SAMPLE

RNAV Training for ATC 2007
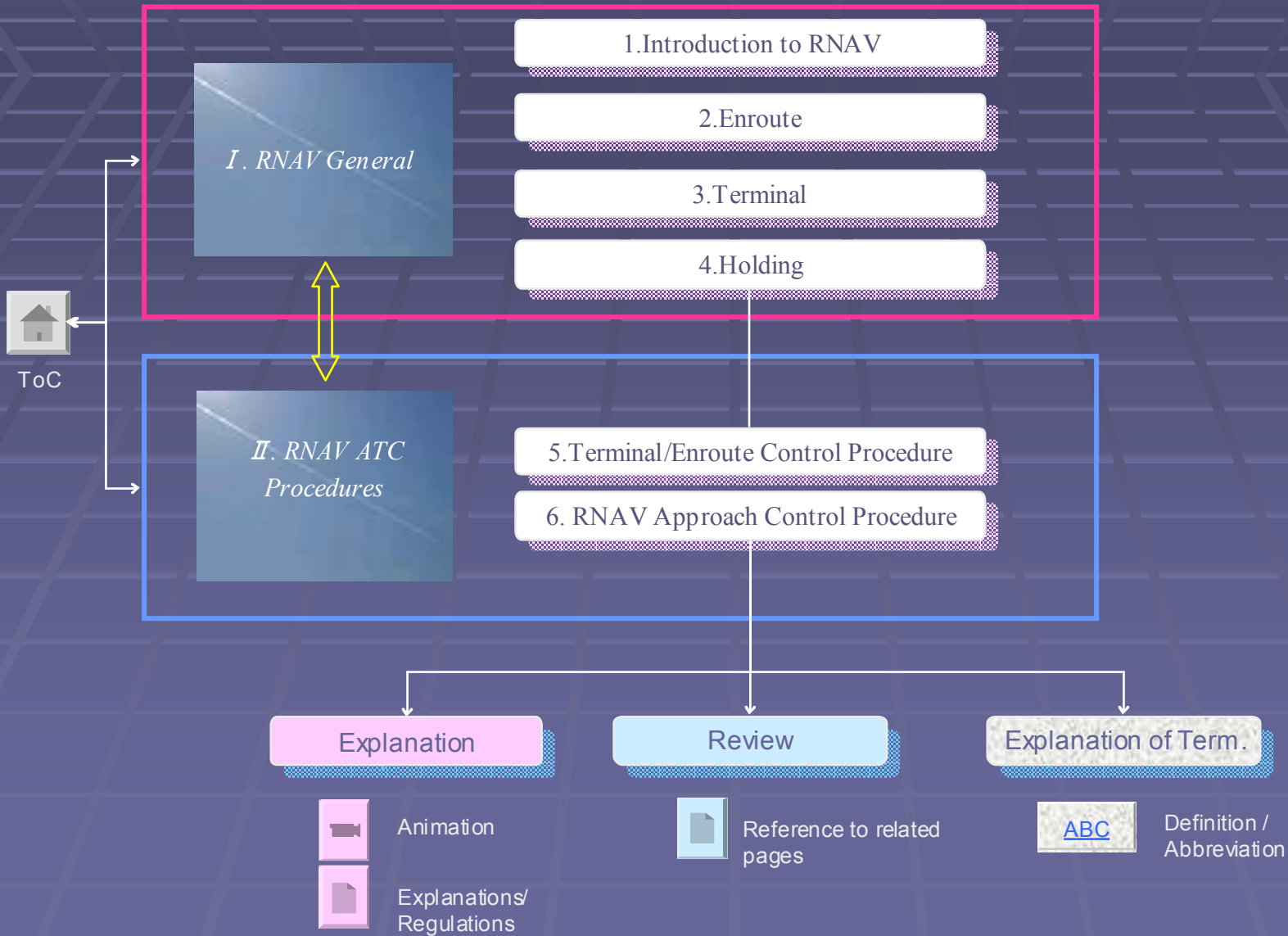
Air Traffic Control Association Japan

Important Notice

- This material is intended for information purpose only.

- ATCAJ and JCAB are exempt from claims for any loss or damage caused as a result of the use of this material.

- ATC Procedures and other methods indicated in this material are those applicable in Japan (Fukuoka FIR). It may be possible to implement other solutions in other states so far as they are in accordance with relevant ICAO regulations.

Objectives of Training

- Understand the Principle of RNAV

- Understand the Concept of Procedure Design Criteria

- Understand the Flight Operation and Performance of Aircraft

- Understand the ATC Procedures related to RNAV Performance Requirements

Structure of the Material

Ⅰ. RNAV General

- 1.Introduction to RNAV
- 2.Enroute
- 3.Terminal
- 4.Holding

Ⅱ. RNAV ATC Procedures

- 5.Terminal/Enroute Control Procedure
- 6. RNAV Approach Control Procedure

ToC

Explanation

Review

Explanation of Term.

Animation

Explanations/ Regulations

Reference to related pages

ABC

Definition / Abbreviation

I. RNAV General

RNAV Training for ATC - Part I

▶ To Part II

Part I: RNAV General

1. Introduction to RNAV

1.1 Principle of RNAV

1.2 General Rule

1.1 Principle of RNAV

What is RNAV?

RNAV(AREA NAVIGATION)

☐ A method of navigation which permits aircraft operation on any desired flight path within the coverage of the station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these

☐ Position is estimated using GNSS (GPS, etc.), IRS, DME, VOR

➢ Flight management by FMS based on NAVIGATION DATA BASE.

➢ Position is updated by the combination of various types of sensors.

➢ Operational approval standards, navigation performance, etc. are established.

☐ RNAV Routes are established as ATS Route within Radar Coverage
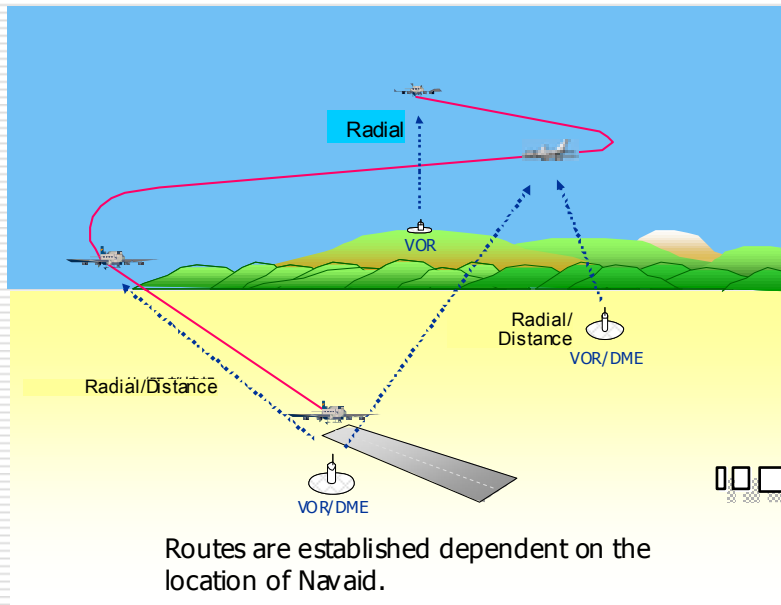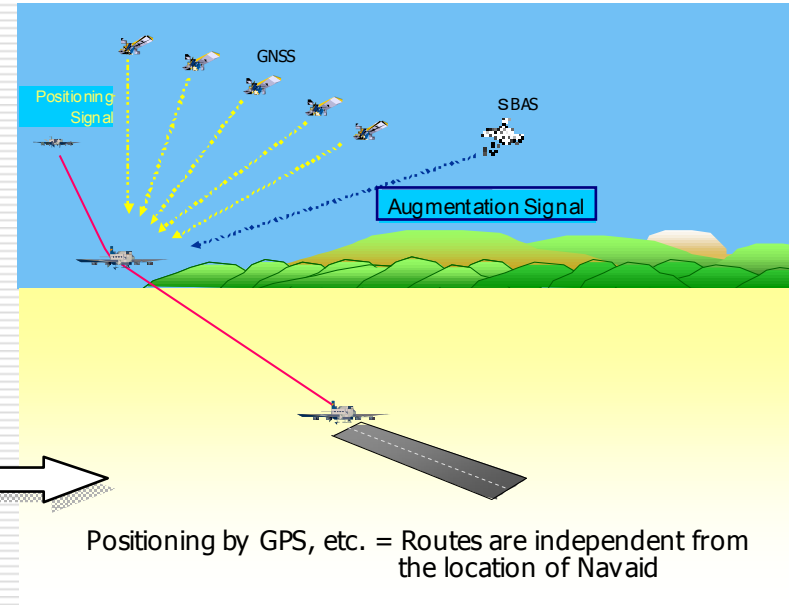
⚠ Assumed that Radar Control is provided.

ATC Procedures   NAVIGATION DATABASE and FMS

1.1 Principle of RNAV
Benefit of RNAV

Conventional Route	RNAV Route

Radial

VOR

Radial/Distance

VOR/DME

Radial/Distance

VOR/DME

Routes are established dependent on the location of Navaid.

GNSS

Positioning Signal

SBAS

Augmentation Signal

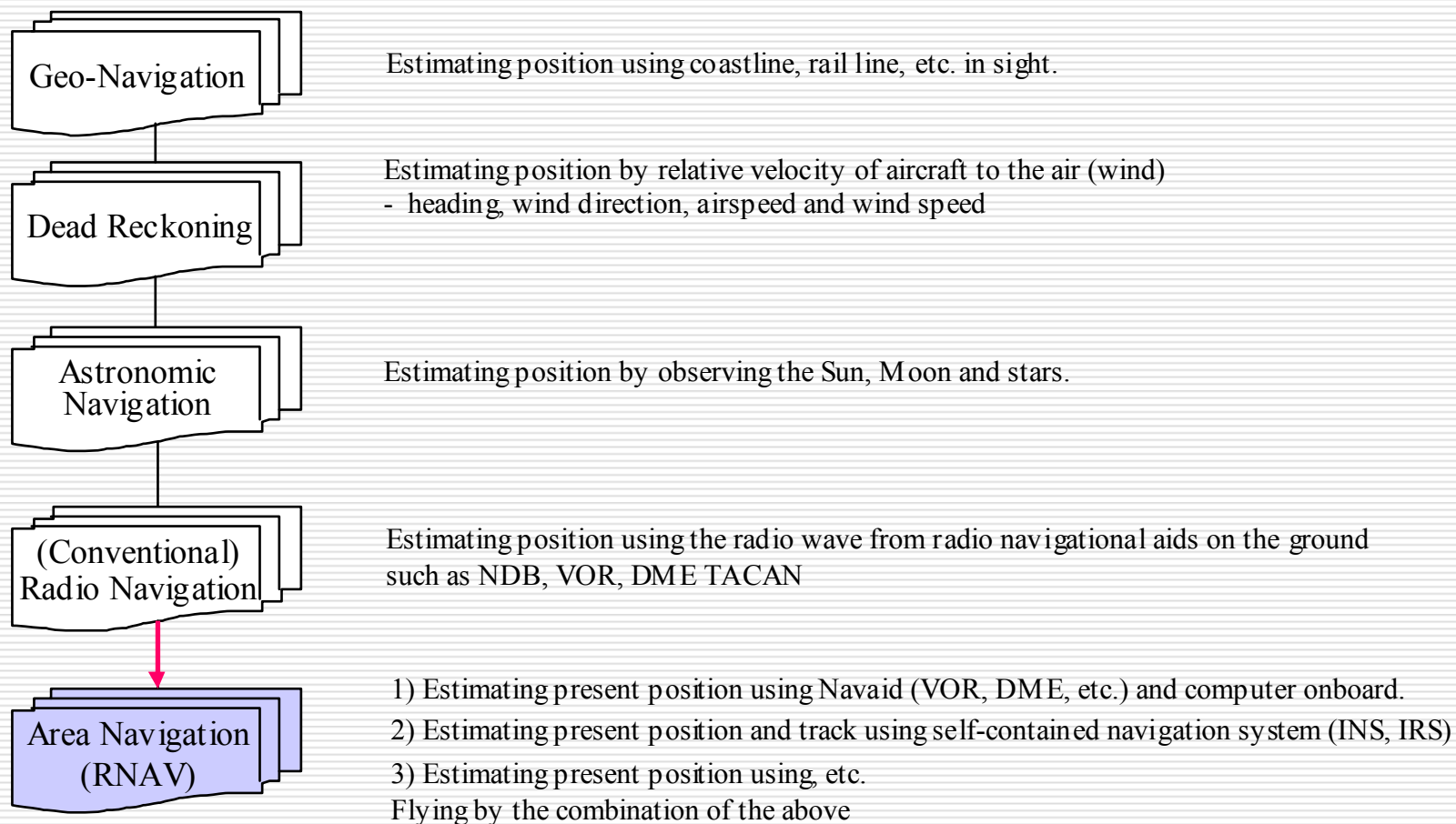Positioning by GPS, etc. = Routes are independent from the location of Navaid

Main Benefit = Shorter route distance,
Improved Navigation Performance,
Avoidance of obstacles, Noise Abatement
More effective route structure
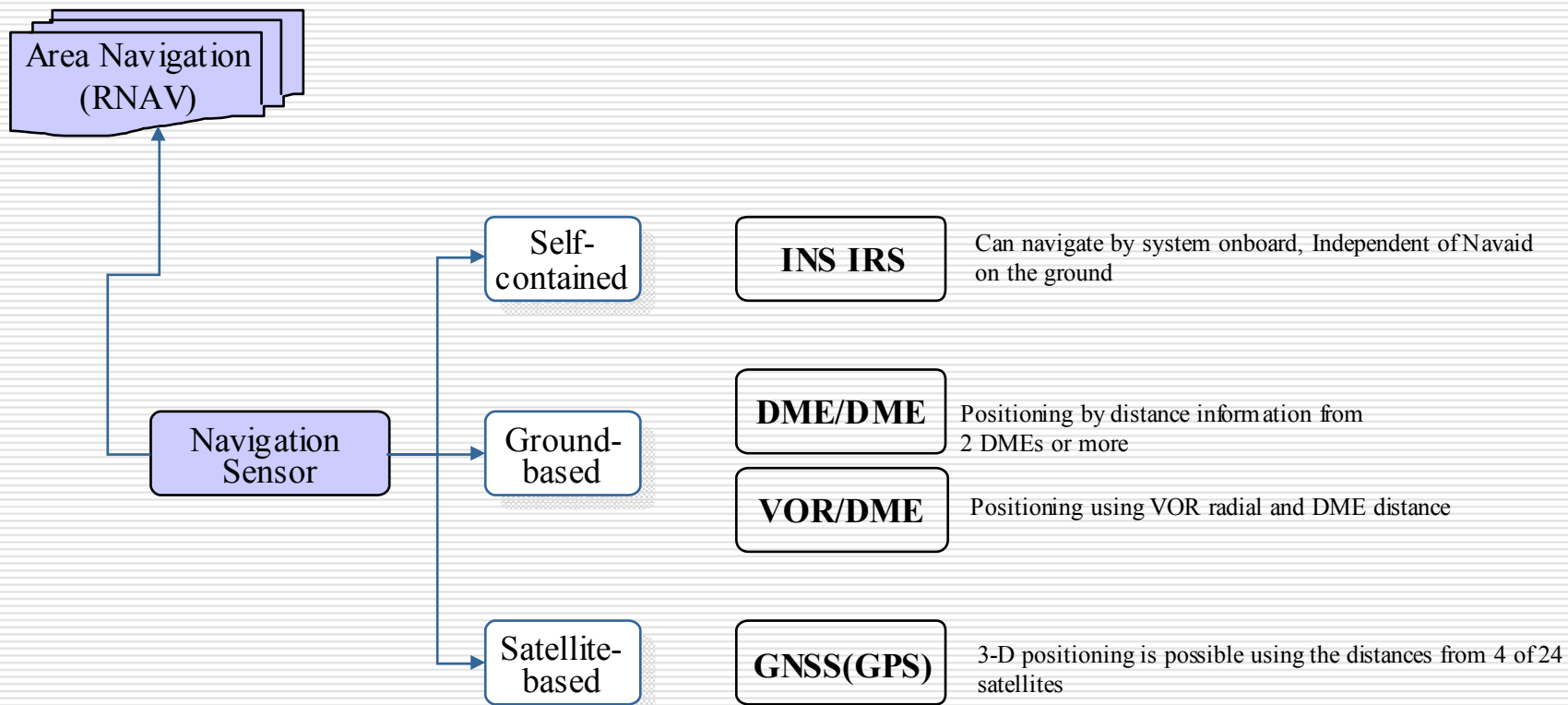
1.1 Principle of RNAV

Type of Navigation

Geo-Navigation	Estimating position using coastline, rail line, etc. in sight.
Dead Reckoning	Estimating position by relative velocity of aircraft to the air (wind) - heading, wind direction, airspeed and wind speed
Astronomic Navigation	Estimating position by observing the Sun, Moon and stars.
(Conventional) Radio Navigation	Estimating position using the radio wave from radio navigational aids on the ground such as NDB, VOR, DME TACAN
Area Navigation (RNAV)	1) Estimating present position using Navaid (VOR, DME, etc.) and computer onboard. 2) Estimating present position and track using self-contained navigation system (INS, IRS) 3) Estimating present position using, etc. Flying by the combination of the above

1.1 Principle of RNAV

Sensors used for RNAV

Area Navigation
(RNAV)

Navigation
Sensor

Self-
contained

INS IRS   Can navigate by system onboard, Independent of Navaid
on the ground

Ground-
based

DME/DME   Positioning by distance information from
2 DMEs or more

VOR/DME   Positioning using VOR radial and DME distance

Satellite-
based

GNSS(GPS)   3-D positioning is possible using the distances from 4 of 24
satellites

