Cruise limitations in mountainous area

Eduard Algar
Alberto Muñoz
Marc Xapelli

Index


Introduction

The purpose of this project is assess the cruise limitations for an Airbus A320-200 aircraft scheduled to fly from Dubai International Airport (OMDB), United Arabian Emirates, to Beijing Capital International Airport (ZBAA), China.

The main goal of the project is to study the impact of a sudden loss of cabin pressure or an engine failure at the critical point(s) of the route.

The following conditions given in the SoW will be followed:

- The aircraft is dispatched with a take-off mass of 69.000 kg and 60.000 kg at the moment the emergency occurs.
- Cruise altitude of FL370 until PURPA fix and FL371 upon it.
- Route: MAXMO – A419 – BND – A453 – KN – A453 – GN – A453 – KB – G206 – PURPA – W112 – HTN – W112 – QIM – W112 – NOLEP – W112 –CHW – B215 – YBL – A596 – DKO – A596 – BAV– A596 – SZ – A596 – TZH – A596 – KM
- ISA-10ºC atmospheric conditions along the entire route.
- No-wind conditions all along the flight.
- Consider EU-OPS regulations and that the aircraft is RNP equipped.
- The aircraft is equipped with a 22 minutes chemical oxygen system.

Procedures to obtain the optimal route

1. Draw the route segment of interest:
    1. Assess the terrain bellow.
    2. Obtain altitude-distance data.
    3. Plot the terrain in python conjunctly with the descend profiles.
    4. Adjust the descend profiles to match the terrain.
    5. From the projection graph obtain NRP1 & NRP2
2. Escape route determination:
    1. Project the descend profile using polygons among the route.
    2. Determine critical areas for further research.
    3. Design optimal scape routes & implement them using Navaids
3. Reassess the results enforcing that safety minima also ensures to descend to FL100 below critical time.


Draw the route
segment of interest:

1.1 Draw the route segment of interest

- Skyvector.com ⍰ Lat/Long for every fix:
- Convert data to a ,txt and process using Python 3 to generate a .kml.

- waypoint.py
- relieve.py

Waypoint	Route / Altitude	wDir / Temp (dev)	wSpd	TAS	Track / WCA	TH / Var	MH	GS	Dist	ETE / ETO	ATE / ATO	Fuel / EFR	Fuel AFR
OMDB													
PATOX	Ð▸	296°	16	110	51°	43°	41°	116	844.1	7h22		0.0	
	8000	10°C (+10°)			-8°	-2°				7h22		0.0	
NOLEX	Ð▸	164°	2	110	32°	33°	30°	111	22.6	12		0.0	
	8000	5°C (+5°)			+1°	-2°				7h34		0.0	
TAPIS	Ð▸	188°	1	110	32°	32°	30°	111	45.9	25		0.0	
	8000	5°C (+5°)			+0°	-3°				7h59		0.0	
GULNI	Ð▸	45°	2	110	60°	60°	57°	108	52.1	29		0.0	
	8000	5°C (+5°)			-0°	-3°				8h28		0.0	
SURVI	Ð▸	116°	2	110	61°	62°	59°	109	19.8	11		0.0	
	8000	5°C (+5°)			+1°	-3°				8h39		0.0	
PURPA	Ð▸	109°	2	110	64°	65°	62°	108	266.6	2h27		0.0	
	8000	3°C (+4°)			+1°	-3°				11h05		0.0	
HTN 113.1	Ð▸	198°	5	110	87°	90°	86°	112	214.4	1h56		0.0	
	8000	-4°C (-4°)			+2°	-3°				13h01		0.0	
VIDUT	Ð▸	296°	3	110	75°	74°	71°	112	172.6	1h36		0.0	
	8000	-3°C (-3°)			-1°	-3°				14h38		0.0	
DJQ 114.7	Ð▸	73°	6	110	73°	73°	71°	104	102.4	59		0.0	
	8000	-3°C (-3°)			-0°	-2°				15h37		0.0	
QIM 114.3	Ð▸	61°	7	110	131°	128°	125°	107	5.9	3.3		0.0	
	8000	-3°C (-3°)			-4°	-2°				15h40		0.0	
DJQ 114.7	Ð▸	63°	7	110	311°	315°	313°	112	5.9	3.1		0.0	
	8000	-3°C (-3°)			+3°	-2°				15h43		0.0	
NOLEP	W112	61°	7	110	81°	80°	77°	103	155.5	1h27		0.0	
	8000	-3°C (-3°)			-1°	-2°				17h10		0.0	
	Ð▸	139°	3		349°	350°			5.2			0.0	

