Getting to grips to “High Elevation Airport Operations” project

Presented by
Capt JP HOUDIN, Flight Ops Support Director
High Elevation Operation

1. Airport characteristics
2. AC (Advisory circulars) - Regulation
3. Airline experience / Safety analysis
4. Airsafety - Aircrew / Passenger
5. Aircraft and Engine characteristics
6. Aircraft and Engine design
7. Aircrew training
8. Approval process of HEAOps

8 Chapters to be developed
Airbus task sharing

A/P compatibility
EIYS
Legal dept
STLO
Medical
EV - STL
BS, BL – E - S
STO
S

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Status of HEAOps project

Objective
- To prepare a **Airbus Reference document** dealing with High Elevation Airport Operations = **HEAOps**
- Initiated by Airbus China Flight Operation Department, Captain J.P. Houdin:
  - Leads the building of a specific Document (name to be defined), and ensures regular updates,
  - Establish cooperation with selected worldwide HEA operators and Regulatory departments, (CAAC, EASA, ICAO)
  - Review all aspects links to High Elevation Airport Operations

Peter TIARKS Requirements:
"**Delivery**: The draft Document shall be delivered to ST by December 2013 (project duration estimated with 18 months)"

"**Team composition, workload and cost**
- The Airbus team will be composed of 8 Members from Airbus China who will have to allocate approximate 20% of their working time. (total of 21 man months) and M.Post from SEU and Larry ROCKLIFF both of them estimated workload of 10% (3.6 man months)
- The cost for travel for coordination meeting with the CAAC and Airlines will be covered in the AOP of each department
- Cost for events with CAAC and Airlines will be covered by Airbus China Government Affairs."

**PROGRESS STATUTS**
- CAAC: CAAC review of AC121 pending, next meeting with CAAC Chengdu in May 2013.
- Airbus: FEEDBACK Only Marketing dept in Toulouse, (SA, Cargo)
- ACSSO established cooperation with TBA and CCA in Chengdu (Ops feedback and flight data analysis), (still need to do with South US airlines)
- Operational visits in China to explain the performance and A/C mod’s
- Growing demand for HEA Operation development – Airline request more support
<table>
<thead>
<tr>
<th>Topic</th>
<th>Team Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport characteristics</td>
<td>JP/HOU Maggie</td>
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<td>AC (Advisory circulars) - Regulation</td>
<td>J.P/ BO Juan /CAAC</td>
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<tr>
<td>Airline experience / Safety analysis</td>
<td>a) Airbus MIA with FAA&lt;br&gt;b) B.Delprat with CAAC, CSC, TBA</td>
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<td>B.Delprat and YANG Zhigang</td>
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<tr>
<td>Aircraft and Engine characteristics</td>
<td>STL (JR?, Steve?, Majun)</td>
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<td>Eric VR, YANG Zhigang</td>
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<tr>
<td>Aircrew and Ground staff training</td>
<td>Larry ROCKLIFF + Jp HOUDDIN,</td>
</tr>
<tr>
<td>Approval process / HEAOps Requirements</td>
<td>SC (M.Sherf)/M.Post from SEU</td>
</tr>
</tbody>
</table>
High Elevation Airport Worldwide Distribution

*definition Airbus
Above 9200ft
10 airports in China
4 above 14000ft

30% airports in China among 38 worldwide
37 airports are above 9200 ft, 30 are located in South America and China.

11 new airports will be built between 2011-2020 in Tibet region.
Bangda, the world highest altitude airport

A319 has excellent takeoff performance and range capability from Bangda

A319 is in operation with RNP in Ali, Bangda, Lhasa, Linzhi, Yushu, Huangshan, Lijiang, Pangzhihua, Xining, Yanji
Over 80% operations in Tibet are by A319
Over 94% operations in Tibet are by A319+A330

A319 sharklet with CFM56-5B7
124 passengers at 95 kg each
2% fuel conservatism
CAAC domestic flight profile
5% airway allowance
85% annual wind
Airbus, from a new comer to a major player

Airbus Aircraft in China 1985 ~ 2010

- First Airbus aircraft entered into China: 1985
- First A320 entry China in 1995
- End 2010: 654 aircraft
- End 2010 A320 Family: 550 aircraft

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Airbus aircraft are preferred for Tibet operations
OAG, Aug., 2009

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<th>Flights/week</th>
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<td>LXA-KTM:</td>
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Market Share

