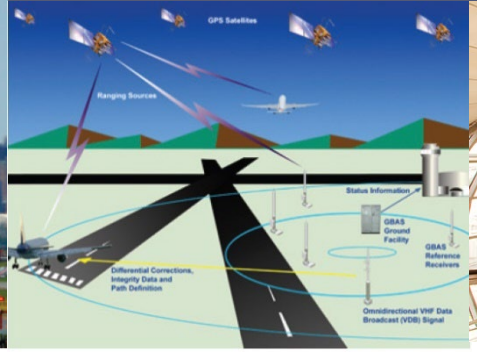


Aeronautical Communication and Navigation

Aircrafts, Airports, Phases of Flight, Aeronautical charts

Professor Dr. Pornchai Supnithi

Telecommunications Engineering Department, School of Engineering

Center of Excellence in GNSS and Space Weather

http://iono-gnss.kmitl.ac.th

History

1901 Radio transmission across the Atlantic, England

1903 Wright Brothers – first ever manned flight, USA

1911 Cal Rodgers, $50,000-prize ambition (if < 30 days)
First transcontinental flight (84-hr in the air)
75 stops, 16 crashes, many hospital visits
Modified Wright brothers plane (EX)
35-horsepower engine, 50-60 MPH

History

1914 January, 1st.
First commercial flight, St.Petersburg – Tampa, Florida, USA, $400
5-m altitude, 21 miles, 23 minutes
Benoist XIV plane

1919 London-Paris flight
2 hr 30 min., £21 per passenger

1946 Cathay Pacific of Hong Kong
1947 Malayan Airways Limited (later Singapore, Malaysia Airlines
1951 Japan Airlines
1960 Thai Airways International

Many types of aerial vehicles

Worldwide numbers

~240 airlines

~45,000 airports (World)

~ 50 airports (Thailand)

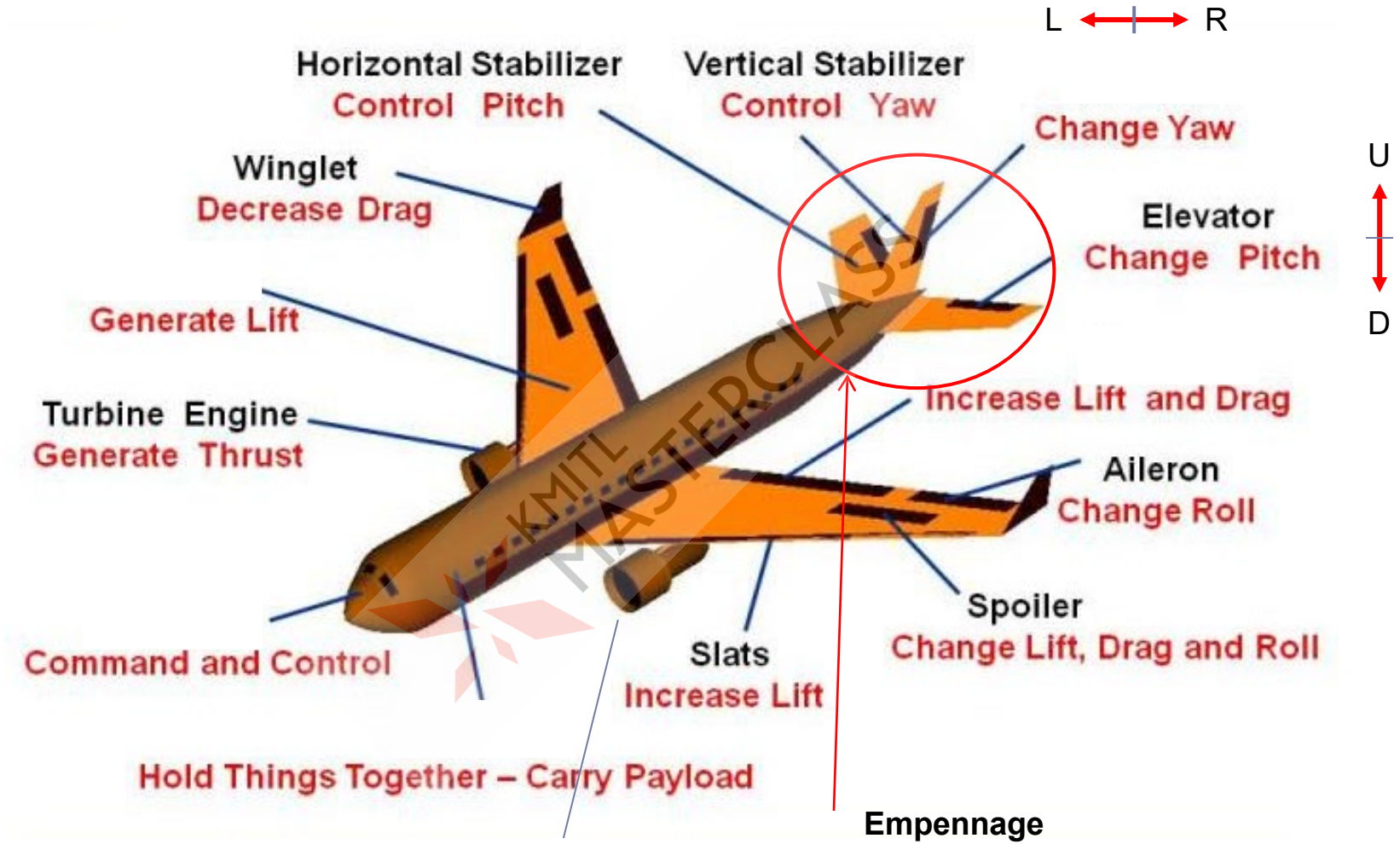
5

June 29th, 2018
(Busiest Air Travel on Record)

202,157 planes in 24 hours

https://www.weforum.org/agenda/2018/07/the-world-s-busiest-day-for-air-travel-mapped

Aircraft parts and functions



Four Forces of Flight

LIFT

$\frac{1}{2} * p * v^2 * A * C_L$

THRUST

DRAG

$\frac{1}{2} * p * v^2 * A * Cd$

WEIGHT (gravity)

Lift

$$L = A_s * C_L * (\tfrac{1}{2} * p * v^2)$$

P = air density (kg/m^3)
v = velocity (m/s)
A_s = wing surface area (m^2)
C_L = coefficient of lift (no unit)

Exercise:

Compute the Lift given the following paramters

A_s = 510 m^2
C_L = 0.52
p = 0.30267 kg/m^3
v = 265 m/sec
Aircraft weight = 286 tons

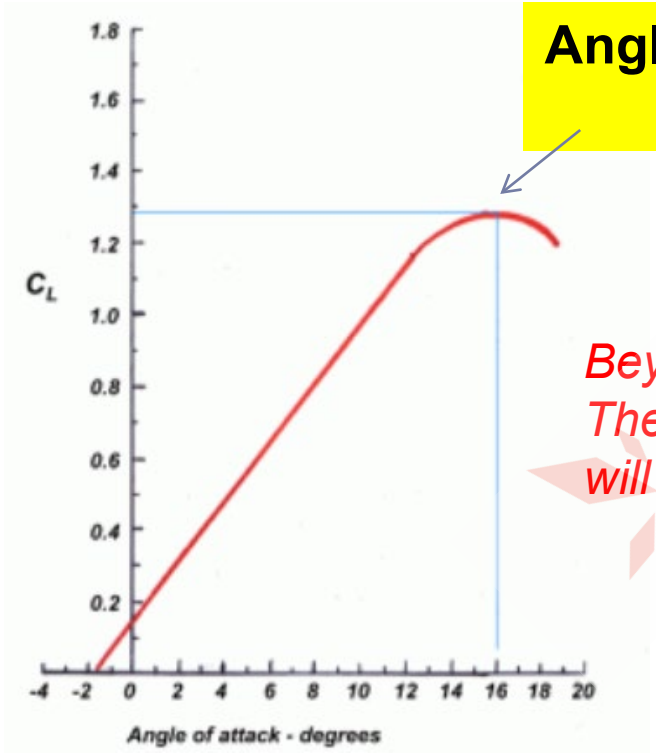
1 MPH = 0.44704 m/s

➔ $L = A_s * C_L * (½ * p * v^2)$
$= 510x\ 0.52x\ (1/2)\ x0.30267x265^2$
= 2,817,762.027 (newtons, N)
= 287,233.56 (kg) ~ 287 tons

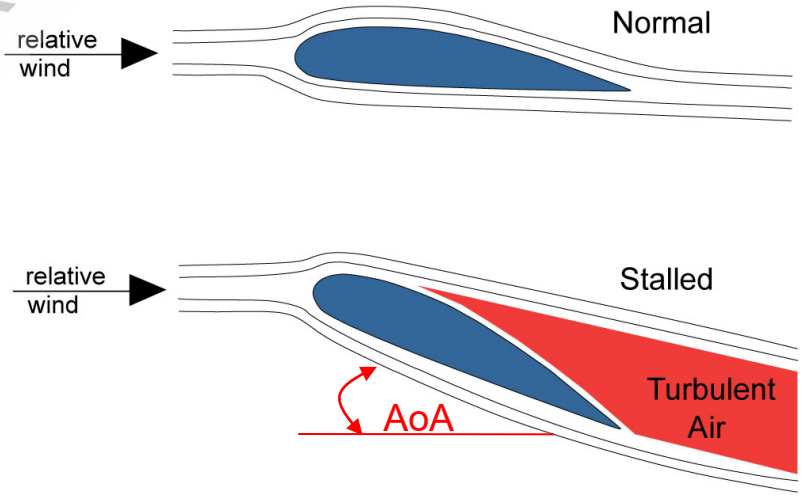
1 kg = 9.81 N

Angle of Attack (AoA), Stall

AoA = The angle which the Lift coefficients C will decrease.