waypoints.txt: Bloc de notas

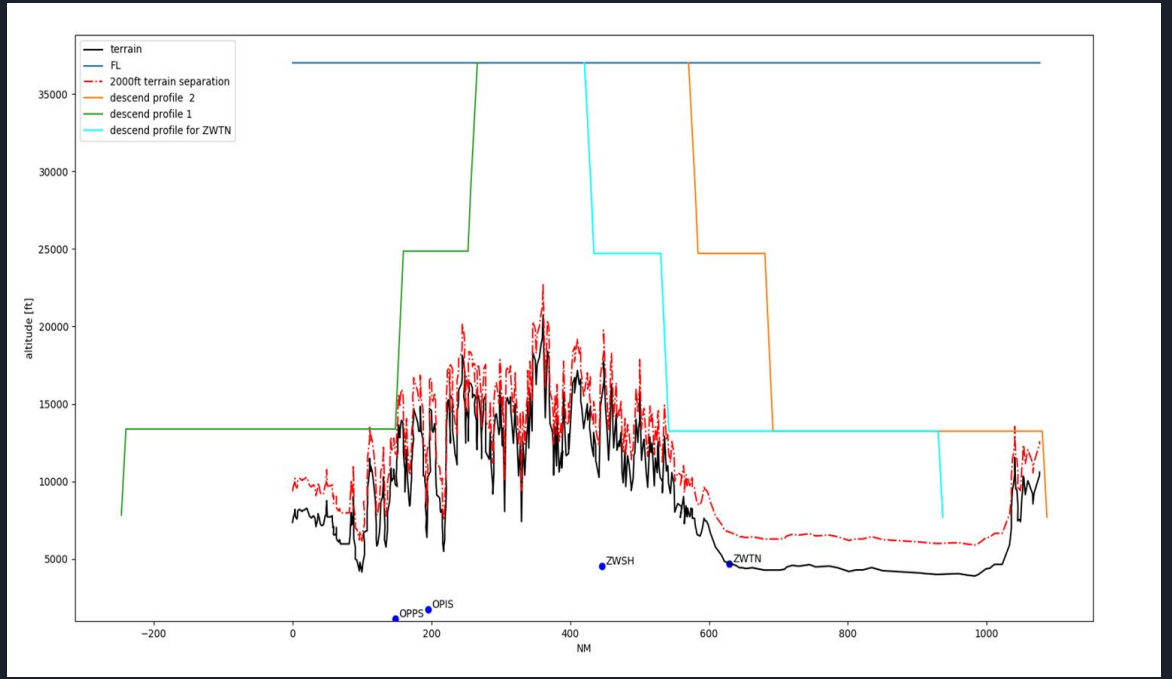
Archivo Edición Formato Ver Ayuda

```
lat(N)          long(E)
33°32.90'       068°25.20'      PATOX
33°52.07'       068°39.60'      NOLEX
34°31.00'       069°09.00'      TAPIS
34°56.62'       070°04.05'      GULNI
35°06.10'       070°25.20'      SURVI
35°36.98'       071°30.97'      DUGIN
36°57.63'       075°25.20'      PURPA
37°02.20'       079°52.10'      HTN
37°44.80'       083°22.03'      VIDUT
38°00.93'       084°51.46'      TEPUT
38°13.00'       085°26.60'      DJQ
38°09.10'       085°32.20'      QIM
38°13.00'       085°26.60'      DJQ
38°34.50'       088°42.50'      NOLEP
```

1.1 Segment + 1.2 Vertical profile

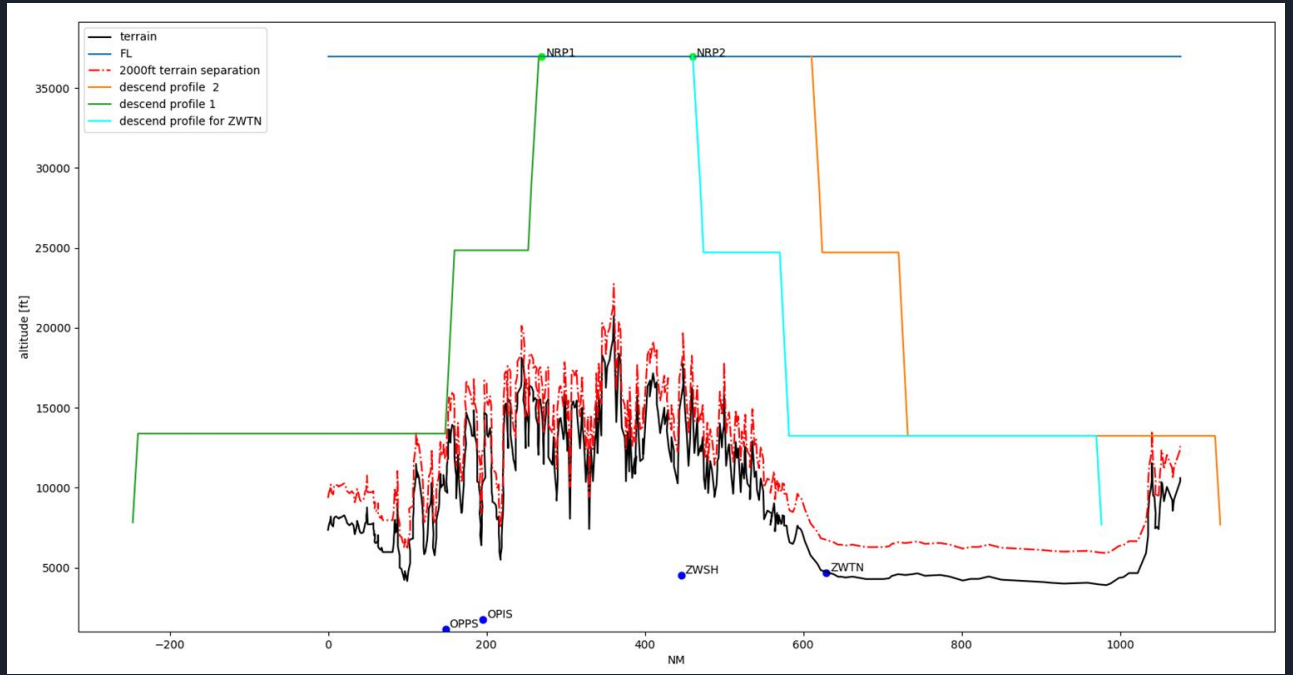
1.3 Initial results

- Adjusting the descend to the 2000ft terrain separation.
- Ignoring the +1000ft in Chinese airspace:
  - 1000ft ~304.8m.
  - Not a big difference.
  - Flying lower → more restrictive = higher safety margins



