Use of GPS in non WGS-84

PRESENTED BY:
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GPS Position Updating in non WGS-84

Agenda

• WGS Coordinate Systems—The History
• Coordinate Systems and Your Avionics
• Changing Industry Position on Use of GPS in non-WGS-84 Areas
• General Operating Techniques
• Finding Coordinate System for your Trip
GPS Position Updating in non WGS-84

WGS Coordinate Systems— the History

• WGS – World Geodetic System
  – Geodetic system (mathematical model of the earth)
  – Developed by DOD for global mapping
  – Models an approximation or the earth’s sea level known as the ellipsoid

• WGS 84 datum
  – Developed in the mid-80s for use with GPS
  – Improved navigation accuracy

Sources: DOD World Geodetic System 1984; Geodesy for the Layman, Defense Mapping Agency
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WGS84 Coordinate Systems— the History

• WGS-84 adopted by ICAO as standard geodetic reference
  – Contracting states agreement on implementation by 1998
  – Publication of ICAO WGS-84 Manual
    • Set standards for accuracy and resolution of aeronautical data
    • Required new WGS-84 surveys and charting

Sources: ICAO Document 9674 – World Geodetic System- 1984
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WGS84 Coordinate Systems— the History – Cont’d

- In 2016 – not yet 100% compliance
  - As a result we have instrument procedures designed and coded in coordinate systems inconsistent with GPS
  - Use of RNAV may result is position error (e.g., UTSB)

Sources: Honeywell RAAS database; Jeppesen WGS-84 Status Report
GPS Position Updating in non WGS-84
WGS84 Coordinate Systems – the History – Cont’d

Sources: Honeywell RAAS database; Jeppesen WGS-84 Status Report

BUKHARA, UZBEKISTAN (UTSB)

WGS-84 Status: NC

Green line represents AIP published coordinates

Position error ~ 260 ft.
GPS Position Updating in non WGS-84

WGS-84 Coordinates and Your Avionics

• Flight Management System
  – Waypoints contained in the navigation database may or may not conform to WGS-84, depending on country compliance

• Global Positioning System - GPS
  – Coordinates received by GPS satellites are WGS-84

• Terrain Awareness System / EGPWS
  – EGWPS databases using SRTM (Shuttle Terrain Mapping) are WGS-84 compliant
  – EGPWS uses GPS as basis for alerting
    • Terrain warnings will be accurate
  – Runway location is also derived from the EGPWS database

Source: Honeywell Position Paper – Use of GPS in Non-WGS-84 Countries
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Some Existing Restrictions

- Early industry guidance did not allow use of FMS/GPS in non-WGS-84
- Limitations today still vary by OEM
- Positions changing to allow its use

Source: Honeywell GIV Pilot Guide
GPS Position Updating in non WGS-84
WGS-84 Coordinates and Your Avionics

- Synthetic Vision (Honeywell)
  - Terrain information is from EGPWS terrain database (WGS-84 compliant)
  - Runway and obstacles information is derived from the navigation database
    - May not conform to actual location in non-WGS-84 airspace

Sources: Honeywell Position Paper – Use of GPS in Non-WGS-84 Countries
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Changing Industry Positions

• Operational experience with GPS Navigation
  – Large fleet of GPS-equipped aircraft globally
  – RNAV operations with GPS proven reliable
• Valuable situational awareness with GPS
  – Beneficial in areas of unfamiliar, complex and/or foreign airspace
  – Areas with very little ground-based nav infrastructure for FMS updating
• Availability and accuracy of EGWPS and synthetic vision
  – Terrain location and display is accurate relative to aircraft position

Sources: Honeywell Position Paper – Use of GPS in Non-WGS-84 Countries
GPS Position Updating in non WGS-84
Changing Industry Positions – Cont’d

• Increasing worldwide compliance to WGS-84
  – Approximately 97% compliance and increasing
• Radio nav aid substitution / raw data monitoring (AC 90-108)
  – Required on procedures in non-WGS-84 areas
  – Ensure navigational accuracy required for the procedure

Sources: Honeywell Position Paper – Use of GPS in Non-WGS-84 Countries
GPS Position Updating in non WGS-84
Honeywell White Paper - Position Change

• Old Position – Disable GPS when flying an approach in non-WGS-84
  – Reflected in Honeywell Pilot Guides
  – Took guidance away from flight crew in areas where it may be extremely valuable
  – Nuisance messages are common
    • FMS and CAS messages result from the disabling of GPS on many aircraft
  – Requires alternate procedures
GPS Position Updating in non WGS-84

Honeywell White Paper - Position Change – Cont’d

• New Position
  – Compliance with country-specific requirements relating to the use of GPS is mandatory
  – AFM requirements are controlling and supersede any conflicting guidance that may exist in this or other documentation.
  – Flying RNAV approaches in non-WGS-84 airspace is not recommended
  – Radio-based (VOR, NDB, etc.) approaches are authorized using GPS updating provided the underlying nav aid is tuned and monitored to ensure aircraft position accuracy relative to the published procedure. If at any time during the approach the GPS position does not match the raw data, the raw data shall be used for navigation. (Reference AC 90-108 for additional information)
  – If the underlying nav aid is out of service or the onboard radio(s) is inoperative, the use of the FMS to fly the procedure is not authorized.