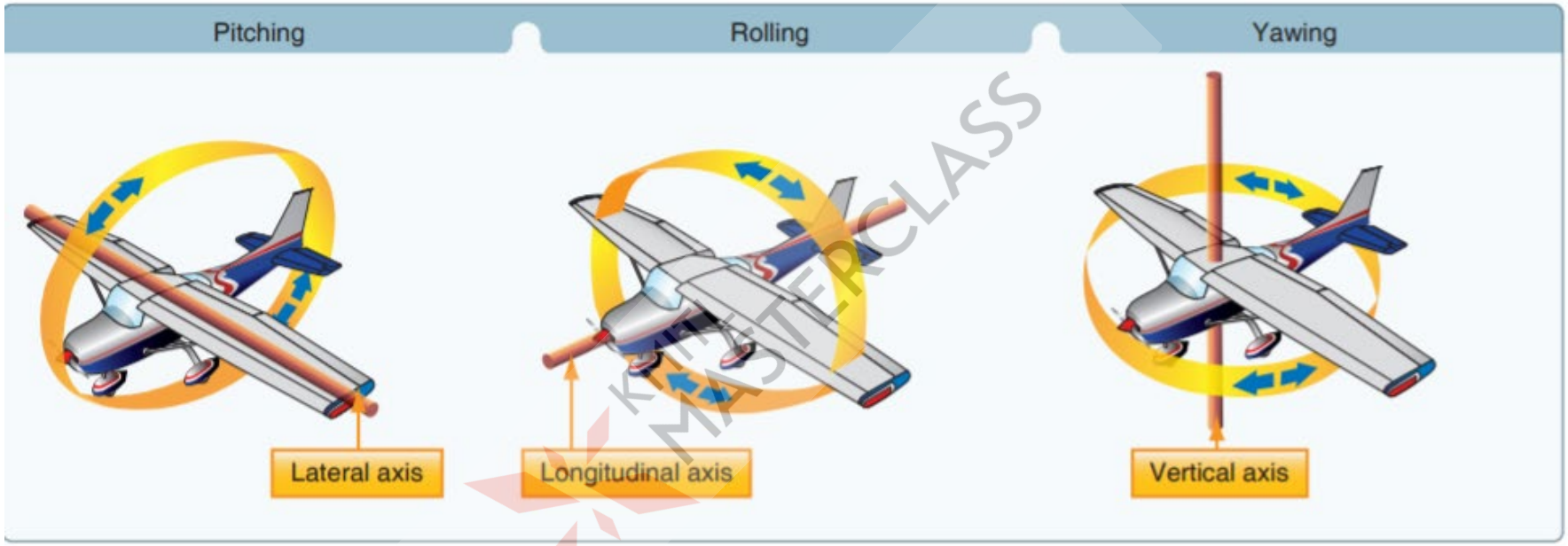


Beyond AoA, The aircraft will nose dive.

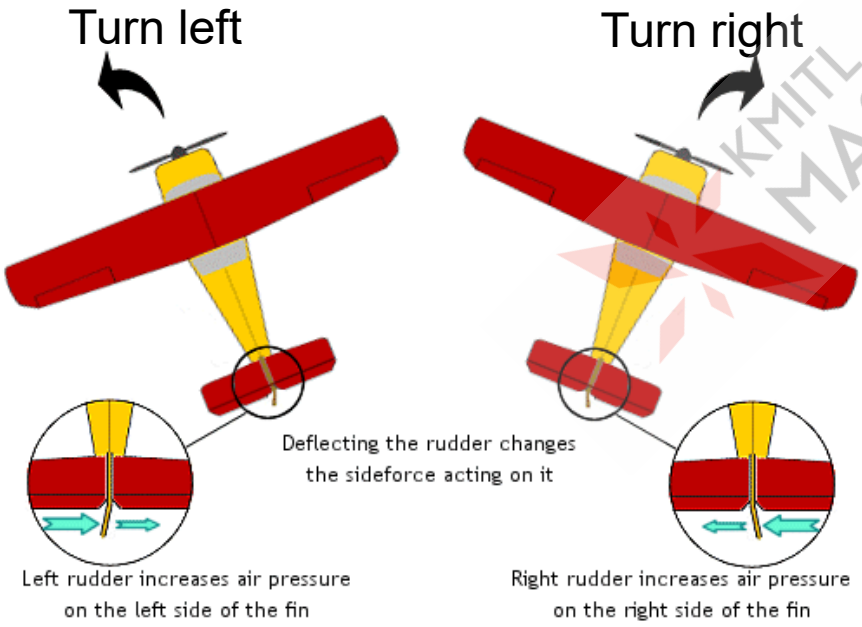


http://rckavalaacroteam.com/lift-factor/

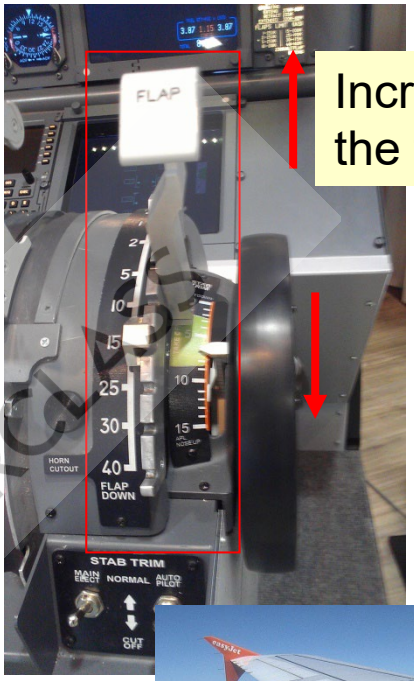
Roll, Pitch, Yaw



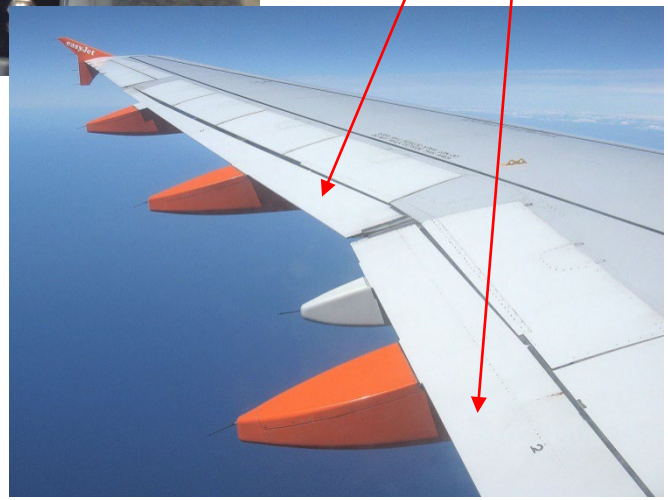
Rudder



Flap



Extending flap Increases the amount of lift



Movement control

While taxiing..

Steering tiller

In the air

Yoke/Flight Control Column

Push backward – Descend

Tilt right

Tilt left

Pull forward – Ascend

Inside the cabin of Boeing 737

Engine start, Fuel, Electricity, Generator, A/C Lights around the plane, hydrolics, temperature Seat belt sign, Cabin Pressure

Speed, Auto-pilot Heading, Altitude

Monitor: Position, Skyline, Fuel, Backup screen

Data Entry, Flight plan screen

Communication and Navigation transponder/ panels

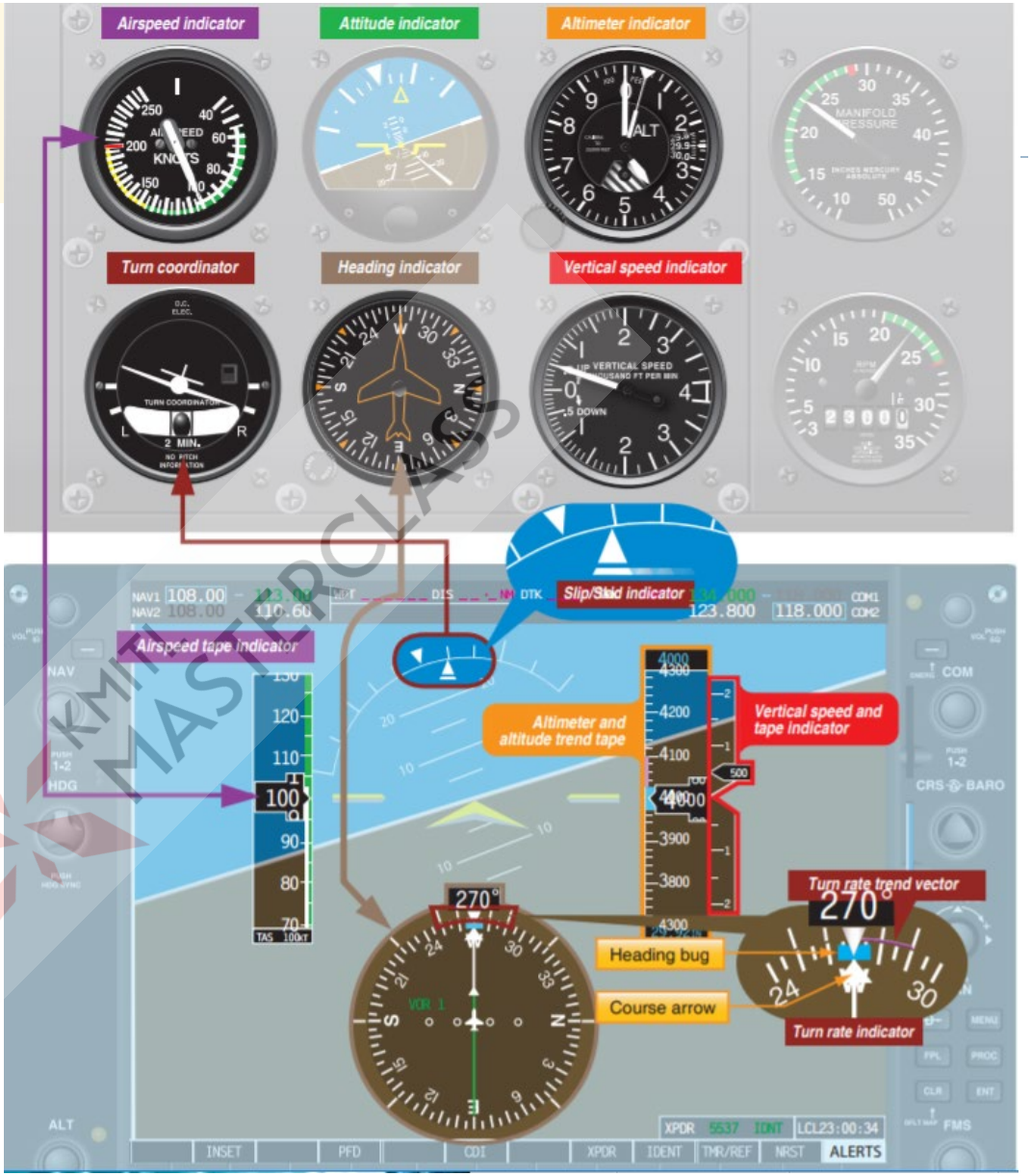
Mechanical control: Throttle, Flap, reverse throttle

