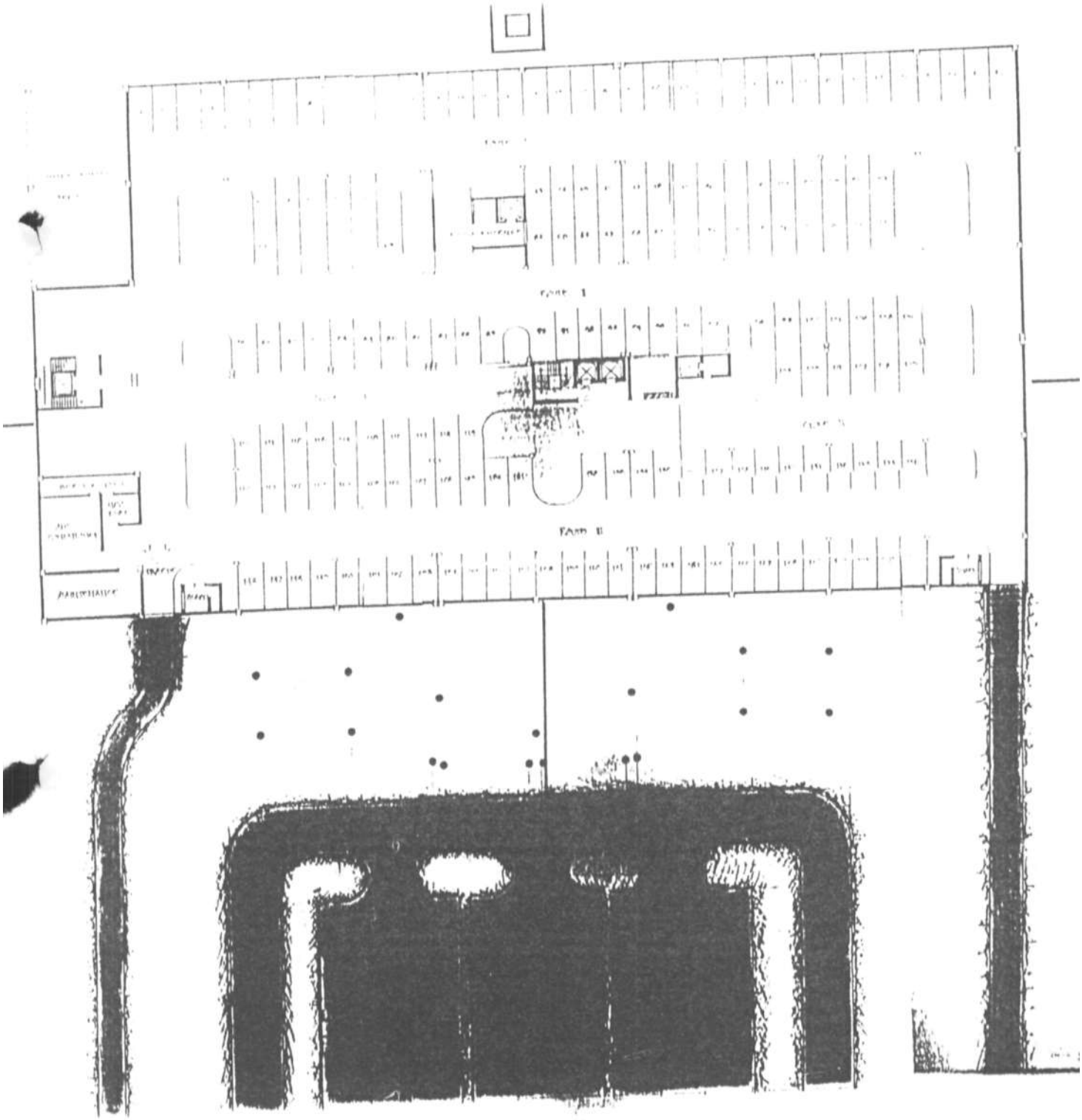

LAND SIDE ELEVATION
RIGHT SIDE ELEVATION



LAND SIDE APPROACH ELEVATION

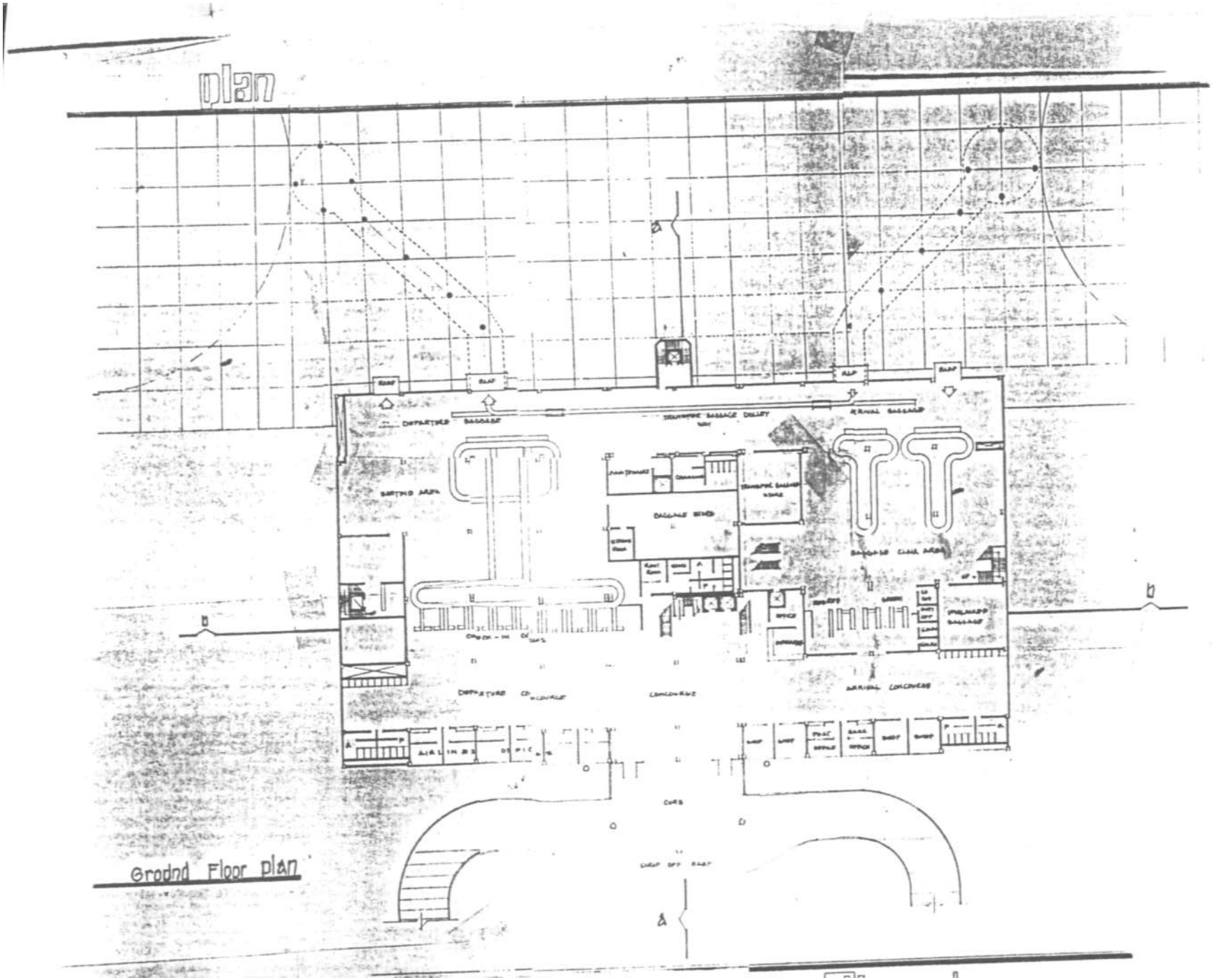