1.4 Final results

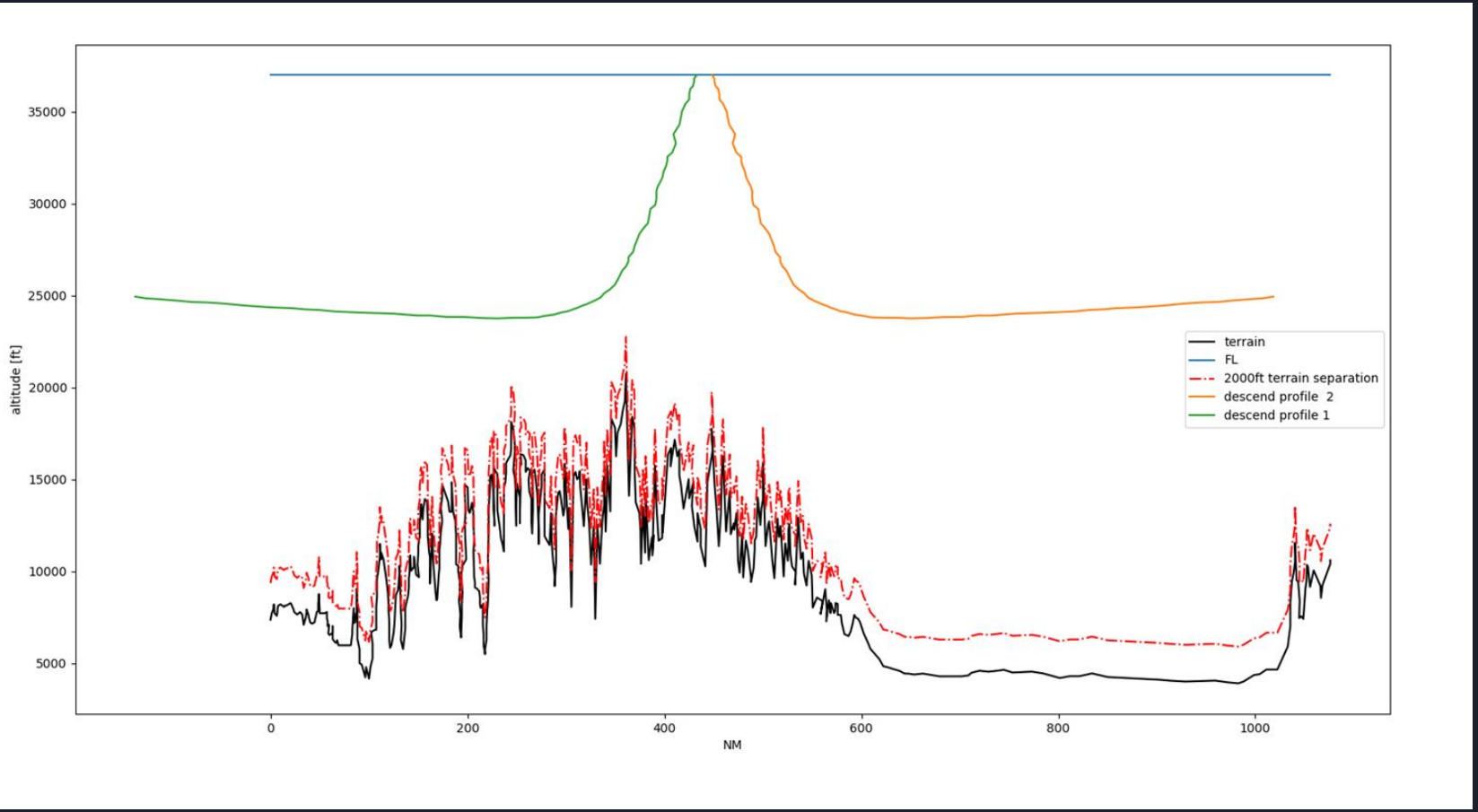
- Define NRPs.
- NRP2 adjusted to meet requirements for diversion alternates.
- NRP1:
  - 36°20'6.00"N
  - 73°35'37.00“
  - 95 DME PURPA
- NRP2:
  - 36°37'28.00"N
  - 74°19’05.00"E
  - 55 DME PURPA



Engine failure

- Fishbone graph.
- Consideration: Fly as high as possible:
  - Higher terrain separation.
  - Pneumatic pressure Packs available = Cabin pressurized
  - Longer range.
  - Higher fuel margins to divert
  - Larger glide path in case of 2X
- 77 samples from the graph:
- Conclusion: No restrictions/ escape routes applicable:

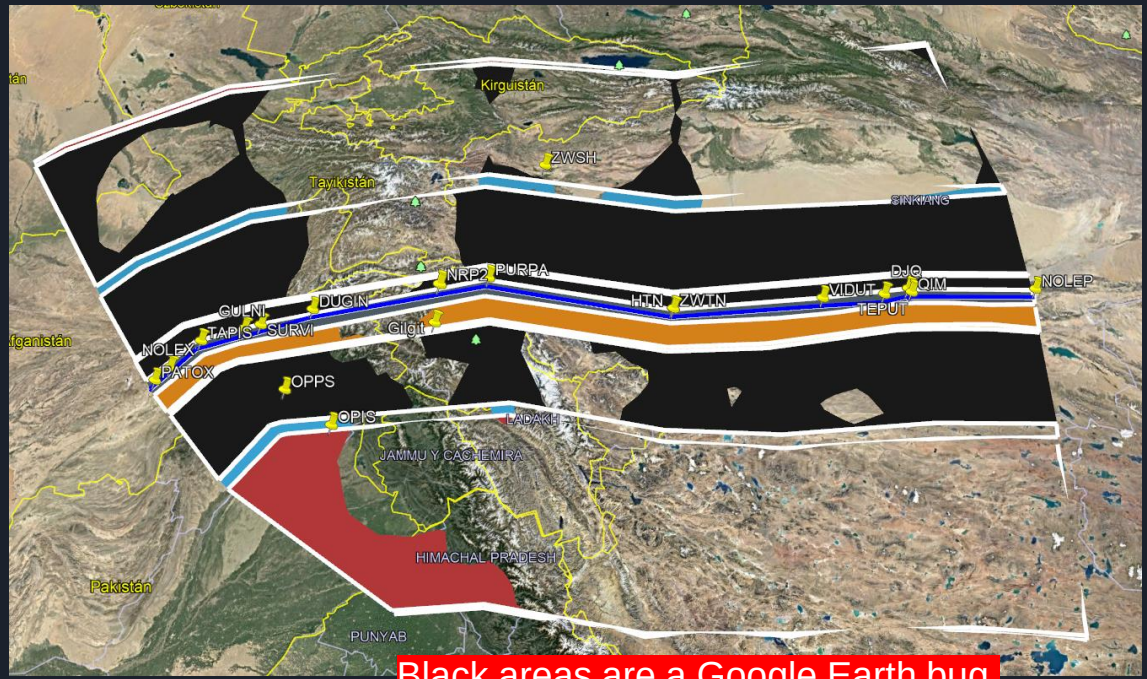
Engine out profile




Escape routes

2.1 Objective

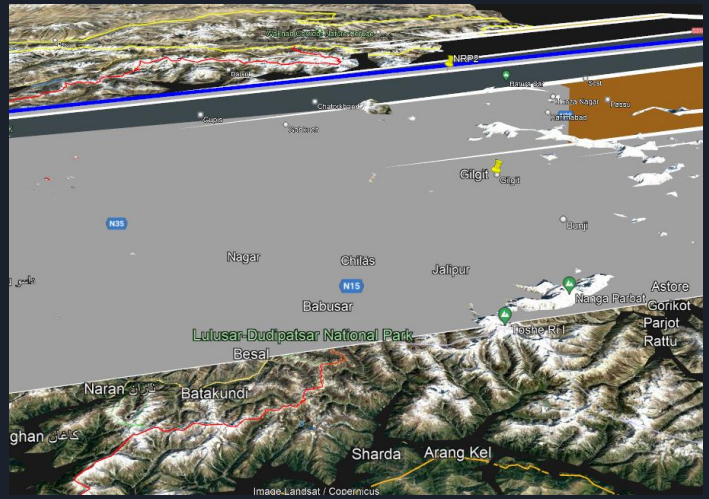
- Determine all terrain hazards along any possible escape profile. How?
  - Extending from every point of the route a descend path using polygons.
- Each colour represents a step of the descend path
- Each cruise area has. 2000ft subtracted.



Black areas are a Google Earth bug, nothing wrong with the code/files

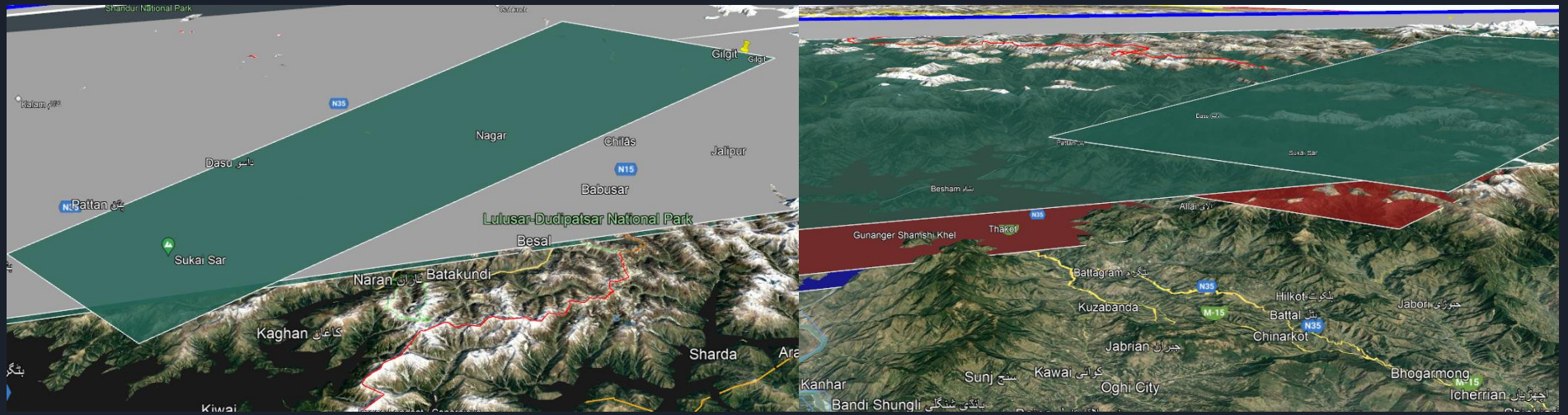
2.1 Explanation

- If the terrain crosses the polygon: minima is not reached.
- Is it normal to have vast areas not covered?
  - Answer: Earth's curvature affect along vast regions. However it is a good method to discard areas of terrain, if it complains now, it will when analysing with more detail.
- Create smaller polygons for areas of interest initially not complying in our area of interest:
- Clearly alternate after NRP2 complies.
- Further study for alternate between NRP1 & NRP2