1.1 Principle of RNAV

Self-Contained Navigation

Inertial Navigation
    Navigation calculating the distance obtained by integrating Acceleration (inertia) generated while object is moving.
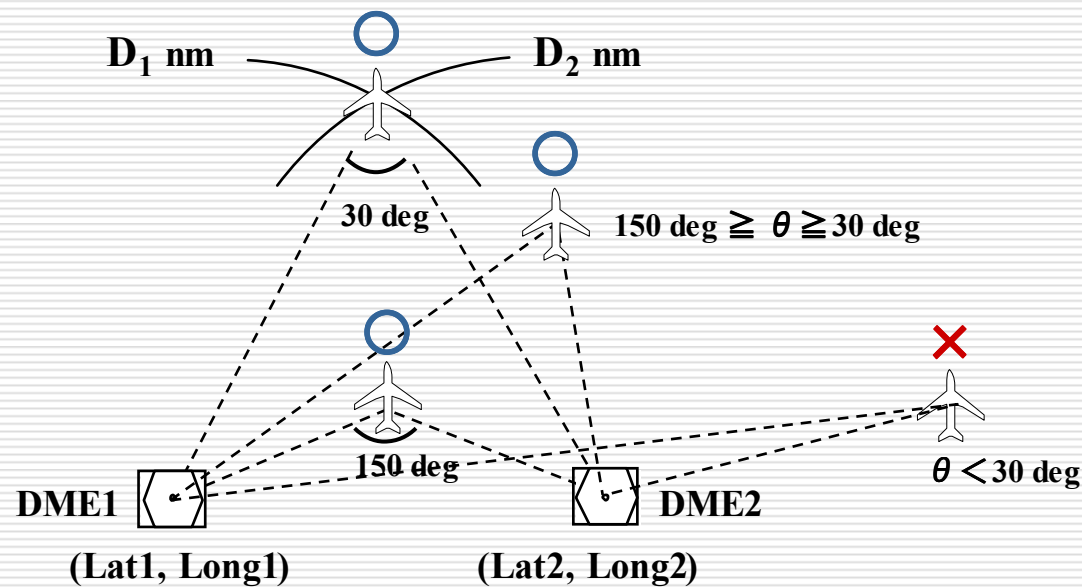
```
                          Sensor    ┌──────────────┐         ┌──────────┐
                       ┌──────────> │ Mechanical Gyro │ ----> │   INS    │
┌──────────────────┐   │            └──────────────┘         └──────────┘
│ Navigation System │───┤
└──────────────────┘   │   Sensor   ┌──────────────┐         ┌──────────┐
                       └──────────> │  Laser Gyro  │  ----> │   IRS    │
                                    └──────────────┘         └──────────┘
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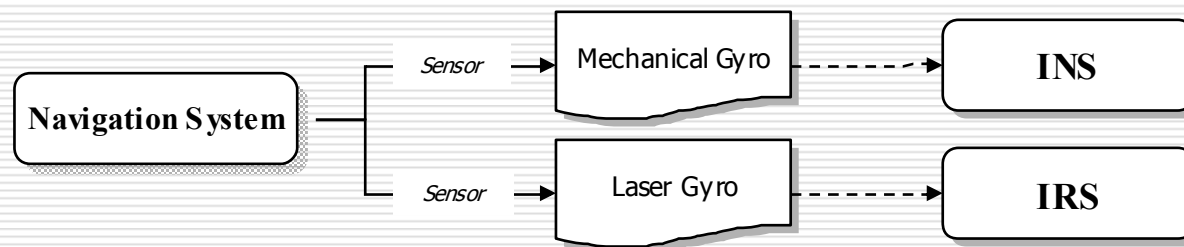
1.1 Principle of RNAV

Ground-based: DME/DME

- ☐ Calculates position (Lat/Long) using distances from 2 DMEs
- ☐ Required Data = VOR/DME Position (Lat/Long)
- ☐ The closer two stations are to one line, the greater the error becomes. Therefore, most appropriate combination of DMEs are automatically selected of which relative angle is between 30 – 150 degrees.
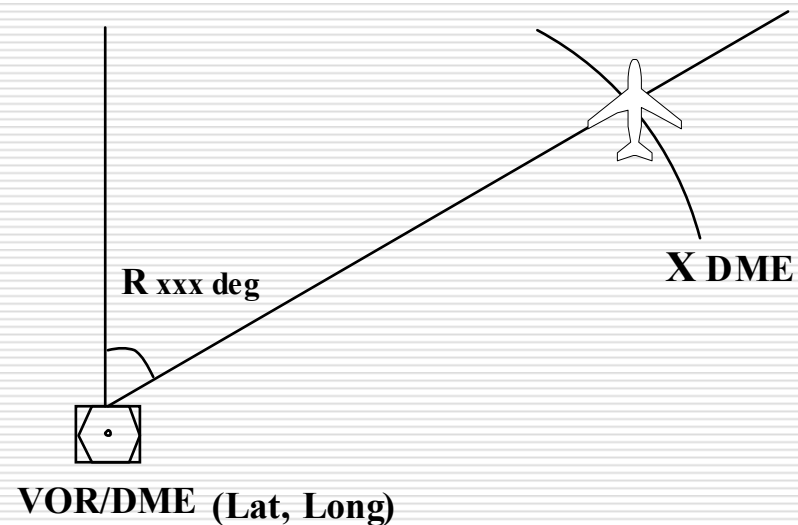
D_1 nm D_2 nm

30 deg

$150 \text{ deg} \geqq \theta \geqq 30 \text{ deg}$

150 deg

$\theta < 30 \text{ deg}$

DME1   DME2

(Lat1, Long1)   (Lat2, Long2)

RNAV(DME/DME) Image

1.1 Principle of RNAV

Ground-based: VOR/DME

- ☐   Calculates position (Lat/Long) using radial / distances from VOR/DME
- ☐   Required Data = VOR/DME position (Lat/Long)

X DME

R xxx deg

VOR/DME **(Lat, Long)**

1.1 Principle of RNAV

Satellite-based: GNSS
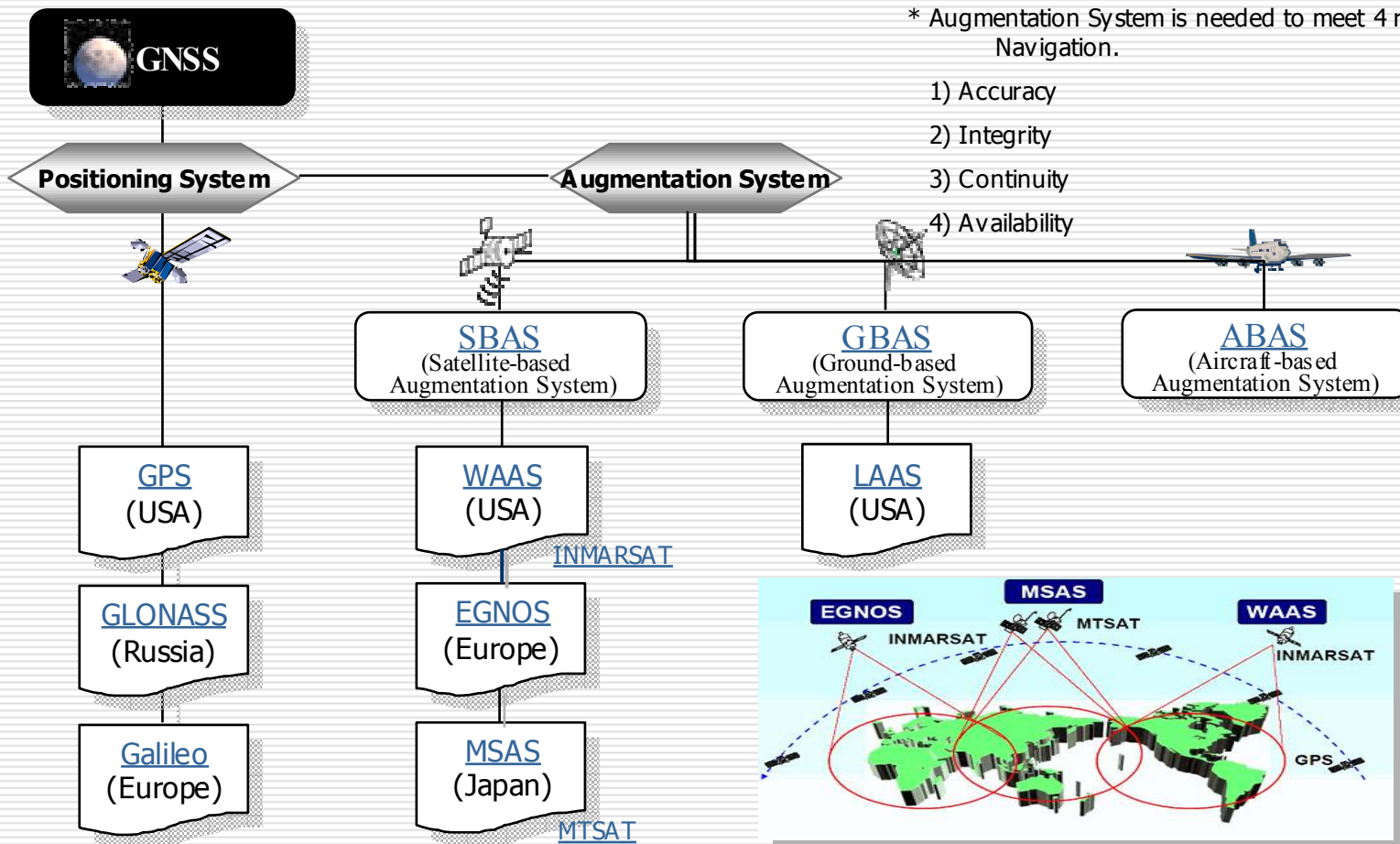
GNSS

* Augmentation System is needed to meet 4 requirements for GNSS Navigation.

1) Accuracy

2) Integrity

3) Continuity

4) Availability

Positioning System — **Augmentation System**

SBAS
(Satellite-based Augmentation System)

GBAS
(Ground-based Augmentation System)

ABAS
(Aircraft-based Augmentation System)

GPS
(USA)

WAAS
(USA)

INMARSAT

LAAS
(USA)

GLONASS
(Russia)

EGNOS
(Europe)

Galileo
(Europe)

MSAS
(Japan)

MTSAT

EGNOS INMARSAT MSAS MTSAT WAAS INMARSAT GPS

Positioning by GPS - MSAS

1.1 Principle of RNAV

Satellite-based: GNSS

☐ Position is defined by the distances from satellites

■ Receiving signal from 4 satellites or more:
Can calculate aircraft position

■ Receiving signal from 5 satellites
Can check if the signal is OK ⇒RAIM Function

■ Receiving signal from 6 satellites or more:
Can determine which satellite is causing error ⇒FDE Function

Positioning by GPS

1.1 Principle of RNAV
Satellite Based: Navigation Requirements

☐ High performance and reliability is essential to make use of GNSS for air navigation.

➢ Navigation System must meet the following requirements:

a. Accuracy: The degree of conformity of a estimated position to its actual (true) Position

b. Integrity: The ability to alert when error occur

c. Continuity: The degree to which the system could continue to operate without interruption

d. Availability: The proportion of time a system is in a functioning condition.

1.1 Principle of RNAV

Satellite-based: GNSS receiver (1/3)

☐ RAIM (Receiver Autonomous Integrity Monitoring)

  ■ Function to detect the discrepancy of GPS satellite (to achieve Integrity)

  ■ Monitor the integrity of GPS signal and determine positioning could be appropriately conducted.

  ■ Alert to the pilot in case of discrepancy.

☐ RAIM Prediction

  ■ Predict the location of GPS satellites and scheduled outage based on the information issued by USA.

  ■ Location and date/time is determined and informed where and when RAIM functions cannot be available,.

RAIM Prediction Service

1.1 Principle of RNAV

Satellite-based: GNSS receiver (2/3)

☐ Receiver "Mode" is automatically selected for each flight phase:

Enroute Mode   30NM from ARP or furtherer

Terminal Mode   Within 30NM from ARP

Approach Mode   After 2NM prior to FAF (Final Approach Fix)

☐ RAIM Alert Limit (IMAL) and CDI Sensitivity is different for each mode.

	30NM from ARP		30NM from ARP	
Terminal Mode		Enroute Mode	Terminal Mode	

2NM from FAF

Approach Mode
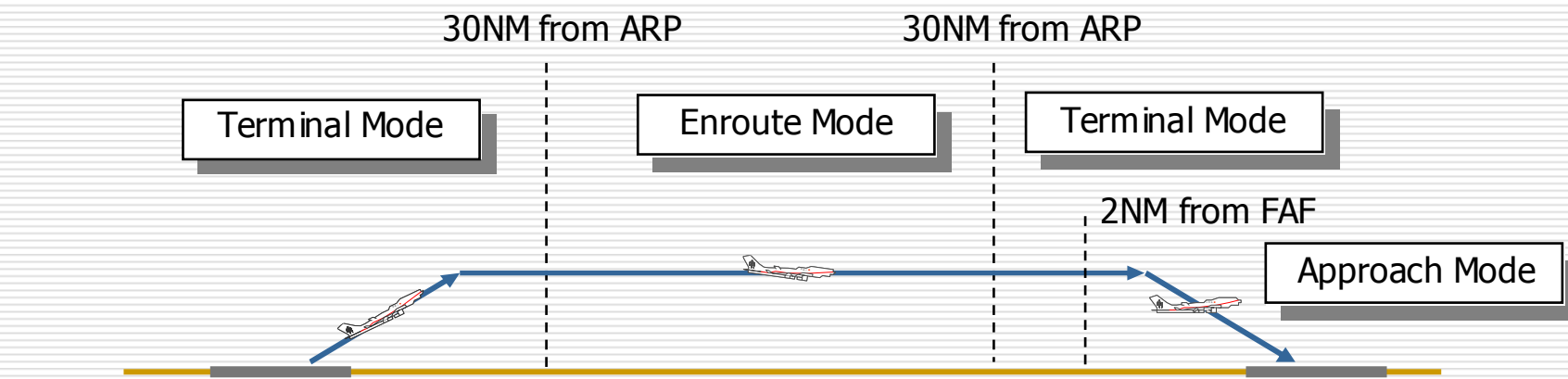
RAIM Alert Limit

1.1 Principle of RNAV

Satellite-based: GNSS receiver (3/3)

☐ Specifications for each Mode

■ **Enroute Mode:**
    ☐ RAIM Alert Limit (IMAL) = 2.0NM
    ☐ CDI Sensitivity = 5.0NM

■ **Terminal Mode:**
    ☐ RAIM Alert Limit (IMAL) = 1.0NM
    ☐ CDI Sensitivity = 1.0NM

■ **Approach Mode:**
    ☐ RAIM Alert Limit (IMAL) = 0.3NM
    ☐ CDI Sensitivity = 0.5NM

⚠ Area width for RNAV routes are different for each receiver Mode.

1.1 Principle of RNAV
PBN (Performance-Based Navigation) (1/3)

■ Concept to classify navigation not by sensor type,
but by navigation performance

*Performance-based Navigation

PBN*

RNAV — "Onboard performance monitoring and alert" is NOT required.

RNP — "Onboard performance monitoring and alert" is required.

RNAV10* (RNP10) — Oceanic

RNAV5 RNAV1 — Enroute — SID/STAR

RNP4 — Oceanic

Basic RNP1/2 RNP APCH RNP AR APCH — Enroute — SID/STAR — RNP APCH

Future development
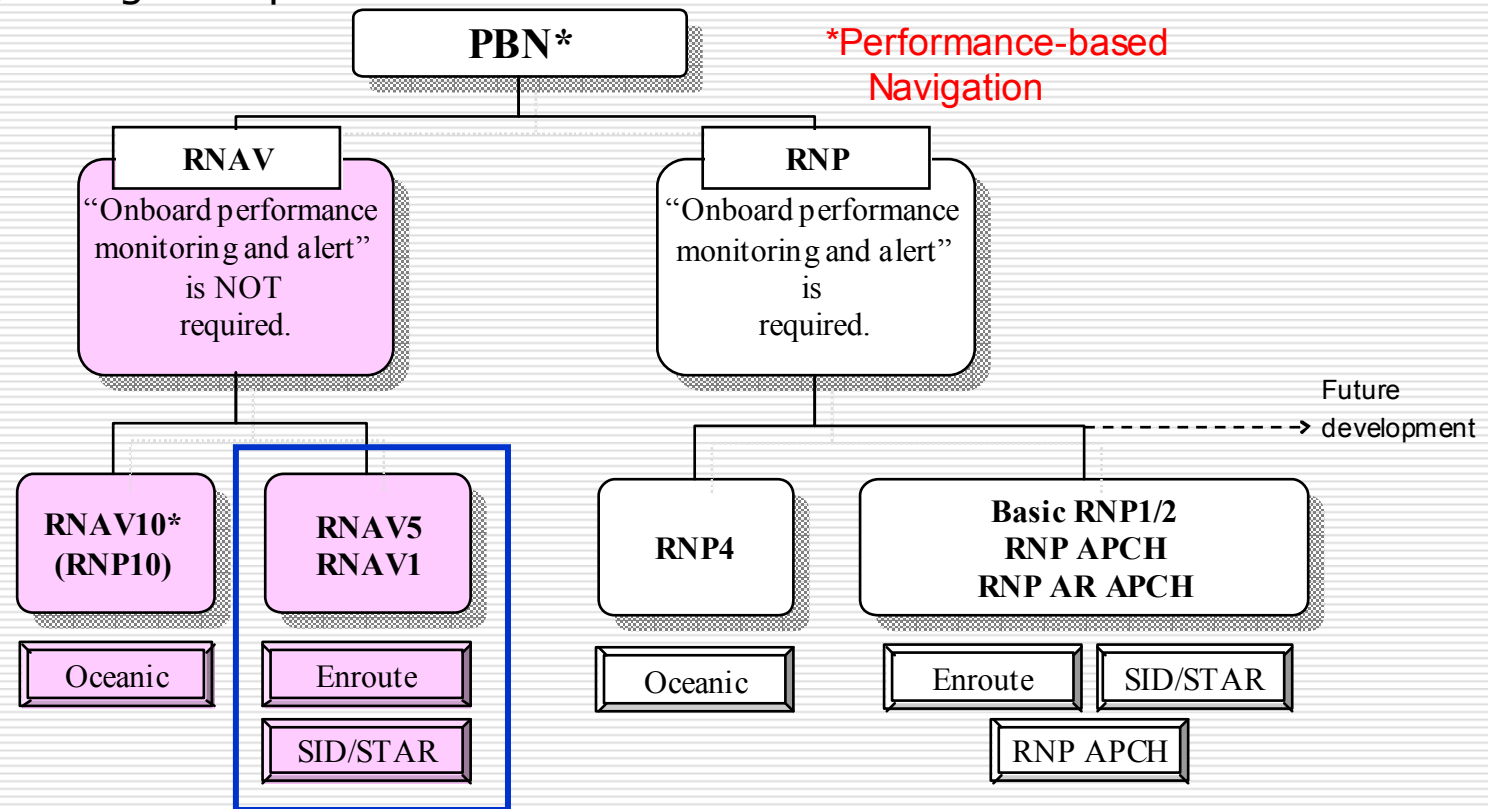
*RNP10: RNP10 is not classified as "RNP operation". However such term is still used since it is already used in current documentation, etc.

1.1 Principle of RNAV
PBN (Performance-Based Navigation) (2/3)

☐ RNP x (x=RNP value)
Such navigation specification that the lateral total system error must be within +/- x NM for at lease of 95 % of the flight time, and that described performance requirements (see next page) are met.

■ e.g.: RNP 4, RNP 1

☐ RNAV x (x=RNAV value)
Such navigation specification that the lateral total system error must be within +/- x NM for at lease of 95 % of the flight time, but that described performance requirements (see next page) are NOT met.

■ e.g.: RNAV 1, RNAV 5

⚠ Accuracy value is not absolute! It is possible that aircraft might deviate more than +/- x NM.

1.1 Principle of RNAV

PBN (Performance-Based Navigation) (3/3)

☐ RNP Performance Requirements - - - - - - - - - - - - - - - **_MONITORING & ALERT_**

Containment Region

Region defined by the value of "2 x RNP" on both side of the defined route

Accuracy **+** Containment

Containment Integrity

Functionality to alert, with the probability of not less than 99.999%, when the required performance is not achieved.

Containment Continuity

Capable of RNP-RNAV for not less than 99.999% of total flight time

RNAV-xx

RNP-xx

Containment Region

2×RNP Value

RNP Value

RNP Value

Accuracy 95%

Alert!

1. Introduction to RNAV

1.1 Principle of RNAV

1.2 General Rule

1.2 General Rule

Waypoint: F/O and F/B

- ☐ RNAV FIX is established as Waypoint(WP).

- ☐ Defined by Latitude and Longitude (Lat/Long).

- ☐ Two types of WP: Fly-by (F/B) WP and Fly-over (F/O) WP

  - ■ Position that aircraft must over-fly, such as MAPt, is designated as F/O WP.

  - ■ Symbols for publication

Fly-by   **Fly-over**

Track

MAPt must be designated as Fly-over WP
no matter if turn is specified or not.
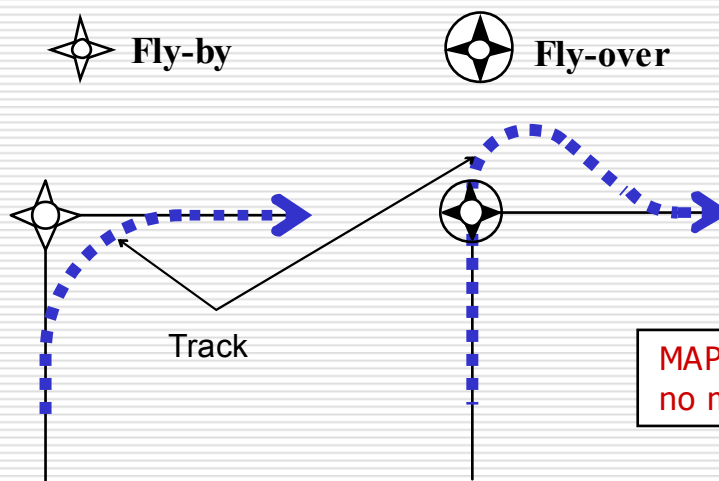
1.2 General Rule
Waypoint: Tolerance

□ WP Tolerance (GNSS)

Cross-Track Tolerance (XTT)
Along-Track Tolerance (ATT)

ATT

XTT

RNP Value

RNP case
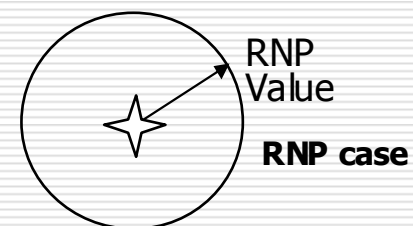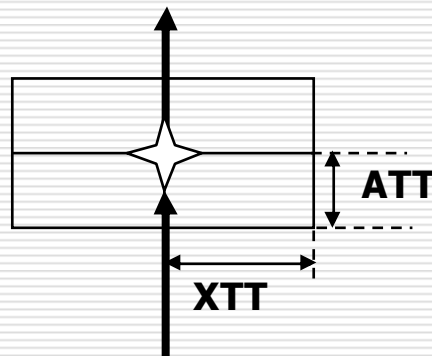
■ ATT= RAIM Alert Limit (IMAL)

■ XTT= IMAL + FTT (Flight Technical Tolerance)

■ Turning WP has ATT/XTT for the segments before and after it. These tolerance can be different between the segments concerned.

After turn

Before turn
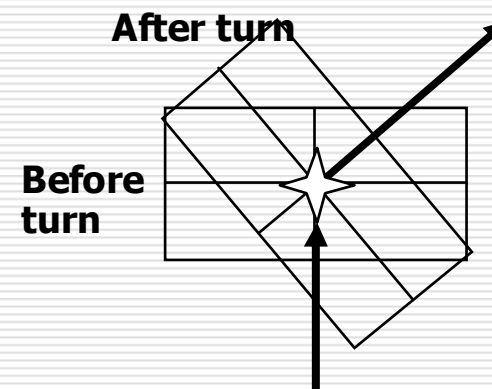
1.2 General Rule
Minimum Leg Length

☐ Minimum Leg Length between turning WPs is provided for smooth turn

☐ Parameter for
Minimum Leg Length

1. Type of WP
(F/O or F/B)

2. Bank Angle

3. Speed (IAS)

4. Track Change

Minimum Stabilization
Distance

FUJII

YASSI

Fly-by Waypoint

Fly-over Waypoint
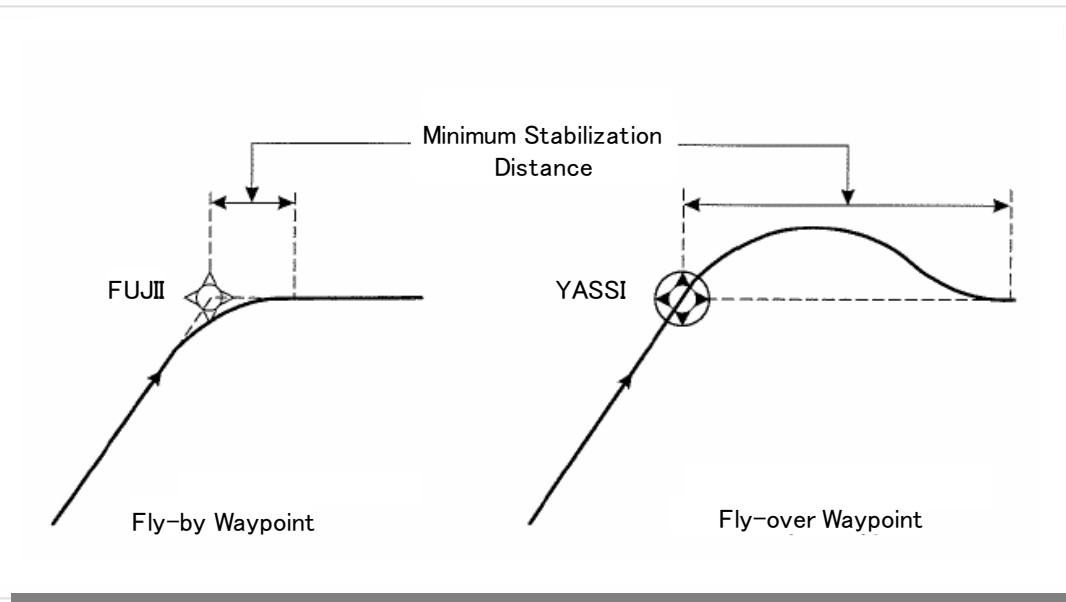
☐ Sum of Minimum Stabilization Distances (MSD) for 2 WP
= Minimum length for the leg

Applicable Bank Angle

1.2 General Rule

Minimum Leg Length - F/B WP to F/B WP

- ☐ Minimum Length = A1(F/B MSD)+A2(F/B MSD)
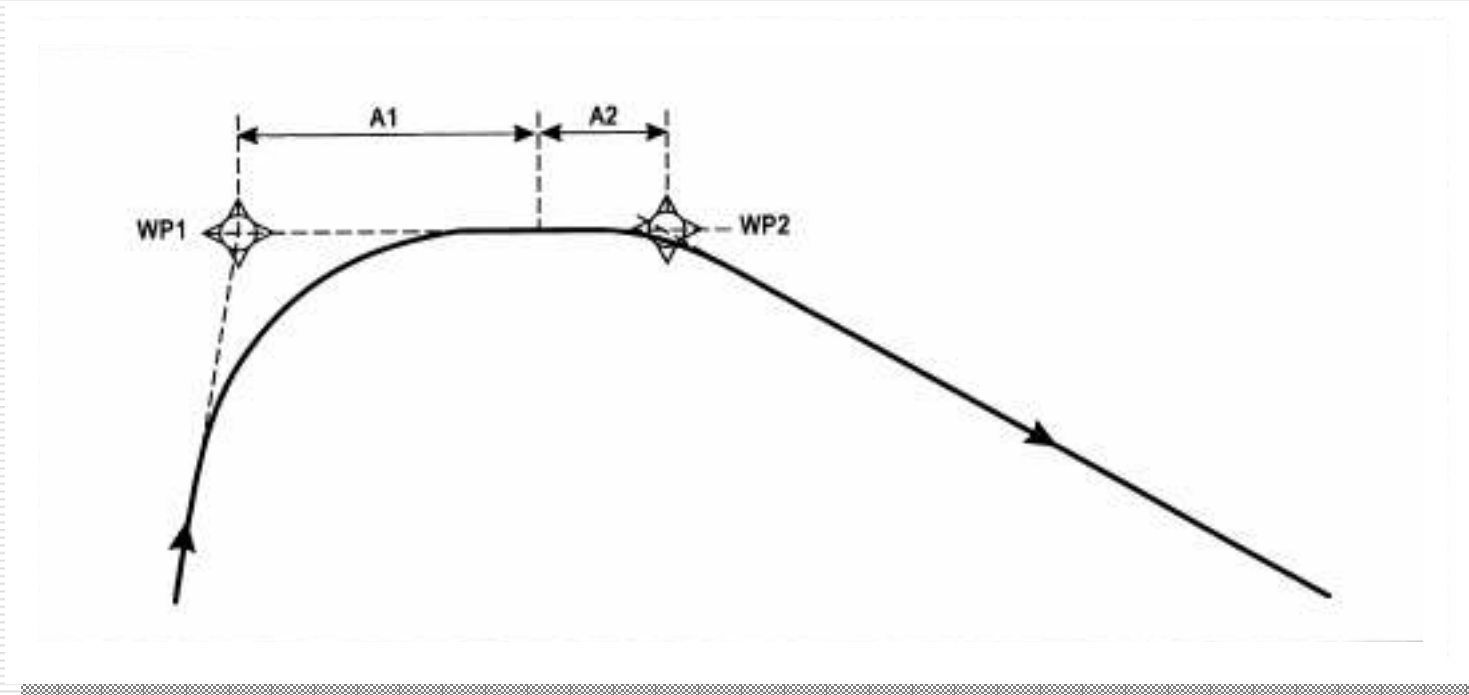
1.2 General Rule

Minimum Leg Length - F/B WP to F/O WP

☐ Minimum Length = A1 (F/B MSD) + 0 = A1

* MSD is not applied prior to WP2 as it is F/O WP.
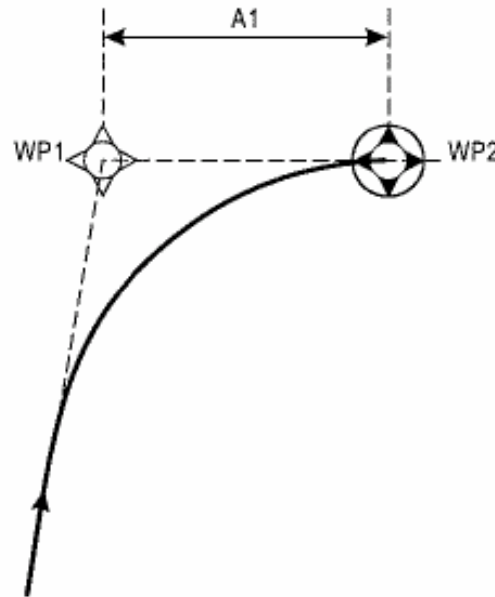
1.2 General Rule

Minimum Leg Length - F/O WP to F/O WP

☐   Minimum Length = B1 (F/O MSD) + 0 = B1
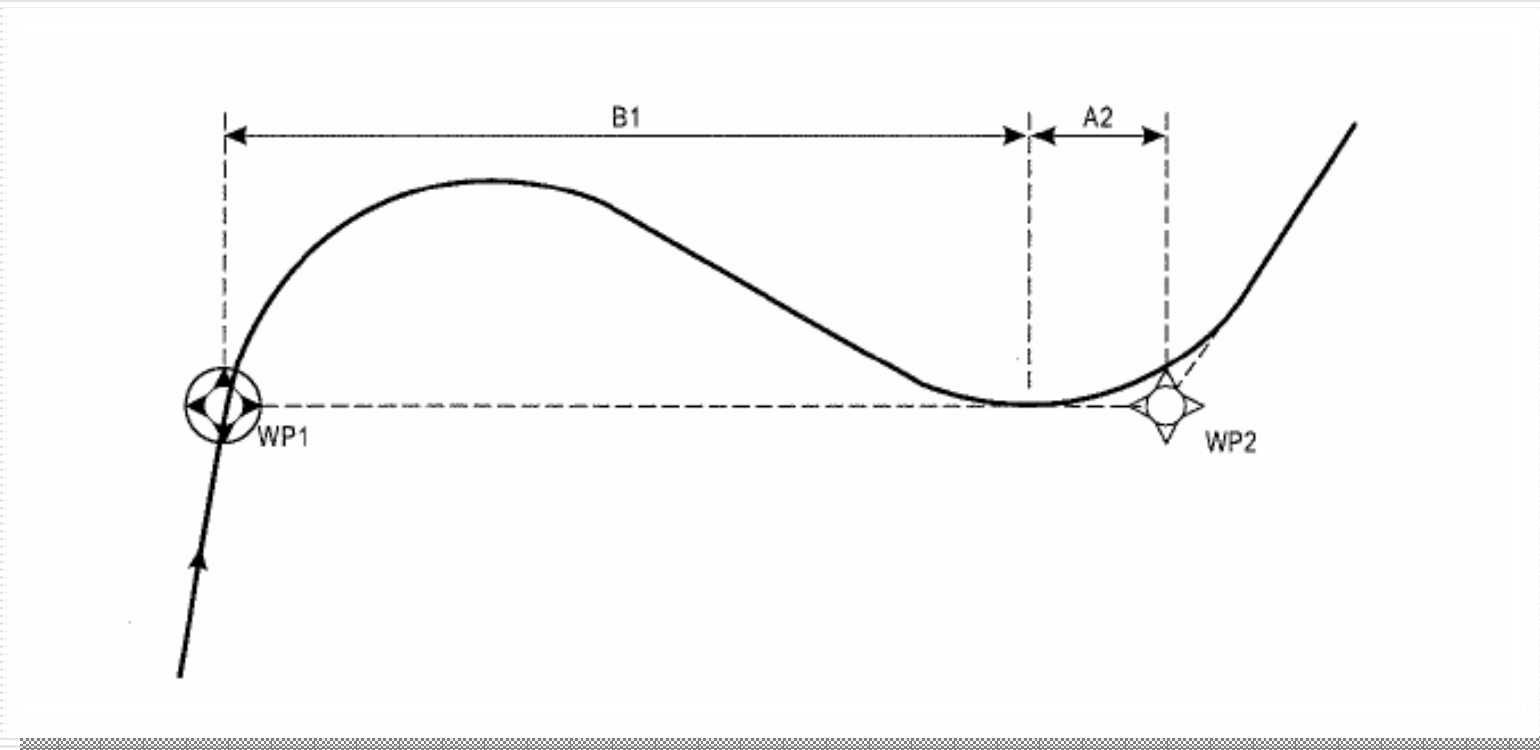
      * MSD is not applied prior to WP2 as it is F/O WP.
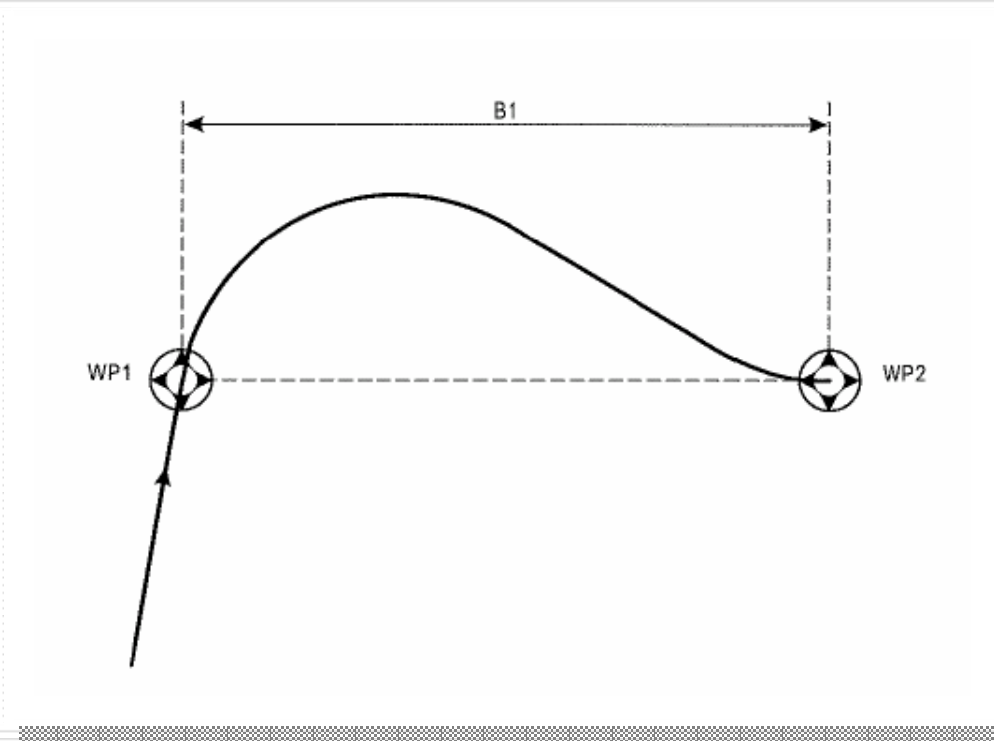
1.2 General Rule

Minimum Leg Length - F/O WP to F/B WP

☐   Minimum Length = B1 (F/O MSD) +A2 (F/B MSD) = B1 + A2

1.2 General Rule

Turn Area

☐ Parameters for Turn Area

- Altitude

- Temperature