Flight Instruments

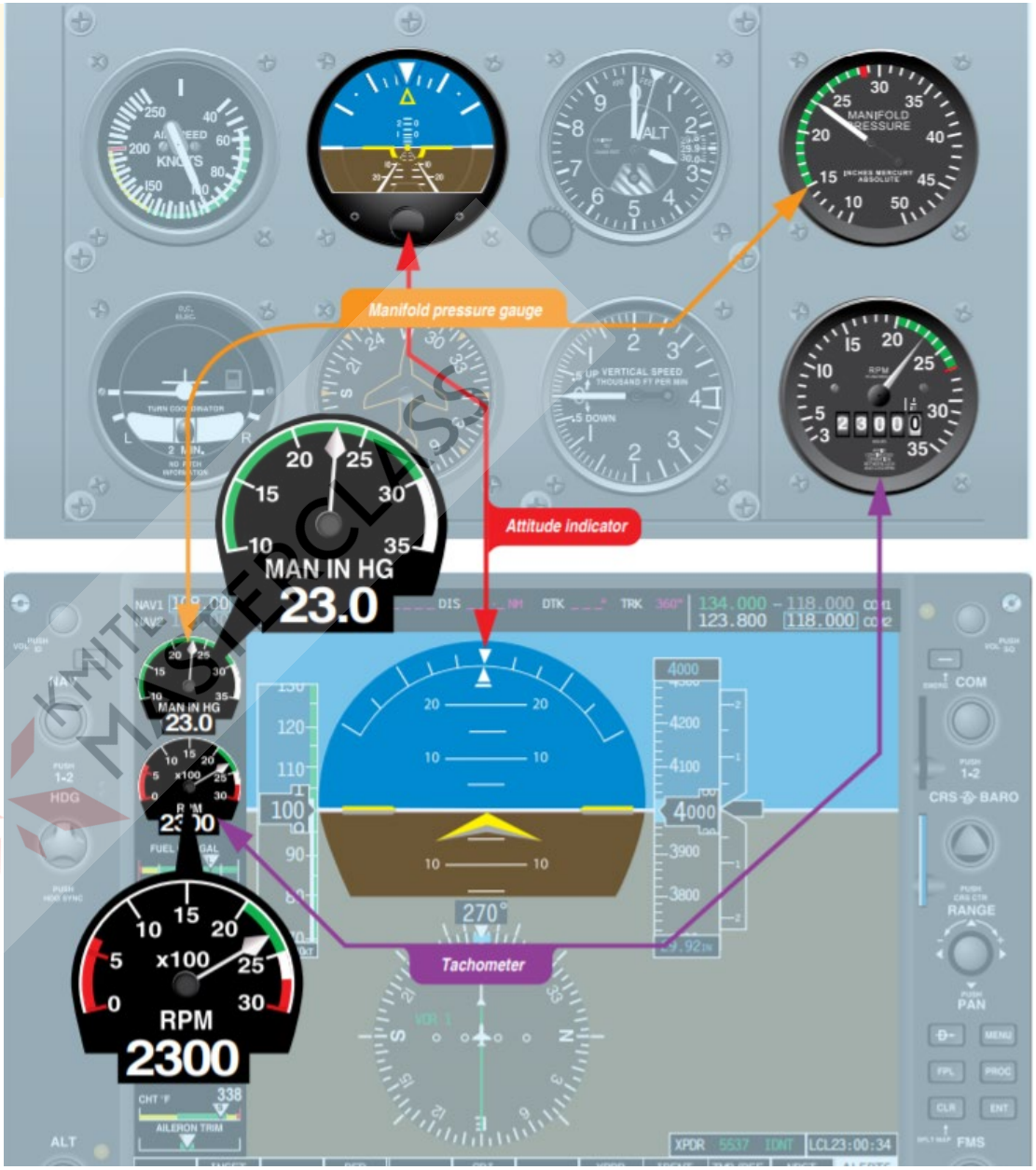
Analog

Digital

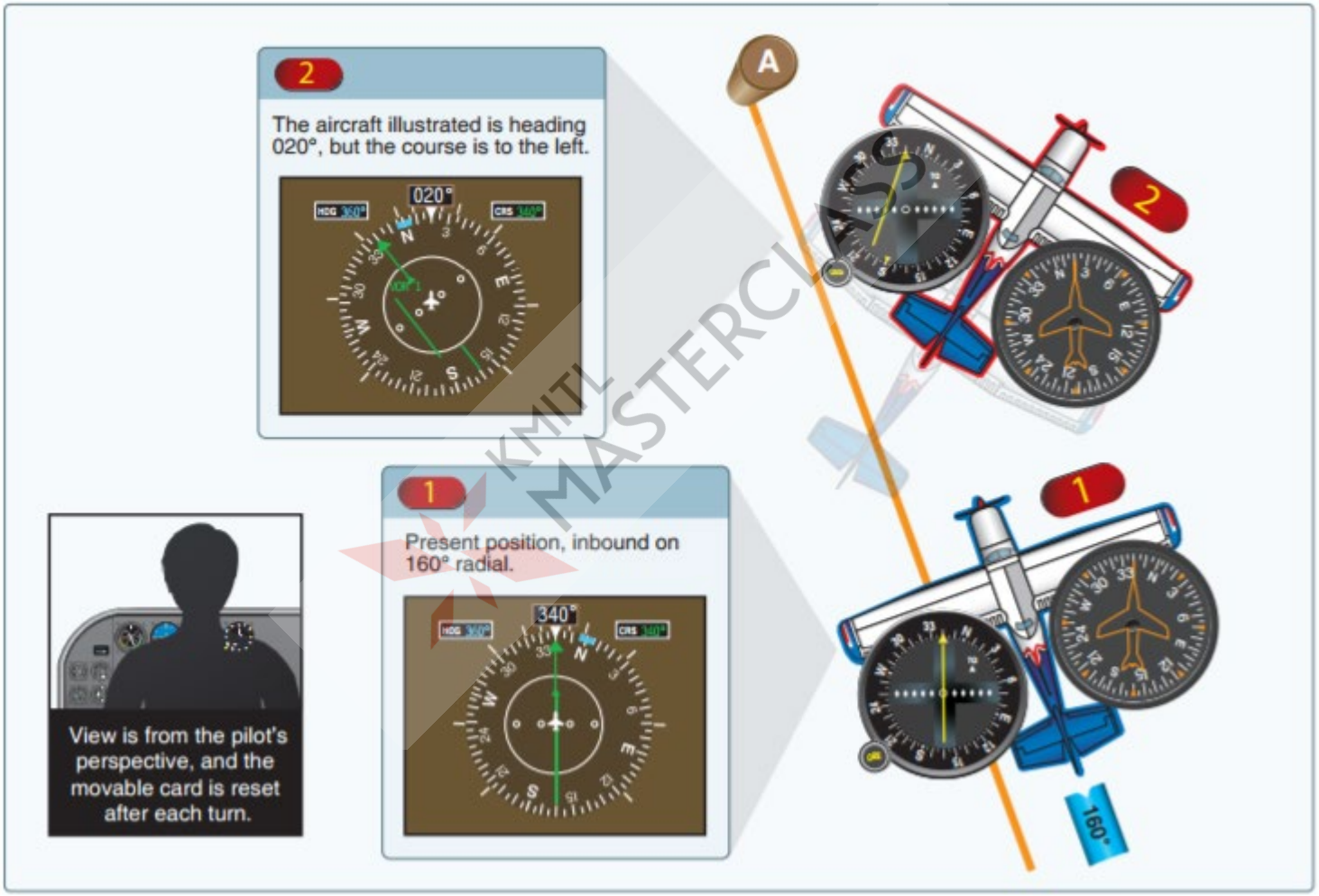
Performance Instruments



Control Instruments



Navigation Instruments (1)



Navigation Instruments (2)

NATO/ICAO Phonetic Alphabet

A	Alpha	AL FAH
B	Bravo	BRAH VOH
C	Charlie	SHAR LEE
D	Delta	DELL TAH
E	Echo	ECK OH
F	Foxtrot	FOKS TROT
G	Golf	GOLF
H	Hotel	HO TELL
I	India	IN DEE AH
J	Juliet	JEW LEE ETT
K	Kilo	KEY LOH
L	Lima	LEE MAH
M	Mike	MIKE
N	November	NO VEM BER
O	Oscar	OSS CAH
P	Papa	PAH PAAH
Q	Quebec	KEH BECK
R	Romeo	ROW ME OH
S	Sierra	SEE AIR RAH
T	Tango	TANG GO
U	Uniform	YOU NEE FORM
V	Victor	VIK TAH
W	Whiskey	WISS KEY
X	X-ray	ECKS RAY
Y	Yankee	YANG KEY
Z	Zulu	ZOO LOO