- A319: 68%
- A330/A333: 18%
- 737: 7%
- 757: 7%
**Airbus aircraft are preferred for Tibet operations**

OAG, Jan., 2010

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<td>LXA-KTM:</td>
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</table>

**Market Share**

- A319: 88%
- A330: 8%
- 757: 4%

**In winter, A319 tacked about 90% of Tibet market**
### Airports with Elevation > 9,200ft

<table>
<thead>
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<th>Airport_ICAO</th>
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<td>A319 and A330</td>
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<td>LPB</td>
<td>SLLP</td>
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* A319s have been operated in UIO, LPB, JUL, and CUZ, and A330s in UIO only.
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<td>Elev (ft)</td>
<td>Take-off procedures type</td>
<td>Landing procedures type</td>
<td>Number of flights/year/A/C</td>
<td>Average T (°C)</td>
<td>Min T(°C)</td>
<td>Max T(°C)</td>
<td>Visibility (m)</td>
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</table>
In this high elevation area, there will be 11 new airports constructed between 2011-2020.

The Highest Elevation Airport
Qamdo Bangda Airport is the airport with the highest elevation in the world. The elevation of the structure is 14,219 feet or 4,334 meters. In addition to this, the structure has the longest runway, which has a length of 18,045 feet or 5,500 meters.

High Elevation Airport characteristics
Chinese projects

In this high elevation area, there will be 11 new airports constructed between 2011-2020.
On Nov. 23, Daocheng Yading Airport, the world's highest civil airport at an elevation of 4,441 meters, welcomed the first landing of an Air China Airbus A319 passenger aircraft, registration B-6226. The aircraft then took off again and made test flight successfully in the airport' airspace, marking that the world's highest civil airport is going to be put into operation soon.

Located 50 km from Daocheng County of the Tibetan Autonomous Prefecture of Garze, southwest China's Sichuan Province, the regional airport is a 4C-class airport, with a 4,200-meter-long runway and four tarmcs. The 4,441-meter-high airport has surpassed Tibet Changdu Bangda Airport which is at an elevation of 4,334 meters, becoming the highest civil airport in the world.

The airport, which has completed the construction on August 29, 2012, is expected to be put into operation in May 2013. After the operation of the airport, it will take only one hour for tourists flying from Chengdu, the capital of Sichuan Province to Daocheng.
High Altitude must be defined
- Type of operation (commercial, type of aircraft,..)
- Define types of access and facilities
- Analyse weather phenomenon which impact performance, FDA, minimum, design of procedures
- type of weather impact on engine performance
- PCN and runway design
- Review existing app and proposal for other types (RNP)
- highlight the new projects

High Elevation definition

(1) definition CAAC
Above 1500m
94 airports

(2) definition Airbus
Above 9200ft
37 airports
# CAAC Flight Standards Department

**AC No.:** AC-121-21  
**Issuing Date:** March 2, 2007  
**Initiated by:** Operations Management Division  
**Approved by:** Jiang Huaiyu

## High Elevation Airport Operation Regulation for Air Carriers

### 1. Purpose

1.1 As the further extension of CCAR-121, this advisory circular is issued to provide guidelines for air carriers (hereinafter “airlines”) who apply for high elevation airport operation and implement safety management at high elevation airports.

1.2 This advisory circular is issued to assist CAAC in approving and supervising high elevation airport operation.

### Advisory Circular

**Very High**  
**CAAC Above 8000 ft**  
10 airports

**High**  
**CAAC Above 4922 ft**  
5 airports

---

## Federal Aviation Administration

### Memorandum

**Date:** May 26, 2006  
**To:** Manager, Seattle Aircraft Certification Office, AMS-108N  
**From:** Manager, Transport Airplane Directorate, AMS-110  
**Prepared by:** Clint Jones, AMS-129

**Reg. No.:** T07709E-1

### Subject:

- **Equivalent Level of Safety (ELS) for High Altitude Landings**
- **Operations for Boeing 777-MLC/Airplane (FAA Project Number HD7709E-1)**

### Background

In accordance with the provisions of § 21.21(b)(5), Boeing submitted a request for an equivalent level of safety to the requirements of § 25.841(a)(10) when applied to the 777-MLC/777-300/777-200/777-900 takeoff and landing operations at airports with field elevations between 3,000 feet and 14,500 feet. Boeing wishes to obtain approval for takeoff and landing operations at airports with elevations up to 14,500 feet and do so without activation of the 10000 feet cabin altitude warning. Boeing has designed a dual fault cabin altitude warning system that its believes will provide an equivalent level of safety (ELS) to the requirements of § 25.841(a)(10). Boeing documentation calls this the High Altitude Operation System.