FL 290 Area

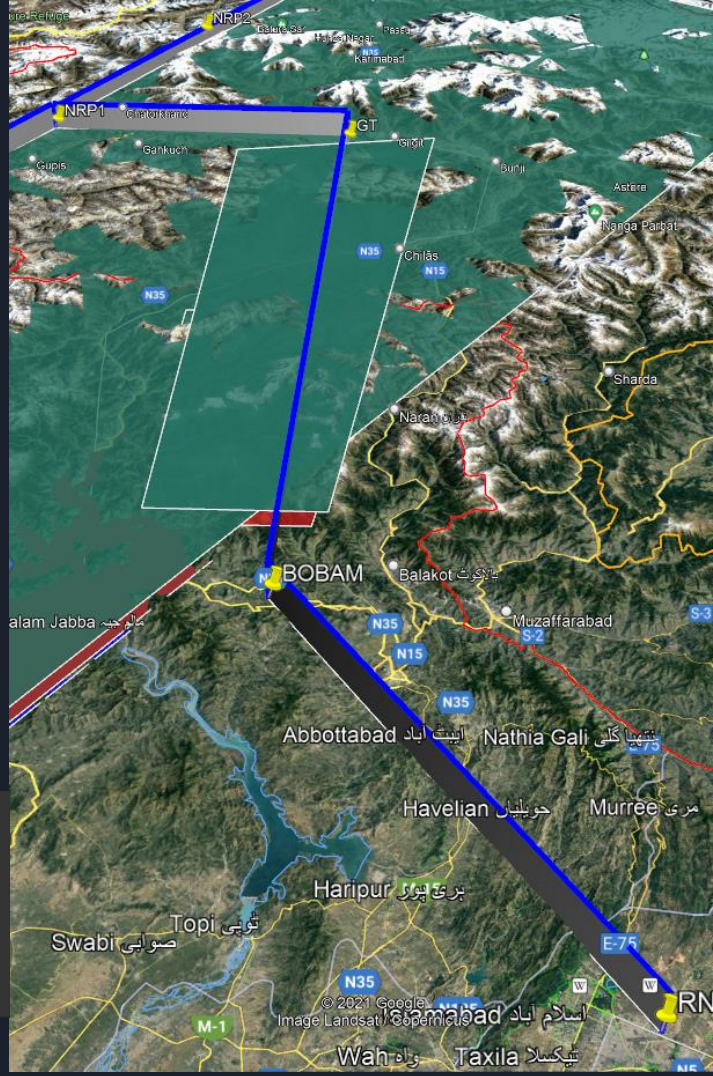
Escape 1



- FL250
- FL140
- FL100
- Quick way to determine if the area is suitable, Google Earth ruler to determine 5nm lateral separation large lateral margins available

Escape 1 route proposal

- From NRP1 (Most restrictive point +2.5mis prior descend), perform the emergency descend path
- Generate a KML file with Python.
- Obtain the vertical relief profile:
- OPRN no longer available (ceased operations in 2018) **OPIS** new airfield for Islamabad.



From NRP2

- From PURPA:

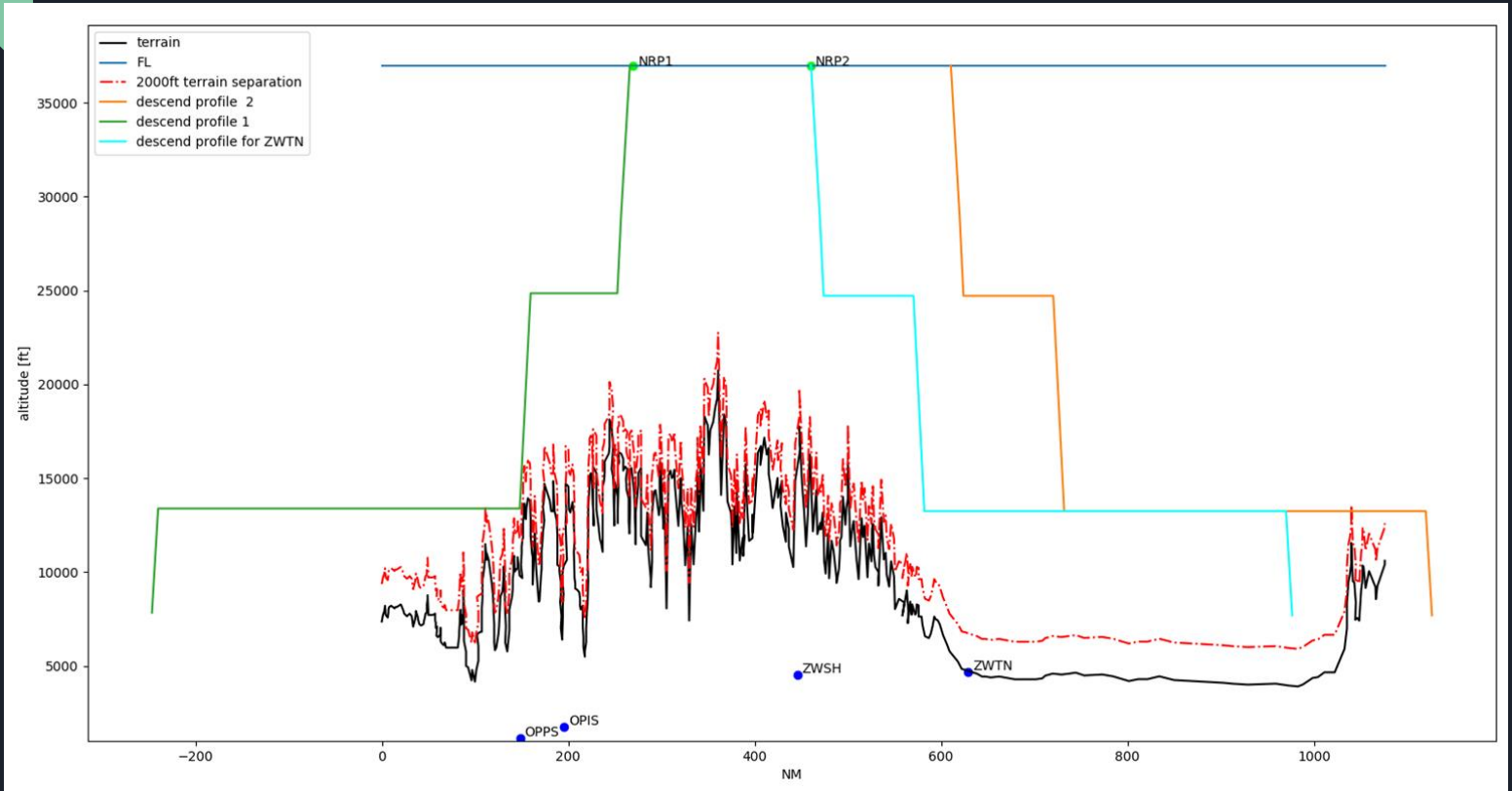
A) Continue the route to HTN

A) Perform the proposed escape route

Results validation

Validation for Route 1

Validation for Escape 2A



Validation for Escape 2B

Escape Procedure Design

Requirements

- Simple to fly.
- SoW → Only Navaids (disregard PBN capabilities).
- Use recommendations according to ICAO PANS OPS manual