Call Sign

- Unique designation for a transmitting station

- Aircraft
  - Type A: Registration number (marks)
    - (Thailand) HS321 → *Hotel Sierra three-two-one*
    - (USA) *N978CP* → *November-niner-seven-eight-Charlie-Papa*
    - (Britain) G4980 →
  - Type B: Company/Agency + Registration Marks
  - Type C: Flight number
    - Thai113
    - KLM645

Call Sign

- President of the United States
  - Air Force One (US Air Force aircraft)
  - Air Force One Foxtrot (when only the family of the President is aboard.)
  - Marine One (US Marine aircraft)
  - Navy One (US Navy aircraft)
  - Executive One (civilian aircraft)

- Vice President of the United States
  - Air Force Two (US Air Force aircraft)

Unit for Altitude – Flight level

- Normally, we use “feet” (ft) for Altitude
- After about 11,000 ft ➔ Call flight level (FL)

FLAAA = AAA x 100 feet

FL300 = 30,000 ft

Units for Distance/Speed

1 NM (nautical mile) = 1.852 km
= 6,076.1 feet

1 NM ~ 1.15 x statute mile (SM)

1 knot = 1 NMPH = 1.15 MPH = 1.852 km/hr

1 mach = 758 MPH

Exercise:

A flight is at 'En Route' level of FL300 and speed of 450 MPH, what is

(a) the height from ground in km, and
(b) the speed in km/hr, knots, and machs?

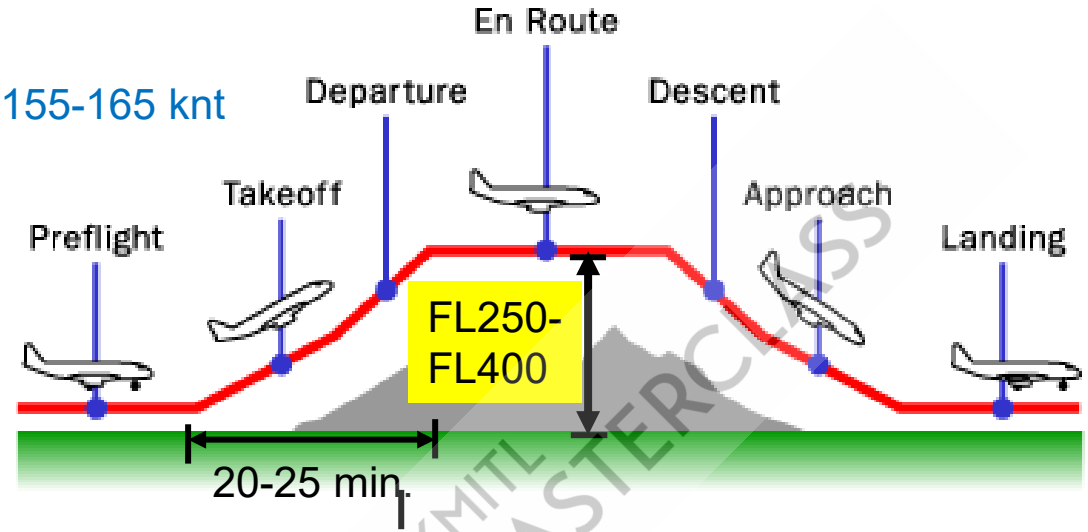
(a) 33,000 ft = 33,000x0.3048 m
= 10,058.4 m ~ 10 km

(a) 450 MPH = 450x1.852/1.15
= 724.7 km/hr
= 450/1.15 = 391.3 knots
= 450/758 = 0.593 mach

Phases of Flight

475-500 knts
878-926 km/hr

Boeing 747
Takeoff speed = 155-165 knt

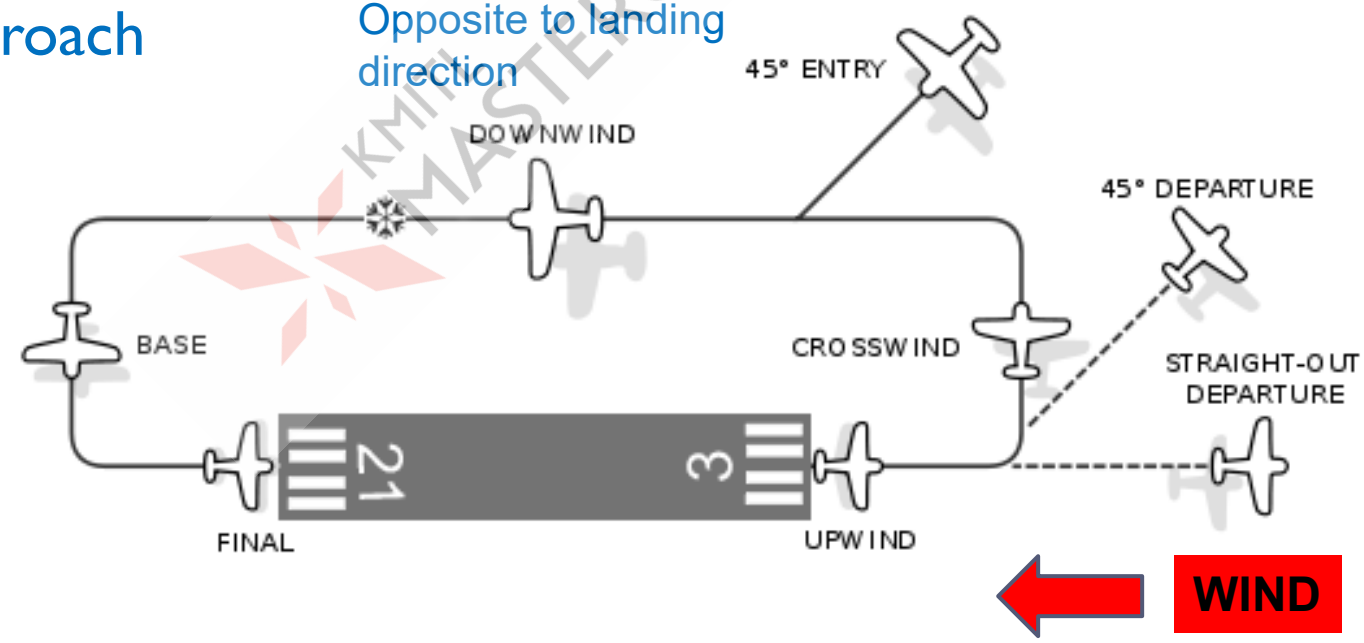


Preflight -This portion of the flight starts on the ground and includes flight checks, push-back from the gate and taxi to the runway.
Takeoff - The pilot powers up the aircraft and speeds down the runway.
Departure - The plane lifts off the ground and climbs to a cruising altitude.
En route - The aircraft travels through one or more center airspaces and nears the destination airport.
Descent - The pilot descends and maneuvers the aircraft to the destination airport.
Approach - The pilot aligns the aircraft with the designated landing runway.
Landing - The aircraft lands on the designated runway, taxis to the destination gate and parks at the terminal.

Typical Traffic Patterns

There are five different legs of the traffic pattern:

- Upwind Leg
- Crosswind Leg
- Downwind Leg
- Base Leg
- Final Approach

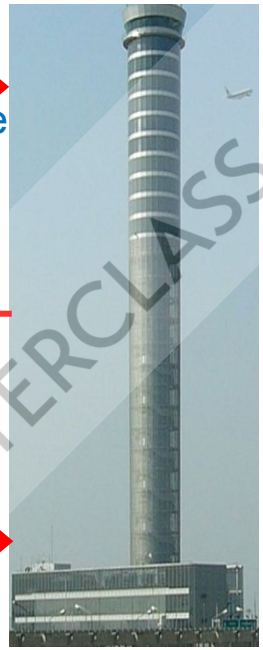


Procedures of Departure

1. Request clearance delivery (RCD) File a flight plan

2. Clearance delivery (CLD)

3. Clearance delivery acknowledgement (CDA)



flight data person reviews the weather and flight-plan information and enters the flight plan into the host computer.

The computer generates a **flight progress strip** that will be passed from controller to controller throughout your flight.

ATC Clearance Frequency

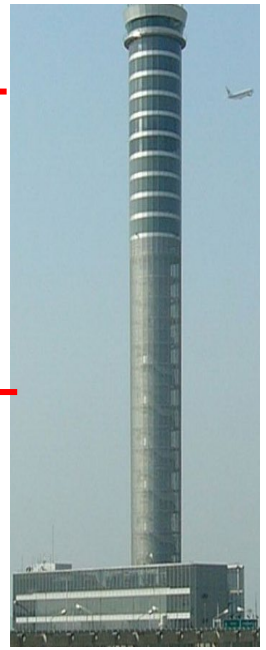
Be prepared to enter different frequencies for Tower, Departure, etc.