- Speed (IAS)

- Wind Effect

- Bank Angle

- WP Tolerance

F/B WP   *F/O WP*

⚠ Wider area is needed than F/B case

- Flight Technical Tolerance (Pilot reaction time, Bank Establishment Time)
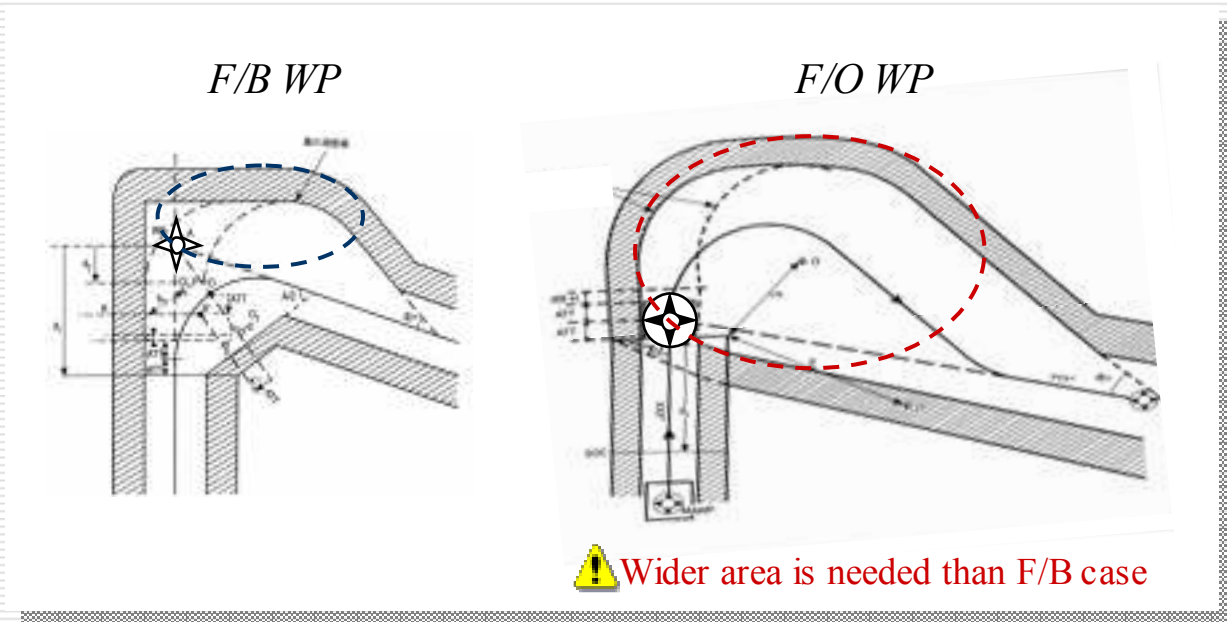
2. Enroute

- General
- Area / Obstacle Clearance

2. Enroute
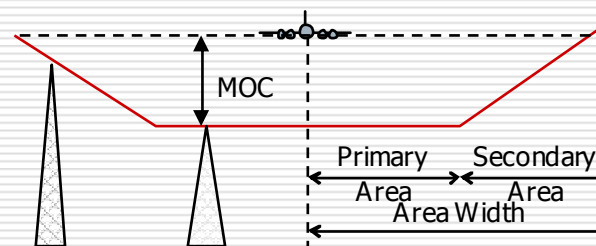
General

☐   RNAV Route ⚠ Accuracy as "RNAV5" is required.

➢   "VOR/DME", "DME/DME" and "GNSS" as assumed as sensor.
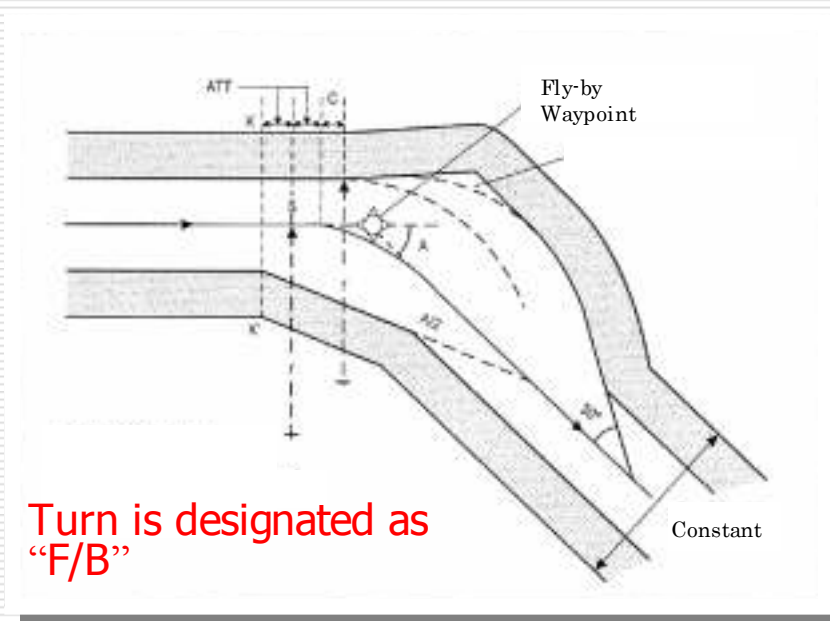
* It is difficult to specify the sensor for Enroute RNAV.

2. Enroute

Area / Obstacle Clearance

- ☐ Area has constant width (+/-10NM)

  - ➤ Primary Area: +/-5NM

  - ➤ Secondary Area: 5NM on both sides

- ☐ MOC: Primary Area: 2,000ft

MOC

Primary Area | Secondary Area
Area Width

Fly-by Waypoint

Constant

Turn is designated as "F/B"

3. Terminal

3.1 Departure

3.2 Arrival /Approach

3.3 T/Y Bar and TAA

3.4 APV / Baro-VNAV

3.1 Departure

General (1/2)

- ❑ RNAV Departure Procedure ⚠ Accuracy as "RNAV1" is required.

  - ➢ DME/DME and GNSS is assumed as the navigation sensor.

  - ➢ Greater of the following two types of areas is applied;
    - ➢ GNSS criteria or
    - ➢ DME/DME criteria.

- ❑ Classified into Straight Departure and Turning Departure(Turn > 15 degrees)

PBN (Performance-Based Navigation)

3.1 Departure

General (2/2)

☐   It is assumed that aircraft climb straight until reaching 120m (394ft) after takeoff.

☐   Procedure Design Gradient (PDG) for aircraft

    Nominal = 3.3% (200ft/NM)
     * Origin of the climb is assumed to be 5m above Departure End of Runway(DER).

☐   Obstacle Identification Surface (OIS)

    Nominal=2.5%

    ■   Normally no obstacle penetrates this surface.

    ■   In case of penetration:
     1)   Avoid the obstacle by turn, or
   2)   Raise PDG.

⚠ Such PDG (%) is to be published by AIP.

Avoidance of obstacle by designated PDG

3.1 Departure

Straight Departure

☐   GNSS Area semi width:

➢   Spray by 15 degrees on both sides from DER.

➢   3NM (Const.) until reaching 30NM from ARP.

➢   Spray by 15 degrees on both sides, from the point of 30NM from ARP, until area semi-width reaches 8.00NM.
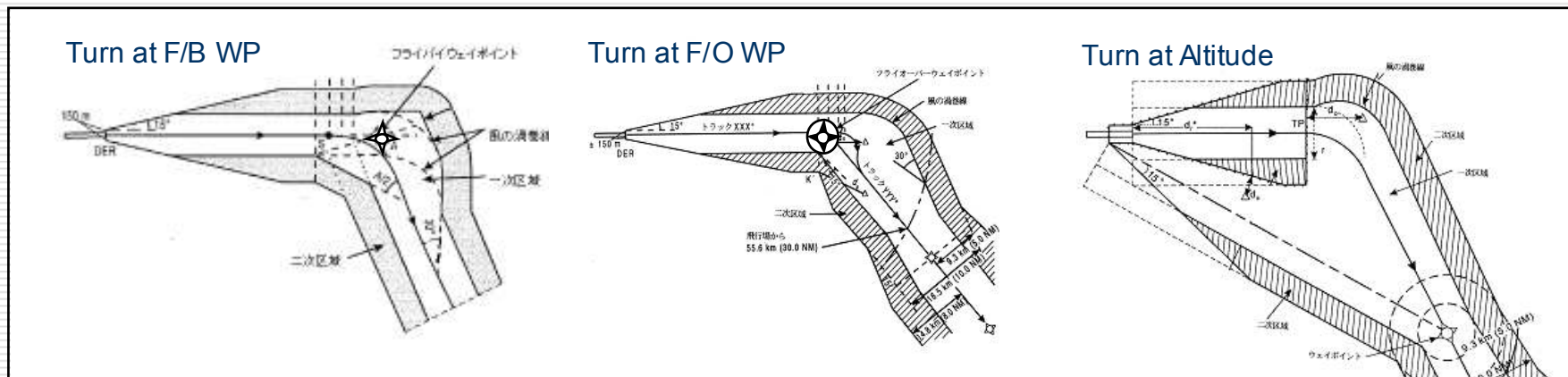
© Air Traffic Control Association Japan, All Right Reserved
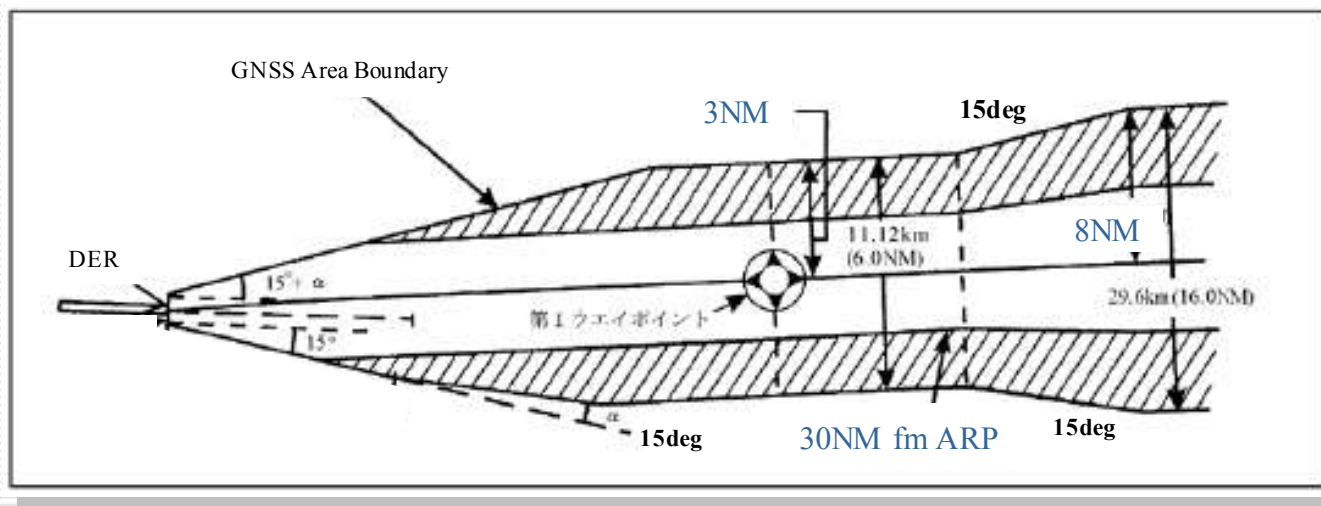
3.1 Departure

Turning Departure

☐ **Type of Turn**
  - ■ Turn at Fly-By WP
  - ■ Turn at Fly-Over WP
  - ■ Turn at altitude / height

☐ **Parameter for Turn Area**
  - ■ IAS … Area can be reduced by specifying the IAS ,then an obstacle can be avoided.
  - ■ Bank Angle
  - ■ PILOT Flight Technical Tolerance
  - ■ Wind Effect

Turn at F/B WP

Turn at F/O WP

Turn at Altitude

3.1 Departure

Turning Departure - Minimum Stabilization Distance (MSD)

☐　　It is assumed that aircraft climb straight until reaching 120m (394ft) after takeoff.

　* Therefore, straight climb is assumed until 1.9NM from DER　(in case of 3.3% PDG)

■　　For F/B WP: Minimum Distance between DER-WP
　　　= 1.9NM + ATT(Along-Track Tolerance) + A1

■　　For F/O WP:　Minimum Distance between DER-WP =　1.9NM + ATT
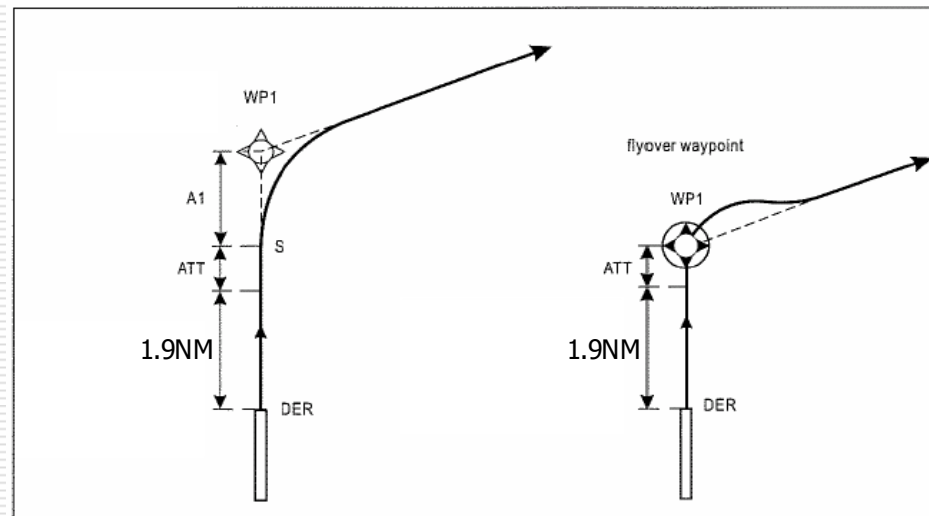
3. Terminal

3.2 Arrival / Approach
General(1/2)

☐   RNAV Arrival   ⚠ Accuracy as "RNAV1" is required

   ➢   DME/DME and GNSS is assumed as the navigation sensor.

   ➢   Greater of the following two types of areas is applied; GNSS criteria or DME/DME criteria.

      ● STAR
      ● Approach Procedure (until intermediate approach)

☐   RNP Approach (* Published as RNAV (GNSS) RWY xx APCH)

   ➢   GNSS is assumed as the navigation sensor.

      ● Initial Approach
      ● Intermediate Approach
      ● Final Approach
      ● Missed Approach

PBN (Performance-Based Navigation)

3.2 Arrival / Approach

General(2/2)

☐ GNSS Area width is derived not from navigation accuracy, but from RAIM Alert Limit(IMAL).

■ ATT = IMAL

■ XTT = IMAL+FTT (Flight Technical Tolerance)

■ Area semi width = 2 x XTT

➢ 8.0NM (IAF outside 30NM, Missed Approach WP, DEP)

➢ 3.0NM (IAF within 30 NM from ARP, IF , Missed Approach WP, DEP)

➢ 1.2NM (FAF)

➢ 1.0NM (MAPt)

GNSS Approach Segment   GNSS Area (Reference)   Waypoint Tolerance

3.2 Arrival/Approach

Initial Approach Segment (1/2)

☐ Area width

■ Within 30NM from ARP:
+/- 8.0NM

■ Converging by 30 degrees at 30NM from ARP

☐ MOC (Minimum Obstacle Clearance) and Descent Gradient:

■ MOC : 984 ft (Primary Area)

■ Optimum Gradient: 4.0%

⚠ Area width is different for each GNSS receiver mode.

Area semi width =8NM

Turning Area

En route MODE

Terminal MODE

Area semi-width = 8NM

30NM from ARP

Area semi-width= 3NM
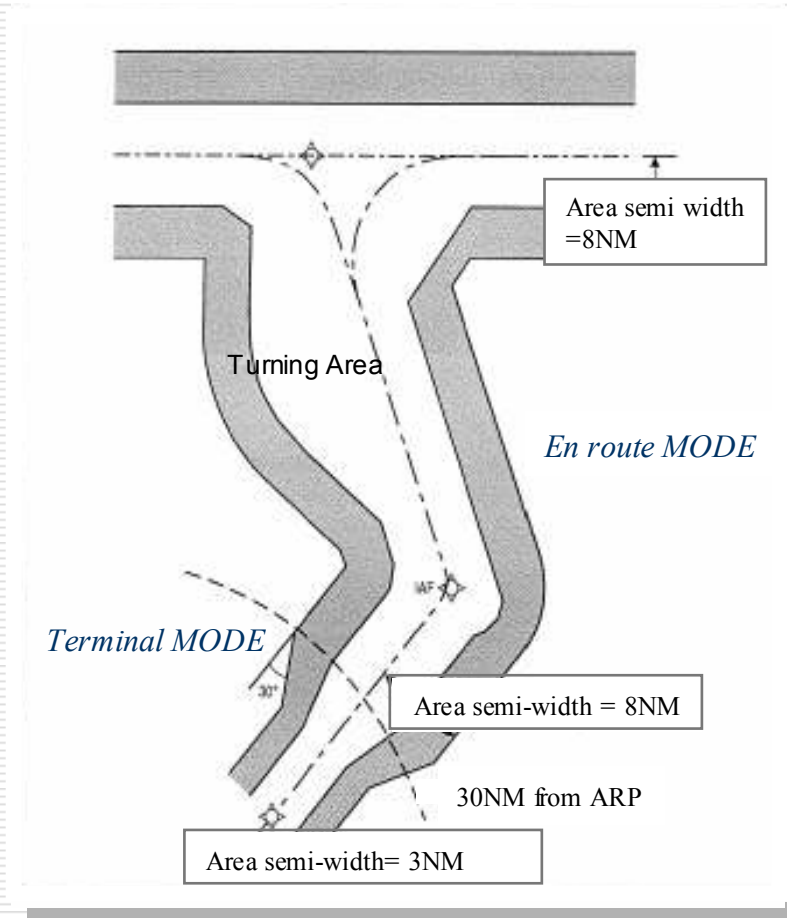
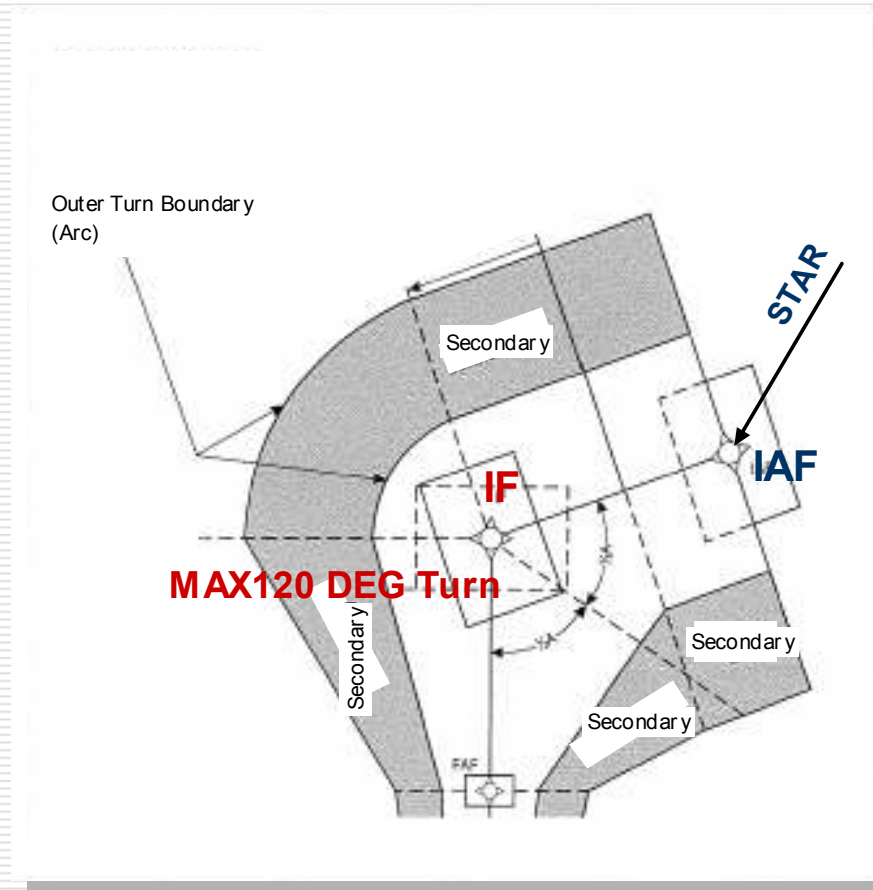## 3.2 Arrival / Approach

Initial Approach Segment (2/2)

- ❑ **Alignment**

  - ➤ Turn at IF: max 120 degrees

- ❑ **Segment Length**

  - ➤ Optimum: 5NM

  - ➤ Initial segment following STAR
    Minimum: 6NM

Outer Turn Boundary (Arc)

Secondary

STAR

IAF

IF

MAX120 DEG Turn
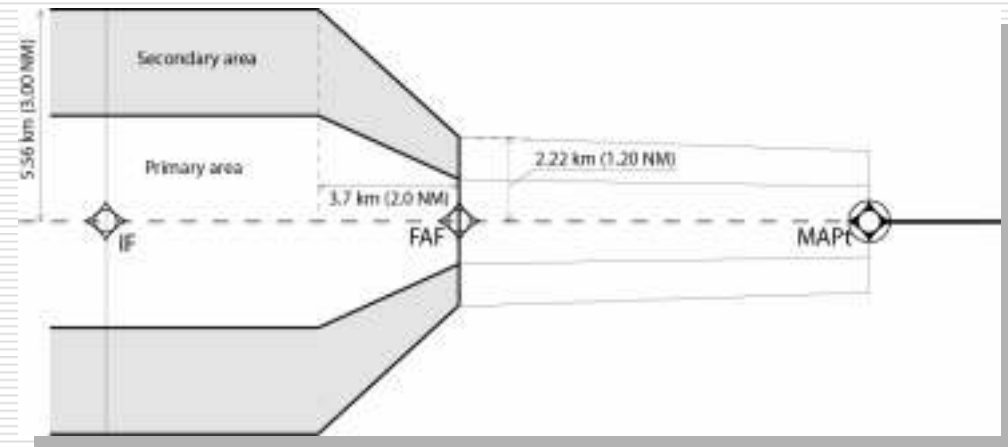
Secondary

Secondary

Secondary

3.2 Arrival/Approach

Intermediate Approach Segment

☐ Alignment: Align with Final Approach Segment so far as possible.
                  * Turn at FAF: Max 30 degrees

☐ Segment Length: Determined by turns at IF and FAF
                  * Minimum 2NM of straight segment is to be established.

☐ Area Width: Constant as +/-3NM until 2NM to FAF,
                  then converge to 1.2NM at FAF

☐ Obstacle Clearance
   and Descent Gradient

■ MOC : 492 ft (Primary Area)
■ Optimum Gradient: FLAT

3.2 Arrival/Approach

Final Approach Segment

☐ Alignment

■ In principle, align with runway centerline.

☐ Segment Length

■ Optimum Length: 5NM

☐ Area

■ Secondary Area is applied.

■ Primary Area/Secondary Area widths at FAF and MAPt are combined.

☐ Obstacle Clearance and Descent Gradient

■ MOC : 246ft (Primary Area)

■ Optimum Gradient: 5.2% (3degrees)

GNSS Approach Segment

3.2 Arrival/Approach

Missed Approach Segment (1/2)

☐ MAPt is established as Fly-over WP no matter if turn is specified at MAPt or not.

☐ Rule for "Minimum Leg Length" is applied to Distance from MAPt to MATF or MAHF (F/O to F/O).
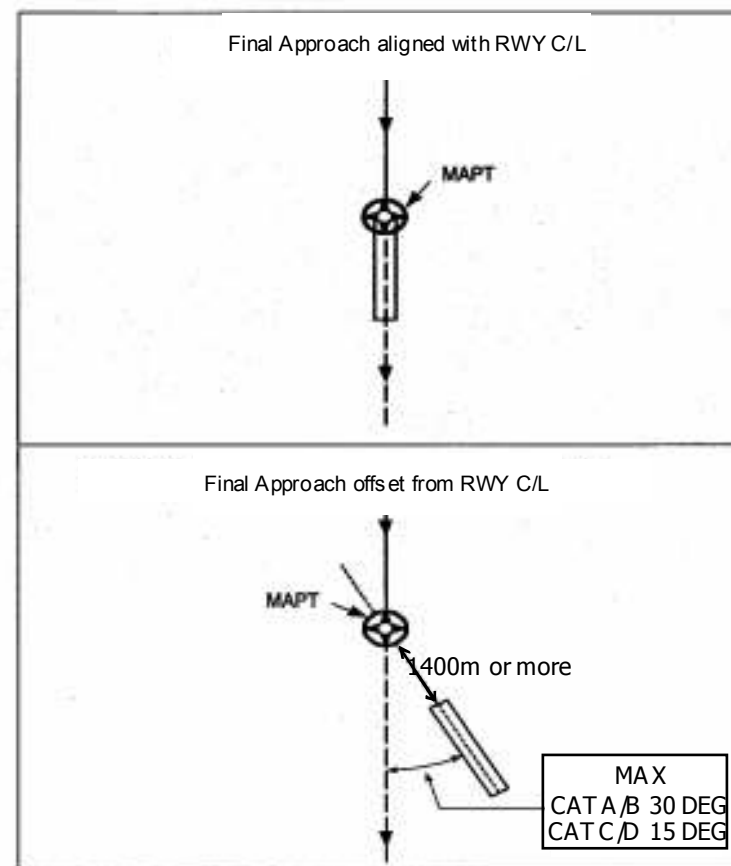
Minimum Leg Length(F/O to F/O)

3.2 Arrival/Approach

Missed Approach Segment (2/2)

- ☐ MAPt Location:

- ➢ Final Approach Path aligned with RWY C/L:
  At or prior to Threshold(THR)

- ➢ Offset Final Approach Path:
  At the intersection of Final Approach Path and Extended runway centerline

- ☐ Area:

- ➢ Diverges by 15 DEG on both sides from MAPt tolerance until reaching +/-3.0NM.
  * Due to poorer CDI sensitivity of GNSS receiver for Missed Approach

Final Approach aligned with RWY C/L

MAPT

Final Approach offset from RWY C/L

MAPT

1400m or more

MAX
CAT A/B 30 DEG
CAT C/D 15 DEG

3. Terminal

3.3 T/Y Bar and TAA

T/Y Bar: General

What are T-Bar, Y-Bar?

- ☐ Construction of Initial Approach(es) for smooth interception to RNAV(final) Approach

- ☐ Normally, reversal procedure is not necessary.

- ☐ Y-Bar is used when 90-deg arrangement (T-Bar) is not practicable.
  (However, turn at IF is Max 70 deg)

- ☐ Effective when airspace is sufficient. However, maybe ineffective for mountainous area.
  (MVA, altitude restriction for obstacle, etc.)

T-bar Contruction

3.3 T/Y Bar and TAA

T/Y Bar: Direct to IAF/IF

- ☐ IAF in use depends on the direction which aircraft comes from.

- ☐ Following turns are assumed, in principle:

  For T-bar:
   - Within 90 deg for turns at IAF / IF

  For Y-bar:

   - Within 70 deg for turns at IAF (center)
   - 70-110 deg for turns at IAF (R/L)
   - Within 70 deg for turns at IF

- ☐ "Direct" to IAF or IF is possible.

- ⚠ "Direct" must be within 90 deg for T bar and Y bar

- ⚠ Direct to FAF is not allowed.

Y-bar Construction

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3.3 T/Y Bar and TAA
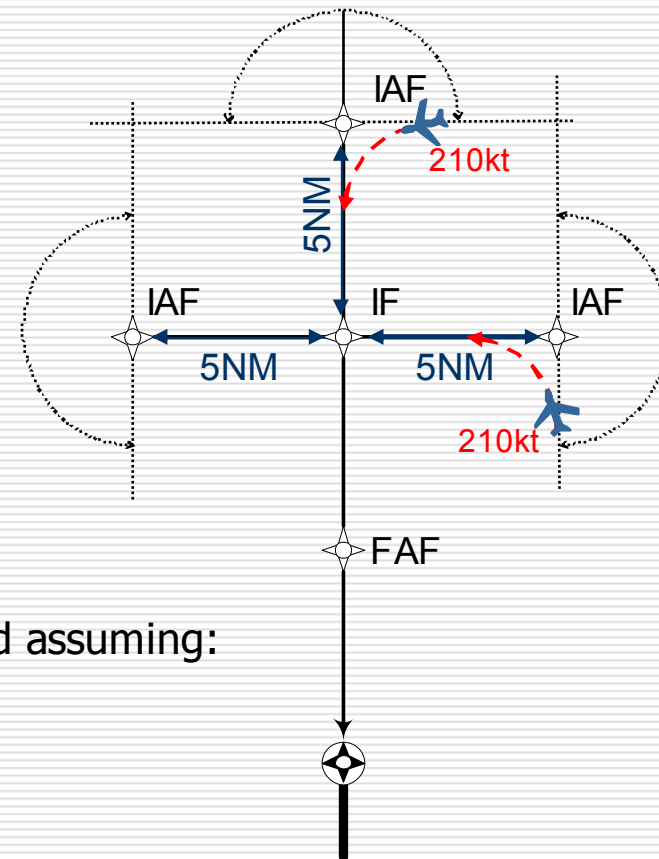
T/Y Bar: Initial Approach Segment (IAF – IF)

☐ Segment Length:

■ Max: (No limitation)

■ Optimum: 5.0NM

Note: Optimum length (5.0NM) meets the requirement of "Minimum Leg Length" for majority of aircraft. (F/B to F/B)

Optimum Segment Length (5.0NM) is established assuming:

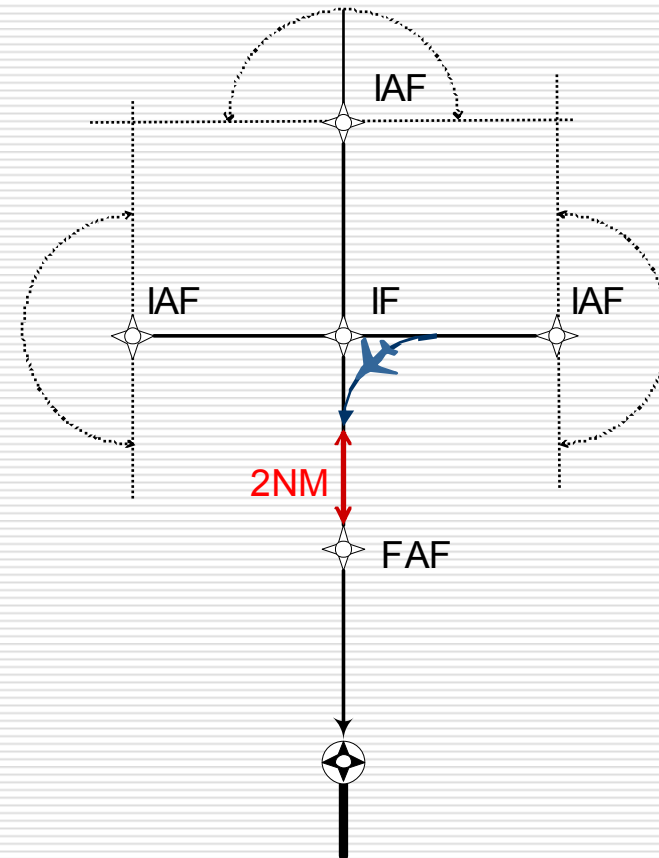- Altitude at or below 10,000

- IAS 210kt or less

3.3 T/Y Bar and TAA

T/Y Bar: Intermediate Approach Segment (IF – FAF)

☐　Align with Final Approach Path, in principle

☐　Segment Length:

■　Minimum leg length is established in accordance with turn at IF, FAF.

■　Straight segment (min, 2NM) is established prior to FAF.

IAF

IAF　　　　IF　　　　IAF

2NM

FAF

3.3 T/Y Bar and TAA

TAA: General

- ☐ Terminal Arrival Altitude (TAA) is established in combination with T/Y Bar.

- ☐ TAA is published for smooth descent and entry to the approach and also for the use in emergency. It is used as flight altitude until IAF (or IF) of T/Y Bar.
