G650 Driftdown Procedures and Systems' Assessment
**Scenario**

North Atlantic / Random Route / Westbound
FL450 / M0.98 / 80,000 lbs / ISA + 5°C
SLOP R2, left engine flames out after crossing ETP 2

**Scenario's Objectives:**

1. Review relevant oceanic procedures
2. Aviate, navigate and communicate
3. Assess how an engine failure affects other systems
• NAT High Level Airspace (OTS)
• Random Routes
• Equal Time Point (ETP)
• NAT OPS Bulletin 2018-005
• G650 Engine Out Driftdown Procedures
• G650 Engine Out Scenario
• G650 Systems' Assessment

- Electrical System
- Hydraulic System
- Flight Control System
- Fuel System
- Pneumatic System
North Atlantic (NAT) High Level Airspace (HLA)
Organized Track System (OTS)

1. Uni-directional and concentrated flow of traffic between North America and Europe

2. The OTS consists of two (2) major alternating flows:
   - A <span style='background-color: #ff69b4'>Westbound</span> flow departing Europe in the morning
   - An <span style='background-color: #ff69b4'>Eastbound</span> flow departing North America in the evening
3. Westbound traffic crosses 030°W between 1130-1930
OTS tracks are published by Shanwick at 2200Z

4. Eastbound traffic crosses 030°W between 0100-0800
OTS tracks are published by Gander at 1400Z

5. Tracks are based on minimum time

6. A track message identification (TMI) number provides OTS coordinates and flight levels available on each track

7. Special authorization, including RVSM, is required

8. The NAT's OTS presents considerable challenges:

   - Very congested oceanic airspace with reduced vertical and horizontal separation
   - Large distances to a limited number of suitable alternate airports
   - No ATC radar surveillance
   - Direct pilot-controller communication is limited
9. **Vertical Separation**

- 1,000'

10. **Lateral Separation**

- **PBCS Track**
  - Performance-based Communication & Surveillance
  - FL 350 - 390
  - PBCS Authorization Required

- **Non-PBCS Track**
  - 1°
  - 60 NM

11. **Longitudinal Separation (Mach Number Technique)**

- 10 MINUTES

- 5 MINUTES (PBCS Track)
Random Routes

1. Random routes are those which remain clear of the OTS.

2. Random routes can also join or leave an outer track of the OTS.

3. Random routes can be above (or below) an OTS track(s).
An ETP is a geographical location along the route of flight in which it takes the same time to continue to the Airport Ahead as it does to return to the Airport Behind.

ETPs are also referred to as "Critical Point".

ETPs are computed for long overwater flights and are based on ground speed (wind factor).
ETP formula:

\[
\text{Ground distance to ETP} = \frac{(D)(GSA)(GSB)}{GSA + GSB} = \text{nm}
\]

\[D = \text{Distance} \rightarrow \text{Airport Ahead} \]

\[GSA = \text{Ground speed to continue to Airport Ahead} \]

\[GSB = \text{Ground speed to return to Airport Behind} \]

TAS: 480 KCAS
Wind: P40 KTS
Dist: 2500 NM
GSA: 520 KTS
GSB: 440 KTS

\[\text{ETP} = \frac{(2500)(440)}{520 + 440} = 1146 \text{ NM} \]
In oceanic airspace ETPs are computed also between suitable alternate airports.

There are three types of ETPs:

1. Loss of engine ETP - (1E INOP)

   Engine Out Driftdown charts

   Wind

   28,000' 28,000'

   50 Kts Headwind 50 Kts Tailwind

   Ground Speed 220 Kts Ground Speed 320 Kts

   Airport Behind 400NM 590NM Airport Ahead

   Final driftdown altitude as per chart
2) Loss of level ETP - Pressurization (DEPRESS)

Pneumatics-EH

Emergency Descent Procedure

Wind

10,000'

30 Kts Headwind
Ground Speed 240 Kts

430 NM

Airport Behind

10,000'

30 Kts Tailwind
Ground Speed 300 Kts

560 NM

Airport Ahead

3) Maintain level ETP - Medical (MEDICAL)

Wind

80 Kts Headwind
Ground Speed 400 Kts

390 NM

Airport Behind

80 Kts Tailwind
Ground Speed 560 Kts

600 NM

Airport Ahead
- Plot ETPs on plotting chart

- **Do not enter ETPs into FMS otherwise ADS-C will send position reports of non-existing waypoints to ATC**