Procedures of Departure

Tower Frequency

Ground controller directs the pilot to push back from gate, taxi to the takeoff runway, Short hold.

gives final clearance for takeoff



After takeoff

En Route

- Talk to ATC at waypoints
- at transition altitude (different for each country)
- at different altitudes
- Obtain Weather info
- Send ADSB signals
- etc…

Radio signal

flight number, altitude
airspeed, destination

Radar signal

Tower Frequency

Activates a transponder device in the aircraft

Descending

En Route

-Set ILS frequency (localizer, GS)
- Descend to fixed altitudes (based on flight plan)
- Set descending speed (based on flight plan)
- May change due to traffic condition
- Talk to ATC or read from ACARS printout
- Checklist (VREF, landing velocity (ex. 140 knts)

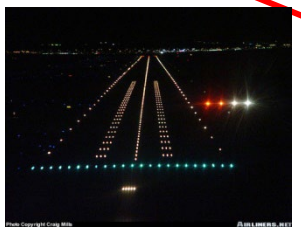
(Arrival) Frequency

Descend

Localizer

(Arrival)
Tower Frequency

Turns to
Localizer
signal



Rear wheels
land first

Radio frequencies at VTBS

Communication

Service designation	Call sign	Frequency	Hours of operation	Remarks
1	2	3	4	5
APP	Bangkok Approach	122.35 MHz / 262.5 MHz 124.35 MHz / 262.5 MHz 125.2 MHz / 262.5 MHz 121.7 MHz / 262.5 MHz 125.8 MHZ (2) 121.5 MHz(1) / 243.0 MHz (1)		(1) Emergency frequency (2) Clearance delivery for aircraft departing to adjacent aerodromes and helicopters operating within BKK CTR
APP	Suvarnabhumi Departure	119.25 MHz		(3) For RWY 01R/19L (4) For RWY 01L/19R
ARR	Suvarnabhumi Arrival	133.6 MHz 126.3 MHz 133.4 MHz 121.5 MHz	H24	
TWR	Suvarnabhumi Tower	118.2 MHz (3) / 274.5 MHz 119.0 MHz (4) 121.5 MHz (1)/ 243.0 MHz (1)	East rwy West rwy	
SMC	Suvarnabhumi Ground	121.65 MHz / 275.8 MHz 121.75 MHz 121.95 MHz	East apron Main apron West apron	
ATIS	Suvarnabhumi Airport	127.8 MHz / 278.6 MHz		D-ATIS Synthesis Voice Broadcast

Navigation

1	2	3	4	5	6	7
DVOR/DME	SVB	111.4 MHz CH51X		13 39 32.5 N 100 43 53.2 E		
ILS CAT II LOC/DME RWY 01L	I-SWS	109.1 MHz CH28X		13 42 22.3 N 100 44 37.8 E		
GP		331.4 MHz		13 40 27.8 N 100 44 03.6 E		
ILS CAT II LOC/DME RWY 19R	I-SWN	109.5 MHz CH32X		13 40 07.5 N 100 44 02.4 E		
GP		332.6 MHz	H24	13 42 03.9 N 100 44 28.9 E		RWY01L/19R and RWY01R/19L ILS LOC coverage expanded service volume up to 25 DME altitude not below 2 500 ft AMSL.
ILS CAT II LOC/DME RWY 01R	I-SES	110.1 MHz CH38X		13 41 39.3 N 100 45 42.1 E		
GP		334.4 MHz		13 39 33.4 N 100 45 13.1 E		
ILS CAT II LOC/DME RWY 19L	I-SEN	110.5 MHz CH42X		13 39 15.0 N 100 45 04.2 E		
GP		329.6 MHz		13 41 19.0 N 100 45 40.9 E		

ATC Clearance

Frequency	Outbound routes
120.8 MHz	A464 (SOUTHBOUND), G458, M751, W19, W31
133.8 MHz	A1 (EASTBOUND), A202, W1
135.8 MHz	N891, G474, R468 (EASTBOUND)
128.7 MHz	A1/L507, A464 (NORTHBOUND), B346, G463/P646, R468 (WESTBOUND), R474, W9, W21

Airports

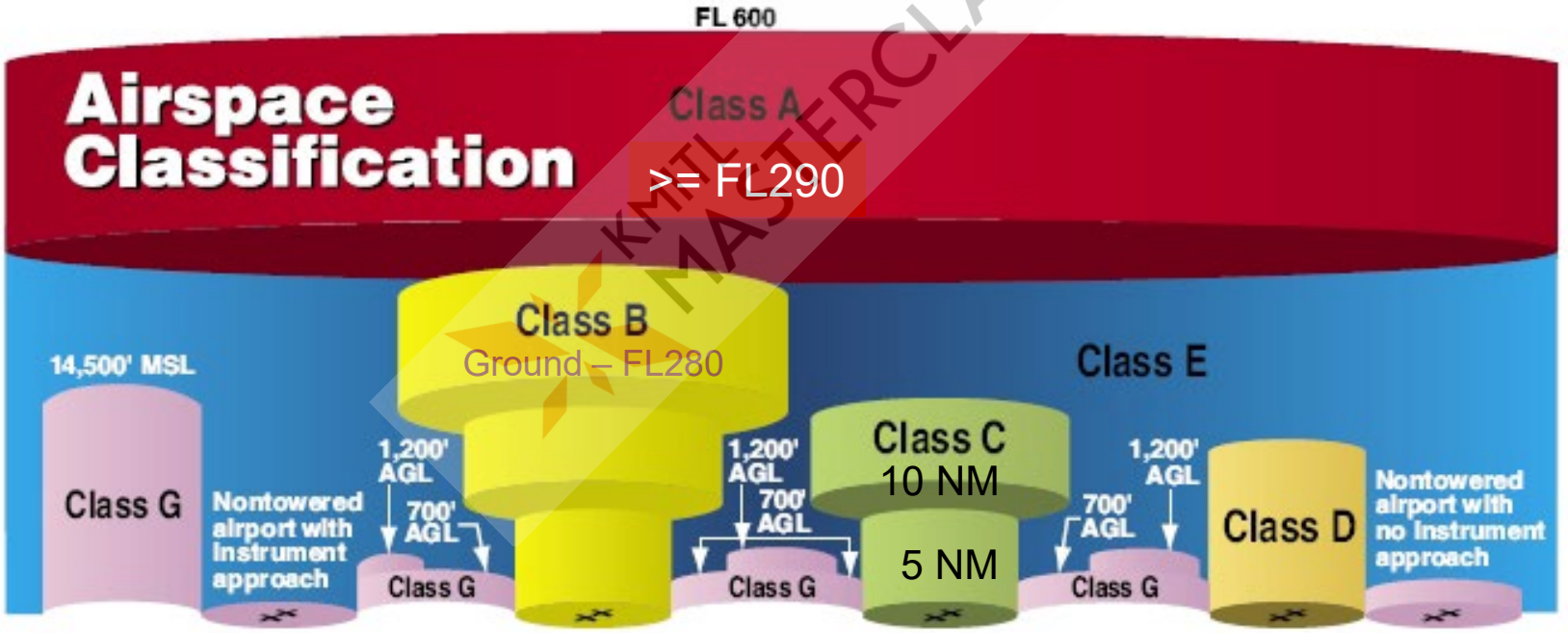
- **Controlled airport (Towered airport)**
  - Air traffic control (ATC)
  - Two-way radio with ATC
- **Uncontrolled airport**
  - No ATC, two-way radio, not required
  - Common Traffif Advisory Frequency (CTAF)

Other categories:

- Civil airports
- Military/government airports
- Private airports

Airspace Classification

- Controlled Airspace
  - Class A,B,C,D,E
- Uncontrolled Airspace
  - Class G



Future Airspace

https://www.youtube.com/watch?v=q2bJBrEzQCo

Air Traffic Control Tower

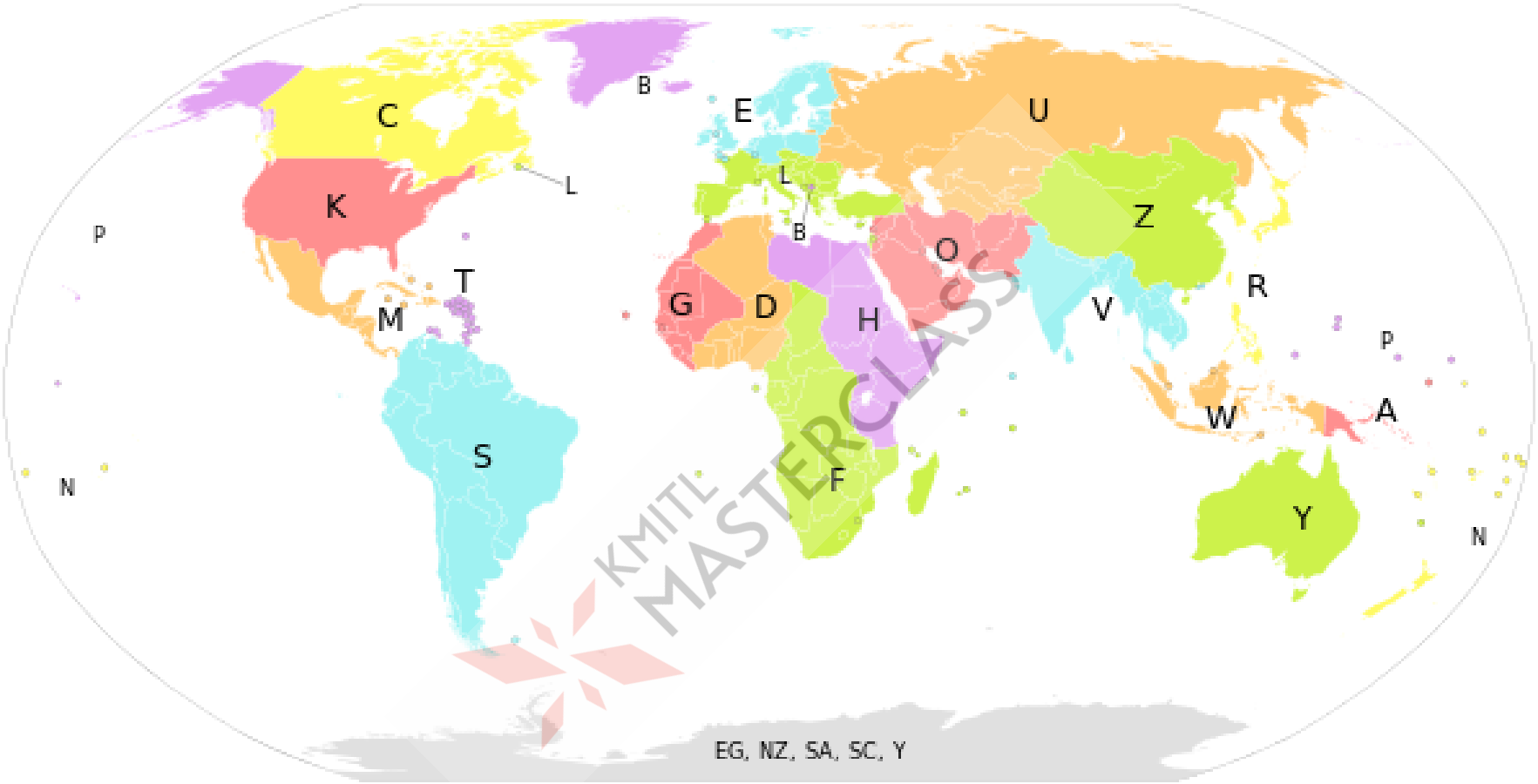
132.2 m
from ground

The control tower at Suvarnabhumi Airport is the tallest one in the world!