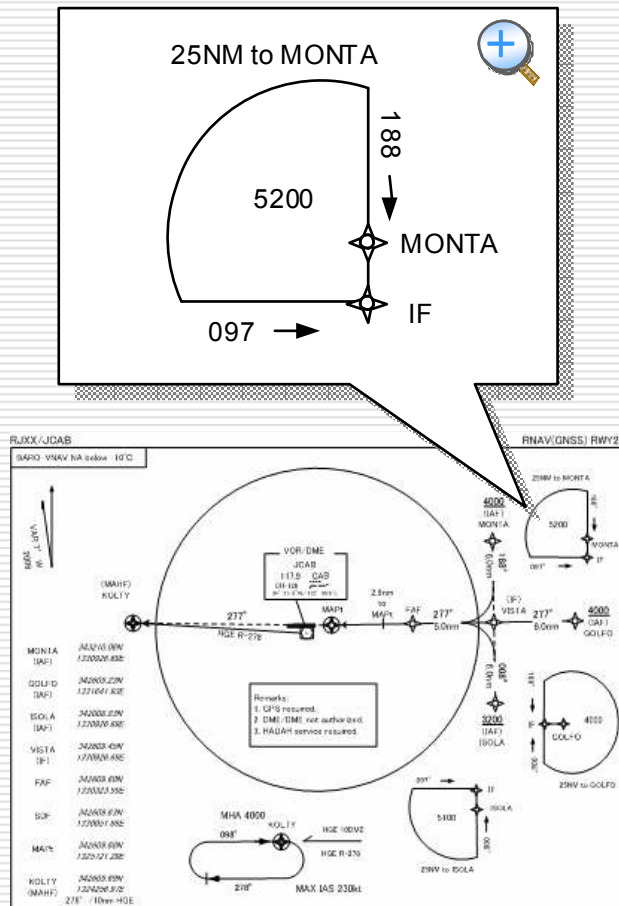
- ☐ Area

  - ➢ Centered on IAF(or IF)

  - ➢ Radius = 25NM + Buffer Area(5NM)

  - ➢ Obstacle Clearance(MOC) = 1,000ft

  - ➢ Sectorized by the line connecting IF-IAF.
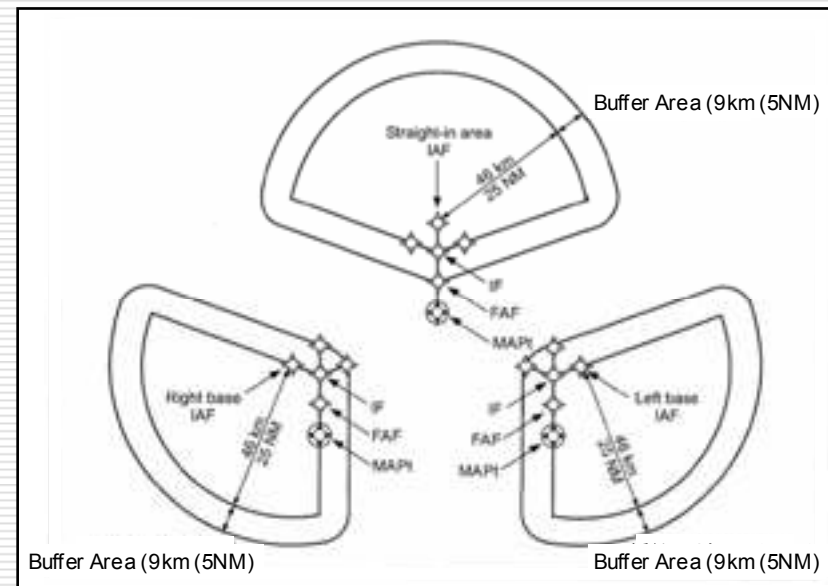
3.3 T/Y Bar and TAA

TAA: Publication

□   TAA is indicated as Icon in the Chart

□   Information indicated by Icon:
  ■   TAA Center (IAF or IF)
  ■   Radius
  ■   Bearing of TAA boundary
  ■   Minimum Altitude

□   IAF is named as WP
  ■   Then, Icon and Approach procedure is combined.

□   WPT name for IF is not indicated in the Icon.
    Indicated as "IF"

  * To avoid misunderstandings by Pilot for TAA center.

3. Terminal

3.4 APV / Baro VNAV

General(1/3)

- ☐ APV: Approach Procedure with Vertical Guidance

  Utilize vertical/lateral guidance, but does not meet the requirements for Precision Approach. Followings fall into APV.

  - ■ APV/Baro-VNAV : 3 deg vertical path is generated by pressure altimeter and FMS
  - ■ APV-I/ II: APV using SBAS

- ☐ DA established instead of MDA.

- ☐ FAF and MAPt for LNAVApproach is applied.
  APV/Baro-VNAV is regarded as another mode of operation of RNAV Approach (RNP APCH), and published in the same approach chart.

  - ■ VNAV MINIMA is also published.

  ⚠ VNAV is used in combination with RNAV (RNP) Approach Procedure.

3.4 APV / Baro VNAV
General(2/3)

☐   Published <u>VPA</u>(Vertical Path Angle) : 3deg (Max 3.5 deg)

☐   THR Crossing Height (<u>RDH</u>: Reference Datum Height): 50ft

☐   Final Approach Course must align with runway centerline.

⚠ VNAV not permitted for offset approach

3.4 APV / Baro VNAV

General(3/3)

Effect by Temperature

☐ While trying to fly the published altitude on Intermediate Segment, actual flight altitude is lower in cold days than in warm days since air mass is compressed.

☐ Therefore, procedure is designed considering:

    a.   Obstacle is assessed assuming cold days.

    b.   Lowest vertical path shall not be less than 2.5 deg even in cold days.

    c.   Minimum temperature for which Baro-VNAV is authorized is published.

FAP

Temp.
Correction

Nominal VPA

Minimum VPA
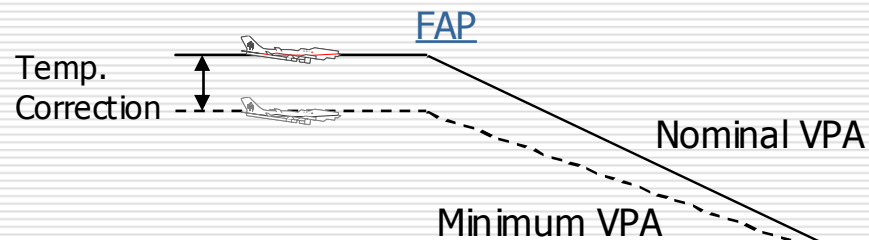
3.4 APV / Baro VNAV

Publication: Approach Procedure Naming Convention
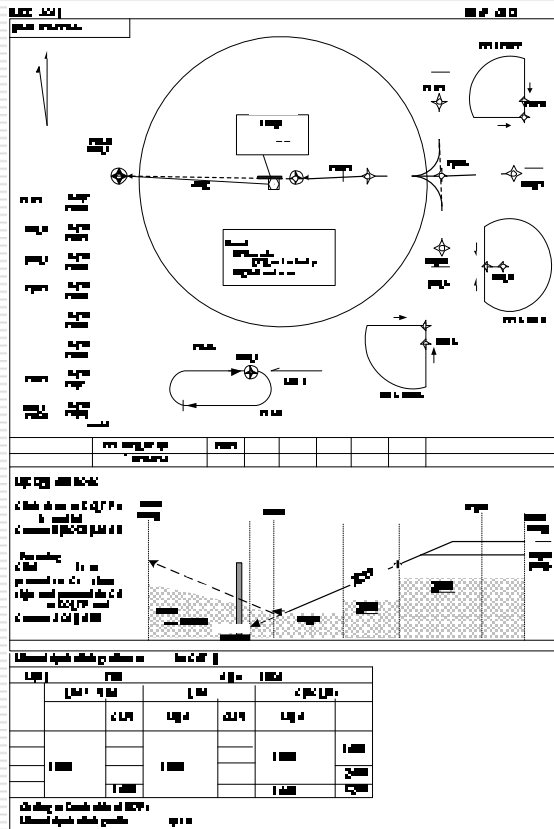
RNAV(Sensor) RWY xx

Note1 "VNAV" is not included in the procedure title.

eg. RNAV(GNSS) RWY18

Note 2 Sensor type is not called upon issuing approach clearance.

eg. *"CLEARED FOR RNAV RWY18 APPROACH."*

3.4 APV / Baro VNAV

Publication: PLAN VIEW

BARC VNAVNA belo   1C℃

Mim. Temp for
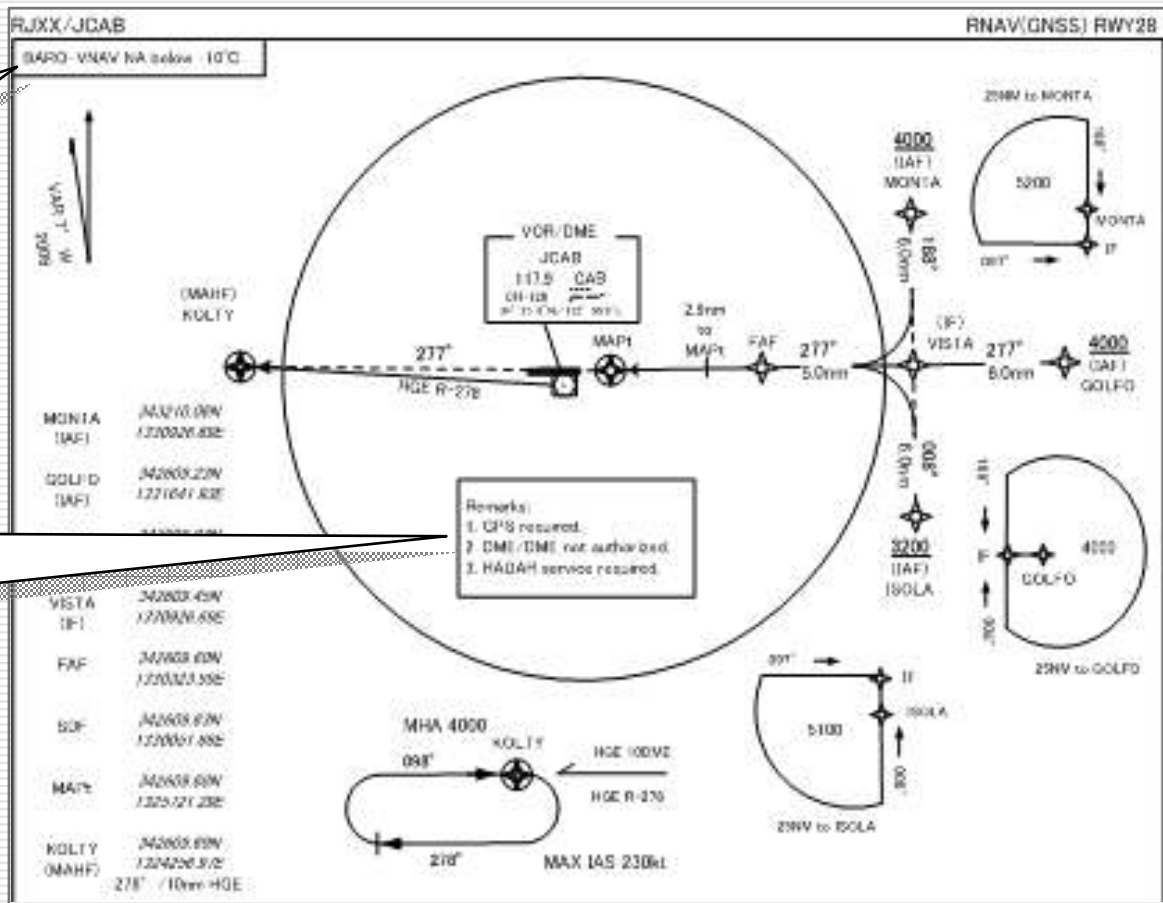Baro-VNAV

Remarks:
    GPS require
    DMI DME no
authorize
    RADAR service require

Navigation Requirements

3.4 APV / Baro VNAV

Publication: PROFILE VIEW

RDH (Reference Datum Height)

VPA (Vertical Path Angle)
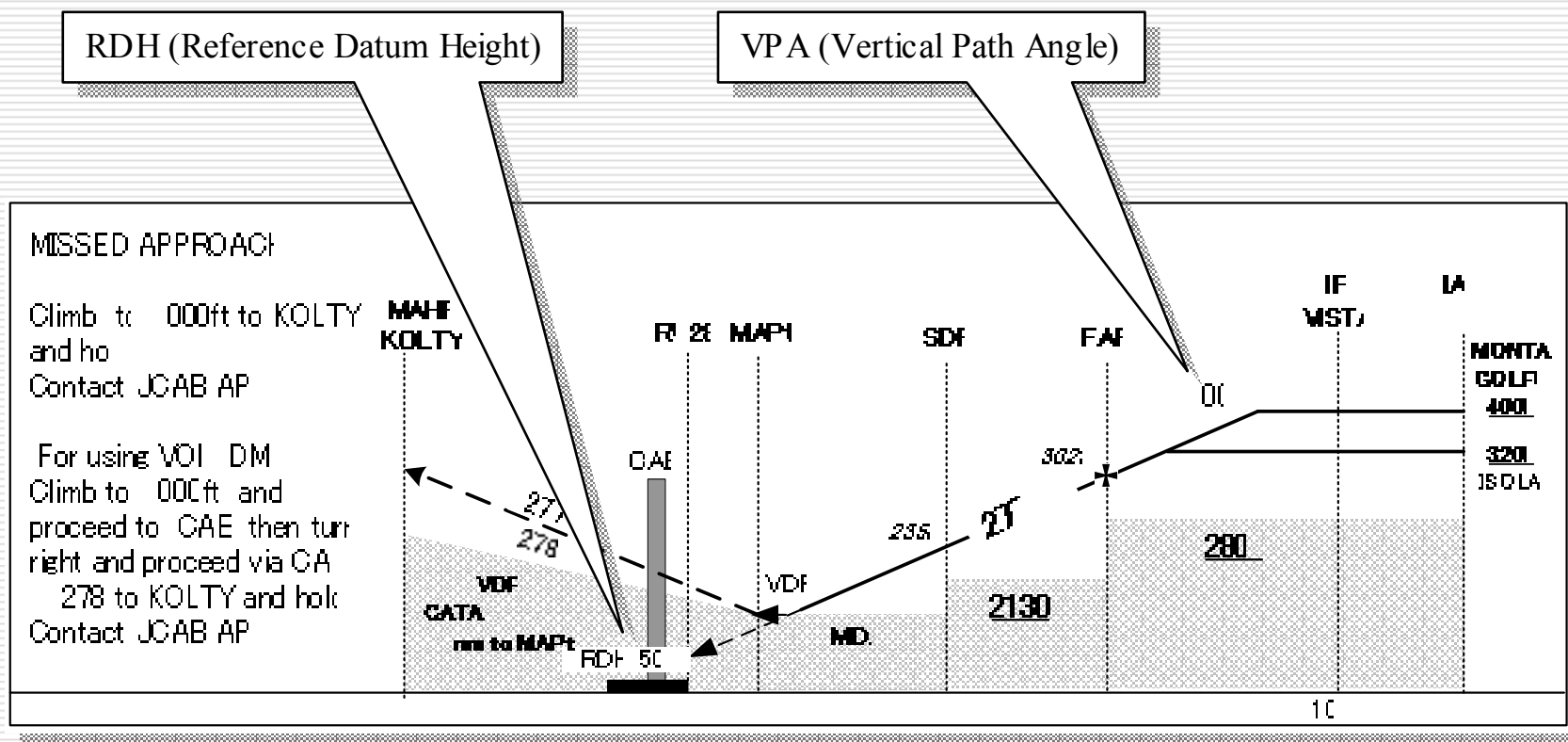
3.4 APV / Baro VNAV
Publication: MINIMA

☐   Minima Table

LNAV –only MNM   "MDA" and "RVR or CMV":   Indicated as "LNAV"

LNAV/VNAV MNM   "DA" and "RVR or CMV":   Indicated as "LNAV/VNAV"

Missed Apch climb gradient mi   % for CAT

MINIM/	THR elev 1067				AD elev 108€		
	LNAV VNA\		LNAV			CIRCLIN(	
CAT	DA H	CM\	MD/ H		CM\	MD/ H	VI9
A	150C 433	1200	150C 433		1200	1550 46₄	1600
B		130C			130C		
C		140C			140C		2400
D		160C			160C	1640 55₄	3200

Circling to South side of RWY only

Missed Apch climb gradient of   % up to 1€ 0C

3.4 APV / Baro VNAV

Publication: Contingency Procedure

☐ Missed Approach by conventional navigation, based on ground NAVAID,is also published in case that RNAV (RNP) approach cannot be continued due to discrepancy in GPS receiver, etc.
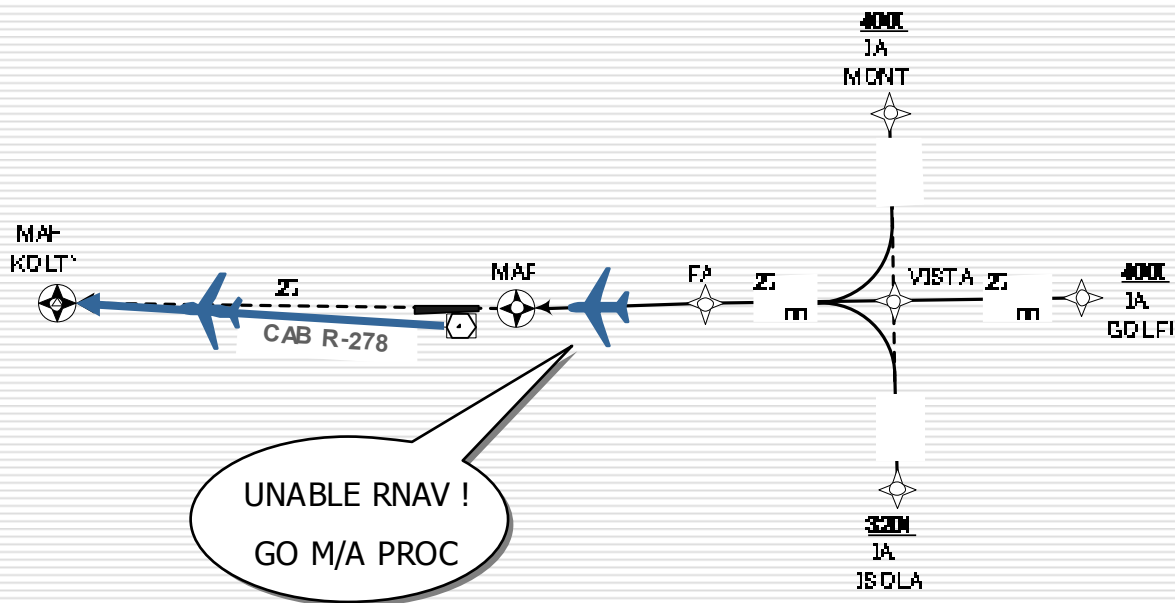
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4. Holding

- General
- Type
- Entry Procedure

4. Holding

General

- ☐ Holding pattern is designed and published assuming Conventional Navigation (Radio Navigation) in case of missed approach due to GPS discrepancy, etc..

- ☐ Area for RNAV Holding can be smaller than that for Conventional Navigation.
  - * For RNAV holding, it is not necessary to account for wind drift since it can adjust the track by modify bank angle.

- ☐ RNAV Holding WP mush be established such that position could be confirmed using bearing/distance from NAVAID.

- ☐ Holding WP(MAHF) is established as Fly-over WP.

- ☐ Obstacle Clearance
  - ➤ MOC : 984ft (Primary Area)

4. Holding

Types of RNAV Holding

☐ 3 Types of RNAV Holding.

a) 1-WP RNAV Holding

b) 2-WP RNAV Holding

　　Not established since not all types of aircraft is
　　capable.

c) Area Holding

　　Not feasible due to quite wide area.

Only 1-WP Holding is established at present.

1-WP Holding　　　　2-WP Holding

Area Holding
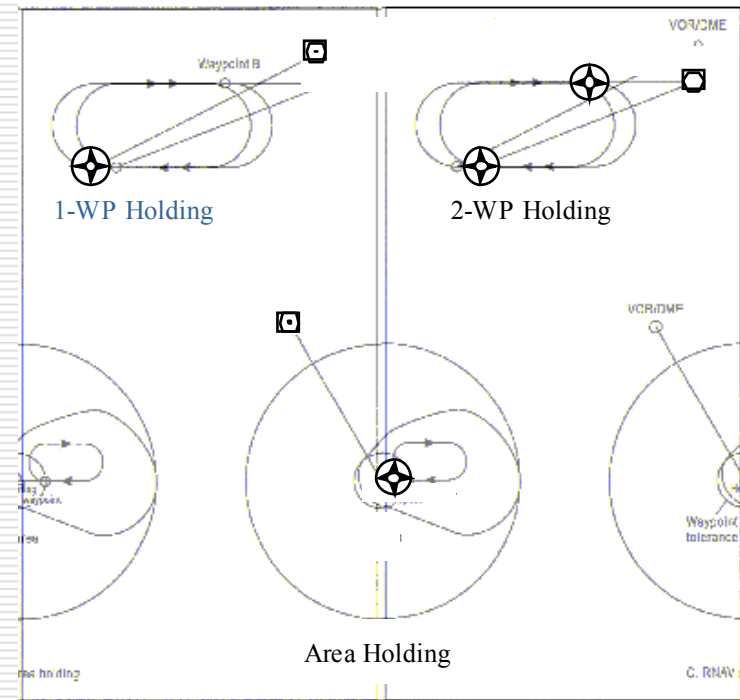
Types of RNAV Holding

4. Holding

Entry Procedure

☐   1 WP HOLDING:

☐   As same as for Conventional Navigation
- Parallel entry
- Offset entry
- Direct entry

Entry Sectors
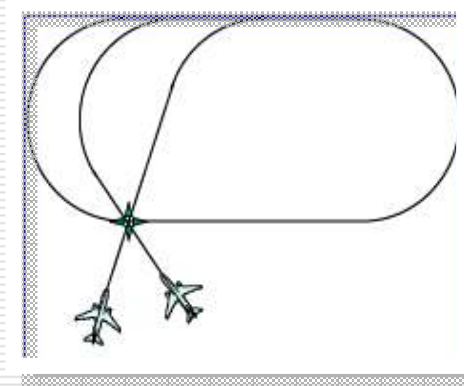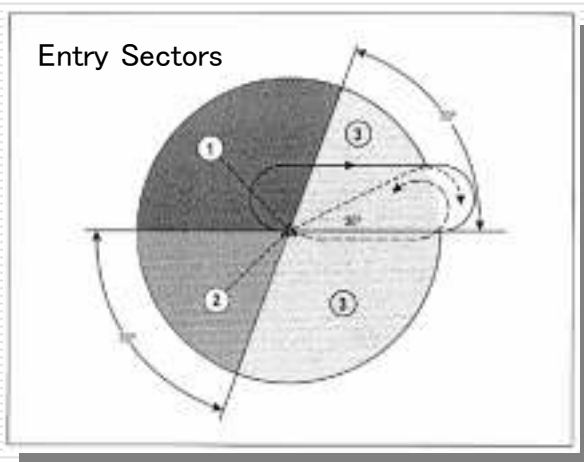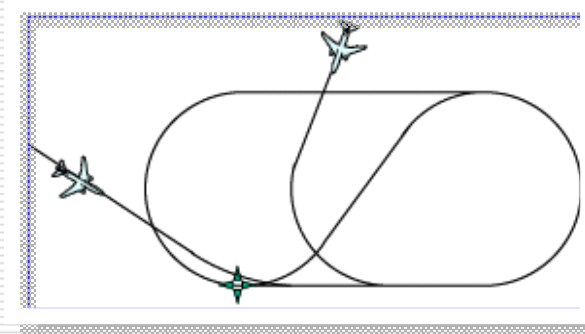
II. RNAV ATC Procedures

RNAV Training for ATC - Part II

Part II: RNAV ATC Procedures

5. Terminal/Enroute ATC Procedures

5.1   General

5.2   Terminal RNAV ATC Procedures(RNAV1)

5.3   Enroute RNAV ATC Procedures(RNAV5)

5.1 General

RNAV1 / RNAV5

☐ **RNAV1**

Navigation specification including the lateral total system error within +/- 1 NM for at least of 95 % of the flight time, and other over navigation performance / functionality requirements.

Position-updated with the following sensors (and their combination).

- DME/DME/IRU (Update by 2 or more DMEs and IRU)
- GNSS

☐ **RNAV5**

Navigation specification including the lateral total system error within +/- 5 NM for at least of 95 % of the flight time, and other over navigation performance / functionality requirements.

Position-updated with the following sensors (and their combination).

- VOR/DME
- DME/DME
- INS or IRS
- GNSS

PBN (Performance-Based Navigation)   RNAV System

5.1 General

Flight Plan (1/6): RNAV1 Requirements

☐ In principle, RNAV1 route can be flown by
(a) DME/DME-equipped aircraft that has either IRU or GPS, and
(b) SBAS-equipped aircraft.

⚠ RNAV1 is not approved for DME/DME-only RNAV aircraft.

⚠ RNAV1 is not approved for -only RNAV aircraft.

Equipment capable of RNAV1

DME/DME/IRU

IRU	GNSS		
DME/DME	IRU	GNSS	SBAS
○	DME/DME	DME/DME	○

* GNSS (GPS and/or SBAS)

Equipment NOT capable of RNAV1

Only — DME/DME — ✕
Only — GPS — ✕
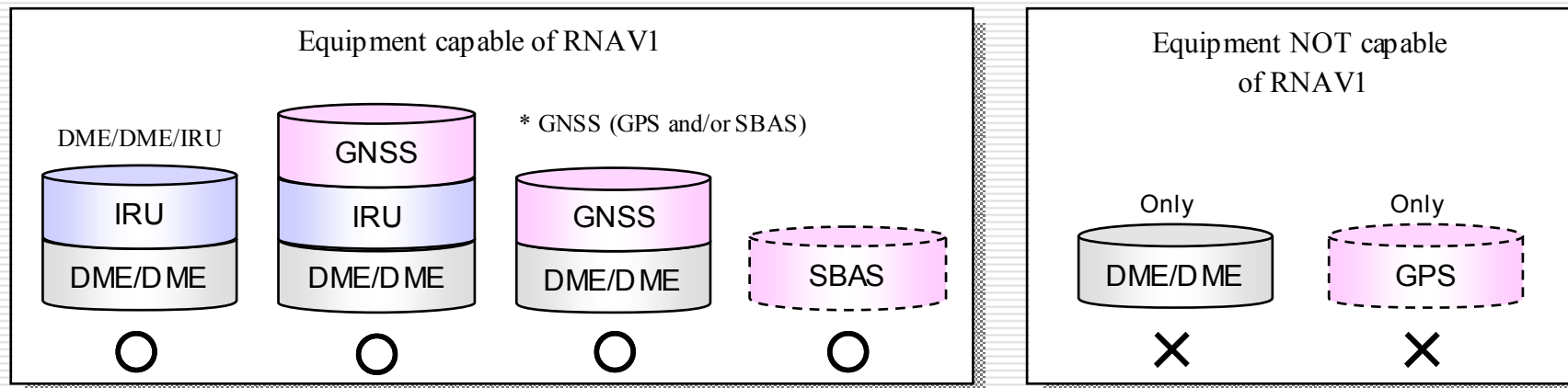
⚠ DME GAP (explained later) on RNAV1 route can be flown using IRU or GPS.

* Flight Plan is made based on these requirements.

5.1 General

Flight Plan(2/6): RNAV5 Requirements

□ RNAV5 route can be flown by aircraft updating its position by (a) 1-VOR/DME, (b) DME/DME, (c) INS, (d) IRS, (e) GNSS and (f) the combination of these sensors.

□ Aircraft with DME/DME-only cannot flight-plan on RNAV 5 route with DME GAP. (RNAV5 is not permitted.)

⚠ RNAV5 is not approved for GPS-only RNAV aircraft

Equipment capable of RNAV5

* GNSS (GPS and/or SBAS)

INS/IRS   GNSS

VOR/DME   DME/DME

○

Equipment NOT capable of RNAV5

Route with DME GAP

Only   Only

GPS   DME/DME

✕   ✕
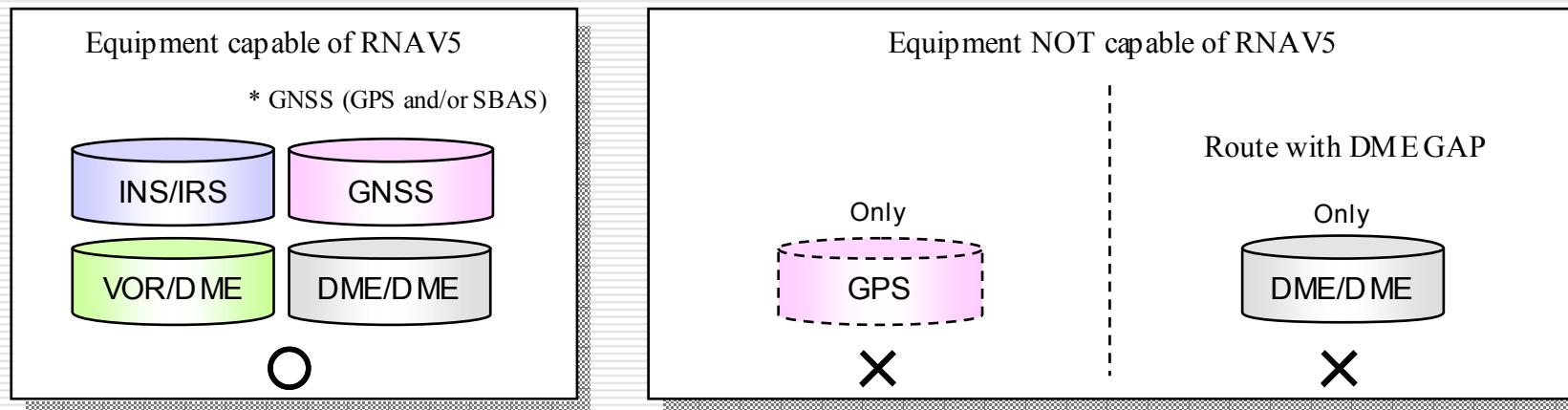
* Flight Plan is made based on these requirements.

5.1 General

Flight Plan(3/6): Flight Plan File

☐ RNAV1/5 Capable aircraft

✈ In Flight Plan Item 10, "Z" and followings are to be filled.

➢ RNAV1-Capable Aircraft: "NAV/RNAV1"
➢ RNAV5-Capable Aircraft: "NAV/RNAV5"
➢ RNAV1/RNAV5-Capable: Aircraft "NAV/RNAV1 RNAV5"

Reference: RNP Capable Aircraft
✈ In Flight Plan Item 10, "R" and followings are to be filled..

➢ RNP4-capable Aircraft: "NAV/RNP4"
➢ RNP-capable Aircraft: "NAV/RNP10"
➢ RNP4/RNP10-capable Aircraft: "NAV/RNP4 RNP10"
➢ (Other example of Combination)
RNP4/RNAV5-capable Aircraft: "Z", "R", and "NAV/RNAV5 RNP4"

5.1 General

Flight Plan(4/6): Indication on Strip

☐ RNAV1/5-capable aircraft is indicated in Strip as follows:

Strip for For ACC

CAB007		1145	RJAA		RJAA*340 <FATR> FAIRY	
0007 R5					Y84 GULEG A590 SKATE	
B744/H						
0707 W	SS 476				── WMKK	0607−1045

<Description>

➢ RNAV1=R1 RNAV5=R5 RNP4=P RNP10=A

➢ RNAV1+RNAV5=R15

➢ RNAV1+RNP4=R1P   RNAV1+RNP10=R1A

➢ RNAV5+RNP4=R5P   RNAV5+RNP10=R5A

➢ RNAV1+RNAV5+RNP4=RP RNAV1+RNAV5+RNP10=RA

5.1 General

Flight Plan(5/6): Indication on Strip (Cont'd)

☐ RNAV1/5-capable aircraft is indicated on Strip as follows:

Strip for Terminal Control

CAB007	0707	RJCC	SID < > SNE Y11			
B744/H	210		R15			
0007/C	1145		W	JTT 070607-1015		

CAB007	0707	RJTT	280			
B744/H	TLE	1145	R1			
0007/C			GOC	JCC 070607-1015		

<Description>

➤ RNAV1=R1 RNAV5=R5

➤ RNAV1+RNAV5=R15

5.1 General

Flight Plan(6/6): Radar Scope

☐ RNAV1/5-capable aircraft is indicated on Radar Scope Data Block as follows:

On air

On Ground