- **Alternate airports can be ahead or behind (left or right) of current position**

- As you cross each waypoint along your route make a mental note and brief where your alternate airport is. This could help you decide direction of turn **Q 45° R** (Doc 4444)

- ETP fuel calculations **assume** a straight line to the alternate airport and do not take into account OTS tracks, weather deviations or an IAP

- The Quad Four maneuver (15NM lateral offset), and a descent below the OTS tracks before a turn to the alternate airport is made, will require more fuel

- Starting the APU (back up AC power) will **increase** fuel consumption by **264** lbs/hour (less fuel on landing)
NAT OPS Bulletin 2018-005

Contingency procedures in NAT HLA airspace associated with inability to comply with assigned clearance

Special Procedures

If a revised ATC clearance cannot be obtained:

1) Turn $30^\circ$ or more away from the track

L or R:

Direction of turn based on position of aircraft in relation to other OTS tracks, direction to the alternate airport, SLP, etc.
2A) If able to maintain assigned flight level:

A) Acquire same direction 5 nm offset track

B) Once established on a 5 nm offset climb or descend as follows:

Below 41,000': 500'

At 41,000':

Above 41,000': 500'
2B) If unable to maintain assigned flight level:

A) Minimize rate of descent to what's operationally feasible

B) Acquire same direction 5 NM offset track

C) DESCEND to FL290 or lower

D) Once below FL290 establish and maintain a vertical offset of 500' from normal levels and proceed as required until ATC clearance is received
3) Establish communications with ATC and nearby aircraft on **121.5** and **123.45 MHz**

4) Turn on all external lights

5) Ensure transponder is ON
Deviations around severe weather

Revised ATC clearance not possible

1) If \( \leq 5 \text{ nm} \) deviation — **maintain** assigned flight level

2) If \( > 5 \text{ nm} \) deviation — **adjust** altitude as follows:

"Turning North descend, Turning South climb."
"Turning North descend, Turning South climb."

SAND = South Ascend North Descend

3) Establish communications with ATC and nearby aircraft on 121.5 and 123.45 MHz

4) Turn on all external lights

5) Ensure transponder is ON
Wake Turbulence

1) Strategic Lateral Offset Procedures (SLOP)
2) Standard Operating Procedure throughout NAT region
3) Pilot selects one of three options:
   - Cleared Track Centerline
   - 1 NM Right of Centerline
   - 2 NM Right of Centerline
4) No ATC approval is required
5) Coordination with preceding aircraft, if required, on 123.45 MHz
6) A wake turbulence encounter must be reported
AFM: NONE

AOM: CHAPTER 28 S.E. RANGE, 2B-24-00

The G650’s MCDU calculates and displays single engine range information - range and time to fuel reserves and to zero fuel at the optimum LRC altitude and speed when operating with one engine inoperative (OEI).

1) Perf

2) LSK 5R - S.E. Range
AOM: [CHAPTER 11] Engine Out Driftdown, 11-05-00

- This section describes the driftdown procedure:

1. At the failure of an engine apply MCT on operating engine. Deceleration is performed at the initial altitude before start of the descent.
2. Descent Mach is maintained until descent KCAS is intercepted.
3. At the final driftdown altitude the start cruise KCAS is the single engine long range cruise (LRC).
4. Adjust Thrust as required to maintain the start cruise KCAS.

- This section also provides an example that explains how to use and interpret the driftdown charts.

QRH: [ENGINES-EB] Engine Out Driftdown Charts

- This section provides two (2) sets of charts:
  - ISA +5°C and +20°C
- Temperature adjustment notes are also provided.
**G650 Engine Out Scenario**

1. Left engine rolled back and flamed out
2. Aircraft yawed left
3. Autothrottle disengaged
4. Cruise speed began to decay

With the loss of **50%** of available thrust the aircraft will not be able to maintain altitude.