Air traffic controllers (ATC)

Responsible for the separation and efficient movement of

- aircraft and vehicles operating on the taxiways and runways of the airport itself
- aircraft in the air near the airport, generally 5 to 10 nautical miles (9 to 18 km) depending on the airport procedures.



Map of world regions classified according to the first letter of the ICAO airport code.

Air Traffic Control (ATC)

The services are divided into three sectors:

1. Aerodrome Control Service
2. Approach/Departure Control Service

   (both 1 and 2)

   - provided at all commercial airports throughout Thailand
   - within a 30 NM radius from each airport
   - Transition altitudes: 11,000 feet
3. Area Control Service (Tung Mahamek)

   - Enroute

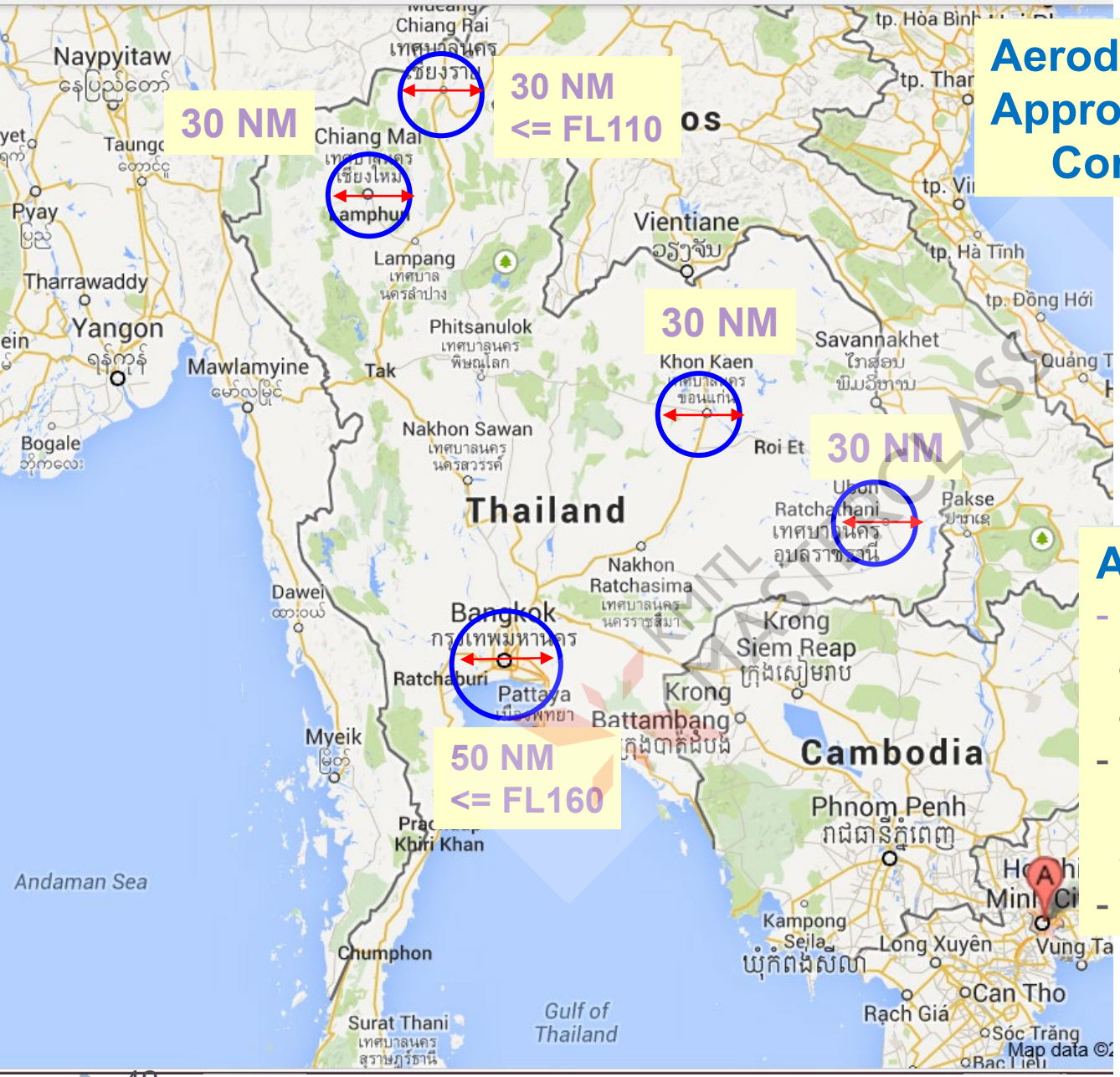
Ground Control (ler)

- Responsible for all ground traffic, aircrafts taxi
  - Gates ➔ takeoff runways
  - Landing runways ➔ Gates.

- Clearance to taxi, you receive this on the ground frequency. At Suvarnabhumi airport, ground is, for example, 121.75 MHz.

- Which way to taxi and which runway to go to for takeoff?

- Once your plane reaches the designated takeoff runway, the ground controller passes the strip to the Arrival/Departure controller.



Aerodrome Control Service
Approach/Departure Control Service

ALL AIRPORTS

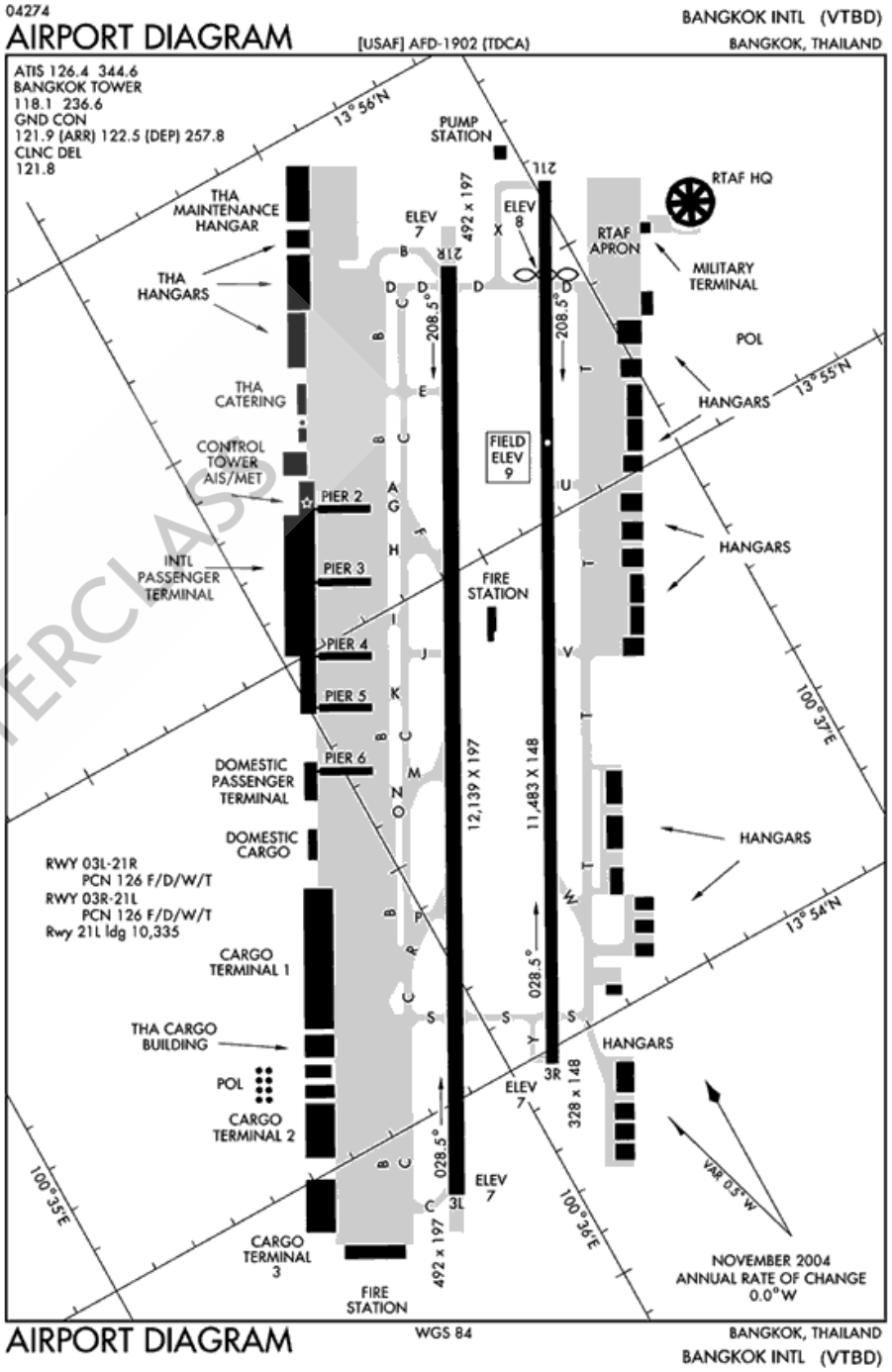
Area Control Center

- whole of Thailand airspace outside the airport area
- and part of South China Sea west of Cambodia
- FL135 to FL460