Chart for escape 1

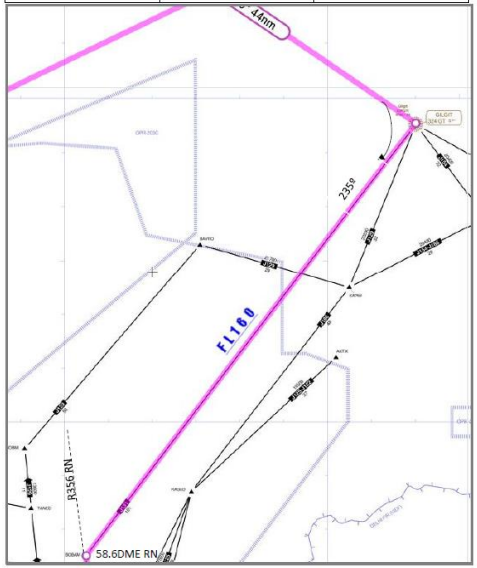
IBERIA

Dpto. De ingeniería y operaciones

REV 08/12/21

Decompression between NRP1 and NRP2

NAME	CODE	Frequency
GILGIT	GT	224
ISLAMABAD	RN	121.1



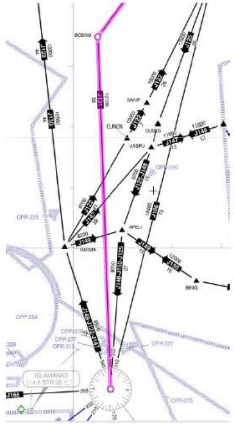
Descompresión entre NRP1 y NRP2:	Decompression between NRP1 and NRP2:
Volar y descender a FL250 directos a GT 324 Volar BOBAM manteniendo FL160 o superior Seguir radial 356 RN hasta 0DME RN	Descend FL250 direct to GT 324 Fly BOBAM while maintaining FL160 or higher Fly radial 356 RN until 0DME RN

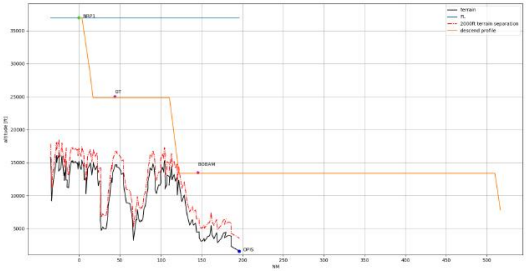
1

IBERIA

Dpto. De ingeniería y operaciones

REV 08/12/21





2

Chart for escape 2

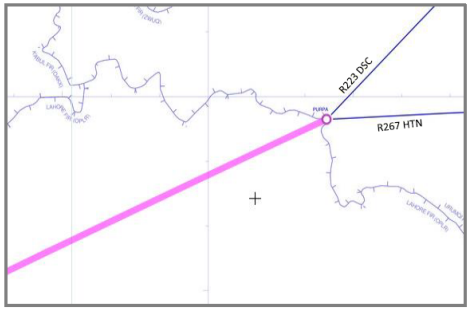
IBERIA

Dpto. De ingeniería y operaciones

REV
08/12/21

Decompression after NRP2

NAME	CODE	Frequency
HOTAN	HTN	113.1
YARKANT	DSC	112.5
KASHI	KHG	115.7



Descompresión después NRP2:	Decompression after NRP2:
Seguir hasta PURPA para luego carta A **(recomendada)** o carta B	Follow to PURPA and then Plate A **(recommended)** or Plate B

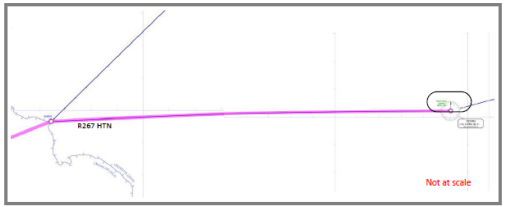
IBERIA

Dpto. De ingeniería y operaciones

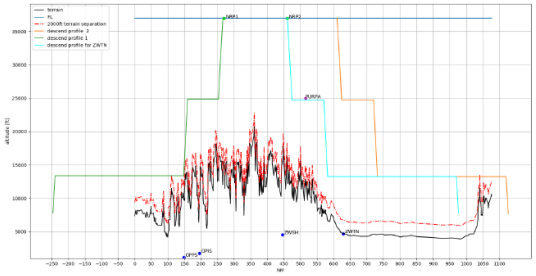
REV
08/12/21

Decompression after NRP2 Plate A:

NAME	CODE	Frequency
HOTAN	HTN	113.1
YARKANT	DSC	112.5
KASHI	KHG	115.7



Descompresión después NRP2 A:	Decompression after NRP2 A:
Volar radial 267 HTN Realizar hipódromos sobre HTN hasta alcanzar FL100	Fly radial 267 HTN Perform racetracks on HTN until reaching FL100