```
CAB1234
009 B74D
OPPAR ROAH
*PAD  R1R5
```
E

```
CAB1234
B74D OPPAR
34R  R1
```

<Description>

➢ RNAV1=R1 RNAV5=R5

➢ RNAV1+RNAV5=R1R5

5.1 General

DME GAP

☐ DME GAP

Segment on the Route where Combination of DME signal which meets designated navigation accuracy requirement can NOT be received.

⚠ Such GAP is published on AIP.

⚠ It is not allowed for aircraft which can meet RNAV navigation requirements only by DME/DME to fly on the route including DME Gap.

⚠ Upon filing flight plan, pilot must determine if he/she can overfly the DME Gap.

Determination of flight is pilot discretion!

Flight Plan RNAV5 Requirement   DME Requirement for flying GAP   DME GAP   Overview of DME/DME RNAV

5.1 General

Critical DME

☐ Critical DME

A DME facility that, when unavailable, results in a navigation service which is insufficient for an operation based on DME/DME or DME/DME/IRU along a specific route or procedure.

⚠ Such DME and segment which is affected by its outage is published on AIP.

⚠ Aircraft shall notify ATC when it cannot meet RNAV requirements to continue RNAV operation due to unserviceablily of the DME.

⚠ ATC shall notify aircraft concerned about the situational change caused by such unplanned unserviceablily.

Determination of flight is pilot discretion!

Critical DME

5.1 General

Waypoint (1/2)

☐   Waypoint

A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation.

Waypoints are identified as either of :

◇   Fly-by Waypoint
A waypoint which requires turn anticipation to allow tangential interception of the next segment of a route or procedure

◈   Fly-over Waypoint
A waypoint at which a turn is initiated in order to join the next segment of a route or procedure

5.1 General

Waypoint (2/2)

⚠ Aircraft commence "inside" turn prior to reaching fly-by waypoint. On the other hand, aircraft will commence turn after reaching waypoint in case of fly-over waypoint.

⚠ Navigation System has a function of "turn anticipation" to transition to the next segment upon turning at fly-by waypoint. "Turn Anticipation Distance" prior to F/B WP depends on aircraft speed, bank angle, etc.

⚠ Track after passing fly-over waypoint depend on aircraft speed, bank angle and leg type of the next segment (explained later).

Turn Anticipation Distance

Track

Fly-by

Fly-over

Turn Area
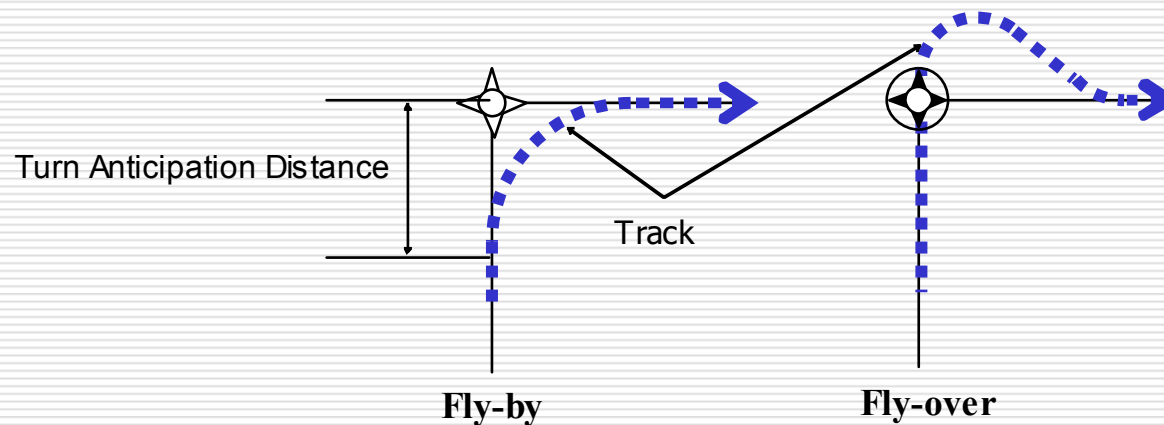
5.1 General

Path/Terminator (1/2)

☐ Path and Terminator

➢ 2-letter alphabetical code to define the type of leg used in terminal procedures (Departure/Arrival/Approach Procedure)

➢ Used to encode the flight procedures into such format that can be read by airborne navigation system.

➢ The first letter indicates "path" (mode of flight), and the second one indicates "terminator" (way of termination of the leg).

Leg Type	Description
IF (Initial Fix)	The point where a flight path begins
TF (Track to Fix)	The great circle track between two waypoints
DF (Direct to Fix)	The route segment that begins from an aircraft's present position to a fix
CF (Course to Fix)	The inbound (magnetic) course to a fix
CA (Course to Altitude)	The (magnetic) course until reaching the terminating altitude
VA (Heading to Altitude)	The (magnetic) heading flight until reaching the terminating altitude
VM (Heading to Manual Termination)	The (magnetic) heading flight terminated by manual intervention
VI (Heading to Next Leg Intercept)	The (magnetic) heading until intercepting the next leg
FM (Course from a Fix to a Manual Termination)	The (magnetic) course from a fix terminated by manual intervention

5.1 General

Path/Terminator (2/2)

☐ Leg Type and Textual Description

➢ Expressions in textual description of flight procedures correspond to the leg type in use.

Expression in Text Description	Leg Type
WAYPOINT ID (underlined)	(with Underline) = FLY OVER
WAYPOINT ID	(without Underline) = FLY BY
To (Waypoint)	TF leg
To (Waypoint) on track XXX deg	CF leg
Direct to (Waypoint)	DF leg
Climb on track XXX deg, at or above XXXX feet, turn right/left	CA leg
Climb on heading XXX deg, at or above XXXX feet, turn right/left	VA leg
From (Waypoint) to XXXX feet on heading XXX deg	VA leg
Continue on heading XXX deg	VM leg
Continue on track XXX deg	FM leg

⚠ Flight track can be predicted from the expression
in the description (and type of Icon (◇ ◈) used for waypoints).

5.1 General

Leg Type and Turn Anticipation (1/2)

FLY OVER

ALPHA   1,200'

090 deg

150 deg
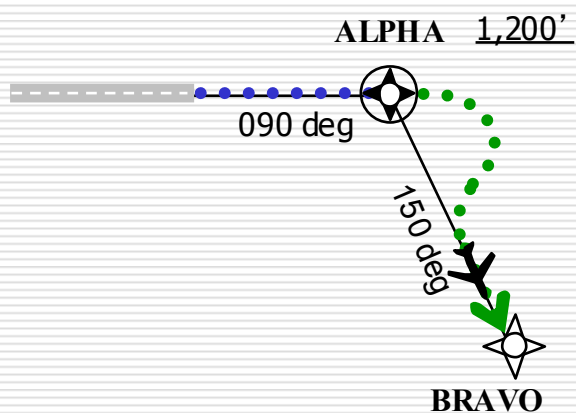
BRAVO

Climb **to ALPHA on track 090** deg,

at or above 1,200ft,

turn right **to BRAVO**…

CF Leg

TF Leg

FLY OVER

ALPHA   1,200'
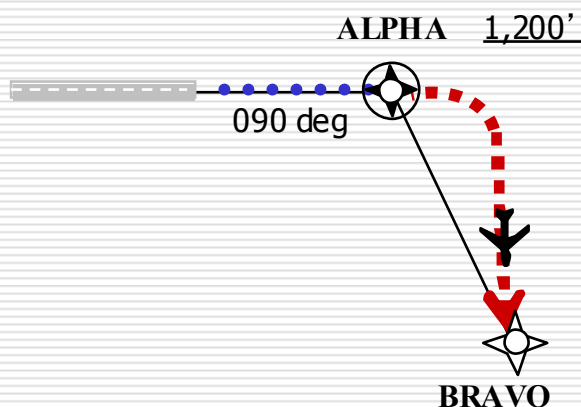
090 deg

BRAVO

Climb **to ALPHA on track 090** deg,

at or above 1,200ft,

turn right **direct to BRAVO**…

CF Leg

DF Leg

5.1 General

Leg Type and Turn Anticipation (2/2)
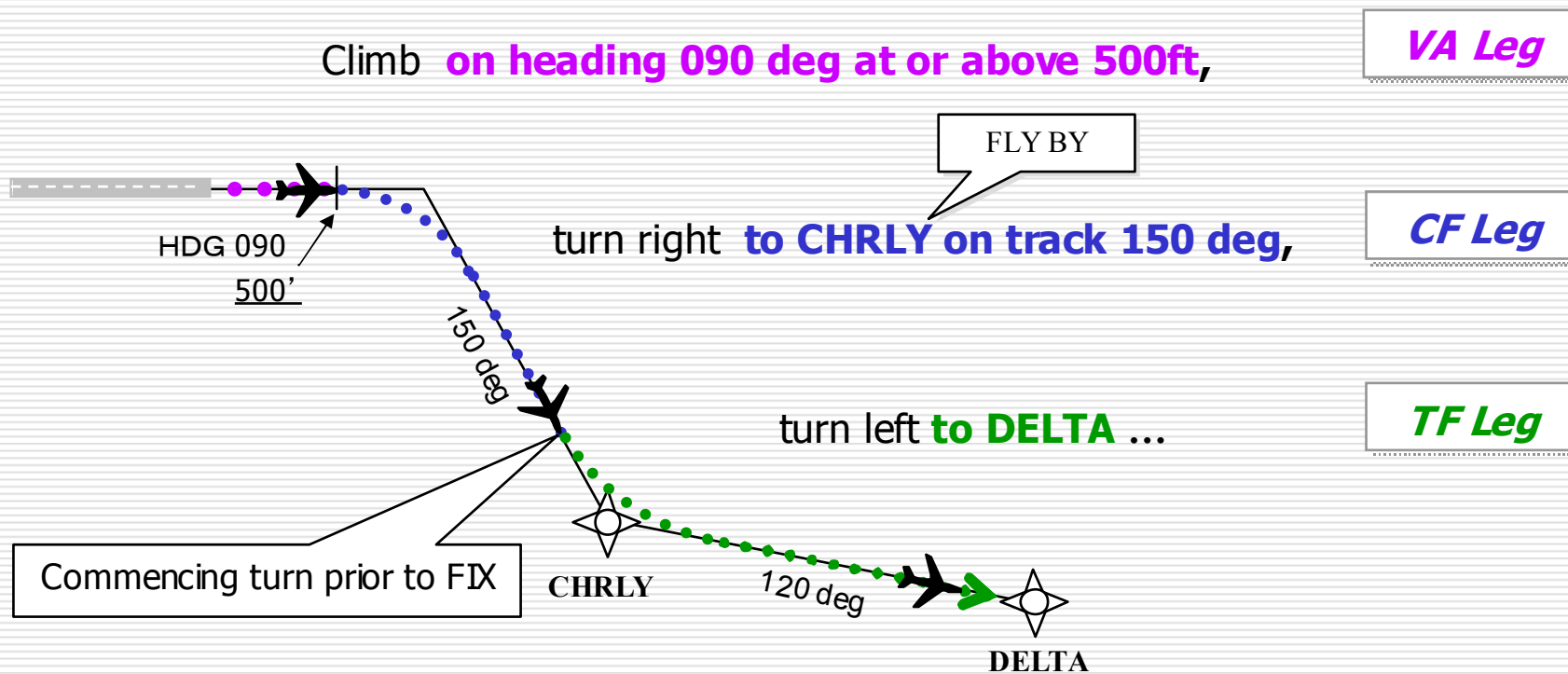
Climb **on heading 090 deg at or above 500ft**,

FLY BY

turn right **to CHRLY on track 150 deg**,

turn left **to DELTA** ...

VA Leg

CF Leg

TF Leg

HDG 090

500'

150 deg

Commencing turn prior to FIX

CHRLY

120 deg

DELTA

5. Terminal/Enroute ATC Procedures

5.1   General
5.2   Terminal RNAV ATC Procedures (RNAV1)
5.3   Enroute RNAV ATC Procedures (RNAV5)

5.2 RNAV 1

Application of ATC Procedure

☐ ATC procedures described below are applicable to aircraft flying on the following procedures to which RNAV1 Navigation Specifications are prescribed.

➢ Standard Instrument Departure (SID), and Transitions

➢ Standard Instrument Arrival (STAR)

➢ Instrument Approach Procedure (for Initial Approach)

☐ Limited to such situation where radar control service can be provided.

⚠ RNAV1 Routes are established within radar coverage.

ATC Procedures   ATC Procedures

5.2 RNAV 1

Radar Vector

☐ Upon vectoring to RNAV1 Route, vector is to be conducted toward a fix on the route.

☐ Instruct "Direct to a fix" upon terminating the vector.

e.g. *"Fly heading 070 for vector to BRAVO."*

"Resume own navigation direct BRAVO."

DIRECT TO WAYPOINT

5.2 RNAV 1

Direct to a Fix

- ☐ "Direct to a Fix" should be instructed form the sector indicated below so far as practicable.
- ➤ Course change toward the next segment is not more than 45 deg
- ➤ At least 6 NM (9NM for 10,000 ft or above) prior to the fix

ALPHA   BRAVO   Smooth intercept and prevention of overshoot

45 deg or less   CHRLY

6NM or more

(9NM or more for ALT10,000FT or above)

⚠ It is to be noted that actual flight track depends on the type of fix (F/B or F/O), leg Type of the next segment, wind effect, speed, altitude, rate of turn, etc.

Path and Terminator   Estimation of Track
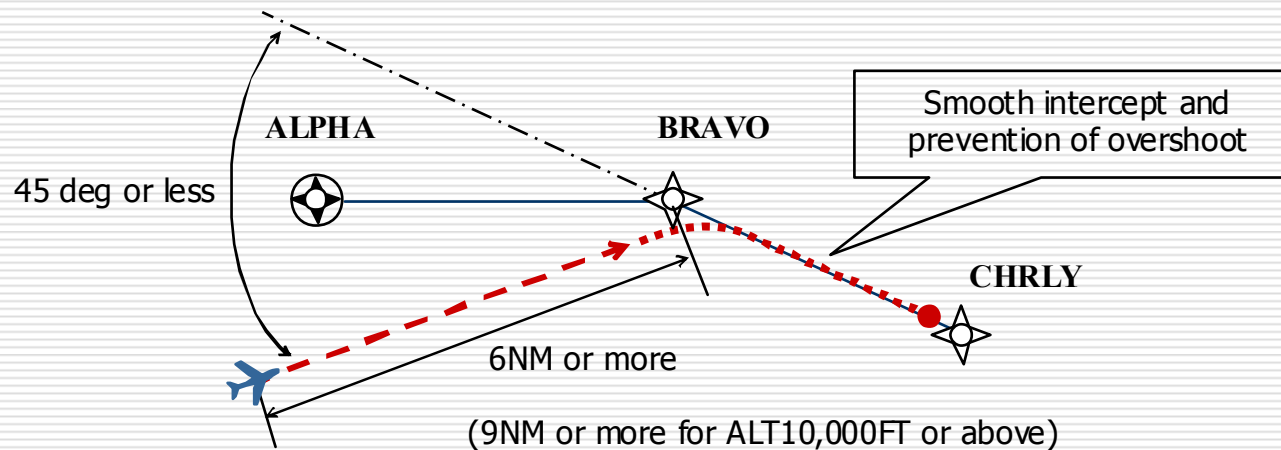
5.2 RNAV 1

Contingency Procedures

☐ When radar control service cannot be provided due to Outage of Radar,etc, or when it is advised by pilot that he/she cannot continue flying on RNAV1 route due to any discrepancy in RNAV equipment, outage of Critical DME, ATC shall make coordination with related ATC organization, and take the following action:

➢ **To aircraft in pre-flight phase,** inform that flying on RNAV1 route cannot be cleared, and issue clearance for an alternate route determined as a result of coordination with other ATC organizations concerned.

> **UNABLE TO ISSUE** *(designator)* **DEPARTURE** [or **ARRIVAL**] *(reason if necessary).*

> 〔e.g.〕 *Unable to issue MORIYA ONE RNAV DEPARTURE due to outage of ASR.*

> *Expect to issue MORIYA NINE DEPARTURE, stand by for the clearance.*

➢ **To aircraft in flight,** issue clearance for flying on an alternate route using adjacent NAVAID.

> 〔e.g.〕 *PILOT: UAL001, unable ASAHI NORTH RNAV ARRIVAL*

> *due to failure of RNAV receiver. Request amended clearance.*

> *ATC: UAL001, roger, recleared direct TLE VOR, hold north, maintain 9,000ft.*

⚠ It is to be informed by a pilot as such in case he/she cannot fly RNAV1 route for any reason.

ATC Procedures   Critical DME

5.2 RNAV 1

Confirmation of Capability of Flight

☐   Ask a pilot and confirm if he/she can fly RNAV1 route concerned, if necessary.

ADVISE IF ABLE *(designator)* **DEPARTURE** [or **ARRIVAL**].

〔e.g.〕 *Advise if able MORIYA ONE RNAV DEPARTURE.*

⚠ The phraseology above is provided for such cases that it is necessary to check the capability upon clearing for SID/STAR. Capability of the aircraft to fly RNAV1 (and RNAV5) route can be checked by referring to flight Plan, Strip, etc.

⚠ It is to be informed by a pilot as such in case he/she cannot fly RNAV1 route for any reason.

〔e.g.〕 *PILOT: Unable MORIYA ONE RNAV DEPARTURE due to RNAV type.*

5.2 RNAV 1

Example of Publication (1/5)

☐ Procedures are published using:

➤ Charts

➤ Textual Description
➤ Tabular Form (with leg type)

⚠ Navigational requirements are indicated,
such as Navigation Accuracy, etc.

RWY34R/34L

Rcmd Path Terminator	Fix ID (Waypoint Name)	Fly Over	Distance (NM)	MAG Track (TRUE Track)	Turn Direction	Altitude (FT)	Speed Limit (kt)	Vertical Angle	Navigation Performance
VA	–	–	–	337° (329.9°)	R	+500	–	–	RNAV 1
DF	SNE01	–	–						RNAV 1
TF	SNE02	–	–						RNAV 1
TF	SNE	–	15.0	(003.0°)	–	–	–	–	RNAV 1

Note RWY34R: 5.0% climb gradient required up to 520ft.
RWY34L: 5.0% climb gradient required up to 680ft.

Chart

Textual Description

5.2 RNAV 1

Example of Publication (2/5)

RJTT / TOKYO INTL   RNAV DEP

MORIYA ONE RNAV DEPARTURE   **RNAV 1**

NOTE 1) DME/DME/IRU or GNSS required
     2) RADAR required

Critical DME	GOC (5.0nm to SNE − 20nm to SNE)
DME GAP	2.0nm to SNE02 − 10.8nm to SNE
Inappropriate Navaids	SHT, YOK, HUT

DESIGNATION	COORDINATES
SNE 01	35 36 32.1 N I 39 57 36. 8E
SNE 02	35 40 19.8 N I 39 57 51. 6E
SNE	35 36 05.4 N I 39 58 53. 2E

MORIYA ONE RNAV DEPARTURE
RWY16R/16L: Climb on heading 157° M, at or above 800ft,
  turn left, direct to SNE01, turn left to SNE02, then to SNE.
RWY34R/34L: Climb on heading 337° M, at or above 500ft,
  turn right, direct to SNE01, turn left to SNE02, then to SNE.
RWY 04: Climb on heading 042° M, at or above 500ft,
  turn left, direct to SNE01, turn left to SNE02, then to SNE.
RWY 22: Climb on heading 222° M, at or above 500ft,
  turn right, direct to SNE01, turn left to SNE02, then to SNE.

Note: RWY34R: 5.0% climb gradient required up to 520ft.
       RWY34L: 5.0% climb gradient required up to 680ft.
       RWY22 : 5.0% climb gradient required up to 560ft.

Navigation Accuracy

RNAV1

Critical DME, DME Gap and Inappropriate Navaid

Critical DME	GOC (5.0nm to SNE −2.0nm to SNE
DME GAP	2.0nm to SNE02 −10.8nm to SNE
Inappropriate Navaids	SHT, YOK, HUT

Such Navaid are indicated that is determined to be inappropriate for RNAV operation as a result of flight inspection, etc.

Navigational Requirements

NOTE 1) DME/DME/IRU or GNSS required

     2) RADAR service required

Critical DME   DME GAP

5.2 RNAV 1

Example of Publication (3/5): Chart

DESIGNATION	COORDINATES
SNE 01	35 36 32.1N 139 57 36.8E
SNE 02	35 40 19.8N 139 57 51.6E
SNE	35 56 05.4N 139 58 53.2E

SNE

SNE02

SNE 01

FIX Data

Obstacle

TV antenna :350.5 m (356 degrees nm fm DER)

Crane :65.9m (346 degrees nm fm DER)

At or above 500 ft

At or above 800 ft

HM

Flare stack :79.57 m (192 degrees nm fm DER)
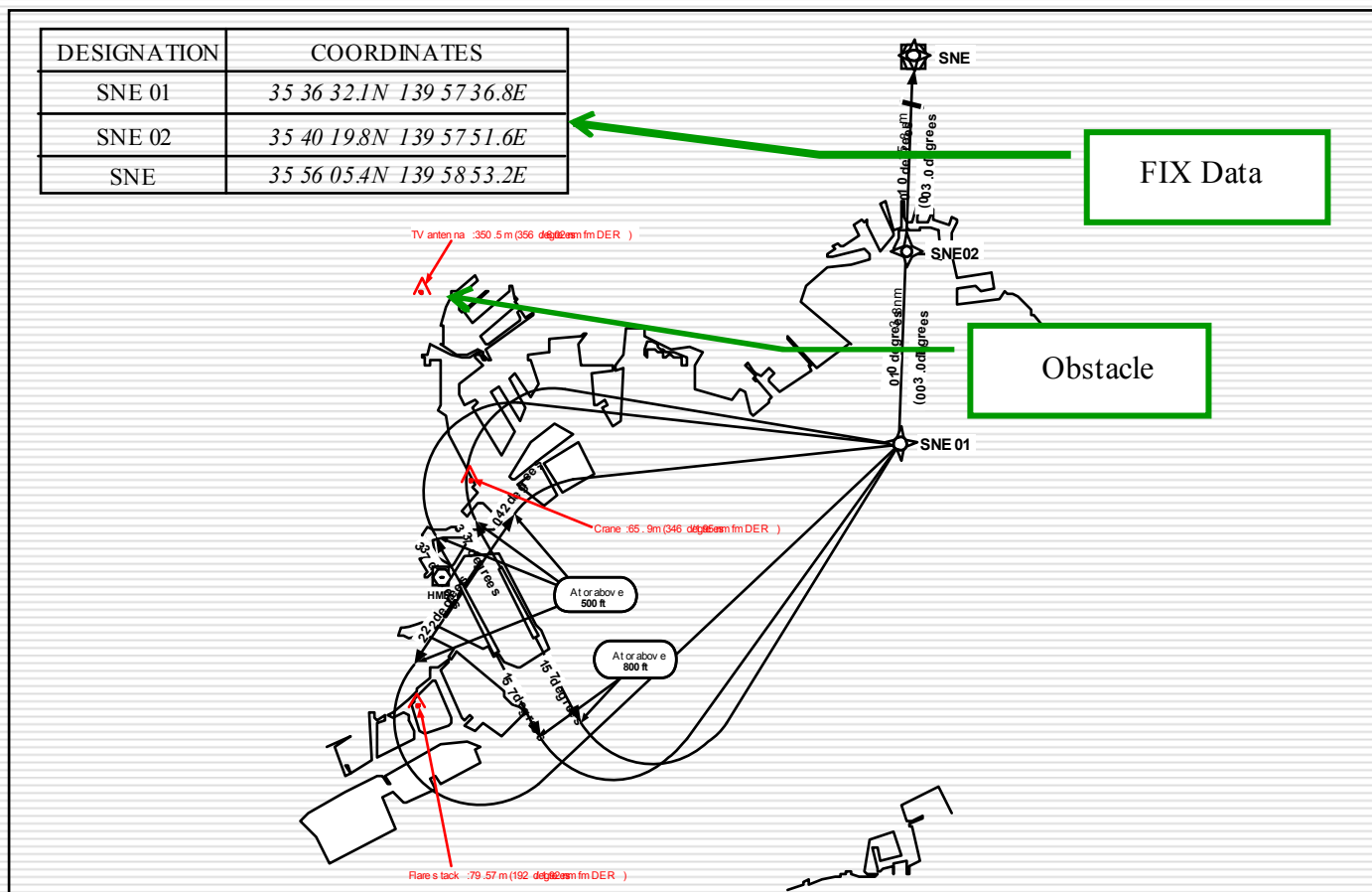
5.2 RNAV 1

Example of Publication (4/5): Textual Description

MORIYA ONE RNAV DEPARTURE

Expression corresponding to Leg Type

RWY16R/16L: Climb on heading 157degreesM, at or above 800ft,
turn left, direct to SNE01, turn left to SNE02, then to SNE.

RWY34R/34L: Climb on heading 337degreesM, at or above 500ft,
turn right, direct to SNE01, turn left to SNE02, then to SNE.

RWY04: Climb on heading 042degreesM , at or above 500ft,
turn right, direct to SNE01, turn left to SNE02, then to SNE.

RWY22: Climb on heading 222degreesM, at or above 500ft,
turn left, direct to SNE01, turn left to SNE02, then to SNE.

Note :   RWY34R: 5.0% climb gradient required up to 520ft.

RWY34L: 5.0% climb gradient required up to 680ft.

RWY22 :   5.0% climb gradient required up to 560ft.

Restrictions, etc.:
Predetermined PDG
(Procedure Design Gradient)

Path Terminator   Departure: General (PDG)

5.2 RNAV 1

Example of Publication (5/5): Tabular Form

RWY34R/34L

Rcmd. Path Terminator	Fix ID (Waypoint Name)	Fly Over	Distance (NM)	MAG Track (TRUE Track)	Turn Direction	Altitude (FT)	Speed Limit (kt)	Vertical Angle	Navigation Performance