Don Muang Terminal Diagram (VTBD)

Runway

- 21R/03L
- 03R/21L
- 3494 m x 61 m
- Asphalt



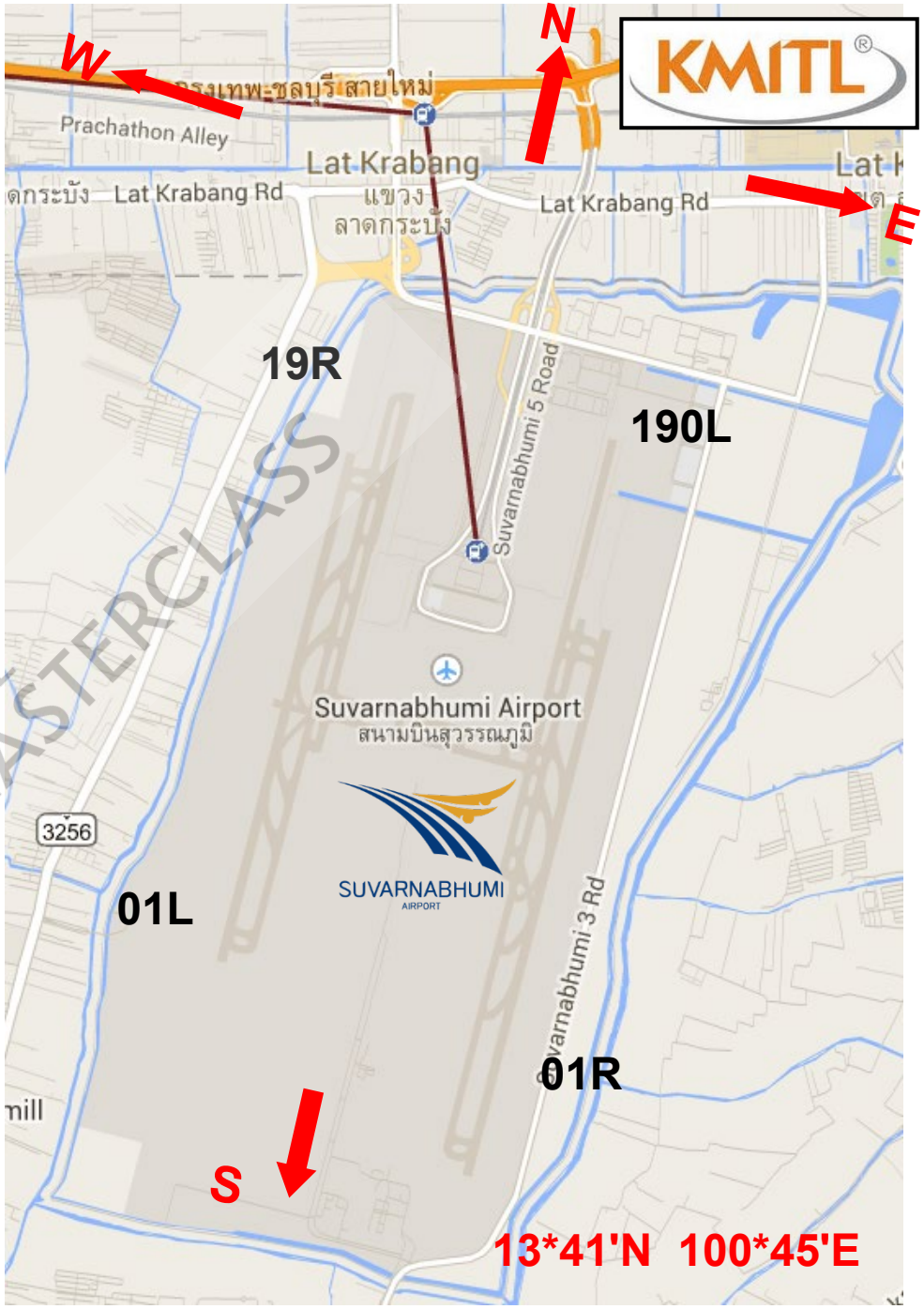
Suvarnabhumi Airport (VTBS)