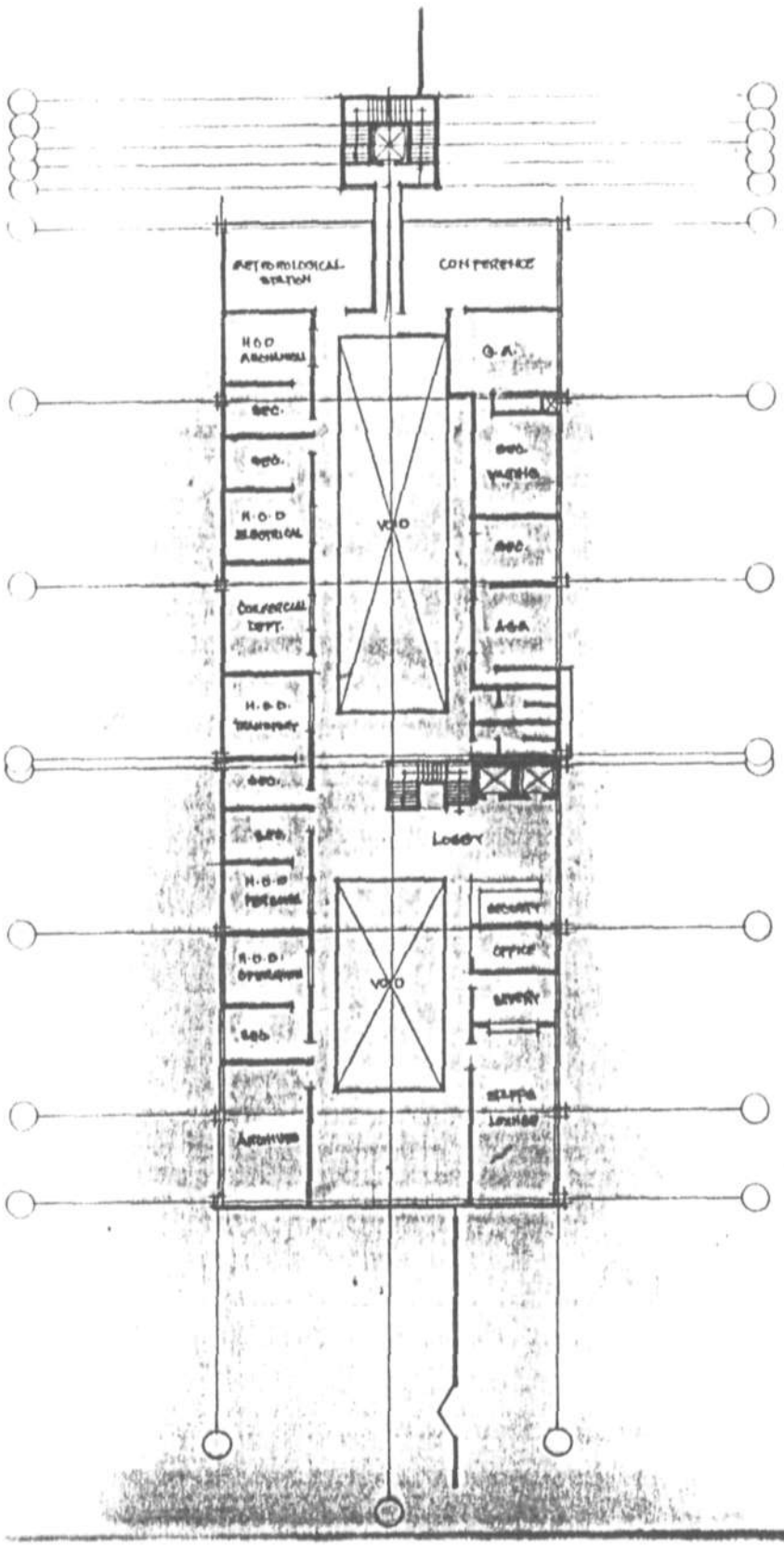
LEFT SIDE ELEVATION



Calabar international Airpo

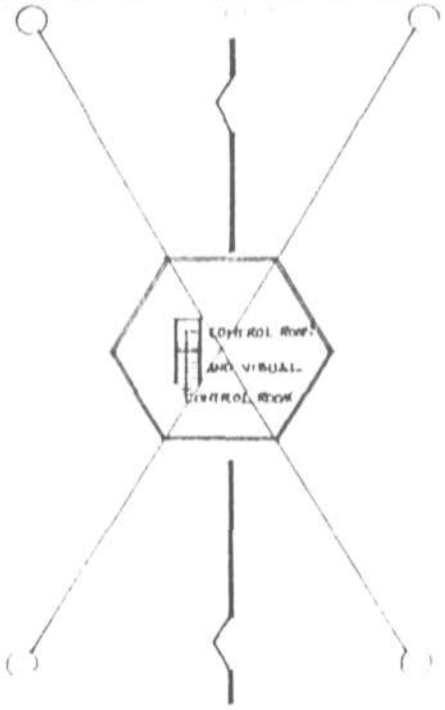
cargo t