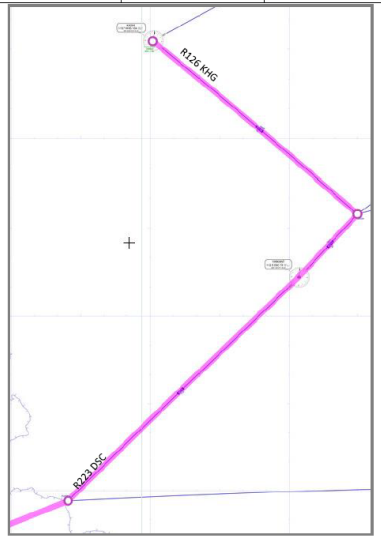
IBERIA

Dpto. De ingeniería y operaciones

REV
08/12/21

Decompression after NRP2 Plate B:

NAME	CODE	Frequency
HOTAN	HTN	113.1
YARKANT	DSC	112.5
KASHI	KHG	115.7

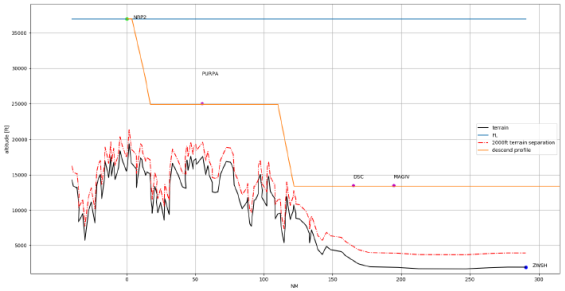


Descompresión después NRP2 B:	Decompression after NRP2 B:
Volar radial 223 DSC hasta interceptar radial 126 KHG, volar directos KHG.	Fly radial 223 DSC to intercept radial 126 KHG, fly direct KHG.

IBERIA

Dpto. De ingeniería y operaciones

REV
08/12/21




LIDO OFP
Ampliation

[OFP]

IBE8905 17DEC2021 OMDB-ZBAA A20N ECNJY RELEASE 0952 17DEC21
OFP 1 DUBAI INTL-BEIJING CAPITAL
WX PROG 1709 1712 1715 1718 1721 OBS 1706 1706 1706 1706 1706

ATC C/S	IBE8905	OMDB/DXB	ZBAA/PEK	CRZ SYS	CI 60
17DEC2021	ECNJY	1020/1040	1819/1827	GND DIST	3609
A320-251N / LEAP-1A26			STA 1735	AIR DIST	3305
		CTOT:....		G/C DIST	3157
				AVG WIND	282/062
MAXIMUM TOW	79000	LAW 67400	ZFW 64300	AVG W/C	P040
ESTIMATED TOW	79000	LAW 62598	ZFW 60113	AVG ISA	P001
				AVG FF KGS/HR	2142
				FUEL BIAS	P00.0
ALTN ZSJN				TKOF ALTN	.....

FL STEPS OMDB/0370/

*** ETOPS/ETP FLIGHT ***

DISP RMKS PAYLOAD/CARGO LIMITED BY MTOW
WARNING: FLIGHT TIME EXCEEDS AIRCRAFT RANGE
ERROR: AIRWAY "A453" USES INVALID ENDPOINTS
ERROR: AIRWAY "W112" USES INVALID ENDPOINTS
ERROR: AIRWAY "W112" USES INVALID ENDPOINTS
ERROR: AIRWAY "W112" USES INVALID ENDPOINTS
ERROR: AIRWAY "B215" USES INVALID ENDPOINTS
ERROR: AIRWAY "A596" USES INVALID ENDPOINTS
ERROR: AIRWAY "A596" USES INVALID ENDPOINTS
ERROR: AIRWAY "A596" USES INVALID ENDPOINTS
ERROR: AIRWAY "A596" USES INVALID ENDPOINTS
ERROR: AIRWAY "A596" USES INVALID ENDPOINTS
ERROR: FIX OR AIRWAY "A419" NOT FOUND
ERROR: FIX OR AIRWAY "-" NOT FOUND
ERROR: FIX OR AIRWAY "BAV-" NOT FOUND

PLANNED FUEL

FUEL	ARPT	FUEL	TIME
TRIP	PEK	16402	0739
CONT 5%		820	0023
ALTN	TNA	1505	0044
FINRES		877	0030
ETOPS/ETP		0	0000
MINIMUM T/OFF FUEL		19604	0916
EXTRA		-717	0000
T/OFF FUEL		18887	0857
TAXI	DXB	230	0020
BLOCK FUEL	DXB	19117	
PIC EXTRA		.....	
TOTAL FUEL		.....	

REASON FOR PIC EXTRA .....

FMC INFO:

FINRES+ALTN	2382
TRIP+TAXI	16632

NO TANKERING RECOMMENDED (P)

ATIS:
.
.

RVSM: ALT SYS	LEFT:	STBY:	RIGHT:

TIMES

	ESTIMATED	SKED	ACTUAL
OUT	1020Z/1420L	1020Z/1420L	......Z
OFF	1040Z/1440L	1040Z/1440L	......Z
ON	1819Z/0219L	1727Z/0127L	......Z
IN	1827Z/0227L	1735Z/0135L	......Z
BLOCK TIME	0807	0715	.....

WEIGHTS

	EST	MAX	ACTUAL	
PAX	152		.....	
CARGO	0.0		.....	
PAYLOAD	15.8		.....	
ZFW	60.1	64.3	.....	
FUEL	19.1	19.1	.....	POSS EXTRA 0.0
TOW	79.0	79.0	TOW	
STAB TRIM			.....	
LAW	62.6	67.4	.....	