The primary objective is to get away from the track and to descend below the OTS in order to proceed direct to the enroute alternate airport.
1. Fly the Aircraft
   - The autopilot will remain engaged
   - The autothrottle will disconnect
   - There will be a bit of yaw as the left engine rolls back and forth while the FADEC attempts to keep the engine from flaming out but it eventually does
   - Regain and maintain directional control

2. Set Maximum Continuous Thrust (MCT) on Operating Engine (SMC/TRS)

   To determine MCT press on SMC then press LSK 4L. MCT EPR will be boxed

   - Advance R Thrust Lever until EPR matches MCT
   - Apply rudder and trim as necessary
③ Call for Engine Out Driftdown checklist

Expect speed to continue decaying

As the Pilot Monitoring (PM) reaches for the iPad, turns it on, opens GAC’s PlaneBook, and selects:

- QRH
- Engines - EB
- Engine Out Driftdown Charts

• Select HDG on Guidance Panel, sync it and rotate HDG Knob > 30° Right (direction to Equal Time Point (ETP) Alternate Airport - XYZ3
• Create a **5 NM offset** (MCDU/Progress page)

1) **PROG**
2) **NEXT** **NEXT**
3) Scr**atch Pad: **R 5**
4) **↓** LSK 1R

• Select **LNAV** on Guidance Panel

• Ensure **FMS** is captured/annunciated on PFD's Flight Mode Annunciator
- The PM should have by now determined the driftdown Mach/KCAs and initial cruise altitude from the **Engine Out Driftdown Charts**

1. **PERF**
2. LSK 1L - Perf Init
3. **PREV**

<table>
<thead>
<tr>
<th>Initial Altitude</th>
<th>Initial Driftdown Weight - 1000 Lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>0.83/224</td>
</tr>
<tr>
<td>85</td>
<td>46</td>
</tr>
<tr>
<td>80</td>
<td>2193</td>
</tr>
<tr>
<td>75</td>
<td>275</td>
</tr>
<tr>
<td>45</td>
<td>217</td>
</tr>
<tr>
<td>43</td>
<td>24,500</td>
</tr>
</tbody>
</table>

**Engine Out Driftdown**

- **DSCNT MACH/KCAS**
- **TIME**
- **FUEL**
- **DIST**
- **START CRUISE ALTITUDE**

**PERFORMANCE INIT-1B 5/5**
- **B.O.W.** PASS/0 lb 54,000 10/155
- **FUEL (GROSS)** PASS WT 23,150 (23,150) 1750
- **CARGO** GROSS WT 500 80,000
4) SET DRIFTDOWN SPEED AND ALTITUDE

- **Deceleration from Mach 0.88 to Driftdown Mach 0.83** should be at the initial altitude of 45,000 feet before the start of the descent.

- Expect speed decay to increase while turning away from the track.

- Ideally, descent commences once established on the 5 nm offset.

- Speed control

```
SPEED 0.83  FLCH VERSUS
```
⑤ Commence driftdown

An engine out driftdown is a trade-off of available altitude for maximum forward distance.

The AFM, AOM and QRH do not provide guidance as to which vertical mode to use.

The use of FLCH to accurately maintain the driftdown Mach/kcAs would seem logical. Unfortunately its use may result in oscillations as the AFCS continuously corrects for speed deviations.

The use of VS/FPA may be a better option.
What if?

If the engine had failed prior to crossing ETP 2 a diversion to XYZ 2 would have been necessary.

Once established on a same direction 5 NM lateral offset an expedited descent through FL290 (below OTS tracks) would have been required before initiating a turn-back diversion across the flow of adjacent traffic above.
Communicate - time to alert everyone

- ATC: Declare Mayday and intentions

  - Datalink (CPDLC/ADS-C)

  1) NAV
  2) LSK 1R - ATC
  3) ATC Logon/Status 1/2
  4) LSK 6L - ATC Index
  5) LSK 1L - Emergency
  6) LSK 1L - Mayday
  7) Populate Emergency Report
  8) Verify it and send it
OTHER TRAFFIC:

- Broadcast your situation, position and intentions on 121.5 and 123.45 MHz
- Turn on all external lights
- Monitor TCAS
- Look for contrails/traffic

 teg Secure failed engine

- QRH
- Engines - EB
- Engine Shutdown Inflight

APU START:

- APU provides an additional source of:
  - Backup Electrical AC power
  - Pneumatic Bleed Air for engine air start
QRH

ALTERNATE NORMALS - NG

APU Inflight Operation

- Maximum Altitude for APU Start:

NON ASC 123:

Starts are possible from
30,000' to 39,000'

Guaranteed at or below 30,000'

![Diagram of airplane and control panel]
- QRH
- Alternate Normals - NG
- APU Inflight Operation

- Maximum Altitude for APU Start = ASC 123:

  - Starts are possible from 37,000' to 39,000'
  - Guaranteed at or below 37,000'

![Diagram of airplane and control panel]
⑨ Change Destination Airport

- Once safely below the OTS (< FL290) proceed direct to the ETP Airport (make sure to enter and verify the correct ICAO code)
- Update flight plan winds
- If you haven’t already received a revised ATC clearance contact ATC and request one
- Squawk Transponder Code 7700
- Set ADS-C to emergency

⑩ Flight Crew to Cabin Crew: TEST

T = Type of emergency
E = Exit/Evacuation plan
S = Signals (2 minutes, 10 seconds, EZ Victor)
T = Time to prepare
Flight Dispatch/Maintenance Department

Notify your Dispatch Team about your situation, intentions and requirements.

The above can be done through your Communications Service Provider (CSP).

Arrival and Landing

- D: Destination
- A: Arrival
- L: Landing
- C: Cruise Altitude
- A: Activate Vectors
- R: RAIM
The failure of either engine will result in:

1. Loss of an Integrated Drive Generator (IDG)

The remaining IDG is capable of powering the entire electrical power system.
② Break Power Transfer

Failure of either engine will result in a momentary interruption in power to an ESS DC bus.

A break power transfer will result in the activation of emergency power (E-Batts)

FWD E-BATT ➔ ON when L ESS DC AND/OR R ESS DC < 20 Volts, even momentarily

AFT E-BATT

③ Crew Actions:

- Re-arm E-Batts

- Reset RA1 or RA2 miscompare on affected Primary Flight Display (PFD)

(SMC/SENSOR/RA1 OR 2)
Hydraulic System

The failure of either engine will result in:

1. Loss of an engine-driven Hydraulic pump (EDP)
2. The Power Transfer Unit (PTU) will take over the duties of the inoperative EDP as soon as hydraulic system pressure drops below 2400 psi

The following components will be lost:

- Redundant hydraulic power to flight controls
- Left thrust reverser
- Mid spoiler panel
The Flight Control System (FCS) is electrically-controlled and hydraulically-actuated.

There is sufficient redundancy to ensure that the failure of an engine does not adversely impact its capability.
From an Electrical point of view the failure of an Integrated Drive Generator (IDG) due to an engine flameout does not affect the Flight Control Computers (FCC). The remaining IDG can power the entire electrical power system, including both FCCs.
From a hydraulic point of view the failure of either engine will result in the loss of an engine-driven hydraulic pump (EDP).

- Loss of midboard spoilers only
- All actuators powered by the left hydraulic system operate in damped bypass mode
- Maximum speed: 285 KCAS/M0.90
The failure of either engine will not affect any fuel system components.

1. A fuel imbalance condition will quickly develop and must be addressed as per:
   - QRH
   - Alternate Normals - NG
   - Fuel balancing Inflight

![Fuel Imbalance Diagram]
1) Open crossflow valve

X-flow
Open

Fuel crossflow valve open

2) Turn off pumps on light side. One at a time!

L pumps
Alt Main
OFF OFF

R pumps
Alt Main
OFF OFF
After reassessing the status of the fuel imbalance reset the timer by cycling the crossflow valve closed and then, if required, open it again.
Caution should be exercised to ensure there is always positive fuel pressure prior to cycling the crossflow valve. Without pump pressure the operative engine will:

A) < 20,000' = suction feed
B) > 20,000' = run erratically and flameout
Pneumatic System

Failure of the left engine reduces the pneumatic system's redundancy but not capability.

1. The remaining engine can provide the necessary bleed air (high pressure and temperature) via its own side's pneumatic system.

2. Opening the isolation valve allows the operating engine to provide bleed air to the opposite side's ECS pack.
In the event icing conditions are present during the descent and diversion to the enroute alternate airport the operative engine’s wing anti-ice system can provide the necessary hot bleed air to heat up the other wing. This is possible via a crossover duct.
4. Cowl anti-icing protection is only available for the operating engine.
Thank you!

Questions, comments or errors...please send me an email: ivan@code7700.com