### Applicable regulations:

- § 21.21(b)(5), 25.841(e)(3)(ii)(A)(i), and (B)(3), 25.109(a), and 25.147(a)(1)
- § 25.1471(b)(1)

### Proposal:

**HIGH from 10000ft to 15000ft**

---

**For Airbus**

**HIGH? Above 9200ft? Very High Above 14500 ft?**

**14500ft?**

**9200ft?**

**We need TO STANDARDIZE THE DEFINITIONS**
High Elevation Airports includes General High Elevation Airports and Very High Elevation Airports

**Very High Elevation Airports**
> 8000 ft (2438 m)

**General High Elevation Airports**
> 4922 ft (1500 m)
Increasing number of high elevation airports built or planned in China in recent years, especially in the Xizang Province.

Safety issue: high altitude operations are more challenging.

October, 28-29, 2004: Seminar on High Elevation Airport Operation Management and Support, held by CAAC in Chengdu, with regional administration offices and airlines.

CAAC Advisory Circular
AC-121-21, March 2, 2007
High Elevation Airport Operation Regulation for Air Carriers
CAAC Advisory Circular
Entry requirements

Airline
- Required experience different if the airline is based or not at high elevation
- Staff skills related with very high elevation operations

Aircraft
- Respect of the flight envelop
- Special oxygen needs
- Technical specifications for very HE (CP, engines, self start capability)

Pilot
- Age
- First officer
- Training
- Captain

Airlines operations management
- Establish a specific manual based on the CAAC-AC
- Adapt the operations management

More details: see CAAC Advisory Circular Detailed.pptx or CAAC AC HEA.pdf
CAAC Advisory Circular
Operational requirements

Aircraft maintenance
- 120min ETOPS Standards

Dispatch
- Weather
- TOW
- Dispatch department
- Real-time
- HEA Operations
- Dispatch training

Aircraft performance analysis
- TOW
- V1 / VR / V2
- Landing
- Scheduling
- EOSID procedure
- HEA Operations

Crew training
- Pilots
- Captain at VHEA: experience in line with CCAR 121.469
- Cabin crew: syllabus adapted for HEA
  Training incorporated to the annual training

Demonstration flight
- Required for all aircrafts at very high elevation airport
- Below, CAAC decides whether it is necessary or not

Aviation sanitation
- Oxygen
- Crew health recommendations at very high elevation
- Contingency plan for plague

More details: see CAAC Advisory Circular_detailed.pptx
or CAAC AC HEA.pdf
Airline experience / Safety analysis

1. History of airline operating at HEA
2. Safety reports
3. Performance reports
4. Commercial reports
5. Participation airlines

Comments:
- REVIEW OF experience
- PERFORMANCE
- SYSTEMS,
- SAFETY

Questions:
An A319 taking off with a rotation rate that is 1 deg/s slower than normal can result in a 4 to 5 knot liftoff speed increase.

We need FDA to issue Operating Rules

We need FDA to assess pilot performance vs speed computation

We need quick FDA process to take rapid repair decision
Cabin crew training should take into account hypoxia knowledge.

We need airline experience and medical analysis to assess passenger and crew behaviour.

Safety equipments could be required on board or at the airport.

- 8,000 ft to the threshold of prolonged hypoxia and without excessive fatigue;
- 12,000 ft for the threshold for use of oxygen in all conditions. The threshold of 8,000 ft is that of civil aviation. The threshold of 12,000 ft is that of military regulations (STANAG 3198 AMD) and is quoted in the FAR regulations (Part 91, Part 121 & Part 135).
Aircraft and Engine characteristics
Atmosphere and Aerodynamics, Air speed,

1. Take off performance
2. In flight performance
3. Landing performance
4. Mission payload capability
5. Information and training
6. System failure

Comments:
- REVIEW OF experience
- PERFORMANCE
- SYSTEMS
- SAFETY

Questions:
Aircraft and Engine characteristics
Atmosphere and Aerodynamics, Air speed,

- **起飞 Take off**
  - 起飞距离 TOD
  - 爬升梯度 Climb Gradients
  - 压力高度 Pressure altitude
  - 爬升梯度 Climb gradient
  - 最大起飞重量 MTOW

- **着陆 Landing**
  - 空中着陆距离 IFLD
  - 压力高度 Pressure altitude

- **复飞 Go Around**
  - 发动机推力 Engine Thrust
  - 爬升梯度 Climb gradient

- **空中着陆距离 IFLD**
Example:
- Code 5 is tire speed limit
- 204kt GS = 170 IAS
在给定的空速情况下真空速(TAS)随高度的增加而增加。

Flying at a given airspeed leads to increase the A/C TAS with Altitude increase.