VA	—	—	—	337deg. (329.9deg.)	—	+500	—	—	RNAV1
DF	SNE01	—	—	—	R	—	—	—	RNAV1
TF	SNE02	—	3.8	010deg. (003.0deg.)	L	—	—	—	RNAV1
TF	SNE	—	15.8	010deg. (003.0deg.)	—	—	—	—	RNAV1

Note: RWY34R: 5.0% climb gradient required up to 520ft.
RWY34L: 5.0% climb gradient required up to 680ft.

"R" for right turn and "L" for left turn

"Y" is inserted for F/O WP

Recommended leg type

⚠️ "Recommended leg type" is no more than recommendation. As actual coding may be different among aircraft types, actual flight path may slightly different among aircraft types.

5. Terminal/Enroute ATC Procedures

5.1 General

5.2 Terminal RNAV ATC Procedures (RNAV1)

5.3 Enroute RNAV ATC Procedures (RNAV5)

5.3 RNAV 5

Application of ATC Procedure

☐ ATC procedures described below are applicable to aircraft flying on the route to which RNAV5 Navigation Specifications are prescribed (RNAV5 Route).

☐ Limited to such situation where radar control service can be provided.

⚠️ RNAV5 Routes are established within radar coverage.

5.3 RNAV 5

Radar Vector

☐ Upon vectoring to RNAV5 Route, vector is to be conducted toward the route or toward a fix on the route.

☐ Instruct "Direct to a fix" upon terminating the vector.

e.g. *"Fly heading 070 for vector to BRAVO."*

"Resume own navigation direct BRAVO."

5.3 RNAV 5

Direct to a Fix

☐ "Direct to a Fix" should be instructed form the sector indicated below so far as practicable.

➤ Course change toward the next segment is not more than 45 deg.

➤ At least 6 NM (9NM for 10,000ft or above) prior to the fix.

ALPHA

BRAVO

Smooth intercept and prevention of overshoot

45 deg or less

DIRECT BRAVO

CHRLY

6NM or more
(9NM or more for ALT10,000FT or above)

⚠ It is to be noted that actual flight track depends on the type of fix (F/B or F/O), leg type of the next segment, wind effect, speed, altitude, rate of turn, etc.

Estimation of Track
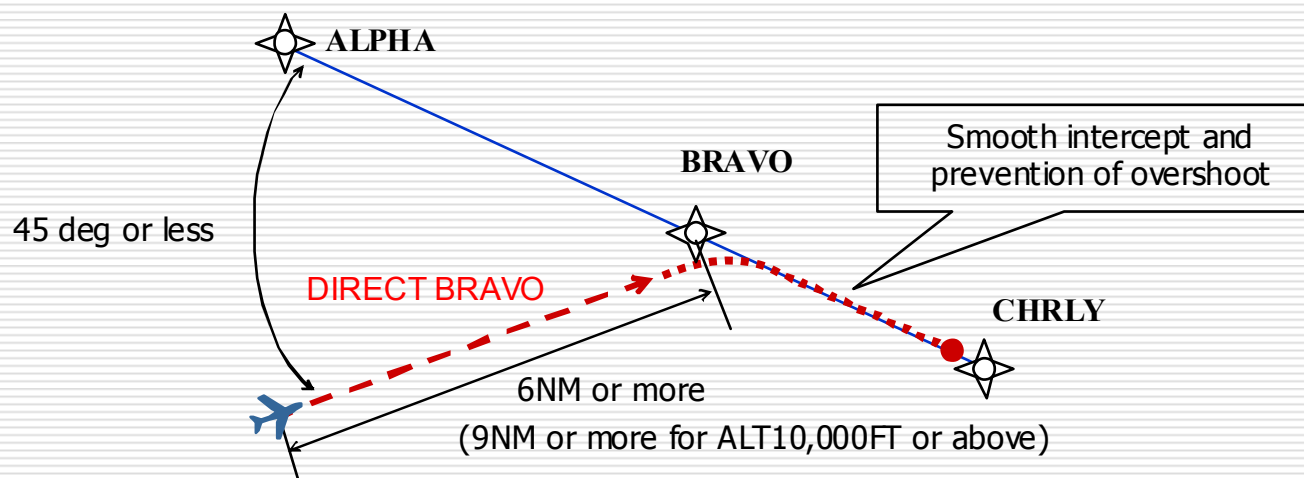
5.3 RNAV 5

Contingency Procedures

☐ When radar control service cannot be provided due to Outage of Radar,etc, or when it is advised by pilot that he/she cannot continue flying on RNAV5 route due to any discrepancy in RNAV equipment, outage of Critical DME, ATC shall make coordination with related ATC organization, and take the following action:

➢ **To aircraft in pre-flight phase,** inform that flying on RNAV5 route cannot be cleared, and issue clearance for an alternate route determined as a result of coordination with other ATC organizations concerned.

       UNABLE TO ISSUE *(RNAV route designator), (reason).*

➢ **To aircraft in flight,** issue clearance for flying on an alternate route using adjacent NAVAID.

    〔e.g.〕 PILOT: *UAL001, unable Y10 due to failure of RNAV receiver. Request amended clearance.*

    ATC: *UAL001, roger, recleared direct TLE VOR, hold north, maintain 9,000ft.*

⚠ It is to be informed by a pilot as such in case he/she cannot fly RNAV5 route for any reason.

ATC Procedures   Critical DME

6. RNAV Approach ATC Procedures

- Application of ATC Procedure
- Radar Vector
- Direct to a Fix
- Approach Clearance / Speed Control

6. RNAV Approach

Application of ATC Procedure

☐   RNAV(GNSS)Approach Procedures* are established

* Meet Navigation Specification for "RNP APCH", however, published as "RNAV (GNSS) RWY XX APCH" considering the current situation that such procedures has already been published.

☐   For RNAV(GNSS)Approach, Initial approaches which have T/Y Bar arrangement are established as well as STAR.

⚠ Missed Approach Procedures are designed based on conventional navigation in case that approach cannot be continued due to discrepancy of GNSS, etc.

T/Y Bar   Publication – Contingency Procedure

6. RNAV Approach

Radar Vector

☐ Upon vectoring to RNAV Approach Procedure, vector is to be conducted toward Initial Approach Fix (IAF) or Intermediate Approach Fix (IF).

☐ Instruct "Direct to a fix" upon terminating the vector.

e.g. *"Fly heading 070 for vector to PUNCH."*

"Resume own navigation direct ROCCA."

6. RNAV Approach

Direct to a Fix

☐   "Direct to a Fix" should be instructed form the sector indicated below so far as practicable.

➢   Within 90 deg from
   the Initial Approach Segment or
   the Intermediate Approach Segment
   to be intercepted.

➢   Maintain the altitude at or above
   Minimum Vectoring Altitude
   (MVA)

90°
IAF

90°   Initial Approach Segment
IF   IAF
90°

Intermediate Approach Segment

FAF

Final Approach Segment

MAPt

(2)－1
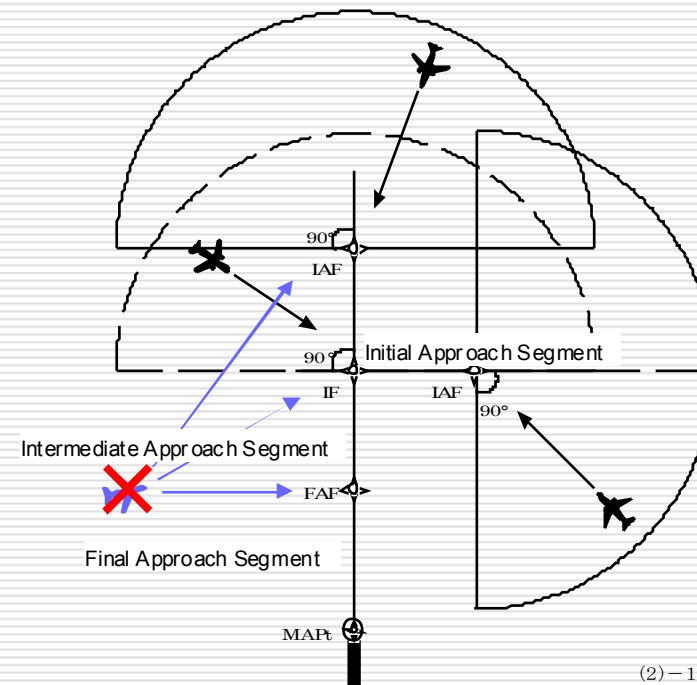
6. RNAV Approach

Approach Clearance/Speed Control

☐ Approach clearance is to be issued before the aircraft reaches IAF/IF.

☐ Approach clearance is to be issued with the distance from the fix.

e.g. *"10NM south of EMINA. Cleared for RNAV RWY30 approach."*

Approach procedure Title : RNAV (GNSS) RWY30

⚠ (Sensor Type) indicated in the bracket in the procedure title
is not included in the clearance.

☐ IAS over 210kt shall not be instructed upon crossing IAF.

Summary of RNAV ATC Procedures

Summary of RNAV1/5 ATC Procedures

DIRECT TO

DIRECT TO

DIRECT TO

IAF IAF

IF

IAF

Flight Plan

500FT
LNAV Engage

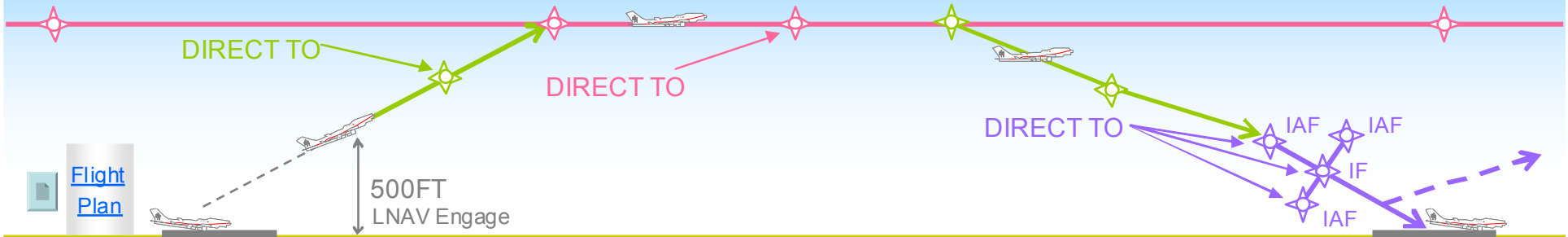| Operation	UP DATE	RNAV1	RNAV5	RNAV1	RNP APCH
ATC Procedure	▶ SID		▶ ENROUTE AIRWAY	▶ STAR	▶ RNAV(GNSS)
Sensor	DME/DME/IRU GNSS		VOR/DME, DME/DME INS, IRS, GNSS	DME/DME/IRU GNSS	GNSS
Applicable Airspace	Within Radar Coverage * RWY POSITION UP DATE (IRU) * LNAV Engage before reaching 500ft		Within Radar Coverage	Within Radar Coverage	Within / Out of Radar Coverage
DME GAP	Update by published sensor type		Update by published sensor type DR (not allowed at moment)	Update by published sensor type	—
	Determination of flight is pilot discretion.				
Critical DME	Affected area is published. / Notification to Unplanned Outage Determination of flight is pilot discretion.				—
Direct to a FIX	Within 45 deg At least 6 NM (9NM for 10,000ft or above) prior to the fix				Within 90 deg Direct to IAF or IF IAS 210kt or less
Contingency	Issue clearance for flying on an alternate route using adjacent NAVAID.				Missed Approach
Track	It is to be noted that actual flight track depends on navigation performance, speed, wind effect, rate of turn etc. during turn.				—

Direct to a Fix (RNAV1 / 5)

"Direct to a Fix" should be instructed form the sector indicated below so far as practicable.

➢ Course change toward the next segment is not more than 45 deg.
➢ At least 6 NM (9NM for 10,000ft or above) prior to the fix.

ALPHA   BRAVO

Smooth intercept and prevention of overshoot

45 deg or less

CHRLY

6NM or more

(9NM or more for ALT10,000FT or above)
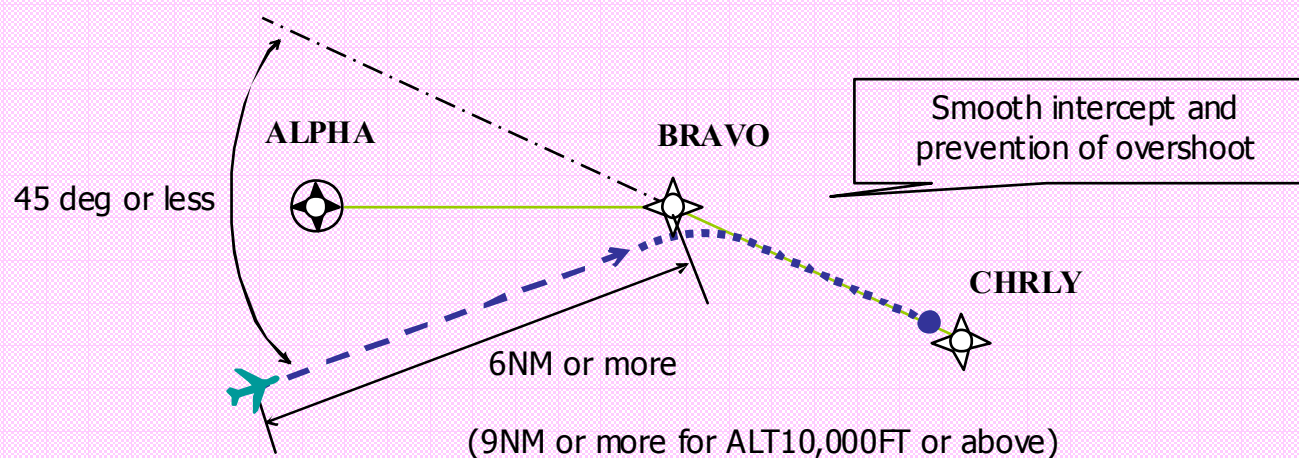
⚠ It is to be noted that actual flight track depends on the type of fix (F/B or F/O), leg Type of the next segment, wind effect, speed, altitude, rate of turn, etc.
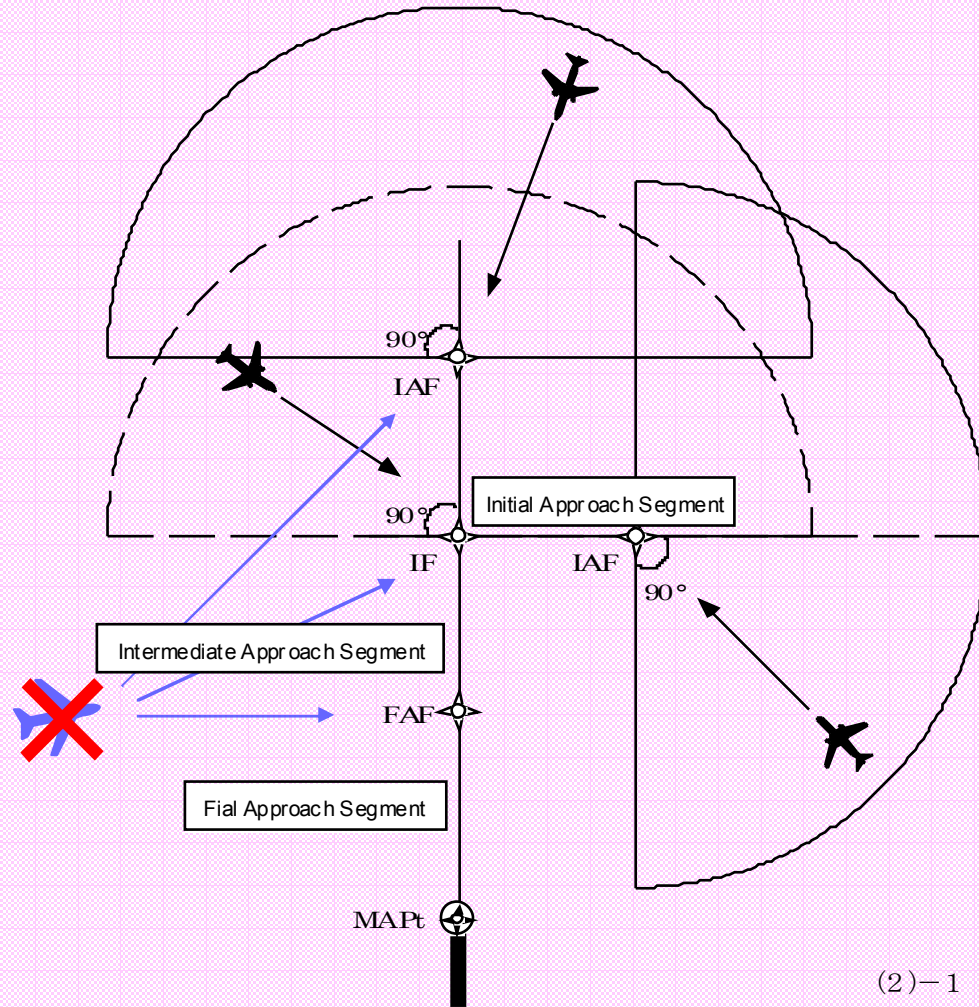
Estimation of Track   Path Terminator

◀ Back   Next ▶

ATC Procedure (TAA)

90°

IAF

Initial Approach Segment

90°

IF

IAF

90°

Intermediate Approach Segment

FAF

Fial Approach Segment

MAPt

(2)-1

Estimation of Track

Actual flight track by aircraft to intercept next leg depends on various elements such as navigation performance, distance to waypoint, wind condition, speed, rate of turn and altitude. ATC must take account of the fact that aircraft may overshoot the predetermined path when, for example, large amount of course change is required near a fly-by waypoint during radar vector to the waypoint.

Figure 1 below shows that aircraft may overshoot to infringe "AREA 1" upon being instructed "direct to BRAVO (Fly-by waypoint)" since distance to BRAVO is not enough and since the turn angle to the next leg is large.

Figure 2 indicates such case that the aircraft is instructed to "direct to BRAVO" with an angle less than 45 deg and with distance longer than 6NM (9NM for an altitude at or above 10,000ft) for smooth turn. Therefore, upon vectoring aircraft on RNAV routes/procedures, ATC must estimate the aircraft track and issue such an appropriate instruction to the pilot that aircraft should not make such overshoot.

ALPHA   BRAVO   AREA1

TF Leg

CHRLY

Figure 1

ALPHA   BRAVO   AREA1

TF Leg

CHRLY
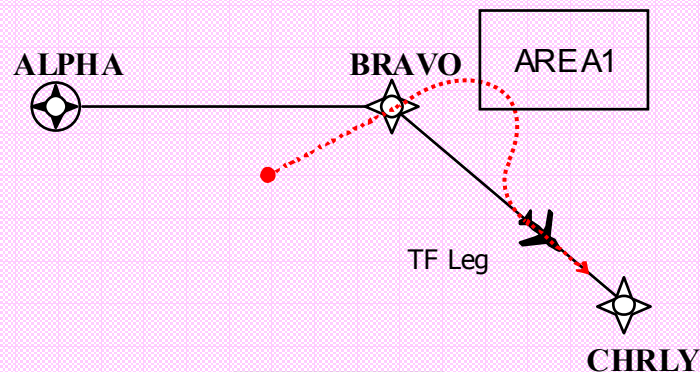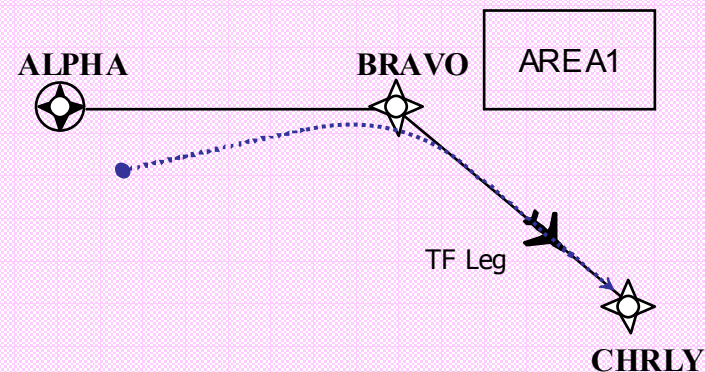
Figure 2

Overview of DME/DME RNAV

Position update by DME

Shorter flight distance

RANGE

RANGE

RANGE

RANGE

RANGE

RANGE

RANGE

RANGE

RANGE

Conventional (Radio Navigation) Route

DME pair within 30-150 DEG
is automatically selected

Back

DME GAP

DME Coverage

DME Coverage

Area where position update by 2 or more DME is achievable.

Position update by DME pair of 30 – 150 deg
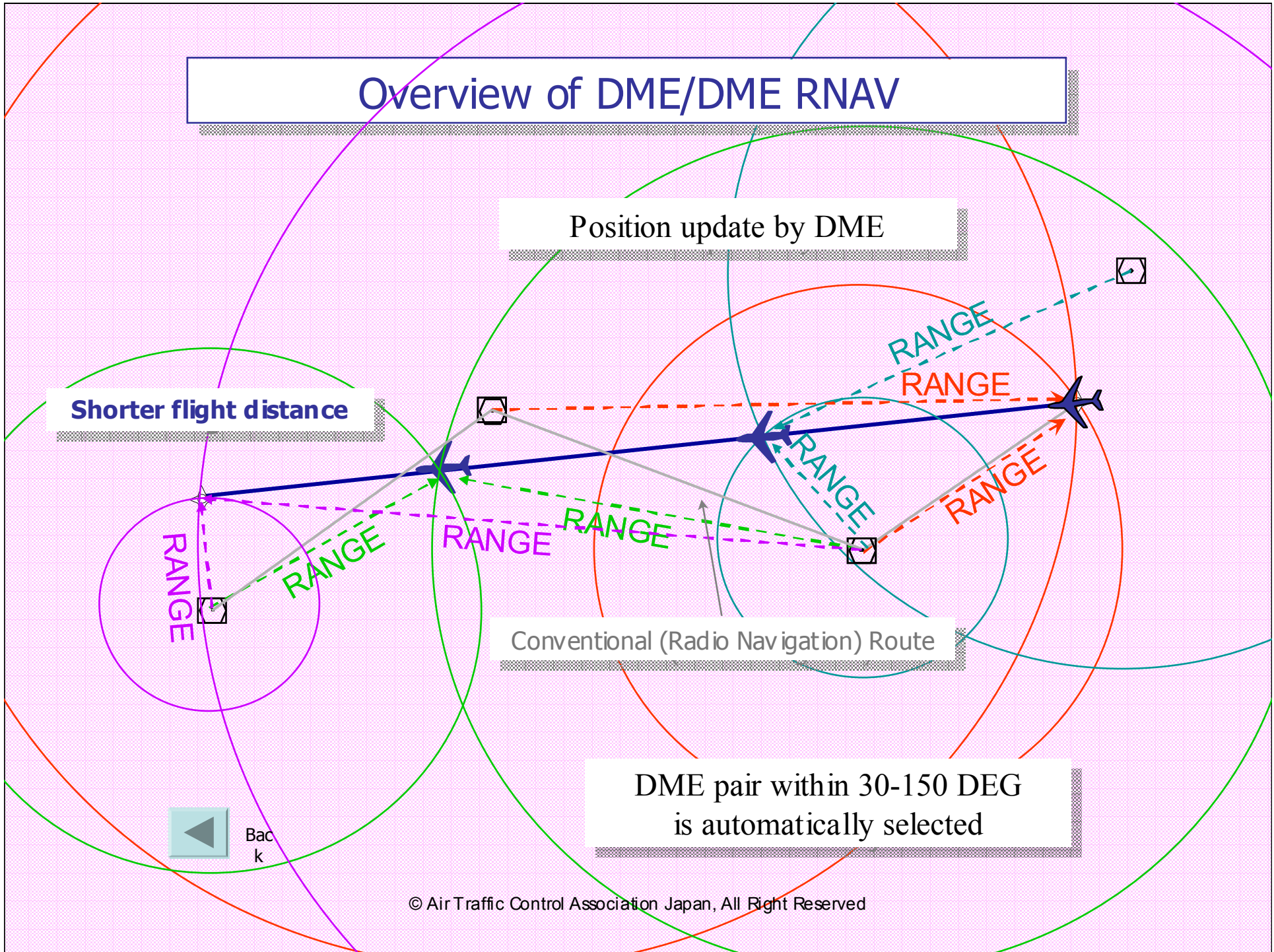
Position update by DME pair of 30 – 150 deg

Area where position update by 2 or more DME is achievable.

DME Gap

DME Coverage

DME Coverage

Coverage of DME less than two;

Does not meet the requirement for DME position upd1ate (30 – 150 deg)

It is not allowed for aircraft which meet RNAV navigation requirements only with DME/DME to fly on DME Gap.
(Navigation by IRS, GNSS, etc. is permitted so far as meeting other requirements)

Pilot will inform ATC, if unable to fly RNAV, as such.
(Determination of flight is pilot discretion!)

Back

Requirement for flying over DME GAP (1/2)

✈ **Aircraft equipped with <u>INS, IRS, GNSS or VOR/DME</u> RNAV can fly over DME GAP if any VOR/DME exists within 75NM from the DME GAP that can be used for position update.**

⚠️ It is assumed that RNAV using V/D within 75NM can satisfy navigation accuracy for RNAV5.

⚠️ Even for DME GAP, the same area is constructed as for the segment without DME GAP.

⚠️ Noted as "INS, IRS, GNSS or VOR/DME required" in AIP.

✈ **Aircraft equipped with <u>INS, IRS or GNSS</u> can fly over DME GAP even if no VOR/DME exists within 75NM from the DME GAP that can be used for position update.**

⚠️ The DME GAP must be within the coverage of some other Navaid so that navigation can be achieved by the Navaid in case of contingency when using GNSS.

⚠️ Even for DME GAP, the same area is constructed as for the segment without DME GAP.

⚠️ Noted as "INS, IRS or GNSS required" in AIP.

✈ When none of the above is the case, Dead Reckoning is permitted without obliging any requirement for sensors.

⚠️ Area is expanded for the DME GAP.

⚠️ No requirement for sensor onboard is provided in AIP.

Despite of above, Dead Reckoning is not permitted for a while.

•For a while, it is not allowed for aircraft which meet RNAV navigation requirements only with DME/DME (without INS, IRS or GNSS) to fly on DME Gap, although technically possible.

Requirement for flying over DME GAP (1/2)

DME GAP

Within 75NM (V/D RNAV-equipped aircraft is permitted for the GAP)
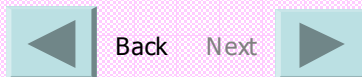
Flying over GAP
INS, IRS, GNSS
or (VOR/DME)
required

Secondary Area — Secondary Area

Primary Area

Secondary Area — Secondary Area

10nm

Area is not expanded assuming navigation accuracy is satisfied.

Area Semi-width for RNAV5 Route =10nm

Flying over GAP
No requirement for Sensor is published

Secondary Area — Secondary Area

15degrees   15degrees

Primary Area

Primary Area

Secondary Area — Secondary Area

10nm

Area is expanded assuming dead reckoning

DME GAP

For a while, Dead reckoning is not permitted.
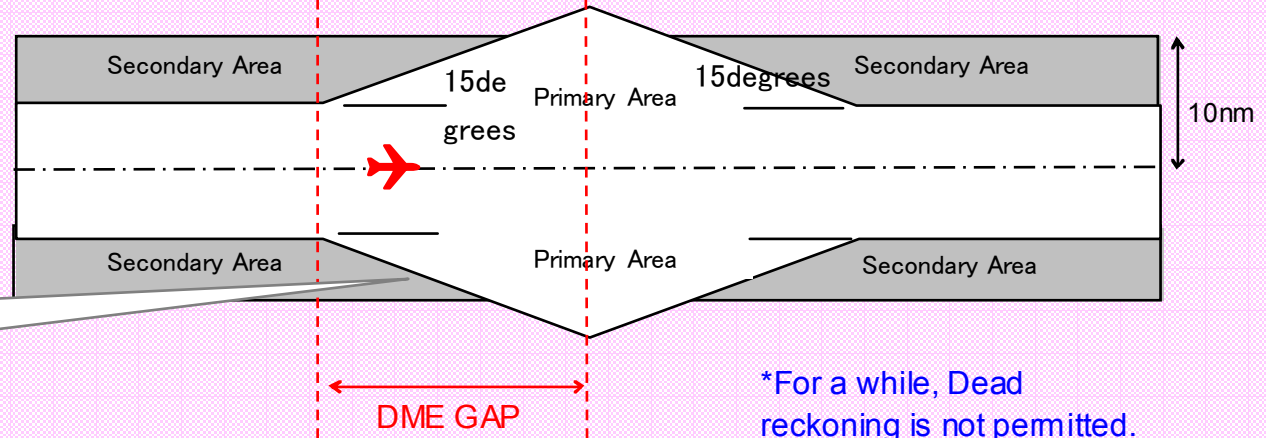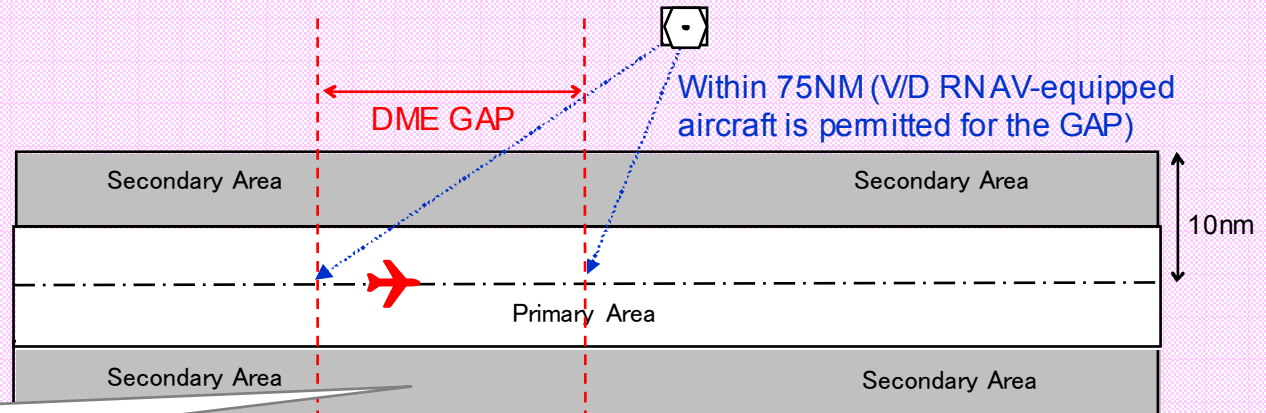
⚠ Determination of flight over DME GAP is pilot discretion!

◀ Back

Critical DME

DME Coverage

DME Coverage

DME Coverage

DME Coverage

DME Coverage
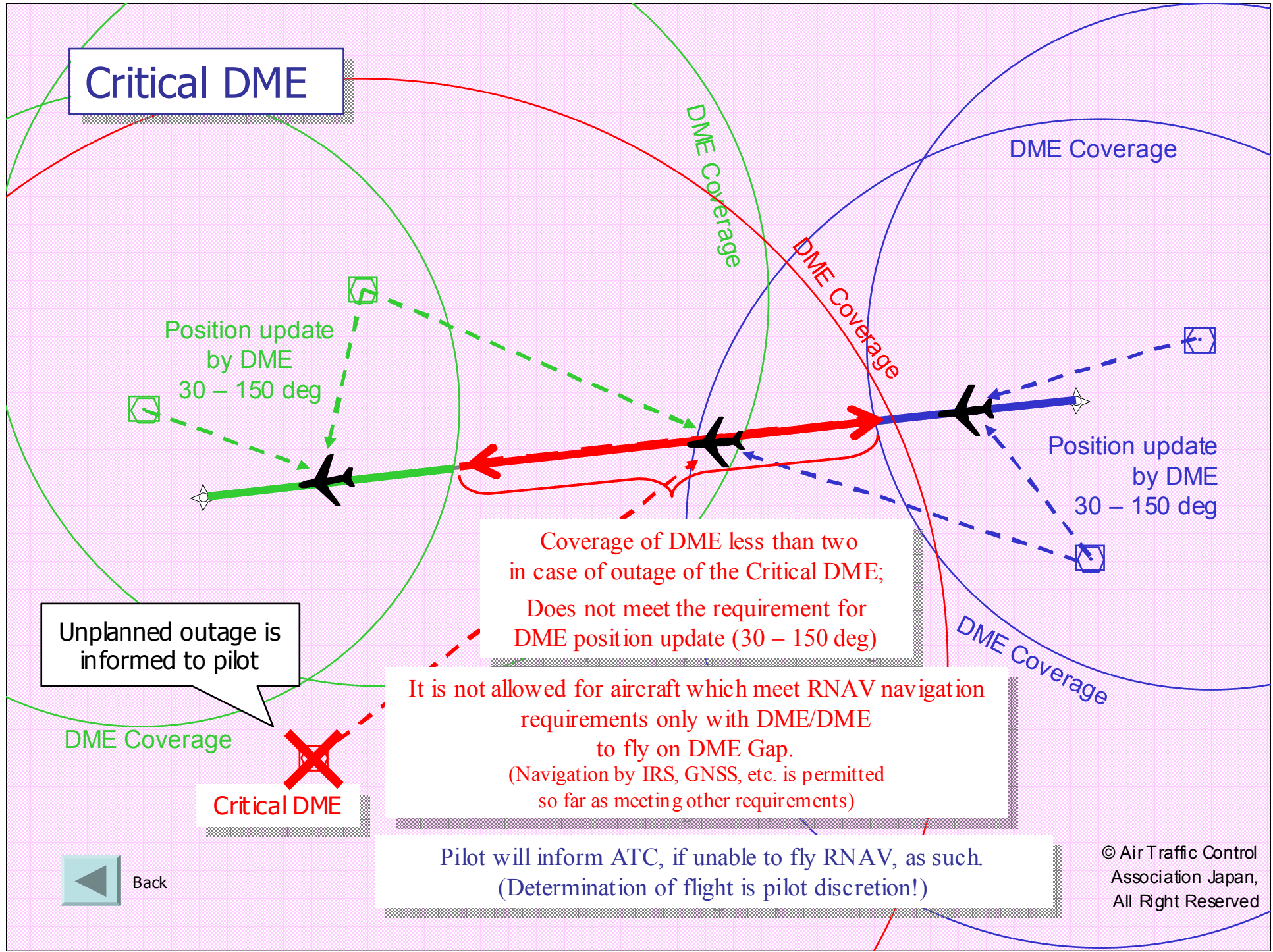
DME Coverage

Position update
by DME
30 – 150 deg

Position update
by DME
30 – 150 deg

Unplanned outage is
informed to pilot

Critical DME

Coverage of DME less than two
in case of outage of the Critical DME;

Does not meet the requirement for
DME position update (30 – 150 deg)

It is not allowed for aircraft which meet RNAV navigation
requirements only with DME/DME
to fly on DME Gap.
(Navigation by IRS, GNSS, etc. is permitted
so far as meeting other requirements)

Pilot will inform ATC, if unable to fly RNAV, as such.
(Determination of flight is pilot discretion!)

Back

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Association Japan,
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DIRECT TO WAYPOINT

ATC *"Cleared to ALPHA via ALPHA ARRIVAL."*