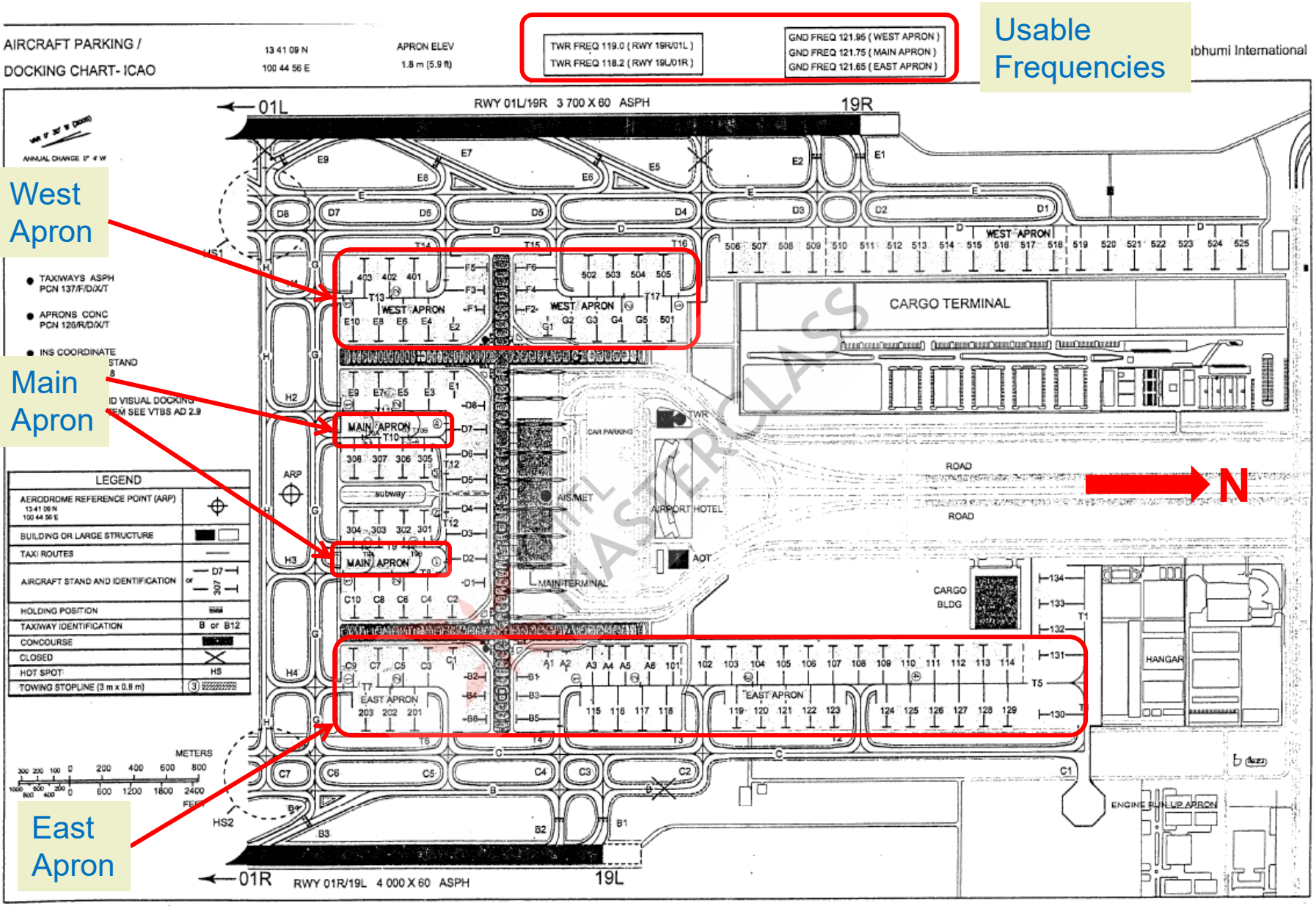
Runway

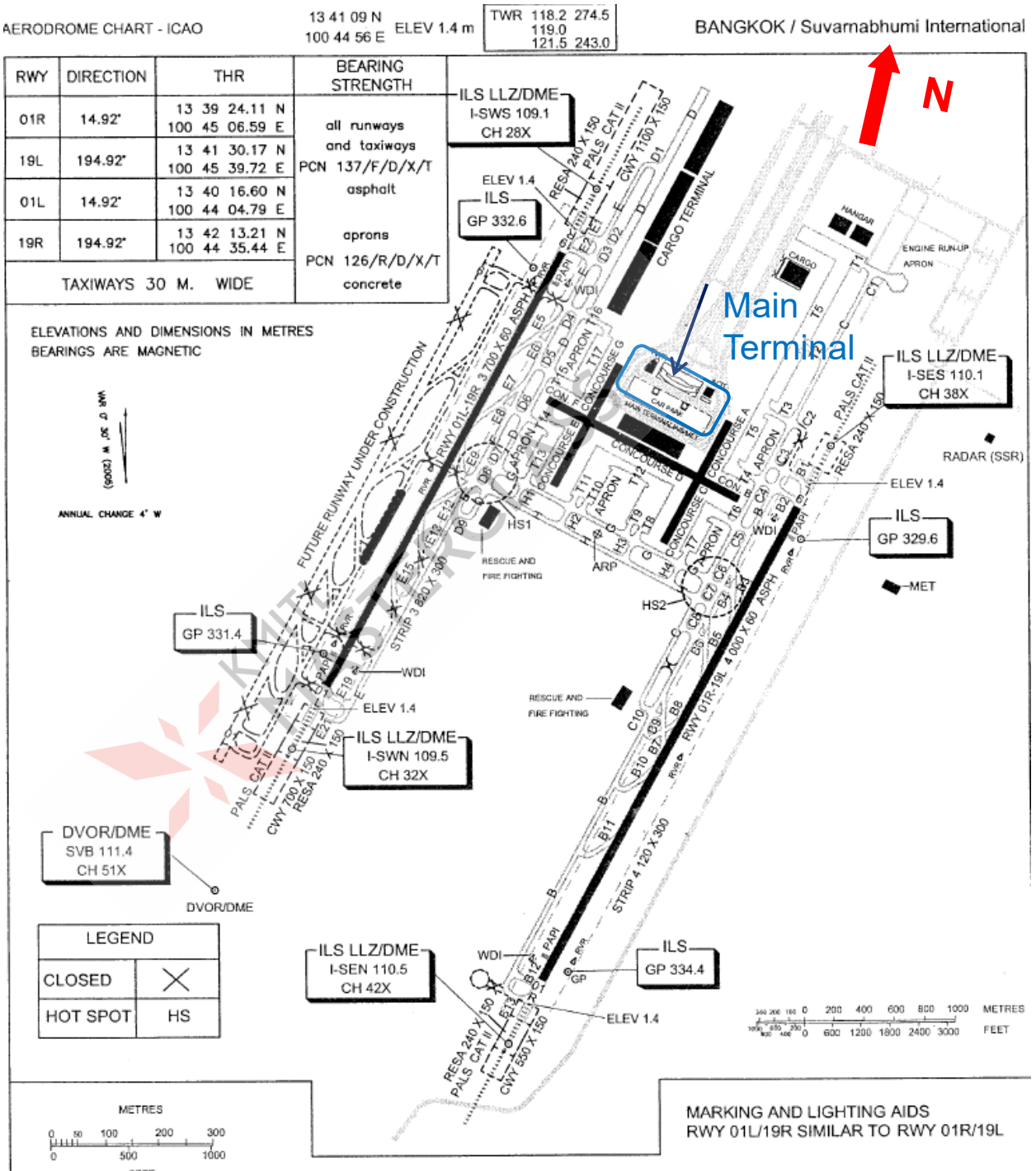
- 01R/19L (14.42°, 190.42°)
- 01L/19R
- (LxW) =3700 m x 60 m
- Asphalt

Taxiway

- 30-m wide



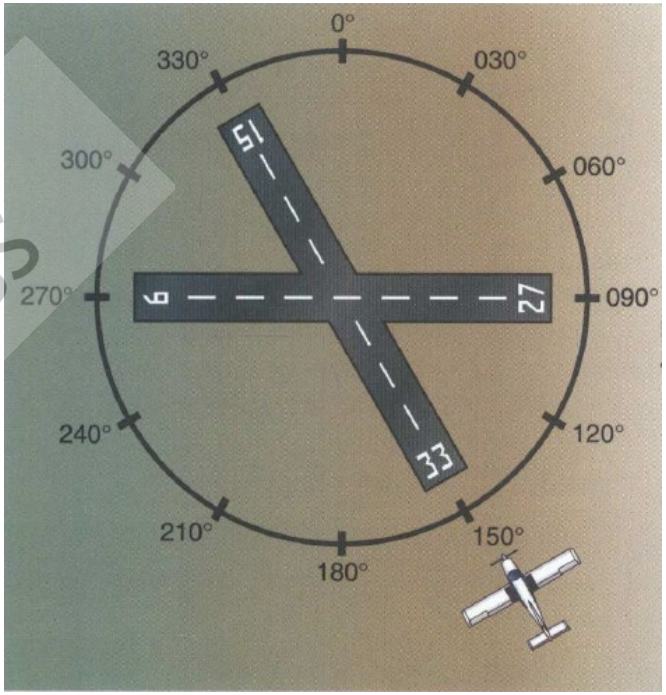

AIRCRAFT PARKING / DOCKING CHART- ICAO
13 41 09 N
100 44 56 E
APRON ELEV 1.8 m (5.9 ft)
TWR FREQ 119.0 (RWY 19R/01L)
TWR FREQ 118.2 (RWY 19L/01R)
GND FREQ 121.95 (WEST APRON)
GND FREQ 121.75 (MAIN APRON)
GND FREQ 121.65 (EAST APRON)
Usable Frequencies
West Apron
Main Apron
East Apron
01L
RWY 01L/19R 3 700 X 60 ASPH
19R
01R
RWY 01R/19L 4 000 X 60 ASPH
19L
WEST APRON
MAIN APRON
EAST APRON
CARGO TERMINAL
MAIN TERMINAL
AIRPORT HOTEL
CAR PARKING
CARGO BLDG
HANGAR
ENGINE RUN UP APRON
ROAD
N
TWR
AIS/MET
AOT
ARP
subway
TAXIWAYS ASPH PCN 137/F/D/X/T
APRONS CONC PCN 126/R/D/X/T
LEGEND
AERODROME REFERENCE POINT (ARP)
BUILDING OR LARGE STRUCTURE
TAXI ROUTES
AIRCRAFT STAND AND IDENTIFICATION
HOLDING POSITION
TAXIWAY IDENTIFICATION
CONCOURSE
CLOSED
HOT SPOT
TOWING STOPLINE (3 m x 0.8 m)
METERS
Department of Civil Aviation
AIP AMDT 6/11

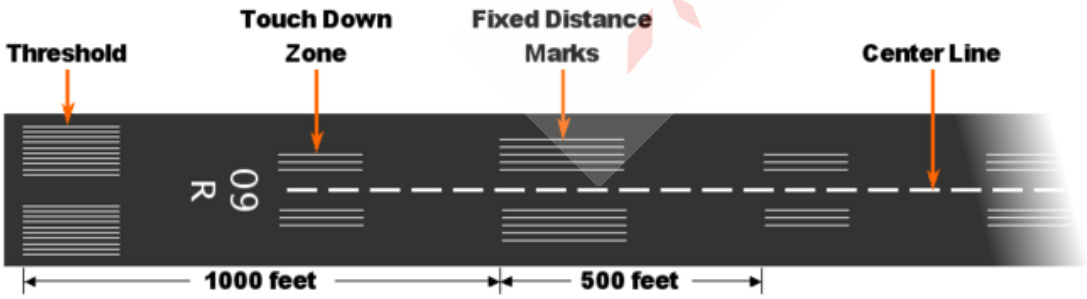

AERODROME CHART - ICAO
13 41 09 N
100 44 56 E
ELEV 1.4 m
TWR 118.2 274.5
119.0
121.5 243.0
BANGKOK / Suvarnabhumi International
RWY | DIRECTION | THR
01R | 14.92° | 13 39 24.11 N 100 45 06.59 E
19L | 194.92° | 13 41 30.17 N 100 45 39.72 E
01L | 14.92° | 13 40 16.60 N 100 44 04.79 E
19R | 194.92° | 13 42 13.21 N 100 44 35.44 E
TAXIWAYS 30 M. WIDE
BEARING STRENGTH
all runways and taxiways PCN 137/F/D/X/T asphalt
aprons PCN 126/R/D/X/T concrete
ELEVATIONS AND DIMENSIONS IN METRES
BEARINGS ARE MAGNETIC
VAR 0° 30' W (2005)
ANNUAL CHANGE 4' W
N
Main Terminal
ILS LLZ/DME
I-SWS 109.1
CH 28X
ILS
GP 332.6
ELEV 1.4
ILS LLZ/DME
I-SES 110.1
CH 38X
RADAR (SSR)
ILS
GP 329.6
MET
ILS
GP 331.4
ILS LLZ/DME
I-SWN 109.5
CH 32X
DVOR/DME
SVB 111.4
CH 51X
ILS LLZ/DME
I-SEN 110.5
CH 42X
ILS
GP 334.4
CARGO TERMINAL
HANGAR
ENGINE RUN-UP APRON
MAIN TERMINAL/APRON
CONCOURSE A
CONCOURSE B
CONCOURSE C
CONCOURSE D
CONCOURSE E
CONCOURSE F
CONCOURSE G
FUTURE RUNWAY UNDER CONSTRUCTION
RWY 01L-19R 3,700 X 60 ASPH
STRIP 3 60 X 300
RWY 01R-19L 4,000 X 60 ASPH
STRIP 4 120 X 300
RESCUE AND FIRE FIGHTING
HS1
HS2
ARP
WDI
PAPI
PALS CAT II
RESA 240 X 150
CWY 150 X 150
CWY 60 X 150
LEGEND
CLOSED
HOT SPOT HS
METRES
FEET
MARKING AND LIGHTING AIDS
RWY 01L/19R SIMILAR TO RWY 01R/19L

Runways

- Runway number: between 01 and 36
- Indicates magnetic direction
  - 327° ➔ 330° ➔ Runway 33
  - A runway numbered 09 points east (90°)
  - A runway 18 is south (180°)
  - A runway 27 points west (270°)
  - A runway 36 points to the north (360° rather than 0°)

Magnetic north reference





Q: What is difference in runway number on the opposite side?

Taxiway

- Path on an airport connecting runways with ramps, hangars, terminals and other facilities

Location sign for a taxiway

Direction sign to taxiway Bravo

VFR vs. IFR runways

- VFR = Visual flight rule
  - Rely on visual information
- IFR = Instrumental flight rule
  - Need instruments

References

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