- 对于相同的空速，转弯半径随着压力高度的增加而增加。
- For the same airspeed, radius of turn increase with pressure altitude increase.
Required Runway length vs Airport Elevation

Conditions:
ISA, No Wind, 1013 Rwy dry-No obstacle

A319-IAE MTOW 75.5T
A319-CFM MTOW 75.5T

Max Tire speed

Example (approx data)

TORA/TODA/ASDA (m)  15000ft
3,500   60.8
3,600   61.1
3,700   61.5
3,800   61.6
3,900   61.8
4,000   61.9
4,100   62.0
4,200   62.1
Aircraft and Engine characteristics
Atmosphere and Aerodynamics, Air speed,
An increased limit from 195kt to 197kt or a new tire design would reduce significantly the revenue lost.

Corrective actions after this kind of events increases revenue lost as well as preventive actions.

Avianca has reduced those events in SKBO by changing the rotation technique policies, and aircraft take off configuration, but for flights departing from SLLP it has been necessary to reduce the payload capacity (~2 TON).
Performance Benefit

Bump option is effective for hot and/or high conditions

• Bump option increases TOGA thrust rating (up to 10%)
A319 has more RNP ops approvals …..

<table>
<thead>
<tr>
<th>Airport</th>
<th>Type</th>
<th>Design</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangda</td>
<td>A319</td>
<td>Naverus</td>
<td>In operation</td>
</tr>
<tr>
<td>Jiuzhai</td>
<td>A319</td>
<td>Naverus</td>
<td>In process</td>
</tr>
<tr>
<td>Lhasa</td>
<td>A319</td>
<td>Naverus</td>
<td>In operation</td>
</tr>
<tr>
<td>Linzhi</td>
<td>A319</td>
<td>Naverus</td>
<td>In operation</td>
</tr>
<tr>
<td>Yushu</td>
<td>A319</td>
<td>Naverus</td>
<td>In process</td>
</tr>
<tr>
<td>Huangshan</td>
<td>A319</td>
<td>Quovadis</td>
<td>In operation</td>
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<td>Lijiang</td>
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<td>In operation</td>
</tr>
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<td>Panzhihua</td>
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<td>Quovadis</td>
<td>In process</td>
</tr>
<tr>
<td>Xining</td>
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<td>In process</td>
</tr>
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<td>Yanji</td>
<td>A319</td>
<td>Quovadis</td>
<td>In operation</td>
</tr>
<tr>
<td>Lhasa</td>
<td>A330</td>
<td>Naverus</td>
<td>In operation</td>
</tr>
<tr>
<td>Sanya</td>
<td>A330</td>
<td>Quovadis</td>
<td>In process</td>
</tr>
</tbody>
</table>

...... and *is operating* on all of high altitude airports
Aircraft and Engine design – Customisation
Special design and equipments, new systems (FAN, ATSAW)

1. Engines
   - FADEC
   - BUMP

2. HEA kit (Overhead panel)
   - Pressurisation
   - Oxygen

3. Information
   - Flysmart

4. Systems
   - FMGC (RNP-AR)
   - FANS
   - ATSAW
   - FWC

5. HEAOps requests

6. BRAKING
   - Brake fan
   - Wheels

7. Feb 2013 - High Altitude Operations
High altitude operations depend much on the local airworthiness authorities requirements.

For example, the CAAC requires a 55mn passenger oxygen supply in case of emergency decent. However, other high altitude configurations not in CAAC jurisdiction could have the basic 15 mn oxygen supply or the optional 22 mn. This also depends on the emergency descent possibilities.

All Chinese high altitude configurations have the highest thrust engines installed but please note that other configurations could have engines with less thrust. This has to be calculated on a case by case basis.

For China,

- Increased design weights MTOW 70T, MLW 62.5T, MZFW 58.5T (WV 005)
- Certification for high altitude ops up to 14500 ft (this installs, amongst others, the switch NORMAL/HIGH ALT in passenger oxygen system)
- Extended duration of passenger gaseous oxygen system
- Highest thrust engine IAE or CFM
- CPC (SA)

Please note that the gaseous oxygen system is not retrofittable according the program policy note attached.