TERRAIN CLEARANCE CHECK

DD CHECK - TERRAIN CLEARANCE CHECK DISABLED

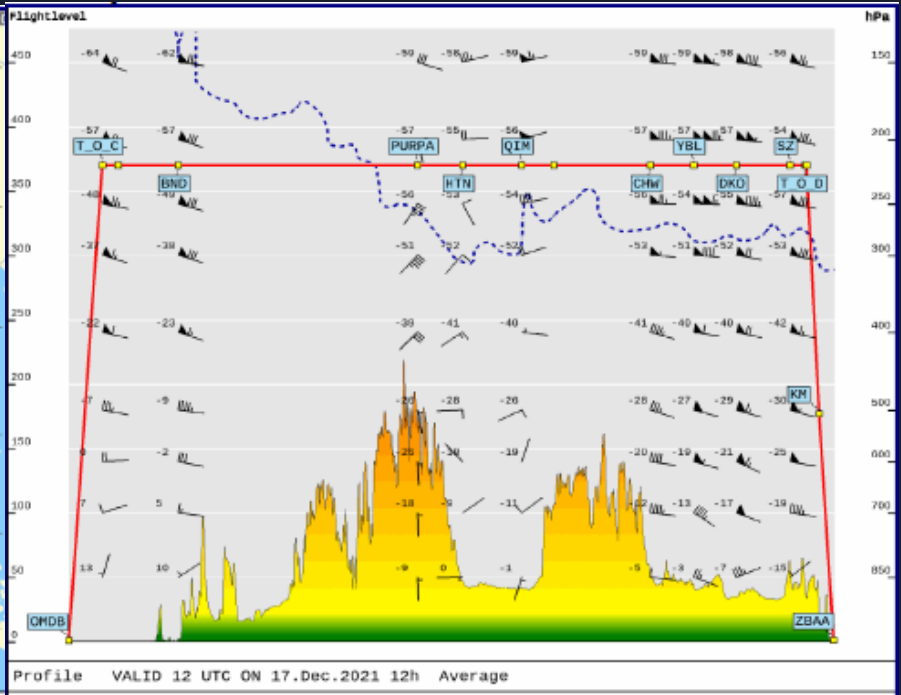
DP CHECK - TERRAIN CLEARANCE CHECK DISABLED

FLIGHT LOG

MOST CRITICAL MORA 28800 FEET AT BND///MXSHR 06 AT PURPA

AWY / POSITION / IDENT / FREQ	LAT / LONG	EET / TTLT	ETO / ATO	FL / MORA / DIS	IMT / ITT / RDIS	MN / TAS / GS	WIND / COMP / SHR	OAT / TDV / TRP	EFOB / AFOB	PBRN / ABRN
				273					18.9	0.2
DUBAI INTL	N2515.2	...		21	274		M068			
OMDB	E05521.9	0000	...		3609	382			....	....
DCT				370	272	.78	288/070	M54	16.9	2.2
T O C	N2525.5	0029	...	21	273	450	M068	P03		
	E05249.7	0029	...	159	3450	382	2	574	....	....
BAHRAIN FIR/UIR										
-OBBB	N2525.6	0000	...							
	E05248.6	0029	...	0	3450					
DCT				370	065	.80	281/078	M54	16.5	2.7
MAXMO	N2530.1	0011	...	54	067	460	M077	P03		
MAXMO	E05127.5	0040	...	74	3376	383	2	563	....	....
TEHRAN FIR										
-OIIX	N2612.5	0013	...							
	E05330.9	0053	...	113	3263					
DCT				370	052	.79	285/078	M55	15.2	3.9
BANDAR ABBA	N2711.8	0020	...	288	054	453	P059	P02		
BND	E05622.0	0113	...	170	3093	512	1	531	....	....
117.20										
KARACHI FIR										
-OPKR	N2936.8	0035	...							
	E06106.2	0148	...	274	2819					
KABUL FIR										
-OAKX	N2943.8	0002	...							
	E06119.8	0150	...	16	2803					
LAHORE FIR										
-OPLR	N3446.7	0115	...							
	E07111.5	0305	...	588	2215					
DCT*				370	084	.79	304/055	M56	10.0	9.1
PURPA	N3656.5	0032	...	221	087	454	P016	P01		
PURPA	E07524.5	0337	...	250	1965	470	6	399	....	....
URUMQI FIR										
-ZWUQ	N3656.3	0000	...							
	E07522.9	0337	...	0	1965					
W112				1130	072	.79	350/017	M56	9.0	10.1
HOTAN	N3702.2	0029	...	75	074	456	P002	P01		
HTN	E07952.1	0406	...	214	1751	458	5	326	....	....
113.10										

Flight: IB8905 Dep / Dest: DXB / PEK



Profile VALID 12 UTC ON 17.Dec.2021 12h Average

Flight: IB8905 Dep / Dest: DXB / PEK

ICAO FLIGHT PLAN

```
FF OMAEZQZX OBBBZQZX OIIXZQZX OAKXZQZX OPLRZQZX ZWUQZQZX ZLHWZQZX
ZBPEZQZX
170952 CYULSBFP
(FPL-IBE8905-IS
-A20N/M-SDE2E3FGHIJ1RWXY/LB1
-OMDB1020
-N0460F370 DCT MAXMO DCT BND DCT PURPA/K0845S1130 W112 HTN DCT YBL
DCT DKO DCT KM DCT
-ZBAA0729 ZSJN
-PBN/A1B1C1D1O1S2 DOF/211217 REG/ECNJY EET/OBBB0029 OIIX0054
OPKR0149 OAKX0151 OPLR0305 ZWUQ0337 ZLHW0510 ZBPE0635 OPR/IBE PER/C
RALT/ZLLL RMK/TCAS)
```

CONCLUSSIONS:

- A320N has better perf than A320-200 but doesn't comply (maybe if customized yes):
  - FP exceed aircraft performance ➔ Operation is not possible
- ETOPS 90 approval required.
- Very encouraging to extend actual emergency oxygen supply