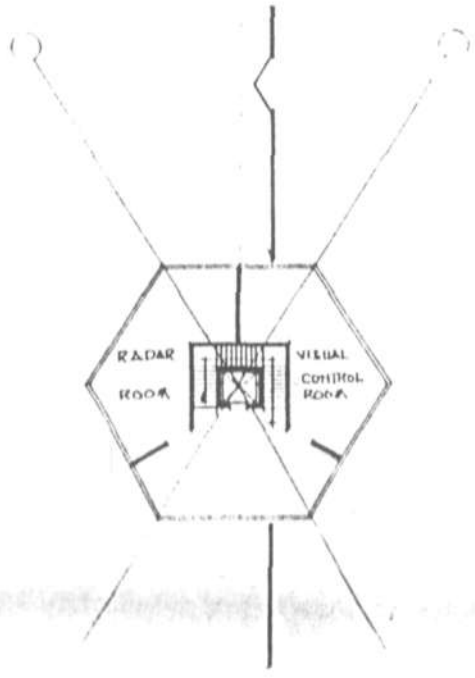

plan
DEPARTURES BAGGAGE
ARRIVAL BAGGAGE
BAGGAGE HALL
DEPARTURE CONCOURSE
ARRIVAL CONCOURSE
KERB
Ground Floor plan