"Recleared DIRECT ALPHA via YANKY.

Cleared for RNAV RWY27 APPROACH"

⚠️ Instruction for altitude is required as ever.

PILOT ACTION

Next Page ▶
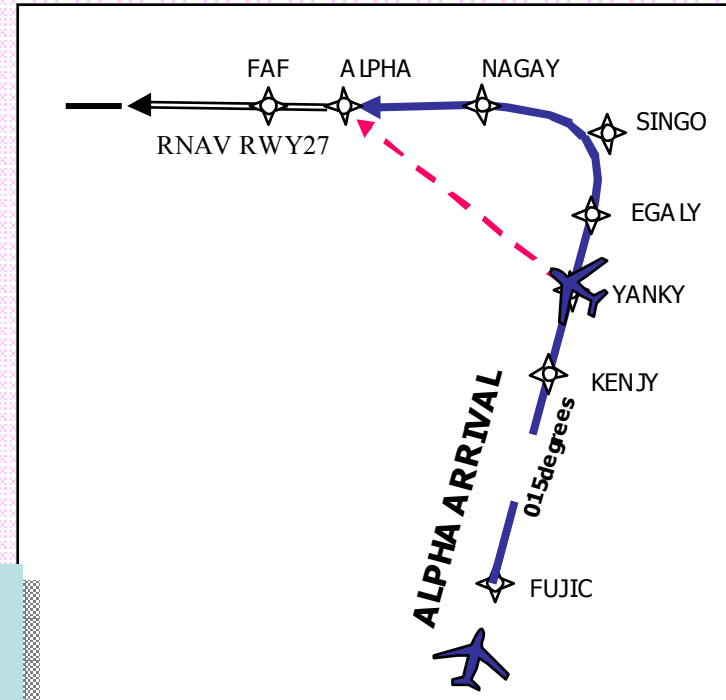
1/2		
270° ALPHA	4NM	170/3000A
270° FAF	4NM	170/3000A
270° RNAV 27	10NM	150/1000A
270° RWY27		
	RTE COPY>	
	INTC CRS	
< ERASE ALPHA		

PUSH!
PUSH!
PUSH!

INIT REF | RTE | DEP APR | ATC | VNAV
FIX | LEGS | HOLD | FMC COMM | PROG | EXEC

DIRECT TO WAYPOINT

⚠️ Waypoint to "DIRECT TO" must be on the cleared route except for RNAV approach with T/Y bar arrangement.

⚠️ ATC must take account of the fact that "DIRECT TO" actual track might be affected by aircraft performance such as turn radius, descent profile, speed limitation, etc.

⚠️
• FIX to be by-passed as a result of "DIRECT TO" or FIX already passed is DROPPED from FMS LIST(Active waypoint list).

⚠️
• It is to be noted that "DIRECT TO" the DROPPED FIX.

— FMS as well as Navigation Display (ND) maintain the route information after the FIX to "Direct to", and update the planned route.

— Then, aircraft can resume own-navigation on the planned route after the FIX.

"ALPHA" will automatically becomes "Active waypoint.
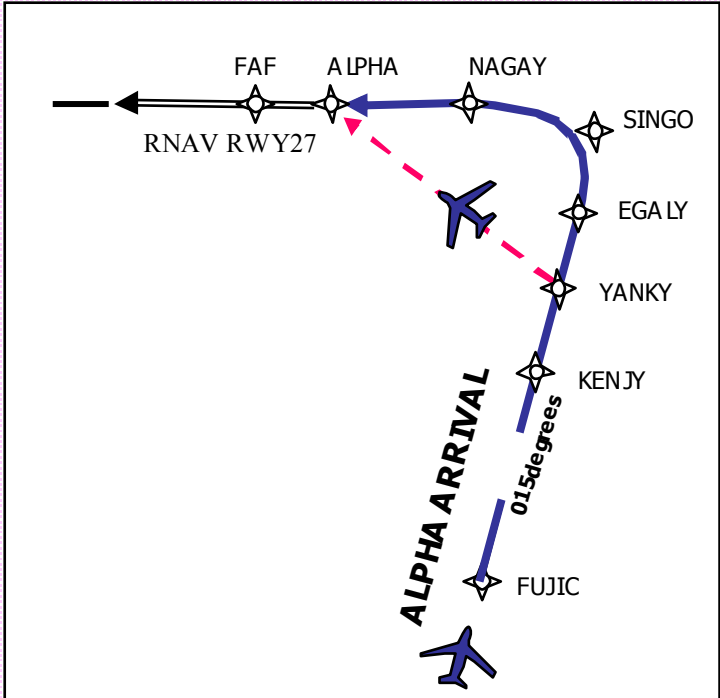
Back

NAVIGATION DATA BASE and FMS

FMS: Flight Management System

➢ System that automatically conduct the management of flight (navigation, control, trust, etc.) during all phase of flight from takeoff to landing.

➢ Navigation Data Base that includes wide range of navigation data (runway, airway, Navaid, terminal procedures, etc.) is stored.

➢ Pilot can retrieve the data through CDU (Control Display Unit).

➢ Provides information on Lateral navigation (L-NAV) and Vertical navigation (VNAV).

➢ Navaid used for update (such as VOR, DME) are automatically selected, without manual intervention by a pilot, from the onboard data base, and tuned in accordance with the flight path.

➢ Navigation information is indicated on EFIS (Electric Flight Instrument System) as well as CDU, which provides pilot with easy acknowledgement of situational awareness.

➢ Aircraft of the generation of B767 and A310 or later are equipped with FMS as standard system

Navigation Data

Navigation Data Base

NAVIGATION DISPLAY (ND)

CDU

Back
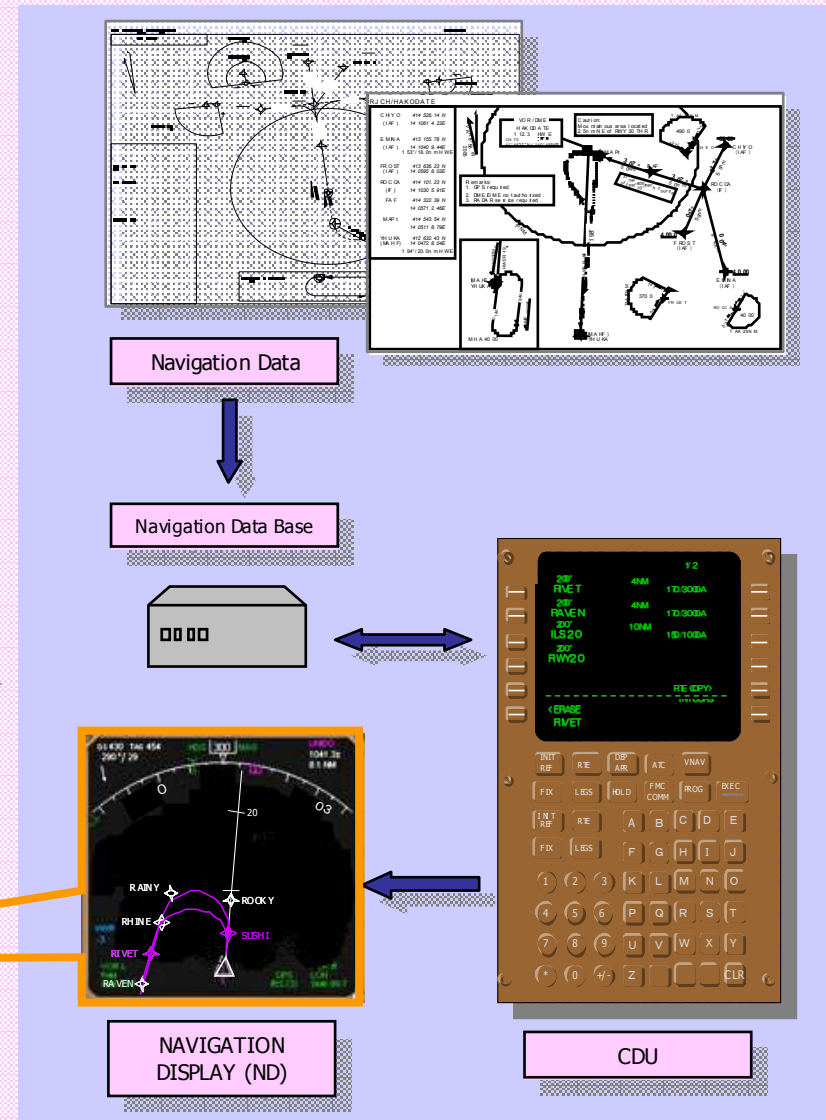
RNAV System (Overview)

a) RNAV MAP

Flight Display

GNSS NAV UNIT

b) Multi-Sensor

Integrated Flight Display

IRS

VOR

DME

GNSS NAV Management Unit

c) Dual Multi-Sensor

Monitoring /Alert system

GNSS NAV Management Unit

VOR

DME

IRS

VOR

DME

Back
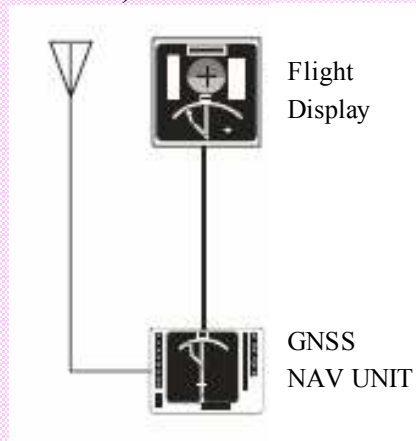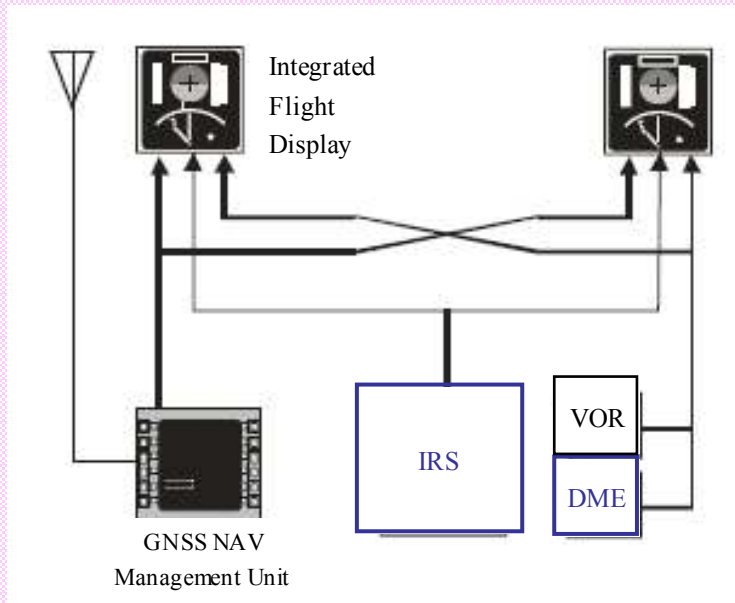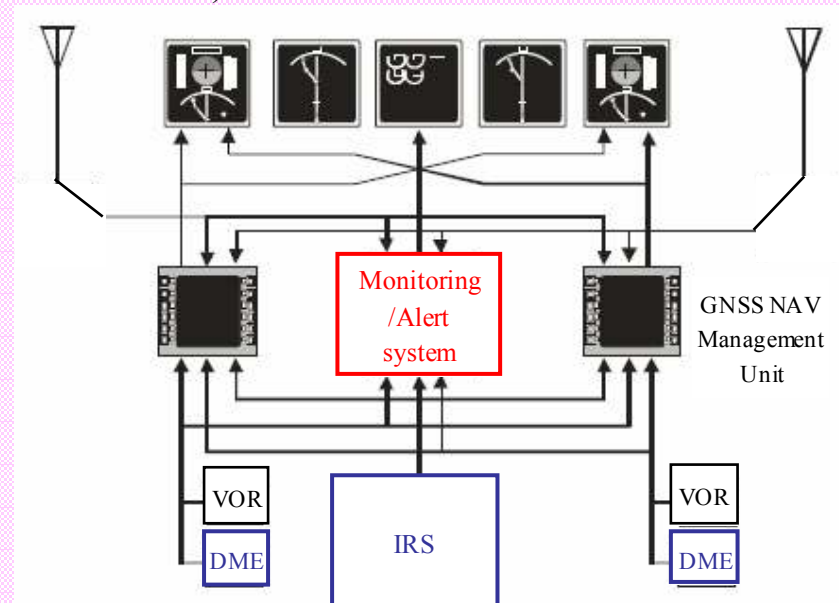
Positioning by GPS

GPS satellites are orbiting at an altitude of approximately 20,200 kilometers, and there are 30 actively broadcasting satellites in the GPS constellation. .

By determining the position of, and distance to, at least three satellites, the receiver can compute its position. Receivers typically do not have perfectly accurate clocks and therefore track one or more additional satellites to correct the receiver's clock error.

If signal from 5 satellites are received, it is possible to monitor if there is some error in the signal from satellites to determine if the user could use GPS or not.(RAIM Function)

If signal from 6 or more satellites are received, it is possible to determine which satellite affects the accuracy the worst, and to make positioning, with integrity, using the rest of the receivable satellite by eliminating it.(FDE Function)

From Website of Geographical
Survey Institute, Japan

* Accuracy of GPS

GPS has accuracy of 6m lateral and 8m vertical (95%), while it is affected by Ionospheric effect, Satellite clock error, ephemeris error, etc.

Back

Positioning by GPS - MSAS

- MSAS is a system that augmentation GPS positioning through the use of additional satellite-broadcast messages. The system is commonly composed of multiple ground stations, located at accurately-surveyed points. Information messages are created and sent to one or more satellites for broadcast to the end users.

- With MSAS, accuracy, integrity, availability etc. or GPS positioning are drastically improved.

Conventional Route

DIST

VOR

RAD/DIST

VOR/DME

RAD/DIST

VOR/DME

Routes are dependent on location of Nav aid

RNAV Route

GPS

Positioning Signal

MTSAT

Augmentation Signal

Monitor

Augmentation Signal

Enable Shorter flight distance & straight-in approach

Master Station

GMS (Ground Monitor Station)
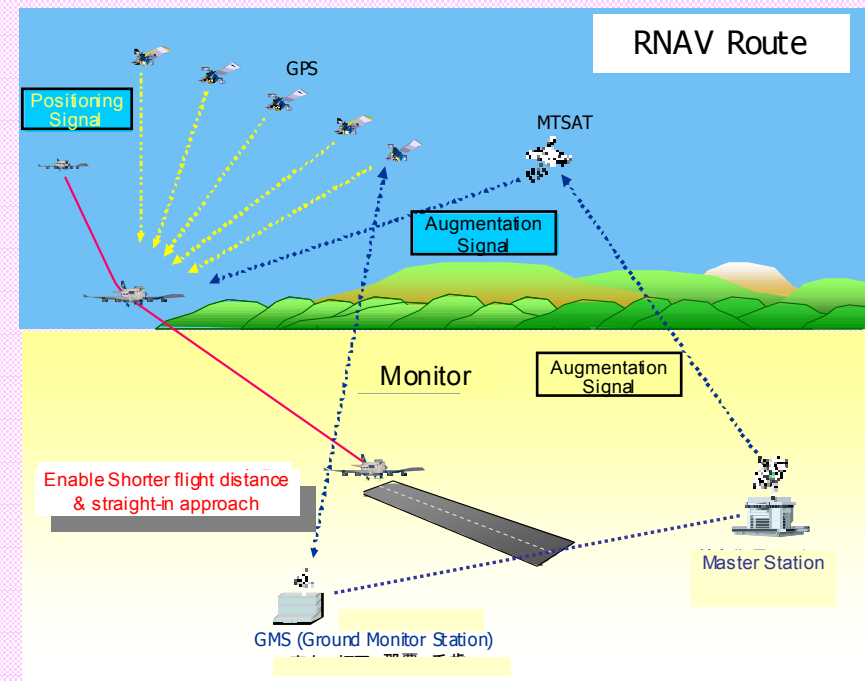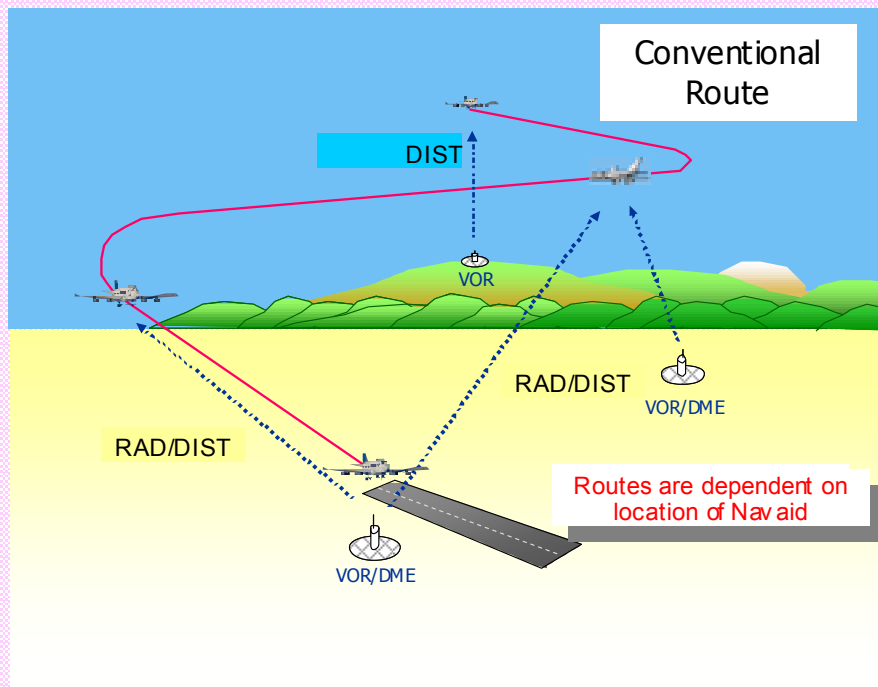
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RAIM Prediction Service

1. Service Provider

Air Traffic Management Center (ATMC), JCAB

ATMC

GPS NOT available
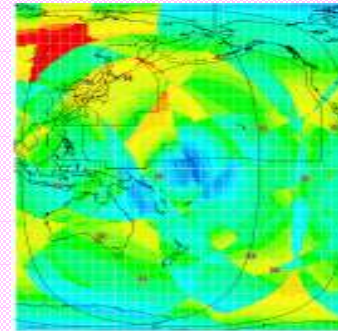
2. Method

1) By MSAS monitoring system

2) Using GPS signal on its orbit

3) Predict the availability of GPS positioning at aerodrome where flight procedures using GPS are established up to 48 hours (RAIM Prediction).

3. Provision of Information

RAIM information is provided as NOTAM at aerodrome.

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RAIM Alert Limit(Integrity Monitor Alert Limit - IMAL)

It is essential to monitor the reliability of positioning onboard while positioning accuracy is affected by such elements as ionospheric effect, satellite clock error, ephemeris error.

⇒ Calculate navigation performance with Confidence Level (99.99999%)

⇒ Compare with predetermined alert limit and issue alert if the performance exceeds the limit.

SBAS

GPS GPS GPS

GPS

Constellation and No. of receivable GPS satellite

Ionospheric effect

RAIM Alert Limit

Actual Path

Error   Error

Desired Path

Confidence Level   Confidence Level

Available   NOT Available (alert issued)
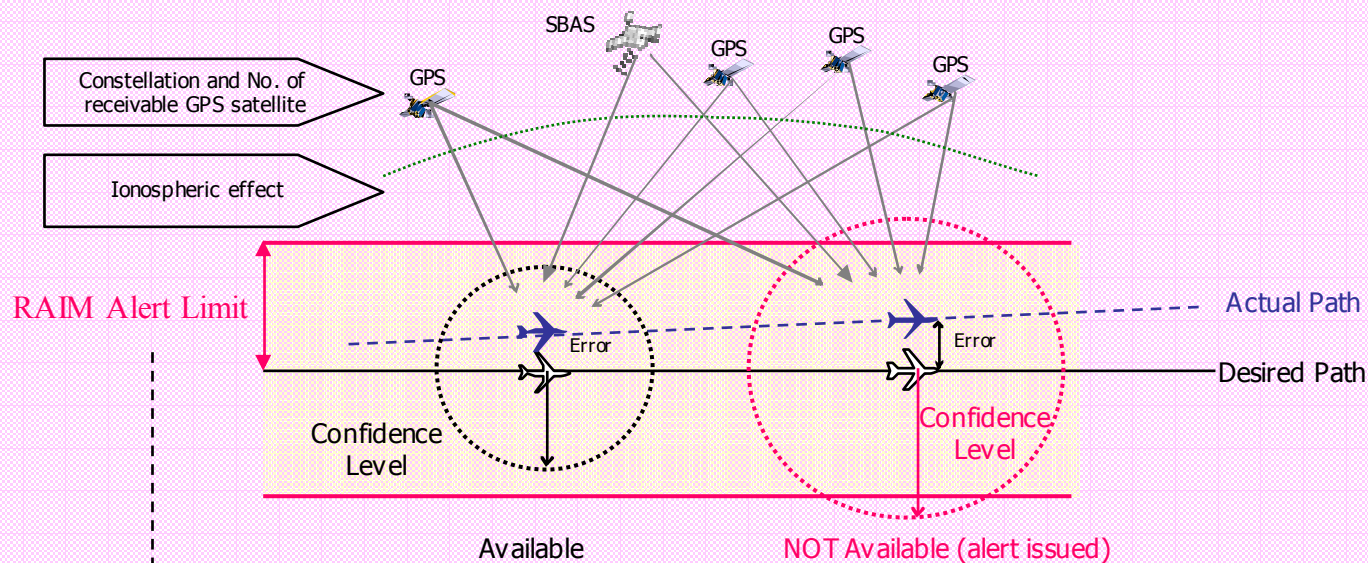
Receiver Mode	RAIM Alert Limit (IMAL)	CDI Sensitivity
Enroute	2.0NM	5.0NM
Terminal	1.0NM	1.0NM
Approach	0.3NM	0.3NM

Back

Bank Angle (for determining MSD)

Phase	Bank Angle
Arrival	25 deg
Approach	25 deg
Missed Approach	15 deg
Departure	15 deg
Enroute	15 deg

GNSS Area (Reference)

	IAF/ MAHF (1) (km/NM)	IAF/ MAHF (2) (km/NM)	Fix in initial segment (km/NM)	IF (km/NM)	FAF (km/NM)	MAPt (km/NM)	Fix in missed approach segment or departure procedure (km/NM) (2)	Fix in missed approach segment or departure procedure (km/NM) (1)
Navigation system accuracy (3)	0.23/0.12	0.23/0.12	0.23/0.12	0.23/0.12	0.23/0.12	0.23/0.12	0.23/0.12	0.23/0.12
Integrity monitor alarm limit (3)	3.70/2.00	1.85/1.00	1.85/1.00	1.85/1.00	0.56/0.30	0.56/0.30	1.85/1.00	3.70/2.00
Time to alarm	30 sec	10 sec	10 sec	10 sec	10 sec	10 sec	10 sec	30 sec
FTT	3.70/2.00	0.93/0.50	0.93/0.50	0.93/0.50	0.56/0.30	0.37/0.20	0.85/0.50	3.70/2.00
ATT	3.70/2.00	1.85/1.00	1.85/1.00	1.85/1.00	0.56/0.30	0.56/0.30	1.85/1.00	3.70/2.00
XTT	7.41/4.00	2.78/1.50	2.78/1.50	2.78/1.50	1.11/0.60	0.93/0.50	2.78/1.50	7.41/4.00
Area semi-width (4)	14.82/8.00	5.56/3.00	5.56/3.00	5.56/3.00	2.22/1.20	1.85/1.00 (5)	5.56/3.00	14.82/8.00

(1)   Outside 30NM from ARP

(2)   Within 30NM from ARP

From PANS-OPS Vol. II, Table III-1-2-2

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RNAV (GNSS) Approach Segment

MOC

Primary Area

Secondary Area

Semi-area width

30NM fm ARP

Initial Approach

30deg

Initial Approach

8.0nm

Intermediate Approach

Secondary Area

Missed Approach

Final Approach

15deg

1.0nm

1.2nm

3.0nm

Primary Area

1.0nm

1.2nm

3.0nm

Primary Area

FAF

IF

IAF

15deg

MAPt

Secondary Area

8.0nm

Approach Mode

Terminal Mode

Enroute Mode

2NM from FAF
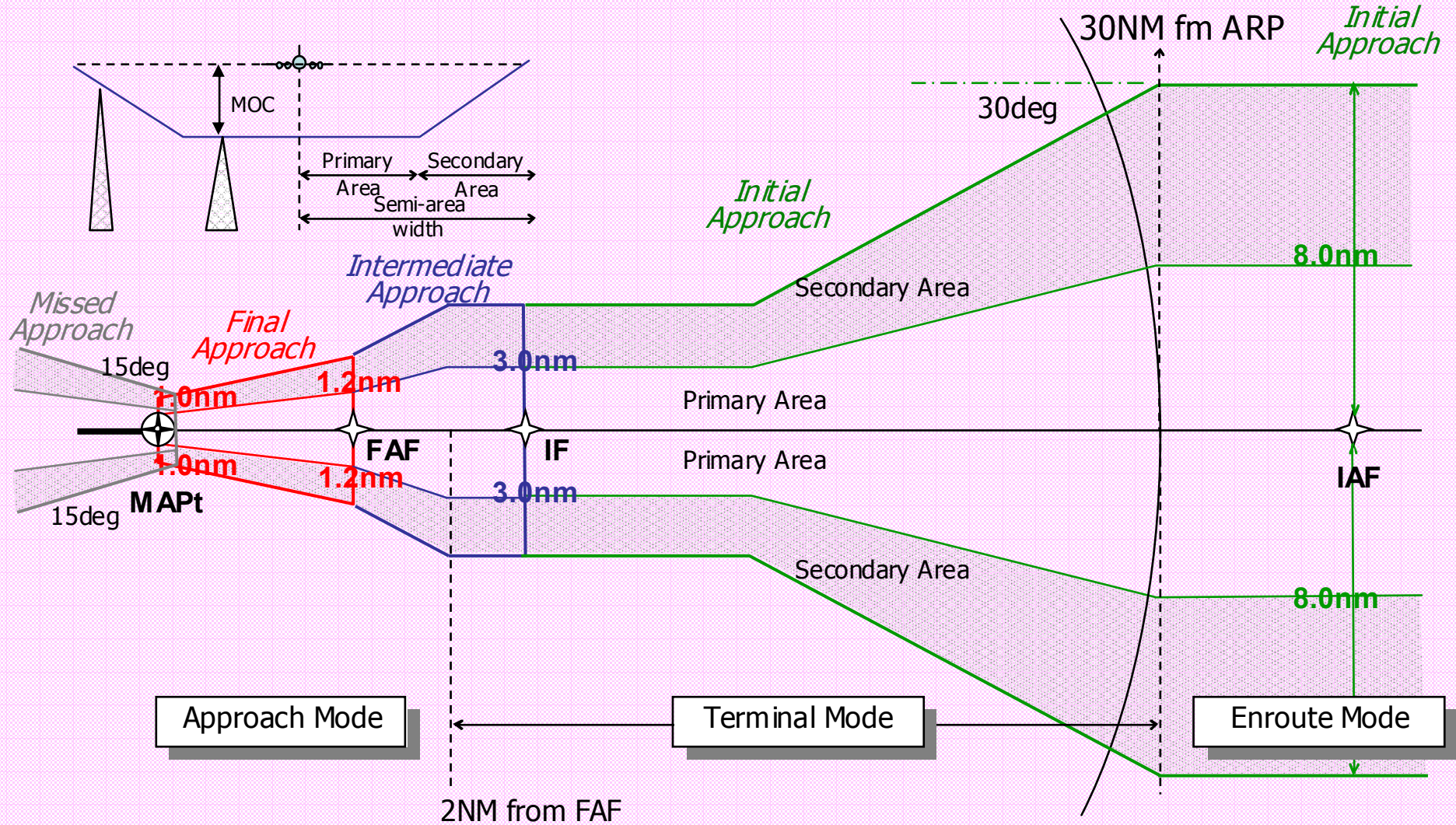
Back

Avoidance of Obstacle by Specifying PDG
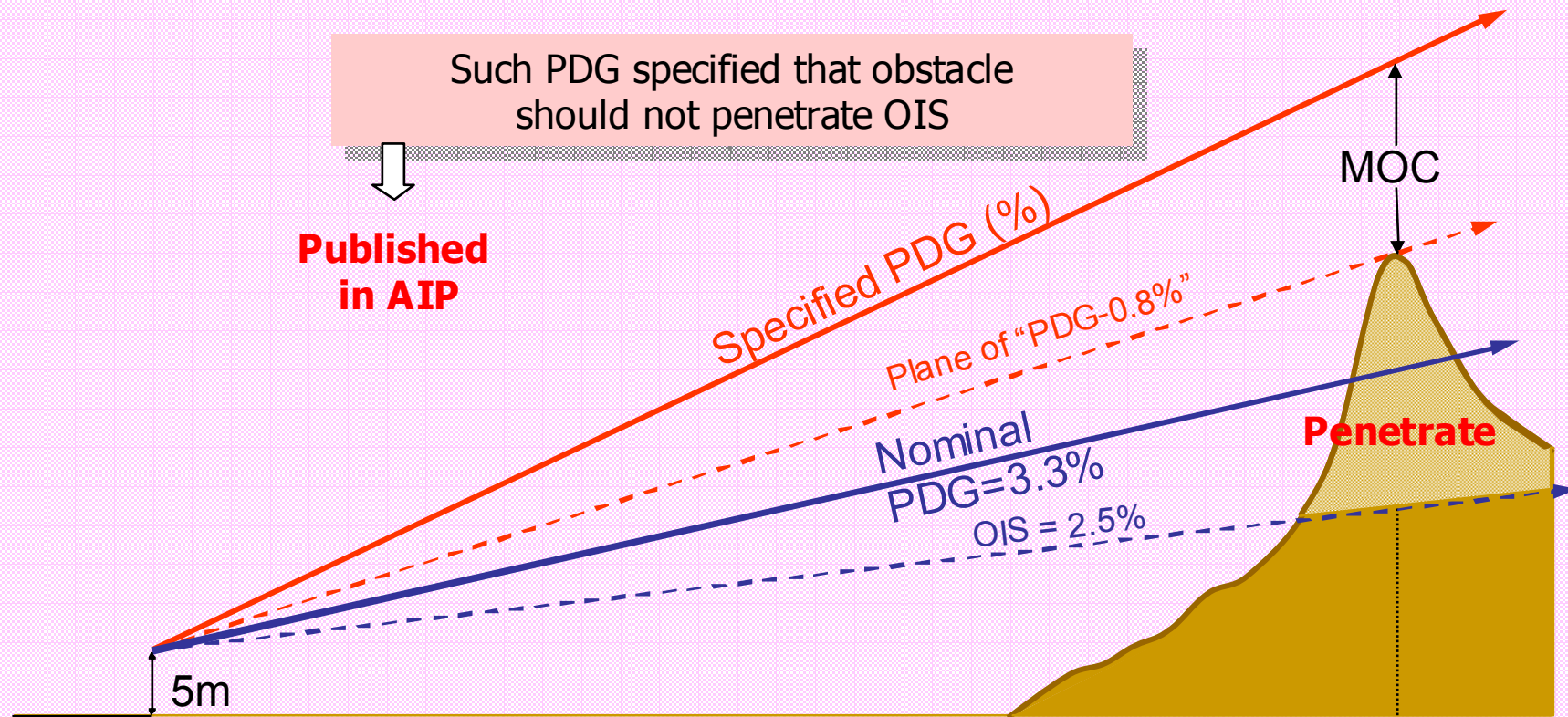
Such PDG specified that obstacle should not penetrate OIS

Published in AIP

Specified PDG (%)

Plane of "PDG-0.8%"

Nominal
PDG=3.3%

OIS = 2.5%

MOC

Penetrate

5m

Obstacle is assessed against Obstacle Identification Surface (OIS) of which gradient is 2.5%.

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Avoidance of Obstacle by Turn (1/5)

Turn Area
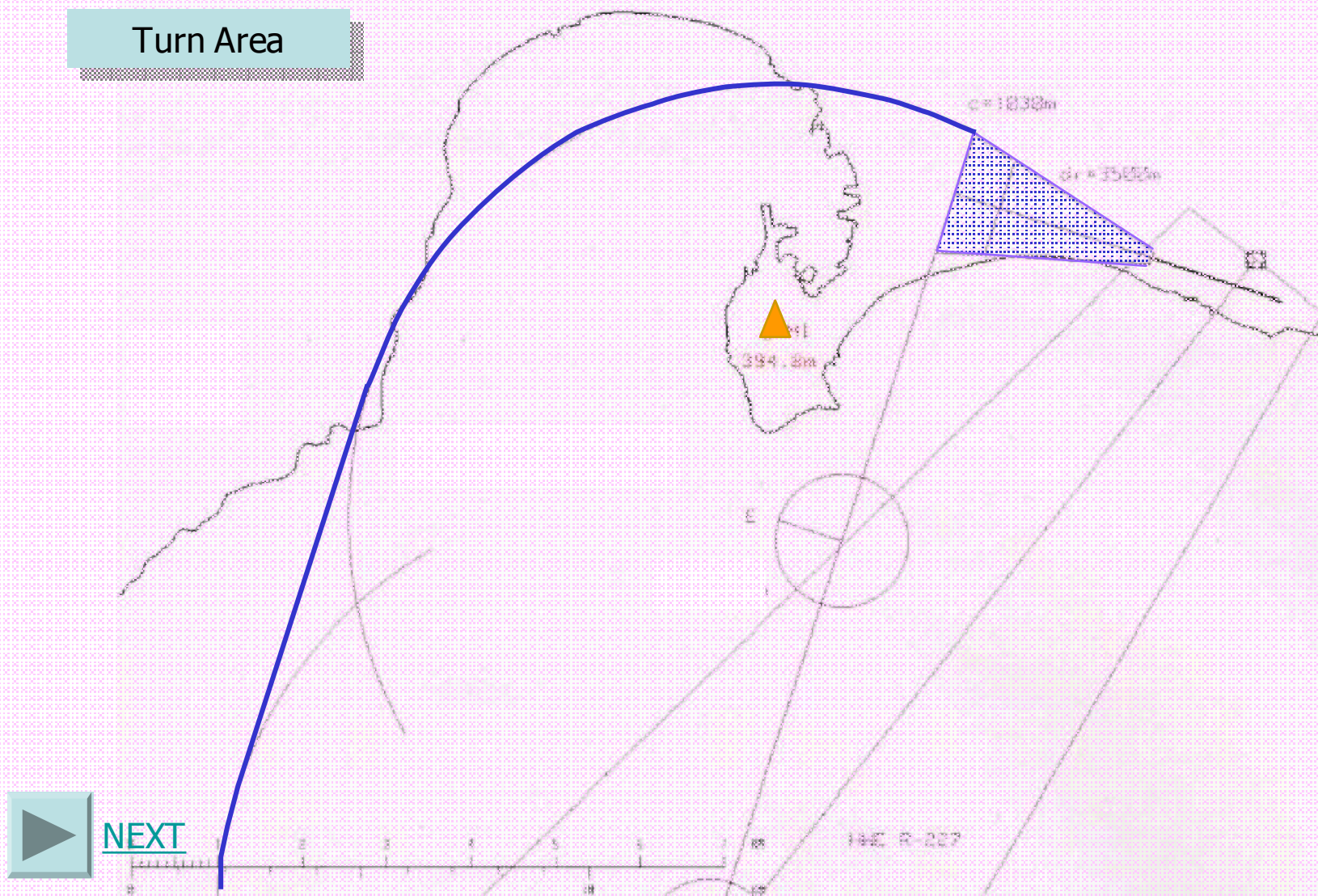
NEXT

Avoidance of Obstacle by Turn (2/5)

Reduction of Turn Area

1) IAS Limitation   Obstacle cannot be not avoided yet.

IAS Limitation
(Speed Reduction)

TP

PDG=3.3%

120m

5m

3500m

PILOT

Wind Factor
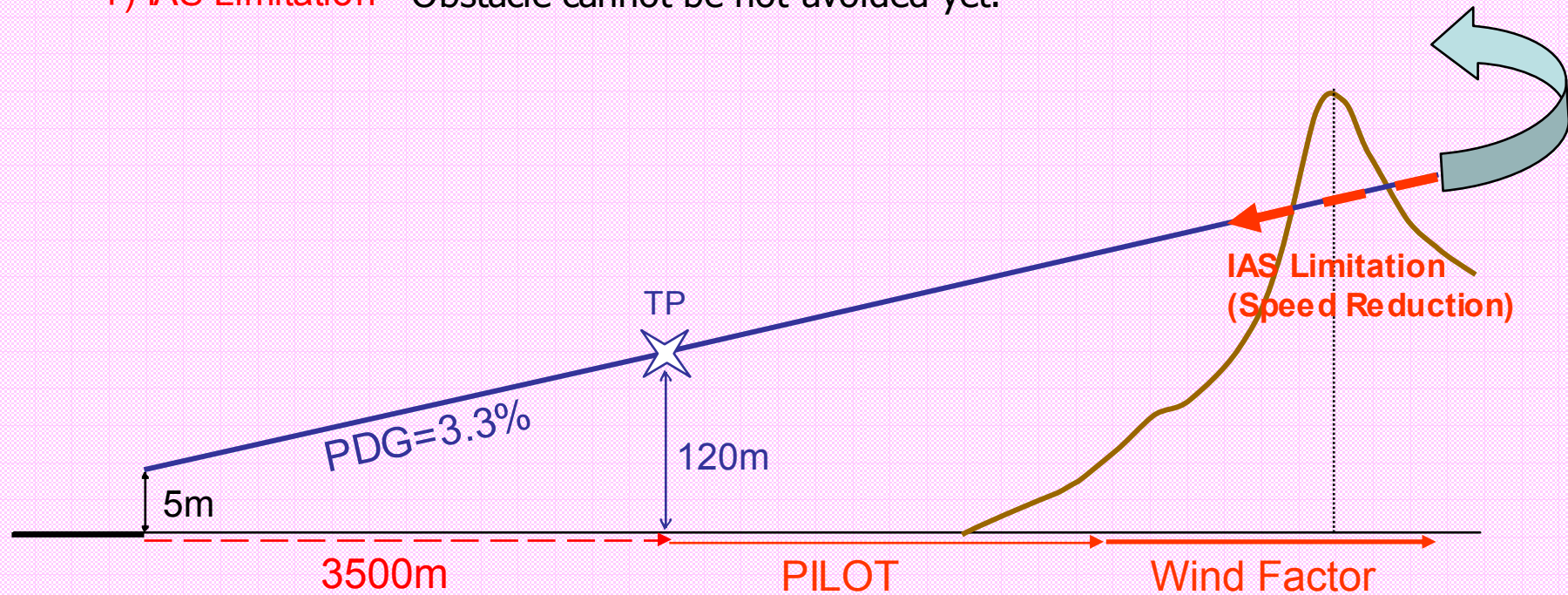
▶ NEXT

Avoidance of Obstacle by Turn (3/5)

Reduction of Turn Area
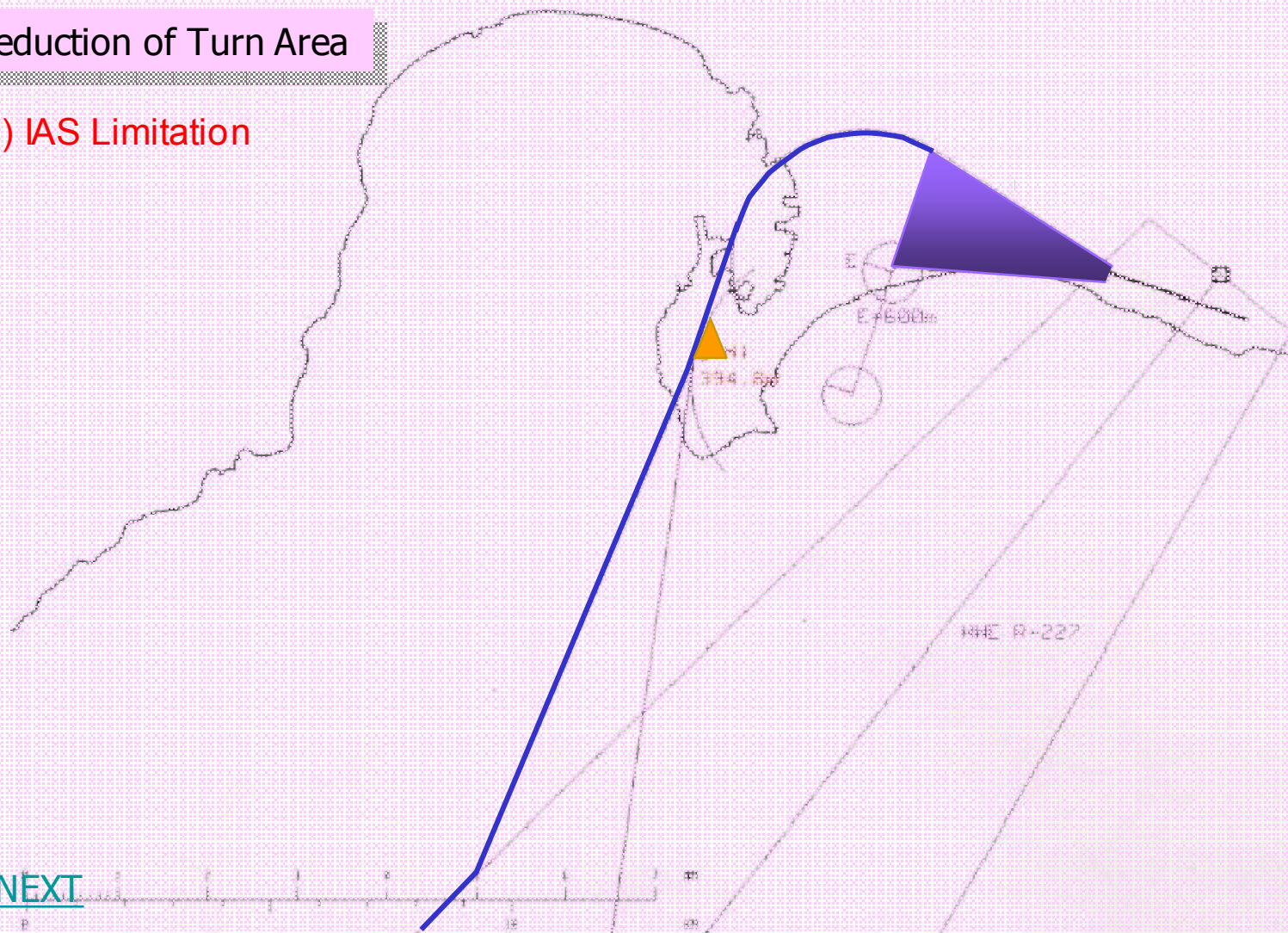
1) IAS Limitation

NEXT

Avoidance of Obstacle by Turn (4/5)

Reduction of Turn Area

1) IAS Limitation

2) Specifying PDG   Avoiding Obstacle
(let obstacle out of Turn Area)

3.3%PDG

5%PDG

TP

TP

120m

120m

5m

2300m

PILOT

Wind Factor

▶ NEXT
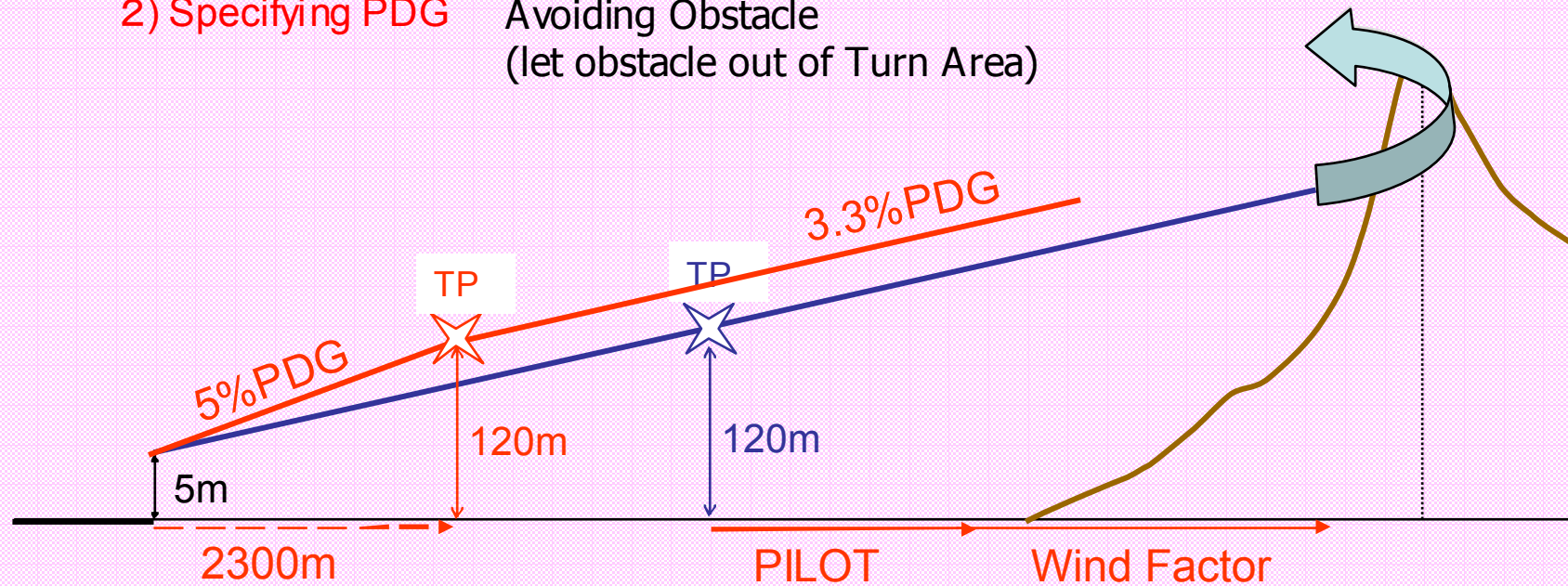
Avoidance of Obstacle by Turn (5/5)

Reduction of Turn Area

1) IAS Limitation
2) Specifying PDG

Out of Turn Area

Departure Route

Back

A

ABAS	**Aircraft Based Augmentation System**
	An augmentation system that augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft.
	Note.- The most common form of ABAS is Receiver Autonomous Integrity Monitoring (RAIM).
	Ref: SBAS GBAS
APV	**Approach Procedure with Vertical guidance**
	An instrument approach procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations

Back

C

CDI	**Course Deviation Indicator** Cockpit instrument displaying relative position of the aircraft to defined path.
CMV	**Converted Meteorological Visibility** A value (equivalent to an RVR) which is derived from the reported meteorological visibility, as converted.
Critical DME	**Critical DME** A DME facility that, when unavailable, results in a navigation service which is insufficient for the oparation based on DME/DME or DME/DME/IRU along a specific route or a procedure.

Back

D

DA / DH	**Decision Altitude / Decision Height**
	A specified altitude or height in the precision approach or approach with vertical guidance at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.
	Note 1.— Decision altitude (DA) is referenced to mean sea level and decision height (DH) is referenced to the threshold elevation.
	Note 2.— The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In Category III operations with a decision height the required visual reference is that specified for the particular procedure and operation.
	Note 3.— For convenience where both expressions are used they may be written in the form "decision altitude/height" and abbreviated "DA/H".
DER	**Departure End of Runway**
	The end of the runway that is opposite the landing threshold. It is sometimes referred to as the stop end of runway.
Descent Fix	**Descent fix**
	A fix established in a precision approach at the FAP to eliminate certain obstacles before the FAP, which would otherwise have to be considered for obstacle clearance purposes.
DME GAP	**DME Gap**
	Segment on the Route where Combination of DME signal which meets designated navigation accuracy requirement cannot be received

E

EGNOS	**Euro Geostationary Navigation Overlay Service** A satellite-based augmentation system providing navigation service meeting Annex 10 requirements that provides navigation service in the European Region.. Ref: SBAS - WAAS (USA), MSAS(Japan)

F

FDE	**Fault Detection and Exclusion** The function performed by some GNSS receivers, which can detect the satellite in error and exclude it from the position determination. Ref: RAIM
FAF	**Final Approach Fix** The fix which identifies the beginning of the final approach segment.
FAP	**Final Approach Point** The point at which nominal glide path intercept the intermediate segment minimum altitude for precision approach and approach procedure with vertical guidance.
FAS	**Final Approach Segment** The segment of an instrument approach procedure in which alignment and descent for landing are accomplished.

Back

G

Galileo	Global Navigation Satellite System (GNSS) planned by the European Union (EU) and European Space Agency (ESA) as an alternative to the GPS operated by USA and the GLONASS by Russia.
GBAS	**Ground Based Augmentation System** An augmentation system in which the user receives augmentation information directly from a ground-based transmitter Ref: LAAS(USA)