Sources: Honeywell Position Paper – Use of GPS in Non-WGS-84 Countries
GPS Position Updating in non WGS-84
Finding the Coordinate System for your Trip

- Sources to find WGS-84 Compliance
  - Jeppesen website

http://ww1.jeppesen.com/company/publications/wgs-84.jsp
GPS Position Updating in non WGS-84

Finding the Coordinate System for your Trip – Cont’d

- Sources to find WGS-84 Compliance
  - State AIP (aeronautical information publication) data

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### GEN 2.1-2
23 July 2015

#### AIP NEPAL

3. **Horizontal reference system**

3.1. **Name / designation of system**

All published geographical coordinates indicating latitude and longitude are expressed in terms of the World Geodetic System—1984 (WGS-84) geodetic reference datum.

3.2. **Projection**

Projection is expressed in term as Universal Transverse Mercator (UTM).

3.3. **Ellipsoid**

Ellipsoid is expressed in terms of the World Geodetic System—(WGS-84) ellipsoid.

3.4. **Datum**

The World Geodetic System—(WGS-84) is used.

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Airway Manual/Air Traffic Control/State Rules and Procedures / Middle East/Nepal - Rules and Procedures

**Nepal - Rules and Procedures**

**GENERAL**

In general, the air traffic rules and procedures in force, and the organisation of the air traffic services are in conformity with ICAO Standards, Recommended Practices and Procedures.

Units of measurement used in all air and ground operations are as listed in the following table:

<table>
<thead>
<tr>
<th>Measurement of</th>
<th>SI Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance used in navigation, position reporting, etc.</td>
<td>Nautical Miles and Thousands</td>
</tr>
<tr>
<td>Radial distance and lines, and distances such as those relating to aerodromes (e.g., runway and taxiway distances)</td>
<td>Kilometers</td>
</tr>
<tr>
<td>Altitude, altitudes and heights</td>
<td>Feet</td>
</tr>
<tr>
<td>Horizontal speed including wind speed</td>
<td>Knots</td>
</tr>
<tr>
<td>Vertical speed</td>
<td>Feet per minute</td>
</tr>
<tr>
<td>Wind direction for taking off and landing</td>
<td>Degrees True</td>
</tr>
<tr>
<td>Wind direction excess for taking off and landing</td>
<td>Degrees Magnetic</td>
</tr>
<tr>
<td>Meteorological data including runway visual range</td>
<td>Kilometers or Meters</td>
</tr>
<tr>
<td>Altimeter setting</td>
<td>Hectopascals</td>
</tr>
<tr>
<td>Temperature</td>
<td>Degrees Celsius</td>
</tr>
<tr>
<td>Weight</td>
<td>Metric Tons or Kilograms</td>
</tr>
<tr>
<td>Time</td>
<td>Hours and Minutes, the day of 24hr beginning at midnight UTC</td>
</tr>
</tbody>
</table>

**WGS-84 IMPLEMENTATION STATUS**

WGS-84 compliant.

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Nepal AIP – Gen Tables and Codes / Jeppesen ATC Pages: State Rules and Procedures
GPS Position Updating in non WGS-84
Finding the Coordinate System for your Trip – Cont’d

- Sources to find WGS-84 Compliance
  - Contact the state aviation authority directly

GPS Position Updating in non WGS-84

Summary

• Country compliance with WGS-84 continues to increase - (97.3%)
  – China, Russia are compliant
• GPS position updating is beneficial for normal operations in non-WGS-84
  – Allows full use of FMS, including SVS
  – Must monitor underlying navaid when flying non-RNAV arrivals or approaches
  – Must not be prohibited by the country in which you’re operating or the AFM
• Less than 25 RNAV approaches exist in non-WGS-84 Airspace
  – Although procedures are supposed to be developed using WGS-84, Operators should contact the state aviation authority directly if operating in these areas
• Important to understand relationship of FMS/GPS position to EGPWS and SVS information, and may be different between avionics manufacturers
GPS Position Updating in non WGS-84

Q&A

• Q1: Are non-GNSS approaches flown differently in WGS-84 vs. non WGS-84 airspace?
  
a) Yes
b) No
GPS Position Updating in non WGS-84

Q&A

b) No
GPS Position Updating in non WGS-84

Q&A

• Q2: What’s the most accurate way to determine if a approach or arrival is WGS-84 compliant?
  a) Approach Plate
  b) Contacting the Authority Directly
  c) Navigation Database
  d) AIP Data
GPS Position Updating in non WGS-84

Q&A

b) Contacting the Authority Directly
GPS Position Updating in non WGS-84

Q&A

• Q3: Can I use GPS in partial or non WGS-84 airspace?
  a) Always
  b) Never
  c) Yes, unless OEM or country-specific requirements prohibit it’s use
GPS Position Updating in non WGS-84

Q&A

c) Yes, unless OEM or country-specific requirements prohibit its use