Concerning the communications system, CES used to have 2 HF transceivers but this has changed to 1 HF and one SATCOM with cockpit voice interface.

The dual advisory ice detection system could be useful.

Other configurations outside China include options as:

- Water/waste freezing protection for extended flight conditions
- 15 knots tailwind certification at landing
- 15 knots tailwind certification at take off
### Aircraft and Engine design

Special design and equipments, new systems (FAN, ATSAW)

<table>
<thead>
<tr>
<th>Models</th>
<th>Airbus Modification</th>
<th>Maximum Altitude for Takeoff and Landing (ft)</th>
<th>System Change Specific Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>320-111</td>
<td>Basic</td>
<td>8000</td>
<td></td>
</tr>
<tr>
<td>320-211</td>
<td>MOD 23671</td>
<td>9200</td>
<td></td>
</tr>
<tr>
<td>320-212</td>
<td>Basic</td>
<td>9200</td>
<td></td>
</tr>
<tr>
<td>320-214</td>
<td>MOD 23108 Cr</td>
<td>9200</td>
<td></td>
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<tr>
<td>320-232</td>
<td>MOD 23109 Cr</td>
<td>9200</td>
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</tr>
<tr>
<td>320-233</td>
<td>MOD 23409</td>
<td>9200</td>
<td></td>
</tr>
<tr>
<td>320-231 (fitted with a 4-wheel bogie)</td>
<td>Basic</td>
<td>8000</td>
<td></td>
</tr>
<tr>
<td>320-231 (fitted with a 4-wheel bogie)</td>
<td>MOD 20127 Cr MOD 21533</td>
<td>12000 (only JAA (1))</td>
<td>NO</td>
</tr>
<tr>
<td>320-233</td>
<td>MOD 25015</td>
<td>14100</td>
<td>YES (2)</td>
</tr>
<tr>
<td>320-233</td>
<td>MOD 25015</td>
<td>14100</td>
<td>YES (3)</td>
</tr>
<tr>
<td>All A321 models</td>
<td>Basic</td>
<td>9200</td>
<td></td>
</tr>
<tr>
<td>All A319 models</td>
<td>Basic</td>
<td>9200</td>
<td></td>
</tr>
<tr>
<td>319-115</td>
<td>MOD 25615</td>
<td>14100</td>
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<tr>
<td>319-131</td>
<td>MOD 25615</td>
<td>14100</td>
<td>YES (4)</td>
</tr>
</tbody>
</table>

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1. Due to the "EXCESS CAB ALT" warning, the FAA does not certify an extension above 9200 ft without a modification of the pressurization system.
2. The DGAC certified operational procedures for operations above 9200 ft, to clear the "EXCESS CAB ALT" warning when triggered.
3. The CPCs design change prevents the "EXCESS CAB ALT" warning from triggering above 9200 ft. Moreover, a dedicated "HIGH ALT LDG" switch is embodied to prevent oxygen mask deployment.
4. A specific procedure provides the new "EXCESS CAB ALT" warning setting in high altitude. It also specifies the use of the "HIGH ALT LDG" switch.
Aircraft performance and systems review

Aircraft handling- flying techniques

Part A : Pilot Briefing

Part B : Simulator exercise (A320 or A330)

• Each crew perform 2h (2 crews)
Aircrew and Ground staff training

1. Airport design
2. Weather phenomenon
3. Medical aspects

1. Loading envelop (Theory)
2. Multiple Errors or ZFW and T/O speeds
3. GTG to Weight and Balance

1. Decision Speed – Characteristic speeds
2. Gradients all phase of flight
3. Use@doc (FCOM’s, MEL)
4. Use of EFB
5. Flight preparation

1. Rejected Take off – Tire speed
2. All Engine & OEO after T/O
3. In flight Shut down
4. S/F failures
5. Landing safe
6. Go around

1 day training- 4h on ground, 2h simulator per crew
Operational evaluation of each HEA Ops procedure
- As required, development of specific flight crews procedures.
- Validation of the Navigation database.

Flight Operational Safety Assessment (FOSA)
The use of EASA certified HEA values alleviate the need for a FOSA.

Aircrew and Ground staff training

Operational documentation
Procedure charts, specific flight crew procedures, limitations.
Required equipment.

HEA monitoring program