GLONAS	**Global Orbiting Navigation Satellite System** The satellite navigation system operated by the Russian Federation. One of the most significant feature of GLONAS is that each satellite transmit signal in different frequency while GPS satellites with that in the same frequency.
GNSS	**Global Navigation Satellite System** A worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary to support the required navigation performance for the intended operation. Ref: GPS (USA) GLONASS (Russia)
GPS	**Global Positioning System** The satellite navigation system operated by US government.

Back

INMARSAT	**INternational MARine SATellite telecommunication organization** INMARSAT Plc. is an company founded in 1979 so as to provide international telecommunication using telecommunication satellites. Its was originally founded as the International Maritime Satellite Organization (IMSO) established for the purpose of establishing a satellite communications network for the maritime community.
Intermediate Approach Segment	**Intermediate Approach Segment** The segment of an instrument approach procedure between either the intermediate approach fix and the final approach fix or point, or between the end of a reversal, racetrack or dead reckoning track procedure and the final approach fix or point, as appropriate.
IF	**Intermediate Approach Fix** A fix that marks the end of an initial segment and the beginning of the intermediate segment.
Initial Approach Segment	**Initial Approach Segment** That segment of an instrument approach procedure between the initial approach fix and the intermediate approach fix or, where applicable, the final approach fix or point..
IAF	**Initial Approach Fix** A fix that marks the beginning of the initial segment and the end of the arrival segment, if applicable.

Back

IAP	**Instrument Approach Procedure**
	A series of predetermined maneuvers by reference to flight instruments with specified protection from obstacles from the initial approach fix, or where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply. Instrument approach procedures are classified as follows.
	Non-Precision Approach (NPA) procedure
	An instrument approach procedure which utilizes lateral guidance but does not utilize vertical guidance.
	Approach Procedure with Vertical guidance (APV)
	An instrument procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations.
	Precision Approach (PA) procedure
	An instrument approach procedure using precision lateral and vertical guidance with minima as determined by the category of operation.
	Note.- Lateral and vertical guidance refers to the guidance provided either by:
	a) a ground-based navigation aids; or
	b) computer generated navigation data.

L

LAAS	**Local Area Augmentation System** Ground-based augmentation system (GBAS) operated by US government. It can provide precision approach. Ref: GBAS
LNAV	**Lateral Navigation** A function of area navigation (RNAV) equipment which calculates, displays, and provides guidance in the horizontal plane. .

Back

M

MSAS	**MTSAT Satellite-based Augmentation System**
	Satellite-based augmentation system (SBAS) operated by Japan. It consists of satellite (MTSAST), Ground Monitor Station (GMS), Monitor and Ranging Station (MRS), Master Control Station (MCS), Network Communication Subsystem (NCS) as well as GPS as its core satellite system.
	Ref: WAAS(USA), EGNOS (Europe)
MTSAT	**Multi-functional Transport Satellite**
	Artificial satellite operated by Japan, used for air navigation service and meteorological observation service. MTSAT forms a part of MSAS (MTSAT Satellite-based Augmentation System).
MDA/MDH	**Minimum Decent Altitude / Minimum Decent Height**
	A specified altitude or height in a non-precision approach or circling approach below which descent must not be made without the required visual reference.
	Note 1.- Minimum descent altitude (MDA) is referenced to mean sea level and minimum descent height (MDH) is referenced to the aerodrome elevation or to the threshold elevation if that is more than 2m(7ft) below the aerodrome elevation. A minimum descent height for a circling approach is referenced to the aerodrome elevation.
	Note 2.- The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In case of a circling approach the required visual reference is the runway environment.
	Note 3.- For convenience when both expressions are used they may be written in the form "minimum descent altitude/height" and abbreviated "MDA/H".

M

MEA	**Minimum Enroute Altitude** The altitude for an en-route segment that provides adequate reception of relevant navigation facilities and ATS communications, complies with the airspace structure and provides the required obstacle clearance.
MSA	**Minimum Sector Altitude** The lowest altitude which will provide a minimum clearance of 300m(1000ft) above all objects located in an area contained within a sector of a circle of 46km(25NM) radius centered on a radio navigational aids.
MSD	**Minimum Stabilization Distance** The minimum distance to complete a turn maneuver and after which a new maneuver can be initiated. The minimum stabilization distance is used to compute the minimum distance between waypoints.
MAHF	**Missed Approach Holding Fix** A fix that marks the end of the missed approach segment and the centre point for the missed approach holding.
MAPt	**Missed Approach Point** That point in an instrument approach procedure at or before which the prescribed missed approach procedure must be initiated in order to ensure that the minimum obstacle clearance is not infringed.
MATF	**Missed Approach Turning Fix** A fix different from MAPt that marks a turn in the missed approach segment.

Back

N

NPA	**Non-Precision Approach Procedure** An instrument approach procedure which utilizes lateral guidance but does not utilize vertical guidance.

Back

O

OCA / OCH	**Obstacle Clearance Altitude / Obstacle Clearance Height**
	The lowest altitude or the lowest height above the elevation of the relevant runway threshold or the aerodrome elevation as applicable, used in establishing compliance with appropriate obstacle clearance criteria. *Note 1.- Obstacle clearance altitude is referenced to mean sea level and obstacle clearance height is referenced to the threshold elevation or in the case of non-precision approaches to the aerodrome elevation or the threshold elevation if that is more than 2m(7ft) below the aerodrome elevation. An obstacle clearance height for a circling approach is referenced to the aerodrome elevation.* *Note 2.- For convenience when both expressions are used they may be written in the form "obstacle clearance altitude/height" and abbreviated "OCA/H".*

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P

Path and Terminator	**Path and Terminator** 2-letter alphabetical code to define the type of leg used in terminal procedures (Departure/Arrival/Approach procedure). It is used to encode the flight procedures into such format that can be read by airborne navigation system. The first letter indicate "path" (mode of flight), and the second one indicates "terminator" (way of termination of the leg).
PDG	**Procedure Design Gradient** Climb gradient assumed for procedure design. It starts at the beginning of OIS (Obstacle Identification Surface) which is 5m (16ft) above DER. For SIDs, nominal value is 3.3%.
Primary Area	**Primary Area** A defined area symmetrically disposed about the nominal flight track in which full obstacle clearance is provided. Ref: Secondary Area
Procedure Altitude/ Height	**Procedure Altitude/Height** A specified altitude/ height flown operationally at or above the minimum altitude/height and established to accommodate a stabilized descent at a prescribed descent gradient/angle in the intermediate/final approach segment.
PA	**Precision Approach Procedure** An instrument approach procedure using precision lateral and vertical guidance with minima as determined by the category of operation.

Back

R

RAIM	**Receiver Autonomous Integrity Monitoring** A form of ABAS whereby a GNSS receiver processor determines the integrity of the GNSS navigation signals using only GPS signals or GPS signals augmented with altitude (baro aiding). This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one additional satellite needs to be available with the correct geometry over and above that needed for the position estimation for the receiver to perform the RAIM function.
RDH	**Reference Datum Height** The height of the extended glide path or a nominal vertical path at the runway threshold.
RNAV	**Area Navigation - RNAV** A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained navigation aids, or a combination of these. **RNAV (Navigation) Specification:** A navigation specification which <u>does not</u> include requirements for on-board performance monitoring and alerting.
RNAV 1	Navigation with navigation specification including the lateral total system error within +/- 1 NM for at lease of 95 % of the flight time, and other over navigation performance / functionality requirements.
RNAV 5	Navigation with navigation specification including the lateral total system error within +/- 5 NM for at lease of 95 % of the flight time, and other over navigation performance / functionality requirements.
RNP	**Required navigation performance** (Historically) Navigation Performance required for the flight within an airspace. **RNP (Navigation) Specification:** A navigation specification which <u>includes</u> requirements for on-board performance monitoring and alerting.

S

SBAS	**Satellite Based Augmentation System** A wide-coverage augmentation system in which the user receives augmentation information from a satellite-based transmitter. Ref: WAAS(USA), EGNOSS(Europe), MSAS(Japan)
Secondary Area	**Secondary Area** A defined area on each side of the primary area located along the nominal flight track in which decreasing obstacle clearance is provided. Ref: Primary Area
SID	**Standard Instrument Departure** A designated Instrument Flight Rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a flight commences.
STAR	**Standard Instrument Arrival (Standard Terminal Arrival Route)** A designated Instrument Flight Rule (IFR) arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach procedure can be commenced.

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T

TAA	**Terminal Arrival Altitude** The lowest altitude that will provide a minimum clearance of 300 m (1000 ft) above all objects located in an arc of a circle defined by a 46 km (25 NM) radius centred on the initial approach fix (IAF), or where there is no IAF on the intermediate approach fix (IF), delimited by straight lines joining the extremity of the arc to the IF.
T bar / Y bar	**T bar / Y bar** Construction of Initial Approach(es) for smooth interception to RNAV(RNP) (final) Approach. Normally, reversal procedure is not necessary. Y bar is applied when T bar construction is not practicable.

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V

VPA	**Vertical Path Angle** Angle of the published final approach descent in Baro-VNAV procedures.
VDP	**Visual Decent Point** A defined point on the final approach course of a non-precision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided the approach threshold of that runway, or approach lights, or other markings identifiable with the approach and of that runway are clearly visible to the pilot.
VNAV	**Vertical Navigation** A function of area navigation (RNAV) equipment which calculates, displays, and provides guidance in the vertical plane.

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W

WAAS	**Wide Area Augmentation System** Satellite-based augmentation system (SBAS) operated by US government. It can provide approach procedure with vertical guidance (APV). . Ref: SBAS - EGNOS(Europe), MSAS(Japan)
Waypoint	**Waypoint** A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Waypoints are identified as either. **Fly-by waypoint.** A waypoint which requires turn anticipation to allow tangential interception of the next segment of a route or procedure, or **Flyover waypoint** A waypoint at which a turn is initiated in order to join the next segment of a route or procedure.

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END

RNAV Training for ATC 2007

Air Traffic Control Association Japan

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