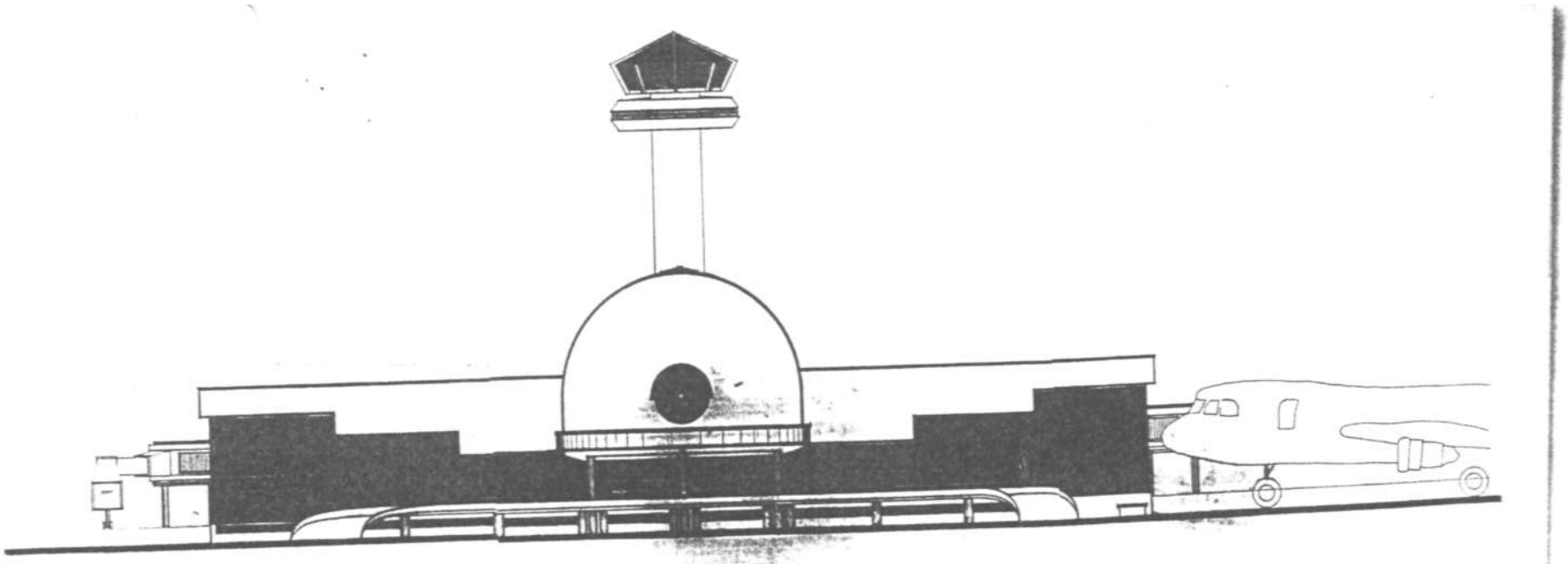


Phn

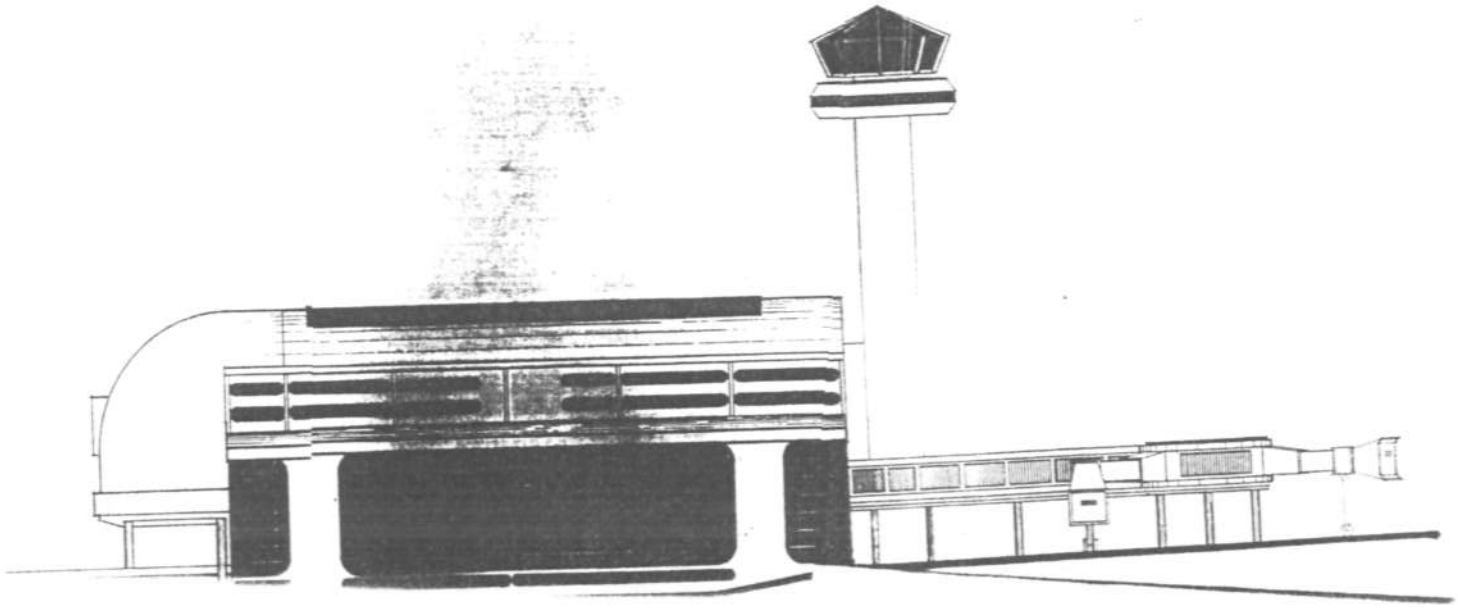
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CONTROL ROOM
AND VISUAL
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VISUAL
CONTROL
ROOM



SIDE APPROACH ELEVATION





AIR SIDE ELEVATION

